JOBIN YVON
OPTICS & SPECTROSCOPY
INSTRUMENTS S.A.

HR 460

User Manual

HR460 Rapid Scanning Imaging Spectrograph/Monochromator

User Manual

Part Number 31 087 043

COPYRIGHT

NOTICE TO THE USER

This manual should not be construed as any representation or warranty with respect to the unit named herein. Occasionally, changes or variations exist in the software that are not reflected in the manual. Generally, should such changes or variations exist and affect the product significantly, a release note would accompany the manual. In such a case, be sure to read the release note before using the product.
Trademarks: IBM, PC-XT, PC-AT are registered trademarks of International Business Machines Corporation; DATALINK, DATASCAN, SPECTRAVIEW-1D,SPECTRAVIEW-2D, Spectrum One, QuikScan, QuikView, AutoScan, SpectraMax are registered trademarks of INSTRUMENTS S.A..

INSTRUMENTS S.A. / JOBIN-YVON
All Rights Reserved
Written, Designed and Printed in FRANCE
NP/HR460.PSX/1193
31 087 042
November 17, 1993

JOBIN-YVON	Division of Instruments S.A. - 16-18, rue du Canal 91165 LONGJUMEAU Cedex (France) Tel. : (33) 1/64.54.13.00 - Telex : JOBYVON 602882 F Telecopy : (33) 1/69.09.07.21
INSTRUMENTS S.A. Inc.	J-Y Optical System Division - 6, Olsen Avenue, EDISON, New Jersey 08820 (U.S.A.) Tel. : (1) 908/494.86.60 - Telex : 219 960 ISA UR Telecopy : (1) 908/494.87.96
INSTRUMENTS S.A. GmbH	Bretonischer Ring 13 - 85630 GRASBRUNN 1 (Germany) Tel. : (49) 89/460.20.51 - Telecopy : (49) 89/463.197
INSTRUMENTS S.A. UK Ltd	2-4 Wigton Gardens - STANMORE, Middlesex HA7 1BG (Great Britain) Tel. : (44) 81/204.81.42 - Telecopy : (44) 81/204.61.42
INSTRUMENTS S.A. ITALIA	Via Cesare Pavese 35/AB - 20090 OPERA (Milano) (Italy) Tel. : (39) 2/57 60 30 50 - Telecopy : (39) 2/57.60.08.76
INSTRUMENTS S.A. Nederland	Prins Bernhardlaan 10 (Rijnstaete Building) - P.O. Box 56 2400 AB ALPHEN a/d Rijn (Netherlands) Tel. : (31) 0/1720-33323 - Telecopy : (31) 0/1720-39532

Contents

About the Manuals...

You may have more than one manual, depending on your system configuration. To find the manual that has the information you need, these guidelines may help.

- Each manual generally covers a product and the features and accessories peculiar to and/ or contained within that product.
- Accessories that can be applied to other products are normally covered by separate documentation.
- Software that is exclusively used with one instrument or system is covered in the manual for that product.
  Software that can be used with a number of other products is covered in its own manual.
- If you are reading about a product that interacts with other products, you will be referred to other documentation as necessary.

1 Overview of the HR460

The HR460 is a new generation spectrometer. It includes several new innovations, along with the best of proven technology and features.

1.1 Total Automation

All moving parts of the HR460 are automated. The slits, scanning drive, interchangeable turrets, shutters, and side port selection mirrors are controlled remotely by any of several computer/software options or the KeyLink/HandScan via the optional 232 Interface. The system performance and function can be altered without direct access to the instrument. With the computer program control, it is possible to automatically adjust bandpass, change gratings, switch detectors or inputs without operator intervention.

1.2 Rapid Scanning Wavelength Drive

A unique high speed sine drive moves the HR460 grating in steps that correspond to linear increments of wavelength change at the exit slit, or the center pixel of an array detector. The constant step size simplifies control, and eliminates the possibility of disparities in scanned data that could arise from using a direct worm drive that may have significant unevenness of wavelength movements. For 1200 g/mm gratings a step equals 0.00625 nm. Step sizes for all other grating groove densities can be calculated by applying an inversely proportional scale factor. For example: a 300 g/mm grating would move 0.025 nm per step. This conversion is done automatically by controllers and Software.

1.3 Optical Design Optimized for Imaging

Optical performance is radically improved over earlier designs by a unique Czerny-Turner configuration utilizing a proprietary aspheric optical correction. The optical correction provides for exceptional imaging capabilities. Astigmatism, inherent in classical Czerny-Turner systems, is negligible. The fast (f/7 or f/5.3) system delivers near perfect spectral imaging over an area 25.4 mm wide by 15 mm high in the spectrograph image plane. The computer aided geometric design prevents rediffracted light from reaching the detector. With other designs this rediffracted light can be detected as a spurious signal.

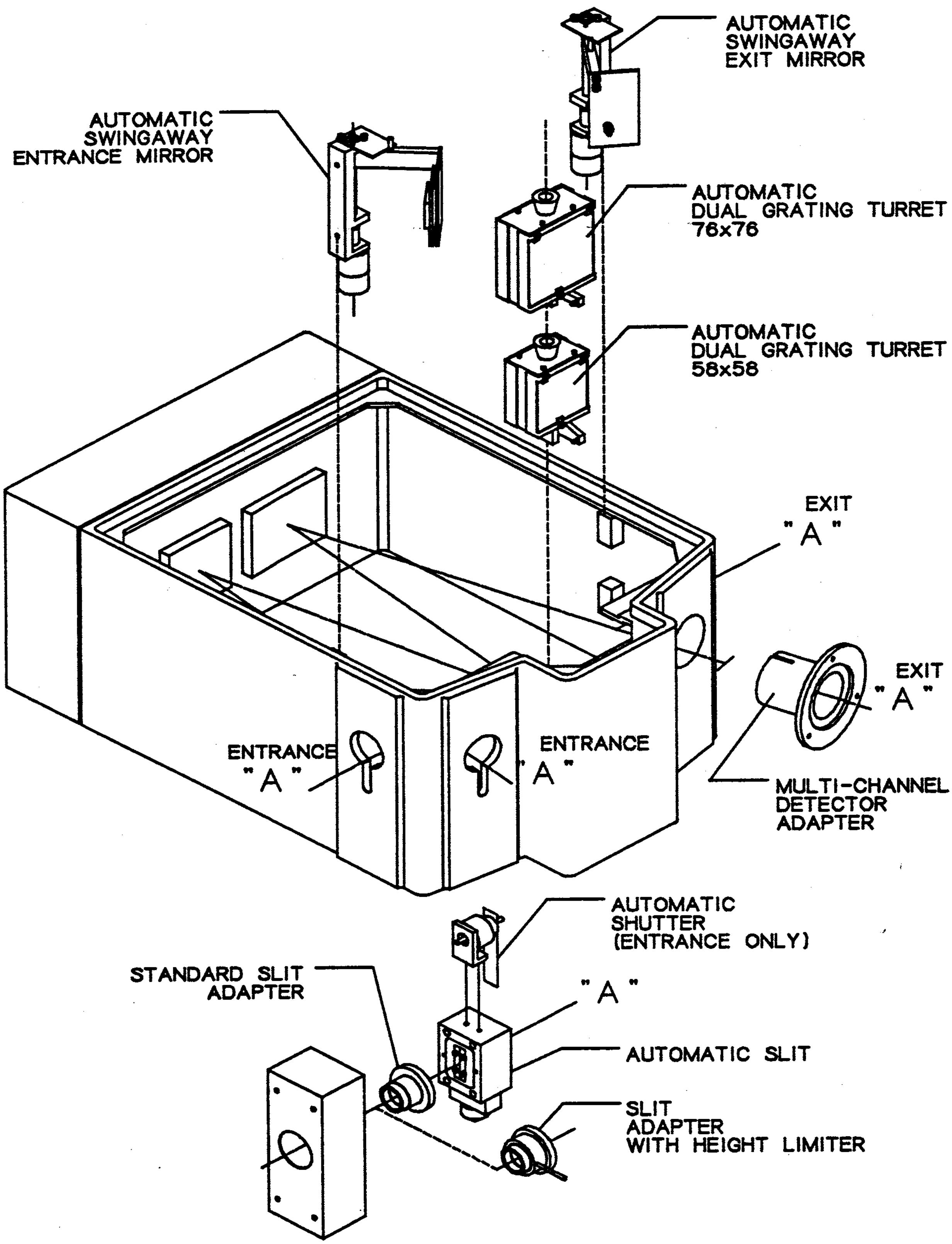


Figure 1: HR460 Options

1.4 Interchangeable Dual Grating Turret

The Instrument is equipped with a grating turret. Two grating turret sizes are available: 58 x 58 mm^2 and 76 x 76 mm^2. To maintain image quality, throughput, and flatness of field it is essential that the grating be scanned by rotating on the correct axis, a vertical axis, at the center of the face of the grating. This turret indexes the selected grating using a turret pivoting axis that is separate from the scanning axis. Either selected grating is positioned so that the center of its face is exactly on the scanning axis. By scanning the grating on this axis, throughput and image quality are preserved to the maximum extent possible throughout the scanning range. Because the turret is interchangeable, there is no limitation on the number of different gratings that can be mounted in a system.

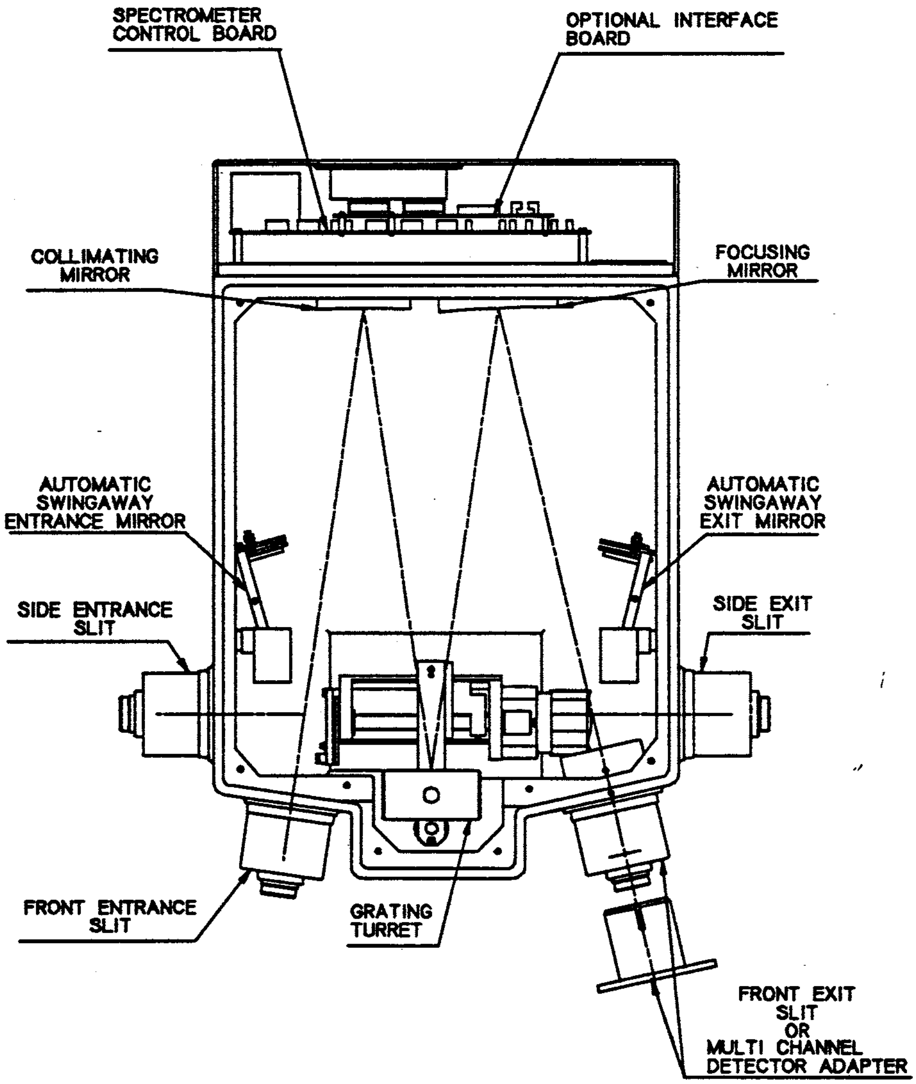


Figure 2: HR460 Component Locations

2 Unpacking

Your HR460 was shipped in packing designed to protect it from harm under normal shipping conditions.
If shipping damage is noticed upon delivery, the carrier should note such damage on the receipt, and sign all copies. This will facilitate processing a damage claim with the carrier. Open the top of the shipping container and remove packing material until the instrument is exposed.

CAUTION: Do not use slit housings or other protrusions for lifting. Reach down around the edges of the instrument, grasp the bottom, and carefully lift it out of the remaining packing. Place it on a sturdy table. Check through the packing and gather the small parts, cables, and documents that were shipped with it.

2.1 Inspection for Damage

Inspect the instrument for visible evidence of any damage. Check that all readily visible mechanical and electrical components are in their proper places and are intact. **If damage is evident, do not operate the instrument. Notify the Customer Service Department and the carrier at once.**

Many public carriers do not recognize claims for concealed damage reported later than 3 days after delivery. For a shipping damage claim, inspection by the carrier agent is normally required. For this reason, the original packing should be retained as evidence. While the manufacturer is not liable for damage in transit, the company will extend every effort to aid and advise.

2.2 Initial Setup

2.2.1 Precaution

CAUTION: Take care not to touch any of the optical surfaces in the instrument. Damage can easily occur and degrade performance. Such damage is not covered by the warranty. Fingerprints on a grating surface cause permanent damage. Once a fingerprint is on a grating, it is probably best to leave it alone. (See Cleaning Optics under **Installation and Care of Optics.**) Attempts to remove a fingerprint usually do not significantly restore any lost grating performance, even though the cosmetic appearance may be improved. There is a high risk of cleaning attempts contributing to further damage and degradation of performance.

WARNING: Never move the internal accessories like the swing-away mirrors by hand. The miniature gearhead motors are delicate and expensive. Forcing them manually may result in time consuming, costly repair.

2.2.2 Instrument preparation

The Instrument is delivered with two internal protections which must be removed before the usage.

Procedure

1 Place the HR460 instrument on a sturdy table,
2 The power supply must be turned off,
3 Unscrew the four knurled knobs (No.1, Fig.4, page 13) securing the small cover (No.2, Fig.4) located on the top side of the HR460,
4 Remove the nylon protection sleeve located on the turret axis (No.1, Fig.3).
5 Remove the cushioning material wrapped around the turret arm.

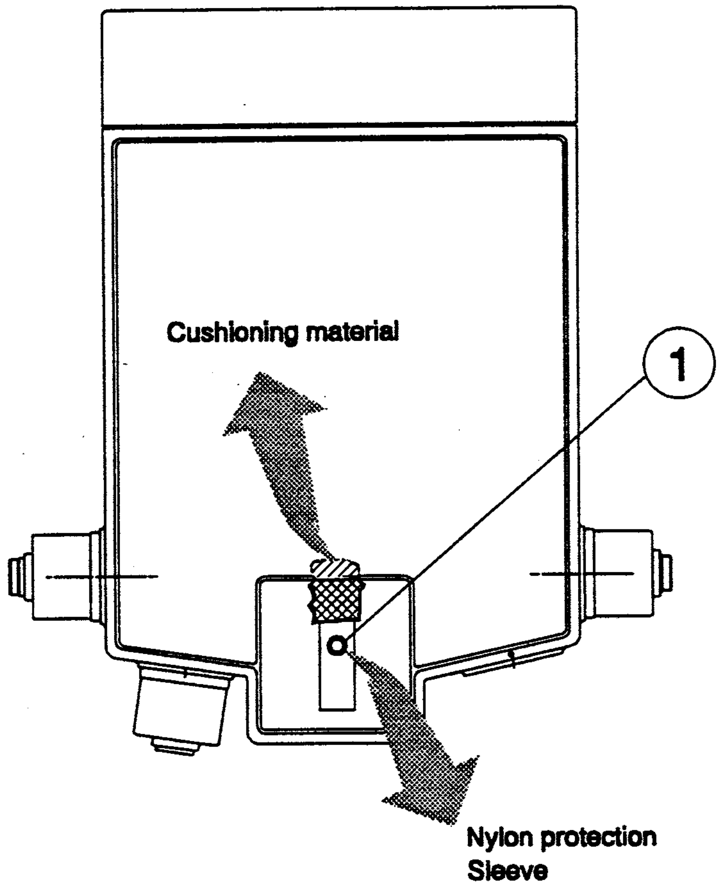


Figure 3

2.2.3 Grating turret installation

The grating turret is packed in a foam block. A cover located on the top of the HR460 instrument allows the User to install and interchange the grating turret. The following procedure details the Grating Turret installation:

Procedure

1 Place the HR460 instrument on a sturdy table,
2 The power supply must be turned off,
3 Unscrew the four knurled knobs (No.1, Fig.4) securing the small cover (No.2, Fig.4) located on the top side of the HR460,
4 Open the foam block containing the Grating Turret and unscrew the nut which secure the Grating Turret on the top side of the device **(DO NOT TOUCH THE GRATINGS !)**,
5 Using the black button (No.4, Fig.5) located on the top side of the Turret, lift up and remove the Grating Turret from the foam block and place the turret inside the HR460. The orientation of the turret is important and must be complied with the figure 5. An engraved point (No.3, Fig.5) on the Turret is used to position the Turret to the correct orientation. The Turret must be mounted on the axis (see No.2, Fig.5). The Grating Turret is installed when the Turret gear is positioned on the driving gear of the HR460.
Note: The mark No.1, Fig.5 shows the stop of the Turret Grating movement.

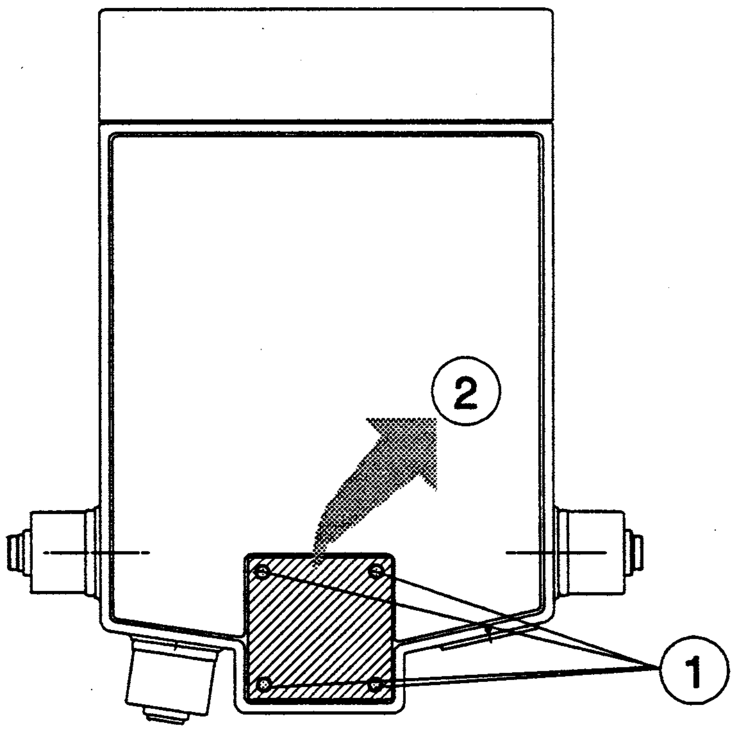


Figure 4

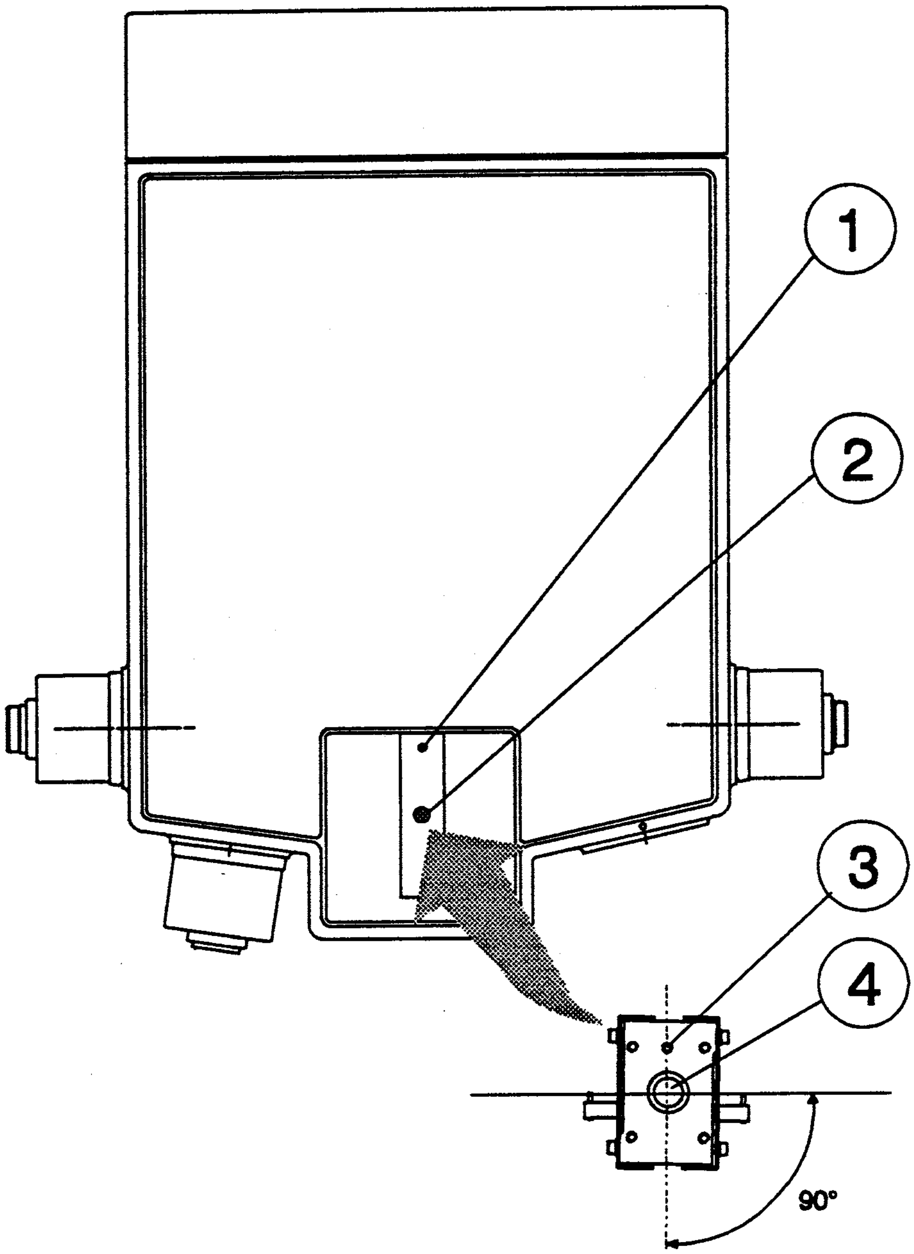


Figure 5

2.2.4 Environmental Considerations

The spectrometer should be kept in an atmosphere free of dust, corrosives and smoke. For specified performance, the HR460 should be operated in a room where temperature control is maintained within ± 2° C.

3 Electrical Connections

The electrical connectors on the HR460 are clustered on the rear panel. Connections for controllers or computers vary depending on the options present. The locations of the connectors are shown in the Figure 6.

3.1 Power Connection

- The HR460 requires connection to an AC power source. The connector for the line cord, the power switch, fuse and 240/220/120/110 Volts selection are provided in an integrated power module. Refer to **Appendix A** (page 47): HR460 AC Power selection and Fusing, for further information.

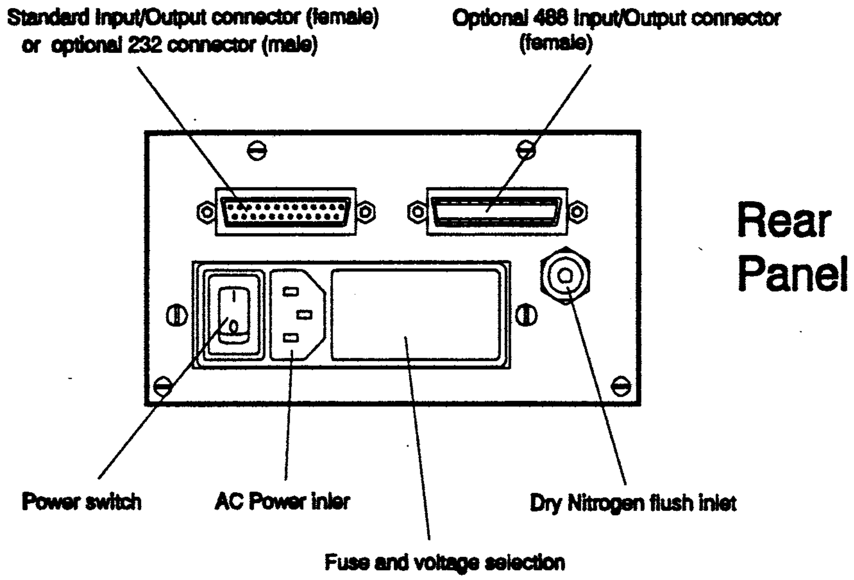


Figure 6

3.2 Control Cable Connections

The cable connections for the HR460 vary, depending on the Interface used and the controlling device or computer attached. The table shown below lists the cable connections to the HR460 that are required for the various configurations. Some configurations involving a controller and a computer will require other cabling between the controller and the computer. Refer to the manual for your controller for further information. If used, connect a nitrogen tube (inner diameter 7 mm) to the nitrogen inlet.
The locations of the connectors are shown on the Figure 6.

3.3 Shutter Cable Connections

Connect the shutter cable to the electronic driver connector and refer to the detector system manual to determine proper connection to the detector control electronics.

HR460 Control Interface Cabling

Interface type	HR460 connector	Cable number	Connected to	Software/Controller Options
Standard Spectrometer I/O (TTL)	25 pin "D" female	33990A	DataLink/DataScan Mono Drive 1 or 2 connector	AutoScan, SpectraMax or user program via DataLink-/DataScan Programmer's Instruction Set
Standard Spectrometer I/O (TTL)	25 pin "D" female	33990A	SPECTRAVIEW-1D/QuikScan Motor Drive connector on Digital card	SpectraMax, QuikView or AutoScan or user program via PDALOAD.EXE driver
Optional 232 Interface	25 pin "D" male	36406	KeyLink/HandScan connector	KeyLink/HandScan controller
Optional 232 Interface	25 pin "D" male	97133	PC COM port, High memory accessible	QuikView, SpectraMax if special ordered for use with 232 link-HR460
Optional 232 Interface	25 pin "D" male	97133	PC COM port, RS232	User program via HR460 Programmer's Instruction Set
Optional 488 Interface	24 contact "D" female	User provided cable	IEEE-488 GPIB	User program via HR460 Programmer's Instruction Set

Connector pin assignments are listed in Appendix B.

4 Software Installation and Control Interfacing

The HR460 must be controlled by an external controller or computer. The full automation of all moving parts of the spectrometer makes it unnecessary to have direct physical access to the instrument.

Several Software options are available to control the HR460, such as AutoScan for use via a DataLink/DataScan controller, QuikView for use in conjunction with a SPECTRAVIEW-1D Photodiode Array detector, and the ultimate high performance SpectraMax Software which controls all the Systems (Scanning, PDA, CCD features etc...). Each of these are configured at the factory to match the supplied hardware.

Each group of controlling options is outlined in this section, along with directions to further documentation, if necessary.

Refer to the **Electrical Connections** section for appropriate cable connections.

At this point, the installation procedure branches. Please find the subsection pertaining to the Software/Controller relating to the System.

4.1 JYS Driver

The JYS.SYS driver is a low level interface to software. Writing programs utilizing device drivers such as JYS.SYS require considerable programming skills, and are therefore not recommended for the occasional or novice programmer.
The documentation for JYS.SYS is available on request. Please contact the ISA representatives.

4.2 Optional KeyLink/HandScan

If the HR460 will be controlled by a KeyLink/HandScan, please refer to the KeyLink/-HandScan User Manual.

4.3 Optional 232 and 488 Interfaces, and DataLink/DataScan Controller

Example programs using the Programmer's Instruction Set is provided on a diskette for use with on a PC running MS DOS 3.3 or later version. Please refer to the Programmer's Instruction Set section of the 232/488 Interfaces User Manual for setup procedures and information about writing own programs with the Instruction Set. Please use the sample programs provided on the support diskette to verify communications and perform the HR460 **Initial Checks** (page 29).

The DataLink/DataScan and the 232 Interface can also be used with the KeyLink/-HandScan. If a KeyLink/HandScan is used, please perform the **Initial Checks** with the KeyLink/HandScan, then refer to the Programmer's Instruction Set section of the 232/488 Interface Manual to begin writing own programs to control the HR460.

NOTICE: the optional 232 Interface that connects to the KeyLink/HandScan can also be used to control the HR460 from a computer. In this case, please note that the diskette delivered with the 232 Interface contains files to get a programmer started writing routines for a DOS PC using the GWBasic programming language.

4.4 Optional AutoScan Software

The AutoScan Software controls the HR460 via the DataLink/DataScan controller. Please refer to the AutoScan User Manual to set up the Software then read and acquaint the following chapters: ***Starting AutoScan Software, Software Organization and A Brief Lesson***. Then return to the HR460 manual **Initial Checks** chapter (page 29).

4.5 Optional SPECTRAVIEW-1D/QuikScan PDA system

If the HR460 is to be controlled by a PC computer along with a SPECTRAVIEW-1D-/QuikScan diode array system, please refer to the SPECTRAVIEW-1D/QuikScan Manual to install the controller boards and the QuikView Software manual to acquaint with the software. Then return to the HR460 manual **Initial Checks** (page 29) section.

4.6 Optional SpectraMax Software

If the HR460 is to be controlled by a PC computer along with a SPECTRAVIEW-1D/QuikScan diode array system, or a Scanning Monochromator System or a SPECTRAVIEW-2D/Spectrum One CCD System, please refer to the SpectraMax User Manual to install the controller or specific boards. Read carefully the Software User manual to acquaint with the Software. Then return to the HR460 manual **Initial Checks** section (page 29).

4.7 PDALOAD.EXE Driver

The PDALOAD.EXE driver is installed with the QuikView software that is provided with the SPECTRAVIEW1-D/QuikScan photodiode array detector. Please complete the SPECTRAVIEW-1D/QuikScan installation and check out the HR460 with the QuikView Software.

PDALOAD programming extension
This method of programming requires considerable programming skill, and is therefore not recommended for the novice or occasional programmer. The programming documentation is available on request. An experienced programmer can used the PDALOAD.EXE driver to control the HR460 instrument.

4.8 The Standard Parallel Input/Output Interface

The Parallel I/O or Interface Control Circuits consist of 3 input and 2 output buffers (they are all uni-directional).

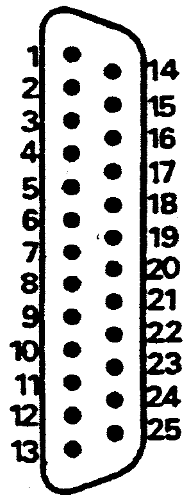
4.8.1 *Electrical specifications*

The buffers are TTL compatible and the pinout is arranged to be consistent with the full line of monochromators. Some monochromators require an additional driver interface.

The input signals are terminated in the traditional 220/330 ohm pull-up/pull--down arrangement, the termination then feeds a Schmitt trigger input (74 HCT14).

The output buffers are TTL 74 HC 9114 open collector drivers which should be terminated at the receiving end in the same manor as the input signals are terminated.

I/O Standard Control Connector

Pin	Signal Name	Function	Female DB25 connector (external view)
1	SELECT_CLOCK	Clock to select next divice	
2	GND	Signal return	
3	DIR	Direction or position to set selected divice	
4	GND	Signal return	
5	STEP*	Used to generate step pulse or clock position	
6	GND	Signal return	
7	INDEX*	Low (0V) if wavelength is selected device	
8	GND	Signal return	
9	SENSE	Selected device sense output	
10	GND	Signal return	

5 Options and Accessories Installation

A full line of options and accessories are available for the HR460 from light sources, optical fibers and Interfaces to detectors and sample compartments. Most of these are shipped with separate documentation.

IMPORTANT: Note that the accessories which change the HR460 Hardware configuration require the DATALINK/DATASCAN firmware upgrading. This file is usually delivered with the ordered accessory and is located on a diskette. For example the 232 interface option must be installed and firmware upgraded with the file 232_SCAN.INI.

All of the available options and accessories detailed below must be factory installed with the exception of the 232 and 488 Interfaces, the Multichannel adapter and the interchangeable Dual Grating Turret.

5.1 HR460 basic options

The following two main versions of the HR460 are available. Each of these versions can be upgraded with the additional options and accessories described on page 23.

REFERENCE	DESCRIPTION
11 070 180	**HR 460 S** - Focal length: 460 mm - Aperture f/7 with 58 x 58 mm^2 grating - Asymetrical Czerny-Turner optical configuration - Flat Field: 25.4 mm width x 15 mm height - Includes stepper motor and an interchangeable Dual Grating Turret for 58 x 58 mm^2 grating - Additional front and side slits can be adapted later (swing-away motorized mirror required) - **Minimum requirements:** . Two slits, or one slit with a multichannel adapter . One grating

11 070 181	**HR 460 SHL** - Focal length: 460 mm - Aperture f/7 with 76 x 76 mm^2 grating - Asymetrical Czerny-Turner optical configuration - Flat Field: 25.4 mm width x 15 mm height - Additional front and side slits can be adapted later (swing-away motorized mirror required) - **Minimum requirements:** . Two slits, or one slit with a multichannel adapter . One grating

The Spectrometer has motorized adjustable slits located at the entrance and exit ports. The slits are controlled remotely by the KeyLink/HandScan or the Computer. Since the dispersion of the HR460 with 1200 g/mm gratings is 1.76 nm/mm, opening the slits by 0.1 mm allows an additional 0.176 nm of spectral bandwidth to pass through the instrument. In this case, a slit setting of 0.880 mm equates to a 1.55 nm bandpass. Assuming broadband light entering the spectrometer, the bandpass at the exit for moderate to narrow slit widths will approximate a Gaussian distribution. The nominal bandpass is measured at half of the peak intensity.

5.2 HR 460 optional options and accessories

Part Number	Description
	HR460 ENTRANCE AND EXIT PORTS
23 024 510	Computer-controlled axial entrance slit.
23 024 530	Computer-controlled lateral entrance slit. Including computer-controlled swing-away mirror for HR460 side entrance port .
23 024 540	Computer-controlled axial exit slit.
23 024 550	Computer-controlled lateral exit slit. Including computer-controlled swing-away mirror for HR460 side exit port .
23 024 090	Multichannel adapter (axial mounting only). For PDA or CCD detectors.
23 024 560	Computer-controlled axial entrance slit. Including remote control shutter for dark subtraction and detector protection .
23 024 570	Computer-controlled lateral entrance slit. Including computer-controlled swing-away mirror for side entrance port and a remote control shutter for dark subtraction and detector protection.
	Accessories
23 024 080	Interchangeable Dual Grating Turret for HR460 S (58 x 58 mm^2)
23 024 070	Interchangeable Dual Grating Turret for HR460 SHL (76 x 76 mm^2)
23 024 120	Slit Height Reducer
46 011 007	RS-232 Interface
46 011 009	IEEE-488 Interface

6 Installation and Care of Optical Components

6.1 Mirrors and Gratings

The mirrors and gratings in the spectrometer require no routine maintenance. Still, care should be exercised to prevent damage to their surfaces which will degrade throughput. The spectrometer should be kept in an atmosphere free of dust, corrosives and smoke. Be careful to avoid touching a grating surface.

WARNING: Never turn the swing-away mirrors by hand when the power is on. The gearhead motors are delicate. Forcing them manually may result in time consuming, costly repair.

Dust or other solid debris should be blown off with dry dusting gas or nitrogen. **Be sure to hold cans of dusting gas upright. If they are tilted or inverted, liquid propellant may be discharged, causing greater damage to the optic.** If particles cannot be dislodged, consider leaving well enough alone, rather than risking surface damage. A fingerprint on a mirror or grating surface should be flushed off as soon as practical by squirting the surface of the mirror with research-grade methanol from a clean squeeze bottle. The power to the HR460 should be turned off to avoid damage to the electronics, and should remain off until all traces of methanol vapor have dissipated, precluding any risk of ignition. Gratings should be removed from the instrument for flushing. When flushing a mirror, place some paper towels below the mirror to absorb the excess methanol. Blow off the grating or mirror with dry dusting gas or nitrogen to prevent spots or streaks. Be careful to avoid squirting or splashing the electronics or mechanical components. If the flow from the wash bottle does not remove the fingerprint, call the Customer Service for further advice.

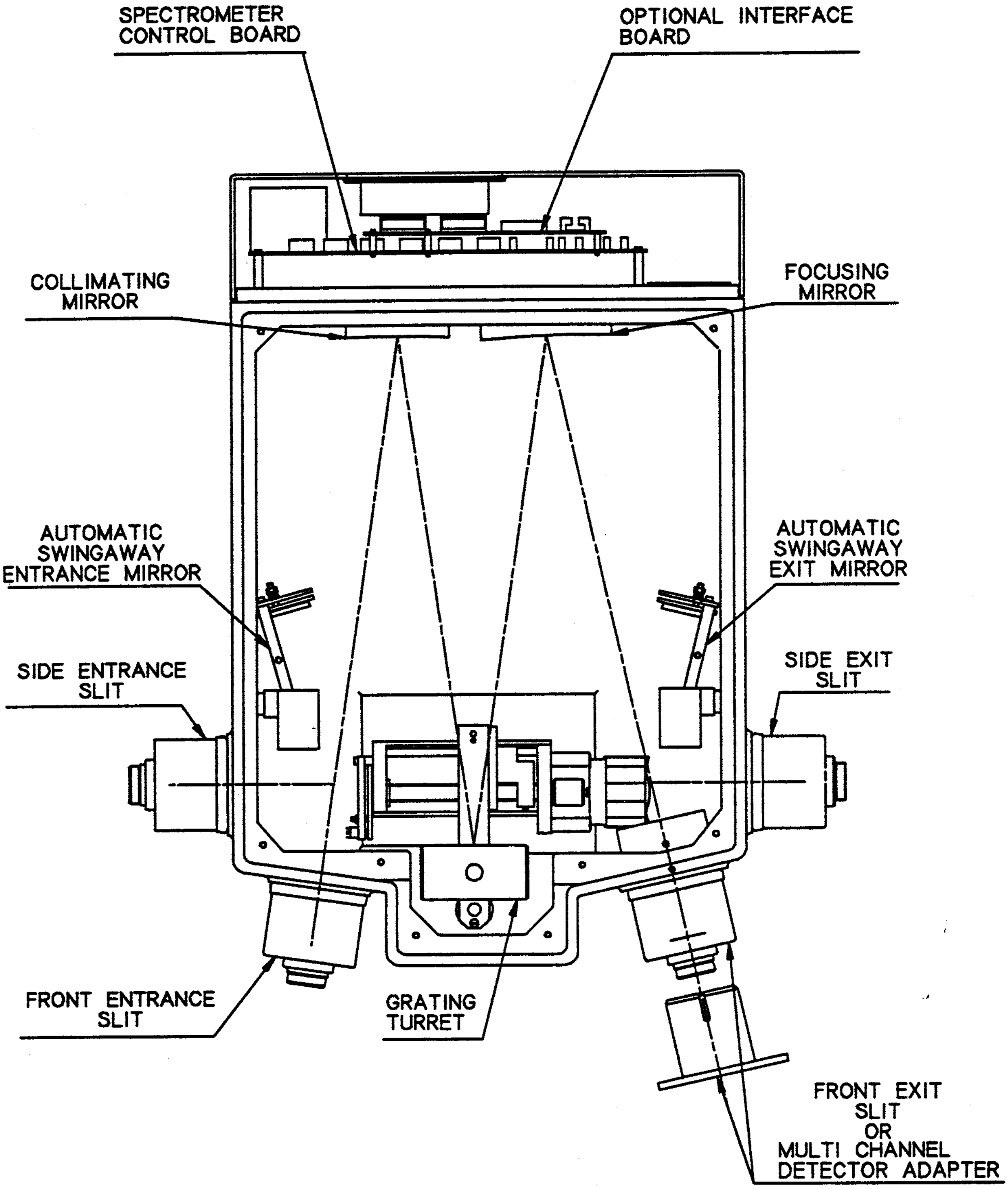


Figure 8: HR460 Component Locations

6.2 Grating Turret

Systems are supplied with a Grating Turret delivered in a foam block. Each grating on the Turret assembly is factory aligned. Never remove a grating from the Turret or disturb the factory adjustment.

Select either grating on the turret automatically, using the controller or software that is connected to the system. Refer to the manual that pertains to your system's controller or software.

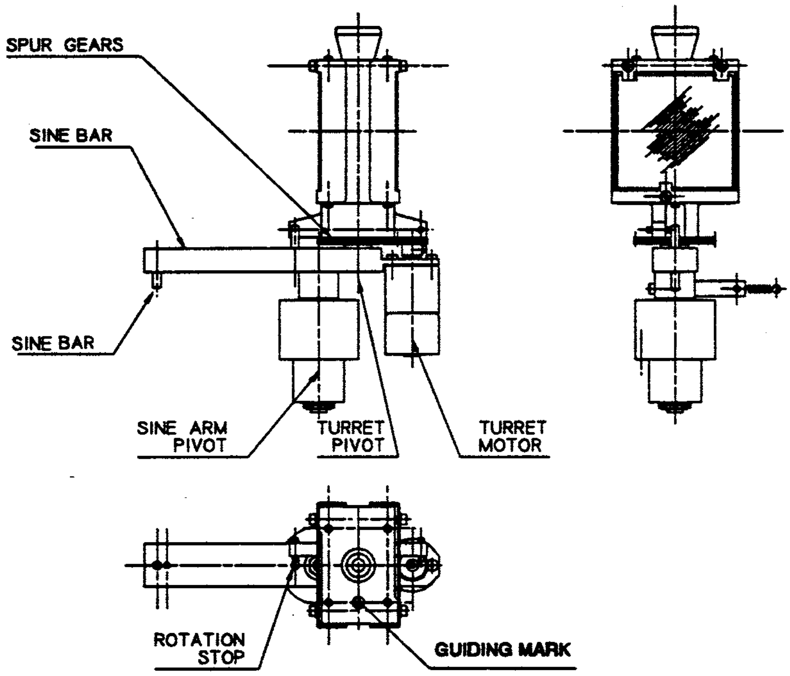


Figure 9: Interchangeable Grating Turret

To mount or change the interchangeable turret see the installation procedure detailed page 13.

6.3 Spectrograph Exit Port

The HR460 has an adapter to mount and support most multichannel array detectors that conform to the industry standard three bolt circular pattern and focal plane position. The SPECTRAVIEW-1D/QuikScan and SPECTRAVIEW-2D/Spectrum One detectors fit, of course, as do most other manufacturer's spectroscopic array detectors. If the detector is coming from another manufacturer, please refer to the spectrograph port interface drawing in the **Mechanical Interfacing** section and compare dimensions with the detector or documentation you have with your array system. The spectrograph port provides for translation in and out to locate the array in the focal plane, and rotation to align the array pixels with the vertical slit image.

7 Initial Checks

7.1 Equipment Required:

- KeyLink/HandScan or IBM PC/AT 100% compatible computer.
- If using a computer, you will also need the Datascan/232/488 support diskette.
- Mercury lamp, or fluorescent room light.
- Photodetector and detection electronics.

7.2 Checkouts

For KeyLink/HandScan, AutoScan, QuikView, SpectraMax controlled systems, the wavelength, slit, turret, mirror, and shutter drives will run through a self-test and self-calibration when the controlling program or device runs a hardware initialization routine. For a fully loaded system, this may require a few minutes, as each automated device is initialized in sequence. At the end of the initialization, the slits will be "closed" to a nominal width of 10 microns. Following initialization, depending on the controller you use, the wavelength drive will be positioned at the calibration switch at the high end of its travel, or the system will set the various drives to their last-used positions.

Assuming that there was no damage discovered during unpacking and installation, the optics in the HR460 should require no further attention.
As an initial check to determine that the calibration and alignment are good, you may verify that the visible mercury lines are passed through the exit. To check this, illuminate the entrance slit with the mercury lamp, and with the controller, tune the wavelength drive to 546 nm. Note that the correct steps/nm factor must be used when configuring your controller. A 1200 g/mm grating in a HR460 requires 160 steps/nm factor. Other grating groove densities require proportionally more or less steps/nm. With the slits opened to 250 microns, the green line should be visible through the exit slit. If your system has no exit slit, hold a piece of ground glass as a focus screen in the center of the spectrograph focal plane to find the green image of the entrance slit (frosted tape on a microscope slide makes a good substitute, or use tracing paper). Extra lamp intensity, or a darkened room may help you see it. The same test can be repeated at the 577 and 579 nm orange doublet lines.

If you wish to accurately check calibration, mount a photodetector at the exit, and close the slits to 13 microns and set the height limiter to 1 mm. when you scan past the spectral lines that your detector responds to, they should peak within +/- 0.1 nm of their indicated wavelengths, if you are using a 1200 g/mm grating. For other gratings, the tolerance scales inversely to g/mm. Note that all calibration scans should be made in the direction of increasing wavelength. When moving to shorter wavelengths, overshoot by at least 10 nm with a 1200 g/mm grating, (or 1600 steps in any case) to allow for backlash correction. Backlash correction is automatic with KeyLink/HandScan, QuikView, AutoScan and SpectraMax Softwares. Refer to the calibration data shipped with the instrument for the calibration plots that were run on the spectrometer prior to shipment from the factory.

8 Optical Interfacing Considerations

8.1 Grating Selection

Once the spectrometer itself is chosen, a key variable in determining the working specifications of the system is the grating.

Groove density affects resolution or bandpass or coverage on an array detector. The grating can often be chosen to enhance sensitivity over a range of wavelengths of interest. There are gratings available to allow the HR460 to be used from 180 nm to 50 µm and beyond. In many cases resolution or throughput can be enhanced by choosing a higher groove density. Or you may change the spectral coverage on your array by selecting a different groove density than you are now using.
NOTICE: Dry nitrogen (rectified) gas must be diffused inside the instrument when the working wavelength is positionned below 200 nm. The gas inlet is located on the rear panel.

The blaze wavelength of a Ruled grating is its wavelength of peak efficiency. generally the efficiency will stay stronger farther toward longer wavelengths than shorter. Although Ruled gratings can be highly efficient, beware of the inevitable grating ghosts that can reduce signal to noise ratios. This is not apparent from efficiency data. The effect can be quite distracting when using a single grating system in conjunction with a laser. Even worse, if the signal of interest is weak compared to the laser, as in Raman spectroscopy, for example. The ghosts are caused by minute mechanically induced errors in groove spacing. Even using state-of-the-art dual interferometer controlled ruling engines cannot eliminate this problem entirely. Generally, the ghosts are most severe in high groove density gratings, Ghost intensity increases as the square of groove density.

Most systems using Low density gratings for broad coverage on an array, or blazed for the Infrared do not suffer significantly from ghosts. Ruled gratings remain the best choice for these cases.

Standard Holographic gratings are created by optical holographic techniques, and as a result, have no spacing error, hence no ghosts. They generally exhibit broader response, at the expense of high peak efficiency. There are Holographic gratings optimized for wavelengths from the UV to the near IR.

The newer Blazed Holographic gratings provide the high efficiency comparable to that of a ruled grating without the ghosts. For many cases in the UV and Visible, these are now the best gratings available.

The growing list of available gratings is too extensive to describe adequately in this manual. The gratings are also too important to system performance to make quick, uninformed selections.

Contact the sales representative for detailed information and advice in selecting gratings for your specific applications. In order to assure User of optimal selections for the applications, we need to know:

- The total range of wavelengths you wish to work over
- The spectral resolution/bandpass you need
- The type of source you are using
- The spectroscopic phenomenon you will observe, i.e., emission, absorption, transmission, fluorescence, Raman, etc.
- The type and spectral response of your detector
- If an array detector is used, the size if the pixels and the array size
- For arrays also, the coverage required in a single readout.

8.2 Optical Coupling at the Entrance Slits

To allow the HR460 to provide its maximum throughput, one of the most important considerations is the proper coupling of light into the entrance slit. The ideal is to maximize the signal of interest, while minimizing noise. To accomplish this, some understanding of the optical requirements is helpful.

The HR460, like most spectrometers, is an imaging system. An image at the entrance slit will be dispersed into its various wavelengths, and for each wavelength present in the signal, an image of the entrance image (as masked by the entrance slit) will be formed at the exit.

The best results are obtained when your signal is imaged on the entrance slit, on the optical axis that is defined by the center of the slit and the center of the collimating mirror. If the signal is visible light, a quick check can be made by placing a white card in front of the collimating mirror. You should see homogeneous illumination across the entire active surface. If some image or structure is observed in the card, the image is probably not well focused at the entrance.

To optimize the signal to noise ratio, it is important that the collimating mirror is filled, but not overfilled by the signal beam. Underfiling usually implies that more signal can be obtained, by using faster collection optics. Overfilling the spectrometer optics can only increase the possibility of stray light reaching the detector. Limit the aperture of the beam so that the collimating mirror is just filled.

8.3 Exit Slit Considerations

Bandpass in optical spectrometers is determined by multiplying the dispersion by the exit slit width, or the width of the image of the entrance slit that is formed at the exit. The magnification factor is the ratio of the entrance arm to the exit arm lengths. Concerning the HR460, the ratio is 1. Hence, the image of the entrance slit at the exit is the same than the entrance slit width.

8.4 Spectrograph Port Focusing

Please refer to the instructions provided with the array detector, and set it up in a realtime display mode for final adjustment. If realtime display is not available, the alignment will take longer, as you must view the change in detected signal after each trial adjustment.

If you have a linear Photodiode Array with raw video output, displayed the video on an X-Y monitor or oscilloscope with video intensity on the Y axis versus horizontal pixel position on the X axis. The raw video display updates in true realtime. With no lag time, you will be less likely to overshoot the optimum.

The HR460 spectrograph port provides for translation in and out to locate the array in the focal plane, and rotation to align the array pixels with the vertical slit image. The goal is to get the best focus and vertical alignment. to start, set up a spectral lamp at the entrance (e.g. Mercury, neon, or fluorescent desk lamp). Acceptable results can often be attained without coupling optics, provided that the source or reflected beam is directly on the optical axis entering the slit. (For best results, the lamp should be properly coupled to the entrance slit. See the Optical Interfacing section for further information.)

Set the spectrometer drive to the wavelength of a known spectral line, such as the mercury 546.1 nm emission line. Set the entrance slit to the width of a pixel on your array, or slightly smaller. Adjust the light intensity until you have a low to mid scale signal on the display. Ideally, set the HR460 to a wavelength region where several lines are imaged on various parts of the array simultaneously. With multiple lines, you can optimize focus over the entire array. If this is not possible, then move the spectrometer drive to position spectral lines alternately at the center and ends of the array. While observing the realtime spectral display, rotate the detector to minimize the width of the image on the array. Then translate the detector in and out to find the best focus.

As you approach the proper focus, the peak will become narrower, and the intensity will be more concentrated in the central pixels of the peak.. Best focus is reached at maximum detected intensity in the central pixel. Be careful not to be fooled by apparent intensity fluctuations that may occur as a function of small movements of a narrow image being shared between adjacent pixels. For an unintensified array detector, the full width at half maximum (FWHM) should be 3-4 pixels. For intensified detectors, there is a spreading of the image due to the intensifier, so FWHM will be 4-5 pixels. Be sure that the display of your detection system is set up to display intensity versus pixels. Expand sufficiently on the horizontal pixel axis that you can easily discern individual pixels.

Optimization of the focus adjustment is an iterative process. Repeat the rotation and translation with successively smaller movements until no further improvement is observed.

If you are using a CCD, it is best to check the rotation of the detector via an image display, after obtaining what you think is the best focus and rotation as described above. If the rotation is correct, the image of a spectral line with full slit height should be perpendicular to the x axis.

Through the careful attention during alignment, you can be assured that you will realize the exceptional performance capability that was designed and built into your HR460.

9 Overall dimensions

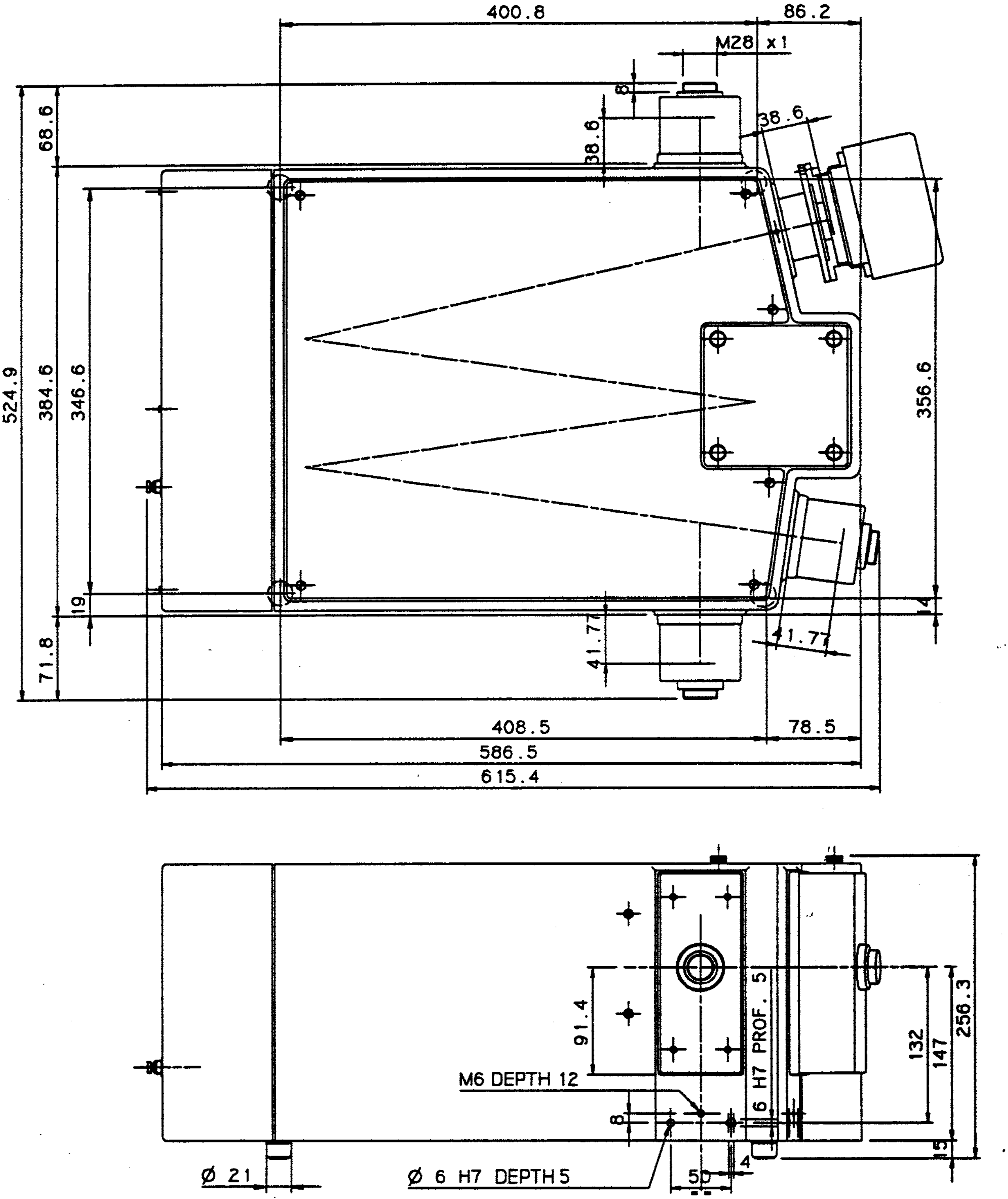


Figure 10: HR460 Dimensions

10 Application Examples

The HR460 is quite versatile, and may be operated in various ways, depending on the measurement and the requirements of associated equipment such as detectors. Following are a few representative operating examples for typical uses.

10.1 As a Monochromatic Illuminator

With a broadband light source directly coupled to an entrance slit, the HR460 can provide a specific bandpass at the exit. The spectral bandpass can be varied by changing the slit widths. The scan drive facilitates tuning or selecting the central wavelength of the exiting beam.
One might wish to alternately illuminate samples with two wavelengths of light to perform two measurements, let's say transmission at 580 nm, and fluorescence excited by 400 nm light.
The HR460 imaging optics maintain a small illumination spot size at the exit. (Traditional designs spread the spot, reducing its intensity. This is due to aberrations that are eliminated by the HR460 design.) For the two measurements the bandpasses can be optimized independently. Under computer control the motorized slits change as programmed. The high speed drive minimizes slewing time.

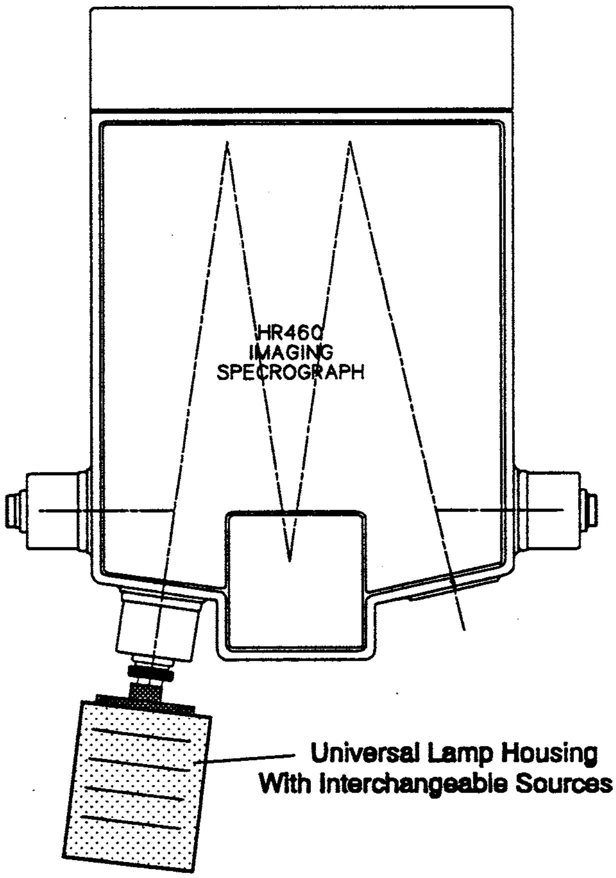


Figure 11: HR460 as a Monochromatic Illuminator

The Universal Lamp Housing (P/N: 11 075 484) includes a universal plate on which is mounted the lamp with the reflecting elliptical mirror. The following interchangeable Lamp Sources are available:

11 075 490	75 Watts Xenon Light Source,
11 075 492	Deuterium Light Source,
11 075 491	70 Watts Globar Light Source,
11 075 504	70 Watts Tungsten/Halogen Light Source.

10.2 As a Scanning Monochromator

Another typical application of the HR460 is the measurement of the spectral output of something that emits light. This could be a lamp, or the sun, or a laser diode, a glow discharge... or whatever. If the source is stable over the range of seconds to minutes, or can be pulsed reproducibly, the HR460 can be scanned to sequentially present the wavelengths to the detector for measurement.

In this case, using a controller or computer, the start and end wavelengths, as well as the scan speed, signal integration time, and wavelength increment between datapoints are programmed.

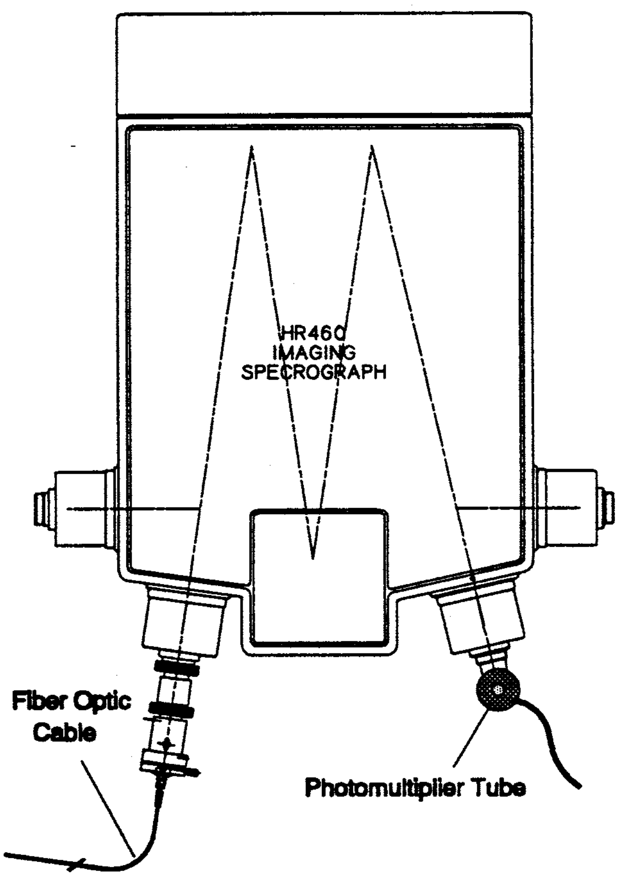


Figure 12: HR460 as a Scanning Monochromator

10.3 As a Simple Spectrograph

Some measurements must be made practically instantaneously, such as logging or monitoring changes in a spectrum from a process. This requires the simultaneous detection of signals over a range of wavelengths. A linear detector such as a PDA positioned in the focal plane of the HR460 can capture transient spectral distributions with a time resolution that depends only on the readout or gating time of the detection system.
To set up for this scenario, the light from the process is coupled via an optical fiber to the entrance slit. to minimize coupling loss, an optional fiber optic interface is used to aperture match the fiber to the spectrometer. The SPECTRAVIEW-1D/QuikScan PDA detector is mounted at the focal plane in the exit of the HR460.

If acquisition of wavelengths beyond the width of the array are required, a tradeoff may be made by using a lower groove density grating that will not disperse the wavelengths so widely. Of course, with closer spacing, resolution would be lower. An alternative, if experimental conditions permit, would be to keep the higher resolution grating, but acquire more than one region, using the rapid slewing capability of the HR460 to quickly reposition the grating. Depending on the software you are using, overlapping regions may be "glued" to form continuous spectra.

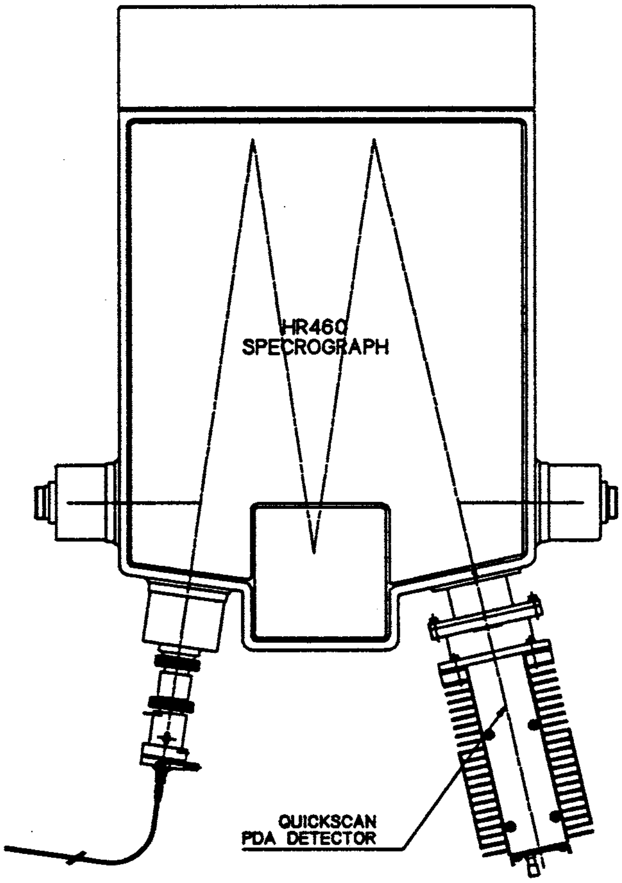


Figure 13: HR460 as a Spectrograph

10.4 As an Imaging Spectrograph

Multiple spectra from light imaged at various heights in the entrance slit can be simultaneously detected with a two dimensional array such as a CCD. The capabilities of a simple spectrograph are multiplied. This is made possible by the imaging optics, which permit close vertical spacing of signals without crosstalk, unlike conventional designs.

A stack of optical fibers imaged on the entrance slit can each carry separate spectral signals from various locations. All of the signals will be captured by the detector during the same exposure time.

Alternatively, a "slice" of a sample or reaction can be imaged directly into the entrance slit. The HR460 provides the two-dimensional image quality required to study the spatial/spectral profile of a flame, or other source that exhibits a varied distribution of spectral signals.

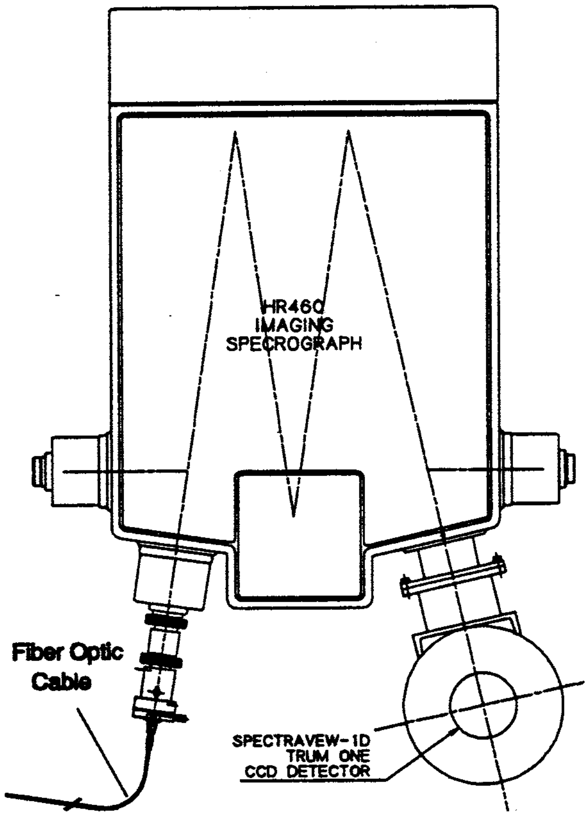


Figure 14: HR460 as an Imaging Spectrograph

11 Specifications/Parameters

Focal Length (Entrance/Exit):	454.89 mm / 451.87 mm
Entrance Aperture Ratio:	f/7 with 58 x 58 mm^2 grating f/5.3 with 76 x 76 mm^2 grating
Image Magnification at the Exit:	1
Scanning range with 1200 g/mm grating:	0-1300 nm
Multichannel coverage with 1200 g/mm grating:	45 nm over 25.4 mm array width
Flat Field Area in Focal Plane:	25.4 mm wide x 15 mm high
Spectral Dispersion with 1200 g/mm grating:	1.76 nm/mm
Spectral Resolution as a scanning monochromator with 1200 g/mm grating:	≤ 0.07 nm at 546 nm
Vertical Image Quality:	Resolve 25 fibers, 200 µm each, in 0.5"
Wavelength Positioning Accuracy:	± 0.15 nm
Wavelength Repeatability:	± 0.05 nm
Maximum Scan / Slew Rate:	45 nm/second
Wavelength Drive Step Size for 1200 g/mm grating:	0.00625 nm/step
Steps/nm factor for 1200 g/mm grating	160 steps/nm
Slit Width Drive Step Size:	12.5 µm/step
Overall Length:	616 mm
Overall Width:	525 mm
Overall Height:	257 mm
Weight:	21.5 kg

Software Setup Parameters

The following parameters must be entered in the ***Monos and Motors Setup*** screen from the Setup Main Menu of the SpectraMax/Auto-Scan/QuikView softwares.

Parameters	
Base Grating	1200 gr/mm
Order	1
Step/base unit	160 / nm
Min. limit (nm)	-10
Max. limit (nm)	1300
Min. Freq. (Hz)	2560
Max. Freq. (Hz)	5500
Ramp Time (ms)	2000
Backlash (steps)	320
Entrance focal length (mm)	454.89
Exit focal length (mm)	451.87
Included angle (°)	16.5
Incline angle (°)	0
Trigger_cal1	0
Trigger_cal2	-1
Display Precision	2
Modulo Move	N.A.
Params	N.A.
Slope	N.A.
Calibration position	Enter the factory calibration value*

* The factory calibration value is printed on a label located on the HR460 chassis.

12 In Case of Difficulty...

Your HR460 is designed to provide years of reliable service. If you are experiencing a problem, reviewing this section before contacting us will save time and help you eliminate some simple errors that can be easily corrected.

12.1 Troubleshooting

Some of the more common difficulties that may be encountered are listed below. With each, some suggestions are given that will help correct the problem for most cases.

Spectrometer not responding to any commands:

- Be sure the power cord is connected to live power. Double check that the switch is on, and check the fuse. Refer to Appendix A for proper fuse requirements.
- Check external cable connections. See the **Electrical Connections** section for proper external cable connections.
- Check internal ribbon cable connections, and jumpers on circuit boards. See the circuit board layout drawings appendix.
- Review the section under **Control Interfacing** that pertains to your controller or computer interface software.
- Check system software or firmware configuration to see that it matches the actual hardware. See **Software Installation** for more information.

Spectrometer responds to some commands, but not all.

- Check to be sure that the failing command is valid, that parameters are within limits for that drive or function
- If you purchased software from us with your system, using the documentation provided with your software, check to see that it matches the actual hardware. In particular, check that the device you wish to control is configured properly.
- If you are running your own software, stop your program and load the software diskette provided with the system to see if the device in question can be controlled. See the subsection that applies to your system under **Software Installation** for more information.

Side port mirror does not move:

- Check control cable connections. See **Electrical Connections** section.
- Review the section under **Control Interfacing** that pertains to your controller or computer interface software.
- If you are using your own program, as opposed to software purchased with the system, pay particular attention to interfacing setup connections and parameters.

Background signal too high, background reduced when room lights are turned off:

- Be sure all covers are in place
- Make sure that the area between the source or sample and the entrance slit is enclosed, and light tight. Block the entrance slit as a test.

- Check detector mounting and/ or housing for light leaks.
- Starting from the detector, close exit and entrance slits and shutters in turn to determine where stray light may be entering the system. Note that to prevent damage to the knife edges, the slits do not close completely, and will therefore not block all of the light, however, with the signal blocked, reducing the slit width will reduce any stray light that is passing through it.
- Be sure all openings and screw holes are plugged.
- Check that the cover, side, and baseplate should fit tightly, light seals should be partly compressed, not flattened.
- If leaks persist, use a small flashlight in a dark room to isolate where the leaks are by shining at any suspicious part or joint in the system. and observing detected signal levels.

Signal too noisy:

- Try to increase signal strength at the detector. See **Optical Interfacing Considerations** for suggestions.
- Check for light leaks as suggested under "Background signal too high" in this section.
- If noise is reduced by turning off the spectrometer, rearrange power connections to be sure the spectrometer, source, and detector are tied to the same ground and, if possible, the same power circuit.
- Adding redundant grounds to various points in the total system often helps. Please understand that ground loops and electromagnetic interference can sometimes be challenging problems. In extreme cases, the best approach is to patiently experiment by trying various combinations of grounding connections. As a general rule, try to keep ground wires short, make tight connections, avoid painted, coated, and anodized surfaces when possible. Consider a "star ground" of wires radiating from a single, central location, preferably connected to a grounded metal table surface under the system.
- In extreme cases, such as working with or around high powered pulsed lasers or other high energy apparatus, it may be helpful to construct RFI / EMI shields or cages to contain the noise at its source, or to isolate the detection system from the noise. In these cases, colleagues who are working with similar apparatuses may be your best resource for noise control suggestions.

13 Service Policy

If you need assistance in resolving a problem with your instrument, contact us directly, or through our representative or affiliate in your area.

Often it is possible to correct, reduce, or localize the problem to a replaceable component through discussion with our Customer Service Engineers.

All our Instruments are covered by a warranty. Service for out-of-warranty instruments is also available, for a fee. Contact us for details and cost estimates.

If an instrument or component must be returned, The method described in this section should be followed to expedite servicing and reduce your down-time.

If your problem relates to software, please verify your computer's operation by running any diagnostic routines that were provided with it. Be ready to provide version numbers for the DOS that you are using, as well as the software version and firmware version of any controller or interface options in your system. Also knowing the memory type and allocation, and other computer hardware configuration data from the PC's CMOS Setup utility may be useful.

13.1 Return Authorization

All Instruments and Components returned to the factory must be accompanied by a Return Authorization Number issued by our Customer Service Department. You may contact the representative or affiliate Customer Service department for your area.

To issue a Return Authorization number, we require:

- The model and serial number of the instrument
- A list of items and/or components to be returned
- A description of the problem, including operating settings
- The instrument user's name, mailing address, telephone, and telefax numbers
- The shipping address for shipment of the instrument to you after service
- Your Purchase Order number and billing information for any non-warranty services
- The Original Sales Order number is helpful to know
- Your Customer Account Number, if known, is also helpful
- Any special instructions

13.2 Packing the HR460

To prepare your HR460 for shipment, it is important to **open all the slits** and **position the monochromator on 0 nm.**

Remove the Grating Turret from the instrument and secure it inside the foam block. Reverse the Installation procedure described page 13.

Appendix A: HR460 AC Power Selection and Fusing

Input Voltage	Fuse
100 Vac	1/2 A slow blow
120 Vac	1/2 A slow blow
220 Vac	1/4 A slow blow
240 Vac	1/4 A slow blow

Appendix B: HR460 Interface Connector Pin Assignments

Standard Spectrometer I/O (TTL) Interface connector

Pin#	Name	Function
9	Select Clock	Input to step through addressable devices
22	Ground	For Select Clock
10	Direction	Input to assert direction for device to move. High is forward, generally toward longer wavelengths.
23	Ground	For Direction
11	Step	Pulse input to move a stepping device. Negative true (normally high) clocks on rising edge.
24	Ground	For Step
12	Index	Output, low when wavelength drive is selected
25	Ground	For Sense and Index
13	Sense	Output gives phase or position of device selected

Optional 232 Interface connector

Pin#	Name	Function
2	TXD	Transmits data from the RS-232 interface
3	RXD	Receives data
6	DTR	Data Terminal Ready (to receive a byte)
7	Ground	Reference/ return for all other lines
22	+5V	To assert other lines high as required for additional handshaking

Optional 488 Interface connector

Contact#	Name	Function
1	DIO 1	Data input / output line
2	DIO 2	Data input / output line
3	DIO 3	Data input / output line
4	DIO 4	Data input / output line
5	EOI (24)	End Or Identify
6	DAV	Data Valid
7	NRFD	Not Ready For Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHIELD	Protective Shield
13	DIO 5	Data input / output line
14	DIO 6	Data input / output line
15	DIO 7	Data input / output line
16	DIO 8	Data input / output line
17	REN (24)	Remote Enable
18	GND (6)	Signal ground for DAV
19	GND (7)	Signal ground for NRFD
20	GND (8)	Signal ground for NDAC
21	GND (9)	Signal ground for IFC
22	GND (10)	Signal ground for SRQ
23	GND (11)	Signal ground for ATN
24	GND LOGIC	Signal ground for EOI, REN

Appendix C: Spectrometer Control Board Data

Optional Jumpers

J1	Wavelength Drive Direction	Not installed for HR460
J200	DC Motor Direction (set of 4)	Only the SIDE ENT jumper is installed in HR460
J201	Half Step Motor Direction (set of 4)	None installed for HR460

P2 I/O Control Connector
(dual 5 pin straight header, 0.1 inch centers)

Pin	Nomenclature	Description
1	SELECT_CLOCK	Clock to select next device
2	GND	Signal return
3	DIR	Direction or position to set selected device
4	GND	Signal return
5	STEP*	Used to generate step pulse or clock position
6	GND	Signal return
7	INDEX*	Low (0v) if wavelength is selected device
8	GND	Signal return
9	SENSE	Selected device sense output
10	GND	Signal return

Appendix D: Circuit Board Drawings

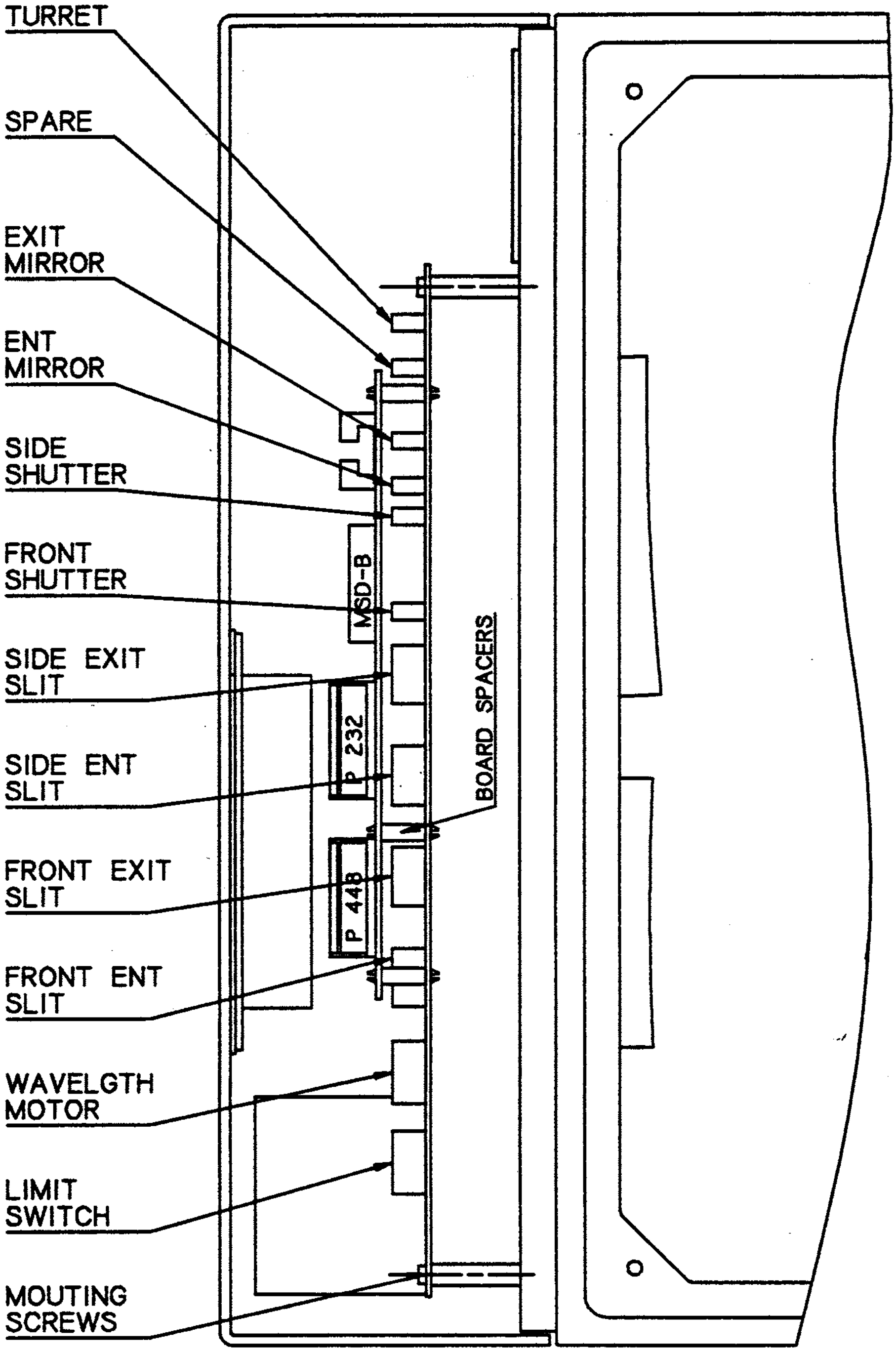


Figure 15: Circuit Board Location

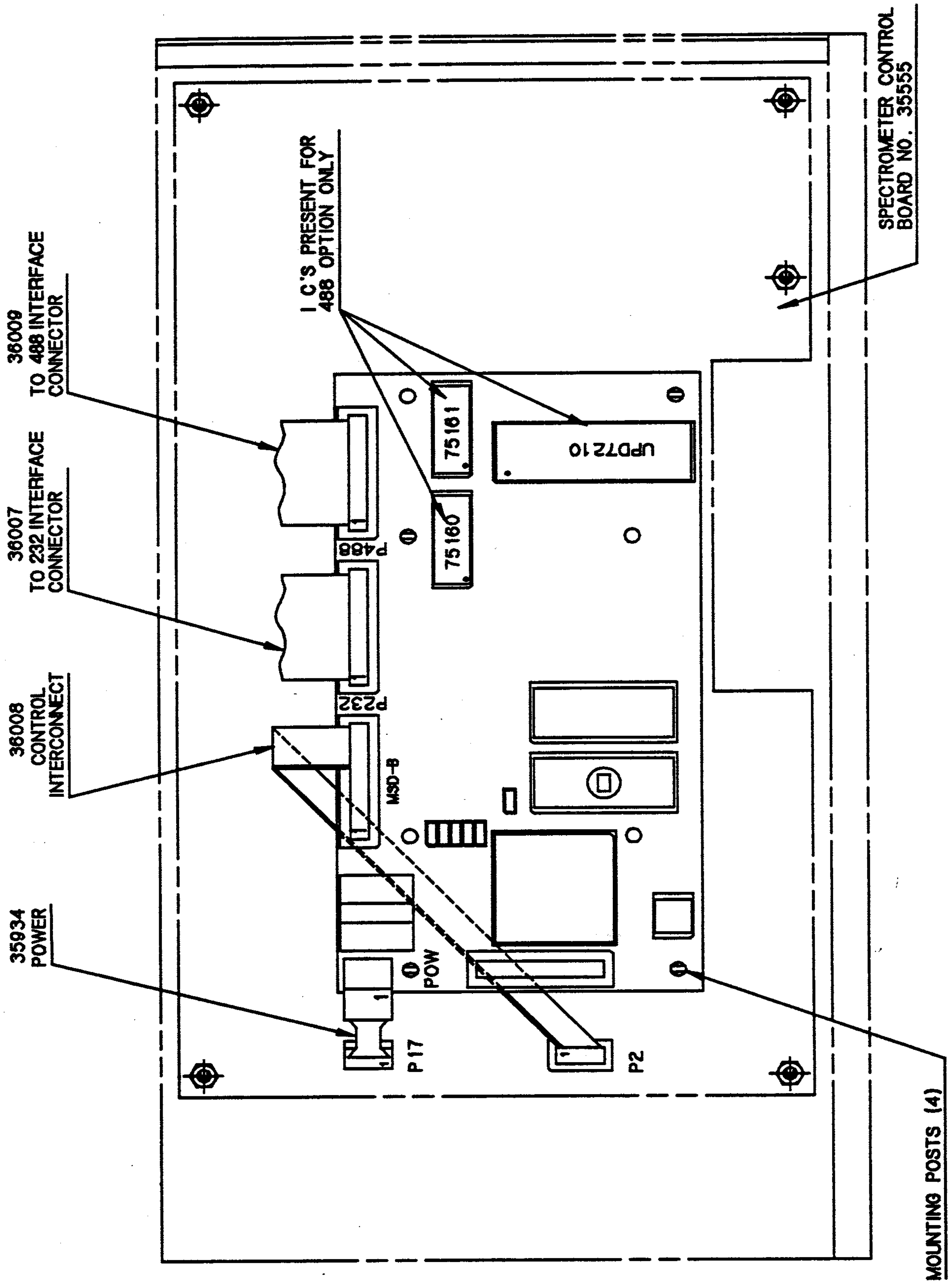


Figure 16: 232/488 Interface Location and Connections

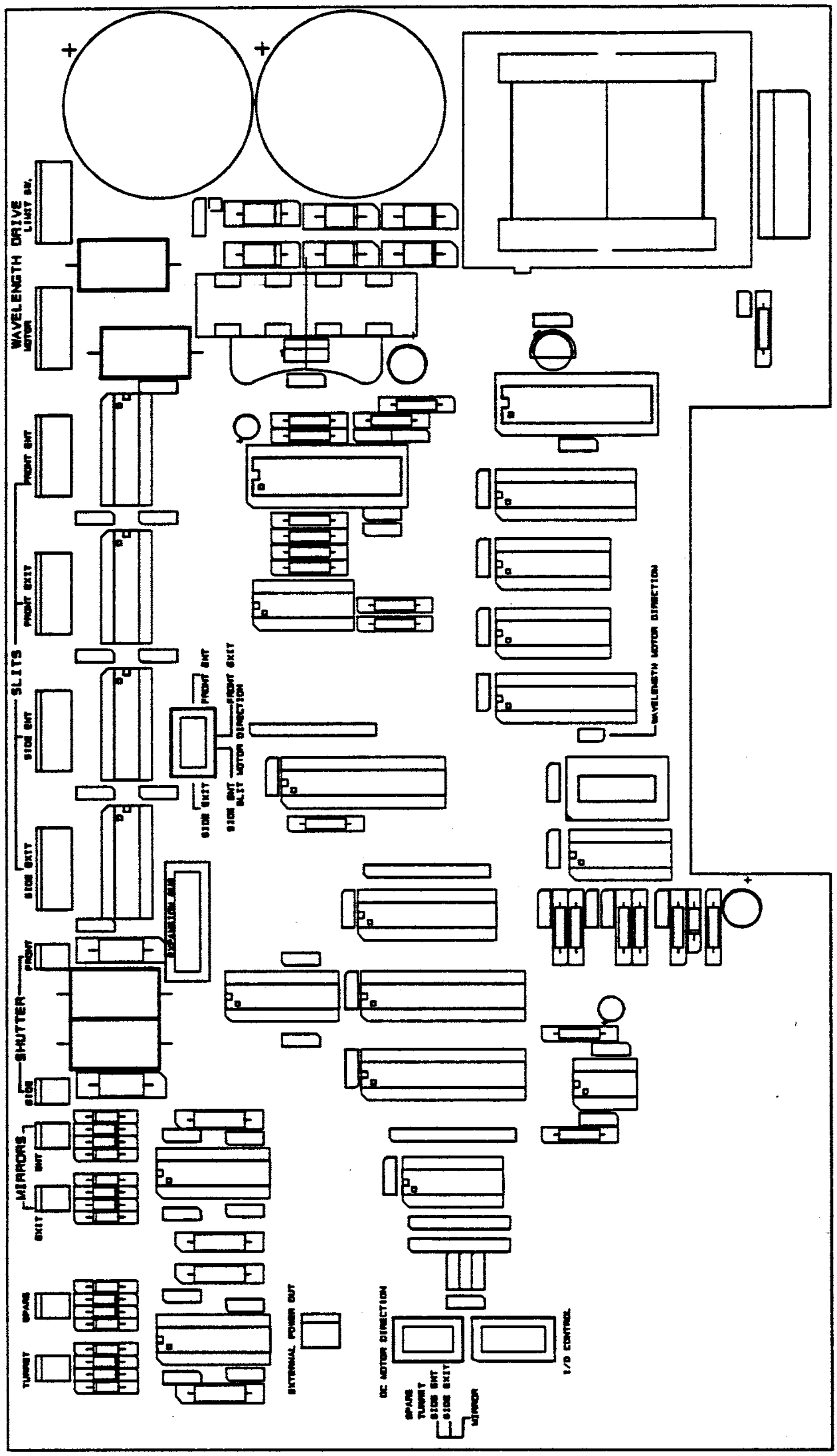


Figure 17: Spectrometer Control Board Connector & Jumper Locations