Operation Manual

Four Channel Shutter Driver

SR474

Stanford Research Systems

Revision 1.0 • February 9, 2009

Certification

Stanford Research Systems certifies that this product met its published specifications at the time of shipment.

Warranty

This Stanford Research Systems product is warranted against defects in materials and workmanship for a period of one (1) year from the date of shipment.

Service

For warranty service or repair, this product must be returned to a Stanford Research Systems authorized service facility. Contact Stanford Research Systems or an authorized representative before returning this product for repair.

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Contents

General Information

The SR474 Four Channel Shutter Driver is a flexible instrument capable of driving and providing I/O interfaces for up to four external SR470 Series Laser Shutter heads.

The shutter heads can be controlled through rear-panel TTL level inputs that accept external timing signals. Alternately, each of the four channels can be individually controlled manually through front panel buttons or through a remote interface.

The Global Control section of the front-panel allows you to set all channels to their "normal" or "$\overline{Normal}$" states. Remote operation is supported with GPIB, RS-232 and Ethernet computer interfaces. All instrument functions can be controlled and read over any of the interfaces. Shutter faults are automatically detected and result in audible, visible and electronic alarms.

Safety and Preparation for Use

WARNING **Dangerous voltages, capable of causing injury or death, are present in this instrument. Use caution whenever the instrument covers are removed. Do not remove the covers while the unit is plugged into a live outlet.**

CAUTION Never connect any of the shutter output ports to anything besides an SR470 Series Laser Shutter head.

Line Voltage

The universal input power supply of the SR474 accommodates any voltage in the range 90 VAC to 260 VAC, with a frequency in the range 47 Hz to 63 Hz.

Line Cord

The SR474 has a detachable, three-wire power cord for connection to the power source and to a protective ground. The exposed metal parts of the instrument are connected to the outlet ground to protect against electrical shock. Always use an outlet which has a properly connected protective ground.

The shields of the six rear-panel BNC ports, the rear-panel Chassis Ground binding post, and the metal chassis of the instrument are all connected to Earth through the power-line-outlet ground.

Line Fuse

There are two line fuses internal to the SR474 that may not be serviced by the user.

If no front panel LEDs are lit when line power is applied and the power switch is in the "on" position, contact Stanford Research Systems.

Service

Do not attempt to service or adjust this instrument unless another person, capable of providing first aid or resuscitation, is present.

Do not install substitute parts or perform any unauthorized modifications to this instrument. Contact the factory for instructions on how to return the instrument for authorized service and adjustment.

Environment

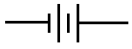
This product is intended for use only in a clean and dry laboratory environment. Operation in other environments may cause damage to the product. To reduce the risk of fire or electrocution do not expose this product to rain or excessive moisture. Be careful not to spill liquid of any kind onto or into the product.

Laser Safety

⚠ WARNING

Certain hazards are always present when working with laser radiation. Visible and invisible beams of light have the potential to cause serious bodily injury including blindness or death and to cause significant damage to property. While the SR474 is designed for use with laser systems, **it is fully the users responsibility to ensure that safe operating conditions are maintained and to provide for fail-safe operation whenever an equipment failure could lead to a hazardous situation**.

Symbols you may Find on SRS Products

Symbol	Description
	Alternating current
	Caution - risk of electric shock
	Frame or chassis terminal
	Caution - refer to accompanying documents
	Earth (ground) terminal
	Battery
	Fuse
	On (supply)
	Off (supply)

Notation

The following notation will be used throughout this manual.

WARNING A warning means that injury or death is possible if the instructions are not obeyed.

CAUTION A caution means that damage to the instrument or other equipment is possible.

Typesetting conventions used in this manual are:

- Front-panel buttons are set as Button.
- Front-panel indicators are set as *Remote*.
- Remote command names are set as *IDN?.
- Literal text other than command names is set as `OFF`.

Remote command examples will all be set in monospaced font. In these examples, data sent by the host computer to the SR474 are set as `straight teletype font`, while responses received by the host computer from the SR474 are set as *`slanted teletype font`*.

Specifications

Operation

Shutter Type	SR470 Series Laser Shutters.
Shutter Outputs	Four independent channels.
Shutter State	Shutter states can be individually controlled, either manually from front-panel inputs or from external TTL level inputs.
Shutter Polarity	Each channel can be individually set for "normally open" or "normally closed" operation using rear-panel DIP switches.
Channel Enable	Front-panel Enable buttons individually enable or disable each channel.
Global Control	Front-panel global Reset and Set buttons command all shutter channels under manual control to their *Normal* or $\overline{Normal}$ states.
Alignment Mode	Front-panel Align buttons for each channel (active when in manual mode) open and close shutters at 1 Hz chopping rate to assist with mechanical alignment.
Gate/Inhibit	The rear panel AUX I/O port can be configured to allow or disallow TTL control of one or all shutter channels depending on the value of an input TTL level.
Fault Detection and Reporting	Automatic detection of shutter disconnect or fault, with indicator LEDs for each channel. Rear panel TTL $\overline{Alarm}$ output plus audible alarm, which can be muted from the front panel.
Display Blanking	Front panel LEDs can be disabled by holding the front-panel Local button for 2 s.
Remote Operation	Shutter polarity and some communications parameters are controlled by rear-panel DIP switches. All other instrument functions are controllable over GPIB, RS-232, and Ethernet interfaces.

Electrical and Mechanical

Shutter Outputs	Voltages	+12 VDC, +4.5 VDC
	Current limits per channel	1.20 A max (12 VDC)
		0.25 A max (4.5 VDC)
	Signal lines	Serial TX, Serial RX, logic-level control
	Connector type	Mechanically compatible with 6-pin IEEE 1394 cables.
	Cable length	10 ft (3 m) max
	Cable shield	Grounded or floating (internal jumpers)
I/O ports	Level inputs	4 TTL compatible rear panel input BNC connectors, internally pulled up to +3.3 VDC through 100 kΩ.
	Auxiliary I/O	1 rear-panel BNC connector; TTL level, multi-purpose.
	Alarm output	1 rear-panel TTL output BNC connector
Interfaces	Shutter outputs	4 rear-panel shutter connectors
	Host interface	RS-232; DB–9 (female) DCE
		GPIB
		Ethernet; 10/100Base-T
Operating	Temperature	0 °C to 40 °C, non-condensing
	Power	90 VAC to 260 VAC, 47 Hz to 63 Hz
		85 W max
Physical	Weight	7 lbs
	Dimensions	8.25″ W × 4″ H × 11″ D

1 Getting Started

This chapter gives you the necessary information to get started quickly with the SR474 Four Channel Shutter Driver.

In This Chapter

1.1 Introduction to the Instrument

The SR474 Four Channel Shutter Driver is ideally suited for applications requiring one or several laser shutters in situations where external timing or control signals are available.

1.1.1 Overview

The basic function of the SR474 Four Channel Shutter Driver is to provide power, manual control, and I/O interfaces to between one and four SR470 Series Laser Shutters. The shutters connect to outputs on the rear panel of the instrument, and can be controlled by rear-panel TTL level inputs or manually from either the front panel or remote interfaces.

1.1.2 Power-on State

The SR474 stores its operation state in non-volatile memory, including the configurations of the four shutter channels and the remote interfaces.

At power-on, the SR474 will return to its previous configuration after a brief system check and initialization.

1.2 Front-Panel Operation

The front panel of the SR474 (Figure 1.1) provides simple controls for the operator and displays the shutter states at a glance. The panel is divided into five sections: four identical sections that each correspond to a single shutter channel, and a Global Control section.

1.2.1 Individual channel controls

The four shutter channels can be individually controlled and monitored through the front panel sections labeled "**Channel 1**" through "**Channel 4**." The interface for each channel is identical.

The top half of the channel interface has two keys, State and Enable along with status indicators for four possible states that are possible for each shutter channel: *OPEN*, *CLOSED*, *OFF*, and *FAULT*. These states are mutually exclusive and in most cases exactly one of the four indicators is lit.

The bottom half of the channel interface has the key Source and associated indicators for selecting and monitoring the mode of channel control. The Align key provides automatic opening and closing to assist with mechanical alignment of your shutter head.

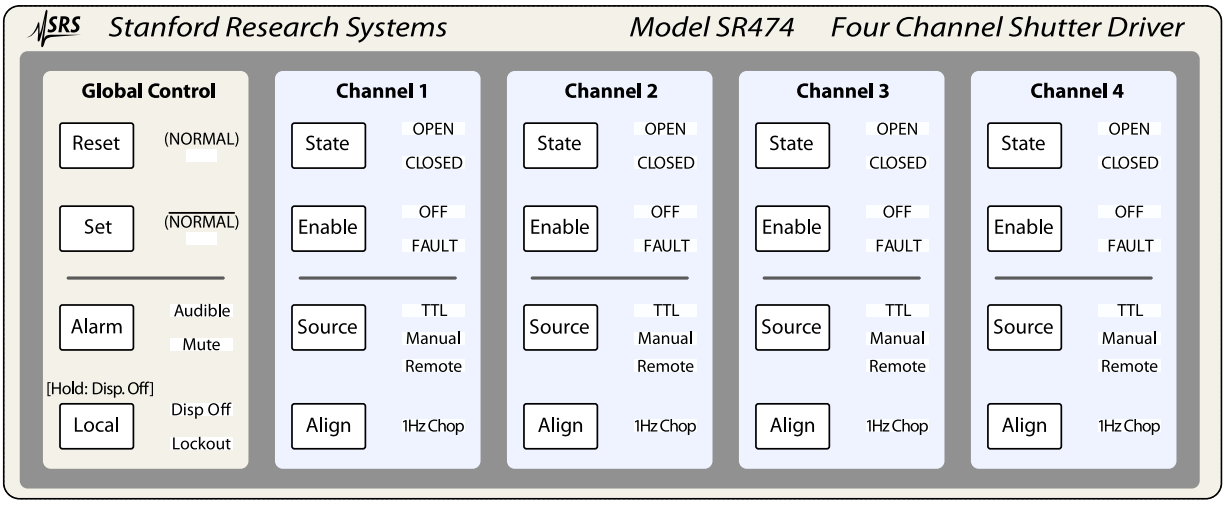


Figure 1.1: The SR474 front panel.

1.2.1.1 State key

The State key for each channel toggles the state of that channel's shutter head between open and closed when the channel is enabled and in manual control mode.

When a channel is switched away from manual control, the "manual state" of the channel is remembered for when it is eventually switched back to manual control.

1.2.1.2 Enable key

The Enable key for channel *n* turns on or off the the shutter head connected to the channel *n* output.

If a given channel is initially in the *OFF* state, then pressing Enable will cause the SR474 to attempt to enable the shutter head connected to that channel. If the head powers on successfully, the channel will display its state with either the *OPEN* or *CLOSED* indicator.

If Enable is pressed when there is not a shutter head present on that channel, or if there is head but it reports a fault, the channel will not be enabled, but will instead light up the *FAULT* indicator. This also turns on the audible alarm, if not muted, and causes the rear-panel alarm output to be asserted. In the event of a fault in the channel, pressing Enable will clear the *FAULT* indicator and to return the channel to the *OFF* state.

Note: The shutter "logic" power supply (at +4.5 VDC) is always provided to each connected shutter when the SR474 is powered on, whether or not the channel is enabled. This is a separate power supply from the +12 VDC line that provides power to the motor (coil) in an attached shutter head.

When a channel of the SR474 is in the *OFF* state, a shutter head connected to that channel is said to be in *Standby* mode. In this mode, the logic power supply provides power for serial communications, but the +12 VDC power supply is not available to change the position of the shutter blade. The shutter blade position is therefore indeterminate.

1.2.1.3 Source key

The Source key for channel *n* selects the mode of control for a shutter head connected to the channel *n* output.

Two of the indicators by the key, *TTL* and *Manual*, are mutually exclusive and indicate which of the two possible control modes is selected for the shutter. Pressing the Source key will toggle between these two modes.

In the *Manual* source mode, the state of the shutter is controlled to be open or closed by direct user input, as selected by the State key and its indicators (§1.2.1.1).

In the *TTL* source mode, the state of the shutter is controlled by the level of the rear-panel TTL input for that channel. When the rear-panel TTL input is high (unasserted), the shutter is commanded to be in the *Normal* state. When the TTL input is low (asserted), the shutter is commanded to be in the $\overline{Normal}$ state.

The polarity of each shutter channel is either *normally open* or *normally closed* as determined by the configuration of the rear-panel DIP switches (§1.3.7).

The third indicator near the Source key is the *Remote* indicator. This indicates when the instrument is addressed over a remote interface. The channel is then in the *Remote* mode. Local control of the channel can be re-established by pressing the Source key. The mode can also be cleared for all channels at once by pressing the Local key in the lower left hand coner of the front panel. See also §1.2.3 for more about remote and lockout modes.

1.2.1.4 Align key

The Align key for each channel enables an alignment mode, where the shutter is commanded to chop (open and close) at a rate of ap-

proximately 1 Hz. This mode is intended to help facilitate mechanical alignment and identification of the shutter heads. This function is only available when connected shutter head is enabled and in the *Manual* control mode.

1.2.2 Global controls

The four keys in the Global Control section of the front panel provide functions that address all four channels or the instrument as a whole.

1.2.2.1 Global manual control: Set and Reset

The top half of the Global Control section has two keys, Reset and Set. These keys affect all channels that are currently enabled and in the *Manual* source mode, and are only operational when the instrument is under local control. Pressing Set commands each affected shutter channel to its $\overline{Normal}$ state, and pressing Reset returns each affected shutter channel to its *Normal* state.

If a shutter channel is not in *Manual* mode when Reset or Set is pressed, the saved "manual state" will be updated for when the channel is eventually returned to manual control.

Holding down either Reset or Set for approximately two seconds will *force* global Set/Reset, meaning that all four channels will be placed in the *Manual* source mode and all enabled channels will be commanded to their respective *Normal* / $\overline{Normal}$ states.

Each shutter channel on the SR474 can independently be configured to be normally open or normally closed by setting rear-panel DIP switches (§1.3.7).

1.2.2.2 Alarm key

The Alarm key toggles the configuration of the SR474 audio alarm between the states of *Audible* and *Mute*.

The rear-panel $\overline{Alarm}$ output (§1.3.6) is asserted (pulled low) whenever at least one of the four shutter channel *FAULT* indicators is lit. In the event that an alarm is asserted, the SR474 will continuously emit a loud siren-like noise to attract attention if the *Audible* mode is selected. No alarm noise will be made while the *Mute* mode is selected.

An active audio alarm can be silenced by pressing the Alarm key, switching the unit to the *Mute* state. An alarm can also be silenced by clearing the fault that is causing the alarm– for example, by pressing

the Enable key to turn off a channel that has its *FAULT* indicator lit.

The alarm functions are intended to help draw attention to fault conditions that might otherwise be difficult to detect. For example, if an enabled shutter head is disconnected, that shutter's channel will be placed into the fault condition. The expected configuration of the SR474 is also saved, such that if a shutter head is accidentally disconnected during a power outage, a fault will be declared in that channel when power is restored, and cannot be cleared by merely cycling the power. Operator action is required to clear a fault condition.

1.2.2.3 Utility Functions: Local, Display Off

The bottom button in the Global Control section is the Local key. Pressing this key restores the instrument to local control after it has been accessed over one of the remote interfaces. See also §1.2.3 for more about local and remote modes.

The Local key has an alternate function, which is to turn off most of the front-panel LED indicators when the key is held down for 2 s. When this is done, all front panel LEDs will go dark except for the *Disp Off* indicator by the Local key. To turn the display back on, hold the key for 2 s again. Turning off the display may be helpful because it prevents the *OPEN* and *CLOSED* indicators from blinking synchronously with shutter operation; a potential nuisance in certain laboratory environments.

1.2.3 Remote lockout and front-panel operation

When a host computer accesses the SR474 over one of the remote interfaces, it normally places the unit in the *Remote* state, where most manual input is not allowed. This is indicated by the *Lockout* indicator, which is located by the Local key at lower left corner of the front panel.

To return to front panel operation from *Remote* mode, press the Local key. It is also possible to individually return any of the four shutter channels to local control by pressing its Source key. This selection takes the relevant channel out of remote mode.

The SR474 can also be placed into *complete lockout* mode by using the LOCK? query over a remote interface. In this mode the *Lockout* indicator is lit, but the instrument will not respond to any front panel input, including the Local key. This mode can only be disabled using the UNLK? query over a remote interface or by cycling the power to the instrument, as described in §2.6.4.

1.2.4 Restoring factory default configuration

The SR474 can be reset to its factory-default settings by power cycling the unit with the Reset key depressed. This is equivalent to sending the *RST command over one of the remote interfaces. It performs the following actions:

1. Turn off all shutter channels
2. Place all shutters in manual control
3. Set all shutters to the unasserted (*Normal*) state
4. Turn off chopping (alignment mode) on all channels
5. Select *Audible* alarm mode
6. Turn the display on
7. Select manual configuration for the rear Aux I/O port

Recalling factory default settings this way does not affect the interface configuration. Most of the interface configuration is determined by the rear panel DIP switches. However, an internal ip address can be configured via the remote interfaces. These values may be reset to factory defaults by power cycling the unit with the Local key depressed. In this case the internal IP addresses are set to 0.0.0.0, and compatibility mode is disabled.

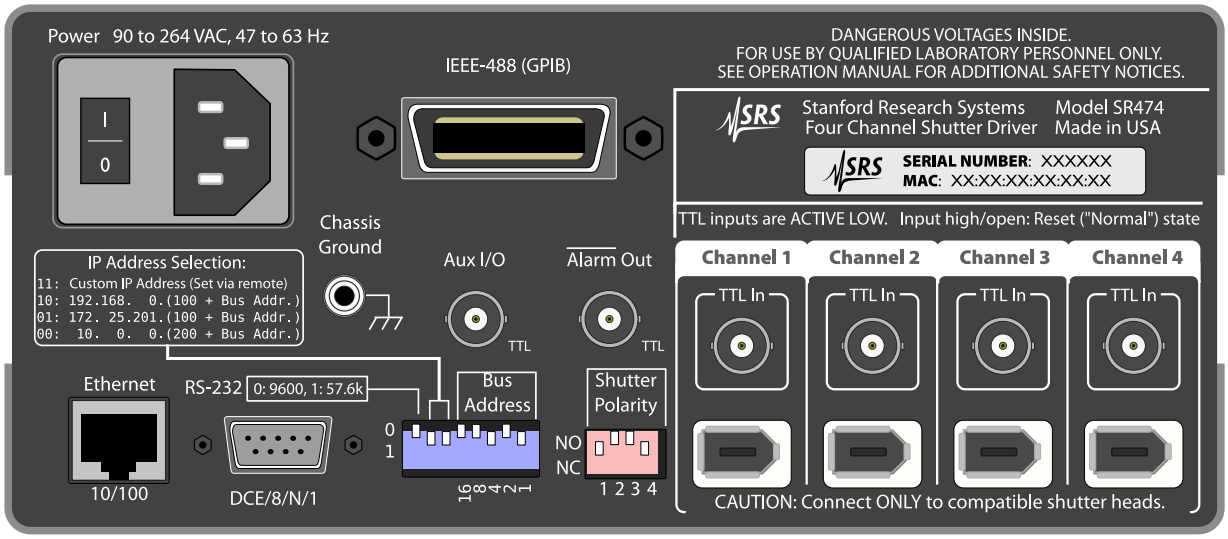


Figure 1.2: The SR474 rear panel.

1.3 The SR474 Rear Panel

The rear panel of the SR474 (see Figure 1.2) provides input and output connectors for controlling the four shutters, an alarm output,

an auxiliary I/O port, a chassis-grounded binding post, three remote interfaces, configuration DIP switches, and the power entry module.

The SR474 serial number and ethernet MAC address are printed on a label located on the back side.

1.3.1 Power entry

The power entry module is located on the upper left side of the rear panel and contains an integrated power switch.

The universal input power supply of the SR474 accommodates any voltage in the range 90 VAC to 260 VAC, with a frequency in the range 47 Hz to 63 Hz.

The SR474 has a detachable, three-wire power cord for connection to the power source and to a protective ground. The exposed metal parts of the instrument are connected to the outlet ground to protect against electrical shock. Always use an outlet which has a properly connected protective ground.

1.3.2 Chassis ground

This binding post is connected to the SR474 chassis and to earth ground.

1.3.3 TTL Inputs

The primary control inputs for the SR474 Four Channel Shutter Driver are the four rear-panel BNC inputs corresponding to the four shutter channels.

Each channel's input, labeled "TTL In," accepts an externally generated logic-level input signal that controls the state of a shutter connected to that channel, when the channel is both enabled and set to the *TTL* source mode. The inputs are internally pulled up to +3.3 VDC through 100 kΩ and are compatible with +5 VDC (TTL) input signals.

The inputs are *active low*. A signal that is unasserted, i.e., logically high or open (disconnected), commands the associated shutter to its *Normal* state. An input signal that is asserted, i.e., pulled low, commands an affected shutter to its $\overline{normal}$ state.

Note: The shield of each input BNC is connected to earth ground.

1.3.4 Shutter connectors

The SR474 has four output connectors, each of which provides power and interface connections for an external SR470 Series Laser Shut-

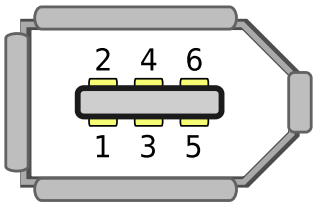


Figure 1.3: Shutter connector pinout, as seen looking into one of the connectors on the rear panel.

Connector Pin	Description
1	+12 V to shutter head (Coil power supply)
2	Ground
3	TX (Serial to shutter head)
4	RX (Serial from shutter head)
5	+4.5 V to shutter head (Logic power supply)
6	Control signal to shutter head (logic level)

Table 1.1: Shutter connector pinouts

ter head.

⚠ CAUTION

Never connect any of the shutter output ports to anything other than an SR470 Series Laser Shutter head.

The pinout for the connector is shown in Fig. 1.3 and the signal names are shown in Table 1.1.

The shield of each shutter connector is connected to earth ground as it ships from the factory. Please see §1.3.9 about grounding considerations for more information.

1.3.5 Aux I/O port

The rear-panel Auxiliary I/O BNC connector (labeled "Aux I/O") is a multifunction port that can be configured over any remote interface. It can be used for manual TTL-level input or output, as a gate/inhibit input for one or all shutters, or an output to provide a sync signal that follows the state of one or all shutter channels. The factory default setting is configured for manual control, with high output.

The Aux I/O port is internally pulled up to +5 VDC through a 10 kΩ resistor.

1.3.6 Alarm output

The $\overline{Alarm}$ *Out* rear-panel BNC connector is a TTL output that is normally held high at +5 VDC. This signal is asserted (driven low) whenever one or more of the four shutter channel *FAULT* indicators is lit.

The $\overline{Alarm}$ output port is always active. The polarity of the signal is such that the SR474 will no longer hold the $\overline{Alarm}$ signal at +5 VDC in the event that it loses line power.

1.3.7 Shutter polarity switches

The polarity of each shutter channel is either *normally open* or *normally closed* as determined by the configuration of the rear-panel switches.

The four Shutter Polarity DIP switches are slightly recessed into the chassis to prevent accidental changes. A switch in the "up" position– labeled "NO" – sets the corresponding channel to be *normally open*, and the "down" position – labeled "NC" – sets the corresponding channel to be *normally closed*.

Any changes made to the polarity switches will take effect after a brief delay.

1.3.8 Remote interfaces

Remote operation of the SR474 is supported with GPIB, RS-232 and Ethernet computer interfaces. These interfaces are primarily configured by the rear-panel DIP switches.

For additional information about the remote interface configuration, please see §2.4.

1.3.8.1 IEEE-488 GPIB

The SR474 comes with an IEEE-488 port for communicating over GPIB. The port is located on the rear panel of the SR474. The GPIB address is configured with the rightmost five positions of the larger DIP switch block; these position are labled "Bus Address."

The DIP switches encode the GPIB bus address as a binary number in the range 0 to 31. The labels printed around the DIP switch indicate the polarity and bit order: A switch represents a binary '0' in the "up" position or a binary '1' in the "down" position, and the least-significant bit is on the right hand side. A setting of *up-up-down-up-down*, reading left to right on the bus address switches (as shown in Figure 1.2), represents a binary 00101, correspoding to bus

address 5. As a special case, address 31 (all five bus address switches down) is reserved as a setting to disable the SR474 GPIB interface.

Any changes made will not take effect until the instrument is power cycled.

1.3.8.2 Ethernet

The SR474 comes standard with an RJ-45 network communications port located on the rear panel. The port may be used to communicate with the SR474 over a 10/100 Base-T ethernet connected network or LAN. The SR474 supports static network configuration as determined by the rear panel DIP switches. Any changes made to the interface configuration will not take effect until the interface is reset or the unit is power cycled.

Config. Switches	IP Address	Subnet Mask	Gateway
11	*Custom Address*	*Custom*	*Custom*
10	192.168.0.(100 + *Bus Address*)	255.255.255.0	0.0.0.0
01	172.201.25.(100 + *Bus Address*)	255.255.0.0	0.0.0.0
00	10.0.0.(200 + *Bus Address*)	255.0.0.0	0.0.0.0

Table 1.2: IP Address configuration

The IP Address configuration is primarily selected by switches 2 and 3 of the larger DIP switch; these position are labeled "IP Address Selection." As with the GPIB address selection, a switch either represents a binary '0' in the up position, or a binary '1' in the down position. There are four possible ways to arrange these two switches: 00, 01, 10, and 11. The corresponding configurations are shown in Table 1.2.

These switches give a number of possible static IP addresses that may be useful for your SR474 depending on your network environment. As an example, with the two switches set to 00 (both up) and the (GPIB) Bus Address set to 15, the IP address will be configured as 10.0.0.215, the subnet mask will be 255.0.0.0, and the default gateway will be 0.0.0.0. Using a remote interface, it is also possible to assign custom values for these three parameters. Set the configuration switches to 11 to use your custom value.

1.3.8.3 RS-232

The SR474 comes standard with an RS-232 communications port located on the rear panel of the SR474. The RS-232 interface connector

is a standard 9 pin, type D, female connector configured as a DCE (transmit on pin 3, receive on pin 2). The factory default communication parameters are set to: 8 Data bits, 1 Stop bit, No Parity, No Hardware Flow Control. All of these parameters are fixed. The baud rate may be set to either 9600 to 57600 via the leftmost switch on the large DIP switch block. Any changes made to the interface configuration will not take effect until the unit is power cycled.

1.3.9 Shutter grounding considerations

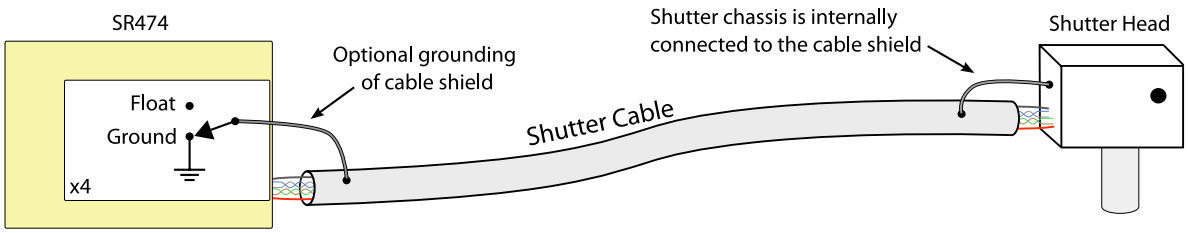


Figure 1.4: Grounding the shield of the shutter cable.

For reliable operation of a shutter head connected to the SR474 it is essential that the shield of the cable to the shutter is properly grounded.

The grounding scheme for the shutter cable is shown in Fig. 1.4. The cable connects a rear-panel output to an external shutter head. Inside the shutter head, there is an electrical connection between its chassis (case) and the shield of the cable. If the chassis of the shutter head is electrically connected to earth ground, for example by way of attachment to a grounded optical table, then the shield will be grounded as well. The SR474 can internally connect the cable shield to ground or leave it floating, as selected by an internal jumper for each channel. The factory default setting is to ground the shield for each of the four shutter channels.

If a shutter head is properly grounded and thereby providing a suitable ground to the cable shield, it may be desirable to remove the shield-ground connection for that channel inside the SR474.

The procedure for removing shield-ground connection for a channel inside the SR474 is as follows. First, turn off and unplug the unit. Wait one minute after removing power to reduce the risk due to residual voltages inside the instrument. To remove the top cover, first remove the two large screws each from the top halves of the left and right sides of the instrument. The cover can now be removed by carefully sliding it back towards the rear of the instrument while

tilting it up (from the rear). The ground connections for the cable shields are in the form of four three-pin headers, each of which is located by the shutter connector for its channel. The jumper locations on the circuit board are listed in Table 1.3. A two-pin jumper on the header selects whether the cable shield is in the grounded or floating configuration, as illustrated in Fig. 1.5. Replace the cover of the instrument before once again attaching it to power.

Jumper location	Shutter channel
J202	1
J206	2
J210	3
J214	4

Table 1.3: Grounding jumper locations

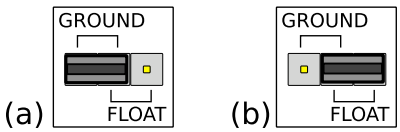


Figure 1.5: Shutter cable ground selection header. Part (a) shows the cable shield grounded at the SR474 with the jumper over the two pins marked "GROUND" and part (b) shows the cable ground floating, where the jumper sits over the two pins marked "FLOAT."

⚠ WARNING **Dangerous voltages, capable of causing injury or death, are present in this instrument. Use extreme caution whenever the instrument covers are removed. Do not remove the covers while the unit is plugged into a live outlet.**

2 Remote Operation

This chapter describes operating the SR474 over the serial interface.

In This Chapter

2.1 Index of Common Commands

symbol	definition
i,j	Integers
c	Channel number, 1-4
s	Single ASCII character
b	Hexadecimal formatted byte(s)
(*?*)	Required for queries; illegal for set commands
var	Parameter always required
{*var*}	Required parameter for set commands; illegal for queries
[*var*]	Optional parameter for both set and query forms

IEEE-488 Commands

Status Reporting Commands

Instrument Control Commands

Interface Commands

2.2 Alphabetic List of Commands

L

M

P

R

S

T

U

X

2.3 Introduction

The SR474 may be remotely programmed via the GPIB interface, the RS-232 serial interface, or the LAN ethernet interface using a simple command language documented in this chapter. Any host computer interfaced to the SR474 can easily control and monitor the operation of the SR474.

Most of the SR474 instrument settings are stored in non-volatile memory, and at power-on the instrument returns to the state it was last in when power was removed. Exceptions are noted in the command descriptions.

2.4 Interface Configuration

As detailed in §1.3.8, most of the SR474 remote interface configuration is set via rear-panel DIP switches. The GPIB and RS-232 interfaces settings completely determined by those switches. The ethernet interface can also be configured by the rear-panel DIP switches to use a user selectable "custom" IP address that is settable by remote command.

2.5 Commands

This section provides syntax and operational descriptions for remote commands.

2.5.1 Command syntax

Communications with the SR474 uses ASCII characters. All commands are 4-characters long and are case-insensitive. Standard IEEE-488.2 defined commands begin with the "*" character followed by 3 letters. SR474 specific commands are composed of 4 letters.

The four letter mnemonic (shown in CAPS) in each command sequence specifies the command. The rest of the sequence consists of parameters.

Commands may take either *set* or *query* form, depending on whether the "?" character follows the mnemonic. *Set only* commands are listed without the "?", *query only* commands show the "?" after the mnemonic, and *optionally query* commands are marked with a "(?)".

Parameters shown in { } and [ ] are not always required. Parameters in { } are required to set a value, and are omitted for queries. Parameters in [ ] are optional in both set and query commands. Parameters listed without any surrounding characters are always required.

Do NOT send ( ) or { } or [ ] as part of the command.

The command buffer is limited to 255 bytes, with 25 byte buffers allocated to each of up to 3 parameters per command. If the command buffer overflows, both the input and output buffers will be flushed and reset. If a parameter buffer overflows, a command error will be generated and the offending command discarded.

Commands are terminated by either a semicolon, a ⟨CR⟩ (ASCII 13), or a ⟨LF⟩ (ASCII 10). If the communications interface is GPIB, then the terminating character may optionally be accompanied by an EOI signal. If the EOI accompanies a character other than a ⟨LF⟩, a ⟨LF⟩ will be appended to the command to terminate it. Execution of the command does not begin until a command terminator is received. White space is ignored.

Aside from communication errors, commands may fail due to either syntax or execution errors. Syntax errors can be detected by looking at bit 5 (CME) of the event status register (*ESR?). Execution errors can be detected by looking at bit 4 (EXE) of the event status register. In both cases, an error code, indicating the specific cause of the error, is appended to the error queue. The error queue may be queried with the LERR? command. Descriptions of all error codes can be found in the section Error Codes, starting on page 2 – 22 .

2.5.1.1 Command parameters

In the following description of commands the parameter *c* identifies a channel. It must be an integer from 1 to 4. A parameter *i* denotes an integer value. Restrictions limiting the range of valid values will be noted in the command description.

2.5.1.2 Examples

Commands may be given with a simple example illustrating their usage. In these examples, all data sent by the host computer to the SR474 are set as `straight teletype font`, while responses received the host computer from the SR474 are set as *`slanted teletype font`*.

The usage examples vary with respect to set/query, optional parameters. These examples are not exhaustive, but are intended to provide a convenient starting point for user programming.

2.6 Command List

2.6.1 Common IEEE-488.2 Commands

*CLS — Clear Status

*CLS Clear Status immediately clears the ESR register as well as the LERR error buffer.

Example: `*CLS`

*ESE(?) {*i*} — Standard Event Status Enable

Set (query) the Standard Event Status Enable register {to *i*}. Bits set in this register cause ESB (in STB) to be set when the corresponding bit is set in the ESR register.

*ESR? — Standard Event Status Register

Query the Standard Event Status Register. Upon executing a *ESR? query, the returned bits of the *ESR register are cleared. The bits in the ESR register have the following meaning:

Bit	Meaning
0	OPC operation complete
1	Reserved
2	QYE query error
3	DDE device dependent error
4	EXE execution error
5	CME command error
6	Reserved
7	PON power-on

Example: `*ESR?⟨CR⟩`
176

The returned value of 176 (= $2^7 + 2^5 + 2^4$) indicates that PON, CME, and EXE are set.

*IDN? Identify

Read the device identification string; returns a string similar to the following:

Example: *IDN?⟨CR⟩
Stanford Research Systems,SR474,s/n004025,ver1.00

*OPC(?) Operation Complete

The set form sets the OPC flag in the ESR register when all prior commands have completed. The query form returns '1' when all prior commands have completed, but does not affect the ESR register.

*PSC(?) {*i*} Power-on Status Clear

Set (query) the Power-on Status Clear flag {to *i*}. The Power-on Status Clear flag is stored in nonvolatile memory in the SR474, and thus, maintains its value through power-cycle events. If the value of the flag is 0, then the Service Request Enable and Standard Event Status Enable Registers (*SRE, *ESE) are stored in non-volatile memory, and retain their values through power-cycle events. If the value of the flag is 1, then these two registers are cleared upon power-cycle.

Example: *PSC 1⟨CR⟩
Set the Power-on Status Clear to 1

Example: *PSC?⟨CR⟩
1
Returns the current value of Power-on Status Clear.

*RCL *i* Recall Instrument Settings

Recall instrument settings from location *i*. The parameter *i* may range from 0 to 9. Locations 1 to 9 are for arbitrary use. Location 0 is used for current instrument settings. It is continually updated after each key press instrument settings, and restored upon power-on. See *SAV for a list of settings that are restored.

Example: *RCL 3⟨CR⟩
Recall instruments settings from location 3.

---

*RST — Reset the Instrument

Reset the SR474 to default configuration. This is equivalent to power cycling the unit with the Reset key depressed; see also §1.2.4.

The following commands are internally executed upon *RST:

1. Turn off all shutter channels
2. Place all shutters in manual control
3. Set all shutters to the unasserted (*normal*) state
4. Turn off chopping (alignment mode) on all channels
5. Select *Audible* alarm mode
6. Turn the display on
7. Select manual configuration for the rear AUX I/O port

Example: `*RST⟨CR⟩`

---

*SAV *i* — Recall Instrument Settings

Save instrument settings to location *i*. The parameter *i* may range from 0 to 9. Locations 1 to 9 are for arbitrary use. Location 0 is used for current instrument settings. This location is overwritten after each key press, and restored upon power-on.

The following settings are saved:

1. Enable state of each shutter
2. Source for each shutter
3. Manual state of each shutter
4. Auxiliary I/O configuration
5. Alarm Mute/Audible selection
6. Display on/off state

Example: `*SAV 3⟨CR⟩`
Save current instruments settings to location 3.

---

*SRE(?) {*i*} — Service Request Enable

Set (query) the Service Request Enable register {to *i*}. Bits set in this register cause the SR474 to generate a service request when the corresponding bit is set in the STB register.

*STB? Status Byte

Query the standard IEEE 488.2 serial poll status byte. The bits in the STB register have the following meaning:

Bit	Meaning
0	FAULT1
1	FAULT2
2	FAULT3
3	FAULT4
4	MAV - message available
5	ESB-ESR summary bit
6	MSS - master summary bit
7	Reserved

Example: `*STB?⟨CR⟩`
113

A return of '113' indicates that FAULT1, MAV, ESB, and MSS are set. FAULT1 indicates that a fault was detected on channel 1. MAV indicates that a message is available in the output queue. ESB indicates that an enabled bit in ESR is set. MSS reflects the fact that at least one of the summary bits is set.

*WAI Wait for Command Execution

The instrument will not process further commands until all prior commands including this one have completed.

Example: `*WAI⟨CR⟩`
Wait for all prior commands to execute before continuing.

2.6.2 Status Reporting Commands

LERR? Last Error

Query the last error in the error buffer. Errors are returned on a first-in-first-out basis.

Upon executing a LERR? query, the returned error is removed from the error buffer. See the section Error Codes later in this chapter for a description of the possible error codes returned by LERR?. The error buffer has space to store up to 20 errors. If more than 19 errors occur without being queried, the 20th error will be 254 (Too Many Errors), indicating that errors were dropped.

FLTS? Fault Status

Query the current fault status of all four channels. Two bits of fault information are allocated to each channel as follows:

Bit	Meaning
0	Channel 1 fault status bit *a*
1	Channel 1 fault status bit *b*
2	Channel 2 fault status bit *a*
3	Channel 2 fault status bit *b*
4	Channel 3 fault status bit *a*
5	Channel 3 fault status bit *b*
6	Channel 4 fault status bit *a*
7	Channel 4 fault status bit *b*

Each channel may return the following fault responses:

Bit *b*	Bit *a*	Fault information
0	0	No fault
0	1	Disconnect fault
1	0	Fault reported by shutter
1	1	12 V power fault

If the shutter reported a fault, use the SERR command to identify the cause.

Example: FLTS?⟨CR⟩
9

A return of 9 (= $2^3 + 2^1$) gives bits (*b*,*a*)= (1, 0) for channel 2 and (*b*,*a*)= (0, 1) for channel 1. These results indicate that the shutter head on channel 2 reports a fault condition and that there is no shutter head connected to channel 1.

2.6.3 Instrument Control Commands

ASRT(?) [*c*{,}]{*i*} Assertion State

Set (query) the assertion state [*of c*] {to *i*}. If the optional parameter *c* is not given, then set (query) the assertion state of all channels.

When *c* is given, then channel *c* is asserted if *i* is equal to 1, and unasserted if *i* is equal to zero. The query form returns the number 2 if shutter state is indeterminate.

When *c* is not given, bits 0 to 3 of *i* identify the assertion state of shutters 1 to 4. If the bit is 0 the state is unasserted. If the bit is 1 the state is asserted. The query form sets bits 4 to 7 if the corresponding shutter state is indeterminate.

Example: `ASRT 10⟨CR⟩`
Assert shutters 2 and 4. Unassert shutters 1 and 3.

Example: `ASRT 3,1⟨CR⟩`
Place shutter 3 in the asserted state.

Example: `ASRT?⟨CR⟩`
`210`
A return of 210 would indicate that shutters 1, 3, and 4 are in an indeterminate state and that shutter 2 is asserted.

Example: `ASRT? 3⟨CR⟩`
`1`
A return of 1 indicates that shutter 3 is asserted.

AUXC(?) {*i*,*c*} Auxiliary I/O Configuration

Set (query) the auxiliary configuration {to *i*,*c*}. The parameter *i* controls the auxiliary I/O configuration according to the following table:

i	Configuration
0	Manual Configuration. State controlled by AUXI command.
1	Inhibit TTL. Channel *c* reverts to manual state when AUX input is asserted low.
2	Sync Output. Output is asserted low according to the assertion state of channel *c*.

As a special case, a value of *c* equal to 0 refers to all channels. Sync output with *c* equal to 0 is asserted according to the logical OR of the assertion state of channels 1-4.

Example: `AUXC 1,0⟨CR⟩`

Configure Aux I/O as input; inhibit TTL (revert to manual state) of all channels when input signal is asserted low.

Example: `AUXC?⟨CR⟩`
2,1
A return of 2,1 indicates that the Aux I/O output is asserted according to the assertion state of channel 1.

AUXI(?) {*i*}

Auxiliary I/O State

Set (query) the Aux I/O BNC port state {to *i*}. The set form sets the value applied to the BNC when it is configured for manual I/O. The query form always reads the current value of the BNC. A value of 0 indicates the BNC is logic low. A 1 indicates the BNC is logic high.

To configure the Aux I/O port for input, set `AUXI 1` to place it in the unasserted state. (The input hardware has a positive pull-up resistor.)

CHOP(?) *c*{,*i*}

Alignment Mode

Set (query) alignment mode– i.e., continuous chopping– of shutter *c* {to *i*}. If parameter *i* is 0, alignment mode is turned off. If it is 1, alignment mode is turned on. This command will fail if the given shutter is not under manual control. See §1.2.1.4 for more about alignment mode.

DISP(?) {*i*}

Display On/Off

Set (query) the display state {to *i*}. If parameter *i* is 0 the display is turned off. If it is 1 the display is turned on. See §1.2.2.3 for more about display blanking.

ENAB(?) *c*{,*i*}

Enable Shutter

Set (query) the enable state of shutter *c* {to *i*}. If parameter *i* is 0 the shutter is off. If it is 1 then shutter is on. The query form will return 2 if a fault has been detected for the given shutter. The fault is cleared when the shutter is turned off. Changing the state of a shutter from disabled to enabled takes 500 ms to complete.

See §1.2.1.2 for more about shutter head operation and standby modes.

FSET *i*

Force Global Set/Reset of All Shutters

Force all shutters to manual control and set the state according to parameter *i*. If *i* is 0, place all shutters in the unasserted state. If 1, place them in the asserted state. This action can be executed from the front panel by pressing and holding the Reset or Set keys for about 2 seconds.

GSET *i*

Global Set/Reset of All Shutters

Set the manual state of all shutters according to parameter *i*. If *i* is 0, the manual state is unasserted state. If it is 1, it is asserted. If a given shutter is under manual control, its state is updated accordingly. If it is under TTL control it will return to the given state when it is eventually switched back to manual control. This action can be executed from the front panel by pressing the Reset or Set keys.

MODE(?) *c*{,*i*}

Shutter Mode

Set (query) the alternate mode for shutter *c* {to *i*}. Valid modes range from 0 to 3 with zero being the default mode. The set form sends the byte '0', '1', '2' or '3' to the shutter. The effect of different modes is hardware dependent; please see the shutter head manual for descriptions of the available modes. The query form returns bits 12 and 13 of the shutter status byte (see SSTB).

Since the mode setting is stored in the volatile memory of the shutter head, not in the SR474 , the mode setting is lost whenever the SR474 or the individual shutter head is reset or re-enabled.

MODL? *c*

Shutter Model

Query the model number for shutter *c*. This should return something like 'SR475' if the shutter is an SR475 shutter. This command sends 'X' to the shutter and returns the response.

MUTE(?) {*i*}

Mute Alarm

Set (query) the mute status on the audible alarm. If *i* is 0 alarms are audible. If 1, alarms are muted.

POLR? *c*

Shutter Polarity

Query the polarity for shutter *c*. A value of 0 indicates the shutter is normally open. A value of 1 indicates the shutter is normally closed. Polarity can only be changed from the rear panel (§1.3.7).

RATE? *c*

Maximum Rate

Query the maximum rate at which shutter *c* can operate. A return of 100 would indicate that it can operate at 100 Hz. This command sends 'R' to the shutter and returns the response.

SCMD(?) *c,s*(,*b*)

Shutter Command

Send ascii bytes *s* followed optionally by hex bytes *b* to shutter *c*. Send back the shutter response if the query form is used.

Example: `SCMD?1,T⟨CR⟩`
35
Send the ASCII byte 'T' to shutter 1 and return the response. This returns the shutter board temperature.

SERR? *c*

Shutter Error Word

Query the shutter error word for shutter *c*. This command sends 'W' to the shutter and returns the response.

SPOS? *c*

Shutter Position

Query the shutter position for shutter *c*. A value of 1 indicates the shutter is open. A value of 0 indicates the shutter is closed. A value of 1 indicates the shutter position is indeterminate. This command sends 'S' to the shutter and returns the response.

SSER? *c*

Shutter Serial Number

Query the shutter serial number for shutter *c*. This command sends 'Y' to the shutter and returns the response

SRCE(?) *c*{,*i*}

Source of Control

Set (query) the shutter source of control for channel *c* {to *i*}. If *i* is 0, the shutter is under manual control. If 1, the shutter is under TTL control.

Example: `SRCE 3,1⟨CR⟩`
Place shutter 3 under TTL control.

SSTB? *c*

Shutter Status Byte

Query the shutter status byte for shutter *c*. This command sends 'Z' to the shutter and returns the response.

STAT(?) [*c*{,}]{*i*} Open/Closed State

Set (query) the open/closed state [*of c*] {to *i*}. If the optional parameter *c* is not given, then set (query) the state of all channels.

When *c* is given, then the shutter on channel *c* is open if *i* is equal to 1, and closed if *i* is equal to zero. The query form returns the number 2 if shutter state is indeterminate.

When *c* is not given, bits 0 to 3 of *i* identify the open/closed states of shutters 1 to 4. If the bit is 0 the shutter is closed. If the bit is 1 the shutter is open. The query form sets bits 4 to 7 if the corresponding shutter state is indeterminate.

Example: `STAT 10⟨CR⟩`
Open shutters 2 and 4. Close shutters 1 and 3.

Example: `STAT 1,1⟨CR⟩`
Open shutter 1.

Example: `STAT?⟨CR⟩`
210
A return of 210 would indicate that shutters 1, 3, and 4 are in an indeterminate state and that shutter 2 is open.

Example: `STAT? 3⟨CR⟩`
1
A return of 1 indicates that shutter 3 is open.

TEMP? *c* Shutter Temperature

Query the current board temperature in °C of shutter *c*. This command sends 'T' to the shutter and returns the response.

2.6.4 Interface Configuration Commands

COMP *i* Compatibility Mode

Enter the SR474's compatibility mode. If the parameter *i* is set to 1, the instrument enters compatibility mode.

In compatibility mode the single ASCII bytes '@' through 'I' control the open and close states of all shutters. The ASCII byte 'Z' is used to return the instrument to normal mode. This mode can be used to provide syntax compatibility with some legacy shutter systems.

The complete list of commands available while in Compatibility Mode is as follows:

ASCII byte Symbol	Decimal	Command
@	64	Open channel 1
A	65	Close channel 1
B	66	Open channel 2
C	67	Close channel 2
D	68	Open channel 3
E	69	Close channel 3
F	70	Open channels 1-4
G	71	Close channels 1-4
H	72	Open channel 4
I	73	Close channel 4
Z	90	Exit compatibility mode

Control bytes in compatibility mode are acted upon immediately. (Command terminators such as ⟨CR⟩ are ignored.) Compatibility mode, as set by COMP 1, will be cancelled by power cycling the SR474. If compatibility mode is desired at turn-on, it can be enabled with the IFCF command.

EMAC?

Ethernet MAC Address

Query the SR474's ethernet MAC address.

EPHY(?) *i*{,*j*}

Ethernet Physical Layer Configuration

Set (query) the physical configuration item *i* {to *j*}. The parameter *i* may be one of the following:

i	Configuration
0	Enable/disable Auto-negotiation of link speed
1	Set link speed to 10 Base-T or 100 Base-T

When auto-negotiation is enabled, the manual link speed selection is ignored. When auto-negotiation is disabled, the manual speed selection is used to configure the link. Under certain circumstances the auto-negotiation of link speed may fail. To avoid this, the SR474 defaults to manually configured 100 Base-T link speed. When setting the link speed, a value of *j* equal to 0 selects 10 Base-T, and a value of 1 selects 100 Base-T.

Example: EPHYS0,0⟨CR⟩
Disable auto-negotiation of link speed

Example: EPHYS1,1⟨CR⟩
Manually configure link for 100 Base-T operation

IFCF(?) *i*{,*j*} Interface Configuration

Set (query) interface configuration parameter *i* {to *j*}. The parameter *i* may be one of the following:

i	Configuration parameter
0	RS-232 Baud Rate (query only)
1	GPIB Address (query only)
2	IP Address (query only)
3	Subnet Mask (query only)
4	Default Gateway (query only)
5	Enable/Disable TCPIP interface
6	Enable/Disable Raw Socket access on port 5025
7	Enable/Disable Telnet access on port 5024
8	Enable/Disable VXI-11 access
9	Set/Query Static IP Address
10	Set/Query Subnet Address/Network Mask
11	Set/Query Default Gateway
12	Enable/Disable compatibility mode at startup

Set *j* to 0 to disable a setting and 1 to enable it. Parameters 9–11 require an IP address in the form 'a.b.c.d' where each letter is a decimal integer in the range 0–255. Parameters 24 indicate the active IP configuration. Parameters 9–11 are used to when the rear panel DIP switches are set to '11'.

Example: `IFCF 7,0`⟨CR⟩
Disable Telnet Access

Example: `IFCF 9,192.168.10.5`⟨CR⟩
Set IP address to `192.168.10.5`

Example: `IFCF 10,255.255.255.0`⟨CR⟩
Set network mask to `255.255.255.0`

Example: `IFCF?4`⟨CR⟩
`192.168.10.1`

The returned value indicates the active default gateway.

IFRS *i*

Interface Reset

Reset one of the communications interfaces. The parameter *i* identifies the interface to reset:

i	Configuration parameter
0	RS-232
1	GPIB
2	TCP/IP

When an interface is reset, it is changed to its power-on state. Before an interface is re-activated, the relevant rear panel dip switch states are scanned to determine the appropriate configuration.

LCAL

Go to Local

Revert to local control of the instrument. This enables the front panel key pad for instrument control. This command is only active on telnet, raw-socket, and RS-232 connections. The other interfaces have built in functionality for implementing this functionality.

LOCK?

Request Lock

Request the instrument lock. The SR474 returns 1 if the lock is granted and 0 otherwise. When the lock is granted, no other instrument interface may alter instrument settings until the lock is released via the UNLK command or the power is cycled. It also forces a complete lockout of the front panel.

UNLK?

Release Lock

Release a previously acquired instrument lock. Returns 1 if the lock was released, otherwise 0. If UNLK? returns 0 and it is necessary to verify that the instrument is not presently locked from any other interface, acquire the lock with LOCK? before executing the UNLK? query.

REMT

Go to Remote

Enable remote control of the instrument. In this mode, the front panel key pad is disabled, so that control of the instrument can only occur via the remote interface. This command is only active on telnet, raw socket, and RS-232 connections. The other interfaces have built in functionality for implementing this functionality.

XTRM *i*{,*j*}{,*k*} Set Interface Terminator

Set the interface terminator that is appended to each response to *i* *j* *k*. The default terminator is '⟨CR⟩⟨LF⟩', i.e., ASCII character 13, followed by ASCII character 10. The interface terminator may be set to a different sequence of up to three characters in length by executing XTRM with parameters that consist of the decimal equivalent of the ASCII characters desired, separated by commas.

Example: `XTRM 65,66,13`
Set the interface terminator to 'AB⟨CR⟩'

2.7 Error Codes

The SR474 contains an error buffer that stores up to 20 error codes associated with errors encountered during power-on self tests, command parsing, or command execution. The ERR LED will be highlighted when a remote command fails for any reason. The errors in the buffer may be read one by one by executing successive LERR? commands. The meaning of each of the error codes is described below.

2.7.1 Execution Errors

Error Code	Meaning
0	**No Error** No more errors left in the queue.
10	**Illegal Value** A parameter was out of range.
11	**Illegal Mode** The action is illegal in the current mode. This might happen, for instance, if chopping is enabled when a shutter is under TTL control.
12	**No Shutter Response** A query was made to a shutter but it didnt respond.
13	**Bad Shutter Response** A query was made to a shutter but the response was not in the expected format.
15	**Not Allowed** The requested action is not allowed because the instrument is locked by another interface.

2.7.2 Query Errors

Error Code	Meaning
30	**Lost Data** Data in the output buffer was lost. This occurs if the output buffer overflows, or if a communications error occurs and data in output buffer is discarded.
32	**No Listener** This is a communications error that occurs if the SR474 is addressed to talk on the GPIB bus, but there are no listeners. The SR474 discards any pending output.

2.7.3 Device Dependent Errors

Error Code	Meaning
40	**Failed ROM Check** The ROM checksum failed. The firmware code is likely corrupted.

2.7.4 Parsing Errors

Error Code	Meaning
110	**Illegal Command** The command syntax used was illegal. A command is normally a sequence of four letters, or a '*' followed by three letters.
111	**Undefined Command** The specified command does not exist.
112	**Illegal Query** The specified command does not permit queries
113	**Illegal Set** The specified command can only be queried.

(Continues)

Parsing errors, continued:

Error Code	Meaning
114	**Null Parameter** The parser detected an empty parameter.
115	**Extra Parameters** The parser detected more parameters than allowed by the command.
116	**Missing Parameters** The parser detected missing parameters required by the command.
117	**Parameter Overflow** The buffer for storing parameter values overflowed. This probably indicates a syntax error.
118	**Invalid Floating Point Number** The parser expected a floating point number, but was unable to parse it.
120	**Invalid Integer** The parser expected an integer, but was unable to parse it.
121	**Integer Overflow** A parsed integer was too large to store correctly.
122	**Invalid Hexadecimal** The parser expected hexadecimal characters but was unable to parse them.
126	**Syntax Error** The parser detected a syntax error in the command.

2.7.5 Communication Errors

Error Code	Meaning
170	**Communication Error** A communication error was detected. This is reported if the hardware detects a framing, or parity error in the data stream.
171	**Over Run** The input buffer of the remote interface overflowed. All data in both the input and output buffers will be flushed.

2.7.6 Other Errors

Error Code	Meaning
254	**Too many errors** The error buffer is full. Subsequent errors have been dropped.