M-77700A

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MS257™
MONOCHROMATOR AND SPECTROGRAPH

MODEL 77700 A

USER MANUAL

Please read these instructions completely before operating this equipment. The specification and operating instructions apply only to the model(s) covered by this manual. If there are any questions or problems regarding the use of this equipment, please contact Newport or the representative from whom this equipment was purchased.

Rev: 02-12-07

TABLE OF CONTENTS

LIST OF FIGURES

I SAFETY OPERATING PRECAUTIONS

Electrical: The MS257™ requires line 120/220 VAC for operation. Do not attempt to work in the electrical compartment without first disconnecting the power cord, since you may contact high voltage areas inside the compartment.

MS257™ has an internal microprocessor and should be installed with appropriate surge/EMI/RFI protection on all power lines. Dedicated power lines or line isolation may be required for some extremely noisy sites.

The circuits used in MS257™ are extremely sensitive to static electricity and radiated electromagnetic fields and therefore MS257™ should not be used nor stored in close proximity to EMI/RFI generators, electromagnetic/electrostatic field generators, radioactive devices, or other similar sources of high energy fields. Some examples of equipment, which can cause problems, are plasma sources, arc welders, radio frequency generators, x-ray instruments, and pulsed/ triggered gas discharge optical sources. Operation of MS257™ close to intense pulsed sources (lasers, xenon strobes or arc lamps, and the like) may compromise performance, if shielding is inadequate, and may cause permanent damage to the microprocessor. Do not place any containers containing liquids on top of the instrument. There is a danger that liquid may enter the ventilation holes in the electronics compartment and cause a short circuit. This may cause the instrument to fail.

Mechanical: Avoid dropping, sudden shocks, or rough handling of the monochromator since this may cause the system to lose its calibration and may destroy the high precision drive components or optics.

Do not use more than finger force in tightening down the grating mounts, since this may cause damage to the drive assembly

Optical: Do not touch any optical surfaces since this is likely to cause irreparable damage. (Do not attempt to clean any optical surface except by blowing off dust or lint particles with a stream 19f dry clean air or nitrogen).

II INTRODUCTION

MS257™ isn't just another monochromator. It is the heart of a completely automated spectral data acquisition system. All you need is a PC and a detector system.

MS257™ is an F/3.9 instrument with a focal length of 257mm for use as a monochromator, true flat field spectrograph or imaging spectrograph. It incorporates the latest advances in optical design; high speed wavelength drives, and total system automation.

MS257™ is unique because of the degree of automation built right in. MS257™ has the intelligence to be truly automated - tell it once what gratings, filters and detector ports need to be selected at what wavelengths, and it will change them automatically for you. Now you can take a spectrum from the UV right out into the infrared in a single scan. Using one of the multiple grating turrets, a filter wheel for order sorting, the flip mirror for detector port selection, and appropriate (detectors, you can take a single scan without manual intervention.

MS257™ has been designed with a flat exit image plane, and oversized focusing mirror to serve (as a true flat field spectrograph. Adapter flanges are available for InstaSpec™ diode arrays and CCD detectors, as well as detectors made by other manufacturers.

The imaging version of MS257™ has special corrected optics, toroidal mirrors, which correct the final image for astigmatism and enable point to point spectral imaging of the input source or sources. The optics have been designed to work with CCD detectors which are used to record simultaneous spectra from multiple sources.

Key Features:

- 1, 2, 3, or 4 grating turret with automatic grating switching
- Rapid high torque motor drive
- Solid cast housing for optical stability and light tightness
- 2 detector ports with automatic detector switching
- Motorized slits for automatic bandpass selection
- Advanced optical design for negligible stray light
- Tilted focal plane for eliminating re-entrant spectra from detectors
- Corrected optics for spectral imaging (version 77702)
- Fine focus adjustment for diode arrays and CCDs
- Internal shutter for dark scans
- Automated auxiliary input port option
- Separate electronics compartment for exceptional temperature stability
- On board microprocessor for automated control Complete computer control vai RS-232 or IEEE-488

III SETUP AND MOUNTING

After unpacking, you have to mount **MS257™** at a place that is convenient for you, install grating turret with gratings and remove covers from optics. After this you have to plug in the power cord.

***** WARNING *****

DO NOT PLUG IN THE POWER CORD UNTIL YOU HAVE READ ALL THE SAFETY PRECAUTIONS.

III.1 MOUNTING MS257™ TO A FLAT SURFACE

There are three 1/4-20 tapped holes under the casting, these can be used to screw in the supplied adjustable feet or to mount to other objects. Please refer to Figure 1.

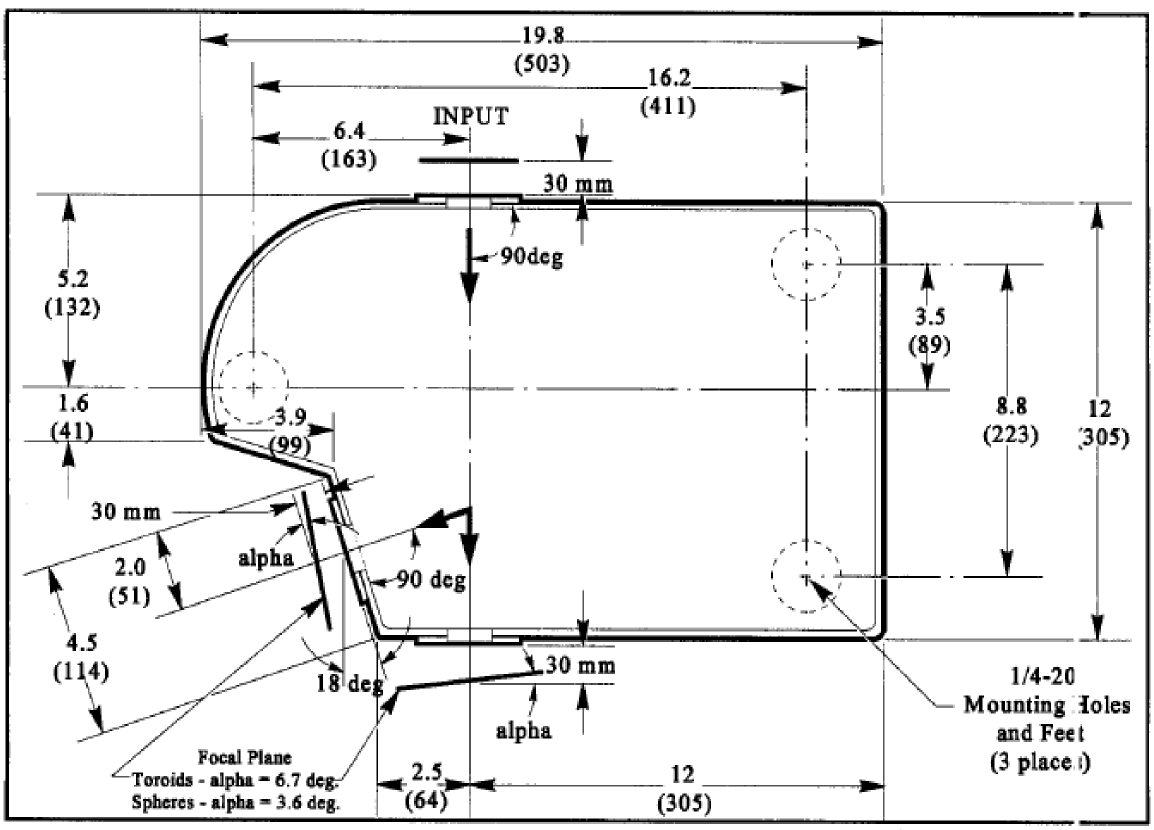


Figure 1: Dimension Diagram of the MS257™

III.2 MOUNTING OTHER INSTRUMENTS TO MS257™

Sources, detectors and other instruments that have an Oriel 1.5 inch (47 mm) female flange can be easily attached to any of the MS257™ slit housings at the input or output.

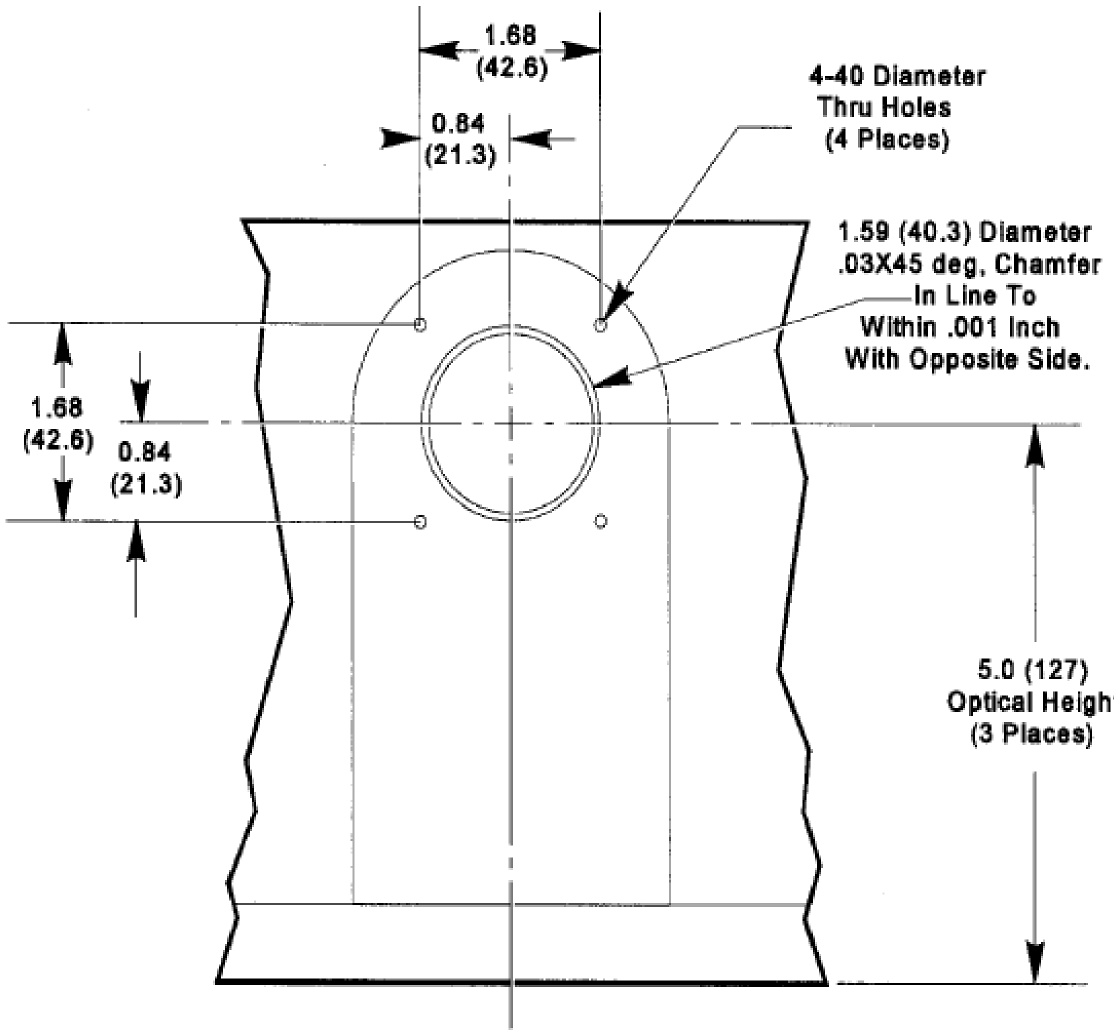


Figure 2: Bolt Pattern for the Input and Output Ports

Instruments can be mounted directly to MS257™ at any of the input or output ports (Figure 2).

III.3 TURRET MOUNT

In order to protect the most sensitive part of the instrument during transportation, the grating turret comes separately from the housing. The turret installation includes the following steps:

In order to protect…

If you have a Quadruple Grating Turret

- Put gloves on to avoid fingerprinting the gratings.
- Remove the MS257™ cover.
- Remove the rubber band holding the grating covers in place.
- **Leave the protective cover on the gratings.**
- Make sure the grating turret cable is hanging freely at the side of the turret.
- Locate the grating turret on the drive platform by aligning the two captive bolts with their holes, and the center with the platform boss.
- Adjust the position of the turret until it locates on the alignment pin and sits flush with the platform.
- Connect the turret cable.
- Using a long flat tip screwdriver gently tighten the two mounting bolts.
- Do not over tighten!
- Remove the bottom and side protective grating covers, and lastly the upper grating cover. For the bottom grating, let the plastic cover drop straight down and remove it horizontally without touching or scraping the bottom grating surface.
- Be very careful not to touch the gratings.
- Replace the MS257™ cover.

If you have a Single Grating Turret

- Remove the MS257™ cover.
- **Leave the protective cover on the grating until the mount is screwed down.**
- Locate the grating mount and twist clockwise to correctly align it.
- Using a long flat tip screwdriver gently tighten the two mounting bolts. **Do not over tighten!**
- Remove the protective grating cover.
- **Be very careful not to touch the gratings.**
- Replace the MS257™ cover.

IV QUICK START

IV.1 WORKING WITH THE HAND-CONTROLLER

The Hand Controller (Model 77709) controls the MS257™ via an RJ11 jack (back panel). Below the LCD screen are five LEDs that indicate the status of various functions. The two immediate concerns are:

- **Power LED is** ON: The MS257TM is powered up and the Hand Controller is proper if connected.
- **Local** LED **is** ON: When the Hand Controller has control of the MS257™ this indicator will be on. To activate the LED, press the "Local" button. The LCD screen will also turn on and indicate the current status of the instrument.

For further instructions about operations with the Hand Controller, please refer to section VII of this manual.

IV.2 WORKING WITH A PC

- Connect the MS257™ to your PC. If you purchased the optional IEEE-488 interface the instrument is preset for GPIB communication, else connect the MS257™ to your PC's COM1 or COM2 serial port using the supplied 9-pin, male-to-female cable.
- Use the utility software (details in section V1.2 Utility and Configuration software) to test the instrument.

V INSTRUMENT DESCRIPTION

V.1 LAYOUT AND MAJOR FEATURES

Figure 3 shows a layout of the MS257™. See Specifications for more information.

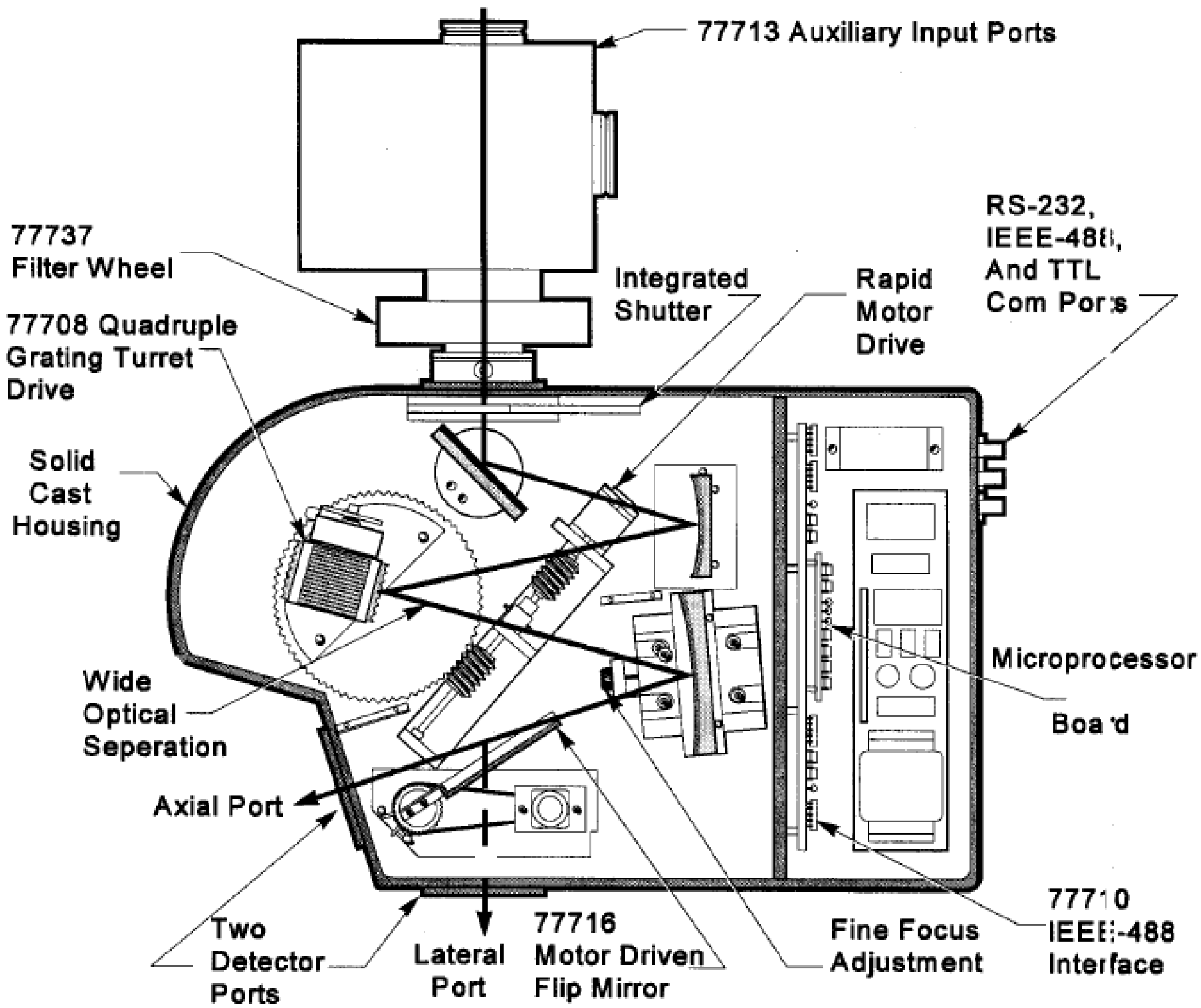


Figure 3: Layout of the MS257™

VI CONFIGURATION VERSATILITY

Use as a monochromator

Figure 4 depicts the MS257™ in use as a monochromator. The "in-line" configuration uses a turning mirror at the exit port. This can be either the 77718 Replaceable Turning Mirror on the 77716 Motorized Output Flip Mirror. When the mirror is not in position, the axial port is selected as the exit port.

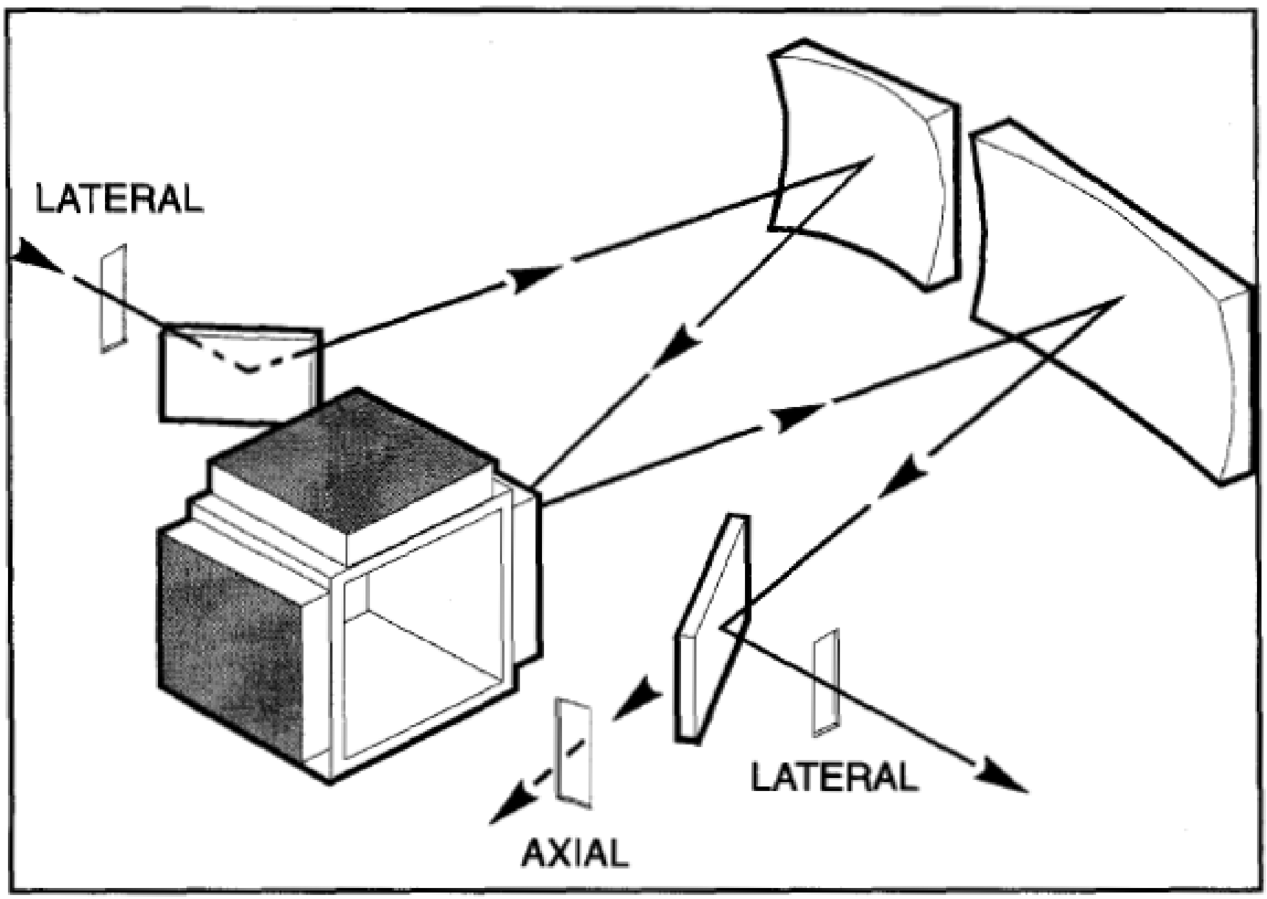


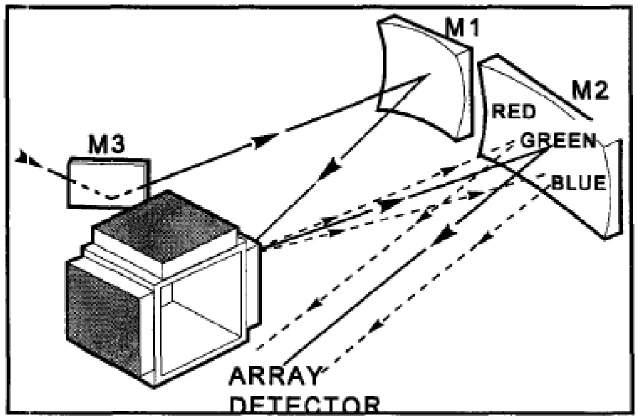
Figure 4: Diagram Representation of MS257™ as a Monochromator

Use as a Spectrograph

Figure 5 depicts the MS257™ in use as a spectrograph. The axial port can take dectectors over 4in (100 mm) in diameter depending on the distance they need to be mounted from the port face. This port can readily accommodate InstaSpec™ detectors as well as several other manufacturers. Note the sense of the spectrum at the exit ports that at the side port is reversed from that at the axial port.

Use as an Imaging Spectrograph

Figure 6 depicts the MS257™ in use as an imaging spectrograph. This is similar to the conventional spectrograph except that the sources are spatially imaged at the exit plane so that there is a separate spectrum for each input source.



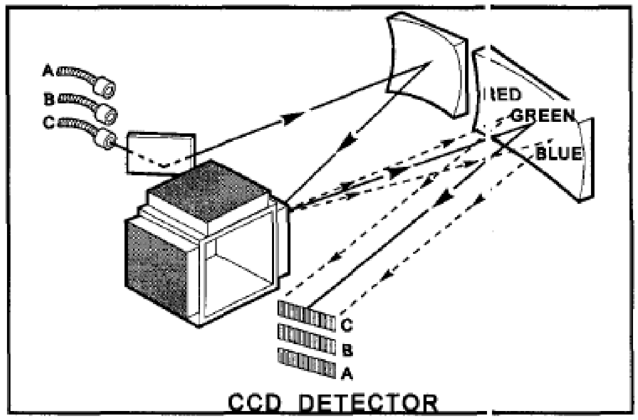


Figure 5: Diagram Representation of the MS257™ as a Spectrograph

Figure 6: Diagram Representation of the MS257™ as an imaging Spectrograph

VI.1 INSTRUMENT FEATURES

Hand Controller

MS257™ can be is controlled by using the Hand Controller, a terminal program to send MS257™ BASIC language commands or a stand alone computer program. See the relevant section for details of these methods of operation.

Negligible Strav Light

Great attention has been paid to eliminating stray light. The wide open optical layout and exaggerated tilt of the exit focal plane ensure this. While other designs may be more compact it is inevitable that they'll suffer from 're-entrant' spectra at certain grating angles. It is important that diffracted light not be allowed to reflect from the mirrors, or from the face of a focal plane detector such as a diode array or CCD, back onto the grating. This light can then be re-diffracted and cause ghost images or stray light at the detector. MS257™ was designed to remove this possibility for CCD detectors even as large as 28mm x 28mm.

Calibrated Motor Drive

MS257™ uses an ultra rapid stepper motor drive, with an oversize worm gear to ensure high precision and stability. Our computer controlled worm drive is much better than most sine drive mechanisms. It allows separate calibration factors to accommodate for differences between gratings with nominally the same lines per millimeters (for example, 1200 l/mm blazed and holographic ones). -Scans are automatically linearized so that the wavelength intervals are equal, no matter what your choice of units: nanometers, microns, or wavenumber.

In an ideal world the wavelength should be able to be calculated directly from the step position (grating angle). However gears are not perfect and are slightly nonconcentric and have surface finish flaws, therefore there is a significant deviation in real position (angle and therefore wavelength) from theoretical. This is corrected by mapping the entire drive, and charting the divergence of real from theoretical drive angle. Mathematical curve fitting is then used to correct the step position and give real wavelength.

MS257™ is spectrally mapped at the factory with a system default calibration for the grating drive. Remapping of the drive should not be attempted by unauthorized personnel, and if remapping is necessary the entire MS257TM should be returned to the factory.

Integrated Shutter

MS257™ Monochromator includes a shutter with stray light rejection better than 0.001 % for dark scans, and dark current measurements. The shutter is automatically closed when changing gratings and filters in order to protect the detector from possible high light intensities at various grating angles, particularly the zero order white light. This safety feature may be turned off by setting the shutter to the manual mode.

MS257™ imaging spectrograph includes a normally closed shutter. An optional fast shutter, normally closed, is available for pulsed work. Exposure times can be as short a 5 ms, with repetition rates as fast as 40 Hz. Neither normally closed shutters automatically react to grating changes. All shutters can be controlled through the MS257™ command language, or via an externally applied TTL signal. A synchronizing output signal is also available from the fast shutter for very precise timing of external events.

VII INSTRUMENT OPERATION

VII.1 INSTRUMENT CONFIGURATION

The instrument configuration is maintained as a collection of parameters and values. Suitable factory defaults are provided. Figure 7 shows how the configuration management commands affect the instrument's parameters. There are three configuration stores:

- The **Active Configuration** is the current setup. This is always saved and restored on power UP.
- The **Saved Configuration** is a default configuration which you can save and then load to override the current configuration.
- The **Factory Configuration** is a default configuration, and allows you to load the configuration originally set at the factory.

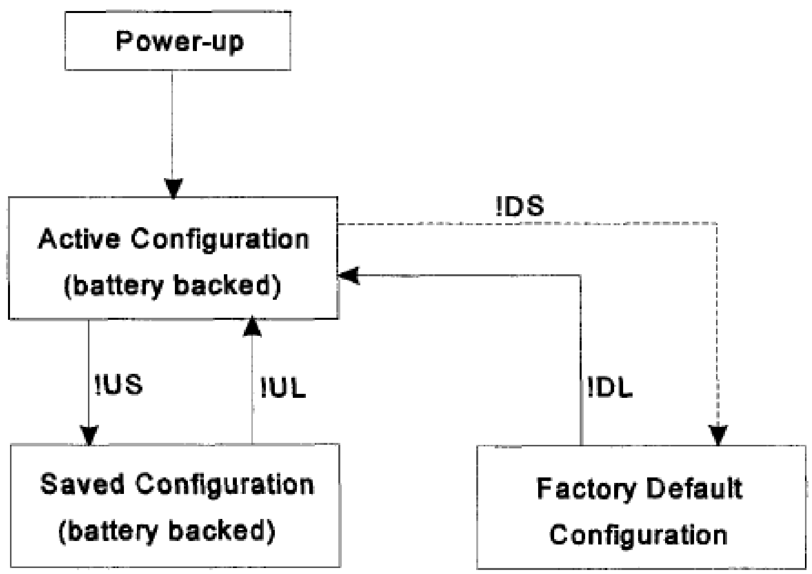


Figure 7: MS257™ Configuration State Transition Diagram

Configurations can be saved and loaded in several ways:

- The Hand Controller allows you to save your active configuration as the user, and lo reload the user configuration.
- The Configuration software allows you to save your active configuration as the user and to reload the user configuration, or reload the factory default configuration.
- A computer or terminal can be used to send commands, which save your active configuration as the user and reload the user configuration, or reload the factory default configuration.

Individual Grating Calibration

Each grating is precisely aligned on its mount or grating turret. However small offsets or calibration adjustments may be required for each grating. The calibration should be performed for each port in use. The procedure is very simple and is as follows:

- Select a grating.
- Select a source with prominent spectral lines for calibration purposes.
- Use very small slit sizes, or if using a diode array or CCD, small entrance slit.
- Drive the grating to a spectral line such as a HeNe line at 632.8 nm or a Hg line **2 t** 546 nm.
- Step the motor drive using the Hand Controller or MS257™ BASIC programming language until the line is centered at the output slit, or in the case of a diode array or CCD at the center pixel.
- Use the **Calib** command on the Hand Controller or **CALWAV** command if using; L terminal or PC, and enter the correct wavelength for the spectral line.
- You have finished recalibrating the grating for that port.
- Change detector port using the Hand Controller or MS257™ BASIC programming language if your MS257™ unit is equipped with an Output Flip Mirror. Never change port manually.
- Repeat the procedure for the other detector port if it is being used.
- Repeat the procedure for each grating on the turret.

Fine Focus Adjustment

In order to obtain the best optical performance, a fine focus adjustment was included. This enables precise translation of the exit mirror to optimize the image onto focal plane detectors such as diode (arrays and CCDs. These detectors do not have a precisely known detector position which is why they may have to be focused to achieve best resolution. Note that after refocusing you may require a new spectral calibration.

Minimizing Stray Light

Stray light is unwanted light which interferes with the light being measured or transmitted. This results in additional noise to light measurements; at best, incorrect measurements, at worst, the inability to measure any signal.

a. Light Leaks

The worst sources of stray light are light leaks, through misplaced covers, and slit holders and detectors without adequate sealing. Make sure that all covers, detectors and flanges are well seated and screwed down.

b. Overfilling

If the **F** number of the source is lower than the F number of the monochromator this produces what is called overfilling, the light will spill over the sides of the entrance mirror and will reflect around the housing causing stray light. MS257™ has baffling to prevent overfilling, but even then the light has already entered the housing and must be absorbed by the baffles. It is better to match the: source F number to the monochromator's F number and prevent overfilling.

c. From the Walls

Light is dispersed by the grating; the selected wavelengths strike the exit mirror and are imaged at the exit focal plane. Other wavelengths, zero order 'white' light, and other orders of the diffracted light strike interior walls and must be absorbed before they bounce around and emerge at the exit (as stray light at the detector. MS257™ makes use of light traps and baffles as well as black paint In order to minimize the amount of light, which can eventually find its way to the detector.

d. From the Grating

Gratings are not perfect reflectors and a certain amount of incident light is scattered and contributes, to stray light. In fact gratings are a major source of stray light since they are within the optical path. Imperfect rulings or ion etched blazed lines contribute to stray light. Often the major source of stray light is dust and sometimes fingerprints. Keep the gratings clean by minimizing dust and occasionally blowing them clean with dry clean air or nitrogen.

e. From the Mirrors

Mirrors gradually accumulate dust, and can have imperfections. These surfaces scale light and add to stray light. If the bevels of the mirrors are not adequately masked these also add to the scatter. Often the major source of stray light is dust and sometimes fingerprints. Keep the mirrors clean by minimizing dust and occasionally blowing them clean with dry clean air or nitrogen.

f. From the Detector

The detector has never been considered a source of stray light, since with monochromators there is a very small exit slit through which light would have to reenter once it has reflected off the (detector surface. Spectrographs however have wide flat focal plane detectors which readily reflect light. The shiny surface of a silicon diode array can reflect as much as 20% of the light back into the spectrograph. The stray light can be extremely significant in certain areas of the spectrum, particularly if light from relatively high intensity wavelengths are finally reimaged onto areas of the detector which are recording low intensity wavelengths. MS257™ has the focal plane angled in such a way as to direct light reflected from the detector away from the mirrors and grating and into 'safe' baffles.

NOTE: The stand alone Configuration program is included for setup and configuration of MS257™™ (and its accessories. The software enables you to upload a variety of configuration files to MS257™™ for different setups. Both RS-232 and IEEE-488 protocols are supported. Communications via IEEE require the National Instrument® GPIB board for your PC. This program does not allow you to (change the parameters, you will have to do this with a text editor or word processor.

VII.2 UTILITY AND CONFIGURATION SOFTWARE

The Monochromator Utility Software CD-ROM contains:

- Installation setup for MonosUtility software.

  The utility application provides easy access to almost all MS257™ functions.
- Two folders (RS232 and IEEE-488) with MS257™ configuration applicator installation setup.
- Factory.cfg file. Unique file for each instrument with configuration parameters recorded.

VII.2.1 MS257™ Utility Software

Program Description

The program is written in National Instrument's LabVlEW and is based on collection of MS257™ Vls. The Utility Program diagram may serve as an example or starting point for further development in LabVIEW. If you are a LabVlEW programmer and own a full LabVlEW development environment you can load the Utility Program source code along with MS257™ Vls from the Newport web site. There are two versions of the Vls, one each for the RS-232 and IEEE-488.

Installation

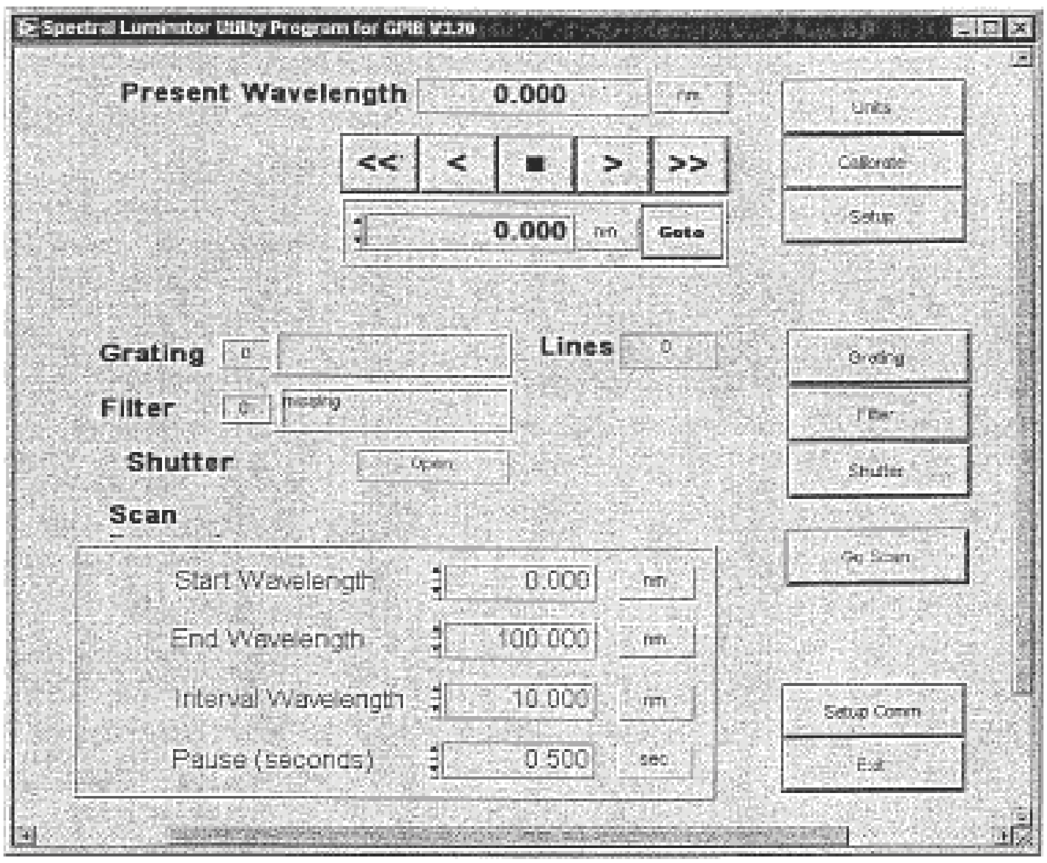
- Insert the Monochromator Utility Software CD-ROM
- Click Start, open Control Panel window and double-click on the Add/Remove grams icon.
- Follow the installation instructions that appear on the screen. The test box named ‘Command line for installation program' should display CD drive letter followed b '\Setup.exe7. Click 'Finish' to proceed with installation process.
- Select Custom Setup to install utility software for 77700 supporting RS232 or GPIB communication. The Custom Setup dialog window will list all Oriel's Monochromators by model number. Uncheck all model numbers except those you choose to install and always leave the Run Time checked. Typical and Compact type of setups will install utility software for all Oriel's Monochromators. If default installation was performed any type of setup will place the executable program(s) in C:\ProgramFiles\OrielInstruments\MonosUtility

<< IMPORTANT NOTE >>
For the software to send proper numeric format to the instrument, Windows Regional Settings in Control Panel must be set to English (United States).

Running the Program

- Launch the application from Start/Programs/MonosUtility.
- Enter the COM port number if you are using RS232 communication protocol. For GPIB communication set GPIB board index and MS257™ address. The default GPIB index should be set to 0 and address to 6.

- Control or view your instrument settings by invoking specific (Grating, Filter, Port, Shutter, Units) dialog windows using push buttons on main window.
- To move the instrument to a prescribed wavelength, simply enter a value in the 'Wavelength' edit box, then click on 'GoTo'.
- Fine motion control is achieved by clicking either the '>>' button to move forward or the '<<' button to move backward.
- 'Calibrate' menu item can be used to induce wavelength offset in the MS257™ memory.
- 'Setup' dialog displays gratings parameters and filters labels. To edit filter label select number (1,..5). Please do not change the gratings parameters unless you intend to override factory configuration parameters of your instrument.
- Outlined section with Scan Parameters can be used to setup scan activated by 'Go Scan' button.



MS 257 Utility Program. Main window

VII.2.2 MS257™ Configuration Software

Program Description

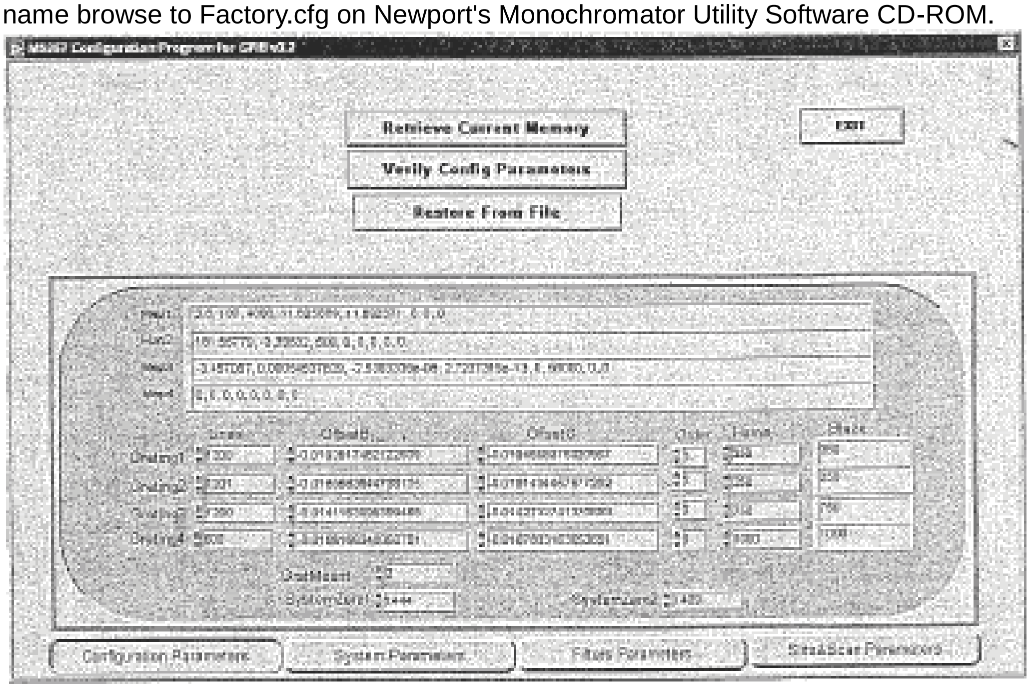
The MS257™ configuration program is written in National Instruments LabVIEW. This program should be used only if corruption or disappearance of MS257™'s memory occurs.

Installation

- Insert the Monochromator Utility Software CD-ROM.
- Click Start, open Control Panel window and double-click on the Add/Remove Programs icon.
- Follow the installation instructions that appear on the screen. Use browser to select Setup.exe from 77700cfgGPIB or 77700cfgRS232 folder from Newport's CD-ROM. If default installation was performed the executable program will be saved in c:\Program Files\OrielInstruments\77700cfg ... \.

Running the Program

- Launch the configuration program from Start/Programs/77700cfg ...
- Use the 'Retrieve current memory' menu to read MS257TM memory and save to a file.
- To view the retrieved memory selectively click any one of the four buttons at t le bottom of the screen.
- Compare MS257™ configuration parameters with factory configuration parameters (Factory.cfg on Newport's Monochromator Utility Software CD-ROM) by selecting ''/Verify Config Parameters'.
- If necessary to restore MS257™ memory click the 'Restore From File' and when asked for file name browse to Factory.cfg on Newport's Monochromator Utility Software CD-ROM.



MS257™ Configuration Program main window.

VII.3 77709 HAND CONTROLLER

The Hand Controller is a very compact hand held device with backlit LCD, and 40 key keypad. Virtually every function of the MS257™ can be controlled from the keypad, from simply moving to (a particular wavelength to setting up the grating and filter selections, and automatic changeover (points. It comes with a 14 ft (4.5 m) cable.

MS257™ Hand Controller Operation

The Hand Controller controls MS257™ via an RJ11 jack on the back panel. System parameters may be edited from the controller's front panel. The grating's position can be changed from the handcontroller and devices can be selected (filters, slits, slow shutter, output flip mirror and grating changer).

The Hand Controller has three functional areas:

- 5 System Status LEDs
- 4 x 20 LCD screen for system information and parameter editing
- 5 x 8 Keypad (10 numeric, *5* editing keys, 24 command keys, 1 shift key)

MS257™ starts up in the Remote mode of operation (controlled via the RS-232 or the IEEE-488 (port). To initiate control by the hand controller the **Local** command key must be pressed. The shifted command, **Rem,** returns control of MS257TM to the remote control of a host computer.

Transfer of control of MS257™ between the Hand Controller and a host computer can only be initiated with the Hand Controller.

Configuring the MS257™ Hand Controller

The Hand Controller comes preconfigured and ready for use. You may alter the configuration using this procedure:

- Apply power to the Hand Controller while holding down any of its keys.
- Release the key when a version number appears in the upper left hand corner of the LCD. The word 'CONTRAST' should then appear in this same area. The contrast can then be adjusted using the **Step>** and **Step<** keys. Press **Go Wav** when the contrast is set as desired.
- The next number in the corner should be '9600' bond rate. If it is not use the **Step:,** and **Step<** to find '9600' and press **Go Wav.**
- The next number in the corner should be '8n11. If it is not use the **Step>** and **Step<** to find '8n11 and press **Go Wav.**
- Now press **Local** and the Hand Controller status should show on the LCD.

The LCD Screen Layout

- The super twist backlit liquid crystal display has four 20 character lines. The backlight can be turned on and off by pressing the **Local** key.

  System information is displayed as shown below:

Line 1:	Wave:	Gr:
Line 2:	Lines:	Blz:
Line 3:	F1:	F2:
Line 4	>	

- **Line 1** indicates the wavelength position in the currently specified units (see Units key), and the Grating number in use.
- **Line 2** indicates the number of lines/mm for selected grating, and the blaze label assigned to grating.
- **Line 3** indicates filter wheel information, first for Filter wheel and then for Filter wheel 2, the selected filter position and filter label assigned to that filter are displayed.
- **Line 4** is the command prompt line where all parameters are edited and the command status is reported after a key has been pressed. A > sign is displayed if the command has been accepted, or an error code is displayed if there is a problem.

The System LEDs

Below the LCD screen are five LEDs that indicate the status of various functions:

Power - MS257™ is powered up and the Hand Controller is properly connected

'Wait - The wavelength drive is stationary at a data point.

Shutr - The shutter is activated (closed for the normally opened; opened for the normally closed versions).

PortB - The detector port **B** is in use.

Sending Commands Using the Hand Controller

System parameters can be queried or changed using the Hand Controller's keys:

Action Keys (Lt. Blue) - These keys cause an immediate action to take place and have no parameters. After the key is pressed the prompt line indicates the action taken or an error code if there is a problem.

(Command Keys (Red, Orange, Green, Lt. Blue, and Dark Blue Borders) - The majority of keys; are termed command keys. Command keys are all the keys which control a MS257™ parameter. "The command keys are grouped by related function. When a command key is pressed the (command with its current parameter value are displayed on the prompt line. The cursor is positioned at the start of the field to be edited. The parameter can be edited by using the **DEL** key (and entering a new parameter. Various parameters can be reviewed by simply pressing the respective command keys in sequence.

Numeric Keys (Black) - These are used in entering parameter values.

Shift Key (Yellow) - Some command keys have the upper division colored yellow, these indicate the keys' **Shift** command. **Shift** functions do not need two fingers (hands) to operate since the **Shift** key can be pressed with one finger and locks for the next key press, then it returns to normal.

Clear Key (CLR) - This clears the value field in the prompt line of the current value.

Delete Key (DEL) - This deletes the character at the previous position.

Enter Key (ENT) - If **ENT** is pressed immediately after a command key then the current parameter (associated with that command is preserved. If **ENT** is pressed after a new parameter has been typed, this accepts the displayed parameter for the associated command, it executes a **RETURN** (and the LCD and LEDs are updated. If the parameter is illegal an error code is reported on the prompt line (see the MS257™ Programming Manual for the error codes).

Escape Key (ESC) - **This** aborts any command and parameter entry and returns the > prompt. Pressing another command key will have the same effect and will initiate a new command. If **ESC** is pressed when a table of parameters is being entered, all parameters are discarded.

Parameter Tables

Parameters for changeover tables for grating turrets, filter wheels and detector port need to be (entered as tables. **A** table consists of a list of records each having a wavelength and the corresponding selected device number. The prompt indicates the record number with wavelength and device. The cursor is positioned at the start of the parameter to be edited, first the wavelength 1s edited and then the selected device number. Each parameter is viewed or entered in turn with **ENT** required for each one in the list. The **ENT** key moves through the fields, after the position field it goes to the next record's wavelength field. The first record's wavelength is always zero and cannot be edited. At the last record the **"ENT"** causes the table to be accepted. For entry of tables smaller than a table's size, enter **0** wavelength and **0** position in unused records. **All records must be entered to accept any portion of the table.**

Example: **>[Shift] [Grat]**
Wav:Gr>O:<u>1</u> [ENT]
Wa v:Gr><u>2</u>00:2 [ENT]
Wav:Gr>200:<u>2</u> [ENT]
Wav:Gr><u>3</u>00:3 [ENT]
Wav:Gr>300:<u>3</u> [ENT]
Wav:Gr><u>5</u>00:4 [ENT]
Wav:Gr>500:<u>4</u> [ENT]

ln the above example, the command was entered for the Grating Table, Shift Grat, the response displayed the parameters for the first record. In this case the first grating is in position to begin with. When ENT is pressed the second record is displayed and the cursor is on the start of the changeover wavelength. The wavelength was changed to 250. When ENT is pressed the wavelength is accepted and the cursor is on the grating position. This process is repeated until all the records are accepted.

Selecting Auto Mode

The wavelength changeover table is not used by MS257™ unless the device is placed under automatic operation. This is done by selecting '0' for the device position. The prompt line indicates the device's current position and whether or not the device's automatic change over mode is enabled. Selecting '0' for a device's position enables the automatic mode, any other valid position disables automatic mode.

Example:

LCD Display	Action and Explanation
>**[F1]** F1 Pos>3:Auto F1 Pos>4:Auto **[ENT]** > >**[F1]** Pos>4:Manual	Press the **[F1]** key Response shows filter 3 and Auto Press number 4 and **[ENT]** Response > Press the **[F1]** key Response shows filter 4 and Manual
>**[Grat]** Grat Pos>2:Manual Grat Pos>0:Manual **[ENT]** ≥ >**[Grat]** Grat Pos>2:Auto	Press the **[Grat]** key Response shows grating 2 and Manual Press number 0 and **[ENT]** Response is > Press the **[Grat]** key Response shows grating 2 and Auto
>**[Port]** Out Port>C:Manual Out Port>O:Manual **[ENT]** > >**[Port]** Out Port>B:Auto	Press the **[Port]** key Response shows Port C and Manual Press number 0 and **[ENT]** Response is > Press the **[Port]** key Port B is selected in Auto mode

Key	**Shifted Key**	**Command Type**	**Description**
Abort		Action	Aborts a scan in progress. The Prompt Line is ‘Aborted>’ or an error code.
Go		Action	Initiates a scan. If system information is enabled (Inf) the Prompt Line is ‘Scanning>’. The LCD general information and LEDs are updated during the scan. If system information is disabled for faster scans (No Inf) the Prompt Line is only the wavelength position. The WAIT LED signals at each scan data point.
Go Hme		Action	Drives the grating to its home position. The Prompt Line is ‘Homed.’
Go Wav		Read/Write	The Prompt Line is ‘Wav>’. Enter the desired wavelength position.
Step>		Action	Moves the grating up by one motor step position. The Prompt Line is ‘Stepup>’.
Step<		Action	Moves the grating down by one motor step position. The Prompt Line is ‘Stepdown>’.
	Step>	Read/Write	Moves the grating up by the step position value entered. Prompt Line = ‘Stepup>’. Enter the number of steps to move.
	Step<	Read/Write	Moves the grating down by the step position value entered. Prompt Line = ‘Stepdown>’ Enter the number of steps to move.
Start		Read/Write	Sets the start wavelength for a scan. The Prompt Line is ‘Start Wv>’. Enter the starting wavelength of a scan.
End		Read/Write	Sets the end wavelength for a scan. The Prompt Line is ‘End Wav>’ enters the end wavelength of a scan.
Grat		Read/Write	Selects the grating. The Prompt Line is ‘Gr Pos>’ grating position’:Manual’ or grating position’:Auto’. Enter the desired position, 0 for Auto.
Grat	Table	Read/Write	Wavelength Changeover Table key. The Prompt Line is e.g. ‘1)Wav:Gr>0:’ there is one record for each grating position. Enter wavelength and device position number.
Lines		Read/Write	Sets the current grating’s lines/mm. The Prompt Line is ‘Lines>’. Enter the number of lines/mm.
	Blaze	Read/Write	Sets the current grating’s 4 character blaze label. The Prompt Line is ‘Blaze>’.
Home		Read/Write	Sets the current grating’s Home wavelength position. The Prompt Line is ‘Home>’. Enter the home wavelength.
	Calib	Read/Write	Sets the current step position for the current grating to be the calibrated wavelength. The Prompt Line is ‘Cal Wav>’. Enter the calibration wavelength.
	Points	Read/Write	Sets the number of data points in a scan. The Prompt Line is Points>’. Enter the number of points.
Intvl		Read/Write	Sets the wavelength interval between scan data points. The Prompt Line is ‘Interval>’. Enter the interval between data points.
	Wait	Read/Write	Sets the wait time at each data point for a scan. The Prompt Line is ‘Wait>’. Enter the wait time at each data point.
F1		Read/Write	Filter wheel 1 position ‘:Manual’ or ‘:Automatic’. The Prompt Line is ‘F1 Pos>’. Enter the filter number.
	Table (F1)	Read/Write	Wavelength Changeover Table Key for Filter wheel 1. The Prompt Line is e.g. ’1)Wav:F1>0:’. There are 9 records in the table. Enter the wavelength and device position number.

F2		Read/Write	Filter wheel 2 position ':Manual' or :'Automatic'. The Prompt Line is 'F2 Pos>'. Enter the filter number.
	Table (F2)	Read/Write	Wavelength Changeover Table key for Filter wheel 2. The Prompt Line is e.g. '1)Wav:F2>0:'. There are 9 records in the table. Enter the wavelength and device position number.
F1 Lbl		Read/Write	Sets the 4 character label for the current filter wheel 1 position. The Prompt Line is 'F1 Label>'. Enter the label.
	F2 Lbl	Read/Write	Sets the 4 character label for the current filter wheel 2 position. The Prompt Line is 'F2 Label>'. Enter the label.
Inf		Action	Enable reporting of system information during a scan. The Prompt Line is 'Info On>'.
	No Inf	Action	Disable reporting of system information during a scan. The Prompt Line is 'Info Off>'.
Int St		Action	Disable esternal BNC/GO signal from controlling scans. The Prompt Line is 'Int Strt>'.
Ext St		Action	Enable external BNC/GO signal from controlling scans. The Prompt Line is 'Ext Strt>'.
Slit A		Read/Write	Set the width of Slit A. The Prompt Line is 'Slit A>'. Enter the slit size in micrometers.
Slit B		Read/Write	Set the width of Slit B. The Prompt Line is 'Slit B>'. Enter the slit size in micrometers.
	Slit C	Read/Write	Set the width of Slit C. The Prompt Line is 'Slit C>'. Enter the slit size in micrometers.
	Band	Read/Write	Set the bandpass used for automatically adjusting the slits. Prompt Line="Bandpass>". Enter the bandpass in wavelength units. () indicates slit adjustment is set manually using the Slit commands.
Port		Read/Write	Select detector port. The Prompt Line is e.g. "OutPort>C:Manual". Enter the output port B or C, 0 is for automatic selection.
	Table (Port)	Read/Write	Wavelength Changeover Table for the detector port. The Prompt Line is e.g.'1)Wav:OP>0:C'. Enter the wavelength and output port.
Op Sh		Action	Opens the slow shutter. The Prompt Line is 'Op Shtr>'.
	Cl Sh	Action	Closes the slow shutter. The Prompt Line is 'Cl Shtr>'.
	Load	Action	Recalls the saved system parameters. The Prompt Line is 'Lcaded>'.
Save		Action	Saves the current system parameters. The Prompt Line is 'Saved>'.
	Ver	Action	MS257™ firmware vision number. The Prompt Line is e.g. '1.00>'.
Units		Read/Write	Set the wavelength units. The Prompt Line is 'Units>'. Enter the wavelength units as nanometers (NM), microns (UM), or wave number (WN).
	Rem	Action	Change control of MS257™ to the host computer. The LCD is blanked, control of MS257 is released to the RS-232 or IEEE-488 port. The Prompt Line is '>'.
Local		Action	Change control of MS257™ to the Hand Controller. The Prompt Line is '>'. The 'Power' LED indicates if the handcontroller is plugged into MS257™. Each time the key is pressed the LCD backlight is toggled.

VII.4 COMMUNICATIONS

Communicating with MS257™

There are four ways of sending commands to MS257™:

- Using the Hand Controller. MS257™ is already configured for operation with a Hand Controller
- Using the RS-232 interface and protocols. MS257™ is already configured for operation via RS-232 communications.
- Using the IEEE-488 interface and protocols. Communications via IEEE-488 require the IEEE-488 interface board, model 77710.
- Direct digital (TTL) communications are also provided for particular functions.
- RS-232 Interface. MS257™ includes an RS-232 interface, and access is provided via the DB-9 connector on the rear panel (Figure 8). The baud rate is fixed at 9,600.

If an IEEE-488 interface is present then it must be disconnected in order for the RS-232 interface to be used. The IEEE-488 interface is disconnected by unplugging the **internal** IEE 5488 cable nkom the top of the interface board **within** the electronics compartment. It is not sufficient to unplug an IEEE-488 communications cable from the external IEEE-488 connector. See the Programming Manual for further information on using the RS-232 interface.

IEEE-488 lnterface

In order to use the IEEE-488 interface you require the IEEE-488 lnterface Board (model 77710). Access is provided via the 25 pin connector installed on the rear panel (Figure 8). See the Programming Manual for further information on using the IEEE interface.

IEEE-488 lnterface Board Installation Procedure

The IEEE-488 lnterface Board is set at the factory for a primary address of 6. It also occupies 1 bus address below the primary (default = 5). If you know that these settings conflict with other IEEE-488 devices you are using, consult the MS257™ Programming Manual on how to change the board's address.

- Remove the MS257™ cover and insert the interface board into the IEEE-488 connector next to the optical/electrical compartment wall. Press down firmly.
- Push the two plastic retaining posts, mounted in the wall, through the hole as in the top of the IEEE-488 interface board until they click into position.
- Connect the internal IEEE-488 cable to the top connector on the IEEE-488 interface board.

Direct control of MS257™

IMS257™ is the first commercial monochromator/spectrograph to have digital input/output communication facilities built into the unit. Figure 8 shows the BNC connectors at the back of lMS257™. These enable the scanning process to be closely integrated with data acquisition by providing the following TTL synchronizing signals:

- **ID Port Assignment** - A TTL signal (high) is output from the 'Port' BNC con lector when the output Port is Port B. A TTL signal (low) is output from the 'port' BNC connector where the output port is Port C.

- **External Triggering of a Scan** - If External Triggering is enabled (see the Programming Manual), scans can be initiated by applying an external TTL signal (to high**)** to the 'Go' BNC connector. This is equivalent to sending a GO command via the RS-232 or IEEE interfaces, or pressing the GO button on the hand Controller.

- **External Control of a Scan** - Scans can be placed in a Handshaking node. This requires a GO signal at each data point. This enables the Wait time, the time spent stationary at each data point to be controlled by an external source. This is particularly useful for fine control of data collection, so that the scan can be paused at each data point, and is only resumed when data acquisition is fully completed. This requires both External Triggering and Handshaking to be enabled (see the Programming Manual). This is equivalent to sending a GO command via the RS-232 or IEEE interfaces, or pressing the GO button on the hand Controller at each data point. An external TTL pulse must be applied to the 'Go' BNC connector at each data point before - resume.

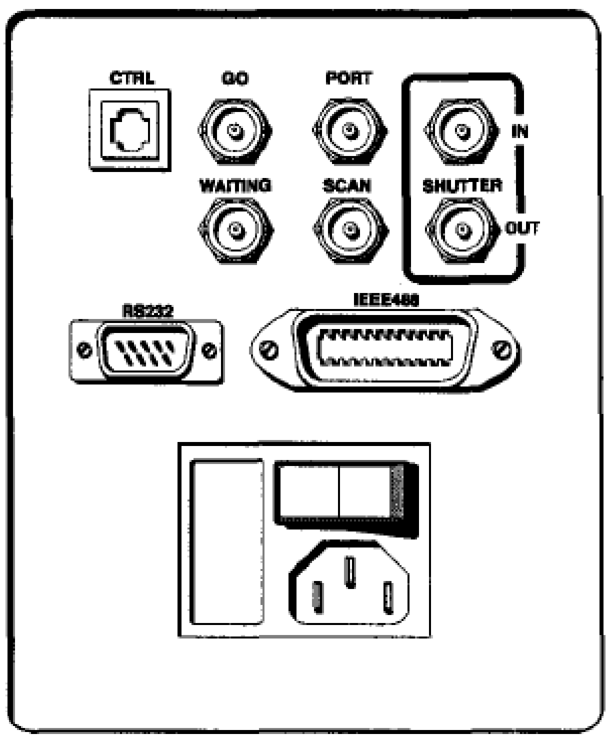


Figure 8: Rear Panel showing RS-232, IEEE and TTL connectors

- **Data Point Signaling** - A gate TTL signal (high) is output at the ‘Waiting' BNC connector when the drive is stationary at each data point. This resumes he low state when the drive starts scanning again. This can be useful for signaling when a data point wavelength has been reached. It is particularly useful for fine control of data collection, so that data acquisition can be triggered at each data point, when the drive is no longer moving.

- **Scan Duration Signaling** - A gate TTL signal (high) is output at the 'Scan' BNC connector during the entire time that the drive is scanning, from the start wavelength to the end wavelength. This is useful for controlling an external instrument such as a chart recorder, oscilloscope, or process control module.

- **Shutter Control** - The internal shutter can be triggered by an external TTI. gate signal (high) applied to the 'Shutter In' BNC connector. The shutter remains activated as long as the signal remains high. Both normally open and normally closed shutters can be activated. The standard internal shutter is closed by a TTL signal, the 77739 normally closed slow shutter is opened by a TTL signal, and the 77717 normally closed fast shutter is opened by a TTL signal.

- **Shutter Synchronization** - A synchronizing TTL signal (high) is output a1 the 'Shutter Out' BNC connector when the fast shutter (model 7771 7) is more than 90% open. This is useful for synchronizing external detectors such as CCD detectors with the shutter opening.

VIII PROGRAMMING MS257™

MS257™ can be controlled using the Hand Controller or by direct communication with the internal microprocessor. We have provided three levels of program control:

- Direct communication via RS-232 or IEEE-488 using the MS257™ BASIC: language
- Direct communication using National Instruments LabVlEW Vl's for inclusion in custom programs
- *TRA CQq32 Data Acquisition Software*

MS257™ Basic

We have designed MS257™ to be programmed with a minimum of trouble for control by custom written software. Control is that much easier because many functions can be left up to the internal microprocessor, although of course every function can be directly programmed if Teed be. A (detailed separate manual is provided with explanations of all the programmable functions and (command structures. The syntax is very similar to BASIC and can easily be understood by anyone with an understanding of the BASIC language. Communication is via RS-232 or IEEE-488 protocols.

Device drivers

Preceded device drivers written in Borland International's C++ are available to facilitate full program control and error handing via RS-232 or IEEE-488 communications. These device drivers are written for use with Borland's C++ and National Instrument's LabWindows®.

Spectroscopy Program

A stand alone program, model 77784, is available which enables MS257™ to be operated in conjunction with Merlin, our Digital Lock-in detector. Merlin can support two detectors and can thus be used with MS257™ to automate detector changes during a spectral scan. The program is DOS based for PC compatible computers, and has a mouse driven graphical interface. It enables scans to be made in Intensity units, % Transmittance, Absorbance or % Reflectance, with full support for input source, grating, filter, and detector switching, as well as slit control. The program is intended for simple data collection, viewing and printing of scans, and saving the data to disk is excellent for the trouble-free operation of MS257™ and Merlin, enabling scans to be taken with multiple grating, filter and detector changes from the UV to the IR. The data can be graphically displayed on the monitor, zoomed, printed, and saved to disk for analysis and data presentation by other software packages such as Galactic Industries' Spectra calc™ and Grams™, Microcac's Origin™, Aardvark Automation's lnspectr™, or a spreadsheet. The program is intended for simple data collection, viewing of scans, and saving the data to disk. There is no expert intelligence for signal optimization or data correction, and no facility for data manipulation.

IX ACCESSORIES

IX.1 GRATING TURRETS

The drive can take kinematically interchangeable grating turrets. The Quadruple grating turret offers an unequaled degree of automation with no compromise in optical performance. This high precision turret scans about the face of the selected grating, as do traditional monochromators, thus offering the best resolution and light throughput over the grating scan range. The grating selection mechanism uses a second motor perpendicular to the scan axis, so it does not interfere with the accurate wavelength positioning of the grating (patent pending). The Quadruple turret requires that the gratings be mounted at the factory.

IX.2 CONFIGURING MS257™ FOR A NEW TURRET

If you have a MS257™ with a Standard Drive there is no need to configure the system for the new turret type in use. MS257™ will recognize whether it has a Single or Quadruple grating turret.

The Single Grating Mount

The Single Grating Mount is a kinematic mount, it can be removed and replaced without losing the calibration. Each grating comes prealigned in a sturdy mount. The mount simply screws down onto the drive. For detailed information about the Grating Turret installation see section III.

The Quadruple Grating Turret

The Quadruple Grating Turret is a kinematic mount, it can be removed and replaced without losing the calibration. Up to four gratings come prealigned in a sturdy mount. The turret simply screws down onto the drive. For detailed information about the Grating Turret installation see section III.

IX.3 GRATINGS

The gratings available are listed in Table 1: Other gratings can be specially ordered from Newport:

Groove Spacing Lines/mm	Blaze Wavelength (nm)	Type	Peak % Efficiency	Wavelength	Wavelength Range > 10% eff.	Reciprocal Dispersion (nm/mm)	Array Bandpass (nm)	Model Number
2400	250	Holo	65	180-700+	175-700+	1.6	35	77740
1800	500	Ruled	65	300-1050+	250-1050+	2.1	52	77753
1200	250	Holo	80	180-650	175-1000	3.2	82	77741
1200	350	Ruled	80	200-1400+	180-1400+	3.2	82	77742
1200	750	Ruled	80	450-1400+	400-1400+	3.1	79	77752
600	200	Ruled	70	180-500	175-700	6.4	163	77743
600	400	Ruled	85	250-1300	200-1600	6.5	163	77744
600	1000	Ruled	80	600-2500	550-3000	6.4	163	77745
400	1200	Ruled	90	700-2500	650-3000	9.7	246	77746
300	400	Ruled	80	250-1150	245-1500	12.8	325	77747
300	2000	Ruled	90	1100-5000	1000-5500	12.9	325	77748
200	1050	Ruled	85	600-2200	550-2500	19.3	490	77749
150	4000	Ruled	95	2500-12000	2500-15000	25.8	653	77750
75	8000	Ruled	80	4500-20000	4500-23000+	51.7	1300	77751

Configuring MS257™ for the New Gratings

You will have to configure MS257™ for the new gratings you have just installed. This can be done in two ways:

Using the Hand Controller select a grating (GRAT), change the number of lines/mm (LINES), blaze (BLAZE), and changeover points (CHNGR). Save the new parameters (SAVE).

Using a text editor or word processor edit the Configuration file, change the grating lines/mm, blaze and changeover points. Resave the file, and using the Configuration program open the file and download it to MS257™.

IX.4 SLITS

Three types of slits may be used with MS257™

- Fixed slit housing and various interchangeable fixed slits
- Micrometer Driven Slit Assembly
- Motorized Slit Assembly

Mounting Slit Assemblies

All slit assemblies are mounted using four 4-40 screws. The input slit assemblies are oriented by an alignment pin in the MS257™ housing that fits into a precision hole in each slit assembly. The exit slit assemblies do not have alignment pins and this allows you to slightly rotate the assemblies in order to obtain the best throughput and resolution.

If you are mounting an exit slit assembly then use this procedure:

- Use a light source to illuminate the input slit.
- Set the wavelength to zero, or a prominent spectral line.
- Adjust or change the input slit to a small slit width.
- Adjust or change the exit slit to the same slit width.
- Adjust the rotation of the exit assembly until it appears to be parallel to the image, the image height should be at a maximum.
- Tighten the mounting screws.

Interchangeable Fixed Slits

Interchangeable fixed slits are available for applications where precisely repeatable slit widths are important or where the expense of continuously variable slits is not warranted. Each of the slits listed in the table below is available separately mounted in machined slides for quick and repeatable interchange into the fixed slit housings. The model 77721 fixed slit housing has a flange which enables mounting of all Oriel 1.5 inch (47 mm) series accessories.

When inserting a fixed slit make sure that the slit plate is correctly oriented. There is a notch on one side of the slit plate and this should match up with a pin inside the fixed slit housing. If the plate is correctly inserted the Oriel logo should face the exterior and the slit should lie n the center of the aperture. Make sure that the slit plate is fully inserted for best reproducibility (See Figure 9).

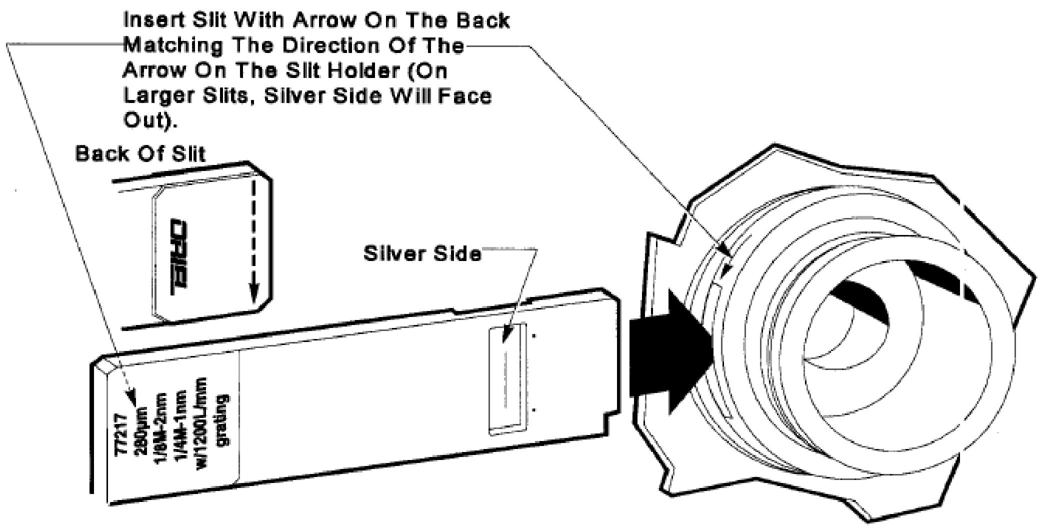


Figure 9: Using Fixed Slits with MS257™

Important Tips for proper slit installation:

- The slit should always be inserted with its reflective side facing out (for example, towards the light source or the detector.)
- If the slit entrance is located on the right side of the slit holder, then the slit should be inserted with the notch located in the upper left corner.
- If the slit entrance is located on the left side of the slit holder, then the slit should be inserted with the notch located in the lower right corner (this will keep the reflective side facing out). Figure 9 illustrates the correct slit insertion from the left side of t7e slit holder.

Micrometer Driven Slit Assembly

The 77720 Micrometer Driven Slit Assembly has continuously adjustable slits from c.4 μm to 3.5 mm in width, giving bandpasses from 0.1 nm to 10 nm (for 1200 l/mm grating). The slit height is 15 mm. The micrometer drive is metric and a 10 pm movement of the micrometer spindle corresponds to a 10 μm change in slit width.

Motor Driven Slit Assembly

The 77722 Motor Driven Slit Assembly has continuously adjustable slits from c.4 μm to 2.3 mm in width. The slit height is 15 mm. The motor drive uses a micro stepping motor and each step corresponds to a 2 pm change in slit width. The slits are controlled directly by MS257™. Each slit can be individually set or they can all be placed under the automatic control of MutiSpec 257 in order to maintain a constant bandpass at all wavelengths. The required bandpass call be entered using the **Bandpass** command, or **Band** on the Hand Controller. The motorized slit; require the installation of the 77712 Motorized Slit Controller Board. This can be done at the factory or by a competent technician.

Automatic control works well for bandpass significantly larger than resolution. However, you may, want to experimentally determine proper slit settings when working at bandpass values close to the instrument resolution if accurate bandpass value is of critical importance.

Slits and Instrument's Bandpass

This is the band of wavelengths passed by the monochromator at any one wavelength setting. It may be obtained by multiplying the slit width by the reciprocal linear dispersion, and is usually in units of nm. At large slit widths the bandpass is synonymous with resolution, but at small slit widths the effect of aberrations tend to limit the resolution even though the bandpass may be very small. Use the term resolution instead of bandpass, it is more meaningful. See the section on Bandpass (and Resolution in the Gratings section).

The concept of bandpass is particularly well suited however to spectrographs. In this case a wide wavelength range is spread over an array or CCD. The reciprocal linear dispersion is meaningless here because it can vary significantly over the focal plane.

The bandpass does still vary with grating angle but other than at extreme angles it is a good representation of the wavelength range lover the focal plane. The Bandpass of the monochromator can be calculated from the **Fehler! Verweisquelle konnte nicht gefunden werden.**. To do this you have to multiply the reciprocal dispersion by the slit width (assuming that instrument has the same width input and output slit. The number you obtained has to be greater than the resolution. If not so, it means that you are below the resolution limit and your bandpass will be determined by the resolution rather than spectral bandpass of the slit).

Filter Wheels

MS257™ can automatically control up to two optional filter wheels. These can each hold up-to five filters (bandpass, neutral density, interference). The filter wheels are mounted externally so that the refractive index and thickness of the filters do not affect the focal distance to the collimating or imaging mirror, which could significantly affect resolution. The filter wheel is placed outside and at the entrance port. The ribbon connector plugs into either of the two 10 pin sockets at the side of the housing. The left socket is defined a filter wheel #1 and the right socket is filt3r wheel #2. Mount the filter wheel(s) directly on the slit housing using the Oriel flange mounts. Wavelength changeover points can be loaded into MS257™ so that the filters are selected as scanning progresses. See the section on the Hand Controller or Programming Manual for details.

IX.5 INPUT AND OUTPUT PORTS

Replaceable Side Exit Mirror

The standard configuration for MS257™ is for the output beam to exit via the axial port (Port C). Port B can be used as the exit port instead; there is the in-line configuration. The 77718 Replaceable Side Exit Mirror is required to adapt MS257™ for use with Port B.

This is mounted in the following manner:

- Remove the MS257™ cover.
- Face the side exit port (Port B).
- Set down the Replaceable Side Exit Mirror on the mounting pin, and rotate the base clockwise until it rests against the alignment pin.
- Insert and tighten the two 6-32 socket head mounting screws.
- Replace the MS257™ cover.

Output Port

The output port can be switched from the axial (Port C) to the side port (Port B) and vice versa using the 77716 Motorized Output Flip Mirror. This is a high precision device which will repeatedly align the output beam with either port to better than ±0.05 nm. This is essential if scans involve (detector changes and are to be accurate and repeatable. Control of the mirror is through the Hand Controller or MS257™ BASIC programming language.

The Motorized Flip mirror is mounted in the following manner:

- Remove the MS257™ cover.
- Face the side exit port (Port B).
- Set down the Flip Mirror on the mounting pin, and rotate the base clockwise until it rests against the alignment pin.
- Insert and tighten the two 10-32 socket head mounting screws.
- Replace the MS257™ cover.
- Do not rotate the mirror by pressing against the back or sides of the mirror, if you need to rotate the mirror manually do so by moving the contact alignment bar at the base of the mount.

Input Control

The 77713 auxiliary input port is used to convert MS2517™ to have two selectable input ports. This is particularly useful for scans, which cover wavelength ranges that would benefit from a switch of sources, such as UV to VISIIR. The selection of input port can also be done under MS257™'s automatic control.

IX.6 FIBER OPTIC ACCESSORIES

A wide variety of optical fibers and accessories are available for coupling to MS257™. Some of the more specialized fibers and accessories are shown below:

Name	Model	Description
Slit Fiber	77534	Single fiber bundle with ST input and one 6.0 mm x 200 μm 'slit' output. Used to increase efficiency of light coupling to a monochromator.
Reflectance inspection fiber	77559	ST input leading to outer ring fibers at common end. 6.0 mm x 200 μm 'slit' output from inner core in common end. Used for fluorescence measurements.
Fluorescence inspection fiber	77560	ST input leading to inner core of fibers at common end. 6.0 mm x 200 μm 'slit' output from outer ring of fibers in common end. Used for fluorescence measurements.
Three chemical fiber optic	77544	Three ST input 200 μm fibers, common output of vertically aligned 200 μm fibers spaced 1.5 mm apart. Used for multi source (multi track) spectroscopy using an imaging spectrograph with CCD detector.
Five channel fiber optic	77546	Five ST input 200 μm fibers, common output of vertically aligned 200 μm fibers spaced 0.75 mm apart. Used for multi source (multi track) spectroscopy using an imaging spectrograph with CCD detector.
Nine channel fiber optic	77552	Nine ST input 200 μm fibers, common output of vertically aligned 200 μm fibers spaced 0.40 mm apart. Used for multi source (multi track) spectroscopy using an imaging spectrograph with CCD detector.
F number Matcher	77529	With F-No. matcher use Multi-Track fibers 77616, 77617, 77618, 77619, 77620, 77621.

X SPECIFICATIONS

Specifications (with 1200 l/mm grating and 10 *μ*m slit, at 546 nm)

System

Design:	Assymetrical Czerny-Turner
Configuration:	In line using turning mirrors, plus axial port
Ports:	1 input, 2 output 2 input with Auxiliary Input Port accessory
Usable wavelength range:	170 nm to 24 µm
F number (input):	3.9
Input focal length:	220.00 mm
Exit focal length:	257.36 mm
Included Angle at grating:	23.66^0
Main Mirrors:	
77700	Spherical
77702	Toroidal
Optical height:	5 inch (127 mm)
Stray Light:	0.03% at 250 nm (Deuterium + Glass fiber) 0.0015% (20 nm) from 633 nm laser line
Overall Dimensions:	19 x 12 x 7.25 in (48 x 30 x 18.5 cm)
Weight:	40 to 45 LB (18 to 20.5 kg)
Power Requirements	90-264 Vac; 50/60 Hz 1.6A max @ 120 Vac, 0.8A max @ 240 Vac

Optical Field

Full field:	28 mm x 28 mm
Flat field (**77702, 77705**):	28 mm x 10 mm
Field tilt relative to mounting face:	
77000	3.1^0
77702	6.7^0
Field tilt relative to optical plane:	$<0.1^0$
Focal plane clearance:	30.0 mm

Wavelength

Reciprocal dispersion:	3.22 nm/mm
Wavelength resolution:	0.1 nm typical, <0.15 max.
Wavelength accuracy:	±0.1 nm, < 0.15 max.
Wavelength repeatability:	±0.015 nm typical, < 0.03 max.
Wavelength step size:	0.028 nm
Temperature stability:	c. 0.01 $nm/^0C$
Wavelength Drift:	c. 0.0001 nm/hr

Imaging

Image horizontal magnification (**77700**):	1.1
Image vertical magnification (**77705**):	1.6
Imaging spatial resolution (200 µm fiber):	
77702	< 350 µm*
Image vertical stability:	±125 µm
Image horizontal stability:	±5 µm

(* We suggest input channel separation to be > 150 µm for practical systems.)

Gratings	
Grating mounts:	
77700	Single or Quadruple
77702	Single or Quadruple
Grating Rotation:	
77700	Optical Center
77702	Optical Center
Grating Size:	50 x 50 x 6 mm
Kinematic repeatability:	±0.05 nm
Grating change time:	
(Quadruple grating turret)	c. 1sec per grating
Grating selection repeatability	
Wavelength:	±0.05 nm
Image vertical position:	±125 µm
Ports	
Port selection repeatability:	
(Motorized mirror)	±0.05 nm
Port changeover time:	7s
Auxiliary Input Port (optional)	
F number:	4.9
Port selection repeatability:	±0.05 nm
Dimensions:	7.5 x 6.5 x 6 inch (190 x 165 x 150 mm)
Slits	
Fixed slits:	10 µm x 2 mm to 5 mm x 20 mm
Micrometer slits:	Variable from c.4 µm to 3.5 mm x 15 mm
Precision:	±5 µm
Parallelism:	±2 µm
Accuracy:	±10 µm
Motorized slits:	Variable from c.4 µm to 2.3 mm x 15 mm
Precision:	±5 µm
Parallelism:	±2 µm
Step Size:	2 µm
Accuracy:	±10 µm
Drive	
Motor:	High torque Microstepper
Drive:	Worm
Step Size:	3.6 arc sec
Precision:	±0.5 steps
Drive accuracy:	99.9999% rms
Max Speed:	10,000 steps/sec
Calibration:	Interferometrically mapped drive Individual grating calibration factors
System control:	Local control by 77709 Hand Controller Central control by on board CPU Programmed control by external PC

External Interface:	RS-232 (included) TTL (interface) IEEE-488 (optional)
Software:	Configuration software (included) Spectroscopy software (optional) DOS Device drivers (optional)
Hand Controller (optional):	40 key hand held keypad 4 line, (20 character) backlit supertwist LCD 5 status lights Remote/Local control switching 14 ft (4.26 m) cable

Integrated Shutter:

77700:	Normally open
77702:	Normally closed
Aperture:	21 x 13.5 mm
Light Leakage:	<0.001%
Response time:	c.20 ms
Transition rise time:	c.2 ms
Blade coating:	Black anodize
External trigger:	TTL

Fast Shutter (optional):

Configuration:	Normally closed
Aperture:	14 mm diameter
Light Leakage:	<0.01%
Transition rise time:	1.5 ms
Response delay:	2.5 ms
Minimum window:	5.0 ms
Cycle time:	25 ms (intermittent duty)
Blade coating:	$AlMgF_2$
External trigger:	TTL

Filter Wheel (optional):

Filter wheels supported:	2
Aperture:	22 mm
F number (2 wheel installed in series)	3.9
Optical length:	38 mm
Number of filters per wheel:	5
Filter size:	1 inch (25.6 mm)
Maximum thickness:	0.4 inch (10 mm)
Transition time:	c. 1 sec per filter

XI APPENDIX A - BASIC GRATING INFORMATION

F-Number

The F number is the ratio of the focal length to the limiting aperture. The limiting aperture is usually the grating rather than the collimating mirror. The smaller the F number, and the larger the numerical aperture, since F = 1 / (2 x NA), the greater the amount of light collected. However, as the F number decreases so the resolution deteriorates due to increased aberrations, aid of course the greater the size and cost of the instrument due to the larger mirrors. The F number is not a fixed value and changes with grating position, as the grating rotates from a near normal (perpendicular) position so the effective aperture decreases and the F number increases. The quoted F number itself is also not as defined as it seems. The F number is correctly defined as focal length / aperture diameter. However when the aperture is a rectangular grating, what constitutes the diameter? We solve this problem by using a diameter, which would give the equivalent area to the grating. For example: the effective F number of the Oriel 77700 is calculated by using the focal length of 220 mm, and grating size of 50 mm square. The grating has an area of 2500 sq. mm, the diameter of a circle with the same area would be 56.4 mm. The F number would then be 220 / 56.4, i.e. 3.9. Even this is not strictly true since it assumes that the entire grating surface is being used and that it is perpendicular to the incident beam, both of which are rarely true.

The Grating Equation

A typical diffraction grating consists of a substrate with a large number of parallel grooves ruled or replicated in its surface and overcoated with a reflecting material such as aluminum. The quality and spacing of the grooves are crucial to the performance of the grating, but the basic grating equation may be derived by representing a section through the grating surface normal to the ruling direction as a sawtooth pattern, shown in Figure 10.

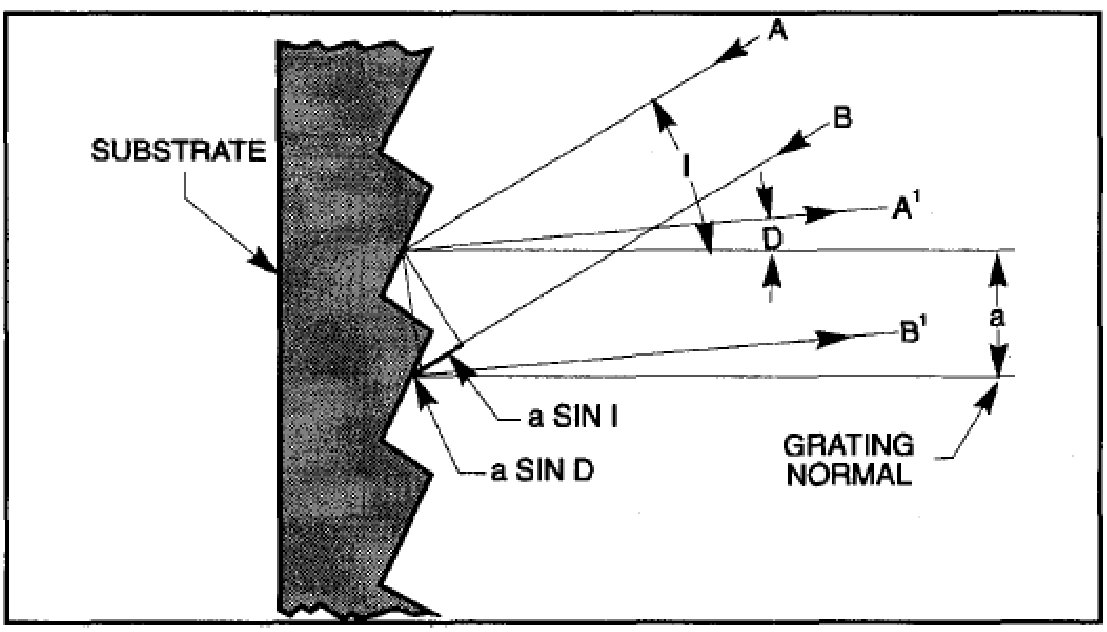


Figure 10: The diffraction geometry of a plane reflection grating.

Light rays **A** and B, of wavelength **l,** incident on adjacent grooves at angle **I** to the grating normal are shown. Consider light at angle D to the grating normal; this light originates from the **A** and **B** rays as they strike the grating. The path difference between the **A'** and **B'** rays can be seen to be a sinD + a sinl, where a is the separation between neighboring grooves.

Summing of the rays A' and B' results in constructive interference only if the path difference is equal to a multiple of the wavelength l :
a(sinl + sinD) = ml,
where **m** is an integer.
This is the basic grating equation, m is called the order of diffraction. Note that if **I** and **D** are on different sides of the grating normal the sign of **D** is assumed to be negative.

We have considered only two grooves. Adding in the other grooves does not change the basic equation but sharpens the peak in the plot of diffracted intensity against angle **D**.

When a parallel beam of monochromatic light is incident on a grating, the light is diffracted from the grating in directions corresponding to **m** = -2, -1, 0, 1, 2, 3, etc. This is shown in Figure 11, and discussed further under "Grating Order" on the following pages.

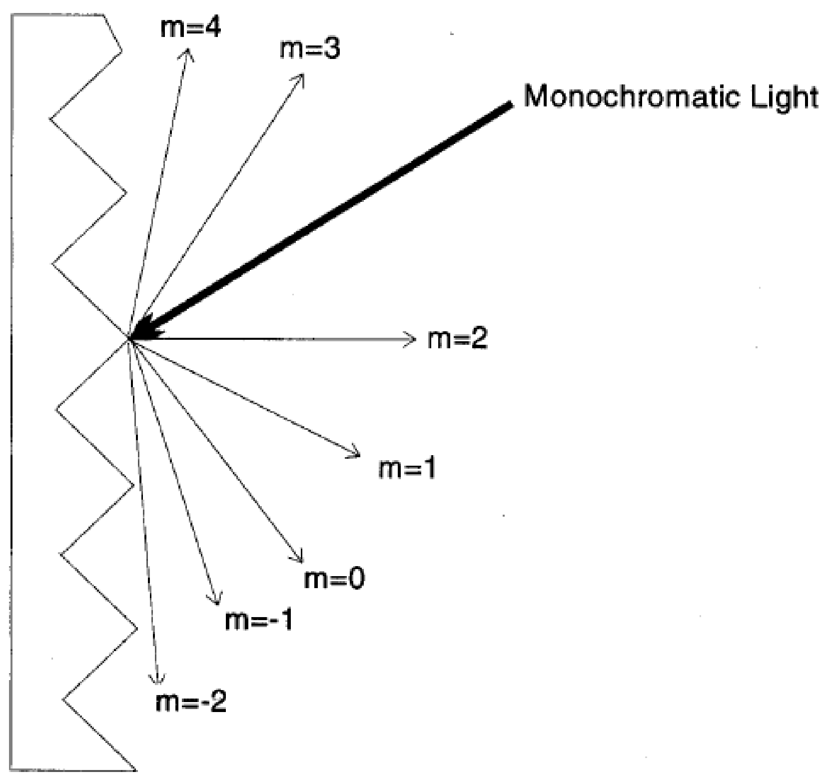


Figure 11: The "Grating Equation" satisfied for a parallel beam of monochromatic light

In our monochromators, the input slit and collimating mirror fix the direction of the input beam that strikes the grating. The output collimating mirror and slit fix the angle **D**, as they determine the - direction that light from the grating must go to exit the monochromator. Only wavelengths, which satisfy the grating equation, pass through the exit slit. The remainder of the light is scattered and absorbed inside the monochromator. As the grating is rotated, the angles **I** and **D** change, although the difference between them remains constant and is fixed by the geometry of the monochromator. The wavelength I changes as the grating angle changes and:

$$\lambda=2*(a*\cos\theta/2)*\sin\varphi$$

where **θ** is the angle between the incident ray and the diffracted ray at the grating, and **φ** is the grating angle relative to the zero order position.

Grating Dispersion

A grating's angular dispersion is proportional to the number of lines it has. The greater the dispersion the more the spectrum is spread out. The monochromator dispersion is usually quoted as (reciprocal) linear dispersion in nm/mm. A monochromator with a 1200 I/mm grating will have exactly half the linear dispersion of the monochromator with a 600 I/mm grating. Note: this only applies at the same grating angle, not wavelength, for both gratings since linear dispersion changes with angle.

It is often asked why there are not gratings with many thousands of lines per millimeter; usually gratings with 2400 lines per millimeter are about the limit. In the case of ruled gratings, it is expensive and difficult to rule finer and more closely spaced lines on a grating. Even though it is possible to have thousands of lines per millimeter on a holographic grating there are more fundamental reasons for not doing so. As the number of lines increases, the wavelength range of the grating decreases, until it is of very little use except for very specialized applications. A 2400 I/mm grating has a maximum range of about 600 nm, a 4800 I/mm grating would have a range of only about 300 nm, and then only in the UV to visible wavelengths.

Bandpass & Resolution

Bandpass is the band of wavelengths passed by the monochromator at any one wavelength setting. It may be obtained by multiplying the slit width by the reciprocal linear dispersion, aid is usually quoted in units of nm.

In a monochromator, the bandpass may be decreased by reducing the width of the slits until a limiting bandpass is reached. The limiting bandpass is called the resolution of the instrument. For a properly illuminated grating the aberrations of the optical system determine the re solution. For 'any instrument, the optical aberrations are minimized by illuminating only the central zone of the input slit.

Since resolution is closely related to dispersion, the higher the dispersion the higher the resolution. If the number of lines per millimeter is doubled the resolution is twice as good. This is a measure (of how finely a monochromator can differentiate between spectral lines. Although there are several (definitions for calculating resolution, a common spectroscopy standard is the width of a single wavelength line at the point of half maximum intensity (also known as FWHM, full width at half maximum). (See Figure 12).

A traditional definition of resolution is the Rayleigh criterion. This definition ensures that two closely spaced wavelengths will be differentiated if the point at which the peaks merge is be1)w the 80 % intensity level for both peaks. The resolution will vary with the size of both input and exit slits, but 'will be limited by optical aberrations no matter how small the slits may be. For example, a practical limit with 250 mm monochromators is a slit size of about 10 pm. Note that it can be misleading to talk about 'raising' the resolution when in fact the resolution number decreases. We use the convention that raising the resolution improves it, although the resolution number actually (decreases, e.g. raising the resolution from 2 nm to 1 nm.

400 l/mm grating.

1200 l/mm grating.

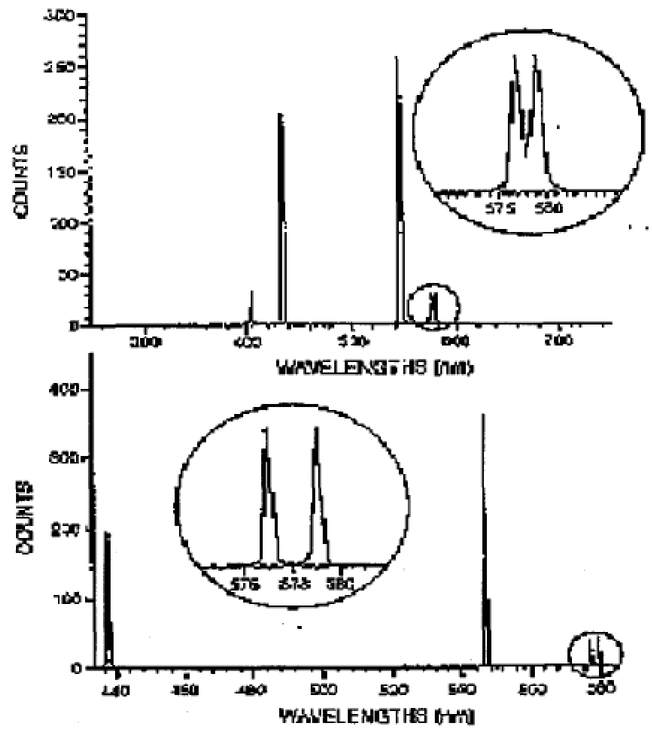


Figure 12: Spectra of emission of the 6035 Mercury Lamp using two different gratings and a 1024 element diode array.

NOTE: The difference in wavelength range and resolution of the 577 and 579 doublet. A glass filter was used to block the second order of UV lines.

When spectrographs are used with diode arrays and CCD detectors, the resolution is often limited by the pixel width. Nyquist sampling theory leads us to calculate the resolution as if an exit slit was equal to two pixels. Thus the limiting resolution of a 77700 spectrograph with a diode array and 25 μm pixels would be about 0.2 nm.

Orders

(Gratings have the property of dispersing light into a series of orders (See Figure 12). The zero (order is simply reflected light, and zero order light defines the zero degree grating angle in a monochromator. The phenomenon of multiple orders can be an advantage since the 2nd order has twice the dispersion of the first order, and so on, but it also has disadvantages, mainly the lack of efficiency in higher orders. If light with a wavelength of 600 nm is dispersed by a grating at a diffraction angle of say 15° then so is a small fraction of light of wavelength 300 nm (the 2nd order), and also 200 nm (the 3rd order). These different wavelengths will all be focused onto the same location at the exit of the monochromator, and hence be recorded erroneously as 600 nm light by a detector. Just to confuse things there are positive and negative orders. Negative orders have diffraction angles, which direct the light at angles greater than the zero order reflected beam. Positive orders have diffraction angles, which direct the light at angles less than thl3 zero order reflected beam. Most light energy is dispersed into the first order, and in the direction ~f the blaze. (See Figure 13.)

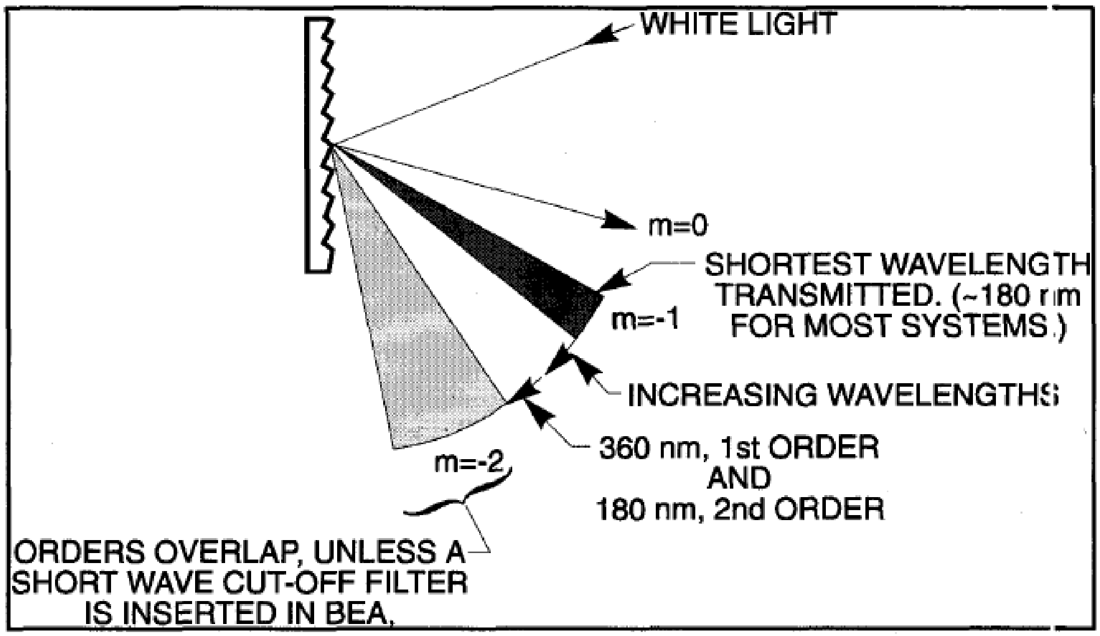


Figure 13: Diffraction orders and overlapping of orders.

NOTE: That negative orders are defined as orders, which are at angles exceeding that of the zero order. Positive orders are not shown for clarity.

Diffraction orders and overlapping of orders. Note that negative orders are defined as orders which, are at angles exceeding that of the zero order. Positive orders are not shown for clarity.

In order to take truly accurate spectra it is necessary to eliminate multiple orders, anti this should be done with order sorting filters. A filter is needed when light is being measured at twice the lowest detectable-wavelength. For example if silica optics are being used in air, the lowest detectable wavelength is about 180 nm, a 360 nm high pass filter will be required when 360 nm light is being measured. It can be inconvenient to change filters when long scans are being made unless the monochromator and filter wheel are under computer control. New types of monochromator such as the MS257TM facilitate taking long scans and changing filters without interrupting the scan. An unresolved problem is that when using variable wide wavelength range spectrographs with diode array or CCD detectors order sorting filters may need to be inserted partially along the array, and would have to be moved if the spectral range is altered.

Blaze

The blaze wavelength is the wavelength at which most energy is dispersed. Gratings can be blazed by making the groove faces at a specific angle to the grating surface. The blaze wavelength is achieved by cutting a groove with an angle such that the facet normal bisects the angle between the incident and diffracted rays if this two are given. (See Figure 10. Blaze is important because it allows a grating to be chosen for optimal efficiency in a given wavelength range. As a general rule you should select a grating with a blaze wavelength at the extreme short wavelength end of the region of interest. This is because most sources and detectors are most efficient at longer wavelengths, and the selection of a short wavelength blazed grating compensates for the lack of radiation at the short end.

Efficiency

About the best efficiency you can expect for a grating, at the blaze wavelength, is about 80%. Thus 80% of the incoming radiation at that wavelength is diffracted into the 1st order, the lest is lost to the remaining orders both positive and negative, absorption and scatter. Light of half the blaze wavelength, which is diffracted with a low efficiency in the first order will often have a greater (efficiency in the second order than in the first. For example, a grating with a blaze wavelength at i500 nm, has an efficiency of only 10% for first order 250 nm light, in the second order tl1e efficiency (of the 250 nm light is 30%.

Sinusoidally grooved gratings have very flat efficiency curves across the operating wavelength range, usually substantially below 50%. Such gratings are regarded as unblazed (See Figure 14).

Polarization

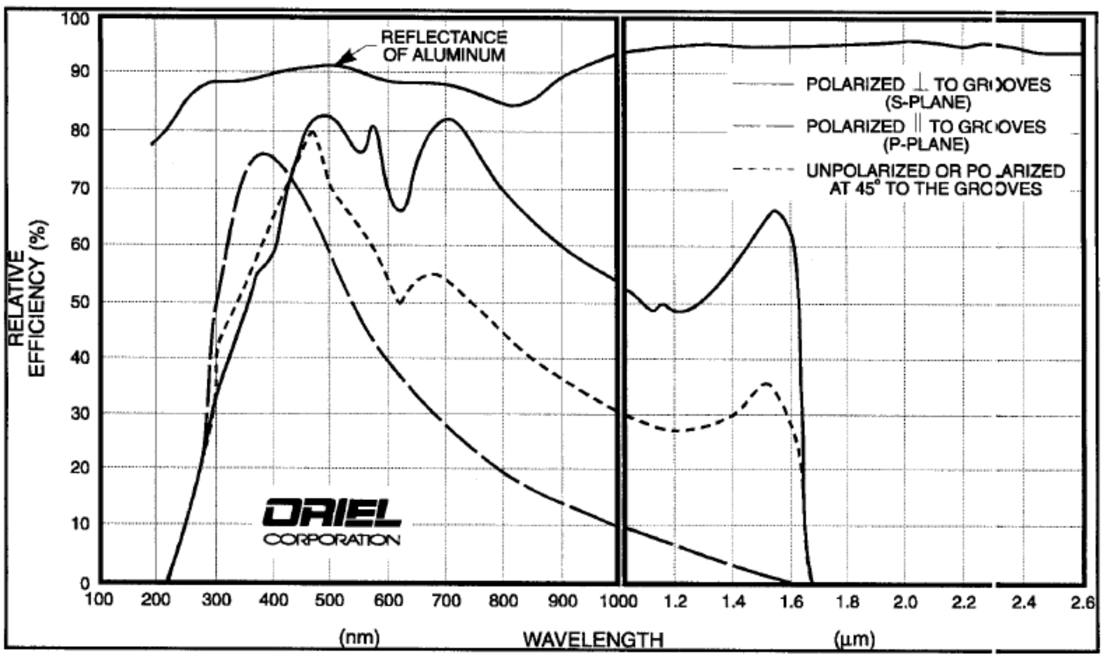


Figure 14: The effect of blazing on the efficiency of a 1200 l/mm diffraction grating.

The diffraction efficiency of a grating usually depends on the polarization of the radiation incident I (on the grating (See Figure 14**).** The effect of polarization on the grating efficiency of 3 1200 l/mm diffraction grating.

Ruled Gratings

The grating grooves can be ruled by a mechanical ruling engine, or etched using a holographic process. Ruled gratings lend themselves to having a blaze angle and offer the highest efficiencies at the blaze wavelengths. They are widely thought to cause a great degree of light scattering, but this is no longer true. New ruled gratings use interferometrically controlled ruling engines which produce very accurate grooves, and very little stray light.

Holographic Gratings

Holographic gratings are created using a interferometric hologram and an etching process. They have the reputation of being the best gratings, but this is also not necessarily so. Sinusoidally grooved gratings produce very little scattered light but have low flat efficiency curves, a though they are generally quite broad. The blazed holographic gratings use etching during the inierferometric process, or an ion gun to form a blaze angle in a secondary process. The former does not produce strong blazing, and while the latter produces high efficiencies at the blaze wavelengths, this produces increased stray light due to the formation of microstructure along the edges of the grooves. Newport offers both rules and holographic gratings to provide the best combination of blaze, efficiency and low light scatter for different wavelength ranges.

XII DECLARATION OF CONFORMITY

DECLARATION OF CONFORMITY		
Manufacturer's name:	Newport	
Manufacturer's address:	150 Long Beach Boulevard	
	Stratford, CT 06615	
	USA	
Declares that the product:		
Product Name	MS257™ MONOCHROMATOR AND SPECTROGRAPH	
Model Number:	77700A, 77700B	
conforms to the following Product Specifications:		
Safety:	EN 61010-1: 2001 2nd Edition	
EMC:	EN 61326:1998, A1:1998, A2:2001	
	EN 61000-3-2:2000	
	EN 61000-3-3:1995, A-1:2001	
complies with the following Directives:		
	89/336/EEC EMC Directive	
	92/31/EEC Amendment	
	93/68/EEC Amendment	
	73/23/EEC Low Voltage Directive	
and accordingly, carries the CE mark.		
Stratford, CT	George Buzel	(Signature)
	George Buzel	(Name)
	Director of Engineering	(Title)

XIII WARRANTY AND RETURNS

Newport warrants that all goods described in this manual (except consumables such as lamps, bulbs, filters, ellipses, etc.) shall be free from defects in material and workmanship. Such defects become apparent within the following period:

1. All products described here, except spare parts: one (1) year or 3000 hours of operation, whichever comes first, after delivery of the goods to the buyer.
2. Spare parts: ninety (90) days after delivery of goods to the buyer.

Newport's liability under this warranty is limited to the adjustment, repair and/or replacement of the defective part(s). During the above listed warranty period, Newport shall provide all materials to accomplish the repaired adjustment, repair or replacement. Newport shall provide the labor required during the above listed warranty period to adjust, repair and/or replace the defective goods at no cost to the buyer ONLY IF the defective goods are returned, freight prepaid, to a Newport designated facility. If goods are not returned to Newport, and the user chooses to have repairs made at their premises, Newport shall provide labor for field adjustment, repair and/or replacement at prevailing rates for field service, on a portal-to-portal basis.

Newport shall be relieved of all obligations and liability under this warranty of:

1. The user operates the device with any accessory, equipment or part not specifically approved or manufactured or specified by Newport unless buyer furnishes reasonable evidence that such installations were not the cause of the defect. This provision shall not apply to any accessory, equipment or part which does not affect the safe operation of the device.
2. The goods are not operated or maintained in accordance with Newport's instructions and specifications.
3. The goods have been repaired, altered or modified by other than authorized Newport personnel.
4. Buyer does not return the defective goods, freight prepaid, to a Newport facility within the applicable warranty period.

IT IS EXPRESSLY AGREED THAT THIS WARRANTY SHALL REPLACE ALL WARRANTIES OF FITNESS AND MERCHANTABILITY. BUYER HEREBY WAIVES ALL OTHER WARRANTIES, GUARANTEES, CONDITIONS OR LIABILITIES, EXPRESSED OR IMPLIED, ARRISING BY LAW OR OTHERWISE, WHETHER OR NOT OCCASIONED BY NEWPORT'S NEGLIGENCE.

This warranty shall not be extended, altered or varied except by a written document signed by both parties. If any portion of this agreement is invalidated, the remainder of the agreement shall remain in full force and effect.

CONSEQUENTIAL DAMAGES

Newport shall not be responsible for consequential damages resulting from misfunctions or malfunctions of the goods described in this manual. Newport's total responsibility is limited to repairing or replacing the misfunctioning or malfunctioning goods under the terms and conditions of the above described warranty.

INSURANCE

Persons receiving goods for demonstrations, demo loan, temporary use or in any manner in which title is not transferred from Newport, shall assume full responsibility for any and all damage while in their care, custody and control. If damage occurs, unrelated to the proper and warranted use and performance of the goods, recipient of the goods accepts full responsibility for restoring the goods to their condition upon original delivery, and for assuming all costs and charges.

RETURNS

Before returning equipment to Newport for repair, please call the Customer Service Department at (203) 377-8282. Have your purchase order number available before calling Newport. The Customer Service Representative will give you a Return Material Authorization number (RMA). Having an RMA will shorten the time required for repair, because it ensures that your equipment will be properly processed. Write the RMA on the returned equipment's box. Equipment returned without a RMA may be rejected by the Newport Receiving Department. Equipment returned under warranty will be returned with no charge for the repair or shipping. Newport will notify you of any repairs not covered by the warranty, with the cost of the repair, before starting the work.

Please return equipment in the original (or equivalent) packaging. You will be responsible for damage incurred from inadequate packaging, if the original packaging is not used.

Include the cables, connector caps and antistatic materials sent and/or used with the equipment, so that Newport can verify correct operation of these accessories.