Infrared Basics

All solid bodies when having temperatures above the absolute zero (-273 °C) emit electromagnetic waves. The range of longer wave lengths beyond the visual spectrum is referenced as infrared radiation. Scientist Wilhelm Wien (1864–1928) has described the relation between a solid body's temperature and its emitting peak wave length by following equation:

λ_{max} =2898 / T
T = Temperature in K (Kelvin)
λ = Wavelength in µm

With this formula the peak emission wave length of any material may be calculated.

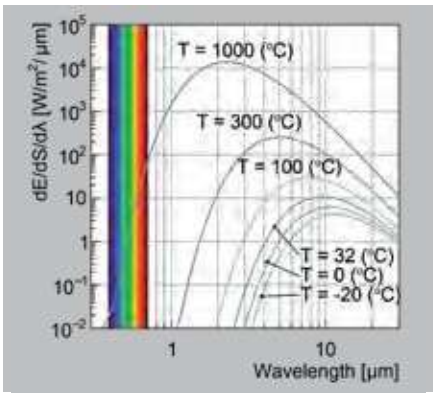


Fig 1:Radiated Energy vs. Wavelength

Max Planck (1858–1947) has described the relation between a solid body's surface temperature and its emitting wave length.

According to Max Planck, the intensity curve of all emitted wave lengths for a solid body is rather broad. For the case of an ideal emitting body the emission spectrum is shown in Figure 1 for selected surface temperatures. Ideal emitters are called "black body".

With the naked eye we can see hot objects at about 1000°C glow red and we can feel the heat, whereas colder objects that cannot be seen glowing, still may emit heat. The human eye's sensitivity is limited to the so-called visible range of 300 to 750 nm. To detect the non-visible infrared-radiation, we need sensors that work in the range beyond, which is 1µm and further. Typical sensors for motion detection use windows 5µm to 14µm.

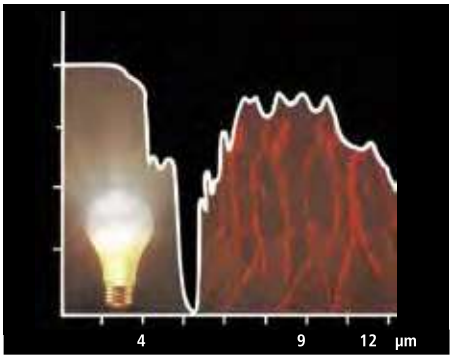
Temperature Dependence

The radiation sent from emitting bodies is temperature dependent. There is another parameter which determines the body's surface property. With this Emissivity factor we can estimate the total emitted radiation power P of a warm object:

$$P_{net} \sim \varepsilon T^4_{obj} + (1-\varepsilon)\, T^4_{amb}$$

The radiated Power is proportional to its surface temperature T [Kelvin] to the Power of 4 and its emissivity. The emissivity ε of the surface of an ideal black body is 1. An opaque object with an emissivity lower than 1 (gray body) will additionally reflect the temperature of the ambient.

Hot objects generally dominate any total radiation over cold objects due to the power of 4 dependence.



Spectral working range versus visible light

The Real World

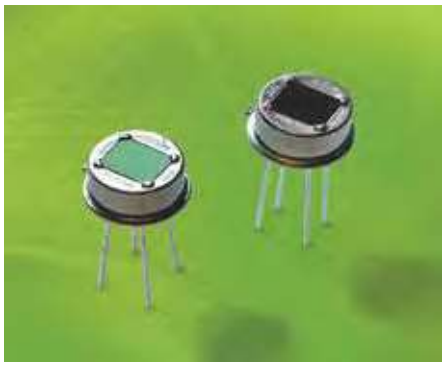
The human skin as well as water have a very high emissivity in the far infrared of above 0.9. The peak emission for human skin temperature is around 10µm and it is barely radiating below 3µm.

Typically, specular objects are highly reflective in the infrared region and contribute less to the total radiation received from the objects surface temperature. Diffuse objects can have a high emissivity and are better suited for measuring their surface radiation.
We further need to consider that properties in the visible spectrum may totally differ from the properties in the IR spectrum.

A human head with a surface temperature of approx. 35°C or 308 K calculates into a peak wavelength of 9.4 µm; the body of a cat at 38°C temperature calculates to 9.3 µm. Pets like cat or dogs have similar body temperature. By this, their radiation is very similar to human, and it is not possible to distinguish humans from cats or dogs by their infrared spectrum.

Infrared Detectors

With detectors for the infrared spectrum there are two major classes by their physical principles: Photon Detectors and Thermal Detectors. Photon Detectors convert radiation directly into free electrons. Thermal Detectors receive radiation, transfer it to raising temperature of the sensing material which changes its electrical property in response to the temperature rise. Photon Detectors such as Photodiodes and Phototransistors range from visible to near infrared.



To detect the radiation of objects at typical ambient temperatures, and slightly above, simple photonic detectors based on PN-doped silicon structures such as CCD or CMOS will not work. Advanced technologies, specific for that use, separate into two major classes: **Photon Detectors** and **Thermal Detectors**. Photon Detectors convert radiation directly into electrons and are typically made from cooled exotic semiconducting materials - these detectors are not the scope of this overview.

Thermal Detectors receive radiation, transfer it to raising temperature of the sensing material which changes its electrical property. The spectral range is also dependant from the absorbtion of the material. These detectors have a broad response from below visible light up to over 100µm. Thermal Detectors are sensitive to the net radiation.

$$P_{net} - \varepsilon T^4_{obj} + (1-\varepsilon)\, T^4_{amb} - T^4_{sens}$$

Fitted with special infrared windows as spectral filters they work in the mid to far infrared range without ambient visible light interference. Excelitas offers a variety of thermal detectors, including Pyrodetectors and Thermopile Detectors. Pyroelectric sensors require a modulated radiation over time in order to respond with a charge flow. While the response of pyroelectric sensors is generally higher than response of Thermopiles, Thermopiles provide a constant voltage output, which is proportional to the net radiation.

Both technologies respond to radiation changes within several milliseconds making them optimal to detect fast temperature modulations. Details are discussed in the corresponding sections.

Filters for Infrared Sensors

Material used for filters and windows must be transparent in the wavelength of interest. Glass for example is generally not suited to sense the temperature of human skin since it absorbs wavelengths above 4µm. Common materials with a broad transmission range are Germanium and Silicon for being used as the internal filter window for IR Sensors. For outside protection only few materials are suitable. Among many plastics, only PP or HD-PE can be used as protection or as fresnel structured optics for presence and motion detection.

Detectors by Excelitas Technologies are fitted with special infrared windows used as spectral filters. They work in the mid to far infrared range and usually block the visible range. Common applications in infrared reference wavelengths from 2 to 20µm. Thus the many windows allow transmission from 5-14µm. Infrared windows for pyrometric applications are defined for the atmospheric window. To avoid atmospheric absorption long range pyrometers apply a sharp cut-on/cut-off window of 8-14µm (G9).

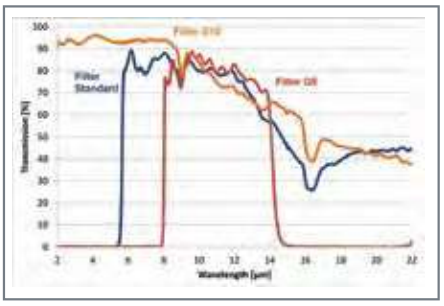


Fig.2

In Fig.2 we show the graph for standard infrared window and the "G9" window. For the special application of Gas Sensing by non-dispersive infrared absorption (NDIR) of a modulated radiation source we offer narrow band filters. The appropriate narrow band optical filters enable detection of Carbon Monoxide, Carbon Dioxide, Natural Gas and other environmental gases, as well as some technical gases. Please refer to the section dedicated to Gas Sensing for details.

Environmental Remarks

Thermal Detectors achieve best results at thermally stable conditions. This applies not only to the detector but also to the environmental conditions. Temperature gradients and temperature changes through direct and indirect heat transfer as well as other thermal influences shall be minimized in order to obtain best measurement results.

The Thermoelectric Effect

The thermoelectric effect (or Seebeck-effect) is known as reverse to the Peltier-effect. By applying a temperature difference to two junctions of two dissimilar materials A and B, a voltage U, which is proportional to the temperature difference is observed.

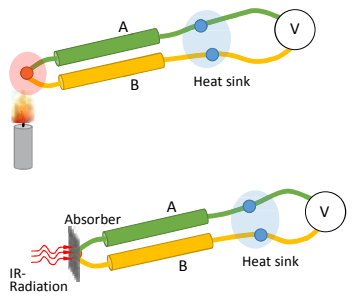


Fig 7: The Seebeck effect

Detector Design

Leopoldo Nobili (1784 - 1835) first used the thermoelectric effect for IR radiation measurement using a "pile" of Bismuth and Antimony contacts. The measure of this effect is called the thermoelectricor Seebeck-coefficient.

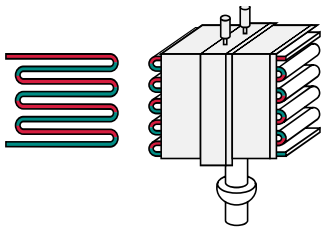


Fig 8: Nobili's Thermopile

For most conducting materials this coefficient is rather low, only few semiconductors possess rather high coefficients. Since the voltage of a single thermoelectric cell is very low, lots of such cells arranged in a series connection achieve a larger signal, making a "pile" of thermo-elements.

Excelitas Thermopile Design

Our thermopile sensors are based on silicon micromachining technology. The central part of a silicon chip is removed leaving only a 1µm thin layer (membrane) of SiO2/Si3N4, which has low thermal conductivity. Onto this membrane thin conductors of two different thermoelectric materials (to form thermos-couples) are deposited.

Both conductors have junctions alternatively in the center of the membrane (hot junctions) and on the bulky part of the silicon substrate (cold junctions). A special IR-absorption layer covers the hot junctions forming the sensors sensitive area.

When exposed to infrared radiation, the absorbed energy leads to a temperature difference between "hot" and "cold" contacts. According to the thermoelectric coefficient of the thermocouples a signal voltage is generated.

The Thermopile Construction

The sensor chip is mounted in good thermal contact into a housing with infrared filter sealing the sensor chip from the environment. The infrared filter serves as window with spectral properties. Excelitas's product portfolio includes detectors of various housings as well as integrated sensors which include temperature compensation and calibration to specified measurement ranges.
We further provide unique construction models with improved thermal shock performance, referred to as ISO-thermal sensor types.

Thermopile Detectors do not require mechanical chopper to sense infrared, they offer simple solutions to infrared measurements.

Thermopile Characteristics

The most important properties of the Thermopile Sensor are it's responsivity, noise, field-of-view and response time.

Responsivity

The responsivity shows low-pass characteristics with a cut off at approximately 30 Hz. Responsivity is measured in Volt per Watt by means of a defined black body radiator. Responsivity data is usually cited with respect to the active detector area, given without the infrared filter. The data shows responsivity tested at 1 Hz electrical frequency.

Noise

The noise of the detector is dominated by the Johnson noise due to the resistance of the thermopile. Noise is given as RMS value in nV/√Hz.

Sensitivity

The data tables do also mention sensitivity, as a characteristic output voltage versus target temperature at 25°C environment temperature. The data are given with standard IR filter and specified at 25°C ambient temperature and different object / blackbody temperatures, e.g. 40°C S(25/40) and 100°C S(25/100). Sensitivity is dependent upon the field-of-view of the detector construction. An example can be seen below for selected thermopile detector series.

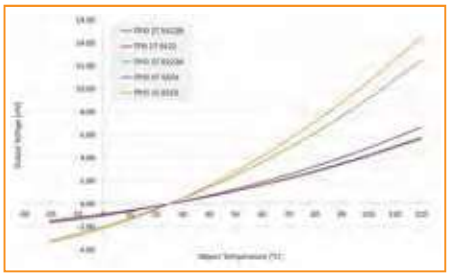


Fig 8:Sensitivity curves

Ambient Temperature Reference

As temperature reference the thermopile detectors include a thermistor which senses the internal temperature.

For exact measurements, the temperature of the detector housing (cold thermopile contacts) must be known. A 100 kOhm thermistor inside the detector housing serves as the ambient temperature reference.

The dependence of the resistance on temperature can be approximated by the following equation:

$$R_T = R_R \cdot e^{B \cdot \left(\frac{1}{T} - \frac{1}{T_R}\right)}$$

RT	NTC resistance in Ω at temperature T in K
RR	NTC resistance in Ω at rated temperature TR in K
T	Temperature in K
TR	Rated temperature in K
B	B value, material-specific constant of NTC thermistor
e	Euler number (e = 2.71828)

The actual characteristic of an NTC thermistor can be roughly described by the exponential relation. This approach, however, is only suitable for describing a restricted range around the rated temperature or resistance with sufficient accuracy. For practical applications, a more precise description of the real R/T curve is required. Either more complicated approaches (e.g. the Steinhart-Hart equation) are used or the resistance / temperature relation is given in tabulated form.

The Field-of-View

The most common use of thermopile detectors is non-contact temperature sensing. All target points within the field-of-view will contribute to the measurement signal. To meet requirements of different applications, Excelitas offers a broad range of sensors with different windows and optics. The field-of-view data describes the dependence of signal from incident angles.

DigiPile® Sensors

Excelitas DigiPile was the first digital output Thermopile Sensor to reach the market, enabling direct connection to a microprocessor and streamlining integration. The Excelitas DigiPile line of Thermal IR Detectors are designed specifically for non-contact temperature measurement and are available in traditional TO-46 and TO-5 metal housings, as well as our SMD (Surface Mount Device) models in an ultra-compact, ceramic-type package.

Our DigiPile sensors feature a highly sensitive ADC input stage, which does not require further amplification, enabling easier integration into customer applications. The DigiPile sensors are available in an ISO-thermal package suited for applications such as ear thermometry.

CaliPile® Sensors

The CaliPile sensors represent the latest innovation in IR sensing. The only one of it's kind, the CaliPile is a multifunction thermal infrared sensor. In addition to traditional non-contact temperature measurement capabilities, CaliPile sensors offer motion detection and presence monitoring across short to medium ranges. To enable these individual functions, the internal circuit combines data storage with calibration data and a number of digital filters. With selectable frequency filters and levels, the CaliPile enables users to set the product into different operating modes. The CaliPile receives calibration data to support temperature-related processing and output. Depending on the model, the sensor is calibrated for an object temperature range up to 200°C. Customers can use a maximum temperature setting to set the trigger level as the interrupt function will alert users when the level is exceeded.

Applications for the CaliPile Series include short-range presence detection with no additional lens requirements, non-contact temperature measurement and overheating protection. It is ideally suited for IoT and smart-home products, lighting and printer sensing, and general industry thermal IR detection.

Thermopile Modules

With its range of Thermopile Modules, Excelitas offers plug-and-play function and streamlined systems integration. The TPMI® modules include the thermopile sensor mounted on a PCB with a connector. The PCB caters to features such as voltage regulation and a noise-reduction filter.

The ISO-thermal module includes integrated temperature compensation for a defined temperature environment and the calibration to a certain object temperature range. TPMI Modules are offered as programmed per customer request, in addition to standard versions. For requirements of defined spot sizes, Excelitas offers sensors with a field-of-view defined by optical apertures, internal lenses or external mirror optics.

Applications for Thermopile Sensors

Thermopile Sensors have been designed for non-contact temperature measurement. The signal of the sensor follows the radiation energy receipt by the sensor. This enables measuring surface temperatures without contact.

For industrial process controls, thermopile sensors are used to remotely monitor temperature as overheating protection. Thermopiles are also suited for domestic appliances such as food monitoring during defrosting, warming-up or cooking. Typical medical applications are body and skin temperature measurement, e.g. forehead and ear thermometry.

TPD 1T 0122

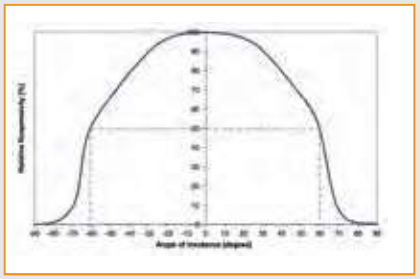
Miniature Thermopile Detector

This Thermopile Detector in TO-46 housing features a miniature housing including a sensitive chip with small optical window. The window is optically coated in the IR band 5-14µm. The housing includes a thermistor for ambient temperature compensation.

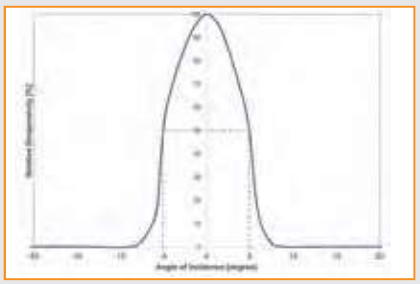
TPD 1T 0122 L3.0

Miniature Thermopile Detector with lens

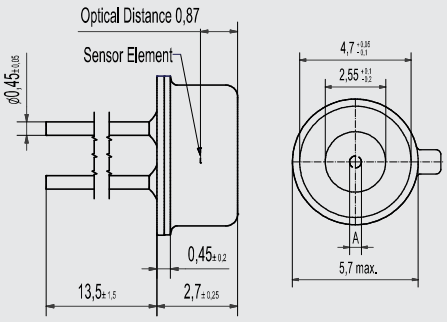
This Thermopile Detector in miniature TO-46 housing includes a focusing lens built into the smallest TO housing based thermopile detector. It includes a specially designed sensing chip and a standard internal Thermistor as temperature reference for temperature compensation. The built-in lens provides the narrow field-of-view for long-range contactless temperature measuring applications.



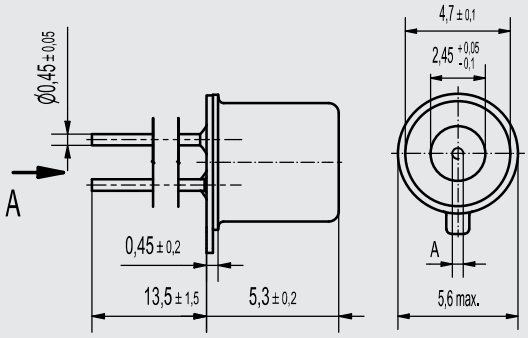
FoV TPD 1T 0122



FoV TPD 1T 0122 L3.0



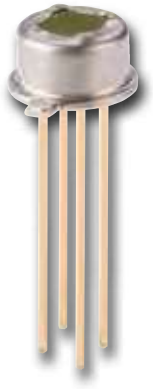
TPD 1T 0122



TPD 1T 0122 L3.0

TPD 1T 0122 L3.0 - TPD 1T 0122

Parameter	Symbol	TPD 1T 0122 L3.0	TPD 1T 0122	Unit	Remarks
Sensitive Area	A	Ø 0.5	Ø 0.5	mm	Absorber Area
Thermopile Resistance	R_{TP}	85…135	85…135	kΩ	25°C
Responsivity	R	77	77	V/W	500°K / 1Hz / Without IR-filter
Sensitivity (T_{det} 25 °C / T_{obj} 40 °C)	S_{40}	18.6	43	µV/K	
Sensitivity (T_{det} 25 °C / T_{obj} 100 °C)	S_{100}	25	56	µV/K	
Time Constant	t	15	15	ms	
Noise Voltage	V_n	42	42	nV/√Hz	25°C
Specific Detectivity	D*	0.8	0.8	10^8 cm√Hz/W	25°C
Temp. Coefficient of Resistance	TC_{RTP}	0,03	0,03	%/K	
Temp. Coefficient of Responsivity	T_{CR}	-0,05	-0,05	%/K	
Field of view	FoV	10	120	Degrees	at 50% intensity points
Thermistor resistance (25°C)	R_{25}	100	100	kΩ	25 °C
Thermistor BETA-value	β	3964	3964	K	defined at 25 °C / 100 °C



TPD 1T 0223

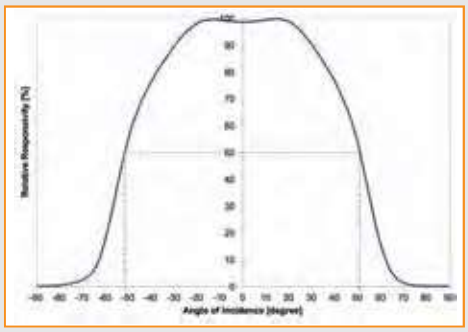
Miniature Thermopile Detector

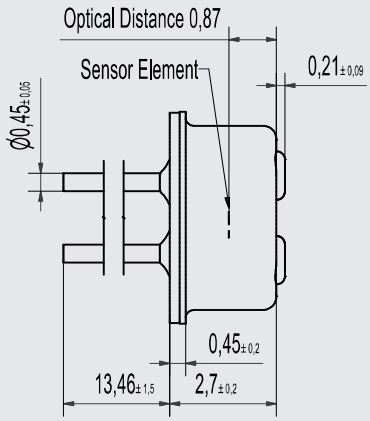
Thermopile Detector in miniature TO housing for general-purpose Detectors in 4.7 mm diameter TO-46 type housings, feature a specially-designed element configuration. The window is available as standard infrared or optional with narrow band-pass for gas-sensing applications. With the narrowband filter a square window is provided.

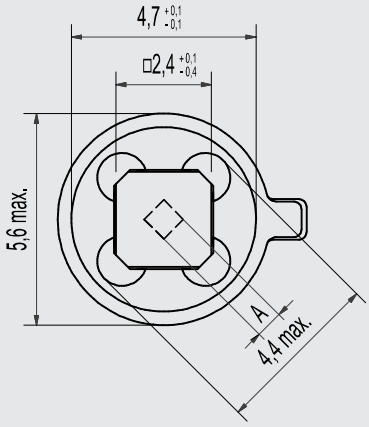
TPD 1T 0223 provides the small absorbing area, and is equipped as standard with an internal thermistor as temperature reference for ambient temperature compensation.

Features and Benefits

- Small housing
- Square window
- Filter options







TPD 1T 0223				
Parameter	**Symbol**	**TPD 1T 0223**	**Unit**	**Remarks**
Sensitive Area	A	0.7 x 0.7	mm	Absorber Area
Thermopile Resistance	R_{TP}	50…100	kΩ	25°C
Responsivity	R	45	V/W	500°K / 1Hz / Without IR-filter
Sensitivity (Tdet 25 °C / Tobj 40 °C)	S_{40}	88	µV/K	
Sensitivity (Tdet 25 °C / Tobj 100 °C)	S_{100}	116	µV/K	
Time Constant	t	22	ms	
Noise Voltage	V_n	35	nV/√Hz	25°C
Specific Detectivity	D*	0.9	10^8 cm√Hz/W	25°C
Temp. Coefficient of Resistance	TC_{RTP}	0,03	%/K	
Temp. Coefficient of Responsivity	TC_R	-0,05	%/K	
Field of view	FoV	104	Degrees	at 50% intensity points
Thermistor resistance (25°C)	R_{25}	100	kΩ	25 °C
Thermistor BETA-value	β	3964	K	defined at 25 °C / 100 °C

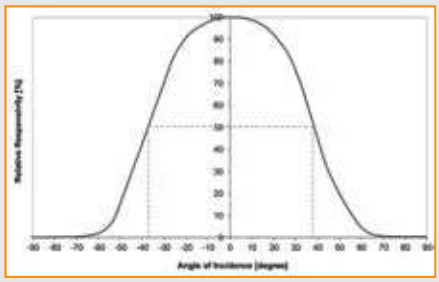
TPiD 1T 0224 • TPiD 1T 0624

Thermopile Detectors

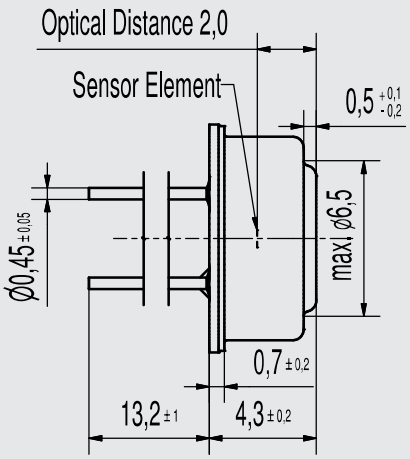
This Thermopile Detector in TO-39 housing offers a sensitive chip placed into the housing with aperture-type, small optical window. This family provides the ISOthermal performance for improved thermal shock resistance. Excelitas offers a range of ISOthermal Thermopile Detectors in TO-39 type housings. Our patented ISOthermal feature provides improved system performance when subjected to thermal shock conditions.

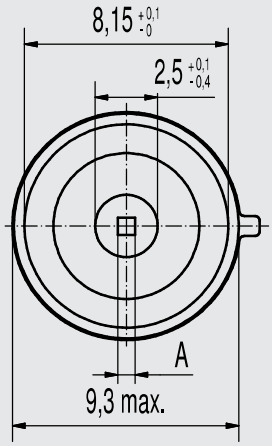
Both types are provided with round window, which also serves as aperture. All feature a specially designed element configuration, each one with different sized absorbing areas. TPiD 1T 0224 provides the smallest absorbing area, TPiD 1T 0624 offers the largest absorbing sensor area and highest sensitivity. All types are equipped as standard with internal thermistor as temperature reference for ambient temperature compensation.

FoV TPiD 1T 0224



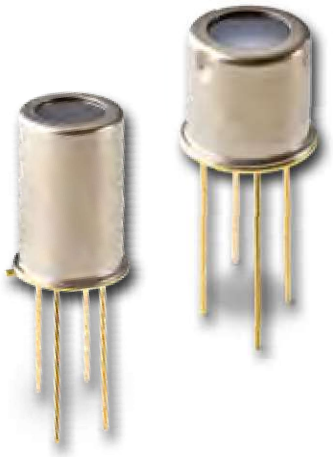
FoV TPiD 1T 0624





TPiD 1T 0224 - TPiD 1T 0624

Parameter	Symbol	TPiD 1T 0224	TPiD 1T 0624	Unit	Remarks
Sensitive Area	A	0.7 x 0.7	1.2 x 1.2	mm	Absorber Area
Thermopile Resistance	R_{TP}	50…100	50…110	kΩ	25°C
Responsivity	R	45	33	V/W	500°K / 1Hz / Without IR-filter
Sensitivity (Tdet 25 °C / Tobj 40 °C)	S_{40}	50	92	µV/K	
Sensitivity (Tdet 25 °C / Tobj 100 °C)	S_{100}	65	120	µV/K	
Time Constant	t	22	27	ms	
Noise Voltage	V_n	35	36	nV/√Hz	25°C
Specific Detectivity	D*	0.9	1.1	10^8 cm√Hz/W	25°C
Temp. Coefficient of Resistance	TC_{RTP}	0,03	0,03	%/K	
Temp. Coefficient of Responsivity	TC_R	-0,05	-0,05	%/K	
Field of view	FoV	70	76	Degrees	at 50% intensity points
Thermistor resistance (25°C)	R_{25}	100	100	kΩ	25°C
Thermistor BETA-value	β	3964	3964	K	defined at 25°C / 100°C



TPD 1T 0226 IRA • TPiD 1T 0226 L5.5

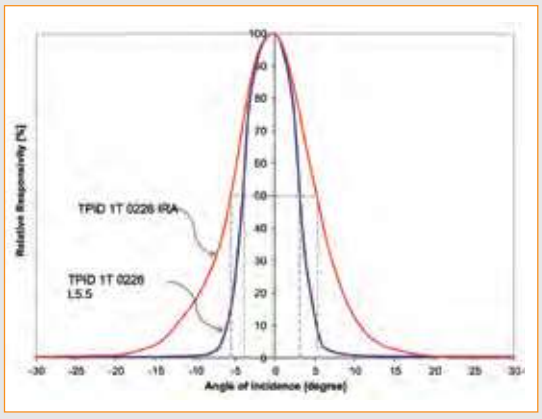
Thermopile Detector with integrated Optics

This Series of Thermopile Detectors with integrated optics offer two different alternatives: IRA type with high metal can which includes an integrated reflector for collecting the radiation receipt, or the L5.5 type with integral lens for focusing radiation towards the sensitive chip.

The IRA type thermopile is specially suited with an internal reflector that reduces the field-of-view and offers a smaller measurement "target" spot than conventional detectors without optics. Due to the reflector, the housing size is taller than other types, although the housing has the same diameter as a standard TO-5 housing.

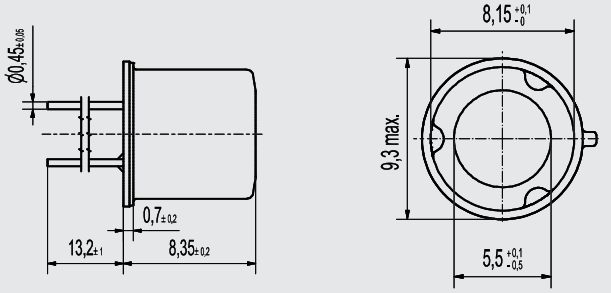
The TPiD 1T 0226 L5.5 provides the ISOthermal performance feature and integral optics. A built-in internal lens provides a field-of-view slightly sharper than the IRA type.

All versions are equipped as standard with an internal thermistor as temperature reference for ambient temperature compensation.

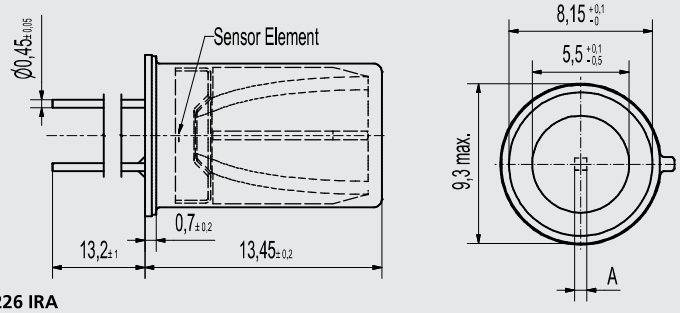


FoV TPD 1T 0226 IRA - TPiD 1T 0226 L5.5 Combined

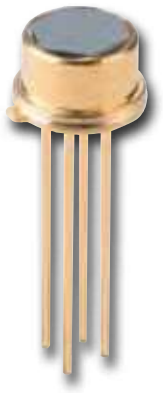
TPiD 1T 0226 L5.5



TPD 1T 0226 IRA



TPD 1T 0226 IRA - TPiD 1T 0226 L5.5					
Parameter	**Symbol**	**TPiD 1T 0226 L5.5**	**TPD 1T 0226 IRA**	**Unit**	**Remarks**
Sensitive Area	A	0.7 x 0.7	0.7 x 0.7	mm	Absorber Area
Thermopile Resistance	R_{TP}	50…100	50…100	kΩ	25°C
Responsivity	R	45	45	V/W	500°K / 1Hz / Without IR-filter
Sensitivity (T_{det} 25 °C / Tobj 40 °C)	S_{40}	20	62	µV/K	
Sensitivity (T_{det} 25 °C / Tobj 100 °C)	S_{100}	27	82	µV/K	
Time Constant	t	22	22	ms	
Noise Voltage	V_n	35	35	nV/√Hz	25°C
Specific Detectivity	D*	0.9	0.9	10^8 cm√Hz/W	25°C
Temp. Coefficient of Resistance	TC_{RTP}	0,03	0,03	%/K	
Temp. Coefficient of Responsivity	TC_R	-0,05	-0,05	%/K	
Field of view	FoV	7	15	Degrees	at 50% intensity points
Thermistor resistance (25°C)	R_{25}	100	100	kΩ	25 °C
Thermistor BETA-value	β	3964	3964	K	defined at 25 °C / 100 °C



TPiD 1T 0122B • TPiD 1T 0222B • TPiD 1T 0622B

ISOThermal Thermopile Detector

This Excelitas Thermopile Detector with ISOthermal design features a special housing concept matched with a sensitive chip and small optical window. As the industry standard for ear thermometry applications, these Thermopile Detectors are referenced as ISOThermal detectors. The patented designs provide superior performance under thermal shock conditions and thereby are best suited for the thympanon ear thermometry.

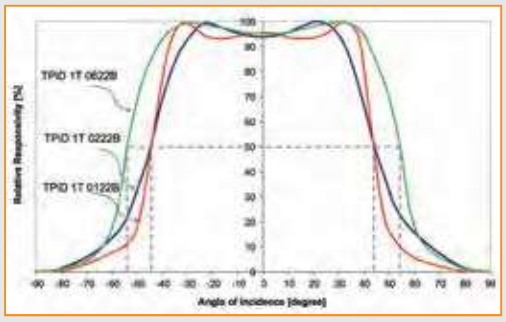
The range comprises TPiD 1T 0122B as the low cost version, whereas the versions TPiD 1T 0222B and TPiD 1T 0622B provide higher signal by high sensitive element designs and larger element area. The physical dimensions of the ISO thermal sensors are equivalent to our TO-46 sensor housings and include a special aperture. All types are equipped with an internal Thermistor as temperature reference for ambient temperature compensation.

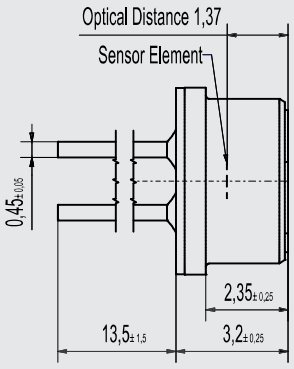
Features and Benefits

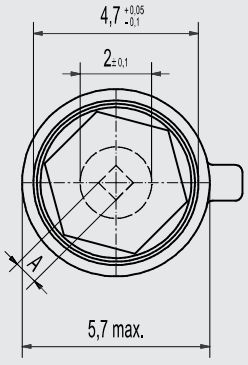
- Patented ISOThermal design
- TO-46 type housing

Target applications

- Ear thermometry







TPiD 1T 0122B, TPiD 1T 0222B, TPiD 1T 0622B

Parameter	Symbol	TPiD 1T 0122B	TPiD 1T 0222B	TPiD 1T 0622B	Unit	Remarks
Sensitive Area	A	Ø 0.5	0.7 x 0.7	1.2 x 1.2	mm	Absorber Area
Thermopile Resistance	R_{TP}	85…135	50…100	50…110	kΩ	25°C
Responsivity	R	92	60	40	V/W	500°K/ 1Hz/ Without IR-filter
Sensitivity (Tdet 25 °C / Tobj 40 °C)	S_{40}	44	95	150	µV/K	
Sensitivity (Tdet 25 °C / Tobj 100 °C)	S_{100}	58	125	200	µV/K	
Time Constant	t	15	22	27	ms	
Noise Voltage	V_n	42	35	36	nV/√Hz	25°C
Specific Detectivity	D*	1.0	1.2	1.3	10^8 cm√Hz/W	25°C
Temp. Coefficient of Resistance	TC_{RTP}	0,03	0,03	0,03	%/K	
Temp. Coefficient of Responsivity	TC_R	-0,05	-0,05	-0,05	%/K	
Field of view	FoV	90	90	110	Degrees	at 50% intensity points
Thermistor resistance (25°C)	R_{25}	100	100	100	kΩ	25 °C
Thermistor BETA-value	β	3964	3964	4092	K	defined at 25 °C / 100 °C

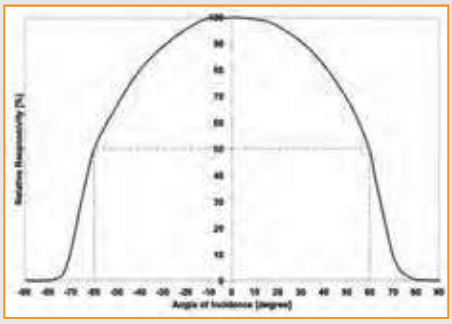
TPiD 1S 0121 • TPiD 1S 0222

Thermopile Detectors, SMD

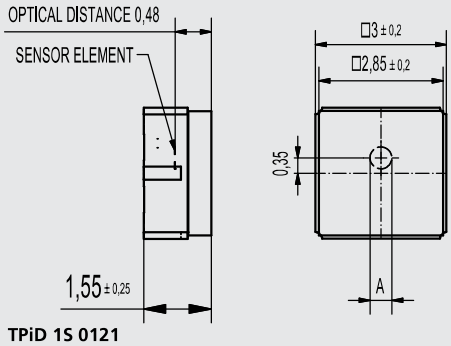
Thermopile Detectors in SMD housings offer two different sensitive chips which require different SMD housing sizes to accommodate either smaller form factor or higher sensitivity performance.

This enables standard SMT assembly processes and affords smaller host system designs. The SMD versions feature the unique ISOthermal performance for applications that are subjected to thermal shock conditions.

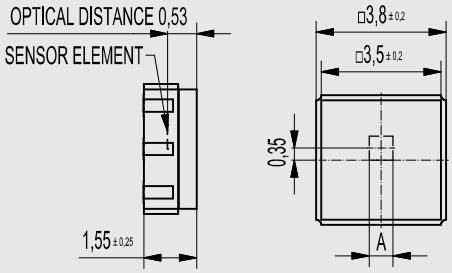
The TPiD 1S 0121 is the smallest SMD version we offer, whereas the TPiD 1S 0222 provides an element with higher sensitivity. Again, these detectors are equipped with an internal thermistor as temperature reference for Thermopile temperature compensation. All SMD parts are supplied in volume in tape & reel packaging.



FoV TPiD 1S 0121 - TPiD 1S 0222 Combined



TPiD 1S 0121



TPiD 1S 0222

TPID 1S 0121 - TPID 1S 0222

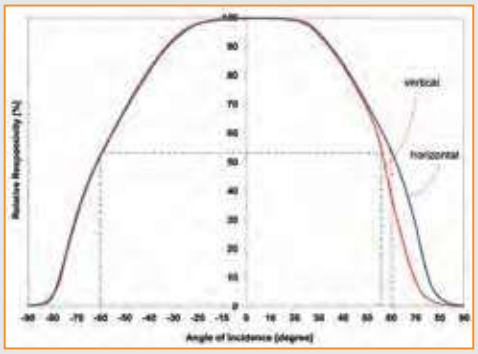
Parameter	Symbol	TPiD 1S 0121	TPiD 1S 0222	Unit	Remarks
Sensitive Area	A	Ø 0.5	0.7 x 0.7	mm	Absorber Area
Thermopile Resistance	R_{TP}	85…135	50…100	kΩ	25°C
Responsivity	R	77	45	V/W	500°/ 1Hz/ Without IR-filter
Sensitivity (Tdet 25 °C / Tobj 40 °C)	S_{40}	42	107	µV/K	
Sensitivity (Tdet 25 °C / Tobj 100 °C)	S_{100}	56	142	µV/K	
Time Constant	t	15	22	ms	
Noise Voltage	V_n	42	35	nV/√Hz	25°C
Specific Detectivity	D*	0.8	1.2	10^8 cm√Hz/W	25°C
Temp. Coefficient of Resistance	TC_{RTP}	0,03	0,03	%/K	
Temp. Coefficient of Responsivity	TC_R	-0,05	-0,05	%/K	
Field of view	FoV	120	120	Degrees	at 50% intensity points
Thermistor resistance (25°C)	R_{25}	100	100	kΩ	25 °C
Thermistor BETA-value	β	4092	4092	K	defined at 25 °C / 100 °C

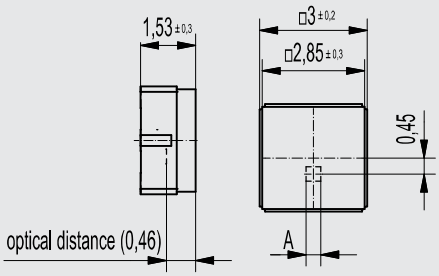
TPiS 1S 1051 • TPiS 1S 1252

DigiPile® Sensors, SMD

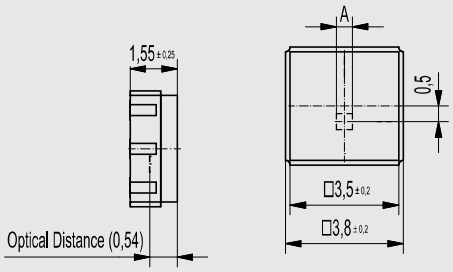
The DigiPile Sensor features a Thermopile sensing chip connected to an internal ADC which provides for amplification and digital conversion. Housed in a specially designed SMD carrier with optical window, the DigiPile offers two different versions of sensing chips.

The SMD type DigiPile provides for a Thermopile with digital 17-bit output. As many other types, this detector is offered with our patented ISOthermal performance. Within the bit stream the thermopile signal is followed by another signal given by an internal temperature reference diode. With the digital output, low interference of electric disturbance is achieved. These features enable optimum designs for a wide range of temperature measurement applications. With TPiS 1S 1051 we provide the smallest housing and smallest thermopile chip available. With TPiS 1S 1252 the housing is slightly larger due to a higher sensitivity thermopile chip to provide enhanced performance.



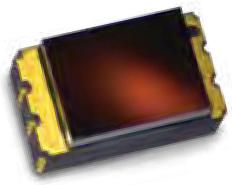


TPiS 1S 1051



TPiS 1S 1252

TPiS 1S 1051 - TPiS 1S 1252					
Parameter	**Symbol**	**TPiS 1S 1252**	**TPiS 1S 1051**	**Unit**	**Remarks**
Operating Conditions					
Operating Voltage	V_{DD}	2,4…3,6	2,4…3,6	V	
Supply Current	I_{DD}	max. 15	15 max.	µA	V_{DD} = 3.3 V
Operating Temperature	T_o	-20…70	-20…70	°C	Parameters may vary from specified values with temperature dependence.
Storage Temperature	Ts	-40…100	-40…100	°C	
Thermopile Characteristics					
Sensitive Area	A	0,51 x 0,51	0,4 x 0,4	mm^2	Absorber area
Sensitivity (T_{det} 25 °C / T_{obj} 40 °C)	S_{40}	400	210	counts/K	
Sensitivity (T_{det} 25 °C / T_{obj} 100 °C)	S_{100}	530	280	counts/K	
Noise of TP		8	8	counts	Tobj = 40°C, Tamb =25°C
Time Constant	t	45	15	ms	
Ambient Temperature Sensor Characteristics					
Sensitivity of Tamb		90	90	counts/K	Linear for Tamb from 0°C to 90°C
Count @ Tamb = 25°C		7000…9400	7000…9400	counts	Range
Optical Characteristics					
Field of View	FoV	120	120 / 116	Degree	At 50% intensity points
Electrical Characteristics					
ADC Resolution Tobj		17	17	Bits	Max Count = 2^{17}
ADC Resolution Tamb		14	14	Bits	Max Count = 2^{14}
ADC Sensitivity of Tobj		0,7…0,9	0,7…0,9	µV/count	
ADC Offset Tobj		64000…65000	64000…65000	counts	Range

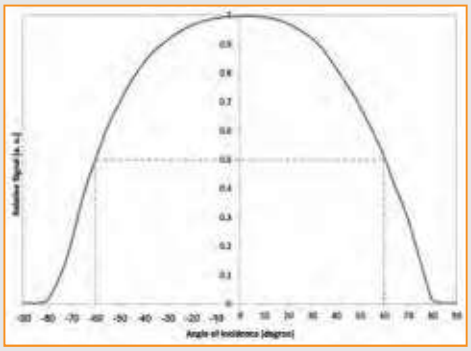


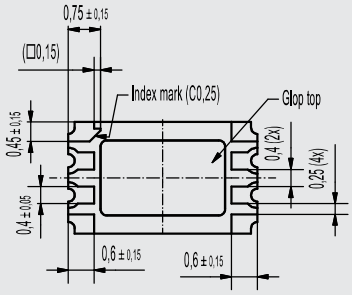
TPiS 1S 1385 • TPiS 1S 0185

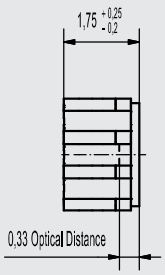
CaliPile® Sensor in SMD Housing

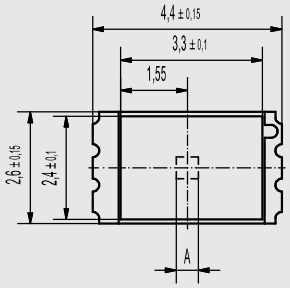
The CaliPile Sensors represent the latest innovation in IR sensing from Excelitas. The only one of it's kind, the CaliPile is a multifunction, thermal infrared sensor. In addition to traditional non-contact temperature measurement capabilities, the CaliPile offers motion detection and presence monitoring across short to medium ranges.

The CaliPile thermopile sensing chip is connected to an internal circuitry and housed in tiny SMD housing. The integrated electronics provide digital conversion and further filtering and processing. The TPiS 1S xx85 Sensor is the SMD version of the CaliPile Series providing I2C bus communication and signal output. An additional interrupt may serve as a 'Yes/No' output for the motion, presence and temperature applications. The TPiS 1S 1385 facilitates an extremely compact SMD form factor, suited for medium-distance human presence detection without additional lens requirements. For short-range and low-cost sensor applications, we offer a less sensitive chip with TPiS 1S 0185.









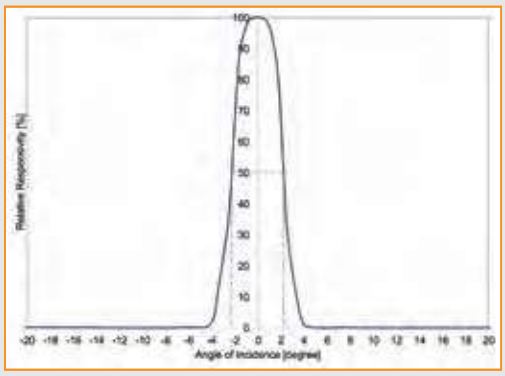
TPiS 1S 1385 - TPiS 1S 0185					
Parameter	**Symbol**	**TPiS 1S 1385**	**TPiS 1S 0185**	**Unit**	**Remarks**
Operating Conditions					
Operating Voltage	V_{DD}	2,6…3,6	2,6…3,6	V	
Supply Current	I_{DD}	15 max.	15 max.	µA	V_{DD} = 3.3 V
Operating Temperature	T_o	-20…85	-20…85	°C	Parameters may vary from specified values with temperature dependence.
Storage Temperature	T_s	-40…100	-40…100	°C	
Thermopile Characteristics					
Sensitive Area	A	0,56 x 0,56	Ø 0.5	mm^2	Absorber area
Sensitivity (T_{det} 25 °C / T_{obj} 40 °C)	S_{40}	400	75	counts/K	
Noise of TP		8	8	counts	Tobj = 40°C, Tamb =25°C
Time Constant	t	30	15	ms	
Ambient Temperature Sensor Characteristics					
Sensitivity of Tamb		170	170	counts/K	Linear for Tamb from 0°C to 85°C
Count @ Tamb = 25°C		11000…17000	11000…17000	counts	Range
Optical Characteristics					
Field of View	FoV	120	120	Degree	At 50% intensity points
Electrical Characteristics					
ADC Resolution Tobj		17	17	Bits	Max Count = 2^{17}
ADC Resolution Tamb		15	15	Bits	Max Count = 2^{15}
ADC Sensitivity of Tobj		0,7…0,9	0,7…0,9	µV/count	
ADC Offset Tobj		64000…65000	64000…65000	counts	Range

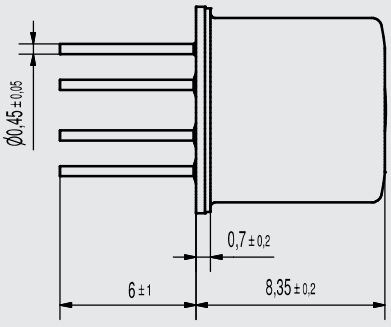
TPiS 1T 1086 L5.5 • TPiS 1T 0186 L5.5

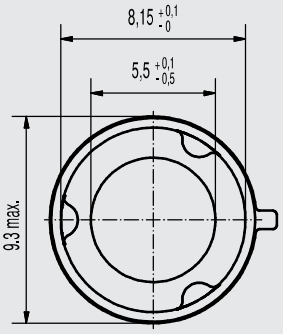
CaliPile® Sensor TO-5 Housing with Lens

CaliPile Sensors represent the latest innovation in IR sensing from Excelitas. The only one of it's kind, the CaliPile is a multifunction, thermal infrared sensor. In addition to traditional non-contact temperature measurement capabilities, the CaliPile offers motion detection and presence monitoring across short to medium ranges.

The CaliPile sensing chip is connected to an internal circuitry within a tall TO-5 housing with built in optical lens. The integrated electronics provide digital conversion and further filtering and processing. The sensor is available as calibrated for temperature ranges of max object temperature 250°C at +/- 3°C for temperature measurement applications working up to 350 / 600°C maximum range. Users may reference the maximum temperature setting as trigger level since the interrupt function will alert users when the level has exceeded.







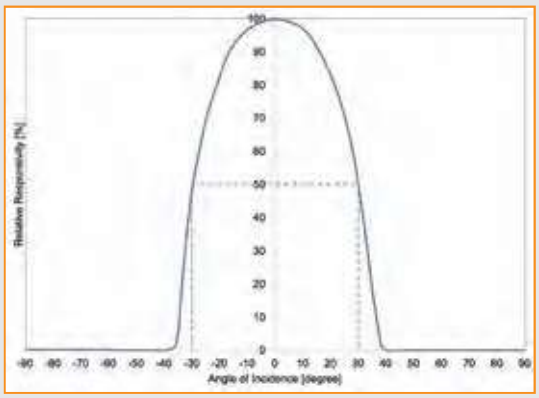
TPiS 1T 1086 L5.5 - TPiS 1T 0186 L5.5					
Parameter	**Symbol**	**TPiS 1T 1086 L5.5**	**TPiS 1T 0186 L5.5**	**Unit**	**Remarks**
Operating Conditions					
Operating Voltage	V_{DD}	2,6…3,6	2,6…3,6	V	
Supply Current	I_{DD}	15 max.	15 max.	µA	V_{DD} = 3.3 V
Operating Temperature	T_o	-20…85	-20…85	°C	Parameters may vary from specified values with temperature dependence.
Storage Temperature	Ts	-40…100	-40…100	°C	
Thermopile Characteristics					
Sensitive Area	A	0,41 x 0,41	Ø 0.5	mm^2	Absorber area
Sensitivity (T_{det} 25 °C / T_{obj} 40 °C)	S_{40}	30	10	counts/K	
Noise of TP	S_{100}	8	8	counts	Tobj = 40°C, Tamb =25°C
Time Constant		15	15	ms	
Ambient Temperature Sensor Characteristics	t				
Sensitivity of Tamb		170	170	counts/K	Linear for Tamb from 0°C to 85°C
Count @ Tamb = 25°C		11000…17000	11000…17000	counts	Range
Optical Characteristics					
Field of View	FoV	5	5	Degree	At 50% intensity points
Electrical Characteristics					
ADC Resolution Tobj		17	17	Bits	Max Count = 2^{17}
ADC Resolution Tamb		15	15	Bits	Max Count = 2^{15}
ADC Sensitivity of Tobj		0,7…0,9	0,7…0,9	µV/count	
ADC Offset Tobj		64000…65000	64000…65000	counts	Range

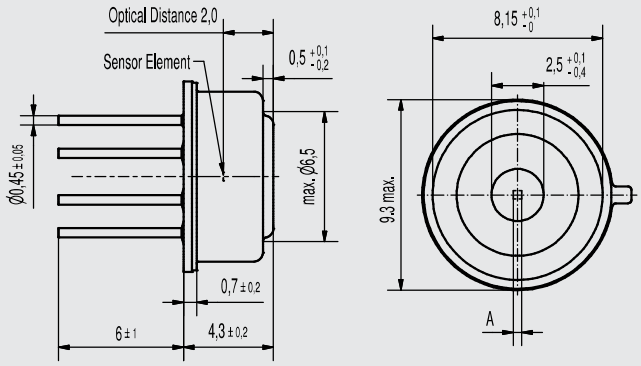
TPiS 1T 1084

CaliPile® Sensor in TO-39 Housing with Window

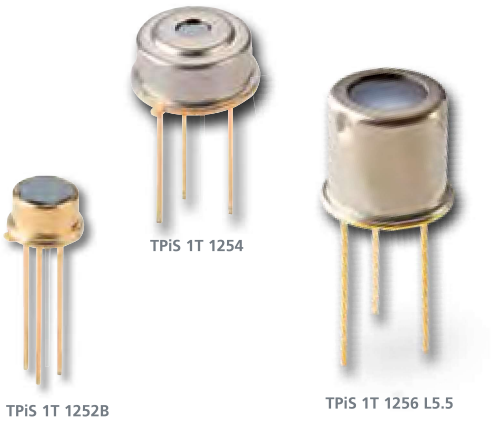
CaliPile Sensors represent the latest innovation in IR sensing from Excelitas. The only one of it's kind, the CaliPile is a multifunction, thermal infrared sensor. In addition to traditional non-contact temperature measurement capabilities, the CaliPile offers motion detection and presence monitoring across short to medium ranges.

The TPiS 1T 1084 sensor represents the TO-39 housing version of the CaliPile IR Sensor Series with small optical window also serving as aperture. The sensor is available as calibrated for temperature ranges of 40- 200°C with +/- 3°C for temperature measurement applications working up to 300°C maximum range. Users may reference the maximum temperature setting as trigger level since the interrupt function will alert users when the level is exceded.





TPiS 1T 1084				
Parameter	**Symbol**	**TPiS 1T 1084**	**Unit**	**Remarks**
Operating Conditions				
Operating Voltage	V_{DD}	2,6…3,6	V	
Supply Current	I_{DD}	15 max.	µA	V_{DD} = 3.3 V
Operating Temperature	T_o	-20…85	°C	Parameters may vary from specified values with temperature dependence.
Storage Temperature	Ts	-40…100	°C	
Thermopile Characteristics				
Sensitive Area	A	0,41 x 0,41	mm^2	Absorber area
Sensitivity (T_{det} 25 °C / T_{obj} 40 °C)	S_{40}	80	counts/K	
Noise of TP		8	counts	Tobj = 40°C, Tamb =25°C
Time Constant	t	15	ms	
Ambient Temperature Sensor Characteristics				
Sensitivity of Tamb		170	counts/K	Linear for Tamb from 0°C to 85°C
Count @ Tamb = 25°C		11000…17000	counts	Range
Optical Characteristics				
Field of View	FoV	60	Degree	At 50% intensity points
Electrical Characteristics				
ADC Resolution Tobj		17	Bits	Max Count = 2^{17}
ADC Resolution Tamb		15	Bits	Max Count = 2^{15}
ADC Sensitivity of Tobj		0,7…0,9	µV/count	
ADC Offset Tobj		64000…65000	counts	Range



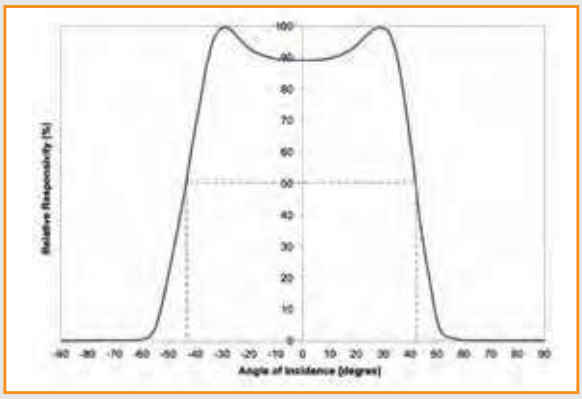
TPiS 1T 1252B • TPiS 1T 1254 • TPiS 1T 1256 L5.5

DigiPile® – ISOthermal Thermopile Sensors

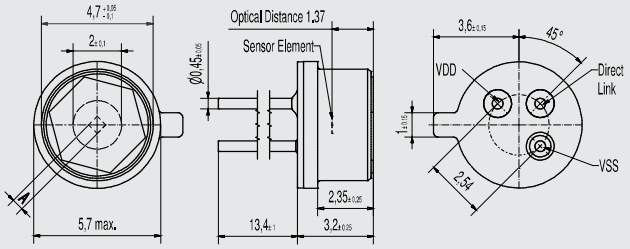
As continuation of Excelitas' focus on innovation and digitization the DigiPile is a Thermopile with digital 17-bit output. The complete range of detectors is offered with our patented ISOthermal performance. Within the bit stream the thermopile signal is followed by another signal given by an internal temperature reference diode. With the digital output, low interference of electric disturbance is achieved. These features enable optimum designs for ear and forehead thermometry.

TPiS 1T 1252B, TPiS 1T 1254, TPiS 1T 1256 L5.5

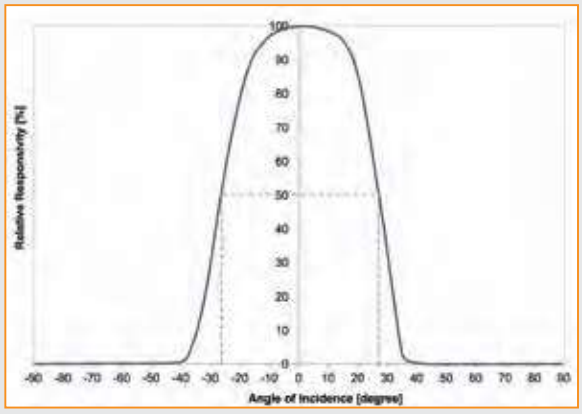
Parameter	Symbol	TPiS 1T 1252B	TPiS 1T 1254	TPiS 1T 1256 L5.5	Unit	Remarks
Operating Conditions						
Operating Voltage	V_{DD}	2,4…3,6	2,4…3,6	2,4…3,6	V	
Supply Current	I_{DD}	15 max.	15 max.	15 max.	µA	V_{DD} = 3.3 V
Operating Temperature	T_o	-20…70	-20…70	-20…70	°C	Parameters may vary from specified values with temperature dependence.
Storage Temperature	T_s	-40…100	-40…100	-40…100	°C	
Thermopile Characteristics						
Sensitive Area	A	0,51 x 0,51	0,51 x 0,51	0,51 x 0,51	mm^2	Absorber area
Sensitivity (T_{det} 25 °C / T_{obj} 40 °C)	S_{40}	290	150	67	counts/K	
Sensitivity (T_{det} 25 °C / T_{obj} 100 °C)	S_{100}	370	200	85	counts/K	
Noise of TP		8	8	8	counts	Tobj = 40°C, Tamb =25°C
Time Constant	t	45	45	45	ms	
Ambient Temperature Sensor Characteristics						
Sensitivity of Tamb		90	90	90	counts/K	Linear for Tamb from 0°C to 90°C
Count @ Tamb = 25°C		7000…9400	7000…9400	7000…9400	counts	Range
Optical Characteristics						
Field of View	FoV	84	56	5	Degree	At 50% intensity points
Electrical Characteristics						
ADC Resolution Tobj		17	17	17	Bits	Max Count = 2^{17}
ADC Resolution Tamb		14	14	14	Bits	Max Count = 2^{14}
ADC Sensitivity of Tobj		0,7…0,9	0,7…0,9	0,7…0,9	µV/count	
ADC Offset Tobj		64000…65000	64000…65000	64000…65000	counts	Range



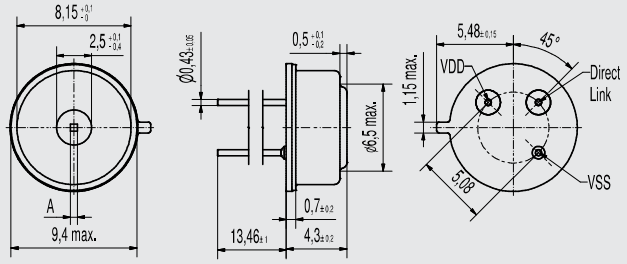
FoV TPiS 1T 1252B



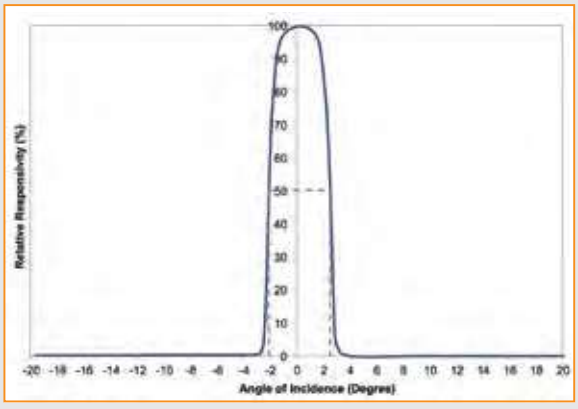
TPiS 1T 1252B



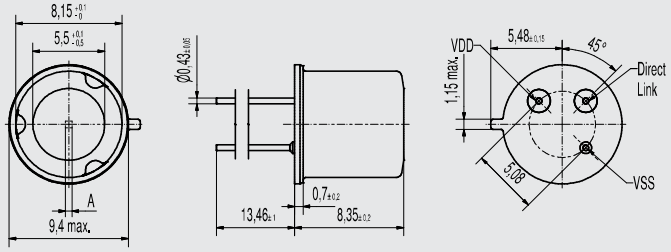
FoV TPiS 1T 1254



TPiS 1T 1254



FoV TPiS 1T 1256 L5.5



TPiS 1T 1256 L5.5

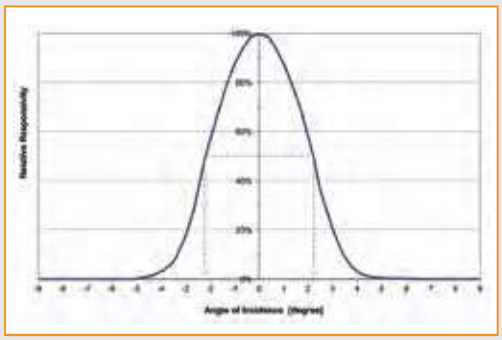
TPiM 1T 0136 L5.5

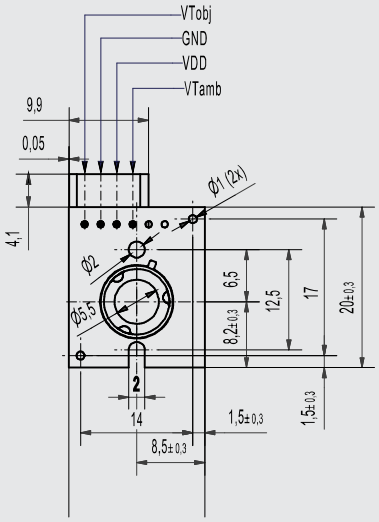
Thermopile Sensor Module with lens

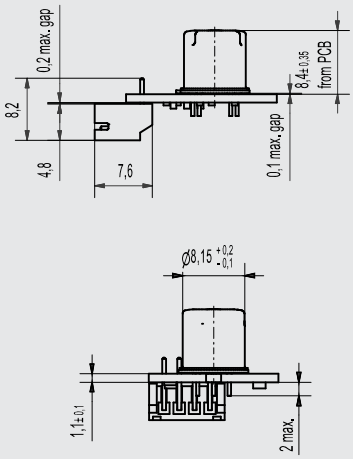
The Module includes the proven concept of TPMI® in TO-5 housing with integral lens sensor on a PCB with connector for easy plug and play. It senses the thermal radiation emitted by objects and converts this to an analog voltage. The product is fully factory-calibrated for an accurate signal output over a specified temperature range and includes optional temperature compensation. The internal signal processing with 8-bit resolution of the control registers and the EEPROM technology allow for calibration as per customer requirements. The Module includes PCB with connector.

As standard two calibration ranges are provided:

- TPiM 1T 0136 L5.5 OAA250 P7 for up to 250°C
- TPiM 1T 0136 L5.5 OAA060 P7 for up to 60°C







TPiM 1T 0136 L5.5				
Parameter	**Symbol**	**TPiM 1T 0136 L5.5**	**Unit**	**Remarks**
Output Voltage Swing	V_O	0.25...(V_{DD} - 0.25)	V	
Resistive Output Load	R_L	50	kΩ	min.
Object Temp Accuracy		1.5	K	+ / -
Response Time	t_{resp}	100	ms	typ.
Supply Voltage	V_{DD}	4.5....5.5	V	
Supply Current	I_{DD}	1.5	mA	typ. ; R_L > 1MΩ
Operating Temp range	T_O	-25....+100	°C	
Storage Temp range	T_S	-40....+100	°C	
ESD tolerance		2.5	kV	Human body model
Field of View , typ.	FoV	4.5	°	at 50% intensity points
Distance to Spot size ratio	D:S	11:1	Degrees	at 50% intensity points

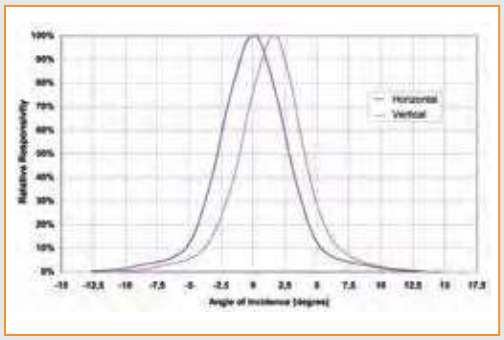
TPM 1T 0134 M

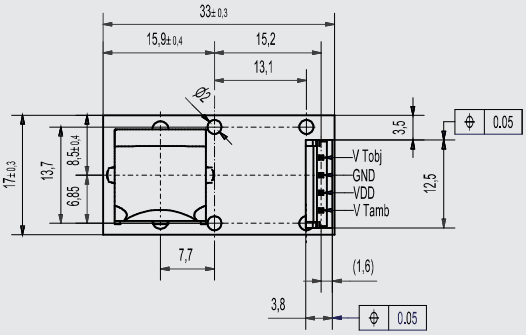
Thermopile Sensor Module

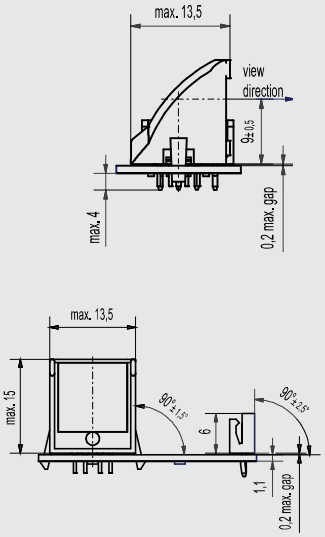
The Module includes the proven concept of TPMI® in TO-5 housing serving as aperture on a PCB with connector for easy plug and play. The product is fully factory-calibrated for an accurate signal output over a specified temperature range and includes optional temperature compensation. The Module includes PCB with connector and is available with reflector allowing narrow field of view, either to right, left or front side.

As standard calibration we provide:

- TPM 1T 0134 OAA140 P6 M for up to 140°C







TPM 1T 0134 M				
Parameter	**Symbol**	**TPM 1T 0134 M**	**Unit**	**Remarks**
Output Voltage Swing	V_O	0.25...(VDD - 0.25)	V	
Resistive Output Load	R_L	50	kΩ	min.
Object Temp Accuracy		1.5	K	+ / -
Response Time	t_{resp}	100	ms	typ.
Supply Voltage	V_{DD}	4.5....5.5	V	
Supply Current	I_{DD}	1.5	mA	typ. ; R_L > 1MΩ
Operating Temp range	T_O	-25....+100	°C	
Storage Temp range	T_S	-40....+100	°C	
ESD tolerance		2.5	kV	Human body model
Field of View, typ.	FoV	5.5	°	at 50% intensity points
Distance to Spot size ratio	D:S	-	Degrees	

Generally Applied IR Windows

Material used for filters and windows must be transparent in the wavelength of interest. Glass for example is generally not suited to sense the temperature of human skin since it absorbs wavelengths above 4µm. Common materials with a broad transmission range are Germanium and Silicon for the filter windows of IR Sensors. For outside protection only few materials are suitable. Among many plastics, only PP or HD-PE can be used as protection or as fresnel structured optics for presence and motion detection.

Detecting Gases

In the early days of the mining industry, the common method for gas detection was to take a bird in a cage along.

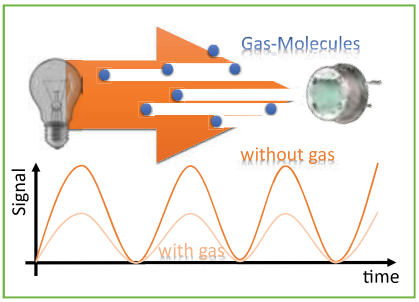
Canary birds were well known as an early warning system for toxic gases. If the bird went unconscious, it was high time to get out. Today electonic sensors have replaced the ancient system.

The now applied NDIR principle requires a combination of Thermal Radiation Source and Infrared Sensor. The selection of source strongly depends on spectral range. For range below 5m popular incandescent miniature lamps can be applied, for long-range thermal sources are required.

When designing NDIR-based gas sensors the selction of available Detectors is split between Pyrodetectors and Thermopile Sensors. Since NDIR usually applies modulated sources to prevent overheating, the engineer has the choice of preference. Both sensor priciples can be called equally suitable when fit with the narrow band window necessary for the speciffic gas absorption.

Special Application Detectors for Gas Sensing

Environmental protection is one of our most serious concerns. Features and instrumentation are required to measure and monitor all kinds of gas in

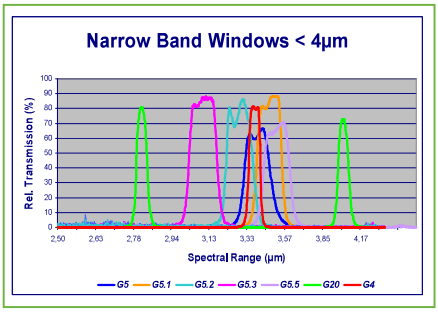


our environment. One of the methods applied is the NDIR technique, a principle of measuring gas concentration by its absorption properties in the infrared range.

Filters for Gas Sensors

The spectral sensitive range of the detectors is defined by a filter window. Common applications in infrared reference wavelengths from 2 to 20 µm. Long-range pyrometers apply a sharp cut-on/cut-off window of 9-14µm (G9) .

Excelitas offers single-channel detectors with such windows as well as Dual-Channel Detectors. When choosing Dual-Channel, typically one channel works as reference fit with a window that will have

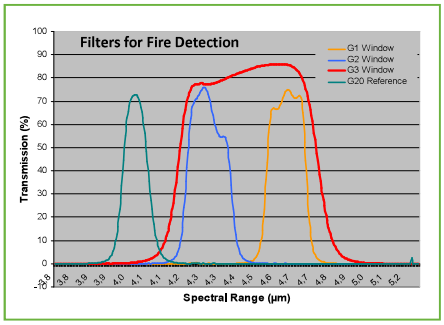


no gas absorption band (G20).
For sensing one specific gas by infrared absorption we offer narrow-band filters to detect specific gas absorption lines. The appropriate narrow band optical filters enable detection of Carbon Monoxide, Carbon Dioxide, Natural Gas and other environmental gases, as well as some technical gases. Please see the range of available filters and specifications.

Fire Detection

Since the exhaust of fire is mainly a hot emission of CO and CO_2, the infrared sensor may also be used for fire detection when fit with a suitable filter.

Our Detectors are applied in single- or dual-channel configurations. With the suited specific narrow-band spectral window our detectors and sensors are a vital part of making our environment more safe, secure and healthy.



Narrow Bands Filter Table

Filter type	Application	CWL	HPB
G1	CO	4.64µm	180nm
G2	CO_2	4.26µm	180nm
G2.2	CO_2	4.43µm	60nm
G2.5	CO_2	4,33µm	160 nm
G2.6	N_2O	4.53µm	85nm
G3	CO+CO_2	4.48µm	620nm
G4	NO	5.3µm	180nm
G5	HC	3.35µm-3,4µm	190nm
G5.1	HC	3.46µm	163nm
G5.2	HC	3,28-3,31µm	160nm
G5.3	HC	3.09µm	160nm
G5.5	HC	3,32-3,34µm	160nm
G5.6	HC	3.42µm-3,451µm	160nm
G5.7	HC	3,30-3,32µm	160nm
G5.9	HC	3.375µm-3,4µm	190nm
G7.1	R12	11.3µm	200nm
G7.2	R134a	10.27µm	210nm
G7.3		12.4µm	180nm
G20	Reference	3,95µm	90nm

PYS 3198TC

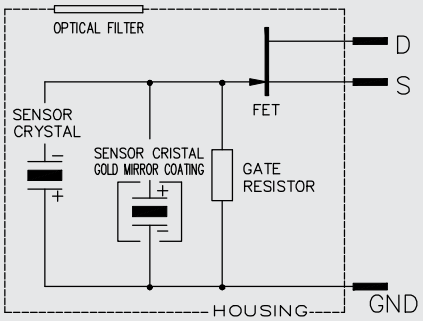
Single-Element Pyrodetector

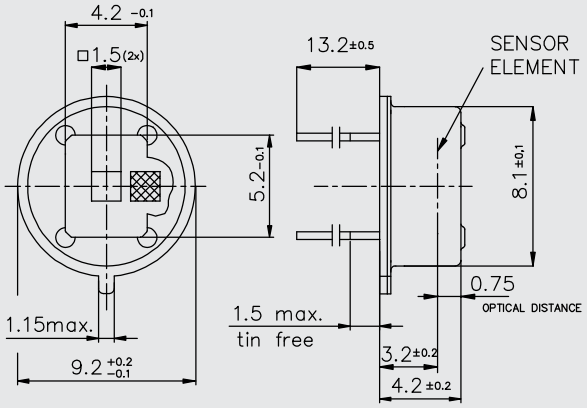
As Single-Element types we reference designs which combine one sensing element with a suited optical window. This makes single-Element types suitable for measurement applications.

One sensing element is placed in the center of the detector. For thermal compensation an additional element which is blinded from radiation is connected in parallel. The TO-5 Metal Housing is equipped with an optical filter window. For gas measuring applications the spectral range is narrowed to match the gas absorption in IR range. As such the detector window suites as spectral narrow band filter. Various configurations are available for detection of more common gasses.

Features and Benefits

- TO-5 metal housing
- Different spectral filters available
- Suited for gas monitoring





PSY 3198TC				
Parameter	**Symbol**	**PYS 3198TC**	**Unit**	**Remarks**
Responsivity, min.	R_{min}	2.2	kV/W	f = 1 Hz
Responsivity, typ.	R	3.5	kV/W	f = 1 Hz
Noise, max.	N_{max}	50	μV_{pp}	0,4…10Hz/20°C
Noise, typ.	N	15	μV_{pp}	0,4…10Hz/20°C
spec. Detectivity	D*	17	10^7cm*√Hz/W	1Hz/ 1Hz BW
Field of View, horizontal	FoV	135	°	unobstructed
Field of View, vertical		122	°	unobstructed
Source Voltage		0,2…1,5	V	47 kΩ, 20°C
Operation Voltage	V_{DD}	2-10	V	unobstructed

PYS 3398TC

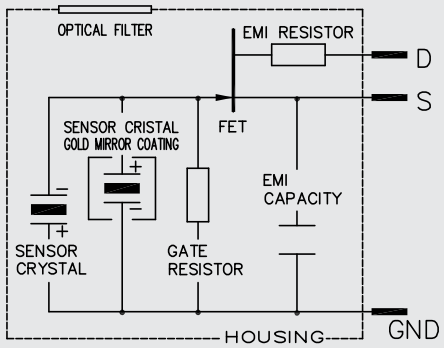
Single-Element Pyrodetector

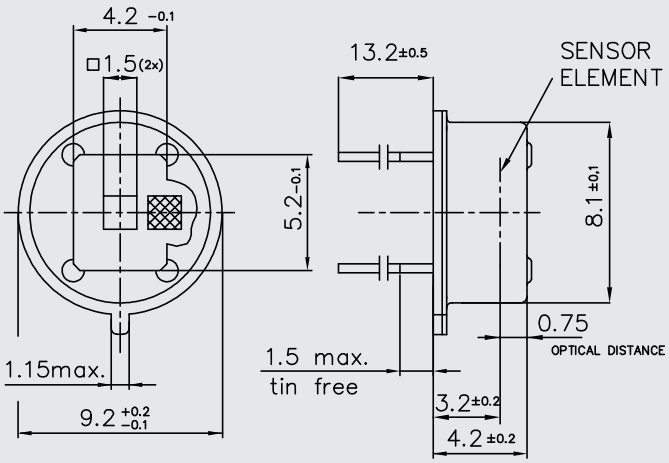
This Single-Element Pyrodetector combines one sensing element with a suited optical window. This makes single-element types suitable for measurement applications. This version of Single-Element Detector is especially resistant to EMI by means of drain resistor and source capacitor.

One sensing element is placed in the center of the detector. For thermal compensation an additional element which is blinded from radiation is connected in parallel. The TO-5 metal housing is equipped with an optical filter window. For gas measuring applications the spectral range is narrowed to match the gas absorption in IR range. As such the detector window suits as spectral narrow-band filter. Various configurations are available for detection of more common gasses.

Features and Benefits

- TO-5 metal housing
- Different spectral filters available
- EMI protection
- Suited for gas monitoring





PSY 3398TC				
Parameter	**Symbol**	**PYS 3398TC**	**Unit**	**Remarks**
Responsivity, min.	R_{min}	2.2	kV/W	f = 1 Hz
Responsivity, typ.	R	3.5	kV/W	f = 1 Hz
Noise, max.	N_{max}	50	μV_{pp}	0,4…10Hz/20°C
Noise, typ.	N	15	μV_{pp}	0,4…10Hz/20°C
spec. Detectivity	D*	17	10^7cm*√Hz/W	1Hz/ 1Hz BW
Field of View, horizontal	FoV	135	°	unobstructed
Field of View, vertical		122	°	unobstructed
Source Voltage		0,2…1,5	V	47 kΩ, 20°C
Operation Voltage	V_{DD}	2-10	V	unobstructed

PYS 3428TC

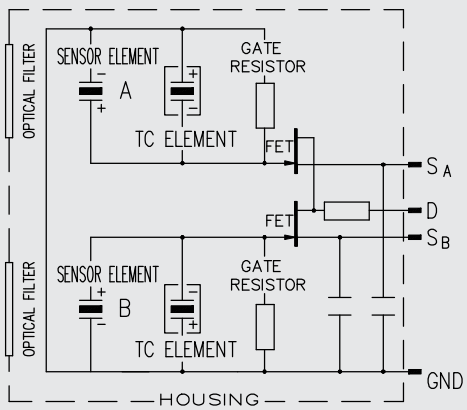
Dual-Channel Pyrodetector

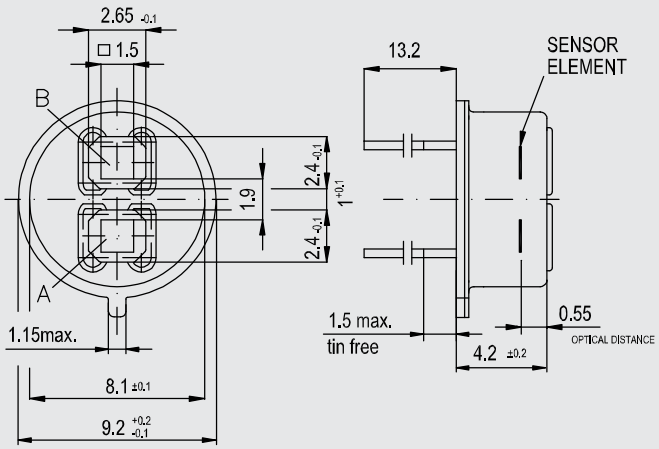
This Single-Element, Dual-Channel Pyrodetector includes two single elements thermally compensated. Each output is optically associated with its own optical window within the TO-5 metal housing. They form individual output signals, thus the name "Dual-Channel".

For gas measuring applications the spectral range is narrowed to match the gas absorption in IR range. Usually one channel is used as reference channel suited with a bandwidth which shows no gas absorption. The second channel serves as the gas sensing output. Various filter selections are available to detect the most prominent gasses.

Features and Benefits

- TO-5 metal housing
- Different spectral filters available
- EMI protection
- Suited for gas monitoring





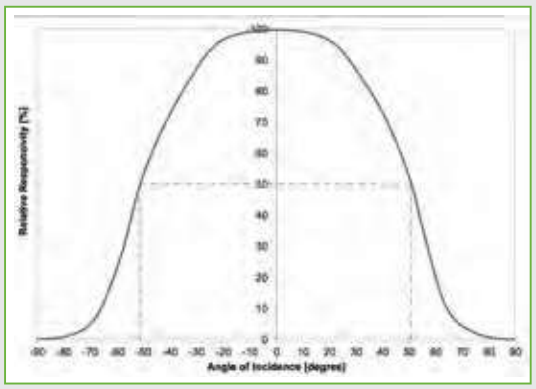
PYS 3428TC				
Parameter	**Symbol**	**PYS 3428TC**	**Unit**	**Remarks**
Responsivity, min.	R_{min}	2.2	kV/W	f = 1 Hz
Responsivity, typ.	R	3.5	kV/W	f = 1 Hz
Noise, max.	N_{max}	50	μV_{pp}	0,4…10Hz/20°C
Noise, typ.	N	15	μV_{pp}	0,4…10Hz/20°C
spec. Detectivity	D*	17	10^7cm*√Hz/W	1Hz/ 1Hz BW
Field of View, horizontal	FoV	77	°	unobstructed
Field of View, vertical		77	°	unobstructed
Source Voltage		0,2…1,5	V	47 kΩ, 20°C
Operation Voltage	V_{DD}	2-10	V	unobstructed

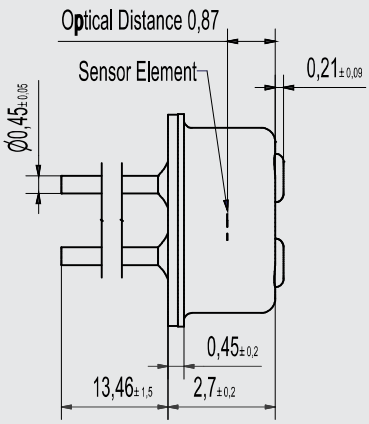
TPD 1T 0623 • TPD 1T 0823

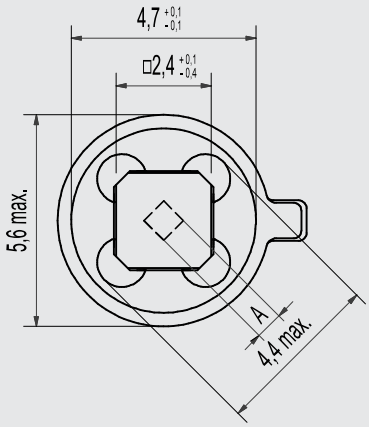
High-Sensitivity Thermopile Detectors

This Thermopile Detector series offered in TO-46 housing with square size window is specially designed for high output signal level. It is equipped with internal Thermistor serving as temperature reference for Thermopile temperature compensation. With the square window size offering wide field of view and the option to select narrow bad filters G1…G5 as per page 36 of this brochure it is the best choice for Gas sensing applications.

The TPD1T 0823 is a special version for fast response when needed in gas sensing applications.







TPD 1T 0623, TPD 1T 0823

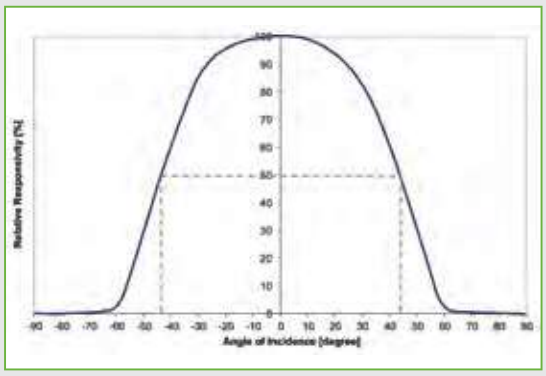
Parameter	Symbol	TPD 1T 0623	TPD 1T 0823	Unit	Remarks
Sensitive Area	A	1.2 x 1.2	1.2 x 1.2	mm	Absorber Area
Thermopile Resistance	R_{TP}	50…110	70…120	kΩ	25°C
Responsivity	R	33	32	V/W	500°K / 1Hz / Without IR-filter
Sensitivity (Tdet 25 °C / Tobj 40 °C)	S_{40}	133	124	µV/K	With standard filter (LWP, cut-on 5.5 µm)
Sensitivity (Tdet 25 °C / Tobj 100 °C)	S_{100}	177	165	µV/K	With standard filter (LWP, cut-on 5.5 µm)
Time Constant	t	27	10	ms	
Noise Voltage	V_n	36	38	nV/√Hz	25°C
Specific Detectivity	D*	1.1	1.1	10^8 cm√Hz/W	25°C
Temp. Coefficient of Resistance	TC_{RTP}	0,03	0,03	%/K	
Temp. Coefficient of Responsivity	T_{CR}	-0,05	-0,05	%/K	
Field of view	FoV	104	104	Degrees	at 50% intensity points
Thermistor resistance (25°C)	R_{25}	100	100	kΩ	25 °C
Thermistor BETA-value	β	3964	3964	K	defined at 25 °C / 100 °C

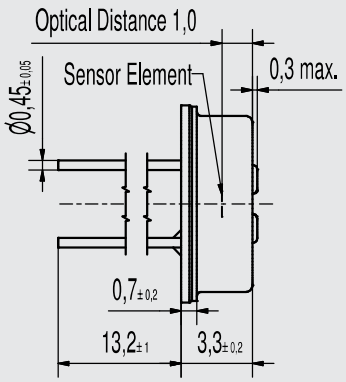
TPD 2T 0625 • TPD 2T 0825

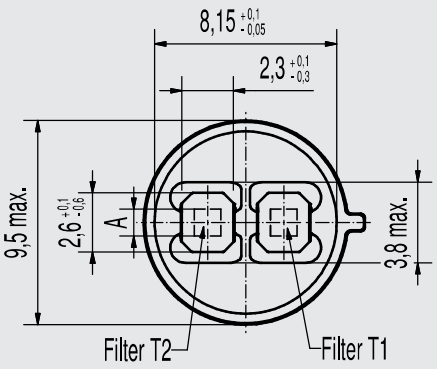
High-Sensitivity Thermopile Detectors

This specially designed Detector offers Dual-Channel performance in a TO-39 housing with two individual optical windows. Typically one window is fitted with a reference filter G20, while the other window is fitted with a narrow-band pass filter selected for a specific gas, see page 36 of this brochure for available selection. It also includes the internal Thermistor as temperature reference for Thermopile temperature compensation.

The TPD 2T 0825 is a special version for fast response when needed in critical gas sensing applications.







TPD 2T 0625, TPD 2T 0825

Parameter	Symbol	TPD 2T 0625	TPD 2T 0825	Unit	Remarks
Sensitive Area	A	1.2 x 1.2	1.2 x 1.2	mm	Absorber Area
Thermopile Resistance	R_{TP}	50…110	70…120	kΩ	25°C
Responsivity	R	33	32	V/W	500°K / 1Hz / Without IR-filter
Sensitivity (Tdet 25 °C / Tobj 40 °C)	S_{40}	115	112	µV/K	With standard filter (LWP, cut-on 5.5 µm)
Sensitivity (Tdet 25 °C / Tobj 100 °C)	S_{100}	155	151	µV/K	With standard filter (LWP, cut-on 5.5 µm)
Time Constant	t	27	10	ms	
Noise Voltage	V_n	36	38	nV/√Hz	25°C
Specific Detectivity	D*	1.1	1.1	10^8 cm√Hz/W	25°C
Temp. Coefficient of Resistance	TC_{RTP}	0,03	0,03	%/K	
Temp. Coefficient of Responsivity	T_{CR}	-0,05	-0,05	%/K	
Field of view	FoV	87	87	Degrees	at 50% intensity points
Thermistor resistance (25°C)	R_{25}	100	100	kΩ	25 °C
Thermistor BETA-value	β	3964	3964	K	defined at 25 °C / 100 °C

Handling

Infrared Sensors are Optical devices and require careful handling in production. As to mechanical recommendations:

- Avoid dropping the devices on the production flow.
- Avoid physical force to detector leads, do not bend leads unless necessary.
- Ensure leads are not damaged when manipulating them.

Electrostatic discharges may destroy the detectors. It is recommended to apply the standard precautions for ESD sensitive devices to prevent potential damage.

The detector windows are optical filters with multi-layer coatings.

- Avoid touching the detector window. To clean windows, use only ethyl alcohol with a cotton swab.
- Do not expose Detectors to chemical fluids such as Freon, Trichloroethylene and other aggressive detergents.

Environmental Conditions

With the construction of metal can and spectral window inserted into the can by a special durable epoxy, the detectors are sealed and tested for long-term enclosure. The detector will pass He-leakage test with maximum leakage rate specification of $5x10^{-8}$ mbar ls-1. Detectors shall not increase noise or change responsivity when exposed to maximum of 95% relative humidity at 30°C.

- Avoid long-term storage at high humidity with high temperatures.

As IR detectors are optical sensors, avoid condensation effects on the detector. Operation below dew points may affect the performance.

Reliability Standards

Excelitas' continuous reliability qualification and monitoring program ensures that all outgoing products meet quality and reliability standards. Tests are performed according to approved semiconductor device standards, such as IEC, MIL, and JDEC (see table). For detailed information please contact Excelitas.

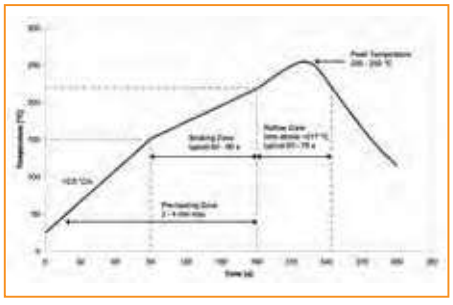
Quality and Reliability Standards

Excelitas strives to meet applicable quality and reliability standards. We are certified ISO 9001:2015 and operate at established SPC and TQM. We are proud to operate under Environmental Management System according to ISO 14001:2015 and the Occupational Safety and Health Management System according to OHSAS 18001: 2007.

All devices employing PCB assemblies are manufactured according IPC-A-610 class 2 guidelines.

Excelitas Thermal Infrared Sensor product line is certified for ANSI/ESD S.20.20:2014.

In case of questions please feel free to contact us for the latest update on our current certificates and forms. Our continuous qualification and reliability program ensures that all products meet the specified performance criteria.



As to outgoing inspection, all devices have to pass 100% testing of major parameters and gross leak in acc. to MiL Std. 883 m 1014C1. Due to high-volume production individual data are not protocolled or stored, statistical data are kept for reference.

Soldering of SMD Devices

The TPiD 1S and TPiS 1S series are lead-free components and fully comply with the RoHS regulations, especially with existing roadmaps of lead-free soldering. Reflow soldering is recommended. A typical lead free reflow profile is shown in figure 4. Specific reflow soldering parameters depend on the solder alloy used.

The device meets MSL1 at 245 °C according to JEDEC standard.

Soldering Conditions

For the soldering of the detectors within PCBs, the typically applied and recommended process is wave soldering. During the automatic wave solder process we strongly advise to restrict preheating to avoid heat exposure through the detector window, if necessary apply a protection cap. When the detector is directly exposed to the radiation of such heaters the detector shall be protected from that heat. Manual soldering is also possible when maintaining similar temperature profiles.

Reflow soldering is not possible for TO housing versions of our detectors. For our range of SMD housing detectors please reference the recommended solder profile.

Pyro Detectors

Pyro Detectors	Analog /Digital	TO5	TO39	SMD	Wall Mount	Ceiling Mount	Gas Monitor	Supply
Dual Element Detectors								
PYD 1398	A1	X			X			2-10V
PYD 1388	A1	X			X			2-10V
PYD 1378	A1	X			X			2-10V
PYD 1798	D1	X			X			3.0V
PYD 1798	D1	X			X			1.8V
PYD 1788	D1	X			X			3.0V
PYD 1598	D1	X			X			1.8V
PYD 1588	D1	X			X			1.8V
PYD 2592	D1			X	X			1.8V
PYD 1794	D1		X		X			3.0V
PYD 2792	D1			X	X			1.8V
Quad Element Detectors								
PYQ 2498	A2	X			X			2-10V
PYQ 1398	A1	X				X		2-10V
PYQ 5448	A2	X				X		2-10V
PYQ 1348	A1	X				X		2-10V
PYQ 1748	D1	X				X		3.0V
PYQ 1548	D1	X				X		1.8V
PYQ 5848	D2	X				X		3.0V
PYQ 2898	D2	X			X			3.0V
Gas Detectors								
PYS 3198	A1						X	2-10V
PYS 3398	A1						X	2-10V
PYS 3428	A2						X	2-10V

Thermopile Detectors

Thermopile Detectors and Sensors	Analog / Digital	TO5	TO39	TO46	SMD	Temp Monitor	Gas Monitor	Presence Detection
TPD 1T 0122 L3.0	A			X		X		
TPD 1T 0122	A			X		X		
TPD 1T 0223	A			X		X		
TPiD 1T 0224	A		X			X		
TPiD 1T 0624	A		X			X		
TPD 1T 0226 IRA	A	X				X		
TPiD 1T 0226 L5.5	A	X				X		
TPiD 1T 0122B	A			X		X		
TPiD 1T 0222B	A			X		X		
TPiD 1T 0622B	A			X		X		
TPiD 1S 0121	A				X	X		
TPiD 1S 0222	A				X	X		
TPiS 1S 1051	D				X	X		
TPiS 1S 1252	D				X	X		
TPiS 1T 1252B	D			X		X		
TPiS 1T 1254	D		X			X		
TPiS 1T 1256 L5.5	D	X				X		
TPiS 1S 1385	D				X			X
TPiS 1S 0185	D				X			X
TPiS 1T 1086 L5.5	D	X				X		
TPiS 1T 0186 L5.5	D	X				X		
TPiS 1T 1084	D		X			X		
TPM 1T 0134 M	A		X			X		
TPiM 1T 0136 L5.5	A	X				X		
TPD 1T 0623	A			X			X	
TPD 1T 0823	A			X			X	