FREQUENTLY ASKED QUESTIONS

VariSpec Liquid Crystal Tunable Filters

How do they work? Tunable filters for VIS or NIR imaging – with no moving parts.

VariSpec™ Liquid Crystal Tunable Filters (LCTFs) from PerkinElmer are like high-quality interference filters, but the wavelengths of light they transmit are electronically controllable, providing rapid, vibrationless selection of any wavelength in the visible and near-infrared spectrum. VariSpec filters' wavelength selection, large apertures, and excellent imaging quality are valuable in a wide variety of applications such as remote sensing for agriculture and defense, chemical imaging, semiconductor process control, machine vision, and biomedical imaging.

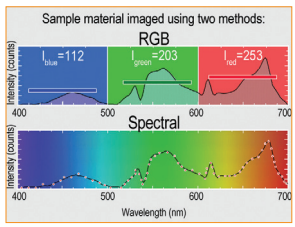
PerkinElmer has manufactured and shipped thousands of LCTFs over the past decade as the leader in tunable imaging filter technology. VariSpec filters feature a fast, plug-and-play USB interface with a free Software Developer's Kit (SDK) that includes Windows® DLL support, LabVIEW™ and Matlab® drivers, as well as a full serial command set for use with other operating systems.

Multispectral Imaging

Visible light is made up of a mixture of wavelengths that our eyes interpret as "color". Remarkably, although we can distinguish millions of different colors or color combinations, we cannot perceive all the wavelength (or "spectral") information in our visual environment. This is because our eyes (as well as conventional color films and color digital cameras) separate visible light, no matter how spectrally complex, into only three color bins: Red, Green, and Blue (RGB).

Light with completely different spectral content can have precisely the same RGB coordinates. For example, when we see a yellow color, we cannot tell if it comes from a "pure" yellow color or from a mixture of red color and green color. Multispectral imaging can.

Multispectral imaging is a technique that provides images of a scene at multiple wavelengths and can generate precise optical spectra at every pixel. CRi's VariSpec filters represent an ideal technology for affordable, precise, and robust multispectral imaging.



Q A What is the transmission of the filters?

The transmission is the percentage of linearly polarized light, oriented so that the maximum transmission is attained, passing through the VariSpec filter relative to the amount that entered. Since the entrance element of the filters is a linear polarizer, transmission of randomly polarized light is half that of linearly polarized light in the correct orientation. Transmission is wavelength dependent. Typical curves taken across the wavelength range of each type of filter are available from PerkinElmer in numerical and graphical form.

Q A What is the damage threshold of the filters?

The damage threshold for reasonably long-term exposure to VIS and NIR energy is 500 mW/cm^2. VariSpec filters absorb light that you do not want to transmitted. VIS model filters have an integral hot-mirror element to reflect unwanted near-infrared light, but longer-wavelength light in the form of thermal energy, for example, can damage the filters. UV light can also cause irreparable damage. Many detectors, such as CCD or CMOS sensors are not particularly sensitive to UV or thermal energy, so it is good practice to utilize heat-absorbing glass, a longpass filter, or to check the temperature of the VariSpec optics to make sure the filter is not being subjected to excessive energy.

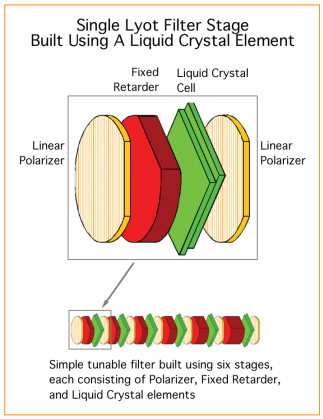
PerkinElmer®
For the Better

Q Is there a single filter that covers the UV to far-infrared range?

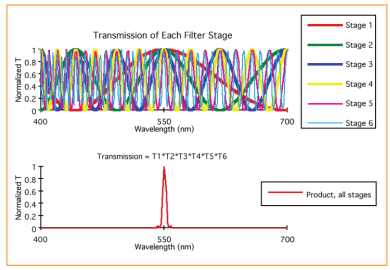
A No. The coatings, polarizing material, glass, and even the index-matching epoxies have different characteristics that can only accommodate specific wavelength ranges without sacrificing performance. Sensors and focusing optics themselves have limitations because of their own materials and construction.

Q How thick are the filters?

A Standard VIS and SNIR filters' optical elements are about 1.5 inches thick. Other models may be thicker. Contact PerkinElmer for more information on specific models.



An illustrative six-stage Lyot filter design is shown here with the addition of LC cells which can be precisely controlled. Typical VariSpec filters utilize 12 or more stages enclosed within a rugged aluminum housing.



The product of each tunable stage results in a narrow range of wavelengths being transmitted. The width of the passband is constant in terms of wavenumber, but varies in terms of wavelength such that a center wavelength selected closer to the blue will have a narrower passband width in nanometers than a center wavelength selected closer to the red.

Principles of Operation

PerkinElmer's patented VariSpec technology utilizes an optical filter design described by Bernard Lyot in 1933. While the design provides a static bandpass, the addition of LC variable retarders provides spectral tuning ability.

Each element transmits light with transparency that varies sinusoidally as a function of wavelength. The transmitted light adds constructively in the desired bandwidth region and destructively everywhere else in the wavelength range. Typical transmission outside the passband is 0.01% or less.

The LC components allow the transparent bandwidth region to be shifted throughout the spectral range of the filter without moving parts. Selectable bandwidth functionality is also available in the PerkinElmer-manufactured LCTFs incorporated within our award-winning Vectra, Nuance, and TRIO multispectral imaging instruments (US Patent No. 7,655,898).

VariSpec filters are very robust. Tunable filter modules have been flight-qualified for NASA space missions and have been used in airborne remote sensing platforms. A patented feedback circuit provides accurate and stable wavelength tuning which can be independent of ambient temperature within the operating range of 10 °C to 40 °C.

Nuance®, TRIO™, and Vectra® Multispectral Imaging Systems

Rely on our powerful and easy to use Nuance, TRIO, and Vectra systems for turnkey, integrated multispectral imaging solutions.

Specifications

	VariSpec VIS / VISR	VariSpec SNIR / NIRR	VariSpec LNIR	VariSpec XNIR
Spectral range	400-720 nm (VIS) 480-720 nm (VISR)	650-1100 nm	850-1800 nm	1200-2450 nm
Bandwidth	7, 10, or 20 nm (VIS) 0.25 nm (VISR)	7 or 10 nm (SNIR) 0.75 nm (NIRR)	6 or 20 nm	9 nm
Aperture	20 or 35 mm	20 mm	20 mm	20 mm
Angle-of-acceptance	7.5 ° half-angle (VIS) 3.5 ° half-angle (VISR)	7.5 ° half-angle (SNIR) 3.5 ° half-angle (NIRR)	3.5 ° half-angle	3.5 ° half-angle
Response time (room temp)	50 ms (VIS) 150 ms (VISR)	150 ms	150 ms	150 ms
Wavelength accuracy	Bandwidth/8 +/- 0.5 nm	Bandwidth/8 +/- 0.5 nm	Bandwidth/8 +/- 0.5 nm	Bandwidth/8 +/- 0.5 nm
Maximum optical throughput	500 mW/cm^2	500 mW/cm^2	500 mW/cm^2	500 mW/cm^2
Operating temp	10 to 40 °C	10 to 40 °C	10 to 40 °C	10 to 40 °C
Storage temp	-15 to 55 °C	-15 to 55 °C	-15 to 55 °C	-15 to 55 °C
Computer interface	USB 1.1	USB 1.1	USB 1.1	USB 1.1
Power supply	USB bus-powered	USB bus-powered	USB bus-powered	USB bus-powered
Software	Free SDK, demo program	Free SDK, demo program	Free SDK, demo program	Free SDK, demo program

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