

# Bandpass Filter Selection Guide



Control the light, see your world



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# Custom Advantage



While stocking over 1,500 standard filters, Andover Corporation has built a worldwide reputation for developing custom, state-of-the-art, filters and coatings.

With our extensive engineering experience and advanced manufacturing facility, we control the entire production process to ensure that you receive only the highest-quality products, attentive service, and timely delivery.

- Fully-automated systems for excellent repeatability and rapid turnaround
- Continuously updated manufacturing processes
- Products that far exceed industry standards for quality

## Optical Polishing

Andover's in-house polishing facility can achieve flatness up to  $\lambda/10$  wave per inch and parallelism of 5 arc seconds or better, with a surface quality of 20/10.

## Engineering Assistance

Andover's in-house engineering staff can provide innovative assistance in optical and mechanical design, to ensure the success of your project.

## Optical Fabrication

Whether you require a filter that's 2mm or 350mm, Andover has fully automated CNC equipment to fabricate exactly what you need, with the quality you expect, and using the optical material of your choice.

## Machine Fabrication

Andover's 3-axis machining centers allow us to fabricate complex tooling quickly and accurately, greatly reducing the lead time for custom components. 3D printing available for prototyping.

## Quality Assurance

Utilizing the Cary 7000 spectrophotometer, Andover is able to measure absolute specular reflection over a wide range of angles, facilitating very accurate measurements of dichroic cube beamsplitter performance, and other complex measurements.

We check all filter glass for striae, bubbles and inclusions using our custom-designed inclusion tester. This instrument **detects minute defects, even in materials that do not transmit visible light.**

Our in-house environmental chambers allow us to perform routine and **custom product testing at temperatures from -62°C to over 500°C.** This capability, along with the ability to vary humidity levels, ensures compliance with your custom specification or MIL standard.

Most interferometers rely on laser light to produce interference fringes. Many bandpass filters cannot be measured with these instruments, as they do not transmit the laser wavelength. To solve this problem, **we constructed a computerized, tunable white light interferometer that produces actual transmitted wavefront interferograms of filters at any wavelength in the range of 350nm–1100nm.**

# About Bandpass Filters

The use of bandpass filters is one of the simplest and most economical ways to transmit a well-defined band of light and to reject all other unwanted radiation. Their design is essentially a thin film Fabry-Perot interferometer formed by vacuum deposition, and consists of two reflecting stacks separated by an even-order spacer layer.

Because the Fabry-Perot filter is Lorentzian in shape, the cut-on and cut-off slopes are shallow and the rate of attenuation in the out-of-band blocking range is slow. To improve the slopes and increase the attenuation in the blocking band, we introduce more cavities into the construction of our standard dielectric bandpass filters.

## Environmental Considerations

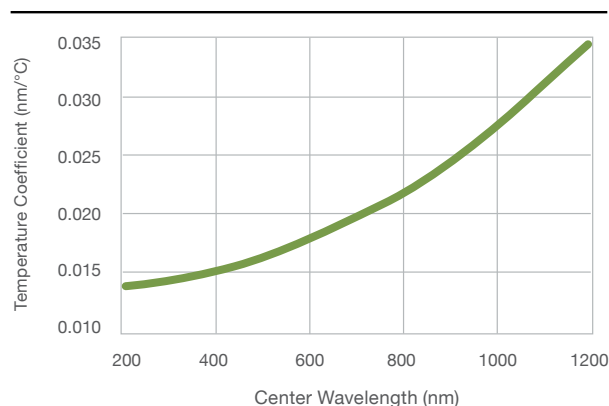
Ambient temperature and optical path geometry are important factors to consider in selecting or specifying bandpass filters.

### Ambient Temperature

The center wavelength of a bandpass filter shifts linearly with changes in ambient temperature—up with a positive change and down with a negative change. The temperature coefficient chart below gives a good approximation of the shift in wavelength for a given temperature change.

To counter these effects, Andover has developed [Temperature Controllers](#) that help to maintain the ambient temperature of bandpass filters.

**Temperature Wavelength Shift Coefficient**



### Angle of Incidence

The central wavelength of the all-dielectric Fabry-Perot filter shifts lower with an increase in the incident angle. The amount of shift depends upon the incident angle and the filter's effective index ( $N^*$ ). This feature can be very useful when tuning a filter to the desired central wavelength. Use the formula below to determine the wavelength shift of a filter in collimated light with incident angles up to  $15^\circ$ .

$$\lambda_\theta = \lambda_o \left[ 1 - \frac{n_o}{n^*} \sin^2 \theta \right]^{\frac{1}{2}}$$

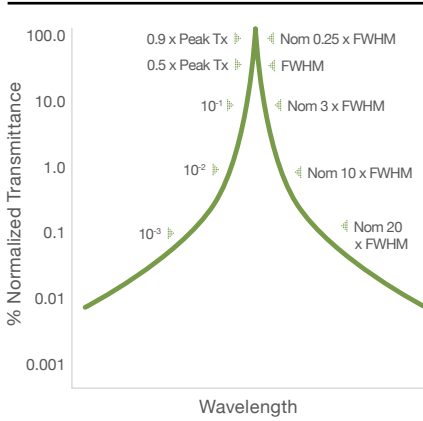
Where:

- $\lambda_\theta$  = Peak wavelength at incident angle  $\theta$
- $\lambda_o$  = Peak wavelength at normal incidence
- $n_o$  = Refractive index of incident medium (air=1.0)
- $n^*$  = Effective index of the filter assembly
- $\theta$  = Angle of incidence

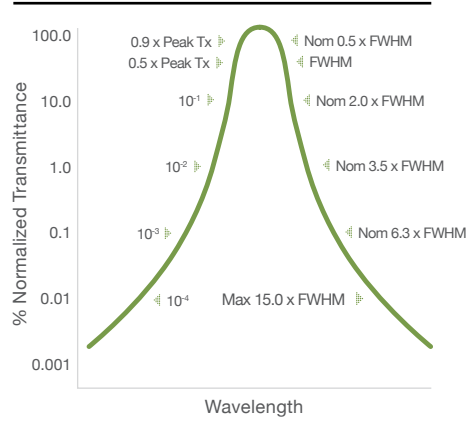
When using a filter with non-collimated light, the wavelength shift will appear somewhat less than that of collimated light at the same angle. In a cone of light, only the central ray is normal to the surface while all others are increasingly off-angle. To approximate this shift, use this same formula and divide the results by two. (This approach works in systems where the full cone angle is up to  $20^\circ$ ).

# Spectral Profiles for Andover's 10 Basic Filter Types

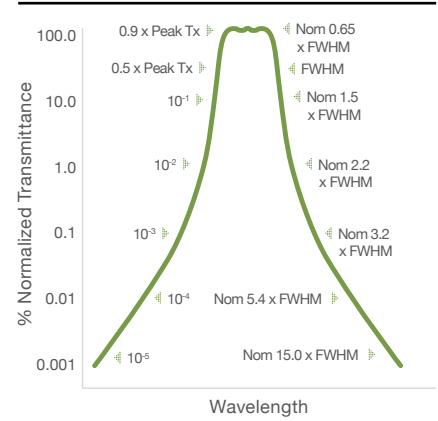
Type 1  
**1 cavity**



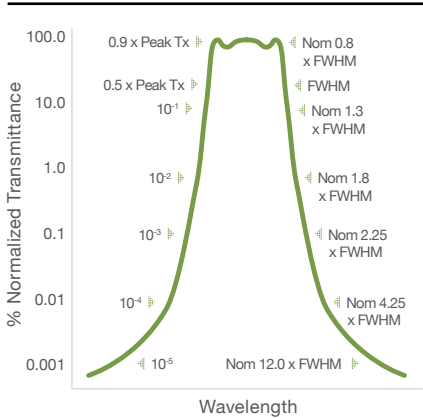
Type 2  
**2 cavity**



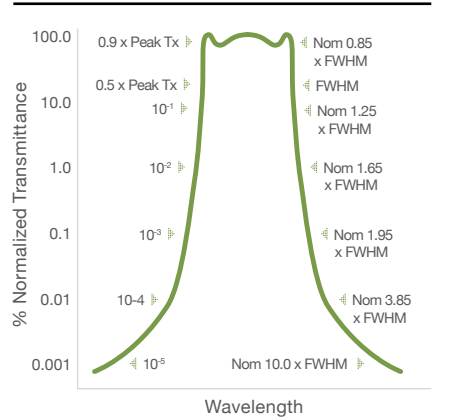
Type 3  
**3 cavity**



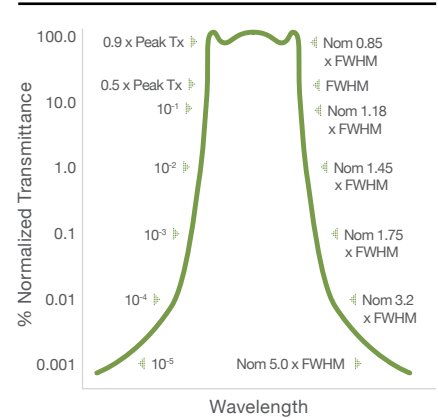
Type 4  
**4 cavity**



Type 5  
**5 cavity**



Type 6  
**6 cavity**



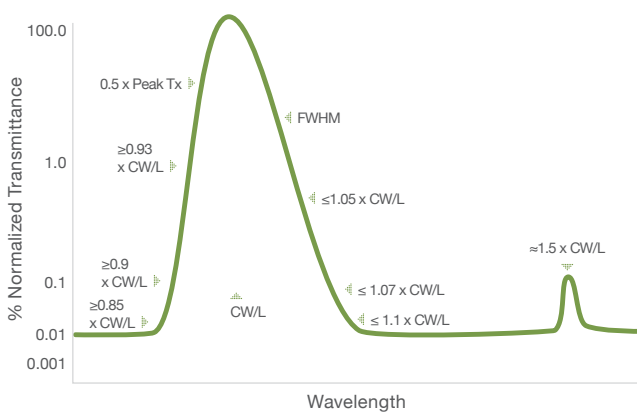
**Filter types 1-6 represent unblocked filter profiles. Bandshape may vary depending upon level of additional blocking**

Normalized Transmittance of Peak (%)	Full Bandwidth Multiplier (Nominal)					
	1 Cavity	2 Cavity	3 Cavity	4 Cavity	5 Cavity	6 Cavity
<b>90.0</b>	0.25 nom.	0.5 nom.	0.65–0.70	0.8–0.9	0.85–0.90	0.85–0.90
<b>10.0</b>	2.5–3.0	1.6–2.0	1.2–1.5	1.1–1.3	1.1–1.25	1.08–1.18
<b>1.0</b>	8.0–10.0	2.8–3.5	1.9–2.2	1.5–1.8	1.4–1.65	1.35–1.45
<b>0.1</b>	15.0–20.0	5.5–6.3	2.9–3.2	2.0–2.25	1.8–1.95	1.6–1.75
<b>0.01</b>	undefined	10.0–15.0	4.9–5.4	3.5–4.25	3.1–3.85	2.9–3.2
<b>0.001</b>	undefined	undefined	10.0–15.0	9.0–12.0	8.0–10.0	4.0–5.0

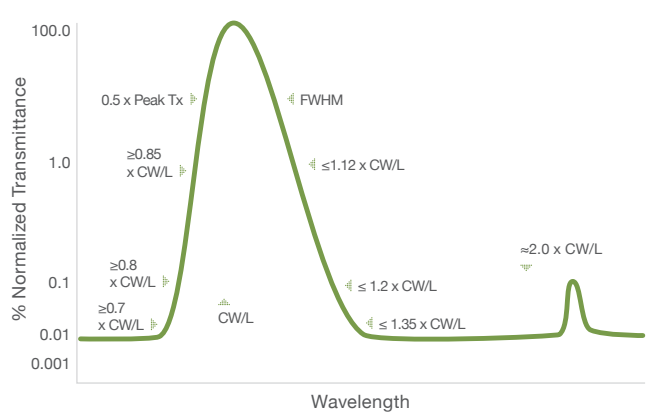


MDM filters are a special type of bandpass filter utilizing dielectric layers (D) surrounded by metallic layers (M). They provide excellent throughput over a wide spectral range, while providing good out-of-band blocking.

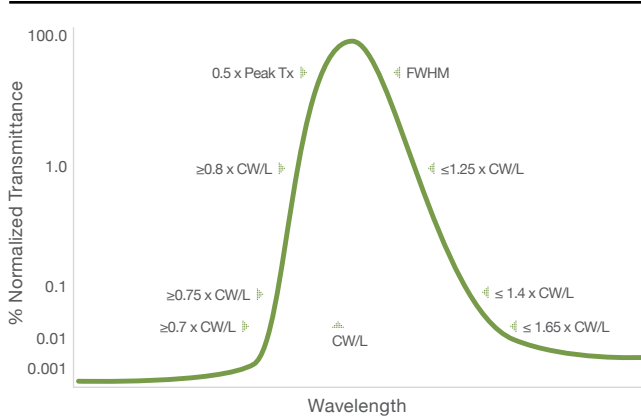
Type 7  
**MDM 10nm BANDWIDTH**



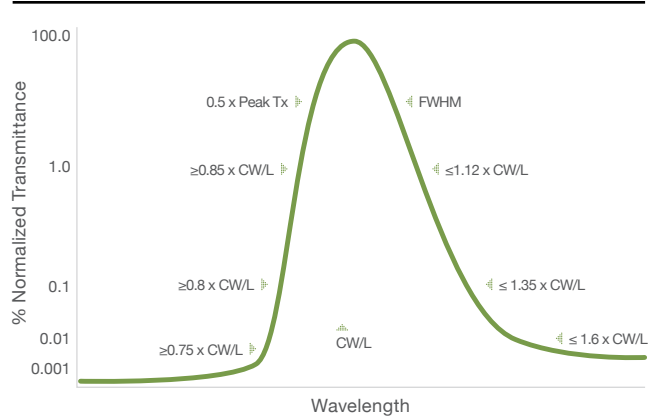
Type 8  
**MDM 25nm BANDWIDTH**



Type 9  
**MDM 10-70nm BANDWIDTH**



Type 10  
**MDM 80-100nm BANDWIDTH**



## Bandpass Filter Selection Guide

There are many variations to a bandpass filter's construction, each with specific advantages. Andover offers a variety of options so that you can select what is best-suited for your application.

Bandpass Filter Types					
Type & Page	Standard Bandpass Filters	High-Transmitting Bandpass Filters	Hard-Coated Narrowband Filters	Hard-Coated Broadband Filters	Semi-Custom Bandpass Filters
<b>Description</b>	Andover's Standard Bandpass filters have been the mainstay of the industry for decades. With our proprietary stabilization and sealing method these filters will generally last for 10-20 years in the field. Their longevity, coupled with their low cost and ready availability, make these a great choice for most applications.	Andover's High-Transmitting Bandpass filters are a variant of the Standard Bandpass filter line. Designed for use with PMTs and photodiodes, they employ only dielectric coatings, and have a blocking range tailored to the detector. This results in higher transmission than their fully-blocked counterparts.	Andover offers one of the broadest ranges of hard-coated narrowband filters in the industry. Our filters feature very high transmission, and dense blocking from UV-1200nm. They are suitable for high-temperature applications.	This line of hard, first-surface coated filters was designed to cover the standard Raman spectroscopy lines. They feature very high transmission over a broad range about the wavelength of interest.	In order to make it simple for customers to custom-tailor a bandpass filter for their application, Andover offers a line of Semi-Custom bandpass filters. Their construction is similar to both the Standard Bandpass and High-Transmitting bandpass filter products. We offer a wide selection of wavelengths, bandwidths and sizes, with two blocking options.
Key Attributes					
<b>Construction</b>	Traditional Laminated	Traditional Laminated	Hard First-surface coatings	Hard First-surface coatings	Traditional Laminated
<b>Wavelength range</b>	193nm - 2400nm	365.0nm - 1550nm	345nm - 785nm	334nm - 1550nm	214nm - 2400nm
<b>Bandwidths</b>	1nm - 100nm	10nm - 40nm	80nm - 300nm	10nm	0.15nm - 80nm
<b>Blocking</b>	OD4 UV-FIR	OD4 UV-800nm or 1000nm	OD4 UV-1200nm	Varies by W/L	OD4 UV-1000nm or UV-FIR
<b>Sizes (diameter)</b>	12.5mm, 25mm and 50mm	12.5mm, 25mm and 50mm	12.5mm, 25mm and 50mm	25mm	12.5mm, 25mm 50mm, custom
Features					
<b>Low cost</b>	✓	✓			
<b>Available from stock</b>	✓	✓	✓	✓	
<b>High-Transmission</b>		✓	✓	✓	✓
<b>Highly customizable</b>					✓
<b>First surface coatings</b>			✓		
<b>Suitable for high temperatures</b>			✓	✓	

# Standard Bandpass Filters

## Typical Applications Include:

- Spectral Radiometry
- Medical Diagnostics
- Chemical Analysis
- Colorimetry



Andover offers one of the most extensive selections of bandpass filters in the industry, including many of the primary laser, mercury, biomedical, and analytical spectral lines.

We use a proprietary method to stabilize our products to prevent drift of peak wavelength with age and hermetically seal each filter for maximum protection against humidity. Each filter is mounted in a black anodized aluminum ring, adding further protection against chipping, scratching, and moisture penetration. This added protection leads to an extended shelf life.

- **Wavelengths from the ultraviolet through the near infrared**
- **Stabilized to prevent drift of peak wavelength over time**
- **Hermetically sealed and protected by an anodized aluminum ring**
- **Custom sizes available**

## General Specifications

<b>Diameter Tolerance:</b>	+0/-0.25mm	
<b>Usable Aperture:</b>	Filter Size	Usable Aperture
	12.5mm Ø	9.0mm Ø
	25.0mm Ø	21.0mm Ø
	50.0mm Ø	45.0mm Ø
<b>Surface Quality:</b>	80-50 (Per MIL-PRF-13830B)	
<b>Optical Quality:</b>	Commercial instrumentation grade	
<b>Out-of-Band Blocking:</b>	1 x 10 <sup>-4</sup> avg. from X-ray to FIR	
<b>Specification Temperature:</b>	+23°C	
<b>Max. Survival Temp Range:</b>	CW/L 214-380nm	-50°C to +50°C
	CW/L 380.1-2400nm	-50°C to +70°C
<b>Humidity Resistance:</b>	Per MIL-C-48497A	
<b>Mechanical:</b>	Mounted in an anodized aluminum ring	

[Order Standard Bandpass Filters](#)

[Threaded Filter Rings Optional](#)

# High-Transmitting Bandpass Filters

## Typical Applications Include:

- Spectral Radiometry
- Medical Diagnostics
- Chemical Analysis
- Colorimetry

Andover offers a high-transmittance variant of its standard bandpass filter selection. By tailoring the blocking range to match the detector, we can provide maximum possible throughput while maintaining good blocking to meet the customer's needs. Wavelengths include all popular laser, mercury biomedical, and analytical spectral lines.

All filters are constructed using the same high-quality materials and methods as our standard bandpass filters, thus providing a highly stable, long-lasting filter.

- Wavelengths from the ultraviolet through the near infrared
- Stabilized to prevent drift of peak wavelength over time
- Hermetically sealed and protected by an anodized aluminum ring
- Transmission as high as 80%
- Custom sizes available

## General Specifications

<b>Diameter Tolerance:</b>	+0/-0.25mm	
<b>Usable Aperture:</b>	Filter Size	Usable Aperture
	12.5mm Ø	9.0mm Ø
	25.0mm Ø	21.0mm Ø
	50.0mm Ø	45.0mm Ø
<b>Surface Quality:</b>	80-50 (Per MIL-PRF-13830B)	
<b>Optical Quality:</b>	Commercial instrumentation grade	
<b>Out-of-Band Blocking:</b>	1 x 10 <sup>-4</sup> avg. from X-ray to FIR	
<b>Specification Temperature:</b>	+23°C	
<b>Max. Survival Temp Range:</b>	CW/L 350-380nm	-50°C to +50°C
	CW/L 380.1-2400nm	-50°C to +70°C
<b>Humidity Resistance:</b>	Per MIL-C-48497A	
<b>Mechanical:</b>	Mounted in an anodized aluminum ring	

[Order High-Transmitting Bandpass Filters](#)

[Threaded Filter Rings Optional](#)

# Hard-Coated Narrowband Filters

## Typical Applications Include:

- Machine Vision
- Biotech Instrumentation
- Medical Devices



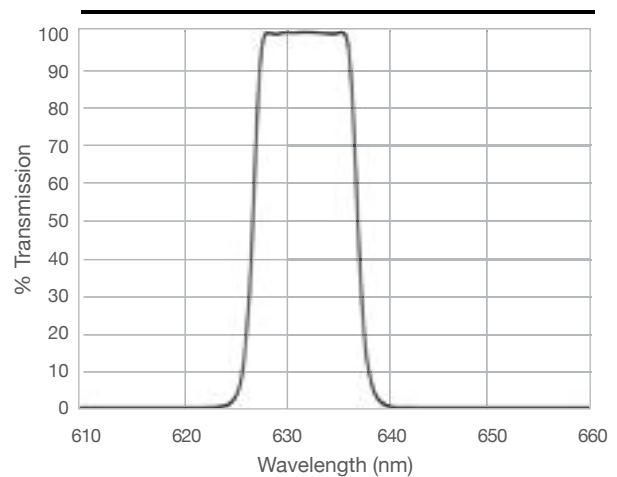
Our first-surface, hard-coat narrowband filters employ plasma-deposited, hard-oxide coatings on Borosilicate Glass and do not utilize any absorbing filter glasses, making them suitable for high temperature applications. They provide a steep transition from a high, peak transmission to OD4 blocking. Available at wavelengths from 334nm to 1550nm, including all major laser lines and atomic absorption lines. All filters are mounted in black anodized aluminum rings to provide protection and easy identification.

- Hard, durable, first-surface coatings
- Suitable for high-temperature applications

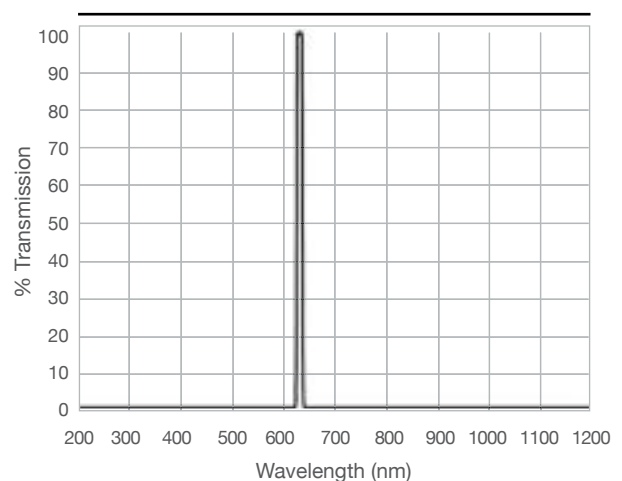
## General Specifications

<b>Thickness:</b>	5.0 ± 0.25mm
<b>Size Tolerance:</b>	+ 0.0mm / -0.1mm
<b>Minimum Clear Aperture:</b>	21mm dia.
<b>Substrate Material:</b>	Borosilicate Glass
<b>Flatness:</b>	3-5 waves
<b>Surface Quality:</b>	80-50 per MIL-C-48497A
<b>Humidity and Abrasion:</b>	Per MIL-C-675A
<b>Durability:</b>	Per MIL-C-48497A
<b>Operating Temperature:</b>	-50°C to +100°C
<b>Mechanical:</b>	Mounted in black anodized aluminum

**632nm Narrowband - 632HC10-25**



**632nm Narrowband - 632HC10-25**



[Order Hard-Coated Narrowband Filters](#)

# Hard-Coated Broadband Filters

## Typical Applications Include:

- Machine Vision
- Biotech Instrumentation
- Medical Devices

Our first-surface, hard coat broadband filters employ magnetron sputtered, hard-oxide coatings deposited on Borosilicate Glass and do not utilize any absorbing filter glasses, making them suitable for high temperature applications. They provide a steep transition from a high, peak transmission to OD4 blocking.

Available at standard Raman wavelengths: 488, 514, 532, 633, 785nm. We offer three standard sizes, with custom sizes available on request.

- Hard, durable, first-surface coatings
- Suitable for high-temperature applications
- Available from stock

## General Specifications

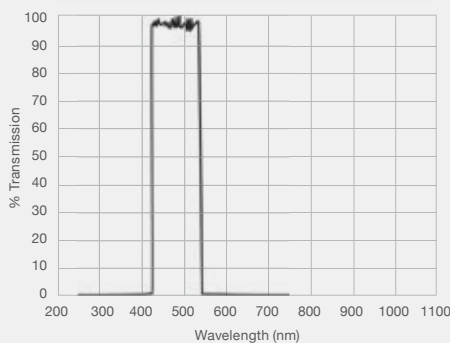
<b>Thickness:</b>	3.1 ± 0.25mm
<b>Size Tolerance:</b>	+ 0.0mm / -0.2mm
<b>Minimum Clear Aperture:</b>	95% of outside dimension
<b>Substrate Material:</b>	Borosilicate Glass (345nm filter utilizes Fused Silica)
<b>Flatness:</b>	3 - 5 waves

<b>Surface Quality:</b>	80 – 50 per MIL-C-48497A
<b>Humidity and Abrasion:</b>	Per MIL-C-675A
<b>Durability:</b>	Per MIL-C-48497A
<b>Operating Temperature:</b>	-50°C to +200°C
<b>Mechanical:</b>	Unmounted

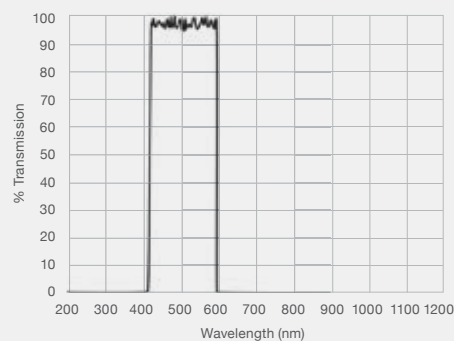
[Order Hard-Coated Broadband Filters](#)

[Threaded Filter Rings Optional](#)

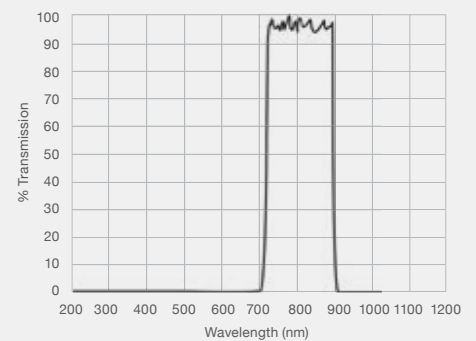
488nm Bandpass - 488HC80-XX



532nm Bandpass - 532HC150-XX



785nm Bandpass - 785HC150-XX



# Semi-Custom Bandpass Filters

## Typical Applications Include:

- Research
- Prototyping
- Instrumentation
- Specific Wavelength Imaging Filters

To specify your semi-custom filter, visit Semi-Custom Bandpass Filters then follow the steps below:

- **STEP 1- Select Bandwidth, Filter Type and CW/L**
- **STEP 2 - Select Blocking Range**
- **STEP 3- Select Size and Corresponding Pat Number**

All other features are predetermined by these three choices. The out-of-band blocking of these filters is  $1 \times 10^{-4}$  within the defined spectral range.

Thanks to a large inventory of substrate materials, Andover Corporation can fabricate and deliver higher-performance commercial quality bandpass filters to your specifications in as soon as 5-10 days from receipt of order.

- **Wavelengths from the visible through infrared**
- **Bandwidths from 0.15nm to 80nm**
- **Short lead times**

[Order Semi-Custom Bandpass Filters](#)

[Threaded Filter Rings](#)



# Astronomy UBVRI Filters

Andover Corporation offers two sets of UBVRI filters—the Johnson/Bessel and the Kron/Cousins types—as standard items. These wideband filters isolate and measure large specific bands of light emitted by astronomical objects. Both types have the same ultraviolet, blue and visible filters but different red and infrared filters. The Johnson/Bessel type is better suited for use with a photomultiplier tube, while the Kron/Cousins type is better suited for use with a Silicon CCD.

- Options for professionals and amateurs alike
- Ideal for photometric calibration

U

B

V

R

I

## Johnson / Bessel Filter Specifications

Nominal CW/L:	365nm	440nm	520nm	630nm	900nm
Nominal FWHM:	60nm	100nm	90nm	120nm	300nm
Nominal Transmission:	> 50%	> 55%	> 70%	> 70%	> 70%

## Kron / Cousins Filter Specifications

Nominal CW/L:	365nm	440nm	520nm	760nm	800nm
Nominal FWHM:	60nm	100nm	90nm	250nm	150nm
Nominal Transmission:	> 50%	> 55%	> 70%	> 70%	> 70%

## General Specifications

<b>Thickness:</b>	5.0mm +/-0.1mm
<b>Size Tolerance:</b>	+0/-0.25mm
<b>Bevels:</b>	Break all sharp edges
<b>Coating Durability:</b>	Per MIL-C-48497A moderate abrasion
<b>Transmitter Wavefront:</b>	1/4 wave or better per 25mm
<b>Parallelism:</b>	30 arc seconds or better
<b>Surface Quality:</b>	60/40 or better per MIL-C-675
<b>Optical Quality:</b>	Image Quality
<b>AR Coatings:</b>	Exterior surfaces (appropriate to the filter passband)

# About **Andover Corporation**

Andover Corporation was established in 1976 with the purpose of designing and manufacturing high-quality optical filters and coatings for a wide variety of applications; including medical instrumentation, fluorescence studies, machine vision, astronomical observation, telecommunications, space-borne systems and defense systems. As the company grows, our focus remains on quality. Our current facility spans 44,000 square feet on 17 acres of land in Salem, NH.

Our facility is custom-designed and state-of-the-art. It includes a automated coating, glass polishing, and fabrication equipment. Our testing capabilities are extensive, comprising of both automated spectrophotometers for broadband spectral measurements, and ultra-high-resolution spectrophotometers for narrowband measurements. Our optical metrology lab features a custom-designed, computer-controlled tunable interferometer to measure transmitted wavefronts beyond the capabilities of a traditional laser interferometer.

## **Quality and Service** that make a Difference

Unlike most optical filter and coating manufacturers, we supply spectral curves and digital data with most orders at no additional charge, saving you the cost of incoming quality control. We'll even help you reduce inventory by shipping your order only when you require it.



## Ordering Information

### Pricing

Current prices are available at [www.andovercorp.com](http://www.andovercorp.com) by clicking on the part numbers for particular items. For a complete price list or a specific quote, contact Andover at 603.893.6888 or [info@andcorp.com](mailto:info@andcorp.com).

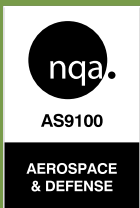
### Purchase Orders

Andover Corporation accepts e-mail, written, and online orders from customers with an open line of credit. New customers must confirm their orders in writing and supply credit references upon request.

### Andover Corporation

4 Commercial Drive  
Salem, NH 03079  
603.893.6888  
[www.andovercorp.com](http://www.andovercorp.com)  
[info@andcorp.com](mailto:info@andcorp.com)

Andover Corporation is an ISO 9001 / AS9100 and ITAR Registered Company



### Blanket Orders

Andover Corporation can help reduce your inventory by scheduling automatic delivery of your order over time. Complete details are available at: [www.andovercorp.com/info](http://www.andovercorp.com/info).

### Payment Terms

Net 30 days from date of invoice for customers with established lines of credit. International customers should check with the sales department to determine if prepayment is required. All foreign orders are subject to shipping and banking fees, and will be screened for compliance with export regulations. For blanket orders, please contact our sales department for special terms and conditions. Andover accepts all major credit cards and company checks.

### Return Policy

Andover Corporation accepts returns of defective items up to one year from the invoice date. Before returning any items, please contact our Technical Sales Staff for a Return Goods Authorization (RGA) number and complete shipping instructions.

### Shipping

Most standard items ship within two days of receipt of an order. All out-of-stock products are shipped within two weeks. For rush orders, One-Day Shipping may be available. All prices are EXW Salem, New Hampshire, USA. Shipments are freight prepaid and billed to the buyer, or charged to your own shipping account.