Windows/Filters for Eltec Pyroelectric Detectors

The window or optical filter used as a window protects the sensing crystal and the preamplifier from contamination, mechanical damage, humidity and air drafts. Detectors without window should only be used for experiments, unless they are properly protected in the equipment.

Windows

Eltec ID	Material	Usefull Wave-lenght Band (µm)	Trans-mission	AR-Coating	Remarks
-0	no window	full spectrum		-	**
-1	germanium	2…40	45%	no	wide band
-2	germanium	8 … 12		yes	CO2 laser
-3	silicon	6 … 25	80%	yes	thermal IR detection, motion detection
-4	sapphire	0.2 … 5		no	**
-5	silicon	1.2 … 15	50%	no	**
-6	quartz	0.12 … 2.0		no	**UV-near IR and IR beyond 100 µm
-8	IRTRAN 2	1.0 ... 14.5	70%	no	** (Zinc sulphide)
-9	KRS5	0.6 … 35	70%	no	**thallium-jodobromide, toxic, soluble
-25	silicon	8 … 14	80%	yes	atmosperic window
-27	CaF	0.125 … 10	85%	no	**Calcium Fluoride
-32	silicon	1.5 … 5	90%	yes	in combination with external gas filters
-42	BaF	0.15 ... 12	85%	no	**Barium Fluoride
-49	ZnSe	0.6 ... 19	70%	no	**Zinc Selenide
-398	BaF	0.15 … 15	85%	no	** thinner version of -42

** These windows do transmit visible light – near IR. Detectors with integral preamplifier (except Model 404)will be affected in operation when such radiation is present.

Bandpass Filters (Filters for gas **detection** are wider than those for gas **analysis**)

Eltec ID	Substrate Material	Center Wavelenghth	Bandwidth (HBW)	Trans-mission	Remarks
-12	germanium	4.48	0.62	70%	Fire /CO_2
-23	sapphire	4.48	0.62	70%	Fire /CO_2
-29	sapphire	4.64	0.18	75%	Carbon monoxide
-30	sapphire	4.35	0.18	70%	CO_2
-32	silicon	1.5 … 5.0	-	92%	use with external gas filters
-43	sapphire	4.30	0.10	75%	CO_2
-55	quartz	3.43	0.14	75%	Methane, Alkanes (C-H – Band)
-79	silicon	4.45	0.156	70%	N_2O
-112	sapphire	4.35	0.155	90%	CO_2 Analysis
-113	sapphire	4.27	0.17	80%	CO_2
-294		8.4			Freon R134a and others
-336	quartz	3.33	0.145	70%	
-380		3.80	0.17	70%	Gas Detection Reference Band

Selecting The Filter

The filter or window protects the sensing element (lithium tantalate crystal) and internal electronics from physical damage and moisture. The filter, when properly selected, will block wavelengths of no interest and pass those desired.
The key to filter selection is to determine what you are looking at and what might interfere. If you are looking at an object, check the black-body chart for wavelength distribution at the object's temperature. Thus, if you desire to sense the presence of a person, only those wavelengths near 10 micrometers carry significant energy. For a person in front of a slightly colder background, the "radiant contrast" is the first deviation of Planck's function and somewhat shifted to the shorter wavelengths. Possible sources of interference are the sun and incandescent lights.
Since the wavelengths of maximum energy for the sun and incandescent lights are much shorter than those for a person, a "long-pass" filter - like ELTEC's HP-7 (-3) (6.5 - 14 micrometers) filter will be quite discriminating. The colder a body, the longer the wavelengths and lower the energy - which is to say there "generally" is little need to attenuate the wavelengths on the long side of the band of interest.

Working with gases, as in a flame flicker at the carbon dioxide absorption wavelength of 4.35 micrometers, a very restrictive "bandpass" filter may be required.

People, Objects and ELTEC's High Pass (HP7) Coated Filter (- 3) and the Atmospheric Filter (-25)
ELTEC's HP7 (-3) filter is most popular because it blocks the shorter wavelengths from the sun and incandescent lights yet gives high transmittance to the band of greatest energies emitted by people or other warm or hot objects. This filter is also chosen for radiometric and industrial control applications. ELTEC's -25 filter is similar to the HP7 except that the response is more closely tailored to the "atmospheric region" of from 8 to 14 micrometers (a region where the normal constituents of the atmosphere do not seriously interfere with the transmission of infrared radiation). By not including the 7 micrometer chunk of the spectrum, difficulties from atmospheric moisture in very long range sensing applications (such as horizon sensors) can be minimized. Both the -3 and -25 filters have semiconductor substrates and are electrically connected to the detector case for electrostatic shielding.

Germanium (Uncoated)(-1)
An excellent IR material with flat transmittance from 2 to 25 micrometers. Its high index of refraction (greater than 4) produces a high reflection loss and thus a transmittance of slightly less than 50% in the thickness used for filters. Germanium is a semiconductor and ELTEC bonds it to the detector case for added electrostatic shielding. Note: Germanium also has transmittance from 40 to beyond 300 micrometers.

Germanium (Anti-reflection coated 10.6 μm)(-2)
A much higher transmittance than uncoated germanium, but not a flat response. However, the transmittance is optimized for 10.6 carbon dioxide lasers. It is also high in the bandwidth of room temperature objects and for work in the "atmospheric window" of 8 to 14 micrometers. The semiconductor filter affords electrostatic shielding.

Silicon (-5)
An excellent infrared bandpass material because it has good chemical resistance and high resistance to thermal shock. There is usually a strong absorption band at 9 micrometers ... and then transmittance into the far infrared. Actual transmittance varies with the purity of the silicon. Although silicon does not pass visible light, it can transmit enough near-IR to affect photosensitive transistors on detectors. As a semiconductor, silicon affords electrostatic shielding. Note that this filter does not have an anti-reflection coating and thus has transmission less than 50%. Also see the -32 filter.

Ultraviolet Grade Fused Quartz (-6)
A high transmission passband from ultraviolet to about 2 micrometers. Since it passes visible light, it must be used with a detector with encapsulated electronics or with a light barrier between the electronics and the filter. Quartz has excellent chemical resistance. Note: Quartz "turns on" again at about 100 micrometers and has high transmittance in the far infrared.

Sapphire (-4)
A high transmittance passband from the UV to about 6 micrometers. And, like quartz, sapphire "turns on" again in the far infrared — from beyond 100 micrometers but with a lower transmittance than quartz. Sapphire has exceptional chemical resistance and resistance to scratching.

KRS-5 (-9)
Also known as thallium bromoiodide, this material has high and flat transmittance from 0.6 (visible yellow) to 35 micrometers. Actual transmittance extends to 60 micrometers but decreases steadily beyond 35. Since 35 micrometers corresponds to the wavelength of maximum energy of a blackbody at -190C, the KRS-5 filter affords great range in thermal instruments as well as in chemical analysis. (Protection of electronics from visible light, as mentioned for quartz, also apply to the -4, and -9 filters)

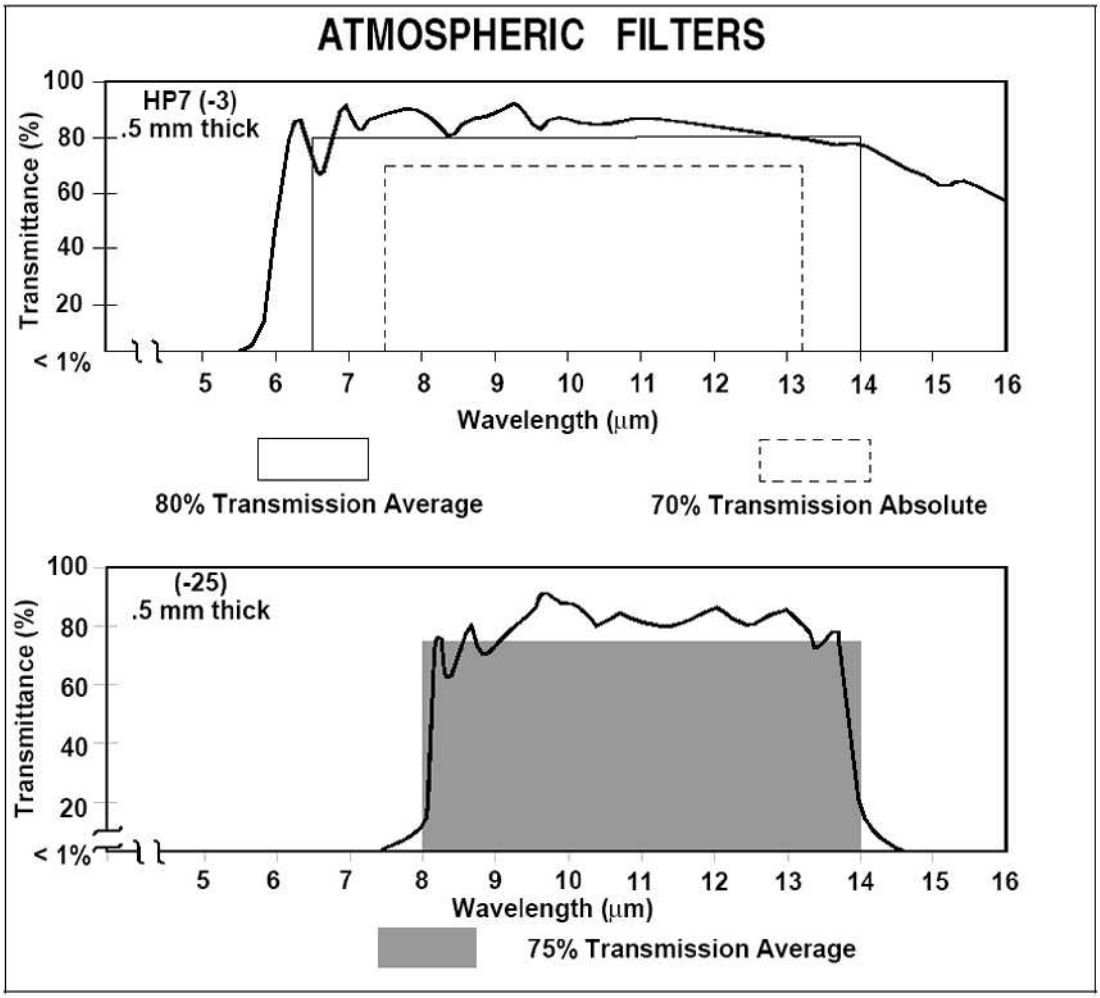
Fire Filters
ELTEC has filters with high transmission at the carbon dioxide absorption/ emission band of 4.35 micrometers. Atmospheric CO2 attenuates energy in this band from the sun and distant infrared sources. This leaves the 4.35 band free for detection of nearby flame flicker (given only slight attenuation in a short distance). ELTEC's -23 filter is especially designed for this application having enough spectral breadth to accommodate wavelength shifts caused by angle of incidence and filter temperature. Moreover, the -23 filter is on a sapphire substrate and completely blocks all wavelengths longer than 6 micrometers. ELTEC's -12 filter has almost identical bandpass characteristics to the -23 filter except that it is on a germanium substrate. The -12 filter is used where there is a sapphire optical element in the system anyway and the long wave blocking is not needed. Note: Although the -12 offers electrostatic shielding, its bandpass opens up again after 6 micrometers. The -43 filter is a very narrow-band fire or CO2 filter (on sapphire).

Gas Analysis CO2 (4.268μm)(-113) & Broadband (-32)
Applications for gas analysis usually require narrow band filters such as one centered at 4.268 micrometers for carbon dioxide. Yet, a more common option for instrumentation is to obtain a broad bandpass filter (1.5 to 5μm) with linear, high transmission for the detector and use specific optical filters in revolving wheels or other configurations. This latter approach simplifies detector selection and stocking and can simplify filter procurement in that the suitability for inclusion in a detector is no longer a consideration.
On the other hand, volume production or the use of expensive filters is made more economical by inclusion in the detector because the detector filter is only 5mm square and a given area of filter material is more efficiently used. Note that kerf loss, chipping or other factors affecting yield must be considered when calculating the economies of dicing a filter blank.

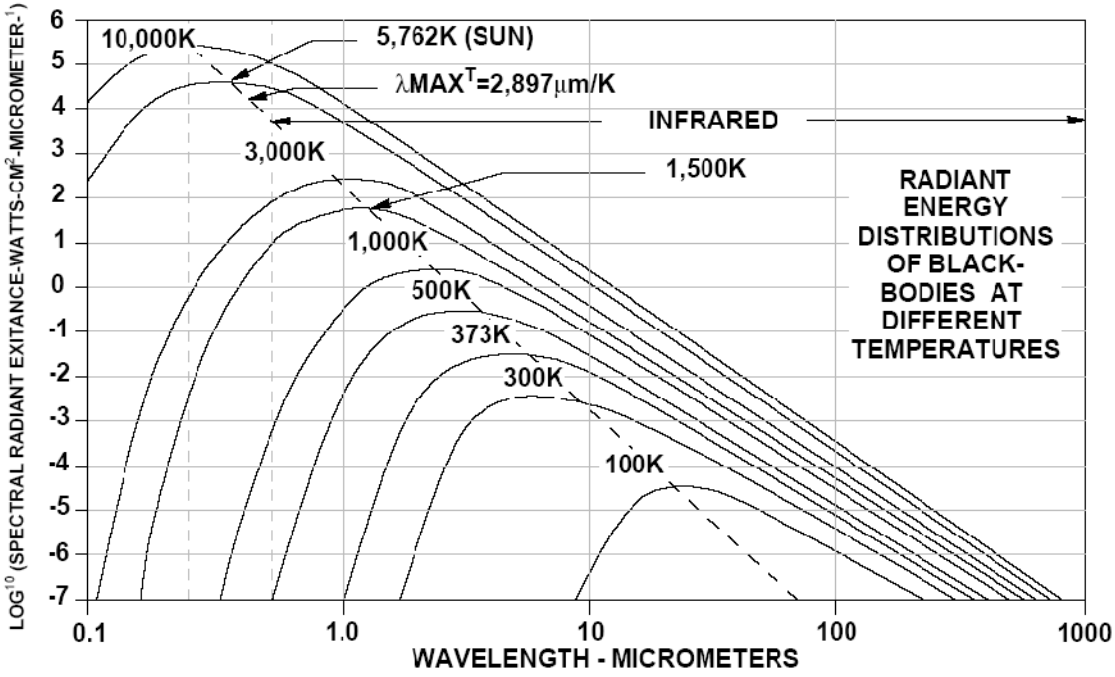
Calcium Fluoride (-27)
This material is useful from the sharp cutoff in the ultraviolet below 0.125 micrometers through the mid-infrared of the spectrum. It has high and flat transmission in all regions making it suitable for instrumentation applications. It is especially useful in the ultraviolet (but can sustain some transmission loss from radiation in prolonged high-altitude or space environment).

Barium Fluoride (-42)
Excellent transmission from the ultraviolet through long wave infrared. Excellent material for laboratory instruments.
A thinner version (-398), is available where longer wavelength transmission is a necessity.

Zinc Selenide (-49)
Zinc selenide (-49) is an excellent material with flat transmission from visible yellow to 15 micrometers. It has much better environmental stability than barium fluoride. It is the preferred material for carbon dioxide lasers at 10.6 micrometers due to extremely small internal absorption. High usage means that window material is almost always quickly available. Uncoated transmission is 70% (index of refraction n = 2.4). (Blocking the electronics from visible light is required for the -27, -42, -49, and -398 filters)



-3 and –25 filters for warm / hot object detection



Blackbody Spectrum

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