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Princeton Instruments

Model VM-504

0.39 Meter Triple Grating Vacuum Monochromator Operating Instructions

VM-504 s/n:
SD3 s/n:

PRINCETON INSTRUMENTS
VM-504
Operating Instructions

CONTENTS:

I. Description

Princeton Instruments' VM-504:
The Model VM-504 is a fast f/5.4, 0.39 meter focal length vacuum monochromator featuring, triple indexable gratings, microprocessor control, computer compatibility and optional multiple slit positions. From a computer using the Monochromator Control Software you can easily change gratings, adjust scanning speed, set "go to" wavelengths, program repeating scans and "manually" scan via jog buttons. Refer to the Acton Monochromator Control Software Manual for more details. The multiple port option allows the selection of either one of the two entrance or two exit ports by simply moving diverter mirrors in or out of the beam.

VM-504 Scan Mechanism:
In place of the conventional sine drive system found in most monochromators, the VM-504 utilizes Direct Digital Scanning (DDS). A DDS system permits grating rotation up to 65 degrees, offering the user maximum scanning range from each grating installed. Microprocessor control enables the DDS system to emulate a sine drive system to provide precise linear scanning with respect to wavelength. The result is a wavelength scanning system that combines the linear scanning of a precision sine drive system with the simplicity and versatility of a direct digital scanning arrangement.

SD3-504 Electronics:
The VM-504 controller contains a built-in microprocessor and computer connection for control of the monochromator from a computer. Computer control is provided through a standard USB port or RS-232 COM port. Refer to the Acton Monochromator Control Software Manual for more information on the supplied software.

Triple Indexable Gratings:
This VM-504 feature allows 1, 2, or 3 gratings to be installed for maximum versatility. Grating selection is a done through the Monochromator Control Software on the computer that keeps you informed of the grating specifications, such as groove spacing and blaze wavelength all without breaking vacuum.

Moveable Diverter Mirrors: (optional)
If the instrument is equipped with side mounted slits, moveable diverter mirrors are provided to direct the beam to these ports. A control lever for moving each diverter mirror is located on the bottom of the instrument housing. This lever controls the diverter mirror position, thus allowing the user to choose the straight through or side slit position. Note that this is a manual operation on the VM-504 and is not controlled through Monochromator Control Software.

II. VM-504 Specifications

Focal Length: 0.39 Meters

Optical System: Czerny-Turner type with end slit positions and optional multi-port configuration featuring with an in-line 180 degree optical path.

Wavelength Scanning System: Direct Digital Scanning with exclusive SD3-504 electronics.

Scan Linearity: The VM-504 scans linear with respect to wavelength.

Coating: Unless otherwise specified the grating and mirror will be Al & MgF2 coated for maximum reflectivity in the vacuum ultraviolet region of the spectrum.

Triple Indexable Gratings: Customer may select 1, 2, or 3 gratings at time of instrument purchase. Standard gratings are 68 X 68mm. Larger 68 X 84mm gratings are also available to maintain an effective f/5.4 aperture ratio out to 1.2µm with 1200 g/mm grating.

Resolution: 0.06nm with standard 1200 g/mm grating, 10µm wide X 4mm high slits, measured at 435.8nm.

Reciprocal Linear Dispersion: Nominal 2.1nm/mm with 1200 g/mm grating installed.

Aperture Ratio: f/5.4

Wavelength Operating Range: 115nm to 1.4µm with 1200g/mm grating installed.

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

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

Slits: Standard slits are bilaterally adjustable from 5µm to 3.0mm, via external micrometer. Slit height is manually adjustable from 0 - 20mm.

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

VM-504 Dimensions:
Length: 19" (483 mm)
Width: 16" (406 mm)
Height: 9.5" (241 mm)
Optical Axis Height: 5-7/16" (138 mm)
Weight: Approximately 75 lbs

SD3-504 Dimensions:
Length: 5.3" (135 mm)
Width: 7" (645 mm)
Height: 2.3" (58 mm)
Weight: Approximately 1.5 lbs

Electrical Requirements: 120/240 VAC 2 Amp.

III. Instrument Setup

General Description:

The instrument is shipped completely assembled, tested, and ready for immediate installation. If the instrument is to be stored before use, notify Princeton Instruments for storage instructions.

For shipping purposes, some optical components are covered. The following procedure is recommended to prepare the instrument for use.

1. Unpacking and Inspection:

Carefully unpack and examine both the VM504 monochromator and the scan controller unit. If there is any indication of physical damage, report the condition immediately to the carrier, Princeton Instruments and save all packing material.

2. Removal of Protective Covers:

To remove the protective covers on the optical components, the instrument cover must be removed. This should be done only by personnel familiar with optical surfaces, vacuum systems and instrumentation.

A. Remove instrument cover by completely loosening the four cap screws in the cover. Note: These screws are captive. Grasp the cover by its edges, lift up, and place it on a clean dry surface.

CAUTION: Optical surfaces are now exposed -- Do not touch, talk or breathe over these surfaces. Observe proper vacuum procedures when handling components exposed to the instrument vacuum.

B. Aluminum shipping covers are attached over the collimating and focusing mirror masks with rubber bands. It is recommended that the mirror cover be held against the mirror masks while cutting and removing the rubber bands on both mirror assemblies. Assure that all the rubber bands are removed from the chamber. Remove only the blank aluminum mirror covers.

NOTE: DO NOT LOOSEN OR REMOVE ANY SCREWS!

C. Replace instrument cover after checking o-ring and sealing surface for cleanliness.

3. Pumping Port:

A pumping port is provided in the base of the instrument for direct connection to a pumping system. A pumping system up to 30 lbs can be supported from the instrument. A small turbomolecular pump can be connected directly if properly balanced. However, cryo pumps or pumps that vibrate must be isolated or instrument performance will be affected. Refer to the enclosed pictorial drawing for pumping port specifications. Pumping adapters to various

standard flanges are available as an option. These option adapters are shipped attached to the pumping port if specified.

4. Optional Gauge Port:

An optional gauge port can be provided in the cover that accepts 3/4 inch diameter gauge tubes directly.

5. Optional Side-Slit Ports:

If the instrument is supplied with optional side slits, externally controlled diverter mirrors for slit port selection are provided.

NOTE: The diverter mirror control levers are held in place for shipping with rubber bands. To remove the rubber bands, carefully cut the bands and remove them from the diverter mirror control levers.

6. VM-504 Monochromator to SD3-504 External Scan Controller Connection:

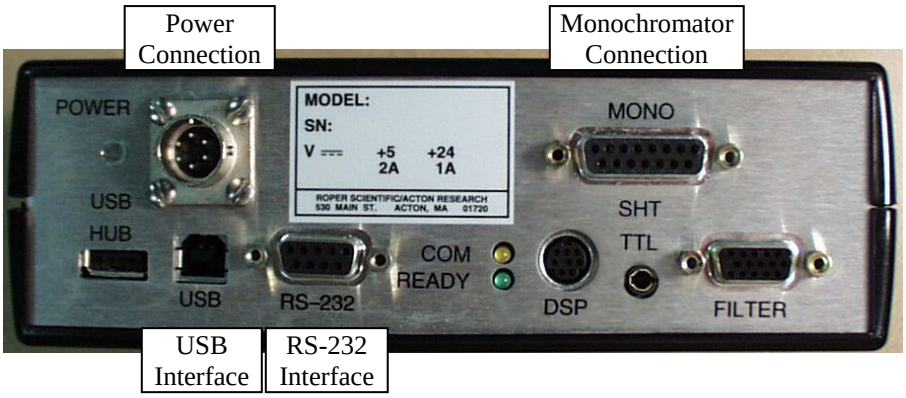
Connect the motor drive cable between the 15 pin D connector (J1) on the monochromator and the 15 pin D connector (J1) on the SD3-504.

Pin #-Monochromator	Description	Pin #-SD3
1	Motor – A1	1
2	Motor – A2	2
3	Motor – B1	3
4	Motor – B2	4
5	Open	5
6	Shield–(Controller Only)	6
7	Interrupt Module +5V	7
8	Interrupt Module GND	8
9	Interrupt Module 1 LED K	9
10	Interrupt Module 2 LED K	10
11	Interrupt Module 1 LED A	11
12	Interrupt Module 1 OUT WORM	12
13	Interrupt Module 2 LED A	13
14	Interrupt Module 2 OUT MOTOR	14
15	Open	

Table 1: *J1 - Motor Drive Connector at Monochromator and SD3-504*

7. SD3 Cable Connections:

The figure below shows the cable connections necessary for operation from a computer through the COM ports or with USB. Refer to the Monochromator Control Software for Windows for operation with a computer.



The following computer cables are supplied with the SD3:

CC-499-2 IBM PC or compatible 9 pin female (DB9S) connector to 9 pin male connector (DB9P).

3650-USB-06 USB Cable Type A to Type B.

If neither of these cables is compatible with your system, consult Princeton Instruments for a custom cable. If you have facilities for constructing a custom cable, use the RS232 pin arrangement shown in Table 2.

Pin #	Description
1	open
2	RD data from SD3 to computer
3	TD data from computer to SD3
4	open
5	ground
6	open
7	RTS
8	CTS
9	open

Table 2: *RS232 Computer Interface Pin Arrangement:*

A terminal or RS232 computer port must be set up as follows: 9600 baud, 8 data bits, no parity, 1 start bit, 1 stop bit.

Pin #	Description
1	+5V
2	GND
3	GND
4	+24V

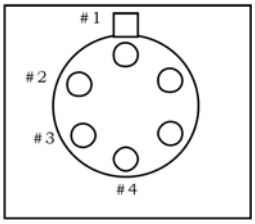


Table 3: *Power Input Pin Arrangement:*

IV. Instrument Operation:

General:

The instrument should be kept sealed at all times, and under vacuum if possible. Only vacuum-compatible material should be exposed to the vacuum of the instrument. When operating the instrument in the vacuum ultraviolet region, the vacuum should be better than 5 x 10-4 Torr before turning on any vacuum ultraviolet light sources.

The optical surfaces are extremely delicate and can be permanently damaged by mechanical contact with anything. Do not touch, talk, or breathe over the optical surfaces. After long periods of use the optical surfaces can become contaminated and therefore have a drastically reduced efficiency. Consult Princeton Instruments Bulletin #20 on care of use of VUV coatings before operation. Princeton Instruments can generally recoat the optical components and obtain their original efficiency, depending of course on the condition of the surfaces. Please contact Princeton Instruments directly if you believe the optical surfaces are contaminated or damaged.

1. Slit Width Adjustment

The slit width of each bilateral slit assembly is adjustable from 0.005 millimeters to 3 millimeters (5 to 3,000 µm) by a micrometer located on the slit housing. The micrometer knob is graduated in 0.01 millimeter (10 µm) increments.

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

The micrometer knob should not be rotated below a reading of 0.00 or above 3.00. A micrometer setting of less than 0.005 millimeters (5 µm) should not be used, because a stop is provided to prevent the slit jaws from touching each other.

2. Slit Height Adjustment:

The slit height is controlled by a pair of horizontal baffles located in the slit housing, and must be set prior to mounting accessories on the slit housings. The horizontal baffles are mounted on a pair of graduated blocks, located in the slit housing. The graduations on the blocks are 1mm apart; the center graduation is red. To adjust the baffles, loosen the screws at each end of the horizontal baffle and set the baffles 1/2 the total desired slit height above and below the center graduation.

NOTE: In most optical systems, resolution deteriorates with increasing slit height; therefore, if maximum resolution is required, slits of one to four millimeters should be used.

3. Slit Port Selection:

To select the desired slit port position the diverter mirror is either move into or out of the beam. The control lever for the diverter mirror is located at the base of the slit end of the instrument. To select the end position exit slit, gently move the mirror control lever toward the end position until it rests against a stop. To select the side exit port, gently move the control lever toward the side port until it rests against a stop. The user may operate the moveable diverter mirror at any time to select an end or side slit.

4. Air Inlet Valve:

An air inlet valve is supplied to bring the main instrument chamber to atmospheric pressure, and is located in the instrument housing. The valve is open when the handle is in line with the valve body, and closed when the handle is 90 degree to the valve body.

CAUTION: Verify that the vacuum system is in the proper mode before opening air inlet valve.

V. Controlling the VM-504 with the SD3 SpectraDrive Controller

Description:
The Princeton Instruments SD3 SpectraDrive Controller is used with the Acton series AM and VM Monochromators in conjunction with Acton Monochromator Control Software to provide the electronic drive for wavelength positioning, diverter mirror control and filter positioning. The SD3 also provides the link between the monochromator and the computer. Both USB 1.1 and RS-232 are supplied as standard interfaces.

1. Setup:
Each AM and VM monochromator ships with an SD3 controller and the software installation disk for Monochromator Control Software. Refer to the instruction manual for your specific AM or VM monochromator for unpacking and setup instructions. This manual is located on the Monochromator Control Software installation disk. After the monochromator is in position, grating installed and all packing materials removed, connect the monochromator control cable between the monochromator and the MONO connector on the rear panel of the SD3. Connect the power supply shipped with the SD3 to the POWER connector on the rear panel of the SD3. This power supply provides +5 volts DC for the SD3 control logic and +24 volts DC for the motor drives. With the power supply switch in the off position, connect the line cord provided with the SD3 to the power supply and the AC line. The power supply will operate with line voltages between 100 and 250 volts AC, 50/60 Hz. Use the Monochromator Control Software install disk to install the software on your computer. This icon for this software on your computer is labeled Acton. Turn on the power switch on the SD3 power supply and the monochromator should initialize to zero wavelength.

2. Controlling the AM or VM Monochromator with Acton Software:
The Monochromator Control Software is normally installed in the directory C:\Program Files\Acton. This directory contains subdirectories Bin and Data. The Bin directory contains the executable code. There will normally be an Acton icon on the desktop that can be used for starting the software. If this icon is not on the desktop, go to the Acton Bin directory and start the software. When the Monochromator Control software loads, there is a main screen with selections for operating the monochromator and various setup functions. Click on the Operation box and a screen will come up which allows for basic control of the monochromator wavelength. All functions of this software are described in the Monochromator Control Software manual supplied on the Monochromator Control Software install CD.

3. Controlling the AM or VM Monochromator with User Generated Software or LabVIEW:
The Monochromator Control Software install disk contains a folder named Acton_SDK. This folder contains DLLs with example code in Delphi, Visual Basic, C++ and LabVIEW and well as a folder with examples for use of the COM interface.

4. Controlling the AM or VM Monochromator at the Command Level:

Although it requires more programming on the user's part, the SD3 can also be controlled with direct commands through its USB 1.1 port or RS-232 port. The same command set, listed below, is used for both RS232 and USB.

Commands can be sent as single commands or grouped in strings of commands. All commands are single words (contain no spaces) and all commands in a string are separated by at least one space. Parameters, if needed, precede the command and are separated from the command by at least one space (e.g. 546.7 GOTO).

For RS232 operation, the port set-up is 9600 baud, 8 data bits, 1 stop bit and no parity. A convenient tool for trying out this mode of operation is the program HyperTerminal supplied with the Windows operating system. The USB 1.1 port with the driver supplied also shows up as and is treated like a com port – although a very fast one. All commands or strings of commands must be terminated with a carriage return (0D hex). The SD3 responds to a command when the command has been completed by returning the characters **OK** followed by carriage return and line feed (hex ASCII sequence 20 6F 6B 0D 0A). The default condition is to echo each character that is sent to the SD3 with the RS-232 interface and to not echo the commands when using the USB interface. When sending a command or string of commands, it is important to wait for the SD3 to complete the processing of that command string before sending another command.

Monochromator Wavelength Movement Commands:

GOTO	Goes to a destination wavelength at maximum motor speed. Accepts destination wavelength in nm as a floating point number with up to 4 digits after the decimal point or whole number wavelength with no decimal point.
<GOTO>	Same as GOTO (For compatibility with software written for previous Acton series models.)
NM	Goes to a destination wavelength at constant nm/min rate specified by last NM/MIN command. Accepts destination wavelength in nm as a floating point number with up to 4 digits after the decimal point or whole number wavelength with no decimal point.
<NM>	Same as NM (For compatibility with software written for previous Acton series models.)
>NM	Similar to NM except it returns control to user immediately rather than waiting for Completion of monochromator wavelength move. Can be used with? NM or MONO-?DONE below. This command must be terminated with MONO-STOP listed below. NOTE: Use the NM command when communication with the monochromator during the scan is not required.
?NM	Returns present wavelength in nm to 0.01nm resolution with units nm appended. e.g. ?NM 300.00 nm
MONO-?DONE	Used with >NM command to determine if monochromator has reached the destination. Returns 0 if move is not complete, 1 if move is complete.

MONO-STOP Stops the monochromator wavelength move after use of the >NM command.

NM/MIN Sets constant scan rate in nm/min to 0.01 nm/min resolution. e.g. 10.0 NM/MIN

?NM/MIN Returns present scan rate in nm/min to 0.01 nm/min resolution with units nm/min appended. e.g. ?NM/MIN 100.00 nm/min

Grating Control Commands:

GRATING Recalls parameters for the specified grating from non-volatile memory. Up to nine (9) gratings are allowed. This command takes a grating number from 1 - 9. e.g. 3 GRATING

?GRATING Returns the number of the grating presently being used numbered 1 - 9.

?GRATINGS Returns the list of installed gratings with position, groove density and blaze. The present grating is specified with an arrow.

The following command is used for grating installation by Acton part #:

INSTALL Installs new grating parameters into the non-volatile memory of the AM monochromator. Uses the part # of the grating to specify the parameters.
e.g. 1-120-500 5 INSTALL places a 1200 g/mm grating blazed at 500nm into the second grating position on #5.

The following commands are used for grating installation by grating parameters:

SELECT-GRATING Specifies the grating number to be installed 1 - 9.

G/MM Specifies groove density of grating to be installed in g/mm. e.g. 1200 G/MM

BLAZE Specifies the blaze wavelength and units of the grating to be installed with 7 characters of the user's choice. Unlike other commands, this command is issued before the parameters. After the command is issued, the SD3 responds with " " . Seven characters are then entered (these may be numbers, letters, spaces or special characters).

UNINSTALL Used to remove a grating and its parameters from the SD3 non-volatile memory e.g. 3 UNINSTALL

Diverter Control Commands:

EXIT-MIRROR	Designates the exit diverter mirror to receive the diverter control commands. This command is for AM monochromators that can accept two diverter mirrors. The AM monochromators will accept this command but it is not required in these monochromators.
ENT-MIRROR	Designates the entrance diverter mirror to receive the diverter control commands. This command is for AM monochromators that can accept two diverter mirrors.
FRONT	Moves the designated diverter mirror to position the beam to the front port position.
SIDE	Moves the designated diverter mirror to position the beam to the side port position.
?MIRROR	Returns the position of the designated diverter mirror with the responses “front” and “side”.
?MIR	Returns the position of the designated diverter mirror with the responses 0 for front and 1 for side.

Calibration Commands:

INIT-OFFSET	Sets the offset value for the designated grating. Default values are 25600 for all gratings. The grating designator used with this command is grating# - 1. e.g. 25590. 0 INIT-OFFSET for setting offset on grating #1. NOTE: This command requires a decimal point after the offset value. For the new parameters of this command to take effect, the monochromator must be initialized with the MONO-RESET command or by turning the power off and back on.
INIT-GADJUST	Sets grating adjustment value for the designated grating. Default values are 10000 for all gratings. The limits on the parameter for this command are +/- 1000 for all gratings. The grating designator used with this command is the grating # - 1. e.g. 9993 1 INIT-GADJUST for setting gadjust on the second grating. NOTE: This command is to maintain compatibility with previous Acton applications. For new applications, use the INIT-SP300-GADJUST command below. No decimal point is used with this command. For the new parameters of this command to take effect, the monochromator must be initialized with the MONO-RESET command or by turning the power off and back on.
MONO-EESTATUS	Returns setup and grating calibration parameters for all gratings.
RESTORE FACTORY SETTINGS	Returns all parameters including grating calibration parameters to the original factory calibrated settings. NOTE: This command will overwrite any calibration parameters set by the user.

MONO-RESET	Initializes AM monochromator. Necessary after using INIT-OFFSET, INIT-GADJUST or INIT-SP300-GADJUST.
HELLO	Same as MONO-RESET. Used to maintain compatibility with existing applications.
MODEL	Returns model number of AM or VM monochromator. e.g. MODEL AM-505
SERIAL	Returns serial number of AM or VM monochromator. e.g. SERIAL 37480263

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

Default Values:

TURRET	#1
GRATING	#1
WAVELENGTH	0.0 nm
SCAN SPEED	200.0 nm/min
INIT-GRATING	Selects which of the three gratings on the installed in the AM monochromator will go to after finding 0.0 nm on the first grating of the installed turret. e.g. 2 INIT-GRATING selects the second grating as the default. Accepts values 1 - 9.
INIT-WAVELENGTH	Sets an initial wavelength for the SD3 after initialization. E.G. 435.84 INIT-WAVELENGTH
INIT-SRATE	Sets an initial scan rate for the SD3. E.G. 200.0 INIT-SRATE

Appendix A

Certification

Princeton Instruments certifies that this instrument was thoroughly tested and inspected and found to meet the specifications furnished by Princeton Instruments when it was shipped from the factory.

Warranty

Princeton Instruments instruments and accessories are warranted for a period of one full year from date of delivery to be free from defects in material and workmanship and to conform to the specifications furnished by Princeton Instruments. The corporation's obligation under this warranty is limited to servicing or adjusting an instrument returned to the factory, prepaid, and to repairing or replacing at the factory any part or parts thereof. All purchased items carry the original manufacturer's warranty.

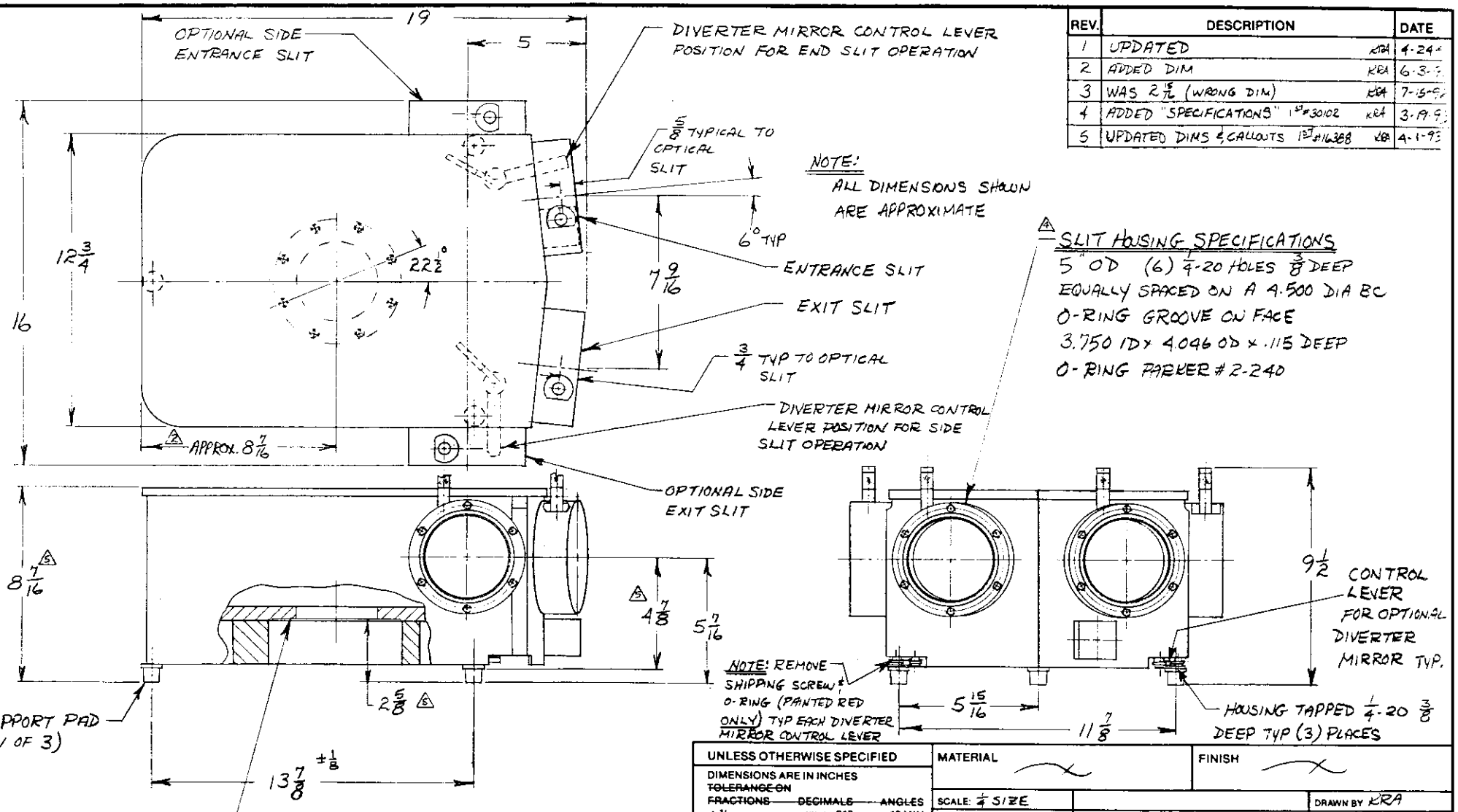
Princeton Instruments shall not be liable for consequential damages resulting from accident, alteration, misuse, improper installation, operation on low or excessive voltages or any use in violation of the operating instructions furnished by Princeton Instruments.

If any defect appears within the warranty period, the purchaser shall promptly notify Princeton Instruments. No material will be accepted for repair or replacement without prior authorization from Princeton Instruments. Upon such authorization and in accordance with instructions of Princeton Instruments, parts, materials or equipment for which repair or replacement is requested shall be returned to Princeton Instruments for examination, with shipping charges prepaid by the purchaser. Final determination as to whether a product or part is actually defective rests with Princeton Instruments.

In such cases where necessary repairs are not covered by this warranty, an estimate of repair charges will be submitted to the purchaser before servicing the equipment.

Princeton Instruments reserves the right to make changes or improvements upon its products without imposing any obligations upon itself to install the same upon its products previously manufactured.

This warranty is expressly in lieu of all other obligations or liabilities on the part of Princeton Instruments, and Princeton Instruments neither assumes, nor authorizes any other person to assume for them, other obligations or liability in connection with the sale of equipment manufactured by Princeton Instruments.



REV.	DESCRIPTION		DATE
1	UPDATED	KRA	4-24-
2	ADDED DIM	KRA	6-3-
3	WAS 2 5/16 (WRONG DIM)	KRA	7-15-9
4	ADDED "SPECIFICATIONS" 1ST #30102	KRA	3-19-9
5	UPDATED DIMS & CALLOUTS 1ST #16388	KRA	4-1-93

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
~~TOLERANCE ON FRACTIONS ± 1/64 DECIMALS .xx ± .010 .xxx ± .005 ANGLES ± 15 MIN~~
~~MACH. SURFACE 92 MAX. REMOVE ALL BURRS & BREAK SHARP EDGES .010R. MAX.~~

MATERIAL | FINISH

SCALE: 1/4 SIZE | DRAWN BY KRA
DATE: 3-19-91 | NEXT ASS'Y | QTY 1

Princeton Instruments
15 DISCOVERY WAY
ACTON, MA 01720

DWG. TITLE: VM-504 PICTORIAL | SIZE: B | DWG NO.: 8504-050-01 | REV.: E