

Monochromators

- Design & Operation
- Optical Coatings
- Standard Mini-Chrom
- Digital Mini-Chrom
- Scanning Mini-Chrom
- Scanning Digital Mini-Chrom

For Applications In:
Analytical Chemistry
Physics
Life Sciences
Engineering
Communications





Optometrics Corporation has, for more than thirty years, designed and manufactured optical components and instruments for university, industrial and government laboratories and the OEM markets.

Optometrics Corp. has manufactured over 20,000 Mini-Chrom monochromators since their initial introduction in 1978. The majority have been incorporated into a variety of analytical and biomedical instruments made and marketed by leaders in their respective fields.

Mini-Chrom monochromators are currently being used as the principal optical assembly in numerous types of instruments and analyzers. When not integrated into other manufacturers' products, Mini-Chroms are used in basic and applied research projects in industrial, government and university laboratories. The combination of excellent performance, low cost and small size has contributed to the widespread use of the Mini-Chrom.

Facilities

Optometrics' facility in Ayer, Massachusetts contains space for offices, engineering, R&D and production. Equipment that support our broad range of capabilities include:

- Four metal vacuum coating systems;
- Three thin-film soft coated filter vacuum coating systems;
- Two Ion-Assisted Deposition hard coat vacuum coating systems;
- Three grating ruling engines;
- Production holographic laboratory;
- R&D holographic laboratory;
- Full replication and lamination facilities;
- Full assembly, alignment and test facilities;
- Full complement of test equipment for spectral testing from the UV to the Far Infrared, for mechanical and flatness testing, for humidity and environmental testing;
- Extensive marking, packaging and bar coding equipment and capabilities

Products

- **Gratings**
Originals and Replicated, Ruled and Holographic; Grazing Incidence, Echelles, Telecom and Transmission Gratings
- **Beamsplitters**
Reflecting/Transmitting Beamsplitters, Transmission Grating Beamsplitters, Beam Dividers/Combiners
- **Optical Components**
Mirrors, Lenses, Windows, Flats, Beamsplitters, Prisms
- **Filters**
Hard and Soft Coated, Near Ultraviolet, Visible, Near Infrared, Dichroic and Laser Line Filters



- **Infrared & Laser Products**
Laser Gratings, Holographic and Ruled Wire Grid Polarizers
- **Monochromators**
Mini-Chrom Monochromators



- **Systems & Accessories**
Monochromatic Light Modules, Sample Compartments, Detectors, Light Sources, Modular Recording Spectrophotometers
- **SPF-290S**
Spectrophotometer for determining Sunscreen Protection Factors

Plus specialized packaging, bar coding and Kanban stocking arrangements for all OEM customers.

| Monochromators

Goals

Optometrics goal is to provide advanced optical components and systems for use in wavelength selection applications in:

- Analytical Chemistry
- Life Sciences
- Telecom Applications
- Physics
- Education
- Space Sciences

and other applications where high quality optics are key.

In order to accomplish this, the Company has assembled state-of-the-art facilities and people to produce:

- diffraction gratings: ruled & holographic, original & replicated, reflection and transmission
- interference filters
- optical components
- laser gratings & products
- monochromators & accessories
- spectrophotometers
- wire grid polarizers: ruled & holographic

OEM Services

Optometrics caters, in particular, to the needs of its OEM customers by offering special services such as:

- Kanban stocking arrangements
- Custom packaging programs
- Bar coding capabilities
- Code names for complete confidentiality
- Higher level pre-aligned optical assemblies

The company is also proud of its ability to support customers in all phases of the product development cycle.

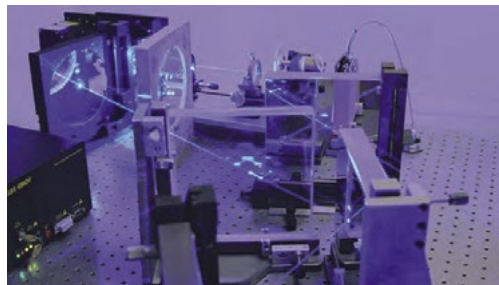


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Monochromators | Design and Operation

MONOCHROMATOR DESIGN AND OPERATION

Mini-Chroms are compact, in-line Fastie-Ebert monochromators with a 74 mm pathlength, applicable for general spectroscopy or for use as a component in a system. All incorporate one of a wide selection of replicated gratings from the UV to IR (ruled or holographic) and gratings are also available with aluminum or gold coatings depending upon application. All monochromators also include a set of fixed, interchangeable entrance and exit slits. Optional sets of slits are available to optimize either resolution or throughput.

The small size of the Mini-Chrom still results in resolution comparable to that of many larger, more costly, conventional monochromators.

Mini-Chroms are available in four types: Standard, Digital, Scanning and Scanning Digital. The primary differences in the four types relate to how the wavelength is selected and displayed. Each type is available in several wavelength ranges from the ultraviolet to the near infrared.

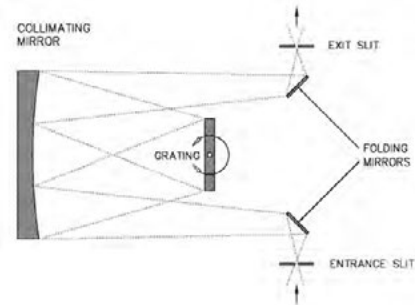
OPERATION

All Mini-Chroms are optically identical Fastie-Ebert in-line monochromators with an effective aperture of $f/3.9$ and 74 mm focal length. As shown in the optical diagram, polychromatic radiation is focused at the entrance slit and reflected by a folding mirror onto a spherical collimating/focusing mirror. This mirror collimates the radiation and directs it onto the grating, where it is diffracted. Once separated into a spectrum, the radiation is directed back to the collimating/focusing mirror, after which a segment of the dispersed radiation is focused at the exit slit via a second folding mirror. The wavelength of monochromatic radiation exiting the instrument is dependent upon the angular position of the grating. A sine drive mechanism is used to rotate the grating, either manually or via a stepping motor, so that discrete wavelengths are sequentially focused at the exit slit in a linear fashion.

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

BEAM GEOMETRY AND ALIGNMENT

To ensure maximum wavelength accuracy and system throughput, the effective aperture of the input beam must be $f/3.9$ or greater. If the input radiation has a faster (less than $f/3.9$) effective aperture, the input folding mirror will be overfilled and stray light will increase significantly. In addition, the converging (input) beam must be normal (perpendicular) to the plane of the entrance slit. Failure to align the beam properly with the entrance slit will adversely affect throughput and resolution (see page 9 for a pre-aligned visible source).



Optical Diagram

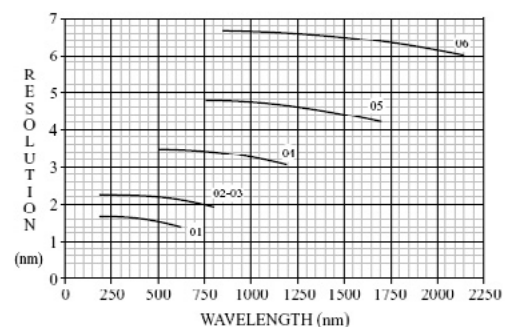
RESOLUTION

Resolution is a quantifiable indicator of the spectral purity of radiation exiting the monochromator. It is a function of the focal length of the monochromator, the dispersion of the grating and the width of the entrance and exit slits. In Mini-Chroms, only the slit widths can be changed.

Resolution is inversely proportional to slit width, i.e. as slit width decreases, resolution increases. Throughput, however, varies directly with the square of the slit width. Halving the width of a slit will therefore decrease throughput by a factor of four. Resolution is also affected by wavelength, but to a much lesser extent than changing the slits.

CHANGING SLITS

Changing the 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, slit cover and two banana plugs. The banana plugs allow the assembly to be easily inserted or removed while assuring alignment of the slit with the monochromator. Note: Slits should always be changed in pairs.



Monochromator resolution vs. wavelength by model number (using 300 μ slits)

Specifications | Monochromators

GENERAL SPECIFICATIONS- MONOCHROMATORS

Specifications that apply only to a specific type of Mini-Chrom are listed following the description of each type.

f Number..... 3.9
 Focal Length..... 74 mm
 Grating..... 2 cm square
 Slits..... see page 6
 Stray Light:

Models with holographic gratings¹..... ≤ 0.003%
 Models with ruled gratings²..... ≤ 0.02%
 Wavelength Accuracy (as a % of wavelength)..... ± 0.2%
 Wavelength Reproducibility..... ± 0.15%
 Wavelength Readability..... 0.2 nm
 Dimensions..... Type dependent

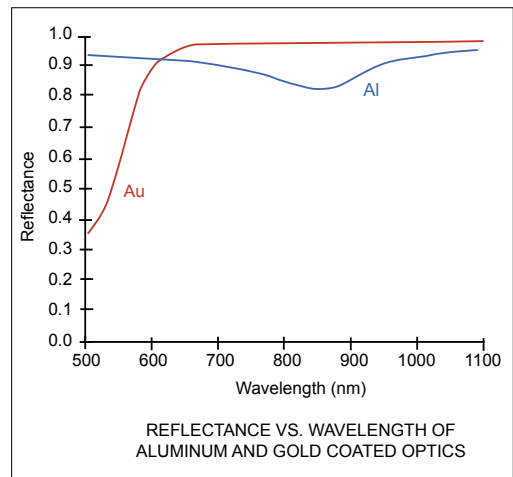
Wavelength accuracy is given as a percentage of wavelength. This means that, at 400 nm, the accuracy would be 400 nm ± 0.2% or 400 nm ± 0.8 nm. At 800 nm, the accuracy in the same Mini-Chrom would be 800 nm ± 0.2% or 800 nm ± 1.6 nm.

¹ measured 10 nm from 632.8 nm (HeNe laser line).

² measured 20 nm from 1265.6 nm (second order HeNe laser line).

OPTICAL COATINGS

All optical surfaces in the Mini-Chroms are coated with aluminum which has a high reflectance throughout the UV-VIS-NIR spectral range. Aluminum does, however, exhibit a decrease in reflectance at approximately 850 nm. If your application requires maximum efficiency in this area, an optional gold coating on all optical surfaces may be required. Note that the reflectance of gold falls to very low levels below 600 nm.



Models Available and Resolution

MODEL	GRATING SPACING/BLAZE AND TYPE	LINEAR DISPERSION (nm/mm)	WAVELENGTH RANGE	RESOLUTION* (nm) FOR SLIT WIDTHS OF:					
				50 μ	100 μ	150 μ	300 μ	600 μ	1 mm
01	2400/250 nm Holographic	5.54	190-650 nm	0.28	0.55	0.83	1.66	3.32	5.54
02	1800/250 nm Holographic	7.41	200 - 800 nm	0.37	0.74	1.11	2.22	4.44	7.41
03	1800/500 nm Holographic	7.21	300 - 800 nm	0.36	0.72	1.08	2.16	4.32	7.21
04	1200/750 nm Ruled	11.29	500 nm - 1.2 μ	0.56	1.13	1.69	3.39	6.77	11.29
05	830/1.2 μ Ruled	15.42	750 nm - 1.7 μ	0.77	1.54	2.31	4.63	9.25	15.42
06	600/1.6 μ Ruled	21.45	850 nm - 2.2 μ	1.07	2.14	3.22	6.43	12.87	21.45

*Resolution = (Slit Width) x (Linear Dispersion)

Monochromators | Standard Mini-Chrom

STANDARD MINI-CHROM

The Standard Mini-Chrom (MC) is a manual unit which utilizes a micrometer for wavelength selection and read-out. Turning the micrometer causes, via a precision sine bar drive, rotation of the diffraction grating which positions the desired wavelength at the exit slit.

Wavelength in nanometers (nm) is read directly from the micrometer in models 01, 02, 03, and 04. Near infra-red models (05 and 06) require the micrometer reading to be doubled, to 2 nm per division, for wavelength selection and readout.

Standard Mini-Chroms are used in a variety of applications that require an inexpensive, small yet high performance monochromator. They are used in physics, chemistry, engineering and the life sciences for research, development and teaching. Overall dimensions in mm: 150 x 59 x 49; Weight 0.5 Kg (1.1 lbs).

The addition of a reticle and comparator converts the Standard visible Mini-Chrom (model 03) to a hand held spectrograph. The unit (cat. no. 6-0109) can be used to identify the emission lines of various elements such as Hg and Na from a fluorescence or discharge lamp. Removal of the comparator and reticle converts the hand held spectrograph back to a standard Mini-Chrom.



Standard Mini-Chrom

CATALOG NO.	MODEL NO.	WAVELENGTH RANGE
6-0101	MC1-01	190 nm - 650 nm
6-0102	MC1-02	200 nm - 800 nm
6-0103	MC1-03	300 nm - 800 nm
6-0104	MC1-04	500 nm - 1.2 μ
6-0105	MC1-05	750 nm - 1.7 μ
6-0106	MC1-06	850 nm - 2.2 μ
6-0107	MC1-05G	750 nm - 1.7 μ
6-0108	MC1-06G	850 nm - 2.2 μ
6-0109	MC1-03S	300 nm - 800 nm

Models 05G and 06G utilize gold coated optics for superior reflectance in the NIR.
 Models 03S include a comparator and reticle for use as a hand-held spectrograph.

Scanning Mini-Chrom | Monochromators

SCANNING MINI-CHROM

The Scanning Mini-Chrom monochromator (SMC) is designed to be driven by stepping or servocontrolled motors. No wavelength readout is provided. All 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 proportionately increases the wavelength of radiation at the exit slit. Scanning Mini-Chroms are used in applications requiring either single or repetitive scans of wavelength intervals or the sequential selection of discrete wavelengths. To prevent mechanical damage due to inadvertently exceeding wavelength limits, all Scanning Mini-Chroms are supplied with dual photosensors that function as high and low limit switches. Overall dimensions in mm: 95 x 59 x 49; Weight 0.45 Kg (1.0 lb).



ADDITIONAL SPECIFICATIONS

Drive Hysteresis. 3.6 deg typ., 14 deg max.

Scanning Mini-Chrom

CATALOG NO.	MODEL NO.	WAVELENGTH RANGE
6-0201	SMC1-01	190 nm - 650 nm
6-0202	SMC1-02	200 nm - 800 nm
6-0203	SMC1-03	300 nm - 800 nm
6-0204	SMC1-04	500 nm - 1.2 μ
6-0205	SMC1-05	750 nm - 1.7 μ
6-0206	SMC1-06	850 nm - 2.2 μ
6-0207	SMC1-05G	750 nm - 1.7 μ
6-0208	SMC1-06G	850 nm - 2.2 μ

Models 05G and 06G utilize gold coated optics for superior reflectance in the NIR.

Monochromators | Digital Mini-Chrom

DIGITAL MINI-CHROM

The Digital Mini-Chrom (DMC) is a manually operated monochromator that utilizes a digital counter for wavelength selection. 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 directly in nanometers (nm) from a counter on models 01, 02, 03, 04 and 05. Near infrared model (06) requires the counter reading to be doubled, to 2 nm per division, for wavelength selection and readout. Overall dimensions in mm: 139 x 59 x 49; Weight: 0.7 Kg (1.5 lbs).



WAVELENGTH READABILITY

The wavelength on all Digital Mini-Chroms can be selected and read to 0.2 nm.

Digital Mini-Chrom

CATALOG NO.	MODEL NO.	WAVELENGTH RANGE
6-0401	DMC1-01	190 nm - 650 nm
6-0402	DMC1-02	200 nm - 800 nm
6-0403	DMC1-03	300 nm - 800 nm
6-0404	DMC1-04	500 nm - 1.2 μ
6-0405	DMC1-05	750 nm - 1.7 μ
6-0406	DMC1-05G	750 nm - 1.7 μ
6-0407	DMC1-03S	300 nm - 800 nm
6-0408	DMC1-06	850 nm - 2.2 μ
6-0409	DMC1-06G	850 nm - 2.2 μ

Models 05G and 06G utilize gold coated optics for superior reflectance in the NIR. Models 03S include a comparator and reticle for use as a hand-held spectrograph.

Scanning Digital Mini-Chrom | Monochromators

SCANNING DIGITAL MINI-CHROM

The Scanning Digital Mini-Chrom (SDMC) includes an integral stepping motor which can be controlled by a calibrated drive such as the PCM-02 via a 15-pin connector. The SDMC is similar to the Digital Mini-Chrom in that it includes a four digit counter for wavelength readout and a dial for manual wavelength selection. For near infrared model (06), the four digit counter reading must be doubled, to 2 nm per division, for wavelength selection and readout. Dual photosensors that function as high and low limit switches are included for use in the scanning mode. The Scanning Digital Mini-Chrom can be used for all applications that require the convenience of a built-in wavelength readout as well as applications requiring scanning to a selected wavelength or over a wavelength interval. Overall dimensions in mm: 197 x 59 x 49; Weight 0.9 Kg (1.9 lbs).



Scanning Digital Mini-Chrom

CATALOG NO.	MODEL NO.	WAVELENGTH RANGE
6-0501	SDMC1-01	190 nm - 650 nm
6-0502	SDMC1-02	200 nm - 800 nm
6-0503	SDMC1-03	300 nm - 800 nm
6-0504	SDMC1-04	500 nm - 1.2 μ
6-0505	SDMC1-05	750 nm - 1.7 μ
6-0506	SDMC1-05G	750 nm - 1.7 μ
6-0507	SDMC1-06	850 nm - 2.2 μ
6-0508	SDMC1-06G	850 nm - 2.2 μ

Models 05G and 06G utilize gold coated optics for superior reflectance in the NIR.

Monochromators | Accessories

Monochromator Accessories

SLIT SETS

Your choice of a pair of slits are included with each Mini-Chrom. Additional slit sets can be purchased to optimize resolution or throughput. Slits are available in 50, 100, 150, 300, 600 and 1000 micron widths, all 4 mm in height.

MONOCHROMATOR APERTURE ADAPTER

Adapter converts slit(s) aperture to SMA connector compatible with Amphenol 905 series fiber optic connectors.



HOLMIUM CALIBRATION FILTER

Comprised of 2.5 mm thick holmium oxide glass epoxied in a metal holder, the cell holder fits in all spectrophotom-

eters that accept standard 1 cm square cells. A reference scan showing calibration wavelengths from 350 nm to 800 nm is included. A comparison between the reference scan and the indicated wavelength takes only a few seconds.

HIGHER ORDER BLOCKING FILTER ASSEMBLY

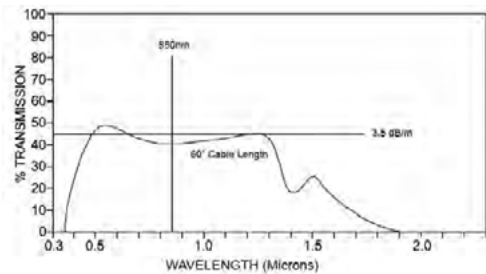
Required to block higher order ($\lambda/2$, $\lambda/3$, $\lambda/4$, etc.) radiation. Higher order blocking filters are Optometrics' Long Pass Cut-On filters in an assembly which includes the monochromator slit. Plugs directly into the Mini-Chrom monochromator.



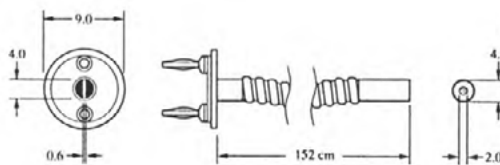
FIBER OPTIC CABLE

The F. O. Cable plugs directly into the Mini-Chrom, functionally replacing the exit slit. It is supplied with a 600 micron slit assembly for use on the entrance side. The other end of the cable terminates in a conventional circular bundle. The cable is 152 cm (5 feet) long with a rectangular (4.0 x 0.6 mm) fiber array and slit adapter on one end and a 2.0 mm diameter bundle on the other. Non-standard cable configurations are available on request.

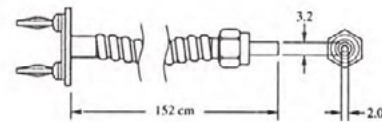
For applications below 400 nm, quartz fibers are available as special order items.



Typical transmission for 1/8" diameter bundles of glass fibers in 12", 36", 60" and 156" lengths



Standard Fiber Optic Bundle



Fiber Optic Bundle with SMA 905 Stainless Steel Connector

Accessories | Monochromators

Slit Sets and Other Accessories

CATALOG NO.	DIMENSIONS	ACCESSORY DESCRIPTION
6-9001	50 μ x 4mm	Slit Pair
6-9002	100 μ x 4mm	Slit Pair
6-9003	150 μ x 4mm	Slit Pair
6-9004	300 μ x 4mm	Slit Pair
6-9005	600 μ x 4mm	Slit Pair
6-9006	1000 μ x 4mm	Slit Pair
6-9200	-	Monochromator Aperture Adapter
6-9500	-	Holmium Oxide Filter Holder and Reference Scan
7-2505	-	Fiber Optic Cable without SMA Connector
7-2506	-	Fiber Optic Cable with SMA Connector

Higher Order Blocking Filter Assembly

CATALOG NO.	MINI-CHROM MODEL NO.	CUT-ON WAVELENGTH
6-91XX	01	375 nm
6-92XX	02	420 nm
6-93XX	03	420 nm
6-94XX	04	630 nm
6-95XX	05	1200 nm
6-96XX	06	1200 nm

Assembly includes slit. Specify slit size by including the last two digits from slit set catalog numbers above. For example, a blocking filter assembly for a model 03 Mini-Chrom including a 600 μ slit is catalog no. 6-9305.

Rev: 2/3/10