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# SC-5500 Integrating Sphere System Control


**SYMBOLS USED IN THIS MANUAL** ..... **III**

**INTRODUCTION** ..... **1**

**GENERAL INFORMATION** ..... **2**

Accessories ..... 2
General Applications ..... 2
Calibrations ..... 3
Standard Calibration Guide ..... 4

**FRONT PANEL** ..... **5**

On/Off Power ..... 5
LCD Display ..... 5
CAL ..... 6
OPTIONS ..... 6
ZERO ..... 6
NORM ..... 6
RANGE ..... 6
UP ▲ ..... 7
DOWN ▼ ..... 7
TALK ..... 7
LISTEN ..... 7
REMOTE ..... 7

**BACK PANEL** ..... **8**

Detector Input Ports ..... 8
Line Voltage Input Module ..... 9
Digital Output Control ..... 11
RS-232C Computer ..... 11
IEEE-488 Interface ..... 11

**OPERATION** ..... **12**

Initial Preparations ..... 12
Power Input ..... 12


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Detector Input ..... 12
Powering Up ..... 13
Selecting Operating Modes with the Functions Buttons ..... 13
Data Adjusting ..... 16
Ranging ..... 17

**COMPUTER INTERFACING ..... 18**
IEEE-488 Interface Connections ..... 18
RS-232C Interface Connections ..... 19
Lamp Power Supply, Detector Multiplexer, and Variable Attenuator Connections ..... 19
Digital Output Port Pin Settings ..... 19
Interface Command Descriptions ..... 21

**INTRODUCTION TO SC-5500 PROGRAMMING ..... 24**
IEEE-488 Programming ..... 24
RS-232C Programming ..... 27

**SPECIFICATIONS ..... 30**
Current Input Characteristics at 25•C ..... 30
Voltage Input Characteristics at 25•C ..... 30
SC-5500 Specifications (continued) ..... 31

**APPENDIX I. LIBRARY OF SC-5500 COMMANDS ..... 32**

**APPENDIX II. OPTIONAL RACK MOUNTING KIT ..... 34**



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# SYMBOLS USED IN THIS MANUAL

Triangular shaped symbols used in this manual indicate a warning. Two types of triangular symbols are used in the SC-5500 Manual:



**Electrical Shock Hazard**



**Caution**



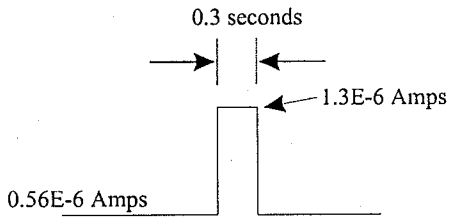
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# Labsphere Product Update

As part of our continuous program of product improvement we are providing information about your SC-5500 Integrating Sphere System Control instrument operating with Firmware Revision A7 or prior:

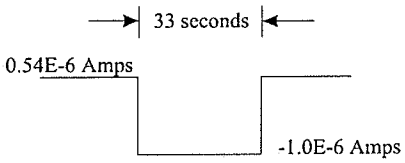
- Occasional intermittent false readings from the SC-5500 have been observed.
- This problem may occur *seldom* or *never* with your instrument.
- This will *not* affect the long-term usability and reliability of your instrument.
- Firmware Revision A8 is available to resolve this occasional intermittent issue.

When using the SC-5500 with Firmware Revision A7 or prior as a radiometer and observing the detector current via a computer or on the front panel display, on rare occasions a positive spike may occur for approximately 0.3 seconds. See Example 1.




**Example 1. False Positive Spike**

When using the SC-5500 with Firmware Revision A7 or prior as a radiometer and observing the detector current via a computer *or* the front panel display, on rare occasions a negative spike may occur. See Example 2 below.




**Example 2. False Negative Spike**

Firmware Revision A8 and further information is available by contacting the Labsphere Customer Service Department at

**☎(603) 927-4266.**

Addendum to most recent revision of SC-5500 Manual SX-01635-000.

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# INTRODUCTION

The SC-5500 Integrating Sphere System Control is the core of all Labsphere Integrating Sphere Systems. It is an advanced microprocessor-based radiometer that accommodates silicon, germanium, and photomultiplier tube detectors. It is equipped with both an RS-232C serial port and IEEE-488 bus interfaces. These standardized interfaces make it possible for a computer to control and record data from the radiometer. The IEEE-488 and RS-232C interfaces also enable the SC-5500 Integrating Sphere System Control to operate peripheral instrumentation, such as variable attenuators, detector multiplexers, and lamp power supplies, via a personal computer.

The SC-5500 Integrating Sphere System Control has an onboard microprocessor which provides the capacity to program the unit for specific requirements. By incorporating various available spheres, detectors, and filter assemblies, Labsphere can prepare the SC-5500 Integrating Sphere System Control to perform many specific tasks.



The appropriate line voltage for the SC-5500, either 115 or 230 VAC, was set prior to shipping, however it can be changed externally. Double check that the correct line voltage is set on the line voltage input module. Failure to operate the unit at the appropriate line voltage may cause serious damage. Refer to the Line Voltage Input section.



User servicing is not recommended. Removal of the top panel of the unit without first unplugging the AC line could result in electrical shock.



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# GENERAL INFORMATION

## *Accessories*

The SC-5500 Integrating Sphere System Control is compatible with the following Labsphere Integrating Sphere System components:

- Reflectance/Transmittance Spheres, Uniform Source Spheres, Laser Power Measurement Spheres, Lamp Measurement Spheres, and General Purpose Spheres.
- Photopic Silicon, Unfiltered Silicon, Germanium, and Chromaticity Detector Assemblies.
- Lamp Power Supplies
- Variable Attenuators
- Detector Multiplexers
- Haze Meters

## *General Applications*

- Radiometry
- Photometry
- Laser power measurements
- Infrared measurements
- Reflectance measurements
- Low level measurements
- Spectral analysis
- Transmission measurements
- Analytical instruments testing
- Remote Control of peripheral instrumentation
- Spectroscopy



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## *Calibrations*

Upon your request, Labsphere will calibrate your SC-5500 Integrating Sphere System Control and its accompanying system components in Labsphere's Optical Calibration Laboratory before shipping. The Calibration Certificate describes the methods and equipment used for the specified calibration. Labsphere maintains records of all calibrations completed.



**Note:** Labsphere calibrated your SC-5500 Integrating Sphere System Control to meet your specific needs. The calibration is NOT valid with any other system, accessory or application.

A sticker certifying the accuracy of the SC-5500 Integrating Sphere System Control calibration, the calibration date, and the suggested date to send the instrument back for recalibration is located on the rear panel.



If the calibration seal is broken, the warranty is no longer valid.

If you should wish to use new or different equipment with the system, contact the Labsphere Customer Service Department at **(603) 927-4266**. Your Sales Representative can arrange for you to send the equipment along with the SC-5500 Integrating Sphere System Control and the rest of the system to Labsphere for proper calibration. Up to 100 specific calibration coefficients for various assemblies and measurements may be programmed into the SC-5500 Integrating Sphere System Control.



Calibrations for specific detector assemblies and accessories to be used with the SC-5500 are programmed into the unit at the user's request. To avoid possible inaccurate results, do not use detectors and accessories that have not been calibrated with this particular SC-5500.



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## *Standard Calibration Guide*

| Calibration | Description | Typical Units |
|---|---|---|
| Luminance of source | Programs the SC-5500 to display the luminance of a uniform source. | foot lamberts |
| Radiance of source | Programs the SC-5500 to display the radiance of a uniform source, integrated over a specified spectral band. | $W/m^2$ sr |
| Power Input (first wavelength) | Single Wavelength. Programs the SC-5500 to display total power entering a sphere at a specified wavelength. | watts at *x* wavelength |
| Power Input (each additional wavelength) | Single Wavelength. Programs the SC-5500 to display total power entering a sphere at a specified wavelength. | watts at *x* wavelength |
| Power Input | Multiple Single Wavelengths. Programs the SC-5500 to display total power entering a sphere at 33 single wavelengths from 300 to 1100 nm, every 25 nm. | watts at *x* wavelength |
| Luminous Flux Input | Programs the SC-5500 to display total luminous flux entering a sphere. | lumens |
| Alternate Units | Programs the SC-5500 to display an existing calibration in alternate units: e.g., NITS and foot lamberts. | |

Optional radiometric and photometric calibrations are also available. Talk to your Labsphere Sales Representative for more information.



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# FRONT PANEL

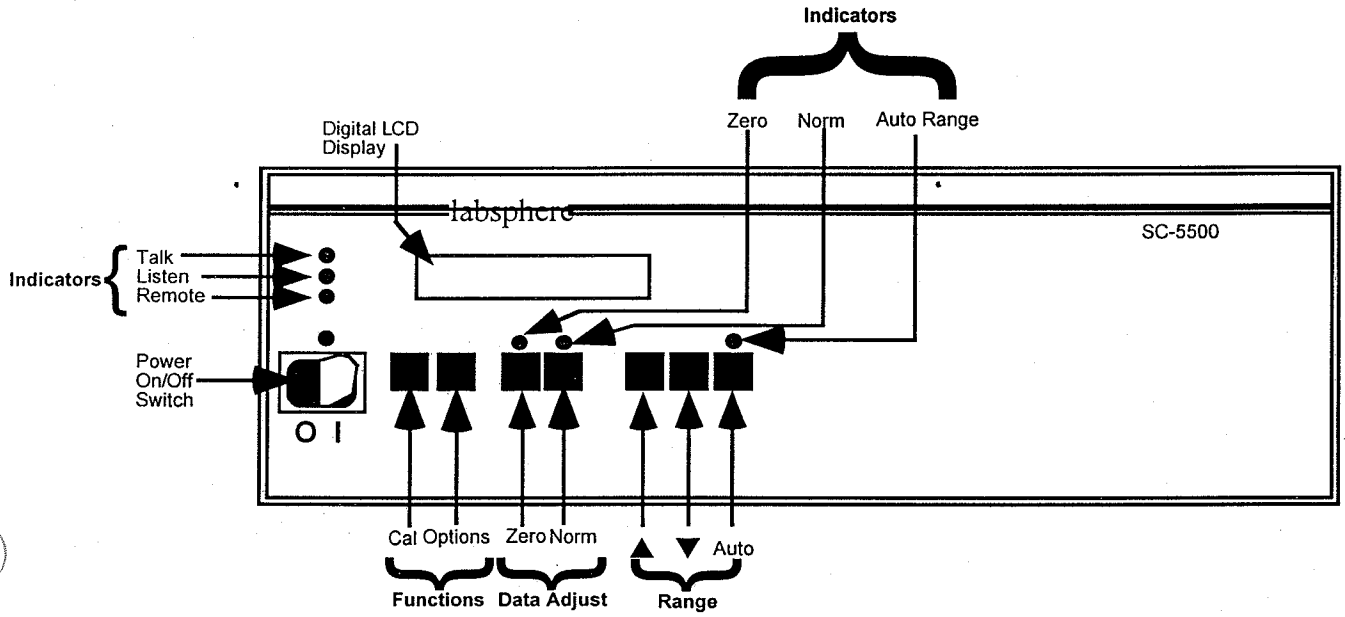



**Figure 1. SC-5500 Front Panel.**

## *On/Off Power*

Power for the SC-5500 Integrating Sphere System Control is activated with a front-panel rocker switch. Pressing the switch to the **I** (right, **ON**) position activates instrument power, signified by a green light directly above the power switch, and a responding LCD display. Pressing the switch to the **O** (left, **OFF**) position deactivates the instrument.

## *LCD Display*

The display panel consists of two rows of backlit LCD digital readout. It may be set for either analog or digital readings, and the backlight may be turned off for dark room use. See Options.



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## *CAL*

Allows the operator to scroll through and choose an appropriate pre-programmed calibration coefficient.

## *OPTIONS*

Allows the operator to access the programmed features of the SC-5500 Integrating Sphere System Control which include:

- Selecting between 3-1/2 and 4-1/2 digit display.
- Selecting between analog or digital display.
- Enabling or disabling the digital filter.
- Activating or deactivating the front panel lights.
- Activating or deactivating the display back lighting.
- Selecting the IEEE address.
- Selecting the baud rate.
- Setting parity for the RS-232 port.
- Formatting data bits.
- Displaying the responsivity for various calibrations.

## *ZERO*

Allows the operator to make relative measurements by storing the current reading in memory and subtracting it from all subsequent readings.

## *NORM*

Allows the operator to make measurements as normalized value by dividing subsequent readings by the current reading.

## *RANGE*

Allows the operator to manually set the operating range for the detector by using the **UP** ▲ and **DOWN** ▼ buttons. Pushing the adjacent **AUTO** button the instrument automatically determines the optimum range. A green light above the **AUTO** button indicates when the instrument is in the autoranging mode.



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### *UP* ▲

Allows the operator to manually uprange the radiometer. Additionally, **UP** is used in the options mode for scrolling.

### *DOWN* ▼

Allows the operator to manually downrange the radiometer. Additionally, **DOWN** is used in the options mode for scrolling.

### *TALK*

A green light indicates when the SC-5500 Integrating Sphere System Control is sending information through the IEEE-488 or the RS-232C interface to a remote computer terminal.

### *LISTEN*

A green light indicates when the SC-5500 Integrating Sphere System Control is receiving information through the IEEE-488 or the RS-232C interface from a remote computer terminal.

### *REMOTE*

A green light indicates that the SC-5500 Integrating Sphere System Control is being operated by a remote computer and that the front-panel control buttons are deactivated.



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# BACK PANEL

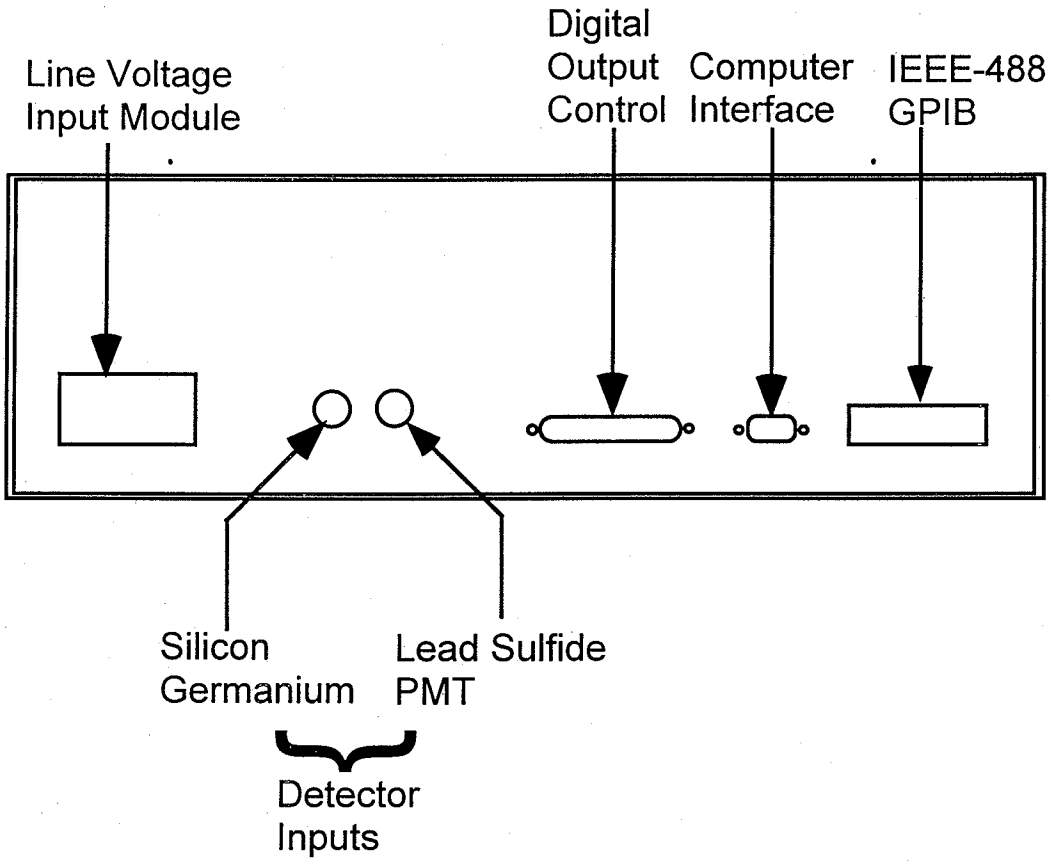



**Figure 2. SC-5500 Back Panel.**

## *Detector Input Ports*

Two twist-lock-type triaxial connectors link Labsphere's five available detectors with the SC-5500 Integrating Sphere System Control. The connector on the left accepts silicon and germanium detectors and the one on the right accepts PMT detectors.



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## *Line Voltage Input Module*

**CAUTION:** Make all connections with the AC line power OFF !

### Voltage Setting

The AC line voltage input module, located on the rear panel, features a fuse holder and voltage cartridge that displays the factory-set line input voltage (115 or 230 VAC). The 115 volt setting has an effective range of 100-120 volts. The 230 volt setting has an effective range of 220-240 volts. See Figure 3.

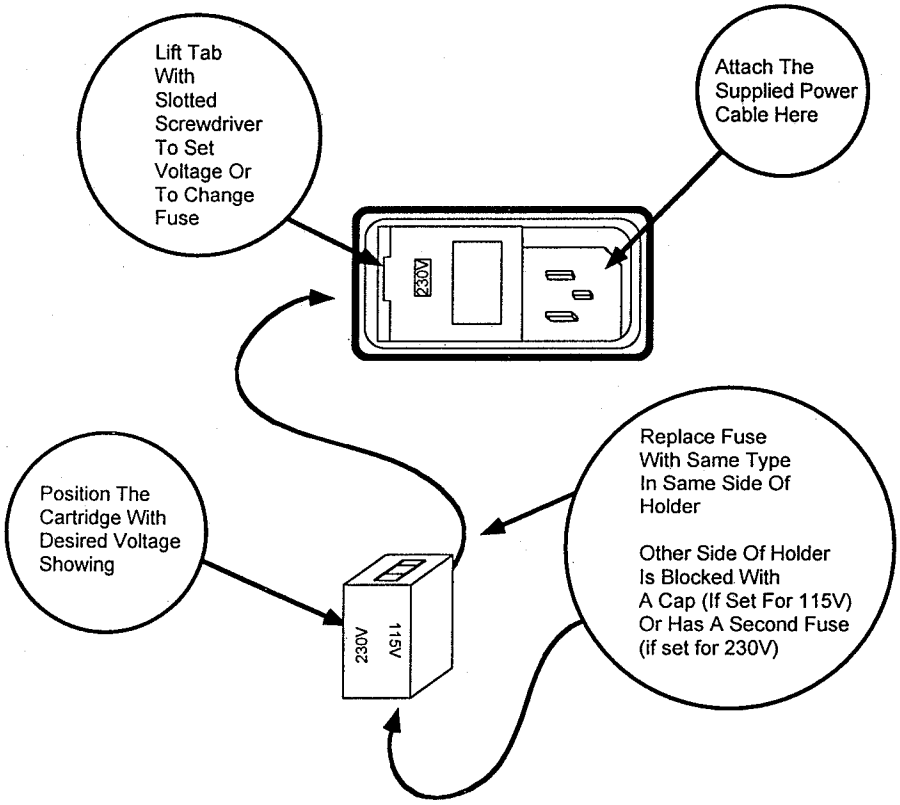



**Figure 3. AC Line Input Module.**



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The voltage cartridge has been set at Labsphere prior to shipping. Should you ever need to change it , make sure the desired setting of 115 or 230 VAC is facing toward you (so that you can read it) when the cartridge is installed.

To change the input voltage, remove the power cord and use a slotted screwdriver to gently pry up the plastic tab on the left tab of the module (Figure 3). Pull out the voltage cartridge with the same method of prying up the left tab. Flip the cartridge around so that the desired voltage (115 or 230 VAC ONLY) is facing you (so that you can read it) and reinsert the cartridge. The 230 VAC setting requires two fuses (see Fuse Replacement section below).

**Fuse Replacement**

To remove the fuse, first remove the power cord and use a slotted screwdriver to gently pry up the plastic tab on the left tab of the module (Figure 3). Pull out the voltage cartridge with using the same method (prying up the left tab). Gently pry the fuse out by lifting the metal end with a slotted screwdriver. Replace the fuse by pushing on the metal ends with the fingers. Ensure that the desired voltage (115 or 230 VAC ONLY) is facing you (so that you can read it) and reinsert the cartridge.

Be sure to replace with a fuse of the same value only. The SC-5500 uses a **1 amp, 250 volt, slow-blow GDA-type fuse.**

**Two fuses are required if operating at 230 VAC.**



**Note:** An open fuse may indicate a serious problem. Always use caution. If a second fuse blows, contact Labsphere's Customer Service Department at (603) 927-4266.

**Power Cable**

To connect the AC power cable, first ensure that the proper voltage is indicated on the module (Figure 3). Align the cable's female connector with the AC Line Input Module's male three-pronged input connector and push it firmly into place.



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### *Digital Output Control*

A standard 37-pin digital output connector allows the SC-5500 Integrating Sphere System Control to control peripheral instrumentation.

### *RS-232C Computer*

A 9-pin interface connector allows the SC-5500 Integrating Sphere System Control Interface to communicate information back and forth with a personal computer.

### *IEEE-488 Interface*

A standardized input and output interface integrates the SC-5500 Integrating Sphere System Control into a computer-bus network, allowing it to communicate with various other instruments.



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# OPERATION

The SC-5500 Integrating Sphere System Control may be controlled manually or it may be operated remotely by a computer. This section deals with manual control of the instrument. See Instructions for computer interfacing for how to operate the instrument with a computer.

## *Initial Preparations*



**CAUTION**: Make all connections with the AC line power in the OFF position!

## *Power Input*

The AC line input module is located on the upper right side of the rear panel. Instructions on changing the factory-set input voltage are in the Line Voltage Input Module section in this manual. Only supply the correct voltage to the SC-5500 according to the instructions in the Power Input Module section.

To connect the AC power cable, align the cable receptacle with the input adapter's three prongs and push it firmly into place.

## *Detector Input*

To attach a detector assembly to the SC-5500 Integrating Sphere System Control, align the notches of the twist-lock-type triaxial connector with the two horizontal pins of the instrument adapter. Then push in the connector and turn it clockwise until the pins rest in their respective sockets.

Make sure to attach the detector assembly to the appropriately labeled adapter. Failure to do so will result in inaccurate readings.



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## *Powering Up*

Plug the AC Power into an appropriate outlet. Depress the power button on the lower left side of the front panel control to turn the SC-5500 Integrating Sphere System Control on. The display should read "Labsphere SC-5500" and all the front panel LEDs should come on for approximately ten seconds while the instrument runs internal tests. At the end of the tests, all LEDs except the power button LED should turn off. Allow the SC-5500 ten minutes of warm up time for best performance.

## *Selecting Operating Modes with the Functions Buttons*

The default settings for the calibrations and the option functions are programmed into the SC-5500 Integrating Sphere System Control according to customer specifications at time of purchase. These are the settings that are displayed at each initialization of the system, and the SC-5500 Integrating Sphere System Control always resets itself to them once the power is turned off.



**Note:** If you wish to use different calibration and option modes than the original default settings, you must change the settings after each initialization.

### Calibrations

The SC-5500 is always calibrated to monitor voltage input on CAL0 and current input on CAL1.

Once the detector assembly is in place and the power is on, the running display of the SC-5500 Integrating Sphere System Control will show the detector reading. The selected default setting calibration number (and units) are also displayed.

The additional calibration coefficients are specific to only one sphere/detector assembly. When the assembly is changed, the calibration that corresponds with the new assembly must be selected from those already programmed in the SC-5500 Integrating Sphere System Control.



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To use other calibrations stored in the SC-5500 Integrating Sphere System Control, push the **CAL** button and scroll through until the desired calibration number is shown in the upper right corner of the display. Refer to the calibration certificate for the calibration number that corresponds with the desired instrument assembly or wavelength.

### Options

Push the **OPTIONS** button to scroll through the available options. The **UP** and **DOWN** buttons under the range heading allows selection of settings within a certain options mode. To return from the options mode to the running display mode, push the button labeled **CAL**.

### Digit Display

With the first options mode, push the **UP** (▲) or **DOWN** (▼) button to choose between 3 1/2 and 4 1/2 digit display. (The default setting at power up is **3 1/2 digits**.)



**Note:** The 4 1/2 digit resolution refers to that available for measuring the current or voltage of the detector. Applying calibration factors may decrease this resolution at the display.

### Display Format

In the second options mode, push the **UP** (▲) or **DOWN** (▼) button to choose between digital display format, which shows the measurement along with the units, or analog display format, which shows the measurement along with a proportional sliding-bar graph. (The default setting at power up is **analog**.)

### Digital Filter

In the third options mode, push the **UP** (▲) or **DOWN** (▼) button to enable or disable the SC-5500 Integrating Sphere System Control's digital filter. Enabling the filter reduces background fluctuations, thereby providing more stable readings. Disabling the filter provides quicker, continuous readings. (The default setting at power up is **OFF**.)



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### Front Panel Lights

In the fourth options mode, push the **UP** (▲) or **DOWN** (▼) button to toggle the front panel lights on and off. The off position reduces ambient light in a dark room situation. (The default setting at power up is **ON**.)

### Back Light

In the fifth options mode, push the **UP** (▲) or **DOWN** (▼) button to toggle the display's back light on and off. The off position reduces ambient light in a dark room situation. (The default setting at power up is **ON**.)

### IEEE Address

In the sixth options mode, push the **UP** (▲) or **DOWN** (▼) button to select an IEEE address between 1 and 15. **DO NOT** choose an address that conflicts with the address of another device in the system. This option is for computer interfacing with an IEEE-488 bus only; it is not pertinent to simple bench-top operation. Yet, if the default-set address differs from the one assigned in the operator's computer programming, the IEEE address must be reset with the SC-5500 Integrating Sphere System Control's front panel controls after each initialization of the instrument. (The default address at power up is **10**.)

### Baud Rate

In the seventh options mode, push the **UP** (▲) or **DOWN** (▼) button to select a baud rate of 9600, 4800, 2400, 1200, 600, or 150. This option is for use with a RS-232C computer interface only; it is not pertinent to simple bench-top operation. Yet, if the default-set baud rate differs from the one assigned in the operator's computer programming, the appropriate baud rate must be reset with the SC-5500 Integrating Sphere System Control's front panel controls after each initialization of the instrument. (The default setting at power up is **9600 bits per second**.)



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### Parity

In the eighth options mode, push the **UP** (▲) or **DOWN** (▼) button to set parity equal to **ODD**, **EVEN**, or **NONE**. This option is for use with a RS-232C computer interface only. If the default-set parity differs from the one assigned in the operator's computer programming, the appropriate parity must be reset with the SC-5500 Integrating Sphere System Control front panel controls after each initialization of the instrument. (The default setting at power up is **none**.)

### Data Formats

In the ninth options mode, push the **UP** (▲) or **DOWN** (▼) button to set the data format as 8 Data Bits - 1 Stop Bit, 8 Data Bits - 2 Stop Bits, 7 Data Bits - 1 Stop Bit, or 7 Data Bits - 2 Stops Bits. This option is for use with a RS-232C computer interface only. If the data format setting differs from the one assigned in the operator's computer programming, the appropriate data format must be reset with the SC-5500's front panel controls after each initialization of the instrument. (The default setting at power up is **8 data bits, 1 stop bit**.)

### Responsivity

In the tenth options mode, push the **UP** (▲) or **DOWN** (▼) button to scroll through the various calibration factors. (The default setting at power up is **1.0000**.)

## *Data Adjusting*

### Zeroing Readings to Make Relative Measurements

Push the **ZERO** button to adjust detector readings relative to one established measurement. When the zero mode is activated, the current measurement is stored in memory and subtracted from all subsequent measurements. A green LED above this button indicates when the zero function is activated.

The purpose of the zero function is to automatically subtract background light from actual signals. Consequently, the instrument is programmed to operate correctly when the total measured power is higher than when the zero function was initiated. If the total measured power drops below the value that was present when the zero was initiated, the instrument will display negative numbers. These negative numbers are unreliable and should not be used.



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### Normalizing Readings to Make Relative Measurements

Push the **NORM** button to adjust the detector readings relative to one established measurement. When the normalizing mode is activated, the current measurement is stored in memory and all subsequent measurements are divided by it. A ratio between the established normalizing measurement and all subsequent measurements is then displayed. A green LED above this button indicates when the norm function is activated.

## *Ranging*

### Manual Adjustment of Dynamic Range

The **UP** and **DOWN** buttons under the **RANGE** heading on the front panel allow detector sensitivity adjustment by changing the pre-amp gain of the SC-5500. Pushing these two buttons causes the running display to scroll through the ranges of the detector. When measuring the detector current, seven decades of dynamic range are available. Alternatively, five decades of dynamic range are available when measuring the detector output in volts.

If the signal from the detector exceeds the set dynamic range, the display will read **OVERFLOW**. In this case, the sensitivity of SC-5500 Integrating Sphere System Control must be decreased or the radiant flux on the detector reduced before the display will function properly again.

### Automatic Ranging

Push the **AUTO** button under the **RANGE** heading on the front panel to automatically set the optimum range. A green LED above this button indicates when the automatic range mode is activated.



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# COMPUTER INTERFACING

**CAUTION**: Make all interface connections with the AC line power OFF!

The SC-5500 Integrating Sphere System Control is equipped with both an IEEE and an RS-232C interface. These interfaces allow for the transmission of data and commands between a computer and the SC-5500 Integrating Sphere System Control, and between a computer and other external devices. In order for such control to be possible, all the interface devices, including the computer, must have the appropriate software, and the hardware must meet IEEE or RS-232C standards. The proper cables must be ordered separately. This section addresses these concerns and outlines basic operation of the interface networks.

## *IEEE-488 Interface Connections*

To connect an IEEE-488 interface cable to the SC-5500 Integrating Sphere System Control, align the adapter with the right side port labeled **IEEE 488 INTERFACE.** Push the adapter firmly into place and then secure it by tightening the two thumb screws on either side.

The adapter is designed to allow parallel connections on one instrument. Do not stack more than three adapters on any one instrument, as this may overload the network and cause damage to the system.

### Selecting the IEEE Address

Once the SC-5500 Integrating Sphere System Control has been connected to the IEEE bus, its primary address must be assigned for appropriate identification of commands sent between the instrument and the computer.

Set the primary address using the options key and the **UP** ▲ and **DOWN** ▼ scroll buttons on the front panel of the SC-5500 Integrating Sphere System Control.

Values between 1 and 15 are possible, but the selected address must not be the same as that of another instrument in the system.



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## *RS-232C Interface Connections*

To connect an RS-232C interface cable to the SC-5500 Integrating Sphere System Control, align the 9-pin connector with the middle port labeled **COMPUTER INTERFACE.** Push the connector firmly into place and secure it by tightening the two screws. A null modem adapter is required between most computers and the SC-5500.

## *Lamp Power Supply, Detector Multiplexer, and Variable Attenuator Connections*

A custom designed cable connecting the SC-5500 with a lamp power supply, variable attenuator, detector multiplexer, or other peripheral accessory is supplied with the instrument, only if specified in the order.
To connect peripheral accessory to the SC-5500 Integrating Sphere System Control, align the 37-pin connector with the left side port labeled **DIGITAL OUTPUT CONTROL.**

Push the connector firmly into place. Secure it by tightening the two screws. At the other end of the cable is a plug that fits into the appropriately marked jack on the peripheral accessory.

## *Digital Output Port Pin Settings*

The digital output port of the SC-5500 Integrating Sphere System Control has the capacity to send up to 32 TTL compatible signals for controlling external devices. There are a total of 37 pins in the plug. Five of them are reserved for grounding purposes. There are four different ports containing eight bits each.



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Figure 4 illustrates the schematic location of each pin; the table lists the numerical correlations between the pins and the port and bit identification numbers. Instructions on how to use these identification numbers to operate external devices from a computer are included in the following section on control commands.

| Pin Number | Port Number | Bit Number |
|---|---|---|
| 1 | 1 | 1 |
| 2 | 1 | 2 |
| 3 | 1 | 3 |
| 4 | 1 | 4 |
| 5 | 1 | 5 |
| 6 | 1 | 6 |
| 7 | 1 | 7 |
| 8 | 1 | 8 |
| 9 | 2 | 1 |
| 10 | 2 | 2 |
| 11 | 2 | 3 |
| 12 | 2 | 4 |
| 13 | 2 | 5 |
| 14 | 2 | 6 |
| 15 | 2 | 7 |
| 16 | 2 | 8 |
| 17 | 3 | 1 |
| 18 | 3 | 2 |
| 19 | 3 | 3 |
| 20 | gnd | |
| 21 | gnd | |
| 22 | gnd | |
| 23 | gnd | |
| 24 | gnd | |
| 25 | 3 | 4 |
| 26 | 3 | 5 |
| 27 | 3 | 6 |
| 28 | 3 | 7 |
| 29 | 3 | 8 |
| 30 | 4 | 1 |
| 31 | 4 | 2 |
| 32 | 4 | 3 |
| 33 | 4 | 4 |
| 34 | 4 | 5 |
| 35 | 4 | 6 |
| 36 | 4 | 7 |
| 37 | 4 | 8 |

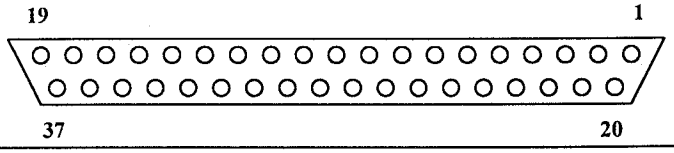



**Figure 4. Digital Output Port Pin Settings**



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## *Interface Command Descriptions*

Variations of nine specific commands are used to control the SC-5500 Integrating Sphere System Control. This section outlines these commands alphabetically and gives descriptions for each one. These commands are described again in Appendix I for easy reference. They may be used in conjunction with all ASCII data formats.



**Note:** These commands are case sensitive; CAPITAL LETTERS must be used. All commands must be followed by the EXECUTE command (**X**). The SC-5500 Integrating Sphere System Control will not act upon any command until it receives the **X** command. A carriage return or "enter" is not required to execute a command.



**Note:** If an incorrect command is sent to the SC-5500 Integrating Sphere System Control from the computer, the display of the instrument will read **INVALID MESSAGE** for approximately five seconds before it clears itself.



**Note**: A string of commands, up to 100 characters long, may be entered, followed by a single **X**. These commands will all be executed at once.

### Automatic Ranging A*n*

**AØX**
Sets the SC-5500 in the auto ranging mode.

**A1X**
Turns off the auto ranging mode.

### Calibrations C*n*

**C*n*X**
Typing **C** and the number that corresponds to a calibration stored in the SC-5500 sets the instrument for that specific calibration. (***n***) is the one or two digit decimal number of the calibration. Example: **C0X** sets the SC-5500 to Cal 0, **C1X** sets the SC-5500 to Cal 1. (C0 is factory set to display **volts**, C1 is factory set to display **amps**.)



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**Data Relay** **O*n***

**OØX**
Tells the SC-5500 to relay only one detector measurement to the computer for display. (This is not allowed for IEEE 488 operation, but is required for RS-232 operation.)

**O1X**
Tells the SC-5500 to relay continuous detector measurements for display. (This is not allowed for IEEE 488 operation, but is required for RS-232 operation.)

**Digit Display** **H*n***

**HØX**
Formats the detector readings for 3-1/2 digits on display and over computer interface.

**H1X**
Formats the detector readings for 4-1/2 digits on display and over computer interface.

**Digital Output Control** **P*n* J*m* (K*m*)**

**Pn J*m*X**
Sends a +5 volt charge to the pin that corresponds with the bit (**J*m***) of the port (**P*n***). (***n***) is a decimal number from 1 to 4; (***m***) is a decimal number from 1 to 8.
e.g. **P2 J3X** Sets bit 3 of port 2 high.

**P*n* K*n*X**
Shuts down the voltage to the pin that corresponds with the bit (**K*n***) of the port (**P*n***).
e.g.: **P2 K3X** Sets bit 3 of port 2 low.

**Normalizing Data** **N*n***

**NØX**
Sets the SC-5500 in the normalize mode.

**N1X**
Turns off the normalize mode.



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**Manual Ranging** **R*n***

**R*n*X**
Sets the dynamic range of the SC-5500's detector measurements. When measuring current, 7 decades of dynamic range are available. In terms of interface commands, **R0** corresponds with the most sensitive range and continues as such up through **R6**, which corresponds with least sensitive range.
When measuring voltage, 5 decades of dynamic range are available.
**R1** corresponds with the least sensitive range and continues as such up through **R5**, which corresponds with the most sensitive range.

**Remote Operation** **L*n***

**LØX**
Sets the SC-5500 in the remote control mode. In this mode the front panel controls of the instrument are deactivated.
**L1X**
Turns the remote control mode off and reactivates the front panel controls.

**Zeroing Data** ***Zn***

**ZØX**
Sets the SC-5500 in the zeroing mode.

**Z1X**
Turns off the zeroing mode.



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# INTRODUCTION TO SC-5500 PROGRAMMING

## *IEEE-488 Programming*

This is to familiarize the new owner of an SC-5500 with the basics of programming the instrument via the IEEE-488.

The SC-5500 can be controlled through an IEEE-488 general purpose interface bus (GPIB) interface in several manners. Most IEEE-488 interfaces that are installed on a computer come with a diagnostic software package that allow for direct communications to the bus. Using this software will allow for command string characters to be sent to the SC-5500. Another mode would be via a communications program written in some form of intermediate language, such as QuickBasic.

Commands given to the SC-5500 **must be sent in capital letters** and each command has to be followed with an **X**. For instance, to activate the AUTORANGE function via the terminal program, the following command must be sent, **A0X**. The "**A0**" is the actual command to instruct the SC-5500 to switch to the autorange mode. The **X** tells the SC-5500 to EXECUTE the command. Complete strings of commands may be sent all at once as long as the final command is the **X**. For example, to instruct the SC-5500 to switch to 4-1/2 digit mode, toggle to autorange, and also to use the voltage readout, the following string can be sent, **H1A0C0X**.

When working with a user-designed terminal program in another language, such as QuickBasic, standard communication program design must be followed. For instance, when using Quick Basic, a Quick Library must be formed that has the various commands used for communication with the interface. Then, within the program, a reference has to be made to that particular library in order to use the interface supported commands. Once communications have been established, use the method of the current language (that language the program is being written in) to send strings to the communications port.

All references to programming and structure will assume use of the National Instruments GPIB interface package, IBIC (the Interface Bus Interactive Control software provided with National Instruments GPIB boards to allow direct communications to the IEEE-488 bus). For other IEEE interfaces, use these examples to form the correct program structure to generate the same response.



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When addressing the SC-5500 through the IEEE interface, common bus initializations, device clears and device finds are required. Then, using the IBIC command structure, My Talk Address and My Listen Address must be set for the communications board and the SC-5500. Then, when addressing the SC-5500 to perform an instruction, an IBCMD (Interface Bus Command) statement can be sent out to set up the nature of the communication occurring (i.e. SC-5500 as a TALKER and the interface board as a LISTENER). Once the communication parameter has been established, string commands as described in Appendix I can be sent to instruct the SC-5500 to perform the required actions.

If, during the process of sending commands to the SC-5500, a string or character is sent that the SC-5500 does not recognize, an **INVALID COMMAND ERROR** status message will be displayed on the front panel of the SC-5500. The duration of the display will be as long as required to clear the buffer of the characters. If there is a sufficient amount of "garbage" characters in the buffer, it may become necessary to power off the SC-5500 and then power it back on.

The following program has been included to give an example of how to use QuickBasic to provide the interface to the SC-5500:

**Programming Example:**

```
initialization:
        REM $INCLUDE: 'c:\at-gpib\qbasic\qbdecl.bas'    'INCLUDE file that points the program to
                                                        'the area where the IEEE-488 Quick Library
                                                                'of commands
        scread$ = "?_J "                                'Sets MyTalk address (MTA) to 10 and
                                                        'MyListen address (MLA) to 0
        scwrite$ = "?_*@"                               'Sets (MTA) to 0 and
                                                        '(MLA) to 10
        CALL IBFIND("DEVA", 10)                         'Find SC-5500 at address 10
        CALL SendIFC(0)                                 'Send InterFace Clear
        CALL DevClear(0, 10)                            'Clear SC-5500 bus
        CALL IBCMD(0, scwrite$)                         'Send MTA/MLA
        CALL IBWRT(0, "P1C1K1H1L0X")                    'Set SC-5500 for 4 1/2 Digits, to Cal 0 and
                                                        'Remote ON operation
        r$ = SPACE$(12)                                 'Set up display readback string for 12
                                                        'characters in 4 1/2 digit mode
        CLS
AutoRange:
        CALL IBCMD(0, scwrite$)                         'Send MTA/MLA
```



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```
        CALL IBWRT(0, "A0X")          'Turn on Autorange
        SLEEP 5
        CALL IBCMD(0, scwrite$)       'Send MTA/MLA
        CALL IBWRT(0, "A1X")          'Turn off Autorange


ReadBack:
        CALL IBCMD(0, scwrite$)       'Send MTA/MLA
        CALL IBWRT(0, "O0X")          'Send back one display value ie 1.0000E-3
                                      '<CR><LF>
        CALL IBCMD(0, scread$)        'Send MTA/MLA
        CALL IBRD(0, r$)              'Receive into program the display value
```



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## *RS-232C Programming*

This is to familiarize the new owner of an SC-5500 with the basics of programming the instrument via the RS-232C.

The SC-5500 can be controlled through the RS-232 by use of a standard terminal program. You will need to supply a NULL MODEM ADAPTER to use with a communications cable when attaching the SC-5500 to a communications port of a computer (Figure 4). The SC-5500 RS-232C communications interface is configured as a standard computer serial interface, thus in order for communications to take place, the talk and listen lines must be reversed. This is accomplished through the use of a null modem.

Once connected, the proper communication parameters must be entered through the options panel of the SC-5500. The default setting for serial communications on the SC-5500 are a baud rate of 9600, 8 data bits, no parity and one stop bit. Once configured, simple commands may be sent across the serial line to the SC-5500.

Commands given to the SC-5500 **must be sent in capital letters** and each command has to be followed with an **X**. For instance, to activate the AUTORANGE function via the terminal program, the following command must be sent , **A0X**. The **A0** is the actual command to instruct the SC-5500 to switch to the autorange mode. The **X** tells the SC-5500 to EXECUTE the command. Complete strings of commands may be sent all at once as long as the final command is the **X**. For example, to instruct the SC-5500 to switch to 4-1/2 digit mode, in autorange and use the voltage readout the following string can be sent, **H1A0C0X**.

When using a user designed terminal program in another language, like QuickBasic, standard communication program design must be followed. For instance, the command interface port must be OPENed using the standard **OPEN COM** statement, followed by the correct communication parameters such as baud rate, parity, data words and stop bits. The mode in which the port can be opened will determine in which direction data can be sent. For instance, if the port is opened as **FOR RANDOM** then the command to transmit and receive data to/from the SC-5500 may be sent. Then, use the method of the language that the program is being written in to send strings to the communications port.



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If, during the process of sending commands to the SC-5500, a string or character is sent that the SC-5500 does not recognize, an **INVALID COMMAND ERROR** status message will be displayed on the front panel of the SC-5500. The duration of the display will be as long as required to clear the buffer of the characters. If there is a sufficient amount of "garbage" characters in the buffer, it may become necessary to power off the SC-5500 and then power it back on.

The following program has been included to give an example on how to use QuickBasic to provide the interface to the SC-5500:

Programming Example:

```
initialization:
        OPEN "com1:9600,N,8,1,ASC" FOR RANDOM AS #1     'Open comm port 1 at 9600 baud, no
                                                        'parity, 8 data bits, 1 stop bit, ASC
                                                        'formatted data and in RANDOM
                                                        'mode for bi-directional
                                                        'communications
        PRINT #1, "C1H1L1X"                     'Set SC-5500 for 4 1/2 Digits, to Cal 0 and to '
                                                'Remote mode operation
        CLS
        SLEEP 1                                 'Pause for command to be processed by SC-5500
AutoRange:
        PRINT #1, "A0X"                         'Turn on Autorange
        SLEEP 5                                 'Pause for command to be processed by SC-5500
        PRINT #1, "A1X"                         'Turn off Autorange
ReadBack:
        PRINT #1, "O0X"                         'Send back one display value ie 1.0000E-3
                                                '<CR><LF>
        INPUT #1, reading$                      'Receive into program the display value
        CLOSE #1
```



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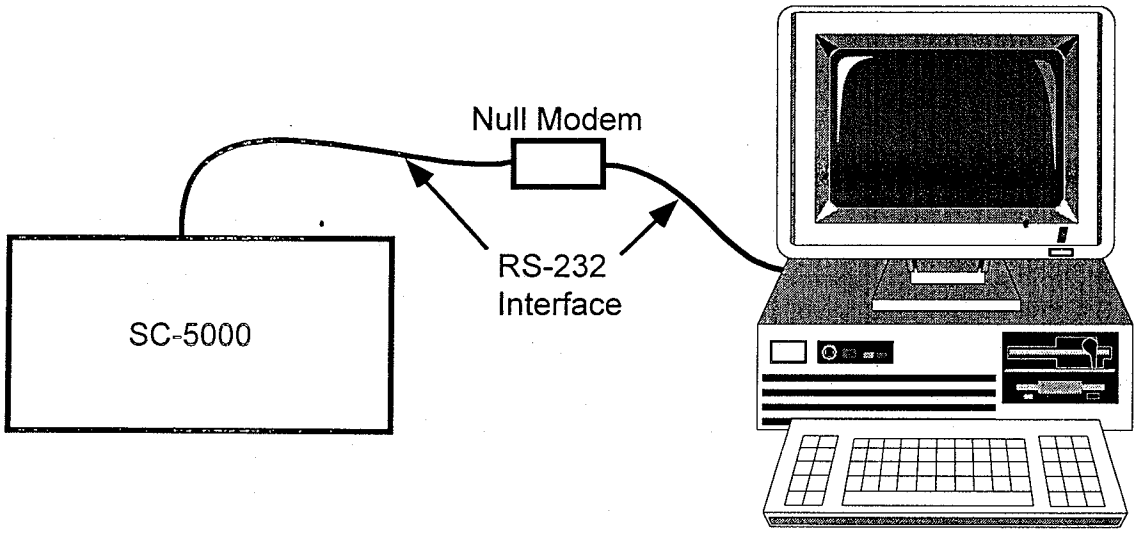



**Figure 5. Configuration of SC-5500 with an RS-232 interface.**



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# SPECIFICATIONS

## *Current Input Characteristics at 25•C*

| Range | Resolution | Accuracy (24-Hour) (% rdg. + counts) | Accuracy (1 Year) (% rdg. + counts) |
|---|---|---|---|
| 1 nA | 0.1 pA | 0.05 + 2 | 0.1 + 5 |
| 10 nA | 1 pA | 0.05 + 1 | 0.1 + 2 |
| 100 nA | 10 pA | 0.05 + 1 | 0.1 + 2 |
| 1 µA | 100 pA | 0.05 + 1 | 0.1 + 2 |
| 10 µA | 1 nA | 0.05 + 1 | 0.1 + 2 |
| 100 µA | 10 nA | 0.05 + 1 | 0.1 + 2 |
| 1 mA | 100 nA | 0.05 + 1 | 0.1 + 2 |

Temperature Coefficient: ± (0.02% of reading + 0.5 counts) per•C
Input Bias Current: 0.2 pA maximum

## *Voltage Input Characteristics at 25•C*

| Range | Resolution | Accuracy (24-Hour) (% rdg. + counts) | Accuracy (1 Year) (% rdg. + counts) |
|---|---|---|---|
| 10 mV | 1 µV | 0.05 + 2 | 0.1 + 5 |
| 100 mV | 10 µ V | 0.05 + 1 | 0.1 + 2 |
| 1 V | 100 µV | 0.05 + 1 | 0.1 + 2 |
| 10 V | 1 mV | 0.05 + 1 | 0.1 + 2 |
| 50 V | 5 mV | 0.05 + 1 | 0.1 + 2 |



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## *SC-5500 Specifications (continued)*

| | |
|---|---|
| Temperature Coefficient: | ± (0.02% of reading + 0.5 counts) per•C |
| Noise Referred to Input: | 100 nV RMS/(Hz)^.5 |
| Input Bias Current: | 10 pA maximum |
| Input Impedance: | • 100 Meg Ohm in parallel with • 100 pF |
| Analog Input: | Single Channel |
| Input Connector: | twist-lock-type triaxial |
| Isolation: | 500 volts to ground |
| Common Mode Voltage: | 10 volts |
| CMRR: | 120 dB at DC to 60 Hz |
| Bandwidth: | Detector dependent. 10 Hz at full bandwidth. |
| Maximum Reading Rate: | 12 readings per second |
| Maximum Input: | ± 70 volts or 10 mA |
| ADC Resolution: | 16 bits |
| Nonlinearity: | ± 1 count |
| Calibration: | No trim pots. All calibrations done digitally and correction factors stored in the EPROM. Up to 100 calibration coefficients may be stored in the EPROM. |
| Compatible Detectors: | Si, Ge, and PMT. |
| Power: | 100-120/220-240 VAC; 50/60 Hz 1/0.5 Amp |
| Operating Environment: | 0• to 50•C<br>0% to 70% relative humidity at 35•C<br>Linearly derates 3% relative humidity per •C from 35• to 50•C |
| Dimensions: | 8¨ W x 13.5¨ D x 3.5¨ H |
| Weight: | 8 lbs. (3.63 kg.) |
| Sensitivity: | 0.1 pA/1.0 µV |
| Resolution: | 4.5 digits |
| Computer Interface: | IEEE-488;<br>RS-232C (Default settings: 8 data bits, 1 stop bit, no parity, 9600 baud.) |



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# APPENDIX I. LIBRARY OF SC-5500 COMMANDS

This is a library of string commands that the SC-5500 controller will accept upon for various programming tasks. A string of up to 100 characters may be entered followed by a single **X** for execution of the string tasks.

Automatic Ranging

| | |
|---|---|
| **A0X** | Sets the SC-5500 into automatic ranging mode |
| **A1X** | Turns off auto ranging mode |

Calibrations

| | |
|---|---|
| **C0X** | Default VOLTAGE mode setting |
| **C1X** | Default CURRENT mode setting |
| **CnX** | Allows for switching to any factory programmed installed calibration position such as foot-lamberts or lumens. These calibrations are not defaults but customer requested. |

Data Relay

| | |
|---|---|
| **O0X** | Instructs the SC-5500 to send only ONE display reading across the serial bus. |
| **O1X** | Instructs the SC-5500 to send a continuous stream of readings from the front panel display across the serial bus |

Digit Display

| | |
|---|---|
| **H0X** | Formats the SC-5500 display to 3 1/2 digits |
| **H1X** | Formats the SC-5500 display to 4 1/2 digits |

Digital Filter

| | |
|---|---|
| **F0X** | Turns on the digital filter for smoothing of display readings |
| **F1X** | Turns off the digital filter |

Digital Output Control

| | |
|---|---|
| **PnJmX** | Sends a +5 volt level to the pin that corresponds with the bit number (**Jm**) of the port (**Pn**). (**n**) is a decimal number from 1 to 4; (**m**) is a decimal number from 1 to 8. |
| **PnKmX** | Sends a +0 volt level to the pin that corresponds with the bit number (**Km**) of the port (**Pn**). (**n**) is a decimal number from 1 to 4; (**m**) is a decimal number from 1 to 8. |



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Normalizing Data

**N1X** Sets the SC-5500 into the normalize mode

**N0X** Turns off the normalize mode

Manual Ranging

**RnX** Sets the dynamic range of the SC-5500 detector measurements. When measuring current, seven decades of dynamic range are available. When measuring voltage, five decades of dynamic range are available. In terms of instructing the SC-5500 which range to switch to use the chart below:

| Current Mode Ranges | | Resolution | Voltage Mode Ranges | | Resolution |
|---|---|---|---|---|---|
| R6X | E-3 | 1 mA | R0X | E-2 | 10 mV |
| R5X | E-4 | 100 uA | R1X | E-1 | 1 mV |
| R4X | E-5 | 10 uA | R2X | E-0 | 1 V |
| R3X | E-6 | 1 uA | R3X | E+1 | 10 V |
| R2X | E-7 | 100 nA | R4X | E+2 | 100 V |
| R1X | E-8 | 10 nA | | | |
| R0X | E-9 | 1 nA | | | |

Remote Operation

**L0X** Sets the SC-5500 in the remote control mode. In this mode the front panel controls of the instrument are deactivated.

**L1X** Turns off the remote control mode and reactivates front panel control of the instrument.

Zeroing Data

**Z0X** Sets the SC-5500 into the zero mode.

**Z1X** Turns off the zero mode.



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# APPENDIX II. OPTIONAL RACK MOUNTING KIT

The following procedure is provided for Labsphere instruments equipped with the optional rack mounting kit. The kit contains two brackets and mounting hardware. See Figure 6 below.

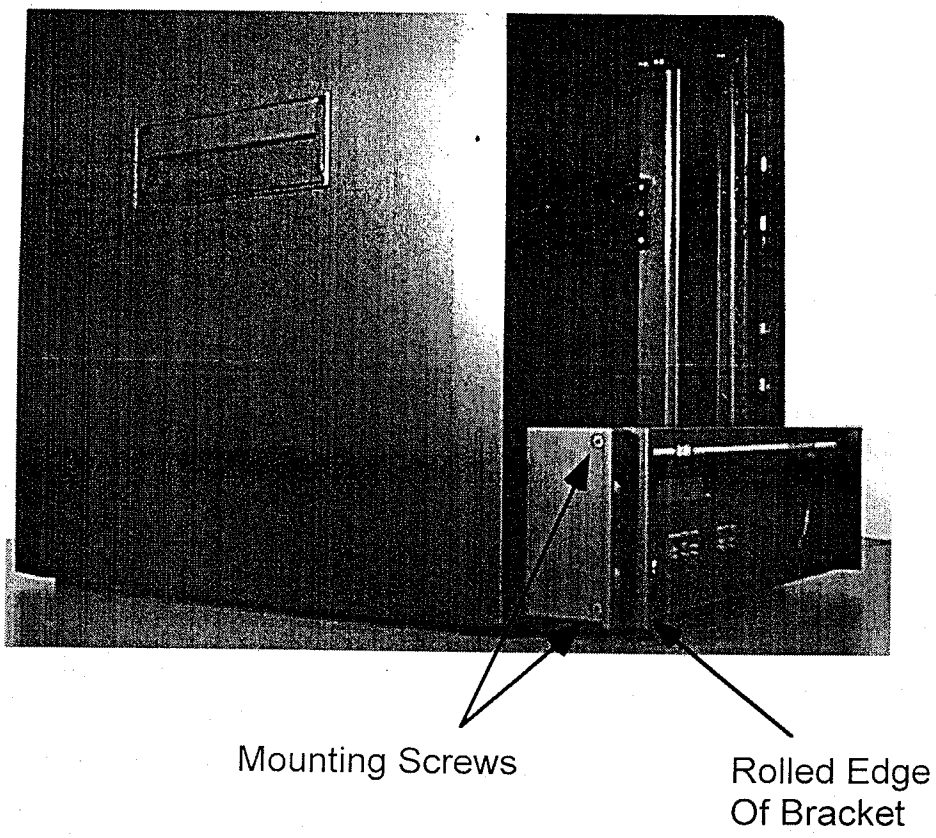



**Figure 6. Side view of instrument and rack.**

1. Place the instrument in the rack as shown in Figure 6.
2. Attach the brackets as shown, with the rolled edge positioned toward the front of the instrument. Use the two sets of 2 black flat-head screws provided to attach both brackets. Secure with a Phillips screwdriver.
3. Locate the four clip-type nuts provided, and position them on the rack as shown in Figure 7 and Figure 8.



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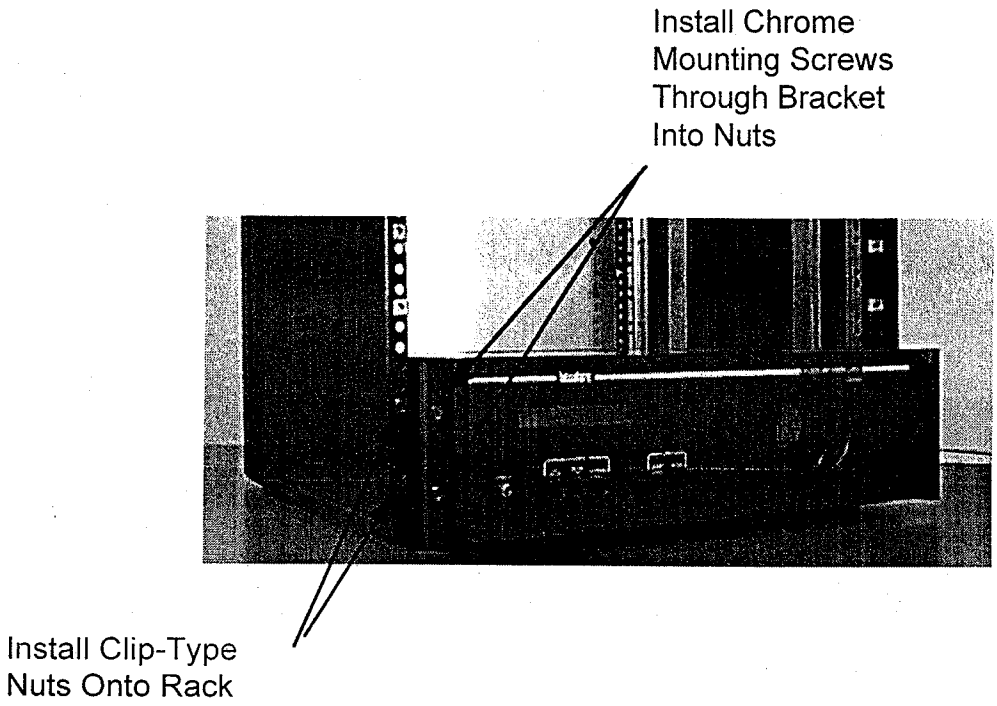



**Figure 7. Front view of rack and instrument.**

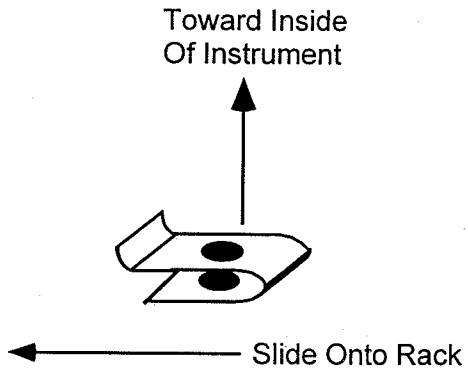



**Figure 8. Clip-Type Nut.**



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4. Install chrome mounting screws through brackets into the clip-style nuts as shown in Figure 7 and Figure 8. Secure with a Phillips screwdriver.

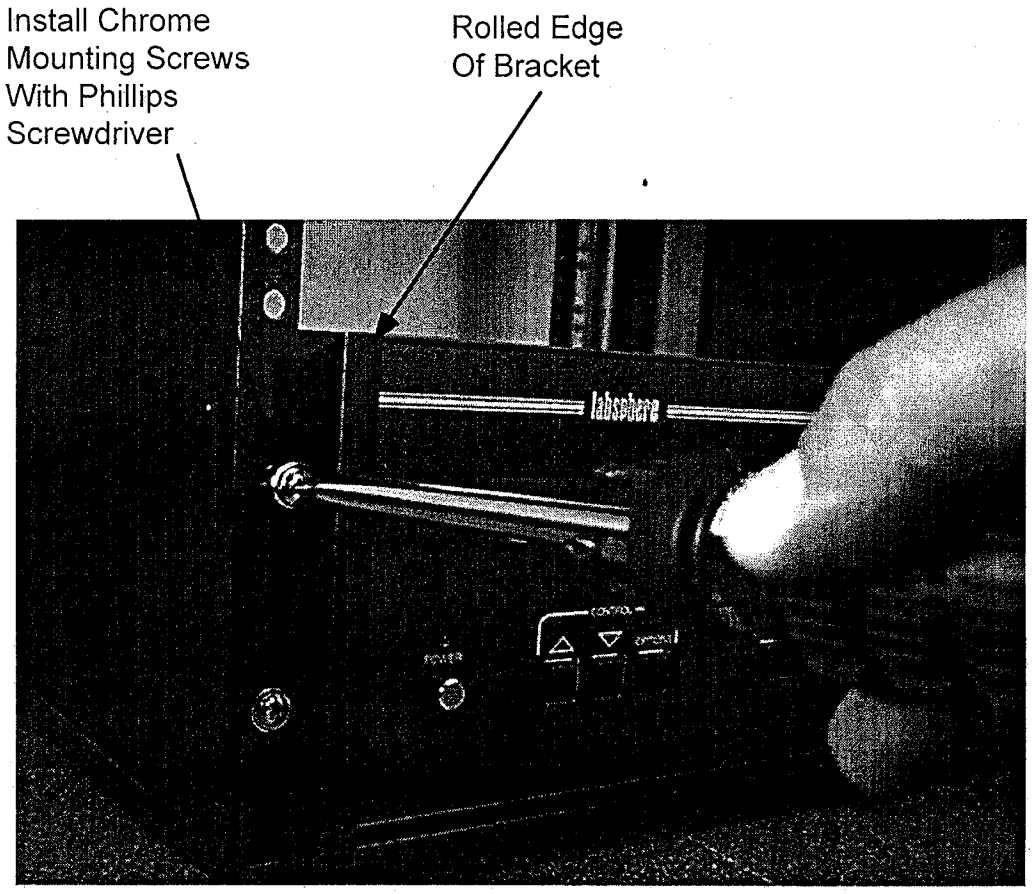



**Figure 9. Attaching chrome mounting screws.**

**This completes the installation of the Rack Mount Kit.**



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