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Operating Instructions Acton Series SP-2500i



0.500 Meter Focal Length Triple Grating Imaging Monochromator / Spectrograph

Acton SP-2500i Operating Instructions

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I: Brief Introduction and SP-2500i Description

Brief Introduction:

This instruction manual is intended to assist you in set-up and operation of your new SP-2500i monochromator/spectrograph. Even if you are an experienced user of spectroscopic equipment, we suggest that you follow the manual (at least initially) to insure proper setup and operation. If you have any questions about the information contained in this manual, please feel free to contact the Princeton Instruments customer service department at techsupport@princetoninstruments.com or (800) 874-9789 / (609) 587-9797.

SP-2500i Description:

The SP-2500i is a 500mm focal length monochromator/spectrograph. It features an astigmatism corrected optical system, triple indexable gratings and triple grating turret. The SP-2500i includes a direct digital grating scan mechanism with full wavelength scanning capabilities, plus built-in RS-232 and USB computer interfaces, for use with the supplied Monochromator Control software.

II: SP-2500i Specifications

Note: Each SP-2500i is operated for at least 15 minutes prior to calibration to insure optimum stability. End users should follow this practice if their application calls for optimum stability & reproducibility.

Every SP-2500i monochromator or spectrograph includes a triple grating turret for 1, 2, or 3 gratings, 32-bit microprocessor controlled scanning, built-in RS-232 and USB interfaces, and micrometer controlled entrance slit.

Specifications (1200g/mm Grating)

- Focal length:** 500 mm
 - Aperture Ratio:** f/6.5 (68x68mm gratings)
 - Optical Design:** Imaging Czerny-Turner with original polished aspheric mirrors (optional second entrance slit available)
 - Optical Paths:** 90° standard, 180° and multi-port optional
 - Scan Range:** 0 to 1400 nm mechanical range
 - Operating Range:** 185 nm to the far infrared with available gratings and accessories
 - Resolution:** 0.05 nm at 435.8 nm
 - Dispersion:** 1.7 nm/mm (nominal)
 - Accuracy:** ±0.2 nm
 - Repeatability:** ±0.05 nm
 - Drive Step Size:** 0.0025 nm (nominal)
 - Focal Plane Size:** 27 mm wide x 14 mm high
 - CCD Focus Arrangement:** Exclusive O-ring sealed sliding tube with unique 3-point focus stop/fine focus adjustment mechanism
 - Detector Coverage:** ~42.5 nm across a 1.0" wide focal plane (~85nm: 600 g/mm grating)
 - Standard Slits:** Micrometer adjustable from 10 µm to 3 mm wide. Slit heights: 4 & 14 mm
 - Grating Mount:** Triple grating turret for 1, 2, or 3 gratings
 - Interchangeable Grating Turrets:** Optional
 - Grating Change Time:** Less than 20 seconds
 - Grating Drive System:** 32-bit microprocessor controlled direct digital scanning (DDS) system.
 - Scan Linearity:** The SP-2500i scans linear with respect to wavelength
 - Size:** 21" long (534 mm) 11" wide (280 mm) 8" high (203 mm) 4.875" (123.8 mm) optical axis height
 - Weight:** 40 lbs (18 kg)
- Tested and conforms to **European CE Standards**

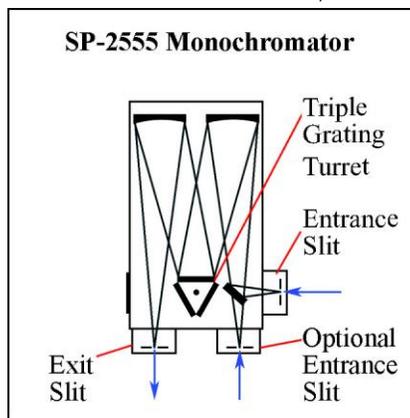


Figure 1. Includes a 90° optical path, and micrometer adjustable entrance and exit slits.

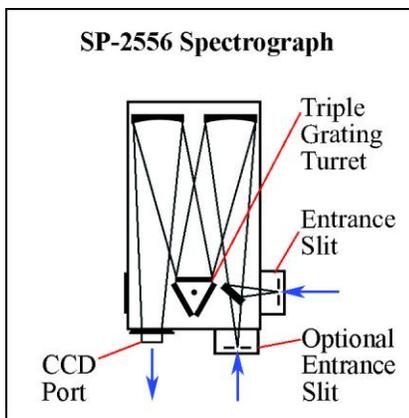


Figure 2. Includes a 90° optical path, large 14 mm X 27 mm focal plane, plus sliding tube CCD adapter with exclusive focus-stop.

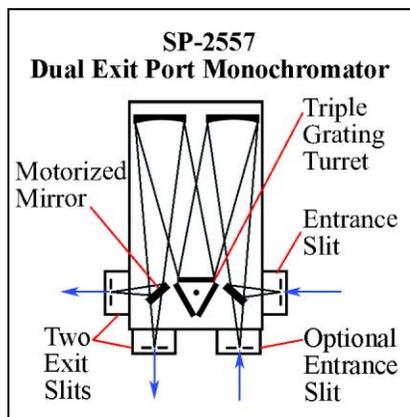


Figure 3. Includes micrometer controlled dual exit slits (90° & 180°), and motorized mirror for rapid, computer-controlled exit slit selection.

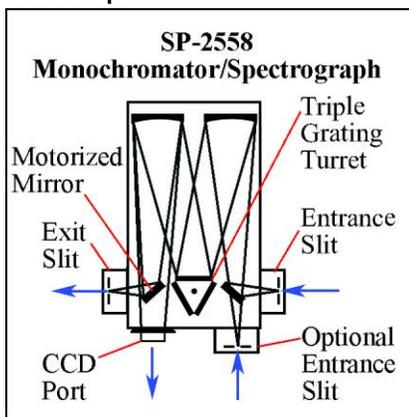


Figure 4. Includes dual exit ports; one exit slit and one sliding CCD adapter with motorized mirror for rapid, computer-controlled exit slit selection.

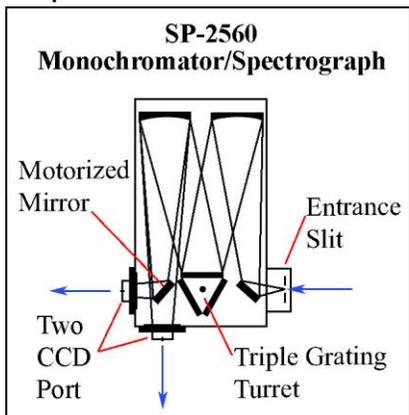


Figure 5. Includes dual exit ports; two sliding CCD adapters with motorized mirror for rapid, computer-controlled exit port selection.

III. SP-2500i Setup

Section III-A: Unpacking and Inspection

Carefully unpack and examine the SP-2500i and any accessories purchase.

Note: Report any damage immediately to the carrier and to Princeton Instruments, and save the packing material.

Section III-B: Connecting the SP-2500i Monochromator/Spectrograph to the Computer

The SP-2500i is designed for operation by computer using RS-232 or USB, and this method of control enables wavelength scanning at a pre-set linear scan rate, change of scanning speeds, grating selection, rapid GOTO wavelength positioning, change of grating turrets if available, and "jog" wavelength positioning. Figure 6 on the next page shows the cable connections necessary for operation from a computer through the COM ports or with USB. Refer to the Monochromator Control software for Windows for operation with a computer.

Controlling the SP-2500i with Monochromator Control Software:

The Monochromator Control software is a stand-alone Acton Series software program for basic scanning and calibration. Utilities for grating updates and communications are also included. Normally, the software is installed in the directory C:\Program Files\Princeton Instruments\MonoControl. This directory contains the subdirectories Bin and Data. The Bin directory contains the executable code for the program.

Upon installation, a Monochromator Control icon is usually placed on the desktop for starting the software. If this icon is not on the desktop, check for the program in the Windows Start menu\Programs or go directly to the MonoControl\Bin directory and start the software there. When the Monochromator Control software loads, there is a main screen with selections for monochromator operation and for various setup functions. (If the buttons are grayed out, exit the program, connect an Acton Series spectrometer, wait for the spectrometer to initialize, and then restart the program.) Click on the Operation button and a screen will come up which allows for basic control of the monochromator wavelength. All functions of this software are described in the Monochromator Control software manual supplied on the Monochromator Control software install CD.

Controlling the SP-2500i Monochromator at the Command Level:

Although it requires more programming on the user's part, the monochromator can also be controlled with direct commands through its USB 1.1 port or RS-232 port. This operation is described in Section IV.

SP-2500i Cable Connections: RS-232 or USB

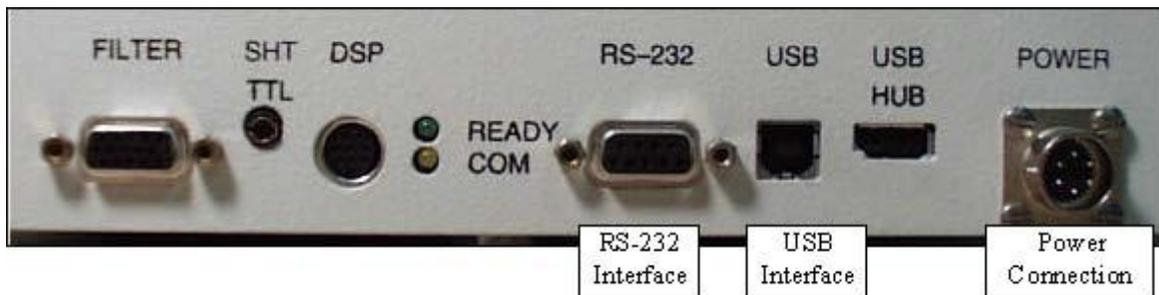


Figure 6. Details of the RS-232, USB, and Power Connections on the SP-2500i

Section III-C: Cables and Connections for SP-2500i

The following computer cables are supplied with the SP-2500i:

- CC-499-2 IBM AT or compatible 9 pin female (DB9S) connector to 9 pin male connector (DB9P).
- 3650-USB-06 USB Cable Type A to Type B.

If neither of these cables are compatible with your system, consult Princeton Instruments for a custom cable. If you have facilities for constructing a custom cable, use the RS-232 pin arrangement shown in Table 1. See also Appendix B.

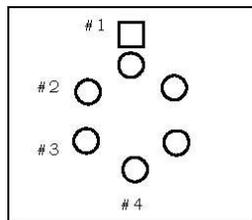
Table 1: RS-232 Computer Interface Pin Arrangement:

Pin#	Description
1	Open
2	RD data from SP-2500i to computer
3	TD data from computer to SP-2500i
4	open
5	Ground
6	Open
7	RTS
8	CTS
9	open

A terminal or RS-232 computer port must be set up as follows: 9600 baud, 8 data bits, no parity, 1 start bit, 1 stop bit.

Table 2: Power Input Pin Arrangement:

Pin#	Description
1	+5V
2	GND
3	GND
4	+24



Section III-D: Mounting Accessories to the SP-2500i Slit Assemblies

All Acton accessories come with their own set of instructions for proper mounting and operation. The instructions below are only general information. Please refer to the individual instructions for detailed information.

Accessories: The full range of Acton accessories mount directly to the SP-2500i slit assemblies. To assist you in mounting accessories, a drawing of the standard slit assemblies has been provided in Appendix V-C. The general procedure for mounting an accessory to the slit is as follows:

1. Place the accessory directly against the face of the slit body. Light sources normally mount on the entrance slit, detectors on the exit slit. Other accessories such as fiber bundles normally mount on the entrance slit, but are also compatible with the exit slit.
2. Using four (4) 8-32 screws normally provided with the accessory, secure the accessory to the slit body.

Light sources fitted with light collection/focusing optics are normally factory aligned to the standard slit.

Note: In some instances with light sources, there is limited access to the bottom two screw holes. In this case, Princeton Instruments provides special slotted holes in the light source housing to facilitate mounting of the source to the slit.

Section III-E: Detector Mounting Instructions: Mounting Focal Plane Detectors to the SP-2500i Spectrograph

The standard mounting flange for CCDs and diode arrays accommodates detectors with two different bolt circles. There are three (3) equally spaced #10-32 tapped holes on a 3.60" bolt circle, and three (3) equally spaced holes on a 3.88" bolt circle designed to accept #10-32 button head screws. A baffle is mounted in the array detector mounting flange to define the focal plane area. This baffle has two sets of mounting holes 90 degrees apart which permit the mounting to be rotated 90 degrees to accept different array detectors.

To mount an array detector to the SP-2500i, use the following procedure:

1. The array detector mounting flange has a sliding tube, which fits inside the front plate of the SP-2500i.

Note: At this point it is very important to check the focal plane distance of the array detector. This is the distance from the front mounting surface of the array detector to the actual CCD or diode array element. Because array detector focal distances vary, the correct distance is crucial in order to determine if a spacer is required for proper focus. This spacer is provided with spectrographs. If the detector focal plane distance falls between .67" and 1.00", then no spacer is required.

2. Using a 1/8" Allen wrench, loosen the two (2) set screws located at the top and side of the front plate. Gently slide the array detector mounting flange all the way out of the SP-2500i housing. Make sure that the sliding tube and O-ring are kept clean.
3. Remove the shipping cover from the sliding tube, and the spacer if not required.
4. Position the array detector mounting flange against the array detector, and match the hole patterns. When correctly positioned, the baffle aperture orientation should match the detector array orientation. If it does not align properly, contact Princeton Instruments.

Note: Refer to the Detector System Manual for specific instructions on how to mount the array detector to the mounting flange. These instructions vary with the detector nose design.

5. Fasten the array detector mounting flange to the detector. Then, carefully slide this assembly back into the SP-2500i housing.
6. Tighten the #10-32 set screw on the top of the front plate first, and then tighten the one on the side.

Section III-F: Slit Width Adjustments in the Model 716 Bilateral Slits

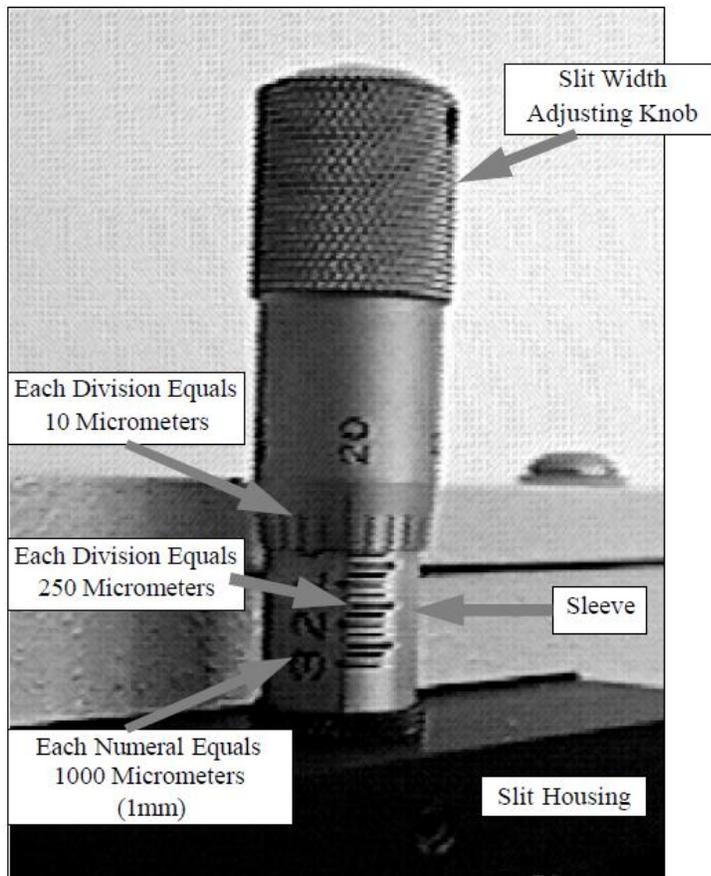
The slit width of each bilateral slit assembly (716 type) is adjustable from 0.010 millimeters to 3 millimeters (10 to 3,000 μm) by a micrometer knob located on the top of the slit housing. The micrometer knob is graduated in 0.010 millimeter (10 μm) increments.

Each clockwise revolution of the micrometer knob increases the slit width 0.25 millimeters (250 μm). For maximum reproducibility, the slit width should be set in a clockwise direction (increasing slit widths) each time it is changed. Refer to the drawing below.

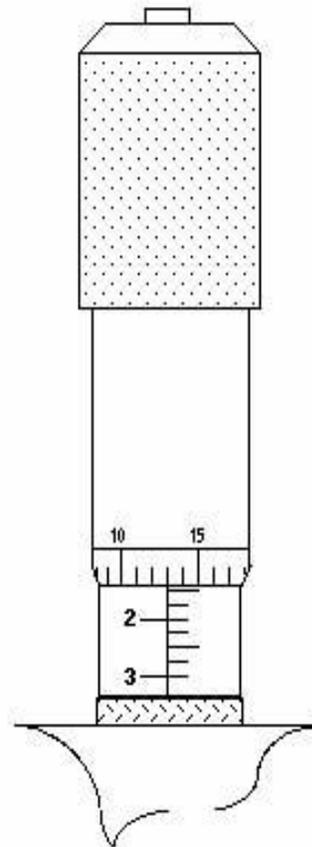
The micrometer knob should not be rotated below a reading of 0.00 or above 3.00. A micrometer setting of less than 0.010 millimeters (10 μm) should not be used, because a stop is provided to prevent the slit jaws from contacting each other.

Note: Damage May Be Done If Slit Jaws Are Opened Wider Than 3.0 mm.

Slit Width Micrometer Settings Slit Width Adjustable from 10 Micrometers to 3000 Micrometers (3 mm)



**Figure 7. Slit Width Setting:
200 Micrometers (0.200 mm)**



**Figure 8. Slit Width Setting:
1380 Micrometers (1.38 mm)**

IV: SP-2500i Operation

Section IV-A: Initialization

When power is turned ON to the SP-2500i, it initializes to a wavelength of 0.0nm for grating number 1. If the power is switched OFF and then ON again to the SP-2500i, it will re-initialize. Initialization gives the system a reference, or starting position to keep track of wavelength position, grating location, and other parameters. Alternative start-up parameters can be programmed if the factory defaults are not suitable (See Appendix A).

Section IV-B: Operating the SP-2500i Using a Computer

The Acton series Monochromator is controlled from a computer using the supplied Monochromator Control Software and using the RS-232 or USB interface. Princeton Instruments' WinSpec or SpectraSense software can be used to operate the instrument.

Controlling the SP-2500i Monochromator at the Command Level:

Although it requires more programming on the user's part, the monochromator can also be controlled with direct commands through its USB 1.1 port or RS-232 port. The same command set, listed below, is used for both RS-232 and USB.

Commands can be sent as single commands or grouped in strings of commands. All commands are single words (contain no spaces) and all commands in a string are separated by at least one space. Parameters, if needed, precede the command and are separated from the command by at least one space (e.g., 546.07 GOTO).

For RS-232 operation, the port set-up is 9600 baud, 8 data bits, 1 stop bit and no parity. A convenient tool for trying out this mode of operation is the program HyperTerminal supplied with the Windows operating system. The USB 1.1 port with the driver supplied also shows up as and is treated like a com port – although a very fast one. All commands or strings of commands must be terminated with a carriage return (0D hex). The monochromator responds to a command when the command has been completed by returning the characters OK followed by carriage return and line feed (hex ASCII sequence 20 6F 6B 0D 0A). The default condition is to echo each character that is sent to the monochromator with the RS-232 interface and to not echo the commands when using the USB interface. When sending a command or string of commands, it is important to wait for the monochromator to complete the processing of that command string before sending another command.

Monochromator Wavelength Movement Commands:

GOTO	Goes to a destination wavelength at maximum motor speed. Accepts destination wavelength in nm as a floating point number with up to 3 digits after the decimal point or whole number wavelength with no decimal point.
<GOTO>	Same as GOTO (For compatibility with software written for previous Acton SP series models.)
NM	Goes to a destination wavelength at constant nm/min rate specified by last NM/MIN command. Accepts destination wavelength in nm as a floating point number with up to 3 digits after the decimal point or whole number wavelength with no decimal point.
<NM>	Same as NM (For compatibility with software written for previous Acton SP series models.)
>NM	Similar to NM except it returns control to user immediately rather than waiting for completion of monochromator wavelength move. Can be used with ?NM or MONO-?DONE below. This command must be terminated with MONO-STOP listed below. Note: Use the NM command when communication with the monochromator during the scan is not required.
?NM	Returns present wavelength in nm to 0.01nm resolution with units nm appended. e.g., ?NM 300.00 nm
MONO-?DONE	Used with >NM command to determine if monochromator has reached the destination. Returns 0 if move is not complete, 1 if move is complete.
MONO-STOP	Stops the monochromator wavelength move after use of the >NM command.

NM/MIN Sets the scan rate in nm/min to 0.01 nm/min resolution with units nm/min
?NM/MIN Returns present scan rate in nm/min to 0.01 nm/min resolution with units nm/min

Grating Control Commands:

GRATING Places specified grating in position to the wavelength of the wavelength on the present grating. Up to nine (9) gratings are allowed on three (3) turrets. This command takes a grating number from 1 - 9. **IMPORTANT NOTE:** This command assumes that the correct turret is specified by the **TURRET** command. For example, using grating numbers 1, 4 and 7 will place the first grating on the installed turret into that position and call up the parameters for the grating number specified.

?GRATING Returns the number of gratings presently being used numbered 1 - 9.

?GRATINGS Returns the list of installed gratings with position groove density and blaze. The present grating is specified with an arrow.

TURRET Specifies the presently installed turret or the turret to be installed.
e.g., if installing the second turret, issue the command 2 **TURRET** to insure using the correct parameters.

?TURRET Returns the correctly installed turret numbered 1 - 3.

The following command is used for grating installation by Acton part number:

INSTALL Installs new grating parameters into the non-volatile memory of the SP-2500i monochromator. Uses the part number of the grating to specify the parameters.
e.g., 1-120-500 5 **INSTALL** places a 1200 g/mm grating blazed at 500nm into the second grating position on turret number 2.

The following commands are used for grating installation by grating parameters:

SELECT-GRATING Specifies the grating number to be installed 1 - 9.

G/MM Specifies groove density of grating to be installed in g/mm.
e.g., 1200 G/MM

BLAZE Specifies the blaze wavelength and units of the grating to be installed with 7 characters of the user's choice. Unlike other commands, this command is issued before the parameters. After the command is issued, the SP-2500i responds with "" . Seven characters are then entered (these may be numbers, letters, spaces or special characters).

UNINSTALL Used to remove a grating and its parameters from the SP-2500i non-volatile memory.

Diverter Control Commands:

EXIT-MIRROR Designates the exit diverter mirror to receive the diverter control commands. This command is for Acton SP series monochromators that can accept two diverter mirrors. The SP-2500i monochromators will accept this command but it is not required in these monochromators.

ENT-MIRROR Designates the entrance diverter mirror to receive the diverter control commands. This command is for Acton SP series monochromators that can accept two diverter mirrors. The SP-2500i monochromators will not accept this command.

FRONT Moves the designated diverter mirror to position the beam to the front port position.

SIDE Moves the designated diverter mirror to position the beam to the side port position.

?MIRROR Returns the position of the designated diverter mirror with the responses "**front**" and "**side**".

?MIR Returns the position of the designated diverter mirror with the responses **0** for front and **1** for side,

Slit Width Control Commands (for Motorized Slits only):

FRONT-EXIT-SLIT	Designates front exit slit to receive slit control commands. Note: The designation remains in effect until changed by another slit designator. This command does not have to be repeated until the designated slit is changed.
SIDE-EXIT-SLIT	Designates side exit slit to receive slit control commands.
FRONT-ENT-SLIT	Designates front entrance slit to receive slit control commands.
SIDE-ENT-SLIT	Designates side entrance slit to receive slit control commands.
MICRONS	Sets the slit width for the designated slit in the range of 10 to 3000 microns to 1 micron resolution.
?MICRONS	Returns the slit width setting in microns to the nearest 1 micron.

Grating Calibration Commands:

INIT-OFFSET	Sets the offset value for the designated grating. Default values are 0 for gratings 1, 4 and 7; 1536000 for gratings 2, 5 and 8; and 3072000 for gratings 3, 6, and 9. The limits on the settings are +/-2500 for a 1200 g/mm grating. This corresponds to an error of greater than +/- 5 nm for a 1200 g/mm grating. The limits are adjusted for grating groove density, e.g., error for a 600 g/mm grating is +/- 5000. The grating density designator used with this command is grating number - 1. e.g., 3072056. 8 INIT-OFFSET for setting offset on grating number 9 - 3rd grating on turret number 3. Note: This command requires a decimal point after the offset value.
INIT-GADJUST	Sets grating adjustment value for the designated grating. Default values are 10000 for all gratings. The limits on the parameter for this command are +/- 1000 for all gratings. The grating designator used with this command is the grating number 1. e.g., 9993 1 INIT-GADJUST for setting gadjust on the second grating of turret number 1. Note: This command is to maintain compatibility with previous Acton SP series applications. For new applications, use the INIT-SP500-GADJUST command below.
MONO-EESTATUS	Returns setup and grating calibration parameters for all gratings.
RESTORE FACTORY SETTINGS	Returns all parameters including grating calibration parameters to the original factory calibrated settings. Note: This command will overwrite any calibration parameters set by the user.
MONO-RESET	Initializes Acton SP series monochromator. Necessary after using INIT-OFFSET, INIT-GADJUST.
HELLO	Same as MONO-RESET. Used to maintain compatibility with existing applications.
MODEL	Returns model number of the Acton SP series monochromator. e.g., MODEL SP-2558
SERIAL	Returns serial number of the Acton SP series monochromator. Format is 7 digits with the first 3 digits being the model number. e.g., SERIAL 25060232

The following are the Start-Up parameters and their default values:

Default Values: TURRET #1 GRATING #1 WAVELENGTH
0.0 nm SCAN SPEED 100.0 nm/min

INIT-GRATING Selects which of the three gratings on the installed turret the SP-2500i will go to after finding 0.0 nm on the first grating of the installed turret. e.g., 2 INIT-GRATING selects the second grating as the default. Accepts values 1 - 9.

INIT-WAVELENGTH Sets an initial wavelength for the SP-2500i after initialization. e.g., 435.84 INIT-WAVELENGTH

INIT-SRATE Sets an initial scan rate for the SP-2500i. e.g., 500.0 INIT-SRATE

Section IV-C: Focusing and Alignment of Array Detectors

With the array detector properly mounted to the SP-2500i, use the following procedure to align and focus the array detector to the SP-2500i optical system. It is assumed that the array detection system is running with SpectraSense or WinSpec.

1. Mount a light source such as a mercury pen-ray type to the entrance slit of the SP-2500i. Princeton Instruments offers a standard mercury lamp, Model MS-416, designed for this purpose. Any light source with line output can be used. If there are no "line" sources available, it is possible to use a broad band source such as tungsten for the alignment. If this is the case, use only a wavelength setting of 0.0nm for alignment purposes.
2. With the SP-2500i properly connected to the controller or computer, turn the power ON and move the spectrograph to a wavelength of 435.8 nm if using a mercury lamp, or 0.0 nm for a broad band source, or another wavelength corresponding to a spectrum produced by another "line" source.
3. With the array detector operating, check the image of the light source if running in an imaging mode with a CCD. Otherwise check the line intensity and shape.
4. Using a 1/8" Allen wrench, loosen the two (2) #10-32 set screws (approximately 2 turns) located on the top and side of the front plate, and slowly slide the array detector IN or OUT until the sharpest image is achieved, or the sharpest line is achieved.

CAUTION: The set screws must be loose when turning the thumb wheel adjustment, or severe damage will occur. The distance between the edge of the array detector mounting flange and the instrument MUST NOT exceed .33".

5. Move the thumb wheel until it just makes contact with the array detector mounting flange. This enables you to rotate the detector without changing the focus position. Rotate the detector for correct alignment. The thumb wheel adjustments may be used to precisely position the detector -one eighth of a turn of the thumb wheel changes the detector position by approximately 1/10th of a millimeter.
6. After each adjustment, ensure the array detector mounting flange is in contact with the thumb wheel and the two (2) push screws. Tighten the #10-32 set screw on the top of the front plate first, and then tighten the one on the side to secure the detector.
7. Best spectral resolution is obtained when the array detector is aligned to the SP-2500i. The light source can be removed if desired, and replaced by fiber optics or other light sources.
8. If fibers or other imaging optics are used to bring light into the SP-2500i, they may require adjustment along the optical axis to achieve best vertical image quality.

Section IV-D: Converting the SP-2500i from Monochromator to Spectrograph, or Spectrograph to Monochromator

Monochromator to Spectrograph: This procedure requires that you have the monochromator version, Model SP-2555 or SP-2557, plus the array detector mounting flange. May require a spacer.

1. Using a 1/8" Allen wrench, loosen the two (2) #10-32 set screws located on the top and side of the front plate.
2. Remove the four (4) 8-32 socket head cap screws (SHCS) which secure the exit slit to the SP-2500i housing. Details of the slit assemblies can be found in the drawing located in the Appendices Section.
3. Gently slide the exit slit assembly out of the SP-2500i housing and store in a clean, dry area. An exit slit assembly is attached to a sliding tube which is removed along with the slit body.
4. Slide the array detector mounting flange into the SP-2500i housing so that it rests against the housing. It may be necessary to turn the focus-stop thumb wheel counter clockwise so that it does not interfere with the array detector mounting flange.
5. The SP-2500i has now been converted from monochromator to spectrograph.
6. Refer to Sections III-E "Mounting Focal Plane Detectors..." and IV-C "Focus and Aligning Array Detectors" for actual mounting, alignment, and focus of array detectors.

Spectrograph to Monochromator : This procedure requires that you have the spectrograph version, Model SP-2556 or SP-2558, plus the Model SP-716-2 exit slit assembly. May require a spacer.

1. Using a 1/8" Allen wrench, loosen the two (2) #10-32 set screws located on the top and side of the front plate.
2. Gently slide the array detector mounting flange out of the SP-2500i housing.
3. Remove the array detector if attached, then store the array detector mounting flange in a clean, dry place.
4. Locate the Model SP-716-2 exit slit assembly, then gently slide it into the SP-2500i housing until it rests against the housing. Exit slit assemblies are attached to a sliding tube to fit the SP-2500i housing.
5. Using four (4) 8-32 socket head cap screws (SHCS), secure the slit assembly against the SP-2500i housing. There are four (4) tapped holes in the SP-2500i housing to facilitate mounting the exit slit.

Note: The slit aperture is slightly offset in the slit assembly. It should be oriented so that the aperture is on the upper side when properly mounted to the SP-2500i. On the bilateral slits, the micrometer points upward. Please refer to the drawing in the Appendices section of this manual for correct orientation if necessary.

6. The SP-2500i has now been converted from spectrograph to monochromator.

V: Appendices and Schematic Drawings

Appendix V-A: Selecting Alternate Start-Up Parameters

The following are the Start-Up parameters and their default values:

GRATING	#1
WAVELENGTH	0.0 nm
SCAN SPEED	100.0 nm/min

Each of the above may be changed through the RS-232 port or USB port using the following commands. These values are stored in non-volatile memory and will be in effect after the next power-up.

INIT-GRATING	Selects which of the two gratings on the installed turret the SP-2500i will go to after finding 0.0 nm on the first grating. e.g., 2 INIT-GRATING selects the second grating as the default
INIT-WAVELENGTH	Sets an initial wavelength for the SP-2500i after initialization. e.g., 435.84 INIT-WAVELENGTH Notice that two digits after the decimal point are required.
INIT-SRATE	Sets an initial scan rate for the SP-2500i. e.g., 500.00 INIT-SRATE Notice that two digits after the decimal point are required.

The following command is used to return all grating parameters and start-up parameters to the original factory settings. **Note:** Any gratings installed at a later date (after initially receiving the SP-2500i) will be erased from memory using this “restore command”.

RESTORE-FACTORY-SETTINGS Returns all parameters, including grating calibration parameters, to the original factory calibrated settings. **Note:** This command will overwrite any calibration parameters set by the user.

Appendix V-B: Cable Connection Diagrams - Monochromators & Spectrographs to Computer

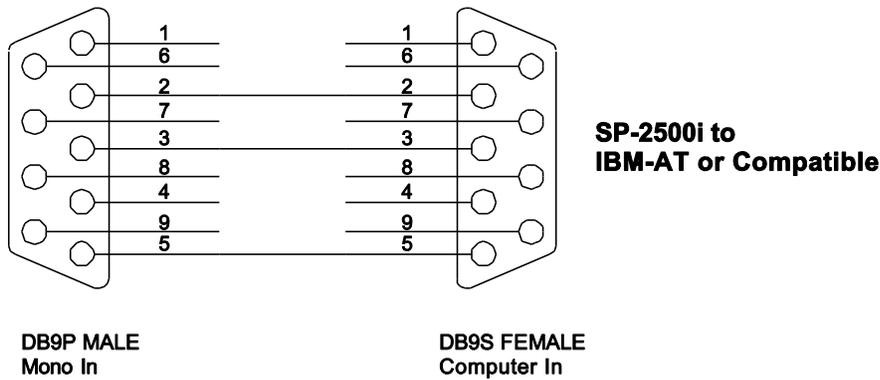


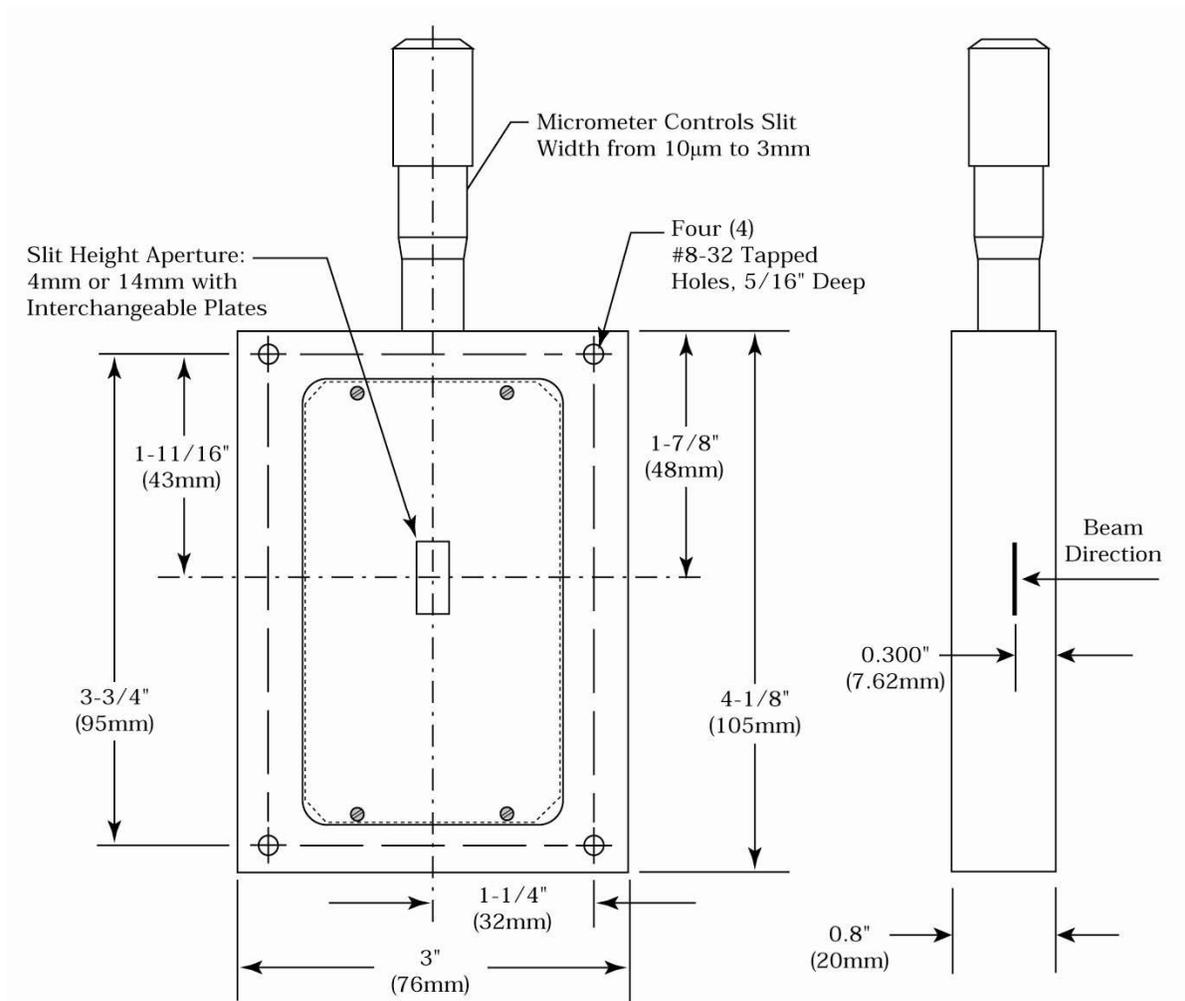
Figure 9. RS-232 Cable Wiring



Figure 10. Cable Connections (Back Panel)

- POWER** Power connection +5 and +24 Volts
- USB HUB** USB Hub 1.1 compatible.
- USB** USB connection to computer.
- RS-232** RS-232 connection to computer.
- READY** Ready light is on when the instrument is ready to operate. (Green light comes on after the instrument initializes. Yellow = busy)
- COM** Com light flashes when communicating with the computer.
- DSP** DSP connection to connect two monochromators as doubles.
- SHT TTL** SHT TTL connection for TTL control of shutter.
- FILTER** Filter driver connection for Acton FA-2448 Filter Wheel

Appendix V-C: Standard Slit Assembly Drawing



Appendix V-D: Accessories Listing

SP-2500i Monochromators & Spectrographs

- SP-2555** **SP-2500i, 500mm Monochromator:** Micrometer adjustable entrance/exit slits, 90° optical path, internal image correction with original polished aspheric optics, a triple grating turret, exclusive SpectraDrive™ stepping motor scanning system with 32-bit microprocessor control, RS-232 and USB computer interfaces, plus scan control software for Windows. Computer with RS-232 or USB and gratings are required for operation.
- SP-2556** **SP-2500i, 500mm Spectrograph:** Same as above Model SP-2555, except with micrometer controlled entrance slit, 14 mm X 27 mm focal plane, sliding tube CCD adapter with exclusive focus stop and standard multichannel detector adapter flange. Provides a 90° optical path.
- SP-2557** **SP-2500i, 500mm Dual Exit Port Monochromator:** Same as SP-2555, except with micrometer controlled entrance slit, two micrometer controlled exit slits and a motorized exit port selection mirror. Provides 90° and 180° optical paths.
- SP-2558** **SP-2500i, 500mm Monochromator/Spectrograph:** Same as SP-2555, except with micrometer controlled entrance and exit slits 180° apart, motorized port selection mirror and multichannel detector adapter on 90° port.
- SP2560** **SP2500i, 500mm Spectrograph:** Same as SP-2558, except with side exit port fitted for second multichannel detector adapter (detector adapters on 90° and 180° exit ports). Make(s) and Model(s) of both array detectors and positions must be provided. For example: Princeton Instruments PIXIS:400BR on front exit and Photometrics Cascade II:512 on side exit.

Slit Assemblies: Bilaterally Adjustable

- SP-716-1** **Bilaterally adjustable ENTRANCE slit assembly** for SP-2500i monochromator or spectrograph. Micrometer adjustable widths from 10 µm to 3mm. Supplied with interchangeable 4.0 mm and 14.0 mm high baffles.
- SP-716-2** **Bilaterally adjustable EXIT slit assembly** with adapter for SP-2500i monochromator. Micrometer adjustable widths from 10 µm to 3 mm. Supplied with interchangeable 4.0 mm and 14.0 mm high baffles.

Triple Grating Turret

- 500-483** **Interchangeable triple grating turret** for the SP-2500i. Requires gratings. Optional second and third turrets.

Other Acton Series Monochromators & Spectrographs

The Acton Series of instruments are also available in 300, 500, and 750 mm focal lengths, each with multiple configurations. Contract your sales engineer or visit our website www.princetoninstruments.com for details.

Light Sources

Sources with 220 V, 50 Hz area also available in all models.

- MS-416** **Low Pressure Mercury Light Source** with power supply and mounting flange for Acton series monochromators and spectrographs. Provides output at typical mercury wavelengths (line output).
- DS-421** **30 Watt Deuterium Light Source** with housing, power supply, mounting flange, and light collection mirror. Provides output from 190 to 350 nm.
- TS-425** **30 Watt Tungsten-Halogen Light Source** with housing, power supply, mounting flange, and light collection mirror. Provides output from 350 nm to >2.0 µm
- TS-428** **250 Watt Tungsten-Halogen Light Source** with housing, AC power supply, mounting flange, variable brightness control and light collection mirror. Provides output from 350 nm to >2.0 µm.

- TS-428-DC** Same as **TS-428** with Regulated DC Power Supply.
- TDS-429** **Dual Light Source** with 30 watt deuterium & 30 watt tungsten-halogen lamps. Includes housing with light collection mirror, mounting flange, and power supply. Provides combined output from 190 to >2.0 μm .
- XS-433** **75 Watt Xenon Light Source** includes power supply, housing, mounting flange and light collection mirror. Provides continuous spectral output from 190 nm to 750 nm and declining continuum out to 2.6 μm .

Detectors and Accessories All detectors include mounting flanges for Acton Series and SpectraPro slit assemblies.

- PD-438** **Universal Photomultiplier Tube Housing** for standard 1 1/8" side window photomultiplier tubes. Requires side window PMT, and photometer/power supply for operation. Accepts Acton tubes P1, P2 or P3 below, or customer specified 1 1/8" side window PMTs.
- PD-439** Same as PD-438 above, also includes integrated **light tight shutter**.
- PD-471** **Photomultiplier Tube Housing** for 1 /8-inch tubes with built in HV supply. Only for SpectraHub.
- P1** **Side Window Photomultiplier Tube** (or equivalent) for wavelength region 185-650 nm. Fits PD-438, PD-439, or PD-471 housing.
- P2** **Side Window Photomultiplier Tube** (or equivalent) for wavelength region from 185-900 nm. Fits PD-438, PD-439, or PD-471 housing.
- P3** **Side Window Photomultiplier Tube** (or equivalent) for wavelength region from 300-1100 nm. Fits PD-438, PD-439, or PD-471 housing.
- SI-440** **General-purpose Single Channel Detector** with a 10 mm diameter active area for use from 400 to 1100 nm. Enclosed in housing with the BNC connector.
- SI-440-UV** **Single Channel Detector** with a UV-enhanced, 10 mm diameter active area for use from 200 to 1100 nm operation.
- SCA-440-UV** **Source Compensation Accessory** with UV silicon photocell (positive current) and housing with beam splitter that redirects a portion of the beam to the UV silicon photocell. Compensates for source fluctuations at a target wavelength. Mounts on the exit slit of a monochromator that is used for illumination.
- ID-441** **InGaAs Detector**, includes pre-amplifier, uncooled version.
- ID-441-C** **InGaAs Detector**, includes pre-amplifier, cooled version, requires Model 442-1A thermoelectric cooling for operation.
- 442-1 A** **Thermoelectric cooling** for ID-441-C detectors.
- SpectraHub** **SpectraHub data acquisition system**, 20-bit A-D converter, single channel detector interface. Requires SpectraSense software.

Filter Wheels and Order Sorting Filter Assemblies

- FA-2448** **Six Position Filter Wheel Assembly.** Manual sample indexing, holds up to six samples, each 1.0" diameter; automated via SP Control Cable. Can be used with the SP-2500i. Requires FA-2448-F Filter Set or customer-supplied filters of 25 mm (1 inch) diameter and 5 mm or less in thickness.
- FA-2448-1** **Order Sorting Filter Assembly.** Includes FA-2448-F Filter Set with 320, 590, 665, and 715 nm filters mounted in FA-2448 filter wheel. Manual indexing of filters for elimination of unwanted second order radiation; automated via SP Control Cable. Can be used with the SP-2500i.
- FA-2448-2** **Motorized Six Position Filter Wheel Assembly,** with stepping motor and FA-2448-4 controller. Enables indexing by computer with RS-232 or USB. Requires computer with RS-232 or USB for computerized operation. Set or customer-supplied filters of 25 mm (1 inch) diameter and 5 mm or less in thickness. For the older SP-500-M and SP-500-S models.
- FA-2448-3** **Motorized Order Sorting Filter Assembly.** Includes FA-2448-F Filter Set with 320, 590, 665, and 715 nm filters mounted in FA-2448 filter wheel. Enables computer controlled indexing of order sorting filters for elimination of unwanted second order radiation. Requires computer with RS-232 or USB for operation. Requires FA-2448-F Filter Set. For the older SP-500-M and SP-500-S models.
- FA-2448-4** **Controller Only** for FA-2448 or 2448-1 filter wheel assemblies. Retrofit kit which enables changing the FA-2448 or 2448-1 from manual to computer controlled indexing. Requires FA-2448 type filter wheel and computer with RS-232 or USB for operation. May require FA-2448-F Filter Set.
- FA-2448-F** **Order Sorting Filter Set.** Includes four filters: 320, 590, 665, and 715 nm.

Fiber Optic Light Guides: All Fiber optic light guides contain 19 fibers, 200 μ m diameter, arranged in a line pattern at the slit end, and round at the source end.

- LG-455-020-1** **UV-VIS Fiber Optic Bundle** 1.0 meter long, for 190 nm to 1100 nm. Requires mount.
- LG-455-020-3** **UV-VIS Fiber Optic Bundle** 3.0 meter long, for 190 nm to 1100 nm. Requires mount.
- LG-456-020-1** **VIS-NIR Fiber Optic Bundle** 1.0 meter long, for 400 nm to 2200 nm. Requires mount.
- LG-456-020-1** **VIS-NIR Fiber Optic Bundle** 3.0 meter long, for 400 nm to 2200 nm. Requires mount.
- FC-446-010** **Fixed-Position Fiber Adapter** is a low-cost solution for positioning fiberoptic bundles directly at the entrance (or exit) ports of SpectraPro spectrometers. Accepts 10 mm diameter ferrule.
- FC-446-020** **Fiber Coupler** with horizontal translation capability for 10 mm diameter fiber optic bundle. Accepts 10 mm diameter ferrule.
- FC-446-021** **Fiber Coupler** with X-Y Micrometer alignment adjustments. Accepts 10 mm diameter ferrule.
- FC-446-030** **Imaging Fiber Adapter** is designed specifically for our imaging spectrometers. The all-reflective design eliminates chromatic aberrations and the aspheric mirror cancels astigmatism, allowing precise imaging of fibers at the spectrograph entrance slit. Includes up/down, left/right screw alignment adjustments. Accepts 10 mm diameter ferrule. Also includes a 0.75" thick spacer to insert an optional FA-2448 series Filter Wheel for order sorting function.

Connecting Cables

- CC-499-2** Cable for IBM-PC AT or compatible computer. 9 pin **female** connector to 9 pin **male** connector.
- 3650-USB-06** USB cable. Type A to B

If the above cables are not compatible with your system, contact Princeton Instruments for a custom cable.

Appendix V-E: Gratings for SP-2500i

Grooves/mm	Blaze Wavelength	Standard Part Number	Mechanical Limit
50	600 nm	1-05-600	
75	8 um	1-07.5-8	
150	300 nm	1-015-300	
150	500 nm	1-015-500	11.2 um
150	800 nm	1-015-800	
150	1.2 um	1-015-1.2	
150	4 um	1-015-4	
300	300 nm	1-030-300	5.6 um
300	500 nm	1-030-500	
300	750 nm	1-030-750	
300	1 um	1-030-1	
300	1.2 um	1-030-1.2	
300	2 um	1-030-2	
600	150 nm	1-060-150	2.8 um
600	300 nm	1-060-300	
600	500 nm	1-060-500	
600	750 nm	1-060-750	
600	1 um	1-060-1	
600	1.2 um	1-060-1.2	
600	1.6 um	1-060-1.6	
1200	150 nm	1-120-150	1400 nm
1200	Blazed Holographic UV †	1-120-HUV	
1200	300 nm	1-120-300	
1200	Holographic VIS ††	1-120-HVIS	
1200	500 nm	1-120-500	
1200	750 nm	1-120-750	
1800	Blazed Holographic UV †	1-180-HUV	933 nm
1800	500 nm	1-180-500	
2400	150 nm	1-240-150	700 nm
2400	240 nm	1-240-240	
2400	Blazed Holographic UV †	1-240-HUV	
2400	Holographic VIS ††	1-240-HVIS	
3600	130 nm	1-360-130	466 nm
3600	240 nm	1-360-240	
3600	Holographic UV †††	1-360-HUV	

Notes:

† Blazed Holographic, 190-450 nm, optimum range

†† Holographic, 450- mechanical limit, optimum range

††† Holographic, 190-466 nm, optimum range

Gold, Silver and Acton Exclusive VUV Reflective Coated Optics are available on Request.

Standard Gratings are 68 X 68 mm. For 68 X 84 mm Gratings, replace leading "1" with "2" in part number.

Ordering Information

Electronic Orders

Electronic orders accepted with proper Company Letterhead and complete contact information.

Fax Orders

Orders may be placed by fax with written confirmation. Please include complete name and address with these orders.

FAX: (978) 263-5086

MasterCard / VISA

MasterCard & VISA accepted for purchases.

Written Orders

Submit all written orders to our mailing address:

Princeton Instruments-Acton

15 Discovery Way
Acton, MA 01720 U.S.A.

Orders accepted subject to current pricing.
All orders FOB Princeton Instruments-Acton or shipping charges & insurance added separately.
All orders subject to new customer approval.

• SpectraPro® is a registered trademark of Acton Research Corporation •

Appendix V-F: Certification and Warranty

Certification

Princeton Instruments certifies that this instrument was thoroughly tested and found to meet the specifications furnished by Princeton Instruments when it was shipped from the factory.

Warranty

Princeton Instruments instruments and accessories are warranted for a period of one full year from date of delivery to be free from defects in material and to conform to the specifications furnished by Princeton Instruments. The company's obligation under this warranty is limited to servicing or adjusting an instrument returned to the factory, prepaid, and to repairing or replacing at the factory any part or parts thereof. All purchased items carry the original manufacturer's warranty.

Princeton Instruments shall not be liable for consequential damages resulting from accident, alteration, misuse, improper installation, operation on low or excessive voltages or any use in violation of the operating instructions furnished by Princeton Instruments.

If any defect appears within the warranty period, the purchaser shall promptly notify Princeton Instruments. No material will be accepted for repair or replacement without prior authorization from Princeton Instruments. Upon such authorization and in accordance with instructions of Princeton Instruments, parts, materials or equipment for which repair or replacement is requested shall be returned to Princeton Instruments for examination, with shipping charges prepaid by the purchaser. Final determination as to whether a product or part is actually defective rests with Princeton Instruments.

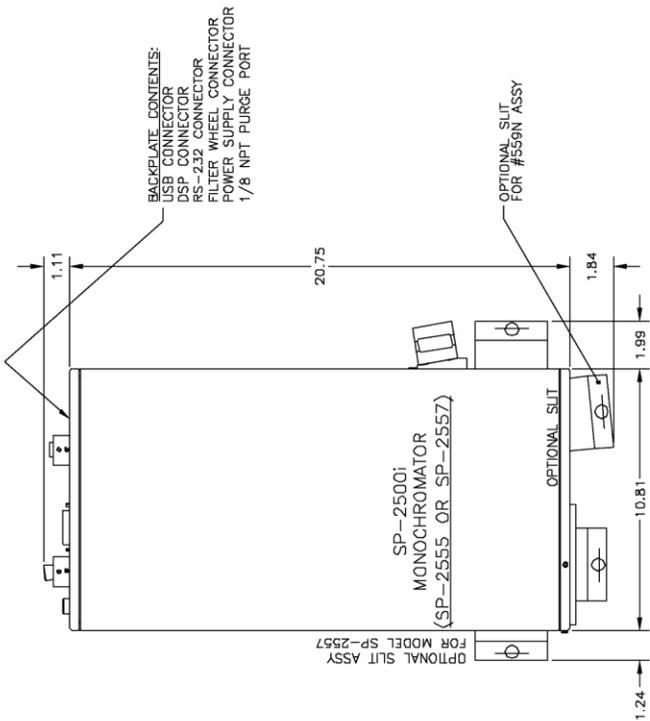
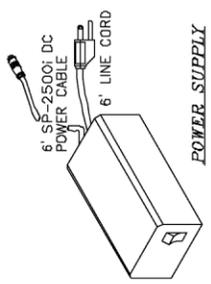
In such cases where necessary repairs are not covered by this warranty, an estimate of repair charges will be submitted to the purchaser before servicing the equipment.

Princeton Instruments reserves the right to make changes or improvements upon its products without imposing any obligations upon itself to install the same upon its products previously manufactured.

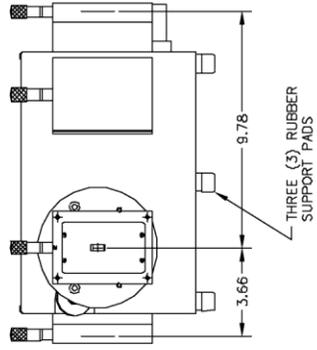
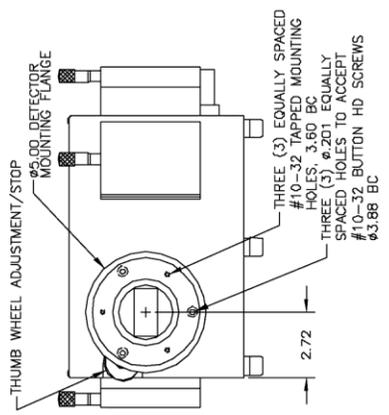
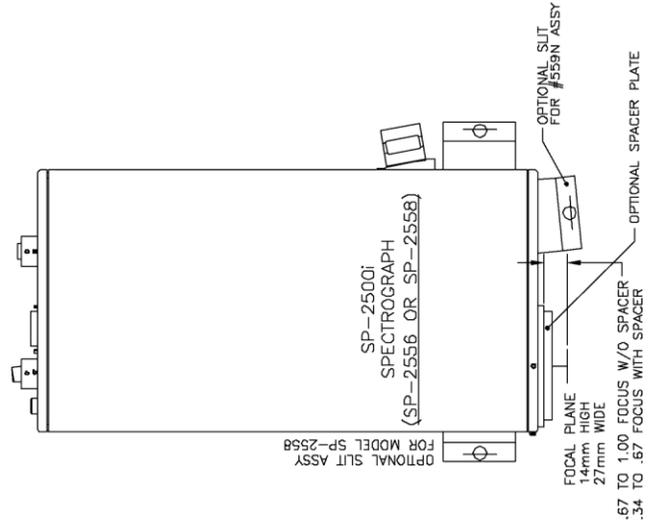
This warranty is expressly in lieu of all other obligations or liabilities on the part of Princeton Instruments, and Princeton Instruments neither assumes, nor authorizes any other person to assume for them, other obligations or liability in connection with the sale of equipment manufactured by Princeton Instruments

Appendix V-G: Drawings

THIS DRAWING REMAINS THE PROPERTY OF PRINCETON INSTRUMENTS AND CONTAINS PROPRIETARY INFORMATION WHICH SHALL NOT BE REPRODUCED OR DISCLOSED WITHOUT WRITTEN AUTHORIZATION



APPROXIMATE WEIGHT: 40 LBS (18.2 Kg)



SCALE: NONE	DIMENSIONS ARE IN INCHES	DRAWN BY: HCL
REV: 5-21-03		REV: 1
Princeton Instruments		15 DISCOVERY WAY
PRINCETON, NJ 08542		ACTION, MA 01720
DWG NO: SP-2500i	84150-600-50	REV: 0

