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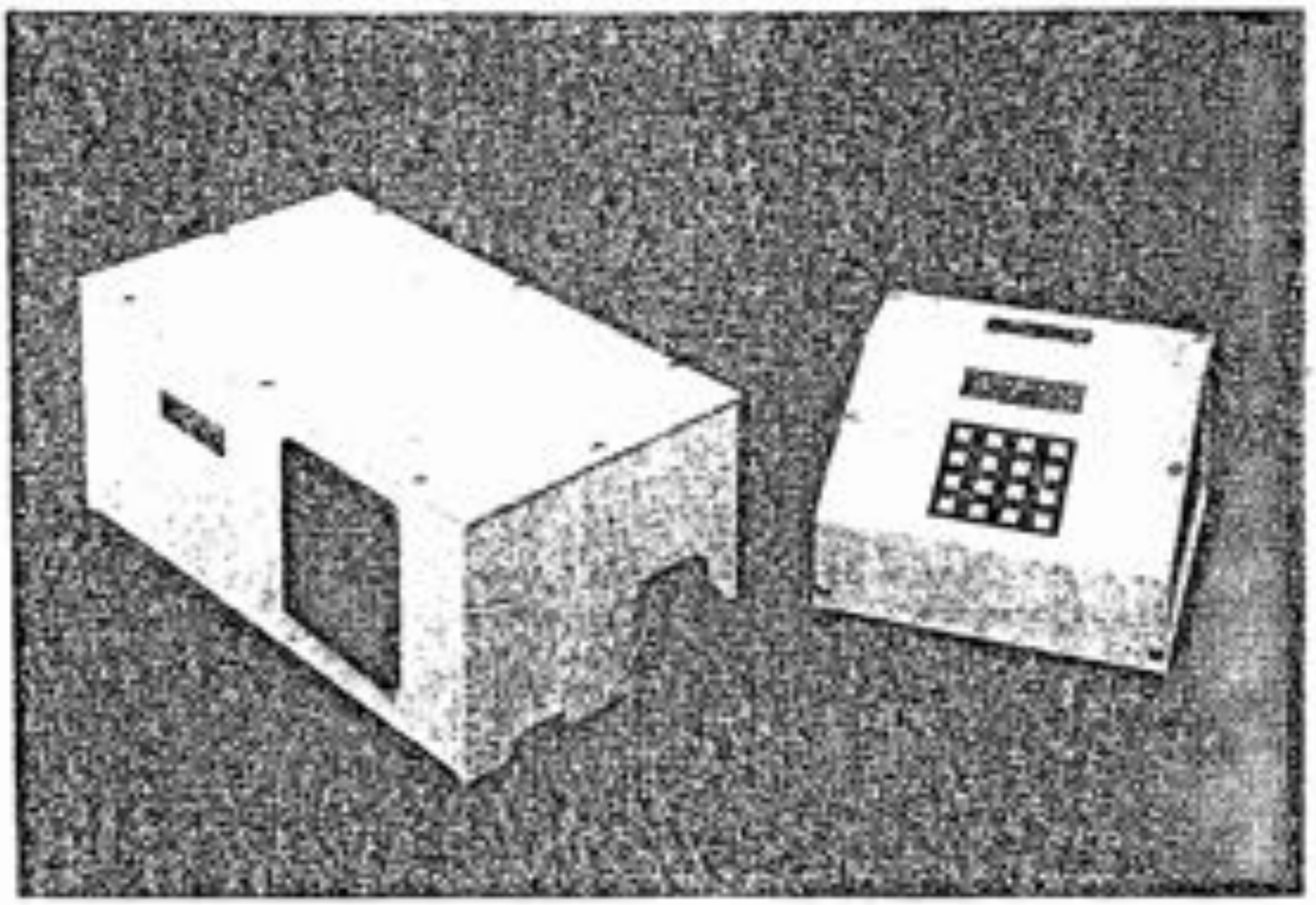
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Monochromators/Vacuum UV Optical Coatings/Excimer Laser Optics

Acton Research Corporation
SpectraPro® 275



0.275 Meter Focal Length Monochromator / Spectrograph
Operating Instructions

Serial #:

ACTON RESEARCH CORPORATION
SpectraPro®- 275
Operating Instructions

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I. Description

ARC's SpectraPro®:
The SpectraPro is a fast f/3.8 monochromator featuring compatibility with focal plane detect (such as OMA™, OSMA™ and CCD), triple indexable gratings, microprocessor control and computer compatibility. From the remote scan controller you can easily change gratings, ac scanning speed, set "go to" wavelengths, program repeating scans and "manually" scan via keys. The SpectraPro automatically tracks each grating using ARC's exclusive Autotrack™ electronics. Autotrack™ tells you which grating is in operating position, the groove spacing blaze wavelength for that grating, and automatically displays the correct wavelength for any grating installed on a large, easy to read LCD display.

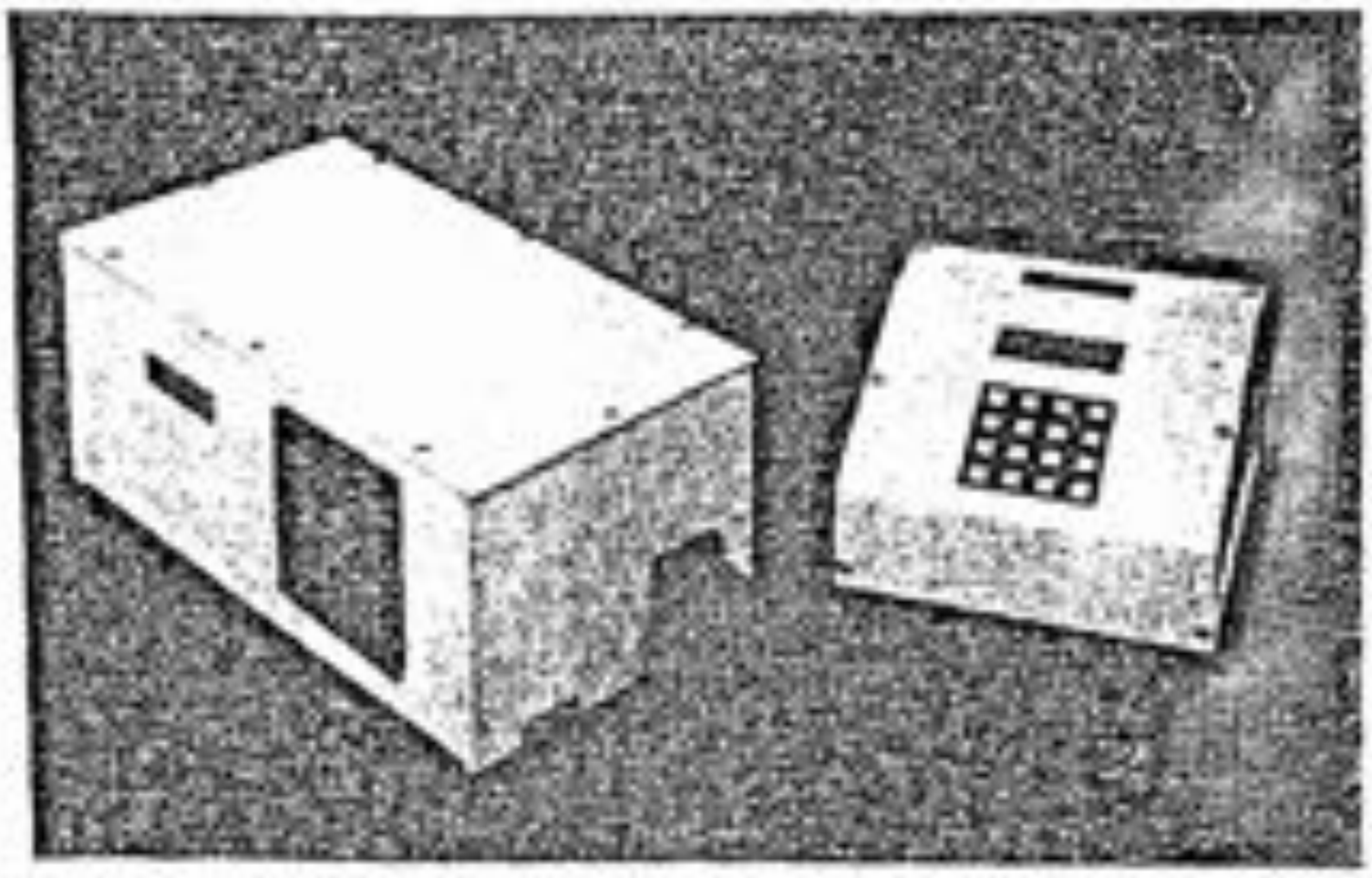


Figure 1
SpectraPro™

Inside the SpectraPro®:
Triple indexable gratings and a direct digital scanning system are standard features that enhance the performance and versatility of the SpectraPro. In addition, the SpectraPro has heat generating motors or electronics inside the optical chamber, therefore any potential the mal distortion problems are eliminated.

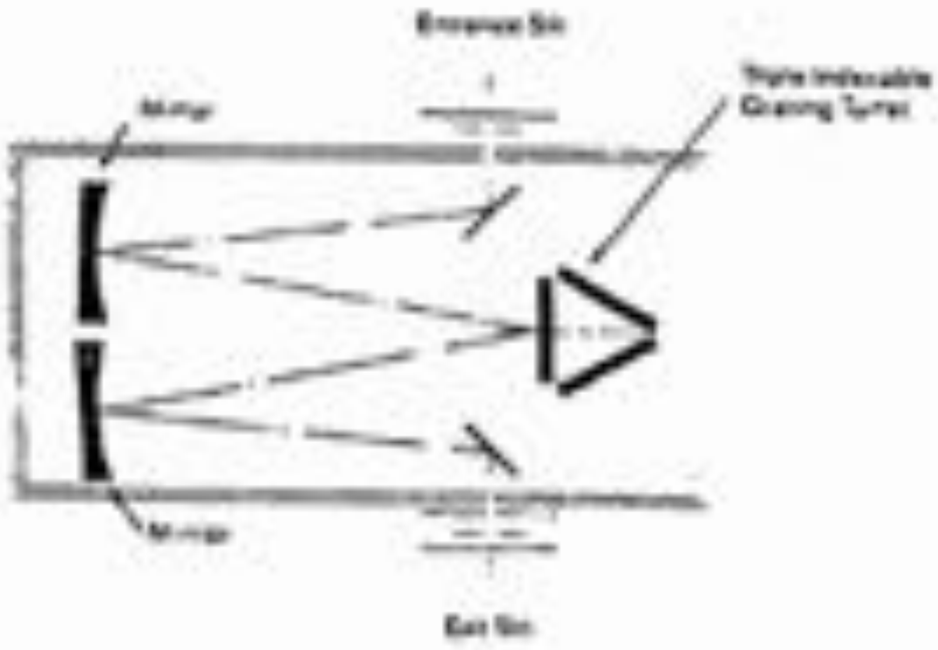


Figure 2
Optical Layout

SpectraPro® Scan Mechanism:
In place of the conventional sine drive system found in most monochromators, the SpectraPro utilizes Direct Digital Scanning (DDS). A DDS system permits grating rotation up to 65 degrees offering the user maximum scanning range from each grating installed. Microprocessor control enables the DDS system to emulate a sine drive system to provide precise linear scanning with respect to wavelength. The result is a wavelength scanning system that combines the linear scanning of a precision sine drive system with the simplicity and versatility of a direct digital scanning arrangement.

Compatibility with Focal Plane Detectors:
The SpectraPro provides a flat 25mm wide focal plane and accepts standard detector systems. ARC offers standard mounts for most major focal plane detection systems. (refer to the SpectraPro accessories listing for available mounts). The instrument's triple indexable gratings enable rapid, "survey" and "zoom" scans of a wide variety of radiation sources.

Autotrack™ Electronics:
The SpectraPro contains a built-in microprocessor with menu driven software for scan control, grating selection and change of scanning speeds. All scanning functions and grating selections are controlled from the SpectraPro remote scan controller. The Autotrack™ electronics system keeps track of gratings and displays correct wavelength and blaze for any grating installed. Computer control is provided through a standard RS-232 connector or optional IEEE 488 port.

Triple Indexable Gratings:
This standard SpectraPro feature allows 1, 2, or 3 gratings to be installed for maximum versatility. Grating selection is a simple push-button operation, and the Autotrack™ electronics system keeps you informed of the grating specifications, such as groove spacing and blaze wavelength

II. SpectraPro® Specifications

NOTE: EACH SPECTRAPRO IS OPERATED FOR AT LEAST 15 MINUTES PRIOR TO CALIBRATION TO INSURE OPTIMUM STABILITY. END USERS SHOULD FOLLOW THIS PRACTICE IF THEIR APPLICATION CALLS FOR OPTIMUM STABILITY & REPRODUCIBILITY.

Focal Length: 275mm

Optical System: Czerny-Turner type with in-line optical path

Wavelength Scanning System: Direct Digital Scanning with exclusive *Autotrack™* electronics.

Scan Linearity: The SpectraPro scans linear with respect to wavelength.

Triple Indexable Gratings: Customer may select 1, 2, or 3 gratings at time of instrument purchase. Standard gratings are 68 X 68mm. Larger 68 X 84mm gratings are also available to maintain an effective f/3.8 aperture ratio out to 1.2µm with 1200 g/mm grating.

Wavelength Display: Large, easy to read back-lit LCD wavelength display. Automatically displays correct wavelength for gratings installed. Displays grating position, groove spacing and blaze wavelength for gratings. Also displays menu options for the built-in microprocessor.

Resolution: 0.1nm with standard 1200 g/mm grating. 10µm slits, measured at 435.8nm.

Reciprocal Linear Dispersion: 3.0 nm/mm with 1200 g/mm grating installed (nominal).

Aperture Ratio: f/3.8

Wavelength Operating Range: Up to the far infrared with available gratings. 185nm to 1.4µm with 1200g/mm grating installed.

Wavelength Accuracy: ±0.2nm / 500nm with a 1200 groove/mm grating.

Wavelength Reproducibility: ±0.05nm with a 1200 groove/mm grating.

Focal Plane Detector Compatibility: 25mm focal plane extends 0.380" beyond the typical Focal Plane Detector Mounting Flange. If the extended focal plane version is supplied, the distance is 0.880" from the focal plane to the mounting surface of the Focal Plane Detector flang Refer to Section IV-E (page 23) if the extended focal plane version is supplied. Provides nominal 592nm coverage with 150g/mm grating, 293nm with 300g/mm grating, 143nm with 600g/n grating, and 67nm with 1200g/mm grating at approximately 500nm.

Slits: Standard slits are bilaterally adjustable from 10µm to 3.0mm, via external micrometer. Standard slit height is 4mm. If specified at time of instrument purchase, other slit heights (up 20mm) can be supplied.

Computer Compatibility: RS-232 port - 9600 baud, no parity, 8 data bits, 1 start bit, 1 stop bit; or optional IEEE 488 port.

SpectraPro Dimensions:

Length: 15.25" (388 mm)
Width: 8.25" (210 mm)
Height: 7.0" (178 mm)
Optical Axis Height: 4.0" (102 mm)
Weight: Approximately 20 lbs (9.0 kg)

Scan Controller Dimensions:

Length: 8.5" (216 mm)
Width: 8.25" (210 mm)
Height: 4.625" (118 mm)

Weight: 5.0 lbs (2.3 kg)

Electrical Requirements: 120/240 Vac switch select 2 Amp fuse.

III. Instrument Setup

A. Unpacking and Inspection

Carefully unpack and examine both the SpectraPro monochromator and the remote scan controller. If there is any indication of physical damage, report the condition immediately to the carrier and save all packing material.

B. Connections to SpectraPro® Monochromator with Remote Scan Controller

Refer to Figure 3 and connect the motor drive cable between the 15 pin D connector (J1) on the monochromator and the 14 pin round connector (J1) on the scan controller. Plug the AC line cord from the scan controller into an AC outlet of the correct line voltage. This voltage will be listed on the rear panel of the scan controller. If the monochromator is to be operated from the scan controller keypad, these are the only connectors necessary. If the monochromator is to be operated from a terminal or computer via RS-232, it is then necessary to connect a cable between the 9 pin connector (J2) on the scan controller and the RS-232 connector on the computer. For operation from an IEEE 488 controller, see Section IV-D.

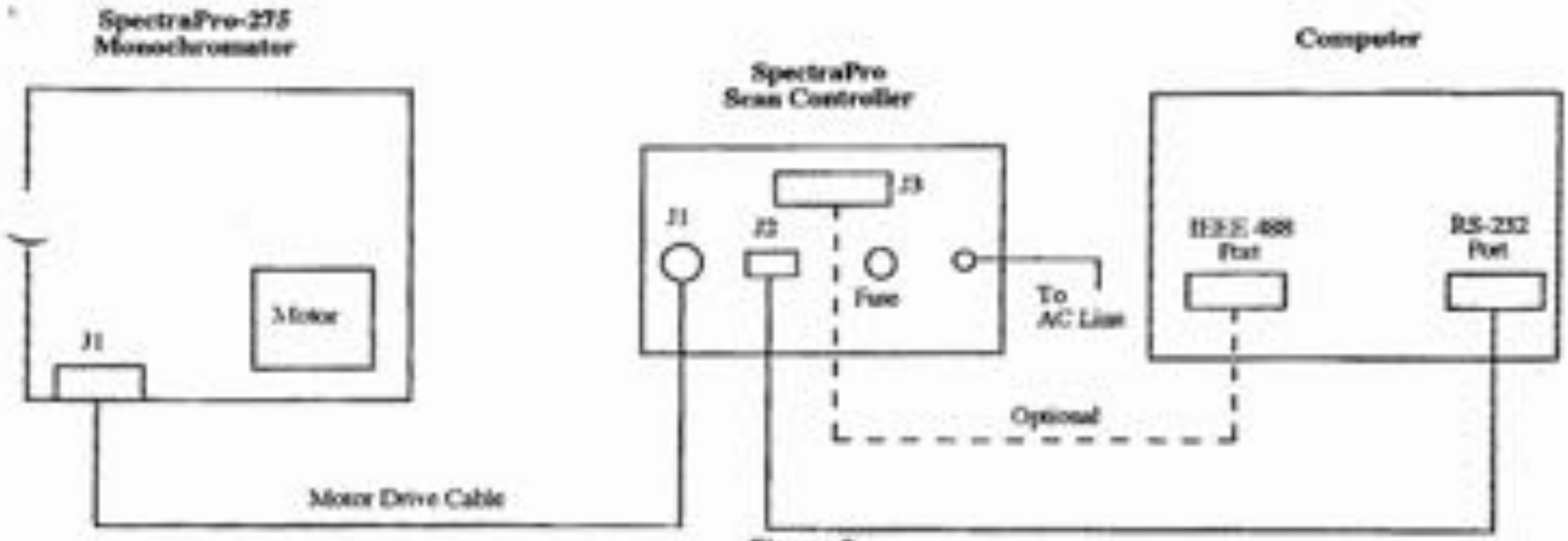


Figure 3
SpectraPro Cable Connections
External Scan Control

C. Cables and Connections for SpectraPro

ARC offers the following RS-232 cables as options:

CC-499-1 IBM PC or XT compatible
25 pin female (DB25S) connector to 9 pin male connector (DB9P).
CC-499-2 IBM AT or compatible
9 pin female (DB9S) connector to 9 pin male connector (DB9P).
CC-499-3 Computer terminal type
25 pin male (DB25S) connector to 9 pin male connector (DB9P).
CC-499-4 9-pin cable for Macintosh computer
CC-499-5 IEEE-488 cable, 4 meters long

If none of these cables are compatible with your system, consult ARC for a custom cable or it may be constructed using a standard DB9-P connector at the monochromator end with the following connections. For details of typical pin connections, see Appendix B.

pin #	description
1	open
2	RD received data to the computer
3	TD transmitted data from the computer
4	open
5	ground
6	open
7	RTS ┐ connect these two
8	CTS ┘ pins together
9	open

Table 1

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

J1 - Motor Drive Connector on Monochromator and Scan Controller

Pin # - Monochromator	Description	Pin # Scan - Controller
1	Motor - A1	1
2	Motor - A2	2
3	Motor - B1	3
4	Motor - B2	4
5	Open	5
6	Shield - (Controller Only)	6
7	Interrupt Module + 5V	7
8	Interrupt Module GND	8
9	Interrupt Module 1 + 2 LED K	9
10	Instrument Ground	10
11	Interrupt Module 1 LED A	11
12	Interrupt Module 1 OUT WORM	12
13	Interrupt Module 2 LED A	13
14	Interrupt Module 2 OUT MOTOR	14
15	Open	

Table 2

J2 - RS-232 Connector - External Scan Controller

Same as Table 1 - Section III-B

J3 - IEEE 488 Port - External Scan Controller

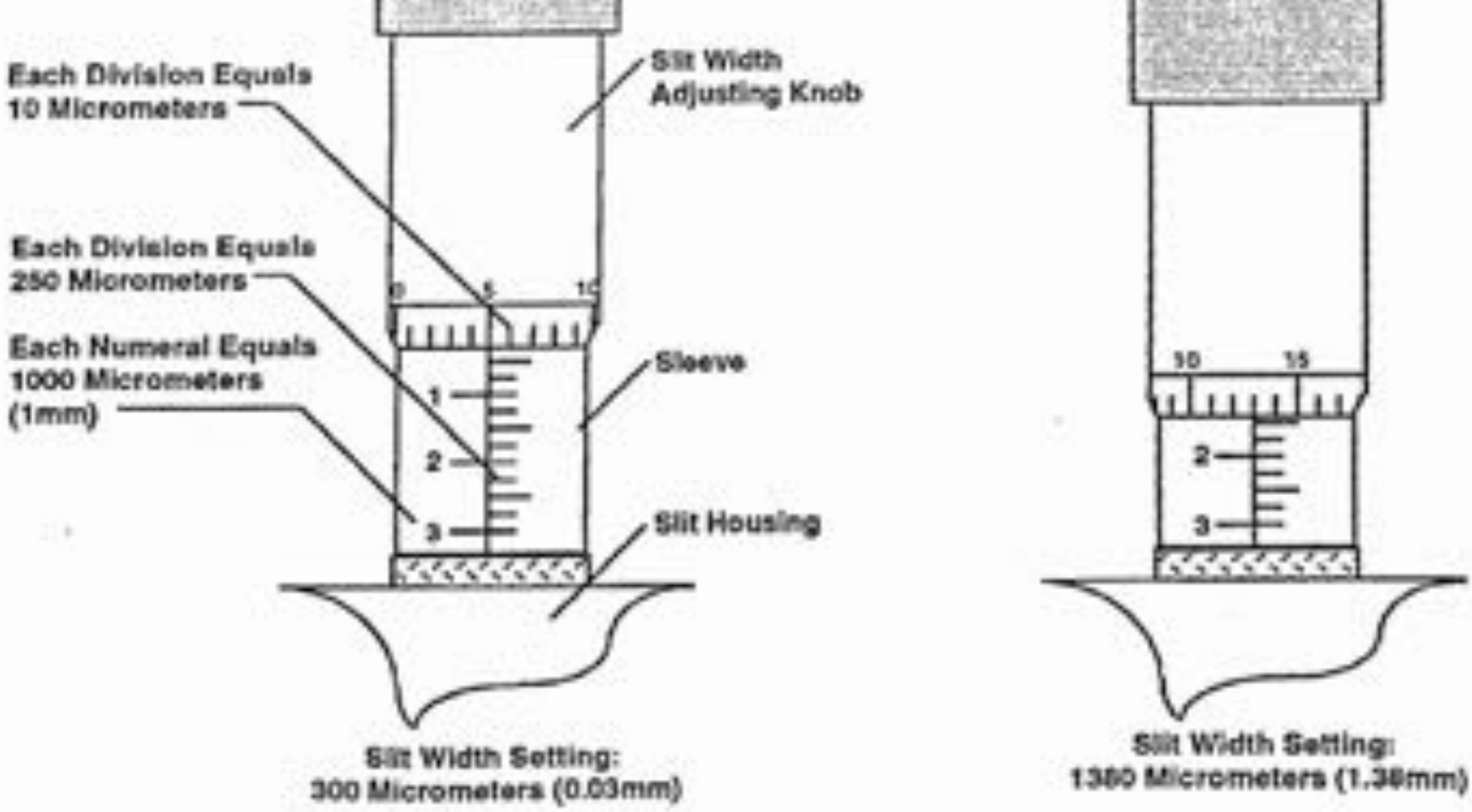
D. Slit Width Adjustment

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

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

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

NOTE: DAMAGE MAY BE DONE IF SLIT JAWS ARE OPEN TO MORE THAN 3.0µ.



IV. Operation

A. Initialization:

NOTE: EACH SPECTRAPRO IS OPERATED FOR AT LEAST 15 MINUTES PRIOR TO CALIBRATION TO INSURE OPTIMUM STABILITY. END USERS SHOULD FOLLOW THIS PRACTICE IF THEIR APPLICATION CALLS FOR OPTIMUM STABILITY & REPRODUCIBILITY.

The SpectraPro power switch is located on the back of the remote scan controller.

NOTE: DO NOT DISCONNECT OR CONNECT THE CABLE BETWEEN THE REMOTE SCAN CONTROLLER AND THE MONOCHROMATOR WITH THE POWER ON. TIGHTEN SCREWS ON CONTROLLER CABLE BEFORE POWERING UP INSTRUMENT.

When power is switched "on" to the SpectraPro, the unit will automatically find zero wave on grating #1 and set the wavelength counter to that value. Scan speed is set to 100.0 nm/ minute. (See Appendix A for method of setting alternate initial wavelength and grating) The message "INITIALIZING" is displayed during this process. If there is a malfunction in the monochromator during initialization, the message "ZERO NOT FOUND" will be displayed. Switch the power off and back on again. If the "ZERO NOT FOUND" message appears again, contact Acton Research Corporation for assistance.

With no cable connected to the RS-232 port of the SpectraPro the instruction message in Figure 4 will be displayed when initialization is complete.

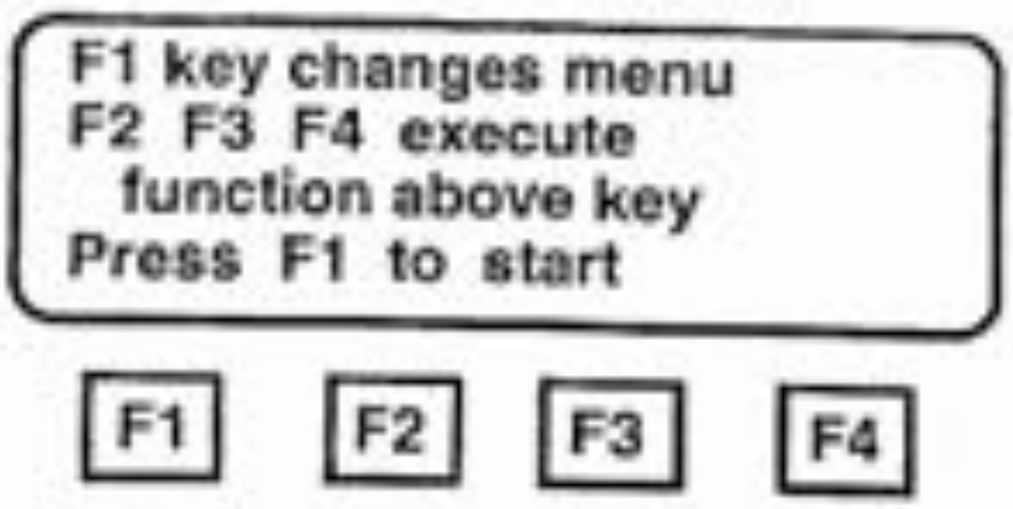


Figure 4 Instructions

Pressing F1 when this message is displayed will bring up the Rate menu described in Section B1.

If a computer or computer terminal is connected to the RS-232 port of the SpectraPro during initialization, the monochromator will be set for external control and the keypad will be inactive. The bottom line of the display will show "COMPUTER CONTROL" in this case.

A reset function is available if it is desired to re-initialize the system after power has been applied. Press the reset key and the F1 key on the keypad simultaneously to perform the same initialization procedure as switching on the power.

B. Menus:
All functions of the SpectraPro monochromator are accessed through the menus displayed on the four line LCD display.

1. RATE
Shown below is the RATE menu for setting the monochromator scan rate in nm/minute.

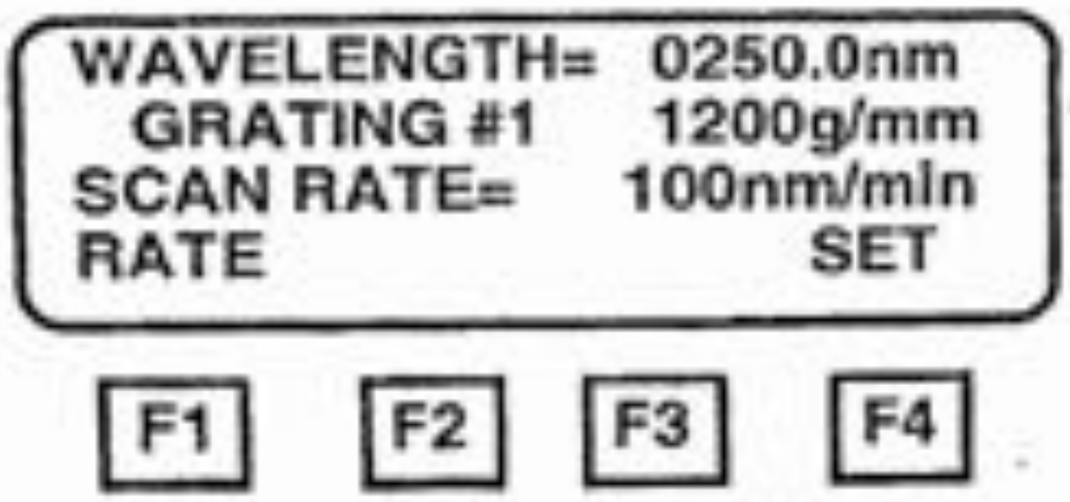


Figure 5
Rate Menu

For this menu and all others, the name of the active menu is the label above the F1 key on the keypad.To change the active menu, press the F1 key and the next active menu will be displayed. There are five primary menus - RATE, SCAN, JOG, REPS (or repeat scans) and GRAT (or grating select.) Pressing F1 when GRAT is displayed will cause the unit to scroll back to the RATE menu. While in a menu, the function keys F2, F3, and F4 when pressed perform the function in the menu on the last line of the display above the key. For example in the RATE menu, pressing the F4 key allows the user to SET the scan rate. In this case, selecting SET displays a secondary menu for entering the digits of the scan rate.

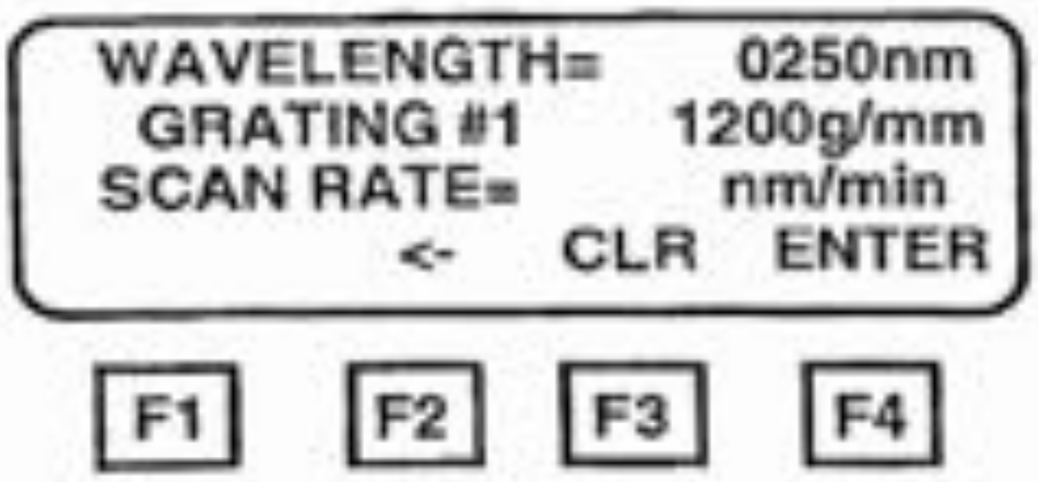


Figure 6
Parameter Entry Menu

Input the desired scan rate from the digits on the keypad. After selecting a SCAN RATE, ente the number by pressing the F4 ENTER key. If a mistake is made during keying in the numbe before pressing F4, it can be corrected by backspacing over the digit just keyed with the F2 <- function or the entire number can be cleared with the F3 CLR function. Scan rates from 0.1 nm/min to the maximum shown in Table 3 below may be entered. Only whole numbers for scan rate are displayed, however. Rates below 1.0 nm/min are displayed as zero.

The maximum scan rate is a function of the grating selected. The maximum values for each grating spacing is listed in the Table 4. If a number larger than the maximum scan rate is entered, either from the keypad for from an external computer, the scan rate defaults to the maximum allowed value.

Grating Spacing grooves/mm	Max. Scan Speed NM / Min.
3600	250
2400	375
1200	750
600	1500
300	3,000
150	6,000
75	6,000
50	6,000
20	6,000

Table 3

Maximum Allowable Scanning Wavelength for Each Grating

2. λ – Wavelength Scanning and Selection

Shown below is the λ menu as it appears on the LCD display. λ is used to scan the monochromator to a selected wavelength at the scan rate set by the RATE menu.

```
WAVELENGTH=    0250.0nm
  SCAN TO      0350.0nm
SCAN RATE=     100nm/min
 λ    SCAN  GOTO  SET
```

Figure 7
Scan Menu

F1 F2 F3 F4

To change the destination wavelength, press the F4 key under the display label SET. As with the RATE menu described previously, this causes a secondary menu to be displayed for entering the digits of the scan destination. After the destination wavelength has been entered, the above λ menu will be displayed again.

If the F2 "SCAN" function is selected, the monochromator will advance to the wavelength selected by "SET" at the scan rate previously selected in the rate menu. If the F3 "GOTO" function is selected, the monochromator will advance to the selected wavelength at the fastest motor speed. When either the "SCAN" or "GOTO" functions are selected, the label "STOP" replaces "GOTO" in the last line of the display and the F3 key may be used to stop the monochromator while it is advancing to the selected wavelength. When the monochromator has stopped, either by reaching the desired wavelength or by the F3 "STOP" function, the label "GOTO" replaces "STOP" in the last line of the display and the F3 key returns to the normal "GOTO" function.

The maximum value for the destination wavelength is also a function of the grating selected. The maximum value for each grating is shown in Table 4. If a wavelength greater than the maximum allowed value is entered from either the keypad or the computer, the value defaults to the maximum allowable wavelength.

Grating Spacing grooves/mm	Maximum Allowable Wavelength - nm
3600	465
2400	700
1200	1400
600	2800
300	5600
150	11,200
75	22,400
50	33,600
20	84,000

Table 4

Upper Wavelength Limit for Each Grating

When entering wavelengths from the remote scan controller, a wavelength to the nearest 1 nm or 0.1nm can be entered (e.g. 500 or 500.0). **(Note on entering to the nearest 0.1nm: On some coarse groove spaced gratings, the wavelength display will round to the ne est whole number; however, the SpectraPro will scan or go to the desired wavelengt corresponding to the 0.1nm input.)** When entering from a computer, however, wavelen must be entered to the nearest 0.1nm (e.g. 500.0 - see Section IV-C)

The wavelength indicator on line 1 of the display will update as the monochromator scans. The scan can be stopped at any time by selecting the F3 STOP menu function. At this poi another menu can be selected with the F1 key or the scan can be resumed with the F2 SC/ or F3 GOTO functions. When scanning from high to low wavelengths, the monochromator goes below the destination wavelength and then up to the wavelength to insure the greates repeatability.

3. JOG

The third menu, JOG, permits positioning the monochromator without keying in a destinatio wavelength. This function is useful for going quickly from one region of the spectrum to another or for searching for a peak. There are two jog speeds, FAST - the maximum scan for the grating selected (see Table 2) and SLOW - 1/250 the maximum rate is the default value. Other slow jog speeds can be set through the RS-232 or IEEE ports (see Section V, Appendix A). The JOG menu is shown below in Figure 8.

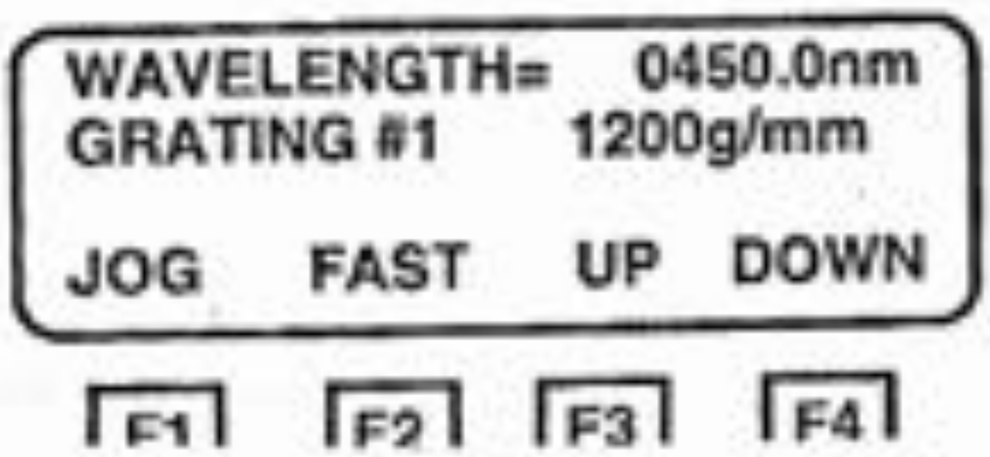


Figure 8

Jog Menu

Fast or slow jog speeds are selected with the F2 function key. The jog function itself is controlled by either the F3 key for increasing wavelengths or the F4 key for decreasing wavelengths. The wavelength changes while the key is depressed and stops when the function is released. The wavelength indicator on line 1 updates as the monochromator changes wavelength.

NOTE: If precise wavelength information is required after a jog, it is important to always end the last jog in the up direction, so that the desired wavelength is approached in the direction of increasing wavelength.

4. REPS (or Repetitive Scans)

The REPS menu enables repetitive scanning between two wavelengths at the selected scan rate. This menu is shown below:

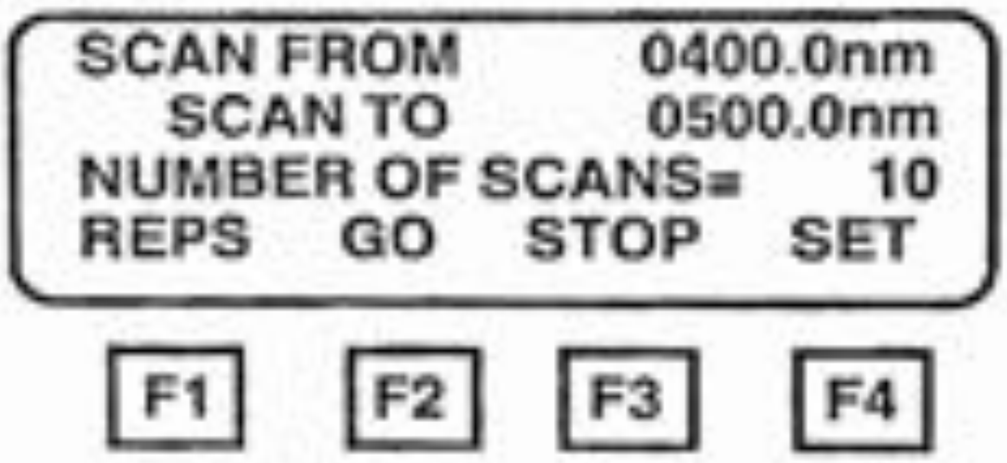


Figure 9
Repetitive Scan Menu

When entering the REPS menu, if the parameters Start Wavelength, End Wavelength and Number of Scans are correct, the scans may be started by selecting the F2 GO function. If any of the three are changed it is necessary to re-enter all three. Selecting F4 SET will cause the following menu.

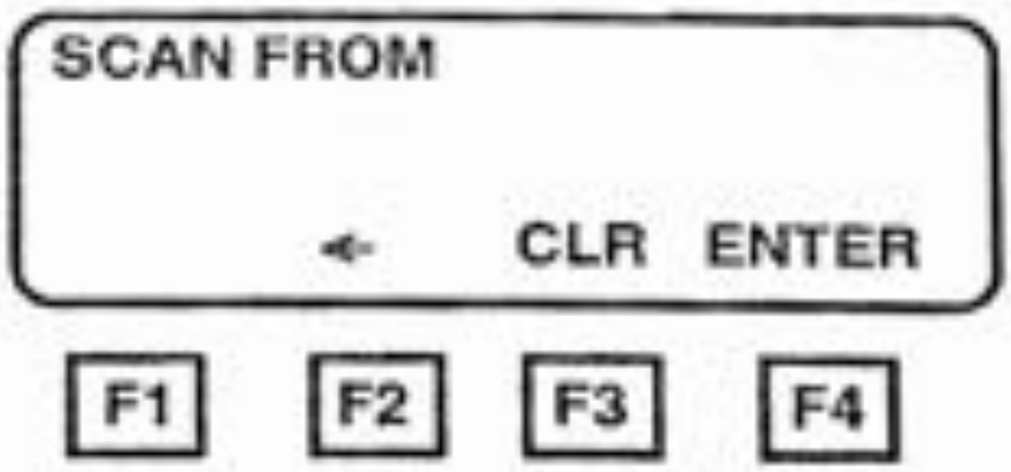


Figure 10
Second Repetitive Scan Menu

As with the RATE and λ menus, enter the desired SCAN FROM wavelength from the keypad. When this wavelength is entered, the following menu is displayed:

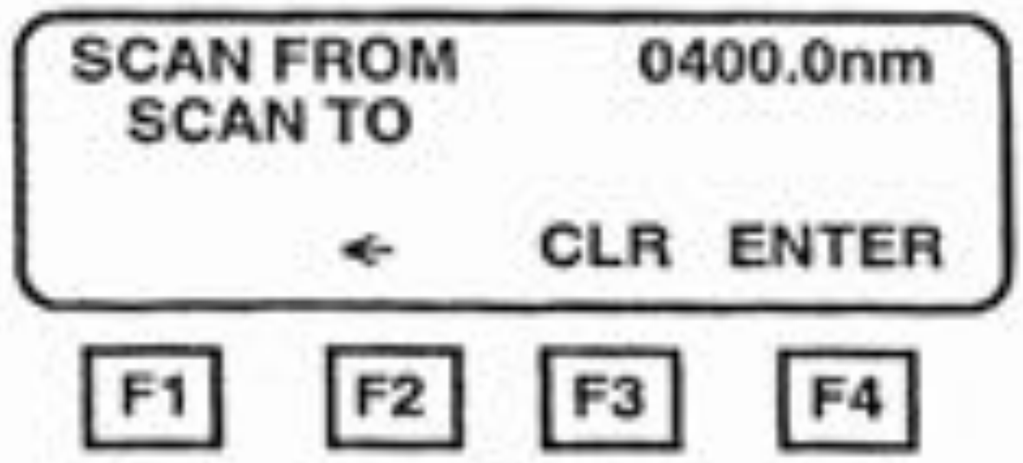


Figure 11
Third Repetitive Scan Menu

As above, enter the desired SCAN TO wavelength. The selected parameters are displayed in the following menu.

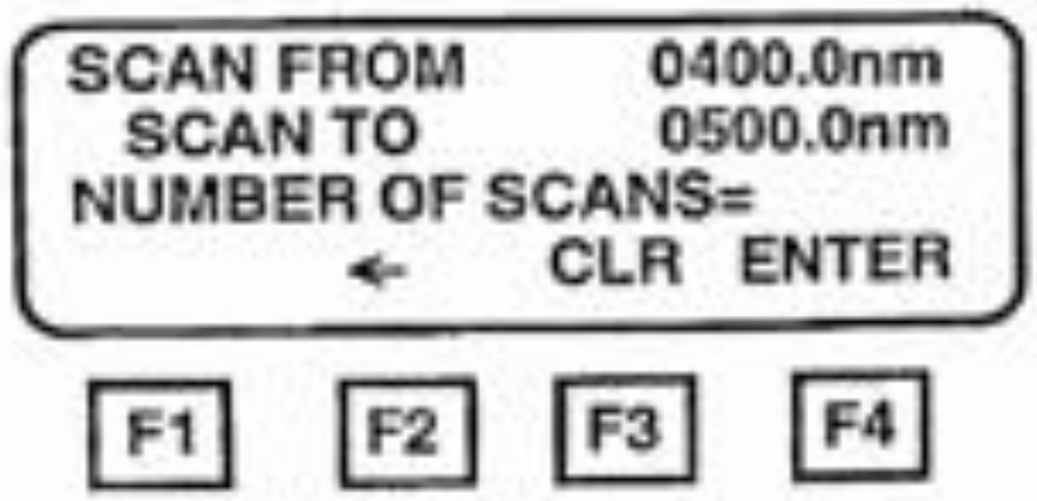


Figure 12
Fourth Repetitive Scan Menu

Enter the NUMBER OF SCANS desired from 1 to 99. When ENTER is selected, the original REPS menu (Figure 9) is again displayed. F2 GO will start the scans and while scanning, the current wavelength and number of scans are updated and displayed. When returning to the "SCAN FROM" wavelength after a scan, the monochromator goes at the maximum motor speed. The monochromator stops at the "SCAN TO" wavelength after the selected number of scans are completed. The scans can be stopped with the F3 STOP function. If scanning is resumed after stopping, the scans will start from scan 1.

5. GRAT (or Grating Select)

The Grating Select menu, Figure 13, indicates the gratings installed in the SpectraPro and allows selection of any one the the gratings.

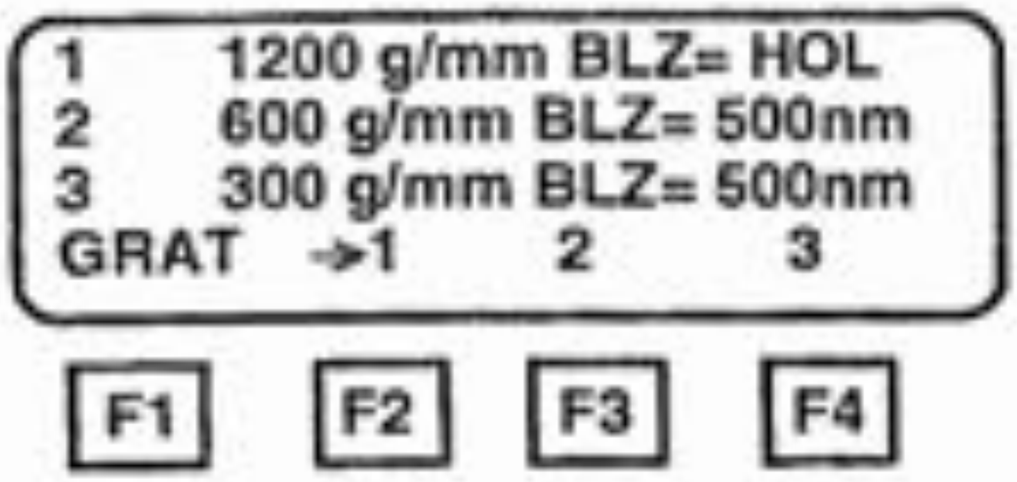


Figure 13
Grating Select Menu

The arrow indicates the grating in operating position. To select a different grating, press the function key below the desired grating number. Changing gratings takes approximately 45 seconds. While the grating is changing, the bottom line of the display indicates " CHANGING GRATING ". When changing gratings, the SpectraPro will go to the wavelength indicated in the wavelength display before the grating change, provided this wavelength is not too high for the newly selected grating. If it is too high, a default wavelength of 200nm will be used for the new grating. No other functions may be selected until the grating change is completed.

C. Operation from External Computer

The SpectraPro can be controlled externally by a computer or computer terminal. For cont through the RS-232 port, the external control mode is entered by initializing (reset or powe the SpectraPro when a computer or computer terminal is attached to the RS-232 port thro connecting cable as described in Section III-B or by selecting the rate menu and pressing F followed by the Reset key. See Section IV-D for operation through optional IEEE 488 port.

The following Functions are available:

- **SCAN**: User indicates a desired wavelength and the SpectraPro scans to that wavelength at the present scan speed selected.

- **GO TO SCAN**: User indicates a desired wavelength and the SpectraPro races to that wavelength at maximum motor speed.

- **Setting of the Scanning Speed**: User indicates desired scanning speed in nm per minute

- **Grating Selection**: User selects desired grating (1, 2, or 3) for operation.

- **Repeat Scans**: User indicates beginning wavelength, end wavelength, number of scans and any delay between scans.

In addition, the user may ask for information such as the present wavelength , current gra operating position, and the current scanning speed.

COMMAND	COMMAND FUNCTION	EXAMPLE
NM/MIN	Sets Scanning Speed	**100.0 NM/MIN** (this tells the SpectraPro to scan at 100.0 nm/minute)
NM	Scans to destination wavelength at the selected scan rate.	**250.0 NM** (this tells the SpectraPro to scan to a wavelength of 250.0nm)
GOTO	Goes to destination wavelength at maximum speed.	**250.0 GOTO** (This tells the SpectraPro race to 250nm at maximum motor speed
GRATING	Selects a grating for operation	**2 GRATING** (this tells the SpectraPro to index grating number two into operating position)

The following commands can be used when it is necessary to move to a wavelength position with greater motor step resolution than the **NM** command. Note that this will not necessarily pr vide greater optical resolution.

<NM> Sets the destination wavelength to the nearest 0.01nm at the selected scan rate. Example: 546.07 **<NM>** (This tells the SpectraPro to scan to a wavelength of 546.07nm) NOTE: Two digits after the decimal point are required

<GOTO> Same as <NM> above except monochromator goes at maximum speed.

REPEATING SCAN COMMANDS: THE USER MUST INPUT THE FOLLOWING SCAN PARAMETERS TO ENABLE REPETITIVE SCANS

COMMAND	COMMAND FUNCTION	EXAMPLE
SCAN-FROM	Starting wavelength for scans	**350.0 SCAN-FROM** (this tells the SpectraPro to start at 350.0nm)
SCAN-TO	End wavelength for scans	**500.0 SCAN-TO** (this tells the SpectraPro to end at 500.0nm)
#SCANS	Number of scans to perform	**12 #SCANS** (this tells the SpectraPro to complete 12 scans)
SCAN-DELAY	Indicates delay between scans	**3 SCAN-DELAY** (this tells the SpectraPro to stop for a 3 second delay between repeating scans.
START-SCANS	Starts scans	**START-SCANS** (this tells the SpectraPro to begin scanning)

Other Commands:

?NM	Displays present wavelength
?NM/MIN	Displays present scanning speed
?GRATINGS	Displays gratings installed, with the line describing the grating currently in operating position, shifted slightly to the left. Also displays groove spacing and blaze wavelength for each grating.
?GRATING	Displays the number of the selected grating.

INPUT	Takes the SpectraPro out of external control and returns control to the remote keypad. To return to external control from the remote scan controller, go to the rate menu and press F2 followed by the RESET key. NOTE: THIS COMMAND ONLY WORKS WITH RS-232 AND NOT WITH IEEE-488.

NOTE

Commands must be typed exactly as they appear in this description. This includes all decimal points, hyphenations, and spaces between words and numbers. The SpectraPro software will only recognize these commands as they are shown here. If part of the command is missing, the program will not function properly and the incorrect command will be displayed with a question mark (?). Incorrect numeric input can cause erroneous results or statements such as "NOT ENOUGH PARAMETERS" or "STACK UNDERFLOW" to be returned.

For example, the parameters for NM, NM/MIN, GOTO, SCAN-FROM and SCAN-TO must be entered with a decimal point and exactly one digit after the decimal point. (e.g. 200.0 NM). The parameters for GRATING, #SCANS and SCAN-DELAY must be entered as integer numbers. The value for SCAN-DELAY is retained in non-volatile memory and is used as the default time between repeat scans with either keypad or computer control.

When controlling the SpectraPro through a user computer program, all commands and their parameters must be separated by at least one space and each command or command sequence must be terminated by a carriage return.

The SpectraPro responds to a command only after that command or command string is completed. The response is OK<CR> <LF> (e.g. Hex ASCII Sequence 20 6F 6B 0D 0A). When writing a computer control program for the SpectraPro, it is advisable to wait for the "OK <CR> LF" sequence after sending out a command or string of commands to indicate that the command or string of commands has been completed. Also, the default condition is to echo each character that is sent to the SpectraPro. If no echo is desired, the command NO-ECHO will suppress the echo. The command ECHO will return the SpectraPro to the default echo state.

D. IEEE -488 Interface Option for SpectraPro Monochromators

The IEEE-488 interface option allows control of the SpectraPro monochromator from the IEEE-488 bus. All of the commands and status requests described in Section C - Operation from External Computer - are available through the IEEE-488 option. The following standard interface functions are provided:

SH1, AH1, T2, L2, SR1, RL1 (NOTE: The local lockout command is not accepted but the front panel is automatically locked out when the monochromator controller has been addressed as a talker or a listener).
PP0, DC0, C0

The GPIB device identifier or address may be sent by dip switches on the interface board or remotely through the RS-232 or IEEE-488 ports. When the internal switch, S1, is set to address 31 (first five switch positions all on), the device address is read from EEPROM at power-up or reset. The factory set device address is 11 and may be changed with the command SET-ID through the GPIB or RS-232 ports (e.g. 5 SET-ID <CR> would set the device address to 5). This device address will remain as set until another SET-ID command is issued. It is not affected by power off or reset. The command ?ID will report back the current device address. The device address may also be set directly by the interface board switch S1 if it is desired to not have the address remotely changeable. Table 6 shows the function of each switch position

S1-1	on = address 1 decimal, off = address 0
S1-2	on = address 2 decimal, off = address 0
S1-3	on = address 4 decimal, off = address 0
S1-4	on = address 8 decimal, off = address 0
S1-5	on = address 16 decimal, off = address 0
S1-6	factory set to on
S1-7	factory set to off
S1-8	factory set to off
S1-9	factory set to on
S1-10	factory set to on

NOTE: Some switches are labeled OPEN/CLOSE instead of OFF/ON.
OFF = OPEN

Table 6

To get into remote operation from the IEEE-488 bus, the SpectraPro must be in local mode under front panel control. Power up or reset the SpectraPro without anything connected to its RS-232 port. When the SpectraPro is then addressed as a listener or a talker through the IEEE-488 bus, the monochromator will then be in remote and the front panel controls will be locked out. To return to front panel control on the SpectraPro from the IEEE-488 controller, make the monochromator a listener and issue a carriage return followed by the GTL command. **(NOTE: The GTL command is the GO TO LOCAL command for the National Instruments PC-2A Controller. Other controllers may use other commands for this action.)** To return to front panel control from the SpectraPro, reset the monochromator by pressing the F1 and RESET keys simultaneously.

The last byte of each command string to the SpectraPro must be a <CR> (hex OD). The end message (EOI line) is accepted but not required. When the SpectraPro is a talker, each string sent back to the controller ends with a <LF> (hex 0A) with the EOI line set.

The SpectraPro will issue a service request based upon the contents of the service request mask which is set by the SET-MASK command and read by the ?MASK command. The bits of the mask are as follows:

bit 0	previously sent command is complete
bit 1	previous command generated an error
bit 7	previous command generated a response which is now ready to be sent

The default value for the service request mask is ø, therefore, no service request is generated. To change the mask to generate a service request on error or response ready, for example issue the command 130 SET-MASK <CR>. This new value is reset to the default value on reset or power-up.

The SpectraPro responds to a serial poll with a status byte that uses the same bit pattern as the service request mask shown above.

The following pages list five example programs in BASIC using the IEEE-488 option. Examples one and two are based upon the PC-488 board and software from Capital Equipment Corp. as the controller and examples A , B and C are based upon the PC-II A board from National Instruments. The first part of the code as well as some of the instructions are unique to the individual boards but are similar to those used with other controllers. Examples 1 and A send the monochromator to 253.7 nanometers and then return control to the SpectraPro front panel. Examples 2 and B request the wavelength from the SpectraPro. These two programs assume the service request mask is set to the value (130 decimal) so that a service request is generated when the SpectraPro has data to send to the controller. The program starts a serial poll and prints the status byte and data from the SpectraPro. Example C reads the monochromator wavelength with the service request mask set to the default value of ø.

Program Listing

```
1   ' Example program 1: send monochromator to a wavelength
10 DEF SEG=&HC400                                    ' memory segment for PC<>488
20 INITIALIZE=0                                      ' offsets for PC<>488 routines
30 TRANSMIT=3 : RECEIVE=6
50 SEND=9 : SPOLL=12 : ENTER=21
60 MY.ADDRESS%=21 : LEVEL%=0                         ' make PC a controller at address 21
70 CALL INITIALIZE (MY.ADDRESS%,LEVEL%)
80 MONO%=11                                          ' monochromator address is 11
81 T$="UNT UNL MTA LISTEN"+STR$ (MONO%)              ' listen
82 CALL TRANSMIT (T$,STATUS%)
83 IF STATUS%<>0 THEN PRINT " status =";STATUS% : STOP
84 T$="DATA '253.7 NM' 13"                           ' send grating to 253.7 nm
85 CALL TRANSMIT (T$,STATUS%)
86 IF STATUS%<>0 THEN PRINT " status = "; STATUS% : STOP
90 T$="DATA 13 GTL"                                  ' go to local
95 CALL TRANSMIT (T$,STATUS%)
97 IF STATUS%<>0 THEN STOP
100END
```

```
1   'Example 2: request wavelength, wait for SRQ, serial poll
2   '           service request mask = 130  ( 82 hex )
10 DEF SEG=&HC400
20 INITIALIZE=0                                      ' offsets for PC<>488 routines
30 TRANSMIT=3 : RECEIVE=6
50 SEND=9 : SPOLL=12 : ENTER=21
60 MY.ADDRESS%=21 : LEVEL%LEVEL%0                    ' make PC a controller at address 21
70 CALL INITIALIZE (MY.ADDRESS%,LEVEL%)
80 MONO%=11                                          ' monochromator address is 11
81 T$="UNT UNL MTA LISTEN"+STR$(MONO%)               ' listen
82 CALL TRANSMIT (T$,STATUS%)
83 IF STATUS%<>0 THEN PRINT "status =";STATUS% : STOP
90 T$="DATA    '?NM'  13"                            ' ask for position
91 CALL TRANSMIT (T$.STATUS%)
92 IF STATUS%<>0 THEN PRINT " status=":STATUS% : STOP
115 '--- now, wait for SRQ status bit---
125 IF (INP(&H2BA) AND &H40)=0 THEN 125
131 ' -- SRQ has occurred, now read the result
133 CALL SPOLL (MONO%,POLL%.STATUS%)
134 IF STATUS%<>0 THEN PRINT " status =";STATUS% : STOP
135 PRINT" serial poll = ";POLL%
136 T$="UNL MLA"
137 CALL TRANSMIT (T$,STATUS%)
138 IF STATUS%<>0 THEN PRINT " status =":STATUS% : STOP
140 T$="TALK"+STR$ (MONO%)
141 CALL TRANSMIT (T$.STATUS%)
142 IF STATUS%<>0 THEN PRINT " status=":STATUS%: STOP
147 R$=SPACE$(255)                                   'get up to 255 characters from device
150 CALL RECEIVE (R$,LENGTH%,STATUS%)
160 IF STATUS%<>0 THEN PRINT "status =";STATUS% : STOP
170 PRINT " data received '";LEFT$(R$,LENGTH%);"'"
180 T$="UNT UNL MTA LISTEN "+STR$ (MONO%)            ' listen
181 CALL TRANSMIT (T$,STATUS%)
182 IF STATUS%<>0 THEN PRINT " status =":STATUS% : STOP
250 END
```

```
1  CLEAR ,59000! : IBINIT1=59000! : IBINIT2=IBINIT1+3 : BLOAD "bib.m", IBINIT1
2  CALL IBINIT1 (IBFIND,IBTRG,IBCLR,IBPCT,IBSIC,IBLOC,IBPPC,IBBNA,IBONL,IBRSC,IB
   SRE,IBRSV,IBPAD,IBSAD,IBIST,IBDMA,IBEOS,IBTMO,IBEOT,IBRDF,IBWRTF,IBTRAP)
3  CALL IBINIT2 (IBGTS,IBCAC,IBWAIT,IBPOKE,IBWRT,IBWRTA,IBCMD,IBCMDA,IBRD,IBRDA,
   IBSTOP,IBRPP,IBRSP,IBDIAG,IBXTRC,IBRDI,IBWRTI,IBRDIA,IBWRTIA,IBSTA%,IBERR%,IBCNT%)
10 REM  Example A: send monochromator to a wavelength
20 UDNAME$="SP275"
30 CALL IBFIND (UDNAME$, UD%)
35 REM  check for error on ibfind call
40 IF UD% < 0 THEN GOTO 200
45 REM  send command to sp275
50 WRT$="253.7 nm" + CHR$ ($ED)
60 CALL IBWRT (UD%,WRT$)
65 REM  check for error on function call
70 IF IBSTA% < 0 THEN GOTO 300
75 REM  go to local at monochromator
78 FOR I=1 TO 100 : NEXT I
80 CALL IBLOC (UD%)
85 REM  check for error on function call
90 IF IBSTA% < 0 THEN GOTO 300
100 GOTO 500
200 REM  ibfind error
205 PRINT "ibfind error": STOP
300 REM  function call error
305 PRINT "gpib function call error" : STOP
500 END
```

```
1  CLEAR ,59000! : IBINIT1=59000! : IBINIT2=IBINIT1+3 : BLOAD "bib.m", IBINIT1
2  CALL IBINIT1 (IBFIND,IBTRG,IBCLR,IBPCT,IBSIC,IBLOC,IBPPC,IBBNA,IBONL,IBRSC,IBSRE,
   IBRSV,IBPAD,IBSAD,IBIST,IBDMA,IBEOS,IBTMO,IBEOT,IBRDF,IBWRTF,IBTRAP)
3  CALL IBINIT2 (IBGTS,IBCAC,IBWAIT,IBPOKE,IBWRT,IBWRTA,IBCMD,IBCMDA,IBRD,IBRDA,
   IBSTOP,IBRPP,IBRSP,IBDIAG,IBXTRC,IBRDI,IBWRTI,IBRDIA,IBWRTIA,IBSTA%,IBERR%,IBCNT%)
10 REM  Example B: request wavelength, wait for data ready, read wavelength
15 REM  using National PCIIA board with RQS byte = hex 0A
17 REM  Service request mask = 0
20 UDNAME$="SP275"
30 CALL IBFIND (UDNAME$,UD%)
35 REM  check for error on ibfind call
40 IF UD% < 0 THEN GOTO 200
45 REM  send command to sp275
50 WRT$= "IWM " + CHR$(4HD)
60 CALL IBWRT (UD%,WRT$)
65 REM  check for error on function call
70 IB IBSTA% < 0 THEN GOTO 300
113 REM  PRINT "IBSTA% = "; IBSTA%
116 CALL IBRSP (UD%,SPR%)
118 IF (  (SPR% AND 129)  <> 129 )  THEN 116
125 PRINT "SPR = "; SPR%
130 RD$=SPACE$(255)
140 CALL IBRD (UD%,RD$)
145 IF IBSTA% < 0 THEN GOTO 300
150 PRINT " data received ="; LEFT$(RD$,IBCNT%);
160 REM PRINT " status = "; IBSTA%
170 GOTO 500
200 REM  ibfind error
205 PRINT  "ibfind error": STOP
300 REM  function call error
305 PRINT "gpib function call error" : STOP
500 END
```

```
1   CLEAR ,590001 : IBINIT1=590001 : IBINIT2=IBINIT1+3 : BLOAD "bib.m",IBINIT1
2   CALL IBINIT1 (IBFIND,IBTRG,IBCLR,IBPCT,IBSIC,IBLOC,IBPPC,IBBNA,IBONL,IBRSC,IBSRE,
    IBRSV,IBPAD,IBSAD,IBIST,IBMDA,IBEOS,IBTMO,IBEOT,IBRDF,IBWRTF,IBTRAP)
3   CALL IBINIT2 (IBGTS,IBCAC,IBWAIT,IBPOKE,IBWRT,IBWRTA,IBCMD,IBCMDA,IBRD,IBRDA,
    IBSTOP,IBRPP,IBRSP,IBDIAG,IBXTRC,IBRDI,IBWRTI,IBRDIA,IBWRTIA,IBSTA%,IBERR%,IBCNT%)
10  REM  Example C:  request wavelength, do serial poll, read wavelelngth
15  REM  using National PCIIA board with EOS byte = hex 0A
17  REM  Service request mask = 130  ( 82 hex )
20  UDNAME$="SP275"
30  CALL IBFIND (UDNAME$,UD%)
35  REM  check for error on ibfind call
40  IF UD% < 0 THEN GOTO 200
45  REM  send command to sp275
50  WRT$= "?NM " + CHR$(&ND)
60  CALL IBWRT (UD%,WRT$)
65  REM  check for error on function call
70  IF IBSTA% < 0 THEN GOTO 300
75  REM  wait for RQS
90  MASK%=&H4800
100 Call IBWAIT (UD%,MASK%)
105 REM  check for error or timeout
110 IF (IBSTA% AND &HC000) <> 0 THEN GOTO 300
113 REM  PRINT "IBSTA% = "; IBSTA%
116 CALL IBRSP (UD%,SPR%)
117 PRINT "SPR = ";  SPR%
120 REM  read wavelength from monochromator
130 RD$=SPACE$(255)
140 CALL IBRD (UD%,RD$)
145 IF IBSTA% <0 THEN GOTO 300
150 PRINT " data received = "; LEFT$(RD$,IBCNT%);
160 REM  PRINT " status = "; IBSTA%
170 GOTO 500
200 REM  ibfind error
205 PRINT "ibfind error":  STOP
300 REM  function call error
305 PRINT "gpib function call error" : STOP
500 END
```

E. Installing the Model MF-449 or MF-450 Mounting Flange and Focal Plane Adjustment Micrometer (Optional)

MF-449 and MF-450 Installation Procedures

The Model MF-449 or Model MF-450 mounting flange replaces the exit slit and spacer plate on the SpectraPro monochromator. The following procedure is recommended for mounting the MF-449 or MF-450 flange:

1) Locate the MF-449 or MF-450 flange and the four mounting screws (8-32 x 3/8 long) provided.

2. Locate on the face of the exit slit housing four 8-32 socket head cap screws. Remove these four screws, the exit slit assembly and the 1/4 inch thick spacer plate. Store these 6 items in a clean, dry area.

3) Locate the red dot on top of the MF-449 or MF-450 mounting flange. With the red dot on the top, attach the mounting flange to the port (where the exit slit assembly was removed) with the four 8-32x3/8" screws provided.

4) Attach the OMA™ or OSMA™ detector to the mounting flange.

Focus Adjustment Procedures

Due to the slight variations in the distance from the mounting flange of the detector to its focal plane, it may be necessary to adjust the focusing mirror in the SpectraPro to obtain the optimum resolution. After mounting the focal plane detector to the SpectraPro and becoming familiar with its operation, the following procedure is recommended for optimizing focus.

1) Locate the focal plane adjustment micrometer (shipped separately) and the mirror mounting spindle, as shown in the Figure 14.

2) Assure the micrometer spindle is not protruding beyond the end of the mounting block and attach the mounting block to the mirror spindle using the 8-32 cap screw supplied.

3) Rotate the micrometer spindle gently until the spindle just contacts the mirror mount. Do not apply excess force. Note and record the micrometer setting. This is the focus setting to use if an exit slit is re-installed.

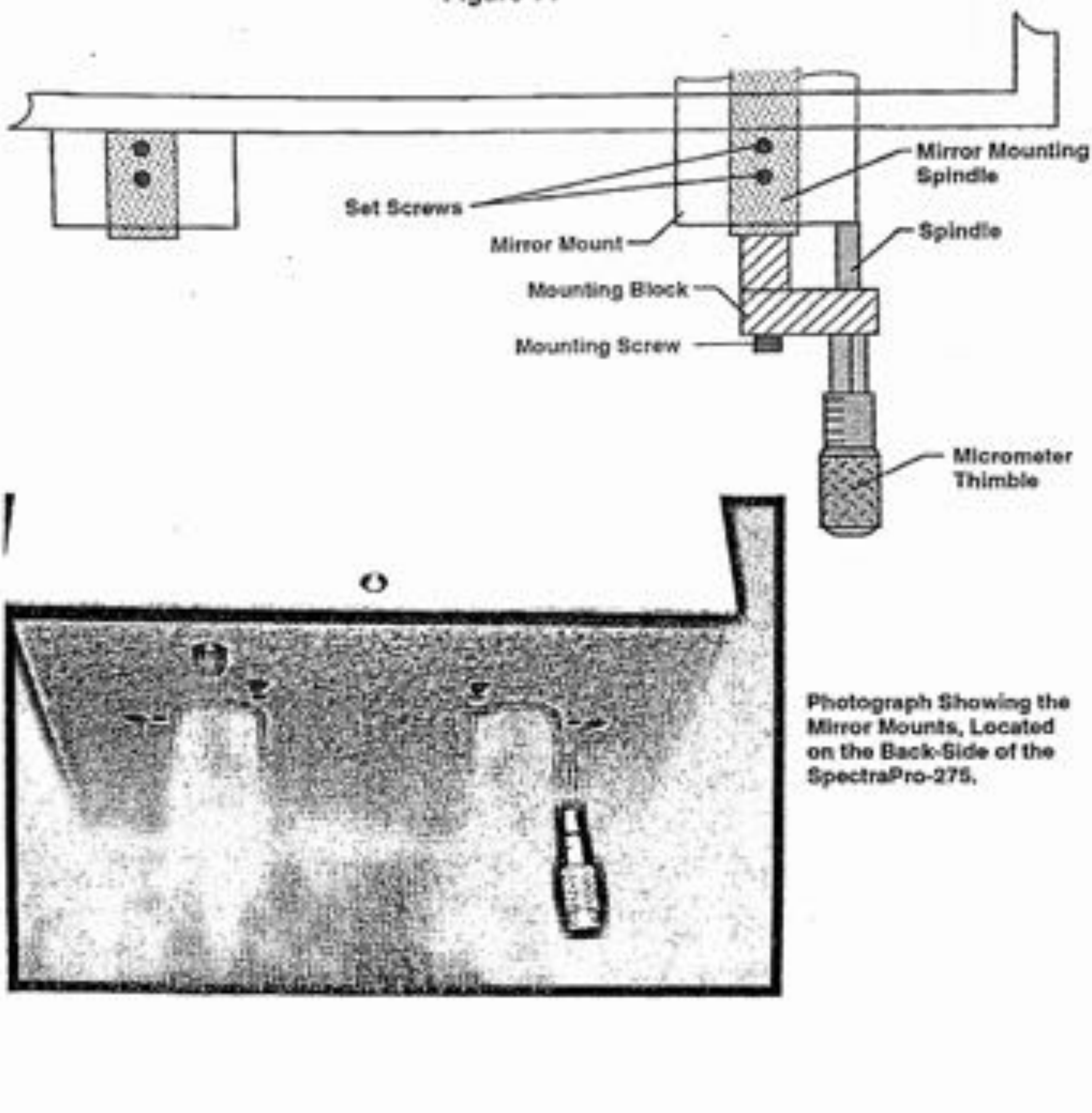
4) It is recommended that focus adjustments be made in 0.003" increments, or 3 divisions on the micrometer thimble. The total adjustment required should not exceed 0.080".

5) To make a focus adjustment, loosen the 2 set screws securing the mirror mounting spindle (approximately 1/8 turn). Gently push on the end of the mounting block while turning the thimble clockwise 0.003", or 3 divisions. Assure the micrometer spindle contacts the mirror mount and re-tighten both set screws. To assure repeatable results, gently rotate the mirror mounting spindle slightly clockwise and counterclockwise while tightening the set screws. This assure that the set screws will align correctly with the machined flat spot

6) Check resolution. Adjust focus 0.003", or 3 divisions, in the same direction and recheck resolution. If resolution improves, continue moving in the same direction until optimum resolution is achieved. If resolution degrades, adjust for focus in the opposite direction until optimum resolution is achieved.

NOTE: Total movement should not exceed the original setting (as recorded in step #3) by more than +/- 0.060".

Figure 14



Photograph Showing the Mirror Mounts, Located on the Back-Side of the SpectraPro-275.

V. Appendix A

A. Selecting Alternate Start-Up Parameters

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

GRATING	#1
WAVELENGTH	0.0NM
SCAN SPEED	100.0 NM/MIN
DELAY BETWEEN REPEAT SCANS	0. Seconds
SLOW JOG SPEED	Maximum Scan Rate Divided By 250

Each of the above may be changed through the RS-232 port or optional IEEE 488 port using the following commands. These values are stored in non-volatile memory and will be in effect after the next reset or power-up.

INIT-GRATING - Selects the grating to which the SpectraPro will go after finding 0.0nm on grating #1. (e.g. 2 INIT-GRATING <ENTER> Valid numbers are 1, 2 or 3.)

INIT-WAVELENGTH - Sets an initial starting wavelength for the monochromator. (e.g. 250.00 INIT-WAVELENGTH <ENTER> Notice that unlike the other wavelength commands, INIT-WAVELENGTH requires 2 digits after the decimal point.)

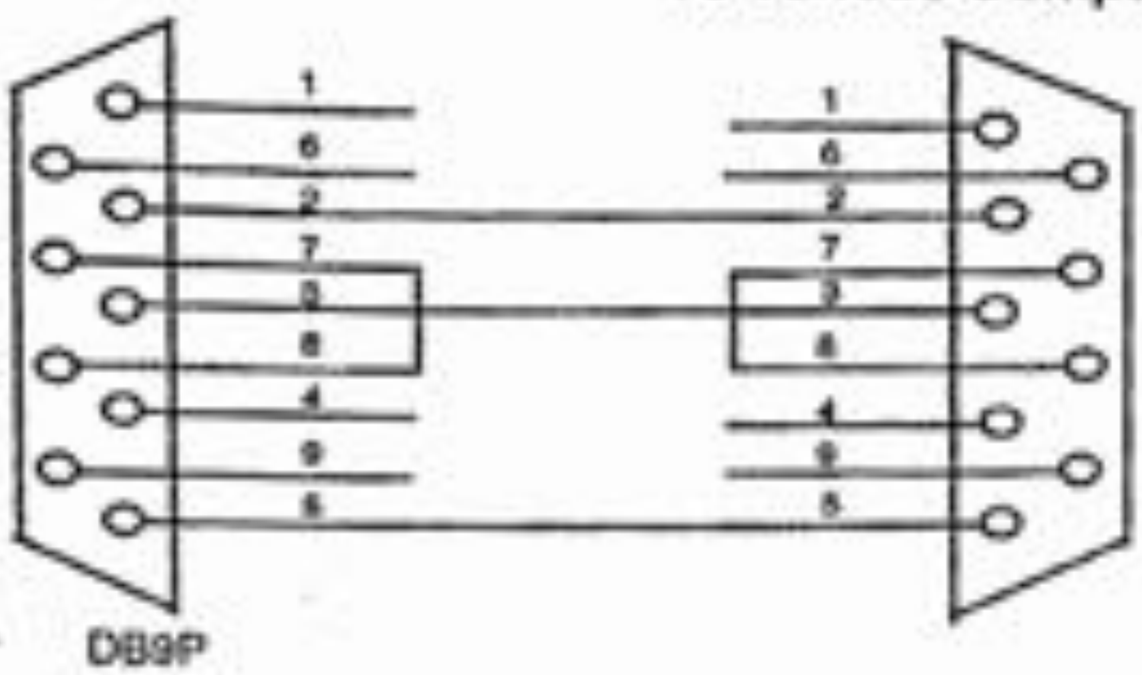
INIT-SRATE - Sets an initial scan rate for the monochromator. (e.g. 500.00 INIT-SRATE <ENTER> Note that like INIT-WAVELENGTH above, two digits after the decimal point are required)

INIT-DELAY - Sets the delay in seconds for the beginning of each repeat scan. The range is 0 to 32767 seconds. (e.g. 5 INIT-DELAY <ENTER>)

INIT-SLOWJOG - Sets the slow jog rate by entering the factor by which the fast jog rate or maximum scan speed is divided. (e.g. 75 INIT-SLOWJOG <ENTER> would set the slow jog rate to the fast jog rate divided by 75. In the case of a 1200 groove grating, the slow jog rate would then be 10 nm/min.)

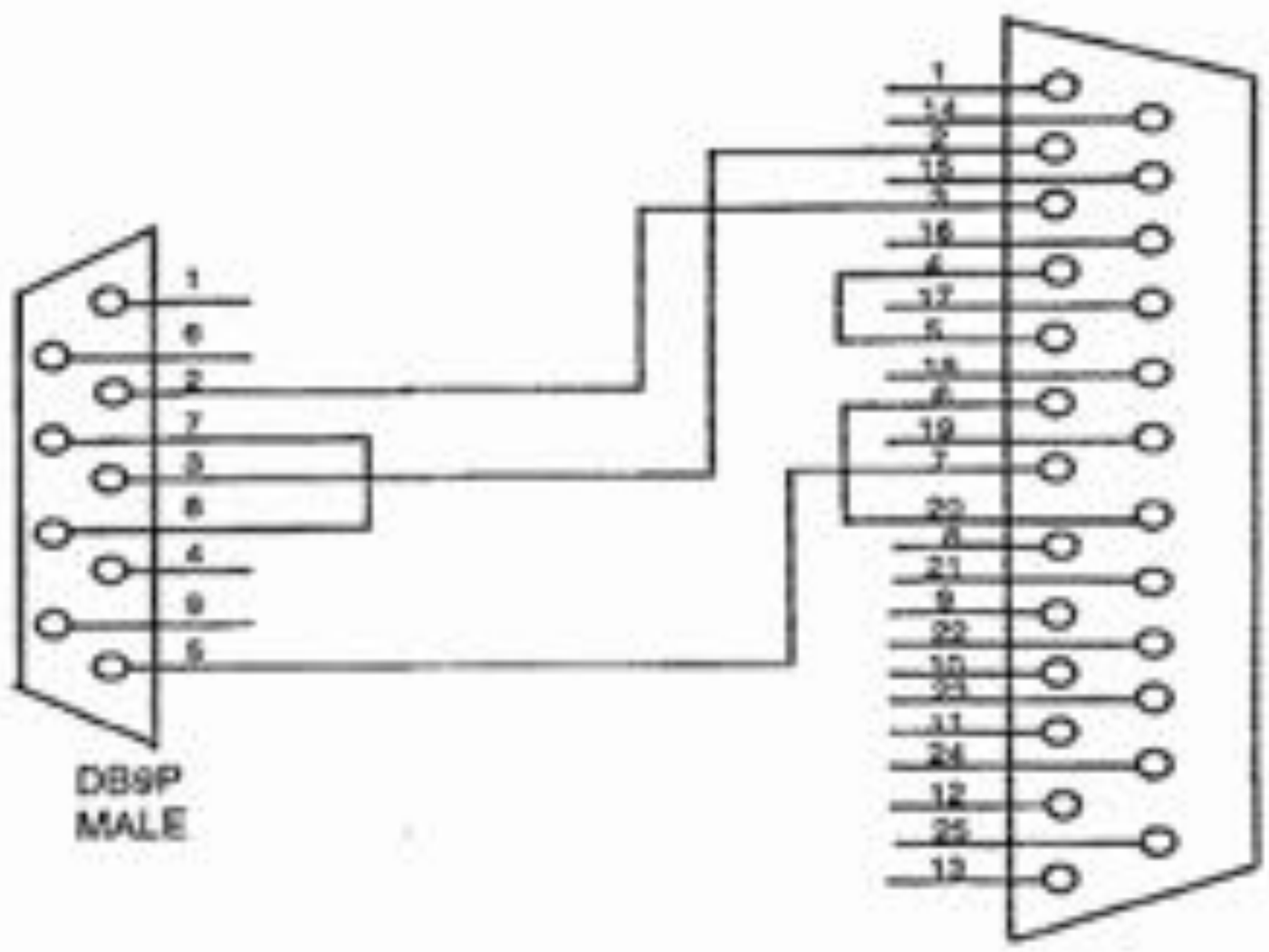
Appendix B

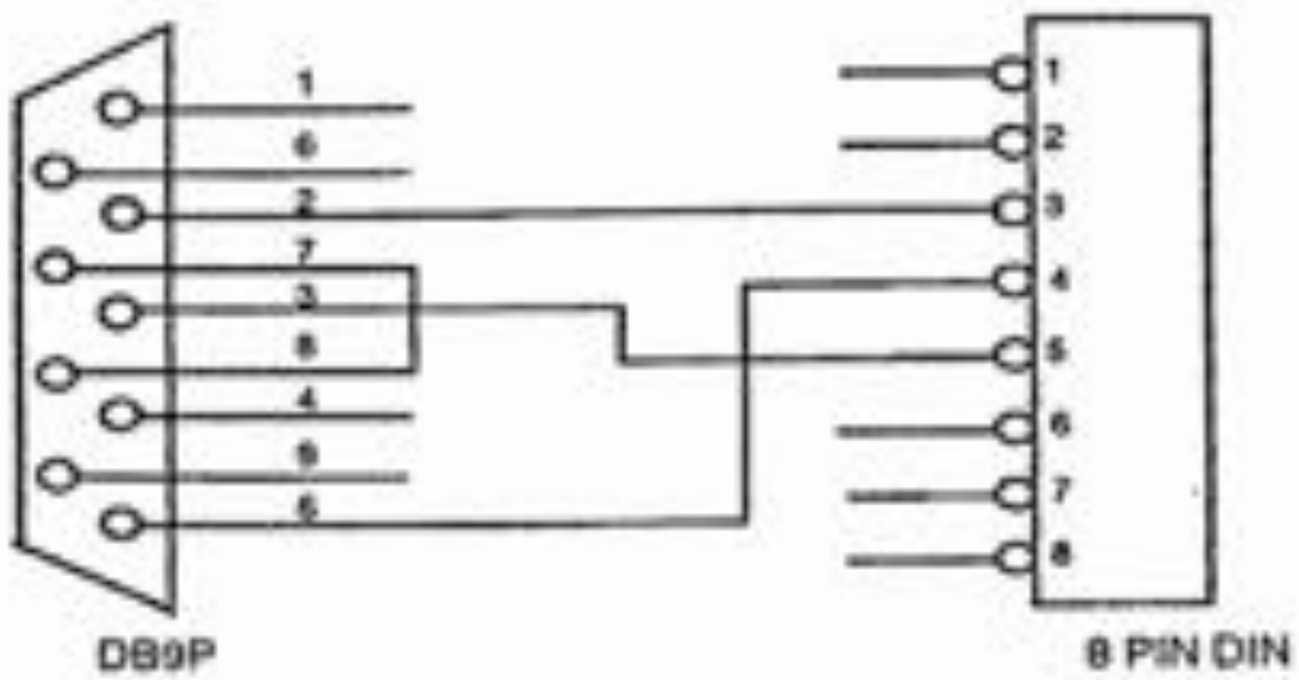
Cable Connection Diagrams: SpectraPro Monochromators & Spectrographs To Various Computers



SpectraPro to PC-AT or Compatible

SpectraPro to PC-XT Or Terminal





SpectraPro to Macintosh Computer Modem or Printer Port

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