TECHNICAL INFORMATION

Glossary

INFRARED DETECTORS

Infrared photodetectors are semiconductor electro-optical devices that convert infrared radiation into an electrical signal.

PHOTOCONDUCTIVE DETECTORS: PC

Photoconductive detectors are based on the photoconductive effect. Infrared radiation generates charge carriers in the semiconductor's active region decreasing its resistance. The resistance change is sensed as a current change by applying a constant voltage bias. The devices are characterized by near-linear current-voltage characteristics. The electric field E in photoconductors is constant across the device. It equals the ratio of bias voltage V_b and distance between contacts L:

$$E=V_b/L$$

The optimum bias voltage is specified in the Final test report (supplied with each VIGO device) and depends on the detector size, active element temperature and spectral response.

PHOTOVOLTAIC DETECTORS: PV, PVM

Photovoltaic detectors (photodiodes) are semiconductor structures with one (PV) or multiple (PVM), homo- or heterojunctions. Absorbed photons produce charge carriers that are collected at the contacts, resulting in external photocurrent. Photodiodes have complex current-voltage characteristics. The devices can operate either at flicker-free zero bias or with reverse voltage. A reverse bias voltage is frequently applied to increase responsivity, and differential resistance, improve high-frequency performance and increase the dynamic range.

Photovoltaic detectors are more vulnerable to electrostatic discharges than photoconductors.

PHOTOELECTROMAGNETIC DETECTORS: PEM

Photoelectromagnetic detectors are based on the photoelectromagnetic effect based on the spatial separation of optically generated electrons and holes in the magnetic field. The devices do not require electrical bias and show no flicker noise 1/f. The PEM devices are typically used as fast, uncooled detectors of long-wavelength radiation.

ACTIVE ELEMENT MATERIAL $Hg_{1-x}Cd_xTe$

Mercury Cadmium Telluride (MCT) is a variable band gap alloy, commonly used for the fabrication of photodetectors with tunable spectral response.

Mercury Cadmium Telluride (MCT) is a chemical compound of cadmium telluride (CdTe) and mercury telluride (HgTe) with a tunable bandgap from the shortwave infrared to the very long-wave infrared regions. The amount of cadmium (Cd) in the alloy can be chosen so as to tune the optical absorption of the material to the desired infrared wavelength.

ACTIVE ELEMENT MATERIAL $InAs_{1-x}Sb_x$

Indium Arsenide Antimonide is a variable band gap compound semiconductor material that belongs to the III-V group of semiconductors, which includes elements from columns III and V of the periodic table. InAsSb is a ternary alloy formed by combining indium (In), arsenic (As), and antimony (Sb). The specific composition can vary, and different ratios of these elements can be used to tailor the material's properties for specific applications.

ACTIVE ELEMENT MATERIAL InGaAs

Indium gallium arsenide is a ternary alloy (chemical compound) of indium arsenide (InAs) and gallium arsenide (GaAs). Indium and gallium are group III elements of the periodic table while arsenic is a group V element. Alloys made of these chemical groups are referred to as "III-V" compounds. InGaAs has properties intermediate between those of GaAs and InAs. InGaAs is a room-temperature semiconductor. The principal importance of GaInAs is it's application as high-speed, high-sensitivity photodetectors.

ACTIVE AREA, A, mm×mm

The physical area of a photosensitive element; it's the active region that converts incoming optical radiation into an electric output signal.

$$A = W(width) \times L(length)$$

In photoconductors, L is the distance between the contacts.

OPTICAL AREA, A_O, mm×mm

The apparent optical area of the detector that is "seen". It is equal to the physical area of the detector's active element unless an optical concentrator is used. The optical detector area can be significantly magnified in detectors supplied with optical concentrators, i.e. immersion microlenses (see chapter Optical immersion).

$$A_O = W_O(optical\ width) \times L_O(optical\ length)$$

CUT-ON WAVELENGTH, $\lambda_{cut\text{-}on}$ (10%), µm

The shorter wavelength at which a detector's responsivity reaches 10% of the peak value.

PEAK WAVELENGTH λ_{peak}, µm

The wavelength of the detector's maximum responsivity.

SPECIFIC WAVELENGTH, λ_{spec}, µm

The wavelength for which the parameters (detectivity and responsivity) in the datasheets are given.

CUT-OFF WAVELENGTH, $\lambda_{cut\text{-}off}$ (10%), µm

The longer wavelength at which a detector responsivity reaches 10% of the peak value.

NORMALIZED DETECTIVITY, D*, cm·Hz$^{1/2}$/W

The signal-to-noise ratio (SNR) at a detector output normalized to 1 W radiant power, a 1 cm^2 detector active or optical area and a 1 Hz noise bandwidth.

NOISE EQUIVALENT POWER, NEP, nW/Hz$^{1/2}$

The incident power on the detector generates a signal output equal to the 1 Hz bandwidth noise output. Stated another way, the NEP is the signal level that produces a signal-to-noise ratio (SNR) of 1.

PHOTOCURRENT, I_{ph}, A

The photocurrent is the current generated by infrared radiation, which is not in thermal equilibrium with the detector. For small irradiation, the photocurrent is proportional to incident radiation power P.

$$I_{ph} = R_i \cdot P$$

R_i is the current responsivity.

CURRENT RESPONSIVITY, R_i, A/W

Current responsivity is the ratio of photocurrent and power of radiation. The current responsivity is typically measured for monochromatic radiation (the spectral current responsivity) and blackbody radiation (the blackbody current responsivity). The responsivity typically remains constant for weak radiation and tends to decrease with stronger radiation.

TIME CONSTANT, τ, ns

Typically, detector time response can be described by the one-pole filter characteristics. Time constant is the time it takes the detector to reach 1/e≈37% of the initial signal value. The time constant is related to the 3dB high cut-off frequency f_{hi}:

$$\tau = 1/(2\pi \cdot f_{hi})$$

Time constant for one pole filter is related to 10-90% rise time t_r:

$$t_r = 2.2 \cdot \tau$$

FLICKER NOISE, 1/f

It is a frequency-dependent noise. It occurs in any biased devices.

1/f NOISE CORNER FREQUENCY f_c, Hz

Frequency, at which the low-frequency noise equals the white noise (e.g. the Johnson or shot noise), the flicker noise dominates at $f<f_c$.

ACTIVE ELEMENT TEMPERATURE, T_{chip}, K

The detector active element temperature.

ACCEPTANCE ANGLE, Φ, deg.

The acceptance angle is the maximum cone angle at which incoming radiation can be captured by a detector. Radiation coming from a larger angle will not reach the detector. In systems without external objectives, the acceptance angle and Field of View (FOV) are identical.

INFRARED DETECTION MODULES

The detection module integrates a detector, preamplifier, thermoelectric cooler, and other components (detector biasing circuit, heat dissipation system, optics etc.) in a common package. The operation of detection modules can be described in a similar way as for detectors, by specifying their spectral and frequency characteristics of responsivity and detectivity.

VOLTAGE RESPONSIVITY, R_v, V/W

The output voltage is divided by the optical power incident on the detector. For spectra measurements, it can be expressed as:

$$R_v(\lambda)=R_i(\lambda)\cdot K_i$$

LOW CUT-OFF FREQUENCY, f_{lo}, Hz

The minimum frequency at which a detection module gain reaches -3dB of the peak value or 0 for DC coupling devices.

HIGH CUT-OFF FREQUENCY, f_{hi}, Hz

The maximum frequency at which a detection module gain reaches -3dB of the peak value. f_{hi} of the preamplifier may differ from f_{hi} of the detection module.

NOISE MEASUREMENT FREQUENCY, f_0, Hz

The frequency at which output voltage noise density is measured selectively.

TRANSIMPEDANCE, K_i, V/A

Current to voltage conversion ratio:

$$K_i=V_{out}/I_{in}$$

CURRENT SIGNAL, I_{in}, A

Current signal from photodetector when exposed to incident radiant power.

OUTPUT NOISE VOLTAGE DENSITY, v_n, nV/Hz$^{1/2}$

Noise voltage density measured at preamplifier output.

OUTPUT IMPEDANCE, R_{out}, Ω

Impedance that appears in series with the output from an ideal amplifier.

LOAD RESISTANCE, R_{load}, Ω

Resistance of the detection module's load.

OUTPUT VOLTAGE, V_{out}, V

Output signal of the detection module.

OUTPUT VOLTAGE OFFSET, V_{off}, mV

Output DC voltage of the detection module without input signal.

POWER SUPPLY INPUT, $+V_{sup}$ and $-V_{sup}$, V

Supply voltage required for correct detection module operation.

POWER SUPPLY CURRENT, I_{sup}, mA

Supply current consumption during correct detection module operation.

GND

Point of zero potential. It is a common power supply ground and signal ground.

AMBIENT OPERATING TEMPERATURE, T_{amb}, °C

Ambient temperature during test measurements.

THERMOELECTRIC COOLERS AND THERMOELECTRIC COOLER CONTROLLERS

MAXIMUM THERMOELECTRIC COOLER CURRENT, I_{max}, A

Maximum current resulting in greatest ΔT_{max}.

MAXIMUM THERMOELECTRIC COOLER VOLTAGE V_{max}, V

Maximum voltage drop resulting in greatest ΔT_{max}.

MAXIMUM HEAT PUMPING CAPACITY, Q_{max}, W

Q_{max} rated at $\Delta T=0$. At other ΔT cooling capacity should be estimated as:

$$Q=Q_{max}\cdot(1-\Delta T/\Delta T_{max})$$

MAXIMUM TEMPERATURE DIFFERENCE, ΔT_{max}, K

ΔT_{max} rated at $Q=0$. At other Q the temperature difference should be estimated as:

$$\Delta T=\Delta T_{max}\cdot(1-Q/Q_{max})$$

TEMPERATURE STABILITY, K

It indicates the possible error in the temperature on the thermoelectric cooler.

TEMPERATURE READOUT STABILITY, mK

It indicates the possible error in a readout of the temperature of the thermoelectric cooler provided by the controller.

DETECTOR TEMPERATURE SETTLING TIME, s

Time that is taken by the cooling system to reach the appropriate temperature of the detector active element.

MAXIMUM TEC OUTPUT CURRENT, $I_{TEC\ max}$, A

Maximum current that is provided by the controller to the thermoelectric cooler.

OUTPUT VOLTAGE RANGE, V

Range of voltage on the output of the module.

POWER SUPPLY VOLTAGE, V_{sup}, V_{DC}

Supply voltage required for correct thermoelectric cooler controller operation.

POWER SUPPLY CURRENT, I_{sup}, mA

Supply current required for correct thermoelectric cooler controller operation.

SERIES RESISTANCE OF THE CONNECTING CABLE, Ω

Material parameter. It is the resistance of the supply cable. It depends on the cable length.

Precautions for use

OPERATING TEMPERATURE

A detector should be operated at its optimal temperature given in the Final test report (delivered with every device).

MAXIMUM VOLTAGE

Do not operate the photovoltaic detector at higher bias voltages than suggested in the Final test reports and datasheets (delivered with every device). Be careful using ohmmeters for photovoltaic detectors! Standard ohmmeters may overbias and damage the detector. This is especially true for small physical area or SWIR photovoltaic detectors. A bias of 10 mV can be used for resistance measurements of any type of detector. Ask for conditions of I-V plot measurements!

USAGE

Devices can operate in the 10% to 80 % humidity, in the -20°C to 30°C ambient temperature range. Operation at >30°C may reduce the performance of the standard Peltier coolers.

Ask for devices that can operate in the 30°C to 80°C ambient temperature range.

STORAGE

The following conditions should be fulfilled for safe and reliable operation of the detector:

- store in dark place, 10% to 90% humidity and -20°C to 50°C temperature,
- avoid exposure to direct sunlight and strong UV/VIS light as this may result in degradation of the detector performance,
- avoid electrostatic discharges at leads therefore, the devices should be stored having leads shorted.

HANDLING

Particular attention should be paid to not scratching the surface of the window. A damaged window may entirely degrade the detector's performance. Excessive mechanical stress applied to the package itself or to a device containing the package may result in permanent damage. The Peltier element inside thermoelectrically cooled detectors is susceptible to mechanical shocks. Great care should be taken when handling cooled detectors.

CLEANING THE WINDOW

Keep the window clean. Use a soft cotton cloth damped with isopropyl alcohol and wipe off the surface gently if necessary.

MECHANICAL SHOCKS

The Peltier elements may be damaged by excessive mechanical shock or vibration. Care is recommended during manipulations and normal use. Drop impacts against a hard surface are particularly dangerous.

MECHANICAL INSTALLATION

The maximum tightening torque of the TO8 detector header fixing screw is 0.3 Nm.

SHAPING LEADS

Avoid bending the leads at a distance less than 2 mm from the base of the package to prevent glass seal damage. When shaping the leads, a maximum of two right angle bends and three twists at a distance minimum of 6 mm from the base of the package.

Keep the leads of the detecting element shorted when shaping!

SOLDERING LEADS

IR detectors can be easily damaged by excessive heat. Special care should be taken when soldering the leads. Usage of heat sinks is highly recommended. Tweezers can be used for this purpose; when soldering, clamp a lead at a place between the soldering iron and the base of the package. To avoid the destructive influence of ESD and other accidental voltages (e.g. from a non-grounded soldering iron) rules for handling LSI integrated circuits should be applied to IR detectors too. Leads should be soldered at 370°C, below 5 s.

BEAM POWER LIMITATIONS

Damage thresholds, specified as integrated power of incoming radiation:

- For devices without immersion microlens irradiated with continuous wave (CW) or single pulses of more than 1 µs duration, irradiated power on the active area must not exceed 100 W/cm^2.The irradiance of a pulse shorter than 1 µs must not exceed 1 MW/cm^2.
- For optically immersed detectors irradiated with CW or single pulse longer than 1 µs irradiance on the apparent optical active area must not exceed 2.5 W/cm^2. The irradiance of the pulse shorter than 1 µs must not exceed 10 kW/cm^2.
- For repeated irradiation with pulses shorter than 1 µs, the equivalent CW irradiation, average power over the pulse-to-pulse period should be less than the CW damage threshold according to the equation:

$$\text{equivalent CW radiationpower density} = \frac{\text{pulse peak power}}{\text{focus area}} \cdot \text{pulse duration} \cdot \text{repetition rate}$$

Saturation thresholds vary by detector type and can be provided upon request.

Optical immersion technology

DESCRIPTION

In order to improve performance and get the best signal-to-noise ratio of the devices, optical immersion technology may be applied. It is successfully used in all types of VIGO detectors.

Optical immersion is a monolithic integration of detector active element with hyperhemispherical microlens (default). It makes the optical linear size of the detector's active area ~11 times larger compared to its physical size. This results in an improvement of the detectivity D* by one order of magnitude. Also, the detector's electric capacitance C_d is reduced by a factor of two orders of magnitude compared to the conventional detector of the same optical area. Acceptance angle Φ is reduced to ~36 deg. – the microlens naturally shields background radiation which is one of the factors of noise. Hemispherical microlens is available as a custom option.

Optical power limitations for optically immersed detectors are more restrictive than for detectors without immersion microlens. For more information – see the chapter Precautions for use.

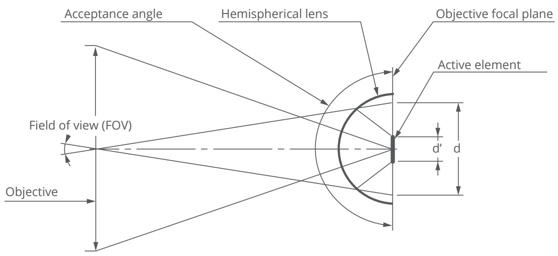
OPTICALLY IMMERSED DETECTOR PARAMETERS

Parameter	Microlens shape			
	Hemisphere		Hyperhemisphere	
	Theory	GaAs	Theory	GaAs
L	R	R	R·(n+1)	4.3·R
d/d′	n	3.3	n^2	10.9
D^*_{imm}/ $D^*_{non\text{-}imm}$	n	3.3	n^2	10.9
Acceptance angle, Φ, deg.	~180	~180	2·arcsin(1/n)	~36

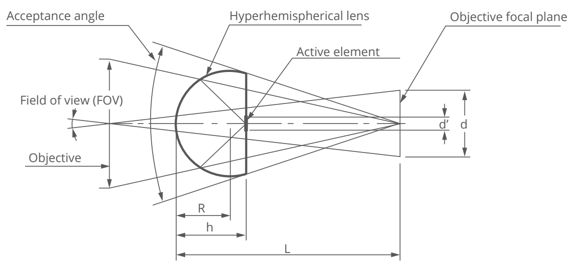
n = 3.3 refractive index of GaAs (the microlens material)
R – microlens radius
L – lens face to the objective focal plane distance
d – optical (apparent) detector size
d′ – physical detector size
h = R + R/n, microlens thickness

FUNCTION AND PROPERTIES OF THE IMMERSION MICROLENS

Hemispherical



Hyperhemispherical



Preamplifiers for infrared detectors

DESCRIPTION

Preamplifiers are used to amplify weak signals from low noise detectors and provide optimal conditions for detector operation. Preamplifiers protect detectors against overbias and make the detector/preamplifier system immune to electromagnetic interference.

VIGO offers a variety of transimpedance preamplifiers, AC and DC coupled, with narrow and wide bandwidths, dedicated for integration with detectors in common packages. The transimpedance preamplifiers are preferable in most applications due to inherent linearity and good frequency response.

TRANSIMPEDANCE PREAMPLIFIERS

The current readout of infrared detectors is typically achieved in transimpedance (TI) preamplifiers. An important advantage of the TI-amp is the ability to maintain the detector at a constant bias voltage, equal to the voltage applied to the non-inverting input of the op-amp.

A simple description of the detector/TI preamplifier system is presented in Figure 1.

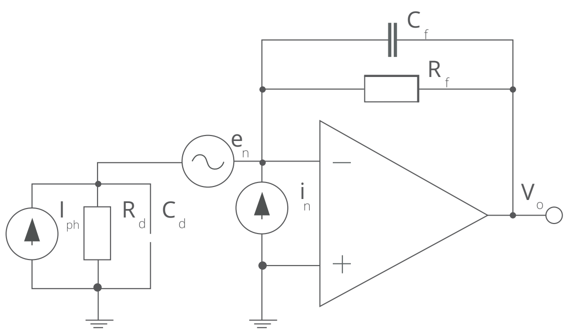


Figure 1. Transimpedance circuit for infrared detector

The detector is modeled by a photocurrent source I_{ph}, shunt resistance R_d and capacitance C_d. The photocurrent is proportional to the input optical power P and detector current responsivity R_i.

$$I_{ph}=R_i\cdot P$$

A transimpedance preamplifier is an operational amplifier with feedback resistance R_f. Feedback capacitance C_f is used to set system bandwidth and eliminate gain peaking at high frequencies.

The output voltage of the transimpedance preamplifier is:

$$V_0=Z_f\cdot I_{ph}$$

The transimpedance gain Z_f can be approximated by one-pole filter characteristics:

$$Z_f=R_f/(1+2\cdot\pi\cdot f)^2\cdot C_f^2\cdot R_f^2)^{1/2}$$

with cut-off frequency:

$$f_\infty=1/(2\pi f\cdot C_f\cdot R_f)$$

It should be noted that the cut-off frequency is typically greater compared with the voltage preamplifier when bandwidth is limited by the detector $R_d\cdot C_d$ time constant. For frequencies less than the 3dB cut-off frequency f_∞, transimpedance is equal to the R_f. In consequence, the circuit converts linearly optical input power P into output voltage:

$$V_0=R_i\cdot R_f\cdot P$$

with resulting voltage responsivity $R_v=R_i\cdot R_f$ independent of frequency, detector resistance and capacitance.

Unfortunately, the above considerations are limited to the maximal frequencies dependent on detector capacitance and resistance, op-amp gain-bandwidth product and other factors.

NOISE

As follows from the transimpedance circuit (Figure 1) the preamplifier noise current can be approximated as:

$$i_{PA}^2=4KT/R_f+i_n^2+e_n^2/Z_d^2$$

Where i_n and e_n are the op amp open input noise current and short input noise voltage, respectively. Z_d is the detector impedance:

$$Z_d=R_d/(1+2\cdot\pi\cdot f)^2\cdot C_d^2\cdot R_d^2)^{1/2}$$

At low frequencies, preamplifier noise (frequently called „floor noise level") is not dependent on frequency:

$$i_{PA}^2=4KT/R_f+i_n^2+e_n^2/R_d^2$$

At high frequencies the noise current increases due to decreasing detector impedance:

$$i_{PA}=2\pi f\cdot C_d\cdot e_n$$

Incorrect frequency compensation of transimpedance amplifier may cause a remarkable increase in the noise level near the top cut-off frequency, as shown in Figure 2.

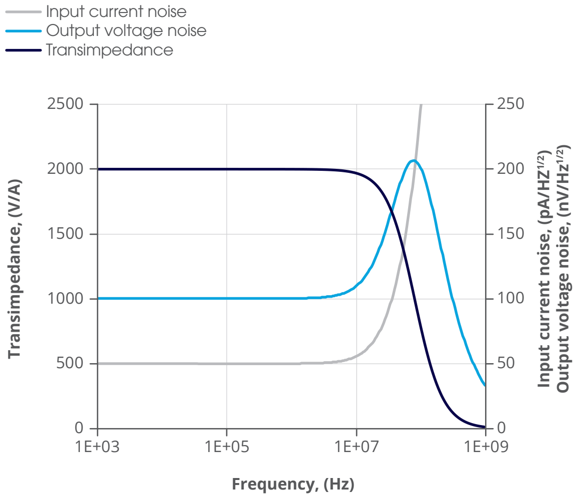


FIGURE 2. Output noise density and frequency response of the transimpedance amplifier

HOW PREAMPLIFIER AFFECT SYSTEM PERFORMANCE

The total input current noise of a detection module is:

$$i_n^2=i_{PA}^2 + i_d^2$$

This results in degradation of the overall detectivity of the detector/preamplifier system by i_n/i_d factor.

The degradation may be significant for low impedance detectors having low resistance <50 Ω or, at high frequencies, having large capacitance.

The design of preamplifiers is dependent on required bandwidth, gain, detector resistance, capacitance and other factors. The crucial step is the selection of suitable op-amps or discrete transistors. Bipolar op-amps are characterized by large i_n (~2 pA/Hz$^{1/2}$) and low e_n (~1 nV/Hz$^{1/2}$), in contrast to FET-based preamplifiers where i_n (~1 fA/Hz$^{1/2}$) is low and e_n (~5 nV/Hz$^{1/2}$) is high. Therefore, the low e_n-bipolar op-amps suit well to low Z_d detectors (which means low resistance, high capacitance and high frequencies). FET-based op-amps are useful for high Z_d detectors operating at low frequencies.

Thermoelectric cooling, heat sinking

THERMOELECTRIC COOLING

Cooling of infrared detectors reduces noises, increases responsivity, and shifts the cut-off wavelength $\lambda_{cut\text{-}off}$:

- toward longer wavelengths – in HgCdTe detectors,
- toward shorter wavelengths – in InAs and InAsSb detectors.

Two-, three- and four-stage thermoelectric coolers are available. The operation of TE coolers is based on the Peltier effect. Thermoelectric coolers are supplied with a DC power supply.

HEAT SINKING

Suitable heat sinking is necessary to dissipate heat generated by the Peltier cooler or excessive optical irradiation. Since heat is almost 100% dissipated at the base of the detector header, it must be firmly attached to the heat sink.

A thin layer of heat-conductive epoxy or silicon (thermal) grease should be used to improve thermal contact between the detector header and the heat sink to maximize heat transfer. Heat sinking via the detector cylindrical cap or via the mounting screw is not sufficient.

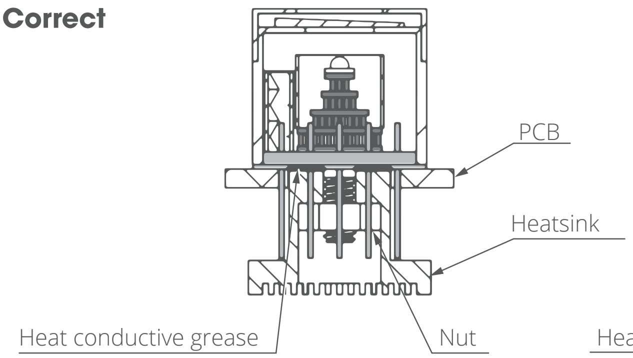
A heatsink thermal resistance of ~2 K/W is typically recommended for 1TE, 2TE and 3TE coolers. For a 4TE cooler, a heatsink thermal resistance of ~1 K/W is recommended.

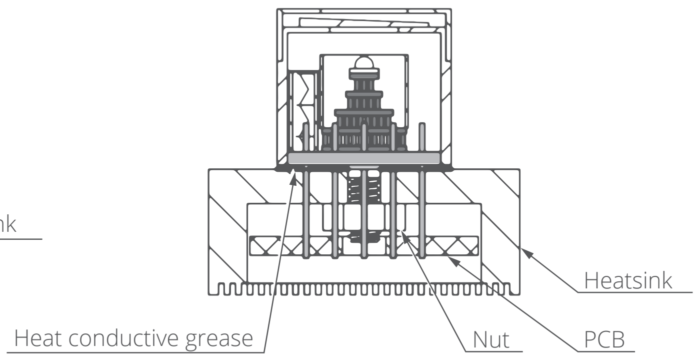
THERMOELECTRIC COOLERS PARAMETERS

Parameter	Stage of thermoelectric cooling				Unit
	1TE	2TE	3TE	4TE	
Active element temperature, T_{chip}	~253	~230	~210	~197	K
Maximum TEC voltage, $V_{TEC\ max}$	0.4	1.3	3.6	8.3	V
Maximum TEC current, $I_{TEC\ max}$	1.67	1.2	0.45	0.4	A

HEATSINK PLACEMENT

Correct





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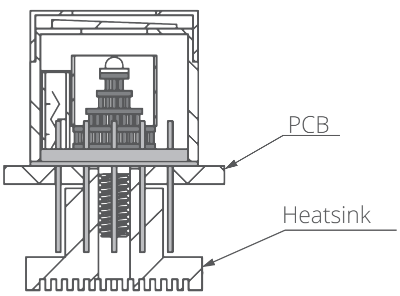
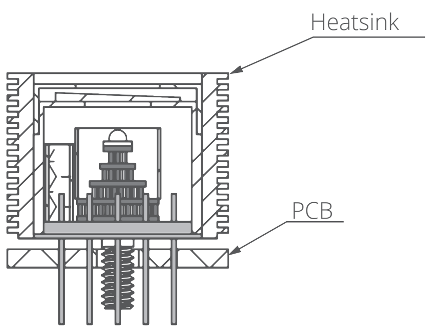
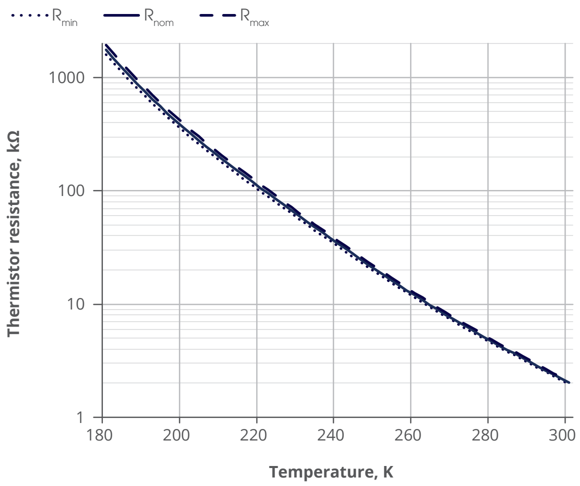




Temperature sensor characteristics

THERMISTOR

Thermoelectrically cooled detectors are equipped with a built-in thermistor to provide precise control and measurements of detector active element temperature. The electricity applied to between terminals of thermistors should be under the maximum power dissipation at 25°C (100 mW) not to destroy the thermistor. For the measurement of resistance, the power should not exceed 1 mW.



T, K	T, °C	R_{min}, kΩ	R_{nom}, kΩ	R_{max}, kΩ
180	-93	1594.97	1757.95	1935.84
182	-91	1336.02	1469.90	1615.75
184	-89	1124.16	1234.66	1354.81
186	-87	950.46	1042.11	1141.58
188	-85	807.57	883.99	966.78
190	-83	689.57	753.62	822.88
192	-81	591.68	645.64	703.89
194	-79	510.07	555.75	604.98
196	-77	441.68	480.54	522.34
198	-75	384.05	417.25	452.91
200	-73	335.23	363.71	394.26
202	-71	293.65	318.17	344.43
204	-69	258.05	279.23	301.88
206	-67	227.41	245.76	265.36
208	-65	200.91	216.85	233.85
210	-63	177.89	191.77	206.55
212	-61	157.81	169.92	182.79
214	-59	140.22	150.80	162.03
216	-57	124.76	134.02	143.83
218	-55	111.14	119.25	127.83
220	-53	99.10	106.21	113.72
222	-51	88.44	94.67	101.25
224	-49	78.98	84.44	90.21
226	-47	70.57	75.37	80.42
228	-45	63.09	67.30	71.73
230	-43	56.42	60.12	64.01
232	-41	50.49	53.74	57.15
234	-39	45.19	48.05	51.04
236	-37	40.47	42.98	45.61
238	-35	36.26	38.47	40.77

T, K	T, °C	R_{min}, kΩ	R_{nom}, kΩ	R_{max}, kΩ
240	-33	32.51	34.45	36.47
242	-31	29.16	30.87	32.64
244	-29	26.18	27.68	29.24
246	-27	23.51	24.84	26.21
248	-25	21.14	22.30	23.51
250	-23	19.02	20.05	21.11
252	-21	17.13	18.04	18.98
254	-19	15.45	16.25	17.07
256	-17	13.95	14.65	15.38
258	-15	12.61	13.23	13.87
260	-13	11.41	11.96	12.53
262	-11	10.34	10.83	11.33
264	-9	9.38	9.82	10.26
266	-7	8.52	8.91	9.31
268	-5	7.75	8.10	8.45
270	-3	7.07	7.37	7.69
272	-1	6.45	6.72	7.00
274	1	5.89	6.13	6.38
276	3	5.38	5.60	5.83
278	5	4.93	5.13	5.32
280	7	4.52	4.69	4.87
282	9	4.15	4.30	4.46
284	11	3.81	3.95	4.09
286	13	3.50	3.63	3.75
288	15	3.22	3.33	3.45
290	17	2.96	3.06	3.17
292	19	2.73	2.82	2.91
294	21	2.51	2.59	2.68
296	23	2.32	2.39	2.46
298	25	2.13	2.20	2.27

Infrared windows and filters

INFRARED WINDOWS

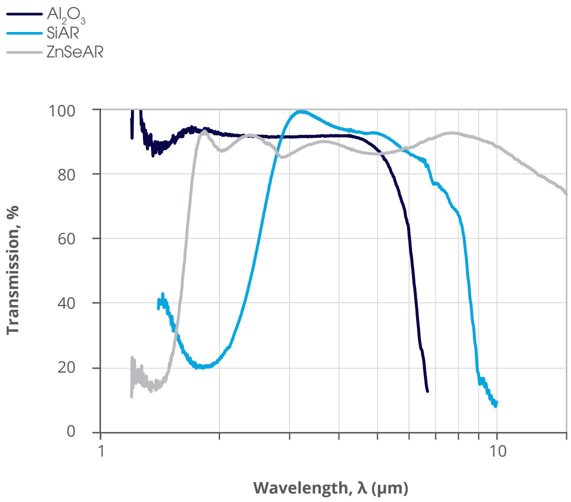
The following types of windows are a VIGO standard:

- 3 deg. wedged sapphire (wAl_2O_3)
- 3 deg. wedged zinc selenide anti-reflection coated (wZnSeAR)
- planar silicon anti-reflection coated (pSiAR)

3 deg. wedged window prevents unwanted interference effects (fringing).

Symbol	Material	Hardness, kg/mm²	Wedging	Anti-reflection coating
wAl_2O_3	sapphire	1370	3°	no
wZnSeAR	zinc selenide	120	3°	yes
pSiAR	silicon	1150	no	yes

Spectral transmission of VIGO IR windows (typ.)



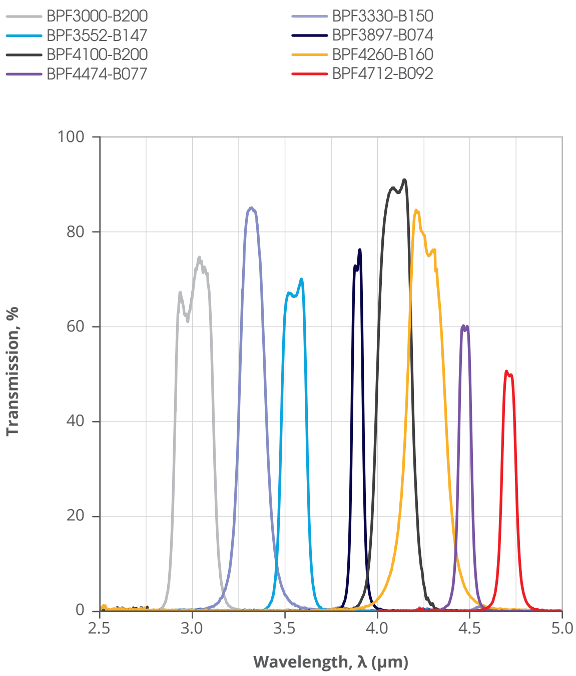
INFRARED FILTERS

Some VIGO detectors can be provided with infrared filters. Bandpass filters are used to transmit only a narrow band of wavelengths, blocking out unwanted infrared radiation. This helps detectors focus on a particular spectral region of interest.

The choice of filter depends on the goals and requirements of the particular infrared sensing application. The following types of filters can be provided upon request:

Symbol	Filter centre wavelength, λ_{cwl}, nm	Hardness, kg/mm²
BPF3000-B200	3000±50	200±30
BPF3330-B150	3330±50	150±30
BPF3552-B147	3552±50	147±30
BPF3897-B074	3897±60	74±20
BPF4100-B200	4100±50	200±30
BPF4260-B160	4260±50	160±30
BPF4474-B077	4474±50	77±20
BPF4712-B092	4712±50	92±20

Spectral transmission of VIGO IR filters (typ.)



Detector packages

PACKAGES FOR UNCOOLED DETECTORS

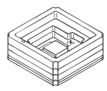
Photoconductive (PC) and photovoltaic (PV, PVM) uncooled detectors are provided in the TO39 (3 pins) package (with or without the window) and in SMD package (with or without wthe window).

The photoelectromagnetic (PEM) detector is provided in the specialized PEM-SMA packages. Due to the magnetic circuit incorporated into the package, the window is mounted to protect the detector against external pollution.

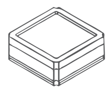
The quadrant (PVMQ) detector is provided in the TO8 package without the window.

PACKAGES FOR TE COOLED DETECTORS

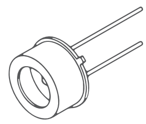
Thermoelectrically cooled detectors are mounted in metal packages: TO39 (8 pins), TO8 and TO66 sealed with the infrared windows. They are filled with dry, heavy, noble gases (Krypton and Xenon mixture) of low thermal conductivity. Water vapour condensation is prevented by a humidity absorber (container mounted inside the package) and careful polymer sealing. For low-temperature fluctuation, anti-convection shields are also mounted.



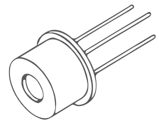
SMD (without window)



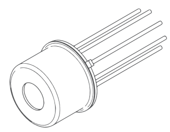
SMD (with window)



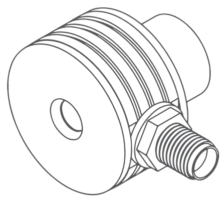
TO39 (3 pins, without window)



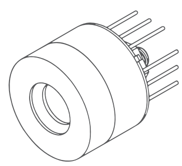
TO39 (3 pins, with window)



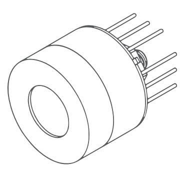
1TE-TO39 (8 pins)



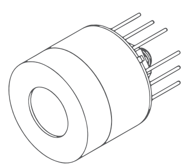
PEM-SMA



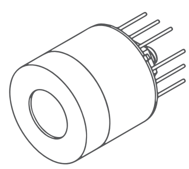
TO8 (quadrant)



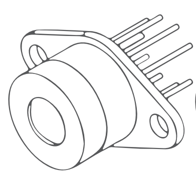
2TE-TO8



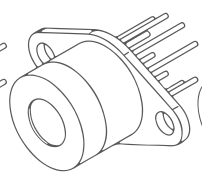
3TE-TO8



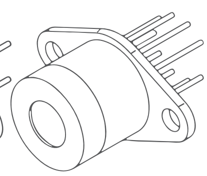
4TE-TO8



2TE-TO66



3TE-TO66



4TE-TO66