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Acton Research Corporation Model VM-504

0.39 Meter Triple Grating Vacuum Monochromator Operating Instructions

ACTON RESEARCH CORPORATION
VM-504
Operating Instructions

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I. Description

ARC's 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 SpectraPro 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.

SD2-504 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 RS-232 connector or IEEE 488 port. Refer to the SpectraPro 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 done from a computer, and the Monochromator Control Software 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.

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° optical path.

Wavelength Scanning System: Direct Digital Scanning with exclusive SD2-504 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

SD2-504 Dimensions:

Length: 10" (254 mm)
Width: 10" (254 mm)
Height: 2" (51 mm)
Weight: Approximately 3 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 ARC 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, ARC and save all packing material.

2. Removal of Protection 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 and 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 adapter to various standard flange 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 locked in position for shipping purposes. Locate each control lever and locking screw/o-ring assembly, as shown in attached pictorial dwg. 8504-050-01 Rev 1. These locking screws painted red must be removed prior to operation. Using an allen wrench, loosen and remove the painted red locking screw/o-ring assemblies, do not remove the other screw and o-ring assembly. Store the removed locking screws for possible later use if moving the instrument.

6. Connections to VM-504 Monochromator with External Scan Controller

Connect the motor drive cable between the 15 pin D connector (J1) on the monochromator and the 15 pin D connector (J1) on the SD2-504. Connect the power supply cable from the Power Supply to the round connector on the SD2-504, then plug the AC line cord from the Power Supply into an AC outlet. Connect a cable between the 9 pin connector (J2) on the scan controller and the RS-232 connector on the computer.

J1 - Motor Drive Connector on Monochromator and SD2-504

Pin #-Monochromator	Description	Pin#
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 Module1 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	

J2 - RS-232 Connector – SD2-504

Same as Table 1 Below

J3 - IEEE 488 Port – SD2-504

ARC offers the following RS-232 cables as options:

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

If none of the above cables are compatible with your system, consult ARC for a custom cable or one may be constructed using a standard DE9-P connector at the monochromator end with the following connections.

Table 1

pin #	description
1	open
2	RD received data to the computer
3	TD transmitted data from the computer
4	open
5	ground
6	open
7	RTS
8	CTS
9	open

connect these two pins together

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

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 5×10^{-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 ARC Bulletin #20 on care of use of VUV coatings before operation. ARC can generally recoat the optical components and obtain their original efficiency, depending of course on the condition of the surfaces. Please contact ARC 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: Assure vacuum system is in proper mode before opening air inlet valve.

V. SD2-504 Operation

1. Computer Control

The Acton Research Corporation AM Monochromator can be controlled from an RS232 terminal or computer using RS232 or IEEE488. The same command set, listed below, is used for both RS232 and IEEE488.

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. All commands or strings of commands must be terminated with a carriage return (0D hex). The SD2-504 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 SD2-504.

When using the IEEE488 (or GPIB) interface, the default device address is 11. The device address can be set to any value from 1 to 30 using the command SET-ID. The command ?ID is used to read back the IEEE address. Each command or string of commands must be terminated with a carriage return (0D hex). When sending a command or string of commands, it is important to wait for the SD2-504 to complete the processing of that command string before sending another command. This is accomplished by checking the status byte. The SD2-504 controls bits in the IEEE488 status byte which can be read from the IEEE488 controller. The command for reading this status byte will be unique to your IEEE controller. For example, with National Instrument controllers, the command is IBRSP. With CEC controllers, the command is SPOLL.

IEEE488 Status Byte Bits:

Bit 0	0 = command is being processed 1 = SD2-504 ready for another command
Bit 1	0 = no errors 1 = SD2-504 detected an error in the command
Bit 7	0 = no response or response has been read 1 = SD2-504 generated a response which is now ready to be sent

Note that with some fast computers, it is necessary to add a few milliseconds delay in your program after sending a command and before checking the status byte to allow time for the status byte to be updated.

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 3 digits after the decimal point or whole number wavelength with no decimal point.
<GOTO>	Same as GOTO (For compatibility with software written for previous SpectraPro 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 3 digits after the decimal point or whole number wavelength with no decimal point.
<NM>	Same as NM (For compatibility with software written for previous SpectraPro 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	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	Places specified grating in position to the wavelength of the wavelength on the present grating. Up to nine (9) gratings are allowed on three (3) turrets. This command takes a grating number from 1 - 9. IMPORTANT NOTE: This command assumes that the correct turret is specified by the TURRET command. For example, using grating numbers 1, 4 and 7 will place the first grating on the installed turret into that position and call up the parameters for the grating number specified.
?GRATING	Returns the number of gratings 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 ARC 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 turret #2.
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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 SD2-504 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 SD2-504 non-volatile memory.

Diverter Control Commands:

EXIT-MIRROR	Designates the exit diverter mirror to receive the diverter control commands. This command is for AM monochromators which 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 which 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 0 for gratings 1, 4 and 7; 1536000 for gratings 2, 5 and 8; and 3072000 for gratings 3, 6, and 9. The limits on the settings are +/- 2500 for a 1200 g/mm grating. This corresponds to an error of greater than +/- 5nm for a 1200 g/mm grating. The limits are adjusted for grating groove density, e.g. error for a 600 g/mm grating is +/- 5000. The grating density designator used with this command is grating# - 1. E.G. 3072056. 8 INIT-OFFSET for setting offset on grating #9. NOTE: This command requires a decimal point after the offset value.
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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 SpectraPro applications. For new applications, use the INIT-SP300-GADJUST command below.

INIT-SP300-GADJUST Sets grating adjustment value for the designated grating. Default values are 1000000 for all gratings. The limits on the parameter for this command are +/-100000 for all gratings. The grating designator used with this command is the grating# - 1.
E.G. 999322 4 INIT-SP300-GADJUST for setting gadjust on the fifth grating.

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 monochromator.
E.G. MODEL AM-505

SERIAL Returns serial number of AM monochromator. Format is 7 digits with the first 3 digits being the model #.
E.G. SERIAL 7480263

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 SD2-504 after initialization.
E.G. 435.84 INIT-WAVELENGTH

INIT-SRATE Sets an initial scan rate for the SD2-504.
E.G. 200.0 INIT-SRATE

NOTE

Commands must be typed exactly as they appear in this description. This includes all decimal points, hyphenations, and spaces between words and numbers. The VM-504 software will only recognize these commands as they are shown here. If part of the command is missing, the program will not function properly and the incorrect command will be displayed with a question mark (?). Incorrect numeric input can cause erroneous results or statements such as "NOT ENOUGH PARAMETERS" or "STACK UNDERFLOW" to be returned.

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

When controlling the VM-504 through a user computer program, all commands and their parameters must be separated by at least one space and each command or command sequence must be terminated by a space and carriage return.

The VM-504 responds to a command only after that command or command string is completed. The response is OK<CR> <LF> (e.g. Hex ASCII Sequence 20 6F 6B 0D 0A). When writing a computer control program for the VM-504, it is advisable to wait for the "OK <CR> LF" sequence after sending out a command or string of commands to indicate that the command or string of commands has been completed. Also, the default condition is to echo each character that is sent to the VM-504. If no echo is desired, the command NO-ECHO will suppress the echo. The command ECHO will return the VM-504 to the default echo state.

Appendix A

Certification

Acton Research Corporation (ARC) certifies that this instrument was thoroughly tested and inspected and found to meet the specifications furnished by ARC when it was shipped from the factory.

Warranty

Acton Research Corporation (ARC) 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 ARC. 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 manufacturers warranty.

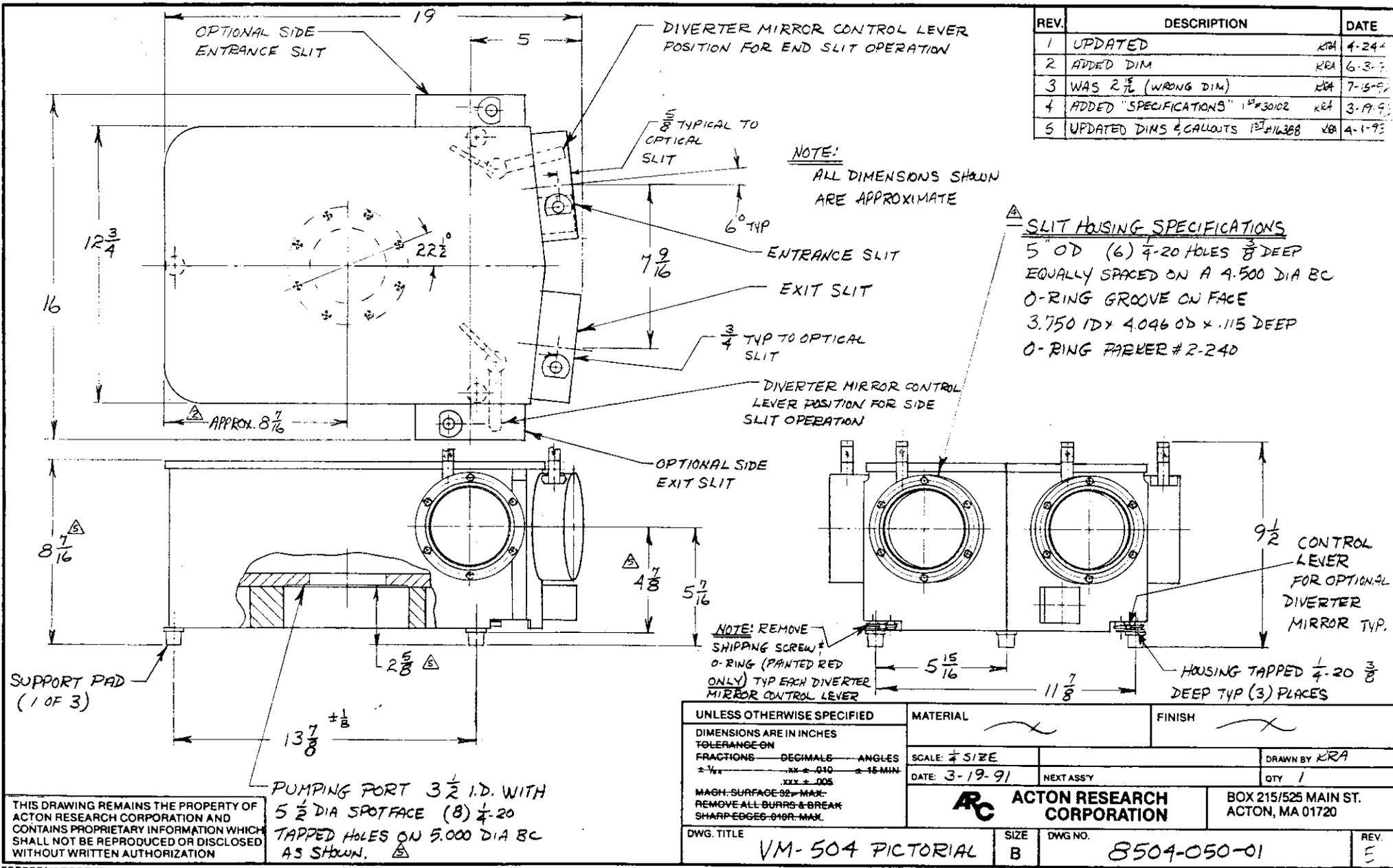
Acton Research Corporation shall not be liable for consequential damages resulting from accident, alteration, misuse, improper installation, operation on low or excessive voltages or any use in violation of the operating instructions furnished by ARC.

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

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.

Acton Research Corporation 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 ARC, and ARC neither assumes, nor authorizes any other person to assume for them, other obligations or liability in connection with the sale of equipment manufactured by Acton Research Corporation.



REV.	DESCRIPTION	DATE
1	UPDATED	KRA 4-24-91
2	ADDED DIM	KRA 6-3-91
3	WAS 2 1/2 (WRONG DIM)	KRA 7-5-91
4	ADDED "SPECIFICATIONS" 12#30102	KRA 3-19-91
5	UPDATED DIMS & CALLOUTS 12#416388	KRA 4-1-95

SLIT HOUSING SPECIFICATIONS
 5" OD (6) 1/4-20 HOLES 3/8" DEEP
 EQUALLY SPACED ON A 4.500 DIA BC
 O-RING GROOVE ON FACE
 3.750 ID x 4.046 OD x .115 DEEP
 O-RING PARKER #2-240

UNLESS OTHERWISE SPECIFIED		MATERIAL	FINISH
DIMENSIONS ARE IN INCHES TOLERANCE ON			
FRACTIONS	DECIMALS	ANGLES	
± 1/16	± .010	± 15 MIN	
	± .005		
MACH SURFACE 32 MAX REMOVE ALL BURRS & BREAK SHARP EDGES .010 MAX		SCALE: 1/2" SIZE	DRAWN BY KRA
		DATE: 3-19-91	QTY 1
		NEXT ASSY	
DWG. TITLE		SIZE	DWG. NO.
VM-504 PICTORIAL		B	8504-050-01
		REV.	
		E	

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PUMPING PORT 3 1/2" I.D. WITH 5 1/2" DIA SPOTFACE (8) 1/4-20 TAPPED HOLES ON 5.000 DIA BC AS SHOWN.