

System 41 Mainframe and RF Modules

Instruction Manual

KEITHLEY

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Manual Print History

The print history shown below lists the printing dates of all Revisions and Addenda created for this manual. The Revision Level letter increases alphabetically as the manual undergoes subsequent updates. Addenda, which are released between Revisions, contain important change information that the user should incorporate immediately into the manual. Addenda are numbered sequentially. When a new Revision is created, all Addenda associated with the previous Revision of the manual are incorporated into the new Revision of the manual. Each new Revision includes a revised copy of this print history page.

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Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Users of this product must be protected from electric shock at all times. The responsible body must ensure that users are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product users in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

As described in the International Electrotechnical Commission (IEC) Standard IEC 664, digital multimeter measuring circuits (e.g., Keithley Models 175A, 199, 2000, 2001, 2002, and 2010) are Installation Category II. All other instruments' signal terminals are Installation Category I and must not be connected to mains.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.


The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.


Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.


When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a  screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

S41/RF6X6 Matrix

RF PARAMETERS:

Frequency:	DC-8GHz	8-18GHz
Insertion Loss:	2.5 dB max	4.0 dB max
VSWR:	1.5:1	2.0:1
Isolation:	70 dB min	60 dB min

SWITCH CONFIGURATION: Non-blocking coaxial matrix with six inputs and six outputs.

IMPEDANCE: 50Ω.

ACTUATION TIME: 15ms.

RF CONTACTS: Break-before-make, normally open

OPERATING LIFE: 1,000,000 operations, cold switched.

SUPPLIED ACCESSORIES

LIGHT PEN Provides interactive programming of channels, cross points, scan lists, and memory.

OPTIONAL ACCESSORIES

8503 **DIN to BNC Trigger Cable:** Provides BNC connector interface to hardware trigger lines.

S41-RMK-1 **Fixed Rack Mount Kit:** Enables rack mounting without chassis support for one System 41 Mainframe.

ORDERING INFORMATION

S41/RF6X6 Non-blocking 6×6 RF coaxial matrix switch system

S41/RF6X6-T Test data on the RF module – must be purchased at the same time the switch system is purchased

GENERAL

DISPLAY: Dual line vacuum fluorescent.

1st Line: 20-character alphanumeric.

2nd Line: 32-character alphanumeric.

Channel status LED grid.

IEEE-488 BUS IMPLEMENTATION: Conforms to SCPI-1990, IEEE-488.2 and IEEE-488.1.

REAR PANEL CONNECTORS:

SMA

IEEE-488

8-pin micro DIN for Trigger Link

8-pin micro DIN for Trigger Link expansion

POWER: 100-240V AC universal input, 50-60Hz, 270VA maximum

STANDARDS:

Safety: Conforms with European Union Directive 73/23/EEC

EMC: Conforms with European Union Directive 89/336/EEC.

ENVIRONMENT:

Operating: 0°C to 50°C, <80% relative humidity (0°C to 35°C).

Storage: -25°C to +65°C.

DIMENSIONS, WEIGHT: 178mm high × 482mm wide × 515mm deep (7 in × 19 in × 20 in). Net weight 11kg (24 lbs).

RACK MOUNTING: Standard 19" rack shelf or chassis support angles.

Specifications subject to change without notice.

S41/RF1X72 Multiplexer

RF PARAMETERS:

Frequency	DC-8GHz	8-18GHz
Insertion Loss	1.0 dB max	2.5 dB max
VSWR	1.5:1	2.0:1
Isolation	70 dB min	60 dB min

SWITCH CONFIGURATION: One 1×72 or two 1×36 or fourteen 1×6 coaxial multiplexers when RF cables are removed.

IMPEDANCE: 50Ω.

ACTUATION TIME: 15ms

RF CONTACTS: Break-before-make, normally open

OPERATING LIFE: 1,000,000 operations, cold switched.

SUPPLIED ACCESSORIES

LIGHT PEN Provides interactive programming of channels, cross points, scan lists, and memory.

OPTIONAL ACCESSORIES

8503 **DIN to BNC Trigger Cable:** Provides BNC connector interface to hardware trigger lines.

S41-RMK-1 **Fixed Rack Mount Kit:** Enables rack mounting without chassis support for one System 41 Mainframe.

ORDERING INFORMATION

S41/RF1X72 1×72 RF coaxial multiplexer switch system

S41/RF1X72-T Test data on the RF module – must be purchased at the same time the switch system is purchased

GENERAL

DISPLAY: Dual line vacuum fluorescent.

1st Line: 20-character alphanumeric.

2nd Line: 32-character alphanumeric.

Channel status LED grid.

IEEE-488 BUS IMPLEMENTATION: Conforms to SCPI-1990, IEEE-488.2 and IEEE-488.1.

REAR PANEL CONNECTORS:

SMA

IEEE-488

8-pin micro DIN for Trigger Link

8-pin micro DIN for Trigger Link expansion

POWER: 100-240V AC universal input, 50-60Hz, 270VA maximum.

STANDARDS:

Safety: Conforms with European Union Directive 73/23/EEC.

EMC: Conforms with European Union Directive 89/336/EEC.

ENVIRONMENT:

Operating: 0°C to 50°C, <80% relative humidity (0°C to 35°C)

Storage: -25°C to +65°C

DIMENSIONS, WEIGHT: 178mm high × 482mm wide × 515mm deep (7 in × 19 in × 20 in). Net weight 10kg (21 lbs).

RACK MOUNTING: Standard 19" rack shelf or chassis support angles.

Specifications subject to change without notice.

S41/RF10X10 Matrix

RF PARAMETERS:

Frequency:	DC-8GHz	8-18GHz
Insertion Loss:	3.5 dB max	5.5 dB max
VSWR:	1.5:1	2.0:1
Isolation:	70 dB min	60 dB min

SWITCH CONFIGURATION: Non-blocking coaxial matrix with ten inputs and ten outputs.

IMPEDANCE: 50Ω.

ACTUATION TIME: 15ms.

RF CONTACTS: Break-before-make, normally open.

OPERATING LIFE: 1,000,000 operations, cold switched.

SUPPLIED ACCESSORIES

LIGHT PEN Provides interactive programming of channels, cross points, scan lists, and memory.

OPTIONAL ACCESSORIES

8503 **DIN to BNC Trigger Cable:** Provides BNC connector interface to hardware trigger lines.

S41-RMK-1 **Fixed Rack Mount Kit:** Enables rack mounting without chassis support for one System 41 Mainframe.

ORDERING INFORMATION

S41/RF10X10 Non-blocking 10×10 RF coaxial matrix switch system

S41/RF10X10-T Test data on the RF module - must be purchased at the same time the switch system is purchased

GENERAL

DISPLAY: Dual line vacuum fluorescent.

1st Line: 20-character alphanumeric.

2nd Line: 32-character alphanumeric.
Channel status LED grid.

IEEE-488 BUS IMPLEMENTATION: Conforms to SCPI-1990, IEEE-488.2 and IEEE-488.1.

REAR PANEL CONNECTORS:

SMA

IEEE-488

8-pin micro DIN for Trigger Link

8-pin micro DIN for Trigger Link expansion

POWER: 100-240V AC universal input, 50-60Hz, 270VA maximum

STANDARDS:

Safety: Conforms with European Union Directive 73/23/EEC

EMC: Conforms with European Union Directive 89/336/EEC.

ENVIRONMENT:

Operating: 0°C to 50°C, <80% relative humidity (0°C to 35°C)

Storage: -25°C to +65°C

DIMENSIONS, WEIGHT: 178mm high × 482mm wide × 515mm deep (7 in × 19 in × 20 in). Net weight 15kg (33 lbs).

RACK MOUNTING: Standard 19" rack shelf or chassis support angles.

Specifications subject to change without notice.

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1 General Information

Introduction

This section contains general information about the System 41.

- Features
- Warranty Information
- Manual Addenda
- Safety Symbols and Terms
- Specifications
- Inspection
- Optional Accessories

Features

Some important System 41 features include:

- High Density Switching — The System 41 can control up to 240 RF switch contacts.
- RF Modules — RF modules available for the System 41 include the Models RF6×6 and RF10×10 (which are full access non-blocking coaxial matrices), and the Model RF1×72 (which is a coaxial multiplexer).
- Close/Open or Scan — The System 41 can simply close and/or open one or more channel patterns, or scan through a specified list of channel patterns.
- Channel LED Display — The real-time LED display monitors the state (closed or open) of all available channels.
- Memory — Pre-programmed channel patterns are saved in memory to accommodate all input/output combinations for the installed RF module. Also, ten customized instrument setups can be saved in memory for later recall.
- IEEE-488 Bus — Bus operation conforms to the IEEE-488.2 and SCPI standards.
- Trigger Link — Allows the System 41 to trigger (or be triggered by) one or more external instruments.
- A light pen provides point and click programming from the front panel.

Warranty information


Warranty information is located on the inside front cover of this instruction manual. Should your System 41 require warranty service, contact the Keithley representative or authorized repair facility in your area for further information. When returning the instrument for repair, be sure to fill out and include the service form at the back of this manual in order to provide the repair facility with the necessary information.


Manual addenda

Any improvements or changes concerning the instrument or manual will be explained in an addendum included with the manual. Be sure to note these changes and incorporate them into the manual.

Safety symbols and terms

The following symbols and terms may be found on an instrument or used in this manual.

The symbol  on an instrument indicates that the user should refer to the operating instructions located in the instruction manual.

The symbol  on an instrument shows that high voltage may be present on the terminal(s). Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading used in this manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading used in this manual explains hazards that could damage the instruments. Such damage may invalidate the warranty.

Specifications

System 41 specifications may be found at the front of this manual.

Inspection

The System 41 was carefully inspected, both electrically and mechanically before shipment. After unpacking all items from the shipping carton, check for any obvious signs of physical damage that may have occurred during transit. Report any damage to the shipping agent immediately. Save the original packing carton for possible future reshipment. The following items are included with every System 41 order:

- System 41
- System 41 Instruction Manual
- Accessories as ordered.

If an additional instruction manual is required, order the manual package, Keithley part number 41MWS-901-00. The manual package includes an instruction manual and any pertinent addenda.

Optional accessories

The following accessories are available from Keithley for use with the System 41.

Model S41-RMK-1 Fixed Rack Mount Kit: Mounts a System 41 to a standard 19-inch rack.

Model 8503 DIN to BNC Trigger Cable: Allows you to connect the trigger link to an external instrument that uses two BNC connectors for external triggering.

Models 8501-1 and 8501-2 Trigger Link Cables: The Model 8501-1 is one meter in length, and the Model 8501-2 is two meters in length.

Model 7007 Shielded IEEE-488 Cables: Connects the System 41 to the IEEE-488 bus using shielded cables to reduce electromagnetic interference (EMI). The Model 7007-1 is one meter in length and has an EMI shielded IEEE-488 connector at each end. The Model 7007-2 is identical to the Model 7007-1, but is two meters in length.

2

Installation and Connections

Introduction

Information in this section is organized as follows:

- **Installation** — Explains how to mount the System 41 in a standard 19-inch equipment rack.
- **Line power, GPIB and trigger link connections** — Summarizes how to connect the System 41 to line power, how to make connections for the GPIB, and how to make connections for external triggering.
- **SMA coaxial connections** — Provides tips to clean SMA connections, and explains how to connect your test cables to the System 41.

Installation

The System 41 must be installed in a standard 19-inch metal equipment rack. The rack must be connected to a known earth ground.

General installation guidelines

In order to meet EN 55022, Class A Radiated Emissions levels, all components in your RF test system require the following:

- All components must be mounted in a metal enclosure or the equivalent. All surfaces of the enclosure must be adequately grounded to adjacent surfaces to provide electrical conductivity. Cables external to the enclosures must be in metal conduit or the equivalent. Using shielded cables and power line filtering is equivalent to using metal conduit.
- The conduit (shielded coaxial cable) must be connected to the enclosures using standard procedures and hardware to ensure electrical conductivity between the enclosures and conduit.

CAUTION To avoid back injury, use two or more people to lift and move the System 41.

Rack mount

A System 41 can be mounted into a standard 19-inch equipment rack using user-supplied angle support brackets, shelf, or Model S41-RMK-1 Fixed Rack Mounting Kit.

Angle support brackets — Perform the following steps to mount the System 41 into the rack using user-supplied angle support brackets or shelf:

1. Select a position in the rack. The System 41 typically takes up 7 inches of vertical space.

NOTE *The chassis must be mounted at a height that is an increment of 1 ¾ inch from the top or bottom of the rack. Attempting to mount the mainframe at a non-incremental height will lead to difficulties with hole alignment.*

2. Install the angle support brackets to the rack and secure them.
3. Lift the System 41 onto the support brackets and slide it into the rack. The four slotted mounting holes in the front panel dictate the location of the captive nut fasteners on the front rack rails. Mark where the supplied fasteners are to be installed, and remove the System 41 from the rack.
4. Install four #10 captive nut fasteners to the front rack rails. Position them such that the captive nuts are located behind the holes of the front rack rails.
5. Lift the System 41 onto the support brackets and slide it into the rack. Secure the chassis to the front rack flanges with four 10-32 × 5/8 inch Phillips pan head screws.

Model S41-RMK-1 Fixed Rack Mount Kit — The following steps summarize rack mounting a System 41. For detailed installation information, see the packing list that is included with the kit.

1. Select a position in the rack. The System 41 typically takes up 7 inches of vertical space.

NOTE *The chassis must be mounted at a height that is an increment of 1 ¾ inch from the top or bottom of the rack. Attempting to mount the mainframe at a non-incremental height will lead to difficulties with hole alignment.*

2. Hold up the System 41 at the selected location in the rack. The four slotted mounting holes in the front panel dictate the location of the captive nut fasteners on the front rack rails. Mark where the supplied fasteners are to be installed.
3. Install the four fasteners so the captive nuts are located behind the appropriate holes on the front rack rails.
4. Loosely attach the two rear support brackets to the sides of the mainframe. Each bracket is secured using two supplied screws.
5. Position the mainframe in the rack to adjust the support brackets, and note the location for the four captive nut fasteners on the rear rack rails.
6. Install the four fasteners so the captive nuts are located behind the appropriate holes on the rear rack rails.
7. Loosely mount the mainframe to the front and rear rack rails using 10-32 × 5/8 inch screws. Secure the rear support brackets to the chassis.
8. Tighten all screws.

Line power, GPIB, and trigger link connections

WARNING Before beginning any connection procedure, make sure the power switch, which is located on the rear panel, is in the off (0) position.

Line power

NOTE Details on power-up are provided in Section 3, "Power-up procedure."

The power module (located on the rear panel of the mainframe) has the AC line power receptacle and the power switch.

With the power switch in the off (0) position, connect the supplied line cord to the AC receptacle on the rear and connect the other end to a grounded AC outlet. There are no line voltage settings for the System 41. It is sensed and set automatically.

GPIB

For GPIB operation, you will have to connect a Model 7007 IEEE-488 cable to the System 41 and to the IEEE-488 interface in your computer.

NOTE Details on IEEE-488 connections and all aspects of GPIB operation are provided in Section 6.

The IEEE-488 connector is located on the rear panel of the System 41. Connect either end of the cable to this connector, and connect the other end to the IEEE-488 connector on your computer.

Trigger link

If you are going to use external triggering in your test system, you will have to connect a Model 8501 trigger link cable from the System 41 to the external instrument that will be sending and/or receiving triggers.

NOTE Details on trigger link connections and all aspects of external triggering are provided in Section 5, "External triggering (Trigger Link)."

There are two trigger link connectors located on the rear panel of the System 41. Connect either end of the trigger link cable to either one of the trigger link connectors. Connect the other end of the trigger link cable to the other instrument. The other trigger link connector can be connected to a second external instrument using another Model 8501 trigger link cable.

If the external instrument(s) use BNC connectors for external triggering (one for input triggers, one for output triggers), you can use the Model 8503 adapter to make the connections.

SMA coaxial connections

CAUTION Before making any connections to the SMA connectors on the System 41, you should be familiar with basic operation as explained in Section 3, “Getting Started”. It is recommended that you perform the operation demos (Section 3, “Operation demos”) before making any SMA connections.

The System 41 uses SMA coaxial connectors suitable for the specified operating frequency range. These input and output connectors are located on the rear panel.

NOTE Connection information that is specific to the installed RF module is provided in Section 4.

Mating connectors must be clean, must meet connector type interface specifications, and must be tightened to the appropriate torque specifications.

SMA connector cleaning

WARNING Contact with exposed conductors carrying RF power may cause burns. Make sure all power is off before cleaning SMA connectors.

System 41 SMA connectors and mating connectors on your test cables must be free of foreign material to prevent performance degradation. Visually inspect the connector using a 4× to 10× magnifying lens. Try to blow foreign material off the connector using canned air (canned air is recommended due to the presence of moisture and oils in air supplied by standard industrial compressors). Use a lint free miniature cleaning swab moistened with clean isopropyl alcohol to wipe off any remaining foreign material.

SMA connector mating

WARNING Contact with exposed conductors carrying RF power may cause burns. Make sure all power is off before connecting test cables. All cables should be properly mated and shielded.

CAUTION Mating connectors with out of tolerance pin depths may destroy the connector. Verify pin depth before mating connectors.

1. Remove all power from your test system.
2. Remove the protective cap from the SMA connector and save for future use. Keep the caps on all unused connectors.
3. Connect your test cable and tighten using a 5/16 inch torque wrench to 7-10 inch-lb.

CAUTION Application of excessive torque may damage the SMA connector.

3

Getting Started

Introduction

CAUTION The RF switches for the standard switching modules are designed for cold switching. Hot switching (especially above 1W) may degrade performance and shorten the life of the switches. If hot switching is required, please consult Keithley Instruments for a customized switching module which incorporates switches specially designed for hot switching applications.

NOTE *Switching procedures in this manual use cold switching. That is, the signal is removed before a switch is closed or opened. However, for low power applications, the RF switches are rated to hot switch up to 1W.*

This section contains introductory information on using your System 41 Switch System. For detailed front panel and IEEE-488 bus operation, refer to Sections 5 and 6, respectively. Section 4 provides reference information for the installed RF module.

The information in this section is arranged as follows:

- **Power-up procedure** — Covers information on connecting the instrument to line power, the power-up sequence, and the cooling fan.
- **Front and rear panel configuration** — Summarizes the controls, light pen receptacle, and the two displays on the front panel of the instrument.
- **Light pen** — Summarizes the basic operations that can be performed with the optional light pen.
- **Display modes** — Covers the two basic display modes and explains how to toggle from one display mode to the other.
- **Channel LEDs, patterns, and assignments** — Shows how the status LEDs correspond to the switch channels, and explains the two formats to specify channels to be opened/closed or scanned.
- **Operation demos** — Demonstrates basic operation using channel patterns. Recommended for first time users.
- **Front panel operation summary** — Summarizes the general procedures to open/close channel patterns and scan channel patterns.
- **Introduction to IEEE-488.2 and SCPI** — Discusses some fundamental information concerning operation over the IEEE-488 bus.

Power-up procedure

The System 41 can be operated from line voltages from 100 to 240VAC at line frequencies from 50 to 60Hz.

Line power connections

Using the supplied power cord, connect the instrument to an appropriate AC power source. The female end of the cord connects to the AC receptacle on the rear panel of the instrument. The other end of the cord connects to a grounded AC outlet.

WARNING The System 41 must be connected to a grounded outlet to maintain continued protection against possible shock hazards. Failure to use a grounded outlet may result in personal injury or death due to electric shock.

Power switch

The power switch is located on the rear panel above the AC receptacle. The “1” position for this rocker switch turns the power on and the “0” position turns power off.

Power-up sequence

On power-up, the System 41 will go through the following sequence:

1. The instrument will perform self-tests on its EPROM and RAM memory elements. If a failure is detected, the instrument will lock up and display the following message:

No Comm Link

NOTE *If a problem develops while the instrument is under warranty, return it to Keithley Instruments, Inc. for repair.*

2. If the instrument passes the self-tests, the firmware revision levels and current selected IEEE-488 address will be displayed. An example of this display is shown as follows:

Model 7002
BXX BYY BZZ IEEE Addr = 07

where:

Model 7002 is the firmware used for the System 41.

BXX is the firmware revision level for the main CPU.

BYY is the firmware revision level for the VFD display.

BZZ is the firmware revision level for the LED display.

7 is the current IEEE-488 Address. Note that the instrument is shipped from the factory with the address set to 7.

Cooling fan

Excessive heat could damage the System 41. It must be operated in an environment where the ambient temperature does not exceed 50°C.

The System 41 uses a cooling fan to help keep it from overheating. The fan is located on the rear panel above the power module. It draws in cool air and expels hot air out the exhaust vent. As viewed from the front of the mainframe, the exhaust vent is located on the right side panel, near the front.

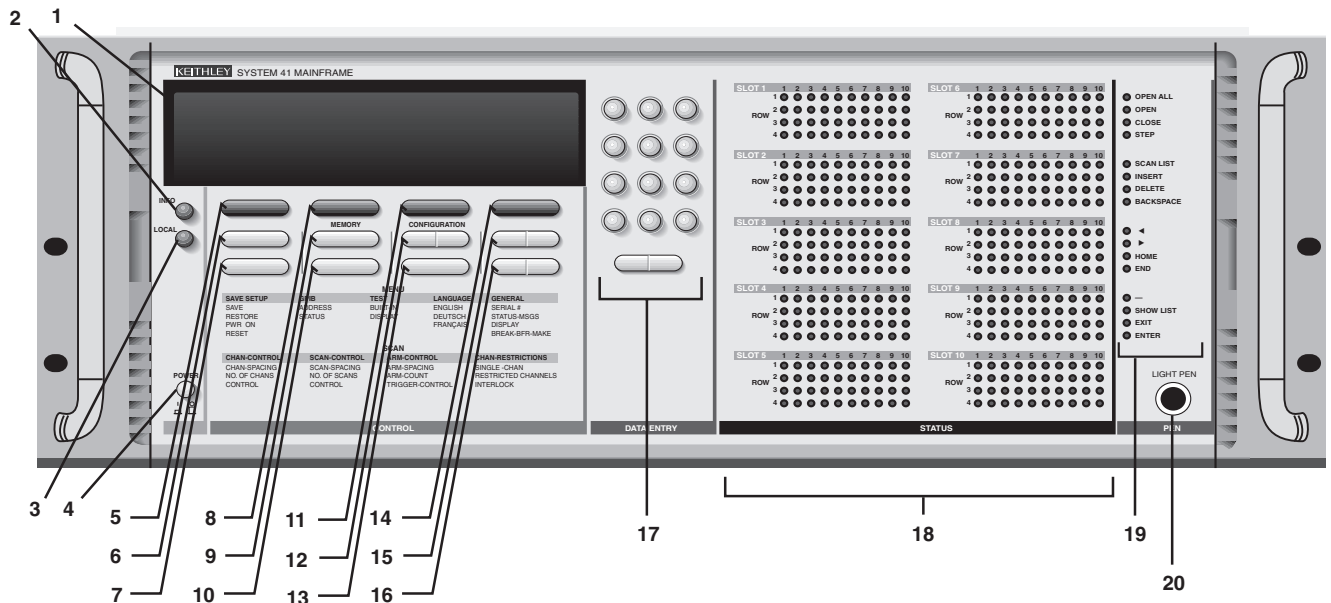
To maintain proper ventilation, the fan intake and exhaust vents must be kept from becoming blocked. When installing the System 41, make sure there is adequate airflow around the rear and side panels to ensure proper cooling. Installing high power dissipation equipment adjacent to the System 41 could cause excessive heating to occur. The specified ambient temperature ($\leq 50^{\circ}\text{C}$) must be maintained around the surfaces of the System 41.

Front and rear panel configurations

Front panel

The front panel of the System 41 is shown in Figure 3-1. This figure includes important abbreviated information that should be reviewed before operating the instrument. Notice that some of the controls are dual-function, rocker-action type keys. These include SCAN/CARD CONFIGURATION, DELETE/INSERT, EXIT/ENTER and ◀/▶ .

Figure 3-1
System 41 front panel



1 Vacuum Fluorescent Display (VFD)

Provides two lines of alpha-numeric information and includes annunciators.

2 INFO

Displays on-line help information. Press again (or EXIT) to cancel message.

3 LOCAL

Cancels remote, restores front panel control.

4 POWER INDICATOR

5 OPEN ALL

Opens all channels of all slots. Also, aborts a scan.

6 SCAN LIST

Toggles between Scan List and Channel List.

7 CLEAR LIST

Clears the displayed Channel List or Scan List.

8 STEP

Takes SYSTEM 41 out of idle state and can be used to step through the Scan List.

9 STORE

Stores channel pattern or list at a specified memory location.

10 RECALL

Restores System 41 to a channel pattern stored at a specified memory location.

11 OPEN

Opens the specified (displayed) channels in Channel List.

12 SCAN CONFIGURATION

Enables CONFIGURE SCAN menu:
CHAN CONTROL
SCAN CONTROL
ARM CONTROL
CHAN RESTRICTIONS

CARD CONFIGURATION

Enables CARD CONFIG MENU:
TYPE
OF POLES
CARD PAIR
DELAY
READ I/O CARD

13 MENU

Enables MAIN MENU:
SAVESETUP
GPIB
DIGITAL I/O
TEST
LANGUAGE
GENERAL

14 CLOSE

Closes specified (displayed) channels in Channel List.

15 DELETE

Deletes selected entry from Channel List or Scan List.

INSERT

Insert an entry at selected location in Channel List or Scan List.

16 EXIT

Use to back out of a menu structure. Cancels INFO message.

ENTER

Execute pending operation. Separate channels, and terminate selected list.

17 Keypad

0-9 Numeric entry
- Channel range separator (i.e. M1-M4).
M Memory location designator (i.e. M6).
◀ Move cursor left.
▶ Move cursor right. Separate channels, and terminate selected list.

18 Channel LEDs

Provides status (on/off or list inclusion). With light pen, use to open/close or include in selected list.

19 Control LEDs (Light Pen)

OPEN ALL Same as OPEN ALL key.
OPEN Same as OPEN key.
CLOSE Same as CLOSE key.
STEP Same as STEP key.
SCAN LIST Same as SCAN LIST key. Indicates selected list.
INSERT Same as INSERT key.
DELETE Same as DELETE key.
BACKSPACE Move cursor left and delete entry.
◀ Same as ◀ key.
▶ Same as ▶ key.
HOME Move cursor to beginning of selected list.
END Move cursor to end of selected list.
- Same as - key
SHOW LIST Toggles between display modes (relay status or list). Indicates selected mode.
EXIT Same as EXIT key.
ENTER Same as ENTER key.

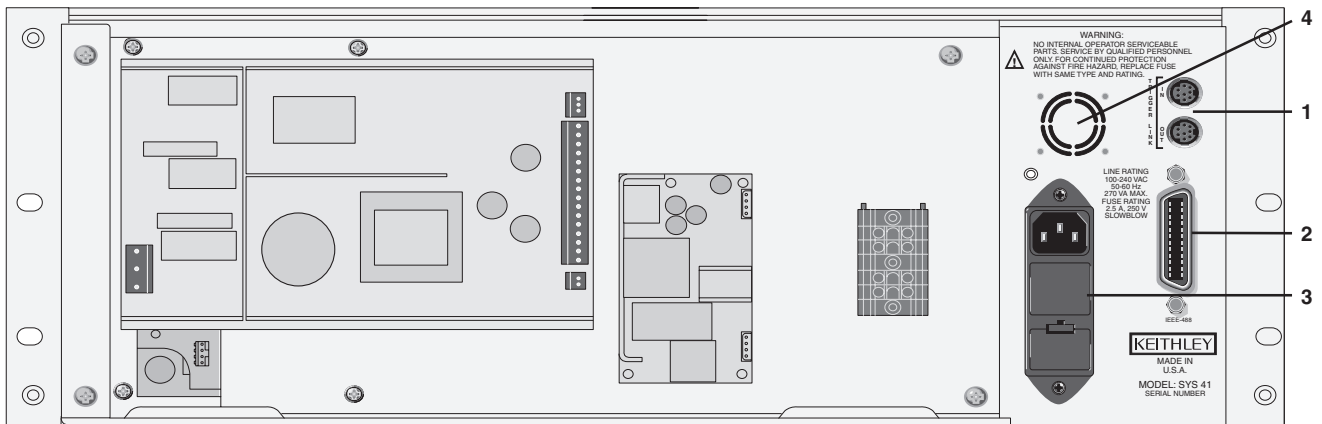
20 LIGHT PEN

Receptacle for plug of light pen.

Rear panel

The rear panel of the System 41 is shown in Figure 3-2 (RF Module not installed). This figure also includes important abbreviated information that should be reviewed before operating the instrument.

Figure 3-2
System 41 rear panel



1 TRIGGER LINK

Two micro 8-pin DIN connectors.
Use trigger link cables.

2 IEEE-488 Connector

Use standard IEEE-488 cables.

3 Line Power Module

Contains the AC power line receptacle, power line fuse, and the power on/off switch.
WARNING: Connect to grounded outlet using three-wire power cord.

4 Intake Vent for Cooling Fan

Quick start

“Quick start” is an exercise to quickly acquaint you with the process to open and close channels. It is not comprehensive enough to use as stand-alone procedures to switch RF signals. It does not address important considerations, such as cold-switching, and does not cover safety issues.

WARNING To eliminate the possibility of electric shock and to prevent inadvertent damage to RF switches, DO NOT connect test signals to the inputs or outputs of the RF module for the following procedures to open/close channels. If there are any signals connected to the RF module, remove them.

In order to connect an RF input to an output, two or more RF switches (channels) must be closed to complete the signal path. To simplify operation, the System 41 uses pre-programmed channel patterns. When a channel pattern (i.e., M1) is specified in the channel list, the RF switches assigned to that channel pattern will close when the channel pattern is closed.

Keep in mind that the RF switches closed by a channel pattern depend on which RF module is installed. For example, channel pattern M10 for the Model RF6x6 module closes the appropriate RF switches to connect Input 2 to Output 4, while M10 for the Model RF10x10 module closes switches to connect Input 1 to Output 10.

NOTE The channel status LEDs indicate channels that are closed (relay status display mode), or channels that are included in the channel or scan list (channel or scan list display mode). See “Display modes” (next topic in this section) for details on selecting the display mode.

Restore defaults

Restoring RESET defaults will ensure that the instrument is properly configured to perform a manual scan.

1. Press the MENU key to display the MAIN MENU.
2. Use the cursor keys (◀ and ▶) to place the cursor on SAVESETUP and press ENTER to display the following menu:
SETUP MENU
SAVE RESTORE PWRON RESET
3. Place the cursor on RESET and press ENTER. The “RESETTING INSTRUMENT” message will be displayed.
4. Press ENTER again. The “RESET COMPLETE” message will be displayed.
5. Press ENTER to return the display to the SETUP MENU.
6. Press EXIT twice to exit from the MAIN MENU.

Open and close channel patterns

1. Set the System 41 to display the channel list:
 - a. Use the SCAN LIST key to display “SELECT CHANNELS”.
 - b. Press OPEN ALL to ensure that there are no closed channels.
 - c. Press CLEAR LIST to clear any channels from the channel list.

2. Perform the following steps to place channel patterns into the channel list.
 - a. Using the keypad, press “M”, key in a channel pattern number, and press ENTER. For example, press “M”, “1”, “3” and then ENTER to place channel pattern M13 in the channel list.
 - b. Repeat step 2a to place additional channels patterns in the channel list.
3. To close the displayed channel pattern(s), press the CLOSE key.
4. To open the channels, press OPEN ALL. Pressing CLEAR LIST will remove the channels from the channel list.

Remote programming — The following command sequence demonstrates how to closes channel patterns:

```
OPEN:ALL          ` Open all channels.
CLOSE (@M1, M15) ` Close channel patterns M1 and M15.
CLOSE:STATe?     ` Request the channels that are closed*.
OPEN:ALL          ` Open all channels.
```

* After sending CLOSE:STATe?, the System 41 must be addressed to talk to obtain the channel list.

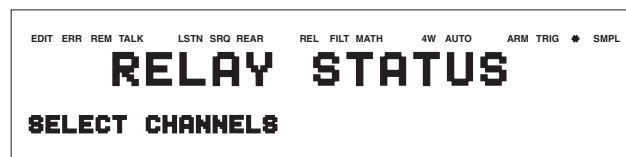
Display modes

There are two basic display modes; the relay status display mode and the list display mode. In the relay status display mode (see Figure 3-3), the channel LEDs provide the open/close status of the available channels. This is the display mode you want to be in when closing/opening channels or scanning so that you can observe the real-time state of each switch in your system.

In a list display mode (see Figure 3-4), the channel LEDs indicate which channels are included in the list (channel list or scan list). Figure 3-5 provides an example of channel status for the two display modes. If you create a list while in this display mode, be sure to toggle back to the relay status display mode before closing/opening channels or scanning.

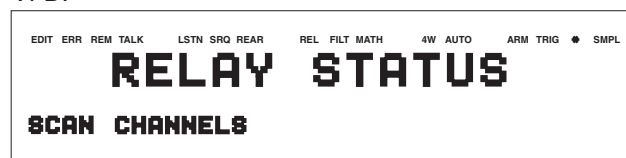
Figure 3-3
Relay status display mode

VFD:



A) Channel List Selected

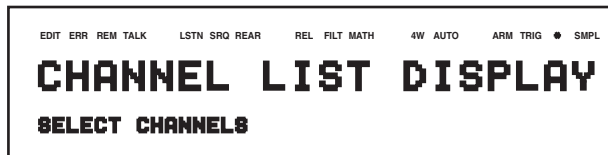
VFD:



B) Scan List Selected

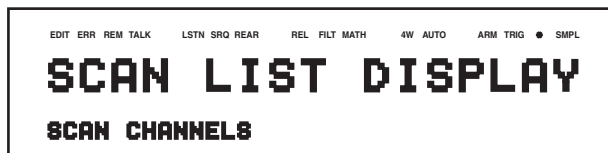
Figure 3-4
List display modes

VFD:



A) Channel List Display Mode

VFD:



B) Scan List Display Mode

Figure 3-5
Status interpretation of channel LEDs

		COLUMN									
SLOT 1		1	2	3	4	5	6	7	8	9	10
(1)	1	●	○	○	○	○	○	○	○	○	○ (10)
(11)	2	○	○	○	●	○	○	○	○	○	○ (20)
(21)	3	○	○	○	○	○	○	○	●	○	○ (30)
(31)	4	○	○	○	○	○	○	○	○	○	○ (40)

● = LED brightly lit

Relay Status

- = Channel closed
- = Channel open

Channel List Display
Scan List Display

- = Channel included in selected list

Changing the display mode (keypad method)

1. Press the MENU key to display the MAIN MENU.
2. Using the cursor keys (◀ and ▶), place the cursor on GENERAL and press ENTER.
3. Place the cursor on DISPLAY and press ENTER to display the following MENU:

CONFIG LED DISPLAY
RELAY-STATUS CURRENT LIST

RELAY STATUS selects the relay status display mode and CURRENT LIST selects the list display mode.

4. Place the cursor on the desired display mode and press ENTER.
5. Use EXIT to back out of the menu structure.

Channel LEDs, patterns, and assignments

There are two formats to specify channels to be opened/closed or scanned. The rudimentary format uses channel assignments (slot and channel), while the preferred format uses pre-programmed channel patterns stored in memory.

Channel LEDs

The 400 channel LEDs on the front panel are arranged in 10 arrays of 40 LEDs each. Six of these arrays are available for System 41 operation. Each LED array corresponds to a mainframe slot. As shown in Figure 3-5, the first row of LEDs corresponds to channels 1 through 10, the second row corresponds to channels 11 through 20, the third row corresponds to channels 21 through 30, and the last row corresponds to channels 31 through 40.

LEDs that are completely turned off indicate that switching channels are not available at those locations. As shown in Figure 3-5, a brightly lit LED indicates that the channel is closed (relay status display mode), or the channel is included in the channel list or scan list.

Channel patterns

A channel pattern is simply a pattern of open and closed channels (switches) that is stored in memory. To simplify operation, the System 41 is shipped with the appropriate channel patterns already stored in memory.

For example, the pre-programmed M1 channel pattern for the RF 6×6 Module has channels 5!6 and 5!18 closed (the rest of the channels are open). When M1 is closed or scanned, channels 5!6 and 5!18 will close to connect Input 1 to Output 1.

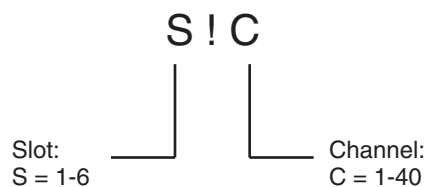
For close/open operation, using channel patterns is the easiest way to create a channel list.

Channel assignments

Channel assignments can be used to close/open channels. A channel assignment is based on the channel number and the mainframe slot assignment for the RF switch. Figure 3-6 shows the general channel assignment format, and Figure 3-7 provides the channel assignments for all six slots. Note that an exclamation point (!) is used to separate the slot and channel number.

Note that the channel assignment format cannot be used for scanning. An RF module requires that two or more channels close at the same time for each step of the scan. That cannot be done using individual channels. You must use channel patterns in a scan list.

Figure 3-6
Channel assignment format



Example: 1 ! 6 = Slot 1, Channel 6

Figure 3-7
Channel assignments

	1	2	3	4	5	6	7	8	9	10
1	S!1	S!2	S!3	S!4	S!5	S!6	S!7	S!8	S!9	S!10
2	S!11	S!12	S!13	S!14	S!15	S!16	S!17	S!18	S!19	S!20
3	S!21	S!22	S!23	S!24	S!25	S!26	S!27	S!28	S!29	S!30
4	S!31	S!32	S!33	S!34	S!35	S!36	S!37	S!38	S!39	S!40

where; S is the slot number (1-6)

Operation demos

A fast and easy way to acquaint yourself with basic front panel operation is to use the following operation demos.

CAUTION To prevent damage to the System 41, the RF switches must be cold switched. For cold switching, test signals must not be present when an RF switch is opened or closed.

Even though the following procedures use cold switching, the demos should be performed with nothing connected to the inputs and outputs of the System 41.

WARNING Before turning the System 41 on, make sure it is connected to a grounded power receptacle using the supplied power cord or equivalent. Failure to properly ground the unit creates a shock hazard that could result in injury or death.

Restoring default settings

To ensure that the demos operate properly, perform the following steps to reset the System 41 to its default settings:

1. Press the MENU key. The MAIN MENU will be displayed.
2. Place the cursor on SAVESETUP using the ◀ and ▶ cursor keys and press the ENTER key. The SETUP MENU will be displayed.
3. Place the cursor on RESET and press ENTER. The “RESETTING INSTRUMENT” message will be displayed.
4. Press ENTER again. The “RESET COMPLETE” message will be displayed.
5. Press ENTER to return the display to the SETUP MENU.
6. Press EXIT twice to exit from the MAIN MENU.

Demo — Close and open channels

This demo will use two pre-programmed channel patterns (M1 and M15) to simultaneously close four channels of the RF module. For the RF 6×6 Module, this would connect Input 1 to Output 1, and Input 3 to Output 3.

Step 1 Select the list display mode

In the list display mode, channel LED status will correspond to channels entered in the channel list.

Press MENU, select GENERAL, select DISPLAY, select SHOW LIST and finally, select CURRENT LIST.

After selecting CURRENT LIST, use the EXIT key to back out of the menu structure.

Note that the SHOW LIST LED is on with the list display mode selected.

NOTE See “Display modes” for details on selecting the list display mode.

Step 2 Display the channel list

The SCAN LIST key toggles between the scan list and the channel list. Press SCAN LIST to display “SELECT CHANNELS.”

Note that the SCAN LIST LED is off (dimly lit) when the channel list is selected.

Step 3 Enter channel patterns (M1 and M15)

To enter the M1 channel pattern, press “M” and “1,” and then ENTER.

To enter the M15 channel pattern, press “M,” “1,” “5,” and then ENTER.

The channel status LEDs that correspond to the M1 and M15 channels will be brightly lit. For example, if the RF 6×6 Module is installed, the LEDs for channels 5!6, 5!18, 4!4 and 4!16 will be brightly lit.

Step 4 Select the relay status display mode

The relay status display mode must be selected in order to view the open and closed channels on the LED display.

Press MENU, select GENERAL, select DISPLAY, select SHOW LIST and finally, select RELAY STATUS.

After selecting RELAY STATUS, use the EXIT key to back out of the menu structure.

Note that the SHOW LIST LED turns off (dimly lit) when the relay status display mode is selected.

NOTE See “Display modes” for details on selecting the list display mode.

Step 5 Remove test signal

Before closing channels, the test signal must be removed from the input of the System 41. It can effectively be removed by setting it to 0V, 0A.

Step 6 Close channels

To close the M1 and M15 channels, press the CLOSE key. The LEDs for the M1 and M15 channels will be brightly lit to indicate that they are channels.

For the RF 6×6 Module, channels 5!6, 5!18, 4!4 and 4!16 will be closed.

Step 7 Apply test signal

With the M1 and M15 channels closed, it is now safe to apply the test signal and perform your tests.

Step 8 Remove test signal

Before opening channels, the test signal must be removed from the input of the System 41. It can effectively be removed by setting it to 0V, 0A.

Step 9 Open channels

With the test signal removed, it is now safe to open channels.

Press OPEN (or OPEN ALL) to open the channels. Note that OPEN opens the channels specified in the channel list, while OPEN ALL also opens channels not specified in the list.

Front panel operation summary

The operation demos (see “Operation demos”) take you through step-by-step procedures to open/close channel patterns. The following information summarizes the general procedure to open/close channel patterns.

CAUTION In order to prevent damage to RF switches (or in the very least, shorten their life), cold switching must be exercised. For cold switching, the test signal(s) must be removed (or set to 0V, 0A) before an RF switch is closed or opened.

CAUTION In order to prevent damage to RF switches and other equipment connected to the System 41, DO NOT close more than one path through any input or output. In other words ...

- NEVER connect an input to more than one output at a time.
- NEVER connect an output to more than one input at a time.

For example, if Input 1 is connected to Output 2, do not connect Input 1 to any other output, and do not connect Output 2 to any other input.

The System 41 is shipped with pre-programmed channel patterns to cover all input/output combinations for the installed RF module. A channel pattern (i.e., M1) is simply a pattern of open and closed channels (switches) stored in memory. For example, for the RF 6×6 Module, channel pattern M1 has channels 5!6 and 5!18 closed (all other channels are open). When you close or scan M1, both those channels will close simultaneously to connect Input 1 to Output 1.

Using channel patterns is the preferred format to open/close channels. However, you can instead specify the individual channels in the channel list. Details on using individual channels in a channel list are provided in Section 5.

NOTE *The channels closed by a channel pattern depends on which RF module is installed in the System 41. For example, the M1 channel pattern for the RF 10×10 Module closes channels 5!10 and 5!30, while the M1 channel pattern for the RF 6×6 Module closes channels 5!6 and 5!18. To determine the actual switches closed by the channel patterns, refer to the documentation for the installed RF module (see Section 4).*

If a pre-programmed channel pattern becomes corrupted (wrong pattern), you can reprogram it. To reprogram a channel pattern, refer to the documentation for the installed RF module in Section 4.

WARNING Before turning the System 41 on, make sure it is connected to a grounded power receptacle using the supplied power cord or equivalent. Failure to properly ground the unit creates a shock hazard that could result in injury or death.

Create channel list and/or scan list

A channel list must be specified in order to close channels, and a scan list must be specified in order to scan channels.

Display mode consideration

When defining a channel list or a scan list (Step 1 of the following procedure), you may want to place the instrument in the list display mode so that channel LED status corresponds to the channels in the selected list. However, after defining the channel list and/or scan list, return the instrument to the relay status display mode so that channel LED status will correspond to open and closed channels.

“Changing the display mode (keypad method)” explains how to change the display mode using the keypad. With the light pen, the display mode is changed by clicking the SHOW LIST LED.

Step 1 Select list

SELECT CHANNELS (channel list)
SCAN CHANNELS (scan list)

Press the SCAN LIST key to toggle between the channel list and the scan list. The EXIT key also selects the channel list.

Step 2 Enter channel patterns

Pressing the CLEAR LIST key removes all channels from the selected list.

Format examples: SELECT CHANNELS M1, M15,
 SCAN CHANNELS M1, M2, M3, M4,

- Use the “M” key, and the number keys to enter a channel pattern.
- Press ENTER after keying in each channel pattern.

Close and open channel patterns

Perform the following steps to control (close/open) the channels defined in the channel list.

Step 1 Make sure the RELAY STATUS display mode is selected

If the instrument is not in the RELAY STATUS display mode, perform the following to select it:

Press MENU. From the MAIN MENU, select GENERAL. From the GENERAL MENU, select DISPLAY. From the CONFIG LED DISPLAY menu, select RELAY STATUS. Use EXIT to back out of the menu structure.

NOTE Refer to “Changing the display mode (keypad method)” if you need a more detailed procedure to change the display mode.

Step 2 Close and open channels

Press the CLOSE key to close the channels specified in the channel list. Pressing the OPEN key will open the channels specified in the channel list. The OPEN ALL key opens all channels, including any channels not included in the list.

Introduction to IEEE-488.2 and SCPI

The following paragraphs discuss fundamental information concerning operation over the IEEE-488 bus. Detailed information on operating the instrument from over the bus is contained in Section 6 of this manual.

SCPI overview

IEEE-488.2 defines a syntax for sending data to and from instruments. It also defines a set of Common Commands that are used to perform basic operations such as reading status registers, providing triggers, and resetting the instrument to default conditions.

SCPI (Standard Commands for Programmable Instruments) defines a standard set of commands (and format) to control every other aspect of instrument operation. Together, IEEE-488.2 and SCPI create a command structure for all programmable instruments.

Compatibility

An instrument that uses the IEEE-488.2 standard and SCPI does not have special hardware requirements. The IEEE-488 interface that you used with the old standard will work with the new standard. Simply connect the System 41 to a computer that is equipped with an IEEE-488 interface.

NOTE The term GPIB (General Purpose Interface Bus) is used in this manual and in the menu structure of the instrument. GPIB is simply another term for the IEEE-488 bus.

Bus connections

Before using the instrument over the bus, you must connect the IEEE-488 connector on the rear panel of the instrument to the IEEE-488 connector of your controller. Use a Keithley Model 7007 or similar IEEE-488 cable for this connection.

Primary address

The primary address of the System 41 must agree with the primary address you intend to specify in the controller's programming language. The factory setting for the primary address is 7, so if you intend to use that address, you need not change it. However, the primary address can be set to any value between 0 and 30 by using the GPIB setup menu (ADDRESS selection) available with the MENU key.

Abbreviated common command summary

Table 3-1 provides an abbreviated list of Common Commands which are defined by the IEEE-488.2 standard. These are the Common Commands that are most used for bus operation. Note that each Common Command is preceded by a star (*).

Table 3-1

Abbreviated common command summary

Mnemonic	Name	Description
*CLS	Clear status	Clears Error Queue and event registers.
*RST	Reset	Returns the System 41 to *RST default conditions (see Table 6-4).
*TRG	Trigger	Issues a bus trigger (same as group execute trigger command; GET).
*SAV <n>	Save	Saves the current setup configuration in memory (n = 0 to 9).
*RCL <n>	Recall	Returns the instrument to the setup configuration stored in memory (n = 0 to 9).

Abbreviated SCPI command summary

Most instrument operations are controlled using SCPI commands. Table 3-2 provides an abbreviated list of the SCPI commands necessary to perform some basic operations.

Not shown in the table are companion query commands for the :ARM and :TRIGger Subsystem commands (:COUNT?, :DELay?, :SOURce?, and :TIMer?). For example, the :TRIGger: SOURce? query command is used to request the currently selected control source. After the query command is sent and the System 41 is addressed to talk, a message identifying the selected control source will be sent to the computer.

Table 3-2
Abbreviated SCPI command summary

:SYSTem :PRESet	Subsystem command path. Set scan to a default configuration (see Table 6-4).
[:ROUte] :CLOSe <list> :STATe? :OPEN <list> ALL :SCAN <list> :POINts?	Subsystem command path. Path and command to close specified channels: Request channels that are closed. Open specified (or all) channels. Path and command to specify channel list: Query number of channels in scan list.
:INITiate :ABORt :ARM :LAYer2 :COUNt <n> :DELay <n> :SOURce <name>	Initiate one trigger (scan) cycle. Reset trigger system. Subsystem command path to configure scan: Path to program scan layer: Program number of scans (1 to 9999, or INFinite). Program delay (0 to 99999.999 seconds). Select control source: HOLD, Immediate, TIMer, MANual, BUS, TLINK. Set timer interval (0.001 to 99999.999 sec).
:TRIGger :COUNt <n> :AUTo :DELay <n> :SOURce <name>	Subsystem command path to program channel layer: Program number of channels (1 to 9999, or INFinite). Enable (on) or disable (off) automatic scan list count. Program delay (0 to 99999.999 sec). Select control source: HOLD, Immediate, TIMer, MANual, BUS, TLINK.
:TIMer <n>	Set timer interval (0.001 to 99999.999 sec).

Notes:

1. Command shortform is indicated by the uppercase characters. For example, instead of sending “:arm:layer2:source immediate,” you can send “:arm:lay2:sour imm.”
2. There must be at least one space between a command word and the parameter.

Abbreviated syntax rules

Some of the basic syntax rules for programming the System 41 are covered in this paragraph. Detailed syntax information is provided in Section 6, “Programming syntax.”

Commands and parameters

The general form for SCPI commands is demonstrated in Table 3-2. They are hierarchical in nature and begin with a root command. For example, to open all channels, send the following command:

```
:OPEN ALL
```

The root command for the above example is :ROUte. This is an optional command word (as indicated by the brackets ([]) in the table) and need not be used.

A space must be used to separate the command word (:OPEN) and the parameter (ALL).

The general form for Common Commands is shown in Table 3-1. Note that each common command is preceded by a star (*).

Typical parameter types used to program the instrument include:

<name> — Name parameter: Select a parameter name from a listed group.

<list> — List of channels. The following example demonstrates proper format:

(@ M1, M15) Channel patterns M1 and M15

**** — Boolean: Enable (1 or on) or disable (0 or off) a function.

<NRf> — Numeric representation format: Number can be expressed as an integer, real number, or an exponent (e.g. 2.3E6).

<n> — Numeric value: An NRf number or one of the following name parameters:

DEFault: Uses the *RST default parameter value

MINimum: Uses the lowest allowable parameter value

MAXimum: Uses the largest allowable parameter value

Most SCPI command words and name parameters have a short-form version. The short form versions are identified in the SCPI tables by the upper case characters. Example:

:TRIGger:SOURce:TIMer? = :trig:sour:tim?

Note from the above example that command words and parameter names are not case sensitive.

Query Commands

This type of command requests (queries) information and is identified by the question mark (?). Example:

:CLOSe:STATe? Queries the channels that are closed.

Whenever a query command is sent, the System 41 must be addressed to talk in order to send the response message to the computer.

Program Messages

A program message is made up of one or more command words sent by the computer to the instrument. Note from Table 3-2 that some programming operations require several command words.

Single Command Message — This program message uses the command words required to perform a single programming operation. Example:

:TRIGger:COUNt:AUTo ON Enables auto scan list count.

Multiple Command Message — This program message contains two or more command operations. Each command string is separated by a semicolon (;). The following example uses the short-form format to reduce the size of the message:

:trig:sour man; :trig:del 0.5

The above program message selects the Manual control source, and then sets delay to 0.5 seconds.

Commands that are on the same command level can be executed without having to repeat the entire command path. For example, the above multiple command message can be formatted as follows:

:trig:sour man; del 0.5

Since :SOURce and :DELay are on the same command level (see Table 3-2), the :TRIGger command word does not have to be repeated for the second command string. Note also that the leading colon (:) for :DELay is not used.

Common commands and SCPI commands can be used in the same program message as long as they are separated by a semicolon (;). Example:

```
*RST; CLOSe (@ M1, M15)
```

Programming example

The following programming example shows the proper sequence for sending commands to close/open channel patterns. Cold switching is used to protect the RF switches from damage.

Example — Closing and opening channel patterns

The following command sequence will close the channels of M1 and M15.

Before sending any of the following commands, make sure that there are no test signals connected to the inputs or outputs of the System 41.

	<u>Comments</u>
*RST; OPEN ALL	1
:CLOSe (@ M1, M15)	2
:CLOSe:STATe?	3

With the channels of M1 and M15 closed, it is now safe to apply the test signal to the System 41. When finished with the test, remove the test signals and send the following command to open the channels:

OPEN (@ M1, M15)	4
------------------	---

Comments

1. Restore the default settings and open all RF switches.
2. Close the channels of M1 and M15.
3. Request the channels that are closed. Note that for this query command you must address the System 41 to talk to obtain the channel list.
4. Open the channels of M1 and M15.

4

RF Modules

Introduction

CAUTION The RF switches for the standard switching modules are designed for cold switching. Hot switching (especially above 1W) may degrade performance and shorten the life of the switches. If hot switching is required, please consult Keithley Instruments for a customized switching module which incorporates switches specially designed for hot switching applications.

NOTE Switching procedures in this manual use cold switching. That is, the signal is removed before a switch is closed or opened. However, for low power applications, the RF switches are rated to hot switch up to 1W.

This section contains reference information for the RF modules. The information for each module is organized as follows:

- **Overview** — Summarizes operation and provides a simplified diagram of the RF switching module.
- **Connections** — Provides connection information that is specific to the installed RF module. General connection information is provided in Section 2.
- **Switch control** — Defines the channel patterns used to control the input/output switching combinations of the RF module. Also summarizes the proper method to close/open and scan channel patterns.
- **Channel pattern memory** — Explains how to check pre-programmed channel patterns, and how to reprogram ones that are inadvertently lost (cleared) or changed.

The RF modules documented in this section are as follows (refer to the RF module installed in your System 41):

- Model RF6×6 module
- Model RF10×10 module
- Model RF1×72 module

Model RF6X6 module

Overview

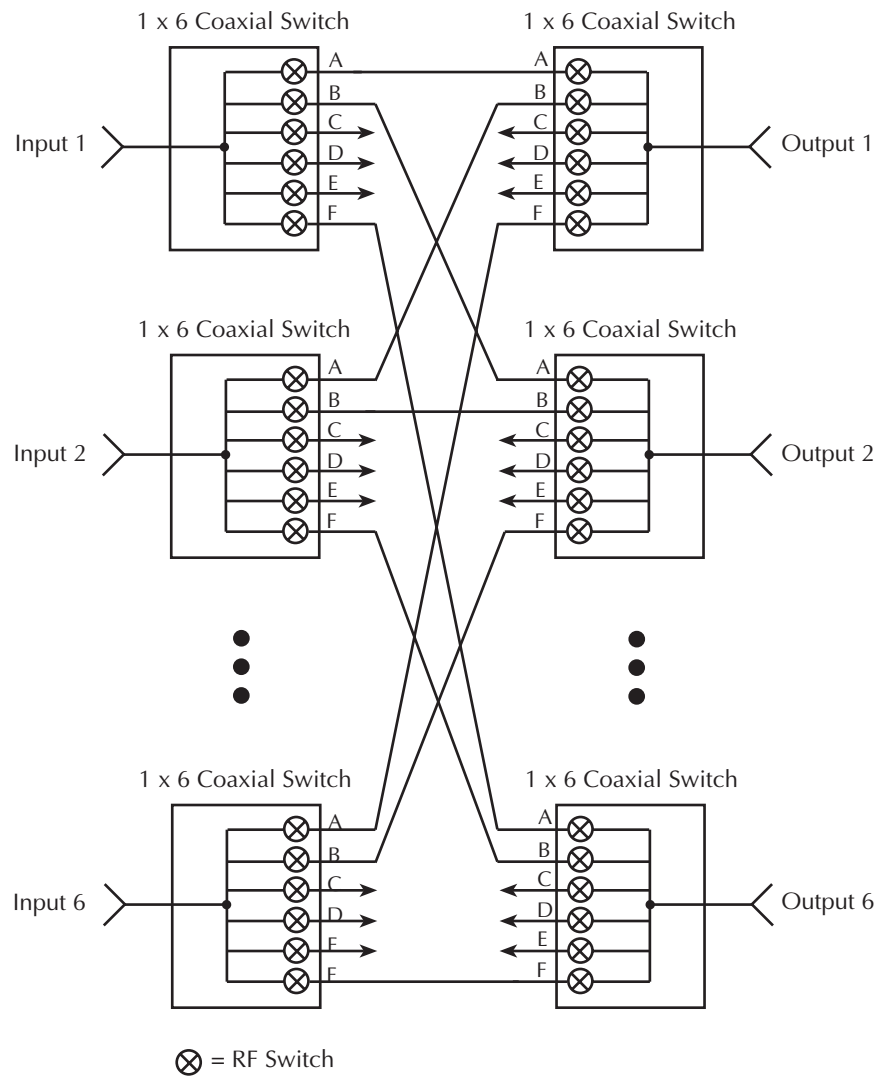
The Model RF6×6 is a full access non-blocking 6×6 RF coaxial matrix. The simplified diagram of the 6×6 RF switching matrix is shown in Figure 4-1. This matrix configuration makes it possible to connect any of the six inputs to any of the six outputs.

As shown in Figure 4-1, each input and each output is made up of a 1×6 coaxial switch; six 1×6 coaxial switches for the inputs, and six 1×6 coaxial switches for the outputs. Therefore, there are 36 RF switches for the inputs, and 36 RF switches for the outputs. When a channel pattern is closed or scanned, two RF switches will close; one for the input and one for the output. The two closed switches provide the input-to-output path for the RF signal.

To keep the drawing simple, Figure 4-1 shows only six of the 12 coaxial switches. Therefore, only the signal paths for Input/Outputs 1, 2, and 6 are shown. However, the signal paths for all input/output combinations are listed in Table 4-1.

Example — Assume the RF test signal is connected to Input 1 and you want to access it at Output 6. To do this, you would close the channel pattern that connects Input 1 to Output 6. For the Model RF6×6, this would be channel pattern M6 as explained in “Switch control”.

Figure 4-1
Model RF6X6 simplified diagram



Connections

The 12 SMA coaxial connectors are located on the rear panel of the System 41. Six connectors are for input (IN 1 through IN 6), and six are for output (OUT 1 through OUT 6). The center conductor of each SMA connector is connected to a 1 × 6 coaxial switch as shown in Figure 4-1. The outer shell of each SMA connector is connected to earth ground.

The techniques to properly (and safely) connect test cables to SMA connectors are provided in Section 2, “SMA coaxial connections.”

WARNING Contact with exposed conductors carrying RF power may cause burns. Make sure all power is off before making or breaking connections.

Switch control

The System 41 has pre-programmed channel patterns to control the installed RF module. These channel patterns cover all input-to-output switching combinations for the RF module.

For the Model RF6×6, each channel pattern closes an input switch and an output switch to route the RF signal through the matrix. The 36 pre-programmed channel patterns for the Model RF6×6 module are provided in Table 4-1. For example, if you want to connect Input 1 to Output 6, you would close M6. Notice that if not using channel patterns, you would have to close channels 5!12 and 5!13 to connect Input 1 to Output 6.

CAUTION In order to prevent damage to RF switches and other equipment connected to the System 41, DO NOT close more than one path through any input or output. In other words ...

NEVER connect an input to more than one output at a time.

NEVER connect an output to more than one input at a time.

For example, if Input 1 is connected to Output 2, do not connect Input 1 to any other output, and do not connect Output 2 to any other input.

CAUTION In order to prevent damage to RF switches (or in the very least, shorten their life), cold switching must be exercised. For cold switching, the test signal(s) must be removed (or set to 0V, 0A) before an RF switch is closed or opened.

The following examples show proper channel list and scan list format. For details on operation, see Sections 3 and 4.

NOTE To assure that you do not inadvertently close more than one path through any input or output, you should routinely open all channels before performing a close operation. To open all channels, press OPEN ALL. Over the bus, send the :OPEN ALL command.

Example	Front Panel Operation	Bus Operation
1	SELECT CHANNELS M4,	:clos (@ M4)
2	SELECT CHANNELS M7, M17,	:close (@ M7, M17)
3	SCAN CHANNELS M1, M5, M2	:scan (@ M1, M5, M2)

Example Notes:

1. Connects Input 1 to Output 4.
2. Simultaneously connects Input 2 to Output 1, and Input 3 to Output 5.
3. Scans three channel patterns. After each channel pattern is scanned, its two switches will open before the next channel pattern is scanned. The first scanned channel pattern connects Input 1 to Output 1, the second scanned channel pattern connects Input 1 to Output 5, and the last scanned channel pattern connects Input 1 to Output 2.

Table 4-1
Model RF6X6 — pre-programmed channel patterns

Connect		Channel pattern	Switch closure	
In	Out			
1	1	M1	5!18	5!6
1	2	M2	5!17	6!6
1	3	M3	5!16	4!6
1	4	M4	5!15	4!12
1	5	M5	5!14	6!12
1	6	M6	5!13	5!12
2	1	M7	6!18	5!5
2	2	M8	6!17	6!5
2	3	M9	6!16	4!5
2	4	M10	6!15	4!11
2	5	M11	6!14	6!11
2	6	M12	6!13	5!11
3	1	M13	4!18	5!4
3	2	M14	4!17	6!4
3	3	M15	4!16	4!4
3	4	M16	4!15	4!10
3	5	M17	4!14	6!10
3	6	M18	4!13	5!10
4	1	M19	4!24	5!3
4	2	M20	4!23	6!3
4	3	M21	4!22	4!3
4	4	M22	4!21	4!9
4	5	M23	4!20	6!9
4	6	M24	4!19	5!9
5	1	M25	6!24	5!2
5	2	M26	6!23	6!2
5	3	M27	6!22	4!2
5	4	M28	6!21	4!8
5	5	M29	6!20	6!8
5	6	M30	6!19	5!8
6	1	M31	5!24	5!1
6	2	M32	5!23	6!1
6	3	M33	5!22	4!1
6	4	M34	5!21	4!7
6	5	M35	5!20	6!7
6	6	M36	5!19	5!7

Channel pattern memory

The 36 pre-programmed channel patterns for the Model RF6×6 Module are stored in memory. However, an illegal operation could cause one or more (or all) channel patterns to be lost (cleared) or changed. In that event, you will have to re-program lost or changed channel patterns.

Checking pre-programmed channel patterns

If you suspect that one or more pre-programmed channel patterns have been inadvertently lost or changed, you can check to see if a suspect channel pattern is closing the correct channels (switches).

CAUTION Make sure there is nothing connected to the input and output connectors of the System 41. If there is, remove all power from the test system and disconnect all test cables.

1. Press OPEN ALL to make sure that all channels are open.
2. The System 41 must be in the relay status display mode (“RELAY STATUS” displayed). If it is not, use the following menu sequence to select it:
Press MENU, select GENERAL, select DISPLAY, select SHOW LIST, select RELAY STATUS
Use the EXIT key to back out of the menu structure.
3. You can use the close/open operation, or scanning to check channel patterns. To check one channel pattern use the close/open operation. To check many (or all) channel patterns, use scanning:
 - **Close/open channel patterns:**
 - a. Create a channel list for the suspect channel pattern. For example, if you wish to check M5, create the following channel list:
SELECT CHANNELS M5,
 - b. Press the CLOSE key. Use Table 4-1 to verify that the two channels for the specified channel pattern are closed. For M5, channels 5!14 and 6!12 should be the only channels closed.
 - c. Press OPEN ALL to open the channels.
 - d. Repeat steps A through C to check another channel pattern.
 - **Scan channel patterns:**
 - a. Create a scan list for the suspect channel patterns. For example, if you wish to check all the channel patterns for Inputs 1 and 2, create the following scan list:
SCAN CHANNELS M1, M2, M3, M4, M5, M6, M7, M8, M9, M10, M11, M12,
 - b. Press the STEP key to arm the scan (ARM indicator turns on).
 - c. Press the STEP key to scan the first channel pattern. For channel pattern M1, channels 5!6 and 5!18 (as shown in Table 4-1) should be the only channels closed.
 - d. Press STEP to scan each channel pattern in the scan, and use Table 4-1 to verify that the correct channels are closed.
 - e. When finished, press OPEN ALL to disable the scan and open all channels.
4. Lost or changed channel patterns can be re-programmed as explained in the next paragraph.

Storing channel patterns in memory

Front panel operation — There are two methods to store channel patterns in memory. The preferred method, which is covered here, specifies the two individual channels in the channel list, and then stores it in the appropriate memory location. For the other method, you must actually close the two individual channels and then store the pattern in the appropriate memory location. Details on both methods are provided in Section 5.

Perform the following steps to store channel patterns in memory:

1. Create the channel list specifying the individual closed channels of the channel pattern. For example, if you are reprogramming channel pattern M1, create the following channel list.
`SELECT CHANNELS 5!6, 5!18,`
Note that f lists the closed channels for every channel pattern.
2. Use the following menu sequence to display the “STORE LIST AT #xxx” message:
Press STORE, select CURRENT LIST
3. Use the keypad to display the appropriate memory location. The channel pattern number indicates its memory location (i.e., M1 belongs in memory location #001, M36 belongs in memory location #036).
4. With the correct memory location displayed, press ENTER.
5. Repeat steps 1 through 4 to reprogram another channel pattern.

GPIB operation — There are two methods to store channel patterns in memory. The preferred method, which is covered here, uses one command to list and save the channels in memory. For the other method, the channels must actually be closed and then the pattern is saved in memory. See :ROUTE subsystem in Section 6 for details on both methods.

Table 4-2 provides the :LIST command strings to reprogram channel patterns.

Table 4-2
Model RF6X6 — commands to store channel patterns in memory

Channel pattern	GPIB command
M1	:MEM:SAVE:LIST (@ 5!18, 5!6), M1
M2	:MEM:SAVE:LIST (@ 5!17, 6!6), M2
M3	:MEM:SAVE:LIST (@ 5!16, 4!6), M3
M4	:MEM:SAVE:LIST (@ 5!15, 4!12), M4
M5	:MEM:SAVE:LIST (@ 5!14, 6!12), M5
M6	:MEM:SAVE:LIST (@ 5!13, 5!12), M6
M7	:MEM:SAVE:LIST (@ 6!18, 5!5), M7
M8	:MEM:SAVE:LIST (@ 6!17, 6!5), M8
M9	:MEM:SAVE:LIST (@ 6!16, 4!5), M9
M10	:MEM:SAVE:LIST (@ 6!15, 4!11), M10
M11	:MEM:SAVE:LIST (@ 6!14, 6!11), M11
M12	:MEM:SAVE:LIST (@ 6!13, 5!11), M12
M13	:MEM:SAVE:LIST (@ 4!18, 5!4), M13
M14	:MEM:SAVE:LIST (@ 4!17, 6!4), M14
M15	:MEM:SAVE:LIST (@ 4!16, 4!4), M15
M16	:MEM:SAVE:LIST (@ 4!15, 4!10), M16
M17	:MEM:SAVE:LIST (@ 4!14, 6!10), M17
M18	:MEM:SAVE:LIST (@ 4!13, 5!10), M18
M19	:MEM:SAVE:LIST (@ 4!24, 5!3), M19
M20	:MEM:SAVE:LIST (@ 4!23, 6!3), M20
M21	:MEM:SAVE:LIST (@ 4!22, 4!3), M21
M22	:MEM:SAVE:LIST (@ 4!21, 4!9), M22
M23	:MEM:SAVE:LIST (@ 4!20, 6!9), M23
M24	:MEM:SAVE:LIST (@ 4!19, 5!9), M24
M25	:MEM:SAVE:LIST (@ 6!24, 5!2), M25
M26	:MEM:SAVE:LIST (@ 6!23, 6!2), M26
M27	:MEM:SAVE:LIST (@ 6!22, 4!2), M27
M28	:MEM:SAVE:LIST (@ 6!21, 4!8), M28
M29	:MEM:SAVE:LIST (@ 6!20, 6!8), M29
M30	:MEM:SAVE:LIST (@ 6!19, 5!8), M30
M31	:MEM:SAVE:LIST (@ 5!24, 5!1), M31
M32	:MEM:SAVE:LIST (@ 5!23, 6!1), M32
M33	:MEM:SAVE:LIST (@ 5!22, 4!1), M33
M34	:MEM:SAVE:LIST (@ 5!21, 4!7), M34
M35	:MEM:SAVE:LIST (@ 5!20, 6!7), M35
M36	:MEM:SAVE:LIST (@ 5!19, 5!7), M36

Model RF10X10 module

Overview

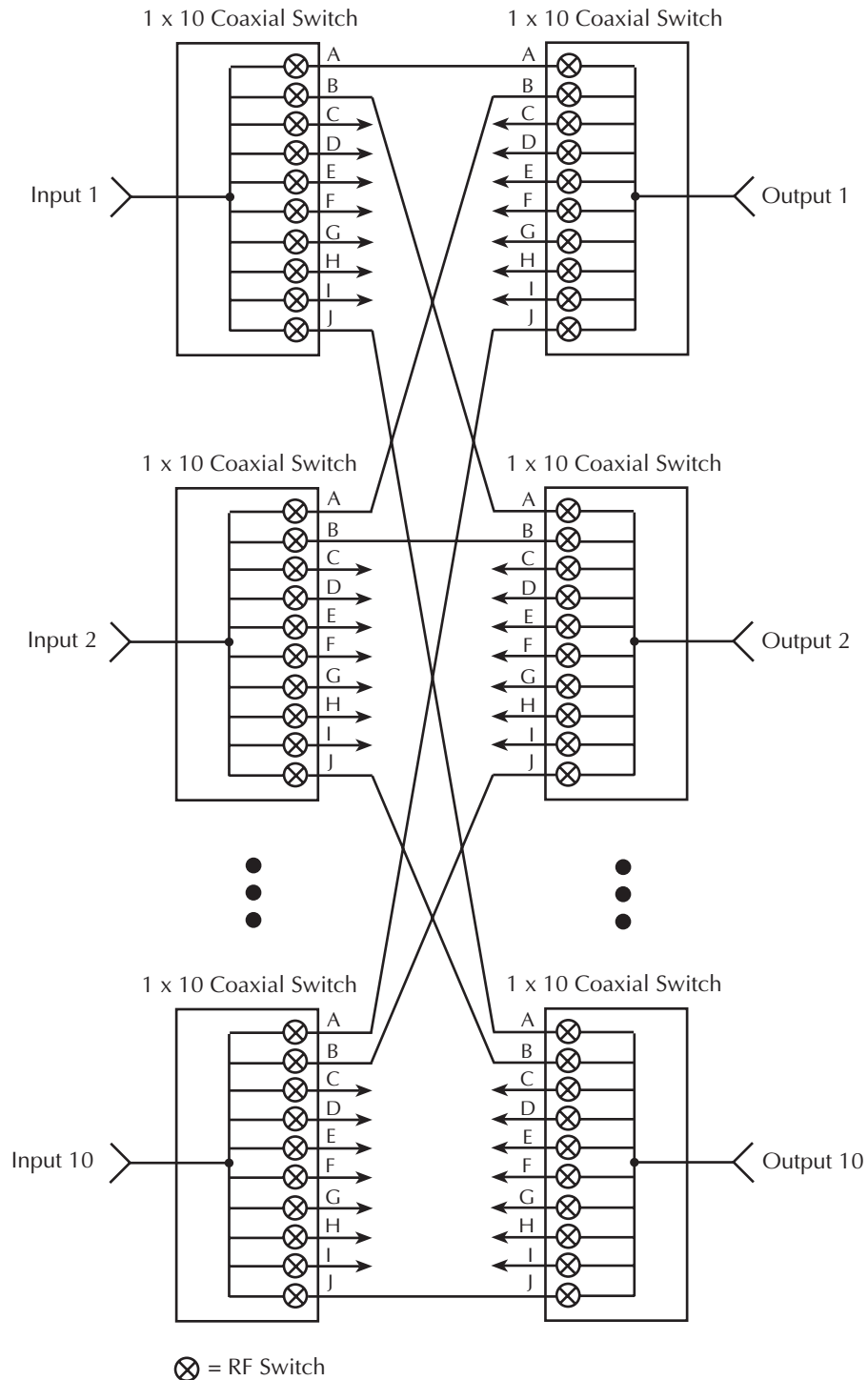
The Model RF10×10 is a full access non-blocking 10×10 RF coaxial matrix. The simplified diagram of the 10×10 RF switching matrix is shown in Figure 4-2. This matrix configuration makes it possible to connect any of the 10 inputs to any of the 10 outputs.

As shown in Figure 4-2, each input and each output is made up of a 1×10 coaxial switch; ten 1×10 coaxial switches for the inputs, and ten 1×10 coaxial switches for the outputs. Therefore, there are 100 RF switches for the inputs, and 100 RF switches for the outputs. When a channel pattern is closed or scanned, two RF switches will close; one for the input and one for the output. The two closed switches provide the input-to-output path for the RF signal.

To keep the drawing simple, Figure 4-2 shows only six of the 20 coaxial switches. Therefore, only the signal paths for Input/Outputs 1, 2, and 10 are shown. However, the signal paths for all input/output combinations are listed in Table 4-3.

Example — Assume the RF test signal is connected to Input 1 and you want to access it at Output 10. To do this you would close the channel pattern that connects Input 1 to Output 10. For the Model RF10×10, this would be channel pattern M10 as explained in “Switch control.”

Figure 4-2
Model RF10X10 simplified diagram



Connections

The 20 SMA coaxial connectors are located on the rear panel of the System 41. Ten connectors are for input (IN 1 through IN 10), and ten are for output (OUT 1 through OUT 10). The center conductor of each SMA connector is connected to a 1 x 10 coaxial switch as shown in Figure 4-2. The outer shell of each SMA connector is connected to earth ground.

The techniques to properly (and safely) connect test cables to SMA connectors are provided in Section 2, “SMA coaxial connections.”

WARNING Contact with exposed conductors carrying RF power may cause burns. Make sure all power is off before making or breaking connections.

Switch control

The System 41 has pre-programmed channel patterns to control the installed RF module. These channel patterns cover all input-to-output switching combinations for the RF module.

For the Model RF10×10, each channel pattern closes an input switch and an output switch to route the RF signal through the matrix. The 100 pre-programmed channel patterns for the Model RF10×10 module are provided in Table 4-3. For example, if you want to connect Input 1 to Output 6, you would close M6. Notice that if not using channel patterns, you would have to close channels 1!20 and 5!25 to connect Input 1 to Output 6.

CAUTION In order to prevent damage to RF switches and other equipment connected to the System 41, DO NOT close more than one path through any input or output. In other words ...

NEVER connect an input to more than one output at a time.

NEVER connect an output to more than one input at a time.

For example, if Input 1 is connected to Output 2, do not connect Input 1 to any other output, and do not connect Output 2 to any other input.

CAUTION In order to prevent damage to RF switches (or in the very least, shorten their life), cold switching must be exercised. For cold switching, the test signal(s) must be removed (or set to 0V, 0A) before an RF switch is closed or opened.

The following examples show proper channel list and scan list format. For details on operation, see Sections 3 and 4.

NOTE To assure that you do not inadvertently close more than one path through any input or output, you should routinely open all channels before performing a close operation. To open all channels, press OPEN ALL. Over the bus, send the :OPEN ALL command.

Example	Front Panel Operation	Bus Operation
1	SELECT CHANNELS M4,	:clos (@ M4)
2	SELECT CHANNELS M7, M17,	:clos (@ M13, M36)
3	SCAN CHANNELS M1, M5, M2,	:scan (@ M1, M5, M2)

Example Notes:

1. Connects Input 1 to Output 4.
2. Simultaneously connects Input 2 to Output 3, and Input 4 to Output 6.
3. Scans three channel patterns. After each channel pattern is scanned, its two switches will open before the next channel pattern is scanned. The first scanned channel pattern connects Input 1 to Output 1, the second scanned channel pattern connects Input 1 to Output 5, and the last scanned channel pattern connects Input 1 to Output 2.

Table 4-3
Model RF10X10 — pre-programmed channel patterns

Connect		Channel pattern	Switch closure	
In	Out			
1	1	M1	5!30	5!10
1	2	M2	5!29	4!10
1	3	M3	5!28	3!10
1	4	M4	5!27	2!10
1	5	M5	5!26	1!10
1	6	M6	5!25	1!20
1	7	M7	5!24	2!20
1	8	M8	5!23	3!20
1	9	M9	5!22	4!20
1	10	M10	5!21	5!20
2	1	M11	4!30	5!9
2	2	M12	4!29	4!9
2	3	M13	4!28	3!9
2	4	M14	4!27	2!9
2	5	M15	4!26	1!9
2	6	M16	4!25	1!19
2	7	M17	4!24	2!19
2	8	M18	4!23	3!19
2	9	M19	4!22	4!19
2	10	M20	4!21	5!19
3	1	M21	3!30	5!8
3	2	M22	3!29	4!8
3	3	M23	3!28	3!8
3	4	M24	3!27	2!8
3	5	M25	3!26	1!8
3	6	M26	3!25	1!18
3	7	M27	3!24	2!18
3	8	M28	3!23	3!18
3	9	M29	3!22	4!18
3	10	M30	3!21	5!18
4	1	M31	2!30	5!7
4	2	M32	2!29	4!7
4	3	M33	2!28	3!7
4	4	M34	2!27	2!7
4	5	M35	2!26	1!7
4	6	M36	2!25	1!17
4	7	M37	2!24	2!17
4	8	M38	2!23	3!17
4	9	M39	2!22	4!17
4	10	M40	2!21	5!17
5	1	M41	1!30	5!6
5	2	M42	1!29	4!6
5	3	M43	1!28	3!6
5	4	M44	1!27	2!6
5	5	M45	1!26	1!6
5	6	M46	1!25	1!16
5	7	M47	1!24	2!16
5	8	M48	1!23	3!16
5	9	M49	1!22	4!16
5	10	M50	1!21	5!16

Table 4-3 (cont.)

Model RF10X10 — pre-programmed channel patterns

Connect		Channel pattern	Switch closure	
In	Out			
6	1	M51	1!40	5!5
6	2	M52	1!39	4!5
6	3	M53	1!38	3!5
6	4	M54	1!37	2!5
6	5	M55	1!36	1!5
6	6	M56	1!35	1!15
6	7	M57	1!34	2!15
6	8	M58	1!33	3!15
6	9	M59	1!32	4!15
6	10	M60	1!31	5!15
7	1	M61	2!40	5!4
7	2	M62	2!39	4!4
7	3	M63	2!38	3!4
7	4	M64	2!37	2!4
7	5	M65	2!36	1!4
7	6	M66	2!35	1!14
7	7	M67	2!34	2!14
7	8	M68	2!33	3!14
7	9	M69	2!32	4!14
7	10	M70	2!31	5!14
8	1	M71	3!40	5!3
8	2	M72	3!39	4!3
8	3	M73	3!38	3!3
8	4	M74	3!37	2!3
8	5	M75	3!36	1!3
8	6	M76	3!35	1!13
8	7	M77	3!34	2!13
8	8	M78	3!33	3!13
8	9	M79	3!32	4!13
8	10	M80	3!31	5!13
9	1	M81	4!40	5!2
9	2	M82	4!39	4!2
9	3	M83	4!38	3!2
9	4	M84	4!37	2!2
9	5	M85	4!36	1!2
9	6	M86	4!35	1!12
9	7	M87	4!34	2!12
9	8	M88	4!33	3!12
9	9	M89	4!32	4!12
9	10	M90	4!31	5!12
10	1	M91	5!40	5!1
10	2	M92	5!39	4!1
10	3	M93	5!38	3!1
10	4	M94	5!37	2!1
10	5	M95	5!36	1!1
10	6	M96	5!35	1!11
10	7	M97	5!34	2!11
10	8	M98	5!33	3!11
10	9	M99	5!32	4!11
10	10	M100	5!31	5!11

Channel pattern memory

The 100 pre-programmed channel patterns for the Model RF10×10 Module are stored in memory. However, an illegal operation could cause one or more (or all) channel patterns to be lost (cleared) or changed. In that event, you will have to re-program lost or changed channel patterns.

Checking pre-programmed channel patterns

If you suspect that one or more pre-programmed channel patterns have been inadvertently lost or changed, you can check to see if a suspect channel pattern is closing the correct channels (switches).

CAUTION Make sure there is nothing connected to the input and output connectors of the System 41. If there is, remove all power from the test system and disconnect all test cables.

1. Press OPEN ALL to make sure that all channels are open.
2. The System 41 must be in the relay status display mode (“RELAY STATUS” displayed). If it is not, use the following menu sequence to select it:
Press MENU, select GENERAL, select DISPLAY, select SHOW LIST, select RELAY STATUS
Use the EXIT key to back out of the menu structure.
3. You can use the close/open operation, or scanning to check channel patterns. To check one channel pattern, use the close/open operation. To check many (or all) channel patterns, use scanning:
 - **Close/open channel patterns:**
 - a. Create a channel list for the suspect channel pattern. For example, if you want to check M5, create the following channel list:
SELECT CHANNELS M5,
 - b. Press the CLOSE key. Use Table 4-3 to verify that the two channels for the specified channel pattern are closed. For M5, channels 1!10 and 5!26 should be the only channels closed.
 - c. Press OPEN ALL to open the channels.
 - d. Repeat steps A through C to check another channel pattern.
 - **Scan channel patterns:**
 - a. Create a scan list for the suspect channel patterns. For example, if you wish to check all the channel patterns for Input 1, create the following scan list:
SCAN CHANNELS M1, M2, M3, M4, M5, M6, M7, M8, M9, M10,
 - b. Press the STEP key to arm the scan (ARM indicator turns on).
 - c. Press the STEP key to scan the first channel pattern. For channel pattern M1, channels 5!10 and 5!30 (as shown in Table 4-3) should be the only channels closed.
 - d. Press STEP to scan each channel pattern in the scan, and use Table 4-3 to verify that the correct channels are closed.
 - e. When finished, press OPEN ALL to disable the scan and open all channels.
4. Lost or changed channel patterns can be re-programmed as explained in the next paragraph.

Storing channel patterns in memory

Front panel operation — There are two methods to store channel patterns in memory. The preferred method, which is covered here, specifies the two individual channels in the channel list, and then stores it in the appropriate memory location. For the other method, you must actually close the two individual channels and then store the pattern in the appropriate memory location. Details on both methods are provided in Section 5.

Perform the following steps to store channel patterns in memory:

1. Create the channel list specifying the individual closed channels of the channel pattern. For example, if you are reprogramming channel pattern M1, create the following channel list.
`SELECT CHANNELS 5!10, 5!30,`
Note that Table 4-3 lists the closed channels for every channel pattern.
2. Use the following menu sequence to display the “STORE LIST AT #xxx” message:
Press STORE, select CURRENT LIST
3. Use the keypad to display the appropriate memory location. The channel pattern number indicates its memory location (i.e., M1 belongs in memory location #001, M100 belongs in memory location #100).
4. With the correct memory location displayed, press ENTER.
5. Repeat steps 1 through 4 to reprogram another channel pattern.

GPIB operation — There are two methods to store channel patterns in memory. The preferred method, which is covered here, uses one command to list and save and channels in memory. For the other method, the channels must actually be closed and then the pattern is saved in memory. See :ROUTE subsystem in Section 6 for details on both methods.

Table 4-4 provides the :LIST command strings to reprogram channel patterns.

Table 4-4
Model RF10X10 — commands to store channel patterns in memory

Channel pattern	GPIB command
M1	:MEM:SAVE:LIST (@ 5!30, 5!10), M1
M2	:MEM:SAVE:LIST (@ 5!29, 4!10), M2
M3	:MEM:SAVE:LIST (@ 5!28, 3!10), M3
M4	:MEM:SAVE:LIST (@ 5!27, 2!10), M4
M5	:MEM:SAVE:LIST (@ 5!26, 1!10), M5
M6	:MEM:SAVE:LIST (@ 5!25, 1!20), M6
M7	:MEM:SAVE:LIST (@ 5!24, 2!20), M7
M8	:MEM:SAVE:LIST (@ 5!23, 3!20), M8
M9	:MEM:SAVE:LIST (@ 5!22, 4!20), M9
M10	:MEM:SAVE:LIST (@ 5!21, 5!20), M10
M11	:MEM:SAVE:LIST (@ 4!30, 5!9), M11
M12	:MEM:SAVE:LIST (@ 4!29, 4!9), M12
M13	:MEM:SAVE:LIST (@ 4!28, 3!9), M13
M14	:MEM:SAVE:LIST (@ 4!27, 2!9), M14
M15	:MEM:SAVE:LIST (@ 4!26, 1!9), M15
M16	:MEM:SAVE:LIST (@ 4!25, 1!19), M16
M17	:MEM:SAVE:LIST (@ 4!24, 2!19), M17
M18	:MEM:SAVE:LIST (@ 4!23, 3!19), M18
M19	:MEM:SAVE:LIST (@ 4!22, 4!19), M19
M20	:MEM:SAVE:LIST (@ 4!21, 5!19), M20
M21	:MEM:SAVE:LIST (@ 3!30, 5!8), M21
M22	:MEM:SAVE:LIST (@ 3!29, 4!8), M22
M23	:MEM:SAVE:LIST (@ 3!28, 3!8), M23
M24	:MEM:SAVE:LIST (@ 3!27, 2!8), M24
M25	:MEM:SAVE:LIST (@ 3!26, 1!8), M25
M26	:MEM:SAVE:LIST (@ 3!25, 1!18), M26
M27	:MEM:SAVE:LIST (@ 3!24, 2!18), M27
M28	:MEM:SAVE:LIST (@ 3!23, 3!18), M28
M29	:MEM:SAVE:LIST (@ 3!22, 4!18), M29
M30	:MEM:SAVE:LIST (@ 3!21, 5!18), M30
M31	:MEM:SAVE:LIST (@ 2!30, 5!7), M31
M32	:MEM:SAVE:LIST (@ 2!29, 4!7), M32
M33	:MEM:SAVE:LIST (@ 2!28, 3!7), M33
M34	:MEM:SAVE:LIST (@ 2!27, 2!7), M34
M35	:MEM:SAVE:LIST (@ 2!26, 1!7), M35
M36	:MEM:SAVE:LIST (@ 2!25, 1!17), M36
M37	:MEM:SAVE:LIST (@ 2!24, 2!17), M37
M38	:MEM:SAVE:LIST (@ 2!23, 3!17), M38
M39	:MEM:SAVE:LIST (@ 2!22, 4!17), M39
M40	:MEM:SAVE:LIST (@ 2!21, 5!17), M40
M41	:MEM:SAVE:LIST (@ 1!30, 5!6), M41
M42	:MEM:SAVE:LIST (@ 1!29, 4!6), M42
M43	:MEM:SAVE:LIST (@ 1!28, 3!6), M43
M44	:MEM:SAVE:LIST (@ 1!27, 2!6), M44
M45	:MEM:SAVE:LIST (@ 1!26, 1!6), M45
M46	:MEM:SAVE:LIST (@ 1!25, 1!16), M46
M47	:MEM:SAVE:LIST (@ 1!24, 2!16), M47
M48	:MEM:SAVE:LIST (@ 1!23, 3!16), M48
M49	:MEM:SAVE:LIST (@ 1!22, 4!16), M49
M50	:MEM:SAVE:LIST (@ 1!21, 5!16), M50

Table 4-4 (cont.)

Model RF10X10 — commands to store channel patterns in memory

Channel pattern	GPIB command
M51	:MEM:SAVE:LIST (@ 1!40, 5!5), M51
M52	:MEM:SAVE:LIST (@ 1!39, 4!5), M52
M53	:MEM:SAVE:LIST (@ 1!38, 3!5), M53
M54	:MEM:SAVE:LIST (@ 1!37, 2!5), M54
M55	:MEM:SAVE:LIST (@ 1!36, 1!5), M55
M56	:MEM:SAVE:LIST (@ 1!35, 1!15), M56
M57	:MEM:SAVE:LIST (@ 1!34, 2!15), M57
M58	:MEM:SAVE:LIST (@ 1!33, 3!15), M58
M59	:MEM:SAVE:LIST (@ 1!32, 4!15), M59
M60	:MEM:SAVE:LIST (@ 1!31, 5!15), M60
M61	:MEM:SAVE:LIST (@ 2!40, 5!4), M61
M62	:MEM:SAVE:LIST (@ 2!39, 4!4), M62
M63	:MEM:SAVE:LIST (@ 2!38, 3!4), M63
M64	:MEM:SAVE:LIST (@ 2!37, 2!4), M64
M65	:MEM:SAVE:LIST (@ 2!36, 1!4), M65
M66	:MEM:SAVE:LIST (@ 2!35, 1!14), M66
M67	:MEM:SAVE:LIST (@ 2!34, 2!14), M67
M68	:MEM:SAVE:LIST (@ 2!33, 3!14), M68
M69	:MEM:SAVE:LIST (@ 2!32, 4!14), M69
M70	:MEM:SAVE:LIST (@ 2!31, 5!14), M70
M71	:MEM:SAVE:LIST (@ 3!40, 5!3), M71
M72	:MEM:SAVE:LIST (@ 3!39, 4!3), M72
M73	:MEM:SAVE:LIST (@ 3!38, 3!3), M73
M74	:MEM:SAVE:LIST (@ 3!37, 2!3), M74
M75	:MEM:SAVE:LIST (@ 3!36, 1!3), M75
M76	:MEM:SAVE:LIST (@ 3!35, 1!13), M76
M77	:MEM:SAVE:LIST (@ 3!34, 2!13), M77
M78	:MEM:SAVE:LIST (@ 3!33, 3!13), M78
M79	:MEM:SAVE:LIST (@ 3!32, 4!13), M79
M80	:MEM:SAVE:LIST (@ 3!31, 5!13), M80
M81	:MEM:SAVE:LIST (@ 4!40, 5!2), M81
M82	:MEM:SAVE:LIST (@ 4!39, 4!2), M82
M83	:MEM:SAVE:LIST (@ 4!38, 3!2), M83
M84	:MEM:SAVE:LIST (@ 4!37, 2!2), M84
M85	:MEM:SAVE:LIST (@ 4!36, 1!2), M85
M86	:MEM:SAVE:LIST (@ 4!35, 1!12), M86
M87	:MEM:SAVE:LIST (@ 4!34, 2!12), M87
M88	:MEM:SAVE:LIST (@ 4!33, 3!12), M88
M89	:MEM:SAVE:LIST (@ 4!32, 4!12), M89
M90	:MEM:SAVE:LIST (@ 4!31, 5!12), M90
M91	:MEM:SAVE:LIST (@ 5!40, 5!1), M61
M92	:MEM:SAVE:LIST (@ 5!39, 4!1), M62
M93	:MEM:SAVE:LIST (@ 5!38, 3!1), M63
M94	:MEM:SAVE:LIST (@ 5!37, 2!1), M64
M95	:MEM:SAVE:LIST (@ 5!36, 1!1), M65
M96	:MEM:SAVE:LIST (@ 5!35, 1!11), M66
M97	:MEM:SAVE:LIST (@ 5!34, 2!11), M67
M98	:MEM:SAVE:LIST (@ 5!33, 3!11), M68
M99	:MEM:SAVE:LIST (@ 5!32, 4!11), M69
M100	:MEM:SAVE:LIST (@ 5!31, 5!11), M70

Model RF1X72 module

Overview

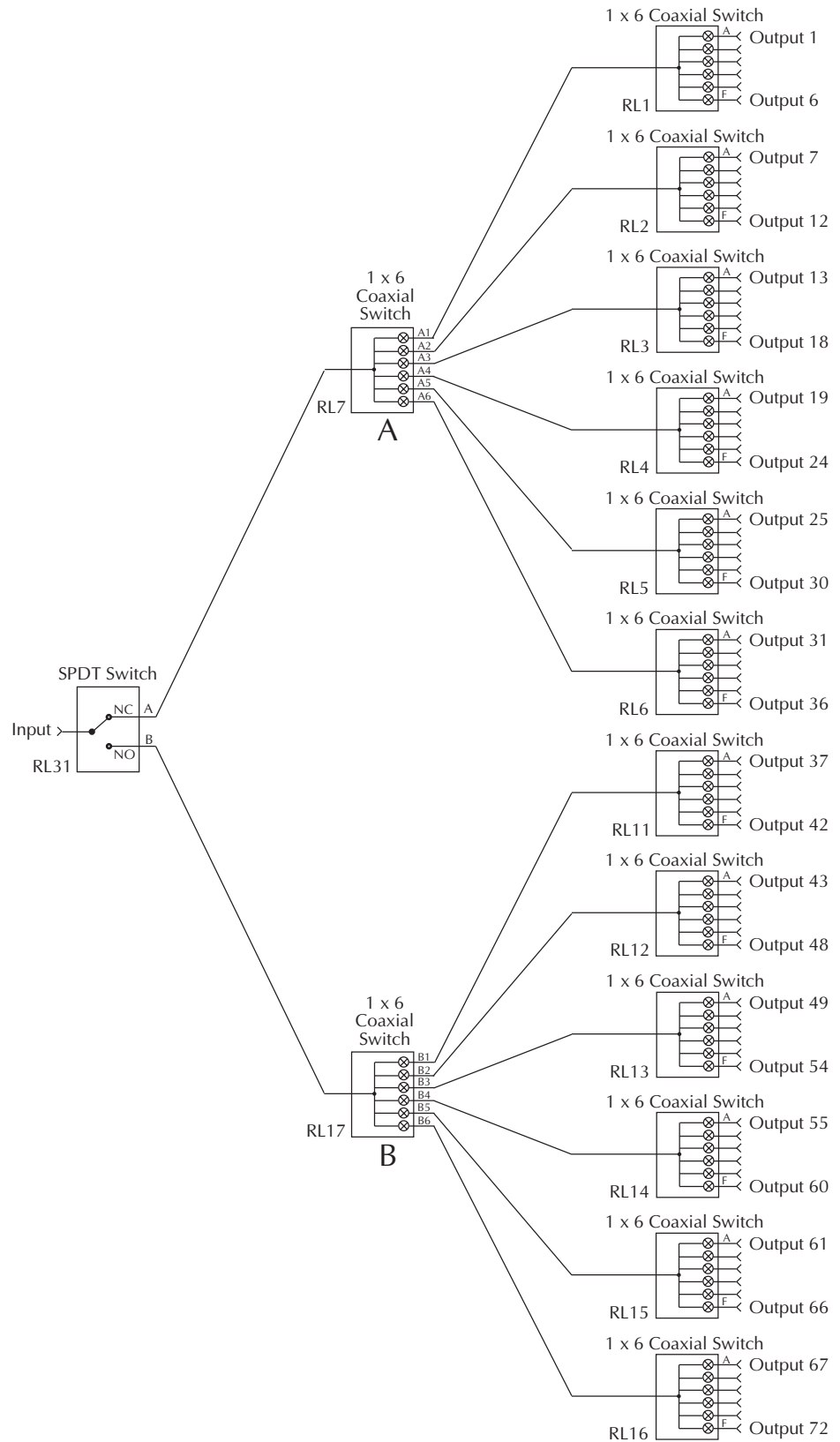
The Model RF1×72 is an RF coaxial multiplexer. The simplified diagram of the 1×72 switching multiplexer is shown in Figure 4-3. This multiplexing configuration allows you to connect the input to any one of 72 outputs.

As shown in Figure 4-3, the 1×72 multiplexer is actually made up of two 1×36 multiplexers (A and B) that feed into a single-pole, double-pole (SPDT) RF switch. The SPDT switch (RL31) is normally closed to connect the input signal to multiplexer A. When RL31 is energized (by closing channel 1!40), the input signal is routed to multiplexer B.

Each 36-output multiplexer is made up of seven 1×6 coaxial switches. When a channel pattern for multiplexer A is closed or scanned, RL31 remains in its normally closed (NC) position and two multiplexer switches close to connect the input to the desired output (1 through 36). When a channel pattern for multiplexer B is closed or scanned, RL31 energizes and two multiplexer switches close to connect the input to the desired output (37 through 72).

Example — if you wish to connect the Input to Output 72, you would close the channel pattern that energizes RL31 and closes the two multiplexer switches that route the RF signal to Output 72. For the Model RF1×72, this would be channel pattern M72 (see “Switch control” for details).

Figure 4-3
Model RF1X72 simplified diagram



Connections

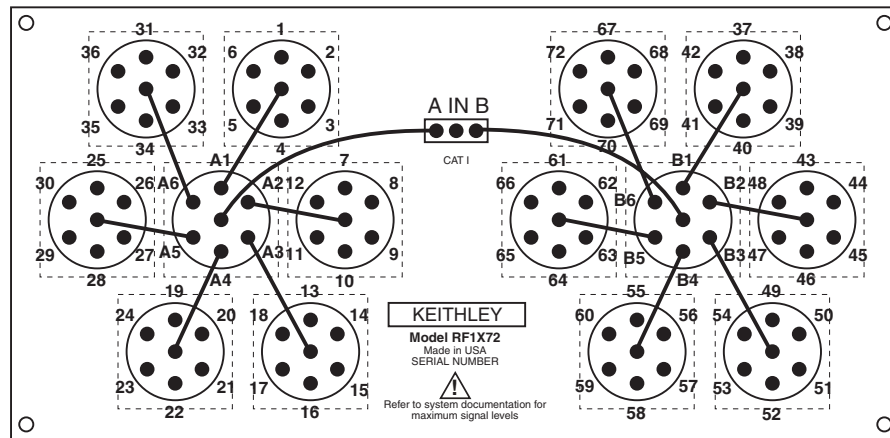
The coaxial switches for the multiplexer are mounted on the rear panel of the System 41 and are shown in Figure 4-4. Your test cables connect directly to the SMA coaxial connectors on the switches. As shown, outputs 1 through 36 are located on the left side of the rear panel, and Outputs 37 through 72 are located on the right side.

The center conductor of each SMA output connector is connected to a coaxial switch as shown in Figure 4-3. The outer shell of all SMA connectors is connected to earth ground.

The techniques to properly (and safely) connect test cables to SMA connectors are provided in Section 2, "SMA coaxial connections."

WARNING Contact with exposed conductors carrying RF power may cause burns. Make sure all power is off before making or breaking connections.

Figure 4-4
Model RF1X72 connections



Switch control

The System 41 has pre-programmed channel patterns to control the installed RF module. These channel patterns cover all input-to-output switching combinations for the RF module.

For the Model RF1×72, each channel pattern closes three RF switches to route the RF signal to the appropriate output. The 72 pre-programmed channel patterns for the Model RF1×72 module are provided in Table 4-5. For example, if you want to connect the Input to Output 60, you would close M60. Note that if not using channel patterns, you would have to close channels 1!40, 2!10, and 2!36 to connect the Input to Output 60.

CAUTION In order to prevent damage to RF switches and other equipment connected to the System 41, DO NOT connect the Input to more than one output at a time.

CAUTION In order to prevent damage to RF switches (or in the very least, shorten their life), cold switching must be exercised. For cold switching, the test signal(s) must be removed (or set to 0V, 0A) before an RF switch is closed or opened.

The following examples show proper channel list and scan list format. For details on operation, see Sections 3 and 4.

NOTE *To ensure that you do not inadvertently connect the Input to more than one output at the same time, you should routinely open all channels before performing a close operation. To open all channels, press OPEN ALL. Over the bus, send the :OPEN ALL command.*

Example	Front Panel Operation	Bus Operation
1	SELECT CHANNELS M4,	:clos (@ M4)
2	SCAN CHANNELS M1, M5, M2,	:scan (@ M1, M5, M2)

Example Notes:

1. Connects the Input to Output 4.
2. Scans three channel patterns. After each channel pattern is scanned, its three switches will open before the next channel pattern is scanned. The first scanned channel pattern connects the Input to Output 1, the second scanned channel pattern connects the Input to Output 5, and the last scanned channel pattern connects the Input to Output 2.

Table 4-5

Model RF1X72 — pre-programmed channel patterns

Mux output	Channel pattern	Closed channels	Signal path
1	M1	1!1 and 1!7	Input → RL31(A) → RL7(A1) → RL1(A) → Output 1
2	M2	1!1 and 1!8	Input → RL31(A) → RL7(A1) → RL1(B) → Output 2
3	M3	1!1 and 1!9	Input → RL31(A) → RL7(A1) → RL1(C) → Output 3
4	M4	1!1 and 1!10	Input → RL31(A) → RL7(A1) → RL1(D) → Output 4
5	M5	1!1 and 1!11	Input → RL31(A) → RL7(A1) → RL1(E) → Output 5
6	M6	1!1 and 1!12	Input → RL31(A) → RL7(A1) → RL1(F) → Output 6
7	M7	1!2 and 1!13	Input → RL31(A) → RL7(A2) → RL2(A) → Output 7
8	M8	1!2 and 1!14	Input → RL31(A) → RL7(A2) → RL2(B) → Output 8
9	M9	1!2 and 1!15	Input → RL31(A) → RL7(A2) → RL2(C) → Output 9
10	M10	1!2 and 1!16	Input → RL31(A) → RL7(A2) → RL2(D) → Output 10
11	M11	1!2 and 1!17	Input → RL31(A) → RL7(A2) → RL2(E) → Output 11
12	M12	1!2 and 1!18	Input → RL31(A) → RL7(A2) → RL2(F) → Output 12
13	M13	1!3 and 1!19	Input → RL31(A) → RL7(A3) → RL3(A) → Output 13
14	M14	1!3 and 1!20	Input → RL31(A) → RL7(A3) → RL3(B) → Output 14
15	M15	1!3 and 1!21	Input → RL31(A) → RL7(A3) → RL3(C) → Output 15
16	M16	1!3 and 1!22	Input → RL31(A) → RL7(A3) → RL3(D) → Output 16
17	M17	1!3 and 1!23	Input → RL31(A) → RL7(A3) → RL3(E) → Output 17
18	M18	1!3 and 1!24	Input → RL31(A) → RL7(A3) → RL3(F) → Output 18
19	M19	1!4 and 1!25	Input → RL31(A) → RL7(A4) → RL4(A) → Output 19
20	M20	1!4 and 1!26	Input → RL31(A) → RL7(A4) → RL4(B) → Output 20
21	M21	1!4 and 1!27	Input → RL31(A) → RL7(A4) → RL4(C) → Output 21
22	M22	1!4 and 1!28	Input → RL31(A) → RL7(A4) → RL4(D) → Output 22
23	M23	1!4 and 1!29	Input → RL31(A) → RL7(A4) → RL4(E) → Output 23
24	M24	1!4 and 1!30	Input → RL31(A) → RL7(A4) → RL4(F) → Output 24
25	M25	1!5 and 1!31	Input → RL31(A) → RL7(A5) → RL5(A) → Output 25
26	M26	1!5 and 1!32	Input → RL31(A) → RL7(A5) → RL5(B) → Output 26
27	M27	1!5 and 1!33	Input → RL31(A) → RL7(A5) → RL5(C) → Output 27
28	M28	1!5 and 1!34	Input → RL31(A) → RL7(A5) → RL5(D) → Output 28
29	M29	1!5 and 1!35	Input → RL31(A) → RL7(A5) → RL5(E) → Output 29
30	M30	1!5 and 1!36	Input → RL31(A) → RL7(A5) → RL5(F) → Output 30

Table 4-5 (cont.)

Model RF1X72 — pre-programmed channel patterns

Mux output	Channel pattern	Closed channels	Signal path
31	M31	1!6 and 2!1	Input → RL31(A) → RL7(A6) → RL6(A) → Output 31
32	M32	1!6 and 2!2	Input → RL31(A) → RL7(A6) → RL6(B) → Output 32
33	M33	1!6 and 2!3	Input → RL31(A) → RL7(A6) → RL6(C) → Output 33
34	M34	1!6 and 2!4	Input → RL31(A) → RL7(A6) → RL6(D) → Output 34
35	M35	1!6 and 2!5	Input → RL31(A) → RL7(A6) → RL6(E) → Output 35
36	M36	1!6 and 2!6	Input → RL31(A) → RL7(A6) → RL6(F) → Output 36
37	M37	1!40, 2!7 and 2!13	Input → RL31(B) → RL17(B1) → RL11(A) → Output 37
38	M38	1!40, 2!7 and 2!14	Input → RL31(B) → RL17(B1) → RL11(B) → Output 38
39	M39	1!40, 2!7 and 2!15	Input → RL31(B) → RL17(B1) → RL11(C) → Output 39
40	M40	1!40, 2!7 and 2!16	Input → RL31(B) → RL17(B1) → RL11(D) → Output 40
41	M41	1!40, 2!7 and 2!17	Input → RL31(B) → RL17(B1) → RL11(E) → Output 41
42	M42	1!40, 2!7 and 2!18	Input → RL31(B) → RL17(B1) → RL11(F) → Output 42
43	M43	1!40, 2!8 and 2!19	Input → RL31(B) → RL17(B2) → RL12(A) → Output 43
44	M44	1!40, 2!8 and 2!20	Input → RL31(B) → RL17(B2) → RL12(B) → Output 44
45	M45	1!40, 2!8 and 2!21	Input → RL31(B) → RL17(B2) → RL12(C) → Output 45
46	M46	1!40, 2!8 and 2!22	Input → RL31(B) → RL17(B2) → RL12(D) → Output 46
47	M47	1!40, 2!8 and 2!23	Input → RL31(B) → RL17(B2) → RL12(E) → Output 47
48	M48	1!40, 2!8 and 2!24	Input → RL31(B) → RL17(B2) → RL12(F) → Output 48
49	M49	1!40, 2!9 and 2!25	Input → RL31(B) → RL17(B3) → RL13(A) → Output 49
50	M50	1!40, 2!9 and 2!26	Input → RL31(B) → RL17(B3) → RL13(B) → Output 50
51	M51	1!40, 2!9 and 2!27	Input → RL31(B) → RL17(B3) → RL13(C) → Output 51
52	M52	1!40, 2!9 and 2!28	Input → RL31(B) → RL17(B3) → RL13(D) → Output 52
53	M53	1!40, 2!9 and 2!29	Input → RL31(B) → RL17(B3) → RL13(E) → Output 53
54	M54	1!40, 2!9 and 2!30	Input → RL31(B) → RL17(B3) → RL13(F) → Output 54
55	M55	1!40, 2!10 and 2!31	Input → RL31(B) → RL17(B4) → RL14(A) → Output 55
56	M56	1!40, 2!10 and 2!32	Input → RL31(B) → RL17(B4) → RL14(B) → Output 56
57	M57	1!40, 2!10 and 2!33	Input → RL31(B) → RL17(B4) → RL14(C) → Output 57
58	M58	1!40, 2!10 and 2!34	Input → RL31(B) → RL17(B4) → RL14(D) → Output 58
59	M59	1!40, 2!10 and 2!35	Input → RL31(B) → RL17(B4) → RL14(E) → Output 59
60	M60	1!40, 2!10 and 2!36	Input → RL31(B) → RL17(B4) → RL14(F) → Output 60
61	M61	1!40, 2!11 and 3!1	Input → RL31(B) → RL17(B5) → RL15(A) → Output 61
62	M62	1!40, 2!11 and 3!2	Input → RL31(B) → RL17(B5) → RL15(B) → Output 62
63	M63	1!40, 2!11 and 3!3	Input → RL31(B) → RL17(B5) → RL15(C) → Output 63
64	M64	1!40, 2!11 and 3!4	Input → RL31(B) → RL17(B5) → RL15(D) → Output 64
65	M65	1!40, 2!11 and 3!5	Input → RL31(B) → RL17(B5) → RL15(E) → Output 65
66	M66	1!40, 2!11 and 3!6	Input → RL31(B) → RL17(B5) → RL15(F) → Output 66
67	M67	1!40, 2!12 and 3!7	Input → RL31(B) → RL17(B6) → RL16(A) → Output 67
68	M68	1!40, 2!12 and 3!8	Input → RL31(B) → RL17(B6) → RL16(B) → Output 68
69	M69	1!40, 2!12 and 3!9	Input → RL31(B) → RL17(B6) → RL16(C) → Output 69
70	M70	1!40, 2!12 and 3!10	Input → RL31(B) → RL17(B6) → RL16(D) → Output 70
71	M71	1!40, 2!12 and 3!11	Input → RL31(B) → RL17(B6) → RL16(E) → Output 71
72	M72	1!40, 2!12 and 3!12	Input → RL31(B) → RL17(B6) → RL16(F) → Output 72

Channel pattern memory

The 72 pre-programmed channel patterns for the Model RF1×72 Module are stored in memory. However, an illegal operation could cause one or more (or all) channel patterns to be lost (cleared) or changed. In that event, you will have to re-program lost or changed channel patterns.

Checking pre-programmed channel patterns

If you suspect that one or more pre-programmed channel patterns have been inadvertently lost or changed, you can check to see if a suspect channel pattern is closing the correct channels (switches).

CAUTION Make sure there is nothing connected to the input and output connectors of the System 41. If there is, remove all power from the test system and disconnect all test cables.

1. Press OPEN ALL to make sure that all channels are open.
2. The System 41 must be in the relay status display mode (“RELAY STATUS” displayed). If it is not, use the following menu sequence to select it:
Press MENU, select GENERAL, select DISPLAY, select SHOW LIST, select RELAY STATUS
Use the EXIT key to back out of the menu structure.
3. You can use the close/open operation or scanning to check channel patterns. To check one channel pattern, use the close/open operation. To check many (or all) channel patterns, use scanning:
 - **Close/open channel patterns:**
 - a. Create a channel list for the suspect channel pattern. For example, if you wish to check M5, create the following channel list:
SELECT CHANNELS M5,
 - b. Press the CLOSE key. Use Table 4-5 to verify that the three channels for the specified channel pattern are closed. For M5, channels 1!1 and 1!11 should be the only channels closed.
 - c. Press OPEN ALL to open the channels.
 - d. Repeat steps A through C to check another channel pattern.
 - **Scan channel patterns:**
 - a. Create a scan list for the suspect channel patterns. For example, if you wish to check the channel patterns for Outputs 1 through 10, create the following scan list:
SCAN CHANNELS M1, M2, M3, M4, M5, M6, M7, M8, M9, M10,
 - b. Press the STEP key to arm the scan (ARM indicator turns on).
 - c. Press the STEP key to scan the first channel pattern. For channel pattern M1, channels 1!1 and 1!7 (as shown in Table 4-5) should be the only channels closed.
 - d. Press STEP to scan each channel pattern in the scan, and use Table 4-5 to verify that the correct channels are closed.
 - e. When finished, press OPEN ALL to disable the scan and open all channels.
4. Lost or changed channel patterns can be re-programmed as explained in the next paragraph.

Storing channel patterns in memory

Front panel operation — There are two methods to store channel patterns in memory. The preferred method, which is covered here, specifies the two individual channels in the channel list, and then stores it in the appropriate memory location. For the other method, you must actually close the two individual channels and then store the pattern in the appropriate memory location. Details on both methods are provided in Section 5.

Perform the following steps to store channel patterns in memory:

1. Create the channel list specifying the individual closed channels of the channel pattern. For example, if you are reprogramming channel pattern M1, create the following channel list.

```
SELECT CHANNELS 1!1, 1!7,
```

Note that Table 4-5 lists the closed channels for every channel pattern.

2. Use the following menu sequence to display the “STORE LIST AT #xxx” message:
Press STORE, select CURRENT LIST
3. Use the keypad to display the appropriate memory location. The channel pattern number indicates its memory location (i.e., M1 belongs in memory location #001, M72 belongs in memory location #072).
4. With the correct memory location displayed, press ENTER.
5. Repeat steps 1 through 4 to reprogram another channel pattern.

GPIB operation — There are two methods to store channel patterns in memory. The preferred method, which is covered here, uses one command to list and save the channels in memory. For the other method, the channels must actually be closed and then the pattern is saved in memory. See :ROUTE subsystem in Section 6 for details on both methods.

Table 4-6 provides the :LIST command strings to reprogram channel patterns.

Table 4-6
Model RF1X72 — commands to store channel patterns in memory

Channel pattern	GPIB command
M1	:MEMory:SAVE:LIST (@ 1!1, 1!7), M1
M2	:MEMory:SAVE:LIST (@ 1!1, 1!8), M2
M3	:MEMory:SAVE:LIST (@ 1!1, 1!9), M3
M4	:MEMory:SAVE:LIST (@ 1!1, 1!10), M4
M5	:MEMory:SAVE:LIST (@ 1!1, 1!11), M5
M6	:MEMory:SAVE:LIST (@ 1!1, 1!12), M6
M7	:MEMory:SAVE:LIST (@ 1!2, 1!13), M7
M8	:MEMory:SAVE:LIST (@ 1!2, 1!14), M8
M9	:MEMory:SAVE:LIST (@ 1!2, 1!15), M9
M10	:MEMory:SAVE:LIST (@ 1!2, 1!16), M10
M11	:MEMory:SAVE:LIST (@ 1!2, 1!17), M11
M12	:MEMory:SAVE:LIST (@ 1!2, 1!18), M12
M13	:MEMory:SAVE:LIST (@ 1!3, 1!19), M13
M14	:MEMory:SAVE:LIST (@ 1!3, 1!20), M14
M15	:MEMory:SAVE:LIST (@ 1!3, 1!21), M15
M16	:MEMory:SAVE:LIST (@ 1!3, 1!22), M16
M17	:MEMory:SAVE:LIST (@ 1!3, 1!23), M17
M18	:MEMory:SAVE:LIST (@ 1!3, 1!24), M18
M19	:MEMory:SAVE:LIST (@ 1!4, 1!25), M19
M20	:MEMory:SAVE:LIST (@ 1!4, 1!26), M20
M21	:MEMory:SAVE:LIST (@ 1!4, 1!27), M21
M22	:MEMory:SAVE:LIST (@ 1!4, 1!28), M22
M23	:MEMory:SAVE:LIST (@ 1!4, 1!29), M23
M24	:MEMory:SAVE:LIST (@ 1!4, 1!30), M24
M25	:MEMory:SAVE:LIST (@ 1!5, 1!31), M25
M26	:MEMory:SAVE:LIST (@ 1!5, 1!32), M26
M27	:MEMory:SAVE:LIST (@ 1!5, 1!33), M27
M28	:MEMory:SAVE:LIST (@ 1!5, 1!34), M28
M29	:MEMory:SAVE:LIST (@ 1!5, 1!35), M29
M30	:MEMory:SAVE:LIST (@ 1!5, 1!36), M30
M31	:MEMory:SAVE:LIST (@ 1!6, 2!1), M31
M32	:MEMory:SAVE:LIST (@ 1!6, 2!2), M32
M33	:MEMory:SAVE:LIST (@ 1!6, 2!3), M33
M34	:MEMory:SAVE:LIST (@ 1!6, 2!4), M34
M35	:MEMory:SAVE:LIST (@ 1!6, 2!5), M35
M36	:MEMory:SAVE:LIST (@ 1!6, 2!6), M36
M37	:MEMory:SAVE:LIST (@ 1!40, 2!7, 2!13), M37
M38	:MEMory:SAVE:LIST (@ 1!40, 2!7, 2!14), M38
M39	:MEMory:SAVE:LIST (@ 1!40, 2!7, 2!15), M39
M40	:MEMory:SAVE:LIST (@ 1!40, 2!7, 2!16), M40
M41	:MEMory:SAVE:LIST (@ 1!40, 2!7, 2!17), M41
M42	:MEMory:SAVE:LIST (@ 1!40, 2!7, 2!18), M42
M43	:MEMory:SAVE:LIST (@ 1!40, 2!8, 2!19), M43
M44	:MEMory:SAVE:LIST (@ 1!40, 2!8, 2!20), M44
M45	:MEMory:SAVE:LIST (@ 1!40, 2!8, 2!21), M45
M46	:MEMory:SAVE:LIST (@ 1!40, 2!8, 2!22), M46
M47	:MEMory:SAVE:LIST (@ 1!40, 2!8, 2!23), M47
M48	:MEMory:SAVE:LIST (@ 1!40, 2!8, 2!24), M48

Table 4-6 (cont.)

Model RF1X72 — commands to store channel patterns in memory

Channel pattern	GPIB command
M49	:MEMory:SAVE:LIST (@ 1!40, 2!9, 2!25), M49
M50	:MEMory:SAVE:LIST (@ 1!40, 2!9, 2!26), M50
M51	:MEMory:SAVE:LIST (@ 1!40, 2!9, 2!27), M51
M52	:MEMory:SAVE:LIST (@ 1!40, 2!9, 2!28), M52
M53	:MEMory:SAVE:LIST (@ 1!40, 2!9, 2!29), M53
M54	:MEMory:SAVE:LIST (@ 1!40, 2!9, 2!30), M54
M55	:MEMory:SAVE:LIST (@ 1!40, 2!10, 2!31), M55
M56	:MEMory:SAVE:LIST (@ 1!40, 2!10, 2!32), M56
M57	:MEMory:SAVE:LIST (@ 1!40, 2!10, 2!33), M57
M58	:MEMory:SAVE:LIST (@ 1!40, 2!10, 2!34), M58
M59	:MEMory:SAVE:LIST (@ 1!40, 2!10, 2!35), M59
M60	:MEMory:SAVE:LIST (@ 1!40, 2!10, 2!36), M60
M61	:MEMory:SAVE:LIST (@ 1!40, 2!11, 3!1), M61
M62	:MEMory:SAVE:LIST (@ 1!40, 2!11, 3!2), M62
M63	:MEMory:SAVE:LIST (@ 1!40, 2!11, 3!3), M63
M64	:MEMory:SAVE:LIST (@ 1!40, 2!11, 3!4), M64
M65	:MEMory:SAVE:LIST (@ 1!40, 2!11, 3!5), M65
M66	:MEMory:SAVE:LIST (@ 1!40, 2!11, 3!6), M66
M67	:MEMory:SAVE:LIST (@ 1!40, 2!12, 3!7), M67
M68	:MEMory:SAVE:LIST (@ 1!40, 2!12, 3!8), M68
M69	:MEMory:SAVE:LIST (@ 1!40, 2!12, 3!9), M69
M70	:MEMory:SAVE:LIST (@ 1!40, 2!12, 3!10), M70
M71	:MEMory:SAVE:LIST (@ 1!40, 2!12, 3!11), M71
M72	:MEMory:SAVE:LIST (@ 1!40, 2!12, 3!12), M72

5 Front Panel Operation

Introduction

CAUTION The RF switches for the standard switching modules are designed for cold switching. Hot switching (especially above 1W) may degrade performance and shorten the life of the switches. If hot switching is required, please consult Keithley Instruments for a customized switching module which incorporates switches specially designed for hot switching applications.

NOTE *Switching procedures in this manual use cold switching. That is, the signal is removed before a switch is closed or opened. However, for low power applications, the RF switches are rated to hot switch up to 1W.*

This section covers all aspects of front panel operation. Paragraphs in this section are organized as follows:

Displays — Covers the two displays of the System 41; the vacuum fluorescent display (VFD) that is used for alphanumeric information and the LED display that provides status information for each channel.

Light pen — Explains how to use the light pen and summarizes the operations that can be performed with it.

Display modes — Covers the two display modes that can be used for normal operation; the relay status display mode and the list display mode.

Channel list and scan list — Provides details on creating channel and scan lists.

Closing and opening channels — Explains how to close and open channels.

Scanning channel patterns — Explains how to scan channel patterns.

Storing and recalling channel patterns — Explains how to create (store) channel patterns, and how to recall them from memory.

Menu — Covers miscellaneous operations and selections controlled from the MAIN MENU.

Card configuration — Covers the various configuration operations for the 10 slots using the CARD CONFIG MENU.

Scan configuration — Covers the CONFIGURE SCAN menu, which is used to configure the three layers of the scan operation.

External triggering (Trigger Link) — Covers external triggering using the trigger link.

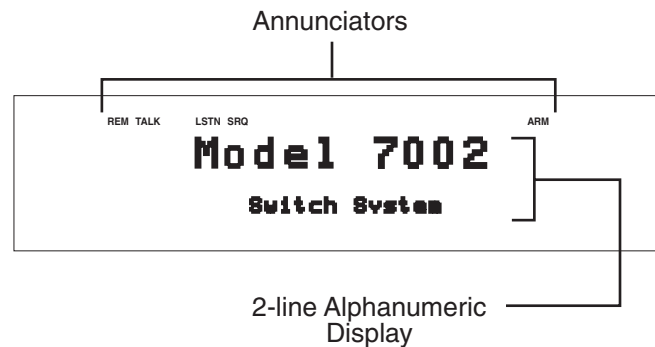
Front panel displays

The System 41 uses two displays. The vacuum fluorescent display (VFD) provides alphanumeric information while the LED array display provides status information for each channel.

Vacuum fluorescent display (VFD)

The vacuum fluorescent display (VFD) is shown in Figure 5-1. It provides two lines of alphanumeric information. The first line can display up to 20 alphanumeric characters and the second line can display up to 32 alphanumeric characters. Also included are annunciators that are located along the top of the display.

Figure 5-1
Vacuum fluorescent display (VFD)



Display messages

Display messages include the various configuration menus, error messages, status messages, and messages associated with operation of the light pen option. Error and status messages for the System 41 are summarized in Table 5-1. Light pen messages are covered in "Changing the display mode."

In addition, the front panel INFO key provides context-sensitive operating information. Pressing EXIT or INFO a second time will cancel the message.

Table 5-1
Error and status messages

Code number	Description
+551	Incorrect software revision (EE)
+550	Forbidden channel error (EE)
+530	Slot 10 identification error (EE)
+529	Slot 9 identification error (EE)
+528	Slot 8 identification error (EE)
+527	Slot 7 identification error (EE)
+526	Slot 6 identification error (EE)
+525	Slot 5 identification error (EE)
+524	Slot 4 identification error (EE)
+523	Slot 3 identification error (EE)
+522	Slot 2 identification error (EE)
+521	Slot 1 identification error (EE)
+510	Saved state error (EE)
+350	Too many channels closed (EE)
+174	Re-entering the idle layers (SE)
+173	Waiting in arm layer 2 (SE)
+172	Waiting in arm layer 1 (SE)
+171	Waiting in trigger Layer (SE)
+161	Program running (SE)
+126	Device calculating (SE)
+125	Device measuring (SE)
+124	Device sweeping (SE)
+123	Device ranging (SE)
+122	Device settling (SE)
+121	Device calibrating (SE)
+101	Operation Complete (SE)
0	No error (SE)
-100	Command Error (EE)
-101	Invalid Character (EE)
-102	Syntax Error (EE)
-103	Invalid Separator (EE)
-104	Data Type Error (EE)
-105	GET not allowed (EE)
-108	Parameter not allowed (EE)
-109	Missing Parameter (EE)
-110	Command Header Error (EE)
-111	Command Header Separator Error (EE)
-112	Program mnemonic too long (EE)
-113	Undefined header (EE)
-114	Header suffix out of range (EE)

Note: Messages associated with light pen operation are located in "Light pen messages."

EE = Error event

SE = Status event

Table 5-1 (cont.)

Error and status messages

Code number	Description
-120	Numeric data error (EE)
-121	Invalid character in number (EE)
-123	Exponent too large (EE)
-124	Too many digits in number (EE)
-128	Numeric data not allowed (EE)
-140	Character data error (EE)
-141	Invalid character data (EE)
-144	Character data too long (EE)
-148	Character data not allowed (EE)
-150	String data error (EE)
-151	Invalid string data (EE)
-154	String too long
-158	String data not allowed (EE)
-160	Block data error (EE)
-161	Invalid block data (EE)
-168	Block data not allowed (EE)
-170	Expression error (EE)
-171	Invalid expression (EE)
-178	Expression data not allowed (EE)
-200	Execution error (EE)
-201	Invalid while in local (EE)
-202	Settings lost due to rtl (EE)
-210	Trigger error (EE)
-211	Trigger ignored (EE)
-212	Arm ignored (EE)
-213	Init ignored (EE)
-214	Trigger deadlock (EE)
-215	Arm deadlock (EE)
-220	Parameter Error (EE)
-221	Settings conflict (EE)
-222	Parameter data out of range (EE)
-223	Too much data (EE)
-224	Illegal parameter value (EE)
-241	Hardware missing (EE)
-260	Expression Error (EE)
-281	Cannot create program (EE)
-282	Illegal program name (EE)
-284	Program currently running (EE)
-285	Program syntax error (EE)
-330	Self Test failed (EE)
-350	Queue overflow (EE)
-410	Query interrupted (EE)
-420	Query unterminated (EE)
-430	Query deadlocked (EE)
-440	Query unterminated after indefinite response (EE)

Note: Messages associated with light pen operation are located in "Light pen messages."

EE = Error event

SE = Status event

Annunciators

The five annunciators along the top of the display indicate the following conditions:

SRQ — Turns on when the unit requests service over the IEEE-488 bus. Programming the Service Request Enable Register allows you to control which conditions will generate an SRQ (see Section 6).

REM — Turns on to indicate that the System 41 is in remote when used over the IEEE-488 bus. The System 41 can be placed in remote by addressing it to listen with the bus REN line true.

TALK — Turns on to indicate that the System 41 is the active talker on the IEEE-488 bus. The unit can be placed in the talker active state by sending it the correct bus talk command, which is derived from the primary address.

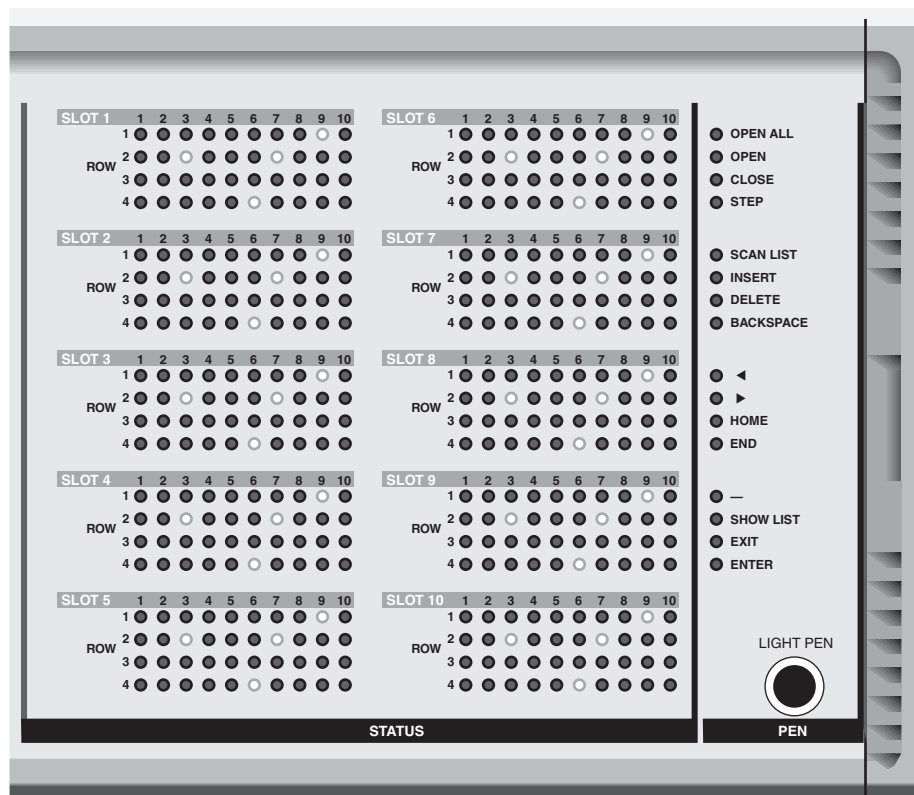
LSTN — Turns on when the unit is an active IEEE-488 bus listener. The System 41 can be placed in the active listener state by addressing it to listen.

ARM — Turns on when the System 41 is taken out of the idle state. A scan can only be performed with the System 41 out of the idle state.

LED display

The LED display (see Figure 5-2) is primarily made up of arrays of light emitting diodes (LEDs). Each 40 LED array corresponds to a mainframe slot. The significance of these channel LEDs depends on which display mode is currently selected; (relay status display mode or a list display mode), and whether or not the LED Graticule is enabled (see “Display modes”).

Figure 5-2
LED display



There is also a column of 16 LEDs located to the right of the channel LEDs. Two of these LEDs, SCAN LIST and SHOW LIST, indicate display mode status.

Note that all of the front panel LEDs can function as control switches with the addition of the light pen option (see “Light pen” for details).

Light pen

When plugged in, the light pen allows you to perform point and click programming using the front panel LEDs. Each LED functions as an electronic switch that is activated (clicked) by the light pen.

***NOTE** The light pen cannot be used to create a scan list. Channel patterns are required in a scan list, and can only be entered using the front panel keys. Details on channel patterns are provided later in this section.*

Light pen connection

The System 41 should be turned off when connecting the light pen.

The LIGHT PEN receptacle is located at the lower right-hand corner of the front panel. There is a release button on the plug for the light pen. With the button at the 12 o'clock position, push the light pen plug into the receptacle. Light pen operation is automatically activated when it is plugged into the mainframe.

The light pen can be removed by pressing the release button and pulling the plug out of the receptacle.

Light pen operations

To activate (click) an LED, place the head of the light pen near the desired LED and press the button on the barrel of the pen. An LED that is clicked blinks for a couple of seconds and then assumes the appropriate state. Note that the associated operation occurs immediately after the LED is clicked and does not wait for the blinking to finish. The blinking simply provides feedback to indicate that you clicked the LED.

Channel LEDs

The significance of these LEDs depends on which display mode is currently selected and whether or not the LED Graticule is enabled (see “Display modes”). Table 5-2 summarizes the significance of the channel LEDs.

In the relay status display mode (RELAY STATUS displayed on the VFD), clicking a channel LED adds that channel to the channel list. For example, if you click an LED for an available channel, the LED blinks for a couple of seconds to indicate that the channel has been added to the list. Keep in mind that the status (open or closed) of the channel is not affected. Clicking an LED simply adds the channel to the channel list.

In the channel list display mode (CHANNEL LIST DISPLAY displayed on the VFD), clicking a channel LED adds (or removes) that channel to (or from) the channel list. For example, a dimly lit (or off) channel LED indicates that channel is not included in the channel list. If you click this dimly lit LED, it blinks for a couple of seconds and then goes to the brightly lit state to indicate that the channel has been added to the channel list. Clicking this brightly lit LED a second time causes it to become dimly lit (or off) indicating that it has been deleted from the channel list.

Table 5-2
Significance of channel LEDs

Display mode	LED graphic	Channel LEDs		
		Off	Dimly lit	Brightly lit
Relay Status	On	Channel not available	Channel open	Channel closed
	Off	Channel not available or Channel open	—	Channel closed
List	On	Channel not available	Channel not included in list	Channel included in list
	Off	Channel not available or channel not included in list	—	Channel included in list

Control LEDs

The 16 control LEDs are located to the right of the channel LEDs. Some of these allow you to perform the same operations that are normally performed using the front panel keys. Clicking one of the following LEDs is analogous to pressing the similarly labeled front panel key.

OPEN ALL	SCAN LIST	▶
OPEN	INSERT	-
CLOSE	DELETE	EXIT
STEP	◀	ENTER

When one of the above LEDs is clicked, the LED will blink for a couple of seconds to indicate that the associated operation is being performed. Note that the SCAN LIST LED also provides status. When the SCAN LIST LED is brightly lit, the scan list is currently selected, and when dimly lit (or off), the channel list is selected.

The following four LEDs do not have front panel key counterparts and are explained as follows:

BACKSPACE — Clicking this LED moves the VFD cursor back (left) to the previous channel entry and removes it from the list. The channel entry could be a single channel or a range of channels. If the cursor is at the home position (first entry in the list), clicking BACKSPACE deletes that channel entry. This is analogous to pressing the ◀ key and then the DELETE key.

HOME — Clicking this LED will move the VFD cursor to the beginning of the list.

END — Clicking this LED will move the VFD cursor to the end of the list.

SHOW LIST — Clicking this LED toggles the instrument between the list display mode (LED brightly lit) and the relay status display mode (LED dimly lit or off).

Light pen messages

The following VFD messages are associated with light pen operations:

Message	Explanation
LIGHT PEN MIS-READ	LED not activated when light pen button is pressed. Occurs when the light pen is too far away from the LED or is not pointed at the LED.
INVALID SELECTION	LED not available for activation. Occurs when clicking an LED for a channel that does not exist (channel LED completely off).
EXIT from menu before using the light pen.	LED not available while in a menu. Occurs when an LED (other than Exit or Enter) is clicked while in a menu structure.

When any of the above messages occur, the operation associated with the LED is simply not performed.

Display modes

There are two basic display modes for the System 41:

Relay status display mode — Use this display mode when opening/closing or scanning channels. The channel LEDs provide the real-time state (on or off) of each channel in the switch system.

List display mode — You can use this display mode when creating a channel list or a scan list. The brightly lit channel LEDs correspond to channels that are included in the selected list.

In addition to the two basic display modes, you can also control the LED graticule. Disabling the LED graticule provides increased contrast between on and off LEDs by eliminating the dimly lit state. Each LED will either be off or brightly lit (see “LED graticule control” for more information).

Relay status display mode

In the relay status mode, the channel LEDs provide real-time status (open or closed) of each available channel. This display mode is denoted by the “RELAY STATUS” message on the VFD which also includes the currently selected list. The following table summarizes the various display messages and LED annunciators for the relay status display mode:

Selected List	VFD Message	Show List LED	Scan List LED
Channel list	See Figure 5-3A	Dimly lit (or off*)	Dimly lit (or off*)
Scan list	See Figure 5-3B	Dimly lit (or off*)	Brightly lit

*LED is off if the LED Graticule is disabled (see “LED graticule control”).

Figure 5-3
VFD relay status mode



A) Channel List Selected (Power-up default)

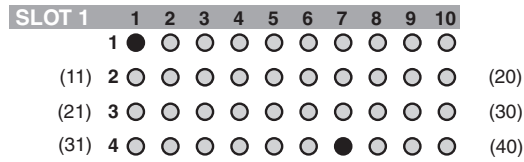


B) Scan List Selected

The significance of each channel LED while in the relay status display mode is explained in Table 5-2.

The channels for each LED array (slot) are numbered 1 through 40 as shown in Figure 5-4.

Figure 5-4
Interpreting channel LEDs (relay status display mode)



Channels 1 and 37 of slot 1 closed

● = Closed channel (Brightly lit LED)

List display modes

In a list display mode, the channel LEDs indicate which channels are included in the selected list. There are two list display modes; the channel list display mode and the scan list display mode. The following table summarizes the various display messages and LED annunciators for the two list display modes:

Display Mode	VFD Message	Show List LED	Scan List LED
Channel list	See Figure 5-5A	Brightly lit	Dimly lit (or off*)
Scan list	See Figure 5-5B	Brightly lit	Brightly lit

*LED is off if the LED Graticule is disabled (see "LED graticule control").

Figure 5-5
VFD list display modes



A) Channel List Selected



B) Scan List Selected

The significance of each channel LED while in a list display mode is summarized in Table 5-2.

A channel LED that is brightly lit indicates that it is included in the selected list. Note that the channel LEDs do not provide complete information about the scan list. They do not indicate the order that the channels are to be scanned and they do not indicate whether a channel is used more than one time in the scan list. The complete scan list, including the order of the channel scan is provided by the VFD.

Channel designations for the list display mode are the same as for the relay status display mode. Figure 5-6 shows that channels 1 and 37 are included in the selected list.

Figure 5-6
Interpreting channel LEDs (list display mode)

		COLUMN									
SLOT 1		1	2	3	4	5	6	7	8	9	10
	1	●	○	○	○	○	○	○	○	○	○
(11)	2	○	○	○	○	○	○	○	○	○	(20)
(21)	3	○	○	○	○	○	○	○	○	○	(30)
(31)	4	○	○	○	○	○	○	●	○	○	(40)

List includes channels 1 and 37 of slot 1.

● = Channel included in list (Brightly lit LED)

Changing the display mode

During normal operation, the instrument is either in the relay status display mode or in a list display mode. The following information explains how to change the display mode.

Front panel keys method

Perform the following steps to change the display mode using the front panel keys:

1. Press MENU to display the MAIN MENU.
2. Using the cursor keys (◀ and ▶), place the cursor on GENERAL and press ENTER to display the GENERAL MENU.
3. Place the cursor on DISPLAY and press ENTER to display the CONFIG LED DISPLAY menu. The cursor position will indicate the currently selected display mode. RELAY-STATUS is the relay status display mode, and CURRENT-LIST is the list display mode.
4. Place the cursor on the alternate display mode selection and press ENTER.
5. Press EXIT two times to back out of the menu structure.
6. The SCAN LIST key toggles between the channel list and the scan list. To select the alternate list, press SCAN LIST.

Light pen method

Perform the following steps to change the display mode using the light pen:

1. The SHOW LIST LED toggles the instrument between the relay status display mode (LED dimly lit or off) and the list display mode (LED brightly lit). If you wish to select the alternate display mode, click SHOW LIST.
2. The SCAN LIST LED toggles the display between the scan list (LED brightly lit) and the channel list (LED dimly lit or off). If the desired list is not already selected, click this LED to select the alternate list.

LED graticule control

LED Graticule control allows you to increase contrast between on and off LEDs by eliminating the dimly lit state for LEDs. With the LED Graticule disabled (off), LEDs will be either off or brightly lit. A disadvantage to disabling the LED graticule is that it is not obvious which channels are available in the test system. Enabling (on) the LED Graticule restores the dimly lit state. Table 5-2 explains the significance of the channel LEDs for the two graticule modes.

LED Graticule control is performed from the MAIN MENU as follows:

```
Press    MENU
Select   GENERAL
Select   DISPLAY
Select   GRATCULE-CONTROL
         ON  OFF
```

Select OFF to disable the LED Graticule or ON to enable it. Note that the detailed procedure to disable or enable the LED Graticule is contained in “GENERAL.”

The instrument will power-up with the LED Graticule enabled unless the graticule OFF condition is saved as the USER SETUP power-on default (see USER SETUP in “SAVESETUP”).

Front panel RESET, and the *RST and :SYSTEM:PRESet bus commands will enable the LED Graticule.

NOTE *If the main CPU firmware is not compatible with the LED display firmware, the following error will occur when trying to disable the LED Graticule:*

```
ERROR:ID CODE = +551
Incorrect software revision
```

If this error should occur, contact Keithley to resolve the firmware incompatibility.

Channel list and scan list

The System 41 can close and open a list of channels, and it can scan a list of channels. The channel list can be made up of channel patterns and/or individual channel assignments, while the scan list must be made up of channel patterns only.

For basic close/open operation, the order of channels in the channel list is not important since all channels in the list will either close or open at the same time. For scan operation, the order of channels is important. Channel patterns will be scanned in the order that they are presented in the list.

- NOTES**
1. A channel list is lost after the instrument is turned off.
 2. Normally, the scan list is not lost (cleared) after the instrument is turned off. However, the scan list clears if any of the following events occur:
 - A channel in the list becomes restricted. A channel becomes restricted by adding it to the restricted list (see “Channel restrictions”).
 - Two or more channels become interlocked. Channels become interlocked by specifying them in the interlock lists (see “Channel restrictions”).
 3. A scan list can contain up to 200 channel patterns (including repeats). An entry that exceeds that limit generates the following error:

ERROR: ID CODE = -223
Too much data

When this error occurs, only the first 200 channel patterns can be scanned.
 4. When a scan list is created or modified over the IEEE-488 bus, the displayed scan list will not update until a display state change occurs (i.e., pressing the SCAN LIST key).

CAUTION In order to prevent damage to RF switches and other equipment connected to the System 41, DO NOT create a channel list or scan list that will close more than one path through any input or output. In other words ...

- NEVER connect an input to more than one output at a time.
- NEVER connect an output to more than one input at a time.

For example, if Input 1 is connected to Output 2, do not connect Input 1 to any other output, and do not connect Output 2 to any other input.

Channel patterns

Using channel patterns to control RF switching is the preferred format. Channel patterns are simple to enter and their use reduces the chance of closing channels that could damage RF switches (see previous CAUTION).

A channel pattern is simply a pattern of closed and open channels stored in memory. The System 41 is shipped with pre-programmed channels patterns that will accommodate all input/output combinations for the installed RF module.

The actual channels closed by a channel pattern depend on which RF module is installed. For example, channel pattern M1 for the RF 10×10 Module closes channels 5!10 and 5!30. For the RF 6×6 Module, M1 closes channel 5!6 and 5!18. See Section 4 to determine the switch closures for all the pre-programmed channel patterns.

The operation demos in Section 3, “Operation demos”, and the operation summary in Section 3, “Front panel operation summary” show how to create a channel list and scan list using channel patterns.

Channel assignments

Channel assignments can be used to create a channel list, but they cannot be used to create a scan list.

NOTE *When scanning, two or more channels must close simultaneously for each step of the scan. You cannot do that using individual channel assignments. You must use channel patterns in a scan list.*

A channel assignment is based on the channel number and slot assignment for the RF switch. The following example shows the proper format for a channel list:

```
SELECT CHANNEL 1!1, 1!37,
```

The above channel list specifies channels 1 and 37 of slot 1. The System 41 can support up to 240 channels (six slots). Channel assignments for the six slots are provided in Figure 5-7.

Perform the following steps to create a channel list using channel assignments:

Step 1: Make sure channel list is selected.

Open/close operations use the channel list, and scan operations use the scan list. The SCAN LIST key toggles between the channel list and the scan list. If the channel list is not already displayed, press SCAN LIST. Note that pressing EXIT will also select the channel list.

NOTE *If you want to display the channels of the selected list on the LED display, make sure that the list display mode is selected. "Changing the display mode" explains how to change the display mode.*

A previously defined list can be cleared from the display by pressing the CLEAR LIST key.

Step 2: Enter slot number and card channel.

1. Enter slot number — Using the keypad, enter the slot number (1 through 6). The separator between slot and channel will automatically be entered after you key in the slot number. For example, if you selected slot 2, the entered channel data will look like this:

```
SELECT CHANNELS  1!
```

2. Enter channel number — Use the keypad to enter the channel number. For example, if you entered channel 4 (with slot 1 previously selected), the entered channel data will look like this:

```
SELECT CHANNELS  1!4
```

At this point, the entered channel can be cancelled by pressing the left cursor key (◀).

Step 3: Enter channel separator or terminator.

Channel separators are required for multiple channel entries, and a terminator should be used after the last entered channel.

The comma (,) is used to separate channels, and serves to terminate the list. After entering a channel, as explained in Step 2, press the right cursor key (▶) or ENTER to put in the comma separator. Another channel can then be keyed-in. After the last channel in the list is keyed-in, use the ENTER key or the right cursor key (▶) to terminate the list. The comma terminator prevents the last entered channel from being cancelled when the left cursor key (◀) is pressed. The following example shows proper format:

```
SELECT CHANNELS 1!1, 1!37, 1!15, 3!35,
```

Step 4: Repeat the basic procedure in steps 2 and 3 to enter all required channels.

Figure 5-7
Channel assignments

Slot 1	1	2	3	4	5	6	7	8	9	10
1	1!1	1!2	1!3	1!4	1!5	1!6	1!7	1!8	1!9	1!10
2	1!11	1!12	1!13	1!14	1!15	1!16	1!17	1!18	1!19	1!20
3	1!21	1!22	1!23	1!24	1!25	1!26	1!27	1!28	1!29	1!30
4	1!31	1!32	1!33	1!34	1!35	1!36	1!37	1!38	1!39	1!40
•										
•										
•										
•										
Slot 6	1	2	3	4	5	6	7	8	9	10
1	6!1	6!2	6!3	6!4	6!5	6!6	6!7	6!8	6!9	6!10
2	6!11	6!12	6!13	6!14	6!15	6!16	6!17	6!18	6!19	6!20
3	6!21	6!22	6!23	6!24	6!25	6!26	6!27	6!28	6!29	6!30
4	6!31	6!32	6!33	6!34	6!35	6!36	6!37	6!38	6!39	6!40

Format: S!C where; S is the slot number (1-6)
C is the channel number (1-40)

Example: 2!36 = Slot 2, Channel 36

Editing a list

Edit keys are available to make changes to a channel list or a scan list. These keys allow you to change channel entries, delete channel entries, or insert channel entries anywhere in the list. When editing, a channel pattern (i.e., M1) is treated as a single channel entry.

1. Changing a channel entry — Perform the following steps to change a channel entry:
 - a. Use the cursor keys to place the cursor at the beginning of the channel entry to be changed.
 - b. Key in the new channel entry, and press the right cursor key (▶) or ENTER to add the comma.
2. Deleting a channel entry — Perform the following steps to delete a channel entry:
 - a. Place the cursor at the beginning of the channel entry to be deleted.
 - b. Press the DELETE key to delete the channel entry.
3. Inserting a channel entry — Perform the following steps to insert a channel entry anywhere in the list:
 - a. Position the cursor at the desired location in the list. The channel entry will be inserted between the cursor and the channel entry before it.
 - b. Press the INSERT key. The following message will be displayed:
INSERTING ENTRY
 - c. Key in the new channel entry, and press the right cursor key (▶) or ENTER to add the comma.
 - d. Press INSERT a second time to cancel the insert edit function.
4. Deleting all channels — The entire list can be cleared by pressing CLEAR LIST.

Summary of channel list and scan list entry keys:

“M” and number keys — Enter memory location of channel pattern (i.e. M1).

Number keys — Enter slot and channel numbers for channel list.

“-” — DO NOT use this key. If you inadvertently enter the hyphen (-), delete the entry as previously explained.

“▶” — Enter channel entry separator (,).

“◀ and ▶” — After terminating list, use cursor keys to select channel entry to be edited.

ENTER: Enter channel entry separator (,) and list terminator (.) (i.e. 1!1,).

INSERT: Create new channel entry at selected location in the list.

DELETE: Clear selected channel entry.

CLEAR LIST: Clear displayed list.

Using the light pen

You can use the light pen to perform many of the same operations that are performed using front panel keys.

Channel LEDs — You can use the light pen to enter individual channel assignments into a channel list. When a channel status LED is clicked, it will be entered into the channel list.

One important operation that the light pen cannot do is enter channel patterns into a channel or scan list. You must use the “M” and number keys to enter channel patterns.

Control LEDs — There are 16 control LEDs located above the connector for the light pen. Clicking any of the following control LEDs is the same as pressing the equivalent front panel key:

OPEN ALL
OPEN
CLOSE
STEP
SCAN LIST
INSERT
DELETE
◀
▶
EXIT
ENTER

BACKSPACE — Clicking this LED moves the cursor back (left) to the previous entry, and removes it from the list. If the cursor is at the home position (first entry), clicking BACKSPACE deletes that entry.

HOME — Clicking this LED moves the cursor to the beginning of the list.

END — Clicking this LED moves the cursor to the end of the list.

“-” — DO NOT click this LED. If you inadvertently enter the hyphen (-), delete the entry as previously explained.

SHOW LIST — Clicking this LED toggles between the list display mode (SHOW LIST LED brightly lit), and the relay status display mode.

Closing and opening channels

A basic operation of the System 41 is to close (and open) channels specified by the user. All the specified channels will either close or open at the same time.

CAUTION In order to prevent damage to RF switches (or in the very least, shorten their life), cold switching must be exercised. For cold switching, the test signal(s) must be removed (or set to 0V, 0A) before an RF switch is closed or opened.

CAUTION In order to prevent damage to RF switches and other equipment connected to the System 41, DO NOT close more than one path through any input or output. In other words ...

- NEVER connect an input to more than one output at a time.
- NEVER connect an output to more than one input at a time.

For example, if Input 1 is connected to Output 2, do not connect Input 1 to any other output, and do not connect Output 2 to any other input.

Perform the following steps to close and open channels:

NOTE *The following procedure assumes that the test signal(s) is, initially, NOT connected to the System 41. The test signal(s) must not be present when a channel (switch) is closed or opened.*

Step 1. Select the channel list.

The channel list must be selected in order to close channels. The SCAN LIST key (or SCAN LIST LED) toggles between the scan list and the channel list. If the channel list is not currently selected, press SCAN LIST (or click the SCAN LIST LED). The following channel list prompt is displayed:

```
SELECT CHANNELS
```

Note that when the scan list is selected, pressing EXIT (or clicking the EXIT LED) will also select the channel list.

Step 2. Define channel list.

NOTE *If you want to display the channel list on the LED display, make sure the list display mode is selected. "Changing the display mode" explains how to change the display mode using the front panel keys. With the optional light pen, the SHOW LIST LED toggles between the relay status display mode and the list display mode.*

Enter channels to be closed into the channel list as explained in "Channel list and scan list." The following example demonstrates proper channel pattern format:

```
SELECT CHANNELS M1, M15,
```

With the RF 6x6 Module installed, the above channel list includes channels 5!6, 5!18, 4!4 and 4!16. When these channels are closed, Input 1 will be connected to Output 1, and Input 4 will be connected to Output 3. Note that the light pen cannot be used to enter channel patterns.

You can instead enter the individual channel assignments as follows:

```
SELECT CHANNELS 5!6, 5!18, 4!4, 4!16,
```

Step 3. Close listed channels.

NOTE *Make sure the relay status display mode is selected in order to monitor the real-time status (open or closed) of each channel on the LED display. "Changing the display mode" explains how to change the display mode using the front panel keys. With the optional light pen, the SHOW LIST LED toggles between the relay status display mode and the list display mode.*

Press the CLOSE key (or click the CLOSE LED) to close the listed channels. If in the relay status display mode, the corresponding channel LEDs become brightly lit to indicate which channels are closed.

Step 4. Apply test signal(s).

With the listed channels closed, it is now safe to apply the test signal(s) to the System 41.

Step 5. Remove test signal(s) and open channels.

When finished, first remove the test signal(s) and then open the channels.

Press the OPEN key (or click the OPEN LED) to open channels that are listed in the channel list. Note that only the listed channels will open. To open unlisted channels, press (or click) OPEN ALL.

NOTES

- CLOSE and OPEN are only functional when the channel list is selected. OPEN ALL opens all channels and is functional at all times no matter what is currently being displayed.*
- It is possible to exceed the current rating of the +28V supply by closing too many channels. If this occurs, a scan will abort (go into idle), all channels will open, and the following message will be displayed:*
ERROR: ID CODE = +350
Too many channels closed

Summary of Close/Open keys and LEDs:

CLOSE — Close channels defined in channel list.

OPEN — Open channels defined in channel list.

OPEN ALL — Open all channels.

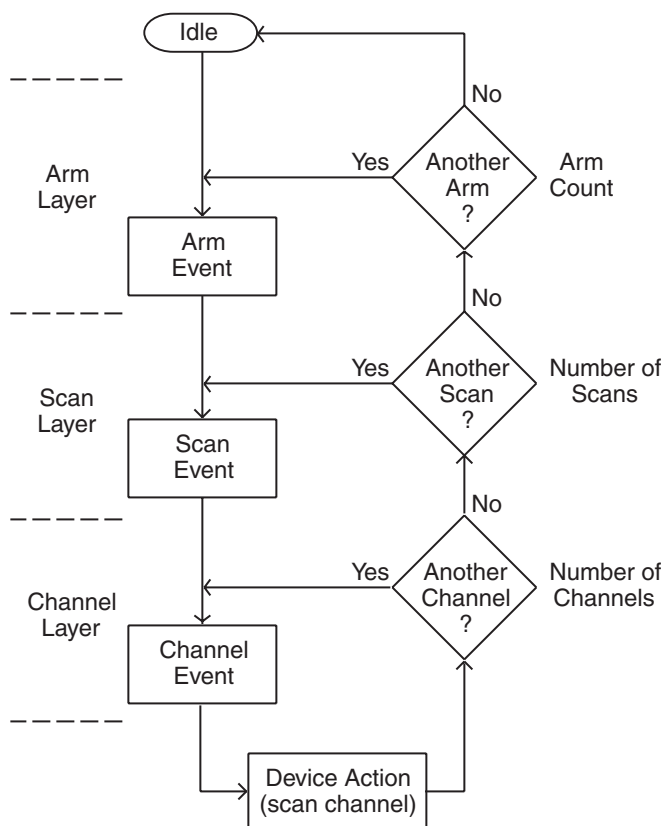
Overview of scan process

The following overview is intended to acquaint you with the basic scan fundamentals without the details of enhanced capabilities. This brief overview is sufficient to support the operation examples in this section.

The simplified model for scan operation is shown in Figure 5-8. As shown, scan operation consists of three layers; the arm layer, scan layer, and channel layer.

Figure 5-8

Simplified model of scan operation



Keep in mind that the RF module must be cold switched. That is, you should not scan a channel pattern while a test signal is applied to the inputs or outputs of the System 41.

When you configure the trigger model, you must hold up operation so that you can remove the test signal(s) before closing and opening channels. The following steps must be performed for each channel pattern to be scanned:

1. Hold up operation.
2. Remove test signal(s) from System 41.
3. Scan channel pattern.
4. Apply test signal to System 41.

To accommodate cold switching, operation is typically held up in the channel layer of the trigger model.

Idle

The instrument is considered to be in the idle state whenever it is not operating within one of the layers of the model. The front panel ARM indicator is off when the instrument is in the idle state.

When the System 41 is taken out of the idle state by pressing STEP (or sending the :INIT or :INIT:CONT ON command over the IEEE-488 bus), the ARM indicator turns on and operation proceeds into the arm layer.

Arm layer

In general, the instrument requires an arm event to allow operation to proceed to the scan layer. With Immediate arm spacing selected, operation immediately proceeds to the next layer when the instrument is taken out of the idle state. With one of the other arm spacing events selected, the instrument waits until the appropriate event occurs.

With Manual arm spacing selected, the instrument waits until the front panel STEP key is pressed. With GPIB arm spacing selected, the instrument waits until a bus trigger (GET or *TRG) is received. With Trigger Link arm spacing selected, the instrument waits until an input trigger is received (via TRIGGER LINK).

After all other scanning operations are completed, the instrument can be returned to the arm layer by programming the instrument for additional arms. The arm count can be set to a finite value (1 to 9999) or to infinity.

After the instrument leaves the arm layer, operation proceeds into the scan layer.

Scan layer

In general, the instrument requires a scan event to allow operation to proceed to the channel layer. With Immediate scan spacing selected, operation immediately proceeds to the next layer. With one of the other trigger scan spacing events selected (Timer, GPIB, Manual, Trigger Link), the instrument waits until the appropriate event occurs. With Timer scan spacing selected, the first pass through the scan layer will occur immediately. For each additional scan, the instrument waits until the Timer times out. The Timer can be set for an interval from 1msec to 99999.999 seconds.

The scan count (number of scans) can be set to a finite value (1 to 9999) or for an infinite number of scans.

After the instrument leaves the scan layer, operation proceeds into the channel layer.

Channel layer

NOTE *Typically, this is the layer where operation is held up to accommodate cold switching. For example, with GPIB channel spacing selected, a channel pattern will not be scanned until you send a bus trigger (*TRG or GET). With operation held up, you can safely apply or remove the test signal(s).*

In general, channel events control the channel scan rate. With Immediate channel spacing selected, a channel is scanned immediately. With one of the other channel spacing events selected (Timer, GPIB, Manual, or Trigger Link), the instrument waits until the appropriate event occurs before scanning a channel. With Timer channel spacing selected, the first channel is scanned immediately. Each additional channel waits for the Timer to time out before it will be scanned.

Typically, the channel count (number of channels to scan) is set to the number of channels that are contained in the Scan List (scan-list-length). However, the channel count can be set to a finite value (1 to 9999) or to infinity.

Scan channel patterns

1. Set the System 41 to display the scan list:
 - a. Use the SCAN LIST key to display “SCAN CHANNELS”.
 - b. Press OPEN ALL to ensure that there are no closed channels.
 - c. Press CLEAR LIST to clear any channels from the scan list.
2. Perform the following steps to place channel patterns into the scan list.
 - a. Using the keypad, press “M”, key in a channel pattern number, and press ENTER. For example, press “M”, “1”, and then ENTER to place channel pattern M1 in the scan list.
 - b. Repeat step 2a to place additional channels patterns in the scan list.
3. Press STEP to take the instrument out of idle, and then press STEP again to scan the first channel pattern in the scan list.
4. Press STEP to scan the second channel pattern. Notice that the first channel pattern opens.
5. Use the STEP key to scan other channel patterns in the scan.
6. When finished, press OPEN ALL to open all channels and abort the scan.

Remote programming — The following command sequence demonstrates how to configure a channel pattern scan:

```
SYSTEM:PREset      ` Configures System 41 for manual scan.
SCAN (@M1:M4)      ` Define scan list (M1, M2, M3 and M4).
INITiate           ` Take System 41 out of idle and arm the scan.
```

Press the LOCAL key to return to front panel operation. The STEP key can now be used to scan channels. When finished, press OPEN ALL to open all channels and terminate the scan.

Storing and recalling channel patterns

A channel pattern is simply a pattern of open and closed channels that is stored in memory. The System 41 is shipped with pre-programmed channel patterns already stored in memory. These channel patterns cover all switching combinations to connect inputs to outputs for the RF module. The actual channels that are closed by a channel pattern depend on which RF module is installed in the System 41.

If a pre-programmed channel pattern is lost (cleared) or inadvertently changed, you will have to reprogram the affected memory location. The required channel closures for all channel patterns are provided in Section 4.

Storing channel patterns (STORE)

There are two methods to store a channel pattern. One method is to actually close and open the desired channels and then save that pattern into memory. The other method is to define a list of channels and then save that channel list into memory. The channels defined in the list will be the closed channels of the pattern. All the unlisted channels will be open.

Perform the following steps to store a channel list in memory:

1. Decide on which storage method you wish to use:
 - a. If you want to store an actual pattern of open and closed channels into memory, go ahead and open and close the desired channels.
 - b. If you want to store a list of the closed channels for the channel pattern, go ahead and define the channel list.
2. Press STORE to display the following menu:
STORE TO MEMORY
RELAY-PATTERN CURRENT-LIST
3. Place the cursor on the appropriate selection:
 - a. Place the cursor on RELAY PATTERN if storing the actual pattern of open and closed channels.
 - b. Place the cursor on CURRENT-LIST if storing the defined channel list.
4. With the cursor on the appropriate selection, press ENTER. One of the following typical messages will be displayed:
STORE CHANS AT #001 or STORE LIST AT #001
Both messages indicate that storage will occur at memory location 1 (M1).

NOTE *You can cancel the store operation at this time by using the EXIT key to back out of the menu structure.*

5. If you wish storage to occur at the displayed memory location proceed to step 6. Otherwise, use the cursor keys (◀ and ▶) and the numeric keypad to key in the desired memory location (001 to 500).
6. To store the channel pattern or list at the displayed memory location, press ENTER.

Recalling channel patterns (RECALL)

As explained throughout this manual, channel patterns are used in a scan list and channel list to control switching. For example:

```
SCAN CHANNELS  M1, M4, M2, M3,  
SELECT CHANNELS M1, M15,
```

Another way to use channel patterns is to immediately access a channel pattern from memory using RECALL. The open/close channel pattern will be reinstated.

NOTE *The drawback to using RECALL is that you can only control (open/close) one channel pattern at a time.*

Recalling a channel pattern using RECALL

Perform the following steps to use RECALL:

1. Press RECALL to display the following typical message:

```
RECALL CHANS AT #001
```

The above message indicates that the channel pattern will be recalled from memory location M1.

NOTE *You can exit from the Recall mode without recalling the channel pattern by pressing EXIT. The instrument will return to the channel list display state.*

2. If you wish to recall the channel pattern from the displayed memory location, proceed to step 3. Otherwise, use the cursor keys (◀ and ▶) and the number keys to key in the desired memory location.
3. To recall the channel pattern from the displayed memory location, press ENTER. The instrument will return to the channel status display state and display the recalled channel pattern.

CAUTION **As soon as the display updates to the selected channel pattern, the corresponding RF switches will also update. Thus, make sure you want to close the switches before recalling a channel pattern.**

MENU

Various instrument operations to configure the System 41 are performed using the front panel MENU. The MENU structure is shown and summarized in Table 5-3.

General rules to use MENU:

1. The MAIN MENU is displayed by pressing the MENU key. The MAIN MENU selections are shown as follows:

```
MAIN MENU  
SAVESETUP GPIB DIGITAL-I/O ▶  
◀ TEST LANGUAGE GENERAL
```

2. Pressing the EXIT key causes the display to back up to the previous menu level. Also, keyed-in parameter changes are ignored if an EXIT is performed. When the MAIN MENU is displayed, pressing EXIT or MENU will disable MENU.

Table 5-3
MENU structure

Menu item	Description
SAVESETUP SAVE RESTORE PWRON FACTORY DEFAULT USER SETUP RESET	Setup Menu: Save setup at a memory location (up to 10). Return System 41 to setup stored at a memory location. Power-on Menu: Power-on to factory default setup conditions. Power-on to setup stored at a memory location. Return System 41 to original power-on setup.
GPIB ADDRESS STATUS	GPIB Setup Menu: Check/change IEEE-488 address. Display IEEE-488 status byte.
DIGITAL-I/O	Not implemented by System 41.
TEST BUILT-IN TESTS DISPLAY TESTS KEYS PATTERNS LED BOARD CHAR SET	Self-Test Menu: For use by Keithley service personnel only. Test Display Board: Verify operation of front panel keys. Verify operation of VFD display. Verify operation of LED display. Display ASCII character set.
LANGUAGE ENGLISH GERMAN FRENCH	Choose System 41 Language: Display messages in English. Display messages in German. Display messages in French.
GENERAL SERIAL # STATUS-MESSAGES DISPLAY LED DISPLAY SETUP SHOW-LIST GRATICULE-CONTROL BREAK BEFORE MAKE	General Menu: Displays serial number, SCPI version, and software revision. Enables/disables status message mode. Display Menu: LED Display Control: Change Display Mode. Disable/enable LED Graticule. Enables/disables Break-Before-Make. To prevent damage to RF switches, DO NOT disable Break-Before-Make. It must be enabled.

- The position of the cursor is denoted by the blinking menu selection or parameter. The cursor is moved from one item to the next using the cursor keys (◀ and ▶).
- A displayed arrow (◀ or ▶) indicates that there is more information or additional menu items to select from. When “▶” is displayed, use the ▶ cursor key to display the additional message(s); and conversely, when “◀” is displayed, use the ◀ cursor key.
- A numeric parameter is keyed in by placing the cursor on the digit to be changed, and pressing the appropriate key on the keypad. After keying in a number, the cursor will move to the next digit to the right.
- A parameter change is only executed when the ENTER key is pressed.
- ENTERing an invalid parameter generates an error and ignores the entry.

8. The INFO key can be used anywhere in the menu structure to display helpful information messages concerning operation. To cancel an information message, press EXIT or INFO a second time.
9. The ENTER, EXIT, ◀ and ▶ keys have LED counterparts. Thus, with the optional light pen, you can click these LEDs instead of pressing the keys.

SAVESETUP

The SAVESETUP menu is used for the following operations:

- Save the current setup conditions in memory for future recall. Up to 10 setups can be saved in memory.
- Restore the instrument to setup conditions stored in memory.
- Set up the power-on (PWRON) configuration. The instrument can be set to power-on to the factory default setup conditions, or power-on to the setup conditions stored at a specified memory location.
- Reset the instrument to the original power-on setup conditions.

Perform the following steps to display the SAVESETUP menu:

1. Press MENU to display the MAIN MENU.
2. Use the cursor keys (◀ and ▶) to place the cursor on SAVESETUP, and press ENTER to access the following menu:

```
SETUP MENU
SAVE RESTORE PWRON RESET
```

SAVE — Use this menu item to save the current setup conditions in memory at a specified memory location. To select SAVE, place the cursor on SAVE and press ENTER. The following typical message will be displayed:

```
SAVE SETUP #0 (0-9)
```

1. To save the current setup at the displayed memory location, press ENTER. The instrument will return to the SETUP MENU.
2. To save the current setup to a different memory location, key in a value (0 to 9) and press ENTER. The instrument will return to the SETUP MENU.

RESTORE — Use this menu item to return the instrument to the setup conditions that are stored in memory at a specified memory location. To select RESTORE, place the cursor on RESTORE and press ENTER. The following typical message will be displayed:

```
RESTORE SETUP #0
```

1. To restore the instrument to the setup conditions stored at the displayed memory location, press ENTER. The instrument will return to the SETUP MENU.
2. To restore the instrument to the setup conditions stored at a different memory location, key in the memory location (0 to 9) and press ENTER. The instrument will return to the SETUP MENU.

PWRON — Use this menu item to select the setup conditions that the instrument will power-on to. To select the PWRON menu item, place the cursor on PWRON and press ENTER. The following menu will be displayed:

```
SET POWER-ON DEFAULT
FACTORY-DEFAULT USER-SETUP
```

FACTORY DEFAULT — With this selection, the instrument will return to the factory default conditions (see Table 5-4) the next time it is turned on. To select the FACTORY-DEFAULT menu item, place the cursor on FACTORY-DEFAULT and press ENTER. The instrument will return to the SETUP MENU.

USER SETUP — Using this selection, the instrument will power-on to the setup conditions saved at a specified memory location. To select USER-SETUP, place the cursor on USER-SETUP and press ENTER. The following typical message will then be displayed:

PWRON DEFAULT = #0

1. To power-on to the setup conditions stored at the displayed memory location, press ENTER. The instrument will return to the SETUP MENU.
2. To power-on to setup conditions stored at a different memory location, key in the memory location (0 to 9) and press ENTER. The instrument will return to the SETUP MENU.

RESET — Use this menu item to reset the instrument to the RESET default setup conditions (see Table 5-4). To select RESET, place the cursor on RESET and press ENTER. The following message will be displayed:

RESETTING INSTRUMENT

Press ENTER to confirm or EXIT to abort. Pressing ENTER will display the following message:

RESET COMPLETE

Press ENTER to return to the SETUP MENU.

NOTE *When finished with SAVE SETUP, use EXIT to back out of the menu structure.*

Table 5-4

Default conditions

Item	Factory default	RESET
Display mode	Relay status	No change
Channel status	All open	All open
Channel list	Cleared	No change
Scan list	No change	No change
GPIB address	No change	No change
Language	No change	No change
Status messages	Off	Off
# of poles	No change	No change
Card pair	Off	Off
Delay	0 sec	0 sec
Channel spacing	Manual (STEP key)	Manual (STEP key)
Number of channels	Scan list length	Scan list length
Channel trigger control	Source	Source
Scan spacing	Immediate	Immediate
Number of scans	Infinite	Infinite
Scan trigger control	Acceptor	Acceptor
Arm spacing	Immediate	Immediate
Arm count	1	1
Arm trigger control	Acceptor	Acceptor
Single channel	Off	Off
Restricted channels	No change	No change
Interlock	No change	No change
Break Before Make	On	On
LED Graticule	On	On

Note: "No change" indicates that the currently set conditions are not affected.

GPIB

The GPIB menu is used for the following operations:

- Check and/or change the address of the IEEE-488 bus.
- Display the status byte of the IEEE-488 bus.

Perform the following steps to display the GPIB menu:

1. Press MENU to display the MAIN MENU.
2. Use the cursor keys (◀ and ▶) to place the cursor on GPIB, and press ENTER to display the following menu:

```
GPIB SETUP MENU
ADDRESS STATUS
```

ADDRESS — Use this menu item to check and/or change the IEEE-488 address. At the factory the address is set to 7, but it can be changed to any value from 0 to 30. To select ADDRESS, place the cursor on ADDRESS and press ENTER. If the address is currently set to 7, the following message will be displayed:

```
ADDRESS = 07 (0-30)
```

1. To retain the displayed address, press ENTER or EXIT. The instrument will return to the GPIB SETUP MENU.
2. To change the address, simply key in a valid value (0 to 30) and press ENTER. The instrument will return to the GPIB SETUP MENU.

STATUS — Use this menu item to display the IEEE-488 status byte. Refer to Section 6 (IEEE-488 Reference) for information on the status byte. To select STATUS, place the cursor on STATUS and press ENTER. If for example, all bits of the status byte are reset to zero, it will be displayed as follows:

```
SHOW STATUS BYTE
EVA = 0 QSB = 0 MAV = 0 ESB = 0 ▶
◀ MSS = 0 OSB = 0
```

When finished viewing the status byte, press either ENTER or EXIT. The instrument will return to the GPIB SETUP MENU.

NOTE When finished with GPIB, use EXIT to back out of the menu structure.

DIGITAL I/O

The System 41 does not have a digital I/O port. If you inadvertently enter the DIGITAL I/O MENU, use the EXIT key to back out of the menu structure.

TEST

The TEST menu is used to test the functionality of front panel keys, and visually check the vacuum fluorescent display (VFD) and LEDs. Refer to Section 8 to perform these tests.

NOTE Built-in-tests are included in the TEST menu. These tests are for use by Keithley service personnel only. If you inadvertently enter the BUILT IN TESTS menu, use the EXIT key to back out of the menu structure.

LANGUAGE

The LANGUAGE menu is used to change the language for display messages. Language selections include:

- Display messages in ENGLISH.
- Display messages in GERMAN.
- Display messages in FRENCH.

Perform the following steps to change the language of display messages:

1. Press MENU to display the MAIN MENU.
2. Use the cursor keys (◀ and ▶) to place the cursor on LANGUAGE and press ENTER. The following language menu selections will be displayed:

```
CHOOSE MENU LANGUAGE
ENGLISH GERMAN FRENCH
```

The cursor will be located on the currently selected language. Note that if a language other than English is currently selected, the menu will be displayed in the selected language.

3. To retain the currently selected language, press EXIT or ENTER. The display will return to the MAIN MENU.
4. To select one of the other languages, place the cursor on the desired language selection and press ENTER. The instrument will return to the MAIN MENU.

NOTE *The selected language becomes the power-up default.*

NOTE *When finished with LANGUAGE, use EXIT to back out of the menu structure.*

GENERAL

The GENERAL MENU is used for the following operations:

- Read the serial # of the System 41.
- Read the SCPI version control number.
- Read the software revision level installed in the System 41.
- Control the Status Message Mode.
- Change the display mode.
- Disable/enable LED Graticule.
- Disable/Enable Break-Before-Make. Note that it must not be disabled.

Perform the following steps to use the GENERAL MENU:

1. Press MENU to display the MAIN MENU.
2. Use the cursor keys (◀ and ▶) to place the cursor on GENERAL and press ENTER. The following menu will be displayed:

```
GENERAL MENU
SERIAL # STATUS-MSGs DISPLAY ▶
◀ BREAK BEFORE MAKE
```


SERIAL # — To display the serial number, SCPI version and software revision level of the instrument, place the cursor on SERIAL # and press ENTER. The following information will be displayed:

```
Serial #XXXXXX
SCPI Version 1992.0 ►
◀ software rev AXX/AYY /AZZ
```

where; AXX is the software revision of the main CPU.

AYY is the software revision of the VFD display CPU.

AZZ is the software revision of the LED display CPU.

When finished, press ENTER or EXIT to return to the GENERAL MENU.

STATUS MESSAGES — This selection is used to enable or disable the status message mode. When enabled, status messages will be displayed to identify specific operations that are performed. Place the cursor on STATUS-MESSAGES and press ENTER. The following message will be displayed:

```
STATUS MESSAGES
OFF ON
```

Place the cursor on the desired state (on or off) and press ENTER. The instrument will return to the GENERAL MENU.

DISPLAY — This selection is used to change the display mode and to disable/enable the LED Graticule for the LED display.

Place the cursor on DISPLAY and press ENTER to display the following menu:

```
LED DISPLAY SETUP
SHOW-LIST GRATICULE-CONTROL
```

Show List — This menu item is used to change the display mode. In the relay status display mode, the channel LEDs correspond to open and closed channels. In the list display mode, brightly lit channel LEDs correspond to the channels included in the selected list. Note that with the optional light pen, the SHOW LIST LED toggles between the two display modes.

Perform the following steps to change the display mode:

1. Place the cursor on SHOW-LIST and press ENTER to display the following message:

```
CONFIG LED DISPLAY
RELAY-STATUS CURRENT-LIST
```

RELAY STATUS selects the relay status display mode, and CURRENT LIST selects the list display mode.

2. Place the cursor on the appropriate selection and press ENTER. The display returns to the LED DISPLAY SETUP menu.

Graticule Control — This selection is used to disable or enable the LED Graticule. When enabled, all available channels are denoted by channel LEDs that are turned on (dimly lit or brightly lit). Channels not available are denoted by channel LEDs that are turned off.

Contrast between on and off LEDs can be increased by disabling the LED Graticule. When disabled, there is no dimly lit state for the LEDs. An LED that would normally be dimly lit is instead turned completely off. Each LED is either off or brightly lit. A disadvantage of this is that it is more difficult to determine which channels are available in the test system.

Perform the following steps to disable or enable the LED Graticule:

1. Place the cursor on GRATICULE-CONTROL and press ENTER to display the following message:
 GRATICULE PATTERN
 ON OFF
 OFF disables the LED Graticule and ON enables it.
2. Place the cursor on the appropriate selection and press ENTER. The display returns to the LED DISPLAY SETUP menu.

- NOTES**
1. *FACTORY DEFAULT power-on, RESET, *RST, and :SYSTem:PRE-Set enables (ON) the LED Graticule. If you want the instrument to power-up with the LED Graticule disabled, you will have to save the OFF condition as the USER SETUP power-on default.*
 2. *If the main CPU firmware is not compatible with the LED display firmware, the following error will occur when trying to disable the LED Graticule.*
 ERROR: ID CODE = +551
 Incorrect software revision
If this error should occur, contact Keithley to resolve the firmware incompatibility.

BREAK-BEFORE-MAKE — This selection is used to enable or disable Break-Before-Make. When enabled, the previous channel will open before the next channel closes during a scan. This ensures that two scanned channel patterns will not be closed at the same time. When recalling a channel pattern from memory, all other channel patterns will open before the channels in the pattern close.

When disabled, Break-Before-Make is no longer ensured. During a scan, this could result in four channels closed momentarily at the same time.

CAUTION To prevent damage to RF switches, Break-Before-Make must always be ON. Never disable Break-Before-Make.

To check the present state of Break-Before-Make, place the cursor on BREAK-BEFORE-MAKE and press ENTER to display the following:

```
BREAK BEFORE MAKE
ON          OFF
```

Cursor position indicates the current state of Break-Before-Make. If not presently on, place the cursor on "ON" and press ENTER. The instrument will return to the GENERAL MENU.

NOTE *When finished with the GENERAL MENU, use EXIT to back out of the menu structure.*

Card configuration

There are five items in the CARD CONFIGURATION MENU (see Table 5-5). However, only the DELAY item is useful to System 41 operation. There is no need to select any of the other menu items.

Table 5-5
CARD CONFIG MENU structure

Menu item	Description
TYPE	Cannot change type for slots 1 through 6. Slots 7 through 10 should be set to "NONE."
# OF POLES	Cannot change setting (1-pole).
CARD PAIR	DO NOT enable any card pairs.
DELAY	Set delay between channels.
READ I/O CARD	Not implemented.

General rules to use CARD CONFIG MENU:

1. The CARD CONFIG MENU is displayed by pressing the CARD CONFIGURATION key. The CARD CONFIG MENU selections are shown as follows:

```
CARD CONFIG MENU
TYPE #-OF-POLES CARD-PAIR ►
◀ DELAY READ-I/O-CARD
```
2. The EXIT key causes the display to back up to the previous menu level. Also, keyed-in parameter changes are ignored if an EXIT is performed. When the CARD CONFIG MENU is displayed, pressing EXIT will disable card configuration.
3. The position of the cursor is denoted by the blinking menu selection or parameter. The cursor is moved from one item to the next using the cursor keys (◀ and ►).
4. A displayed arrow (◀ or ►) indicates that there is more information or additional menu items to select from. When "►" is displayed, use the ► cursor key to display the additional message(s); and conversely, when "◀" is displayed, use the ◀ cursor key.
5. A numeric parameter is keyed in by placing the cursor on the digit to be changed, and pressing the appropriate key on the keypad. After keying in a number, the cursor will move to the next digit to the right.
6. A parameter change is only executed when the ENTER key is pressed.
7. ENTERing an invalid parameter generates an error and ignores the entry.
8. The INFO key can be used anywhere in the menu structure to display helpful information messages concerning operation. To cancel an information message, press EXIT or INFO a second time.
9. The ENTER, EXIT, ◀ and ► keys have LED counterparts. Thus, with the use of the optional light pen, these LEDs can be used instead of the keys.

TYPE

The TYPE menu displays an assignment message for each of the 10 slots. The assignment message for slots 1 through 6 is “7116” and cannot be changed. These slots are reserved for RF switches. The System 41 does not use slots 7 through 10, therefore, they are disabled and assigned the message “NONE.”

If you inadvertently select TYPE, press the EXIT key to back out of the menu structure.

If slot 7, 8, 9 or 10 is enabled, you should disable it. Assuming the graticule is enabled, you can tell if a slot is enabled by its channel LEDs. If the LEDs are completely off, the slot is disabled. If they're dimly lit, the slot is enabled.

Perform the following steps to disable slot 7, 8, 9 and/or 10:

1. While in the SET CARD TYPE menu, place the cursor on the slot number (#7, #8, #9 or #10) and press ENTER.
2. If the message “NONE” is not displayed, use the cursor keys to display it, and press ENTER.
3. To disable another slot, repeat steps 1 and 2.
4. Use the EXIT key to back out of the menu structure.

OF POLES

The # OF POLES menu should not be used.

The RF module uses 1-pole switches. Therefore, all six slots are set for 1-pole switching. You cannot change this setting. Trying to do so will cause this error message:

```
ERROR: ID CODE = -221
Settings conflict
```

If you inadvertently select # OF POLES, press the EXIT key to back out of the menu structure.

CARD PAIR

The CARD PAIR menu should not be used.

CARD PAIR pairs a slot with another slot. For example, if you enable card pair 1&6, closing channel 1!1 will also close 6!1. All card pairs should be kept disabled (OFF).

If you inadvertently select CARD PAIR, press the EXIT key to back out of the menu structure.

DELAY

The DELAY feature sets a channel delay for each of the ten cards installed in the mainframe. The delay can be set from 00000.001 seconds (1msec) to 99999.999 seconds. This delay is in addition to the internally set relay settling time delay.

This user programmed delay is the time delay between channels during a scan. The first delay period occurs after the first channel(s) closes. In other words, the programmed delay does not occur at the beginning of a scan.

If a spacing event (i.e., pressing STEP key) occurs before the delay period expires, it will be ignored and the following message will be displayed:

```
ERROR:ID CODE = -211
Trigger ignored
```

Perform the following steps to set a delay:

1. Press CARD CONFIGURATION to display CARD CONFIG MENU.
2. Place the cursor on DELAY and press ENTER. The following message is displayed:
SET DELAY FOR:
SLOT-#1 #2 #3 #4 #5 ►
◀ SLOT-#6 #7 #8 #9 #10
3. Place the cursor on the slot that you wish to set a delay for and press ENTER. If for example, you select slot 6 and it currently is set for a one second delay, the following message is displayed:
(06) DELAY=00001.000
4. To change the delay period, use the cursor keys and the numeric keypad to key in the new value.
5. With the desired delay period displayed, press ENTER.
6. When finished, use the EXIT key to back out of the menu structure.

READ I/O CARD

This menu is not implemented by the System 41. If you inadvertently select READ I/O CARD, press EXIT to back out of the menu structure.

Scan configuration

Various operations to configure a scan are performed from the CONFIGURE SCAN menu. The menu structure is shown and summarized in Table 5-7.

Keep in mind that the RF module must be cold switched. That is, you cannot scan a channel pattern while a test signal is applied to the inputs or outputs of the System 41.

When you configure the trigger model, you must hold up operation so that you can remove the test signal(s) before closing and opening channels. The following steps must be performed for each channel pattern to be scanned:

1. Hold up operation.
2. Remove test signal(s) from System 41.
3. Scan channel pattern.
4. Apply test signal to System 41.

To accommodate cold switching, operation is typically held up in the channel layer of the trigger model.

General rules to use CONFIGURE SCAN:

1. The CONFIGURE SCAN menu is displayed by pressing the SCAN CONFIGURATION key. The CONFIGURE SCAN menu selections are shown as follows:
CONFIGURE SCAN
CHAN-CONTROL SCAN-CONTROL ►
◀ ARM-CONTROL CHAN-RESTRICTIONS
2. The EXIT key causes the display to back up to the previous menu level. Also, keyed-in parameter changes are ignored if an EXIT is performed. When the CONFIGURE SCAN menu is displayed, pressing EXIT will disable SCAN CONFIGURATION.
3. The position of the cursor is denoted by the blinking menu selection or parameter. The cursor is moved from one item to the next using the cursor keys (◀ and ►).

4. A displayed arrow (◀ or ▶) indicates that there is more information or additional menu items to select from. When “▶” is displayed, use the ▶ cursor key to display the additional message(s), and conversely, when “◀” is displayed, use the ◀ cursor key.
5. A numeric parameter is keyed in by placing the cursor on the digit to be changed, and pressing the appropriate key on the keypad. After keying in a number, the cursor will move to the next digit to the right.
6. A parameter change is only executed when the ENTER key is pressed.
7. ENTERing an invalid parameter generates an error and ignores the entry.
8. The INFO key can be used anywhere in the menu structure to display helpful information messages concerning operation. To cancel an information message, press EXIT or INFO a second time.
9. The ENTER, EXIT, ◀ and ▶ keys have LED counterparts. Thus, with the optional light pen, you can click these LEDs instead of pressing the keys.

Table 5-6

CONFIGURE SCAN menu structure

Menu item	Description
CHAN-CONTROL CHANNEL-SPACING TIMER EXTERNAL GPIB MANUAL TRIGLINK ASYNCHRONOUS SEMI-SYNCHRONOUS IMMEDIATE HOLD NUMBER-OF-CHANS USE-SCANLIST-LENGTH CHAN-COUNT INFINITE ENTER-CHAN-COUNT CONTROL SOURCE ACCEPTOR	Configure Channel Layer: Select channel spacing: Use a timer to select each channel in the scan. Not used by the System 41. Use a bus trigger to select each channel. Use STEP key to select each channel. Use a Trigger Link trigger to select each channel. Use separate lines for In/Out triggers. Use same line for In/Out triggers. Use to scan channels immediately. Use to hold up the scan in the channel layer. Define number of channels to scan: Count = number of channel entries in scan list. User defined count: Repeat channel scanning indefinitely. Count = user defined value (1 to 9999). Select trigger control mode: Enable the Source Bypass. Disable the Source Bypass.
SCAN-CONTROL SCAN-SPACING TIMER EXTERNAL GPIB MANUAL TRIGLINK IMMEDIATE HOLD NUMBER-OF-SCANS INFINITE ENTER-SCAN-COUNT CONTROL SOURCE ACCEPTOR	Configure Scan Layer: Select scan spacing: Use the timer to control scan spacing. Not used by the System 41. Use bus triggers to control scan spacing. Use STEP key to control scan spacing. Use Trigger Link triggers to control scan spacing. Use to pass operation immediately into the channel layer. Use to hold up the scan in the scan layer. Define number of scans to be performed: Repeat scan indefinitely. Count = user defined value (1 to 9999). Select trigger control mode: Enable Source Bypass. Disable Source Bypass.

Table 5-6 (cont.)

CONFIGURE SCAN menu structure

Menu item	Description
ARM-CONTROL ARM SPACING MANUAL IMMEDIATE GPIB EXTERNAL TRIGLINK HOLD ARM-COUNT INFINITE ENTER-ARM-COUNT TRIGGER-CONTROL SOURCE ACCEPTOR	Configure Arm Layer: Select arm spacing control: Use STEP key to arm scanner. Use to arm scanner immediately. Use a bus trigger to arm scanner. Not used by the System 41. Use a Trigger Link trigger to arm scanner. Use to hold up the scan in the arm layer. Define number of times to arm scanner: Continuously re-arm scanner. User defined count value (1 to 9999). Select trigger control mode: Enable Source Bypass. Disable Source Bypass.
CHAN-RESTRICTIONS	DO NOT use. Pre-programmed channel patterns will be lost (cleared) if a channel restriction is used.

CHAN CONTROL

Channel control is used for the following operations:

- To select the event that controls the time period (CHANNEL SPACING) between channel closures of a scan.
- Designate the NUMBER OF CHANS (channels) in the scan.
- Enable or disable the Source Bypass.

NOTE Typically, this is the layer where operation is held up to accommodate cold switching. For example, with GPIB channel spacing selected, a channel pattern will not be scanned until you send a bus trigger (*TRG or GET). With operation held up, you can safely apply or remove the test signal(s).

Perform the following steps to configure the channel layer:

1. Press SCAN CONFIGURATION to display the CONFIGURE SCAN menu.
2. Use the cursor keys (◀ and ▶) to place the cursor on CHAN-CONTROL and press ENTER to access the following menu:

```
CHANNEL CONTROL
CHANNEL-SPACING  NUMBER-OF-CHANS ▶
◀ CONTROL
```

CHANNEL SPACING — Use this menu item to select the event that controls the time period between channel closures of the scan. With the CHANNEL CONTROL menu displayed, select this menu item by placing the cursor on CHANNEL-SPACING and pressing ENTER. The following menu will be displayed:

```
SELECT CHAN SPACING
TIMER  EXTERNAL  GPIB  MANUAL ▶
◀ TRIGLINK  IMMEDIATE  HOLD
```

Timer — Use the timer to control channel spacing. The timer is used to set a time interval between channel closures of the scan. The timer can be set for an interval from zero to 99999.999 seconds with 0.001 second (1msec) resolution. The first interval begins after the first channel of the scan closes. Perform the following steps to use the timer:

1. With the SELECT CHAN SPACING menu displayed, place the cursor on TIMER and press ENTER. A message indicating the currently set time interval (in seconds) will be displayed. If, for example, the timer is set to 1msec, the following message will be displayed:
INTERVAL = 00000.001
2. To retain the displayed timer interval, press EXIT or ENTER. The instrument will return to the CHANNEL CONTROL menu.
3. To set a different time interval, use the keypad to key in the value (in seconds) and press ENTER. The instrument will return to the CHANNEL CONTROL menu.

NOTE *The front panel STEP key (see “MANUAL”) is active with the timer selected. Each press of the STEP key will select the next channel of the scan. This can be used to quickly step through a scan that has a relatively long timer interval.*

External — The External spacing event is not used by the System 41. If you inadvertently select EXTERNAL, go back into the spacing menu and select a different spacing event.

GPIB — With this selection, bus triggers are used to control channel spacing for the scan. Each trigger sent over the bus (GET or *TRG) will open the current channel and close the next channel of the scan. See Section 6 for detailed information on bus triggers.

Select bus triggering from the SELECT CHAN SPACING menu by placing the cursor on GPIB and pressing ENTER. The instrument will return to the CHANNEL CONTROL menu.

NOTE *The front panel STEP key (see “MANUAL”) is active with bus triggering selected. Each press of the STEP key will select the next channel of the scan.*

Manual — With this selection, the front panel STEP key is used to control channel spacing. Each time the STEP key is pressed, the current channel of the scan will open and the next channel will close.

Select manual triggering from the CHANNEL SPACING menu by placing the cursor on MANUAL and pressing ENTER. The instrument will return to the CHANNEL CONTROL menu.

NOTE *The front panel STEP key is active when TIMER, GPIB, or TRIGGER LINK is selected.*

Triglink — With this selection, channel spacing of the scan is controlled by the Trigger Link of the System 41. Trigger Link is an enhanced trigger system that uses up to six lines to direct trigger pulses to and from other instruments. Each trigger stimulus applied to the System 41 will open the current channel and close the next channel of the scan. See “External triggering (Trigger Link)” for details on using the Trigger Link.

NOTE *The front panel STEP key (see “MANUAL”) is active with Trigger Link selected. Each press of the STEP key will select the next channel of the scan.*

Select the Trigger Link from the SELECT CHAN SPACING menu by placing the cursor on TRIGLINK and pressing ENTER. The following menu will be displayed:

```
SET TRIGGERLINK MODE
ASYNCHRONOUS  SEMI-SYNCHRONOUS
```

ASYNCHRONOUS — The asynchronous trigger link mode is used for trigger configurations that require input and output triggers to be routed on separate lines. Perform the following steps to select the asynchronous mode, and to select the input and output trigger lines for the System 41:

1. With the SET TRIGGERLINK MODE menu displayed, place the cursor on ASYNCHRONOUS and press ENTER. The following message will be displayed:

```
SELECT INPUT LINE
#1 #2 #3 #4 #5 #6
```

The position of the cursor indicates the currently selected input line.

2. To select a trigger input line for the System 41, place the cursor on the desired line number and press ENTER. The following message will be displayed:

```
SELECT OUTPUT LINE
#1 #2 #3 #4 #5 #6
```

The position of the cursor indicates the currently selected output line.

3. To select a trigger output line for the System 41, place the cursor on a different line number and press ENTER. The instrument will return to the SELECT CHAN SPACING menu. Note that you cannot use the same trigger line for both input and output.

SEMI-SYNCHRONOUS — In this mode, the input and output triggers for the System 41 are assigned to the same line. Perform the following steps to select the semi-synchronous mode, and to select the trigger line:

1. With the SET TRIGGERLINK MODE menu displayed, place the cursor on SEMI-SYNCHRONOUS and press ENTER. The following message will be displayed:

```
SET SEMI-SYNC LINE
#1 #2 #3 #4 #5 #6
```

The position of the cursor indicates the currently selected trigger line.

2. To select a trigger line for the System 41, place the cursor on the desired line number and press ENTER. The instrument will return to the SELECT CHAN SPACING menu.

Immediate — With this selection, events (such as the Trig Link triggers) do not control channel spacing. Once the scan starts, the System 41 will step through it as fast as the internal settling time and user programmed delay (see "DELAY") will allow.

Select immediate triggering from the SELECT CHAN SPACING menu by placing the cursor on IMMEDIATE and pressing ENTER. The instrument will return to the CHANNEL CONTROL menu.

Hold — When HOLD is selected, channel spacing is suppressed. As a result, the scan is stopped and will not continue until HOLD is cancelled by selecting another channel spacing selection. Select trigger hold from the SELECT CHAN SPACING menu by placing the cursor on HOLD and pressing ENTER. The instrument will return to the CHANNEL CONTROL menu.

NUMBER OF CHANS — Use this menu item to define the number of channel patterns to be scanned. With the CHANNEL CONTROL menu displayed, select this menu item by placing the cursor on NUMBER-OF-CHANS and pressing ENTER. The following menu will be displayed:

```
NUMBER OF CHANNELS
USE-SCANLIST-LENGTH  CHAN-COUNT
```

Use scanlist length — With this selection, the number of channel patterns in the scan list determines the number of channel patterns to scan. For example, if the scan list is made up of M1, M2, M3, and M4, the number of channel patterns to be scanned is four.

Select scan list length from the NUMBER OF CHANNELS menu by placing the cursor on USE SCANLIST LENGTH and press ENTER. The display will return to the CHANNEL PATTERN menu.

Chan count — With this selection, the user determines the number (count) of channel patterns to scan. The user programmed count can be smaller, equal to, or larger than the number of channel patterns in the scan list. For example, if the scan list is made up of four channel patterns (M1, M2, M3, and M4), you can program a count of 12. With this count, the instrument will repeat the channel scan three times.

Select CHAN-COUNT from the NUMBER OF CHANNELS menu by placing the cursor on CHAN-COUNT and pressing ENTER. The following menu will be displayed:

```
CHANNEL COUNT
INFINITE  ENTER-CHAN-COUNT
```

INFINITE — Use this selection to continuously repeat the scan. With the CHANNEL COUNT menu displayed, select this menu item by placing the cursor on INFINITE and pressing ENTER. The display will return to the CHANNEL CONTROL menu.

ENTER-CHAN-COUNT — Use this selection to define the number of channel patterns in the scan. Perform the following steps to define a finite count:

1. With the CHANNEL COUNT menu displayed, place the cursor on ENTER-CHAN-COUNT and press ENTER. A message indicating the current count will be displayed.

```
CHANNEL COUNT = 0010
```

The above message indicates that the current count is set to 10.

2. To program for a different count (1 to 9999), use the keypad to enter the count value.
3. With the desired count value displayed, press ENTER. The display will return to the CHANNEL CONTROL menu.

CONTROL — Use this menu item to enable or disable the source bypass. The source bypass is used to bypass the channel spacing event on the first pass through the channel layer. With the CHANNEL CONTROL menu displayed, select this menu item by placing the cursor on CONTROL and pressing ENTER. The following menu will be displayed:

```
TRIGGER CONTROL
SOURCE  ACCEPTOR
```

Cursor position indicates the current selection.

Source — With this selection, the source bypass is enabled. The channel spacing event will be bypassed on the first pass through the channel layer if TRIG LINK channel spacing is selected. This will allow the first channel pattern in the scan to close without having to wait for the programmed event.

Acceptor — With this selection, the source bypass is disabled.

Place the cursor on the desired selection and press ENTER.

NOTE *When finished with the channel layer, use EXIT to back out of the MENU structure.*

SCAN CONTROL

Scan control is used for the following operations:

- To select the event that controls scan spacing.
- Designate the NUMBER-OF-SCANS to be performed.
- Enable or disable the Source Bypass.

Perform the following steps to configure the scan layer:

1. Press SCAN CONFIGURATION to display the CONFIGURE SCAN menu.
2. Use the cursor keys (◀ and ▶) to place the cursor on SCAN-CONTROL and press ENTER to access the following menu:

```
SCAN CONTROL
SCAN-SPACING  NUMBER-OF-SCANS ▶
◀ CONTROL
```

SCAN SPACING — Use this menu item to select the event that controls the time period between scans. With the SCAN CONTROL menu displayed, select this menu item by placing the cursor on SCAN-SPACING and press ENTER. The following menu will be displayed:

```
SELECT SCAN SPACING
TIMER  EXTERNAL  GPIB  MANUAL ▶
◀ TRIGLINK  IMMEDIATE  HOLD
```

Timer — Use the timer feature to control scan spacing. The timer is used to set a time interval between scans. The timer can be set for an interval from zero to 99999.999 seconds with 0.001 second (1msec) resolution. After a scan is triggered to start, the next scan will start at the end of the programmed timer interval. If however, the programmed timer interval is shorter than the time it takes to complete a single scan, the next scan will not start until the previous scan is completed.

NOTE *The front panel STEP key (see “MANUAL”) is active with the timer selected. Pressing the STEP key after the completion of a scan will start the next scan (assuming the System 41 is programmed for another scan; see NUMBER OF SCANS).*

Perform the following steps to use the timer:

1. With the SELECT SCAN SPACING menu displayed, place the cursor on TIMER and press ENTER. A message indicating the currently set time interval (in seconds) will be displayed:
INTERVAL = 00000.001
2. To retain the displayed timer interval, press EXIT or ENTER. The instrument will return to the SCAN CONTROL menu.
3. To set a different time interval, use the keypad to key in the value (in seconds) and press ENTER. The instrument will return to the SCAN CONTROL menu.

External — The External spacing event is not used by the System 41. If you inadvertently select EXTERNAL, go back into the spacing menu and select a different spacing event.

GPIB — With this selection, bus triggers are used to control scan spacing. Operation will pass into the channel layer when a bus trigger (GET or *TRG) is received by the System 41. See Section 6 for detailed information on bus triggers.

NOTE *The front panel STEP key (see “MANUAL”) is active with bus triggering selected. Pressing the STEP key after the completion of a scan will start the next scan (assuming the System 41 is programmed for another scan; see NUMBER OF SCANS).*

Select bus triggering from the SELECT SCAN SPACING menu by placing the cursor on GPIB and pressing ENTER. The display will return to the SCAN CONTROL menu.

Manual — With this selection, the front panel STEP key is used to control scan spacing. Operation will pass into the channel layer when STEP is pressed.

NOTE *The front panel STEP key is active when TIMER, GPIB or TRIGGER LINK is selected.*

Select manual triggering from the SELECT SCAN SPACING menu by placing the cursor on MANUAL and pressing ENTER. The instrument will return to the SCAN CONTROL menu.

Triglink — With this selection, scan spacing is controlled by the Trigger Link of the System 41. Trigger Link is an enhanced trigger system that uses up to six lines to direct trigger pulses to and from other instruments. Operation passes into the channel layer when the System 41 receives a trigger over the Trigger Link. See “External triggering (Trigger Link)” for details on using the Trigger Link.

NOTE *The front panel STEP key (see “MANUAL”) is active with the Trigger Link selected. Pressing the STEP key after the completion of a scan will start the next scan (assuming the System 41 is programmed for another scan; see NUMBER OF SCANS).*

Select the Trigger Link from the SELECT SCAN SPACING menu by placing the cursor on TRIGLINK and pressing ENTER. The following menu will be displayed:

```
SELECT INPUT LINE
#1 #2 #3 #4 #5 #6
```

The position of the cursor indicates the currently selected input line.

To select a trigger input line for the System 41, place the cursor on the desired line number and press ENTER. The following message will be displayed:

```
SELECT OUTPUT LINE
#1 #2 #3 #4 #5 #6
```

The position of the cursor indicates the currently selected output line.

To select a trigger output line for the System 41, place the cursor on a different line number and press ENTER. Note that you cannot use the same trigger line for both input and output.

Immediate — With IMMEDIATE selected, operation passes immediately into the channel layer. Select immediate scanning from the SELECT SCAN SPACING menu by placing the cursor on IMMEDIATE and pressing ENTER. The instrument will return to the SCAN CONTROL menu.

Hold — When HOLD is selected, scan spacing is suppressed. As a result, operation will not continue until HOLD is cancelled by selecting one of the other scan spacing selections. Select HOLD from the SELECT SCAN SPACING menu by placing the cursor on HOLD and pressing ENTER. The instrument will return to the SCAN CONTROL menu.

NUMBER-OF-SCANS — Use this menu item to define the number of scans to be performed by the System 41. With the SCAN CONTROL menu displayed, select this menu item by placing the cursor on NUMBER-OF-SCANS and press ENTER. The following menu will be displayed:

```
NUMBER OF SCANS
INFINITE ENTER-SCAN-COUNT
```

Infinite — Use this selection to continuously repeat the scan. Select continuous scanning from the NUMBER OF SCANS menu by placing the cursor on INFINITE and pressing ENTER. The display will return to the SCAN CONTROL menu.

Enter-Scan-Count — With this selection, the user determines the number of scans to perform. You can program the System 41 to perform from 1 to 9999 scans. For example, if you enter a scan count of 10, the programmed scan will be performed 10 times. Perform the following steps to enter the scan count:

1. With the NUMBER OF SCANS menu displayed, place the cursor on ENTER-SCAN-COUNT and press ENTER. A message indicating the current scan count will be displayed.

SCAN COUNT = 0001

The above scan count indicates that the System 41 will perform one scan. A value of "0000" indicates that the scan count is set to infinite.

2. To program for a different count (1 to 9999), use the keypad to enter the count value.
3. With the desired count value displayed, press ENTER. The display will return to the SCAN CONTROL menu.

CONTROL — Use this menu item to enable or disable the source bypass. The source bypass is used to bypass the scan spacing event on the first pass through the scan. With the SCAN CONTROL menu displayed, select this menu item by placing the cursor on CONTROL and pressing ENTER. The following menu will be displayed:

TRIGGER CONTROL

SOURCE ACCEPTOR

Source — With this selection, the source bypass is enabled. The scan spacing event will be bypassed on the first pass through the scan layer if TRIG LINK scan spacing is selected. This will allow operation to proceed on into the channel layer without having to wait for the programmed event.

Acceptor — With this selection, the source bypass is disabled.

Place the cursor on the desired selection and press ENTER.

NOTE *When finished with the scan layer, use EXIT to back out of the menu structure.*

ARM CONTROL

Arm control is used for the following operations:

- To select the arming event (ARM SPACING) for the scanner.
- Designate the number of times the scanner is to be armed (ARM COUNT).
- Enable or disable the Source Bypass.

Perform the following steps to configure the arm layer:

1. Press SCAN CONFIGURATION to display the CONFIGURE SCAN menu.
2. Use the cursor keys (◀ and ▶) to place the cursor on ARM CONTROL and press ENTER to access the following menu:

SETUP ARM CONTROL

ARM-SPACING ARM-COUNT ▶

◀ TRIGGER-CONTROL

ARM-SPACING — This menu item is used to select the event that controls the arm spacing. To select this menu item, place the cursor on ARM-SPACING and press ENTER. The following menu will be displayed:

ARM SPACING

MANUAL IMMEDIATE GPIB ▶

◀ EXTERNAL TRIGLINK HOLD

Manual — With this selection, the front panel STEP key is used to control arm spacing. Operation will pass into the scan layer when the STEP key is pressed.

NOTE *The front panel STEP key is active when TIMER, GPIB, or TRIGGER LINK is selected.*

To select manual triggering (STEP key) from the SELECT ARM SPACING menu, place the cursor on MANUAL and press ENTER. The instrument will return to the SETUP ARM CONTROL menu.

Immediate — With this selection, operation will pass immediately into the scan layer.

Select immediate triggering from the SELECT ARM SPACING menu by placing the cursor on IMMEDIATE and pressing ENTER. The instrument will return to the SETUP ARM CONTROL menu.

GPIB — With this selection, bus triggers are used to control arm spacing. Operation will pass immediately into the scan layer when a bus trigger (GET or *TRG) is received by the System 41. See Section 6 for detailed information on bus triggers.

NOTE *The front panel STEP key (see “MANUAL”) is active with bus triggering selected. Pressing the STEP key will pass operation into the scan layer.*

To select bus triggering from the SELECT ARM SPACING menu, place the cursor on GPIB and press ENTER. The display will return to the SETUP ARM CONTROL menu.

External — The External spacing event is not used by the System 41. If you inadvertently select EXTERNAL, go back into the spacing menu and select a different spacing event.

Triglink — With this selection, arm spacing is controlled by the Trigger Link of the System 41. Trigger Link is an enhanced trigger system that uses up to six lines to direct trigger pulses to and from other instruments. Operation passes into the scan layer when the System 41 receives a trigger over the Trigger Link. See “External triggering (Trigger Link)” for details on using the Trigger Link.

NOTE *The front panel STEP key (see “MANUAL”) is active with the Trigger Link selected. Pressing the STEP key will pass operation into the scan layer.*

To select the Trigger Link from the SELECT ARM SPACING menu, place the cursor on TRIGLINK and press ENTER. The following menu will be displayed:

```
SELECT INPUT LINE
#1 #2 #3 #4 #5 #6
```

The position of the cursor indicates the currently selected input line.

To select a trigger input line for the System 41, place the cursor on the desired line number and press ENTER. The following message will be displayed:

```
SELECT OUTPUT LINE
#1 #2 #3 #4 #5 #6
```

The position of the cursor indicates the currently selected output line.

To select a trigger output line for the System 41, place the cursor on a different line number and press ENTER. Note that you cannot use the same trigger line for both input and output.

Hold — When HOLD is selected, arm spacing is suppressed. As a result, operation will not pass into the scan layer until HOLD is cancelled by selecting one of the other arm spacing selections.

Select **HOLD** from the **SELECT ARM SPACING** menu by placing the cursor on **HOLD** and pressing **ENTER**. The instrument will return to the **SETUP ARM CONTROL** menu.

ARM-COUNT — This menu item is used to define the number of times operation will return to the arm layer. With the **SETUP ARM CONTROL** menu displayed, select this menu item by placing the cursor on **ARM-COUNT** and press **ENTER**. The following menu will be displayed:

```
ARM COUNT
INFINITE  ENTER-ARM-COUNT
```

Infinite — Use this selection to continuously return operation to the arm layer. Select continuous arming from the **ARM COUNT** menu by placing the cursor on **INFINITE** and pressing **ENTER**. The display will return to the **SETUP ARM CONTROL** menu.

Enter-Arm-Count — With this selection, the user determines the number of times operation returns to the arm layer. You can program the System 41 to arm up to 9999 times. Perform the following steps to enter the arm count:

1. With the **ARM COUNT** menu displayed, place the cursor on **ENTER-ARM-COUNT** and press **ENTER**. A message indicating the current arm count will be displayed.

```
ARM COUNT = 0001
```

The above arm count indicates that the scanner will arm one time. An arm count of “0000” indicates that infinite is selected.

2. To program for a different count (1 to 9999), use the keypad to enter the count value.
3. With the desired count value displayed, press **ENTER**. The display will return to the **SETUP ARM CONTROL** menu.

TRIGGER CONTROL — Use this menu item to enable or disable the source bypass. The source bypass is used to bypass the arm spacing event on the first pass through the scan. With the **SETUP ARM CONTROL** menu displayed, select this menu item by placing the cursor on **TRIGGER-CONTROL** and pressing **ENTER**. The following menu will be displayed:

```
TRIGGER CONTROL
SOURCE  ACCEPTOR
```

Source — With this selection, the source bypass is enabled. The arm spacing event will be bypassed on the first pass through the arm layer if **TRIG LINK** arm spacing is selected. This will allow operation to proceed on into the scan layer without having to wait for the programmed event.

Acceptor — With this selection, the source bypass is disabled.

Place the cursor on the desired selection and press **ENTER**.

NOTE *When finished with the arm layer, use **EXIT** to back out of the menu structure.*

Channel restrictions

CAUTION **Channel restrictions must NEVER be used. If a channel restriction is used, pre-programmed channel patterns will be lost (cleared). In that event, you will have to reprogram the lost channel patterns as explained in Section 4.**

If you inadvertently select **CHAN RESTRICTION**, press **EXIT** to back out of the menu structure.

If you inadvertently enable a channel restriction, you will have to disable it, and then reprogram any lost channel patterns. The following explains how to disable the three channel restrictions.

1. Press SCAN CONFIGURATION to display the CONFIGURE SCAN menu.
2. Place the cursor on CHAN RESTRICTIONS and press ENTER to display the following menu:

```
CHANNEL RESTRICTIONS
SINGLE-CHAN  RESTRICTED-CHANS ►
◀ INTERLOCK
```

SINGLE CHAN — Use this selection to disable Single Channel.

Perform the following steps to disable Single Channel:

1. With the CHANNEL RESTRICTIONS menu displayed, place the cursor on SINGLE CHAN and press ENTER. The following message is displayed:

```
SINGLE CHANNEL MODE
OFF  ON
```

Cursor position indicates the current state of Single Channel.

2. Place the cursor on OFF and press ENTER. The display returns to the CHANNEL RESTRICTIONS menu.

RESTRICTED CHANS — Use to clear channels from the restricted channel list.

Perform the following steps to clear restricted channels:

1. With the CHANNEL RESTRICTIONS menu displayed, place the cursor on RESTRICTED-CHANS and press ENTER. The following prompt for channels will be displayed:

```
RESTRICTED CHANNELS
SELECT CHANNELS
```

2. If there are any channels or channel patterns in the list, delete them by pressing CLEAR LIST. With the empty list displayed, press EXIT.

INTERLOCK – There are five interlocks. Each interlock has two channel lists; List A and List B. In order to disable Interlock, all ten channel lists must be cleared.

Perform the following steps to clear interlocked channels:

1. With the CHANNEL RESTRICTIONS menu displayed, place the cursor on INTERLOCK and press ENTER to display the following menu:

```
SELECT INTERLOCK
#1 #2 #3 #4 #5
```

2. Place the cursor on interlock #1 and press ENTER. The following message is displayed:

```
INTERLOCK #1
LIST-A LIST-B
```

3. Place the cursor on LIST A and press ENTER to display the list:

```
INTERLOCK #1 LIST A
SELECT CHANNELS
```

The above message shows an empty list. If there are any channels or channel patterns in the list, press CLEAR LIST.

4. Press EXIT to return to this message:

```
INTERLOCK #1
LIST-A LIST-B
```

5. Select List B. If there are any channels or channel patterns in List B, press CLEAR LIST.

6. Press EXIT twice to return to this message:

```
SELECT INTERLOCK
#1 #2 #3 #4 #5
```

7. Repeat the basic procedures in steps 2 through 6 for Interlocks 2 through 5.

- When finished, use the EXIT key to back out of the menu structure.

External triggering (Trigger Link)

The System 41 has external triggering capabilities using the Trigger Link. The Trigger Link has six lines allowing up to six instruments to be controlled using this trigger bus.

Typically, you would want the System 41 to output a trigger after each channel closes and settles. The triggered external device would then perform a particular operation or test. When finished, the external device would then send a trigger back to the System 41 allowing its operation to continue on to another layer of the trigger model.

Using external triggering in the above manner allows you to semi-automate your test system. Since you must cold-switch the RF switches, you will still have to hold up operation somewhere in the trigger model so that you can remove the test signal(s) before closing and opening channels.

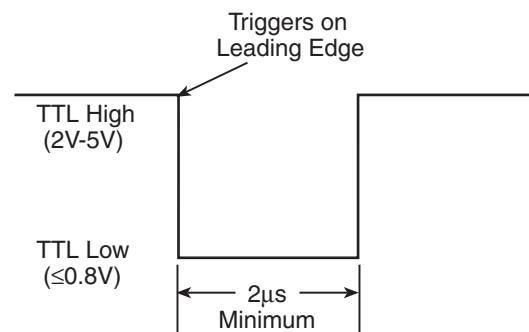
The System 41 can also output a trigger while in the scan and/or arm layers of the trigger model.

Asynchronous operation

The asynchronous operating mode uses separate lines for input and output triggers. An input trigger line requires a falling-edge, TTL-compatible pulse with the specifications shown in Figure 5-9.

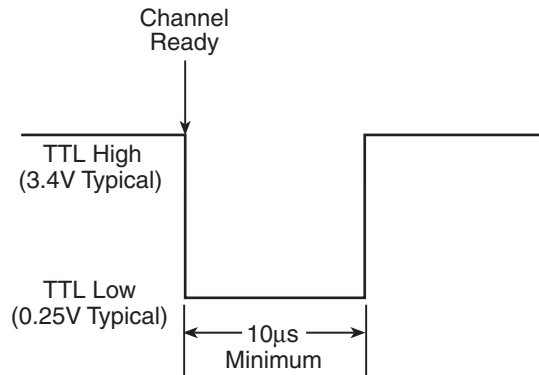
Figure 5-9

Asynchronous trigger input pulse specifications



An output trigger line provides a TTL-compatible output pulse that can be used to trigger other equipment. The specifications for this trigger pulse are shown in Figure 5-10.

Figure 5-10
Asynchronous trigger output pulse specifications

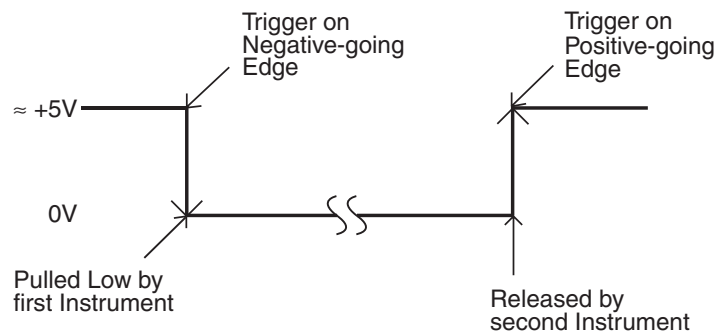


For typical asynchronous Trigger Link operation, the channel layer of the trigger model is configured with Channel Spacing set to TRIGLINK and Triggerlink Mode set to Asynchronous. You must also select input and output lines for the channel layer. Input and output triggers can be set to any of the six lines, but they cannot use the same line. For example, if you select line #1 for input triggers, then output triggers must select one of the other five lines (#2 through #6).

Semi-synchronous operation

In the semi-synchronous Trigger Link mode, all triggering (input and output) in the test system is controlled by a single line. When the normally high (+5V) trigger line is pulled low (0V), a trigger occurs on the negative-going edge. When the trigger line is released, a trigger occurs on the positive-going edge (see Figure 5-11). The advantage of this single line trigger is that as long as one of the instruments in the system holds the line low, the trigger is suppressed. In other words, the trigger will not occur until all instruments in the system are ready.

Figure 5-11
Semi-synchronous trigger link pulse specifications



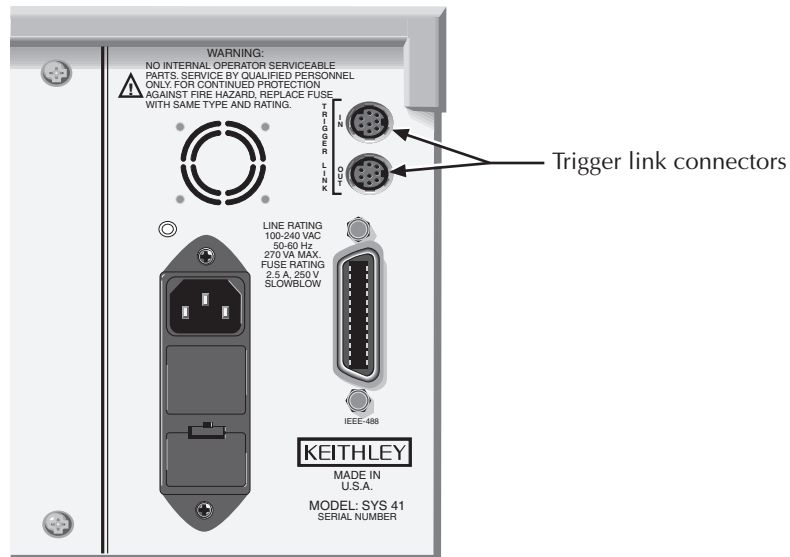
Trigger link connections

The two 8-pin micro DIN sockets for the Trigger Link are shown in Figure 5-12. When connecting the System 41 to an instrument that is also equipped with Trigger Link, use a Keithley Model 8501 Trigger Link Cable. Simply connect one end of the Trigger Link cable to any one of the trigger link connectors on the System 41, and connect the other end to the other instrument.

When connecting the System 41 to an instrument that uses two BNC connectors for external triggering, use the Keithley Model 8503 DIN to BNC Trigger Cable. This cable is terminated with two BNC connectors on one end and a Trigger Link connector on the other end.

NOTE When using external triggering with an instrument that uses BNC connectors (separate input and output), you must use the asynchronous mode of operation. Do not use the semi-synchronous mode.

Figure 5-12
Trigger link connectors



6

IEEE-488 Reference

Introduction

This section contains reference information on programming the System 41 over the IEEE-488 bus and is organized as follows:

IEEE-488 bus connections — Explains instrument connections to the IEEE-488 bus.

Primary address selection — Explains how to set the primary address from the front panel.

General bus commands — Covers the general IEEE-488 commands required for basic operations, such as placing the unit in remote.

Front panel aspects of IEEE-488 operation — Covers status indicators, messages that pertain to bus operation, and the use of the LOCAL key.

Status structure — Explains the various registers and queues that make up the status structure of the System 41.

Trigger model — Explains the scan process (Trigger Model) over the IEEE-488 bus.

Programming syntax — Covers the syntax rules for common commands and SCPI commands.

Common commands — Covers the IEEE-488.2 common commands used by the System 41.

SCPI command subsystems — Covers the SCPI commands used by the System 41.

The IEEE-488 is an instrumentation data bus with hardware and programming standards originally adopted by the IEEE (Institute of Electrical and Electronic Engineers) in 1975 and given the IEEE-488 designation. In 1978 and 1987, the standards were upgraded to IEEE-488-1978 and IEEE-488.1-1987, respectively. The System 41 conforms to these standards.

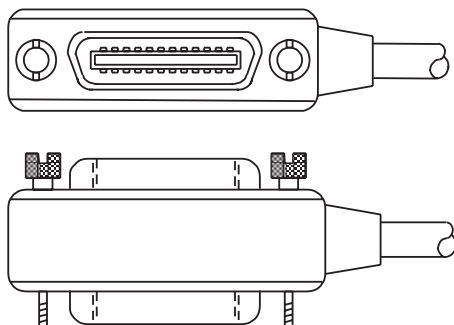
The System 41 also conforms to the IEEE-488.2-1987 standard and the SCPI 1990 (Standard Commands for Programmable Instruments) standard. IEEE-488.2 defines a syntax for sending data to and from instruments, how an instrument interprets this data, and what registers should exist to record the state of the instrument. This subset of commands (common commands) is used to perform basic operations, such as reading status registers, triggering measurements, and resetting the device.

The SCPI standard defines a command language protocol. It goes one step farther than IEEE-488.2 and defines a standard set of commands to control every programmable aspect of an instrument. It also defines what format the parameters for those commands should be in and the format for values returned by the instruments.

IEEE-488 bus connections

The System 41 can be connected to the IEEE-488 bus through a cable equipped with standard IEEE-488 connectors, an example is shown in Figure 6-1. The connector can be stacked to allow a number of parallel connections to one instrument. Two screws are located on each connector to ensure that connections remain secure. Current standards call for metric threads, which are identified with dark colored screws. Earlier versions had different screws, which were silver colored. Do not attempt to use these types of connectors on the instrument, which is designed for metric threads.

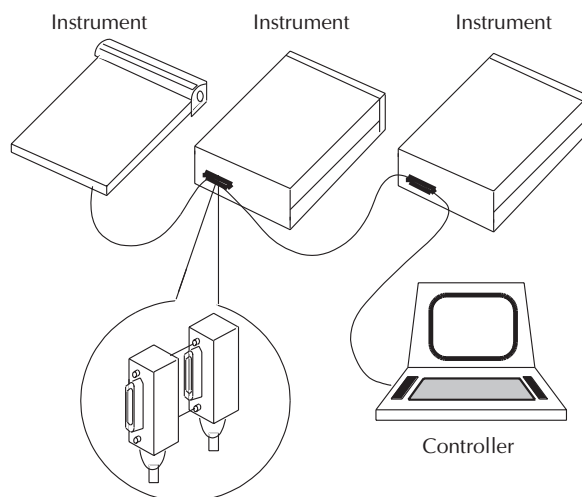
Figure 6-1
IEEE-488 connector



A typical connecting scheme for a multi-unit test system is shown in Figure 6-2. Although any number of connectors could theoretically be stacked on one instrument, it is recommended that you stack no more than three connectors on any one unit to avoid possible mechanical damage.

NOTE *In order to minimize interference caused by electromagnetic radiation, it is recommended that only shielded IEEE-488 cables be used. The Models 7007-1 and 7007-2 shielded IEEE-488 cables are available from Keithley.*

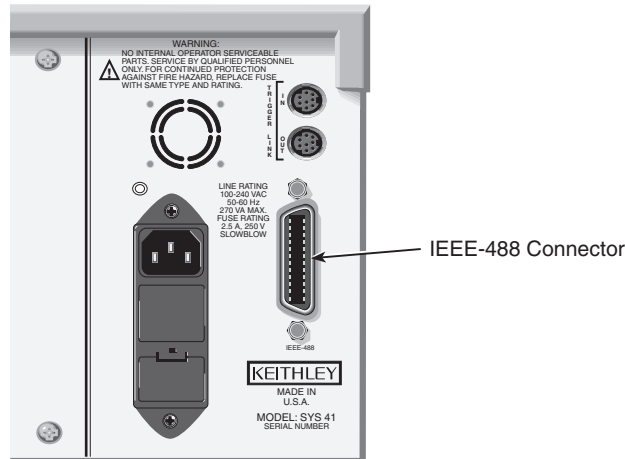
Figure 6-2
IEEE-488 connections



Connect the System 41 to the IEEE-488 bus as follows:

1. Line up the cable connector with the connector located on the rear panel. The connector is designed so that it will fit only one way. Figure 6-3 shows the location of the IEEE-488 connector on the instrument.

Figure 6-3
IEEE-488 connector location



2. Tighten the screws securely, but do not overtighten them.
3. Add additional connectors from other instruments, as required.
4. Make certain that the other end of the cable is properly connected to the controller. Most controllers are equipped with an IEEE-488 style connector, but a few may require a different type of connecting cable. Consult the instruction manual for your controller for the proper connecting method.

NOTE *The IEEE-488 bus is limited to a maximum of 15 devices, including the controller. The maximum cable length is 20-meters, or two meters times the number of devices, whichever is less. Failure to observe these limits may result in erratic bus operation.*

Custom cables may be constructed by using the information in Table 6-1 and Figure 6-4. Table 6-1 lists the contact designations for the bus, and Figure 6-4 shows the contact configuration.

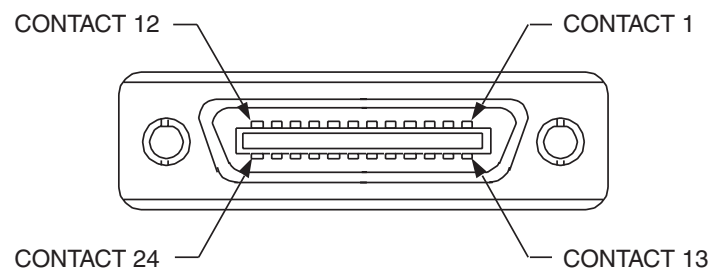
CAUTION IEEE-488 common is connected to digital common. Maximum voltage between digital common and earth ground is 0V.

Table 6-1
IEEE contact designations

Contact number	IEEE-488 designation	Type
1	DIO1	Data
2	DIO2	Data
3	DIO3	Data
4	DIO4	Data
5	EOI (24)*	Management
6	DAV	Handshake
7	NRFD	Handshake
8	NDAC	Handshake
9	IFC	Management
10	SRQ	Management
11	ATN	Management
12	SHIELD	Ground
13	DIO5	Data
14	DIO6	Data
15	DIO7	Data
16	DIO8	Data
17	REN (24)*	Management
18	Gnd, (6)*	Ground
19	Gnd, (7)*	Ground
20	Gnd, (8)*	Ground
21	Gnd, (9)*	Ground
22	Gnd, (10)*	Ground
23	Gnd, (11)*	Ground
24	Gnd, LOGIC	Ground

*Numbers in parentheses refer to signal ground return of referenced contact number. EOI and REN signal lines return on contact 24.

Figure 6-4
Contact configuration



Primary address selection

The System 41 must receive a listen command before responding to addressed commands. Similarly, the unit must receive a talk command before transmitting data. The System 41 is shipped from the factory with a programmed primary address of 7.

The primary address may be set to any value between 0 and 30 as long as address conflicts with other instruments are avoided. Note that controllers are also given a primary address, so do not use that address either. Most frequently, controller addresses are 0 or 21, but you should consult the controller's instruction manual for details. Whatever primary address you choose, you must make certain that it corresponds with the value specified as part of the controller's programming language.

To check the present primary address or to change to a new one, perform the following procedure:

1. Display the MAIN MENU by pressing the MENU key.
2. Use the cursor keys (◀ and ▶) to place the cursor on GPIB and press ENTER. The GPIB SETUP MENU will then be displayed.
3. Use the cursor keys to place the cursor on ADDRESS and press ENTER. The current primary address of the instrument will be displayed. For example, if the instrument is set to primary address 7, the following message will be displayed:
ADDRESS = 07 (0-30)
4. To retain the displayed address, press EXIT three times to return the instrument to the channel status display state.
5. To change the primary address, use the keypad to display the new address value (0 to 30) and press ENTER. Press EXIT two times to return to the channel status display state.

NOTE *Each device on the bus must have a unique primary address. Failure to observe this precaution will probably result in erratic bus operation.*

General bus commands

General commands are those commands, such as DCL, that have the same general meaning regardless of the instrument. Table 6-2 lists the general bus commands.

Table 6-2
General bus commands

Command	Effect on System 41
REN	Goes into remote when next addressed to listen.
IFC	Reset interface; all devices go into talker and listener idle states.
LLO	LOCAL key locked out.
GTL	Cancel remote; restore front panel operation.
DCL	Return all devices to known conditions.
SDC	Returns System 41 to known conditions.
GET	Initiates a trigger.
SPE, SPD	Serial Polls the System 41.

REN (remote enable)

The remote enable command is sent to the System 41 by the controller to set up the instrument for remote operation. Generally, the instrument should be placed in the remote mode before you attempt to program it over the bus. Simply setting REN true does not actually place the instrument in the remote state. You must address the instrument to listen after setting REN true before it goes into remote.

Note that the instrument does not have to be in remote to be a talker.

Also, note that all front panel controls except for LOCAL and the power switch are inoperative while the instrument is in remote. You can restore normal front panel operation by pressing the LOCAL key.

IFC (interface clear)

The IFC command is sent by the controller to place all instruments on the bus in the local, talker, listener idle states. The System 41 responds to the IFC command by canceling front panel TALK or LSTN lights if the instrument was previously placed in one of those states. Note that this command does not affect the status of the instrument; settings, data, and event registers are not changed.

To send the IFC command, the controller must set the IFC line true for a minimum of 100 μ s.

LLO (local lockout)

Use the LLO command to prevent local operation of the instrument. After the unit receives LLO, all its front panel controls except the POWER are inoperative. In this state, pressing the LOCAL will not restore control to the front panel. The GTL command restores control to the front panel.

GTL (go to local)

Use the GTL command to put a remote mode instrument into local mode. The GTL command also restores front panel key operation.

DCL (device clear)

Use the DCL command to clear the GPIB interface and return it to a known state. Note that the DCL command is not an addressed command, so all instruments equipped to implement DCL will do so simultaneously.

When the System 41 receives a DCL command, it clears the Input Buffer and Output Queue, cancels deferred commands, and clears any command that prevents the processing of any other device command. A DCL does not affect instrument settings and stored data.

SDC (selective device clear)

The SDC command is an addressed command that performs essentially the same function as the DCL command. However, since each device must be individually addressed, the SDC command provides a method to clear only selected instruments instead of clearing all instruments simultaneously, as is the case with DCL.

GET (group execute trigger)

GET is a GPIB trigger that is used as an event to control operation. The System 41 reacts to this trigger if it is the programmed control source. The control source is programmed from the SCPI TRIGger subsystem.

SPE, SPD (serial polling)

Use the serial polling sequence to obtain the System 41 serial poll byte. The serial poll byte contains important information about internal functions. Generally, the serial polling sequence is used by the controller to determine which of several instruments has requested service with the SRQ line. However, the serial polling sequence may be performed at any time to obtain the status byte from the System 41.

Front panel aspects of IEEE-488 operation

The following paragraphs discuss aspects of the front panel that are part of IEEE-488 operation, including messages, status indicators, and the LOCAL key.

Error and status messages

Table 4-1 in Section 4 summarizes the error and status messages associated with System 41 operation. Note that the instrument may be programmed to generate an SRQ, and command queries can be performed to check for specific error conditions.

IEEE-488 status indicators

The REM (remote), TALK (talk), LSTN (listen), and SRQ (service request) annunciators show the present IEEE-488 status of the instrument. Each of these indicators is briefly described below.

REM — As the name implies, this indicator shows when the instrument is in the remote state. Note that REM does not necessarily indicate the state of the REM line, as the instrument must be addressed to listen with REM true before the REM indicator turns on. When the instrument is in remote, all front panel keys except for the LOCAL key are locked out. When REM is turned off, the instrument is in the local state, and front panel operation is restored.

TALK — This indicator is on when the instrument is in the talker active state. The unit is placed in this state by addressing it to talk with the correct MTA (My Talk Address) command. TALK is off when the unit is in the talker idle state. The instrument is placed in the talker idle state by sending it an UNT (Untalk) command, addressing it to listen, or with the IFC (Interface Clear) command.

LSTN — This indicator is on when the System 41 is in the listener active state, which is activated by addressing the instrument to listen with the correct MLA (My Listen Address) command. Listen is off when the unit is in the listener idle state. The unit can be placed in the listener idle state by sending UNL (Unlisten), addressing it to talk, or by sending IFC (Interface Clear) over the bus.

SRQ — The instrument can be programmed to generate a service request (SRQ) when one or more errors or conditions occur. When this indicator is on, a service request has been generated. This indicator will stay on until the serial poll byte is read. See “Status byte and service request (SRQ)” for details.

LOCAL key

The LOCAL key cancels the remote state and restores local operation of the instrument.

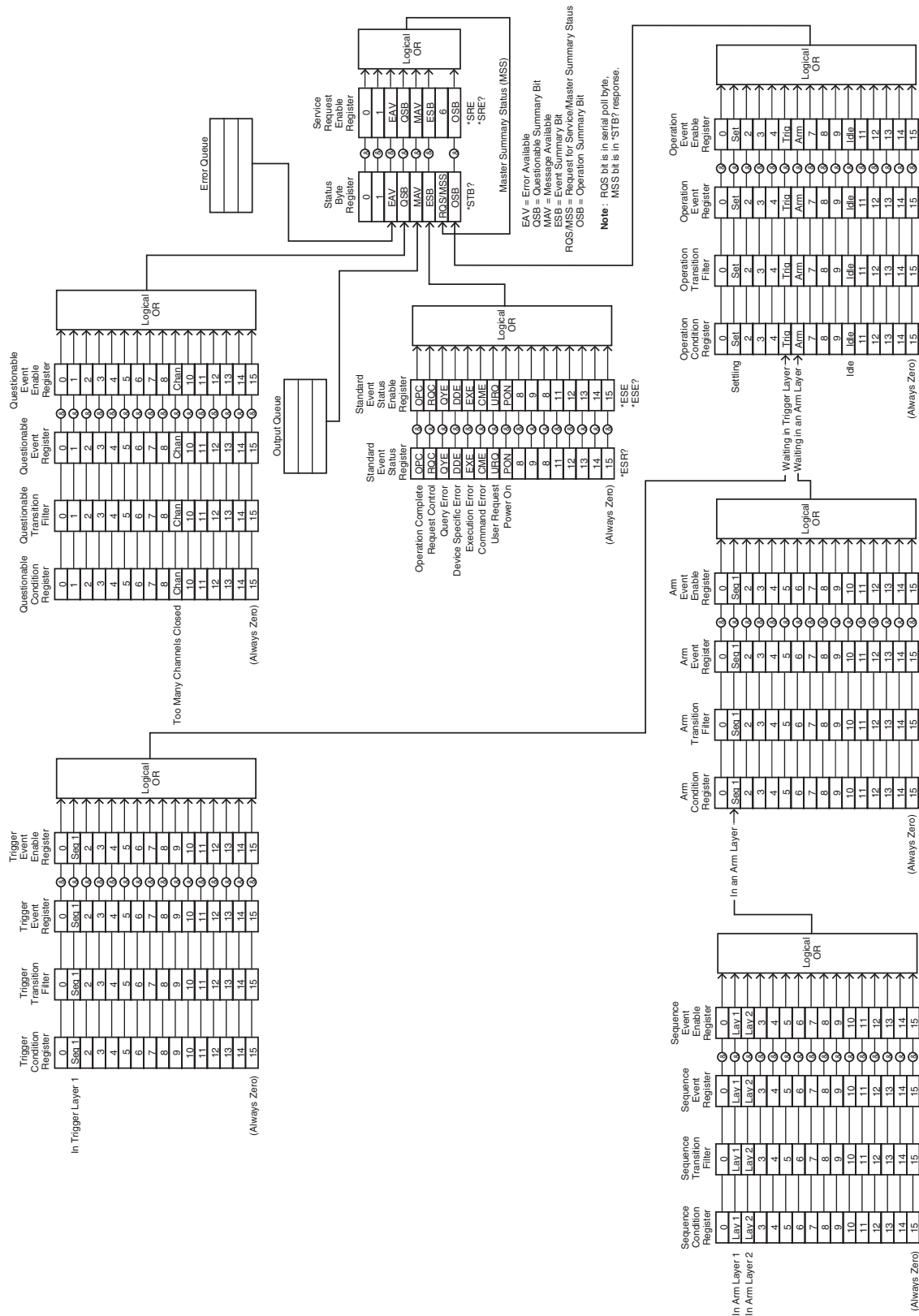
Since all front panel keys except LOCAL are locked out when the instrument is in remote, this key provides a convenient method of restoring front panel operation. Pressing LOCAL also turns off the REM indicator, and returns the display to normal if a user defined message was displayed.

Note that the LOCAL key is also inoperative if the LLO (Local Lockout) command is in effect.

Status structure

The status register structure of the System 41 is shown in Figure 6-5. The following information will explain the various registers and queues that make up this structure.

Figure 6-5
System 41 status register structure

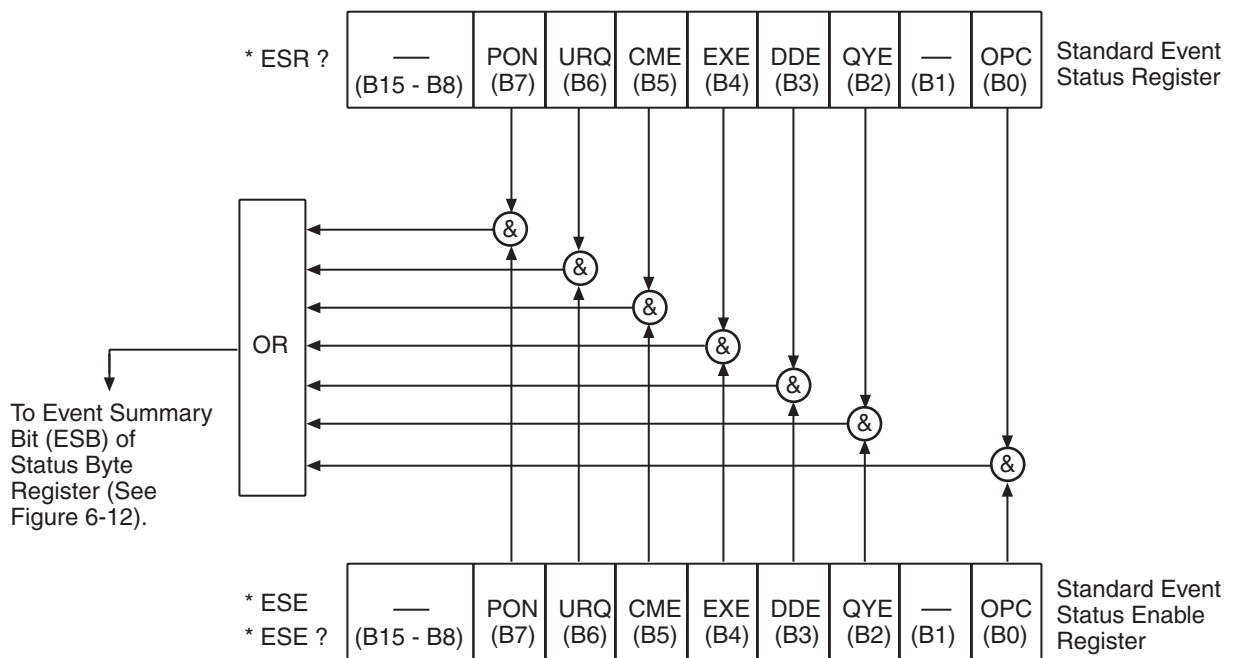


Standard event status

The reporting of standard events is controlled by two 16-bit registers; the Standard Event Status Register and the Standard Event Status Enable Register. Figure 6-6 shows how these registers are structured.

In general, the occurrence of a standard event sets the appropriate bit in the Standard Event Status Register. This register can be read at any time to determine which, if any, standard events have occurred. Also, with the proper use of the Standard Event Status Enable Register, a standard event can set the Event Summary Bit (ESB) of the Status Byte Register. This allows the programmer to take advantage of the service request (SRQ) feature. See "Status byte and service request (SRQ)" for details.

Figure 6-6
Standard event status



PON = Power On
 URQ = User Request
 CME = Command Error
 EXE = Execution Error
 DDE = Device - Dependent Error
 QYE = Query Error
 OPC = Operation Complete

& = Logical AND
 OR = Logical OR

Standard event status register

This is a latched read only register that is used to record the occurrence of standard events. Each used bit in the register represents a standard event. Descriptions of these standard events are provided in “*ESR? — event status register query.”

When a standard event occurs, the appropriate bit in the Standard Event Status Register sets. For example, if you attempt to read data from an empty Output Queue, a Query Error (QYE) will occur and set bit B2 of the status register. A set bit in this register will remain set until an appropriate operation is performed to clear the register. The Standard Event Status Register can be read at any time by using the following common query command (see “*ESR? — event status register query” for details):

*ESR?

Reading this register using the *ESR? command also clears the register. The following list summarizes all operations that clear the Standard Event Status Register:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the *ESR? common command.

Standard event status enable register

This register is programmed by the user and serves as a mask for standard events. When a standard event is masked, the occurrence of that event will not set the Event Summary Bit (ESB) in the Status Byte Register. Conversely, when a standard event is unmasked, the occurrence of that event will set the ESB bit.

A bit in the Standard Event Status Register is masked when the corresponding bit in the Standard Event Status Enable Register is cleared (0). When the masked bit of the Standard Event Status Register sets, it is ANDed with the corresponding cleared bit in the Standard Event Status Enable Register. The logic “0” output of the AND gate is applied to the input of the OR gate and thus, will not set the ESB bit in the Status Byte Register.

A bit in the Standard Event Status Register is unmasked when the corresponding bit in the Standard Event Status Enable Register is set (1). When the unmasked bit of the Standard Event Status Register sets, it is ANDed with the corresponding set bit in the Standard Event Status Enable Register. The logic “1” output of the AND gate is applied to the input of the OR gate and thus, sets the ESB bit in the Status Byte Register.

The individual bits of the Standard Event Status Enable Register can be set or cleared by using the following common command (see “*ESE — event status enable”):

*ESE <NRf>

The Standard Event Status Enable register can be read at any time by using the following common query command (see “*ESE? — event status enable query” for details):

*ESE?

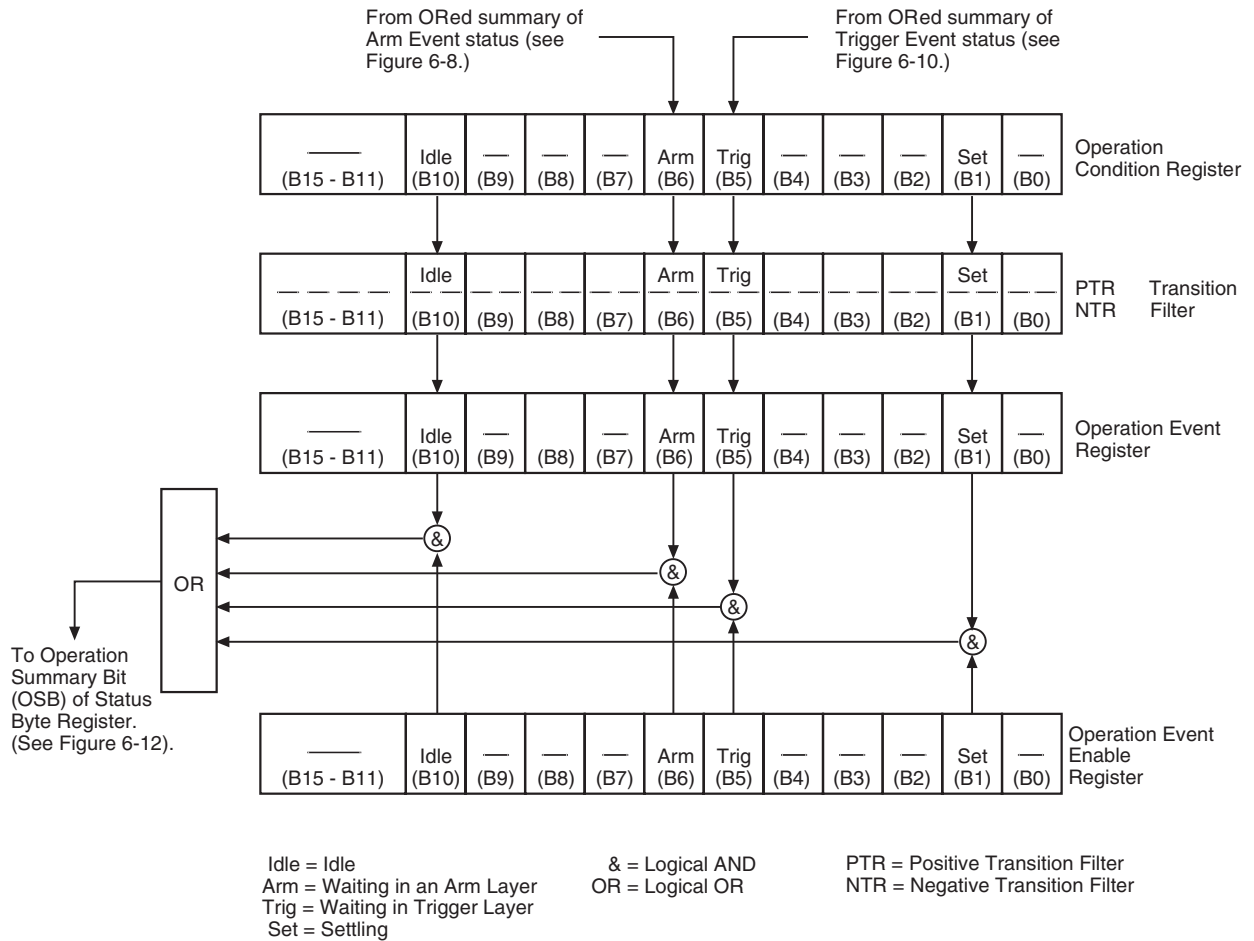
Reading this register using the *ESE? command does not clear the register. The following list summarizes all operations that will clear the Standard Event Status Enable Register:

1. Cycling power
2. *ESE 0

Operation event status

The reporting of operation events is controlled by a set of 16-bit registers; the Operation Condition Register, the Transition Filter, the Operation Event Register, and the Operation Event Enable Register. Figure 6-7 shows how these registers are structured.

Figure 6-7
Operation event status



Notice in Figure 6-5 that bits B5 (Waiting in Trigger Layer) and B6 (Waiting in An Arm Layer) of the Operation Condition Register are controlled by the arm register set and the trigger set and the trigger register set (see “Arm event status” and “Trigger event status” for details). Each of the bits that is used in these registers represents an operation event. Descriptions of the operation event bits are provided in “STATUS subsystem”.

The operation status registers are controlled by the :STATUS:OPERation commands in the :STATUS subsystem (see “STATUS subsystem”).

Operation condition register

This is a real-time 16-bit read-only register that constantly updates to reflect the current operating conditions of the System 41. For example, when the instrument is in idle, bit B10 (Idle) of this register will be set. When the instrument leaves the idle state, bit B10 will clear.

The following SCPI query command can be used to read the Operation Condition Register:

```
:STATus:OPERation:CONDition?
```

The Operation Condition Register and the Transition Filter are used to set the bits of the Operation Event Register. The Transition Filter is discussed next.

Operation transition filter

The transition filter is made up of two 16-bit registers that are programmed by the user. It is used to specify which transition (0 to 1, or 1 to 0) in the Operation Condition Register will set the corresponding bit in the Operation Event Register.

The filter can be programmed for positive transitions (PTR), negative transitions (NTR), or both. When an event bit is programmed for a positive transition, the event bit in the Operation Event Register will set when the corresponding bit in the Operation Event Condition Register changes from 0 to 1. Conversely, when programmed for a negative transition, the bit in the status register will set when the corresponding bit in the condition register changes from 1 to 0.

The individual bits of the transition filter registers can be set or cleared by using the following SCPI commands:

```
:STATus:OPERation:PTR <NRf>  
:STATus:OPERation:NTR <NRf>
```

The transition filter registers can be read at any time by using the following SCPI query commands:

```
:STATus:OPERATION:PTR?  
:STATus:OPERation:NTR?
```

Reading a transition filter register using the above query commands does not affect the contents of the register.

The following operations will set (1) all the bits of the PTR register and clear (0) all the bits of the NTR register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:PTR 65535 and :STATus:OPERation:NTR 0 commands.

Operation event register

This is a latched, read-only register whose bits are set by the Operation Condition Register and Transition Filter. Once a bit in this register is set, it will remain set (latched) until the register is cleared by a specific clearing operation. The bits of this register are logically ANDed with the bits of the Operation Event Enable Register and applied to an OR gate. The output of the OR gate is the Operation Summary Bit (OSB) that is applied to the Status Byte Register. The following SCPI query command can be used to read the Operation Event Register:

```
:STATus:OPERation?
```

Reading this register using the above SCPI command clears the register. The following list summarizes all operations that will clear the Operation Event Register:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the :STATus:OPERation:EVENT? query command.

Operation event enable register

This register is programmed by the user and serves as a mask for the Operation Event Register. When masked, a set bit in the Operation Event Register will not set the Operation Summary Bit (OSB) in the Status Byte Register. Conversely, when unmasked, a set bit in the Operation Event Register will set the OSB bit.

A bit in the Operation Event Register is masked when the corresponding bit in the Operation Event Enable Register is cleared (0). When the masked bit of the Operation Event Register sets, it is ANDed with the corresponding cleared bit in the Operation Event Enable Register. The logic "0" output of the AND gate is applied to the input of the OR gate and thus, will not set the OSB bit in the Status Byte Register.

A bit in the Operation Event Register is unmasked when the corresponding bit in the Operation Event Enable Register is set (1). When the unmasked bit of the Operation Event Register sets, it is ANDed with the corresponding set bit in the Operation Event Enable Register. The logic "1" output of the AND gate is applied to the input of the OR gate and thus, will set the OSB bit in the Status Byte Register.

The individual bits of the Operation Event Enable Register can be set or cleared by using the following SCPI command:

```
:STATus:OPERation:ENABLE <NRf>
```

The following SCPI query command can be used to read the Operation Event Enable Register:

```
:STATus:OPERation:ENABLE?
```

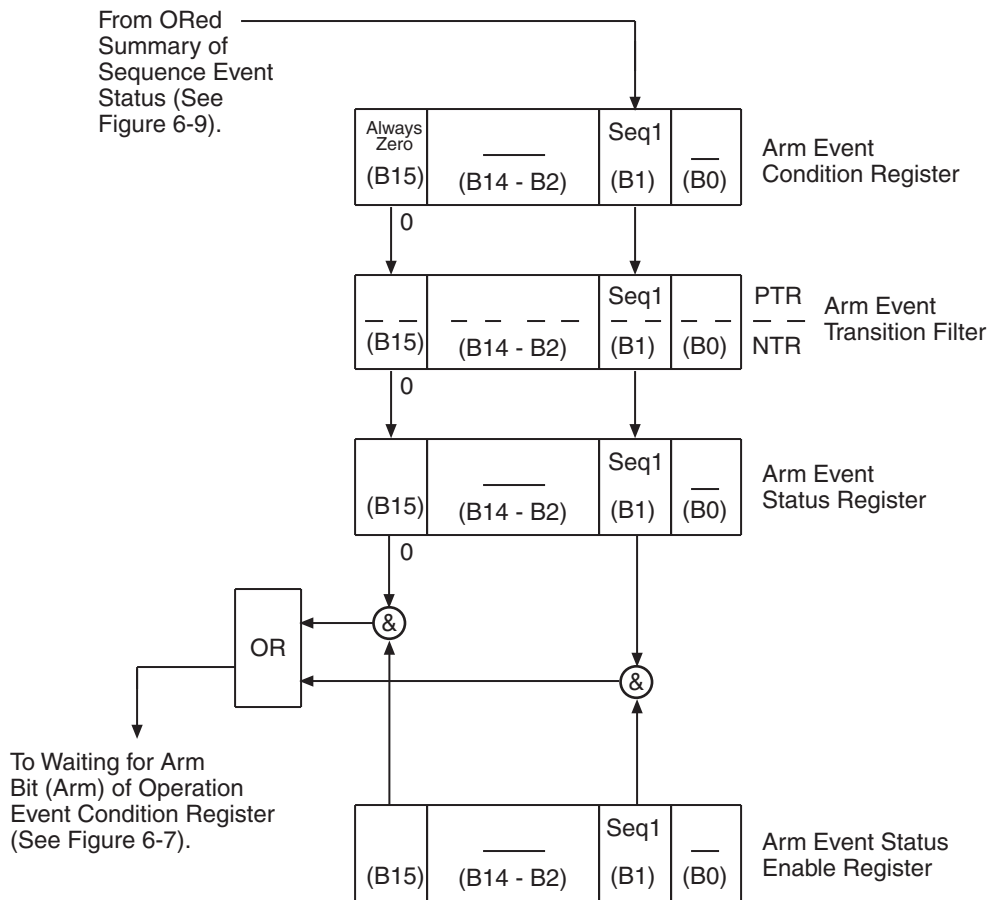
Reading this register using the above SCPI command does not clear the register. The following list summarizes operations that will clear the Operation Event Enable Register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:ENABLE 0 command.

Arm event status

The reporting of the arm event is controlled by a set of 16-bit registers; the Arm Condition Register, the Transition Filter, Arm Event Register, and the Arm Event Enable Register. Figure 6-8 shows how these registers are structured. Notice in Figure 6-5 that bit B1 (In An Arm Layer) of the Arm Condition Register is controlled by the sequence event register set (see “Sequence event status” for details). In general, bit B1 sets when the instrument is in the arm layer (Arm Layer 1) or scan layer (Arm Layer 2) of operation. An explanation of the operation process over the bus is provided in “Trigger Model (IEEE-488 operation).”

Figure 6-8
Arm event status



Seq 1 = Sequence 1 (Set bit indicates that the System 41 is in an arm layer)

& = Logical AND
 OR = Logical OR
 PTR = Positive Transition Register
 NTR = Negative Transition Register

The various registers used for arm event status are described as follows: Note that these registers are controlled by the :STATus:OPERation:ARM commands of the :STATus subsystem (see “STATus subsystem”).

Arm condition register

This is a real-time 16-bit read-only register that constantly updates to reflect the ORed summary of the sequence event register set. In general, if bit B1 is set, the instrument is in an arm layer. The following SCPI query command can be used to read the Arm Condition Register:

```
:STATus:OPERation:ARM:CONDition?
```

The Arm Condition Register and the Transition Filter are used to set the bits of the Arm Event Register. The Transition Filter is discussed next.

Arm transition filter

The transition filter is made up of two 16-bit registers that are programmed by the user. It is used to specify which transition (0 to 1, or 1 to 0) of bit B1 in the Arm Condition Register will set bit B1 in the Arm Event Register.

The filter can be programmed for positive transitions (PTR), negative transitions (NTR) or both. When an event bit is programmed for a positive transition, the event bit in the Arm Event Register will set when the corresponding bit in the Arm Condition Register changes from 0 to 1. Conversely, when programmed for a negative transition, the bit in the status register will set when the corresponding bit in the condition register changes from 1 to 0. The transition filter registers can be set or cleared by using the following SCPI commands:

```
:STATus:OPERation:ARM:PTR <NRf>
```

```
:STATus:OPERation:ARM:NTR <NRf>
```

The transition filter registers can be read at any time by using the following SCPI query commands:

```
:STATus:OPERation:ARM:PTR?
```

```
:STATus:OPERation:ARM:NTR?
```

Reading a transition filter register using the above query commands does not affect the contents of the register.

The following operations will set (1) all the bits of the PTR register and reset (0) all the bits of the NTR register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:ARM:PTR 65535 and :STATus:OPERation:ARM:NTR 0 commands.

Arm event register

This is a latched, read-only register whose bits are set by the Arm Condition Register and Transition Filter. Once a bit in this register is set, it will remain set (latched) until the register is cleared by a specific clearing operation. The bits of this register are logically ANDed with the bits of the Arm Event Enable Register and applied to an OR gate. The output of the OR gate is the Arm Summary Bit that is applied to the Operation Condition Register. The following SCPI query command can be used to read the Arm Event Register:

```
:STATus:OPERation:ARM:EVENT?
```

Reading this register using the above SCPI command clears the register. The following list summarizes all operations that will clear the Operation Event Register:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the :STATus:OPERation:ARM? query command.

Arm event enable register

This register is programmed by the user and serves as a mask for the Arm Event Register. When masked, a set bit (B1) in the Arm Event Register will not set the Waiting for Arm bit in the Operation Condition Register. Conversely, when unmasked, a set bit (B1) in the Arm Event Register will set the Waiting for Arm bit.

Bit B1 in the Arm Event Register is masked when the corresponding bit (B1) in the Arm Event Enable Register is cleared (0). When the masked bit of the Arm Event Register sets, it is ANDed with the corresponding cleared bit in the Arm Event Enable Register. The logic “0” output of the AND gate is applied to the input of the OR gate and thus, will not set the Waiting for Arm bit in the Operation Condition Register.

Bit B1 in the Arm Event Register is unmasked when the corresponding bit (B1) in the Arm Event Enable Register is set (1). When the unmasked bit of the Arm Event Register sets, it is ANDed with the corresponding set bit in the Arm Event Enable Register. The logic “1” output of the AND gate is applied to the input of the OR gate and thus, will set the Waiting for Arm bit in the Operation Condition Register.

Bit B1 of the Arm Event Enable Register can be set or cleared by using the following SCPI command:

```
:STATus:OPERation:ARM:ENABLE <NRf>
```

The following SCPI query command can be used to read the Arm Event Enable Register:

```
:STATus:OPERation:ARM:ENABLE?
```

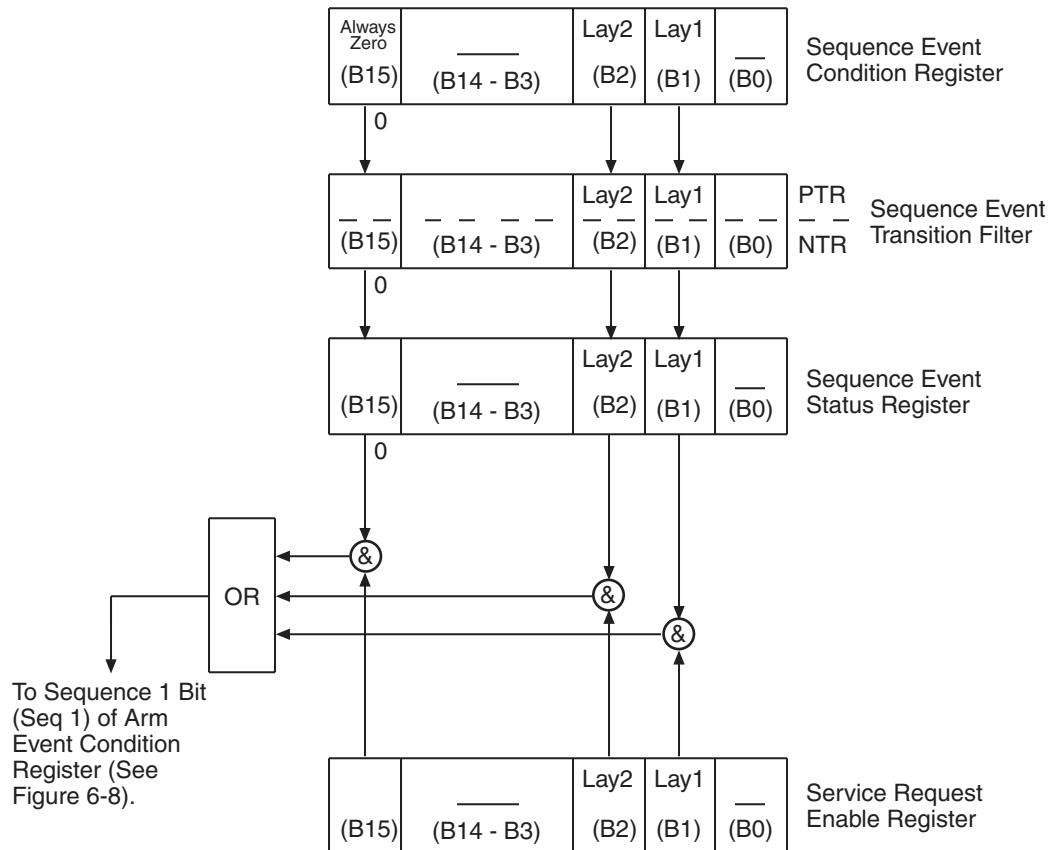
Reading this register using the above SCPI command will not clear the register. The following list summarizes operations that will clear the Arm Event Enable Register:

1. Cycling power.
2. Sending the :STATus:OPERation:ARM:ENABLE 0 command.

Sequence event status

The reporting of sequence events is controlled by a set of 16-bit registers; the Sequence Condition Register, the Transition Register, the Sequence Event Register, and the Sequence Event Enable Register. Figure 6-9 shows how these registers are structured.

Figure 6-9
Sequence event status



Lay1 = Layer 1 (Set bit indicates that System 41 is in Arm Layer 1)

Lay2 = Layer 2 (Set bit indicates that System 41 is in Arm Layer 2)

& = Logical AND
OR = Logical OR
PTR = Positive Transition Register
NTR = Negative Transition Register

Two bits of this register set are used by the System 41 to report sequence events. Bit B1 (In Arm Layer 1) is set when instrument is in (or exited) the arm layer (Arm Layer 1) of operation. Bit B2 (In Arm Layer 2) is set when the instrument is in (or exited) the scan layer (Arm Layer 2). The operation process over the bus is explained in “Trigger Model (IEEE-488 operation).”

The various registers used for sequence event status are described as follows. Note that these registers are controlled by the :STATus:OPERation:ARM:SEQUence commands of the :STATus subsystem (see “STATus subsystem”).

Sequence condition register

This is a real-time 16-bit read-only register that constantly updates to reflect the current arm layer status of the instrument. For example, if the System 41 is currently in the scan layer of operation, bit B2 (In Arm Layer 2) of this register will be set.

The following SCPI query command can be used to read the Sequence Condition Register:

```
:STATus:OPERation:ARM:SEQuence:CONDition?
```

The Sequence Condition Register and the Transition Filter are used to set the bits of the Sequence Event Register. The Transition Filter is discussed next.

Sequence transition filter

The transition filter is made up of two 16-bit registers that are programmed by the user. It is used to specify which transition (0 to 1, or 1 to 0) in the Sequence Condition Register will set the corresponding bit in the Sequence Event Register.

The filter can be programmed for positive transitions (PTR), negative transitions (NTR), or both. When an event bit is programmed for a positive transition, the event bit in the Sequence Event Register will set when the corresponding bit in the Sequence Condition Register changes from 0 to 1. Conversely, when programmed for a negative transition, the bit in the status register will set when the corresponding bit in the condition register changes from 1 to 0.

The transition filter registers can be set or cleared by using the following SCPI commands:

```
:STATus:OPERation:ARM:SEQuence:PTRansition <NRf>
```

```
:STATus:OPERation:ARM:SEQuence:NTRansition <NRf>
```

The transition filter registers can be read at any time by using the following SCPI query commands:

```
:STATus:OPERation:ARM:SEQuence:PTRansition?
```

```
:STATus:OPERation:ARM:SEQuence:NTRansition?
```

Reading a transition filter register using the above query commands does not affect the contents of the register.

The following operations will set (1) all the bits of the PTR register and reset (0) all the bits of the NTR register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:ARM:SEQuence: PTR 65535 and :STATus:OPERation:ARM: SEQuence:NTR 0 commands.

Sequence event register

This is a latched, read-only register whose bits are set by the Sequence Condition Register and Transition Filter. Once a bit in this register is set, it will remain set (latched) until the register is cleared by a specific clearing sequence. The bits of this register are logically ANDed with the bits of the Sequence Event Enable Register and applied to an OR gate. The output of the OR gate is applied to bit B1 of the Arm Condition Register (see “Arm event status”). The following SCPI query command can be used to read the Sequence Event Register:

```
:STATus:OPERation:ARM:SEQuence?
```

Reading this register using the above SCPI command clears the register. The following list summarizes all operations that will clear the Sequence Event Register:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the :STATus:OPERation:ARM:SEQuence? query command.

Sequence event enable register

This register is programmed by the user and serves as a mask for the Sequence Event Register. When masked, a set bit in the Sequence Event Register will not set bit B1 of the Arm Condition Register. Conversely, when unmasked, a set bit in the Sequence Event Register will set the bit B1 of the Arm Condition Register.

A bit in the Sequence Event Register is masked when the corresponding bit in the Sequence Event Enable Register is cleared (0). When the masked bit of the Sequence Event Register sets, it is ANDed with the corresponding cleared bit in the Sequence Event Enable Register. The logic “0” output of the AND gate is applied to the input of the OR gate and thus, will not set bit B1 of the Arm Condition Register.

A bit in the Sequence Event Register is unmasked when the corresponding bit in the Sequence Event Enable Register is set (1). When the unmasked bit of the Sequence Event Register sets, it is ANDed with the corresponding set bit in the Sequence Event Enable Register. The logic “1” output of the AND gate is applied to the input of the OR gate and thus, will set bit B1 of the Arm Condition Register.

The individual bits of the Sequence Event Enable Register can be set or cleared by using the following SCPI command:

```
:STATus:OPERation:ARM:SEQuence:ENABle <NRf>
```

The following SCPI query command can be used to read the Sequence Event Enable Register:

```
:STATus:OPERation:ARM:SEQuence:ENABle?
```

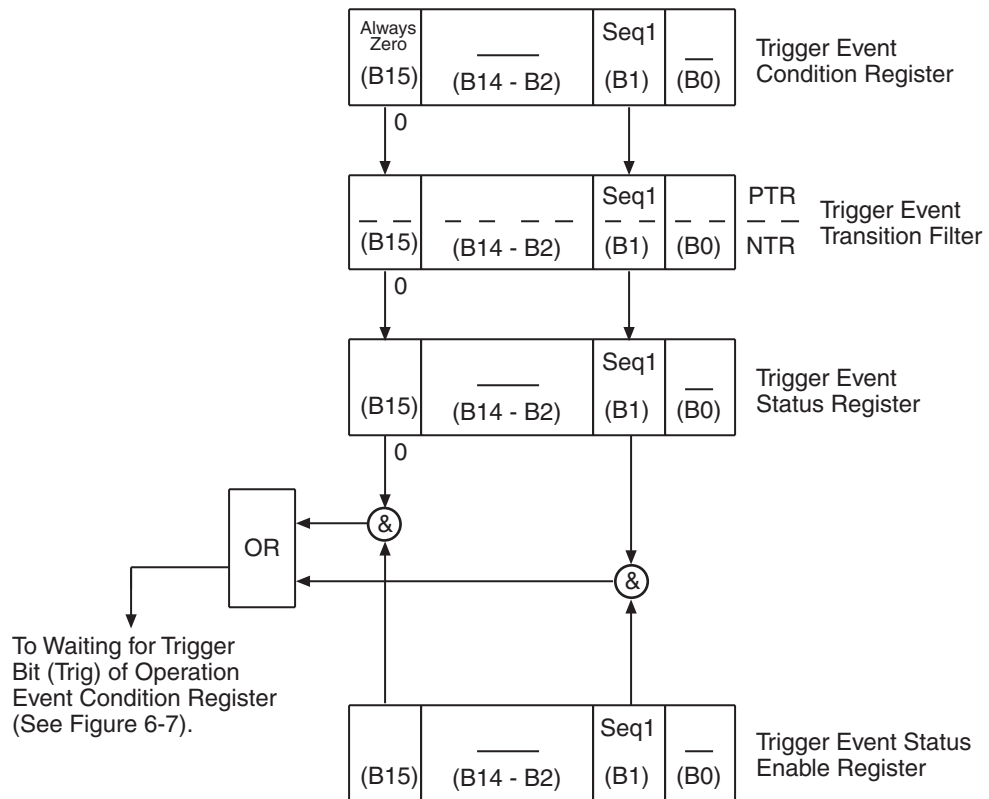
Reading this register using the above SCPI command will not clear the register. The following list summarizes operations that will clear the Sequence Event Enable Register:

1. Cycling power.
2. Sending the :STATus:OPERation:ARM:SEQuence:ENABle 0 command.

Trigger event status

The reporting of the trigger event is controlled by a set of 16-bit registers; the Trigger Condition Register, the Transition Filter, the Trigger Event Register, and the Trigger Event Enable Register. Figure 6-10 shows how these registers are structured.

Figure 6-10
Trigger event status



Seq 1 = Sequence 1 (Set bit indicates that the System 41 is in the Trigger Layer)

& = Logical AND
 OR = Logical OR
 PTR = Positive Transition Register
 NTR = Negative Transition Register

Bit B1 (Seq1) of the register set is used for the trigger event (In Trigger Layer). In general, Bit B1 sets when the instrument is in (or has exited) the measure layer of operation. An explanation of the System 41 operation process is provided in “Trigger Model (IEEE-488 operation).” The various registers used for trigger event status are described as follows: Note that these registers are controlled by the :STATus:OPERation:TRIGger commands of the :STATus subsystem (see “STATus subsystem”).

Trigger condition register

This is a real-time 16-bit read-only register that constantly updates to reflect the trigger layer status of the instrument. If bit B1 is set, the instrument is in the trigger layer (measure layer) of operation.

The following SCPI query command can be used to read the Trigger Condition Register:

```
:STATus:OPERation:TRIGger:CONDition?
```

The Trigger Condition Register and the Transition Filter are used to set bit B1 of the Trigger Event Register. The Transition Filter is discussed next.

Trigger event transition filter

The transition filter is made up of two 16-bit registers that are programmed by the user. It is used to specify which transition (0 to 1, or 1 to 0) of bit B1 in the Trigger Condition Register will set bit B1 in the Trigger Event register.

The filter can be programmed for positive transitions (PTR), negative transitions (NTR) or both. When an event bit is programmed for a positive transition, the event bit in the Trigger Event Register will set when the corresponding bit in the Trigger Condition Register changes from 0 to 1. Conversely, when programmed for a negative transition, the bit in the status register will set when the corresponding bit in the condition register changes from 1 to 0.

The transition filter registers can be set or cleared by using the following SCPI commands:

```
:STATus:OPERation:TRIGger:PTRansition <NRf>
```

```
:STATus:OPERation:TRIGger:NTRansition <NRf>
```

The transition filter register can be read at any time by using the following SCPI query commands:

```
:STATus:OPERation:TRIGger:PTRansition?
```

```
:STATus:OPERation:TRIGger:NTRansition?
```

Reading a transition filter register using the above query commands does not affect the contents of the register.

The following operations will set (1) all the bits of the PTR register and reset (0) all the bits of the NTR register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:OPERation:TRIGger:NTR 0 commands.

Trigger event register

This is a latched, read-only register whose bits are set by the Trigger Condition Register and Transition Filter. Once a bit in this register is set, it will remain set (latched) until the register is cleared by a specific clearing operation. The bits of this register are logically ANDed with the bits of the Trigger Event Enable Register and applied to an OR gate. The output of the OR gate is applied to bit B5 (Waiting for Trigger) of the Operation Condition Register.

The following SCPI query command can be used to read the Trigger Event Register:

```
:STATus:OPERation:TRIGger:EVENT?
```

Reading this register using the above SCPI command clears the register. The following list summarizes all operations that will clear the Trigger Event Register:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the :STATus:OPERation:TRIGger? query command.

Trigger event enable register

This register is programmed by the user and serves as a mask for the Trigger Event Register. When masked, a set bit (B1) in the Trigger Event Register cannot set bit B5 (Waiting for Trigger) of the Operation Condition Register. Conversely, when unmasked, a set bit (B1) in the Trigger Event Register will set bit B5 of the Operation Condition Register.

Bit B1 in the Trigger Event Enable Register is masked when the corresponding bit (B1) in the Trigger Event Register is cleared (0). When the masked bit of the Trigger Event Register sets, it is ANDed with the corresponding cleared bit in the Trigger Event Enable Register. The logic “0” output of the AND gate is applied to the input of the OR gate and thus, cannot set bit B5 of the Operation Condition Register.

Bit B1 in the Trigger Event Register is unmasked when the corresponding bit (B1) in the Trigger Event Enable Register is set (1). When the unmasked bit of the Trigger Event Register sets, it is ANDed with the corresponding set bit in the Trigger Event Enable Register. The logic “1” output of the AND gate is applied to the input of the OR gate and thus, will set bit B5 of the Operation Condition Register.

Bit B1 of the Trigger Event Enable Register can be set or cleared by using the following SCPI command:

```
:STATus:OPERation:TRIGger:ENABle <NRf>
```

The following SCPI query command can be used to read the Trigger Event Enable Register:

```
:STATus:OPERation:TRIGger:ENABle?
```

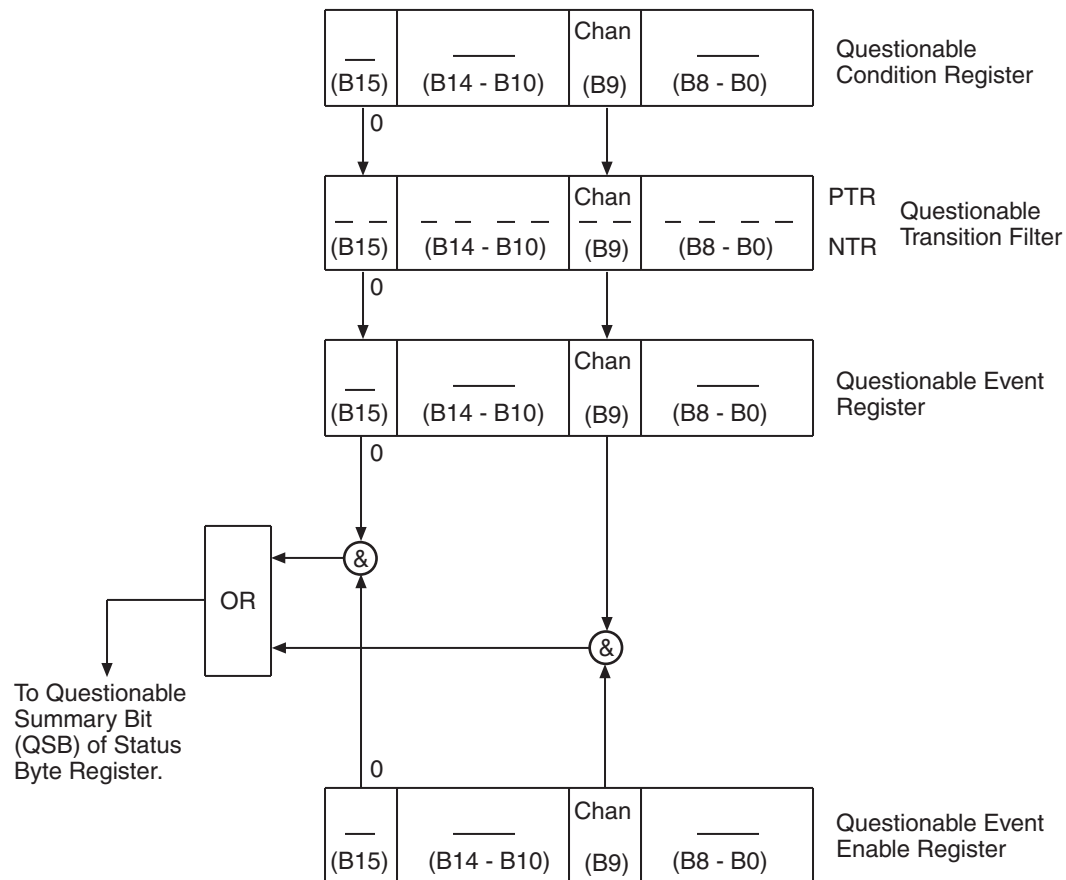
Reading this register using the above SCPI command will not clear the register. The following list summarizes operations that will clear the Trigger Event Enable Register:

1. Cycling power.
2. Sending the :STATus:OPERation:TRIGger:ENABle 0 command.

Questionable event status

The reporting of questionable events is controlled by a set of 16-bit registers; the Questionable Condition Register, the Transition Filter, the Questionable Event Register and the Questionable Event Enable Register. Figure 6-11 shows how the registers are structured. Each of the bits that is used in these registers represent a questionable event. Descriptions of the questionable event bits are provided in "STATus subsystem."

Figure 6-11
Questionable event status



Chan = Too many channels closed

& = Logical AND

OR = Logical OR

PTR = Positive Transition Register

NTR = Negative Transition Register

The questionable status registers are controlled by the :STATus:QUEStionable commands in the :STATus subsystem (see "STATus subsystem").

Questionable condition register

This is a real time 16-bit read-only register that constantly updates to reflect the current operating conditions of the System 41. For example, when too many channels are closed, bit B9 (Chan) will set. After the channels open, bit B9 will clear.

The following SCPI query command can be used to read the Questionable Condition Register:

```
:STATus:QUEStionable:CONDition?
```

The Questionable Condition Register and the Transition Filter are used to set the bits of the Questionable Event Register. The Transition Filter is discussed next.

Questionable transition filter

The transition filter is made up of two 16-bit registers that are programmed by the user. It is used to specify which transition (0 to 1, or 1 to 0) in the Questionable Condition Register will set the corresponding bit in the Questionable Event Register.

The filter can be programmed for positive transitions (PTR), negative transitions (NTR) or both. When an event bit is programmed for a positive transition, the event bit in the Questionable Event Register will set when the corresponding bit in the Questionable Condition Register changes from 0 to 1. Conversely, when programmed for a negative transition, the bit in the status register will set when the corresponding bit in the condition register changes from 1 to 0.

The individual bits of the transition filter registers can be set or cleared by using the following SCPI commands:

```
:STATus:QUEStionable:PTR <NRf>  
:STATus:QUEStionable:NTR <NRf>
```

The transition filter registers can be read at any time by using the following SCPI query commands:

```
:STATus:QUEStionable:PTR?  
:STATus:QUEStionable:NTR?
```

Reading a transition filter register using the above query commands does not affect the contents of the register.

The following operations will set (1) all the bits of the PTR register and clear (0) all the bits of the NTR register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:QUEStionable:PTR 65535 and :STATus:QUEStionable:NTR 0 commands.

Questionable event register

This is a latched, read-only register whose bits are set by the Questionable Condition Register and Transition Filter. Once a bit in this register is set, it will remain set (latched) until the register is cleared by a specific clearing operation. The bits of this register are logically ANDed with the bits of the Questionable Event Register and applied to an OR gate. The output of the OR gate is the Questionable Summary Bit (QSB) of the Status Byte Register. The following SCPI query command can be used to read the Questionable Event Register:

```
:STATus:QUEStionable:EVENT?
```

Reading this register using the above SCPI command clears the register. The following list summarizes all operations that will clear the Questionable Event Registers:

1. Cycling power.
2. Sending the *CLS common command.
3. Sending the :STATus:QUEStionable? query command.

Questionable event enable register

This register is programmed by the user and serves as a mask for the Questionable Event Register. When Masked, a set bit in the Questionable Event Register will not set the Questionable Summary Bit (QSB) in the Status Byte Register. Conversely, when unmasked, a set bit in the Questionable Event Register will set the QSB bit.

A bit in the Questionable Event Register is masked when the corresponding bit in the Questionable Event Enable Register is cleared (0). When the masked bit of the Questionable Event Register sets, it is ANDed with the corresponding cleared bit in the Questionable Event Enable Register. The logic “0” output of the AND gate is applied to the input of the OR gate and thus, will not set the QSB bit in the Status Byte Register.

A bit in the Questionable Event Register is unmasked when the corresponding bit in the Questionable Event Enable Register is set (1). When the unmasked bit of the Questionable Event Register sets, it is ANDed with the corresponding set bit in the Questionable Event Enable Register. The logic “1” output of the AND gate is applied to the input of the OR gate and thus, will set the QSB bit in the Status Byte Register.

The individual bits of the Questionable Event Enable Register can be set or cleared by using the following SCPI command:

```
:STATus:QUEStionable:ENABle <NRf>
```

The following SCPI query command can be used to read the Questionable Event Enable Register:

```
:STATus:QUEStionable:ENABle?
```

Reading this register using the above SCPI command does not clear the register. The following list summarizes operations that will clear the Questionable Event Enable Register:

1. Cycling power.
2. Sending the :STATus:PRESet command.
3. Sending the :STATus:QUEStionable:ENABle 0 command.

Queues

The System 41 uses two queues; the Output Queue and the Error/Status Queue. The queues are first-in first-out (FIFO) registers. They are used to hold data messages and error/status messages respectively. The System 41 Status Model (Figure 6-5) shows how the two queues are structured with the other registers.

Output Queue

The Output Queue is used to hold all data that pertains to the normal operation of the instrument. For example, when a query command is sent, the data message that pertains to that query is placed in the Output Queue.

When a data message is placed in the Output Queue, the Message Available (MAV) bit in the Status Byte Register becomes set. A data message is cleared from the Output Queue when it is read. The Output Queue is considered cleared when it is empty. An empty Output Queue clears the MAV bit in the Status Byte Register.

A message from the Output Queue is read by addressing the System 41 to talk.

Error Queue

The Error Queue is used to hold error messages and status messages. When an error or status event occurs, a message that defines the error/status is placed in the Error Queue. This queue will hold up to ten messages.

When a message is placed in the Error Queue, the Error Available (EAV) bit in the Status Byte Register is set. An error message is cleared from the Error Queue when it is read. The Error Queue is considered cleared when it is empty. An empty Error Queue clears the EAV bit in the Status Byte Register.

An error message from the Error Queue is read by sending either of the following SCPI query commands and then addressing the System 41 to talk:

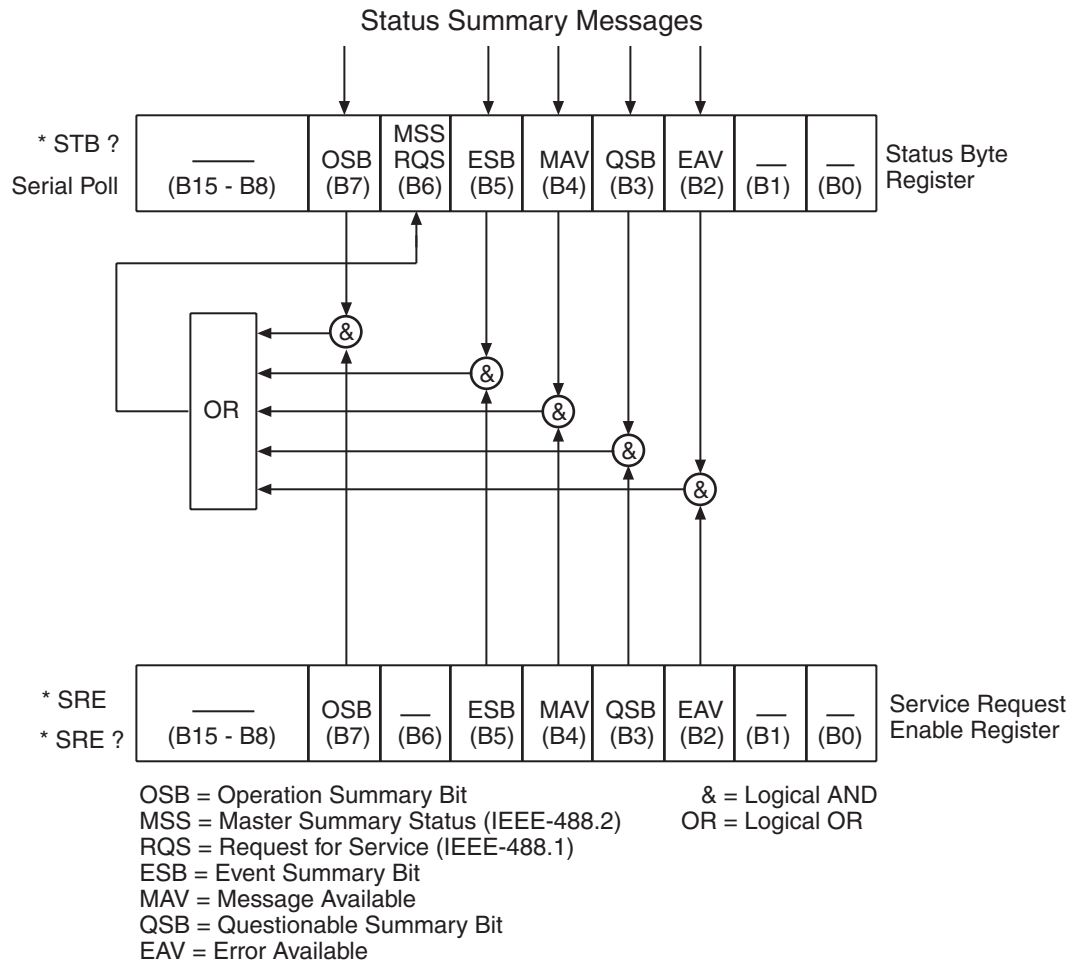
```
:SYSTem:ERRor?  
:STATus:QUEue?
```

Refer to “:QUEue commands” and “:ERRor?” for complete information on reading error messages.

Status byte and service request (SRQ)

Service request is controlled by two eight-bit registers; the Status Byte Register and the Service Request Enable Register. The structure of these registers is shown in Figure 6-12.

Figure 6-12
Status byte and service request (SRQ)



Status byte register

The summary messages from the status registers and queues are used to set or clear the appropriate bits (B2, B3, B4, B5, and B7) of the Status Byte Register. These bits do not latch and their states (0 or 1) are solely dependent on the summary messages (0 or 1). For example, if the Standard Event Status Register is read, its register will clear. As a result, its summary message will reset to 0, which in turn will clear the ESB bit in the Status Byte Register.

Bit B6 in the Status Byte Register is either:

- The Master Summary Status (MSB) bit, sent in response to the *STB? command, indicates the status of any set bits with corresponding enable bits set.
- The Request for Service (RQS) bit, sent in response to a serial poll, indicates which device was requesting service by pulling on the SRQ line.

For description of the other bits in the Status Byte Register, refer to “*STB? — status byte query.”

The IEEE-488.2 standard uses the following common query command that simply reads the Status Byte Register contents:

`*STB?`

When reading the Status Byte Register using the `*STB?` command, bit B6 is called the MSB bit. None of the bits in the Status Byte Register are cleared when using the `*STB?` command to read it.

The IEEE-488.1 standard has a serial poll sequence that will also read the Status Byte Register and is better suited to detect a service request (SRQ). When using the serial poll, bit B6 is called the RQS bit. Serial polling causes bit B6 (RQS) to reset. Serial polling is discussed in more detail later in this paragraph (see “Serial Poll and SRQ”).

The following operations clears all bits of the Status Byte Register:

1. Cycling power.
2. Sending the `*CLS` common command.

NOTE *The MAV bit may or may not be cleared.*

Service request enable register

This register is programmed by the user and serves as a mask for the Status Summary Message bits (B2, B3, B4, B5, and B7) of the Status Byte Register. When masked, a set summary bit in the Status Byte Register will not set bit B6 (MSS/RQS) of the Status Byte Register. Conversely, when unmasked, a set summary bit in the Status Byte Register will set bit B6.

A Status Summary Message bit in the Status Byte Register is masked when the corresponding bit in the Service Request Enable Register is cleared (0). When the masked summary bit in the Status Byte Register sets, it is ANDed with the corresponding cleared bit in the Service Request Enable Register. The logic “0” output of the AND gate is applied to the input of the OR gate and thus, will not set the MSS/RQS bit in the Status Byte Register.

A Status Summary Message bit in the Status Byte Register is unmasked when the corresponding bit in the Service Request Enable Register is set (1). When the unmasked summary bit in the Status Byte Register sets, it is ANDed with the corresponding set bit in the Service Request Enable Register. The logic “1” output of the AND gate is applied to the input of the OR gate and thus, will set the MSS/RQS bit in the Status Byte Register.

The individual bits of the Service Request Enable Register can be set or cleared by using the following common command (see “`*SRE` — service request enable” for details):

`*SRE <NRf>`

The Service Request Enable Register can be read using the following common query command (see “`*SRE?` — service request enable query” for details):

`*SRE?`

The Service Request Enable Register is not cleared when it is read using the `*SRE?` query command. The Service Request Enable Register will clear when power is cycled or a parameter (n) value of zero is sent with the `*SRE` command (`*SRE 0`).

Serial poll and SRQ

Any enabled event summary bit that goes from 0 to 1 will set RQS and generate a service request (SRQ). The user's test program can periodically read the Status Byte Register to check to see if a service request (SRQ) has occurred and what caused it. In the event of an SRQ, the program can, for example, branch to an appropriate subroutine that will service the request. Typically, service requests (SRQs) are managed by the serial poll sequence of the System 41. If an SRQ does not occur, bit B6 (RQS) of the Status Byte Register will remain cleared and the program will simply proceed normally after the serial poll is performed. If an SRQ does occur, bit B6 of the Status Byte Register will set and the program can branch to a service subroutine when the SRQ is detected by the serial poll.

The serial poll will automatically reset RQS of the Status Byte Register. This will allow subsequent serial polls to monitor Bit 6 for an SRQ occurrence generated by other event types. After a serial poll, the same event can cause another SRQ, even if the event register which caused the first SRQ has not been cleared.

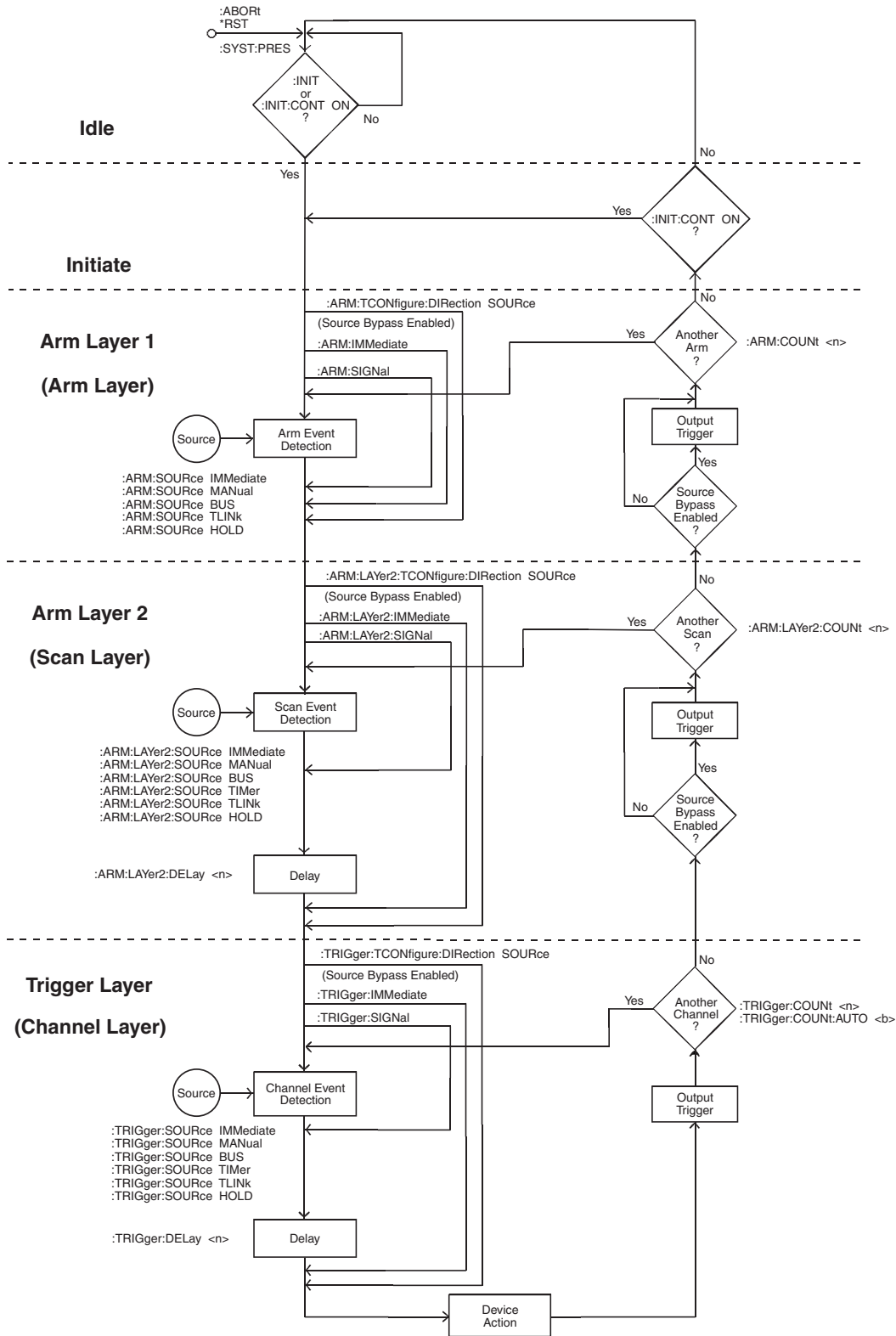
A serial poll clears RQS but does not clear MSS. The MSS bit will stay set until all Status Byte event summary bits are cleared or until the corresponding bits in the service request enable registers are cleared.

The actual serial poll sequence is explained in "Status byte and service request (SRQ)."

Trigger Model (IEEE-488 operation)

The following information describes the operation process of the System 41 over the IEEE-488 bus. The flowchart in Figure 6-13, which summarizes operation over the bus, is called the Trigger Model. It is called the Trigger Model because operation is controlled by SCPI commands from the Trigger subsystem (see "Trigger subsystem"). Notice that key SCPI commands are included in the Trigger Model.

Figure 6-13
Trigger Model (IEEE-488 bus operation)



Keep in mind that the RF module must be cold switched. That is, you cannot scan a channel pattern while a test signal is applied to the inputs or outputs of the System 41.

When you configure the trigger model, you must hold up operation so that you can remove the test signal(s) before closing and opening channels. The following steps must be performed for each channel pattern to be scanned:

1. Hold up operation.
2. Remove test signal(s) from System 41.
3. Scan channel pattern.
4. Apply test signal to System 41.

To accommodate cold switching, operation is typically held up in the trigger layer of the trigger model.

Idle and initiate

The instrument is considered to be in the idle state whenever it is not operating within one of the layers of the Trigger Model. The front panel ARM indicator is off when the instrument is in the idle state. While in the idle state, the instrument cannot perform any scan functions. Over the bus, there are two SCPI commands that can be used to take the instrument out of the idle state; :INITiate or :INITiate:CONTinuous ON.

Notice that with continuous initiation enabled (:INIT:CONT ON), the instrument will not remain in the idle state after all programmed operations are completed. However, the instrument can be returned to the idle state at any time by sending the *RST command, or the :SYST:PRESet command.

Once the instrument is taken out of the idle state, operation proceeds into the arm layer (Arm Layer 1) of the Trigger Model.

Arm layer1

NOTE *For front panel operation, this layer is called the arm layer.*

In general, the instrument requires an arm event to allow operation to proceed to the next layer (Arm Layer 2). With the Immediate control source selected (:ARM:SOURce IMMEDIATE), operation immediately proceeds to the next layer when the instrument is taken out of the idle state. The *RST and :SYSTEM:PRESet commands also set the arm control source to Immediate. With one of the other control sources selected, the instrument will wait until the appropriate event occurs.

With the Manual control source selected (:ARM :SOURce MANUAL), the instrument will wait until the front panel STEP key is pressed. Note that the System 41 must be taken out of remote (press LOCAL key or send GTL over bus) before it will respond to the STEP key. With the Bus control source selected (:ARM:SOURce BUS), the instrument will wait until a bus trigger (GET or *TRG) is received. With the Trigger Link control source selected (:ARM:SOURce TLINK), the instrument will wait until an input trigger is received (via TRIGGER LINK). With the Hold control source selected (:ARM:SOURce HOLD), the instrument will not respond to any of the control source events.

As can be seen in the flowchart, there are three paths that allow operation to loop around the control source. These three paths are described as follows:

1. When the Source Bypass is enabled (:ARM:TCONfigure:DIRection SOURce) and the Trigger Link control source is selected, operation will loop around the control source on the initial pass through Arm Layer 1. If programmed for another arm (arm count > 1), the bypass loop will not be in effect even though it will still be enabled. The Source Bypass loop will reset (be in effect) if operation goes into Idle.
Enabling the Source Bypass also enables the Output Trigger. When operation returns to Arm Layer 1 from Arm Layer 2, an output trigger pulse will occur if the Trigger Link control source is selected. The output trigger pulse will be available on the programmed TRIGGER LINK output line. The Output Trigger in this layer is disabled when the Source Bypass is disabled (:ARM:TCONfigure:DIRection ACceptor).
2. Each time the :ARM:IMMediate command is sent, operation will loop around the arm control source. It is used when you do not wish to wait for a programmed arm event to occur (or when the Hold control source is selected).
3. Each time the :ARM:SIGNal command is sent, operation will loop around the arm control source. It is used when you do not wish to wait for a programmed arm event to occur (or when the Hold control source is selected).

After all other instrument operations have been completed, the instrument can be returned to Arm Layer 1 by programming the instrument for additional arms. The :ARM:COUNt <n> command can be used to set the arm count to a finite value (where <n> = 1 to 9999) or for an infinite (<n> = INF) number of arms. The *RST and :SYSTem:PRESet commands set the arm count to 1.

After the instrument leaves Arm Layer 1, operation proceeds into the scan layer (Arm Layer 2).

Arm layer2

NOTE *For front panel operation, this layer is called the scan layer.*

In general, the instrument requires a scan event to allow operation to proceed to the next layer (trigger layer). With the Immediate control source selected (:ARM:LAYer2:SOURce IMMEDIATE), operation immediately proceeds to the next layer. The *RST and :SYSTem:PRESet commands also set the scan control source to Immediate. With one of the other control sources selected, the instrument will wait until the appropriate event occurs.

With the Timer control source selected (:ARM:LAYer2-SOURce TIMer), operation will immediately proceed into the channel layer on the initial pass through Arm Layer 2. Each additional scan will not occur until the programmed timer interval elapses. The timer can be set to an interval from 1msec to 999999.999 seconds.

With the Manual control source selected (:ARM:LAYer2:-SOURce MANual), the instrument will wait until the front panel STEP key is pressed. Note that the System 41 must be taken out of remote (press LOCAL key or send over bus) before it will respond to the STEP key. With the Bus control source selected (:ARM:LAYer2:SOURce BUS), the instrument will wait until a bus trigger is received (GET or *TRG). With the Trigger Link control source selected (:ARM:LAYer2:SOURce TLINK), the instrument will wait until an input trigger is received (via TRIGGER LINK). With the Hold control source selected (:ARM:LAYer2:SOURce HOLD), the instrument will not respond to any of the control source events.

After the programmed scan event is detected, the instrument will wait for the programmed Delay to time out. The :ARM:LAYer2:DELay <n> command is used to set the Delay (where n = 0 to 999999.999 seconds). The *RST and :SYSTem:PRESet commands set the Delay to zero seconds.

As can be seen in the flowchart, there are three paths that allow operation to loop around the control source. Two of these paths also loop around the Delay. These three paths are described as follows:

1. When the Source Bypass is enabled (:ARM:TCONfigure:DIRection SOURce) and the Trigger Link control source is selected, operation will loop around the control source on the initial pass through arm layer 2. If programmed for another scan (scan count > 1), the bypass loop will not be in effect even though it will still be enabled. The Source Bypass loop will reset (be in effect) if operation goes back into arm layer 1.
Enabling the Source Bypass also enables the Output Trigger. When operation returns to Arm Layer 2 from the trigger layer, an output trigger pulse will occur if the Trigger Link control source is selected. The output trigger pulse will be available on the programmed TRIGGER LINK output line. The Output Trigger in this layer is disabled when the Source Bypass is disabled (:ARM:TCONfigure:DIRection ACceptor).
2. Each time the :ARM:LAYer2:IMMediate command is sent, operation will loop around the scan control source and the Delay. It is used when you do not want to wait for a programmed scan event to occur (or when the Hold control source is selected).
3. Each time the :ARM:LAYer2:SIGNal command is sent, operation will loop around the scan control source. This path functions the same as :ARM:LAYer2:IMMediate except that it does not loop around the Delay.

After all other operations in the next layer have been completed, the instrument can be returned to Arm Layer 2 by programming the instrument for additional scans. The :ARM:LAYer2:COUNT <n> command can be used to set the scan count to a finite value (where <n> = 1 to 9999) or for an infinite (<n> = INF) number of scans. The *RST command sets the scan count to one and the :SYSTEM:PRESet command sets the scan count to infinite.

After the instrument leaves Arm Layer 2, operation proceeds to the Channel Layer (Trigger Layer).

Trigger layer

NOTE *For front panel operation, this layer is called the channel layer.*

NOTE *Typically, this is the layer where operation is held up to accommodate cold switching. For example, with GPIB channel spacing selected, a channel pattern will not be scanned until you send a bus trigger (*TRG or GET). With operation held up, you can safely apply or remove the test signal(s).*

In general, measure events control the channel scan rate. With the Immediate control source selected (:TRIGger:-SOURce IMMEDIATE), operation immediately proceeds to the Delay. The *RST command also sets the measure control source to Immediate. With one of the other control sources selected, the instrument will wait until the appropriate event occurs.

With the Timer control source selected (:TRIGger :SOURce TIMer), the first channel will be scanned immediately. Each additional will be scanned at a rate determined by the programmed timer interval (1msec to 999999.999 seconds).

With the Manual control source selected (:TRIGger :SOURce MANual), the instrument will wait until the front panel STEP key is pressed. Note that the System 41 must be taken out of remote (press LOCAL key or send GTL over bus) before it will respond to the STEP key. The :SYSTEM:PRESet command also selects the Immediate control source.

With the Bus control source selected (:TRIGger :SOURce BUS), the instrument will wait until a bus trigger is received (GET or *TRG). With the Trigger Link control source selected (:TRIGger:SOURce TLINK), the instrument will wait until an input trigger is received (via TRIGGER LINK). With the Hold control source selected (:TRIGger :SOURce HOLD), the instrument will not respond to any of the control source events.

After the programmed channel event is detected, the instrument will wait for the programmed Delay to time out. The :TRIGger:DElay <n> command is used to set the Delay (where n = 0 to 999999.999 seconds).

The *RST and :SYSTem:PRESet commands set the Delay to zero seconds.

As can be seen in the flowchart, there are three paths that allow operation to loop around the control source. Two of these paths also loop around the Delay. These three paths are described as follows:

1. When the Source Bypass is enabled (:ARM :TCONfigure:DIRection SOURce) and the Trigger Link control source is selected, operation will loop around the control source on the initial pass through the Trigger Layer. If programmed to scan another channel, (channel count > 1), the bypass loop will not be in effect even though it will still be enabled. The Source Bypass loop will reset (be in effect) if operation goes back to Arm Layer 2.
2. Each time the :TRIGger:IMMediate command is sent, operation will loop around the control source and the Delay. It is used when you do not wish to wait for a programmed channel event to occur (or when the Hold control source is selected).
3. Each time the :TRIGger:SIGNal command is sent, operation will loop around the channel control source. This path functions the same as :TRIGger:IMMediate except that it does not loop around the Delay.

At this point the first (or next) channel in the Scan List will be scanned (Device Action). When scanning channel patterns, the previous channel will open and the next channel pattern will close (break-before-make). Also included in the Device Action is the internal settling time delay for the relay and any additional programmed settling time delay using the :STIME command of the :ROUte Subsystem (see “[:ROUte] subsystem”).

After a channel pattern is scanned, an Output Trigger will occur if the Trigger Link control source is selected. Output Trigger action will occur as follows:

1. If the asynchronous Trigger Link mode is selected, the output trigger pulse will be available on the programmed TRIGGER LINK output line.
2. If the semi-synchronous Trigger Link mode is selected and the Source Bypass is disabled (:trig :tcon:dir acc), the Trigger Link line will be released (goes high).
3. If the semi-synchronous Trigger Link mode is selected and the Source Bypass is enabled (:trig :tcon:dir sour), the Trigger Link line will be pulled down low and then released.

NOTE See “Trigger subsystem” for details on using the Trigger Link.

After a channel pattern is scanned, the instrument will (if programmed to do so) return to the beginning of the trigger layer to scan another channel. The :TRIGger:COUNt <n> command is used to set the channel count to a finite value (where <n> = 1 to 9999) or for a continuous scan of the Scan List (<n> = INF). The :TRIGger:COUNt :AUTo ON command is used to automatically set the channel count to the length of the Scan List. The *RST command sets the channel count to one and the :SYSTem:PRESet command enables the automatic channel count.

Programming syntax

The following programming syntax information covers both common commands and SCPI commands. For information not covered here, refer to the documentation for the IEEE-488.2 standard and SCPI.

Command words

One or more command words make up the program message that is sent to the computer to perform one or more operations.

1. **Commands and command parameters** — Both common commands and SCPI commands may or may not use a parameter. Examples:

*SAV 0	Parameter (0) required.
*RST	No parameter used with this command.
:INITiate:CONTinuous 	Parameter () required.
:SYSTem:PRESet	No parameter used with this command.

Note that there must be at least one space between the command word and the parameter.

Brackets [] — Throughout this manual, you will find command words that are enclosed in brackets ([]). These brackets are simply used to denote an optional command word that does not need to be included in the program message. For example:

```
:INITiate[:IMMediate]
```

The brackets indicate that :IMMediate is implied (optional) and does not have to be used. Thus, the above command can be sent in one of two ways:

```
:INITiate or :INITiate:IMMediate
```

Notice that the optional command is used without the brackets. **Do not include the brackets when using an optional command word.**

Parameter types — Some of the more common parameter types used in this manual are explained as follows:

- Boolean — Used to enable or disable an instrument operation. In general, 0 or OFF disables the operation, and 1 or ON enables the operation. Specifically, a Boolean parameter is processed as follows:
- While ignoring the sign (+ or -), the parameter value is rounded to an integer.
 - A zero result is interpreted as OFF, and a non-zero result is interpreted as ON.
- Example:
- ```
:INITiate:CONTinuous ON Enable continuous initiation
```
- <name> Name parameter — Select a parameter name from a listed group. Example:
- ```
<name> = RST, PRESet, or SAV0-SAV9
:SYSTem:POSetup RST
```
- <NRf> Numeric representation format — This parameter is a number that can be expressed as an integer (e.g., 8), a real number (e.g., 23.6) or an exponent (2.3E6). When necessary, the System 41 will round real and exponential parameter values to an integer. Example:
- ```
*SAV 6 Save setup in memory location 6.
```

<n> Numeric value — A numeric value parameter can consist of an NRF number or one of the following name parameters; DEFault, MINimum or MAXimum. When the DEFault parameter is used, the instrument will be programmed to the \*RST default value. When the MINimum parameter is used, the instrument will be programmed to the lowest allowable value. When the MAXimum parameter is used, the instrument will be programmed to the largest allowable value.

Examples:

```
:TRIGger:TIMer 0.1 Sets timer to 100msec.
:TRIGger:TIMer DEFault Sets timer to 1msec.
:TRIGger:TIMer MINimum Sets timer to 1msec.
:TRIGger:TIMer MAXimum Sets timer to 999999.999sec.
```

<list> List — This parameter type is used to indicate that a list of channels is required with the command word. The following example demonstrates the proper format for specifying a list:

```
:CLOSe (@ M1, M15) Close channel patterns M1 and M15.
```

**Angle brackets < >** — In this manual, angle brackets (<>) are used to denote parameter type. Do not include the brackets in the program message. For example:

```
:INITiate:CONTInuous
```

The <b> indicates that a Boolean type parameter is required. Thus, to enable continuous initiation, you must send the command with the ON or 1 parameter as follows:

```
:INITiate:CONTInuous ON or :INITiate:CONTInuous 1
```

2. **Query commands** — This type of command requests (queries) the currently programmed status. It is identified by the question mark (?) at the end of the fundamental form of the command. Most commands have a query form. Examples:

```
*OPT? Common query command.
:TRIGger:TIMer? SCPI query command.
```

All commands that require a numeric parameter (<n>) can also use the DEFault, MINimum, and MAXimum parameters for the query form. These query forms are used to determine the \*RST default value, and the upper and lower limits for the fundamental command.

Examples:

```
:TRIGger:TIMer? DEFault Queries the *RST default value.
:TRIGger:TIMer? MINimum Queries the lowest allowable value.
:TRIGger:TIMer? MAXimum Queries the largest allowable value.
```

3. **Case sensitivity** — Common commands and SCPI commands are not case sensitive. You can use upper or lower case, and any case combination. Examples:

```
*RST = *rst
:SCAN? = :scan?
:SYSTEM:PRESet = :system:preset
```

4. **Long-form and short-form versions** — A SCPI command word can be sent in its long-form or short-form version. The command subsystem tables in this section provide the commands in the long-form version. However, the short-form version is indicated by upper case characters. Examples:

|                |                                 |
|----------------|---------------------------------|
| :SYSTem:PRESet | Long-form                       |
| :SYST:PRES     | Short-form                      |
| :SYSTem:PRES   | Long and short-form combination |

Note that each command word must be in long-form or short-form, and not something in between. For example, :SYSTe:PRESe is illegal and will generate an error. The command will not be executed.

There are no short-form versions for common commands.

**Short-form rules** — The following rules can be used to determine the short-form version of any SCPI command:

- a. If the length of the command word is four letters or less, there is no short-form version. Examples:

```
:open = :open
:line = :line
```

- b. The following rules apply to command words that exceed four letters:

- If the fourth letter of the command word is a vowel, delete it and all the letters after it. Examples:

```
:immediate = :imm
:timer = :tim
```

- If the fourth letter of the command word is a consonant, retain it but drop all the letters after it. Example:

```
:asynchronous = :asyn
```

- c. If there is a question mark (?) or a non-optional number included in the command word, it must be included in the short-form version. Examples:

```
:delay? = :del?
:layer2 = :lay2
```

- d. As previously explained, command words or characters that are enclosed in brackets ([]) are optional and need not be included in the program message. Example:

```
:STATus:OPERation[:EVENT]?
```

The brackets ([]) indicate that :EVENT is optional. Thus, either of the following two command program messages are valid:

```
:STATus:OPERation:EVENT? = :STATus:OPERation?
```

Notice that when using the optional word or character, the brackets ([]) are not included in the program message.

The complete short-form version of the above command is as follows:

```
:stat:oper?
```

## Program messages

A program message is made up of one or more command words sent by the computer to the instrument. Each common command is simply a three letter acronym preceded by an asterisk (\*). SCPI commands are categorized into subsystems and are structured as command paths. The following command paths are contained in the :STATus subsystem and are used to help explain how command words are structured to formulate program messages.

|                    |                       |
|--------------------|-----------------------|
| :STATus            | Path (Root)           |
| :OPERation         | Path                  |
| :PTRansition <NRf> | Command and parameter |
| :NTRansition <NRf> | Command and parameter |
| :ENABle <NRf>      | Command and parameter |
| :PRESet            | Command               |

1. **Single command messages** — There are three levels to the above command structure. The first level is made up of the root command (:STATus) and serves as a path. The second level is made up of another path (:OPERation) and a command (:PRESet). The third path is made up of three commands for the :OPERation path. The four commands in this structure can be executed by sending four separate program messages as follows:

```
:stat:oper:ptr <NRf>
:stat:oper:ntr <NRf>
:stat:oper:enab <NRf>
:stat:pres
```

In each of the above program messages, the path pointer starts at the root command (:stat) and moves down the command levels until the command is executed.

2. **Multiple command messages** — Multiple commands can be sent in the same program message as long as they are separated by semicolons (;). Example showing two commands in one program message:

```
:stat:pres; :stat:oper:enab <NRf>
```

When the above message is sent, the first command word is recognized as the root command (:stat). When the next colon is detected, the path pointer moves down to the next command level and executes the command. When the path pointer sees the colon after the semicolon (;), it resets back to the root level and starts over.

Commands that are on the same command level can be executed without having to retype the entire command path. Example:

```
:stat:oper:enab <NRf>; ptr <NRf>; ntr <NRf>
```

After the first command (:enab) is executed, the path point is at the third command level in the structure. Since :ptr and :ntr are also on the third level, they can be typed in without repeating the entire path name. Notice that the leading colon for :ptr and :ntr are not included in the program message. If a colon were included, the path pointer would reset to the root level and expect a root command. Since neither :ptr nor :ntr are root commands, an error would occur.

### 3. Command path rules:

- a. Each new program message must begin with the root command, unless it is optional (e.g., [:SENSe]). If the root is optional, simply treat a command word on the next level as the root.
- b. The colon (:) at the beginning of a program message is optional and need not be used.  
Example:  
:stat:pres = stat:pres
- c. When the path pointer detects a colon (:) it will move down to the next command level. An exception is when the path pointer detects a semicolon (;), which is used to separate commands within the program message (see next rule).
- d. When the path pointer detects a colon (:) that immediately follows a semicolon (;), it resets back to the root level.
- e. The path pointer can only move down. It cannot be moved up a level. Executing a command at a higher level requires that you start over at the root command.

4. **Using common commands and SCPI commands in same message** — Both common commands and SCPI commands can be used in the same message as long as they are separated by semicolons (;). A common command can be executed at any command level and will not affect the path pointer. Example:

```
:stat:oper:enab <NRf>; ptr <NRf>; *ESE <NRf>; ntr <NRf>
```

5. **Program Message Terminator (PMT)** — Each program message must be terminated with an LF (line feed), EOI (end or identify) or an LF + EOI. The bus will hang if your computer does not provide this termination. The following example shows how a multiple command program message must be terminated:

```
:rout:open all; scan (@M1, M2, M3) <PMT>
```

### 6. Command execution rules:

- a. Commands are executed in the order that they are presented in the program message.
- b. An invalid command will generate an error and, of course, not be executed.
- c. Valid commands that precede an invalid command in a multiple command program message will be executed.
- d. Valid commands that follow an invalid command in a multiple command program message will be ignored. Example:  
:rout:open all; harve; scan?  
:open all will execute. Harve is an invalid command and will generate an error. The scan query will be ignored.

## Response messages

A response message is the message sent by the instrument to the computer in response to a query command program message.

1. **Sending a response message** — After sending a query command, the response message is placed in the Output Queue. When the System 41 is then addressed to talk, the response message is sent from the Output Queue to the computer.

There are two special query commands that are used to read the Error Queue. As error and status messages occur they are stored in the Error Queue. This queue is a first-in first-out (FIFO) register. Either of the following two SCPI commands can be used to read the Error Queue:

```
:STATus:QUEue?
:SYSTem:ERRor?
```

After sending either of the above commands, the oldest message in the Error Queue will be moved to the Output Queue. When the System 41 is then addressed to talk (as explained above), the response message will be sent to the computer.

2. **Multiple response messages** — If you send more than one query command in the same program message (see Multiple command messages), the multiple response message for all the queries will be sent to the computer when the System 41 is addressed to talk. The responses are sent in the order that the query commands were sent and will be separated by semicolons (;). Items within the same query are separated by commas (.). The following example shows the response message for a program message that contains four single item query commands:

```
0; 1; 1; 0
```

3. **Response Message Terminator (RMT)** — Each response message is terminated with an LF (line feed) and EOI (end or identify). The following example shows how a multiple response message is terminated:

```
0; 1; 1; 0 <RMT>
```

## Message exchange protocol

The message exchange protocol can be summarized by the two following rules:

**Rule 1. You must always tell the System 41 what to send to the computer.**

The following two steps must always be performed, in this order, to send information from the instrument to the computer:

1. Send the appropriate query command(s) in a program message.
2. Address the System 41 to talk.

**Rule 2. The complete response message (including the RMT) must be received by the computer before another program message can be sent to the System 41.**

## Common commands

Common commands are device commands that are common to all devices on the bus. These commands are designated and defined by the IEEE-488.2 standard.

Table 6-3 summarizes the common commands used by the System 41 and are presented in alphabetical order.

Table 6-3  
*IEEE-488.2 common commands and queries*

| Mnemonic   | Name                           | Description                                                                                                          |
|------------|--------------------------------|----------------------------------------------------------------------------------------------------------------------|
| *CLS       | Clear status                   | Clears all event registers, and Error Queue.                                                                         |
| *ESE <NRf> | Event status enable command    | Sets the contents of the Standard Event Status Enable Register.                                                      |
| *ESE?      | Event status enable query      | Request the programmed value of the Standard Event Status Enable Register.                                           |
| *ESR?      | Event status register query    | Request the programmed value of the Standard Event Status Register and clears it.                                    |
| *IDN?      | Identification query           | Request the manufacturer, model number, serial number, and firmware revision levels of the unit.                     |
| *OPC       | Operation complete command     | Sets the Operation Complete bit in the Standard Event Status Register after all pending commands have been executed. |
| *OPC?      | Operation complete query       | Places an ASCII "1" into the output queue when all pending selected device operations have been completed.           |
| *OPT?      | Option identification query    | Request the assigned model number for all slots.                                                                     |
| *RCL <NRf> | Recall command                 | Returns the System 41 to the setup configuration stored in the designated memory location.                           |
| *RST       | Reset command                  | Returns the System 41 to the *RST default conditions.                                                                |
| *SAV <NRf> | Save command                   | Saves the current setup configuration to the designated memory location.                                             |
| *SRE <NRf> | Service request enable command | Sets the contents of the Service Request Enable Register.                                                            |
| *SRE?      | Service request enable query   | The System 41 returns the value of the Service Request Enable Register.                                              |
| *STB?      | Read status byte query         | Returns the value of the Status Byte Register.                                                                       |
| *TRG       | Trigger command                | This command issues a bus trigger which has the same effect as group execute trigger (GET) command.                  |
| *TST?      | Self-test query                | When this query is sent, the System 41 will perform a checksum test on ROM and return the results.                   |
| *WAI       | Wait-to-continue command       | Wait until all previous commands are executed.                                                                       |

Note: At least one space is required between the command and the parameter.

**\*CLS — clear status**

**Purpose** To clear status registers and error queue.

**Format** \*CLS

**Description** The \*CLS command is used to clear (reset to 0) the bits of the following registers in the System 41:

Standard Event Status Register

Operation Event Register

Questionable Event Register

Error Queue

Trigger Event Register

Sequence Event Register

Arm Event Register

This command also forces the instrument into the operation complete command idle state and operation complete query idle state.



**\*ESE — event status enable**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |                        |    |  |                        |   |  |  |    |  |             |    |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|------------------------|----|--|------------------------|---|--|--|----|--|-------------|----|
| <b>Purpose</b>     | To set the contents of the Standard Event Status Enable Register.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |                        |    |  |                        |   |  |  |    |  |             |    |
| <b>Format</b>      | *ESE <NRf>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                         |        |                        |    |  |                        |   |  |  |    |  |             |    |
| <b>Parameters</b>  | <NRf>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | <ul style="list-style-type: none"> <li>= 0     Clear (reset) register</li> <li>= 1     Set OPC (B0) of enable register</li> <li>= 4     Set QYE (B2) of enable register</li> <li>= 8     Set DDE (B3) of enable register</li> <li>= 16    Set EXE (B4) of enable register</li> <li>= 32    Set CME (B5) of enable register</li> <li>= 64    Set URQ (B6) of enable register</li> <li>= 128   Set PON (B7) of enable register</li> </ul> |        |                        |    |  |                        |   |  |  |    |  |             |    |
| <b>Defaults</b>    | Power-up                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Clears register                                                                                                                                                                                                                                                                                                                                                                                                                         |        |                        |    |  |                        |   |  |  |    |  |             |    |
|                    | *CLS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | No effect                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                        |    |  |                        |   |  |  |    |  |             |    |
|                    | *RST                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | No effect                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                        |    |  |                        |   |  |  |    |  |             |    |
|                    | :STATus:PRESet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | No effect                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                        |    |  |                        |   |  |  |    |  |             |    |
|                    | DCL, SDC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | No effect                                                                                                                                                                                                                                                                                                                                                                                                                               |        |                        |    |  |                        |   |  |  |    |  |             |    |
| <b>Description</b> | <p>The *ESE command is used to set the contents of the Standard Event Status Enable Register. This command is sent with the decimal equivalent of the binary value that determines the desired state (0 or 1) of the bits in the register.</p> <p>This register is used as a mask for the Standard Event Status Register. When a standard event is masked, the occurrence of that event will not set the Event Summary Bit (ESB) in the Status Byte Register. Conversely, when a standard event is unmasked (enabled), the occurrence of that event will set the ESB bit. For information on the Standard Event Status Register and descriptions of the standard event bits, see “*ESE? — event status enable query.” The Status Byte Register is described in “Status byte and service request (SRQ).”</p> <p>A cleared bit (bit set to “0”) in the enable register will prevent (mask) the ESB bit in the Status Byte Register from setting when the corresponding standard event occurs. A set bit (bit set to “1”) in the enable register will allow (enable) the ESB bit to set when the corresponding standard event occurs. For details on the status register structure, refer to “Status structure.”</p> <p>The Standard Event Status Enable Register is shown in Figure 6-14. Notice that the decimal weight of each bit is included in the illustration. The sum of the decimal weights of the bits that you wish to be set is the value that is sent with the *ESE command. For example, to set the CME and QYE bits of the Standard Event Status Enable Register, send the following command:</p> <pre>*ESE 36</pre> <table border="0" style="margin-left: 2em;"> <tr> <td style="padding-right: 1em;">where;</td> <td>CME (bit B5) = Decimal</td> <td style="text-align: right;">32</td> </tr> <tr> <td></td> <td>QYE (bit B2) = Decimal</td> <td style="text-align: right;">4</td> </tr> <tr> <td></td> <td></td> <td style="text-align: right; border-top: 1px solid black;">36</td> </tr> <tr> <td></td> <td>parameter =</td> <td style="text-align: right;">36</td> </tr> </table> <p>If a command error (CME) occurs, bit B5 of the Standard Event Status Register will set. If a query error (QYE) occurs, bit B2 of the Standard Event Status Register will set. Since both of these events are unmasked (enabled), the occurrence of any one of them will cause the ESB bit in the Status Byte Register to set.</p> <p>The contents of the Standard Event Status Event Register can be read by using the *ESE? query command (see next paragraph).</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                         | where; | CME (bit B5) = Decimal | 32 |  | QYE (bit B2) = Decimal | 4 |  |  | 36 |  | parameter = | 36 |
| where;             | CME (bit B5) = Decimal                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 32                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |                        |    |  |                        |   |  |  |    |  |             |    |
|                    | QYE (bit B2) = Decimal                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 4                                                                                                                                                                                                                                                                                                                                                                                                                                       |        |                        |    |  |                        |   |  |  |    |  |             |    |
|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 36                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |                        |    |  |                        |   |  |  |    |  |             |    |
|                    | parameter =                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 36                                                                                                                                                                                                                                                                                                                                                                                                                                      |        |                        |    |  |                        |   |  |  |    |  |             |    |

Figure 6-14  
**Standard Event Status Enable Register**

|                   |                          |                         |                         |                         |                        |                        |    |                        |
|-------------------|--------------------------|-------------------------|-------------------------|-------------------------|------------------------|------------------------|----|------------------------|
| Bit Position      | B7                       | B6                      | B5                      | B4                      | B3                     | B2                     | B1 | B0                     |
| Event             | PON                      | URQ                     | CME                     | DDE                     | EXE                    | QYE                    | —  | OPC                    |
| Decimal Weighting | 128<br>(2 <sup>7</sup> ) | 64<br>(2 <sup>6</sup> ) | 32<br>(2 <sup>5</sup> ) | 16<br>(2 <sup>4</sup> ) | 8<br>(2 <sup>3</sup> ) | 4<br>(2 <sup>2</sup> ) | —  | 1<br>(2 <sup>0</sup> ) |
| Value             | 0/1                      | 0/1                     | 0/1                     | 0/1                     | 0/1                    | 0/1                    | —  | 0/1                    |

Value: 1 = Enable Standard Event  
 0 = Disable (Mask) Standard Event

Events: PON = Power On  
 URQ = User Request  
 CME = Command Error  
 DDE = Device-dependent Error  
 EXE = Execution Error  
 QYE = Query Error  
 OPC = Operation Complete

### \*ESE? — event status enable query

**Purpose** To read the contents of the Standard Event Status Enable Register.

**Format** \*ESE?

**Description** This command is used to acquire the value (in decimal) of the Standard Event Status Enable Register. The binary equivalent of the decimal value determines which bits in the register are set. When the \*ESE? query command is sent, the decimal value is placed in the Output Queue. When the System 41 is addressed to talk, the value is sent from the Output Queue to the computer.

For example, for an acquired decimal value of 48, the binary equivalent is 00110000. For this binary value, bits B4 and B5 of the Standard Event Status Enable Register are set. For information on the Standard Event Status Enable Register, refer to “Status structure.”

The \*ESE? query command does not clear the Standard Event Status Enable Register.

**\*ESR? — event status register query**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                 |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| <b>Purpose</b>     | To read the contents of the Standard Event Status Register and clear it.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                 |
| <b>Format</b>      | *ESR?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                 |
| <b>Defaults</b>    | Power-up                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Clears register |
|                    | *CLS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Clears register |
|                    | *RST                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | No effect       |
|                    | :STATus:PRESet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | No effect       |
|                    | DCL, SDC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | No effect       |
| <b>Description</b> | <p>This command is used to acquire the value (in decimal) of the Standard Event Status Register (see Figure 6-15). The binary equivalent of the returned decimal value determines which bits in the register are set. When the *ESR? command is sent, the decimal value is placed in the Output Queue and the Standard Event Status Register is cleared. When the System 41 is addressed to talk, the value in the Output Queue is sent to the computer.</p> <p>A set bit in this register indicates that a particular event has occurred. For example, for an acquired decimal value of 48, the binary equivalent is 0011 0000. For this binary value, bits B4 and B5 of the Standard Event Status Register are set. These set bits indicate that a device-dependent error and command error have occurred.</p> <p>The bits of the Standard Event Status Register are described as follows:</p> <p><b>Bit B0, Operation Complete (OPC)</b> — Set bit indicates that all pending selected device operations are completed and the System 41 is ready to accept new commands. This bit will only set in response to the *OPC? query command (see “*OPC? — operation complete query”).</p> <p><b>Bit B1</b> — Not Used</p> <p><b>Bit B2, Query Error (QYE)</b> — Set bit indicates that you attempted to read data from an empty Output Queue.</p> <p><b>Bit B3, Device-Dependent Error (DDE)</b> — Set bit indicates that an instrument operation did not execute properly due to some internal condition.</p> <p><b>Bit B4, Execution Error (EXE)</b> — Set bit indicates that the System 41 detected an error while trying to execute a command.</p> <p><b>Bit B5, Command Error (CME)</b> — Set bit indicates that a command error has occurred. Command errors include:</p> <ol style="list-style-type: none"> <li>1. IEEE-488.2 syntax error — System 41 received a message that does not follow the defined syntax of the IEEE-488.2 standard.</li> <li>2. Semantic error — System 41 received a command that was misspelled, or received an optional IEEE-488.2 command that is not implemented.</li> <li>3. The instrument received a Group Execute Trigger (GET) inside a program message.</li> </ol> <p><b>Bit B6, User Request (URQ)</b> — Set bit indicates that the LOCAL key on the System 41 front panel was pressed.</p> <p><b>Bit B7, Power On (PON)</b> — Set bit indicates that the System 41 has been turned off and turned back on since the last time this register has been read.</p> |                 |

Figure 6-15  
**Standard Event Status Register**

|                   |                          |                         |                         |                         |                        |                        |    |                        |
|-------------------|--------------------------|-------------------------|-------------------------|-------------------------|------------------------|------------------------|----|------------------------|
| Bit Position      | B7                       | B6                      | B5                      | B4                      | B3                     | B2                     | B1 | B0                     |
| Event             | PON                      | URQ                     | CME                     | EXE                     | DDE                    | QYE                    | —  | OPC                    |
| Decimal Weighting | 128<br>(2 <sup>7</sup> ) | 64<br>(2 <sup>6</sup> ) | 32<br>(2 <sup>5</sup> ) | 16<br>(2 <sup>4</sup> ) | 8<br>(2 <sup>3</sup> ) | 4<br>(2 <sup>2</sup> ) | —  | 1<br>(2 <sup>0</sup> ) |
| Value             | 0/1                      | 0/1                     | 0/1                     | 0/1                     | 0/1                    | 0/1                    | —  | 0/1                    |

Value: 1 = Event Bit Set  
 0 = Event Bit Cleared

Events: PON = Power On  
 URQ = User Request  
 CME = Command Error  
 EXE = Execution Error  
 DDE = Device-dependent Error  
 QYE = Query Error  
 OPC = Operation Complete

### \*IDN? — identification query

**Purpose** To read the identification code of the System 41.

**Format** \*IDN?

**Description** The \*IDN? query command places the identification code of the System 41 in the Output Queue. When the System 41 is addressed to talk, the identification code will be sent to the computer.

The identification code includes the manufacturer, model number, serial number, and firmware revision levels, and is sent in the following format:

KEITHLEY INSTRUMENTS INC., MODEL 7002, wwwwww, xxxxx,/yyyy/zzzz

where; wwwwww is the serial number  
 xxxxx is the firmware revision level of the digital board  
 yyyy is the firmware revision level of the VFD display  
 zzzz is the firmware revision level of the LED display

## \*OPC — operation complete

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | To set the Operation Complete bit in the Standard Event Status Register after all overlapped commands are complete.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Format</b>      | *OPC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Description</b> | <p>On power-up, or when *CLS or *RST is executed, the System 41 goes into the Operation Complete Command Idle State (OCIS). In this state there are no pending overlapped commands. There are three overlapped commands used by the System 41:</p> <p>:INITiate<br/>:INITiate:CONTinuous ON<br/>*TRG</p> <p>When the *OPC command is sent, the System 41 exits from OCIS and enters the Operation Complete Command Active State (OCAS). In OCAS, the instrument continuously monitors the No-Operation-Pending flag. After the last pending overlapped command is complete (No-Operation-Pending flag set to true), the Operation Complete (OPC) bit in the Standard Event Status Register sets, and the instrument goes back into OCIS.</p> <p>Note that the instrument always goes into OCAS when *OPC is executed. If there are no pending command operations (e.g. trigger model in idle state), the System 41 immediately sets the OPC bit and returns to OCIS.</p> <p>When used with the :INITiate or :INITiate:CONTinuous ON command, the OPC bit of the Standard Event Status Register will not set until the System 41 goes back into the idle state. The initiate operations are not considered finished until the instrument goes into the idle state.</p> <p>When used with the *TRG command, the OPC bit will not set until the operations associated with the *TRG command (and the initiate command) are finished. The *TRG command is considered to be finished when the Device Action completes or when operation stops at a control source to wait for an event (see Trigger Model in “Trigger Model (IEEE-488 operation)”).</p> <p>In order to use *OPC exclusively with the *TRG command you will have to first force the completion of the initiate command so that only the *TRG command is pending. To do this, use the :INITiate:CONTinuous ON command to start the scan and then send the :ABORT command. The abort command places the instrument in the idle layer, which (by definition) completes the initiate command. Since continuous initiation is on, operation will continue on into thme Trigger Model. After sending the *TRG command, the OPC bit will set when the *TRG command is finished.</p> |

**NOTE** See \*OPC?, \*TRG and \*WAI for more information.

**\*OPC? — operation complete query**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | Place a “1” in the Output Queue after all overlapped commands are completed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Format</b>      | *OPC?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Description</b> | <p>On power-up, or when *CLS or *RST is executed, the System 41 goes into the Operation Complete Command Query Idle State (OQIS). In this state there are no pending overlapped commands. There are three overlapped commands used by the System 41:</p> <pre>:INITiate :INITiate:CONTinuous ON *TRG</pre> <p>When the *OPC? command is sent, the System 41 exits from OQIS and enters the Operation Complete Command Active State (OQAS). In OQAS, the instrument continuously monitors the No-Operation-Pending flag. After the last pending overlapped command is completed (No-Operation-Pending flag set to true), an ASCII character “1” is placed into the Output Queue, the Message Available (MAV) bit in the Status Byte sets, and the instrument goes back into OQIS. Addressing the System 41 to talk will send the ASCII “1” to the computer.</p> <p>Note that the instrument always goes into OQAS when *OPC? is executed. If there are no pending command operations (e.g. trigger model in idle state), the System 41 immediately places an ASCII “1” in the Output Queue, sets the MAV bit and returns to OQIS.</p> <p>When used with the :INITiate or :INITiate:CONTinuous ON command, an ASCII “1” will not be sent to the Output Queue and the MAV bit will not set until the System 41 goes back into the idle state. The initiate operations are not considered finished until the instrument goes into the idle state.</p> <p>When used with the *TRG command, an ASCII “1” will not be placed into the Output Queue and the MAV bit will not set until the operations associated with the *TRG command (and the initiate command) are finished. The *TRG command is considered to be finished when the Device Action completes or when operation stops at a control source to wait for an event (see Trigger Model in “Trigger Model (IEEE-488 operation)”).</p> <p>In order to use *OPC? exclusively with the *TRG command you will have to first force the completion of the initiate command so that only the *TRG command is pending. To do this, use the :INITiate:CONTinuous ON command to start the scan and then send the :ABORT command. The abort command places the instrument in the idle layer, which (by definition) completes the initiate command. Since continuous initiation is on, operation will continue on into the Trigger Model. After sending the *TRG command, an ASCII “1” will be placed in the Output Queue and the MAV bit will set when the *TRG command is finished.</p> <p>After *OPC? is executed, additional commands cannot be sent to the System 41 until the pending overlapped commands have finished. For example, :INITiate:CONTinuous ON followed by *OPC? will lock up the instrument and will require a device clear (DCL or SDC) before it will accept any more commands.</p> |

**NOTE**      *See \*OPC, \*TRG, and \*WAI for more information.*

**\*OPT? — option identification query**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | To read the slot assignments for the 10 mainframe slots.                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Format</b>      | *OPT?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Description</b> | <p>The System 41 can accommodate up to 240 RF switch channels (6 slots). Slots 1 through 6 have been assigned the number “7116” and cannot be changed. Since slots 7 through 10 are not used by the System 41, they have been assigned the name “NONE” at the factory.</p> <p>Assuming a user has not changed the assignments for slots 7 through 10, sending *OPT? and addressing the System 41 to talk sends the following response message to the computer:</p> <p>7116, 7116, 7116, 7116, 7116, 7116, NONE, NONE, NONE, NONE</p> |

**\*RCL — recall**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | To return the System 41 to a setup configuration previously stored in memory.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Format</b>      | *RCL <n>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Parameters</b>  | <NRf> = 0 to 9 Memory location                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Description</b> | <p>The System 41 can store up to 10 setup configurations in memory locations 0 to 9. Over the bus, the *SAV command is used to save setup configurations (see “*SAV — save”).</p> <p>The *RCL command is used to return the System 41 to a setup configuration stored at one of the memory locations. For example, if a setup configuration was previously stored at memory location 9, the System 41 can be returned to those setup conditions by sending the following command:</p> <p>*RCL 9</p> <p><i>NOTE The System 41 is shipped from the factory with :SYSTEM:PRESet defaults stored in all ten memory locations (see Table 6-4).</i></p> |

**\*RST — reset**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | To reset the System 41.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Format</b>      | *RST                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Description</b> | <p>When the *RST command is sent, the System 41 performs the following operations:</p> <ol style="list-style-type: none"> <li>1. Returns the System 41 to the *RST default conditions (see Table 6-4).</li> <li>2. Cancels all pending commands.</li> <li>3. Cancels response to any previously received *OPC and *OPC? commands.</li> </ol> <p>The following instrument states are not affected by this command:</p> <p>IEEE-488 address<br/>Standard Event Status Register<br/>Status Byte Register</p> |

Table 6-4  
Default conditions

| Command name           | *RST value   | :SYSTEM:PRESet value |
|------------------------|--------------|----------------------|
| :INITiate              |              |                      |
| :CONTinuous            | OFF          | OFF                  |
| :ARM                   |              |                      |
| :SEQuence[1]           |              |                      |
| :LAYer[1]              |              |                      |
| :COUNt                 | 1            | 1                    |
| :SOURce                | IMMediate    | IMMediate            |
| :TCONfigure            |              |                      |
| :DIRection             | ACcEptor     | ACcEptor             |
| :ASYNchronous          |              |                      |
| :ILINe                 | 1            | 1                    |
| :OLINe                 | 2            | 2                    |
| :LAYer2                |              |                      |
| :COUNt                 | 1            | INFinite             |
| :DELay                 | 0            | 0                    |
| :SOURce                | IMMediate    | IMMediate            |
| :TIMer                 | 0.001        | 0.001                |
| :TCONfigure            |              |                      |
| :DIRection             | ACcEptor     | ACcEptor             |
| :ASYNchronous          |              |                      |
| :ILINe                 | 1            | 1                    |
| :OLINe                 | 2            | 2                    |
| :TRIGger               |              |                      |
| :SEQuence1             |              |                      |
| :COUNt                 | 1            | Scan list length     |
| :AUTO                  | OFF          | ON                   |
| :DELay                 | 0            | 0                    |
| :SOURce                | IMMediate    | MANual               |
| :TIMer                 | 0.001        | 0.001                |
| :TCONfigure            |              |                      |
| :PROTOcol              | ASYNchronous | ASYNchronous         |
| :DIRection             | ACcEptor     | SOURce               |
| :ASYNchronous          |              |                      |
| :ILINe                 | 1            | 1                    |
| :OLINe                 | 2            | 2                    |
| :SSYNchronous          |              |                      |
| :LINE                  | 1            | 1                    |
| [:ROUte]               |              |                      |
| :CONFigure             |              |                      |
| :BBMake                | ON           | ON                   |
| :SLOTX where X=1 to 10 |              |                      |
| :STIME                 | 0            | 0                    |
| :CPAirX where X=1 to 5 | OFF          | OFF                  |
| :SCHannel              | OFF          | OFF                  |
| :DISPlay               |              |                      |
| :SMESsage              | OFF          | OFF                  |
| :WINDow3               |              |                      |
| :GRATicule             | ON           | ON                   |



**\*SAV — save**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | To save the current setup configuration in memory.                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Format</b>      | *SAV <NRf>                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Parameters</b>  | <NRf> = 0 to 9 Memory location                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Description</b> | <p>The System 41 can store up to 10 setup configurations at memory locations 0 to 9 by using the *SAV command. For example, to store the current setup configuration at memory location 6, send the following command:</p> <pre>*SAV 6</pre> <p>Table 6-4 lists the setup items (along with the bus commands to program them), that can be saved by the *SAV command. The *RCL command is used to return the instrument to a saved setup.</p> |

**\*SRE — service request enable**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|-----------------|------------------------|-----------|------|---------------------|----------------|-----------|---------------------|-----------|------|---------------------|--|------|---------------------|--|-------|---------------------|
| <b>Purpose</b>     | To set the contents of the Service Request Enable Register.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                        |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
| <b>Format</b>      | *SRE <NRf>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                        |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
| <b>Parameters</b>  | <table> <tr> <td>&lt;NRf&gt;</td> <td>= 0</td> <td>Clears enable register</td> </tr> <tr> <td></td> <td>= 4</td> <td>Set EAV bit (Bit 2)</td> </tr> <tr> <td></td> <td>= 8</td> <td>Set QSB bit (Bit 3)</td> </tr> <tr> <td></td> <td>= 16</td> <td>Set MAV bit (Bit 4)</td> </tr> <tr> <td></td> <td>= 32</td> <td>Set ESB bit (Bit 5)</td> </tr> <tr> <td></td> <td>= 128</td> <td>Set OSB bit (Bit 7)</td> </tr> </table>                                                                                                                                                         | <NRf>                  | = 0             | Clears enable register |           | = 4  | Set EAV bit (Bit 2) |                | = 8       | Set QSB bit (Bit 3) |           | = 16 | Set MAV bit (Bit 4) |  | = 32 | Set ESB bit (Bit 5) |  | = 128 | Set OSB bit (Bit 7) |
| <NRf>              | = 0                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Clears enable register |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
|                    | = 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Set EAV bit (Bit 2)    |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
|                    | = 8                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Set QSB bit (Bit 3)    |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
|                    | = 16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Set MAV bit (Bit 4)    |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
|                    | = 32                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Set ESB bit (Bit 5)    |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
|                    | = 128                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Set OSB bit (Bit 7)    |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
| <b>Defaults</b>    | <table> <tr> <td>Power-up</td> <td>Clears register</td> </tr> <tr> <td>*CLS</td> <td>No effect</td> </tr> <tr> <td>*RST</td> <td>No effect</td> </tr> <tr> <td>:STATus:PRESet</td> <td>No effect</td> </tr> <tr> <td>DCL, SDC</td> <td>No effect</td> </tr> </table>                                                                                                                                                                                                                                                                                                                 | Power-up               | Clears register | *CLS                   | No effect | *RST | No effect           | :STATus:PRESet | No effect | DCL, SDC            | No effect |      |                     |  |      |                     |  |       |                     |
| Power-up           | Clears register                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                        |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
| *CLS               | No effect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                        |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
| *RST               | No effect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                        |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
| :STATus:PRESet     | No effect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                        |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
| DCL, SDC           | No effect                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                        |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |
| <b>Description</b> | <p>The *SRE command is used to set the contents of the Service Request Enable Register. This command is sent with the decimal equivalent of the binary value that determines the desired state (0 or 1) of each bit in the register.</p> <p>This enable register is used along with the Status Byte Register to generate service requests (SRQ). With a bit in the Service Request Enable Register set, an SRQ will occur when the corresponding bit in the Status Byte Register is set by an appropriate event. For details on register structure, refer to “Status structure.”</p> |                        |                 |                        |           |      |                     |                |           |                     |           |      |                     |  |      |                     |  |       |                     |

The Service Request Enable Register is shown in Figure 6-16. Notice that the decimal weight of each bit is included in the illustration. The sum of the decimal weights of the bits that you wish to set is the value that is sent with the \*SRE command. For example, to set the ESB and MAV bits of the Service Request Enable Register, send the following command:

```
*SRE 34
where; ESB (bit B5) = Decimal 32
 MAV (bit B4) = Decimal 16

 <Nrf> = 48
```

The contents of the Service Request Enable Register can be read using the \*SRE? query command (see next paragraph).

Figure 6-16  
**Service Request Enable Register**

|                   |                          |    |                         |                         |                        |                        |    |    |
|-------------------|--------------------------|----|-------------------------|-------------------------|------------------------|------------------------|----|----|
| Bit Position      | B7                       | B6 | B5                      | B4                      | B3                     | B2                     | B1 | B0 |
| Event             | OSB                      | —  | ESB                     | MAV                     | QSB                    | EAV                    | —  | —  |
| Decimal Weighting | 128<br>(2 <sup>7</sup> ) | —  | 32<br>(2 <sup>5</sup> ) | 16<br>(2 <sup>4</sup> ) | 8<br>(2 <sup>3</sup> ) | 4<br>(2 <sup>2</sup> ) | —  | —  |
| Value             | 0/1                      | —  | 0/1                     | 0/1                     | 0/1                    | 0/1                    | —  | —  |

Value: 1 = Enable Service Request Event  
0 = Disable (Mask) Service Request Event

Events: OSB = Operation Summary Bit  
ESB = Event Summary Bit  
MAV = Message Available  
QSB = Questionable Summary Bit  
EAV = Error Available

**\*SRE? — service request enable query**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | To read the contents of the Service Request Enable Register.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Format</b>      | *SRE?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Description</b> | <p>The *SRE? command is used to acquire the value (in decimal) of the Service Request Enable Register. The binary equivalent of the decimal value determines which bits in the register are set. When the *SRE? query command is sent, the decimal value is placed in the Output Queue. When the System 41 is addressed to talk, the value is sent from the Output Queue to the computer.</p> <p>For example, for an acquired decimal value of 17, the binary equivalent is 0001 0001. This binary value indicates that Bits 4 and 0 of the Service Request Enable Register are set (see previous paragraph).</p> |

**\*STB? — status byte query**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | To read the contents of the Status Byte Register.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Format</b>      | *STB?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Description</b> | <p>The *STB? query command is used to acquire the value (in decimal) of the Status Byte Register. The Status Byte Register is shown in Figure 6-17. The binary equivalent of the decimal value determines which bits in the register are set. The set bits in this register define the operating status of the System 41.</p> <p>When the *STB? query command is sent, the decimal value is placed in the Output Queue. When the System 41 is addressed to talk, the value is sent from the Output Queue to the computer.</p> <p>All bits, except Bit 6, in this register are set by other event registers and queues. Bit 6 sets when one or more enabled conditions occur.</p> <p>The *STB? query command does not clear the status byte register. This register can only be cleared by clearing the related registers and queues. Register and queue structure are explained in “Status structure.”</p> <p>For example, for an acquired decimal value of 48, the binary equivalent is 00110000. This binary value indicates that Bits 4 and 5 of the Status Byte Register are set.</p> <p>The bits of the Status Byte Register are described as follows:</p> <p><b>Bit 0</b> — Not used.</p> <p><b>Bit 1</b> — Not used.</p> <p><b>Bit 2, Error Available (EAV)</b> — Set bit indicates that an error message is present in the Error Queue. The error message can be read using one of the following SCPI commands:</p> <pre>:SYSTem:ERRor?<br/>:STATus:QUEue?</pre> <p>See “:SYSTem subsystem” and “:STATus subsystem” for details.</p> <p><b>Bit 3, Questionable Summary Bit (QSB)</b> — Set bit indicates that too many channels have closed.</p> <p><b>Bit 4, Message Available (MAV)</b> — Set bit indicates that a message is present in the Output Queue. The message is sent to the computer when the System 41 is addressed to talk.</p> |

**Bit 5, Event Summary Bit (ESB)** — Set bit indicates that an enabled standard event has occurred. The event can be identified by reading the Standard Event Status Register using the \*ESE? query command (see “\*ESE — event status enable”).

**Bit 6, Master Summary Status (MSS) / Request Service (RQS)** — Set bit indicates that one or more enabled conditions have occurred to generate a service request (SRQ). Note that the IEEE-488.1 standard designates Bit 6 as the RQS bit and is read by performing a Serial Poll.

**Bit 7, Operation Summary Bit (OSB)** — Set bit indicates that an enabled operation event has occurred. The event can be identified by reading the Operation Event Status Register using the following SCPI command structure:

:STATus:OPERation?

See “STATus subsystem” for details.

Figure 6-17  
**Status Byte Register**

|                   |                          |                         |                         |                         |                        |                        |    |    |
|-------------------|--------------------------|-------------------------|-------------------------|-------------------------|------------------------|------------------------|----|----|
| Bit Position      | B7                       | B6                      | B5                      | B4                      | B3                     | B2                     | B1 | B0 |
| Event             | OSB                      | MSS,<br>RQS             | ESB                     | MAV                     | QSB                    | EAV                    | —  | —  |
| Decimal Weighting | 128<br>(2 <sup>7</sup> ) | 64<br>(2 <sup>6</sup> ) | 32<br>(2 <sup>5</sup> ) | 16<br>(2 <sup>4</sup> ) | 8<br>(2 <sup>3</sup> ) | 4<br>(2 <sup>2</sup> ) | —  | —  |
| Value             | 0/1                      | 0/1                     | 0/1                     | 0/1                     | 0/1                    | 0/1                    | —  | —  |

Value: 1 = Event Bit Set  
0 = Event Bit Cleared

Events: OSB = Operation Summary Bit  
MSS = Master Summary Status  
RQS = Request Service  
ESB = Event Summary Bit  
MAV = Message Available  
QSB = Questionable Summary Bit  
EAV = Error Available

**\*TRG — trigger**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | To issue a GPIB trigger to the System 41.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Format</b>      | *TRG                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Description</b> | <p>The *TRG command is used to issue a GPIB trigger to the System 41. It has the same effect as a group execute trigger (GET). The *TRG command is an overlapped command, while GET is not. See *OPC, *OPC? and *WAI for more information.</p> <p>The *TRG command is used as an arm, scan, and/or channel event to control the scan cycle. The System 41 will react to this trigger if GPIB is the programmed control source. The control source is programmed from the SCPI :TRIGger Subsystem (see “Trigger subsystem”).</p> |

**\*TST? — self-test query**

|                    |                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | To run the self-tests and acquire the results.                                                                                                                                                                                                                                                                                                                            |
| <b>Format</b>      | *TST?                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Description</b> | <p>The *TST? query command is used to perform a checksum test on ROM and place the coded result (0 or 1) in the Output Queue. When the System 41 is addressed to talk, the coded result is sent from the Output Queue to the computer.</p> <p>A returned value of zero (0) indicates that the test passed, and a value of one (1) indicates that the test has failed.</p> |

**\*WAI — wait-to-continue**

|                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Purpose</b>     | To prevent the execution of further commands until all previous overlapped commands are completed.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Format</b>      | *WAI                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Description</b> | <p>There are two types of device commands; Sequential commands and overlapped commands. A Sequential command is a command whose operations are allowed to finish before the next command is executed. An overlapped command is a command that allows the execution of subsequent commands while device operations of the overlapped command are still in progress. The *WAI command is used to hold off the execution of subsequent commands until the device operations of all previous overlapped command are finished. The *WAI command is not needed for Sequential commands.</p> |

**NOTE**      *See \*OPC, \*OPC?, and \*TRG for more information.*

The :INIT command takes the System 41 out of the idle state to enable the scan function. The device operations of the :INIT command are not considered complete until the System 41 goes back into the idle state. Typically, this occurs when all programmed scan operations are completed. By sending the \*WAI command after the :INIT command, all subsequent commands will not execute until the System 41 goes back into the idle state.

The \*TRG command issues a bus trigger which could be used to provide the arm, scan, and channel events for the Trigger Model. By sending the \*WAI command after the \*TRG command, subsequent commands will not be executed until the pointer for the Trigger Model has finished moving in response to \*TRG and has settled at its next state.

## SCPI command subsystems

SCPI commands are categorized into subsystems. The subsystems are presented in alphabetical order as follows:

**:DISPlay subsystem** — Explains the commands used to control user defined text messages.

**:ROUTe subsystem** — Covers commands to open and close channels, create a scan list, and set a channel delay. There are certain features and operating modes that must be either on or off to ensure proper operation. These commands are covered here. Finally, memory commands used to store (save) and recall channel patterns are explained.

**:STATus subsystem** — Covers the commands used to control the status registers of the System 41.

**:SYSTEM subsystem** — Covers miscellaneous commands used to read the software revision level of the System 41, read the error queue, and set the power-on setup configuration.

**Trigger subsystem** — Covers commands used to scan.

## :DISPlay subsystem

The display subsystem controls the display circuitry of the System 41 and is summarized in Table 6-5.

Table 6-5  
**DISPlay command summary**

| Command        | Description                                                                 |
|----------------|-----------------------------------------------------------------------------|
| :DISPlay       |                                                                             |
| [:WINDow[1]]   | Path to locate message to top display.                                      |
| :TEXT          | Path to control user text messages.                                         |
| :DATA <a>      | Define ASCII message “a” using up to 20 characters.                         |
| :DATA?         | Query text message.                                                         |
| :STATE <b>     | Enable (1 or ON) or disable (0 or OFF) message mode.                        |
| :STATE?        | Query text message mode (0 or 1).                                           |
| :WINDow2       | Path to locate message to bottom display.                                   |
| :TEXT          | Path to control user text messages.                                         |
| :DATA <a>      | Define ASCII message “a” using up to 32 characters.                         |
| :DATA?         | Query text message.                                                         |
| :STATE <b>     | Enable (1 or ON) or disable (0 or OFF) message mode.                        |
| :STATE?        | Query text message mode (0 or 1).                                           |
| :WINDow3       | Path to control LED Graticule.                                              |
| :GRATICule <b> | Enable (1 or ON) or disable (0 or OFF) the LED Graticule.                   |
| :SMESsage <b>  | Enable (1 or ON) or disable (0 or OFF) status message mode.                 |
| :SMESsage?     | Query status message mode (0 or 1).                                         |
| :ENABle <b>    | Turn on (1 or ON) or turn off (0 or OFF) the front panel display circuitry. |
| :ENABle?       | Query state of the display (0 or 1).                                        |

Notes:

1. Brackets ([ ]) are used to denote optional character sets. These optional characters do not have to be included in the program message. Do not use brackets ([ ]) in the program message.
2. Angle brackets (< >) are used to indicate parameter type. Do not use angle brackets (< >) in the program message.
3. Upper case characters indicate the short-form version for each command word.
4. At least one space is required between a command word and the parameter.

**:TEXT commands****:DATA <a>**

:DISPlay[:WINDow[1]]:TEXT:DATA &lt;a&gt;

Define message for top display

:DISPlay:WINDow2:TEXT:DATA &lt;a&gt;

Define message for bottom display

**Parameters**

&lt;a&gt; = ASCII characters for message.

**Short-form formats**String :disp:text:data 'aa...a'  
:disp:wind2:text:data 'aa...a'Indefinite block :disp:text:data #0aa...a  
:disp:wind2:text:data #0aa...aDefinite block :disp:text:data #XYaa...a  
:disp:wind2:text:data #XYaa...a

where; Y = number of characters in message:

Up to 20 for top display.

Up to 32 for bottom display.

X = number of digits that make up Y (1 or 2).

**Defaults**

Power-up Null string

\*RST No effect

:SYSTem:PRESet No effect

**Query command**

:DATA? Query the defined text message

Short-form formats: :disp:text:data?  
:disp:wind2:text:data?

Response message: User defined text message

**Description**

These commands define the text messages that you wish to display. The message can be as long as 20 characters for the top display, and up to 32 characters for the bottom display. A space is counted as a character. Excess message characters (over 20 and 32 respectively) will cause error.

A string message must be enclosed in single quotes or double quotes. Both of the following string messages are valid:

'Keithley Model 7002' or "Keithley Model 7002"

An indefinite block message must be the only command in the program message or the last command in the program message. If you include a command after an indefinite block message (on the same line), it will be treated as part of the message and will be displayed instead of executed.

**:STATe <b>**

:DISPlay[:WINDow[1]]:TEXT:STATe <b>                      Control message; top display  
 :DISPlay:WINDow2:TEXT:STATe <b>                      Control message; bottom display

|                           |                           |                                                   |
|---------------------------|---------------------------|---------------------------------------------------|
| <b>Parameters</b>         | <b> = 0 or OFF            | Disable text message for specified display        |
|                           | = 1 or ON                 | Enable text message for specified display         |
| <b>Short-form formats</b> | :disp:text:stat <b>       |                                                   |
|                           | :disp:wind2:text:stat <b> |                                                   |
| <b>Defaults</b>           | Power-up                  | OFF                                               |
|                           | *RST                      | No effect                                         |
|                           | :SYSTem:PRESet            | No effect                                         |
| <b>Query command</b>      | :STATe?                   | Query state of message mode for specified display |
|                           | Short-form formats        | :disp:text:stat?<br>:disp:wind2:text:stat?        |
|                           | Response message:         | 1 (on) or 0 (off)                                 |

**Description**

These commands enable and disable the text message modes. When enabled, a defined message (see previous command) will be shown on the top or bottom portion of the display. When disabled, the message will be removed from the display, and the System 41 will resume normal operation.

A user defined text message remains displayed only as long as the instrument is in remote. Taking the instrument out of remote (by pressing the LOCAL key or sending GTL), cancels the message and disables the text message mode.



**:WINDow3 Command**

:GRATicule <b>  
 :DISPlay:WINDow3:GRATicule <b> Control LED Graticule

**Parameters** <b> = 0 or OFF Disable LED Graticule  
 = 1 or ON Enable LED Graticule

**Short-form formats** :disp:wind3:grat <b>

**Defaults** Power-up ON  
 \*RST ON  
 :SYSTem:PRESet ON

**Query command** :GRATicule? Query state of LED Graticule  
 Short-form format: :disp:wind3:grat?  
 Response message: 1 (on) or 0 (off)

**Description** This command is used to control the LED Graticule. When enabled, all available channels are denoted by channel LEDs that are turned on (dimly lit or brightly lit). Channels not available are denoted by channel LEDs that are turned off.

Contrast between on and off LEDs can be increased by disabling the LED Graticule. When disabled, there is no dimly lit state for the LEDs. An LED that would normally be dimly lit is instead turned completely off. Each LED is either off or brightly lit.

**NOTE** *If the main CPU firmware is not compatible with the LED display firmware, the following error will occur when trying to disable the LED Graticule.*

ERROR:ID CODE = +551  
 Incorrect software revision

*If this error should occur, contact Keithley to resolve the firmware incompatibility.*

**:SMESsage <b>**

:DISPlay:SMESsage &lt;b&gt; Control status messages

**Parameters** <b> = 0 or OFF Disable status messages  
 = 1 or ON Enable status messages

**Short-form formats** :disp:smes <b>

**Defaults** Power-up Saved power-on setup  
 \*RST OFF  
 :SYSTem:PRESet OFF

**Query command** :SMESsage? Query state of status message mode  
 Short-form formats: :disp:smes?  
 Response message: 1 (on) or 0 (off)

**Description** This command is used to enable/disable the status message mode for the System 41. The status message mode is a diagnostic tool that provides real-time messages that relate to the current operating state of the instrument. When the status message mode is disabled, only the error events (EE) in Table 5-1 will be reported to the display.

**:ENABLE <b>**

:DISPlay:ENABLE &lt;b&gt; Control display circuitry

**Parameters** <b> = 0 or OFF Disable display circuitry  
 = 1 or ON Enable display circuitry

**Short-form formats** :disp:enab <b>

**Defaults** Power-up ON  
 \*RST No effect  
 :SYSTem:PRESet No effect

**Query command** :ENABLE? Query state of display  
 Short-form formats: :disp:enab?  
 Response message: 1 (on) or 0 (off)

**Description** This command is used to enable and disable the front panel display circuitry. Disabling the display circuitry allows the instrument to operate at a higher speed. While disabled, the display will be frozen with the following message:

FRONT PANEL DISABLED

Press LOCAL to resume.

As reported by the message, all front panel controls (except LOCAL) will be disabled. Normal display operation can be resumed by using the :ENABLE command to enable the display or by putting the System 41 into local.

## [:ROUTe] subsystem

The ROUTe subsystem is used to control signal routing through the switch system and is summarized in Table 6-6. The brackets indicate that :ROUTe is optional and need not be included in the command message.

Table 6-6  
**ROUTe command summary**

| Command              | Description                                                           |
|----------------------|-----------------------------------------------------------------------|
| [[:ROUTe]            |                                                                       |
| :CLOSe <list>        | Close specified channels.                                             |
| :STATe?              | Query list of closed channels.                                        |
| :CLOSe? <list>       | Query state of specified channels (1 = closed, 0 = open).             |
| :OPEN <list> ALL     | Open specified (or all) channels.                                     |
| :OPEN? <list>        | Query state of specified channels (1 = open, 0 = closed).             |
| :SCAN <list>         | Define scan list.                                                     |
| :POINts?             | Query number of channel patterns in scan list.                        |
| :SCAN?               | Query scan list.                                                      |
| :FCHannels (@)       | Empty “forbidden” channel list.                                       |
| :FCHannels?          | Query channels that cannot be closed.                                 |
| :INterlockX          | Specify interlock (X = [1] to 5).                                     |
| :LIST[1] (@)         | Empty “interlock” channel list.                                       |
| :LIST[1]?            | Query List 1 for specified interlock.                                 |
| :LIST2 (@)           | Empty “interlock” channel list.                                       |
| :LIST2?              | Query List 2 for specified interlock.                                 |
| :CONFigure           | Configuration command path:                                           |
| :BBMake ON           | Enable (1 or ON) Break-Before-Make switching.                         |
| :BBMake?             | Query Break-Before-Make.                                              |
| :SCHannel OFF        | Disable (0 or OFF) Single Channel.                                    |
| :SCHannel?           | Query Single Channel.                                                 |
| :CPAirX OFF          | Disable (0 or OFF) Card Pair X (X = [1] to 5).                        |
| :CPAirX?             | Query Card Pair X (X = [1] to 5).                                     |
| :SLOTX               | Path to configure SLOT X (X = 7 to 10):                               |
| :CTYPe NONE          | Disable specified slot (7 to 10).                                     |
| :CTYPe?              | Query card ID number for specified slot.                              |
| :STIme <n>           | Specify delay (0 to 99999.999 sec) for specified slot (1 to 6).       |
| :STIme?              | Query delay for specified slot.                                       |
| :MEMory              | Path to program memory:                                               |
| :SAVE                | Path to save channel patterns:                                        |
| :LIST <list>, M<num> | Save defined channel pattern at specified memory location (1 to 500). |
| [[:RELays] M<num>    | Save current channel pattern at specified memory location (1 to 500). |
| :RECall M<num>       | Recall channel pattern from memory (1 to 500).                        |

### Notes:

1. Brackets ([ ]) are used to denote optional character sets. These optional characters do not have to be included in the program message. Do not use brackets ([ ]) in the program message.
2. Angle brackets (< >) are used to indicate parameter type. Do not use angle brackets (< >) in the program message.
3. Upper case characters indicate the short-form version for each command word.
4. At least one space is required between a command word and the parameters.



**:STAtE?**

[:ROUte]:CLOSe:STAtE?

Query closed channels

**Short-form  
formats**

:clos:stat?

**Description**

This query command is used to request the channels that are currently closed. For example if channels 1!1 and 1!37 are closed, the following message will be sent to the computer after sending this command and addressing the System 41 to talk:

(@1!1, 1!37)

**:OPEN <list> | ALL**

[:ROUte]:OPEN &lt;list&gt;|ALL

Open specified (or all) channels

**Parameters**

<list> = (@ chanlist)      Open listed channels  
ALL                            Open all channels

where; chanlist is the specified list of channels (channel list) to be opened.

**Short-form  
formats**:open (@ chanlist)  
:open all**Defaults**

Power-up                    All channels open  
\*RST                        No effect  
:SYSTem:PRESet          No effect

**Query  
command**

:OPEN? <list>            Query state of specified channels.  
Short-form formats:      :open? (@ chanlist)  
Response message:        1 = specified channel(s) open.  
                              0 = specified channel(s) not open.

**Description**

The :OPEN command is used to open one or more channels. The <list> parameter is used to define a channel list (chanlist) the specifies which channels to open. The ALL parameter is used to simply open all channels.

The following examples demonstrate various forms for expressing channel entries for a chanlist.

**chanlist**

M1                        Single channel pattern.\*  
M1, M15                Multiple channel patterns separated by commas.\*  
1!1, 1!37               Individual channels separated by commas.

\*Channel patterns cannot be used with the :OPEN? <list> query command.

The :OPEN? <list> query command is used to determine the state (open or not open) of each specified channel. After sending this command and addressing the System 41 to talk, the values for the specified channels will be sent to the computer. A value of "1" indicates that the channel is open, and a "0" indicates that the channel is not open (closed).

You cannot use channel patterns with the :OPEN? <list> query command. You can list individual channels or a range of channels. Example:

- :open? (@1!1, 1!37)      Individual channels separated by commas.
- :open? (@1!1:1!40)      Range of channels (channels 1 through 40 of slot 1)

For example, assume channels 1 and 37 of slot 1 are closed and the following query command is sent:

:open? (@1!1:1!40)

After addressing the System 41 to talk, the following response message will be sent to the computer:

0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1

**:SCAN <list>**

[:ROUTe]:SCAN <list>      Define scan list

**Parameters**

<list> = (@ scanlist)

where; scanlist is the specified list of channel patterns (scan list) to be scanned.

**Short-form formats**

:scan (@ scanlist)

**Defaults**

- Power-up      Last defined scan list
- \*RST      No effect
- :SYSTem:PRESet      No effect

**Query command**

- :SCAN?      Query scan list
- Short-form formats:      :scan?
- Response message:      Currently defined scan list

**Description**

The :SCAN command is used to define a scan list. The list of channel patterns to be scanned (scan list) are included in the <list> parameter.

The following command example shows the proper format for the scan list:

:scan (@ M1, M4, M3, M5)

The order presented in the scan list determines the order of the channel pattern scan. The scan list is not lost after the instrument is turned off.

**:POINTs?**

[:ROUte]:SCAN:POINTs?

Query scan list length

**Short-form  
formats**

:scan:poin?

**Description**

This query command is used to request the number of channel patterns in the scan list. For example, assume the following scan list:

(@ M1, M4, M3, M5)

After the POINT? command is sent and the System 41 is addressed to talk, the value “4” will be sent to the computer to indicate that there are four channel patterns in the scan list.

**:FCHannels (@)**

[:ROUte]:FCHannels (@)

Clear “forbidden” channel list

**Parameters**

(@) = Empty “forbidden” channel list.

**Short-form  
formats**

:fch (@)

**Defaults**

|                |                                       |
|----------------|---------------------------------------|
| Power-up       | Last defined “forbidden” channel list |
| *RST           | No effect                             |
| :SYSTem:PRESet | No effect                             |

**Query  
command**

|                     |                                |
|---------------------|--------------------------------|
| :FCHannels?         | Query “forbidden” channel list |
| Short-form formats: | :fch?                          |
| Response message:   | List of “forbidden” channels   |

**Description**

A “forbidden” channel list defines a list of channels that cannot be closed. If you specify a forbidden channel that is already included in a channel pattern, that channel pattern will be lost (cleared). Therefore, NEVER create a “forbidden” channel list. If a “forbidden” channel list exists, use the following command to clear the list:

:fch (@)

Keep in mind that you can use the :FCHannels? query command to determine if there are forbidden channels. If there are none, the message “(@)” will be returned.

**:INTerlock:LIST commands****:LIST[1] (@)****:LIST2 (@)**

|                                    |                               |
|------------------------------------|-------------------------------|
| :[:ROUte]:INTerlock[1]:LIST[1] (@) | Clear List 1 for Interlock #1 |
| :[:ROUte]:INTerlock[1]:LIST2 (@)   | Clear List 2 for Interlock #1 |
| :[:ROUte]:INTerlock2:LIST[1] (@)   | Clear List 1 for Interlock #2 |
| :[:ROUte]:INTerlock2:LIST2 (@)     | Clear List 2 for Interlock #2 |
| :[:ROUte]:INTerlock3:LIST[1] (@)   | Clear List 1 for Interlock #3 |
| :[:ROUte]:INTerlock3:LIST2 (@)     | Clear List 2 for Interlock #3 |
| :[:ROUte]:INTerlock4:LIST[1] (@)   | Clear List 1 for Interlock #4 |
| :[:ROUte]:INTerlock4:LIST2 (@)     | Clear List 2 for Interlock #4 |
| :[:ROUte]:INTerlock5:LIST[1] (@)   | Clear List 1 for Interlock #5 |
| :[:ROUte]:INTerlock5:LIST2 (@)     | Clear List 2 for Interlock #5 |

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                             |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Parameters</b>         | (@) = Empty “interlock” channel list                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Short-form formats</b> | :int:list (@)<br>:int:list2 (@)<br>:int2:list (@)<br>:int2:list2 (@)<br>:int3:list (@)<br>:int3:list2 (@)<br>:int4:list (@)<br>:int4:list2 (@)<br>:int5:list (@)<br>:int5:list2 (@)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Defaults</b>           | Power-up<br>*RST<br>:SYSTem:PRESet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Last defined interlock lists<br>No effect<br>No effect                                                                                                                                                                                                                                                                                                                                      |
| <b>Query command</b>      | :LIST[1]?<br>:LIST2?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Query List 1 for specified interlock<br>Query List 2 for specified interlock                                                                                                                                                                                                                                                                                                                |
|                           | Short-form formats:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | :int:list? (Interlock #1, List 1)<br>:int:list2? (Interlock #1, List 2)<br>:int2:list? (Interlock #2, List 1)<br>:int2:list2? (Interlock #2, List 2)<br>:int3:list? (Interlock #3, List 1)<br>:int3:list2? (Interlock #3, List 2)<br>:int4:list? (Interlock #4, List 1)<br>:int4:list2? (Interlock #4, List 2)<br>:int5:list? (Interlock #5, List 1)<br>:int5:list2? (Interlock #5, List 2) |
|                           | Response message:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | List of channels                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Description</b>        | <p>An “interlock” channel list defines a list of channels that are interlocked to channels in the other “interlock” list. Interlocked channels cannot be closed at the same time. If you specify channels to be interlocked that are already included in a channel pattern, that channel pattern will be lost (cleared). Therefore, NEVER create an “interlock” channel list.</p> <p>If an “interlock” channel list exists, use the following parameter to clear the list:</p> <p>(@)</p> <p>Keep in mind that you can use the query commands to determine if there are interlocked channels. If there are none, the message “(@)” will be returned for each of the ten query commands.</p> |                                                                                                                                                                                                                                                                                                                                                                                             |



**:CONFigure Commands:****:BBMake ON**

[:ROUte]:CONFigure:BBMake ON Enable Break-Before-Make switching

|                   |         |                                    |
|-------------------|---------|------------------------------------|
| <b>Parameters</b> | 1 or ON | Enable Break-Before-Make switching |
|-------------------|---------|------------------------------------|

|                 |                |                      |
|-----------------|----------------|----------------------|
| <b>Defaults</b> | Power-up       | Saved power-on setup |
|                 | *RST           | On                   |
|                 | :SYSTem:PRESet | On                   |

|                      |                     |                         |
|----------------------|---------------------|-------------------------|
| <b>Query command</b> | :BBMake?            | Query Break-Before-Make |
|                      | Short-form formats: | :conf:bbm?              |
|                      | Response message:   | 1 (on) or 0 (off)       |

**Description** When scanning, keeping Break-Before-Make enabled will assure that the currently closed channel pattern will open before the next channel pattern closes. When it is disabled, the assurance that the current channel pattern will open before the next channel pattern closes is lost. In other words, two channel patterns could momentarily be closed at the same time.

**CAUTION** To prevent damage to RF switches, ALWAYS keep Break-Before-Make enabled (ON). Never disable (OFF) Break-Before-Make.

If Break-Before-Make is disabled, use the following command to enable it:

```
:conf:bbm on
```

Keep in mind that you can use the :BBMake? query command to determine the state of Break-Before-Make.

**:SCHannel OFF**

[:ROUte]:CONFigure:SCHannel OFF Disable Single Channel mode

|                   |            |                              |
|-------------------|------------|------------------------------|
| <b>Parameters</b> | = 0 or OFF | Disable Single Channel mode. |
|-------------------|------------|------------------------------|

|                           |               |
|---------------------------|---------------|
| <b>Short-form formats</b> | :conf:sch OFF |
|---------------------------|---------------|

|                 |                |                      |
|-----------------|----------------|----------------------|
| <b>Defaults</b> | Power-up       | Saved power-on setup |
|                 | *RST           | Off                  |
|                 | :SYSTem:PRESet | Off                  |

|                      |                     |                                |
|----------------------|---------------------|--------------------------------|
| <b>Query command</b> | :SCHannel?          | Query status of Single Channel |
|                      | Short-form formats: | :conf:sch?                     |
|                      | Response message:   | 0 (off) or 1 (on)              |

**Description** The Single Channel mode prevents more than one channel from closing at time. System 41 operation requires that at least two switches (channels) be closed at the same time. Therefore, NEVER enable the Single Channel mode.

If Break-Before-Make is disabled, use the following command to enable it:

```
:conf:sch off
```

Keep in mind that you can use the :SCHannel? query command to determine the state of the Single Channel mode.

### **:CPAirX OFF where; X = [1] to 5**

|                                  |                     |
|----------------------------------|---------------------|
| :[:ROUte]:CONFigure:CPAir[1] OFF | Disable Card Pair 1 |
| :[:ROUte]:CONFigure:CPAir2 OFF   | Disable Card Pair 2 |
| :[:ROUte]:CONFigure:CPAir3 OFF   | Disable Card Pair 3 |
| :[:ROUte]:CONFigure:CPAir4 OFF   | Disable Card Pair 4 |
| :[:ROUte]:CONFigure:CPAir5 OFF   | Disable Card Pair 5 |

**Parameters** = 0 or OFF Disable specified Card Pair.

**Short-form formats**

```
:conf:cpa OFF
:conf:cpa2 OFF
:conf:cpa3 OFF
:conf:cpa4 OFF
:conf:cpa5 OFF
```

**Defaults**

|                |                         |
|----------------|-------------------------|
| Power-up       | Saved power-on setup    |
| *RST           | Disables all Card Pairs |
| :SYSTem:PRESet | Disables all Card Pairs |

**Query command**

```
:CPAirX?
where; X = [1] to 5
```

Short-form formats:

```
:conf:cpa?
:conf:cpa2?
:conf:cpa3?
:conf:cpa4?
:conf:cpa5?
```

Response message: 0 (off) or 1 (on)

**Description** With a Card Pair enabled, the corresponding channels of two slots are controlled concurrently. For example, when channel 5 of slot 1 is closed, channel 5 of slot 6 is also closed.

Card Pair is not beneficial to System 41 operation. Therefore, none of the Card Pairs should be enabled.

If a card pair is enabled, disable it. Keep in mind that you can use the query commands to determine if any of the six card pairs are enabled.

**:CTYPe NONE**

|                                      |                 |
|--------------------------------------|-----------------|
| :ROUte]:CONFigure:SLOT7:CTYPe NONE   | Disable SLOT 7  |
| [:ROUte]:CONFigure:SLOT8:CTYPe NONE  | Disable SLOT 8  |
| [:ROUte]:CONFigure:SLOT9:CTYPe NONE  | Disable SLOT 9  |
| [:ROUte]:CONFigure:SLOT10:CTYPe NONE | Disable SLOT 10 |

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Parameters</b>         | NONE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | = slot disabled                                                                                                                                                                                                |
| <b>Short-form formats</b> | :conf:slot7:ctyp NONE<br>:conf:slot8:ctyp NONE<br>:conf:slot9:ctyp NONE<br>:conf:slot10:ctyp NONE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                |
| <b>Defaults</b>           | Power-up                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | No effect                                                                                                                                                                                                      |
|                           | *RST                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | No effect                                                                                                                                                                                                      |
|                           | :SYSTem:PRESet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | No effect                                                                                                                                                                                                      |
| <b>Query command</b>      | :CYTPe?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Query card ID assignment for specified slot.                                                                                                                                                                   |
|                           | Short-form formats:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | :conf:slot:ctyp?<br>:conf:slot2:ctyp?<br>:conf:slot3:ctyp?<br>:conf:slot4:ctyp?<br>:conf:slot5:ctyp?<br>:conf:slot6:ctyp?<br>:conf:slot7:ctyp?<br>:conf:slot8:ctyp?<br>:conf:slot9:ctyp?<br>:conf:slot10:ctyp? |
|                           | Response message:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Slot assignment (i.e., 7116)                                                                                                                                                                                   |
| <b>Description</b>        | Slots 1 through 6 are reserved for RF switches. These slots are assigned the number “7116” and cannot be changed.<br>The System 41 does not use slots 7 through 10, therefore, they are disabled and assigned the message “NONE.”<br>If slot 7, 8, 9 or 10 is enabled, you should disable it using one of the four :CTYPe commands. Assuming the graticule is enabled, you can tell if a slot is enabled by its channel LEDs. If the LEDs are completely off, the slot is disabled. If they’re dimly lit, the slot is enabled.<br>You can also use the query commands to check slot assignments. If you query slots 1 through 6, the response message will be “C7116.” For slots 7, 8, 9 and 10, the response message will be “CNONE” if the slot is disabled. Any other message (i.e. “C9990”) means that the slot is enabled. |                                                                                                                                                                                                                |

**:STIME <n>**

|                                      |                      |
|--------------------------------------|----------------------|
| [:ROUte]:CONFigure:SLOT[1]:STIME <n> | Set delay for Slot 1 |
| [:ROUte]:CONFigure:SLOT2:STIME <n>   | Set delay for Slot 2 |
| [:ROUte]:CONFigure:SLOT3:STIME <n>   | Set delay for Slot 3 |
| [:ROUte]:CONFigure:SLOT4:STIME <n>   | Set delay for Slot 4 |
| [:ROUte]:CONFigure:SLOT5:STIME <n>   | Set delay for Slot 5 |
| [:ROUte]:CONFigure:SLOT6:STIME <n>   | Set delay for Slot 6 |

**Parameters**

<n> = 0 to 99999.999 Settling time in seconds  
 = DEFault 0 sec  
 = MINimum 0 sec  
 = MAXimum 99999.999 sec

**Short-form formats**

|                      |                      |
|----------------------|----------------------|
| :conf:slot:stim <n>  | :conf:slot4:stim <n> |
| :conf:slot2:stim <n> | :conf:slot5:stim <n> |
| :conf:slot3:stim <n> | :conf:slot6:stim <n> |

**Defaults**

|                |       |
|----------------|-------|
| Power-up       | 0 sec |
| *RST           | 0 sec |
| :SYSTem:PRESet | 0 sec |

**Query command**

|                 |                                           |
|-----------------|-------------------------------------------|
| :STIME?         | Query programmed delay for specified slot |
| :STIME? DEFault | Query *RST default delay                  |
| :STIME? MINimum | Query minimum delay                       |
| :STIME? MAXimum | Query maximum delay                       |

Short-form formats:

|                   |                       |
|-------------------|-----------------------|
| :conf:slot:stim?  | :conf:slot:stim? xxx  |
| :conf:slot2:stim? | :conf:slot2:stim? xxx |
| :conf:slot3:stim? | :conf:slot3:stim? xxx |
| :conf:slot4:stim? | :conf:slot4:stim? xxx |
| :conf:slot5:stim? | :conf:slot5:stim? xxx |
| :conf:slot6:stim? | :conf:slot6:stim? xxx |

where; xxx = def, min or max

Response message: 0 to 99999.999

**Description**

An internally set relay settling time is provided to allow for switch bounce when it closes. At power-up, a settling time is automatically set based on the acquired identification information from the card. The :STIME command allows you to increase the delay for each slot.

The delay value can be entered using the exponent form. For example, instead of sending a parameter value of 2000 (seconds), you can instead send 2E3. To cancel this delay, send this command using a parameter value of 0.

## :MEMory Commands:

Memory commands are used to save channel patterns to memory. Normally, there is no need to do this since channel patterns are pre-programmed at the factory. However, an illegal operation for the System 41 could cause channel patterns to be lost (cleared). In that event, you will have to re-program the channel patterns yourself.

The actual channel closure assignments depend on which RF module is installed in the System 41. Channel closure assignments for each RF module and information to re-program channel patterns are provided in Section 4.

### :SAVE:LIST <list>, M <num>

[:ROUte]:MEMory:SAVE:LIST <list>, M <num>

Save specified channel pattern at a specified memory location

#### Parameters

<num> = a whole number from 1 to 500

Specify memory location

<list> = (@ chanlist)

Specify channel pattern

where; chanlist is the specified list of closed channels

#### Short-form formats

:mem:save:list <list>, M<num>

#### Defaults

Power-up No effect

\*RST No effect

:SYSTem PRESet No effect

#### Description

This command is used to define and save (store) a channel pattern at a memory location. The <Nrf> parameter specifies the memory location for the channel pattern. The <list> parameter defines the channel pattern. When the channel pattern is recalled or scanned, the channels listed in the chanlist will close.

For example, assume the M1 channel pattern for the RF 6x6 Module was lost (cleared). For that M1 channel pattern, channels 1!1 and 1!37 need to close. The following command will re-program the M1 channel pattern.

```
:mem:save:list (@ 1!1, 1!37), M1
```

An alternate method to save a channel pattern is to use the :SAVE[:RELays] command. With this method, you close the desired channels and then save that channel pattern at a memory location.

### :SAVE[:RELays] M<num>

[:ROUte]:MEMory:SAVE[:RELays] M<num>

Save current channel pattern at specified memory location

#### Parameters

<num> = a whole number from 1 to 500

Specify memory location

#### Short-form formats

:mem:save M<num>

#### Defaults

Power-up No effect

\*RST No effect

:SYSTem PRESet No effect

**Description**

This command is used to save (store) the current channel pattern at a memory location. For example, assume the M1 channel pattern for the RF 6×6 Module was lost (cleared). The following steps will re-program that M1 channel pattern:

1. Close channels 1!1 and 1!37. These are the closed channels for the M1 channel pattern. All other channels must be open. The following commands will open all channels and then close channels 1!1 and 1!37:

```
:open all
:clos (@ 1!1, 1!37)
```

2. Now send the following command to save the channel pattern in memory location 1.

```
:mem:sav M1
```

An alternate method to save a channel pattern is to use the :SAVE:LIST command. This allows you to define the channel pattern without having to open and close channels.

**:RECall M<NRf>**

```
[:ROUte]:MEMory:RECall M<NRf>
```

Recall channel pattern from memory

**Parameters**

<NRf> =1 to 500      Specify memory location

**Short-form  
formats**

```
:mem:rec M<NRf>
```

**Description**

This command is used to recall a channel pattern stored at a memory location. Channel patterns can be recalled from memory locations 1 to 500. As soon as the channel pattern is recalled, channels will immediately close and/or open as dictated by the channel pattern. The front panel channel status display will also update to reflect the channel pattern.

## STATus subsystem

The status subsystem is used to control the status registers of the System 41. These registers and the overall status structure are explained in “Status structure.”

The commands in this subsystem are summarized in Table 6-7.

Table 6-7

**STATus command summary**

| Command            | Description                                   |
|--------------------|-----------------------------------------------|
| :STATus            |                                               |
| :OPERation         | Path to control operation event registers:    |
| [:EVENTt]?         | Query event register.                         |
| :ENABle <NRf>      | Program the enable register.                  |
| :ENABle?           | Query enable register.                        |
| :PTRansition <NRf> | Program the positive transition register.     |
| :PTRansition?      | Query positive transition register.           |
| :NTRansition <NRf> | Program the negative transition register.     |
| :NTRansition?      | Query negative transition register.           |
| :CONDition?        | Query condition register.                     |
| :ARM               | Path to control arm event registers:          |
| [:EVENTt]?         | Query event register.                         |
| :ENABle <NRf>      | Program the enable register.                  |
| :ENABle?           | Query enable register.                        |
| :PTRansition <NRf> | Program the positive transition register.     |
| :PTRansition?      | Query positive transition register.           |
| :NTRansition <NRf> | Program the negative transition register.     |
| :NTRansition?      | Query negative transition register.           |
| :CONDition?        | Query condition register.                     |
| :SEQuence          | Path to control the sequence event registers: |
| [:EVENTt]?         | Query event register.                         |
| :ENABle <NRf>      | Program the enable register.                  |
| :ENABle?           | Query enable register.                        |
| :PTRansition <NRf> | Program the positive transition register.     |
| :PTRansition?      | Query positive transition register.           |
| :NTRansition <NRf> | Program the negative transition register.     |
| :NTRansition?      | Query negative transition register.           |
| :CONDition?        | Query condition register.                     |
| :TRIGger           | Path to control trigger event registers:      |
| [:EVENTt]?         | Query event register.                         |
| :ENABle <NRf>      | Program the enable register.                  |
| :ENABle?           | Query enable register.                        |
| :PTRansition <NRf> | Program the positive transition register.     |
| :PTRansition?      | Query positive transition register.           |
| :NTRansition <NRf> | Program the negative transition register.     |
| :NTRansition?      | Query negative transition register.           |
| :CONDition?        | Query condition register.                     |
| :QUESTionable      | Path to control questionable event registers: |
| [:EVENTt]?         | Query the event register.                     |
| :ENABle <NRf>      | Program the enable register.                  |
| :ENABle?           | Query the enable register.                    |

Table 6-7 (cont.)  
**STATus command summary**

| Command            | Description                                  |
|--------------------|----------------------------------------------|
| :STATus            |                                              |
| :QUESTionable      |                                              |
| :PTRansition <NRf> | Program the positive transition register.    |
| :PTRansition?      | Query the positive transition register.      |
| :NTRansition <NRf> | Program the negative transition register.    |
| :NTRansition?      | Query the negative transition register.      |
| :CONDition?        | Query the condition register.                |
| :PRESet            | Return status registers to default states.   |
| :QUEue             | Path to access error queue:                  |
| [:NEXT]?           | Query most recent error message.             |
| :ENABle <list>     | Specify error and status messages for queue. |
| :ENABle?           | Query enabled messages.                      |
| :DISAble <list>    | Specify messages not to be placed in queue.  |
| :DISAble?          | Query disabled messages.                     |

Notes:

1. Brackets ( [ ] ) are used to denote optional character sets. These optional characters do not have to be included in the program message. Do not use brackets ( [ ] ) in the program message.
2. Angle brackets ( < > ) are used to indicate parameter type. Do not use angle brackets ( < > ) in the program message.
3. Upper case characters indicate the short-form version for each command word.
4. At least one space is required between a command word and the parameter.

**[:EVENT]?**

|                                         |                                   |
|-----------------------------------------|-----------------------------------|
| :STATus:OPERation[:EVENT]?              | Query Operation Event Register    |
| :STATus:OPERation:TRIGger[:EVENT]?      | Query Trigger Event Register      |
| :STATus:OPERation:ARM[:EVENT]?          | Query Arm Event Register          |
| :STATus:OPERation:ARM:SEQUENCE[:EVENT]? | Query Sequence Event Register     |
| :STATus:QUESTionable[:EVENT]?           | Query Questionable Event Register |

**Short-form formats**

:stat:oper?  
 :stat:oper:trig?  
 :stat:oper:arm?  
 :stat:oper:arm:seq?  
 :stat:ques?

**Defaults**

Power-up                      Clears (0) all bits  
 \*CLS                            Clears (0) all bits  
 :STATus:PRESet              No effect

**Description**

These query commands are used to query the event registers. After sending one of these commands and addressing the System 41 to talk, a decimal value is sent to the computer. The binary equivalent of this value determines which bits in the appropriate register are set. The event registers are shown in Figure 6-18 through Figure 6-22. Note that querying an event register clears the bits in that register.

For example, assume that querying the Operation Event Register results in an acquired decimal value of 34. The binary equivalent is 0000 0000 0010 0010. For this binary value, bits B5 and B1 of the Operation Event Register are set.

The significance of a set bit in these registers depend on how the transition filter is programmed (see :PTRansition and :NTRansition commands). If an event is programmed for a positive transition (PTR), the corresponding bit in this register will set when the event occurs (0 to 1 transi-



tion). If the event is instead programmed for a negative transition (NTR), the bit will set when the event becomes not true (1 to 0 transition).

**Operation event register:**

**Bit B0** — Not used.

**Bit B1, Settling (Set)** — Set bit indicates that the scan is currently in the settling period for a relay (PTR) or the settling period has expired (NTR).

**Bits B2, B3 and B4** — Not used.

**Bit B5, Waiting for Trigger (Trig)** — Set bit indicates that the instrument is waiting in the Trigger Layer of the trigger model (PTR) or that it has left the Trigger Layer (NTR).

**Bit B6, Waiting for Arm (Arm)** — Set bit indicates that the instrument is waiting in an Arm Layer of the trigger model (PTR) or operation has passed from the arm layers into the trigger layer (NTR).

**Bits B7, B8 and B9** — Not used.

**Bit B10, Idle** — Set bit indicates that the instrument is in the idle state (PTR) or has left the idle state to perform a scan (NTR).

**Bits B11 through B15** — Not used.

Figure 6-18

**Operation Event Register**

| Bit Position      | (B15 - B11) | B10                  | B9 | B8 | B7 | B6              | B5              | B4 | B3 | B2 | B1             | B0 |
|-------------------|-------------|----------------------|----|----|----|-----------------|-----------------|----|----|----|----------------|----|
| Event             | —           | Idle                 | —  | —  | —  | Arm             | Trig            | —  | —  | —  | Set            | —  |
| Decimal Weighting | —           | 1024<br>( $2^{10}$ ) | —  | —  | —  | 64<br>( $2^6$ ) | 32<br>( $2^5$ ) | —  | —  | —  | 2<br>( $2^1$ ) | —  |
| Value             | —           | 0/1                  | —  | —  | —  | 0/1             | 0/1             | —  | —  | —  | 0/1            | —  |

Value: 1 = Operation Event Set  
0 = Operation Event Cleared

Events: Idle = Idle state of the System 41  
Arm = Waiting for Arm  
Trig = Waiting for Trigger  
Set = Settling

**Trigger Event Register:**

**Bit B0** — Not used.

**Bit B1, Sequence 1 (Seq1)** — Set bit indicates that the instrument is in the Trigger Layer (PTR), or that the instrument has exited from the Trigger Layer (NTR).

**Bits B2 through B15** — Not used.

Figure 6-19

**Trigger Event Register**

|                   |          |                        |    |
|-------------------|----------|------------------------|----|
| Bit Position      | B15 - B2 | B1                     | B0 |
| Event             | —        | Seq1                   | —  |
| Decimal Weighting | —        | 2<br>(2 <sup>1</sup> ) | —  |
| Value             | —        | 0/1                    | —  |

Value: 1 = Event Bit Set  
0 = Event Bit Cleared

Events: Seq 1 = Sequence 1

**Arm Event Register:**

**Bit B0** — Not used.

**Bit B1, Sequence 1 (Seq1)** — Set bit indicates that the instrument is in an arm layer (PTR), or that the instrument has exited from the arm layers (NTR).

**Bits B2 through B15** — Not used.

Figure 6-20

**Arm Event Register**

|                   |          |                        |    |
|-------------------|----------|------------------------|----|
| Bit Position      | B15 - B2 | B1                     | B0 |
| Event             | —        | Seq1                   | —  |
| Decimal Weighting | —        | 2<br>(2 <sup>1</sup> ) | —  |
| Value             | —        | 0/1                    | —  |

Value: 1 = Event Bit Set  
0 = Event Bit Cleared

Event: Seq 1 = Sequence 1

**Sequence Event Register:**

**Bit B0** — Not used.

**Bit B1, Layer 1 (Lay1)** — Set bit indicates that instrument operation is in Arm Layer 1 (PTR), or that operation has exited from Arm Layer 1 (NTR).

**Bit B2, Layer 2 (Lay2)** — Set bit indicates that instrument operation is in Arm Layer 2 (PTR), or that operation has exited from Arm Layer 2 (NTR).

**Bits B3 through B15** — Not used.

Figure 6-21

**Sequence Event Register**

|                   |          |                        |                        |    |
|-------------------|----------|------------------------|------------------------|----|
| Bit Position      | B15 - B3 | B2                     | B1                     | B0 |
| Event             | —        | Lay2                   | Lay1                   | —  |
| Decimal Weighting | —        | 4<br>(2 <sup>2</sup> ) | 2<br>(2 <sup>1</sup> ) | —  |
| Value             | —        | 0/1                    | 0/1                    | —  |

Value: 1 = Event Bit Set  
0 = Event Bit Cleared

Event: Lay1 = Layer 1  
Lay2 = Layer 2

**Questionable Event Register:**

**Bit B0 through B8** — Not used.

**Bit B9, Too Many Channels Closed (Chan)** — Set bit indicates that too many channels have closed (PTR), or that those channels have subsequently opened (NTR). This error occurs when the required relay drive current exceeds the current capability of the 28V supply.

**Bit B10 through B15** — Not used.

Figure 6-22

**Questionable Event Register**

|                   |           |                          |         |
|-------------------|-----------|--------------------------|---------|
| Bit Position      | B15 - B10 | B9                       | B8 - B0 |
| Event             | —         | Chan                     | —       |
| Decimal Weighting | —         | 512<br>(2 <sup>9</sup> ) | —       |
| Value             | —         | 0/1                      | —       |

Value: 1 = Questionable Event Set  
0 = Questionable Event Cleared

Event: Chan = Too many channels closed.

**:ENABLE <NRf>**

|                                             |                                            |
|---------------------------------------------|--------------------------------------------|
| :STATus:OPERation:ENABle <NRf>              | Program Operation Event Enable Register    |
| :STATus:OPERation:TRIGger:ENABle <NRf>      | Program Trigger Event Enable Register      |
| :STATus:OPERation:ARM:ENABle <NRf>          | Program Arm Event Enable Register          |
| :STATus:OPERation:ARM:SEQUENCE:ENABle <NRf> | Program Sequence Event Enable Register     |
| :STATus:QUEStionable:ENABle <NRf>           | Program Questionable Event Enable Register |

|                   |           |                                |
|-------------------|-----------|--------------------------------|
| <b>Parameters</b> | <NRf> = 0 | Clear enable register          |
|                   | = 2       | Set bit B1 of enable register  |
|                   | = 4       | Set bit B2 of enable register  |
|                   | = 32      | Set bit B5 of enable register  |
|                   | = 64      | Set bit B6 of enable register  |
|                   | = 512     | Set bit B9 of enable register  |
|                   | = 1024    | Set bit B10 of enable register |

|                           |                               |
|---------------------------|-------------------------------|
| <b>Short-form formats</b> | :stat:oper:enab <NRf>         |
|                           | :stat:oper:trig:enab <NRf>    |
|                           | :stat:oper:arm:enab <NRf>     |
|                           | :stat:oper:arm:seq:enab <NRf> |
|                           | :stat:ques:enab <NRf>         |

|                 |                |                     |
|-----------------|----------------|---------------------|
| <b>Defaults</b> | Power-up       | Clears (0) all bits |
|                 | *CLS           | No effect           |
|                 | :STATus:PRESet | Clears (0) all bits |

|                      |                          |                          |
|----------------------|--------------------------|--------------------------|
| <b>Query command</b> | :ENABLE?                 | Query enable register    |
|                      | Short-form formats:      | :stat:oper:enab?         |
|                      |                          | :stat:oper:trig:enab?    |
|                      |                          | :stat:oper:arm:enab?     |
|                      |                          | :stat:oper:arm:seq:enab? |
|                      |                          | :stat:ques:enab?         |
| Response message:    | Decimal value (see Note) |                          |

Note: The binary equivalent of this decimal value indicates which bits in the register are set. For example, for an acquired decimal value of 96, the binary equivalent is 0000 0000 0110 0000. For this binary value, bits B5 and B6 are set.

These commands are used to set the contents of the event enable registers (see Figure 6-23 through Figure 6-27). An :ENABLE command is sent with the decimal equivalent of the binary value that determines the desired state (0 or 1) of each bit in the appropriate register.

Each event enable register is used as a mask for events (see [:EVENT] for descriptions of events). When a bit in an event enable register is cleared (0), the corresponding bit in the event register is masked and thus, cannot set the corresponding summary bit of the next register set in the status structure. Conversely, when a bit in an event enable register is set (1), the corresponding bit in the event register is unmasked. When the unmasked bit in the event register sets, the summary bit of the next register set in the status structure will set.

The decimal weighting of the bits for each event enable register are included in Figure 6-23 through Figure 6-27. The sum of the decimal weights of the bits that you wish to set is sent as the parameter (<NRf>) for the appropriate :ENABLE command. For example, to set the Idle and Set bits of the Operation Event Enable Register, send the following command:

```
:stat:oper:enab 1026
where; Idle (bit B10) = 1024
 Set (bit B1) = 2
 <NRf> = 1026
```

Figure 6-23

**Operation Event Enable Register**

|                   |             |                            |    |    |    |                         |                         |    |    |    |                        |    |
|-------------------|-------------|----------------------------|----|----|----|-------------------------|-------------------------|----|----|----|------------------------|----|
| Bit Position      | (B15 - B11) | B10                        | B9 | B8 | B7 | B6                      | B5                      | B4 | B3 | B2 | B1                     | B0 |
| Event             | —           | Idle                       | —  | —  | —  | Arm                     | Trig                    | —  | —  | —  | Set                    | —  |
| Decimal Weighting | —           | 1024<br>(2 <sup>10</sup> ) | —  | —  | —  | 64<br>(2 <sup>6</sup> ) | 32<br>(2 <sup>5</sup> ) | —  | —  | —  | 2<br>(2 <sup>1</sup> ) | —  |
| Value             | —           | 0/1                        | —  | —  | —  | 0/1                     | 0/1                     | —  | —  | —  | 0/1                    | —  |

Value: 1 = Enable Operation Event  
0 = Disable (Mask) Operation Event

Events: Idle = Idle state of the System 41  
Arm = Waiting for Arm  
Trig = Waiting for Trigger  
Set = Settling

Figure 6-24

**Trigger Event Enable Register**

|                   |            |                        |    |
|-------------------|------------|------------------------|----|
| Bit Position      | (B15 - B2) | B1                     | B0 |
| Event             | —          | Seq1                   | —  |
| Decimal Weighting | —          | 2<br>(2 <sup>1</sup> ) | —  |
| Value             | —          | 0/1                    | —  |

Value: 1 = Enable Trigger Event  
0 = Disable (Mask) Trigger Event

Event: Seq 1 = Sequence 1

Figure 6-25  
**Arm Event Enable Register**

|                   |            |                |    |
|-------------------|------------|----------------|----|
| Bit Position      | (B15 - B2) | B1             | B0 |
| Event             | —          | Seq1           | —  |
| Decimal Weighting | —          | 2<br>( $2^1$ ) | —  |
| Value             | —          | 0/1            | —  |

Value: 1 = Enable Arm Event  
0 = Disable (Mask) Arm Event

Event: Seq 1 = Sequence 1

Figure 6-26  
**Sequence Event Enable Register**

|                   |            |                |                |    |
|-------------------|------------|----------------|----------------|----|
| Bit Position      | (B15 - B3) | B2             | B1             | B0 |
| Event             | —          | Lay2           | Lay1           | —  |
| Decimal Weighting | —          | 4<br>( $2^2$ ) | 2<br>( $2^1$ ) | —  |
| Value             | —          | 0/1            | 0/1            | —  |

Value: 1 = Event Bit Set  
0 = Event Bit Cleared

Event: Lay1 = Layer 1  
Lay2 = Layer 2

Figure 6-27  
**Questionable Event Enable Register**

|                   |             |                  |           |
|-------------------|-------------|------------------|-----------|
| Bit Position      | (B15 - B10) | B9               | (B8 - B0) |
| Event             | —           | Chan             | —         |
| Decimal Weighting | —           | 512<br>( $2^9$ ) | —         |
| Value             | —           | 0/1              | —         |

Value: 1 = Enable Questionable Event  
0 = Disable (Mask) Questionable Event

Event: Chan = Too many channels closed.

**:PTRansition <NRf>**

|                                                  |                                               |
|--------------------------------------------------|-----------------------------------------------|
| :STATus:OPERation:PTRansition <NRf>              | Program Operation Transition Filter (PTR).    |
| :STATus:OPERation:TRIGger:PTRansition <NRf>      | Program Trigger Transition Filter (PTR).      |
| :STATus:OPERation:ARM:PTRansition <NRf>          | Program Arm Transition Filter (PTR).          |
| :STATus:OPERation:ARM:SEQuence:PTRansition <NRf> | Program Sequence Transition Filter (PTR).     |
| :STATus:QUEStionable:PTRansition <NRf>           | Program Questionable Transition Filter (PTR). |

**Parameters**

|       |        |                             |
|-------|--------|-----------------------------|
| <NRf> | = 0    | Clear PTR register          |
|       | = 2    | Set bit B1 of PTR register  |
|       | = 4    | Set bit B2 of PTR register  |
|       | = 32   | Set bit B5 of PTR register  |
|       | = 64   | Set bit B6 of PTR register  |
|       | = 512  | Set Bit B9 of PTR register  |
|       | = 1024 | Set bit B10 of PTR register |

**Short-form formats**

```

:stat:oper:ptr <NRf>
:stat:oper:trig:ptr <NRf>
:stat:oper:arm:ptr <NRf>
:stat:oper:arm:seq:ptr <NRf>
:stat:ques:ptr <NRf>

```

**Defaults**

|                |                   |
|----------------|-------------------|
| Power-up       | Sets (1) all bits |
| *CLS           | No effect         |
| :STATus:PRESet | Sets (1) all bits |

**Query command**

```

:PTRansition? Query PTR register
Short-form formats: :stat:oper:ptr?
 :stat:oper:trig:ptr?
 :stat:oper:arm:ptr?
 :stat:oper:arm:seq:ptr?
 :stat:ques:ptr?
Response message: Decimal value (see Note)

```

Note: The binary equivalent of this decimal value indicates which bits in the register are set. For example, for an acquired decimal value of 96, the binary equivalent is 0000 0010 0110 0000. For this binary value, bits B6 and B5 are set.

**Description**

These commands are used to program the positive transition (PTR) registers. A positive transition is defined as a 0 to 1 state change in the condition register. Thus, when an event is programmed for a positive transition, the appropriate bit in the corresponding event register will set when the corresponding bit in the condition register changes from 0 to 1. For example, if bit B1 of the Positive Transition Register of the Operation Transition Filter is set, then the relay settling event is programmed for a positive transition. The Set bit (B1) in the Operation Event Register will set at the start of the relay settling period. For details on register structure, see Section 5, "Channel list and scan list."

The PTR registers are shown in Figure 6-28A through Figure 6-32A and include the decimal weight of each bit. The sum of the decimal weights of the bits that you wish to set is the parameter (<NRf>) that is sent with the command. For example, to program the Arm (B6) and Trig (B5) operation events for positive transitions, send the following command:

```
:stat:oper:ptr 96
```

|        |               |   |           |
|--------|---------------|---|-----------|
| where; | Arm (bit B6)  | = | 64        |
|        | Trig (bit B5) | = | 32        |
|        | <NRf>         | = | <u>96</u> |

**Effects of positive transitions on the Operation Event Register:**

| Operation Event | Positive Transition Effect On Operation Event Register |
|-----------------|--------------------------------------------------------|
| Settling        | Sets B1 at the start of the settling period.           |
| Trigger Layer   | Sets B5 when waiting in the Trigger Layer.             |
| Arm Layer       | Sets B6 when waiting in an Arm Layer.                  |
| Idle            | Sets B10 when entering the idle state.                 |

Figure 6-28  
**Operation Transition Filter**

| Bit Position      | (B15 - B11) | B10                        | B9 | B8 | B7 | B6                      | B5                      | B4 | B3 | B2 | B1                     | B0 |
|-------------------|-------------|----------------------------|----|----|----|-------------------------|-------------------------|----|----|----|------------------------|----|
| Event             | —           | Idle                       | —  | —  | —  | Arm                     | Trig                    | —  | —  | —  | Set                    | —  |
| Decimal Weighting | —           | 1024<br>(2 <sup>10</sup> ) | —  | —  | —  | 64<br>(2 <sup>6</sup> ) | 32<br>(2 <sup>5</sup> ) | —  | —  | —  | 2<br>(2 <sup>1</sup> ) | —  |
| Value             | —           | 0/1                        | —  | —  | —  | 0/1                     | 0/1                     | —  | —  | —  | 0/1                    | —  |

Value: 1 = Enable Positive Transition  
0 = Disable Positive Transition

A) Positive Transition (PTR) Register

| Bit Position      | (B15 - B11) | B10                        | B9 | B8 | B7 | B6                      | B5                      | B4 | B3 | B2 | B1                     | B0 |
|-------------------|-------------|----------------------------|----|----|----|-------------------------|-------------------------|----|----|----|------------------------|----|
| Event             | —           | Idle                       | —  | —  | —  | Arm                     | Trig                    | —  | —  | —  | Set                    | —  |
| Decimal Weighting | —           | 1024<br>(2 <sup>10</sup> ) | —  | —  | —  | 64<br>(2 <sup>6</sup> ) | 32<br>(2 <sup>5</sup> ) | —  | —  | —  | 2<br>(2 <sup>1</sup> ) | —  |
| Value             | —           | 0/1                        | —  | —  | —  | 0/1                     | 0/1                     | —  | —  | —  | 0/1                    | —  |

Value: 1 = Enable Negative Transition  
0 = Disable Negative Transition

B) Negative Transition (NTR) Register



**Effects of positive transitions on the Trigger Event Register:**

| Trigger Event | Positive Transition Effect On Trigger Event Register |
|---------------|------------------------------------------------------|
|---------------|------------------------------------------------------|

|            |                                        |
|------------|----------------------------------------|
| Sequence 1 | Sets B1 when waiting in Trigger Layer. |
|------------|----------------------------------------|

Figure 6-29  
**Trigger Transition Filter**

|                   |            |                              |    |
|-------------------|------------|------------------------------|----|
| Bit Position      | (B15 - B2) | B1                           | B0 |
| Event             | —          | Seq1                         | —  |
| Decimal Weighting | —          | 2 <sup>(2<sup>1</sup>)</sup> | —  |
| Value             | —          | 0/1                          | —  |

Value: 1 = Enable Positive Transition  
0 = Disable Positive Transition

## A) Positive Transition (PTR) Register

|                   |            |                              |    |
|-------------------|------------|------------------------------|----|
| Bit Position      | (B15 - B2) | B1                           | B0 |
| Event             | —          | Seq1                         | —  |
| Decimal Weighting | —          | 2 <sup>(2<sup>1</sup>)</sup> | —  |
| Value             | —          | 0/1                          | —  |

Value: 1 = Enable Negative Transition  
0 = Disable Negative Transition

## B) Negative Transition (NTR) Register

**Effects of positive transitions on the Arm Event Register:**

| Arm Event  | Positive Transition Effect On Arm Event Register |
|------------|--------------------------------------------------|
| Sequence 1 | Sets B1 when in an Arm Layer.                    |

Figure 6-30  
**Arm Transition Filter**

|                   |            |                              |    |
|-------------------|------------|------------------------------|----|
| Bit Position      | (B15 - B2) | B1                           | B0 |
| Event             | —          | Seq1                         | —  |
| Decimal Weighting | —          | 2 <sup>(2<sup>1</sup>)</sup> | —  |
| Value             | —          | 0/1                          | —  |

Value: 1 = Enable Positive Transition  
0 = Disable Positive Transition

## A) Positive Transition (PTR) Register

|                   |            |                              |    |
|-------------------|------------|------------------------------|----|
| Bit Position      | (B15 - B2) | B1                           | B0 |
| Event             | —          | Seq1                         | —  |
| Decimal Weighting | —          | 2 <sup>(2<sup>1</sup>)</sup> | —  |
| Value             | —          | 0/1                          | —  |

Value: 1 = Enable Negative Transition  
0 = Disable Negative Transition

## B) Negative Transition (NTR) Register

**Effects of positive transitions on the Sequence Event Register:**

| Sequence Event | Positive Transition Effect On Sequence Event Register |
|----------------|-------------------------------------------------------|
| Sequence 1     | Sets B1 when in Arm Layer 1.                          |
| Sequence 2     | Sets B2 when in Arm Layer 2.                          |

Figure 6-31  
**Sequence Transition Filter**

|                   |            |                        |                        |    |
|-------------------|------------|------------------------|------------------------|----|
| Bit Position      | (B15 - B3) | B2                     | B1                     | B0 |
| Event             | —          | Lay2                   | Lay1                   | —  |
| Decimal Weighting | —          | 4<br>(2 <sup>2</sup> ) | 2<br>(2 <sup>1</sup> ) | —  |
| Value             | —          | 0/1                    | 0/1                    | —  |

Value: 1 = Enable Positive Transition  
0 = Disable Positive Transition

## A) Positive Transition (PTR) Register

|                   |            |                        |                        |    |
|-------------------|------------|------------------------|------------------------|----|
| Bit Position      | (B15 - B3) | B2                     | B1                     | B0 |
| Event             | —          | Lay2                   | Lay1                   | —  |
| Decimal Weighting | —          | 4<br>(2 <sup>2</sup> ) | 2<br>(2 <sup>1</sup> ) | —  |
| Value             | —          | 0/1                    | 0/1                    | —  |

Value: 1 = Enable Negative Transition  
0 = Disable Negative Transition

## B) Negative Transition (NTR) Register

**Effects of positive transitions on the Questionable Event Register:**

| Questionable Event | Positive Transition Effect On Questionable Event Register |
|--------------------|-----------------------------------------------------------|
|--------------------|-----------------------------------------------------------|

|      |                                             |
|------|---------------------------------------------|
| Chan | Sets B9 when too many channels have closed. |
|------|---------------------------------------------|

Figure 6-32

**Questionable Transition Filter**

| Bit Position      | (B15 - B10) | B9                       | (B8 - B0) |
|-------------------|-------------|--------------------------|-----------|
| Event             | —           | Chan                     | —         |
| Decimal Weighting | —           | 512<br>(2 <sup>9</sup> ) | —         |
| Value             | —           | 0/1                      | —         |

Value: 1 = Enable Positive Transition  
0 = Disable Positive Transition

## A) Positive Transition (PTR) Register

| Bit Position      | (B15 - B10) | B9                       | (B8 - B0) |
|-------------------|-------------|--------------------------|-----------|
| Event             | —           | Chan                     | —         |
| Decimal Weighting | —           | 512<br>(2 <sup>9</sup> ) | —         |
| Value             | —           | 0/1                      | —         |

Value: 1 = Enable Positive Transition  
0 = Disable Positive Transition

## B) Negative Transition (NTR) Register

**:NTRansition <NRf>**

|                           |                                                  |                                               |
|---------------------------|--------------------------------------------------|-----------------------------------------------|
|                           | :STATus:OPERation:NTRansition <NRf>              | Program Operation Transition Filter (NTR).    |
|                           | :STATus:OPERation:TRIGger:NTRansition <NRf>      | Program Trigger Transition Filter (NTR).      |
|                           | :STATus:OPERation:ARM:NTRansition <NRf>          | Program Arm Transition Filter (NTR).          |
|                           | :STATus:OPERation:ARM:SEQuence:NTRansition <NRf> | Program Sequence Transition Filter (NTR).     |
|                           | :STATus:QUEStionable:NTR <NRf>                   | Program Questionable Transition Filter (NTR). |
| <b>Parameters</b>         | <NRf> = 0      Clear NTR register                |                                               |
|                           | = 2      Set bit B1 of NTR register              |                                               |
|                           | = 4      Set bit B2 of NTR register              |                                               |
|                           | = 32     Set bit B5 of NTR register              |                                               |
|                           | = 64     Set bit B6 of NTR register              |                                               |
|                           | = 512    Set bit B9 of NTR register              |                                               |
|                           | = 1024   Set bit B10 of NTR register             |                                               |
| <b>Short-form formats</b> | :stat:oper:ntr <NRf>                             |                                               |
|                           | :stat:oper:trig:ntr <NRf>                        |                                               |
|                           | :stat:oper:arm:ntr <NRf>                         |                                               |
|                           | :stat:oper:arm:seq:ntr <NRf>                     |                                               |
|                           | :stat:ques:ntr <NRf>                             |                                               |
| <b>Defaults</b>           | Power-up            Clears (0) all bits          |                                               |
|                           | *CLS                No effect                    |                                               |
|                           | :STATus:PRESet    Clears (0) all bits            |                                               |
| <b>Query command</b>      | :NTRansition?      Query NTR register            |                                               |
|                           | Short-form formats:    :stat:oper:ntr?           |                                               |
|                           | :stat:oper:trig:ntr?                             |                                               |
|                           | :stat:oper:arm:ntr?                              |                                               |
|                           | :stat:oper:arm:seq:ntr?                          |                                               |
|                           | :stat:ques:ntr?                                  |                                               |
|                           | Response message:    Decimal value (see Note)    |                                               |

Note: The binary equivalent of this decimal value indicates which bits in the register are set. For example, for an acquired decimal value of 96, the binary equivalent is 0000 0000 0110 0000. For this binary value, bits B6 and B5 are set.

**Description**

These commands are used to program the negative transition (NTR) registers. A negative transition is defined as a 1 to 0 state change in the condition register. Thus, when an event is programmed for a negative transition, the appropriate bit in the corresponding event register will set when the corresponding bit in the condition register changes from 1 to 0. For example, if bit B1 of the Negative Transition Register of the Operation Transition Filter is set, then the operation event is programmed for a negative transition. The Set bit (B1) in the Operation Event Register will set at the end of the relay settling period. For details on register structure, see "Status structure."

The NTR registers are shown in Figure 6-28B through Figure 6-32B and include the decimal weight of each bit. The sum of the decimal weights of the bits that you wish to set is the parameter (<NRf>) that is sent with the command. For example, to program the Arm (B6) and Trig (B5) events for negative transitions, send the following command:

```
:stat:oper:ntr 96
```

|        |               |   |           |
|--------|---------------|---|-----------|
| where; | Arm (bit B6)  | = | 64        |
|        | Trig (bit B5) | = | 32        |
|        | <NRf>         | = | <u>96</u> |

**Effects of negative transitions on the Operation Event Register:**

| Operation Event | Negative Transition Effect On<br>Operation Event Register |
|-----------------|-----------------------------------------------------------|
| Settling        | Sets B1 at the end of the settling period.                |
| Trigger Layer   | Sets B5 when leaving the Trigger Layer.                   |
| Arm Layer       | Sets B6 when leaving an Arm Layer.                        |
| Idle            | Sets B10 when leaving the idle state.                     |

**Effects of negative transitions on the Trigger Event Register:**

| Trigger Event | Negative Transition Effect On<br>Trigger Event Register |
|---------------|---------------------------------------------------------|
| Sequence 1    | Sets B1 when leaving the Trigger Layer.                 |

**Effects of negative transitions on the Arm Event Register:**

| Arm Event  | Negative Transition Effect On<br>Arm Event Register |
|------------|-----------------------------------------------------|
| Sequence 1 | Sets B1 when leaving an Arm Layer.                  |

**Effects of negative transitions on the Sequence Event Register:**

| Sequence Event | Negative Transition Effect On<br>Sequence Event Register |
|----------------|----------------------------------------------------------|
| Layer 1        | Sets B1 when leaving Arm Layer 1.                        |
| Layer 2        | Sets B2 when leaving Arm Layer 2.                        |

**Effects of negative transitions on the Questionable Event Register:**

| Questionable Event | Negative Transition Effect On<br>Questionable Event Register                                 |
|--------------------|----------------------------------------------------------------------------------------------|
| Chan               | Sets B9 when the channels open after the occurrence of the “too many channels closed” error. |

**:CONDition?**

|                                           |                                       |
|-------------------------------------------|---------------------------------------|
| :STATus:OPERation:CONDition?              | Query Operation Condition Register    |
| :STATus:OPERation:TRIGger:CONDition?      | Query Trigger Condition Register      |
| :STATus:OPERation:ARM:CONDition?          | Query Arm Condition Register          |
| :STATus:OPERation:ARM:SEQUence:CONDition? | Query Sequence Condition Register     |
| :STATus:QUEStionable:CONDition?           | Query Questionable Condition Register |

**Short-form  
formats**

:stat:oper:cond?  
 :stat:oper:trig:cond?  
 :stat:oper:arm:cond?  
 :stat:oper:arm:seq:cond?  
 :stat:ques:cond?

**Description**

These query commands are used to query the contents of the condition registers. Each set of event registers (except the Standard Event register set) has a condition register. A condition register is similar to its corresponding event register, except that it is a real-time register that constantly updates to reflect the current operating status of the instrument.

See [:EVENT] for register bit descriptions. Note from the status structure (Section 5, “Channel list and scan list”) that the condition registers precede the transition filters. Thus, only the PTR descriptions apply to the condition registers.

After sending one of these commands and addressing the System 41 to talk, a decimal value is sent to the computer. The binary equivalent of this decimal value indicates which bits in the register are set.

For example, if sending :stat:oper:cond? returns a decimal value of 1024 (binary 0000 0100 0000 0000), bit B10 of the Operation Condition Register is set indicating that the instrument is in the idle state.

**:PREset**

|                |                                   |
|----------------|-----------------------------------|
| :STATus:PREset | Return 7002 to default conditions |
|----------------|-----------------------------------|

**Short-form  
formats**

:stat:pres

**Description**

When this command is sent, the SCPI event registers are affected as follows:

1. All bits of the positive transition filter registers are set to one (1).
2. All bits of the negative transition filter registers are cleared to zero (0).
3. All bits of the following registers are cleared to zero (0):
  - a. Operation Event Enable Register.
  - b. Questionable Event Enable Register.
4. All bits of the following registers are set to one (1):
  - a. Trigger Event Enable Register.
  - b. Arm Event Enable Register.
  - c. Sequence Event Enable Register.

Note: Registers not included in the above list are not affected by this command.

**:QUEue commands****[[:NEXT]]?**

:STATUS:QUEue[:NEXT]?

Query Error Queue

**Short-form  
formats**

:stat:que?

**Defaults**

|                |                    |
|----------------|--------------------|
| Power-Up       | Clears Error Queue |
| *CLS           | Clears Error Queue |
| :STATUS:PRESet | No effect          |

**Description**

As error and status messages occur, they are placed into the Error Queue. This query command is used to read those messages.

The Error Queue is a first-in, first-out (FIFO) register. Every time you query the queue, the “oldest” message is read and that message is then removed from the queue. The queue will hold up to ten messages. If the queue becomes full, the message “350, ‘Queue Overflow’” will occupy the last memory location in the register. On power-up, the Error Queue is empty. When the Error Queue is empty, the message “0, ‘No error’” is placed in the Error Queue.

The messages in the queue are preceded by a number. Negative (-) numbers are used for SCPI defined messages, and positive (+) numbers are used for Keithley defined messages. The messages are listed in Table 5-1.

After this command is sent and the System 41 is addressed to talk, the “oldest” message in the queue is sent to the computer.

Note: The :STATUS:QUEue[:NEXT]? query command performs the same function as the :SYSTEM:ERROR? query command (see System Subsystem).

**:ENABLE <list>**

:STATUS:QUEue:ENABLE &lt;list&gt;

Enable messages for Error Queue

**Parameters**

list = (numlist)

where; numlist is a specified list of messages that you wish to enable for the Error Queue.

**Short-form  
formats**

:stat:que:enab (numlist)

**Defaults**

|                |                                            |
|----------------|--------------------------------------------|
| Power-up       | Enable error events, disable status events |
| *CLS           | No effect                                  |
| :STATUS:PRESet | Enable error events, disable status events |

**Query  
command**

|                    |                                |
|--------------------|--------------------------------|
| :ENABLE?           | Query list of enabled messages |
| Short-form format: | :stat:que:enab?                |
| Response message:  | numlist                        |

**Description**

On power-up, all error messages are enabled and will go into the Error Queue as they occur. Status messages are not enabled and will not go into the queue. This command is used to specify which messages you want enabled. Messages not specified will be disabled and prevented from entering the queue.



When this command is sent, all messages will first be disabled, then the messages specified in the list will be enabled. Thus, the returned list (:ENABLE?) will contain all the enabled messages.

Messages are specified by numbers (see Table 5-1). The following examples show various forms for expressing a message numlist:

|                    |                                                    |
|--------------------|----------------------------------------------------|
| Numlist = -110     | Single message.                                    |
| = -110, -140, -222 | Messages separated by commas.                      |
| = -110:-222        | Range of messages (-100 through -222).             |
| = -110:-222, -230  | Range entry and single entry separated by a comma. |

Note: To disable all messages from entering the Error Queue, send the following command:

```
:stat:que:enab ()
```

To enable all System 41 messages, send the following command: :stat:que:enab (-150: +550)

## **:DISable <list>**

```
:STATus:QUEue:DISable <list> Disable messages for Error Queue
```

### **Parameters**

<list> = (numlist)

where; numlist is a specified list of messages that you wish to disable for the Error Queue.

### **Short-form formats**

```
:stat:que:dis (numlist)
```

### **Defaults**

|                |                                            |
|----------------|--------------------------------------------|
| Power-up       | Disable status events, enable error events |
| *CLS           | No effect                                  |
| :STATus:PRESet | Disable status events, enable error events |

### **Query command**

|                    |                                 |
|--------------------|---------------------------------|
| :DISable?          | Query list of disabled messages |
| Short-form format: | :stat:que:dis?                  |
| Response message:  | numlist                         |

### **Description**

On power-up, all error messages are enabled and will go into the Error Queue as they occur. Status messages are not enabled and will not go into the queue. This command is used to specify which messages you want disabled. Disabled messages are prevented from going into the Error Queue.

Messages are specified by numbers (see Table 5-1). The following examples show various forms for expressing a message numlist:

|                    |                                                    |
|--------------------|----------------------------------------------------|
| Numlist = -110     | Single message.                                    |
| = -110, -140, -222 | Messages separated by commas.                      |
| = -110:-222        | Range of messages (-100 through -222).             |
| = -110:-222, -230  | Range entry and single entry separated by a comma. |



With one of the SAV parameters selected, the instrument will power on to the setup that is saved in the specified memory location using the \*SAV command.

## :VERSion?

:SYSTem:VERSion?

Read SCPI version

### Short-form formats

:syst:vers?

### Description

This query command is used to read the version of the SCPI standard being used by the System 41. After sending this command and addressing the System 41 to talk, the version code will be sent to the computer. Example code:

```
1991.0
```

The above response message indicates the version of the SCPI standard.

## :ERRor?

:SYSTem:ERRor?

Read Error Queue

### Short-form formats

:syst:err?

### Defaults

|                |                    |
|----------------|--------------------|
| Power-up       | Clears Error Queue |
| *RST           | No effect          |
| *CLS           | Clears Error Queue |
| DCL, SDC       | No effect          |
| :SYSTem:PRESet | No effect          |
| :STATus:PRESet | No effect          |

### Description

As error and status messages occur, they are placed into the Error Queue. This query command is used to read those messages. The Error Queue is a first-in, first-out (FIFO) register. Every time you read the queue, the “oldest” message is read and that message is then removed from the queue.

If the queue becomes full, the message “350, ‘Queue Overflow’” will occupy the last memory location in the register. On power-up, the queue is empty. When the Error Queue is empty, the message “0, ‘No error’” is placed in the Error Queue.

The messages in the queue are preceded by a number. Negative (-) numbers are used for SCPI defined messages, and positive (+) numbers are used for Keithley defined messages. Table 6-1 lists the messages.

After this command is sent and the System 41 is addressed to talk, the “oldest” message in the queue is sent to the computer.

Note: The :SYSTem:ERRor? query command performs the same function as the :STATus:QUEue? query command (see “STATus subsystem”).

## Trigger subsystem

The Trigger Subsystem is made up of a series of commands and subsystems to configure the three layers of the Trigger Model (see Figure 6-13). These commands and subsystems are summarized in Table 6-9.

Table 6-9  
**Trigger command summary**

| Command                                                                                                                | Description                                                                                                                                                                                                                                                |
|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| :INITiate<br>[:IMMediate]<br>:CONTinuous <b>                                                                           | Subsystem command path:<br>Initiate one trigger cycle.<br>Enable (1 or ON) or disable (0 or OFF) continuous initiation of trigger system.                                                                                                                  |
| :CONTinuous?                                                                                                           | Query continuous initiation.                                                                                                                                                                                                                               |
| :ABORt                                                                                                                 | Reset trigger system.                                                                                                                                                                                                                                      |
| :ARM[:SEQuence[1]]<br>[:LAYer[1]]<br>:IMMediate<br>:COUNT <n><br>:COUNT?<br>:SOURce <name>                             | Subsystem command path to configure arm layers:<br>Path to program arm layer 1:<br>Immediately go to Layer2.<br>Program arm count (1 to 9999, or INF).<br>Query arm count.<br>Select control source: HOLD, IMMEDIATE, MANUAL, BUS, TLINK.                  |
| :SOURce?                                                                                                               | Query control source.                                                                                                                                                                                                                                      |
| :SIGNal                                                                                                                | Loop around control source.                                                                                                                                                                                                                                |
| :TCONfigure<br>:DIRection <name><br>:DIRection?<br>:ASYNchronous<br>:ILINe <NRf><br>:ILINe?<br>:OLINe <NRf><br>:OLINe? | Path to configure Triggers:<br>Enable (SOURce) or disable (ACCEptor) Bypass:<br>Query direction.<br>Path to configure asynchronous Trigger Link:<br>Select input line (1 to 6).<br>Query input line.<br>Select output line (1 to 6).<br>Query output line. |
| :LAYer2<br>:IMMediate<br>:COUNT <n><br>:COUNT?<br>:DELay <n><br>:DELay?<br>:SOURce <name>                              | Path to program arm layer 2:<br>Immediately go to Trigger Layer.<br>Program scan count (1 to 9999 or INF).<br>Query scan count.<br>Program delay (0 to 99999.999 sec).<br>Query delay.                                                                     |
| :SOURce?                                                                                                               | Query control source.                                                                                                                                                                                                                                      |
| :TIMer <n>                                                                                                             | Set timer interval (0 to 99999.999 sec).                                                                                                                                                                                                                   |
| :TIMer?                                                                                                                | Query timer.                                                                                                                                                                                                                                               |
| :SIGNal                                                                                                                | Loop around control source.                                                                                                                                                                                                                                |

Table 6-9 (cont.)  
**Trigger command summary**

| Command                                                                                                                                                                                                                                                                                                                                                                                       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| :ARM[:SEquence[1]]<br>:LAYer2<br>:TCONfigure<br>:DIRection <name><br>:DIRection?<br>:ASYNchronous<br>:ILINe <NRf><br>:ILINe?<br>:OLINe <NRf><br>:OLINe?                                                                                                                                                                                                                                       | Path to configure Triggers:<br>Enable (SOURce) or disable (ACCEptor) Bypass.<br>Query direction.<br>Path to configure asynchronous Trigger Link:<br>Select input line (1 to 6).<br>Query input line.<br>Select output line (1 to 6).<br>Query output line.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| :TRIGger[:SEquence[1]]<br>:IMMediate<br>:COUNt <n><br>:AUTO <b><br><br>:AUTO?<br>:COUNt?<br>:DELay <n><br>:DELay?<br>:SOURce <name><br><br>:SOURce?<br>:TIMer <n><br>:TIMer?<br>:SIGNal<br>:TCONfigure<br>:PROTOcol <name><br>:PROTOcol?<br>:DIRection <name><br>:DIRection?<br>:ASYNchronous<br>:ILINe <NRf><br>:ILINe?<br>:OLINe <NRf><br>:OLINe?<br>:SSYNchronous<br>:LINE <NRf><br>:LINE? | Path to program trigger layer:<br>Immediately perform a scan step.<br>Program measure count (1 to 9999, or INF).<br>Enable (1 or ON) or disable (0 or OFF) auto-count (scan-list-length).<br>Query auto-count.<br>Query measure count.<br>Program delay (0 to 99999.999 sec).<br>Query delay.<br>Select control source: HOLD, IMMediate, TIMer, MANual, BUS, TLINk.<br>Query control source.<br>Set timer interval (0 to 99999.999 sec).<br>Request the programmed timer interval.<br>Loop around control source.<br>Path to configure Triggers:<br>Select protocol: ASYNchronous, SSYNchronous.<br>Query protocol.<br>Enable (SOURce) or disable (ACCEptor) Bypass.<br>Query direction.<br>Path to configure asynchronous Trigger Link:<br>Select input line (1 to 6).<br>Query input line.<br>Select output line (1 to 6).<br>Query output line.<br>Path to configure semi-synchronous Trigger Link:<br>Select trigger line (1 to 6).<br>Query trigger line. |

## Notes:

1. Brackets ( [ ] ) are used to denote optional character sets. These optional characters do not have to be included in the program message. Do not use brackets ( [ ] ) in the program message.
2. Angle brackets ( < > ) are used to indicate parameter type. Do not use angle brackets ( < > ) in the program message.
3. Upper case characters indicate the short-form version for each command word.
4. At least one space is required between a command word and the parameter.

**NOTE** *Front panel operation and IEEE-488 operation use different nomenclature for the three layers of the Trigger Model and are summarized as follows:*

#### Trigger Model Layer Nomenclature

| Layer        | Layer Name; Front Panel Operation | Layer Name; IEEE-488 Bus Operation |
|--------------|-----------------------------------|------------------------------------|
| First layer  | Arm Layer                         | Arm Layer 1                        |
| Second layer | Scan Layer                        | Arm Layer 2                        |
| Third layer  | Channel Layer                     | Trigger Layer                      |

## :INITiate commands

### [:IMMediate]

:INITiate[:IMMediate]

Take 7002 out of idle

#### Short-form formats

:init

#### Description

This command takes the System 41 out of the idle state. After the completion of a scan, the instrument will return to the idle state (if continuous initiation is disabled; see next command). This is an overlapped command (see \*OPC, \*OPC?, \*TRG and \*WAI).

### :CONTinuous <b>

:INITiate:CONTinuous <b>

Control continuous initiation

#### Parameters

<b> = 0 or OFF      Disable continuous initiation  
 = 1 or ON        Enable continuous initiation

#### Short-form formats

:init:cont <b>

#### Defaults

Power-up            Saved power-on setup  
 \*RST                OFF  
 :SYSTEM:PRESet    ON

#### Query command

:CONTinuous?      Query continuous initiation  
 Short-form format: :init:cont?  
 Response message: 1 (on) or 0 (off)

#### Description

When continuous initiation is selected (ON), the instrument is taken out of the idle state. At the conclusion of all programmed operations, the instrument will return to Arm Layer 1. This is an overlapped command (see \*OPC, \*OPC?, \*TRG and \*WAI).

**NOTE** *In the event of a "Too many channels closed" error, all channels will open, the instrument will go into idle, and continuous initiation will disable (:INITiate:CONTinuous OFF).*

**:ABORt**

:ABORt Abort operation

**Short-form  
formats**

:abor

**Description**

When this action command is sent, the System 41 will abort its current operations and return to the top of the Trigger Model (idle state). If the \*OPC command has been sent, the OPC bit in the Standard Event Status Register will set. If continuous initiation is disabled, the instrument will go into the idle state. If continuous initiation is enabled, operation will continue on into Arm Layer 1.

The abort command will reset the Source Bypasses of the Trigger Model and reset the scan pointer back to the first channel in the scan list.

**:IMMediate**

|                                         |                                         |
|-----------------------------------------|-----------------------------------------|
| :ARM[:SEQuence[1]][:LAYer[1]]:IMMediate | Bypass arm control source               |
| :ARM[:SEQuence[1]]:LAYer2:IMMediate     | Bypass scan control source and delay    |
| :TRIGger[:SEQuence[1]]:IMMediate        | Bypass channel control source and delay |

**Short-form  
formats**

```
:arm:imm
:arm:lay2:imm
:trig:imm
```

**Description**

These action commands are used to bypass the specified layer of the Trigger Model. They are used when you do not wish to wait for the programmed event. Note from the Trigger Model (Figure 6-13) that :arm:lay2:imm and :trig:imm also bypass the Delay.

The instrument must be waiting for the appropriate event when the command is sent. Otherwise, an error will occur and the command will be ignored. When the command is sent, the bypass will occur and operation will continue on.

Note that :IMMediate is not an instrument setup command. As soon as this command is executed, it will attempt to bypass the specified trigger model layer.

**:COUNT <n>**

|                                         |                         |
|-----------------------------------------|-------------------------|
| :ARM[:SEQuence[1]][:LAYer[1]]:COUNT <n> | Set Arm Layer 1 count   |
| :ARM[:SEQuence[1]]:LAYer2:COUNT <n>     | Set Arm Layer 2 count   |
| :TRIGger[:SEQuence[1]]:COUNT <n>        | Set Trigger Layer count |

**Parameters**

|     |              |                        |
|-----|--------------|------------------------|
| <n> | = 1 to 99999 | Specify count          |
|     | = INF        | Sets count to infinite |
|     | = DEFault    | Sets count to 1        |
|     | = MINimum    | Sets count to 1        |
|     | = MAXimum    | Sets count to 9999     |

**Short-form  
formats**

```
:arm:coun <n>
:arm:lay2:coun <n>
:trig:coun <n>
```

**Defaults**

|                |                                  |
|----------------|----------------------------------|
| Power-up       | Saved power-on setup             |
| *RST           | 1 (all layers)                   |
| :SYSTem:PRESet | 1 (Arm Layer 1)                  |
|                | INF (Arm Layer 2)                |
|                | Scan-list-length (Trigger Layer) |

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Query command</b>      | :COUNT?                    Query programmed count<br>:COUNT? DEFault        Query *RST default count<br>:COUNT? MINimum        Query lowest allowable count<br>:COUNT? MAXimum        Query largest allowable count<br>Short-form formats:        :arm:coun?                :arm:lay2:coun?<br>:arm:coun? xxx        :arm:lay2:coun? xxx<br>:trig:coun?<br>:trig:coun? xxx<br>where; xxx = def, min or max<br>Response messages:        1 to 9999 (for finite count)<br>+9.9e37 (for infinite count)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Description</b>        | <p>These commands are used to specify how many times operation will loop around in the specified layer of operation. For example, if the channel count (:trig:coun) is set to 10, operation will continue to loop around in the Trigger Layer until 10 channels are scanned. After the 10th channel, operation will proceed back up to Arm Layer 2.</p> <p>If you select a finite channel count (:trig:coun) that is greater than the scan-list-length, the first scan will end after the programmed number of channels are scanned. If programmed for another scan, the scan process will continue from the last scanned channel.</p> <p>If you select an infinite channel count (:trig:coun), the scan will loop back to the beginning of the scan list after all channels in the list have been scanned. This process will continue indefinitely.</p> <p>Note that this command is coupled to :TRIGger:COUNt:AUTO (auto-count). When auto-count is enabled, the channel count is set to the scan-list-length. When :TRIGger:COUNt is used to set the channel count, auto-count will automatically disable.</p> |
|                           | <p><b>:AUTO &lt;b&gt;</b></p> <p>:TRIGger[:SEquence[1]]:COUNt:AUTO &lt;b&gt;                    Control auto-count for Trigger Layer</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Parameters</b>         | <b>        = 1 or ON        Enable auto-count (scan-list-length)<br>= 0 or OFF        Disable auto-count                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Short-form formats</b> | :trig:coun:auto <b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Defaults</b>           | Power-up                    Saved power-on setup<br>*RST                         OFF<br>:SYSTem:PRESet            ON                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Query command</b>      | :AUTO?                      Query auto-count<br>Short-form format:        :trig:coun:auto?<br>Response message:        1 (on) or 0 (off)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Description</b>        | <p>With auto-count enabled, the channel count is automatically set to the scan-list-length. For example, if there are currently 6 channel patterns in the scan list, then enabling auto-count will set the channel count to 6. While auto-count is enabled, changing the scan list count will change the trigger count.</p> <p>If the scan list is empty, enabling auto-count will set the channel count to 1.</p> <p>This command is coupled to :TRIGger:COUNt which is used to manually set the channel count. When :TRIGger:COUNt is used to set the channel count, auto-count will automatically disable.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |



**:DElay <n>**

:ARM[:SEquence[1]]:LAYer2:DElay <n>                      Set Arm Layer 2 delay  
 :TRIGger[:SEquence[1]]:DElay <n>                      Set Trigger Layer delay

|                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Parameters</b>         | <n> = 0 to 99999.999    Specify delay in seconds<br>= DEFault            0 second delay<br>= MINimum           0 second delay<br>= MAXimum           99999.999 second delay                                                                                                                                                                                                                                                                                                     |
| <b>Short-form formats</b> | :arm:lay2:del <n><br>:trig:del <n>                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Defaults</b>           | Power-up                      Saved power-on setup<br>*RST                            0 sec<br>:SYSTem:PRESet               0 sec                                                                                                                                                                                                                                                                                                                                               |
| <b>Query command</b>      | :DElay?                        Query the programmed delay<br>:DElay? DEFault                Query the *RST default delay<br>:DElay? MINimum                Query the lowest allowable delay<br>:DElay? MAXimum                Query the largest allowable delay<br>Short-form formats:            :arm:lay2:del?                :trig:del?<br>:arm:lay2:del? xxx        :trig:del? xxx<br>where; xxx = def, min or max<br>Response message:            0 to 99999.999 (seconds) |
| <b>Description</b>        | <p>These delay periods are used to delay operation in the specified layer (Arm Layer 2 and/or Trigger Layer). After the programmed event occurs, the instrument will wait until the delay period expires before proceeding on in the Trigger Model.</p> <p>Note that Arm Layer 1 does not use a Delay.</p>                                                                                                                                                                      |

**:SOURce <name>**

:ARM[:SEquence[1]]:LAYer[1]:SOURce <name>            Specify arm event control source  
 :ARM[:SEquence[1]]:LAYer2:SOURce <name>            Specify scan event control source  
 :TRIGger[:SEquence[1]]:SOURce <name>                Specify channel event control source

|                           |                                                                                                                                                                                                                                                                                                                                                                                               |
|---------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Parameters</b>         | <name> = HOLD                Hold operation in specified layer<br>= IMMEDIATE            Pass operation through specified layer<br>= MANual                 Select manual event<br>= BUS                     Select GPIB trigger as event<br>= TLINK                 Select Trigger Link as event<br>= TIMer                  Select timer as event Note: TIMer not available for Arm Layer 1 |
| <b>Short-form formats</b> | :arm:sour <name><br>:arm:lay2:sour <name><br>:trig:sour <name>                                                                                                                                                                                                                                                                                                                                |
| <b>Defaults</b>           | Power-up                      Saved power-on setup<br>*RST                            IMMEDIATE (all layers)<br>:SYSTem:PRESet                IMMEDIATE (Arm Layer 1 and Arm Layer 2),<br>MANual (TRIGger Layer)                                                                                                                                                                              |

|                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                |                                   |                                    |                                |                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------|------------------------------------|--------------------------------|--------------------------------------|
| <b>Query command</b>                                                                                                                                                                                                                                                                                    | :SOURce?<br>Short-form formats:<br><br>Response message:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Query programmed control source.<br>:arm:sour?<br>:arm:lay2:sour?<br>:trig:sour?<br>HOLD, MAN, IMM, BUS, TLIN, or TIM                                                                                                                                                          |                                   |                                    |                                |                                      |
| <b>Description</b>                                                                                                                                                                                                                                                                                      | <p>These commands are used to select the event control source for the specified layer. With HOLD selected, operation will stop and wait indefinitely in the specified layer. While in HOLD, operation can be continued by sending the :IMMEDIATE command or the :SIGNal command. Keep in mind however, that if the layer count &gt;1, HOLD will again be enforced when operation loops back around.</p> <p>With IMMEDIATE selected (do not confuse :SOURce IMMEDIATE with :IMMEDIATE), operation will immediately pass through the specified layer.</p> <p>A specific event can be used to control operation through a layer. With BUS selected, operation will continue when a GPIB trigger (GET or *TRG) is sent. With TLINK selected, operation will continue when an input trigger via the Trigger Link is received.</p> <p>A TIMER event is available for Arm Layer 2 and the Trigger Layer. With TIMER selected for the specified layer, the event occurs at the beginning of the timer interval, and every time the timer times out. For example, if the Trigger Layer timer is programmed for a 30 second interval, the first pass through the Trigger Layer control source will occur immediately. Subsequent trigger events will then occur every 30 seconds. The interval for the timer is set using the :TIMER command. This timer interval is independent of the :DELAY setting.</p> |                                                                                                                                                                                                                                                                                |                                   |                                    |                                |                                      |
| <b>:TIMER &lt;n&gt;</b>                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                |                                   |                                    |                                |                                      |
| <table border="0" style="width: 100%;"> <tr> <td style="width: 50%;">:ARM:SEquence[1]:LAYer2:TIMER &lt;n&gt;</td> <td style="width: 50%;">Set interval for Arm Layer 2 timer</td> </tr> <tr> <td>:TRIGger:SEquence[1]:TIMER &lt;n&gt;</td> <td>Set interval for Trigger Layer timer</td> </tr> </table> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                | :ARM:SEquence[1]:LAYer2:TIMER <n> | Set interval for Arm Layer 2 timer | :TRIGger:SEquence[1]:TIMER <n> | Set interval for Trigger Layer timer |
| :ARM:SEquence[1]:LAYer2:TIMER <n>                                                                                                                                                                                                                                                                       | Set interval for Arm Layer 2 timer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                |                                   |                                    |                                |                                      |
| :TRIGger:SEquence[1]:TIMER <n>                                                                                                                                                                                                                                                                          | Set interval for Trigger Layer timer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                |                                   |                                    |                                |                                      |
| <b>Parameters</b>                                                                                                                                                                                                                                                                                       | <n> = 0.001 to 99999.999<br>= DEFault<br><br>= MINimum<br>= MAXimum                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Specify timer interval in seconds<br>0.1 second (Trigger Layer counter)<br>1 second (Arm Layer 2 counter)<br>0.001 second<br>99999.999 seconds                                                                                                                                 |                                   |                                    |                                |                                      |
| <b>Short-form formats</b>                                                                                                                                                                                                                                                                               | :arm:lay2:tim <n><br>:trig:tim <n>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                |                                   |                                    |                                |                                      |
| <b>Defaults</b>                                                                                                                                                                                                                                                                                         | Power-up<br>*RST<br>:SYSTEM:PRESet                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Saved power-on setup<br>0.001 second interval<br>0.001 second interval                                                                                                                                                                                                         |                                   |                                    |                                |                                      |
| <b>Query command</b>                                                                                                                                                                                                                                                                                    | :TIMER?<br>:TIMER? DEFault<br>:TIMER? MINimum<br>:TIMER? MAXimum<br>Short-form format:<br><br>Response message:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Query programmed timer interval<br>Query *RST default timer interval<br>Query lowest allowable timer interval<br>Query largest allowable timer interval<br>:arm:lay2:tim? :trig:tim?<br>:arm:lay2:tim? xxx :trig:tim? xxx<br>where; xxx = def, min or max<br>.001 to 99999.999 |                                   |                                    |                                |                                      |
| <b>Description</b>                                                                                                                                                                                                                                                                                      | These commands are used to set the interval for the Arm Layer 2 and Trigger Layer timers. Note that the timer is in effect only if the timer is the selected control source. Also, note that Arm Layer 1 does not use a timer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                |                                   |                                    |                                |                                      |

**:SIGNal**

|                                      |                               |
|--------------------------------------|-------------------------------|
| :ARM[:SEquence[1]][:LAYer[1]]:SIGNal | Bypass arm control source     |
| :ARM[:SEquence[1]]:LAYer2:SIGNal     | Bypass scan control source    |
| :TRIGger[:SEquence[1]]:SIGNal        | Bypass channel control source |

**Short-form formats**

:arm:sign

**Description**

These action commands are used to bypass the specified control source and are used when you do not wish to wait for the programmed event. Keep in mind that the instrument must be waiting for the appropriate event when the command is sent. Otherwise, an error will occur and this command will be ignored.

When this command is sent, the specified control source will be bypassed. This will allow operation to continue. Only the layer's source event between is bypassed; any :DELay time will be observed.

Note that :SIGNal is not an instrument setup command. As soon as this command is executed, it will attempt to bypass the control source.

**TCONfigure commands****:PROTOcol <name>**

:TRIGger[:SEquence[1]]:TCONfigure:PROTOcol &lt;name&gt; Specify Trigger Link protocol

**Parameters**

|                       |                                    |
|-----------------------|------------------------------------|
| <name> = ASYNchronous | Asynchronous Trigger Link mode     |
| = SSYNchronous        | Semi-synchronous Trigger Link mode |

**Short-form formats**

:trig:tcon:prot &lt;name&gt;

**Defaults**

|                |                      |
|----------------|----------------------|
| Power-up       | Saved power-on setup |
| *RST           | ASYNchronous         |
| :SYSTem:PRESet | ASYNchronous         |

**Query command**

|                    |                                        |
|--------------------|----------------------------------------|
| :PROTOcol?         | Query programmed Trigger Link protocol |
| Short-form format: | :trig:tcon:prot?                       |
| Response message:  | ASYN or SSYN                           |

**Description**

This command is used to select the protocol for the Trigger Layer Trigger Link. With ASYNchronous selected, separate trigger lines are used for input and output triggers. With SSYNchronous selected, a single trigger line is used for both input and output triggers.

Note that Arm Layer 1 and Arm Layer 2 only use the asynchronous Trigger Link mode and therefore, the protocol does not have to be selected.

**:DIRection <name>**

|                                                           |                               |
|-----------------------------------------------------------|-------------------------------|
| :ARM[:SEquence[1]][:LAYer[1]]:TCONfigure:DIRection <name> | Control arm Source Bypass     |
| :ARM[:SEquence[1]]:LAYer2:TCONfigure:DIRection <name>     | Control scan Source Bypass    |
| :TRIGger[:SEquence[1]]:TCONfigure:DIRection <name>        | Control channel Source Bypass |

**Parameters**

|                 |                       |
|-----------------|-----------------------|
| <name> = SOURce | Enable Source Bypass  |
| = ACCEptor      | Disable Source Bypass |

**Short-form formats**

```
:arm:tcon:dir <name>
:arm:lay2:tcon:dir <name>
:trig:tcon:dir <name>
```

**Defaults**

|                |                                        |
|----------------|----------------------------------------|
| Power-up       | Saved power-on setup                   |
| *RST           | ACCEptor (all layers)                  |
| :SYSTem:PRESet | ACCEptor (Arm Layer 1 and Arm Layer 2) |
|                | SOURce (Trigger Layer)                 |

**Query command**

|                     |                           |
|---------------------|---------------------------|
| :DIRection?         | Query Source Bypass state |
| Short-form formats: | :arm:tcon:dir?            |
|                     | :arm:lay2:tcon:dir?       |
|                     | :trig:tcon:dir?           |
| Response message:   | SOUR or ACC               |

**Description**

When a Source Bypass is enabled and the External or Trigger Link arm control source is selected, operation will loop around the appropriate control source on the initial pass through that layer. Note that the Source Bypass for Arm Layer 2 and the Trigger Layer also loops around the Delay.

If programmed for another pass through the specified layer (count >1), the bypass loop will not be in effect even though it will still be enabled. The bypass loop will be in effect if operation first goes back into the previous layer (or idle).

Enabling the Source Bypass for Arm Layer 1 and Arm Layer 2 also enables their Output Triggers. When operation leaves Arm Layer 1 or Arm Layer 2, the appropriate output trigger pulse will occur. If the Trigger Link (TLINK) control source is selected, the output trigger will be available on the programmed Trigger Link output line. The Output Trigger in these two layers is disabled when the Source Bypass is disabled.

The Output Trigger in the Trigger Layer is always enabled and occurs after the Device Action.

With ACCEptor selected, the bypass is disabled. Operation will not proceed through the specified layer until the appropriate event occurs.

**:ASYNchronous:ILINE <NRf>**

:ARM[:SEquence[1]][:LAYer[1]]:TCONfigure:ASYNchronous:ILINE <NRf> Select input trigger line; Arm Layer 1  
 :ARM[:SEquence[1]]:LAYer2:TCONfigure:ASYNchronous:ILINE <NRf> Select input trigger line; Arm Layer 2  
 :TRIGger[:SEquence[1]]:TCONfigure:ASYNchronous:ILINE <NRf> Select input trigger line; Trigger Layer

**Parameters**

<NRf> = 1 Line #1  
 = 2 Line #2  
 = 3 Line #3  
 = 4 Line #4  
 = 5 Line #5  
 = 6 Line #6

**Short-form formats**

:arm:tcon:asyn:ilin <NRf>  
 :arm:lay2:tcon:asyn:ilin <NRf>  
 :trig:tcon:asyn:ilin <NRf>

**Defaults**

Power-up Saved power-on setup  
 \*RST 1 (all layers)  
 :SYSTem:PRESet 1 (all layers)

**Query command**

:ILINE? Query programmed input line #  
 Short-form format: :arm:tcon:asyn:ilin?  
 :arm:lay2:tcon:asyn:ilin?  
 :trig:tcon:asyn:ilin?  
 Response message: 1 to 6

**Description**

These commands are used to select an input line for the asynchronous Trigger Link of the specified layer. Keep in mind that asynchronous Trigger Link input and output (see :OLINE) cannot share the same line. If you assign the input to a line that is already being used for the output, an error will occur and the command will be ignored.

**:ASYNchronous:OLINE <NRf>**

:ARM[:SEquence[1]][:LAYer[1]]:TCONfigure:ASYNchronous:OLINE <NRf> Select output trigger line; Arm Layer 1  
 :ARM[:SEquence[1]]:LAYer2:TCONfigure:ASYNchronous:OLINE <NRf> Select output trigger line; Arm Layer 2  
 :TRIGger[:SEquence[1]]:TCONfigure:ASYNchronous:OLINE <NRf> Select output trigger line; Trigger Layer

**Parameters**

<NRf> = 1 Line #1  
 = 2 Line #2  
 = 3 Line #3  
 = 4 Line #4  
 = 5 Line #5  
 = 6 Line #6

**Short-form formats**

:arm:tcon:asyn:olin <NRf>  
 :arm:lay2:tcon:asyn:olin <NRf>  
 :trig:tcon:asyn:olin <NRf>

|                      |                                                                                                                                                                                                                                                                                                                                       |                                                                                                                        |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------|
| <b>Defaults</b>      | Power-up<br>*RST<br>:SYSTem:PRESet                                                                                                                                                                                                                                                                                                    | Saved power-on setup<br>2 (all layers)<br>2 (all layers)                                                               |
| <b>Query command</b> | :OLINe?<br>Short-form formats:<br><br>Response message:                                                                                                                                                                                                                                                                               | Query programmed output line #<br>:arm:tcon:asyn:olin?<br>:arm:lay2:tcon:asyn:olin?<br>:trig:tcon:asyn:olin?<br>1 to 6 |
| <b>Description</b>   | These commands are used to select an output line for the asynchronous Trigger Link of the specified layer. Keep in mind that asynchronous Trigger Link input and output cannot share the same line. If you assign the output to a line that is already being used for the input, an error will occur and the command will be ignored. |                                                                                                                        |

**:SSYNchronous:LINE <NRf>**

:TRIGger[:SEquence[1]]:TCONfigure:SSYNchronous      Specify semi-synchronous Trigger Link line for the Trigger Layer

|                           |                                                                                                                                                            |
|---------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Parameters</b>         | <NRf> = 1      Line #1<br>= 2      Line #2<br>= 3      Line #3<br>= 4      Line #4<br>= 5      Line #5<br>= 6      Line #6                                 |
| <b>Short-form formats</b> | :trig:tcon:ssyn:line <NRf>                                                                                                                                 |
| <b>Defaults</b>           | Power-up                      Saved power-on setup<br>*RST                            1 (Trigger Layer)<br>:SYSTem:PRESet                1 (Trigger Layer) |
| <b>Query command</b>      | :LINE?                        Query programmed output line #<br>Short-form format:            :trig:tcon:ssyn:line?<br>Response message:            1 to 6 |
| <b>Description</b>        | This command is used to select one of the six trigger lines for the semi-synchronous Trigger Link.                                                         |

---

# 7 Maintenance

## Introduction

Maintenance is limited to line fuse replacement and some tests and checks to assure that the instrument is operating properly. Besides the power line fuse, the System 41 has no user-serviceable parts. Do not open the case. If the System 41 is in need of repair, return it to Keithley Instruments.

This section includes the following:

- **Power-up tests** — Summarizes the self-tests performed on power-up.
- **Power line fuse replacement** — Provides the procedure to replace the power line fuse.
- **Cooling fan** — Covers the cooling fan and vents which help keep the instrument from overheating.
- **Non-volatile memory test** — Explains how to test EEPROM and battery backed RAM.
- **Display tests** — Provides tests to check the front panel keys, VFD display, LED board, and the ASCII character set.

## Power-up tests

Install a line cord and turn the power on. The System 41 power supplies automatically adjusts to line voltage and frequency.

The System 41 will perform self-tests on its EPROM and RAM memory elements. If a failure is detected, the instrument will lock up and display the “No Comm Link” message. If the tests pass the ROM revision levels and IEEE-488 address will be displayed briefly.

## Power line fuse replacement

If the System 41 does not turn on at all, the problem could be a blown power line fuse. A blown fuse indicates that the AC power line has shorted. You may replace the fuse, but if it blows again you must return the instrument to Keithley Instruments for repair.

The correct fuse type for the AC power line is as follows:

| Type                             | Keithley part number |
|----------------------------------|----------------------|
| 2.5A, 250V, slow blow, 5 × 20 mm | FU-106-2.5           |

Perform the following steps to replace the power line fuse:

**WARNING** To prevent electrical shock that could result in severe injury or death, disconnect the instrument from the power line and all other equipment.

**NOTE** The fuse carrier is located in the power module, just above the power on/off switch.

1. At the bottom of the fuse carrier, there is a retaining clip. Using a thin-bladed screw driver, push the retaining clip up until the fuse carrier releases from the power module.
2. Pull the fuse carrier out of the power module.
3. Replace the fuse in the carrier. Be sure to use only the specified type fuse.
4. Push the fuse carrier back into the power module until it snaps into place.



## Cooling fan

The System 41 uses a constant-speed cooling fan to help keep it from overheating. This fan should be running whenever the instrument is turned on. The fan is located on the rear panel above the power switch. As viewed from the front of the mainframe, the exhaust vent for the fan is located on the right side panel, near the front.

To maintain proper ventilation, the fan intake and exhaust vents must not be blocked. Adequate airflow around the rear and right side panels must be maintained to ensure proper cooling.

## Non-volatile memory test

The System 41 uses two kinds of non-volatile memory; an EEPROM (electrically erasable programmable read-only memory) and battery backed RAM. The EEPROM stores the IEEE-488 address, power-on setup memories, and other mainframe configuration items. The battery backed RAM stores the scan list and channel patterns.

The following non-volatile memory test stores an IEEE-488 address in EEPROM, and a SCAN LIST in the battery backed RAM. Correct storage of these items after a few power line cycles provides confidence that the non-volatile memory is functioning properly.

1. Press MENU to display the MAIN MENU.
2. Place the cursor on GPIB and press ENTER.
3. Place the cursor on ADDRESS and press ENTER. Note the present GPIB address. When this test is finished, you should return the instrument to this address.
4. Change the GPIB address and press ENTER. If functioning properly, this new address will be retained in EEPROM.
5. Use the EXIT key to back out of the menu structure.
6. Press the SCAN LIST key.
7. Press the CLEAR LIST key.
8. Press “1”, “1” and then ENTER to create the following scan list:

```
SCAN CHANNELS 1!1,
```

If functioning properly, the scan list will be retained in battery backed RAM.

9. Turn off power and wait a few minutes.
10. Turn on power, and repeat steps 1, 2, and 3 to verify that the new GPIB address value is displayed. Use EXIT to back out of the menu structure.
11. Press SCAN LIST and verify the following scan list:

```
SCAN CHANNELS 1!1,
```

If the settings are not retained, one of the following problems may exist:

- Failure to retain the GPIB address indicates a fault with EEPROM.
- Failure to retain the scan list indicates a fault with battery backed RAM.

## Display tests

There are four tests to test the display. These tests check the front panel keys, the vacuum fluorescent display (VFD), the LED board, and the ASCII character set.

**NOTE** *The DISPLAY TESTS menu is selected from the TEST item of the MAIN MENU. In the SELF-TEST MENU, there is an item called BUILT-IN TESTS. These tests are for use by Keithley service personnel only. If you inadvertently select BUILT-IN TESTS, use the EXIT key to back out of the menu structure.*

### Keys test

1. Press the MENU key.
2. Select the TEST option and press ENTER.
3. Under the SELF-TEST MENU, select the DISPLAY-TESTS option and press ENTER.
4. Under DISPLAY TESTS, select KEYS and press ENTER. The display will show “No keys pressed.”
5. Press each key (except POWER) in turn and verify that the corresponding key name is displayed.
6. Verify that the display returns to “No keys pressed” when each key is released, i.e., no sticking keys.
7. When you are done with the key test, press EXIT twice to exit.

### Patterns test

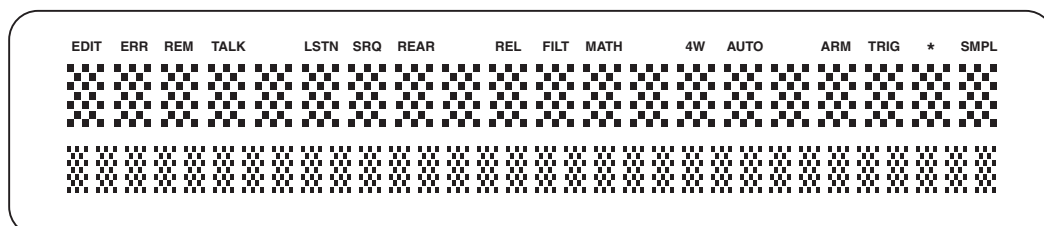
The display PATTERNS test is a visual check of the vacuum fluorescent display (VFD) module. See Figure 7-1.

1. Press the MENU key.
2. Select the TEST option and press ENTER.
3. Under the SELF TEST MENU select the DISPLAY-TESTS option and press ENTER.
4. Under DISPLAY TESTS select PATTERNS and press ENTER.
5. There are five test patterns in the test:

#### Pattern screen 1

A checkerboard pattern of 18 dots appears for all 20 characters in the top row and 32 characters in the bottom row. The annunciators will be shown as in Figure 7-1.

Figure 7-1  
First pattern for display test



### Pattern screen 2

The alternate checkerboard pattern of 17 dots appears for all 20 characters in top row and 32 characters in the bottom row. The annunciators disappear and are replaced by the numbers:

1 2 3 4 5 6 7 8 9 10

### Pattern screen 3

A horizontal bar moves through the seven rows of the first  $5 \times 7$  character position. One and only one bar must be visible at a time. Movement will continue until any key is pressed.

### Pattern screen 4

A vertical bar moves through the five columns of the first  $5 \times 7$  character position. One and only one bar must be visible at a time. Movement will continue until any key is pressed.

### Pattern screen 5

All 35 dots of each  $5 \times 7$  character block will turn on one character at a time. The upper row blocks include a number and (except for positions 5, 9, 13, and 16) an annunciator. Verify that one and only one block illuminates fully for each character position.

The first test pattern automatically appears when the display test commences. Press any key except EXIT to move to each successive pattern.

6. Verify all five patterns, then press EXIT to return to the SELF-TEST MENU.

## LED board test

The display LED-BOARD test is a visual check of the light emitting diodes.

1. Press the MENU key.
2. Select the TEST option and press ENTER.
3. Under the SELF TEST MENU, select the DISPLAY-TESTS option and press ENTER.
4. Under the DISPLAY TESTS menu, select LED-BOARD and press ENTER to start the test. The test can be aborted at any time by pressing any front panel key as indicated by the following message that is displayed while the test is in progress:

LED TEST PATTERNS

Press any key to exit.

The test initially turns off all the LEDs and then turns on the LEDs for column 1. The test will then disable the LEDs for column 1 and turn on the LEDs for column 2. The test will sequence through all the columns including the control LEDs for the light pen. The test will then sequence through each row of the 10 slots. Note that the control LEDs for the light pen will be included in the rows for slots 6 through 10. Note that the LEDs for the column tests are brighter than the LEDs for the row tests.

**Light pen test** — With the LED test running, further tests can be performed using the light pen:

1. While aiming the light pen away from the LED display, press the button on the pen. All LEDs will become dimly lit. Press the light pen button a second time. All LEDs will become brightly lit. Press the button a third time. All LEDs will turn off. Each press of the light pen button repeats the above test sequence.
2. While all LEDs are dimly lit or brightly lit, individual LEDs can be tested by clicking them with the light pen. When the LED is clicked, it will blink on (brightly lit) and off for a couple of seconds.
3. When finished, press any front panel key to exit from the display test.

## Char set test

This test is used to display the ASCII character set.

1. Press the MENU key.
2. Select the TEST option and press ENTER.
3. Under the SELF TEST MENU, select the DISPLAY TESTS option.
4. Under DISPLAY TESTS, select CHAR-SET and press ENTER to display the ASCII character set.
5. Press any key (except EXIT) to scroll through the character set.
6. When finished, use the EXIT key to back out of the menu structure.



# **A** Interface Function Codes

The interface function codes, which are part of the IEEE-488 standards, define an instrument's ability to support various interface functions and should not be confused with programming commands found elsewhere in this manual. The interface function codes for the System 41 are listed in Table A-1. The codes define System 41 capabilities as follows:

**SH (Source Handshake Function)** — SH1 defines the ability of the instrument to initiate the transfer of message/data over the data bus.

**AH (Acceptor Handshake Function)** — AH1 defines the ability of the instrument to guarantee proper reception of message/data transmitted over the data bus.

**T (Talker Function)** — The ability of the instrument to send data over the bus to other devices is provided by the T function. Instrument talker capabilities (T5) exist only after the instrument has been addressed to talk.

**L (Listener Function)** — The ability for the instrument to receive device-dependent data over the bus from other devices is provided by the L function. Listener capabilities (L4) of the instrument exist only after it has been addressed to listen.

**SR (Service Request Function)** — SR1 defines the ability of the instrument to request service from the controller.

**RL (Remote-Local Function)** — RL1 defines the ability of the instrument to be placed in the remote or local modes.

**PP (Parallel Poll Function)** — The instrument does not have parallel polling capabilities (PP0).

**DC (Device Clear Function)** — DC1 defines the ability of the instrument to be cleared (initialized).

**DT (Device Trigger Function)** — DT1 defines the ability of the System 41 to have trigger capabilities.

**C (Controller Function)** — The instrument does not have controller capabilities (C0).

**TE (Extended Talker Function)** — The instrument does not have extended talker capabilities (TE0).

**LE (Extended Listener Function)** — The instrument does not have extended listener capabilities (LE0).

**E (Bus Driver Type)** — The instrument has open-collector bus drivers (E1).

Table A-1  
**System 41 interface function codes**

| Code | Interface function                                             |
|------|----------------------------------------------------------------|
| SH1  | Source Handshake capability                                    |
| AH1  | Acceptor Handshake capability                                  |
| T5   | Talker (basic talker, serial poll, unaddressed to talk on LAG) |
| L4   | Listener (basic listener, unaddressed to listen on TAG)        |
| SR1  | Service Request capability                                     |
| RL1  | Remote/Local capability                                        |
| PP0  | No Parallel Poll capability                                    |
| DC1  | Device Clear capability                                        |
| DT1  | Device Trigger capability                                      |
| C0   | No Controller capability                                       |
| E1   | Open collector bus drivers                                     |
| TE0  | No Extended Talker capability                                  |
| LE0  | No Extended Listener capability                                |





---

**B**  
ASCII Character Codes and  
IEEE-488 Multiline  
Interface Command  
Messages

| Decimal | Hexadecimal | ASCII | IEEE-488 Messages* |
|---------|-------------|-------|--------------------|
| 0       | 00          | NUL   |                    |
| 1       | 01          | SOH   | GTL                |
| 2       | 02          | STX   |                    |
| 3       | 03          | ETX   |                    |
| 4       | 04          | EOT   | SDC                |
| 5       | 05          | ENQ   | PPC                |
| 6       | 06          | ACK   |                    |
| 7       | 07          | BEL   |                    |
| 8       | 08          | BS    | GET                |
| 9       | 09          | HT    | TCT                |
| 10      | 0A          | LF    |                    |
| 11      | 0B          | VT    |                    |
| 12      | 0C          | FF    |                    |
| 13      | 0D          | CR    |                    |
| 14      | 0E          | SO    |                    |
| 15      | 0F          | SI    |                    |
| 16      | 10          | DLE   |                    |
| 17      | 11          | DC1   | LLO                |
| 18      | 12          | DC2   |                    |
| 19      | 13          | DC3   |                    |
| 20      | 14          | DC4   | DCL                |
| 21      | 15          | NAK   | PPU                |
| 22      | 16          | SYN   |                    |
| 23      | 17          | ETB   |                    |
| 24      | 18          | CAN   | SPE                |
| 25      | 19          | EM    | SPD                |
| 26      | 1A          | SUB   |                    |
| 27      | 1B          | ESC   |                    |
| 28      | 1C          | FS    |                    |
| 29      | 1D          | GS    |                    |
| 30      | 1E          | RS    |                    |
| 31      | 1F          | US    |                    |

\*Message sent or received with ATN true.

| Decimal | Hexadecimal | ASCII | IEEE-488 Messages* |
|---------|-------------|-------|--------------------|
| 32      | 20          | SP    | MLA 0              |
| 33      | 21          | !     | MLA 1              |
| 34      | 22          | ”     | MLA 2              |
| 35      | 23          | #     | MLA 3              |
| 36      | 24          | \$    | MLA 4              |
| 37      | 25          | %     | MLA 5              |
| 38      | 26          | &     | MLA 6              |
| 39      | 27          | ,     | MLA 7              |
| 40      | 28          | (     | MLA 8              |
| 41      | 29          | )     | MLA 9              |
| 42      | 2A          | *     | MLA 10             |
| 43      | 2B          | +     | MLA 11             |
| 44      | 2C          | ,     | MLA 12             |
| 45      | 2D          | -     | MLA 13             |
| 46      | 2E          | .     | MLA 14             |
| 47      | 2F          | /     | MLA 15             |
| 48      | 30          | 0     | MLA 16             |
| 49      | 31          | 1     | MLA 17             |
| 50      | 32          | 2     | MLA 18             |
| 51      | 33          | 3     | MLA 19             |
| 52      | 34          | 4     | MLA 20             |
| 53      | 35          | 5     | MLA 21             |
| 54      | 36          | 6     | MLA 22             |
| 55      | 37          | 7     | MLA 23             |
| 56      | 38          | 8     | MLA 24             |
| 57      | 39          | 9     | MLA 25             |
| 58      | 3A          | :     | MLA 26             |
| 59      | 3B          | ;     | MLA 27             |
| 60      | 3C          | <     | MLA 28             |
| 61      | 3D          | =     | MLA 29             |
| 62      | 3E          | >     | MLA 30             |
| 63      | 3F          | ?     | UNL                |

\*Message sent or received with ATN true. Numbers shown represent primary address resulting in MLA (My Listen Address).

| Decimal | Hexadecimal | ASCII | IEEE-488 Messages* |
|---------|-------------|-------|--------------------|
| 64      | 40          | @     | MTA 0              |
| 65      | 41          | A     | MTA 1              |
| 66      | 42          | B     | MTA 2              |
| 67      | 43          | C     | MTA 3              |
| 68      | 44          | D     | MTA 4              |
| 69      | 45          | E     | MTA 5              |
| 70      | 46          | F     | MTA 6              |
| 71      | 47          | G     | MTA 7              |
| 72      | 48          | H     | MTA 8              |
| 73      | 49          | I     | MTA 9              |
| 74      | 4A          | J     | MTA 10             |
| 75      | 4B          | K     | MTA 11             |
| 76      | 4C          | L     | MTA 12             |
| 77      | 4D          | M     | MTA 13             |
| 78      | 4E          | N     | MTA 14             |
| 79      | 4F          | O     | MTA 15             |
| 80      | 50          | P     | MTA 16             |
| 81      | 51          | Q     | MTA 17             |
| 82      | 52          | R     | MTA 18             |
| 83      | 53          | S     | MTA 19             |
| 84      | 54          | T     | MTA 20             |
| 85      | 55          | U     | MTA 21             |
| 86      | 56          | V     | MTA 22             |
| 87      | 57          | W     | MTA 23             |
| 88      | 58          | X     | MTA 24             |
| 89      | 59          | Y     | MTA 25             |
| 90      | 5A          | Z     | MTA 26             |
| 91      | 5B          | [     | MTA 27             |
| 92      | 5C          | \     | MTA 28             |
| 93      | 5D          | ]     | MTA 29             |
| 94      | 5E          | «     | MTA 30             |
| 95      | 5F          | æ     | UNL                |

\*Message sent or received with ATN true. Numbers shown are primary address resulting in MTA (My Talk Address).

| Decimal | Hexadecimal | ASCII | IEEE-488 Messages* |
|---------|-------------|-------|--------------------|
| 96      | 60          | «     | MSA 0, PPE         |
| 97      | 61          | a     | MSA 1, PPE         |
| 98      | 62          | b     | MSA 2, PPE         |
| 99      | 63          | c     | MSA 3, PPE         |
| 100     | 64          | d     | MSA 4, PPE         |
| 101     | 65          | e     | MSA 5, PPE         |
| 102     | 66          | f     | MSA6, PPE          |
| 103     | 67          | g     | MSA 7, PPE         |
| 104     | 68          | h     | MSA 8, PPE         |
| 105     | 69          | i     | MSA 9, PPE         |
| 106     | 6A          | j     | MSA 10, PPE        |
| 107     | 6B          | k     | MSA 11, PPE        |
| 108     | 6C          | l     | MSA 12, PPE        |
| 109     | 6D          | m     | MSA 13, PPE        |
| 110     | 6E          | n     | MSA 14, PPE        |
| 111     | 6F          | o     | MSA 15, PPE        |
| 112     | 70          | p     | MSA 16, PPD        |
| 113     | 71          | q     | MSA 17, PPD        |
| 114     | 72          | r     | MSA 18, PPD        |
| 115     | 73          | s     | MSA 19, PPD        |
| 116     | 74          | t     | MSA 20, PPD        |
| 117     | 75          | u     | MSA 21, PPD        |
| 118     | 76          | v     | MSA 22, PPD        |
| 119     | 77          | w     | MSA 23, PPD        |
| 120     | 78          | x     | MSA 24, PPD        |
| 121     | 79          | y     | MSA 25, PPD        |
| 122     | 7A          | z     | MSA 26, PPD        |
| 123     | 7B          | {     | MSA 27, PPD        |
| 124     | 7C          |       | MSA 28, PPD        |
| 125     | 7D          | }     | MSA 29, PPD        |
| 126     | 7E          | ~     | MSA 30, PPD        |
| 127     | 7F          | DEL   |                    |

\*Message sent or received with ATN true. Numbers represent secondary address resulting in MSA (My Secondary Address).



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# C IEEE-488 Bus Overview

## Introduction

Basically, the IEEE-488 bus is simply a communication system between two or more electronic devices. A device can be either an instrument or a computer. When a computer is used on the bus, it serves to supervise the communication exchange between all the devices and is known as the controller. Supervision by the controller consists of determining which device will talk and which device will listen. As a talker, a device will output information and as a listener, a device will receive information. To simplify the task of keeping track of the devices, a unique address number is assigned to each one.

On the bus, only one device can talk at a time and is addressed to talk by the controller. The device that is talking is known as the active talker. The devices that need to listen to the talker are addressed to listen by the controller. Each listener is then referred to as an active listener. Devices that do not need to listen are instructed to unlisten. The reason for the unlisten instruction is to optimize the speed of bus information transfer since the task of listening takes up bus time.

Through the use of control lines, a handshake sequence takes place in the transfer process of information from a talker to a listener. This handshake sequence helps ensure the credibility of the information transfer. The basic handshake sequence between an active controller (talker) and a listener is as follows:

1. The listener indicates that it is ready to listen.
2. The talker places the byte of data on the bus and indicates that the data is available to the listener.
3. The listener, aware that the data is available, accepts the data and then indicates that the data has been accepted.
4. The talker, aware that the data has been accepted, stops sending data and indicates that data is not being sent.
5. The listener, aware that there is no data on the bus, indicates that it is ready for the next byte of data.

## Bus Description

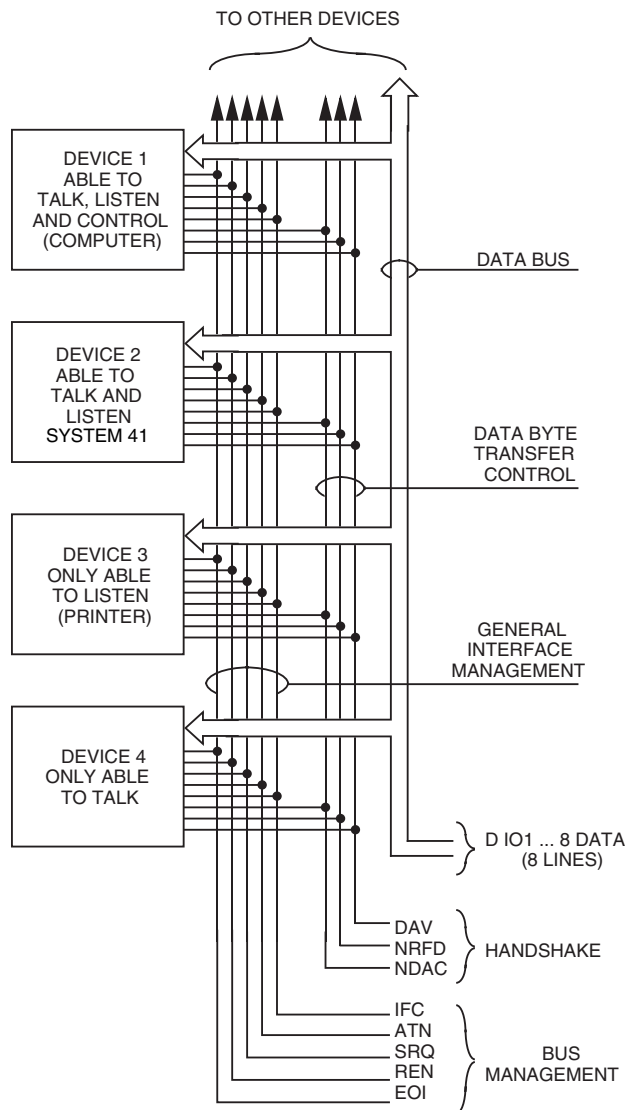
The IEEE-488 bus, which is also frequently referred to as the GPIB (General Purpose Interface Bus), was designed as a parallel transfer medium to optimize data transfer without using an excessive number of bus lines. In keeping with this goal, the bus has only eight data lines that are used for both data and with most commands. Five bus management lines and three handshake lines round out the complement of bus signal lines.

A typical set up for controlled operation is shown in Figure C-1. Generally, a system will contain one controller and a number of other instruments to which the commands are given. Device operation is categorized into three operators: controller, talker and listener. The controller does what its name implies; it controls the instruments on the bus. The talker sends data, while a listener receives data. Depending on the type of instrument, any particular device can be a talker only, a listener only, or both a talker and listener.

There are two categories of controllers: system controller, and basic controller. Both are able to control other instruments, but only the system controller has the absolute authority in the system. In a system with more than one controller, only one controller may be active at any given time. Certain protocol is used to pass control from one controller to another.



Figure C-1  
IEEE-488 bus configuration



The IEEE-488 bus is limited to 15 devices, including the controller. Thus, any number of talkers and listeners up to that limit may be present on the bus at one time. Although several devices may be commanded to listen simultaneously, the bus can have only one active talker, or communications would be scrambled.

A device is placed in the talk or listen state by sending an appropriate talk or listen command. These talk and listen commands are derived from an instrument's primary address. The primary address may have any value between 0 and 31, and is generally set by rear panel DIP switches or programmed in from the front panel of the instrument. The actual listen address value sent out over the bus is obtained by ORing the primary address with \$20. For example, if the primary address is 27 decimal (\$07), the actual listen address is \$27 (\$27 = \$07 + \$20). In a similar manner, the talk address is obtained by ORing the primary address with \$40. With the present example, the talk address derived from a primary address of 7 decimal would be \$47 (\$47 = \$07 + \$40).

The IEEE-488 standards also include another addressing mode called secondary addressing. Secondary addresses lie in the range of \$60-\$7F. Note, however, that many devices, including the System 41, do not use secondary addressing.

Once a device is addressed to talk or listen, the appropriate bus transactions take place. For example: if the instrument is addressed to talk, it places its data string on the bus one byte at a time. The controller reads the information and the appropriate software can be used to direct the information to the desired location.

## Bus Lines

The signal lines on the IEEE-488 bus are grouped into three different categories: data lines, management lines and handshake lines. The data lines handle bus data and commands, while the management and handshake lines ensure that proper data transfer and operation takes place. Each bus line is active low, with approximately zero volts representing a logic 1 (true). The following paragraphs describe the operation of these lines.

### Data lines

The IEEE-488 bus uses eight data lines that transfer data one byte at a time. DIO1 (Data Input/Output) through DIO8 (Data Input/Output) are the eight data lines used to transmit both data and multiline commands and are bidirectional. The data lines operate with low true logic.

### Bus management lines

The five bus management lines help to ensure proper interface control and management. These lines are used to send the uniline commands.

ATN (Attention) — The ATN line is one of the more important management lines in that the state of this line determines how information on the data bus is to be interpreted.

IFC (Interface Clear) — As the name implies, the IFC line controls clearing of instruments from the bus.

REN (Remote Enable) — The REN line is used to place the instrument on the bus in the remote mode.

EOI (End or Identify) — The EOI is usually used to mark the end of a multi-byte data transfer sequence.

SRQ (Service Request) — This line is used by devices when they require service from the controller.

### Handshake lines

The bus handshake lines operate in an interlocked sequence. This method ensures reliable data transmission regardless of the transfer rate. Generally, data transfer will occur at a rate determined by the slowest active device on the bus.

One of the three handshake lines is controlled by the source (the talker sending information), while the remaining two lines are controlled by accepting devices (the listener or listeners receiving the information). The three handshake lines are:

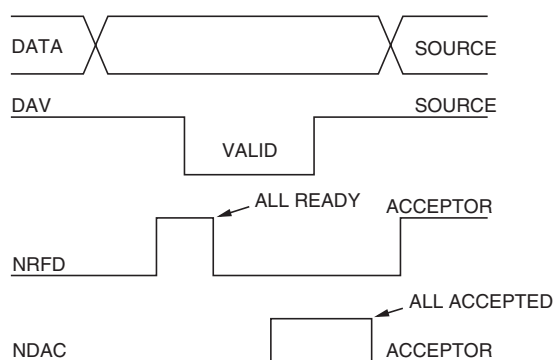
DAV (DATA VALID) — The source controls the state of the DAV line to indicate to any listening devices whether or not data bus information is valid.

**NRFD (Not Ready For Data)** — The acceptor controls the state of NRFD. It is used to signal to the transmitting device to hold off the byte transfer sequence until the accepting device is ready.

**NDAC (Not Data Accepted)** — NDAC is also controlled by the accepting device. The state of NDAC tells the source whether or not the device has accepted the data byte.

The complete handshake sequence for one data byte is shown in Figure C-2. Once data is placed on the data lines, the source checks to see that NRFD is high, indicating that all active devices are ready. At the same time, NDAC should be low from the previous byte transfer. If these conditions are not met, the source must wait until NDAC and NRFD have the correct status. If the source is a controller, NRFD and NDAC must be stable for at least 100nsec after ATN is set true. Because of the possibility of a bus hang up, many controllers have time-out routines that display messages in case the transfer sequence stops for any reason.

*Figure C-2*  
**IEEE-488 handshake sequence**



Once all NDAC and NRFD are properly set, the source sets DAV low, indicating to accepting devices that the byte on the data lines is now valid. NRFD will then go low, and NDAC will go high once all devices have accepted the data. Each device will release NDAC at its own rate, but NDAC will not be released to go high until all devices have accepted the data byte.

The sequence just described is used to transfer both data, talk and listen addresses, as well as multiline commands. The state of the ATN line determines whether the data bus contains data, addresses or commands as described in the following paragraph.

## Bus Commands

The instrument may be given a number of special bus commands through the IEEE-488 interface. This section briefly describes the purpose of the bus commands which are grouped into the following three categories.

1. **Uniline Commands** — Sent by setting the associated bus lines true. For example, to assert REN (Remote Enable), the REN line would be set low (true).
2. **Multiline Commands** — General bus commands which are sent over the data lines with the ATN line true (low).
3. **Common Commands** — Commands that are common to all devices on the bus; sent with ATN high (false).
4. **SCPI Commands** — Commands that are particular to each device on the bus; sent with ATN (false).

These bus commands and their general purpose are summarized in Table C-1.

Table C-1  
IEEE-488 bus command summary

| Command type           | Command                      | State of ATN line | Comments                                                          |
|------------------------|------------------------------|-------------------|-------------------------------------------------------------------|
| Uniline                | REN (Remote Enable)          | X                 | Set up devices for remote operation.                              |
|                        | EOI                          | X                 | Marks end of transmission.                                        |
|                        | IFC (Interface Clear)        | X                 | Clears interface.                                                 |
|                        | ATN (Attention)              | Low               | Defines data bus contents.                                        |
|                        | SRQ                          | X                 | Controlled by external device.                                    |
| Multiline<br>Universal | LLO (Local Lockout)          | Low               | Locks our local operation.                                        |
|                        | DCL (Device Clear)           | Low               | Returns device to default conditions.                             |
|                        | SPE (Serial Enable)          | Low               | Enables serial polling.                                           |
|                        | SPD (Serial Poll Disable)    | Low               | Disables serial polling.                                          |
| Addressed              | SDC (Selective Device Clear) | Low               | Returns unit to default conditions.                               |
|                        | GTL (Go To Local)            | Low               | Returns device to local.                                          |
| Unaddressed            | UNL (Unlisten)               | Low               | Removes all listeners from the bus.                               |
|                        | UNT (Untalk)                 | Low               | Removes any talkers from the bus.                                 |
| Common                 | —                            | High              | Programs IEEE-488.2 compatible instruments for common operations. |
| SCPI                   | —                            | High              | Programs SCPI compatible instruments for particular operations.   |

## Uniline commands

ATN, IFC and REN are asserted only by the controller. SRQ is asserted by an external device. EOI may be asserted either by the controller or other devices depending on the direction of data transfer. The following is a description of each command. Each command is sent by setting the corresponding bus line true.

**REN (Remote Enable)** — REN is sent to set up instruments on the bus for remote operation. When REN is true, devices will be removed from the local mode. Depending on device configuration, all front panel controls except the LOCAL button (if the device is so equipped) may be locked out when REN is true. Generally, REN should be sent before attempting to program instruments over the bus.

**EOI (End or Identify)** — EOI is used to positively identify the last byte in a multi-byte transfer sequence, thus allowing data words of various lengths to be transmitted easily.

**IFC (Interface Clear)** — IFC is used to clear the interface and return all devices to the talker and listener idle states.

**ATN (Attention)** — The controller sends ATN while transmitting addresses or multiline commands.

**SRQ (Service Request)** — SRQ is asserted by a device when it requires service from a controller.

## Universal multiline commands

Universal commands are those multiline commands that require no addressing. All devices equipped to implement such commands will do so simultaneously when the commands are transmitted. As with all multiline commands, these commands are transmitted with ATN true.

LLO (Local Lockout) — LLO is sent to the instrument to lock out the LOCAL key and thus all their front panel controls.

DCL (Device Clear) — DCL is used to return instruments to some default state. Usually, instruments return to their power-up conditions.

SPE (Serial Poll Enable) — SPE is the first step in the serial polling sequence which is used to determine which device has requested service.

SPD (Serial Poll Disable) — SPD is used by the controller to remove all devices on the bus from the serial poll mode and is generally the last command in the serial polling sequence.

## Addressed multiline commands

Addressed commands are multiline commands that must be preceded by the device listen address before that instrument will respond to the command in question. Note that only the addressed device will respond to these commands. Both the commands and the address preceding it are sent with ATN true.

SDC (Selective Device Clear) — The SDC command performs essentially the same function as the DCL command except that only the addressed device responds. Generally, instruments return to their power-up default conditions when responding to the SDC command.

GTL (Go To Local) — The GTL command is used to remove instruments from the remote mode. With some instruments, GTL also unlocks front panel controls if they were previously locked out with the LLO command.

GET (Group Execute Trigger) — The GET command is used to trigger devices to perform a specific action that depends on device configuration (for example, take a reading). Although GET is an addressed command, many devices respond to GET without addressing.

## Address commands

Addressed commands include two primary command groups and a secondary address group. ATN is true when these commands are asserted. The commands include:

LAG (Listen Address Group) — These listen commands are derived from an instrument's primary address and are used to address devices to listen. The actual command byte is obtained by ORing the primary address with \$20.

TAG (Talk Address Group) — The talk commands are derived from the primary address by ORing the address with \$40. Talk commands are used to address devices to talk.

SCG (Secondary Command Group) — Commands in this group provide additional addressing capabilities. Many devices (including the System 41) do not use these commands.

## Unaddress commands

The two unaddress commands are used by the controller to remove any talkers or listeners from the bus. ATN is true when these commands are asserted.

UNL (Unlisten) — Listeners are placed in the listener idle state by the UNL command.

UNT (Untalk) — Any previously commanded talkers will be placed in the talker idle state by the UNT command.

## Common commands

Common commands are commands that are common to all devices on the bus. These commands are designated and defined by the IEEE-488.2 standard.

Generally, these commands are sent as one or more ASCII characters that tell the device to perform a common operation, such as reset. The IEEE-488 bus treats these commands as data in that ATN is false when the commands are transmitted.

## SCPI commands

SCPI commands are commands that are particular to each device on the bus. These commands are designated by the instrument manufacturer, and are based on the instrument model defined by the Standard Commands for Programmable Instruments (SCPI) Consortium's SCPI standard.

Generally, these commands are sent as one or more ASCII characters that tell the device to perform a particular operation, such as setting a range or closing a relay. The IEEE-488 bus treats these commands as data in that ATN is false when the commands are transmitted.

## Command codes

Command codes for the various commands that use the data lines are summarized in Figure C-3. Hexadecimal and the decimal values for the various commands are listed in Table C-2.



*Table C-2*  
**Hexadecimal and decimal command codes**

| Command | Hex value | Decimal value |
|---------|-----------|---------------|
| GTL     | 01        | 1             |
| SDC     | 04        | 4             |
| GET     | 08        | 8             |
| LLO     | 11        | 17            |
| DCL     | 14        | 20            |
| SPE     | 18        | 24            |
| SPD     | 19        | 25            |
| LAG     | 20-3F     | 32-63         |
| TAG     | 40-5F     | 64-95         |
| SCG     | 60-7F     | 96-127        |
| UNL     | 3F        | 63            |
| UNT     | 5F        | 95            |

## Typical command sequences

For the various multiline commands, a specific bus sequence must take place to properly send the command. In particular, the correct listen address must be sent to the instrument before it will respond to addressed commands. Table C-3 lists a typical bus sequence for sending the addressed multiline commands. In this instance, the SDC command is being sent to the instrument. UNL is generally sent as part of the sequence to ensure that no other active listeners are present. Note that ATN is true for both the listen command and the SDC command byte itself.

*Table C-3*  
**Typical addressed command sequence**

|      |         |              | Data bus |     |         |
|------|---------|--------------|----------|-----|---------|
| Step | Command | ATN state    | ASCII    | Hex | Decimal |
| 1    | UNL     | Set low      | ?        | 3F  | 63      |
| 2    | LAG*    | Stays low    | ,        | 27  | 39      |
| 3    | SDC     | Stays low    | EOT      | 04  | 4       |
| 4    |         | Returns high |          |     |         |

\*Assumes primary address = 7.

Table C-4 gives a typical common command sequence. In this instance, ATN is true while the instrument is being addressed, but it is set high while sending the common command string.

*Table C-4*  
**Typical common command sequence**

|      |         |            | Data bus |     |         |
|------|---------|------------|----------|-----|---------|
| Step | Command | ATN state  | ASCII    | Hex | Decimal |
| 1    | UNL     | Set low    | ?        | 3F  | 63      |
| 2    | LAG*    | Stays low  | ,        | 27  | 39      |
| 3    | Data    | Set high   | *        | 2A  | 42      |
| 4    | Data    | Stays high | R        | 52  | 82      |
| 5    | Data    | Stays high | S        | 53  | 83      |
| 6    | Data    | Stays high | T        | 54  | 84      |

Assumes primary address = 7.



## IEEE command groups

Command groups supported by the System 41 are listed in Table C-5. Common commands and SCPI commands are not included in this list.

Table C-5

### IEEE command groups

|                                |                               |
|--------------------------------|-------------------------------|
| <b>HANDSHAKE COMMAND GROUP</b> |                               |
|                                | NDAC = NOT DATA ACCEPTED      |
|                                | NRFD = NOT READY FOR DATA     |
|                                | DAV = DATA VALID              |
| <b>UNIVERSAL COMMAND GROUP</b> |                               |
|                                | ATN = ATTENTION               |
|                                | DCL = DEVICE CLEAR            |
|                                | IFC = INTERFACE CLEAR         |
|                                | REN = REMOTE ENABLE           |
|                                | SPD = SERIAL POLL DISABLE     |
|                                | SPE = SERIAL POLL ENABLE      |
| <b>ADDRESS COMMAND GROUP</b>   |                               |
| LISTEN                         | LAG = LISTEN ADDRESS GROUP    |
|                                | MLA = MY LISTEN ADDRESS       |
|                                | UNL = UNLISTEN                |
| TALK                           | TAG = TALK ADDRESS GROUP      |
|                                | MTA = MY TALK ADDRESS         |
|                                | UNT = UNTALK                  |
|                                | OTA = OTHER TALK ADDRESS      |
| <b>ADDRESSED COMMAND GROUP</b> |                               |
|                                | ACG = ADDRESSED COMMAND GROUP |
|                                | GTL = GO TO LOCAL             |
|                                | SDC = SELECTIVE DEVICE CLEAR  |
| <b>STATUS COMMAND GROUP</b>    |                               |
|                                | RQS = REQUEST SERVICE         |
|                                | SRQ = SERIAL POLL REQUEST     |
|                                | STB = STATUS BYTE             |
|                                | EOI = END                     |



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**D**  
**IEEE-488**  
**Conformance Information**

## Information

The IEEE-488.2 standard requires specific information about how the System 41 implements the standard. Paragraph 4.9 of the IEEE-488.2 standard (Std 488.2-1987) lists the documentation requirements. Table D-1 provides a summary of the requirements, and provides the information or references the manual for that information.

Table D-1

### IEEE-488 documentation requirements

|      | Requirement                                                                   | Description or Reference                                                                      |
|------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| (1)  | IEEE-488 Interface Function Codes.                                            | See Appendix B.                                                                               |
| (2)  | Behavior of System 41 when the address is set outside the range 0-30.         | Error message occurs. Previous address is retained.                                           |
| (3)  | Behavior of System 41 when valid address is entered.                          | No error message. Display returns to GPIB SETUP MENU.                                         |
| (4)  | Power-On Setup Conditions.                                                    | *RST; see Section 6. :SYST:PRES and :SYST:POS; see Section 6.                                 |
| (5)  | Message Exchange Options:                                                     |                                                                                               |
| (a)  | Input buffer size.                                                            | 256 bytes.                                                                                    |
| (b)  | Queries that return more than one response message.                           | None.                                                                                         |
| (c)  | Queries that generate a response when parsed.                                 | All queries (Common Commands and SCPI).                                                       |
| (d)  | Queries that generate a response when read.                                   | None.                                                                                         |
| (e)  | Coupled commands.                                                             | :TRIG:COUNT is coupled to :TRIG:COUNT:AUTO. Enabling Auto sets count to the scan list length. |
| (6)  | Functional elements required for SCPI commands.                               | Contained in SCPI command subsystems tables.                                                  |
| (7)  | Buffer size limitations for block data.                                       | Up to 20 characters for block display messages.                                               |
| (8)  | Syntax restrictions.                                                          | See Section 6.                                                                                |
| (9)  | Response syntax for every query command.                                      | See Section 6.                                                                                |
| (10) | Device-to-device message transfer that does not follow rules of the standard. | None.                                                                                         |
| (11) | Block data response size.                                                     | None.                                                                                         |
| (12) | Common Commands implemented by System 41.                                     | See Section 6.                                                                                |
| (13) | Calibration query information.                                                | Not applicable.                                                                               |
| (14) | Trigger macro for *DDT.                                                       | Not applicable.                                                                               |
| (15) | Macro information.                                                            | Not applicable.                                                                               |
| (16) | Response to *IDN (identification).                                            | See Section 6.                                                                                |
| (17) | Storage area for *PUD and *PUD?                                               | Not applicable.                                                                               |
| (18) | Resource description for *RDT and *RDT?                                       | Not applicable.                                                                               |
| (19) | Effects of *RST, *RCL and *SAV.                                               | See Section 6.                                                                                |
| (20) | *TST information.                                                             | See Section 6.                                                                                |
| (21) | Status register structure.                                                    | See Section 6.                                                                                |
| (22) | Sequential or overlapped commands.                                            | All are sequential except :INIT, :INIT:CONT ON and *TRG which are overlapped.                 |
| (23) | Operation complete messages.                                                  | See *OPC, *OPC? and *WAI in Section 6.                                                        |

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**E**  
SCPI Conformance  
Information

## Introduction

The System 41 complies with SCPI version 1991.0. Table E-1 lists the SCPI confirmed commands and Table E-2 lists the non-SCPI commands.

Table E-1

### Syntax of SCPI confirmed commands implemented by System 41

| Command                                                                                                                                                                                                        | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| :DISPlay<br>[:WINDow[1]]<br>:TEXT<br>:DATA <a><br>:DATA?<br>:STATe <b><br>:STATe?<br><br>:WINDow2<br>:TEXT<br>:DATA <a><br>:DATA?<br>:STATe <b><br>:STATe?<br><br>:ENABle <b><br>:ENABle?                      | Path to locate message to top display.<br>Path to control user text messages.<br>Define ASCII message “a” using up to 20 characters.<br>Query text message.<br>Enable (1 or ON) or disable (0 or OFF) message mode.<br>Query text message mode (0 or 1).<br><br>Path to locate message to bottom display.<br>Path to control user text messages.<br>Define ASCII message “a” using up to 32 characters.<br>Query text message.<br>Enable (1 or ON) or disable (0 or OFF) message mode.<br>Query text message mode (0 or 1).<br><br>Turn on (1 or ON) or turn off (0 or OFF) the front panel display circuitry.<br>Query state of the display (0 or 1). |
| [:ROUTe]<br>:CLOSE <list><br>:STATe?<br>:CLOSE? <list><br>:OPEN <list>ALL<br>:OPEN? <list><br>:SCAN <list><br>:POINTs?                                                                                         | Close specified channels.<br>Query list of closed channels.<br>Query state of specified channels (1 = closed, 0 = open).<br>Open specified (or all) channels.<br>Query state of specified channels (1 = open, 0 = closed).<br>Define scan list.<br>Query number of channels in scan list.                                                                                                                                                                                                                                                                                                                                                              |
| :STATus<br>:OPERation<br>[:EVENT]?<br>:ENABle <NRf><br>:ENABle?<br>:PTRansition <NRf><br>:PTRansition?<br>:NTRansition <NRf><br>:NTRansition?<br>:CONDition?<br>:ARM<br>[:EVENT]?<br>:ENABle <NRf><br>:ENABle? | Path to control operation event registers:<br>Query event register.<br>Program the enable register.<br>Query enable register.<br>Program the positive transition register.<br>Query positive transition register.<br>Program the negative transition register.<br>Query negative transition register.<br>Query condition register.<br>Path to control arm event registers:<br>Query event register.<br>Program the enable register.<br>Query enable register.                                                                                                                                                                                          |

Table E-1 (cont.)

**Syntax of SCPI confirmed commands implemented by System 41**

| Command                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| :STATus<br>:OPERation<br>:ARM<br>:PTRansition <NRf><br>:PTRansition?<br>:NTRansition <NRf><br>:NTRansition?<br>:CONDition?<br>:SEQUence<br>[:EVENT]?<br>:ENABLE <NRf><br>:ENABLE?<br>:PTRansition <NRf><br>:PTRansition?<br>:NTRansition <NRf><br>:NTRansition?<br>:CONDition?<br>:TRIGger<br>[:EVENT]?<br>:ENABLE <NRf><br>:ENABLE?<br>:PTRansition <NRf><br>:PTRansition?<br>:NTRansition <NRf><br>:NTRansition?<br>:CONDition?<br>:QUESTionable<br>[:EVENT]?<br>:ENABLE <NRf><br>:ENABLE?<br>:PTRansition <NRf><br>:PTRansition?<br>:NTRansition <NRf><br>:NTRansition?<br>:CONDition?<br>:PRESet<br>:QUEue<br>[:NEXT]?<br>:ENABLE <list><br>:ENABLE?<br>:DISable <list><br>:DISable? | Program the positive transition register.<br>Query positive transition register.<br>Program the negative transition register.<br>Query negative transition register.<br>Query condition register.<br>Path to control the sequence event registers:<br>Query event register.<br>Program the enable register.<br>Query enable register.<br>Program the positive transition register.<br>Query positive transition register.<br>Program the negative transition register.<br>Query negative transition register.<br>Query condition register.<br>Path to control trigger event registers:<br>Query event register.<br>Program the enable register.<br>Query enable register.<br>Program the positive transition register.<br>Query positive transition register.<br>Program the negative transition register.<br>Query negative transition register.<br>Query condition register.<br>Path to control questionable event registers:<br>Query the event register.<br>Program the enable register.<br>Query the enable register.<br>Program the positive transition register.<br>Query the positive transition register.<br>Program the negative transition register.<br>Query the negative transition register.<br>Query the condition register.<br>Return status registers to default states.<br>Path to access error queue:<br>Query most recent error message.<br>Specify error and status messages for queue.<br>Query enabled messages.<br>Specify messages not to be placed in queue.<br>Query disabled messages. |
| :SYSTem<br>:PRESet<br>:VERSion?<br>:ERRor?                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Return to :SYST:PRES defaults.<br>Query revision level of SCPI standard.<br>Query Error Queue.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

Table E-1 (cont.)

**Syntax of SCPI confirmed commands implemented by System 41**

| Command                                                                                                                                                                         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| :INITiate<br>[:IMMediate]<br>:CONTinuous <b><br>:CONTinuous?                                                                                                                    | Subsystem command path:<br>Initiate one trigger cycle.<br>Enable (1 or ON) or disable (0 or OFF) continuous initiation of trigger system.<br>Query continuous initiation.                                                                                                                                                                                                                                                                                                                                            |
| :ABORt                                                                                                                                                                          | Reset trigger system.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| :ARM[:SEQuence[1]]<br>[:LAYer[1]]<br>:IMMediate<br>:COUNT <n><br>:COUNT?<br>:SOURce <name><br>:SOURce?<br>:SIGNal                                                               | Subsystem command path to configure arm layers:<br>Path to program arm layer 1:<br>Immediately go to Layer2.<br>Program arm count (1 to 9999, or INF).<br>Query arm count.<br>Select control source: HOLD, IMMediate, MANual, BUS, EXTernal.<br>Query control source.<br>Loop around control source.                                                                                                                                                                                                                 |
| :LAYer2<br>:IMMediate<br>:COUNT <n><br>:COUNT?<br>:DELAy <n><br>:DELAy?<br>:SOURce <name><br>:SOURce?<br>:TIMer <n><br>:TIMer?<br>:SIGNal                                       | Path to program arm layer 2:<br>Immediately go to Trigger Layer.<br>Program scan count (1 to 9999 or INF).<br>Query scan count.<br>Program delay (0 to 99999.999 sec).<br>Query delay.<br>Select control source: HOLD, IMMediate, TIMer, MANual, BUS, EXTernal.<br>Query control source.<br>Set timer interval (0 to 99999.999 sec).<br>Query timer.<br>Loop around control source.                                                                                                                                  |
| :TRIGger[:SEQuence[1]]<br>:IMMediate<br>:COUNT <n><br>:AUTO <b><br>:AUTO?<br>:COUNT?<br>:DELAy <n><br>:DELAy?<br>:SOURce <name><br>:SOURce?<br>:TIMer <n><br>:TIMer?<br>:SIGNal | Path to program trigger layer:<br>Immediately perform a scan step.<br>Program measure count (1 to 9999, or INF).<br>Enable (1 or ON) or disable (0 or OFF) auto-count (scan-list-length).<br>Query auto-count.<br>Query measure count.<br>Program delay (0 to 99999.999 sec).<br>Query delay.<br>Select control source: HOLD, IMMediate, TIMer, MANual, BUS, EXTernal.<br>Query control source.<br>Set timer interval (0 to 99999.999 sec).<br>Request the programmed timer interval.<br>Loop around control source. |



Table E-2

**Syntax of non-SCPI commands implemented by System 41**

| Command                                                                                                                                                                                                                                                                                                                                                                              | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| :DISPlay<br>:SMESsage <b><br>:SMESsage?<br>:WINDow3<br>:GRATicule <b>                                                                                                                                                                                                                                                                                                                | Enable (1 or ON) or disable (0 or OFF) status message mode.<br>Query status message mode (0 or 1).<br>Path to control LED Graticule:<br>Enable (1 or ON) or disable (0 or OFF) LED Graticule.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| :OUTPut<br>:TTL[1]<br>:LSENse <name><br>:LSENse?<br>:TTL2<br>:LSENse <name><br>:LSENse?<br>:TTL3<br>:LSENse <name><br>:LSENse?<br>:TTL4<br>:LSENse <name><br>:LSENse?                                                                                                                                                                                                                | Path to set polarity of digital output line 1:<br>Select polarity; active high (AHIGH) or active low (ALOW).<br>Query polarity of line 1.<br>Path to set polarity of digital output line 2:<br>Select polarity; active high (AHIGH) or active low (ALOW).<br>Query polarity of line 2.<br>Path to set polarity of digital output line 3:<br>Select polarity; active high (AHIGH) or active low (ALOW).<br>Query polarity of line 3.<br>Path to set polarity of digital output line 4:<br>Select polarity; active high (AHIGH) or active low (ALOW).<br>Query polarity of line 4.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| :SCAN?<br>:FCHannels <list><br>:FCHannels?<br>:INTerlockX<br>:LIST[1]<br>:LIST[1]?<br>:LIST2<br>:LIST2?<br>:CONFigure<br>:BBMake <b><br>:BBMake?<br>:SCHannel <b><br>:SCHannel?<br>:CPAirX <b><br>:CPAirX?<br>:SLOTX<br>:CTYPe <name><br>:CTYPe?<br>:POLE <NRf><br>:POLE?<br>:STIME <n><br>:STIME?<br>:MEMory<br>:SAVE<br>[:RELays] M<num><br>:LIST <list>, M<num><br>:RECall M<num> | Query scan list.<br>Specify channels that cannot be closed.<br>Query channels that cannot be closed.<br>Specify interlock (X = [1] to 5).<br>Define List 1 for specified interlock.<br>Query List 1 for specified interlock.<br>Define List 2 for specified interlock.<br>Query List 2 for specified interlock.<br>Configuration command path:<br>Enable (1 or ON) or Disable (0 or OFF) Break-Before-Make switching.<br>Query Break-Before-Make.<br>Enable (1 or ON) or Disable (0 or OFF) Single Channel.<br>Query Single Channel.<br>Enable (1 or ON) or Disable (0 or OFF) Card Pair X (X = [1] to 5).<br>Query Card Pair X (X = [1] to 5).<br>Path to configure SLOT X (X = [1] to 10):<br>Assign card ID number for specified slot.<br>Query card ID number for specified slot.<br>Select pole mode (1, 2 or 4) for specified slot.<br>Query pole mode for specified slot.<br>Specify delay (0 to 99999.999 sec) for specified slot.<br>Query delay for specified slot.<br>Path to program memory:<br>Path to save channel patterns:<br>Save current channel pattern at specified memory location (1 to 500).<br>Save defined channel pattern at specified memory location (1 to 500).<br>Recall channel pattern from memory (1 to 500). |

Table E-2 (cont.)

**Syntax of non-SCPI commands implemented by System 41**

| Command                                                                                                                                                                                                                                                                                                                                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| :SENSe[1]<br>:TTL1<br>:DATA?                                                                                                                                                                                                                                                                                                           | Command path to read internal input line.<br>Read internal digital input line.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| :SENSeX<br>:DATA?                                                                                                                                                                                                                                                                                                                      | Specify slot; X=2 (slot 1) through 11 (slot 10).<br>Read digital input for the specified slot.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| :SOURce<br>:TTL[1]<br>[:LEVel] <b><br>[:LEVel]?<br>:TTL2<br>[:LEVel] <b><br>[:LEVel]?<br>:TTL3<br>[:LEVel] <b><br>[:LEVel]?<br>:TTL4<br>[:LEVel] <b><br>[:LEVel]?                                                                                                                                                                      | Digital output line #1.<br>Set line true (1 or ON) or false (0 or OFF).<br>Query state of digital output line.<br>Digital output line #2.<br>Set line true (1 or ON) or false (0 or OFF).<br>Query state of digital output line.<br>Digital output line #3.<br>Set line true (1 or ON) or false (0 or OFF).<br>Query state of digital output line.<br>Digital output line #4.<br>Set line true (1 or ON) or false (0 or OFF).<br>Query state of digital output line.                                                                                                                                                                                                                                                                                  |
| :SYSTem<br>:POSetup <name><br>:POSetup?                                                                                                                                                                                                                                                                                                | Select power-on setup: RST, PRESet, SAV0-SAV9.<br>Query power-on setup.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| :ARM[:SEQuence[1]]<br>[:LAYer[1]]<br>:SOURce TLINK<br>:TCOnfigure<br>:DIRection <name><br>:DIRection?<br>:ASYNchronous<br>:ILINe <NRf><br>:ILINe?<br>:OLINe <NRf><br>:OLINe?<br>:SOURce TLINK<br><br>:LAYer2<br>:TCOnfigure<br>:DIRection <name><br>:DIRection?<br>:ASYNchronous<br>:ILINe <NRf><br>:ILINe?<br>:OLINe <NRf><br>:OLINe? | Subsystem command path to configure arm layers:<br>Path to program arm layer 1:<br>Select control source.<br>Path to configure Triggers:<br>Enable (SOURce) or disable (ACcepter) Bypass:<br>Query direction.<br>Path to configure asynchronous Trigger Link:<br>Select input line (1 to 6).<br>Query input line.<br>Select output line (1 to 6).<br>Query output line.<br>Select control source: HOLD, IMMEDIATE, TIMER, MANUAL, BUS, TLINK, EXTERNAL.<br>Path to program arm layer 2:<br>Path to configure Triggers:<br>Enable (SOURce) or disable (ACcepter) Bypass.<br>Query direction.<br>Path to configure asynchronous Trigger Link:<br>Select input line (1 to 6).<br>Query input line.<br>Select output line (1 to 6).<br>Query output line. |

Table E-2 (cont.)

**Syntax of non-SCPI commands implemented by System 41**

| Command                                 | Description                                                                                                    |
|-----------------------------------------|----------------------------------------------------------------------------------------------------------------|
| :TRIGger[:SEquence[1]]<br>:SOURce TLINK | Path to program trigger layer:<br>Select control source: HOLD, IMMEDIATE, TIMER, MANUAL, BUS, TLINK, EXTERNAL. |
| :TCONfigure                             | Path to configure Triggers:                                                                                    |
| :PROTocol <name>                        | Select protocol: ASYNchronous, SSYNchronous.                                                                   |
| :PROTocol?                              | Query protocol.                                                                                                |
| :DIRection <name>                       | Enable (SOURce) or disable (ACceptor) Bypass.                                                                  |
| :DIRection?                             | Query direction.                                                                                               |
| :ASYNchronous                           | Path to configure asynchronous Trigger Link:                                                                   |
| :ILINE <NRf>                            | Select input line (1 to 6).                                                                                    |
| :ILINE?                                 | Query input line.                                                                                              |
| :OLINE <NRf>                            | Select output line (1 to 6).                                                                                   |
| :OLINE?                                 | Query output line.                                                                                             |
| :SSYNchronous                           | Path to configure semi-synchronous Trigger Link:                                                               |
| :LINE <NRf>                             | Select trigger line (1 to 6).                                                                                  |
| :LINE?                                  | Query trigger line.                                                                                            |



---

# **F** IEEE-488.2 Common Commands

| Mnemonic   | Name                           | Description                                                                                                          |
|------------|--------------------------------|----------------------------------------------------------------------------------------------------------------------|
| *CLS       | Clear status                   | Clears all event registers, and Error Queue.                                                                         |
| *ESE <NRf> | Event status enable command    | Sets the contents of the Standard Event Status Enable Register.                                                      |
| *ESE?      | Event status enable query      | Request the programmed value of the Standard Event Status Enable Register.                                           |
| *ESR?      | Event status register query    | Request the programmed value of the Standard Event Status Register and clears it.                                    |
| *IDN?      | Identification query           | Request the manufacturer, model number, serial number, and firmware revision levels of the unit.                     |
| *OPC       | Operation complete command     | Sets the Operation Complete bit in the Standard Event Status Register after all pending commands have been executed. |
| *OPC?      | Operation complete query       | Places an ASCII "1" into the output queue when all pending selected device operations have been completed.           |
| *OPT?      | Option identification query    | Request the assigned model number for all slots.                                                                     |
| *RCL <NRf> | Recall command                 | Returns the System 41 to the setup configuration stored in the designated memory location.                           |
| *RST       | Reset command                  | Returns the System 41 to the *RST default conditions.                                                                |
| *SAV <NRf> | Save command                   | Saves the current setup configuration to the designated memory location.                                             |
| *SRE <NRf> | Service request enable command | Sets the contents of the Service Request Enable Register.                                                            |
| *SRE?      | Service request enable query   | The System 41 returns the value of the Service Request Enable Register.                                              |
| *STB?      | Read status byte query         | Returns the value of the Status Byte Register.                                                                       |
| *TRG       | Trigger command                | This command issues a bus trigger which has the same effect as group execute trigger (GET) command.                  |
| *TST?      | Self-test query                | When this query is sent, the System 41 will perform a checksum test on ROM and return the results.                   |
| *WAI       | Wait-to-continue command       | Wait until all previous commands are executed.                                                                       |

Note: At least one space is required between the command and the parameter.

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