INSTRUCTION MANUAL

MINI-CHROM MONOCHROMATORS

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MINI-CHROM MONOCHROMATORS

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Manual 6060-0019-C

INTRODUCTION

The Mini-Chrom series of UV-VIS-NIR monochromators are low cost, high performance instruments designed for use in research, quality control, and teaching. They are also used extensively as assemblies in sophisticated analytical and biomedical instrumentation such as clinical chemistry analyzers, HPLC detectors, and UV-VIS-NIR spectrophotometers. The small size of the Mini-Chrom does not degrade performance.

All five types of Mini-Chroms produced by the Optometrics Group are compact, in-line Fastie-Ebert monochromators with identical optical specifications. They differ in the manner in which a wavelength, or wavelength interval, is selected,and the type of wavelength readout utilized. Each type is available in either five or six models that cover specific spectral ranges.

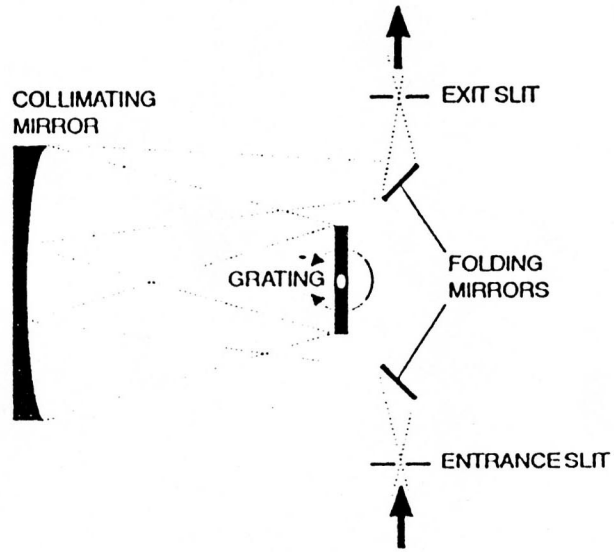
Throughput, resolution, stray light and power handling are comparable to many larger, more expensive monochromators. The Mini-Chrom is specifically designed to minimize astigmatic aberrations, enhancing instrument resolution. Each unit includes a set of fixed (300μ) slits which can be easily changed and wider or narrower slits installed to optimize throughput or resolution respectively.

A variety of peripheral equipment is available that will increase the versatility of the Mini-Chrom in a laboratory environment, including a general purpose photometer, stepping motor controller, Silicon and Germanium detector modules, a sample compartment, and a Tungsten Halogen lamp, housing and power supply.

THEORY OF OPERATION

All Mini-Chroms are optically identical in-line Fastie-Ebert monochromators with an effective aperture of *f* 3.9 and a 74 mm focal length.

As shown in the optical diagram below, polychromatic radiation is focused at the entrance slit of the monochromator and reflected by a folding mirror onto a spherical collimating/ focusing mirror. This mirror collimates and directs the radiation onto a grating, where it is dispersed. The dispersed radiation is directed back onto the collimating/ focusing mirror and a portion of it is focused at the exit slit via a folding mirror.



OPTICAL DIAGRAM

SPECIFICATIONS

General Specifications

Effective Aperture: ƒ 3.9
Focal Length: 74mm
Grating: 2cm square
Damage Threshold: 100 Watt CW, 1 Joule pulsed @ 200 nsec
Slits: 300μ X 4mm standard. See page 19 for additional slit sets.
Operating Temperature: -20 ° C to +80 ° C
Stability: ± 0.02 nm/ ° C typical
Wavelength Accuracy: ± 0.2 %
Reproducibility: ± 0.2 %

Specifications for Digital and Scanning Mini-Chroms

SCANNING MINI-CHROM

Drive Hysteresis: (deg. of shaft revolution): 3.6 ° typ., 14 ° max.
Limit Sensors: Optek KT 870-T51 Opaque Polysulfone Housing

SCANNING MINI-CHROM WITH ANALOG OUTPUT

as under "Scanning Mini-Chrom" with the following additions:
Potentiometer Resistance: 10 K ohms ± 5 %
Potentiometer Linearity: ± 0.3 %
Potentiometer Power Rating: 2.0 Watts @ 40 ° C
Instrument Accuracy: ± 1.0 %

DIGITAL MINI-CHROM

Wavelength Readability: 0.2 nm

SCANNING DIGITAL MINI-CHROM

as under "Digital Mini-Chrom" with the following additions:
Motor Phases: 4 Phase, 75 Ω per phase
Current Rating: 160 mA
Voltage Rating: 12 V D.C.
Steps: 0.9 ° / step, full step; 0.45 ° / step, half step

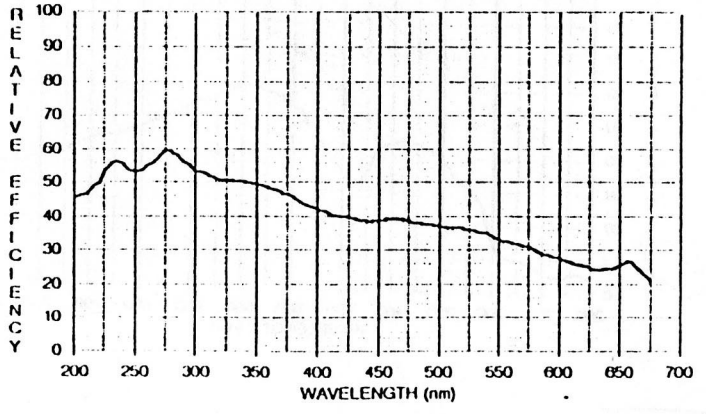
Grating Specifications

Depending on the wavelength range selected (model number) the Mini-Chrom will have a ruled or holographic grating. All holographic gratings are blazed to ensure efficiencies close to those obtained with ruled gratings.

MODEL	GRATING TYPE	BLAZE λ	λ RANGE
01	2400 l/mm HOLO	250 nm	180-650 nm
02	1800 l/mm HOLO	250 nm	200-800 nm
→ 03	1800 l/mm HOLO	500 nm	300-800 nm
04	1200 l/mm RULED	750 nm	500 nm-1.2 μ
05	830 l/mm RULED	1.2 μ	750 nm-1.7 μ
06	600 l/mm RULED	1.6 μ	850 nm-2.2 μ

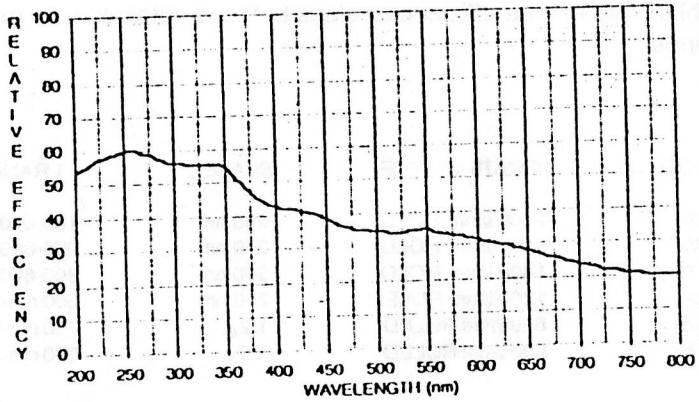
Grating Efficiency Curves

MODEL 01



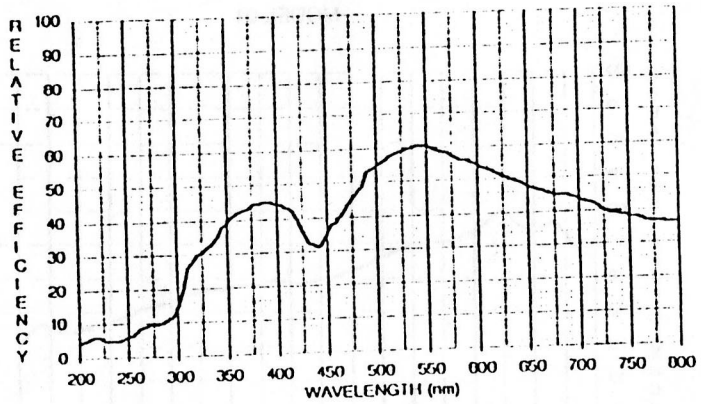
Grating Efficiency Curves *continued*

MODEL 02



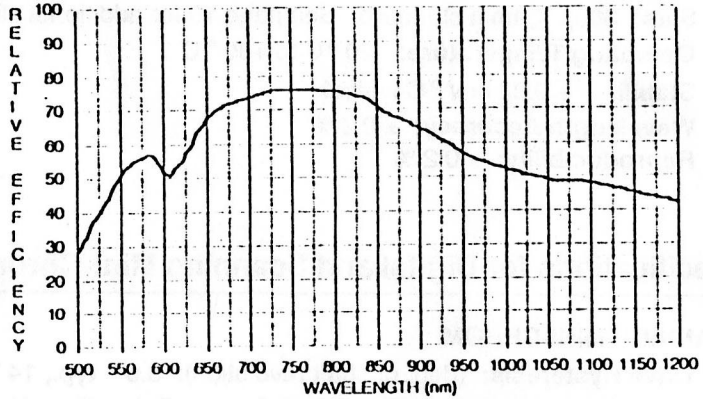
OUR MODEL:

MODEL 03

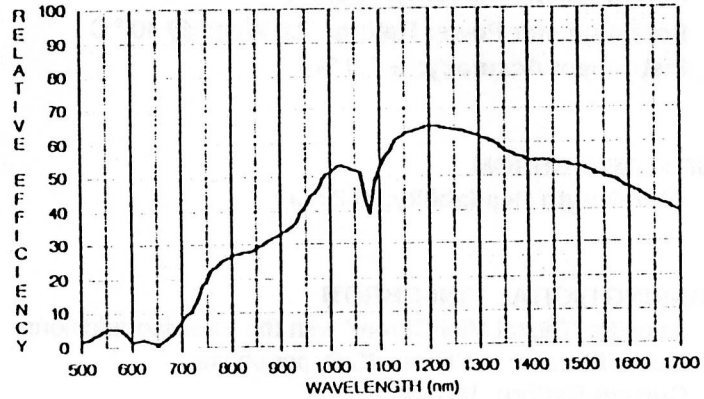


Grating Efficiency Curves *continued*

MODEL 04

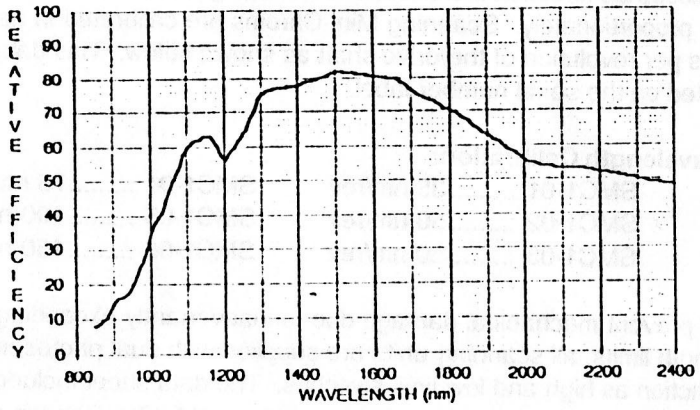


MODEL 05



Grating Efficiency Curves *continued*

MODEL 06



OPERATION

The wavelength of monochromatic radiation at the exit slit of the Mini-Chrom is dependent on the position of the grating. A sine drive mechanism allows the grating to be rotated (manually or via a stepping motor) such that discrete wavelengths are sequentially focused at the exit slit in a linear fashion.

Optimal thruput and wavelength accuracy are attained if the Mini-Chrom is operated under the following guidelines:

Beam Geometry and Alignment

Monochromatic output radiation at the exit slit will have the same cone angle as the input beam if the effective aperture of the input beam is *f* 3.9 or greater and if the converging beam is normal (perpendicular) to the entrance slit. The precision with which the converging beam is aligned to the entrance slit will effect wavelength accuracy and throughput. Note that the input radiation requires an effective aperture of *f* 3.9 or less as use of a faster *f* system will overfill the input folding mirror and increase stray light significantly.

For alignment purposes two dowel pin holes (0.125") are located in the base of the instrument on the optical center line. Two tapped holes (1/4"-20) are also provided in the base to secure the unit.

Second Order Radiation

Second order radiation is a characteristic of grating monochromators that is present when specific combinations of wavelength selection, source radiation and detector sensitivity exist. When present it will be superimposed on the primary (first) order and be of wavelength one half that of the selected wavelength. Second order will only be present if the source is capable of emitting at one half the selected wavelength and will only be detected if the detector is sensitive to radiation one half of the selected wavelength. If present, second order radiation can be eliminated by use of a second order filter (see page 19).

Caution -- Shaft Overrotation

Mechanical stops and limit switches are used in Mini-Chroms to prevent drive shaft rotation beyond the range of the instrument. Forcing the drive shaft after hitting the mechanical stop will damage the unit, requiring factory repair and recalibration.

Standard Mini-Chrom Monochromator

The Standard Mini-Chrom is a manually operated monochromator that utilizes a micrometer head assembly for wavelength selection and readout. Rotation of the micrometer head causes, via a precision sine-bar drive, rotation of the diffraction grating which positions the selected wavelength at the exit slit.

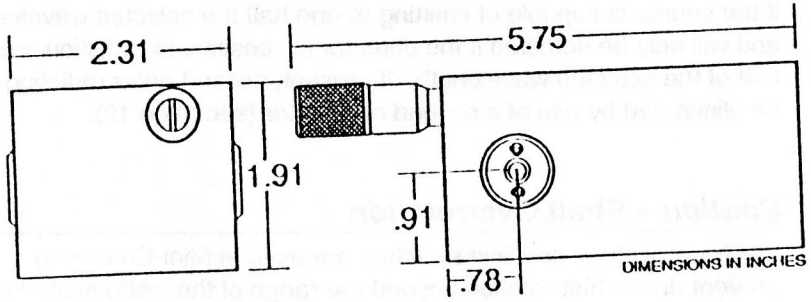
With standard (300μ) slits, resolution varies from 1.66 nm for the model 01 to 6.43 nm for model 06. Narrower slit sets increase resolution but decrease throughput. Wider slits increase throughput at the expense of spectral purity. See pages 18 and 19 for additional information on the availability of additional slit sets.

MODEL	GRATING TYPE	BLAZE λ	λ RANGE
01	2400 l/mm HOLO	250 nm	180-650 nm
02	1800 l/mm HOLO	250 nm	200-800 nm
03	1800 l/mm HOLO	500 nm	300-800 nm
04	1200 l/mm RULED	750 nm	500 nm-1.2 μ
05	830 l/mm RULED	1.2 μ	750 nm-1.7 μ
06	600 l/mm RULED	1.6 μ	850 nm-2.2 μ

MODELS AVAILABLE

Wavelength in nanometers is read directly from the micrometer head on models 01, 02, 03, and 04. Near infra-red models (05 and 06) require the reading on the micrometer head be doubled, i.e., 2nm/division, to select a discrete wavelength.

To ensure maximum reproducibility, the micrometer head should be turned several divisions below the required wavelength and rotated counter-clockwise until the desired wavelength is reached.



OVERALL DIMENSIONS

Scanning Mini-Chrom Monochromator

The Scanning Mini-Chrom monochromator is designed to be controlled by a stepping motor driver or other calibrated drive unit. No wavelength readout is provided. All six models utilize a precision lead screw/ sine bar mechanism to rotate the diffraction grating and sequentially position the selected wavelength(s) at the exit slit. Rotation of the drive shaft in a clockwise direction increases the wavelength of radiation at the exit slit proportionately. Scanning Mini-Chroms are calibrated in nanometers per revolution of the drive shaft as shown below. This data is also noted on the serial number label.

Wavelength Calibration:

SMC1-01 .....35 nm/rev
SMC1-02 .....50 nm/rev
SMC1-03 .....50 nm/rev
SMC1-04 .....75 nm/rev
SMC1-05 .....100 nm/rev
SMC1-06 .....150 nm/rev

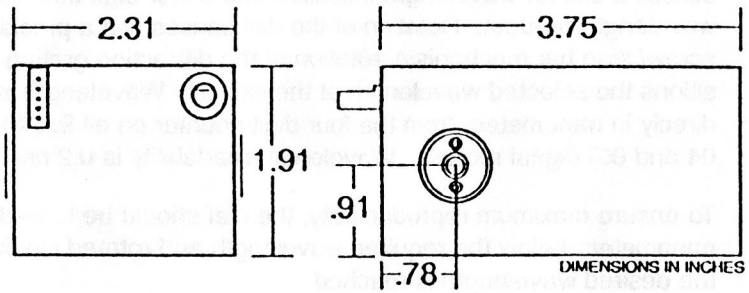
To prevent mechanical damage due to inadvertantly exceeding wavelength limits, all scanning units are supplied with dual photosensors that function as high and low limit switches. The data sheet included with each unit gives the location, in nanometers, of limit switch trip points relative to zero order. A 36" long, five lead cable and connector is provided.

Calibration of the Scanning Mini-Chrom may be accomplished using the trip point of the low limit sensor or by locating zero order position. The low limit sensor is typically set 15nm below zero order; the exact location is indicated on the calibration sheet provided with the instrument. This value can be added to the scan command when motion is initiated from the low limit. Alternately, a detector can be used to locate zero order, allowing wavelength scans to be made relative to this position. Resolution and the degree to which slits can alter resolution is identical with all other Mini-Chroms (see page 18).

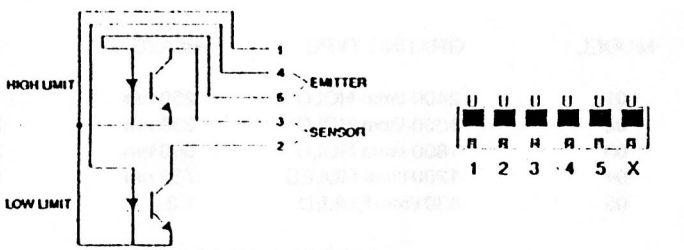
MODEL	GRATING TYPE	BLAZE λ	λ RANGE
01	2400 l/mm HOLO	250 nm	180-650 nm
02	1800 l/mm HOLO	250 nm	200-800 nm
03	1800 l/mm HOLO	500 nm	300-800 nm
04	1200 l/mm RULED	750 nm	500 nm-1.2 μ
05	830 l/mm RULED	1.2 μ	750 nm-1.7 μ
06	600 l/mm RULED	1.6 μ	850 nm-2.2 μ

MODELS AVAILABLE

Scanning Mini-Chrom Monochromator *continued*



OVERALL DIMENSIONS



LIMIT SENSOR CIRCUIT CONNECTOR PINOUT

ELECTRICAL SCHEMATIC

OPTIONAL CONNECTOR
FOR USE WITH CB-1 MOTOR CONTROLLER

Scanning Mini-Chrom Monochromator - Analog Output

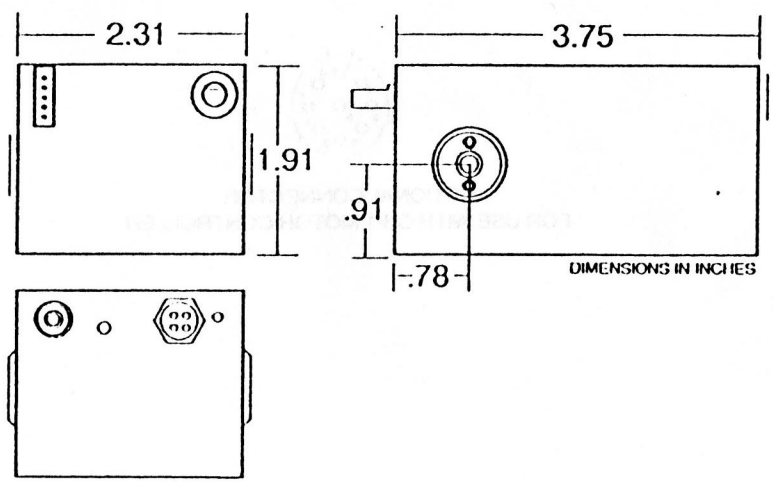
The Scanning Mini-Chrom with analog output is identical to the Scanning Mini-Chrom with the addition of a potentiometer coupled to the wavelength sine bar drive. The analog output from the potentiometer is linear (within the specifications of the potentiometer) with wavelength and can provide a signal to a remote indicator for wavelength readout.

The resistance of the 10 k ohm potentiometer is approximately zero ohms at the low mechanical stop (see data sheet for exact resistance) and increases linearly by 562.5 ohms with each complete clockwise rotation of the drive shaft.

Potentiometer Specifications:

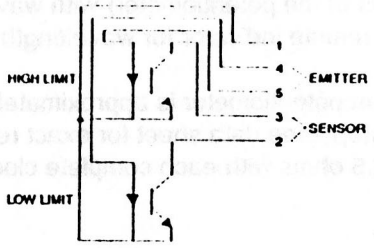
Resistance: 10 K ohms ± 5 %
Linearity: ± 0.3 %
Maximum Power Rating: 2.0 Watts @ 40 °C
Instrument Accuracy: ± 1.0 %

Resolution and the degree to which slits can alter resolution is identical with all other Mini-Chroms (see page 18).

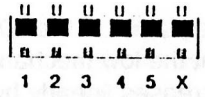


OVERALL DIMENSIONS

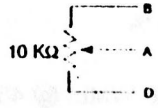
Scanning Mini-Chrom Monochromator - Analog Output
continued



MOTOR / LIMIT SENSOR CIRCUIT



CONNECTOR PINOUT



ANALOG OUTPUT

ELECTRICAL SCHEMATIC

OPTIONAL CONNECTOR
FOR USE WITH CB-1 MOTOR CONTROLLER

Digital Mini-Chrom Monochromator

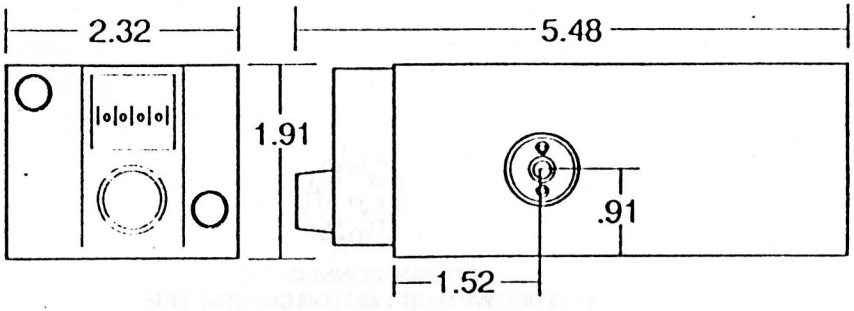
The Digital Mini-Chrom is a manually operated monochromator that utilizes a dial for wavelength selection and a four digit counter for wavelength readout. Rotation of the dial causes, via a precision lead screw/ sine bar mechanism, rotation of the diffraction grating which positions the selected wavelength at the exit slit. Wavelength is read direcly in nanometers from the four digit counter on all five (01, 02, 03, 04 and 05) digital models. Wavelength readability is 0.2 nm.

To ensure maximum reproducibility, the dial should be turned several nanometers below the required wavelength and rotated clockwise until the desired wavelength is reached.

Resolution and the degree to which slits can alter resolution is identical with all other Mini-Chroms (see page 18).

MODEL	GRATING TYPE	BLAZE λ	λ RANGE
01	2400 l/mm HOLO	250 nm	180-650 nm
02	1800 l/mm HOLO	250 nm	200-800 nm
03	1800 l/mm HOLO	500 nm	300-800 nm
04	1200 l/mm RULED	750 nm	500 nm-1.2 μ
05	830 l/mm RULED	1.2 μ	750 nm-1.7 μ

MODELS AVAILABLE



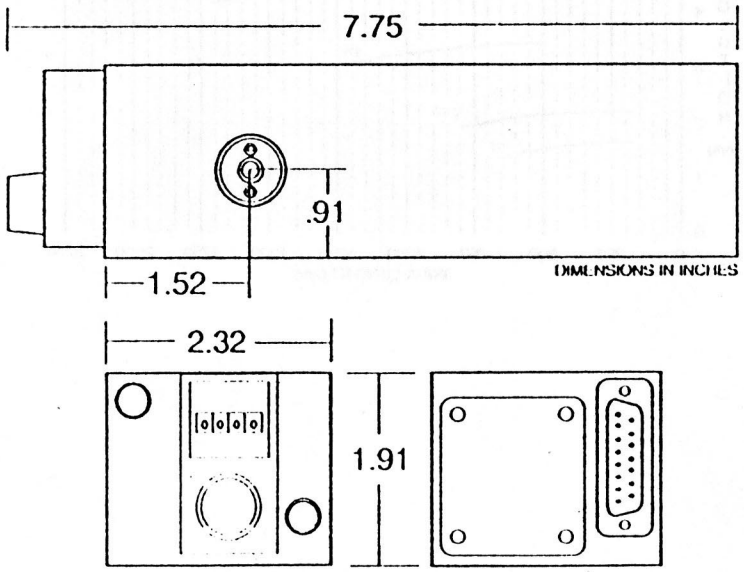
OVERALL DIMENSIONS

Scanning Digital Mini-Chrom Monochromator

The Scanning Digital Mini-Chrom is identical to the Digital Mini-Chrom except that it includes an integral stepping motor. This configuration allows the unit to be operated manually, via a dial, or controlled by a stepping motor controller and driver such as the Optometrics CB-3. The unit utilizes a lead screw/ sine bar mechanism to rotate the grating and dual photosensors that function as high and low limit switches when operated by a stepping motor controller.

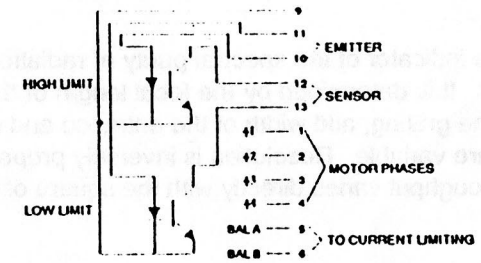
A 15 pin connector, directly compatible with the CB-3 controller allows access to the integral stepping motor and limit switches.

MODEL	RANGE	nm/REV	RESOLUTION FULL STEP (nm/step)	RESOLUTION HALF STEP (nm/step)
SDMC1-01	190-650nm	50	.125	.063
SDMC1-02	200-800nm	50	.125	.063
SDMC1-03	300-800nm	50	.125	.063
SDMC1-04	500nm-1.2μ	100	.25	.125
SDMC1-05	750nm-1.7μ	100	.25	.125



OVERALL DIMENSIONS

Scanning Digital Mini-Chrom Monochromator *continued*



MOTOR / LIMIT SENSOR CIRCUIT CONNECTOR PINOUT

ELECTRICAL SCHEMATIC

SLIT SELECTION AND MONOCHROMATOR RESOLUTION

Resolution is a quantifiable indicator of the spectral purity of radiation exiting the monochromator. It is determined by the focal length of the instrument, dispersion of the grating, and width of the entrance and exit slits. Only the slit widths are variable. Resolution is inversely proportional to slit width while throughput varies directly with the square of the slit width.

For example, changing from a 300μ slit to a 150μ slit will double the resolution, but decrease throughput by a factor of four. Resolution is also affected by wavelength, but to a much lesser extent. Refer to the illustration on the following page.

MODEL	BLAZE λ	LINEAR DISPERSION
01	250 nm	5.54 nm/mm
02	250 nm	7.41 nm/mm
03	500 nm	7.21 nm/mm
04	750 nm	11.29 nm/mm
05	1.2 μ	15.42 nm/mm
06	1.6 μ	21.45 nm/mm

LINEAR DISPERSION AT BLAZE WAVELENGTH

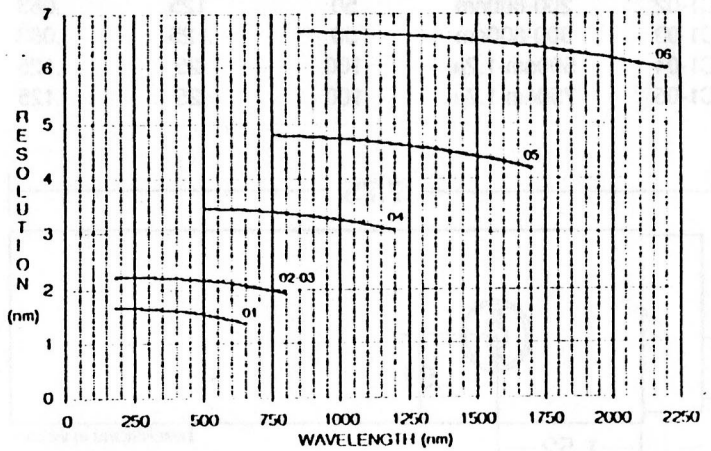
Changing slit assemblies in any Mini-Chrom takes only a few seconds and no tools. The slit assembly consists of a precision slit photo-etched in a black oxide coated brass disc, a slit spacer, cover, and two banana plugs which allow the assembly to be precisely positioned on the monochromator.

Slits should always be changed in pairs.

MODEL	RESOLUTION (nm) @ BLAZE WAVELENGTH 50μ SLIT	100μ SLIT	150μ SLIT	300μ SLIT*	600μ SLIT	1mm SLIT
01	0.28	0.55	0.83	1.66	3.32	5.54
02	0.37	0.74	1.11	2.22	4.44	7.41
03	0.36	0.72	1.08	2.16	4.32	7.21
04	0.56	1.13	1.69	3.39	6.77	11.29
05	0.77	1.54	2.31	4.63	9.25	15.42
06	1.07	2.14	3.22	6.43	12.87	21.45

* A SET OF 300μ SLITS IS SUPPLIED STANDARD WITH ALL MINI-CHROMS

MONOCHROMATOR RESOLUTION * VS. OUTPUT WAVELENGTH



*USING STANDARD 300μ SLITS

ACCESSORIES

Slit Sets

A set of fixed slits (300μ X 4mm) are included with each Mini-Chrom. Additional slit sets can be purchased to optimize resolution or throughput.

CATALOG NO.	DIMENSIONS
06-9001	50μ X 4mm
06-9002	100μ X 4mm
06-9003	150μ X 4mm
06-9004	300μ X 4mm
06-9005	600μ X 4mm
06-9006	1mm X 4mm

Second Order Blocking Filter Assembly

Required when it is necessary to block second order (λ/2) radiation. Assembly includes slit.

Note: Specify slit size by including last two digits of required slit after blocking filter part number, i.e. 06-9403, for a second order filter for model 04 monochromator with a 150μ slit.

CATALOG NO.	MODEL NO.	CUT-ON λ (nm)
06-91XX	01	375
06-92XX	02	420
06-93XX	03	420
06-94XX	04	630
06-95XX	05	1200
06-96XX	06	1200

Monochromator Aperture Adapter

Adapter converts slit(s) aperture to SMA connector compatible with Amphenol 906 series fiber optic connectors.

CATALOG NO.: 06-9200

Fiber Cables With Connectors

Glass or plastic clad fiber cables with single channel SMA connectors on both ends (screws into monochromator aperture adapter, MAA-1).

CATALOG NO.	DESCRIPTION
06-9801	50μ core, 125μ dia., 2m, 400 MHz-Km telecommunications fiber.
06-9802	50μ core, 125μ dia., 5m, 400 MHz-Km telecommunications fiber.
06-9803	100μ core, 140μ dia., 2m, short distance fiber for lower connector and coupling losses.
06-9804	100μ core, 140μ dia., 5m, short distance fiber for lower connector and coupling losses.
06-9805	200μ core, 2m, plastic clad silica fiber for easy alignment and efficient coupling.
06-9806	200μ core, 5m, plastic clad silica fiber for easy alignment and efficient coupling.