

# MS257 USB/RS232

## MONOCHROMATOR AND SPECTROGRAPH



### User's Manual

**MODELS: MS257-M-FH-A, MS257-M-FH-L, MS257-M-FH-D, MS257-M-MC-A, MS257-M-MC-L, MS257-M-MC-D, MS257-M-MT-A, MS257-M-MT-L, MS257-M-MT-D, MS257-S-FH-A, MS257-S-FH-L, MS257-S-FH-D, MS257-S-MC-A, MS257-S-MC-L, MS257-S-MC-D, MS257-S-MT-A, MS257-S-MT-L, MS257-S-MT-D**

**Oriel®**  
**INSTRUMENTS**  
A Newport Corporation Brand

## TABLE OF CONTENTS

1	SAFETY OPERATING PRECAUTIONS .....	4
2	INTRODUCTION .....	5
3	SETUP AND MOUNTING .....	6
	3.1 MOUNTING MS257 TO A FLAT SURFACE.....	6
	3.2 MOUNTING OTHER INSTRUMENTS TO THE MS257 .....	7
	3.3 TURRET INSTALLATION .....	8
4	QUICK START.....	9
	4.1 WORKING WITH THE HAND CONTROLLER .....	9
	4.2 WORKING WITH A COMPUTER .....	9
5	INSTRUMENT DESCRIPTION .....	10
	5.1 LAYOUT AND MAJOR FEATURES .....	10
6	CONFIGURATION VERSATILITY .....	11
	6.1 USE AS A MONOCHROMATOR.....	11
	6.2 USE AS A SPECTROGRAPH .....	12
	6.3 USE AS AN IMAGING SPECTROGRAPH .....	12
	6.4 INSTRUMENT FEATURES .....	13
7	INSTRUMENT OPERATION.....	14
	7.1 INSTRUMENT CONFIGURATION .....	14
	7.2 UTILITY AND CONFIGURATION SOFTWARE .....	16
	7.2.1 MS257 UTILITY SOFTWARE .....	16
	7.2.2 UTILITY SOFTWARE INSTALLATION.....	17
	7.2.3 MS257 CONFIGURATION SOFTWARE .....	25
	7.3 77709 HAND CONTROLLER .....	33
	7.4 COMMUNICATIONS.....	42
8	PROGRAMMING MS257 .....	43
9	ACCESSORIES.....	44
	9.1 GRATING TURRETS.....	44
	9.2 CONFIGURING THE MS257 FOR TURRET INSTALLATION.....	44
	9.3 GRATINGS.....	45
	9.4 SLITS .....	46
	9.5 FILTER WHEELS.....	53
	9.6 INPUT AND OUTPUT PORTS.....	54
10	SPECIFICATIONS.....	57
11	APPENDIX A - BASIC GRATING INFORMATION .....	60
12	DECLARATION OF CONFORMITY .....	67
13	WARRANTY AND RETURNS .....	68
	13.1 CONTACTING ORIEL INSTRUMENTS.....	68
	13.2 REQUEST FOR ASSISTANCE / SERVICE .....	69
	13.3 REPAIR SERVICE .....	69
	13.4 NON-WARRANTY REPAIR .....	70
	13.5 WARRANTY REPAIR .....	70
	13.6 LOANER / DEMO MATERIAL.....	71

## LIST OF FIGURES

Figure 1: Grating Care and Handling .....	4
Figure 2: MS257 Dimensions .....	6
Figure 3: Input and Output Ports .....	7
Figure 4: Mounting Hole Pattern for Ports .....	7
Figure 5: Monochromator Interior Layout.....	10
Figure 6: Light Path of a Monochromator .....	11
Figure 7: Light Path of a Spectrograph .....	12
Figure 8: Light Path of Imaging Spectrograph .....	12
Figure 9: Utility Program Main Window.....	24
Figure 10: Configuration Program main window.....	32
Figure 11: Hand Controller Keypad .....	36
Figure 12: Rear Panel Connections .....	42
Figure 13: Quadruple Grating Turret.....	44
Figure 14: Using Fixed Slits with MS257 .....	47
Figure 15: Micrometer Driven Slit Dimensions.....	49
Figure 16: Micrometer Driven Slit Adjustments.....	50
Figure 17: Micrometer Driven Slit Closed Position .....	50
Figure 18: Motorized Slit .....	51
Figure 19: Filter Installation.....	53
Figure 20: Motorized Flip Mirror .....	55
Figure 21: Dual Source Configuration.....	56
Figure 22: Diffraction Geometry of a Plane Reflection Grating.....	60
Figure 23: The "Grating Equation" .....	61
Figure 24: Grating Resolution .....	63
Figure 25: Diffraction Orders.....	64
Figure 26: Polarization and Efficiency.....	66

## 1 SAFETY OPERATING PRECAUTIONS

### Electrical

The MS257 operates from nominal ac mains of 115/230 Vac. 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.

The 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 the 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

Wear powder-free gloves. Do not wear finger cots – hands should be completely covered. Do not touch any optical surfaces - even if wearing gloves - 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 of dry clean air or nitrogen. Do not allow condensation from talking or breathing to form on the grating. Gratings can be scratched easily! Be very careful when removing the plastic grating covers. A cover for a grating must never touch the grating's front surface. The cover should only touch the edges of the grating. Customers should keep the covers on hand to protect gratings during storage or transportation.

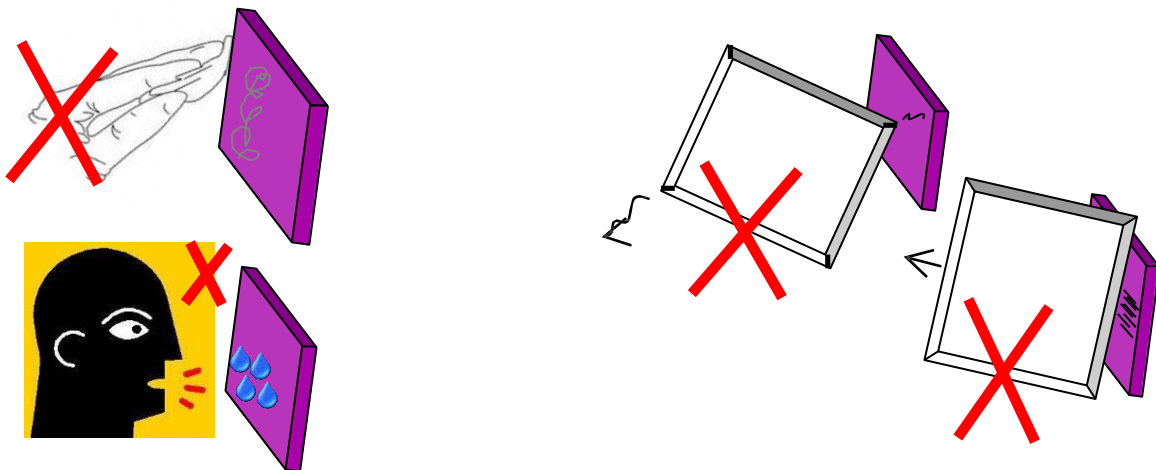


Figure 1: Grating Care and Handling

## 2 INTRODUCTION

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The 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.

The MS257 is an F/3.9 instrument with a focal length of 257 mm 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.

The MS257 has been designed with a flat exit image plane and an 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
- Rigid housing for optical stability with sealed seams for light tightness
- 2 detector ports with automatic detector switching
- Motorized slits for automatic bandpass selection
- Advanced optical design results in negligible stray light
- Tilted focal plane for eliminating re-entrant spectra from detectors
- Corrected optics for spectral imaging (version 77782)
- 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 via USB or RS232



### 3.2 MOUNTING OTHER INSTRUMENTS TO THE 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 assemblies at the ports. Other accessories can also be mounted directly to MS257 at any of the input or output ports (Figure 4).

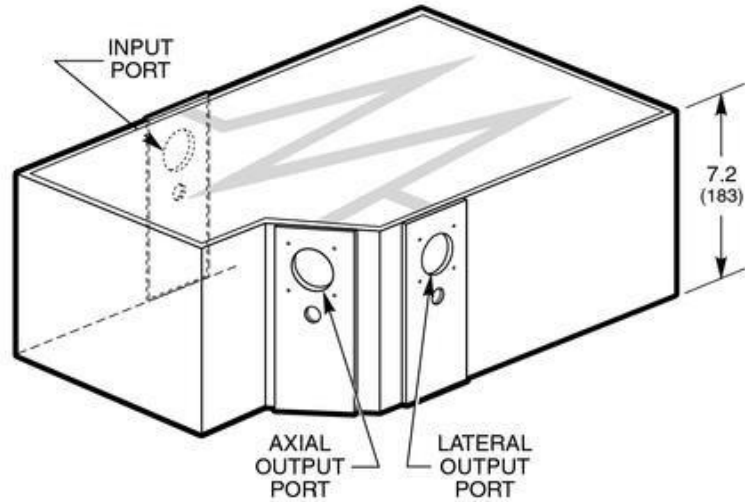


Figure 3: Input and Output Ports

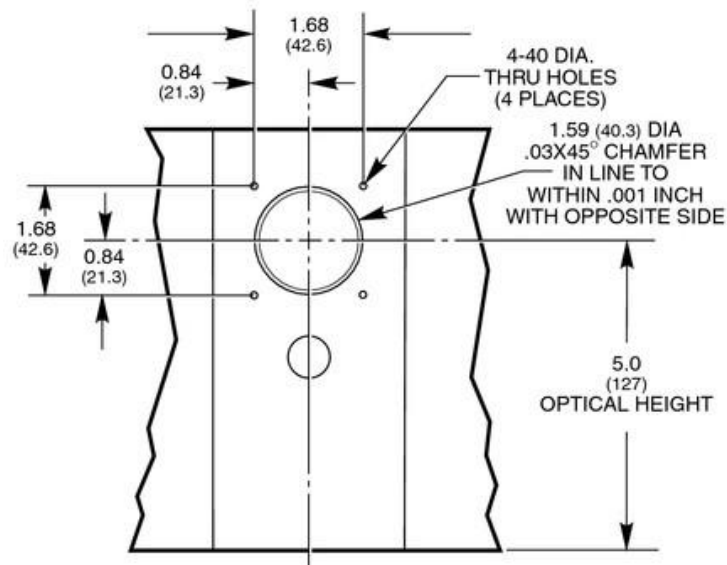


Figure 4: Mounting Hole Pattern for Ports

### 3.3 TURRET INSTALLATION

In order to protect the most sensitive part of the instrument during transportation, the grating turret is packaged separately from the housing.

Install the turret into the instrument using the following procedure:

#### **Quadruple Grating Turret** (may have 2, 3 or 4 gratings installed)

- Put gloves on to avoid fingerprinting the gratings.
- Remove the MS257 cover.
- **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.
- Tighten the two mounting bolts by hand. **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, using all cover screws.

#### **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.
- Tighten the mounting bolt by hand. **Do not over tighten!**
- Remove the protective grating cover.
- **Be very careful not to touch the grating.**
- Replace the MS257 cover, using all cover screws.



## 4 QUICK START

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### 4.1 WORKING WITH THE HAND CONTROLLER

The Hand Controller (Model 77709) controls the MS257 via an RJ11 jack located on the back panel. Below the LCD screen are five LEDs that indicate the status of various functions. To operate the MS257 with the hand controller, ensure that the following two LEDs are ON.

- **Power** LED: The MS257 is powered up and the Hand Controller is connected and working properly.
- **Local** LED: When the Hand Controller has control of the MS257. To activate the LED, press the "Local" button. The LCD screen will turn on and indicate the current status of the instrument.

For further instructions on how to operate the instrument using the Hand Controller, please refer to Section 7.3 of this manual.

### 4.2 WORKING WITH A COMPUTER

- Connect the MS257 to the computer via the provided USB or RS232 cable, or an IEEE to RS232 adapter (Model 77793).
- Use the utility software (details are provided in Section 7.2) to control the instrument.

## 5 INSTRUMENT DESCRIPTION

### 5.1 LAYOUT AND MAJOR FEATURES

Refer to the descriptions of the MS257 accessories throughout this manual for more information on the items shown in Figure 5.

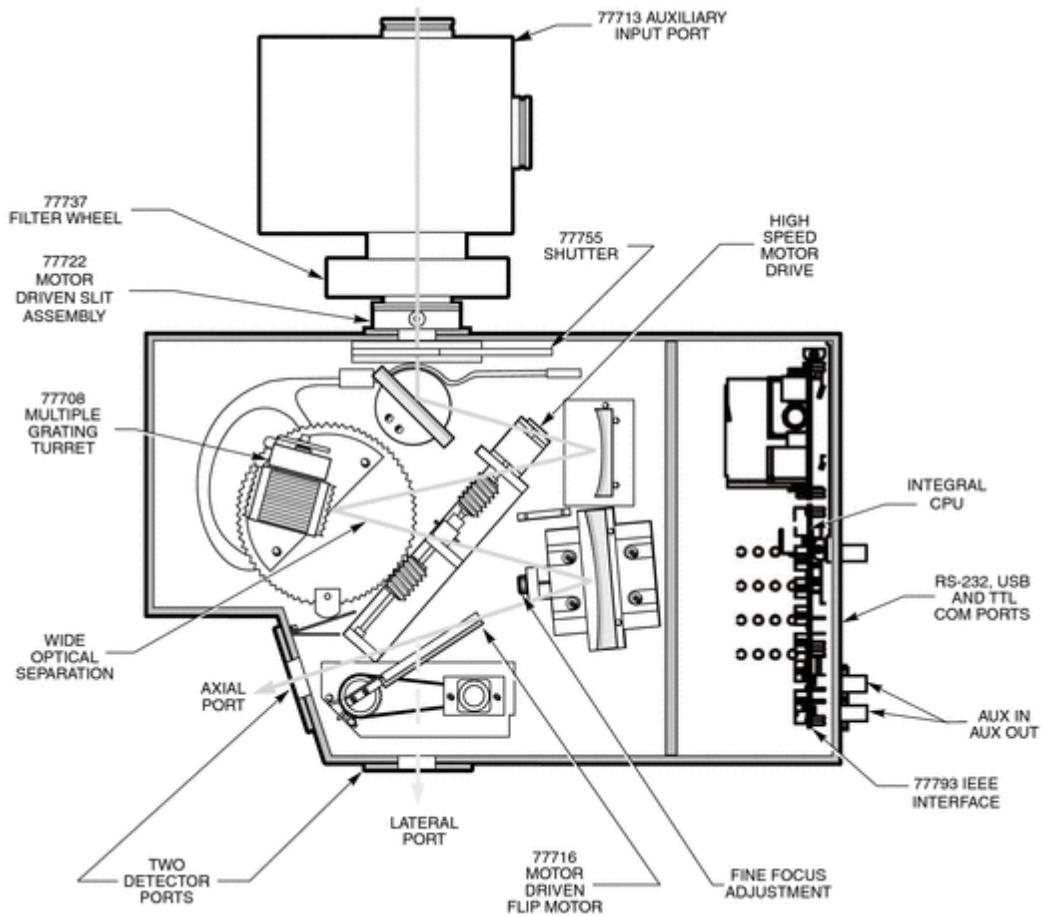


Figure 5: Monochromator Interior Layout

## 6 CONFIGURATION VERSATILITY

### 6.1 USE AS A MONOCHROMATOR

Figure 6 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.

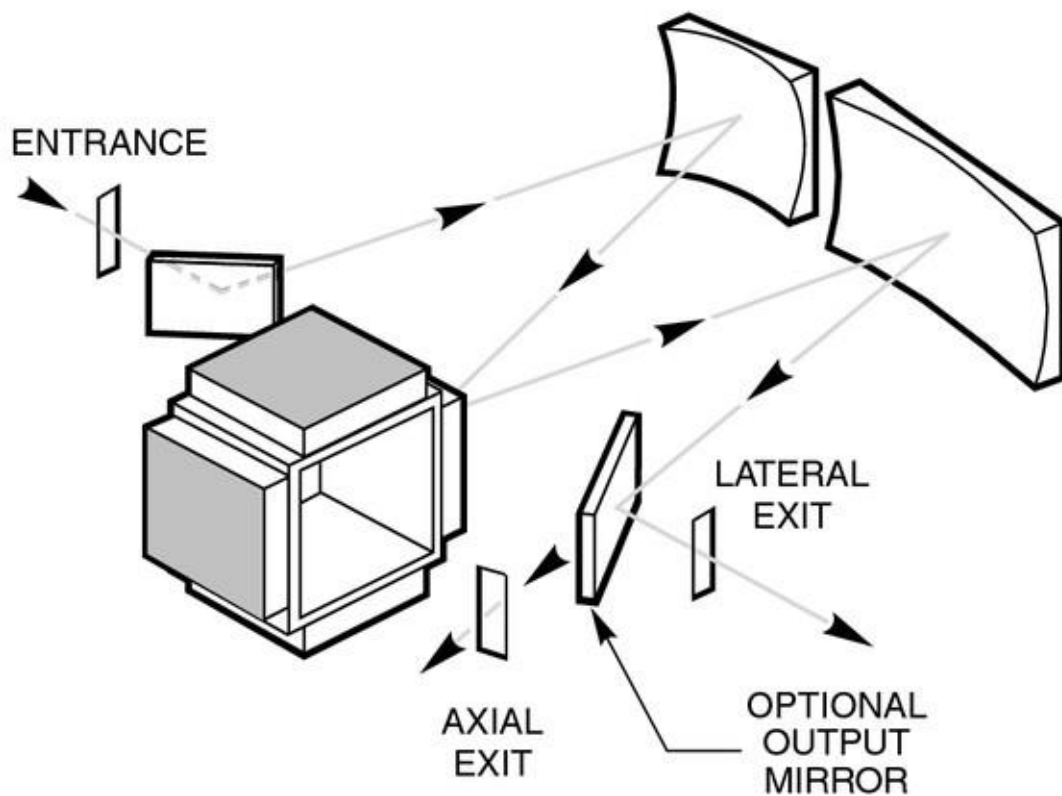


Figure 6: Light Path of a Monochromator

## 6.2 USE AS A SPECTROGRAPH

Figure 7 depicts the MS257 in use as a spectrograph. The axial port accommodates detectors over 4" (100 mm) 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 that the spectrum at the lateral output port is reversed from that of the axial output port.

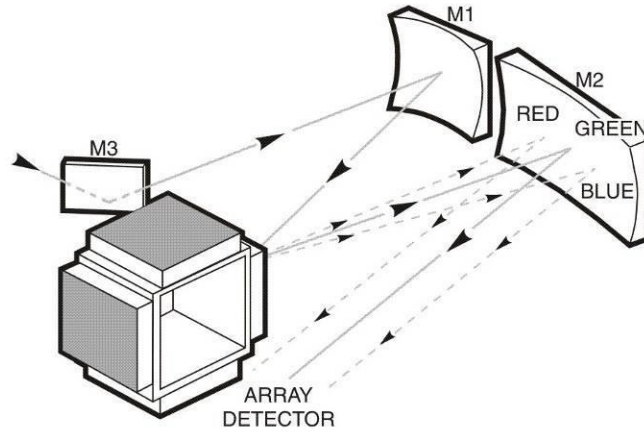


Figure 7: Light Path of a Spectrograph

## 6.3 USE AS AN IMAGING SPECTROGRAPH

Figure 8 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.

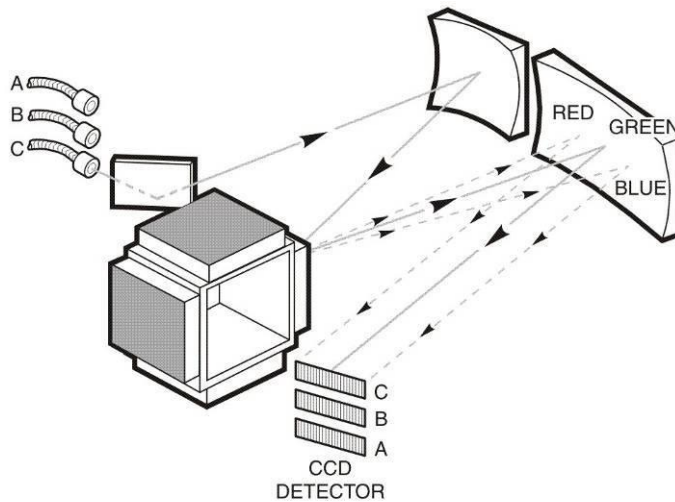


Figure 8: Light Path of Imaging Spectrograph

## 6.4 INSTRUMENT FEATURES

### **Flexible Instrument Control**

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

### **Negligible Stray 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. The MS257 was designed to remove this possibility for CCD detectors - even as large as 28 mm x 28 mm.

### **Calibrated Motor Drive**

The MS257 uses an ultra-rapid stepper motor drive, with an oversize worm gear to ensure high precision and stability. This computer controlled worm drive is superior to 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 ruled grating and a holographic grating). Scans are automatically linearized so that the wavelength intervals are equal, no matter which units are chosen: 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. They are slightly non-concentric and have surface finish flaws, which result in 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 provide real wavelength. The MS257 is spectrally mapped at the factory with a system default calibration for the grating drive. Remapping of the drive should never be attempted by unauthorized personnel. If remapping is necessary, the entire MS257 must be returned to the factory.

### **Integrated Shutter**

There are two internal shutters available for the MS257. Both shutters are normally closed. They can be controlled through the MS257 command language or via an externally applied TTL signal.

The 77755 shutter has stray light rejection better than 0.001% for dark scans and dark current measurements. The shutter may be changed in the field so that it is normally open. Contact the Oriel Instruments service department for details. The 77755 shutter automatically closes 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. The 77717 fast shutter is available for pulsed work. Exposure times can be as short as 5 ms, with repetition rates as fast as 40 Hz. A synchronizing output signal is available from the fast shutter for very precise timing of external events. The 77717 fast shutter does not automatically react to grating changes.

## 7 INSTRUMENT OPERATION

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### 7.1 INSTRUMENT CONFIGURATION

The instrument configuration is maintained as a collection of parameters and values. Suitable factory defaults are provided. The **Active Configuration** is the current setup. This is always saved and restored when powering up the instrument.

#### **Configurations can be saved and loaded in several ways:**

- To save the active user configuration and to reload the user configuration, one may use the Hand Controller, the configuration software or a computer terminal program.

The instrument can be configured by Oriel Instruments to have calibrations saved on CD for more than one grating turret, allowing the user to change the turret and load the appropriate configuration information as needed.

#### **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. This calibration should be performed for each port in use. The procedure is as follows:

1. Select a grating.
2. Select a source with prominent spectral lines for calibration purposes.
3. Use very small slit sizes. If using a diode array or CCD, use a small entrance slit.
4. Drive the grating to a spectral line such as a HeNe line at 632.8 nm or an Hg line at 546 nm.
5. Step the motor drive using the Hand Controller or MS257 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.
6. Use the **Calib** command on the Hand Controller or **CALWAV** command if using the terminal program, and enter the correct wavelength for the spectral line.
7. The recalibration of the grating for that port is now complete.
8. Change the detector port using the Hand Controller or MS257 programming language if the MS257 is equipped with an Output Flip Mirror. Never move the flip mirror manually.
9. Repeat the procedure for the other detector port if it is being used.
10. Repeat Step 1 through 9 for each grating on the turret.

#### **Fine Focus Adjustment**

In order to obtain the best optical performance, a fine focus adjustment feature is included. This enables precise translation of the exit mirror to optimize the image onto focal plane detectors such as diode arrays and CCDs. These accessories do not have a precisely known detector positions, which is why the light may have to be focused to achieve best resolution. Note that after refocusing, one 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, this results in incorrect measurements. At worst, the signal cannot be measured. Stray light can occur for a number of reasons:

- **Incorrect setup**

The most significant sources of stray light are light leakage. Light could enter the MS257 through misplaced covers, as well as slit holders and detectors without adequate sealing. Make sure that all covers, detectors and flanges are well seated and screwed down.

- **Overfilling**

If the F number of the source is lower than the F number of the monochromator this produces what is referred to as overfilling. The light will spill over the sides of the entrance mirror and will reflect around the housing resulting in stray light. The MS257 is designed to prevent overfilling. But even so, 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.

- **Reflections from 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. The 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.

- **Gratings**

Gratings are not perfect reflectors, so 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 even fingerprints. Keep the gratings clean by minimizing dust and occasionally blowing them clean with dry clean air or nitrogen.

- **Mirrors**

Mirrors gradually accumulate dust, and can have imperfections. These surfaces scatter 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 even fingerprints. Keep the mirrors clean by minimizing dust and occasionally blowing them clean with dry clean air or nitrogen.

- **Detectors**

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. The 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.

## 7.2 UTILITY AND CONFIGURATION SOFTWARE

The Monochromator Utility Software CD contains:

- Installation setup for Mono Utility software.  
The utility application provides easy access to almost all MS257 functions.
- A folder with the MS257 configuration application installation setup.
- The Factory.cfg file, which is a unique file for each instrument with configuration parameters recorded. If multiple grating turrets have been calibrated, there will be a file for each one.

### 7.2.1 MS257 UTILITY SOFTWARE

#### Program Description

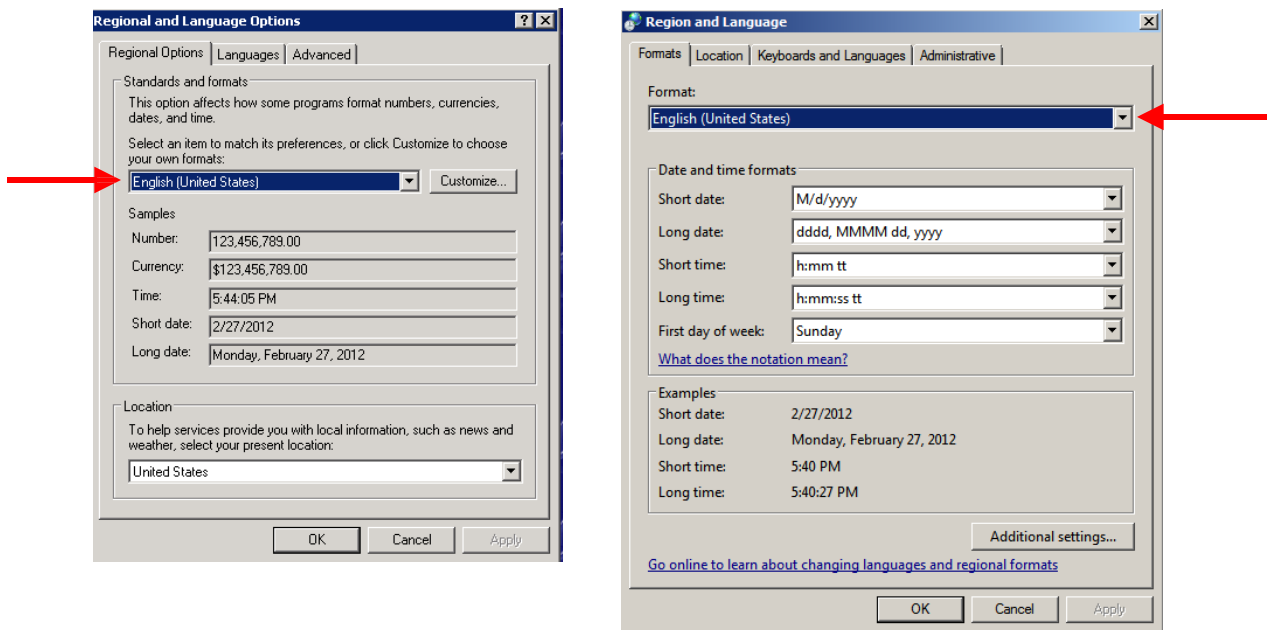
This program is written in National Instrument's LabView and is based on a collection of MS257 VIs. The Utility Program diagram may serve as an example or starting point for further development in LabView. If someone is a LabView programmer and owns a full LabView development suite, that person can load the Utility Program source code along with MS257 VIs from the CD. One can also use the dll file included with the Utility Software to create a unique application in any number of programming languages.

#### << IMPORTANT NOTE >>

For the software to send the proper numeric format to the instrument, the Windows must be set to English (United States). This setting is changed through the Windows Control Panel.

In Windows XP, use the Regional and Language Options setting. The format can be changed under the Regional Options tab.

In Windows 7, use the Region and Language setting. The format can be changed under the Formats tab.

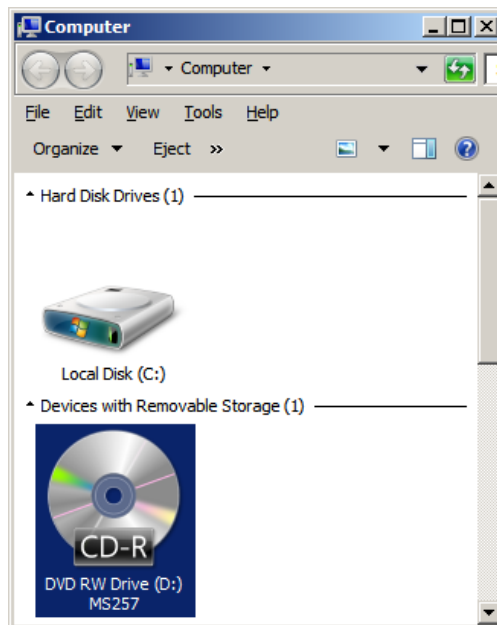




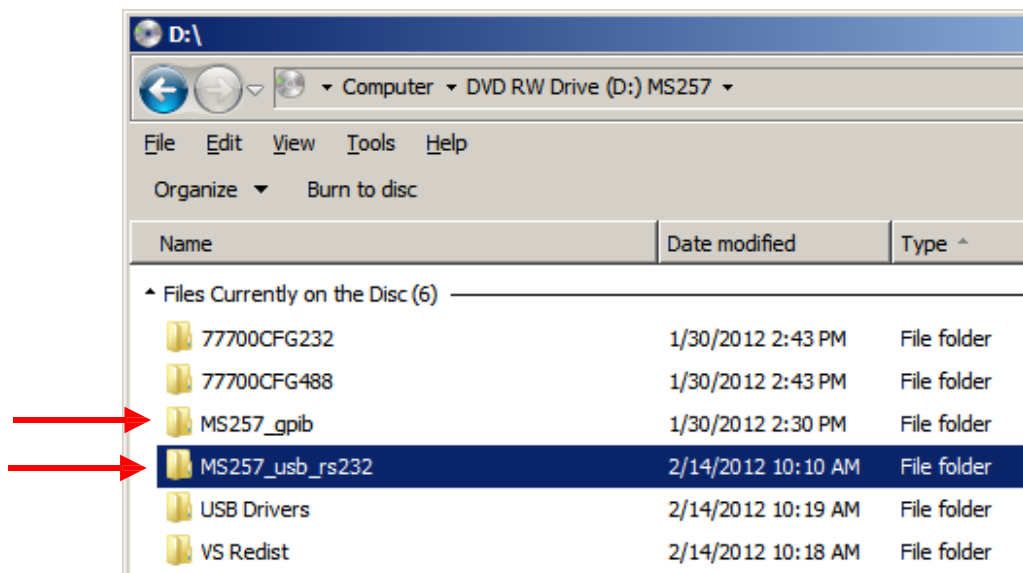
## 7.2.2 UTILITY SOFTWARE INSTALLATION

The MS257 utility program may be installed on computers with Windows XP or Windows 7 32-bit operating systems. It is suggested to exit all programs before running the installer.

Place the installation CD into the computer which will be used to control the MS257. Open the CD to view the contents in Computer (or My Computer if using Windows XP).

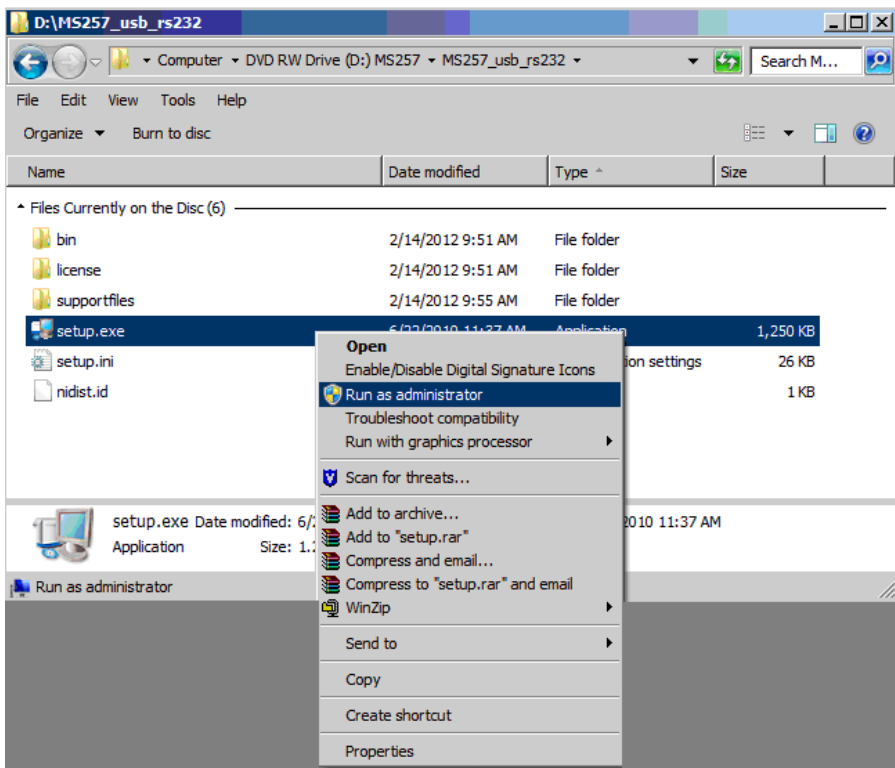


Open the MS257 folder, based upon the communication method being used.

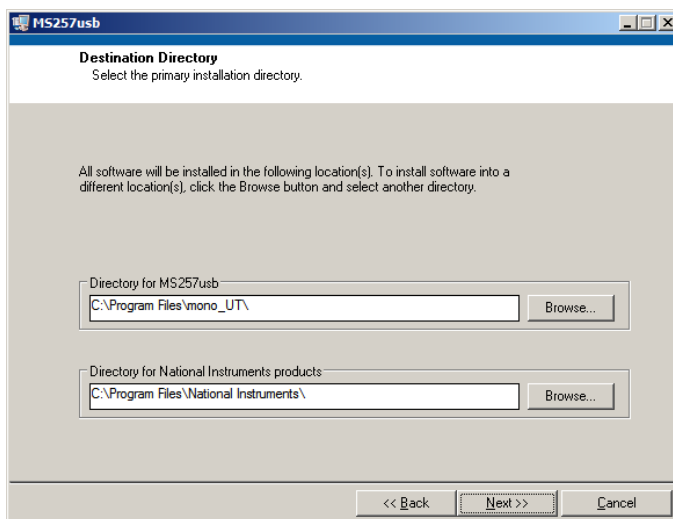


**NOTE:** If one is planning to use GPIB, the 77793 converter will be required to operate the instrument. The 77793 must be set to G Mode.

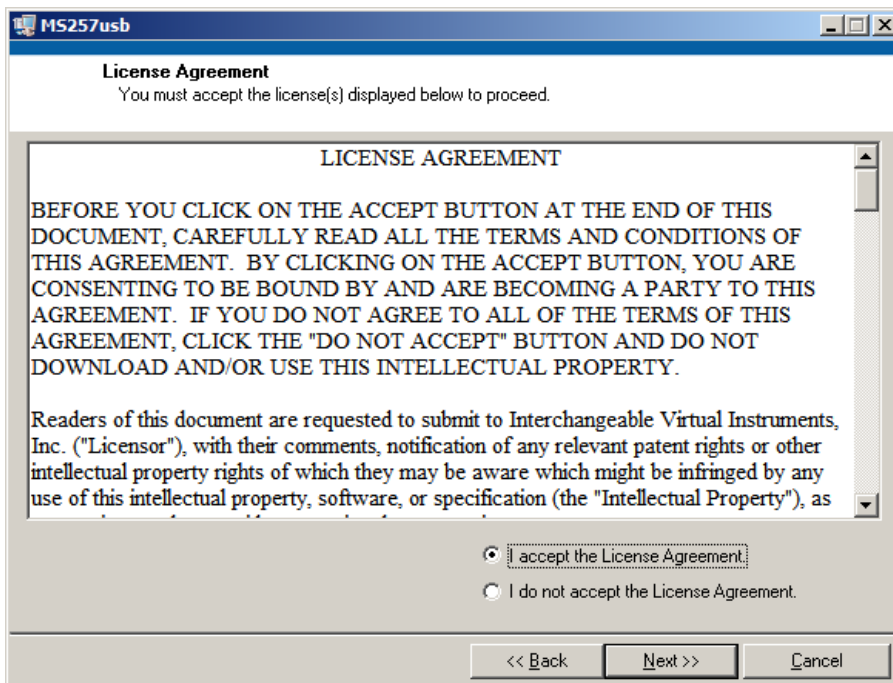
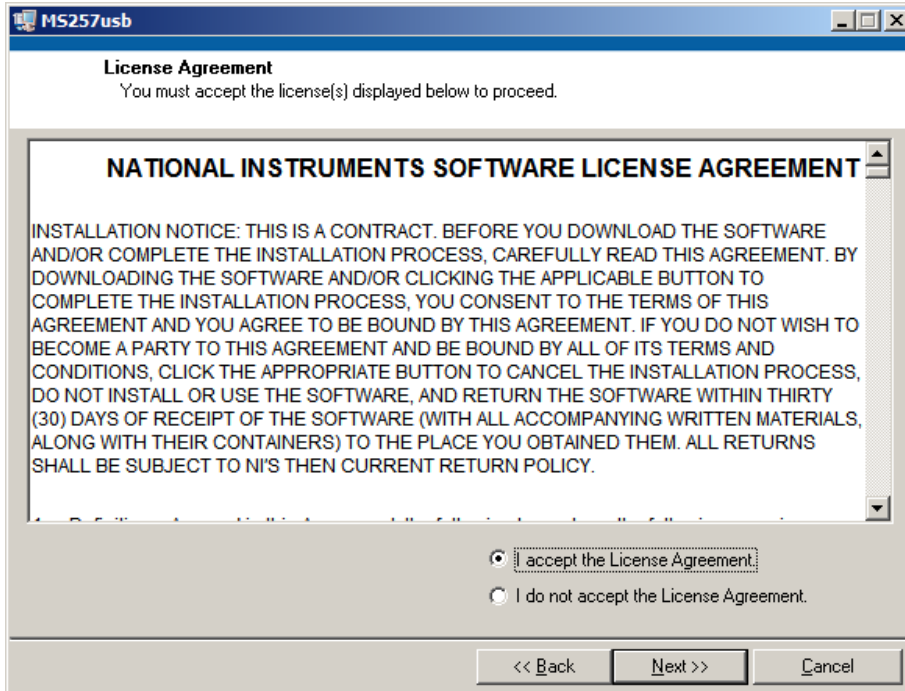
In the MS257 folder, run the setup.exe application.  
If using Windows 7, right click on the application and choose “Run as administrator.”  
In Windows XP, double click to run the application.



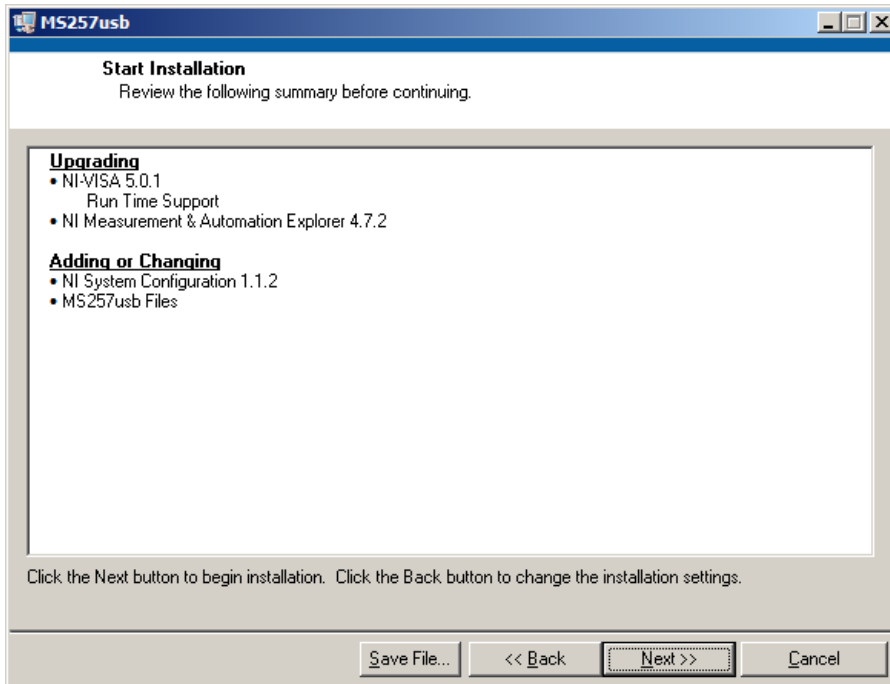
Click Next.



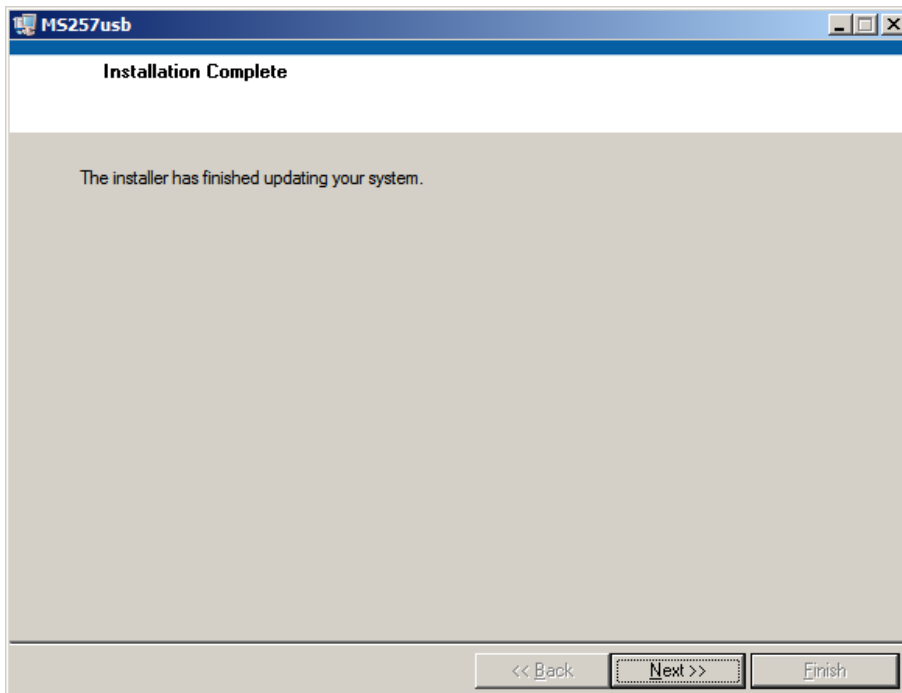
Choose to accept the two License Agreements and click Next to proceed.



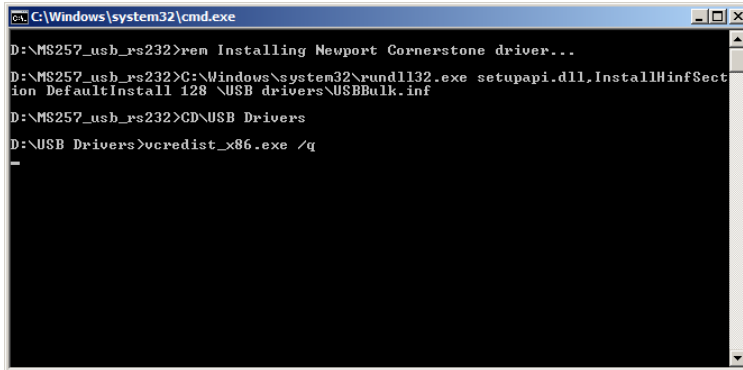
Click the Next button to begin the installation.



When complete, click Next for USB and RS232 installation.  
For the GPIB installation, click Finish.



The following window will appear briefly only if installing the USB/RS232 utility program.

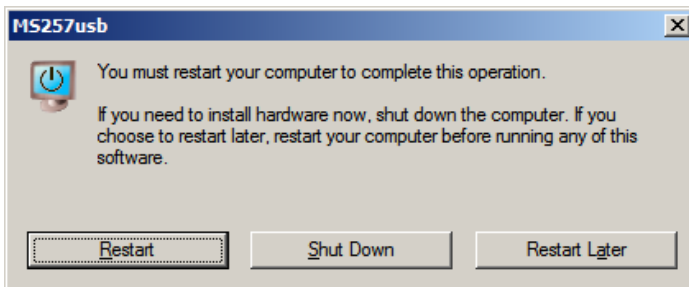


```
C:\Windows\system32\cmd.exe
D:\MS257_usb_rs232>rem Installing Newport Cornerstone driver...
D:\MS257_usb_rs232>C:\Windows\system32\rundll32.exe setupapi.dll,InstallHinfSection DefaultInstall 128 \USB drivers\USBBulk.inf
D:\MS257_usb_rs232>CD\USB Drivers
D:\USB Drivers>vcredist_x86.exe /q
```

If installing onto a Windows XP computer, the following message may appear. Click Continue Anyway.



Restart the computer.

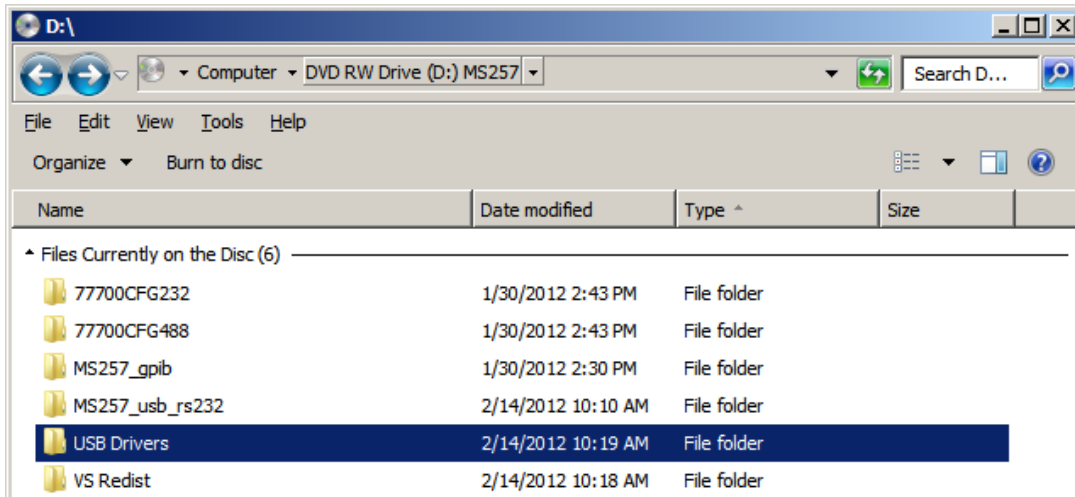


If using Windows XP, the utility program installation is now complete.

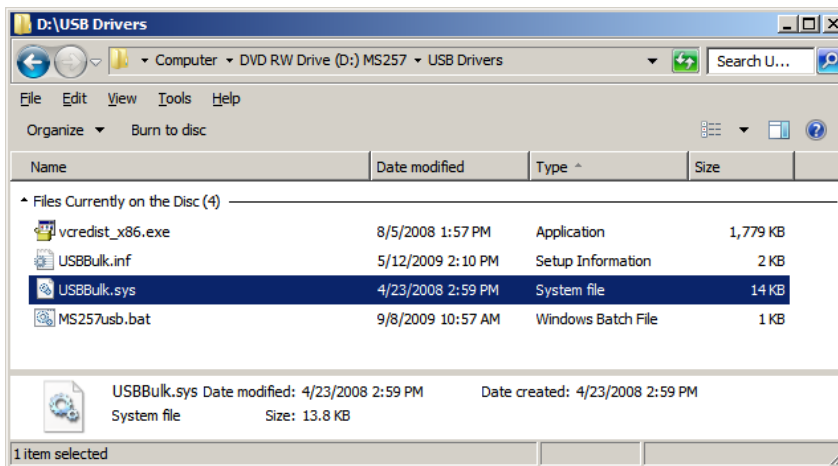
**If using Windows 7, additional steps are required. Details are provided on the following pages.**

## ADDITIONAL INSTRUCTIONS FOR WINDOWS 7, 32-BIT USERS

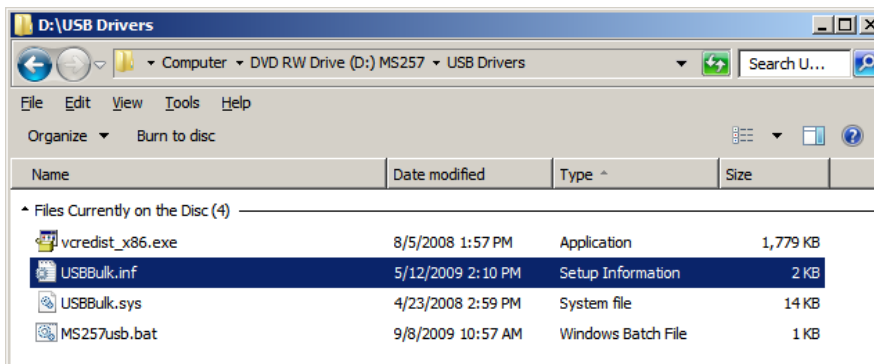
On the CD, open the USB Drivers folder.



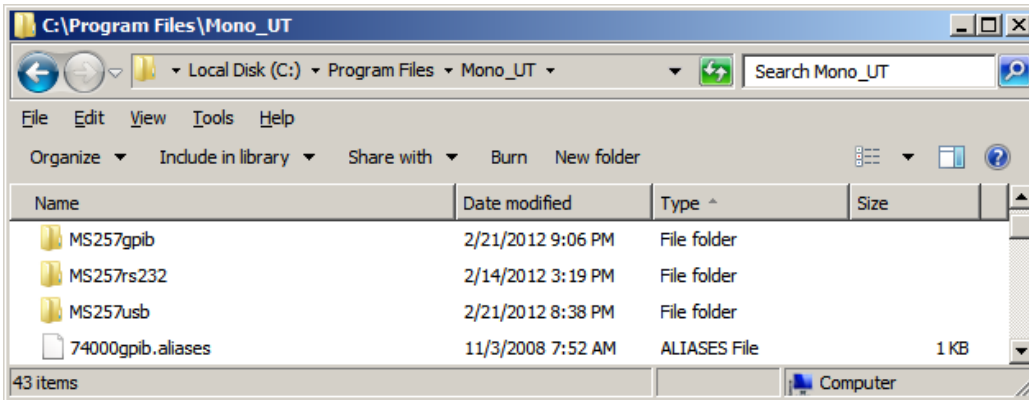
Copy the file USBBulk.sys to the computer's Windows\system32\drivers folder.



Copy the USBBulk.info file to the computer's Windows\Inf folder

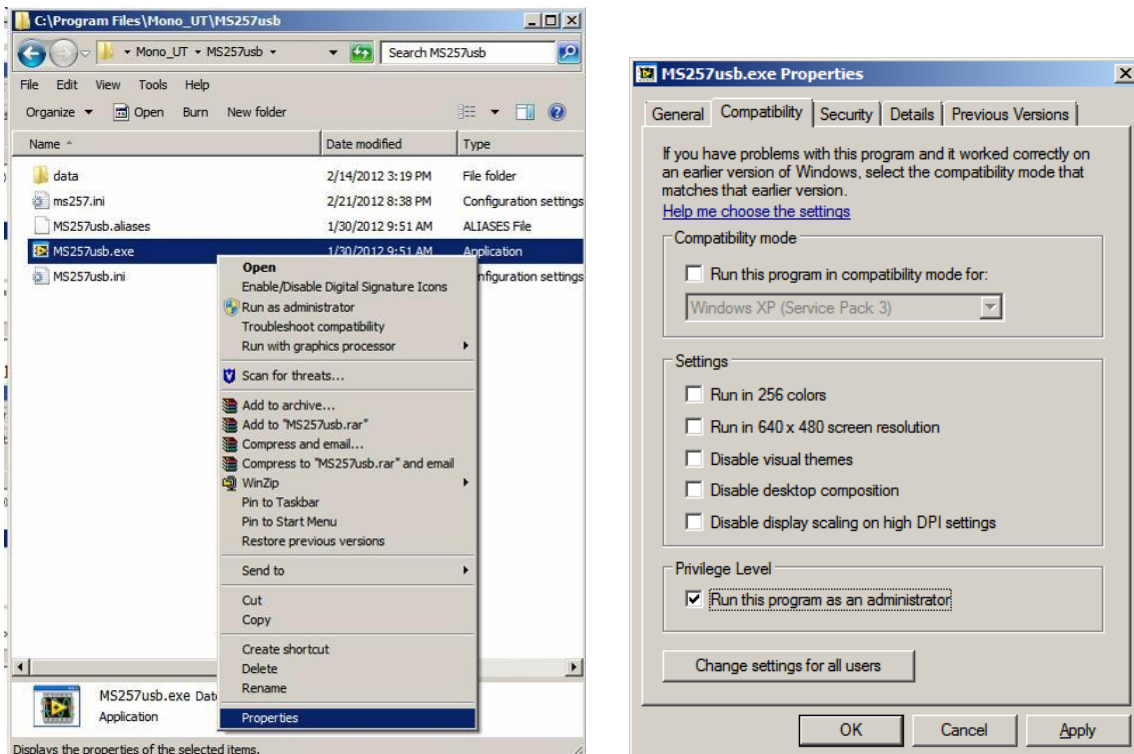


Open the Program Files\Mono\_UT folder on the computer. Then open the folder which contains the utility program, based upon the communications method being used.



Right click on the .exe application and select "Properties".

Click on the "Compatibility" tab. Check the box "Run this program as an administrator" and click OK.



## Using the Utility Software

- Launch the application from Start/Programs/MonosUtility.
- Enter the SERIAL port number if you are trying to communicate to MS257 from the RS232 host. The default port number is set to 1. If unsure of the port, check the Device Manager.
- Control or view the 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 labels, select number (1,..5). Please do not change the gratings parameters unless the intent is to override factory configuration parameters of the instrument.
- The Scan Parameters area in the main window can be used to set up a scan, which would then be activated by 'Go Scan' button.

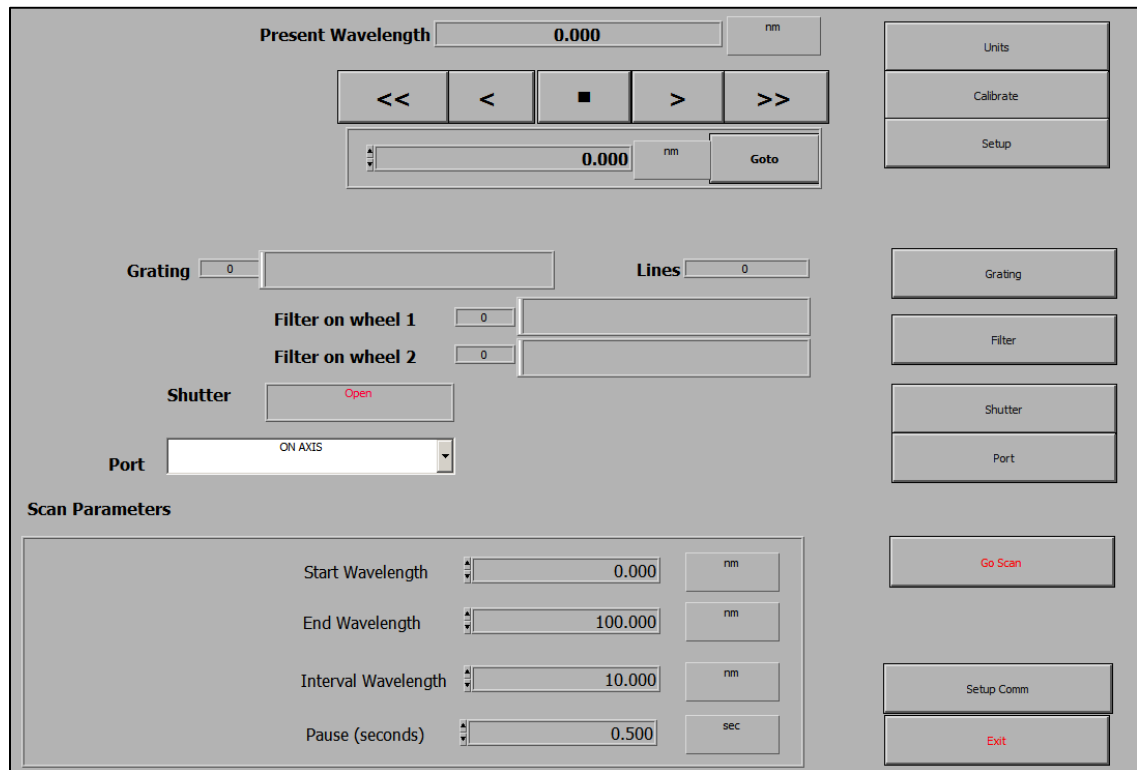


Figure 9: Utility Program Main Window



### 7.2.3 MS257 CONFIGURATION SOFTWARE

#### Program Description

The stand-alone Configuration program is included for setup and configuration of MS257 and its accessories. The software was developed using National Instruments Labview. The Labview Runtime Engine is included on the installation CD to enable use of this program without requiring the full development version of Labview.

The software enables the user to upload a variety of configuration files to the MS257 for different setups through the RS232 port. For example, if one has two different grating turrets, each turret would have its own configuration parameters located in a .cfg file. The .cfg files are created during calibration at the factory and are located on the CD that came with the instrument.

In most cases, only one .cfg file is provided with the instrument. In this situation, the Configuration Software should only be used if the MS257's memory is corrupted or erased. If the instrument is not working properly, review the information found in the instruction manuals. It is suggested to contact the Oriel Instruments service department before .

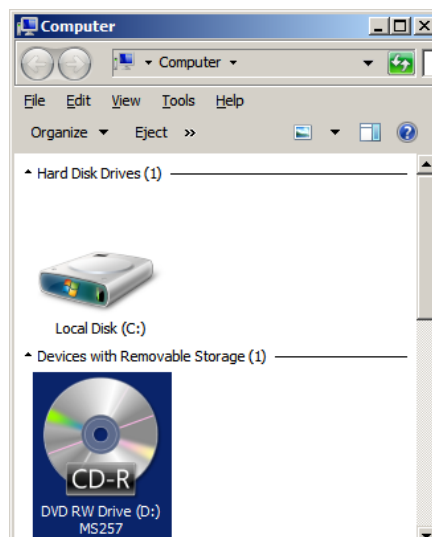
**NOTE:** This program does not allow making changes to the parameters. Changes must be made to the configuration file (.cfg) by using a text editor or word processor software.

The computer must communicate with the instrument through the RS232 connector, not the USB interface. One must use the RS232 port connected directly to a computer, or connected through the 77793 GPIB adapter. USB/RS232 adapters are commercially available if the computer being used does not have a serial port.

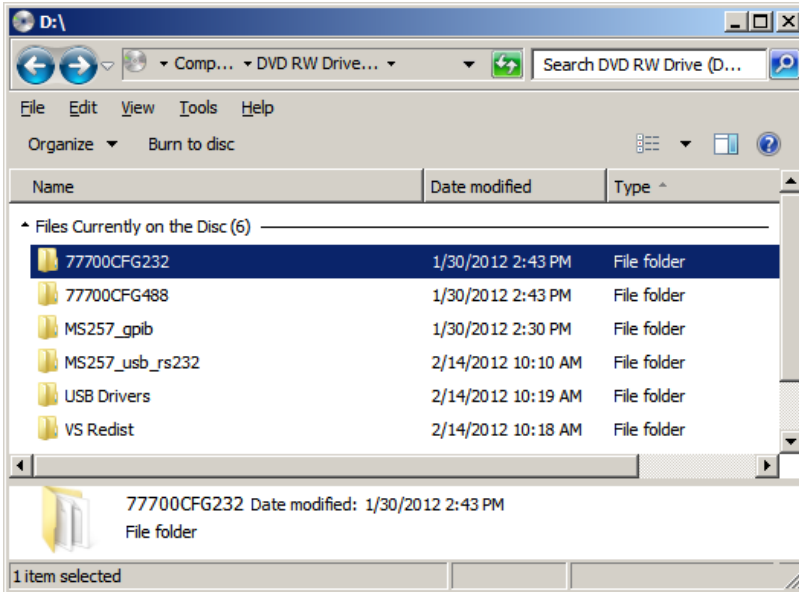
#### Installation

The MS257 configuration program may be installed on computers with Windows XP or Windows 7 32-bit operating systems. It is suggested to exit all programs before running the installer.

Place the installation CD into the computer which will be used to control the MS257. Open the CD to view the contents in Computer (or My Computer if using Windows XP).



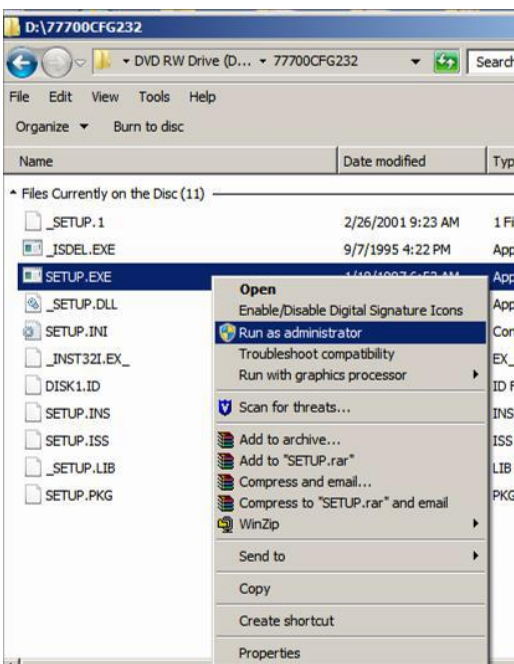
Open the 77700CFG folder, based upon the communication method being used.



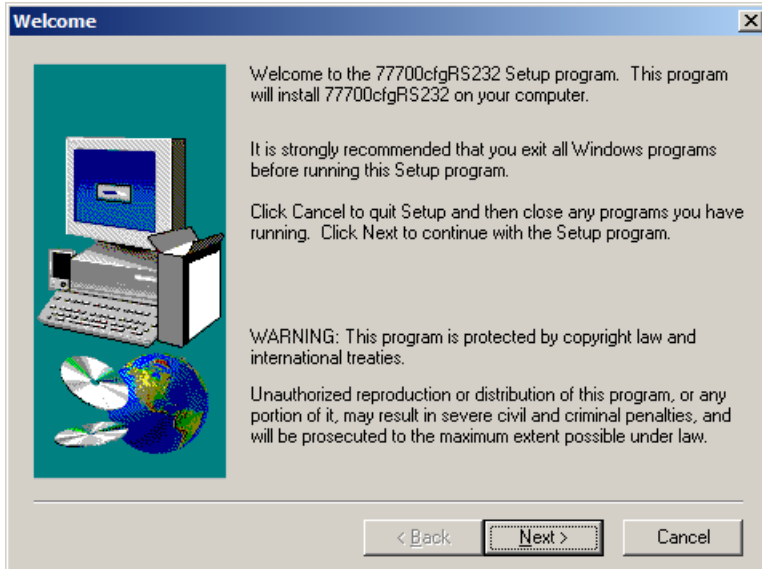
**NOTE:** If one is planning to use GPIB, the 77793 converter will be required to operate the instrument. The 77793 must be set to G Mode.

In the MS257 folder, run the setup.exe application.  
If using Windows 7, right click on the application and choose "Run as administrator."

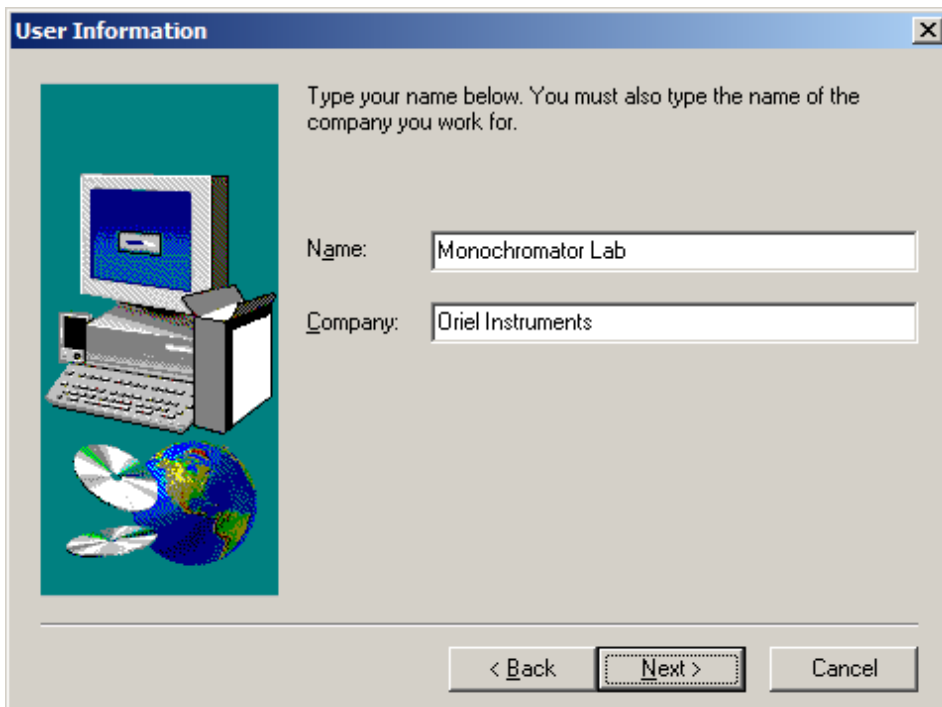
In Windows XP, double click to run the application.



Click Next to continue.

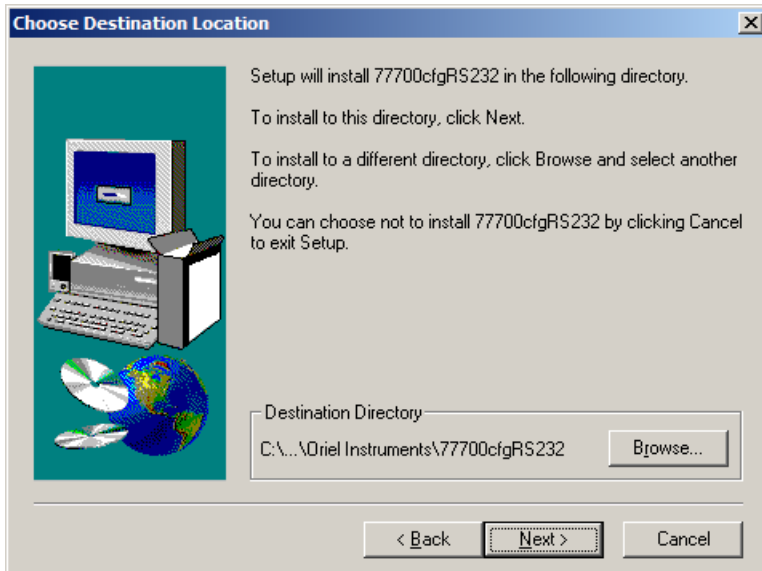


If the GPIB software is being installed, fill in the Name and Company fields and click Next to continue. Both fields must be filled in before proceeding.

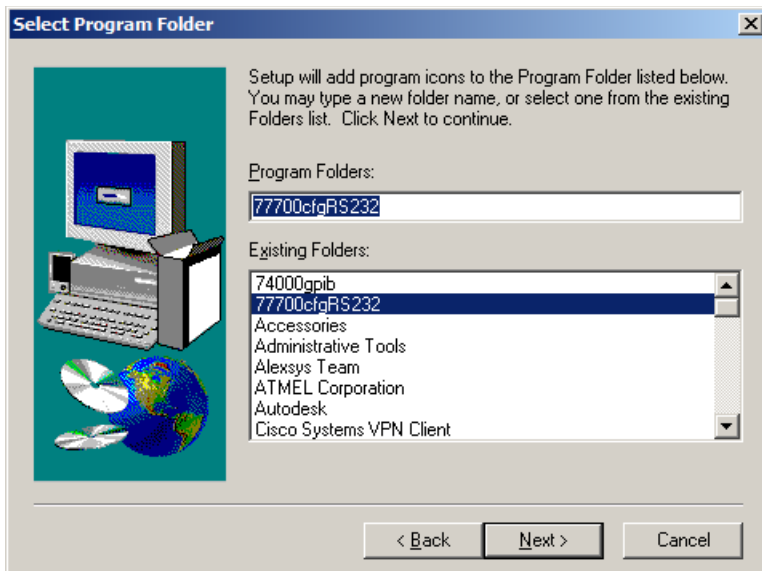


Browse to choose an installation location on the computer, if desired. The default location of the Configuration program will be Program Files\OriellInstruments\77700cfg...

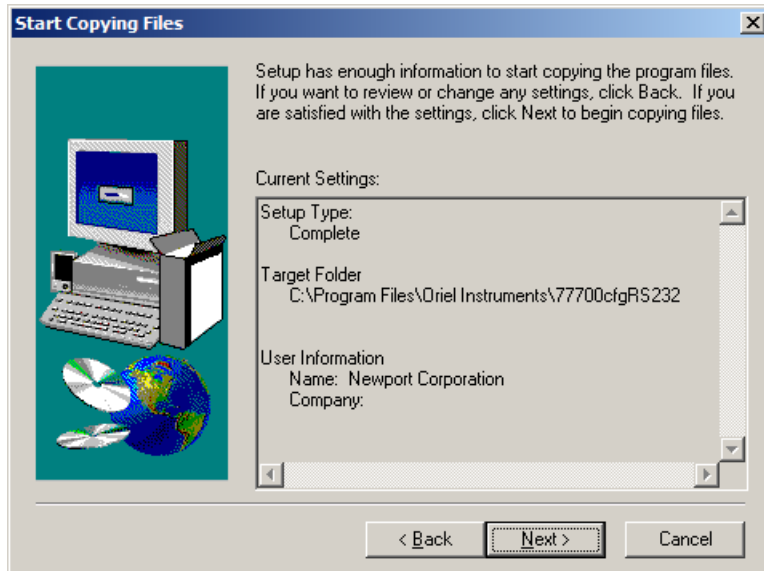
Click Next to proceed.



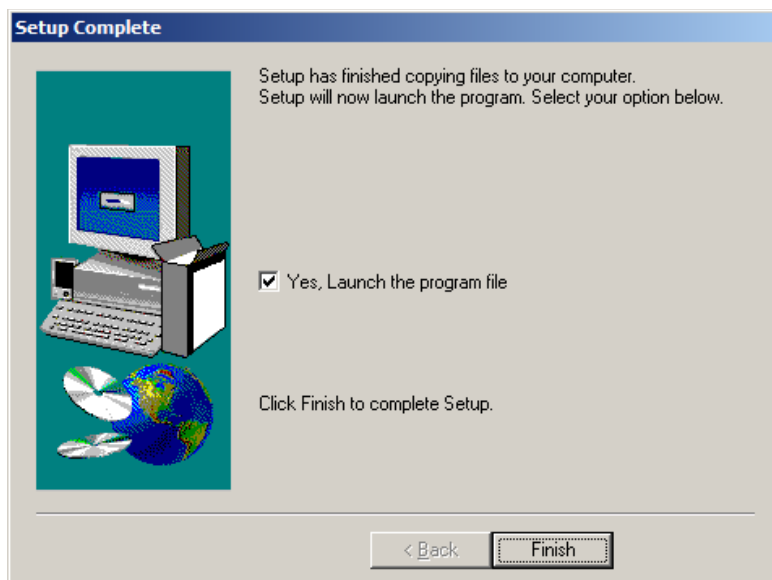
Rename the program folder, if desired, and click Next.



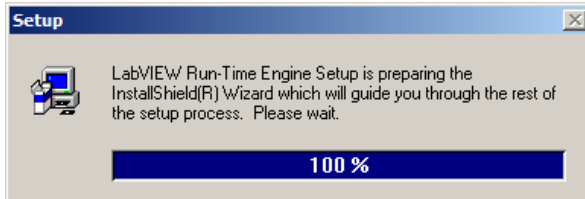
Click Next to proceed.



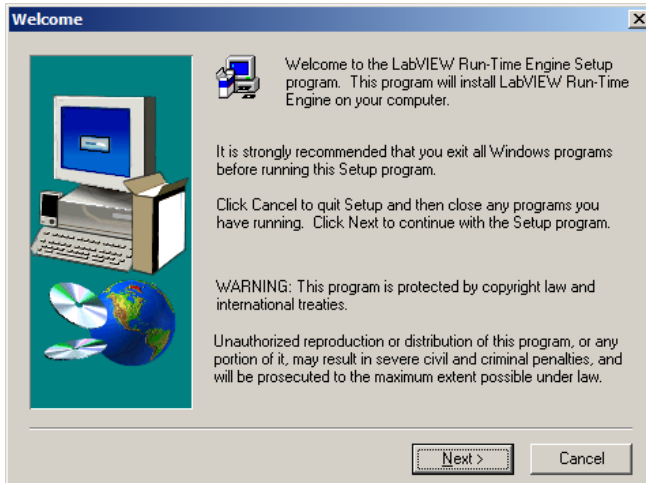
When the setup has been completed, check the box to launch the program file. Then click Finish.



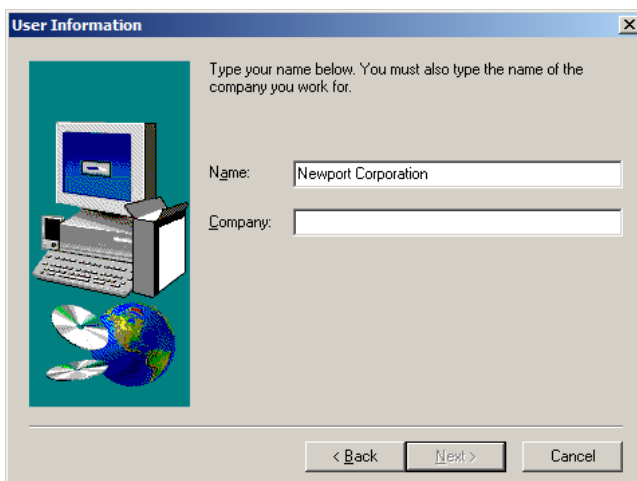
The following window will appear briefly.



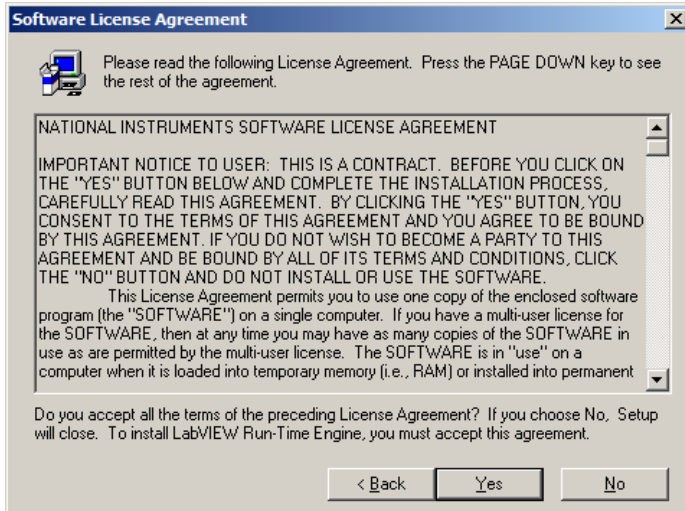
Click Next to proceed with installing the Labview Runtime Engine. Do not cancel this setup, even if a different version had already been installed onto this computer in the past.



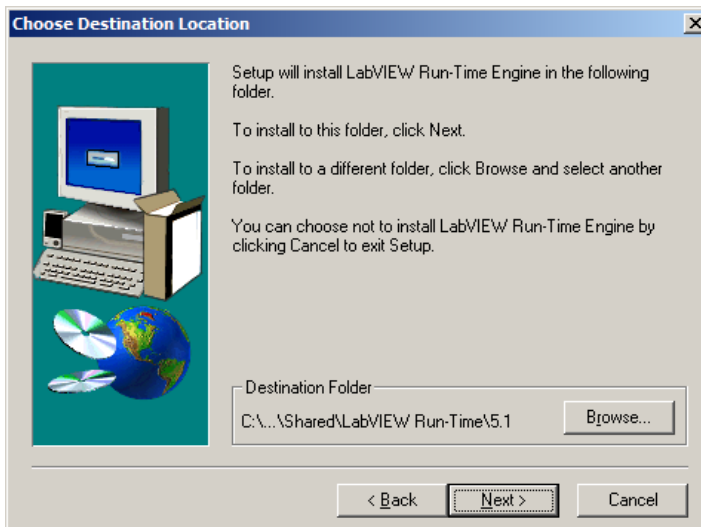
If the GPIB version of the software is being installed, fill in the Name and Company fields before clicking Next. These fields are required to continue with the installation.



Select Yes to accept the license agreement.

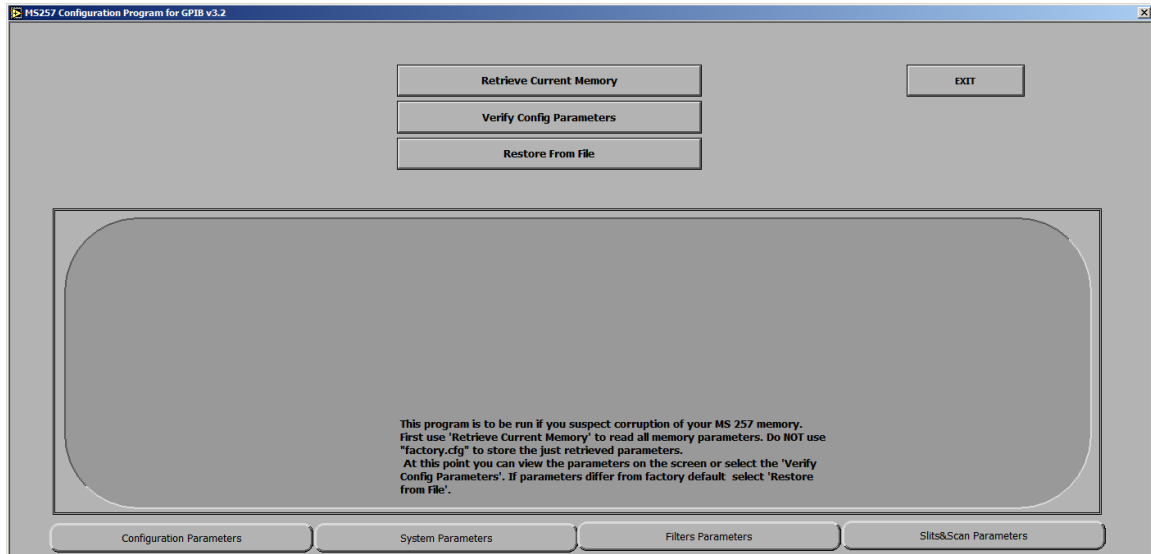


Click Next to install the Labview Runtime Engine into the default directory.

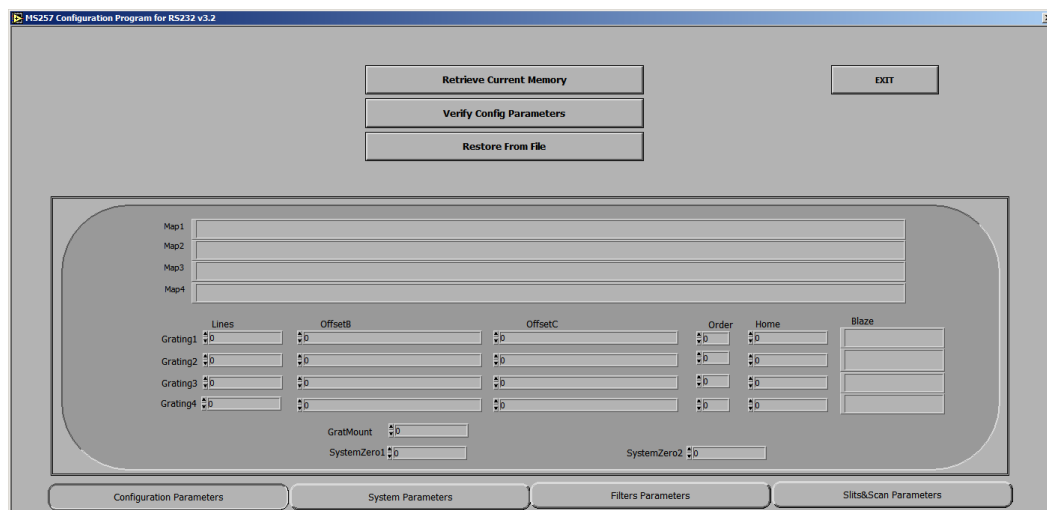


## Using the Configuration Software

- Launch the configuration program from Start/Programs/77700cfg ...



- Use the 'Retrieve Current Memory' menu to read MS257 memory and save to a file.
- To view the retrieved memory selectively, click any one of the four buttons at the 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.



**Figure 10: Configuration Program main window**



### 7.3 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 changing the grating and filter selections. 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 hand controller 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)

The MS257 starts up in the Remote mode of operation (controlled via the USB or RS232 port). To initiate control by the hand controller, the **Local** command key must be pressed. The shifted command, **Rem**, returns control of MS257 to the computer.

Transferring of control of the MS257 between the Hand Controller and the 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' baud 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 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 per mm for the selected grating, and the blaze wavelength label assigned to this grating.
- **Line 3** indicates filter wheel information, first for Filter Wheel 1 and then for Filter Wheel 2, the selected filter position and filter label assigned to that filter.
- **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** - The MS257 is powered up and the Hand Controller is properly connected

**Wait** - The wavelength drive is stationary at a data point when the LED is on.  
 When the LED is blinking, a scan is in progress.

**Shutr** - The shutter is activated (open).

**PortB** - Output 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 MS257 parameters. The command keys are grouped by related function. When a command key is pressed, the command with its current parameter value is 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 for 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 (or 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, 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. If **ESC** is pressed when a table of parameters is being entered, all parameters are discarded. Pressing another command key will have the same effect as would normally occur, and will initiate a new command.



**Figure 11: Hand Controller Keypad**

### **Parameter Tables**

Changeover tables for grating turrets, filter wheels and detector port need to have their parameters 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 is edited and then the selected device number. Each parameter is viewed or entered in turn with the **ENT** key. 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**" saves the table. For creation of tables smaller than an existing 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>0:1 [ENT]  
Wav:Gr>200:2 [ENT]  
Wav:Gr>200:2 [ENT]  
Wav:Gr>300:3 [ENT]  
Wav:Gr>300:3 [ENT]  
Wav:Gr>500:4 [ENT]  
Wav:Gr>500:4 [ENT]

In the above example, the keys Shift and Grat were pressed to display the Grating Table. The response displayed the parameters for the first record. In this case, the first grating was already in the active position. When ENT was pressed the second record is displayed and the cursor is at the start of the changeover wavelength. The wavelength was changed to 250. When ENT was pressed, the wavelength was accepted and the cursor is on the grating position. This process was repeated until all the records were accepted.

**Selecting Auto Mode**

The wavelength changeover table is not used by the MS257 unless the device is placed into automatic operation mode. 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 changeover mode is enabled. Selecting '0' for a device's position enables the automatic mode. Selecting 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 is > 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>0: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>'. Stepup>
Step<		Action	Moves the grating down by one motor step position. The Prompt Line is 'Stepdown>'. 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>'. 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.

Key	Shifted Key	Command Type	Description
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
	No Inf	Action	Disable reporting of system information during a scan. The Prompt Line is 'Info Off>'. Int St
Int St		Action	Disable external BNC/GO signal from controlling scans. The Prompt Line is 'Int Strt>'. Used on legacy models 77700 & 77702.
Ext St		Action	Enable external BNC/GO signal from controlling scans. The Prompt Line is 'Ext Strt>'. Used on legacy models 77700 & 77702.
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 shutter. The Prompt Line is 'Op Shtr>'. CI Sh
	CI Sh	Action	Closes the shutter. The Prompt Line is 'CI Shtr>'. Load
	Load	Action	Recalls the saved system parameters. The Prompt Line is 'Loaded>'. Loaded>'



Key	Shifted Key	Command Type	Description
Save		Action	Saves the current system parameters. The Prompt Line is 'Saved>'. 
	Ver	Action	MS257 firmware version 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 computer. The LCD goes blank, control of MS257 is released to the RS232 or USB 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 hand controller is plugged into MS257. Each time the key is pressed the LCD backlight is toggled. 

## 7.4 COMMUNICATIONS

### Communicating with MS257

There are three ways of sending commands to MS257:

- Using the Hand Controller. The MS257 is already configured for operation with a Hand Controller
- Using the USB or RS232 interface and protocols. The MS257 is already configured for operation via USB or RS232 communications.
- Direct digital (TTL) I/O provided for specific functions.

### Direct control of MS257

The MS257 is the first commercial monochromator/spectrograph to have digital input/output communication facilities built into the unit. Figure 12 shows the connectors at the back of MS257. The BNC connectors enable the shutter to be closely integrated with data acquisition by providing the following TTL synchronizing signals:

- **AUX OUT** - A TTL signal (high) is output from the this BNC connector when the Input Port is set to Port A (axial). A TTL signal (low) is output from the BNC connector when the external input port is set to Port D (lateral).
- **AUX IN** - The normally closed integrated shutter can be opened by an external TTL signal (high) applied to this BNC connector. The shutter remains activated as long as the signal remains high. Note that if the shutter was opened using the utility software, handcontroller or terminal program command, the shutter must be closed prior to applying an external control signal .

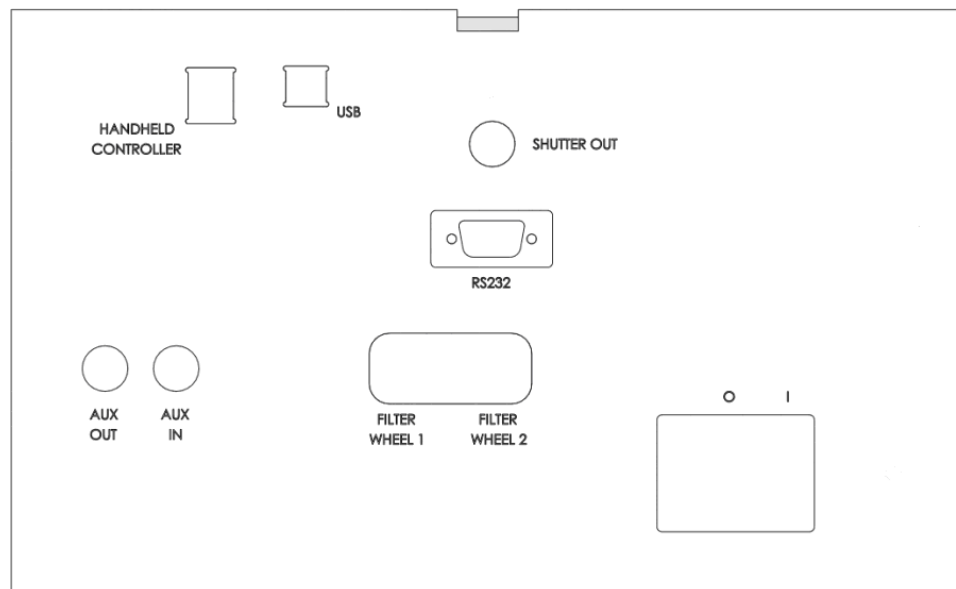


Figure 12: Rear Panel Connections

## 8 PROGRAMMING MS257

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The 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 USB 2.0 using the MS257 command language through a dll.
- Direct communication via RS232 using the MS257 command language.
- Direct communication using National Instruments LabView VIs for inclusion in custom programs.
- TRACQ Data Acquisition Software.

### **MS257 command language**

The MS257 has been designed as that it can easily be programmed and controlled using custom-written software. Control is easy because many functions can be relegated the internal microprocessor, although of course every function can be directly programmed if need be. Programming through the dll allows any language to control the MS257 using USB communication. The user can also control the MS257 through an RS232 cable. For GPIB communication, an adapter cable that works through the RS232 port is available.

## 9 ACCESSORIES

### 9.1 GRATING TURRETS

The drive can control kinematically interchangeable grating turrets. The Oriel Instruments patented 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. All turrets require that the gratings be mounted, aligned and calibrated at the factory.

### 9.2 CONFIGURING THE MS257 FOR TURRET INSTALLATION

With an MS257, there is no need to configure the system for the 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 re-installed without losing the calibration. Each grating comes pre-aligned in a sturdy mount. The mount simply screws down onto the drive. For detailed information about the Grating Turret installation see Section 3.3.

#### 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 pre-aligned in a sturdy mount. The turret simply screws down onto the drive. For detailed information regarding the Grating Turret installation, refer to Section 3.3.

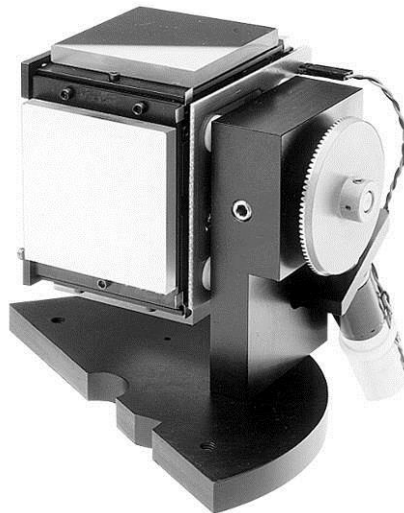


Figure 13: Quadruple Grating Turret

### 9.3 GRATINGS

The standard gratings available for the MS257 are listed below. Other gratings can be specially ordered from Oriel Instruments.

Groove Spacing Lines/mm	Blaze Wavelength (nm)	Type	Peak % Efficiency	Primary Wavelength Region (nm)*	Reciprocal Dispersion (nm/mm)***	Array Bandpass (nm)****	Model Number
2400	250	Holo	65	200 - 700	1.6	41	77740
1800	500	Holo	65	300 - 925**	2.1	53	77753
1200	250	Holo	80	180 - 650	3.2	81	77741
1200	350	Ruled	80	200 - 1400	3.2	81	77742
1200	750	Ruled	80	450 - 1400	3.1	79	77752
600	200	Ruled	70	180 - 500	6.4	163	77743
600	400	Ruled	85	250 - 1300	6.5	165	77744
600	1000	Ruled	80	600 - 2500	6.4	163	77745
600	1250	Ruled	85	750 - 2800**	6.4	163	77767
600	1600	Ruled	90	900- 2800**	6.2	155	77768
400	1200	Ruled	90	700 - 2500	9.7	246	77746
400	1600	Ruled	85	900 - 2900	9.6	244	77769
300	500	Ruled	80	250 - 1150	12.8	325	77747
300	1000	Ruled	85	575 - 2500	12.9	328	77770
300	2000	Ruled	90	1100 - 3400	12.9	328	77748
246.16	226	Ruled	60	190 - 450	15.5	396	77771
200	1000	Ruled	85	600 - 2200	19.3	490	77749
150	300	Ruled	70	190 - 800	25.5	648	77772
150	800	Ruled	85	425 - 1600	25.6	650	77773
150	1250	Ruled	85	725 - 2800	25.7	655	77774
150	4000	Ruled	95	2500 - 9000	25.8	655	77750
121.6	413	Ruled	60	250 - 1000	31.3	798	77754
75	7000	Ruled	80	4500 - 20000	51.7	1313	77751

\* The primary wavelength region is defined by grating efficiency  $\geq 20\%$

\*\* The primary wavelength region for gratings 77753, 77767, 77768 is restricted by the instrument's mechanical design.

\*\*\* The reciprocal dispersion is given at the blaze wavelength.

\*\*\*\* The array band pass assumes a 25 nm wide spectrographic field.

### **Configuring MS257 for the New Gratings**

Gratings should be installed only by users who are extremely experienced with optical calibrations. It is strongly recommended that any grating replacements and recalibrations be performed by trained personnel from Oriel Instruments or Newport Corporation.

The MS257 must be configured for the newly installed grating. This can be done using the following methods:

Use the hand controller to select a grating (GRAT). Change the number of lines/mm (LINES), blaze (BLAZE), and changeover points (CHNGR). Save the new parameters (SAVE).

Use a text editor or word processor software to edit the Configuration file. Change the grating lines/mm, blaze and changeover points. Save the file and use the Configuration program open the file and download it to MS257.

A new grating also requires updating the calibration of the instrument. As mentioned above, performing this process is not recommended. Instead, contact Oriel Instruments or the regional sales representative. They will issue an RMA (Return Material Authorization) number, so that the instrument can be sent to an authorized repair facility for refitting.

## **9.4 SLITS**

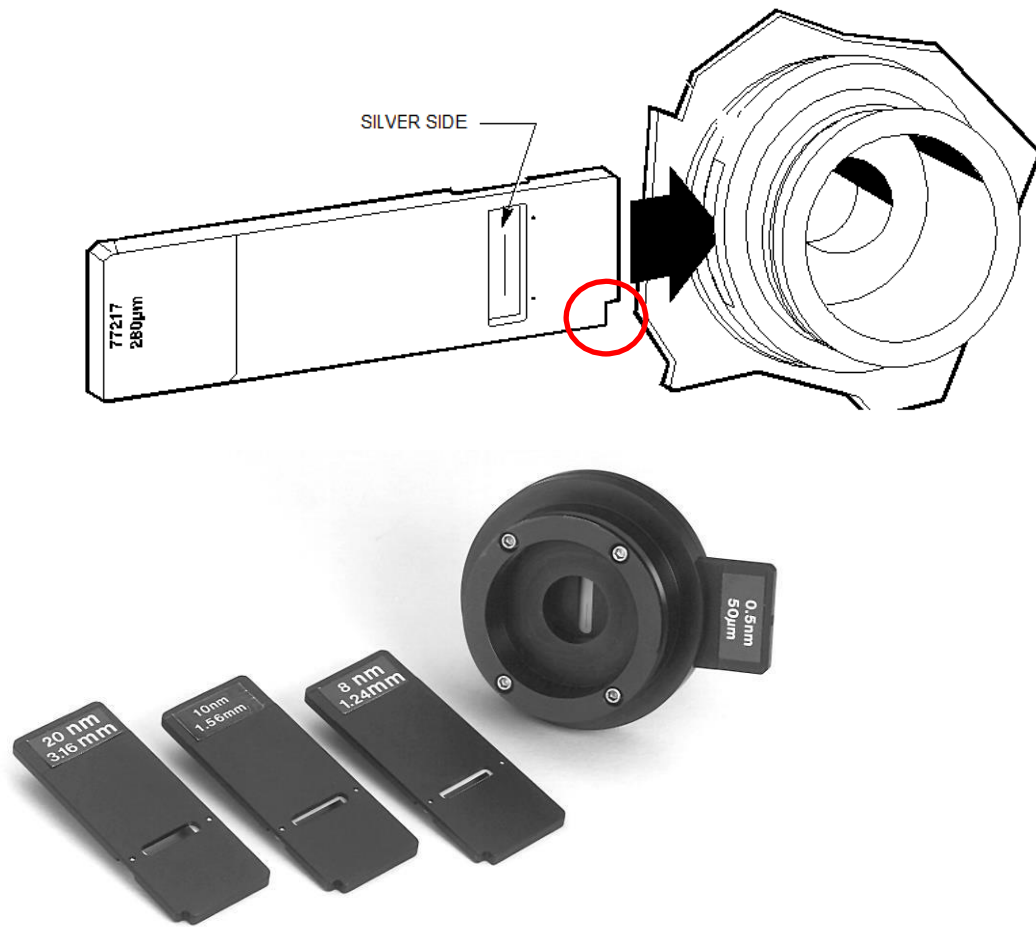
The MS257 must have slits installed in order to function properly. Removing and re-installing or replacing the slits will result in the need to modify the calibration parameters. Three types of slits may be used with MS257:

- Fixed slits of varying widths
- Micrometer driven slit assemblies
- Motorized slit assemblies

### **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 holder has a flange which enables it to be mounted of all Oriel 1.5 inch (47 mm) series accessories.

The fixed slit is inserted into a slit holder, which is mounted to the instrument's port. When inserting a fixed slit, ensure that the slit plate is correctly oriented. There is a notch on one corner of the slit plate which must 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 in the center of the aperture. Make sure that the slit plate is fully inserted for best reproducibility (see Figure 14).



**Figure 14: Using Fixed Slits with MS257**

**Important tips for fixed 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).
- The top portion of the figure above illustrates the correct slit insertion from the left side of the slit holder.

The standard fixed slits available for the MS257 are listed below.

<b>Fixed Slit Model</b>	<b>Slit Width (µm)</b>	<b>Slit Height (mm)</b>	<b>Resolution (nm)</b>
77222	10	2	0.10
77220	25	3	0.15
77725	25	6	0.15
77221	50	3	0.25
77219	50	6	0.25
77728	100	3	0.45
77729	100	10	0.45
77730	200	3	0.8
77731	200	10	0.8
77732	500	15	2
77733	1000	15	4
77734	2000	20	6
77736	1500	15	8
77735	5000	20	20

The typical resolutions listed in the above table apply to use with a 1200 line per mm grating. For other gratings, multiply the resolution listed by 1200 and then divide by the other grating's groove density.

Resolution is defined here as the width of a single wavelength line at the point of half maximum intensity - also known as FWHM, full width at half maximum. Refer to Appendix A for more information on bandpass and resolution.



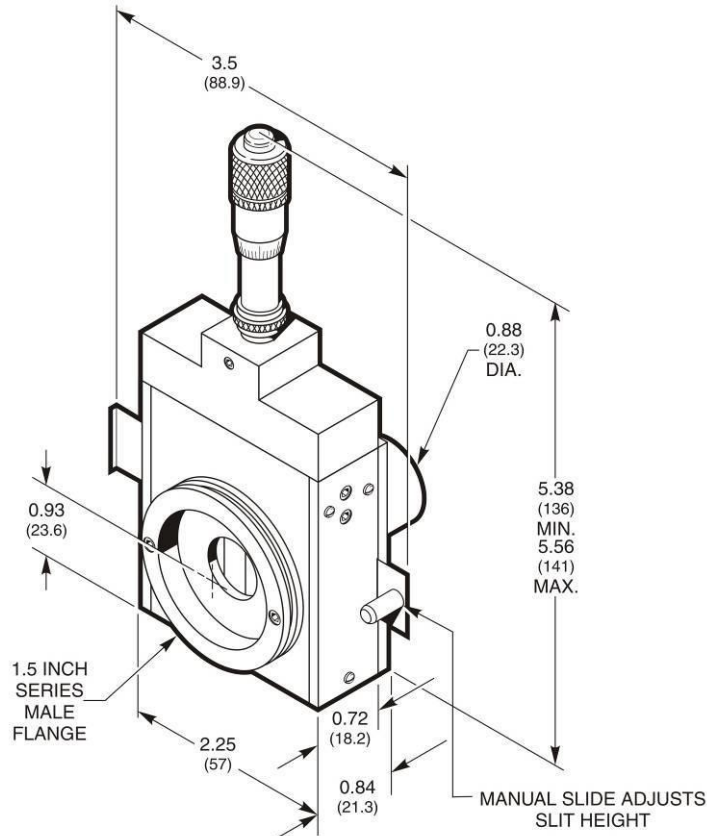
**Micrometer Driven Slit Assembly**

The 74002 Micrometer Driven Slit Assembly uses a precision micrometer drive to adjust the slit width from closed to 3 mm. Apply a 10x multiplier to the micrometer markings to readout the slit opening; thus, each mark on the micrometer barrel corresponds to 10 µm of slit width. The “0” position on the micrometer is the closed position. The height is also continuously adjustable from 3 mm to 12 mm tall, using the manual slide. As a precaution against damaging the slit blades, do not adjust beyond its normal operating range.

Please note that optimum spectral resolution for any monochromator is obtained with short, narrow slits. The 74002 is designed primarily for versatility and convenience in changing resolution and throughput. Fixed slits should be used for the greatest degree of accuracy and repeatability, especially at high resolution.

**Specifications**

Slit Width:	Closed to 3 mm
Slit Height:	3 mm to 12 mm
Precision, Width:	±10 µm
Accuracy, Width:	± 10 µm to 250 µm
	± 5% from 250 µm to 3 mm



**Figure 15: Micrometer Driven Slit Dimensions**

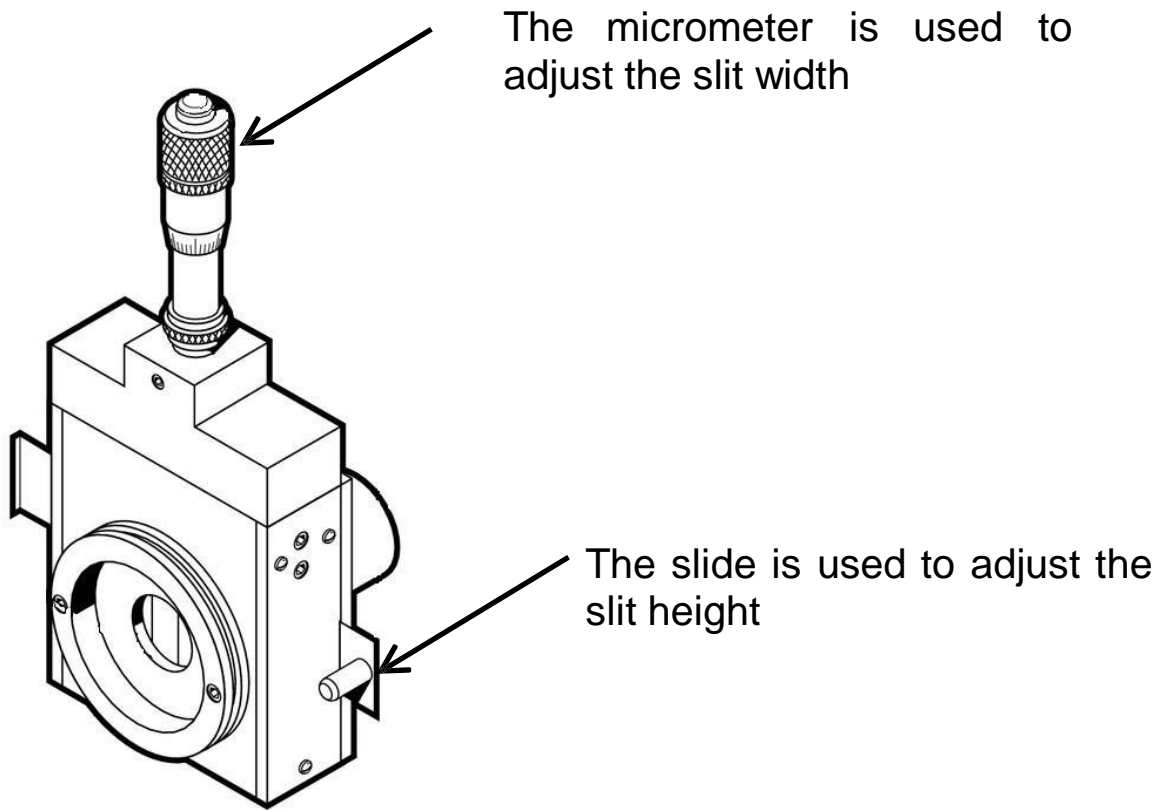
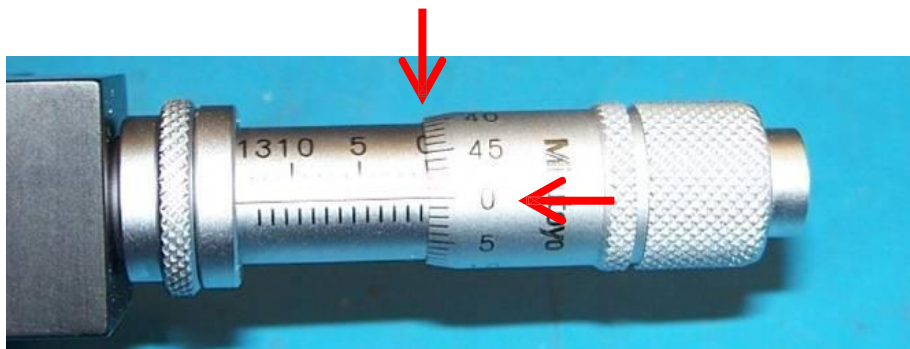


Figure 16: Micrometer Driven Slit Adjustments



**Micrometer setting for a closed slit**

Figure 17: Micrometer Driven Slit Closed Position

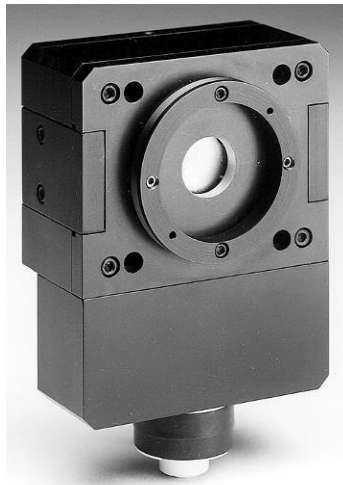
### **Motor Driven Slit Assembly**

The 77722 Motor Driven Slit Assembly has continuously adjustable width from 4  $\mu\text{m}$  to 2000  $\mu\text{m}$ . The slit height is 15 mm. The motor drive uses a micro-stepping motor and each step corresponds to a 2  $\mu\text{m}$  change in slit width. The slits are controlled directly by MS257. Each slit's width can be individually set or they can all be placed under the automatic control of MS257 in order to maintain a constant bandpass at all wavelengths. The required bandpass can be specified using the utility program, hand controller or terminal program.

Note that it is normal for some noise to come from the solenoid, even when the slit width is not changing. The noise level will vary from between motorized slits. The solenoid will get slightly warm when powered on.

When using the hand controller, the following needs to be kept in mind. Commanding the slit to be a width which is an odd number will result in the width being adjusted to the next lower even width. For example, a slit width entered as 7  $\mu\text{m}$  will result in the slit to be set to 6  $\mu\text{m}$  wide. Commanding the slit to be 2  $\mu\text{m}$  wide (which is too narrow) will result in the slit width being set to 4  $\mu\text{m}$ . Commanding the slit to be 3000  $\mu\text{m}$  (which is too wide) will cause error message E0002 to appear on the hand controller display.

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



**Figure 18: Motorized Slit**

### **Slits and the 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 specified in nanometers. At large slit widths the bandpass is synonymous with resolution. But at small slit widths the affect of aberrations tend to limit the resolution even though the bandpass may be very small. Refer to Appendix A, Bandpass and Resolution for more information.

Using the term “resolution” instead of “bandpass” is more meaningful. However, the concept of bandpass is particularly well suited to spectrographs. In this case, a wide wavelength range is spread over an array or CCD. The reciprocal linear dispersion is meaningless in this scenario 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 MS257 can be calculated using the data from Section 9.3. Assuming that instrument has the same width input and output slits, multiply the reciprocal dispersion by the slit width. The number obtained has to be greater than the resolution. If it is not, it means that the instrument will operate below the resolution limit and its bandpass will be determined by the resolution, rather than spectral bandpass of the slit.

### **Mounting Slit Assemblies**

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

The MS257 comes with all slit assemblies installed and the instrument calibrated. Removing and replacing or re-installing the exit slits should only be attempted by personnel who are experienced in optical calibrations. It is strongly suggested to have slits replaced by an authorized service person. Removal of the input slit is never recommended. Recalibration is required whenever a slit is installed – even if it is the same slit being re-attached. Never remove slit assemblies or slit holders for storage or transportation.

When mounting an exit slit assembly, use the following process:

- Use a light source to illuminate the input slit.
- Set the wavelength to zero, or to a prominent spectral line if using a calibration lamp.
- Adjust or change the input slit to a small slit width, or insert a narrow width fixed slit into the slit holder.
- Adjust or change the exit slit to be the same slit width as the input slit.
- 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.

## 9.5 FILTER WHEELS

Up to two optional filter wheels (Model 77737) can be mounted at the input port(s) of the MS257. Each filter wheel holds up to five filters – neutral density, bandpass, interference, etc. The filter wheels are mounted externally to prevent the refractive index and thickness of the filters from affecting the focal distance to the collimating mirror. Altering the focal distance could significantly affect the resolution. A ribbon cable connects each filter wheel to the back panel of the MS257, which can be configured to automatically control filter selection.

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. Refer to the Section on the Hand Controller or Programming Manual for details.

Remove the front cover and the filter retaining rings. Install filters, then re-assemble. It is important to note which filters are installed at each location. This filter number will be displayed in a window when it is being used.

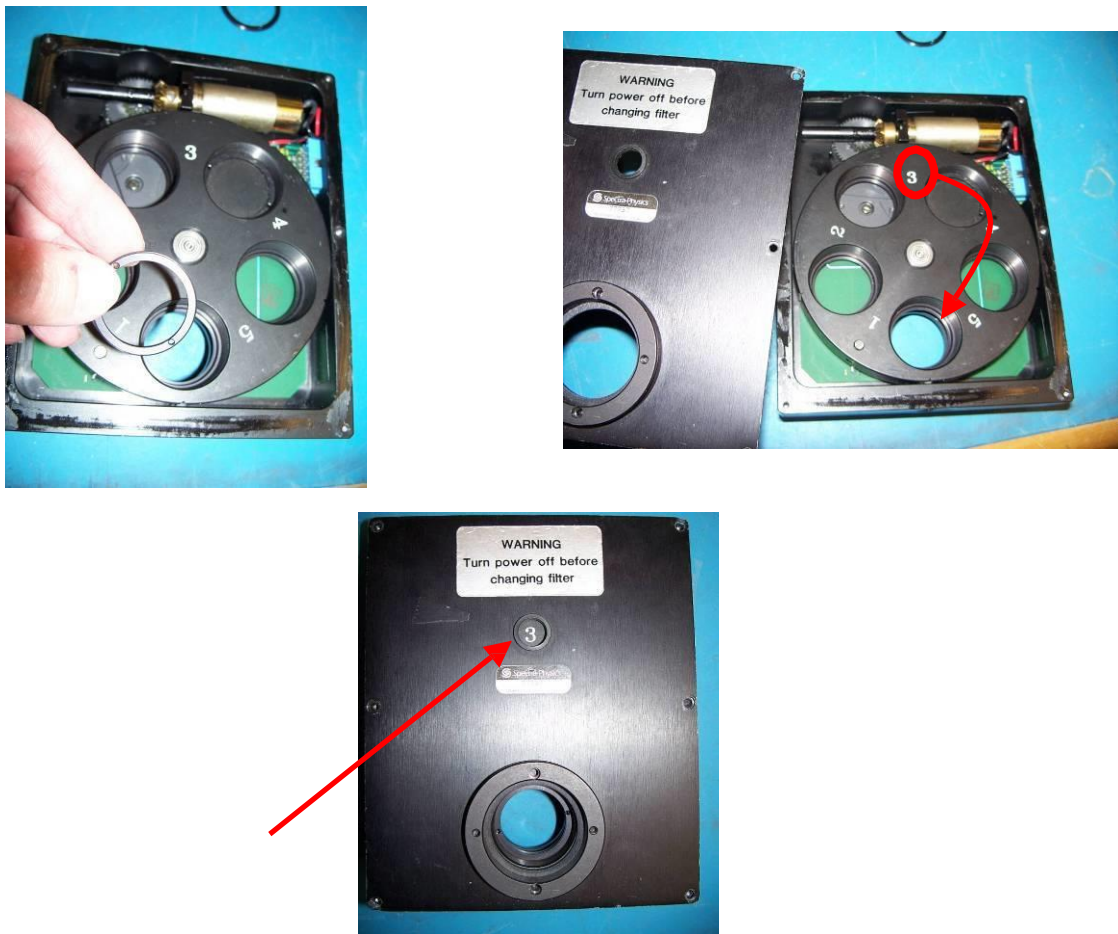


Figure 19: Filter Installation

## 9.6 INPUT AND OUTPUT PORTS

### **Single Output Port Selection**

The standard configuration of the MS257 is to have the output beam exit via the axial port (Port C). The lateral port (Port B) can be used as the sole exit port, with installation of the 77718 Side Exit Mirror.

The side exit mirror installation requires that the instrument be recalibrated. It is strongly suggested to have the installation of the exit mirror and the recalibration performed by Oriel Instruments. Only someone experienced with calibrating optical instrumentation should attempt to install the mirror in the field.

The side exit mirror is installed as follows:

- Remove the MS257 cover.
- Orient the mirror so that reflected light will exit Port B.
- Place the Side Exit Mirror onto the mounting pin, and rotate the base clockwise until it rests against the alignment pin.
- Insert and tighten the two mounting screws (#6-32 socket head cap).
- Replace the MS257 cover.

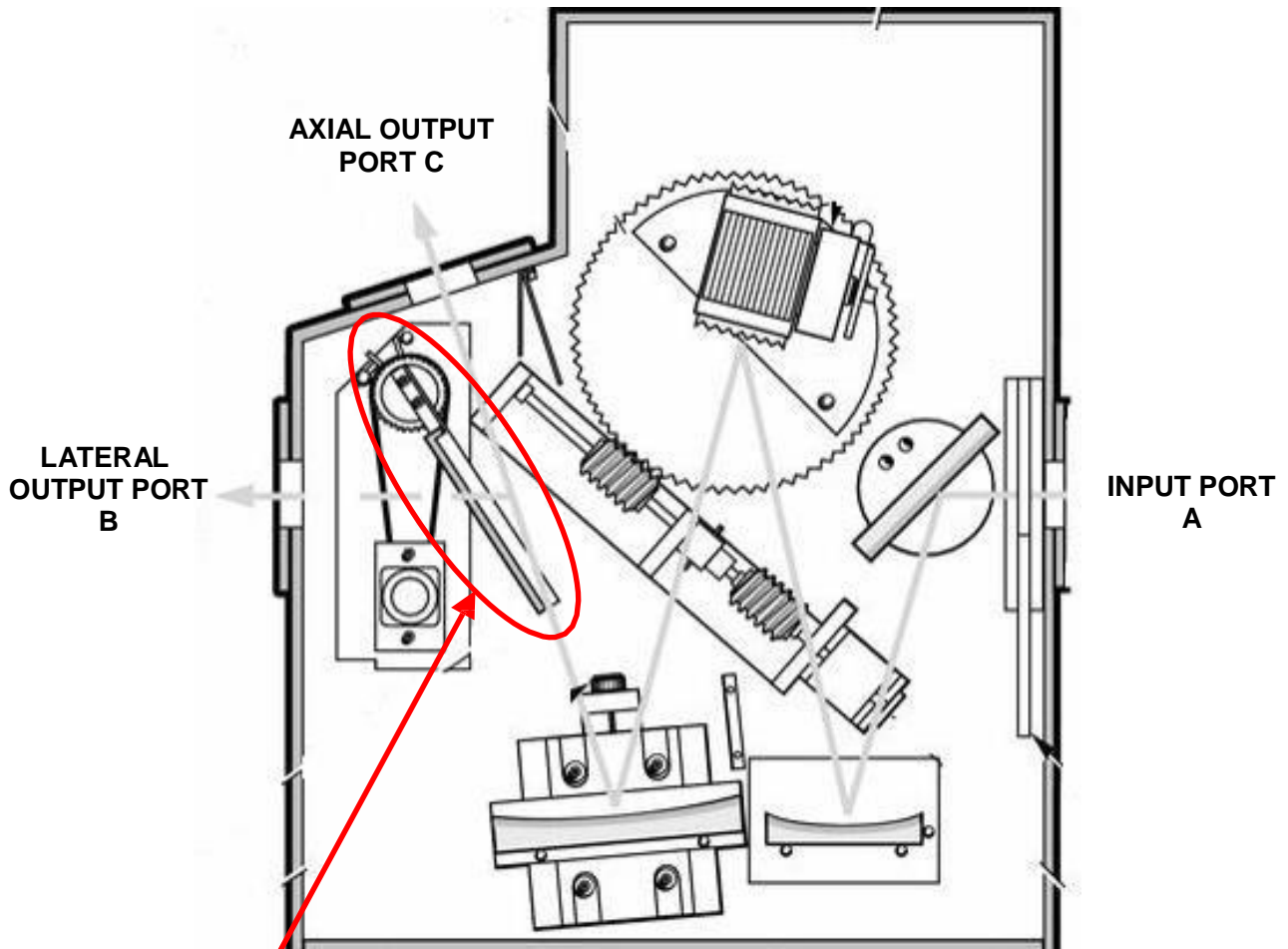
### **Switching Between Two Output Ports**

The output port can be switched between the axial port (Port C) and the lateral port (Port B) 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  $\pm 0.05$  nm. This is essential if scans require two detectors, and must be accurate and repeatable. Port selection can be achieved by using the hand controller, utility program or the MS257 BASIC programming commands.

The side exit mirror installation requires that the instrument be recalibrated. It is strongly suggested to have the installation of the exit mirror and the recalibration performed by Oriel Instruments. Only someone experienced with calibrating optical instrumentation should attempt to install the mirror in the field.

The motorized flip mirror is mounted in the following manner:

- Remove the MS257 cover.
- Orient the mirror so that reflected light will exit Port B when it moves to block Port C.
- Place the flip mirror on the mounting pin, and rotate the base clockwise until it rests against the alignment pin.
- Insert and tighten the two mounting screws (#10-32 socket head cap).
- Replace the MS257 cover.
- Never attempt to turn the mirror by pressing against the back or sides of the mirror. If it is necessary to rotate the mirror manually, do so by moving the contact alignment bar at the base of the mount.



A motorized flip mirror is required to switch between output ports B and C

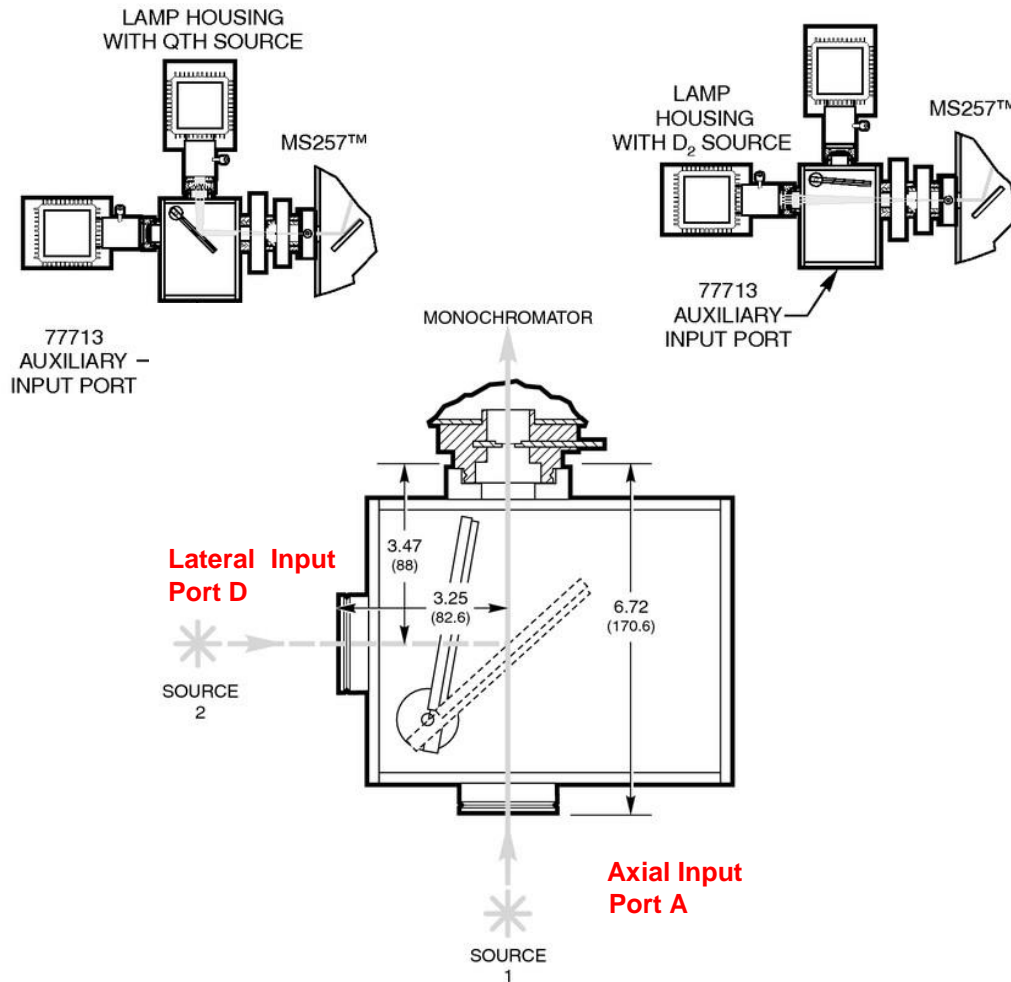
Figure 20: Motorized Flip Mirror

**Switching Between Two Input Ports**

The 77713 Beam Steer is auxiliary input port used to convert MS257 so that it has two selectable input ports available. This is particularly useful for scans which cover wavelength ranges that would benefit from the use of two different sources, such as going from UV to VIS/IR. The selection of input port can also be done under the MS257's automatic control.

The MS257 has dual output ports and can be equipped with multiple gratings for continuous scanning over a very broad wavelength range. Typically, one requires two sources to cover such a broad range. The 77713 allows one to switch between the sources without having to break down the experiment to replace the single source. The mirror is coated with a broadband reflection coating to work over a wide range of wavelengths - from UV to the NIR.

The mirror has two positions. Mirror switching is controlled by a toggle switch on the mirror enclosure, via TTL signal or MS257 automatic control. Precision bearings ensure excellent repeatability.



**Figure 21: Dual Source Configuration**



## 10 SPECIFICATIONS

Unless otherwise stated, all specifications have been determined using monochromator optics, a 1200 line per millimeter grating, a 10  $\mu\text{m}$  x 2 mm slit and light at 546 nm.

### **System**

Design:	Asymmetrical 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 $\mu\text{m}$ (grating dependent)
F number (input):	3.9
Input focal length:	220.0 mm
Exit focal length:	257.4 mm
Included Angle at grating:	23.66°
Mirror Design:	
<b>77781</b>	Spherical
<b>77782</b>	Toroidal
Optical height:	5 inch (127 mm)
Stray Light:	0.03% at 250 nm (Deuterium source & glass filter) 0.0015% 633 nm (laser source)
Overall Dimensions:	19 x 12 x 7.25 in (48 x 30 x 18.5 cm)
Weight:	40 to 45 lbs (18 to 20.5 kg)
Power Requirements	90-264 Vac; 50/60 Hz 1.4A max @ 120 Vac, 0.7A max @ 240 Vac

### **Optical Field**

Full field:	28 mm x 28 mm
Flat field ( <b>77782</b> ):	28 mm x 10 mm
Field tilt relative to mounting face:	
<b>77781</b>	3.1°
<b>77782</b>	6.7° Field
tilt relative to optical plane:	<0.1°
Focal plane clearance:	30.0 mm

### **Wavelength**

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

### **Imaging**

Image horizontal magnification ( <b>77781 &amp; 77782</b> ):	1.1
Vertical magnification ( <b>77782</b> ):	1.6
Imaging spatial resolution ( <b>77782</b> ):	< 350 $\mu\text{m}^*$ (using 200 $\mu\text{m}$ fiber)
Image vertical stability:	$\pm 125$ $\mu\text{m}$
Image horizontal stability:	$\pm 5$ $\mu\text{m}$

\* Oriel Instruments suggests input channel separation to be > 150  $\mu\text{m}$  for practical systems.

**Gratings**

Grating mounts: Single or Quadruple  
Grating Rotation: Optical Center  
Grating Size: 50 x 50 x 6 mm  
Kinematic repeatability: ±0.05 nm  
Quadruple turret grating change time: 1 second per grating  
Grating selection repeatability  
    Wavelength: ±0.05 nm  
    Image vertical position: ±125 µm

**Output Ports**

Port selection repeatability: ±0.05 nm (Motorized mirror)  
Port changeover time: 5 seconds

**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 4 µm to 3.0 mm x 15 mm  
    Precision: ±5 µm  
    Parallelism: ±2 µm  
    Accuracy: ±10 µm  
Motorized slits: Variable from 4 µm to 2.0 mm x 15 mm  
    Precision: ±5 µm  
    Parallelism: ±2 µm  
    Step Size: 2 µm  
    Accuracy: ±10 µm

**Drive**

Motor: High torque micro-stepper  
Drive: Worm Gear  
Step Size: 3.6 arc seconds  
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:**

Hand controller 77709 (optional)  
External computer with software  
MS257 BASIC command language  
(refer to manual M77781B)

**External Interface:**

USB 2.0 (cable included)  
RS232 (cable included)  
GPIB (optional)  
TTL (interface)

<b><u>Software:</u></b>	Utility Software (included) LabView VIs and dll file (included) Spectroscopy software (optional)
<b><u>Hand Controller (optional):</u></b>	40 key hand held keypad 4 line, (20 character) backlit super twist LCD 5 status lights Remote/Local control switching 14 ft (4.26 m) cable
<b><u>Background Shutter:</u></b>	
Behavior:	Normally closed
Aperture:	21 x 13.5 mm
Light Leakage:	<0.001%
Response time:	20 ms
Transition rise time:	2 ms
Blade coating:	Black anodize
External trigger:	TTL
<b><u>Fast Shutter (optional):</u></b>	
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 <sub>2</sub>
External trigger:	TTL
<b><u>Filter Wheel (optional):</u></b>	
Filter wheels supported:	2
Aperture:	22 mm
F number:	3.9
Optical length:	38 mm
Number of filters per wheel:	5
Filter size:	1 inch (25.4 mm)
Maximum thickness:	0.4 inch (10 mm)
Transition time:	1 second per filter

## 11 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.  $F = 1 / (2 \times NA)$ . The smaller the F number, and the larger the numerical aperture, the greater the amount of light collected. However, as the F number decreases, the resolution deteriorates due to increased aberrations. This is compensated for by the instruments size and mirror specifications. The F number is not a fixed value and changes with grating position. As the grating rotates from a near normal (perpendicular) position, the effective aperture decreases and the F number increases.

The specified F number of the MS257 is not as defined as one would first expect. The F number is correctly defined as focal length / aperture diameter. However when the aperture is a rectangular grating, what constitutes the diameter? Oriel Instruments solves this problem by using a diameter which would give the equivalent area to the grating. For example: the effective F number of the Oriel 77781 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. This is still considered to be an approximation since it assumes that the entire grating surface is being used and that it is perpendicular to the incident beam, which is rarely the case.

### **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 over-coated 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 saw tooth pattern, shown in Figure 22.

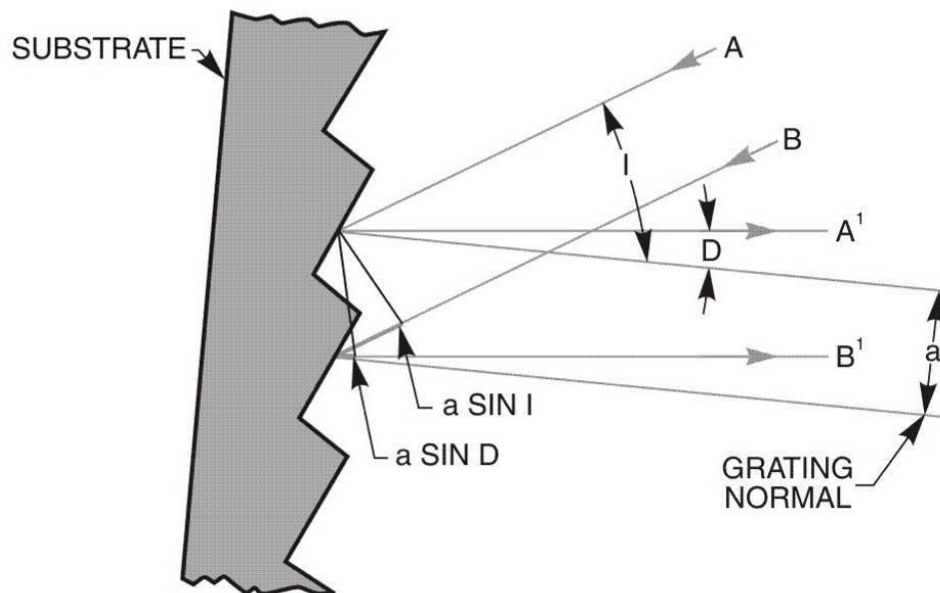


Figure 22: Diffraction Geometry of a Plane Reflection Grating

Light rays **A** and **B**, of wavelength  $\lambda$ , incident on adjacent grooves at angle  $\theta$  to the grating normal are shown. Consider light at angle  $\phi$  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  $a \sin \phi + a \sin \theta$ , 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  $\lambda$  :

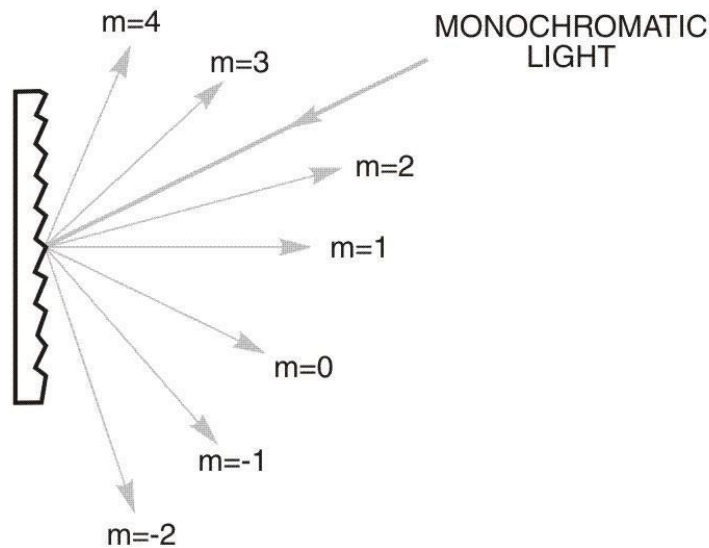
$$a(\sin \theta + \sin \phi) = m\lambda,$$

where  $m$  is an integer.

This is the basic grating equation,  $m$  is called the order of diffraction. Note that if  $\theta$  and  $\phi$  are on different sides of the grating normal the sign of  $\phi$  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  $\phi$ .

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 23, and discussed further under "Grating Orders" in Appendix A.



**Figure 23: The "Grating Equation"**

In monochromators designed by Oriel Instruments, 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  $\phi$ , 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  $\theta$  and  $\phi$  change, although the difference between them remains constant and is fixed by the geometry of the monochromator. The wavelength  $\lambda$  changes as the grating angle changes and:

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

where  $\theta$  is the angle between the incident ray and the diffracted ray at the grating, and  $\phi$  is the grating angle relative to the zero order position.

### **Grating Dispersion**

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

It is often asked why gratings aren't made with many thousands of lines per millimeter. Usually gratings with 2400 lines per millimeter are the upper 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 fundamental reasons for not doing so. As the number of lines increases, the wavelength range of the grating decreases until it is of little use, except for very specialized applications. A 2400 l/mm grating has a maximum range of about 600 nm, but a 4800 l/mm grating would have a range of only about 300 nm - and then only in the UV to visible wavelengths.

### **Bandpass & Resolution**

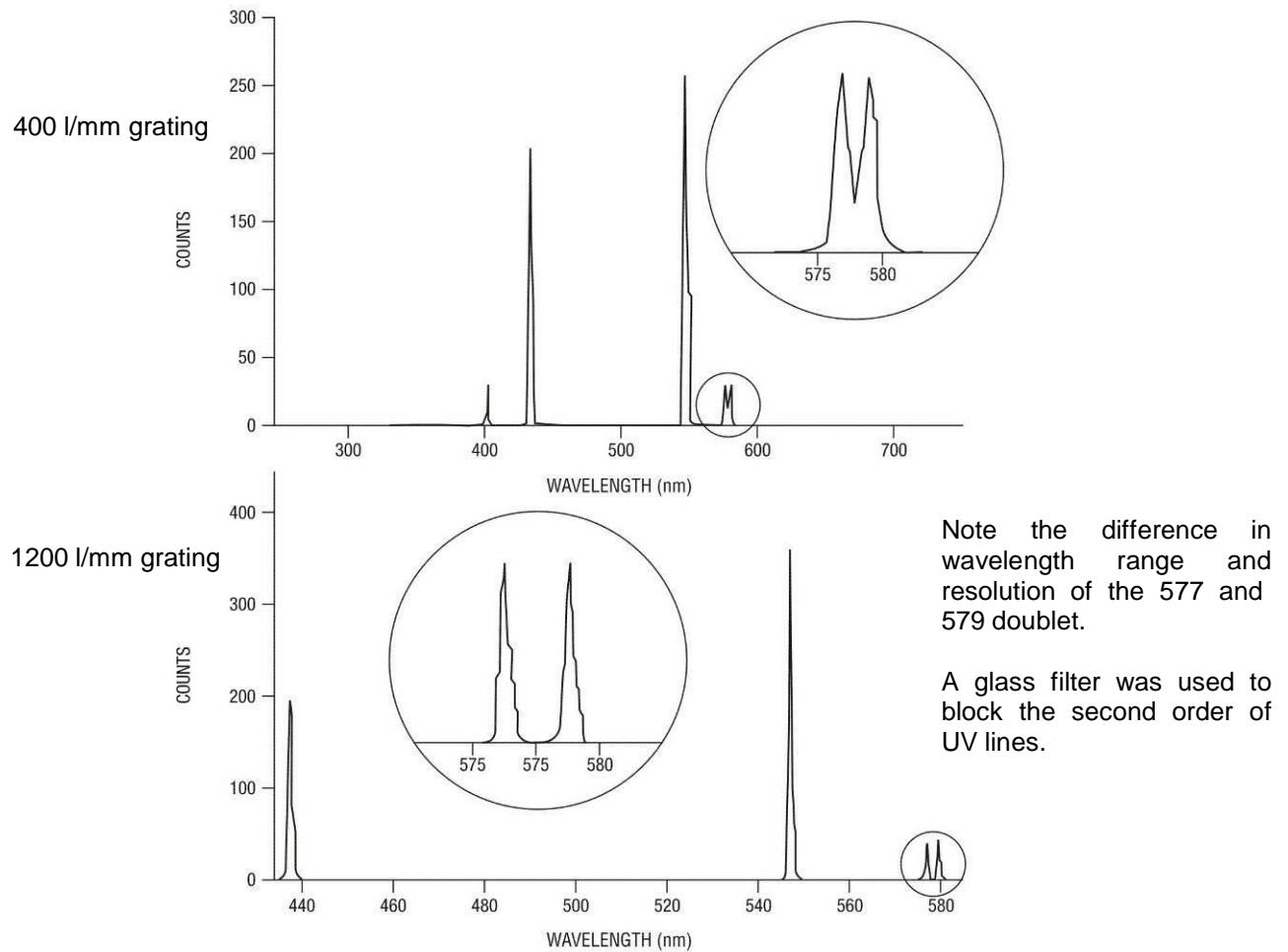
Bandpass is the range of wavelengths passed by the monochromator at any one wavelength setting. It may be obtained by multiplying the slit width by the reciprocal linear dispersion and is usually quoted in nanometers.

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 resolution. For any instrument, the optical aberrations are minimized by illuminating only the central zone of the input slit.

Resolution is a measure of how finely a monochromator can differentiate between spectral lines. Since resolution is closely related to dispersion, higher dispersion results in better resolution. If the number of lines per millimeter is doubled the resolution is twice as good. 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 24).

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 between the 80% intensity levels 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 nm. Note that it can be misleading to talk about "raising" or "increasing" the resolution, when in fact the resolution number decreases. Oriel Instruments uses the convention that raising or increasing the resolution is an improvement, although the resolution number actually decreases, e.g. raising the resolution from 2 nm to 1 nm.



**Figure 24: Grating Resolution**

When spectrographs are used with diode arrays and CCD detectors, the resolution is often limited by the pixel width. Nyquist sampling theory leads to calculating the resolution as if an exit slit were equal to two pixels. Thus the limiting resolution of an MS257 with a diode array and 25  $\mu\text{m}$  wide pixels would be about 0.2 nm.

### Grating Orders

Gratings have the property of dispersing light into a series of orders (See Figure 25). 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. For example, 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. Diffraction orders are an overlapping of orders.

Additionally, 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 the zero order reflected beam. Most light energy is dispersed into the first order and in the direction of the blaze.

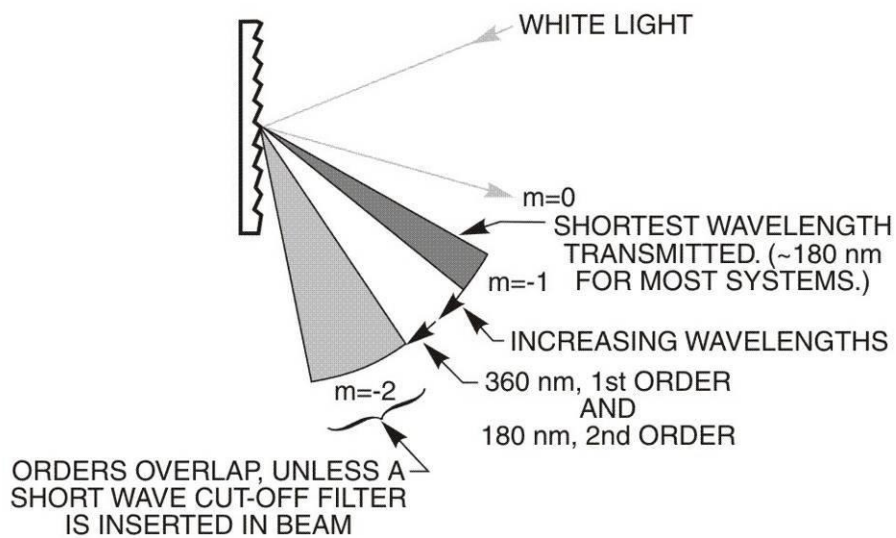


Figure 25: Diffraction Orders

**NOTE:** negative orders are defined as orders, which are at angles exceeding that of the zero order. Positive orders are not shown for clarity in Figure 25.

In order to take truly accurate readings, it is necessary to eliminate multiple orders. This is done by using 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 would 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 automatic computer control. The MS257 allows one to take long scans and change filters without interrupting the scan.



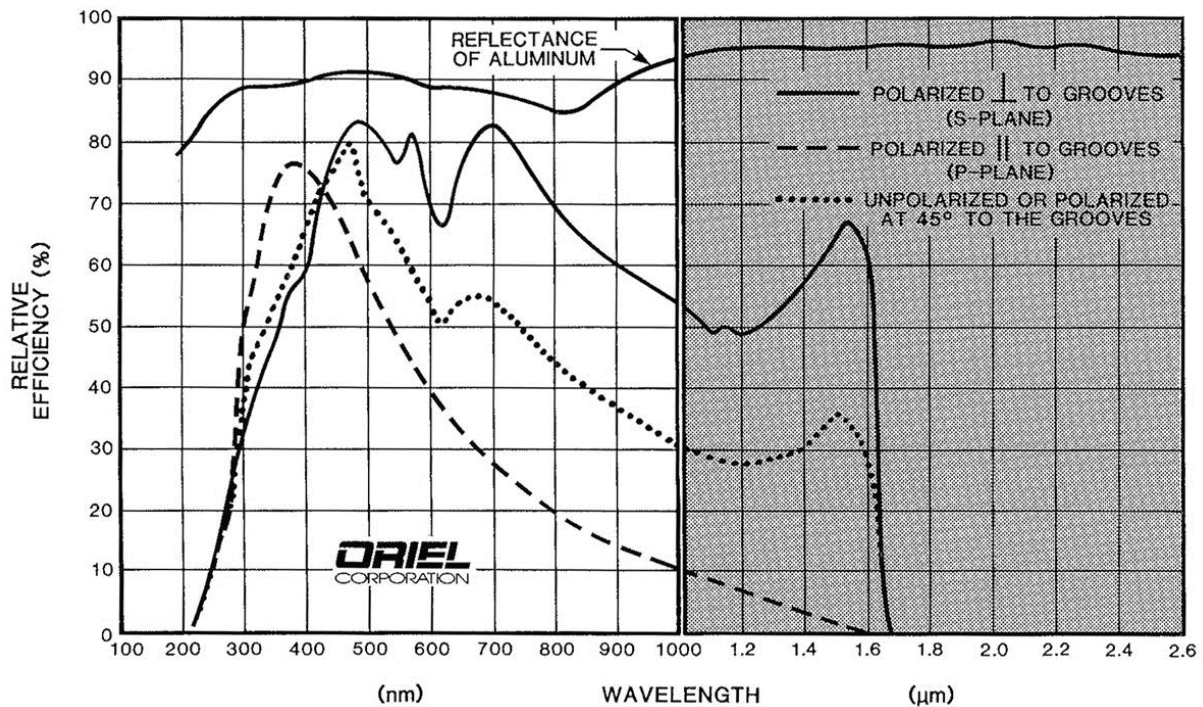
### **Blaze**

The blaze wavelength is the wavelength at which the 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 (see Figure 23). Blaze is important because it allows a grating to be chosen for optimal efficiency in a given wavelength range. As a general rule, one should select a grating with a blaze wavelength at the extreme short wavelength end of the region of interest. This is because the majority of sources and detectors are more efficient at longer wavelengths. The selection of a grating blazed at a short wavelength compensates for the lack of radiation and detector sensitivity in that wavelength region.

### **Efficiency**

The greatest efficiency one 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 rest 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 500 nm has an efficiency of only 10% for first order 250 nm light. In the second order, the 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.



**Figure 26: Polarization and Efficiency**

**Polarization**

The diffraction efficiency of a grating usually depends on the polarization of the radiation incident I (on the grating (See Figure 26). This figure shows the effect of polarization on the grating efficiency of a 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 technology lends itself to having a blaze angle formation, to offer the highest efficiency at the blaze wavelength. 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. This produces 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 for being the "best" gratings, but this is not necessarily the case. Sinusoidally grooved gratings produce very little scattered light but have low flat efficiency curves, although they are generally quite broad. The blazed holographic gratings use etching during the interferometric process, or an ion gun to form a blaze angle in a secondary process. The former does not produce strong blazing. While holographic gratings produce high efficiencies at the blaze wavelengths, there is also an increase in stray light due to the formation of microstructure along the edges of the grooves. Oriel Instruments offers both rules and holographic gratings to provide the best combination of blaze, efficiency and low light scatter for different wavelength ranges.

## 12 DECLARATION OF CONFORMITY

### EC DECLARATION OF CONFORMITY

Manufacturer's name:	Newport Corporation
Manufacturer's address:	150 Long Beach Boulevard Stratford, CT 06615 USA
Declares that the product:	
Product Name:	MS257 USB/RS232
Model Number:	77781, 77782
Type of equipment:	Electrical equipment for measurement, control and laboratory use in industrial locations
conforms to the following Product Specifications:	
Safety:	EN 61010-1:2010
EMC:	EN 61326-1:2006 +cor:2008 +cor:2010
complies with the following Directives:	
	2004/108/EC EMC Directive
	2006/95/EC Low Voltage Directive
and accordingly, carries the <b>CE</b> mark	
<b>CE</b> mark affixed:	Beaune; 01/06/2012
	
Domenic Assalone Site Manager, Oriel Products Division 150 Long Beach Boulevard Stratford, CT 06615 USA	Bruno Rety Authorized to compile technical documentation Group Director, PPT Instrument and Motion Europe Micro-Contrôle Division of Newport Corporation Zone Industrielle 45340 Beaune la Rolande, France

## 13 WARRANTY AND RETURNS

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To obtain information regarding sales, technical support or factory service, United States and Canadian customers should contact Oriel Instruments directly.

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Repair Service: [rma.service@newport.com](mailto:rma.service@newport.com)

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Please have the following information available when requesting assistance or service:

Contact information for the owner of the product.  
Instrument model number (located on the product label).  
Product serial number and date of manufacture (located on the product label).  
Description of the problem.

To help Oriel's Technical Support Representatives diagnose the problem, please note the following:

Is the system used for manufacturing or research and development?  
What was the state of the system right before the problem?  
Had this problem occurred before? If so, when and how frequently?  
Can the system continue to operate with this problem, or is it non-operational?  
Were there any differences in the application or environment before the problem occurred?

## 13.3 REPAIR SERVICE

This section contains information regarding factory service for this product. The user should not attempt any maintenance or service of the system beyond the procedures outlined in this manual. This product contains no user serviceable parts other than what is noted in this manual. Any problem that cannot be resolved should be referred to Oriel Instruments.

If the instrument needs to be returned for service, a Return Material Authorization (RMA) number must be obtained prior to shipment to Oriel Instruments. This RMA number must appear on both the shipping container and the package documents.

Return the product to Oriel Instruments, freight prepaid, clearly marked with the RMA number and it will either be repaired or replaced at Oriel's discretion.

Oriel is not responsible for damage occurring in transit. The Owner of the product bears all risk of loss or damage to the returned Products until delivery at Oriel's facility. Oriel is not responsible for product damage once it has left the facility after repair or replacement has been completed.

Oriel is not obligated to accept products returned without an RMA number. Any return shipment received by Oriel without an RMA number may be reshipped by Newport, freight collect, to the Owner of the product.

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For Products returned for repair that are not covered under warranty, Newport's standard repair charges shall be applicable in addition to all shipping expenses. Unless otherwise stated in Newport's repair quote, any such out-of-warranty repairs are warranted for ninety (90) days from date of shipment of the repaired Product.

Oriel will charge an evaluation fee to examine the product and determine the most appropriate course of action. Payment information must be obtained prior to having an RMA number assigned. Customers may use a valid credit card, and those who have an existing account with Newport Corporation may use a purchase order.

When the evaluation had been completed, the owner of the product will be contacted and notified of the final cost to repair or replace the item. If the decision is made to not proceed with the repair, only the evaluation fee will be billed. If authorization to perform the repair or provide a replacement is obtained, the evaluation fee will be applied to the final cost. A revised purchase order must be submitted for the final cost. If paying by credit card, written authorization must be provided that will allow the full repair cost to be charged to the card.

### 13.5 WARRANTY REPAIR

If there are any defects in material or workmanship or a failure to meet specifications, notify Oriel Instruments promptly, prior to the expiration of the warranty.

Except as otherwise expressly stated in Oriel's quote or in the current operating manual or other written guarantee for any of the Products, Oriel warrants that, for the period of time set forth below with respect to each Product or component type (the "Warranty Period"), the Products sold hereunder will be free from defects in material and workmanship, and will conform to the applicable specifications, under normal use and service when correctly installed and maintained. Oriel shall repair or replace, at Oriel's sole option, any defective or nonconforming Product or part thereof which is returned at Buyer's expense to Oriel facility, provided, that Buyer notifies Oriel in writing promptly after discovery of the defect or nonconformity and within the Warranty Period. Products may only be returned by Buyer when accompanied by a return material authorization number ("RMA number") issued by Oriel, with freight prepaid by Buyer. Oriel shall not be responsible for any damage occurring in transit or obligated to accept Products returned for warranty repair without an RMA number. Buyer bears all risk of loss or damage to the Products until delivery at Oriel's facility. Oriel shall pay for shipment back to Buyer for Products repaired under warranty.

#### WARRANTY PERIOD

All Products (except consumables such as lamps, filters, etc) described here are warranted for a period of twelve (12) months from the date of shipment or 3000 hours of operation, whichever comes first.

Lamps, gratings, optical filters and other consumables / spare parts (whether sold as separate Products or constituting components of other Products) are warranted for a period of ninety (90) days from the date of shipment.

#### WARRANTY EXCLUSIONS

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