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PERFORMANCE TEST RECORD
MONOSPEC 10 MONOCHROMATOR

MODEL NO.: 82510 CUSTOMER: Instrumatic Espaola

SERIAL NO.: 347901 CUSTOMER P.O. NO.: 15850P

SHOP ORDER NO.: 504513 DATE: 10/27/97

1. Instrument Configuration
   1.1 Customers grating(s) installed:

Grating Cat. # 14002003 G/MM 600 Blaze 400-1600 Serial # 17809
Grating Cat. # _____ G/MM _____ Blaze _____ Serial # _____
Grating Cat. # _____ G/MM _____ Blaze _____ Serial # _____

1.2 Customers slit(s) installed, 500, 1000, 2000 microns, and checked for alignment.
1.3 Instrument focused ✓
1.4 Sine drive accuracy +/- 2 nm with 1200 g/mm grating. ✓
(or equivalent with other groove density)

Grating 1 Line	Reading	Grating 2 Line	Reading	Grating 3 Line	Reading
0000nm	0000 nm	0000nm	_____ nm	0000nm	_____ nm
435.8nm	436 nm	435.8nm	_____ nm	435.8nm	_____ nm
546.0nm	546 nm	546.0nm	_____ nm	546.0nm	_____ nm
435.8 II	871.6 nm	435.8 II	_____ nm	435.8 II	_____ nm

1.5 Sine drive mechanical coverage 0000 to 1000 nm. _____

2. Final Inspection:
   2.1 Finish and general appearance satisfactory ✓
   2.2 Wavelength counter locked for shipment ✓
   2.3 All adjustment screws secured with Glyptal ✓
   2.4 Grating secured in position for shipment (epoxy) ✓
   2.5 Interior and exterior of instrument clean ✓
   2.6 Additional gratings and slits packed properly for shipment ✓
   2.7 Operator's manual packed with instrument ✓

Approved by Optical Inspector Will Byrd Date 10/27/97

Final Inspector Doug Thornley Date 10/27/97

SCIENTIFIC MEASUREMENT SYSTEMS, INC.

MonoSpec 10
Model 82-510
OPERATOR'S MANUAL

August 1992
Part Number 15004001
Revision 1

Due to design changes and product improvements, the information in this document is subject to change without notice. Scientific Measurement Systems, Inc. reserves the right to change hardware design which may subsequently affect the contents of this manual. Scientific Measurement Systems, Inc. assumes no responsibility for any errors that may appear in this manual.

TABLE OF CONTENTS

ILLUSTRATIONS

INTRODUCTION

This manual is a guide to operation of the Scientific Measurement Systems, Inc. MonoSpec 10, model 82-510 monochromator. This manual is intended as a basic guide to operation and does not include information on spectroscopic

analysis techniques. It is assumed that the operator is familiar with spectroscopic analysis.

This manual is organized into five major sections. Each major section is subdivided by instrument component or instrument procedure.

1. The System Description section is an overview of the physical components and parameters of the MonoSpec 10.

2. The System Preparation section contains instructions for operation of a newly purchased MonoSpec 10.

3. The Operation section briefly describes instrument functions and controls.

4. The Maintenance section describes instrument upkeep.

5. The Service section contains procedures to adjust the optics and wavelength drive.

1. SYSTEM DESCRIPTION

This section describes the performance parameters and the physical components of the MonoSpec 10.

PERFORMANCE PARAMETERS

Following is a list of the performance parameters of the MonoSpec 10:

Aperture:	f/3.4
Focal Length:	100 mm
Reciprocal Linear Dispersion:	6 nm/mm with a 1200 g/mm grating
Resolution:	Better than 1.0 nm with a 1200 g/mm grating in the region of 200 to 700 nm. The Hg doublet of 577 nm and 579 nm can easily be resolved.
Stray Light:	Stray light is determined by measuring the intensity at 210 nm and at 250 nm and then attenuating the signal with 1/4" green glass which has a transmission of 0% below 300 nm. At 210 nm the stray light is less than 0.5% and at 250 nm the stray light is less than 0.13%. At 10 nm from the 632.8 nm laser line the stray light is less than 0.001%.
Dimensions:	165 mm long X 100 mm wide X 90 mm high. (6.50" X 4.00" X 3.40").

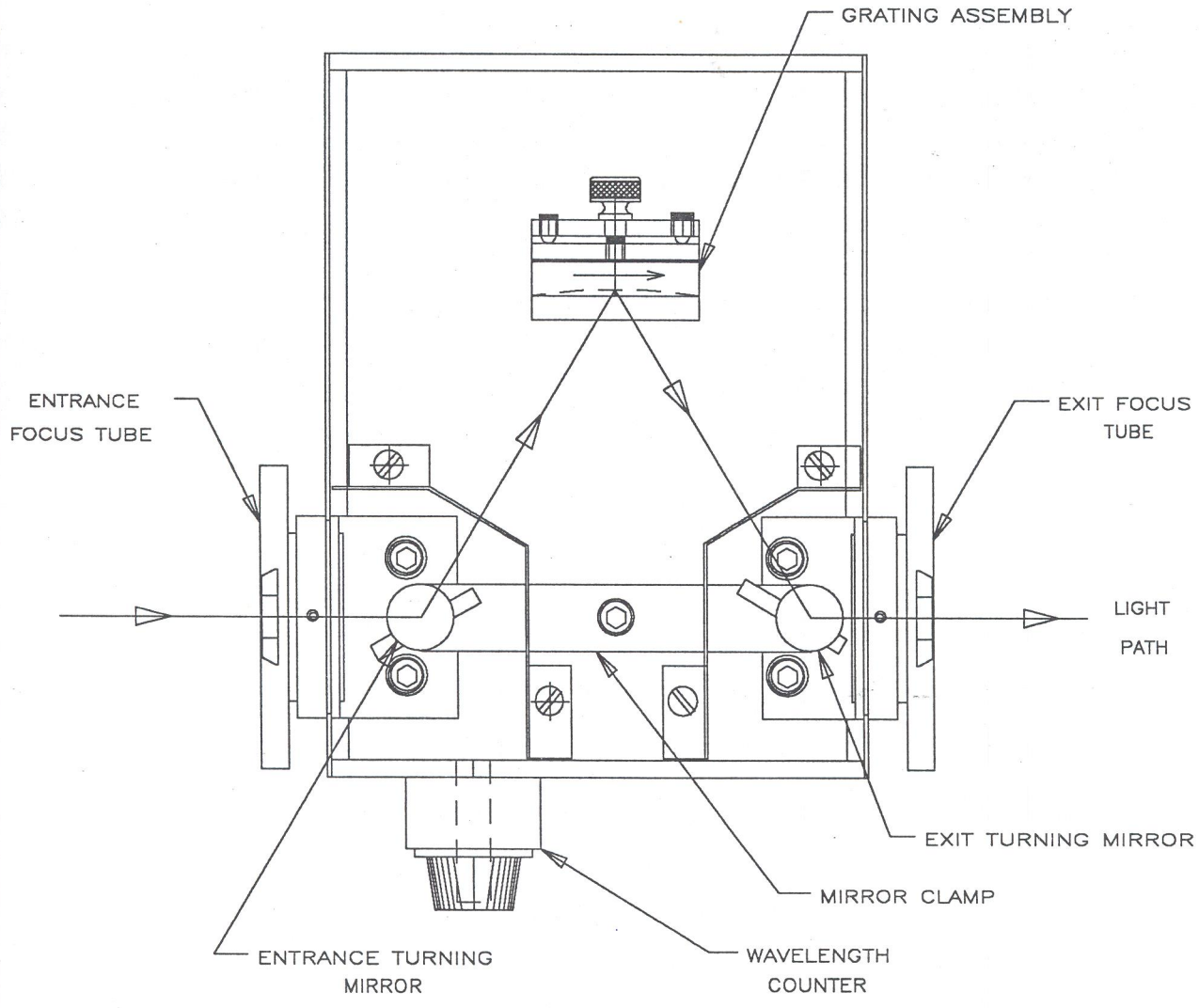
OPTICAL PATH DESCRIPTION

The MonoSpec 10 monochromator employs a concave corrected holographic grating as the diffracting and focusing element in the system. Light enters the system through the entrance slit and is reflected by the entrance turning mirror to the grating. The grating diffracts the light into its component wavelengths and directs these individual wavelengths to the exit turning mirror. The exit turning mirror is aligned to reflect the diffracted light through the exit slit to the detector. The entrance and exit slits are mounted in adjustable focus tubes which can be slid in or out to achieve optimum focus in the system.

The manually controlled wavelength sine drive moves the grating to direct a selected wavelength through the exit slit assembly. The wavelength is read on the 3 digit counter which is set for direct readout in nanometers for a 1200 g/mm grating. (For all other gratings, refer to the simple conversion chart in section 3. to determine actual wavelength).

See figure 1. (page 8)

Figure 1: MonoSpec 10 optical system



2. SYSTEM PREPARATION

If you have just received your MonoSpec 10, the shipping carton should

checked visually for any shipping damage that may have occurred.

Take care when unpacking the MonoSpec 10. The optics and wavelength drive have been pre-adjusted at the factory and should be in good working order when it is received.

Remove the MonoSpec 10 from the plastic shipping bag and carefully clean the exterior of the instrument of any dust or packing material that may have accumulated during shipping.

The Monospec 10 should be inspected before use to make sure it is in good working order. Unlock the wavelength drive knob by moving the locking lever to the left. Gently rotate the knob towards higher wavelengths to verify that the drive runs smoothly. The mechanical coverage of the drive should be between 000.0 and 110.0.

Remove the top cover of the MonoSpec 10 by loosening the six button head screws. (three along each side). Carefully remove the cover. Inspect the turning mirrors and the grating to make sure they are clean. Make sure the grating mounting screw has not loosened during shipment.

CAUTION

Make sure you do not touch the surfaces of the mirrors and grating with anything. Any contact with the aluminum surfaces can result in permanent damage to the optics!

Replace top cover and tighten the six mounting screws.

INSTRUMENT CHECK

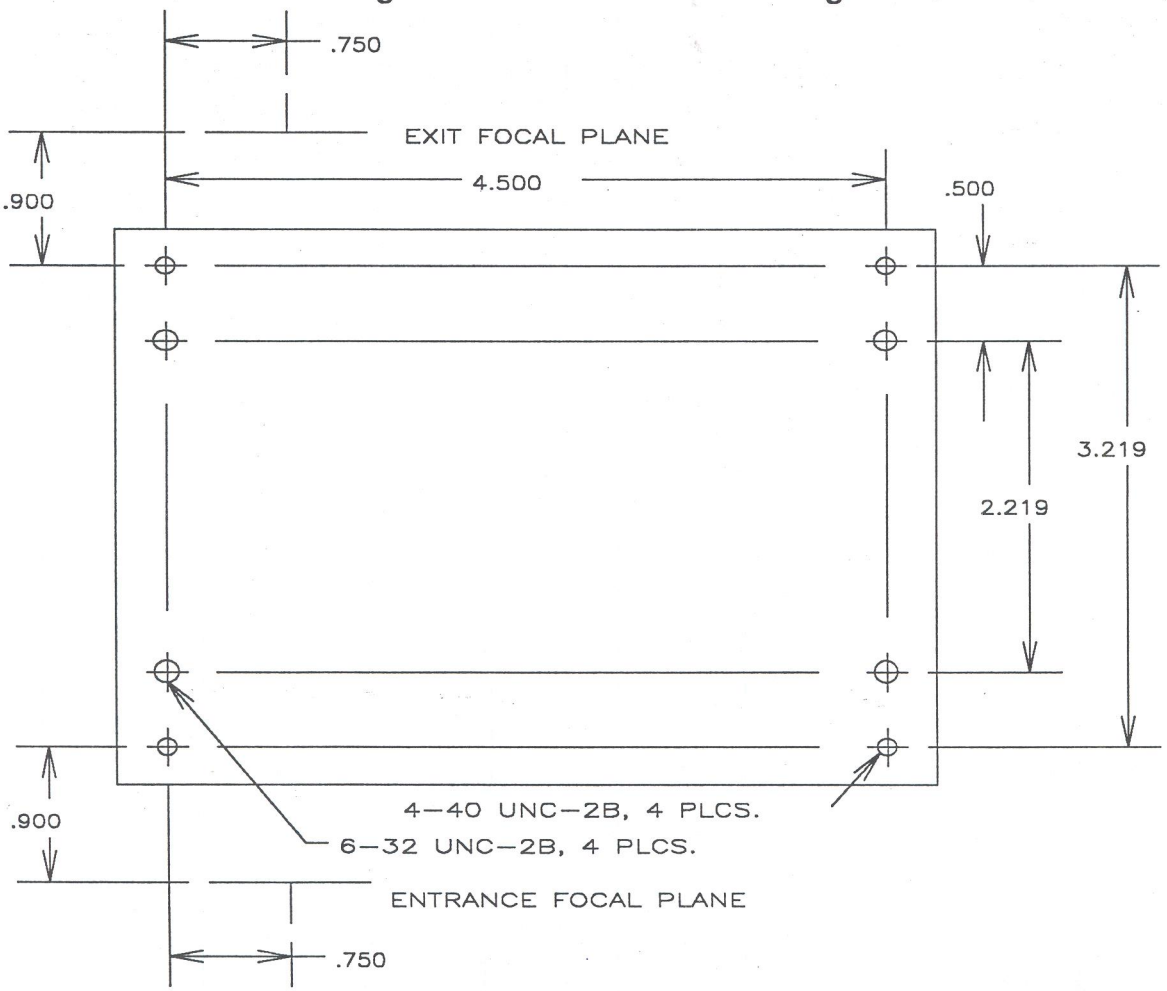
The focus and the wavelength drive calibration of the MonoSpec 10 should be checked before instrument installation and operation. To perform the wavelength calibration check, refer to the Wavelength Calibration Check procedure in section 4 of this manual. For focus correction, refer to the Focus Check and Correction procedure in section 4.

PERMANENT MOUNTING

It is recommended that the MonoSpec 10 be permanently mounted to an optical table or another flat surface. To secure the instrument, remove the four rubber feet from the bottom of the unit. The bottom panel has four other 6-32 tapped holes to be used for permanent mounting. The bottom panel may also be used as a drilling template to locate and drill holes for mounting.

Do not use the two 6-32 tapped holes in either focus tube for mounting the instrument.

Figure 2. Permanent Mounting



3. OPERATION

This section contains a grating selection chart with instructions to mount the grating, a brief discussion on entrance and exit slits, and general instructions on setting up a light source. A conversion table to read the wavelength counter when a grating other than a 1200 g/mm is used has been included as well as available filters, slits, and Mercury lamp source with power supply.

SELECTING AND MOUNTING THE GRATING

If you have purchased more than one grating, the following chart is provided for your convenience so that you can easily select a grating for the spectral range required for you application.

RANGE	G/MM	BLAZE
200 nm to 700 nm	1200	250 nm (Ion etched)
400 nm to 1600 nm	600	sinusoidal holographic
800 nm to 3200 nm	300	sinusoidal holographic

To remove the grating, remove the top cover by loosening the six button head screws. (three along each side). Lift cover straight off. The factory aligned grating has been secured with epoxy. Carefully remove the epoxy with a sharp knife or razor blade. Hold the grating by two edges and loosen the thumb screw located in back of the grating holder. Carefully lift the grating up and out of the unit. To replace the grating, align the tapped hole in the back of the grating holder and secure grating with thumb screw. See figure 4 .

CAUTION!
DO NOT TOUCH THE FRONT SURFACE OF THE GRATING. ANY CONTACT WITH THE ALUMINUM SURFACE WILL RESULT IN PERMANENT DAMAGE TO THE OPTIC!

After replacing a grating, refer to the Optical Alignment procedure in section 5. of this manual.

ENTRANCE AND EXIT SLITS

Narrow slits provide better resolution than wide slits, but wide slits allow more light through the optical system. Select slits at the optimum width for your particular application. To do so, determine the bandpass (FWHM) required in nm for your particular application. Divide by the Reciprocal Linear Dispersion,(RLD), in nm/mm. For the MonoSpec 10, the RLD with a 1200 g/mm grating is 6 nm/mm. This will give you the maximum slit width in mm to be used. Multiply this number by 1000 to convert to μm.

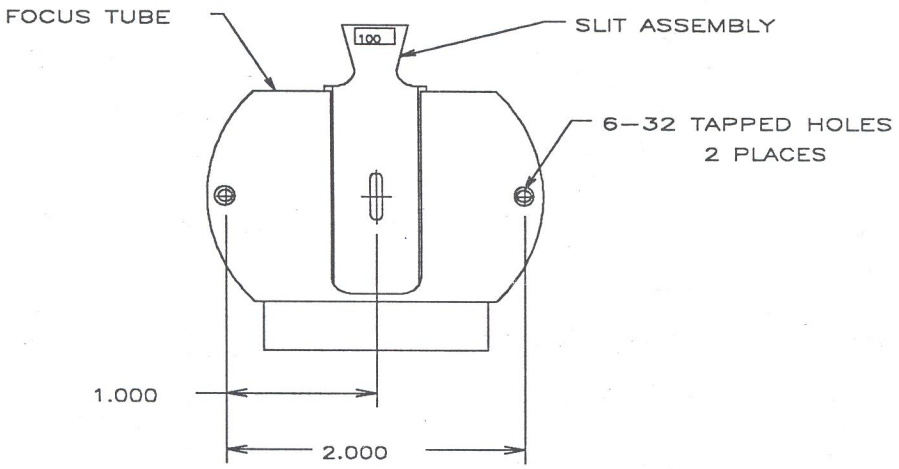
$$\frac{BP(FWHM)nm}{RLD-nm/mm}\times 1000 = Maximum\ Slit\ Width\ (\mu m)$$

LIGHT SOURCE

The light source is placed at the entrance slit of the MonoSpec 10. The light source may be attached to the entrance slit focus tube using the two 6-32 tapped holes provided. See figure

When designing your input optics, i.e. lens or mirror, the f value out of the input optics should be equal to the f value into the monochromator. In the case of the MonoSpec 10, this number is f/3.4.
The input optic should be designed so that the absolute magnification is equal to 1.
Any light source arrangement should be checked visually for complete illumination of the entrance slit and grating.

Figure 3. Slit and Focus Tubes



FILTERS

Filters can be attached to the entrance or the exit slit of the MonoSpec 10 using the two 6-32 tapped holes in either focus tube. The filter assemblies that are available are as follows:

82-464 STRAY LIGHT FILTERS. A filter wheel with six stray light filters. Two open positions are available for other filters. The filters provided are:

1. VIOLET	220 to 420 nm
2. BLUE	300 to 460 nm
3. CLEAR	300 nm to IR
4. ORANGE	580 nm to IR
5. RED	650 nm to IR
6. DARK RED	750 nm to 1.15 μm
7. OPEN	
8. OPEN	

82-465 CUT-OFF FILTERS. This filter wheel offers seven filters providing cut-offs from 350 nm to 650 nm. These are particularly useful in blocking excitation wavelengths and allowing the passing of fluorescence. The filters provided are:

1. CLEAR	350 nm
2. CLEAR	400 nm
3. YELLOW TINT	450 nm
4. YELLOW	500 nm
5. ORANGE	550 nm
6. RED	600 nm
7. DEEP RED	650 nm
8. OPEN	

82-466 CALIBRATION FILTERS. Two Filters are provided for calibration and 3 neutral density filters (O.D. 1,2,3) for performance evaluation. The filters are:

1. HOLMIUM OXIDE - for calibrating in the UV and VIS
2. DIDYMIUM - for calibrating from the VIS to the NIR (1.0 μm).
3. O.D. 1.0
4. O.D. 2.0
5. O.D. 3.0
6. OPEN
7. OPEN
8. OPEN

The didymium filter can also be used for measuring stray light.

82-467 POLARIZATION FILTERS. This wheel contains filters that provide polarization at three different orientations to the E vector. The filters operate in the range of 275 to 750 nm. The filters are:

1. PERPENDICULAR (⊥)
2. PARALLEL (//)
3. 45° (∠)
4. OPEN
5. OPEN
6. OPEN
7. OPEN
8. OPEN

82-468 FILTER WHEEL HOLDER AND COVER. This mounts directly to the entrance or exit slit. The holder will accommodate any two octagonal filter wheels providing for a total of 16 filters available at either slit.

82-464-SP FILTER WHEEL. Octagonal wheel providing space for eight 1/4" by 1/2" filters.

DETECTORS

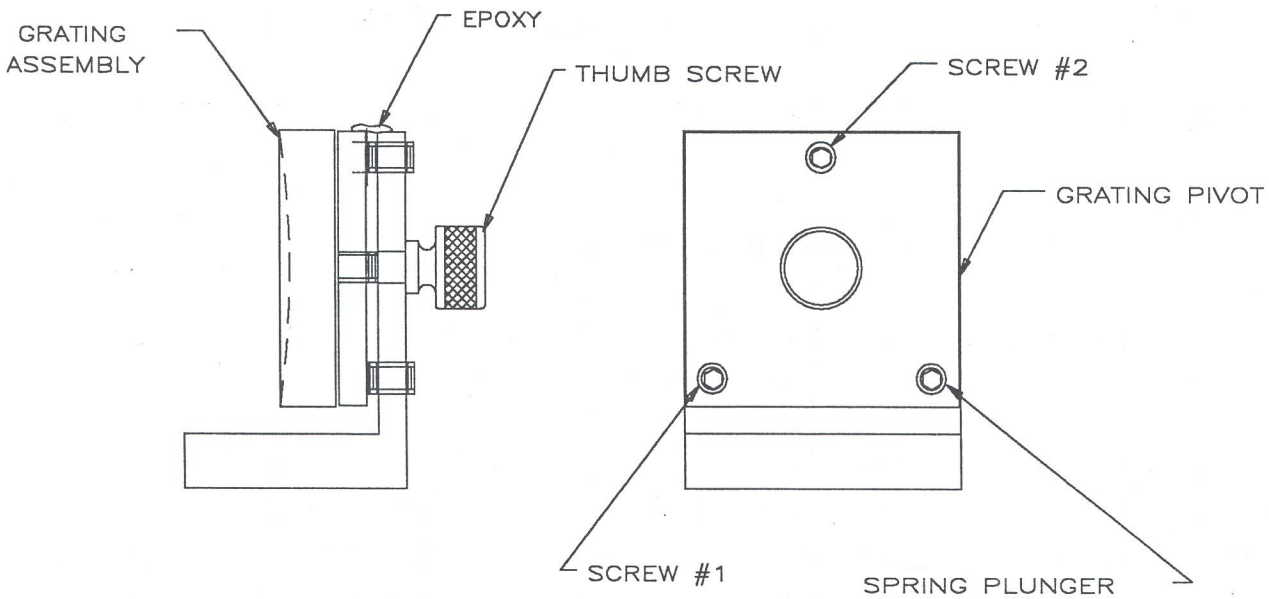
For the MonoSpec 10, a detector such as a photomultiplier tube can be attached to the exit slit using the two 6-32 tapped holes provided. The PMT's available are:

17-724	PHOTOMULTIPLIER TUBE, R212 For use in the 185-670 nm range. (spectral response S-5)
17-742	PHOTOMULTIPLIER TUBE, R955 For use in the 185-800 nm range.
17-736	PHOTOMULTIPLIER TUBE, R406 For use in the 800-1100 nm range. (spectral response S-1)
83-017	SIDE WINDOW PMT HOUSING, with 8 pin octal socket and dynode chain. Includes two coaxial cables terminated with MHV and BNC connectors.

WAVELENGTH CONVERSION

The wavelength counter is designed to read directly in nanometers with a 1200 g/mm grating. When a grating is used with any other groove spacing, the actual counter reading must be converted to give actual wavelength. Multiply the exact counter reading by the factor shown in the chart below to for actual wavelength.

GRATING G/MM	MULTIPLICATION FACTOR
1200	1
600	2
300	4
150	8



. MAINTENANCE

The MonoSpec 10 requires little maintenance. The focus, slit alignment and the wavelength calibration should be checked every six months or if the instrument appears to have drifted out of focus or calibration. The optical surfaces must never be cleaned but may be dusted off if necessary.

This section contains instructions to perform periodic maintenance on the MonoSpec 10. Complete alignment and wavelength drive calibration procedures are covered in section 5, (SERVICE).

WAVELENGTH CALIBRATION CHECK

This procedure should be performed with a Photomultiplier tube to achieve the maximum accuracy of the drive. Other equipment required includes a low pressure mercury lamp and power supply, (SMS part number 10002200), and narrow slits between 25 and 100 µm. This procedure is described with a 1200 g/mm grating in the monochromator. For other gratings, see the Wavelength Conversion Chart in section 3. of this manual.

Install the entrance and exit slits. Place the mercury lamp as close as possible to the entrance slit and turn on power supply.

CAUTION! The mercury lamp emits ultraviolet radiation which can cause severe burns to the eyes. Always operate the lamp with the glass shield in place !

Turn the wavelength drive knob until the counter reads 000 nm. With your eye as close as possible to the exit slit, verify that the zero order white light is visible through the slit. If the white light is not visible, turn the knob towards higher wavelengths until it is. Make a note of the reading.

Turn the wavelength drive knob to 436 on the counter. Verify that the first order blue light is visible through the slit. If the blue light is not visible, scan the wavelength drive back and forth until it is. Make a note of the reading.

Turn the wavelength drive knob to 546 on the counter. Verify that the first order green light is visible through the slit. If the green light is not visible, scan the wavelength drive back and forth until it is. Make a note of the reading.

Turn the wavelength drive knob to 872 on the counter. Verify that the second order blue light is visible through the slit. This line will appear to be more violet in color. If the second order blue light is not visible, scan the wavelength drive back and forth until it is. Make a note of the reading.

If all of the readings are correct within ± 2 nm, the wavelength calibration is satisfactory. If any of the readings differ by more than ± 2 nm, refer to section 5., (SERVICE), and follow the procedure for Wavelength Drive Calibration.

FOCUS CHECK

The following equipment is suggested for checking the focus of the MonoSpec 10 monochromator:

Low pressure Hg lamp and power supply (SMS P/N 10002200)
Narrow slits (25 to 100 μm)
Opaque vellum or diffusion screen

Preset the entrance focus tube to a distance of 6 mm from the front of the focus tube to the surface of the focus tube support. Make sure the focus tube is rotated so that the slit is within 1/2° of vertical.

Remove the exit slit and attach a piece of opaque vellum, or some other material that will diffuse the light, to the surface of the exit focus tube.

Set the Hg lamp at the entrance slit and turn on power supply.

CAUTION: The Hg lamp emits ultraviolet radiation which can cause severe burns to the eyes. Never operate the lamp without suitable eye protection!

Turn the wavelength drive so that the green Hg line is visible through the diffusion screen at the exit focal plane.

Loosen the two locking set screws holding the exit focus tube and slide the tube in and out to until the sharpest image of the line appears on the screen.

Re tighten one of the locking screws to secure the focus tube in place.

Remove the diffusion screen and install the exit slit.

Place your eye about one foot (15 cm) from the slit, even with the center of the slit, and slowly scan back and forth across the green line. See that the image appears and disappears symmetrically within 1 mm at the top and bottom of the slit. If not, rotate the focus tube slightly as necessary.

OPTICAL SURFACES

The optical surfaces of the MonoSpec 10 are the grating and the turning mirrors at the entrance and exit slits. These surfaces will accumulate some dust, but unless the MonoSpec 10 is operated in an extremely dusty atmosphere or the cover is left off for long periods of time, dust should never accumulate enough to interfere with analytical results. It is very unlikely that the optical surfaces will require cleaning throughout the lifetime of the instrument.

If you suspect that a heavy accumulation of dust is interfering with results, remove the cover of the monochromator and visually inspect for heavy dust accumulation on the optical surfaces.

NOTE
IMPORTANT

DO NOT TOUCH THE OPTICAL SURFACES. Make sure that your fingers, sleeves, any papers, etc., do not touch these surfaces or permanent damage may result. If you determine that the optical surfaces require dusting off, carefully blow off the dust with an inert gas such as nitrogen or argon, or with dry compressed air. Do not clean the optical surfaces with tissue, water, brushes, or anything else.

5. SERVICE

This section contains instructions to align the optics of the MonoSpec 10 and to calibrate the wavelength drive. The optical alignment should be performed only if the optics cannot be focused according to the Focus Check procedure in section 4 of this manual. The calibration procedure should be performed only if the wavelength drive does not check out to within +/- 2 nm according to the wavelength calibration check in section 4 of this manual. All procedures are described using a 1200 g/mm grating. Refer to section 3., Wavelength Conversion, for other gratings.

OPTICAL ALIGNMENT

This procedure must be performed before attempting to calibrate the wavelength drive. To align the MonoSpec 10 the following tools are used:
Alignment base, 1.0 mW HeNe laser, 100 µm entrance and exit slits, one pair of leveling slits or black thread, and one pair of 10" lab jacks.

1. Mount the MonoSpec 10 to the alignment base or secure the MonoSpec 10 to an angle plate so that the bottom of the unit is approximately 8" from the table top. This is so that the grating pivot lock nut can be adjusted.

2. Remove the mirror clamp locking screw and lift out the two turning mirrors along with the mirror clamp.

3. Install the leveling slits, (these are slit blanks with a .060" hole in the center. (see figure 5). If leveling slits are not available secure a piece of black thread across the center of both entrance and exit slits with tape, using the two screw holes in the focus tubes for registration. . Align the HeNe laser on the lab jacks so that the beam passes through the center of both the entrance and exit slits.

4. Install the turning mirrors and mirror clamp and start the locking screw into the tapped hole in the optical base. Do not tighten the screw at this time. Rotate the entrance mirror so that the reflected HeNe beam hits the center hole in the grating pivot.

5. Turn the wavelength drive knob so that the counter reads 000 nm. Make sure that the grating pivot is parallel with the rear wall of the housing. If not, loosen the grating pivot locking nut and the sine arm clamp and make the necessary adjustments. Re tighten the sine arm clamp and the lock nut.

6. Install a 1200 g/mm grating. Refer to Section 3., "Mounting the Grating". Adjust the grating so the HeNe beam hits the center of the exit turning mirror.

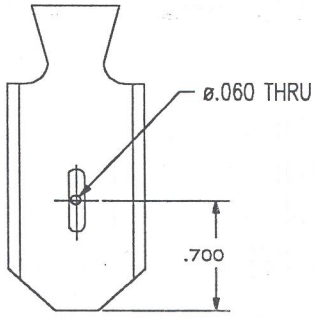
7. Rotate the exit turning mirror so the reflected HeNe beam passes through the center of the exit slit. Tighten mirror clamp locking screw.

The grating must now be leveled.

8. Make sure the HeNe laser is still aligned to pass through the center of the entrance leveling slit and the zero order beam from the grating passes through the hole in the exit leveling slit. Slightly loosen the grating pivot lock nut and the sine arm clamp. Rotate the grating so that the unblazed first order reflected HeNe beam hits the exit slit. Note the position of the beam. Rotate the grating so the first order blazed reflected beam hits the exit slit. Note the position of the beam. If the reflected beam does not pass through the center of the exit slit, the face of the grating must be rotated. Very carefully rotate the grating in the vertical axis to allow all reflected beams to pass through the center of the exit slit.

Note: All factory aligned gratings have been secured with epoxy to maintain alignment.

Figure 5: Leveling Slits



WAVELENGTH DRIVE CALIBRATION

When the calibration of the wavelength drive has a greater error than +/- 2 nm, this procedure should be performed. This procedure is written using a 1200 g/mm grating. Refer to section 3. "Wavelength Conversion" for gratings with rulings other than 1200 g/mm. The following equipment is required to perform the calibration: low pressure Hg lamp and power supply, (SMS part number 10002200), and entrance and exit slits, 50 µm or 100 µm wide.
Note: the rear panel must be removed to gain access to the sine arm adjustments. See figure 6 for location of adjustments

1. Install the 50 µm or 100 µm entrance and exit slits.

2. Set up the Hg lamp so that the light fills the entrance slit.

3. Turn the wavelength drive so the counter reads 000 nm. With your eye against the exit slit verify that the zero order white light is filling the grating. If it is not, adjust grating adjustment screw #1. see figure 4.

4. Turn the wavelength drive so the counter reads 546 nm. Scan the first order green Hg line until full illumination of the grating is observed. Note the counter reading. If the reading is higher than 546 nm, loosen the two cap screws securing the sine arm and slide the sine arm towards the grating pivot. (make arm shorter). If the reading is lower than 546 nm, slide the arm toward the lead screw. (make arm longer). Make very small adjustments when correcting for error!

5. Re-check the reading at 000 nm. If the reading has changed, remove the wavelength drive knob by pulling it straight off the counter, and loosen the two set screws securing the counter to the lead screw. Turn the counter so it reads "0000" when the white light fully illuminates the grating. Re-tighten the set screws.

6. Repeat steps 4. & 5. until the white light fully illuminates the grating at 000, and the green light fully illuminates the grating at 546 nm +/- 2 nm.

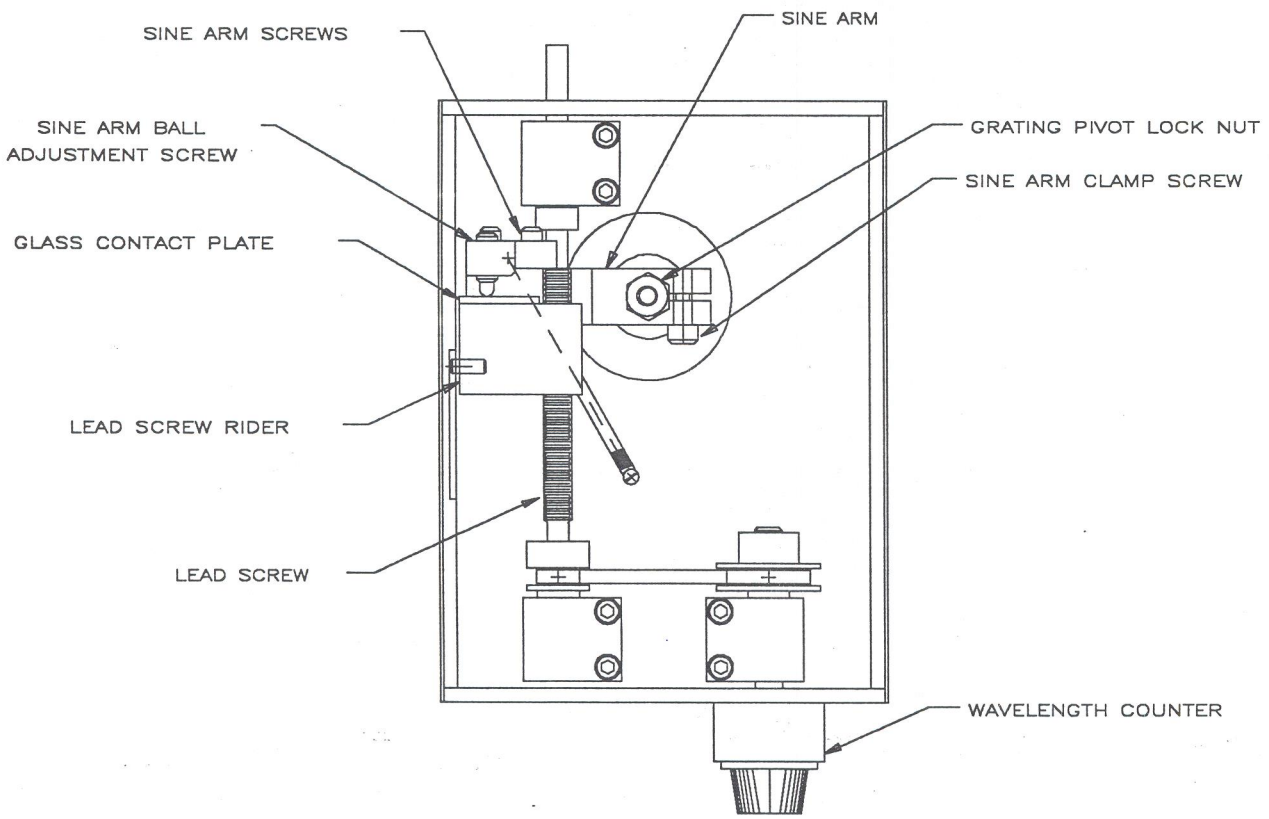
7. Turn the wavelength drive so the counter reads 872 nm. Scan the second order blue line, (436 II), until full illumination is observed at the grating. Note the counter reading. If the counter reading is higher than 872 nm, turn ball adjustment screw CCW. (turn screw out). If the reading is lower than 872 nm, turn ball adjustment screw CW. (turn screw in).

8. After every adjustment re-check zero and make necessary adjustments before proceeding. Repeat steps 4 through 7 until wavelength error is less than +/- 2 nm.

9. After the drive calibration is complete apply a drop of Glyptal or other insulating enamel to the head of all adjustment screws.

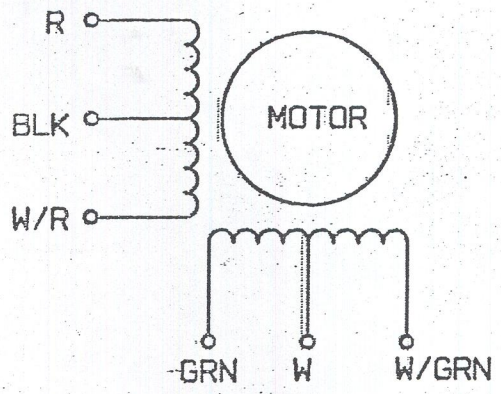
10. Install rear panel, wavelength drive knob, and top and bottom covers.

Figure 6: Calibration Adjustments
MonoSpec 10, Bottom view
(covers removed)

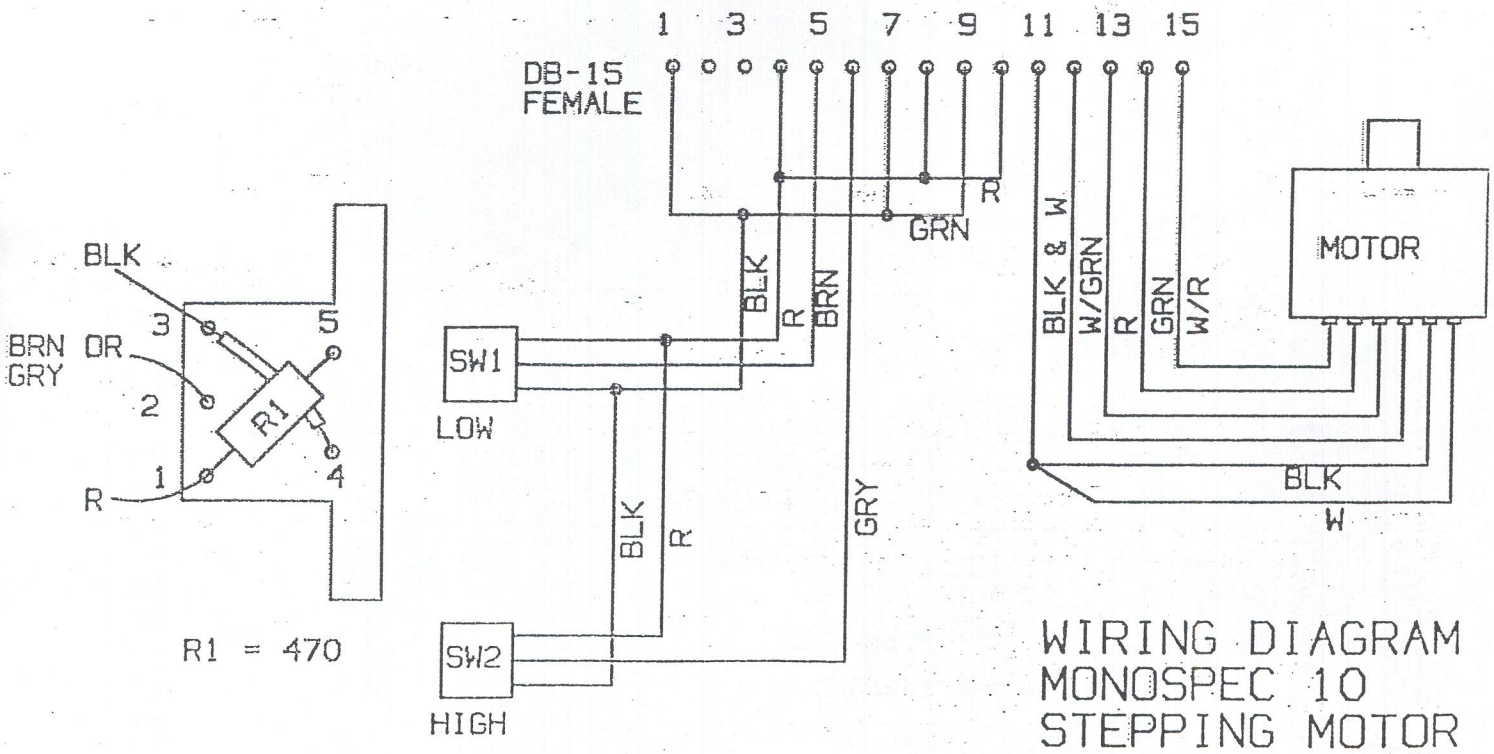


NOTES

1	GND		9	ID2
2	NC		10	ID3
3	NC		11	CENTER TAP MOTOR COIL
4	+5vcc		12	MOTOR
5	SW1 INPUT	LOW	13	MOTOR
6	SW2 INPUT	HIGH	14	MOTOR
7	ID0	GND	15	MOTOR
8	ID1	+5V		



PINS 7 THRU 10 ARE USED TO DETERMINE WHAT MOTOR DRIVE IS CONNECTED TO THE LS 937 MOTOR CONTROLLER; THEY ARE NOT NEEDED TO STEP THE MOTOR.
PINS 5 & 6 ARE ALWAYS HIGH (1).WHEN TRIPPED, THEY GO LOW (0). THESE ARE USED TO STOP THE MOTOR FROM GOING PAST THE LIMITS.



WIRING DIAGRAM
MONOSPEC 10
STEPPING MOTOR