

# Princeton Instruments

15 Discovery Way • Acton, MA 01720 USA

## Operating Instructions **HRS-750**



750mm Triple Grating Imaging Spectrograph  
and Scanning Monochromator

# HRS-750 MANUAL - PRELIMINARY

Thank you for your purchase of the *HRS-750* spectrograph and scanning monochromator and for selecting Princeton Instruments as your provider of precision spectroscopic equipment. PI strives to manufacture equipment of the highest quality and to design our monochromators and spectrographs for easy installation and operation. If you have any questions during set up or use of PI equipment, please do not hesitate to contact our experience technical staff.

This instruction manual will assist you in set-up and operation of your new HRS-750 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 PI customer service department.

The HRS-750 requires a single 9/64<sup>th</sup> Allen wrench for virtually all access, mounting of accessories and adjustments. PI provides the 9/64" wrench along with a 3/32<sup>nd</sup> box wrench (for removal of the exit diverter mirror shipping screw).

What's in the box?

1. HRS-750 spectrograph or monochromator
2. 6" USB cable
3. Memory stick with instruction manual, a complimentary copy of ResXtreme spectral deconvolution software add-in (spectrographs only) and the HRS-750 brochure
4. 9/64" Allen wrench
5. 3/32" "T" Allen wrench
6. Copy of MONOCHROMATOR CONTROL software on USB memory stick
7. If selected at time of purchase, IntelliCal wavelength and Intensity calibration system

# Princeton Instruments HRS-750 Operating Instructions













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## ***Introducing the SpectraPro® HRS-750 Imaging Spectrograph and Scanning Monochromator***

For more than 25 years, SpectraPro spectrometers from Princeton Instruments have set new standards for reliable high-performance spectroscopy. Day in and day out, researchers around the world depend on these popular spectrographs and monochromators for a wide variety of scientific and industrial applications. To date, more than 12,000 papers have been published reporting results acquired utilizing SpectraPro spectrometers. Building upon the legacy of these iconic research instruments, Princeton Instruments has now created an even more versatile, higher-resolution spectroscopy solution. New *SpectraPro* HRS imaging spectrographs include the latest optical, mechanical and software engineering and are capable of facilitating just about any spectroscopy application imaginable.

The *SpectraPro* HRS-750 is a 750mm focal length imaging spectrograph and scanning monochromator featuring the highest precision and performance for demanding light research applications. HRS spectrographs feature the AccuDrive scanning system for superior accuracy and repeatability. Toroidal mirrors correct for astigmatism to permit multichannel fiber applications. Interchangeable triple grating turrets are standard, allowing the HRS-750 to be optimized for the spectral region of interest. Two 30mm wide focal planes are available to accommodate virtually any array detector and a wide selection of accessories, cameras and software are available to meet the requirements of most spectroscopic applications.

# Features & Benefits

	Feature	Benefit(s)
EXCLUSIVE	 AccuDrive scan system	Highest accuracy and repeatability of any direct-drive wavelength scanning system. Very robust. Operates in any orientation with rapid wavelength scanning and grating changes under full computer control.
	 Dual 14 x 30 mm exit ports	Permits mounting and operation of two array detectors or enables the instrument to operate as both a monochromator and a spectrograph.
	 Sliding tube focus	Easy, precise alignment and focus of array detectors. Integrated focus-stop mechanism allows independent focus and rotational adjustments to array detectors.
	 Interchangeable triple-grating turrets	Allows as many as nine gratings per spectrometer for optimized system performance. Choose survey and high-resolution gratings, grating sets to extend wavelength range, or different grating sets for specific applications. Unique CTS-Turrets™ self-align when installed and feature stress-free mounting for high reproducibility.
	 Astigmatism correction	Toroidal mirror reduces astigmatism to enable multichannel spectroscopy.
EXCLUSIVE	 ResXtreme spectral deconvolution	Improves spectrograph spectral resolution, intensity of spectra, and data consistency across focal plane by as much as 60%.
EXCLUSIVE	 IntelliCal calibration system	Push-button wavelength calibration delivers up to 10x greater accuracy than conventional calibration methods. Fast and easy intensity calibration removes unwanted instrument artifacts that can alter spectral data.
	 Extended mechanical scanning range	SpectraPro HRS spectrographs now allow operation to 1500 nm with a 1200 g/mm grating.
	 High-efficiency optical coatings	Acton #1900 Al+MgF <sub>2</sub> coating delivers the highest UV-VIS throughput available on the market. Exclusive enhanced silver offers the highest VIS-NIR throughput available.
EXCLUSIVE	 Convenient computer interface	True plug-and-play USB 2.0 interface.
	 Dimensions Weight	<b>HRS 300:</b> Length: 15.71" (399 mm), Width: 11.0" (279 mm), Height: 8.74" (222 mm) Weight: 43 lbs (19.5 kg) <b>HRS 500:</b> Length: 22.13" (562 mm), Width: 11.84" (301 mm), Height: 8.74" (222 mm), Weight: 50 lbs (22.7 kg)
	 Operating conditions	0°C to 30°C; 80% RH non-condensing

# SpectraPro HRS Specifications



Specifications	HRS-750	HRS-500
Focal length	750 mm	500 mm
Aperture ratio	f/9.7	f/6.5
Spectral resolution with PMT*	0.03 nm with 10 μm wide slits	0.05 nm with 10 μm wide slits
CCD spectral resolution**	0.05 nm	0.07 nm
CCD spectral resolution with ResXtreme	0.03 nm or better (typ.)	0.05 nm or better (typ.)
Reciprocal linear dispersion	1.03 nm/mm	1.52 nm/mm
Wavelength coverage across 26.8 mm wide CCD	27 nm (nominal)	41 nm (nominal)
Focal plane size	14 mm x 30 mm (both exit ports)	14 mm x 30 mm (both exit ports)
Scan range	0 to 1500 nm	0 to 1500 nm
Drive step size	0.002 nm/step	0.002 nm/step
Wavelength accuracy	+/-0.2 nm (up to 0.02 nm with IntelliCal wavelength calibration)	
Wavelength reproducibility	Within 0.004 nm (both scan directions, typ.)	
Turret	Triple-grating interchangeable CTS-Turrets self-align to system when installed	
Grating change repeatability	0.02 nm (typ.)	
Grating size	68 mm x 68 mm standard; 68 mm x 84 mm optional	
Number of turrets allowed	Accepts as many as 3 turrets, each with 3 gratings	
Astigmatism correction	Toroidal mirror reduces astigmatism to permit multichannel spectroscopy	
Computer interface	USB 2.0	
Certification	CE tested to the following standards: EN 55022:2010/AC:2011, EN 61000-3-2:2014, EN 61000-3-3:2013, EN 61000-6-3:2007/A1:2011, EN 61326-1:2013	
Dimensions		
Length	31.75" (806 mm)	22.13" (562 mm)
Width	12.50" (318 mm)	11.84" (301 mm)
Height	9.16" (233 mm)	8.74" (222 mm)
Weight	75 lbs. (34.0 Kg)	50 lbs. (22.7 kg)
Optical axis height	6.155" ±0.435" (156 mm +/- 11 mm), adjustable	

Note: Unless otherwise noted, specifications with a 1200 g/mm grating@ 435.8 nm

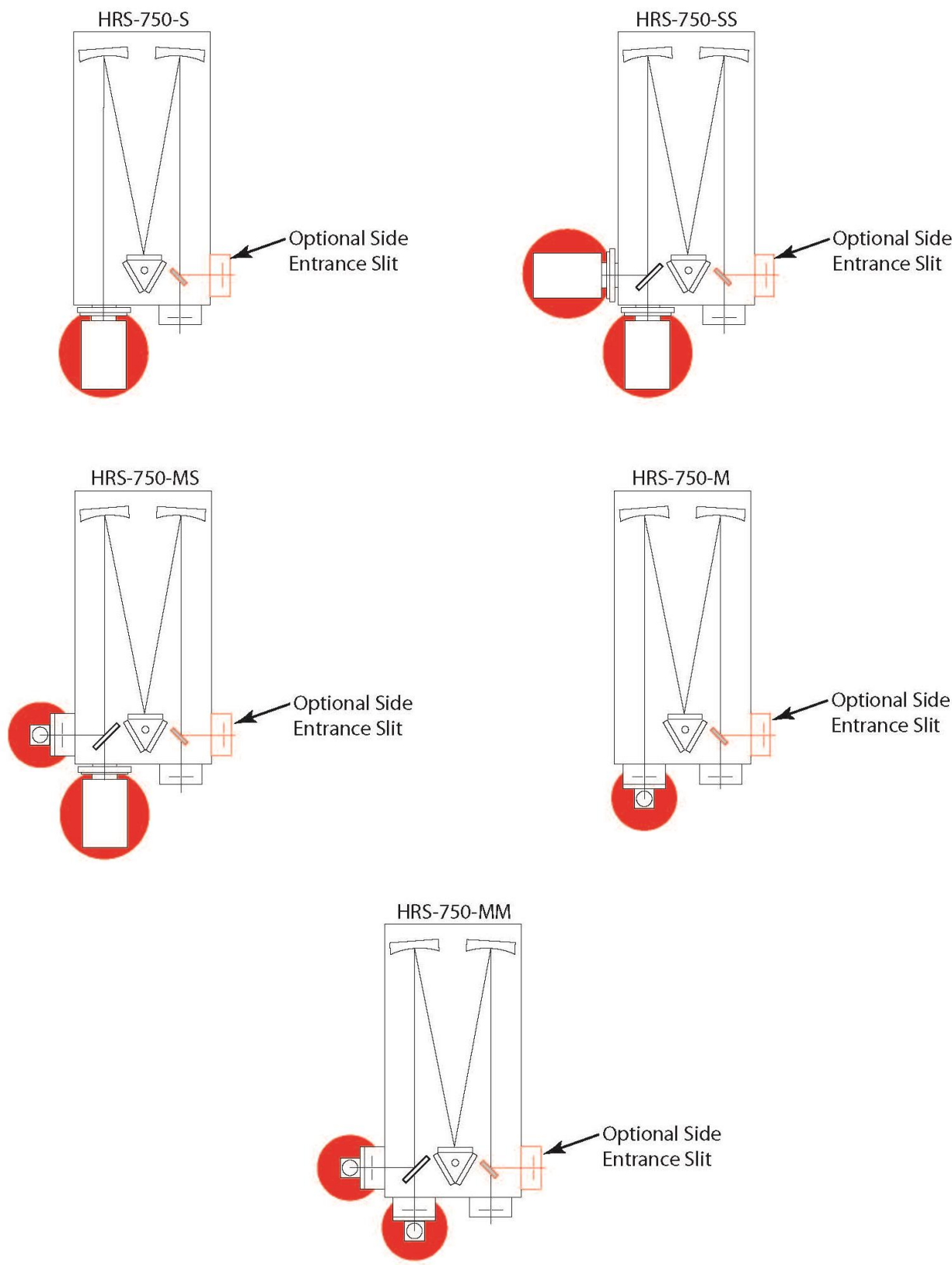
Specifications are subject to change without notice.

\*PMT resolution measured with a 1200 g/mm grating@ 435.8 nm, 10  $\mu$ m slit width, and 4 mm slit height.

\*\*CCD resolution measured at the focal plane center with 10  $\mu$ m slit and a Princeton Instruments PIXIS400F with 20  $\mu$ m pixels@ 546 nm.

For astigmatism-free performance, please see our IsoPlane-320 and 160 spectrographs.

**HRS-750 Models**



## HRS-750 Setup

### **A. Unpacking and Inspection**

Carefully unpack and examine the HRS-750 and any accessories purchased.

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

### **B. Connecting the HRS-750 Monochromator/Spectrograph to a Computer**

The HRS-750 is computer controlled using a standard USB or RS232 connection. Either communication method will enable control of 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 a “jog” function for convenient wavelength positioning.

A copy of **MONOCHROMATOR CONTROL** software is included with the HRS-750 spectrographs and monochromators. This complimentary software allows you to communicate with the HRS-750 perform the functions listed above however please note that MONOCHROMATOR CONTROL is **NOT** a data acquisition software package. For more detailed information and installation instructions for MONOCHROMATOR CONTROL software, please refer the operating manual provided with this software.

**LightField Data Acquisition and Control Software:** LightField is an optional data acquisition software package that seamlessly integrates spectrometers and array detectors into a powerful data acquisition system. LightField automatically detects the presence of the HRS-750 and PI camera when connected using a USB cable and automatically sets up all the operating parameters for the HRS-750 and the array detector. For more information on optional LightField software, please visit the PI website.

### **C. Mounting Accessories to the HRS-750 Slit Assemblies**

All PI 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 PI SpectraPro accessories mount directly to the HRS-750 slit assemblies. A drawing of the standard slit assembly is included in the Appendices Section to assist you in mounting of accessories. To mount an accessory to the slit, the general procedure 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: Certain light sources limit the access to the bottom mounting holes. In this instance, PI provides special slotted holes in the light source housing to facilitate mounting of the light source to the slit.

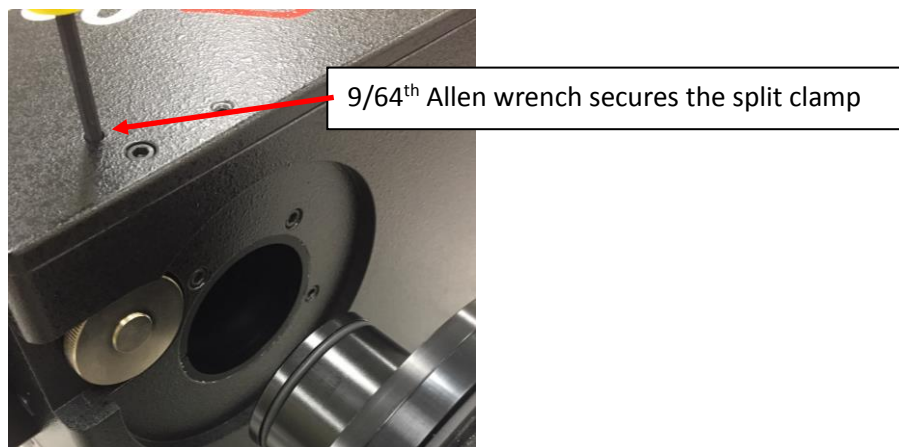
## D. Mounting Focal Plane Detectors to the HRS-750 Spectrograph

The standard mounting flange for CCDs and other array detectors accommodates detectors with a standard *PI spec-mount*. As an option, PI can provide a C-Mount adapter. To mount an array detector to the HRS-750, use the following procedure:

SPEC-MOUNT: The standard PI Spec-Mount includes three hex head bolts for securing the camera to the HRS-750. The camera flange includes three keyhole slots that fit over the hex head bolts.

**NOTE:** Check the focal plane back focal distance of the array detector you plan to install. 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. A spacer is provided with HRS-500 spectrographs. If the detector back focal plane distance is 0.67" or less, then the spacer should be used. If the detector back focal plane distance falls between 0.67" and 1.00", then no spacer is required.

1. The HRS-750 includes a sliding tube detector that fits inside the front or side ports of the HRS-750. A split clamp secures the sliding tube. Refer to the picture below and note the access location for the 9/64<sup>th</sup> Allen wrench to loosen or tighten the split clamp.
  - a. Loosening or tightening the split clamp should only require ½-turn of the screw.
2. Using a 9/64<sup>th</sup> allen wrench, loosen split clamp screw approximately ½-turn. Gently slide the array detector mounting flange all the way out of the HRS-750 housing. Make sure that the sliding tube and O-ring are kept clean.



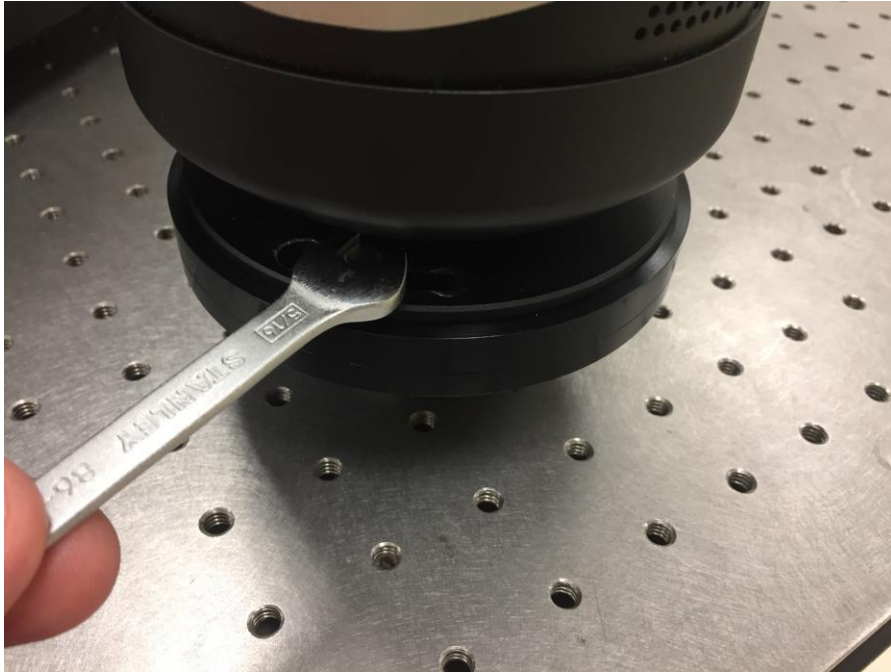
3. Remove the shipping cover from the sliding tube and the spacer if it is not required. Remove the black plastic washers from the three hex head screws and reinsert the screws into the sliding tube adapter.



4. Position the array detector mounting flange against the array detector, and match the hole patterns. The hex head screws should fit through the rounded keyhole slots in the camera flange.



5. Using a 5/16" wrench, fasten the array detector mounting flange to the detector by tightening the three hex-head screws. Then carefully slide this assembly back into the HRS-750 housing.



6. Tighten the split clamp to secure the detector.

Note: the detector is now mounted; however, it requires focusing and alignment to the spectrograph for optimum performance (see Page 18).

## Model 716 Bilateral Slit: Width Adjustments

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

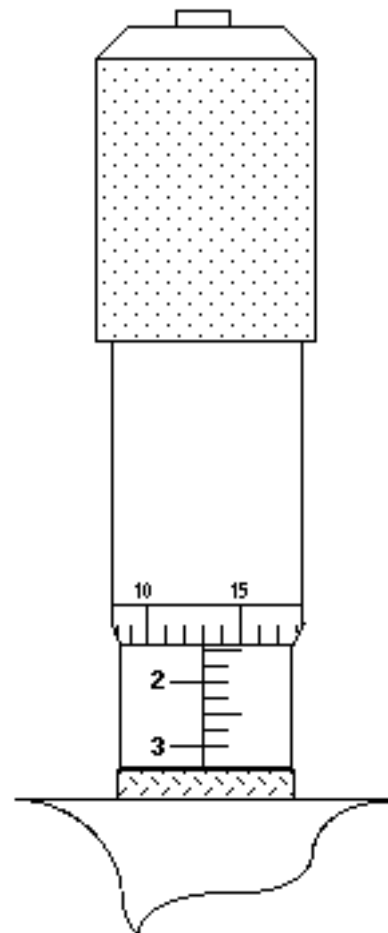
Each clockwise revolution of the micrometer knob increases the slit width 0.25 millimeters (250 $\mu$ m). For maximum reproducibility, the slit width should be set in a clockwise direction (increasing slit widths) each time it is changed. Refer to the drawing below.

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 $\mu$ m) 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 3.0mm.



Slit Width Setting: 200 Micrometers (0.200mm)



Slit Width Setting:  
1380 Micrometers  
(1.38mm)

## **HRS-750 Operation**

### **A. Initialization**

When power is turned ON to the HRS-750, it initializes to a wavelength of 0.0nm for grating number one. If the power is switched OFF and then ON again to the HRS-750, 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). When the HRS-750 initializes, it also identifies the turret installed. This information is used by optional LightField software to set up the correct operating parameters.

### **B. Operating the HRS-750 Using a Computer**

The HRS-750 can be controlled by terminal emulation or by computer using USB or RS232. The same command set listed below can be used for both USB and RS232 connections.

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. 546.7 GOTO).

For RS232 operation, the port set-up is 9600 baud, 8 data bits, 1 stop bit and no parity. All commands or strings of commands must be terminated with a carriage return (0D hex). The HRS-750 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 HRS-750.

#### **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 SpectraPro 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 SpectraPro models.)

## Monochromator Wavelength Movement Commands (continued):

>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	Returns present scan rate in nm/min to 0.01 nm/min resolution with units nm/min appended. E.G. ?NM/MIN 100.00 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.

## Diverter Mirror Control Commands:

EXIT-MIRROR	Designates the exit diverter mirror to receive the diverter control commands. This command is for HRS spectrographs that can accept two diverter mirrors (HRS-750 and HRS-750). HRS-750 spectrographs will accept this command but it is not required.
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ENT-MIRROR	Designates the entrance diverter mirror to receive the diverter control commands. This command is for HRS spectrographs that can accept two diverter mirrors. Note: HRS-300 spectrographs and 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 (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 +/- 5nm 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# - 1. E.G. 3072056. 8 INIT-OFFSET for setting offset on grating #9 - 3rd grating on turret #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 # - 1. E.G. 9993 1 INIT-GADJUST for setting GADJUST on the second grating of turret #1. NOTE: This command is to maintain compatibility with previous applications.
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 HRS monochromator and spectrographs. 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 spectrograph/monochromator. E.G. MODEL HRS-750-S
SERIAL	Returns serial number of HRS spectrograph/monochromator. Format is 7 digits with the first 3 digits being the model #. E.G. SERIAL 3060232

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 SpectraPro 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 SpectraPro after initialization.  
E.G. 435.84 INIT-WAVELENGTH

INIT-SRATE        Sets an initial scan rate for the SpectraPro.  
E.G. 500.0 INIT-SRATE

## C. Focusing and Alignment of Array Detectors

With the array detector properly mounted to the HRS-750, use the following procedure to align and focus the array detector to the HRS-750 optical system. It assumes that the array detector is mounted to the HRS-750 and running for the following procedure.

1. Mount a light source such as a mercury pen-ray type to the entrance slit of the HRS-750. PI offers a standard Mercury/Neon-Argon lamp, IntelliCal, designed for this purpose. Any light source with line output can be used for focus. If there are no “line” sources available, it is possible to use a broadband source such as tungsten for the alignment. If this is the situation, use a wavelength setting of 0.0nm for alignment purposes.
2. With the HRS-750 properly connected to the computer, turn the power ON and move the spectrograph to a wavelength of 546.074nm if using a mercury lamp, or 0.0 nm for a broadband source, or another wavelength corresponding to a known peak 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 9/64<sup>th</sup> Allen wrench, loosen the split clamp screw approximately ½-turn and slowly slide the array detector IN or OUT until the sharpest image is achieved, or the sharpest line is achieved. There is a focus stop thumb wheel screw included at each exit port to assist in fine focus adjustments as well as rotational alignment of the camera to the HRS-750.
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 of the slit image to the CCD. Optional LightField software includes an “align spectrometer” function for this purpose. 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. Tighten the split clamp to secure the detector in position when sharpest focus has been achieved.
7. 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 HRS-750, they may require adjustment along the optical axis to achieve best vertical image quality.

## Appendices and Schematic Drawings

### **Appendix 1: 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 RS232 port using the following commands. These values are stored in non-volatile memory and will be in effect after the next power-up.

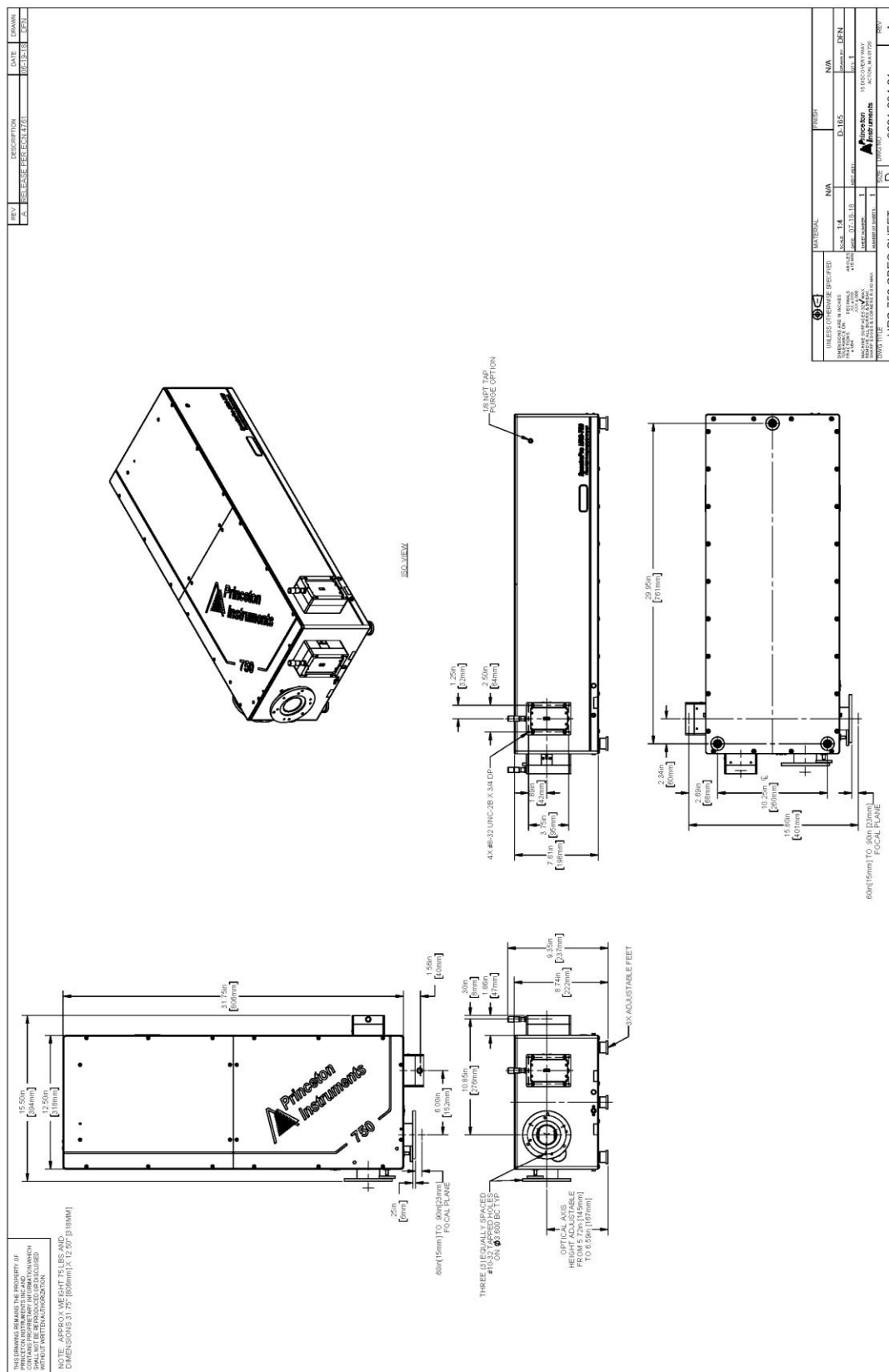
INIT-GRATING	Selects which of the two gratings on the installed turret the HRS-750 will go to after finding 0.0 nm on the first grating. E.G. 2 INIT-GRATING selects the second grating as the default
INIT-WAVELENGTH	Sets an initial wavelength for the HRS-750 after initialization. E.G. 435.84 INIT-WAVELENGTH Notice that two digits after the decimal point are required
INIT-SRATE	Sets an initial scan rate for the HRS-750. 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.

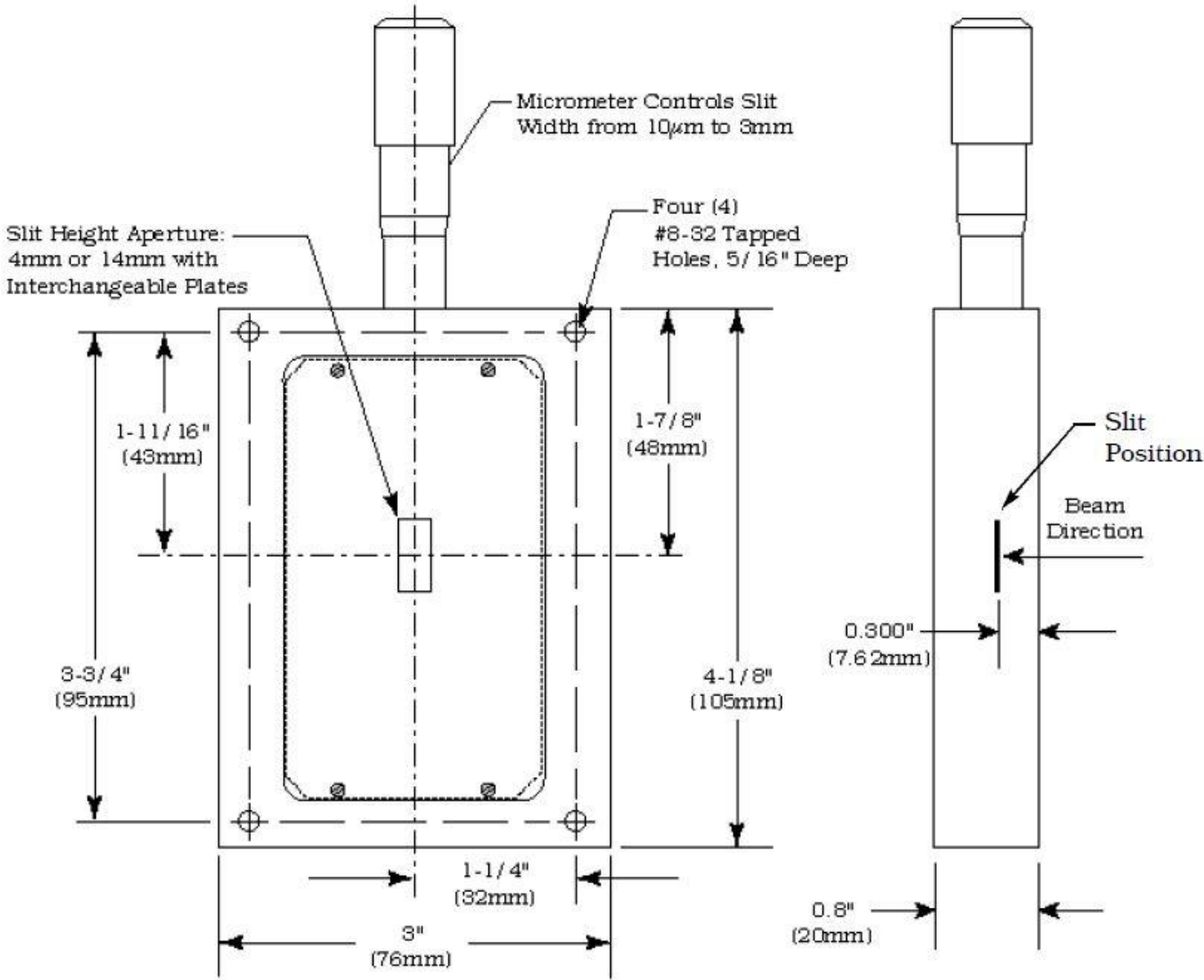
Note that any gratings installed at a later date (after initially receiving the HRS-750) will be erased from memory using this “restore command”.

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.
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**Appendix 3: Outline Drawing, Slit Assembly**



# Standard SpectraPro HRS Gratings



Groove density (g/mm)	Blaze wavelength (nm)	Mechanical scanning range	Optimum wavelength range (nm)		Grating part number (68 mm x 68 mm)
50	600	0 – 36 $\mu$ m	402	950	i1-005-600-P
66.6	740	0 – 27 $\mu$ m	496	1150	i1-006-740-P
75	1800	0 – 24 $\mu$ m	1200	2800	i1-007-1800-P
100	450	0 – 18 $\mu$ m	300	700	i1-010-450-P
100	1500	0 – 18 $\mu$ m	1000	2350	i1-010-1500-P
120	410	0 – 15 $\mu$ m	275	650	i1-012-410-P
150	300	0 – 12 $\mu$ m	200	500	i1-015-300-P
150	500	0 – 12 $\mu$ m	330	800	i1-015-500-P
150	800	0 – 12 $\mu$ m	425	1400	i1-015-800-P
150	1250	0 – 12 $\mu$ m	850	2100	i1-015-1250-P
150	1600	0 – 12 $\mu$ m	1050	2500	i1-015-1600-P
300	200	0 – 8 $\mu$ m	135	325	i1-030-200-P
300	500	0 – 8 $\mu$ m	330	800	i1-030-500-P
300	750	0 – 8 $\mu$ m	500	1200	i1-030-750-P
300	1000	0 – 8 $\mu$ m	650	1600	i1-030-1000-P
300	1200	0 – 8 $\mu$ m	700	2100	i1-030-1200-P
300	1700	0 – 8 $\mu$ m	1100	2700	i1-030-1700-P
300	2000	0 – 8 $\mu$ m	1300	4000	i1-030-2000-P
600	150	0 – 3 $\mu$ m	105	250	i1-060-150-P
600	300	0 – 3 $\mu$ m	200	500	i1-060-300-P
600	500	0 – 3 $\mu$ m	330	800	i1-060-500-P
600	750	0 – 3 $\mu$ m	500	1300	i1-060-750-P
600	1000	0 – 3 $\mu$ m	670	1600	i1-060-1000-P
600	1600	0 – 3 $\mu$ m	1050	2500	i1-060-1600-P
900	500	0 – 2 $\mu$ m	335	800	i1-090-500-P
1200	150	0 – 1500 nm	105	250	i1-120-150-P
1200	300	0 – 1500 nm	200	700	i1-120-300-P
1200	500	0 – 1500 nm	325	1000	i1-120-500-P
1200	750	0 – 1500 nm	475	1500	i1-120-750-P
1200	UV holographic	0 – 1500 nm	200	450	i1-120-HUV-P
1200	VIS holographic	0 – 1500 nm	400	1100	i1-120-HVIS-P
1800	250	0 – 1000 nm	160	400	i1-180-250-P
1800	500	0 – 1000 nm	330	800	i1-180-500-P
1800	670	0 – 1000 nm	450	1100	i1-180-670-P
1800	UV holographic	0 – 1000 nm	200	500	i1-180-HUV-P
1800	VIS holographic	0 – 1000 nm	350	1000	i1-180-HVIS-P
2400	150	0 – 750 nm	105	250	i1-240-150-P
2400	240	0 – 750 nm	160	400	i1-240-240-P
2400	UV holographic	0 – 750 nm	200	500	i1-240-HUV-P
2400	VIS holographic	0 – 750 nm	250	750	i1-240-HVIS-P
3600	240	0 – 500 nm	160	400	i1-360-240-P
3600	UV holographic	0 – 500 nm	200	500	i1-360-HUV-P
MIRROR	—	0 nm	—	—	i1-300-500-MIRROR

\* Specifications at 500 nm, 3600 g/mm calculated at 250 nm

Larger 68 mm x 84 mm gratings are available as an option in 1200, 1800, 2400, and 3600 g/mm to maintain throughput at high grating angles (1200 g/mm at 1000 nm and above, 2400 g/mm at 500 nm and above, etc.)



## **IntelliCal Atomic Emission (AE) light source**

This compact USB-powered AE light source features high stability and spectral line output useful for wavelength calibration. The IntelliCal AE light source includes both Hg and Ne-Ar lamps in a housing designed for mounting to the entrance slit of SpectraPro HRS spectrographs. It includes a toggle switch for lamp selection and a handy reference chart with available emission lines. When used with a Princeton Instruments spectrograph, CCD, and LightField software, this versatile light source enables precise, automated wavelength calibration.

## **Deuterium light sources**

### **DS-421 / DS-421-220**

The 30 watt deuterium light source provides a useful UV continuum from ~190 nm to ~350 nm for the SpectraPro HRS. Negligible visible light output helps minimize stray light. A 110 V or 220 V light source is available.

## **Quartz Tungsten-Halogen (QTH) light sources**

### **TS-425**

The 30 watt QTH light source with DC power supply provides output from ~350 nm to more than 2.5  $\mu\text{m}$ .

### **TS-428**

This 250 watt QTH light source includes variable brightness control, forced-air cooling, and AC power supply.

### **TS-428-DC**

This 250 watt QTH light source features a regulated DC power supply plus variable brightness control and forced-air cooling.

## **Deuterium & Tungsten-Halogen light sources**

### **TDS-429 / TDS-429-220**

The dual light source combines 30 watt deuterium and tungsten-halogen lamps in the same housing for output useful from 190 nm to 2.5  $\mu\text{m}$ . It includes a manually controlled source-selection mirror, power supplies (either 110 V or 220 V), and a forced-air cooling fan.

## **Xenon light source**

### **XS-432**

The 75 watt xenon light source features broad wavelength output from the UV to IR. The advantage of a xenon light source is the small light emission area, which permits efficient light delivery to a monochromator or spectrograph. The XS-432 light source provides a bright continuum from 190 to 750 nm with declining output out to 2.7  $\mu\text{m}$ .



# Light Input



## Fixed-position fiber adapter

### FC-446-010

This fixed-position fiber adapter is designed for general light input to a spectrograph and is not intended for imaging applications. It mounts directly to SpectraPro HRS spectrograph slit assemblies. Optional FC-446-010-FC for fibers with FC-connectors, FC-446-010-SMA for fibers with SMA-905 connectors.

*Note: This adapter cannot be used with motorized slit assemblies.*



## Adjustable fiber adapter

### FC-446-020

This adjustable fiber adapter is designed to hold 10 mm diameter fiber bundles directly at the entrance slit of the SpectraPro HRS. It includes a spring-loaded slide mechanism that facilitates precise horizontal alignment of the fibers to the slit opening. Thumb screws on each side control horizontal adjustment. Optional FC-446-020-FC for fibers with FC-connectors, FC-446-020-SMA for fibers with SMA-905 connectors.



## Universal fiber coupler

### FC-446-021-U

This versatile universal fiber coupler features X-Y micrometer control, 0.12 inches (3 mm) of travel, an interchangeable 10 mm diameter ferrule, an SMA 905 connector, and FC inserts. A slit baffle is included for use with the SpectraPro HRS. Highly recommended for coupling fibers to SpectraPro HRS spectrographs.



## Imaging fiber adapter

### FC-446-030

The imaging fiber adapter refocuses fiberoptic input and is designed for use with filter wheels or other devices placed between the fiber end and the SpectraPro HRS entrance slit. The adapter accepts a 10 mm diameter ferrule and provides horizontal and vertical alignment capabilities. The all-reflective design eliminates chromatic aberrations and the aspheric mirror cancels astigmatism, allowing precise imaging of fibers to the spectrograph entrance slit. There is also a 0.75" (19 mm) thick removable spacer to allow use with filter wheels or other accessories.



## Raman notch filter chamber

### NFC-446-040

The Raman notch filter chamber offers an efficient and easy method for using Raman notch or edge filters with the SpectraPro HRS spectrograph. The chamber collects the output of fibers and collimates the beam, which passes through the filter. A second lens focuses the beam on the entrance slit of the SpectraPro HRS. The chamber includes an adapter for 1.0" (25.4 mm) filters. A micrometer controls the filter angle from 0 to 10° for precise rejection of unwanted Rayleigh scatter. The chamber can also accept non-fiber sources or focused sample images.



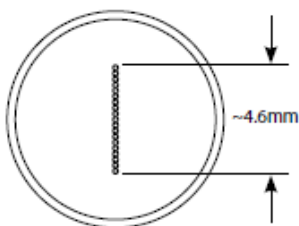
## Sample chamber

### SC-447

The sample chamber features ports with light-tight covers and two quartz lenses. It includes one mounting port for the SpectraPro HRS entrance/exit slit, and two mounting ports for light sources or detection. Requires sample holder.



# Fiberoptic Bundles



## Single-leg fiber bundles (190–1100 nm)

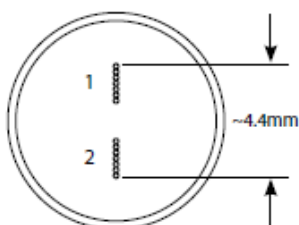
### LG-455-020-1 / LG-455-020-3

This single-leg fiberoptic bundle is designed for use with the SpectraPro HRS when working in the wavelength range from 190 to 1100 nm. It comprises nineteen 200  $\mu\text{m}$  fibers and has an SMA connector at the illumination end and a 10 mm ferrule at the slit end. Fiber configuration is round at the light source input end to a line (column) at the output (slit) end. The bundle is available with a length of either 1 meter (LG-455-020-1) or 3 meters (LG-455-020-3).

## Single-leg fiber bundles (400–2200 nm)

### LG-456-020-1 / LG-456-020-3

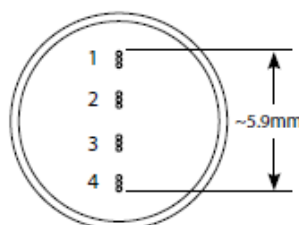
This single-leg fiberoptic bundle is designed for use with the SpectraPro HRS when working in the wavelength range from 400 to 2200 nm. It comprises nineteen 200  $\mu\text{m}$  fibers and has an SMA connector at the illumination end and a 10 mm ferrule at the slit end. Fiber configuration is round at the light source input end to a line (column) at the output (slit) end. The bundle is available with a length of either 1 meter (LG-456-020-1) or 3 meters (LG-456-020-3).



## Two-leg fiber bundle

### BFB-455-7

The two-leg fiberoptic bundle is 1 meter long with seven 200  $\mu\text{m}$  fibers per leg. Designed for use with the SpectraPro HRS when working in the wavelength range from 190 to 1100 nm, it has an SMA connector at the illumination end and a 10 mm ferrule at the slit end. Fiber configuration is round at the two light source input ends to a line (column) at the common output end, with  $\sim 1$  mm spacing between fiber groups. See illustration.



## Four-leg fiber bundle

### QFB-455-3

The four-leg fiberoptic bundle is 1 meter long with three 200  $\mu\text{m}$  fibers per leg. Designed for use with the SpectraPro HRS when working in the wavelength range from 190 to 1100 nm, it has an SMA connector at the illumination end and a 10 mm ferrule at the slit end. Fiber configuration is round at each of the four light source input ends to a line (column) at the common output end, with  $\sim 1$  mm spacing between each fiber group.

Custom fibers available  
on request

## **Appendix 5: Certification and Warranty**

### **Certification**

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

### **Warranty**

Princeton Instruments (PI) 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 PI. The corporation'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 PI.

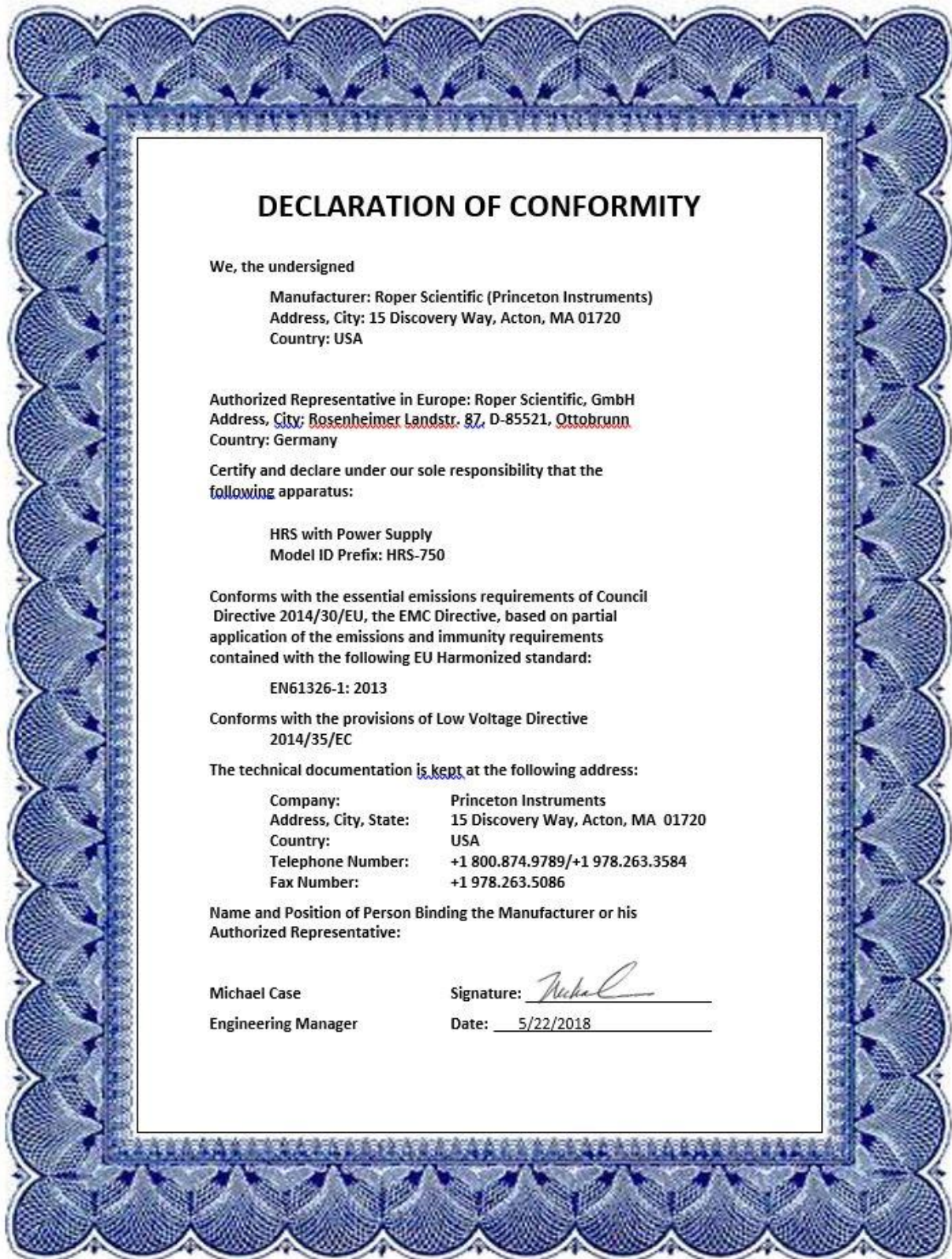
If any defect appears within the warranty period, the purchaser shall promptly notify PI. No material will be accepted for repair or replacement without prior authorization from PI. Upon such authorization and in accordance with instructions of Princeton Instruments, parts, materials or equipment for which repair or replacement is requested shall be returned to PI 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 PI, and PI 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 6: CE Declaration of Conformity



**DECLARATION OF CONFORMITY**

We, the undersigned

Manufacturer: Roper Scientific (Princeton Instruments)  
Address, City: 15 Discovery Way, Acton, MA 01720  
Country: USA

Authorized Representative in Europe: Roper Scientific, GmbH  
Address, City: Rosenheimer Landstr. 87, D-85521, Ottobrunn  
Country: Germany

Certify and declare under our sole responsibility that the following apparatus:

HRS with Power Supply  
Model ID Prefix: HRS-750

Conforms with the essential emissions requirements of Council Directive 2014/30/EU, the EMC Directive, based on partial application of the emissions and immunity requirements contained with the following EU Harmonized standard:


EN61326-1: 2013

Conforms with the provisions of Low Voltage Directive 2014/35/EC

The technical documentation is kept at the following address:

Company:	Princeton Instruments
Address, City, State:	15 Discovery Way, Acton, MA 01720
Country:	USA
Telephone Number:	+1 800.874.9789/+1 978.263.3584
Fax Number:	+1 978.263.5086

Name and Position of Person Binding the Manufacturer or his Authorized Representative:

Michael Case	Signature: <u></u>
Engineering Manager	Date: <u>5/22/2018</u>

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## Ordering Information

### Telephone Orders

Telephone orders may be placed between 7:30AM and 5:00PM EST. Written "Confirmations" are required on all verbal orders.

Telephone: (978) 263-3584

### 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  
P.O. Box 2215  
Acton, MA 01720  
U.S.A.

Orders accepted subject to current pricing.  
All orders FOB Acton or shipping charges  
& insurance added separately.

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