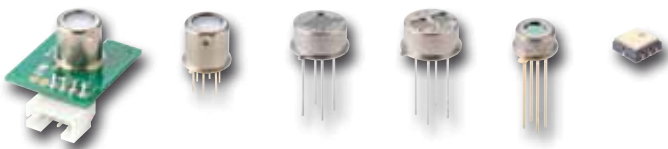


## Infrared Sensing

For Secure Homes, Healthier Families  
and Energy Savings



For a Healthier, Cleaner  
and Safer Tomorrow.

**EXCELITAS**  
TECHNOLOGIES

# Infrared Sensing Technologies

## For a Healthier, Cleaner and Safer Tomorrow.

Excelitas' infrared sensing technologies are playing a vital role in creating a healthier, cleaner and safer tomorrow. Excelitas has gained worldwide recognition for the design and production of high performance pyroelectric detectors, thermopile detectors and sensor modules which – every day – contribute to safeguarding homes, saving energy, and providing comfort. From motion and presence detection to gas detection, thermometry and indoor climate control applications, Excelitas' IR sensing technology and growing product range are meeting your challenges. We are sensing what you need – for the better.

**Sensing what you need –  
from motion sensors for secure homes  
to gas detection systems,  
indoor climate control systems and  
ear thermometers.**

### **Our Infrared Sensing Solutions provide**

- Excellent performance
- Strong reliability
- Innovative features

### **We support our products with**

- Application expertise
- Suitable features and functions
- Special optical filters for gas sensing

### ■ **WORLDWIDE COMMITMENT TO YOUR CHALLENGES**

You can depend on Excelitas' world-class global network of production, R&D, and distribution centers including Montreal, Canada; Wiesbaden, Germany; Singapore; Batam, Indonesia; and Shenzhen, China. We have customer service hubs on each continent to ensure just-in-time delivery. We believe in forging an intimate partnership in which we are communicating proactively with you and refining our forecasts of your requirements to better serve you.

We have the detection technologies and capabilities needed to enhance and accelerate your OEM designs. Our R&D groups are focusing on new products and capabilities for your new and emerging applications. We pride ourselves on deep applications expertise to respond to and anticipate your detection requirements. Feel confident that you can discuss your requirements with our engineers. We thrive on the your challenges and will always try to assist you with sincere assistance based on our know-how and experience.

### ■ **UNPARALLELED QUALITY**

The consistent quality of our products is the foundation for which we build our relationship with you. The global adoption of our detectors in a host of consumer products as well as medical, industrial and commercial applications is testimony to our quality commitment and to your confidence in us.

We implement cutting-edge quality assurance system and measures; SPC and reliability testing are standard procedures at Excelitas. Of course, everything begins with the quality of our raw materials. Inspection procedures transcend all processes and conclude with 100% final inspection for all major parameters. We maintain our certification to major quality and environmental standards, which are subject to regular audits. All of our factories have received certifications for ISO 9001, OHSAS 18001, NLF/ILO-OSH 2001.

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## Sensing for your daily life

1 2

### Home Appliances

Our infrared components enable healthy and safe food processing in microwave ovens, electric cooking hobs, refrigerators and exhaust hoods.





3 4 5 6

### Indoor Home Comfort and Security

Our infrared detectors monitor presence, switch lights, control air conditioning systems and trigger intrusion alarms, contributing to both more secure homes and energy savings.

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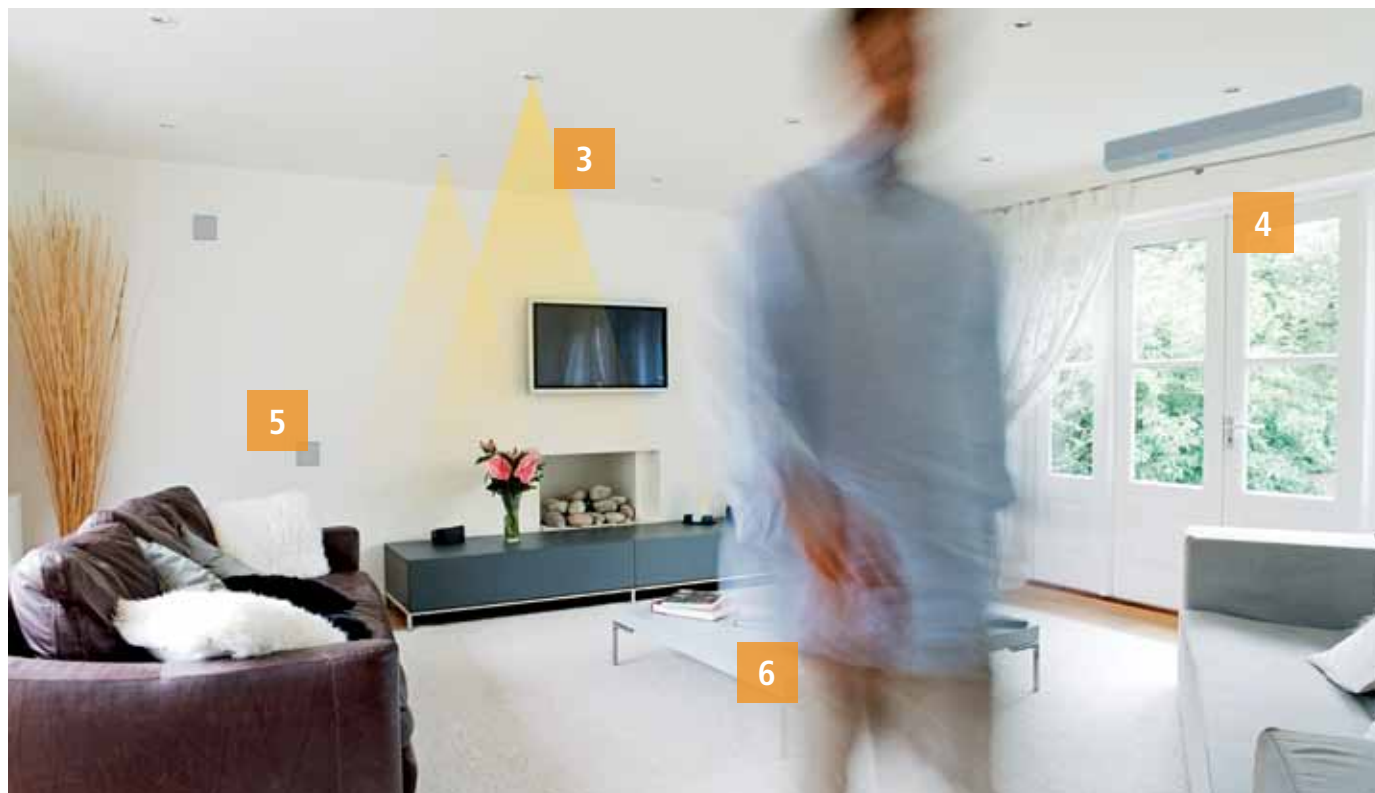
### Thermometry for Healthier Families

Excelitas infrared detectors are used in ear thermometers and forehead thermometry. Similar systems are used in pyrometry to measure temperature at a distance.









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### Energy Conservation and Safety

Our infrared detectors for presence detection are not only making environments safer but also contributing actively to reduction in carbon dioxide emissions.



## Selection Guide Infrared Sensors

Selection Guide					
Application	Requirement	Feature	Remark	Type	Page
Intrusion alarm	RF immunity	White light protection	Analog standard	LHi 968, PYD 1398	12 
Intrusion alarm		Four element, dual channel	Analog standard	PYQ 1488, LHi 1148	13 
Motion sensing	RF immunity	Four element, triple channel	DigiPyro®	PYQ 5868	21 
Motion sensing		Dual element		LHi 778, LHi 878, PYD 1388	14 
Motion sensing	Low profile	Dual element		LHi 874, LHi 944	15 
Motion sensing	Small dimensions	TO-46 housing		PYD 5131	17 
Motion sensing	RF immunity	Small housing, incl.T <sub>ref</sub>	DigiPyro®	PYD 5731	18 
Motion sensing	RF immunity	Standard dual	DigiPyro®	PYD 1978, PYD 1788, PYD 1798	19 
Motion sensing	Dual channel	Four element	DigiPyro®	PYQ 2898	20 
Motion sensing	Miniaturization	Dual element, integr. processing	Smart DigiPyro®	PYD1096	22 
Motion sensing	Miniaturization	Four element, integr. processing	Smart DigiPyro®	PYQ1098	23 
Ceiling mount	Unique FoV	Four element	Single output	LHi 1128, PYQ 1398	16 
Gas monitoring	Narrow band filters	Single channel	Analog standard	LHi 807 TC	24 
Gas monitoring	Narrow band filters	Low noise	Analog	PYS 4198	24 
Gas monitoring	Reference filter	Temp. comp. dual channel	Analog standard	PYS 3228	25 
Gas monitoring	RF immunity	Temp. comp. dual channel	EMI protection	PYS 3428	25 
Gas monitoring	Narrow band filters	Dual channel	DigiPyro®	PYS 3828	26 
Gas monitoring	Narrow band filters	Single channel	DigiPyro®	PYS 3798	27 
Gas sensing	Narrow band filters	Single channel		TPD 1T 0525	28 
Gas sensing	Narrow band filters	Single channel		TPD 1T 0625	28 
Gas sensing	Reference filter	Dual channel		TPD 2T 0625	29 
Gas sensing, measurement	Narrow band filters	Single channel	Small housing	TPD 333	32 
Gas sensing, measurement	Narrow band filters	Single channel	Small housing	TPD 733	32 
Measurement	High S/N ratio	Round aperture, thermistor		TPD 1T 0224	30 
Measurement	High S/N ratio	Round aperture, thermistor		TPD 1T 0524	30 
Measurement	High S/N ratio	Round aperture, thermistor		TPD 1T 0624	30 
Measurement	Small target area	Integral optics		TPD 1T 0626 IRA	31 
Measurement	Small target area	Integral optics		TPD 1T 0626 L5.5	31 
Measurement	Excellent thermal shock perf.	Round aperture, thermistor	Isothermal	TPiD 022B	34 
Ear thermometry	Excellent thermal shock perf.	Round aperture, thermistor	Isothermal	TPiD 012B	34 
Ear thermometry		Round aperture, thermistor	Small housing	TPD 1T 0120, TPD 0122	35 
Non-contact measurement	Integrated signal processing	Round aperture	Fully calibrated	TPS 1T 0134	36 
Non-contact measurement	Integrated signal processing	Integral optics	Fully calibrated	TPS 1T 0136 L5.5	36 
Non-contact measurement	Integrated signal processing	Integral optics	Fully calibrated	TPS 1T 0136 IRA	36 
Non-contact measurement	Integrated signal processing	Pcb w connector	Fully calibrated	TPM 1T 0136 L5.5	40 
Non-contact measurement	Integrated signal processing	Pcb w connector	Fully calibrated	TPM 1T 0134 P(x) M(y)	40 
Presence detection	High spatial resolution	Pcb w connector, integral optics	Multi pixel line	TPiL 8T 2146 L3.9	42 
Presence detection	High spatial resolution	Pcb w connector, integral optics	Multi pixel array	TPiA 16T 4146 L3.9	42 

## Infrared Basics

All solid bodies when having temperatures above the absolute zero ( $-273^{\circ}\text{C}$ ) emit electromagnetic waves. The range of longer wavelengths beyond the visual spectrum is referenced as infrared radiation. The scientist Wilhelm Wien (1864 – 1928) described the relation between a solid body's temperature and its emitting peak wavelength by following equation:

$$\lambda_{\max} = 2898/T$$

$T$  = Temperature in K (Kelvin)

$\lambda$  = Wavelength in  $\mu\text{m}$

Using this law we can calculate the specific peak emission wavelength of any material or body: A human body, of a surface temperature of approx.  $35^{\circ}\text{C}$  or  $308\text{ K}$  gives a peak wavelength of  $9.4\mu\text{m}$ ; a cat of  $38^{\circ}\text{C}$  temperature gives  $9.3\mu\text{m}$ . According to Max Planck (1858 – 1947) the intensity curve of all emitted wavelengths for a solid body is rather broad. For our example above this means we cannot distinguish human beings from the cat by their infrared spectrum.

For various temperatures of an ideal black body radiator the intensity curves of radiated energy versus wavelength are shown in graph 1.

A hot body of  $2000\text{ K}$  emits a lot of energy, some in the visible light range (it glows red or white-hot), some in the infrared. A body of  $500\text{ K}$  emits

radiation in the invisible part of the spectrum, the infrared range, which we can feel, but not see.

### Infrared Detectors

With detectors for the infrared spectrum there are two major types classified by their physical principles: photon detectors and thermal detectors. Photon detectors convert radiation directly into electrons, thermal detectors receive radiation, using it to raise the temperature of a 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, whereas thermal detectors have a broad response from below visible light up to over  $100\mu\text{m}$ . Fitted with special infrared windows as spectral filters they can work in the mid to far infrared range without ambient visible light interference.

### Optical Properties

With respect to optical parameters of detectors and sensors, there are some interesting items to be mentioned: the optical bandwidth, transmission and blocking characteristics of the optical filter and, as major selection criteria, the sensor field of view, and performance of the detector within the field of view. The corresponding charts are given for the various sensors and types.

### Filters for Infrared Sensors

The spectral range of sensitivity for thermal detectors is defined by the filter window. Common applications in infrared reference wavelengths use from  $2$  to  $20\mu\text{m}$ . Infrared windows for pyrometric applications exploit the atmospheric window of  $5$ – $14\mu\text{m}$ , which is served by our standard filter. Long range pyrometers apply a sharp cut-on/cut-off window of  $9$ – $14\mu\text{m}$  (G9) as per graph 2. For the special application of gas sensing 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.

In graph 2 we show the light transmittance graph for standard infrared window and the pyrometric window "G9". As to narrow band infrared filters, the range of available filters and specifications is given in table 1.

Graph 2

#### Broad Band Filters

Infrared Filters  
Transmittance (%)

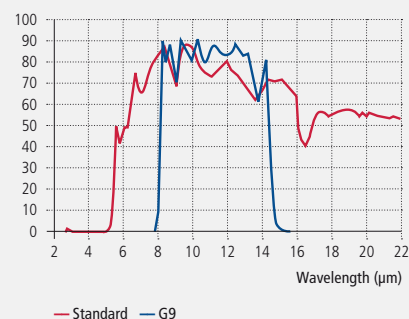


Table 1

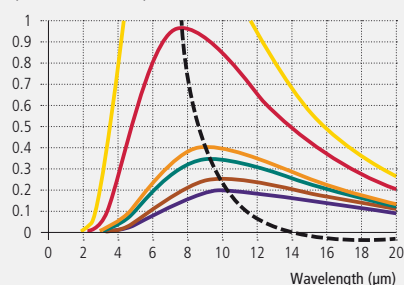
#### Narrow Band Filters

Filter Type	Application	CWL $\mu\text{m}$	HPB $\text{nm}$
G1	CO	4.64	180
G2	CO <sub>2</sub>	4.26	180
G2.2	CO <sub>2</sub>	4.43	60
G2.5	CO <sub>2</sub>	4.33	160
G2.6	N <sub>2</sub> O	4.53	85
G3	CO+CO <sub>2</sub>	4.48	4.79
G4	NO	5.3	180
G5	HC	3.35 - 3.4	190
G5.1	HC	3.46	163
G5.2	HC	3.28 - 3.31	160
G5.3	HC	3.09	160
G5.5	HC	3.32 - 3.34	160
G5.6	HC	3.42 - 3.451	160
G5.7	HC	3.30 - 3.32	160
G5.9	HC	3.375 - 3.4	190
G7.1	FREON R12	11.3	200
G7.2	FREON R134a	10.27	210
G7.3		12.4	180
G20	Reference	3.95	90

Graph 1

#### Radiated Energy vs. Wavelength

Spectral Radiance ( $\text{kJ}/\mu\text{m}$ )



Black Body Temperature

— 150°C — 100°C Boiling Point H<sub>2</sub>O — 40°C  
— 32°C Human Skin — 10°C — 0°C Melting Point H<sub>2</sub>O  
--- Wien's Displacement Law

## Pyroelectric Infrared Detectors

### Pyroelectric Effect

Since ancient times the pyroelectric effect has been known as a property of ferroelectric materials. It is based on a specific behavior of dielectric materials, the phenomenon of a permanent electrical polarization. When changing temperature of such materials, this polarization will increase, or decrease, so we observe a charge displacement. This pyroelectric effect is the basic principle for detectors that can recognize temperature variations. The characteristic value for the permanent polarization, called the pyroelectric coefficient, disappears above the Curie point. The Curie temperature limits the operation temperature range for such detectors. Pyroelectric detectors do not require cooling.

### Detector Design

Within our detectors, a thin slice of pyroelectric material is fitted with electrodes to form a capacitor. Incoming radiation will generate extremely low levels of thermal energy, so the pyroelectric current flow is rather small. It needs a circuit to convert this small current into a convenient signal. The traditional analog detectors apply a high ohmic resistor and a special low-leakage current FET to transform the high impedance of the detector material to a common output resistance. The pyroelectric element's capacitance and the high gate resistance of the FET form an RC circuit, as per graph 3, with a time constant of approx.

1 s., which makes the detector suitable for very low frequencies. Excelitas is the first to having introduced digital technology to pyroelectric detectors with its DigiPyro® family. Here, a special ADC circuit provides amplification, A/D conversion and interfacing to the outside electronics.

### Detector Construction

The pyroelectric material is placed on a special pc-board which provides thermal and mechanical isolation for the delicate pyroelectric material and provides space for the gate resistor and the FET. The connections are made either by wire bonding or conductive bonding. The whole pc-board is placed on to a TO header and closed with a TO cap, which has the relevant optical filter window. The window possesses a special infrared transmission characteristic, selected for the detector application.

### Pyro Characteristics

The most important electrical data of the IR-sensor are its responsivity, balance and noise. Sometimes it is also useful to refer to NEP or  $D^*$ .

### Responsivity

The responsivity shows bandpass characteristics with a maximum at approx. 0.1 Hz radiation modulation. A typical curve "responsivity versus frequency" is indicated below as graph 4.

Responsivity is measured in V/W by means of a defined black body radiator. Responsivity refers to the active sensor area and is usually tested at 1 Hz modulation frequency unless specified differently.

### Balance

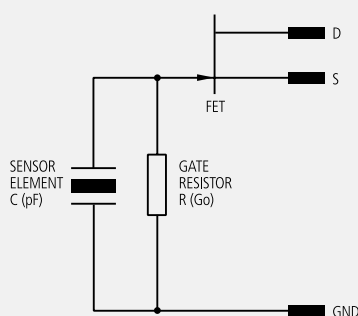
The balance of a dual element detector indicates the common mode rejection also called matching between the two elements. It is an important value for the performance of dual element detectors, applied in motion applications, as it is a measure for distinguishing between moving and fixed objects. It can be specified either in V/W or in % of responsivity.

### Noise

The noise of the sensor consists of three parts: The basic thermal noise of the sensing material, the (Johnson) noise of the high ohmic resistor and the input noise of the FET. The total output of these three parts is rather stable for temperatures below 40° C. Above this temperature, noise increases exponentially with temperature as can be observed with typical active electronic components. Noise is given in  $\mu V$  peak-to-peak or zero-peak. Similar to the dependence of responsivity on frequency, the noise values decrease with frequency from approx. 0.15 Hz to 50 Hz., as per graph 5.

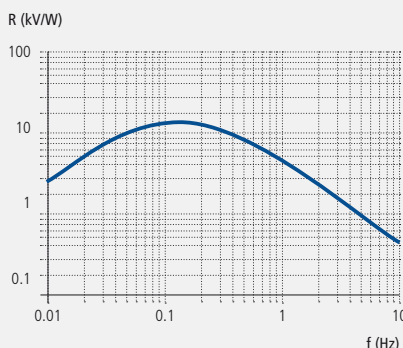
Graph 3

#### Electrical Configuration



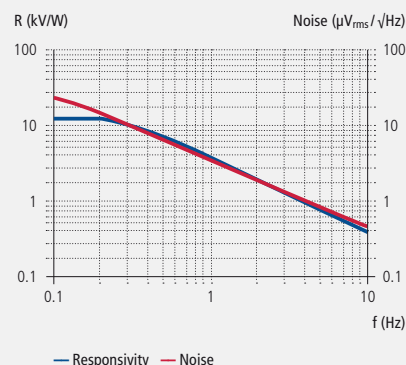
Graph 4

#### Transfer Function



Graph 5

#### Responsivity, Noise vs. Frequency





### Digital Pyrodetectors – A New Family

Pyroelectric detectors are AC type devices and give signals upon change of received infrared radiation. Until today, all available detectors are analog, i.e. they provide an analog signal output. Excelitas is the first to introduce a family of detectors which differ from previous generations by offering a digital signal output.

With the DigiPyro® family Excelitas is offering digital detectors for all these applications and configurations.

#### 1.1 Integrated Electronics

The DigiPyro® series integrates the first stages of circuitry into the detector housing: Amplification of the signal, then the A/D conversion, which needs a voltage reference. Following an internal 10 Hz digital low pass filter the serial interface provides for the “direct link” communication which has a one wire bidirectional communication feature. The whole concept runs using its own internal oscillator, which determines the speed of the internal process. The direct link feature enables the user to have the host  $\mu$ C request the information and its response, so the host controls the communication speed.

#### 1.2 From Analog to Digital

The DigiPyro® series is the first pyroelectric detector family to display information in Bit form as opposed to mV signals of analog detectors.

To give a measure for comparisons of traditional detectors to digital versions, the rule of thumb for signal levels versus bit information can be used:

- Resolution:  $1 \text{ LSB} \approx 6.5 \mu\text{V}$
- Range: 0 to 16383 Counts  $\approx \pm 53.6 \text{ mV}$
- DC Offset: 8192 Counts  $\approx 53.6 \text{ mV}$
- Noise: 6 Counts  $\approx 39 \mu\text{V}$  (with bandpass)

In typical motion electronics the expected signal voltages range from 100  $\mu\text{V}$  to mV values, so the digital signal may range up to approx. 100 bit-count. In gas detection, the output range of analog detectors is up to 2 mV, so the digital output may range up to 20 bit-count. It is most obvious that the dynamic range of the digital detector is wider than these mentioned levels and covers many other applications.

#### 1.3 Digital Zero Signal Line

As the pyroelectric effect generates positive and negative signal amplitudes, the detector circuitry needs an electrical offset to be able to process such signals. In all analog circuitry this value is the offset voltage, which is usually subtracted after the first amplifier stage.

With DigiPyros, the amplification is included already, and the internal voltage reference provides for the required offset. As to the user this offset appears as a digital zero line at about 8000 bit-count, it may vary in series from one part to

the next. To recognize the zero line of the individual detector, the user may either use a digital bandpass or subtract the measured offset from the signal.

#### 1.4 The Host Needs to Filter the Signal

The DigiPyro® does not include any processing intelligence inside, unlike most analog pyrodetectors the DigiPyro® uses a direct communication with the hosting microcontroller without any analog hardware filtering (only the previously mentioned low-pass filter). Thus it becomes necessary to implement all necessary filtering by software filters within the hosting microprocessor of the unit.

### Applications for Pyroelectric Detectors

Pyroelectric detectors had originally been designed as single element types for non-contact temperature measurement. During further research, dual element types were developed with multi-facet mirrors or Fresnel lenses entering the field of motion detection, starting as passive intrusion alarm (burglar alarm, PIR), followed by automatic light switches and security lights and lamps. The same concept is also applied with some automatic door openers.

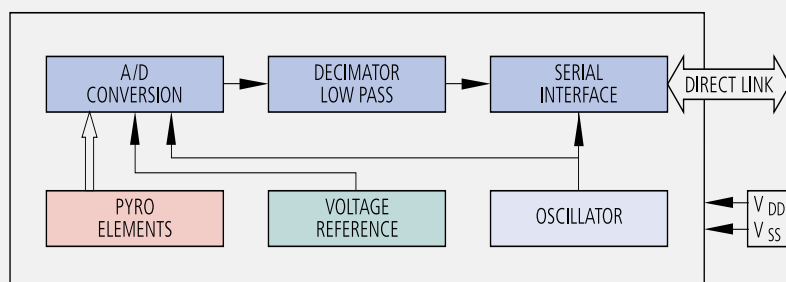
Today the environment and its protection is one of our most serious concerns. Features and instrumentation are required to measure and monitor all kinds of gas in our environment. One of the methods applied is the NDIR technique, a principle of measuring gas concentration by its absorption properties in the infrared range. Our detectors and sensors are a vital part of making our environment safer, more secure and healthy.

Most PIR motion detecting devices have been designed around dual element types, more advanced units apply four element “quad” type configurations.

For gas sensing single element with narrow band filters are applied in single or dual channel configuration.

Graph 6

DigiPyro®



## Thermopile Detectors and Sensors

### The Thermoelectric Effect

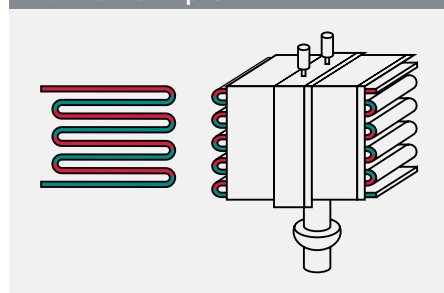
The thermoelectric effect today is known as reverse to the Peltier – or Seebeck effect. By applying a temperature difference to two junctions of two dissimilar materials A and B, a voltage  $U$  which is proportional to the temperature difference is observed.

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 thermoelectric- or Seebeck-coefficient. 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 thermocouples.

Graph 7

#### Nobili's Thermopile

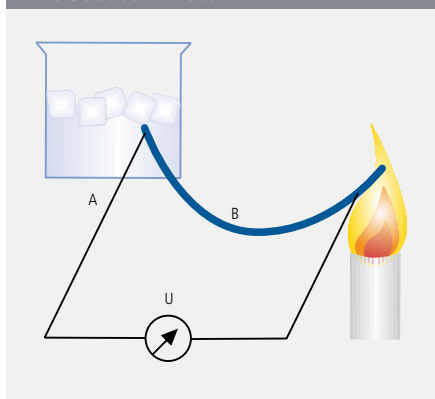


### Excelitas Thermopile Design

Our thermopile sensors are based on the technology of silicon micromachining. The central part of a silicon chip is removed by an etching process, leaving on top only a  $1\ \mu\text{m}$  thin sandwich layer (membrane) of  $\text{SiO}_2/\text{Si}_3\text{N}_4$ , which has low thermal conductivity. Onto this membrane thin conductors of two different thermoelectric materials (to form thermocouples) are deposited. Both conductors have alternatively junctions in the center of the membrane (hot junctions) and on the bulk part of the silicon substrate (cold junctions). A special IR-absorption layer covers the hot junctions creating the sensor's sensitive area.

Graph 8

#### The Seebeck Effect



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.

### Thermopile Detector Construction

The sensor chip is mounted in good thermal contact on to a TO or SMD header. A transistor cap with infrared filter seals the sensor chip from the environment.

Excelitas' product portfolio includes detectors of various sizes, housings and infrared windows, and integrated sensors which include electronics that provide temperature compensation and calibration to a certain measurement range.

Excelitas offers unique constructions to deal with the thermal shock, referenced as ISO-thermal types.

### Advantages

Thermopile detectors can sense continuous infrared radiation, thus they offer simpler design possibility for infrared measurements.

### Thermopile Characteristics

The most important properties of the thermopile sensor are its responsivity, noise, field of view, response time, and for calibrated sensors, the temperature range.

### Responsivity

The responsivity shows low pass characteristics with a cut off at approx. 30 Hz.

Responsivity is measured in Volt per Watt by means of a defined black body radiator. Responsivity data is usually quoted with respect to the active detector area, without the infrared filter. The data show the responsivity value, tested at 1 Hz modulation frequency.

### Noise

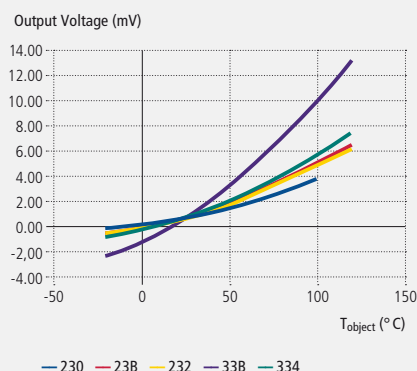
The noise of the detector is dominated by the Johnson noise due to the resistance of the thermopile. Noise is given as RMS value in  $\text{nV}/\sqrt{\text{Hz}}$ .

### Sensitivity

The data tables also mention sensitivity, as a characteristic output voltage versus target temperature at  $25^\circ\text{C}$  environmental temperature. The data are given with standard IR filter as per graph 2. Two parameters are given:  $S(25/40)$  is  $25^\circ\text{C}$  environment,  $40^\circ\text{C}$  Black Body target and  $S(25/100)$ , which is  $25^\circ\text{C}$  environment,  $100^\circ\text{C}$  Black Body target. Sensitivity is depending on the field of view of the detector construction and its filter characteristics. An example can be seen in graph 9 for selected TPS series.

Graph 9

#### Sensitivity vs. Target Temperature



## Thermistor

As temperature reference the thermopile detectors include a thermistor which senses the ambient or case temperature.

## Reference Temperature Sensor

For exact measurements the temperature of the detector housing (cold thermopile contacts) must be known. A 30kOhm or 100kOhm 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:

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

$R_T$  NTC resistance in  $\Omega$  at temperature  $T$  in K

$R_R$  NTC resistance in  $\Omega$  at rated temperature  $T_R$  in K

$T$  Temperature in K

$T_R$  Rated temperature in K (25°)

$B$  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.

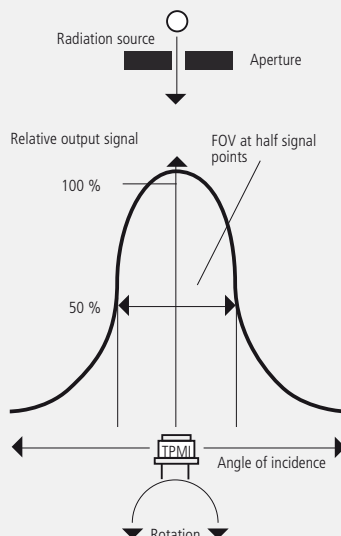
## The Field of View

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 describe the dependence of signal from incident angles.

Graph 10

## Field of View



The TPMI® family is available with different options on optical cap assemblies. We provide housing with aperture opening and filter window only, or with an infrared lens or also with integral mirror.

Such optical features define the viewing angle or as per definition the Field of View (FOV) of the sensor.

The FOV is defined as the difference of the incidence angles that allow the sensor to receive 50 % relative output signal, see also figure shown here, which is a sketch of a testing principle.

	Symbol	Parameter	Min	Typ	Max	Unit
<b>Lens Type (L5.5)</b>						
	FOV	Field of view		7	12	°
	OA	Optical axis		0	±3.5	°
	D:S	Distance to spot size ratio		8:1		
<b>Integral Reflector Type (IRA)</b>						
	FOV	Field of view		15	20	°
	OA	Optical axis		0	±2	°
<b>Standard Aperture Type</b>						
	FOV	Field of view		70	80	°
	OA	Optical axis		0	±10	°

## Temperature Range

Excelitas offers sensors which include pre-amplification, ambient temperature compensation and calibration within a specific temperature range.

## Thermopile Arrays

Further to its range of detectors and sensors, Excelitas offers line arrays and spatial arrays based on thermopile technology.

## 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 the application of measuring surface temperatures without contact. In many industrial process control units thermopile sensors are used to monitor temperature or to serve as overheating protection feature, all without contact to the hot object.

The thermopile technology is also suited for domestic appliances such as food monitoring during automated defrosting, warming-up or cooking.

As with our pyrodetectors, the thermopile detectors with specific filter windows are used as sensing components making our environment safer, more secure and healthy.

# PYROELECTRIC DUAL ELEMENT DETECTORS FOR INTRUSION ALARM

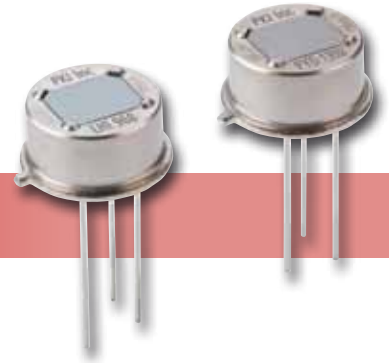
## LHi 968, PYD 1398 – High-End Pyro

### Applications

- Intrusion alarm
- High-end motion sensors

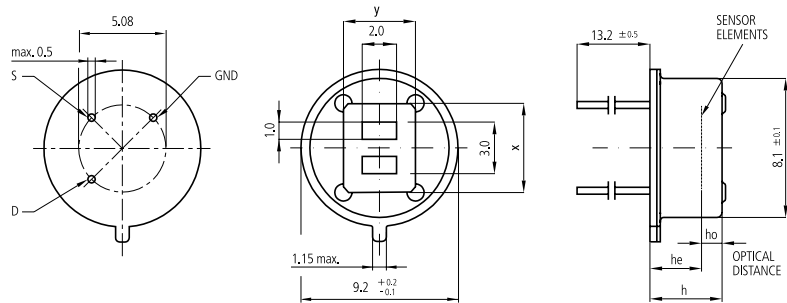
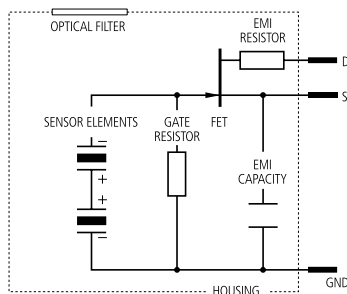
### Features and Benefits

- TO-5 metal housing
- Improved EMI protection
- Improved WLI



### Product Description

The LHi 968 series with standard Dual Element configuration is performance-proven in high-end applications. The LHi 968 design provides for a reduced sensitivity to EMI and excellent White Light Immunity (WLI). The PYD 1398 has higher RF immunity and is optionally available with grading for lower white light sensitivity.



All dimensions in mm

## LHi 968, PYD 1398 – High-End Pyro

Parameter	Symbol	LHi 968	PYD 1398	Unit	Remark
Responsivity, min.	$R_{min}$	3.3	3.3	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R_{typ}$	4.0	4.0	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	10	%	
Noise, max.	$N_{max}$	50	50	$\mu\text{V}_{pp}$	$0.4 \dots 10 \text{ Hz} / 20^\circ \text{C}$
Noise, typ.	$N_{typ}$	20	20	$\mu\text{V}_{pp}$	$0.4 \dots 10 \text{ Hz} / 20^\circ \text{C}$
Spec. detectivity	$D^*$	19	19	$10^7 \text{ cm}^* \sqrt{\text{Hz/W}}$	$1 \text{ Hz} / 1 \text{ Hz BW} / 20^\circ \text{C}$
Field of view, horizontal	FoV	$100^\circ$	$100^\circ$		Unobstructed
Field of view, vertical	FoV	$100^\circ$	$100^\circ$		Unobstructed
Source voltage		0.2 - 1.5	0.2 - 1.5	V	$47 \text{ k}\Omega / 20^\circ \text{C} / 5 \text{ V}$
Operating voltage		2.0 ... 12	2.0 ... 12	V	$47 \text{ k}\Omega / 20^\circ \text{C}$
EMI performance		***	****		
WLI		***	****		
Height	h	4.2	4.2	mm	
Optical element location	he / ho	2.6 / 0.95	2.6 / 0.95	mm	
Filter size	X / Y	5.2 / 4.2	5.2 / 4.2	mm	

\*\*\* Improved, \*\*\*\* Excellent



# PYROELECTRIC FOUR ELEMENT DETECTORS FOR INTRUSION ALARM

PYROELECTRIC DETECTORS FOR INTRUSION ALARM ■

## LHi 1148, PYQ 1488 – High-End Pyro

### Applications

- Intrusion alarm
- Dual channel systems
- High-end motion sensors

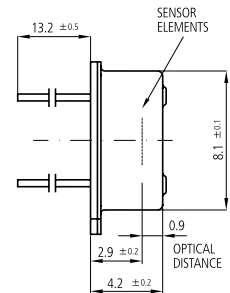
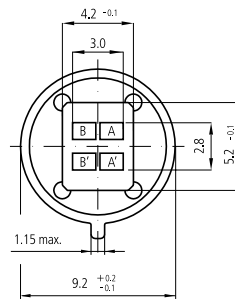
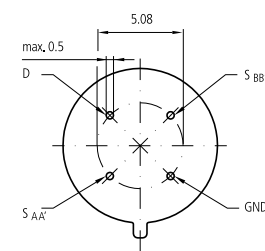
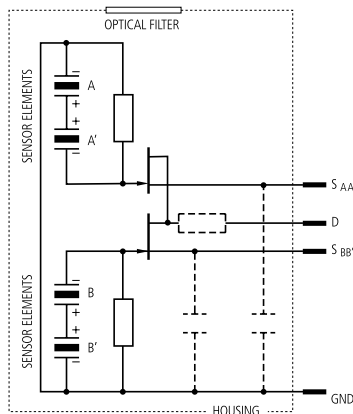
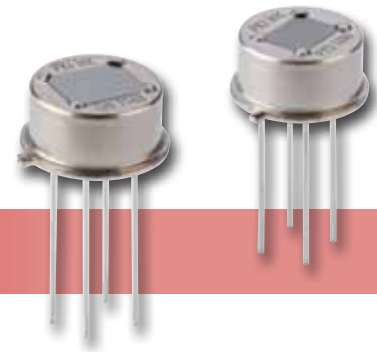
### Features and Benefits

- TO-5 metal housing
- Dual channel
- Reverse/equal polarity
- RF protection option

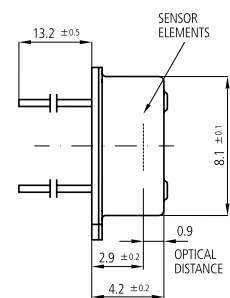
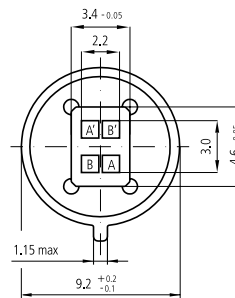
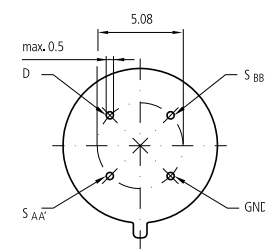
### Product Description

The LHi 1148 series with four element “Quad” configuration offers two independent dual element signals with opposite polarity. This enables separate signal processing option for the two channels to reduce common-mode RF influence and thermal effects.

For ceiling mount applications, we offer the PYQ1488 which has the dual element pairs arranged in a diagonal geometrical arrangement. This enables presence detection without any preference of direction.



LHi 1148



PYQ 1488

All dimensions in mm

## LHi 1148, PYQ 1488 – High-End Pyro

Parameter	Symbol	LHi 1148	PYQ 1488	Unit	Remark
Responsivity, min.	$R_{min}$	4.3	6.0	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R$	5.9	8.0	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	15	10	%	
Noise, max.	$N_{max}$	75	100	$\mu V_{pp}$	0.4...10 Hz / 20° C
Noise, typ.	$N_{typ}$	30	40	$\mu V_{pp}$	0.4...10 Hz / 20° C
Spec. detectivity	$D^*$	16	14	$10^7 \text{ cm}^* \sqrt{\text{Hz/W}}$	1 Hz / 1 Hz BW / 20° C
Field of view, horizontal	FoV	110°	75°		Unobstructed
Field of view, vertical	FoV	70°	58°		Unobstructed
Source voltage		0.2 - 1.5	0.2-1.5	V	47 k $\Omega$ / 20° C / 5 V
Operating voltage		2.0 ... 12	2.0 ... 12	V	47 k $\Omega$ / 20° C

# PYROELECTRIC DUAL ELEMENT DETECTORS FOR MOTION SENSING

PYROELECTRIC DETECTORS FOR MOTION SENSING ■

## LHi 778, LHi 878, PYD 1388 – Low Cost Pyro

### Applications

- Auto light switch
- Wall switch
- Auto lamps

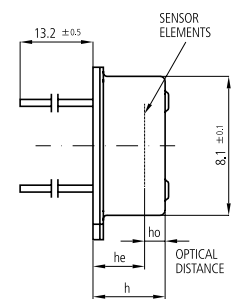
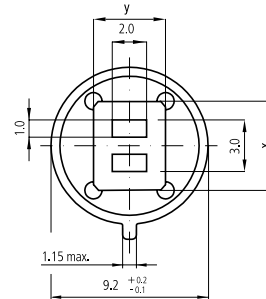
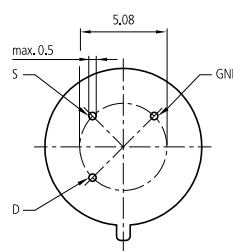
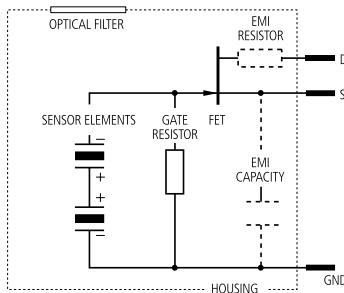
### Features and Benefits

- TO-5 metal housing
- Different window sizes
- EMI protection for PYD1388



### Product Description

This low cost Dual Element detector range offers standard TO-5 housings with different window sizes. The LHi 778 has a smaller window for minimal cost. The PYD1388 has an additional EMI protection option.



All dimensions in mm

## LHi 778, LHi 878, PYD 1388 – Low Cost Pyro

Parameter	Symbol	LHI 778	PYD 1388	LHI 878	Unit	Remark
Responsivity, min.	$R_{min}$	3.3	3.3	3.3	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R_{typ}$	4.2	4.2	4.2	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	10	10	%	
Noise, max.	$N_{max}$	50	50	50	$\mu V_{pp}$	$0.4 \dots 10 \text{ Hz} / 20^\circ \text{C}$
Noise, typ.	$N_{typ}$	20	20	20	$\mu V_{pp}$	$0.4 \dots 10 \text{ Hz} / 20^\circ \text{C}$
Spec. detectivity	$D^*$	20	20	20	$10^7 \text{ cm}^2 \cdot \sqrt{\text{Hz/W}}$	$1 \text{ Hz} / 1 \text{ Hz BW} / 20^\circ \text{C}$
Field of view, horizontal	FoV	$71^\circ$	$95^\circ$	$95^\circ$		Unobstructed
Field of view, vertical	FoV	$71^\circ$	$87^\circ$	$87^\circ$		Unobstructed
Source voltage		0.2 - 1.55	0.2 - 1.55	0.2 - 1.55	V	$47 \text{ k}\Omega / 20^\circ \text{C} / 5 \text{ V}$
Operating voltage		2.0 ... 12	2.0 ... 12	2.0 ... 12	V	$47 \text{ k}\Omega / 20^\circ \text{C}$
EMI performance		*	**	**		
WLI			**	*		Excelitas tester
Height	h	4.2	4.2	4.2	mm	
Optical element location	$h_e / h_o$	3.2/0.75	3.2/0.75	3.2/0.75	mm	
Filter size	X/Y	4/3	4.6/3.4	4.6/3.4	mm	

\* Improved, \*\* Excellent

# PYROELECTRIC DUAL ELEMENT DETECTORS FOR MOTION SENSING

PYROELECTRIC DETECTORS FOR MOTION SENSING ■

## LHi 874, LHi 944 – Low Profile Pyro

### Applications

- Auto light switch
- Wall switch
- Auto lamps with 180° FOV using 2 detectors

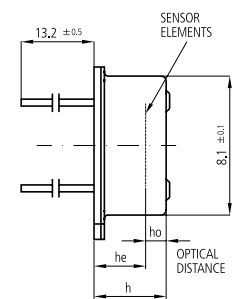
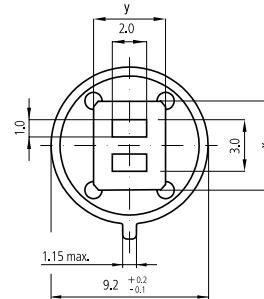
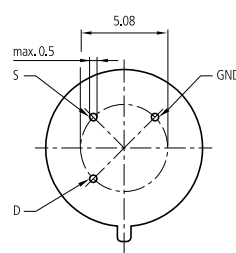
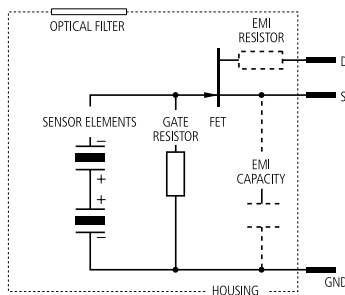
### Features and Benefits

- TO-39 metal housing
- Different window sizes
- EMI protection option



### Product Description

These low profile TO-39 detectors are very well suited with two detectors arranged in one common sensing unit for up to 180 degree view, with an EMI protection in LHi 944.



All dimensions in mm

## LHi 874, LHi 944 – Low Profile Pyro

Parameter	Symbol	LHi 874	LHi 944	Unit	Remark
Responsivity, min.	R <sub>min</sub>	3.3	3.3	kV/W	f = 1 Hz
Responsivity, typ.	R <sub>typ</sub>	4.2	4.2	kV/W	f = 1 Hz
Match, max.	M <sub>max</sub>	10	10	%	
Noise, max.	N <sub>max</sub>	50	50	μV <sub>pp</sub>	0.4...10 Hz / 20° C
Noise, typ.	N <sub>typ</sub>	20	20	μV <sub>pp</sub>	0.4...10 Hz / 20° C
Spec. detectivity	D*	20	20	10 <sup>7</sup> cm <sup>2</sup> √Hz/W	1 Hz / 1 Hz BW / 20° C
Field of view, horizontal	FoV	95°	110°		Unobstructed
Field of view, vertical	FoV	87°	110°		Unobstructed
Source voltage		0.2-1.55	0.2-1.55	V	47 kΩ / 20° C / 5 V
Operating voltage		2.0...12	2.0...12	V	47 kΩ / 20° C
EMI performance		**	**		
WLI		*	*		Excelitas tester
Height	h	3.2	3.2	mm	
Optical element location	he / ho	2.2 / 0.75	2.2 / 0.75	mm	
Filter size	X / Y	4.6 / 3.4	5.2 / 4.2	mm	

\* Improved, \*\* Excellent

# PYROELECTRIC FOUR ELEMENT DETECTORS FOR CEILING MOUNT

PYROELECTRIC DETECTORS FOR MOTION SENSING ■

## LHi 1128, PYQ 1398

### Applications

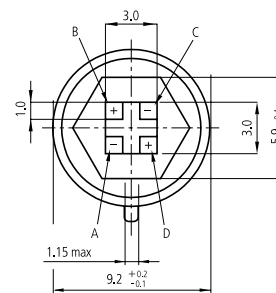
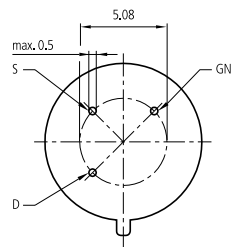
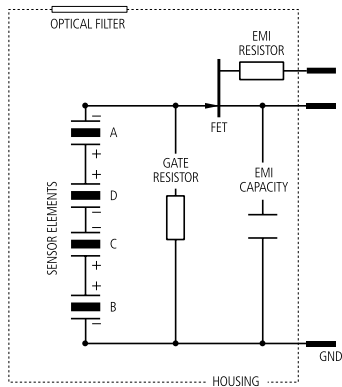
- Ceiling mount alarms
- Ceiling mount light switch

### Features and Benefits

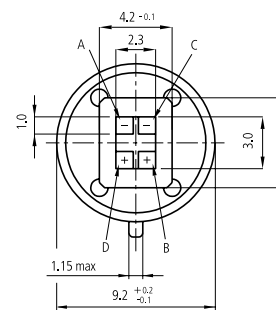
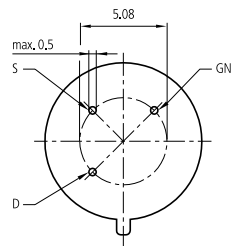
- TO-5 metal housing
- Different window sizes
- Single channel output

### Product Description

This series of four element "Quad" detectors provides all four elements connected to one common output. This configuration enables specific applications in ceiling mount location when applied with suitable lens or mirror optics designs. Two different window options are provided: Large window or standard rectangular window size. For better EMI protection, the built-in capacitor option is available.



LHi 1128



PYQ 1398

All dimensions in mm

### LHi 1128, PYQ 1398

Parameter	Symbol	LHi 1128	PYQ 1398	Unit	Remark
Responsivity, min.	$R_{min}$	5.4	5.4	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R$	6.5	6.5	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	15	%	
Noise, max.	$N_{max}$	100	100	$\mu\text{V}_{pp}$	0.4...10 Hz / 20° C
Noise, typ.	$N_{typ}$	30	40	$\mu\text{V}_{pp}$	0.4...10 Hz / 20° C
Spec. detectivity	$D^*$	8	14	$10^7 \text{ cm}^2 \cdot \sqrt{\text{Hz}} / \text{W}$	1 Hz / 1 Hz BW / 20° C
Field of view, horizontal	FoV	156°	103°		Unobstructed
Field of view, vertical	FoV	125°	97°		Unobstructed
Source voltage		0.2 - 1.55	0.2 - 1.55	V	47 k $\Omega$ / 20° C / 5 V
Operating voltage		2.0 ... 12	2.0 ... 12	V	47 k $\Omega$ / 20° C



# MINIATURIZED DUAL ELEMENT PYRODETECTORS FOR MOTION SENSING



## PYD 5131 – Analog Pyro

### Applications

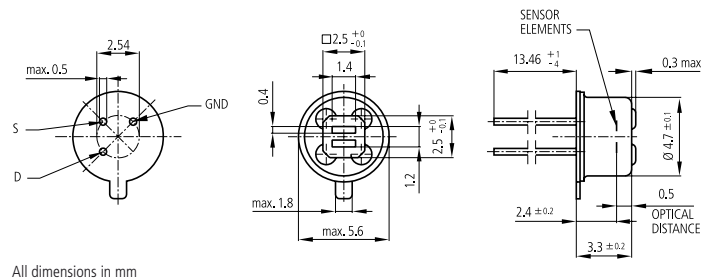
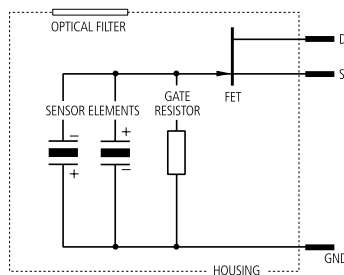
- Auto light switch
- Wall switch

### Features and Benefits

- TO-46 metal housing

### Product Description

This range of pyrodetectors features a miniaturized Dual Element pyro in TO-46 housing. The small housing in connection with a reduced element size and spacing provides potential for reduced-size optics and thus smaller, more discrete, motion detection unit designs.



### PYD 5131 – Analog Pyro

Main Parameter	Symbol	PYD 5131	Unit	Remark
Responsivity, min.	$R_{min}$	9.0	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R_{typ}$	12.3	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	%	
Noise, max.	$N_{max}$	180	$\mu\text{V}_{pp}$	0.4...10 Hz / 20° C
Noise, typ.	$N_{typ}$	75	$\mu\text{V}_{pp}$	0.4...10 Hz / 20° C
Source voltage		0.2 ... 1.5	V	47 k $\Omega$ / 20° C / 5 V
Field of view, horizontal	FoV	99°		Unobstructed
Field of view, vertical	FoV	88°		Unobstructed
Operating voltage		2.0 ... 12.0	V	47 k $\Omega$ / 20° C

# MINIATURIZED DUAL ELEMENT PYRODETECTORS FOR MOTION SENSING



## PYD 5731 – DigiPyro®

### Applications

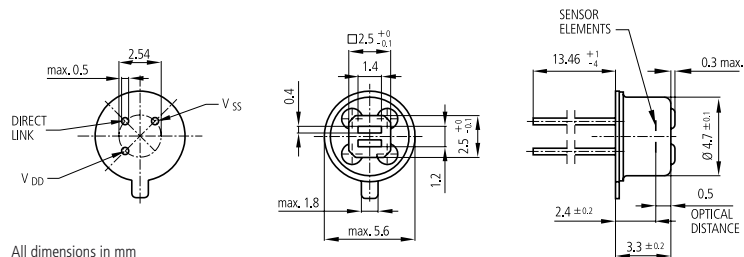
- Auto light switch
- Wall switch

### Features and Benefits

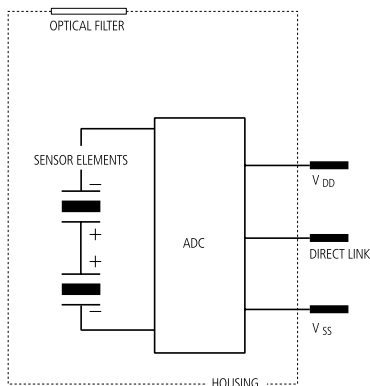
- TO-46 metal housing

### Product Description

With the PYD 5731 Excelitas extends the emerging DigiPyro® family to bring all-digital processing to miniaturized detector designs. The PYD 5731 offers the same direct link interface as the regular PYD 1998 DigPyro®. It features a miniaturized Dual Element pyro in TO-46 housing.



All dimensions in mm



### PYD 5731 – DigiPyro®

Main Parameter	Symbol	PYD 5731	Unit	Remark
Responsivity, min.	$R_{min}$	6.0	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R_{typ}$	9.0	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	%	
Noise	$N$	180	$\mu V_{pp}$	
Field of view, horizontal	FoV	99°		Unobstructed
Field of view, vertical	FoV	88°		Unobstructed
Operating voltage	$V_{DD}$	2.7 ... 3.6	V	
Supply current	$I_{DD}/I_{DDmax}$	10/15	$\mu A$	$V_{DD} = 3.3 \text{ V}$
<b>Digital Data</b>				
Serial interface update time	$t_{REP}$	2/13	ms	speed/interrupt
ADC resolution		14	Bits	Max. count = $2^{14}-1$
Output data format		2 x 14	Bits	
ADC sensitivity		6 ... 7	$\mu V/\text{count}$	
ADC output offset		7000 ... 9200	Counts	
ADC output offset	typ.	8192	Counts	
<b>Temperature Reference</b>				
Gain (temperature)		80	Counts/K	-20° C to +80° C
Linearity		-5 ... +5	%	-20° C to +80° C
<b>Filter</b>				
Digital filter cut off		10	Hz	

# DIGITAL DUAL ELEMENT PYROS FOR MOTION SENSING

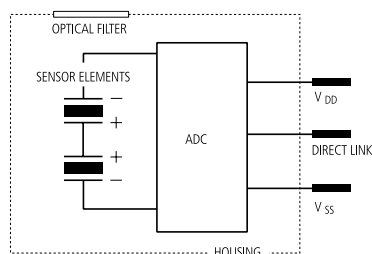
## PYD 1788, PYD 1798 – DigiPyro®

### Applications

- Passive intrusion alarm
- Auto light switch
- Auto lamps

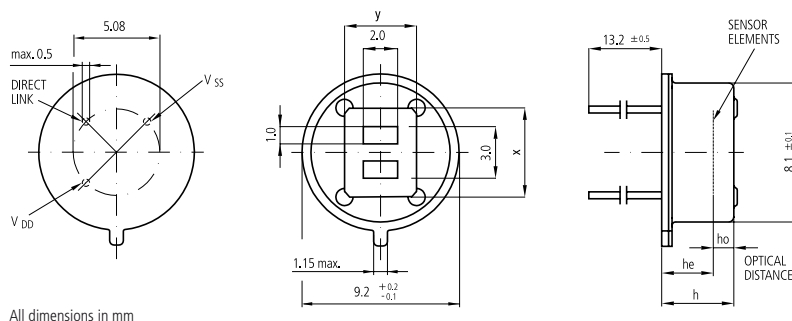
### Features and Benefits

- TO-5 metal housing
- Digital direct link
- Different window sizes
- Excellent EMI protection



### Product Description

The DigiPyro® detector range in TO-5 housing includes 3 variations of Dual Element types, each with a different window size. The element configurations are identical, as well as the internal electronic circuits. Whereas the PYD 1778 represents the lower-cost version with a small window, the PYD 1798 is provided as the superior type in terms of White Light Immunity (WLI) performance and field of view. The output signals are communicated in one 15-bit digital bit stream output via a single wire “direct link” connection to a suitable host microprocessor.



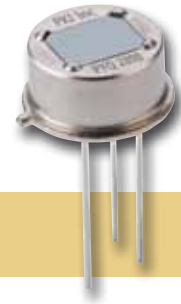
All dimensions in mm

## PYD 1788, PYD 1798 – DigiPyro®

Parameter	Symbol	PYD 1798	PYD 1788	Unit	Remark
Responsivity, min.	$R_{min}$	3.3	3.3	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R$	4	4	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	10	%	
Noise	$N, N_{max}$	78/20	78/20	$\mu V_{pp}$	unobstructed
Field of view, horizontal	FoV	110°	95°		unobstructed
Field of view, vertical	FoV	110°	90°		Excelitas tester
WLI		***	**		
Height	$h$	4.2	4.2	mm	
Optical element location	$he/h_o$	3.1/0.7	3.1/0.7	mm	
Filter size	$X/Y$	5.2/4.2	4.6/3.4	mm	
<b>Digital Data</b>					
Operating voltage	$V_{DD}$	2.7 ... 3.6	2.7 ... 3.6	V	
Supply current	$I_{DD}$	10	10	$\mu A$	$V_{DD} = 3.3 \text{ V}$
	$I_{DDmax}$	15	15	$\mu A$	$V_{DD} = 3.3 \text{ V}$
Serial interface update time	$t_{REP}$	2/13	2/13	ms	speed/interrupt
ADC resolution		14	14	Bits	
Output data format		2x14	2x14	Bits	MSB first
ADC sensitivity		6 ... 7	6 ... 7	$\mu V/\text{count}$	
ADC output offset		7000 ... 9200	7000 ... 9200	Counts	
ADC output offset, typ.		8192	8192	Counts	

\* Standard, \*\* Improved, \*\*\* Excellent

# DIGITAL PYROELECTRIC FOUR ELEMENT DETECTORS FOR MOTION SENSING



## PYQ 2898 – DigiPyro® Dual Channel

### Applications

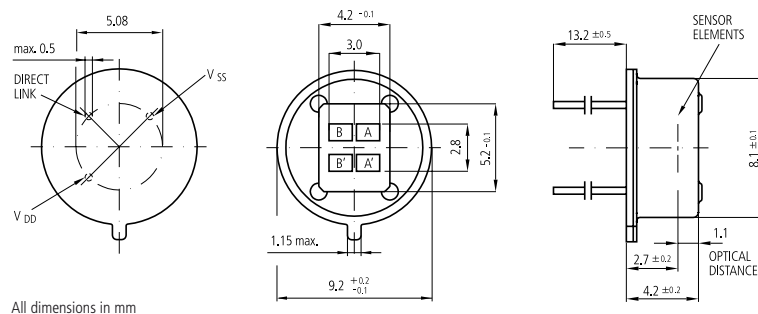
- Passive intrusion alarm
- High-end motion sensing
- Ceiling mount sensors

### Features and Benefits

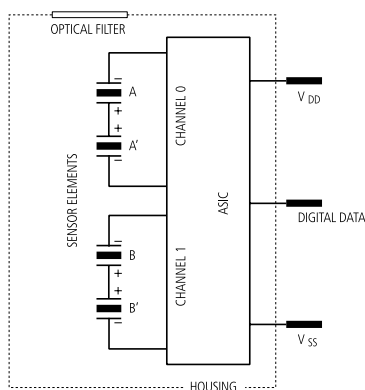
- Digital direct link
- Excellent EMI protection

### Product Description

This family of DigiPyro® detectors in TO-5 housing includes serial signal output, which provides two signal outputs of the 2 element pairs and an additional temperature reference signal. All 3 channels are part of one 42-bit digital bit stream output via a single wire “direct link” connection to a suitable host microprocessor.



All dimensions in mm



### PYQ 2898 – DigiPyro® Dual Channel

Main Parameter	Symbol	PYQ 2898	Unit	Remark
Responsivity, min.	$R_{min}$	3.5	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R$	4.5	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	%	
Noise, max. / typ.		80 / 30	$\mu V_{pp}$	0.4 ... 10 Hz / 20° C
Field of view, horizontal	FoV	96°		Unobstructed
Field of view, vertical	FoV	56°		Unobstructed
Operating voltage	$V_{DD}$	2.7 ... 3.6	V	
Supply current	$I_{DD}$	10	$\mu A$	$V_{DD} = 3.3 \text{ V}$
	$I_{DDmax}$	15	$\mu A$	$V_{DD} = 3.3 \text{ V}$
<b>Digital Data</b>				
Serial interface update time	$t_{REP}$	2/14	ms	speed/interrupt
ADC resolution		14	Bits	Max. count = $2^{14}-1$
Output data format		3 x 14	Bits	
ADC sensitivity		6.1 ... 7	$\mu V/\text{count}$	
ADC output offset		7000 ... 9200	Counts	
ADC output offset, typ.		8192	Counts	
<b>Temperature Reference</b>				
Gain (temperature)		80	Counts/K	-20° C to +80° C
Linearity		-5 ... +5	%	-20° C to +80° C
<b>Filter</b>				
Digital filter cut off		8	Hz	



# DIGITAL PYROELECTRIC FOUR ELEMENT DETECTORS FOR MOTION SENSING



## PYQ 5868 – DigiPyro® Dual Channel

### Applications

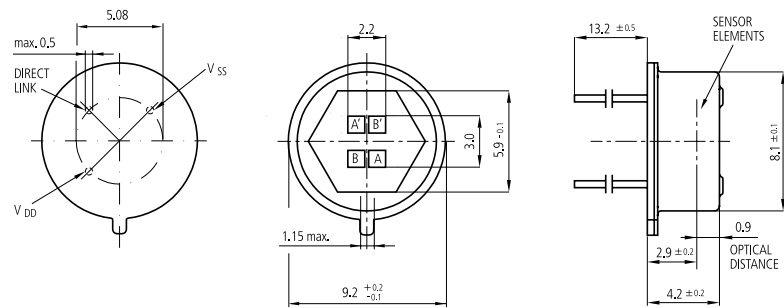
- Passive intrusion alarm
- High-end motion sensing
- Ceiling mount sensors

### Features and Benefits

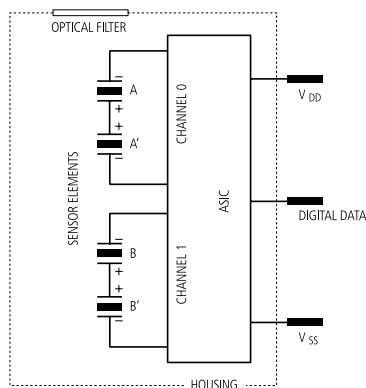
- Digital direct link
- Different element configurations
- Excellent EMI protection

### Product Description

The PYQ 5868 series with “Quad” configuration offers two independent dual element signals in a diagonal geometric arrangement. For ceiling mount applications with suitable ceiling mount design optics, this enables separate signal processing for the two channels to provide signal levels independent of movement direction. The PYQ 5868 offers a wide field of view due to its large window.



All dimensions in mm



### PYQ 5868 – DigiPyro® Dual Channel

Main Parameter	Symbol	PYQ 5868	Unit	Remark
Responsivity, min.	$R_{min}$	6.0	kV / W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R$	8.0	kV / W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	%	
Noise, max. / typ.		100 / 40	$\mu V_{pp}$	0.4 ... 10 Hz / 20° C
Field of view, horizontal	FoV	110°		Unobstructed
Field of view, vertical	FoV	110°		Unobstructed
Operating voltage	$V_{DD}$	2.7 ... 3.6	V	
Supply current	$I_{DDmax}$	10	$\mu A$	$V_{DD} = 3.3 \text{ V}$
<b>Digital Data</b>				
Serial interface update time	$t_{REP}$	2/14	ms	speed/interrupt
ADC resolution		14	Bits	Max. count = $2^{14}-1$
Output data format		3 x 14	Bits	
ADC sensitivity		6.1 ... 7	$\mu V/\text{count}$	
ADC output offset		7000 ... 9200	Counts	
ADC output offset, typ.		8192	Counts	
<b>Temperature Reference</b>				
Gain (temperature)		80	Counts/K	-20° C to +80° C
Linearity		-5 ... +5	%	-20° C to +80° C
<b>Filter</b>				
Digital filter cut off		10	Hz	

# SMART PYROELECTRIC DETECTORS FOR SIMPLE MOTION SENSING

PYROELECTRIC DETECTORS FOR MOTION SENSING ■



## PYD 1096 – Dual Element “Smart DigiPyro®”

### Applications

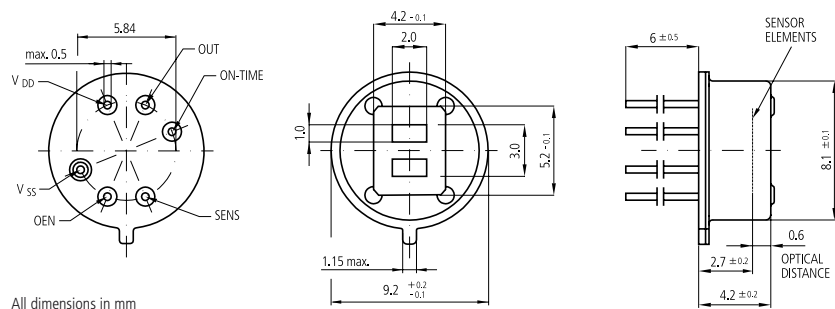
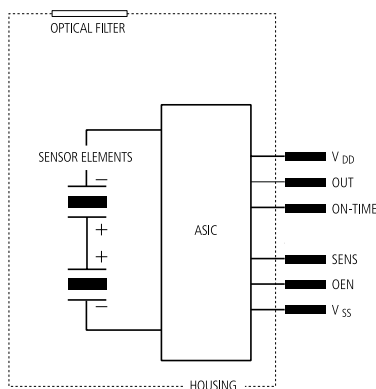
- Simple motion switches
- Auto light switch
- Wall switch

### Features and Benefits

- TO-5 metal housing
- All electronics included

### Product Description

The Smart DigiPyro® series offers a complete motion detector solution, with all electronic circuitry built into the detector housing. Only a power supply and power-switching components need to be added to make the entire motion switch, a timer is included. The series has versions which can include ambient light level and sensitivity adjustments.



### PYD 1096 – Dual Element “Smart DigiPyro®”

Parameter	Symbol	PYD 1096	Unit	Remark
Responsivity, min.	$R_{min}$	3.3	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R$	4.0	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	%	
Noise, max.		80	$\mu V_{pp}$	0.4 ... 10 Hz / 20° C
Field of view, horizontal	FoV	110°		Unobstructed
Field of view, vertical	FoV	110°		Unobstructed
Operating voltage	$V_{DD}$	2.7 ... 3.3	V	
Supply current	$I_{DDmax}$	150	$\mu A$	$V_{DD} = 3.3 \text{ V}$
<b>Digital Data</b>				
ADC sensitivity		6 ... 7	$\mu V/\text{count}$	
Sensitivity threshold		84 ... 672	$\mu V_p$	In steps of m 42 $\mu V$ ; m(2, ..., 16)
On-time		2 ... 4096	s	
OEN (ambient light control)		$0.8 \cdot V_{DD}$	V	
Output driving current		1	$\mu A$	
<b>Filter, Signal Processing</b>				
Digital filter, cut on		0.44	Hz	
Digital filter, cut off		7	Hz	

# SMART PYROELECTRIC DETECTORS FOR SIMPLE MOTION SENSING

PYROELECTRIC DETECTORS FOR MOTION SENSING ■



## PYQ 1098 – Four Element "Smart DigiPyro®"

### Applications

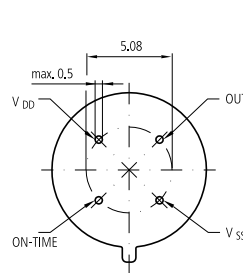
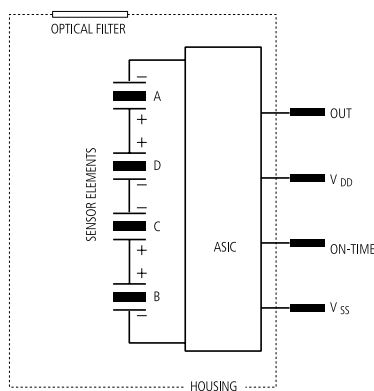
- Simple motion switches
- Auto light switch
- Wall switch

### Features and Benefits

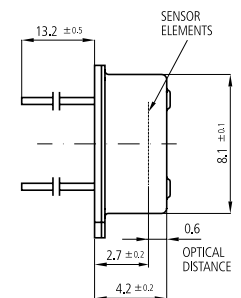
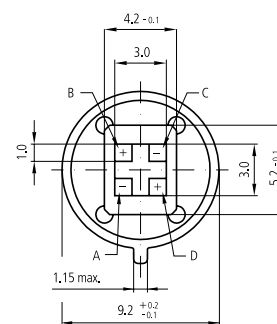
- TO-5 metal housing
- All electronics included

### Product Description

The Smart DigiPyro® series offers a complete motion detector solution, with all electronic circuitry built into the detector housing. Only a power supply and power-switching components need to be added to make the entire motion switch, a timer is included. The series has versions which can include ambient light level and sensitivity adjustments.



All dimensions in mm



### PYQ 1098 – Four Element "Smart DigiPyro®"

Parameter	Symbol	PYQ 1098	Unit	Remark
Responsivity, min.	$R_{min}$	3.3	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R$	4.0	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	%	
Noise, max.		80	$\mu V_{pp}$	$0.4 \dots 10 \text{ Hz} / 20^\circ \text{ C}$
Field of view, horizontal	FoV	$115^\circ$		Unobstructed
Field of view, vertical	FoV	$70^\circ$		Unobstructed
Operating voltage	$V_{DD}$	$2.7 \dots 3.3$	V	
Supply current	$I_{DDmax}$	150	$\mu A$	$V_{DD} = 3.3 \text{ V}$
<b>Digital Data</b>				
ADC sensitivity		$6 \dots 7$	$\mu V/\text{count}$	
Sensitivity threshold		120	$\mu V_p$	
On-time		$2 \dots 4096$	s	
OEN (ambient light control)		-	V	
Output driving current		1	$\mu A$	
<b>Filter, Signal Processing</b>				
Digital filter, cut on		0.44	Hz	
Digital filter, cut off		7	Hz	

# SINGLE ELEMENT PYROS FOR GAS MONITORING



## LHi 807, PYS 4198 – High Sensitivity Pyro

### Applications

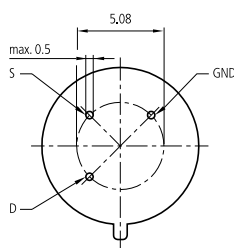
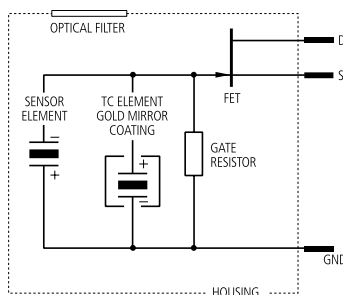
- Gas sensing and monitoring

### Features and Benefits

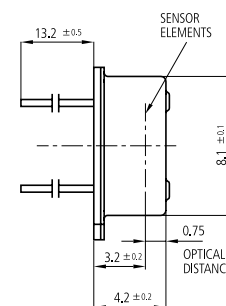
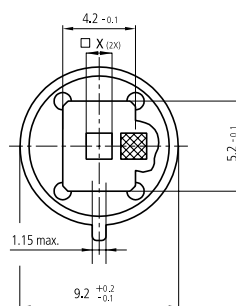
- TO-5 metal housing
- Selection of narrow band filters
- Thermal compensation

### Product Description

The LHi 807 TC series has become a standard solution for gas-sensing applications. It is available with a range of narrow band filters, as specified on page 7 of this catalog for various gas species. The LHi 807 is usually supplied with temperature compensation by a separate “blind” sensing element. Similar features and benefits are included with the PYS 4198 which has large element size of 2 x 2 to offer more signal for non-focused optical systems. It is offered with the thermal compensation element for compensation of thermal effects caused by temperature changes of the housing.



All dimensions in mm



### LHi 807, PYS 4198 – High Sensitivity Pyro

Parameter	Symbol	LHI 807 TC	PYS 4198 TC	Unit	Remark
Responsivity, min.	$R_{min}$	2.2	1.2	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R$	3.5	2.0	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	-	-	%	
Noise, max.	$N_{max}$	50	50	$\mu V_{pp}$	
Noise, typ.	$N_{typ}$	15	10	$\mu V_{pp}$	$0.4 \dots 10 \text{ Hz} / 20^\circ \text{C}$
Spec. detectivity	$D^*$	17	23	$10^7 \text{ cm}^2 \cdot \text{Hz} / \text{W}$	$0.4 \dots 10 \text{ Hz} / 20^\circ \text{C}$
Field of view, horizontal	FoV	$135^\circ$	$126^\circ$		
Field of view, vertical	FoV	$122^\circ$	$105^\circ$		
Source voltage		0.2 ... 1.5	0.2 ... 1.5	V	$47 \text{ k}\Omega / 20^\circ \text{C} / 5 \text{ V}$
Height	$h$	4.2	4.2	mm	
Optical element location	$he / ho$	3.2 / 0.75	2.9 / 1.1	mm	
Filter size	$X / Y$	5.2 / 4.2	5.2 / 4.2	mm	



# PYRODETECTORS FOR GAS MONITORING AND MEASURING



## PYS 3228, PYS 3428 – Dual Channel Pyro

### Applications

- Gas sensing and monitoring

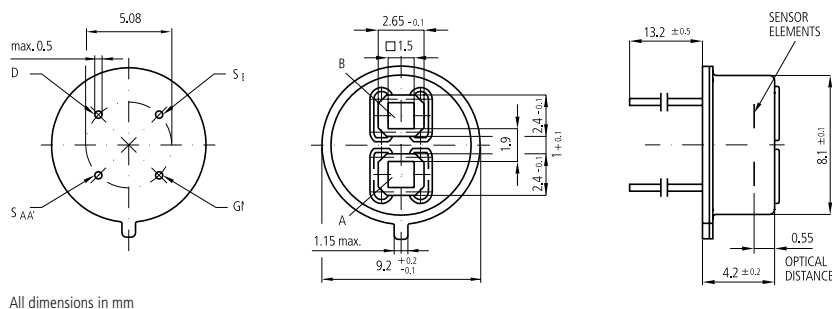
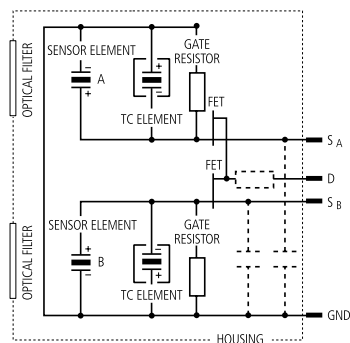
### Features and Benefits

- TO-5 metal housing
- Dual channel output
- Each channel with individual filter window
- Selection of narrow band pass filters
- Thermal compensation option
- EMI protection option

### Product Description

As successor of the LHi 814 series the PYS 3228 dual channel detectors have become standard for gas sensing applications, with two individual elements of size 1.5 x 1.5 and additional temperature compensation. They are available with a range of narrow band pass filters, as specified on page 7 in combination with a reference filter.

The same features are included with the PYS 3428, which offers additional EMI protection by internal capacitors.



### PYS 3228, PYS 3428 – Dual Channel Pyro

Parameter	Symbol	PYS 3228	PYS 3428	Unit	Remark
Responsivity, min.	R <sub>min</sub>	2.2	3.5	kV/W	f = 1 Hz
Responsivity, typ.	R	3.5	5.0	kV/W	f = 1 Hz
Match, max.	M <sub>max</sub>	-	-	%	
Noise, max.	N <sub>max</sub>	50	50	μV <sub>pp</sub>	
Noise, typ.	N <sub>typ</sub>	15	20	μV <sub>pp</sub>	0.4...10 Hz / 20° C
Spec. detectivity	D*			10 <sup>7</sup> cm <sup>2</sup> ·√Hz/W	0.4...10 Hz / 20° C
Field of view, horizontal	FoV	77	77		
Field of view, vertical	FoV				
Source voltage			0.2 ... 1.5	V	47 kΩ / 20° C / 5 V
EMI performance			***		
Height	h	4.2	4.2	mm	
Optical element location	he / ho	/ 0.55	/ 0.55	mm	
Filter size	X / Y	2.65 / 2.4	2.65 / 2.4	mm	

# PYRODETECTORS FOR GAS MONITORING AND MEASURING



## PYS 3828 – Dual Channel DigiPyro®

### Applications

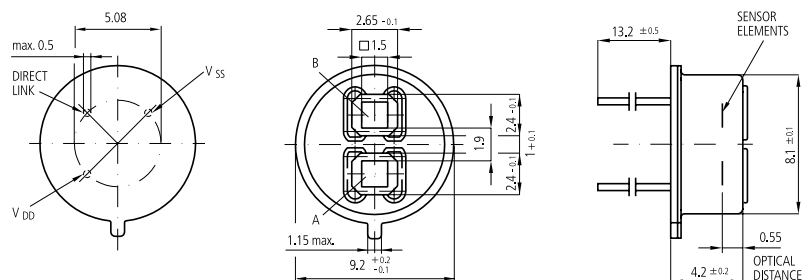
- Gas sensing and monitoring

### Features and Benefits

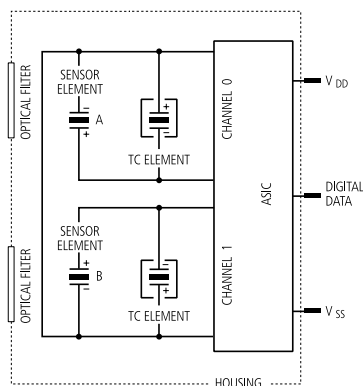
- Digital output
- Two optical channels
- Temp. reference channel
- Temperature compensated elements
- Selection of narrow band pass filters
- TO-5 metal housing

### Product Description

Excelitas extends the family of DigiPyro® detectors to applications in gas sensing. This series includes a special triple channel version, in which two channels having their individual optical (narrow band) windows and an additional temperature reference signal are provided. All 3 channels are output in one 42-bit digital bit stream communicated via a single wire “direct link” interface to a suitable host microprocessor.



All dimensions in mm



### PYS 3828 – Dual Channel DigiPyro®

Main Parameter	Symbol	PYS 3828	Unit	Remark
Responsivity, min.	$R_{min}$	3.3	kV/W	$f = 1 \text{ Hz}$
Responsivity, typ.	$R$	4	kV/W	$f = 1 \text{ Hz}$
Match, max.	$M_{max}$	10	%	
Noise, max.		80	$\mu V_{pp}$	0.4 ... 10 Hz / 20° C
Field of view, horizontal	FoV	70°		Unobstructed
Field of view, vertical	FoV	85°		Unobstructed
Operating voltage	$V_{DD}$	2.7 ... 3.6	V	
Supply current	$I_{DD}$	12	$\mu A$	$V_{DD} = 3.3 \text{ V}$
	$I_{DDmax}$	15	$\mu A$	$V_{DD} = 3.3 \text{ V}$
<b>Digital Data</b>				
Serial interface update time	$t_{REP}$	2/14	ms	speed/interrupt
ADC resolution		14	Bits	Max. count = $2^{14}-1$
Output data format		3 x 14	Bits	
ADC sensitivity		6.1 ... 7	$\mu V/\text{count}$	
ADC output offset		7000 ... 9200	Counts	
ADC output offset, typ.		8192	Counts	
<b>Temperature Reference</b>				
Gain (temperature)		80	Counts/K	-20° C to +80° C
Linearity		-5 ... +5	%	-20° C to +80° C
<b>Filter, Signal Processing</b>				
Digital filter cut off		8	Hz	see note 1)

1) A digital bandpass filter is recommended to cut off output offset.

# SINGLE ELEMENT PYROS FOR GAS MONITORING AND MEASURING

PYROELECTRIC DETECTORS FOR GAS MONITORING ■



## PYS 3798 – DigiPyro®

### Applications

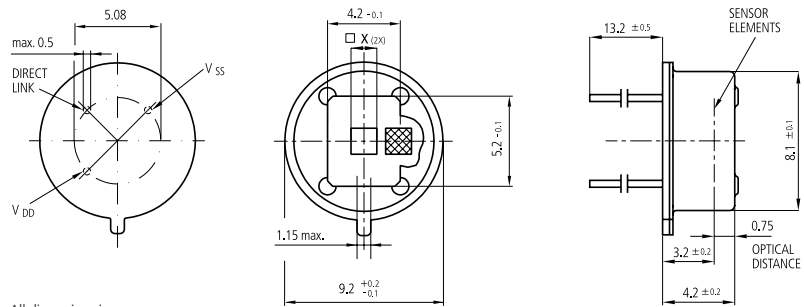
- Gas sensing and monitoring

### Features and Benefits

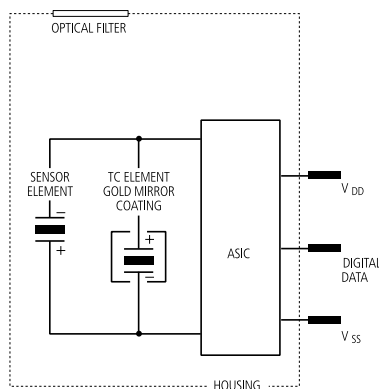
- Digital output
- Internal temperature reference
- TO-5 metal housing
- Selection of narrow band pass filters

### Product Description

Excelitas extends the family of DigiPyro® detectors to applications in gas sensing. The PYS 3798 is the digital equivalent to the analog LHi 807. It includes the additional temperature reference as a separate output. The two signals are presented in one 28-bit digital bit stream communicated via a single wire “direct link” interface to a suitable host microprocessor.



All dimensions in mm

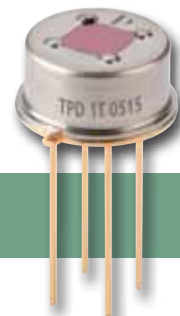


### PYS 3798 – DigiPyro®

Main Parameter	Symbol	PYS 3798	Unit	Remark
Responsivity, min.	R <sub>min</sub>	2.2	kV / W	f = 1 Hz
Responsivity, typ.	R	3.5	kV / W	f = 1 Hz
Match, max.	M <sub>max</sub>	-	%	
Noise, max.		80	μV <sub>pp</sub>	0.4 ... 10 Hz / 20° C
Field of view, horizontal	FoV	135°		Unobstructed
Field of view, vertical	FoV	122°		Unobstructed
Operating voltage	V <sub>DD</sub>		V	
Supply current	I <sub>DD</sub>	10	μA	V <sub>DD</sub> = 3.3 V
	I <sub>DDmax</sub>	15	μA	V <sub>DD</sub> = 3.3 V
<b>Digital Data</b>				
Serial interface update time	t <sub>REP</sub>	13	ms	speed/interrupt
ADC resolution		14	Bits	Max. count = 2 <sup>14</sup> - 1
Output data format		2 x 14	Bits	
ADC sensitivity		6 ... 7	μV/count	
ADC output offset		7000 ... 9200	Counts	
ADC output offset, typ.		8192	Counts	
<b>Temperature Reference</b>				
Gain (temperature)		80	Counts/K	-20° C to +80° C
Linearity		-5 ... +5	%	-20° C to +80° C
<b>Filter, Signal Processing</b>				
Digital filter cut off		8	Hz	see note 1)

1) A digital bandpass filter is recommended to cut off output offset.

# THERMOPILE DETECTORS FOR GAS SENSING



## TPD 1T 0525, TPD 1T 0625 – High Sensitivity Thermopile

### Applications

- Gas sensing and monitoring

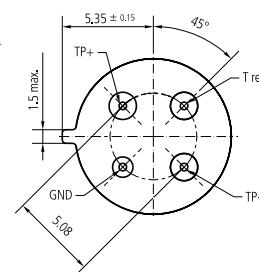
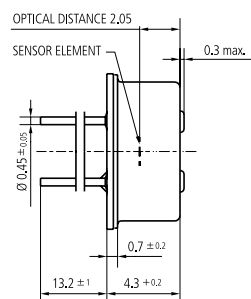
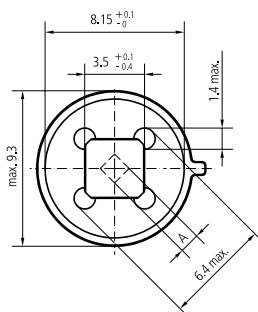
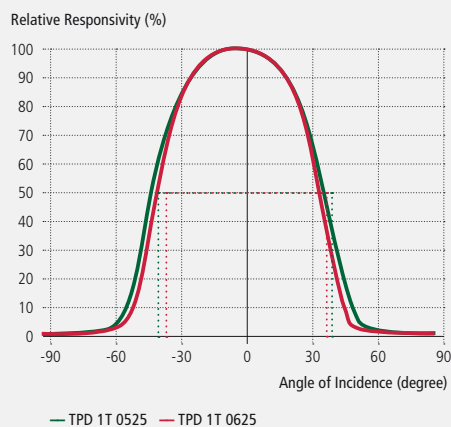
### Features and Benefits

- High sensitivity
- TO-5 metal housing
- Thermistor included
- Narrow band pass filters

### Product Description

These two thermopile detectors are specially designed for high signal output level. They are equipped with an internal thermistor as temperature reference for thermopile temperature compensation. Both series are made in TO-5 housing with a square window. They can be obtained with either a standard IR window or with a narrow band pass filter window as per page 7 of this catalog. With the narrow band pass filters, these detectors are an excellent choice for applications of gas monitoring and detection.

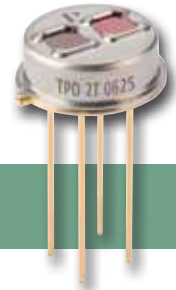
### Field of View



## TPD 1T 0525, TPD 1T 0625 – High Sensitivity Thermopile

Parameter	Symbol	0515	0625	Unit	Remark
Sensitive area	A	1.25 x 1.25	1.2 x 1.2	mm	Absorber area
Sensitive area	A	1.6	1.4	mm <sup>2</sup>	Absorber area
Thermopile resistance	R <sub>TP</sub>	25 ... 70	50 ... 110	kΩ	25° C
Responsivity	R	28	33	V/W	500° / 1Hz/ without IR-filter
Time constant	t	35	27	ms	
Noise voltage	V <sub>N</sub>	29	36	nV / √Hz	25° C
Specific detectivity	D*	1.2	1.1	10 <sup>8</sup> cm <sup>2</sup> /Hz / W	25° C
Temp. coefficient of resistance	TC <sub>RTP</sub>	0.03	0.03	% / K	
Temp. coefficient of responsivity	TC <sub>R</sub>	-0.05	-0.05	% / K	
Field of view	FoV	80	76	Degrees	At 50 % intensity points
Thermistor resistance (25° C)	R <sub>25</sub>	100	100	kΩ	25° C
Thermistor BETA-value	β	3964	3964	K	Defined at 25° C / 100° C

# THERMOPILE DETECTORS FOR GAS SENSING



## TPD 2T 0625 – Dual Channel Thermopile

### Applications

- Gas sensing and monitoring

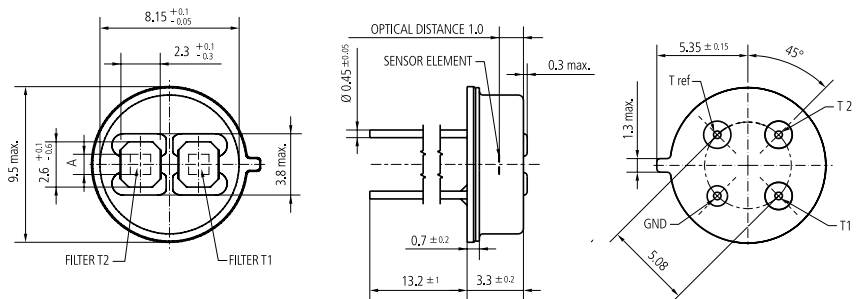
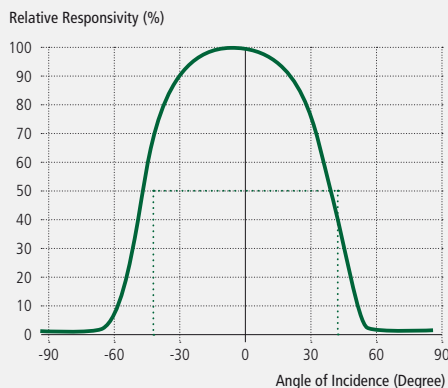
### Features and Benefits

- High sensitivity
- TO-39 metal housing
- Thermistor included
- Two narrow band pass filters

### Product Description

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, where as the other window is fitted with a narrow band pass filter selected for a specific gas (see page 7 of this catalog for available types). The TPD 2T 0625 is also equipped as standard with an internal thermistor as temperature reference for thermopile temperature compensation.

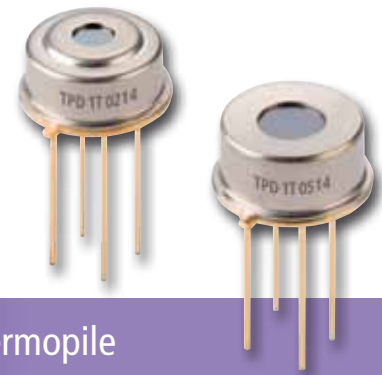
### Field of View



### TPD 2T 0625 – Dual Channel Thermopile

Parameter	Symbol	0625	Unit	Remark
Sensitive area	A	1.2 x 1.2	mm	Absorber area
Sensitive area	A	1.4	mm <sup>2</sup>	Absorber area
Thermopile resistance	R <sub>TP</sub>	50 ... 110	kΩ	25° C
Responsivity	R	33	V/W	500° / 1Hz/ without IR-filter
Time constant	t	27	ms	
Noise voltage	V <sub>N</sub>	36	nV / √Hz	25° C
Specific detectivity	D*	1.1	10 <sup>8</sup> cm <sup>2</sup> /Hz / W	25° C
Temp. coefficient of resistance	TC <sub>RTP</sub>	0.03	% / K	
Temp. coefficient of responsivity	TC <sub>R</sub>	-0.05	% / K	
Field of view	FoV	87	Degrees	At 50 % intensity points
Thermistor resistance (25° C)	R <sub>25</sub>	100	kΩ	25° C
Thermistor BETA-value	β	3964	K	Defined at 25° C / 100° C

# THERMOPILE DETECTORS FOR MEASUREMENT



## TPD 1T 0224, TPD 1T 0524, TPD 1T 0624 – General-Purpose Thermopile

### Applications

- Non-contact temperature measurements
- Pyrometry

### Features and Benefits

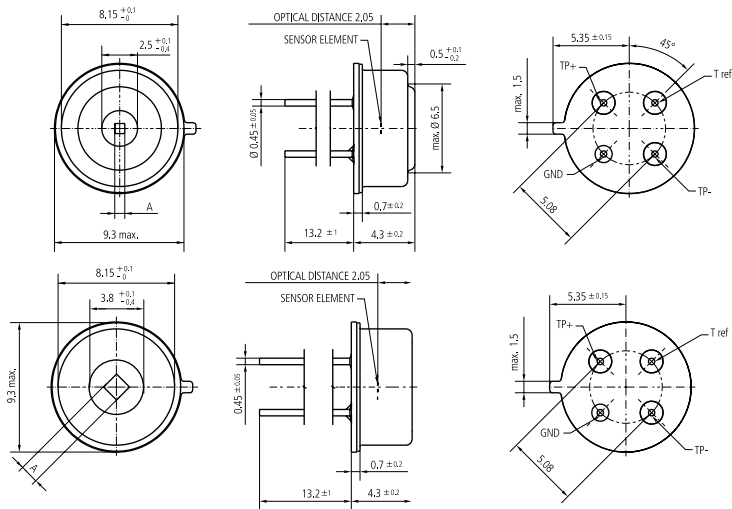
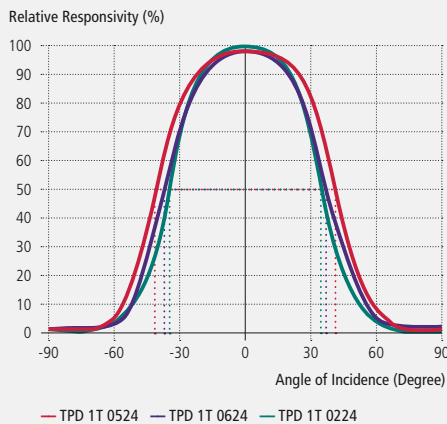
- TO-39 metal housing
- Thermistor included

### Product Description

This is our general-purpose range of thermopile detectors in TO-39 type housings with a round window, which also serves as an aperture. All feature a specially-designed element configuration, each one with a different size of absorbing area.

The TPD 1T 0224 provides the smallest absorbing area, the TPD 1T 0524 offers a strong signal at low sensor resistance with a large absorbing area. The TPD 1T 0624 represents a lower-cost compromise. All types are equipped as standard with an internal thermistor as temperature reference for thermopile temperature compensation.

### Field of View



TPD 1T 0224 and  
TPD 1T 0624

TPD 1T 0524

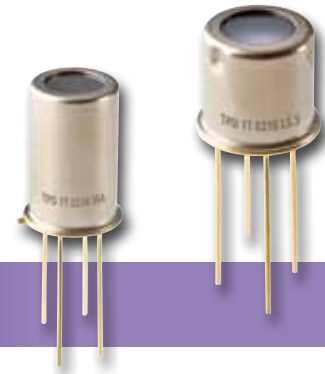
## TPD 1T 0224, TPD 1T 0524, TPD 1T 0624 – General-Purpose Thermopile

Parameter	Symbol	0224	0524	0624	Unit	Remark
Sensitive area	A	0.7 x 0.7	1.25 x 1.25	1.2 x 1.2	mm	Absorber area
Sensitive area	A	0.5	1.6	1.4	mm <sup>2</sup>	Absorber area
Thermopile resistance	R <sub>TP</sub>	50 ... 100	25 ... 70	50 ... 110	kΩ	25° C
Responsivity	R	45	28	33	V/W	500° / 1Hz/ without IR-filter
Sensitivity (T <sub>det</sub> 25° C / T <sub>obj</sub> 40° C)	S <sub>40</sub>	50	110	92	μV/K	With standard filter (LWP, cut-on 5.5 μm)
Sensitivity (T <sub>det</sub> 25° C / T <sub>obj</sub> 100° C)	S <sub>100</sub>	65	150	120	μV/K	With standard filter (LWP, cut-on 5.5 μm)
Time constant	t	22	35	27	ms	
Noise voltage	V <sub>N</sub>	35	29	36	nV / √Hz	25° C
Specific detectivity	D*	0.9	1.2	1.1	10 <sup>8</sup> cm <sup>2</sup> /Hz / W	25° C
Temp. coefficient of resistance	TC <sub>RTP</sub>	0.03	0.03	0.03	% / K	
Temp. coefficient of responsivity	TC <sub>R</sub>	-0.05	-0.05	-0.05	% / K	
Field of view	FoV	70	84	76	Degrees	At 50 % intensity points
Thermistor resistance (25° C)	R <sub>25</sub>	100	100	100	kΩ	25° C
Thermistor BETA-value	β	3964	3964	3964	K	Defined at 25° C / 100° C



# THERMOPILE DETECTORS WITH INTEGRAL OPTICS

## TPD 1T 0226 IRA, TPD 1T 0226 L5.5 – Thermopile



### Applications

- Non-contact temperature measurements
- Thermometry

### Features and Benefits

- TO-type metal housing
- Optics included
- Thermistor included

### Product Description

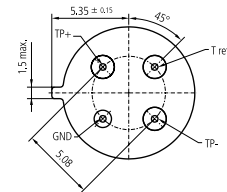
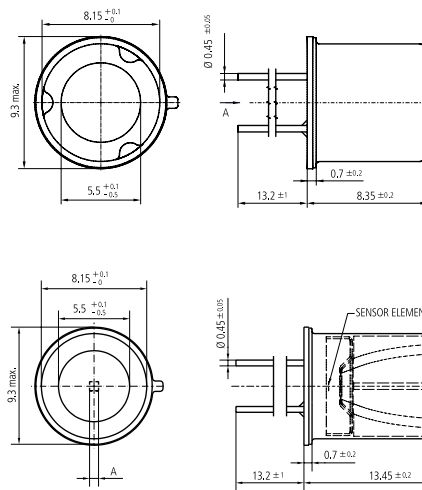
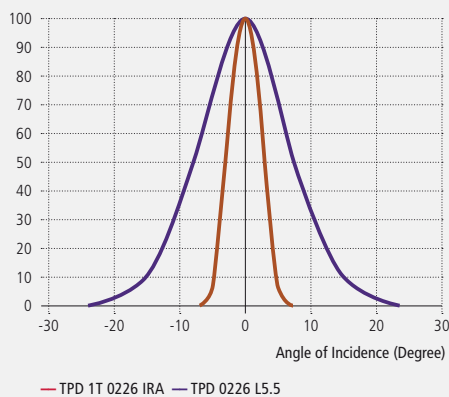
The -IRA type thermopile is specially suited with an internal reflector that reduces the field of view and offers a smaller measurement “target” spot than conventional detectors without optics. Due to the reflector, the housing size is taller than other types, although the housing has the same diameter as a standard TO-39 / TO-5 housing.

The TPD 1T 0226 L5.5 offers similar benefits as the -IRA type, but has an internal lens to reduce the housing’s height. The field of view of this type is sharper than for the IRA type.

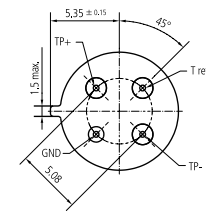
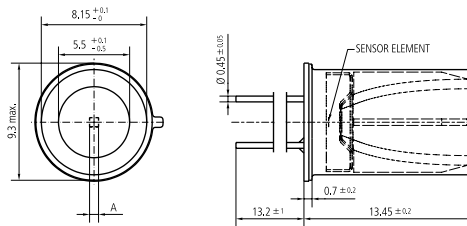
Both series are equipped as standard with an internal thermistor as temperature reference for thermopile temperature compensation.

### Field of View

Relative Responsivity (%)



TPD 1T 0226 L5.5



TPD 1T 0226 IRA

## TPD 1T 0226 IRA, TPD 1T 0226 L5.5 – Thermopile

Parameter	Symbol	0226 L5.5	0226 IRA	Unit	Remark
Sensitive area	A	0.7 x 0.7	0.7 x 0.7	mm	Absorber area
Sensitive area	A	0.5	0.5	mm <sup>2</sup>	Absorber area
Thermopile resistance	R <sub>TP</sub>	50 ... 100	50 ... 100	kΩ	25° C
Responsivity	R	45	45	V/W	500° / 1Hz / without IR-filter
Sensitivity (T <sub>det</sub> 25° C / T <sub>obj</sub> 40° C)	S <sub>40</sub>	-	-	μV/K	With standard filter (LWP, cut-on 5.5 μm)
Sensitivity (T <sub>det</sub> 25° C / T <sub>obj</sub> 100° C)	S <sub>100</sub>	-	-	μV/K	With standard filter (LWP, cut-on 5.5 μm)
Time constant	t	22	22	ms	
Noise voltage	V <sub>N</sub>	35	35	nV / √Hz	25° C
Specific detectivity	D*	0.9	0.9	10 <sup>8</sup> cm·√Hz / W	25° C
Temp. coefficient of resistance	TC <sub>RTP</sub>	0.03	0.03	% / K	
Temp. coefficient of responsivity	TC <sub>R</sub>	-0.05	-0.05	% / K	
Field of view	FoV	7	15	Degrees	At 50 % intensity points
Thermistor resistance (25° C)	R <sub>25</sub>	100	100	kΩ	25° C
Thermistor BETA-value	β	3964	3964	K	Defined at 25° C / 100° C

# MINIATURE THERMOPILE DETECTORS FOR GAS SENSING AND MEASUREMENT

## TPD 0223, TPD 0623 Thermopile

### Applications

- Non-contact temperature measurements
- IR based gas sensors

### Features and Benefits

- TO-46 metal housing
- Square window
- Optical filter options
- Thermistor included

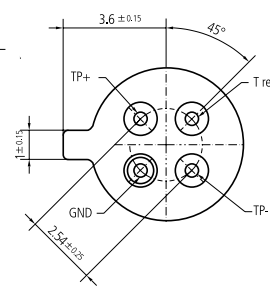
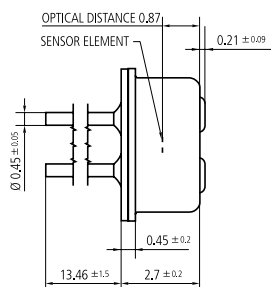
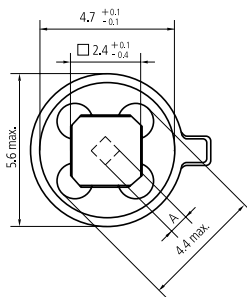
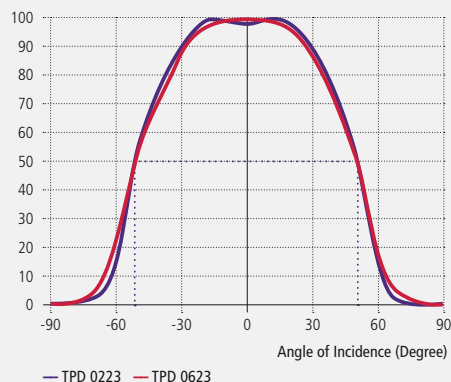
### Product Description

This is our range of general-purpose miniature thermopile detectors in 4.7 mm diameter TO-46 type housings. Both feature a specially-designed element configuration, each one with a different size of absorbing area. The window is available as standard infrared or as narrow band pass filter for gas sensing applications. The TPD0223 provides the smallest absorbing area, the TPD 0623 is a larger design offering strong signals. Both types are equipped as standard with an internal thermistor as temperature reference for thermopile temperature compensation.



### Field of View

Relative Responsivity (%)



### TPD 0223, TPD 0623 Thermopile

Parameter	Symbol	0223	0623	Unit	Remark
Sensitive area	A	0.7 x 0.7	1.2 x 1.2	mm	Absorber area
Sensitive area	A	0.5	1.4	mm <sup>2</sup>	Absorber area
Thermopile resistance	R <sub>TP</sub>	50 ... 100	50 ... 110	kΩ	25° C
Responsivity	R	45	33	V/W	500° / 1Hz/ without IR-filter
Sensitivity (T <sub>det</sub> 25° C / T <sub>obj</sub> 40° C)	S <sub>40</sub>	88	133	μV/K	With standard filter (LWP, cut-on 5.5 μm)
Sensitivity (T <sub>det</sub> 25° C / T <sub>obj</sub> 100° C)	S <sub>100</sub>	116	177	μV/K	With standard filter (LWP, cut-on 5.5 μm)
Time constant	t	22	27	ms	
Noise voltage	V <sub>N</sub>	35	36	nV / √Hz	25° C
Specific detectivity	D*	0.9	1.1	10 <sup>8</sup> cm <sup>2</sup> /Hz / W	25° C
Temp. coefficient of resistance	TC <sub>RTP</sub>	0.03	0.03	% / K	
Temp. coefficient of responsivity	TC <sub>R</sub>	-0.05	-0.05	% / K	
Field of view	FoV	104	104	Degrees	At 50 % intensity points
Thermistor resistance (25° C)	R <sub>25</sub>	100	100	kΩ	25° C
Thermistor BETA-value	β	3964	3964	K	Defined at 25° C / 100° C



# ISOTHERMAL MINIATURE THERMOPILE DETECTORS FOR EAR THERMOMETRY



## TPiD 012B, TPiD 022B Thermopile

### Applications

- Ear thermometry
- General purpose thermometry

### Features and Benefits

- Miniature TO-type metal housing
- Light collecting aperture
- Thermistor included

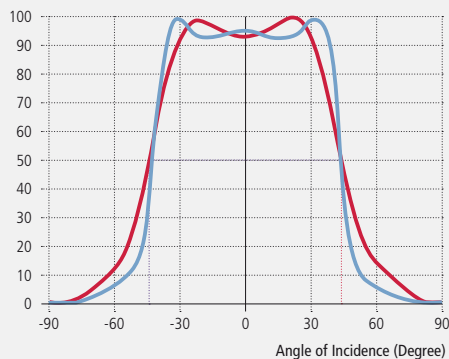
### Product Description

Excelitas offers ear thermometry thermopiles referenced as ISOthermal detector range. The patented designs provide a superior performance of thermopiles under thermal shock conditions.

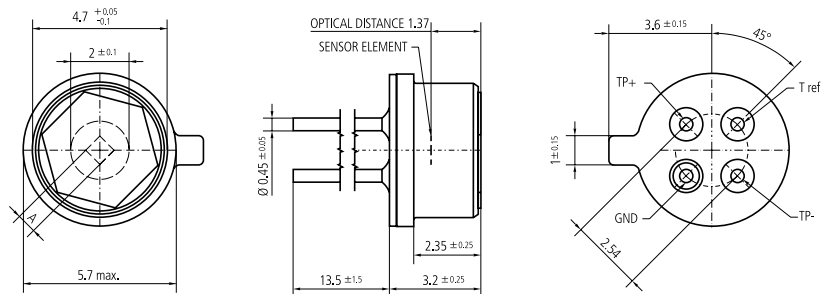
The TPiD 012B is the low cost version, whereas the TPiD 022B provides higher signal. The physical dimensions of the two ISO thermal sensors are equivalent to our TO-46 sensor housings and include a special aperture. Both types are equipped with an internal thermistor as temperature reference for thermopile temperature compensation to further improve accuracy.

### Field of View

Relative Responsivity (%)



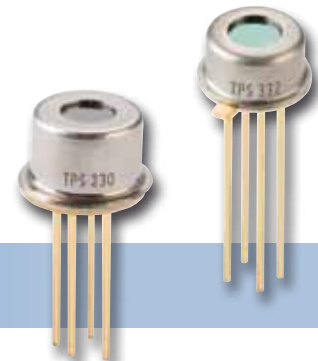
— TPiD012B — TPiD 022B



### TPiD 012B, TPiD 022B Thermopile

Parameter	Symbol	TPiD 012B	TPiD 022B	Unit	Remark
Sensitive area	A	Ø 0.5	0.7 x 0.7	mm	Absorber area
Sensitive area	A	0.2	0.5	mm <sup>2</sup>	Absorber area
Thermopile resistance	R <sub>TP</sub>	85 ... 135	50 ... 100	kΩ	25° C
Responsivity	R	92	60	V/W	500° / 1Hz/ without IR-filter
Sensitivity (T <sub>det</sub> 25° C / T <sub>obj</sub> 40° C)	S <sub>40</sub>	44	95	μV/K	With standard filter (LWP, cut-on 5.5 μm)
Sensitivity (T <sub>det</sub> 25° C / T <sub>obj</sub> 100° C)	S <sub>100</sub>	58	125	μV/K	With standard filter (LWP, cut-on 5.5 μm)
Time constant	t	15	22	ms	
Noise voltage	V <sub>N</sub>	42	35	nV/√Hz	25° C
Specific detectivity	D*	1.0	1.2	10 <sup>8</sup> cm/Hz / W	25° C
Temp. coefficient of resistance	TC <sub>RTP</sub>	0.03	0.03	% / K	
Temp. coefficient of responsivity	TC <sub>R</sub>	-0.05	-0.05	% / K	
Field of view	FoV	90	90	Degrees	At 50 % intensity points
Thermistor resistance (25° C)	R <sub>25</sub>	100	100	kΩ	25° C
Thermistor BETA-value	β	3964	3964	K	Defined at 25° C / 100° C

# ISOTHERMAL MINIATURE THERMOPILE DETECTORS FOR INFANT EAR THERMOMETRY



## TPD 0120, TPD 0122 Thermopile

### Applications

- Ear thermometry
- General purpose thermometry

### Features and Benefits

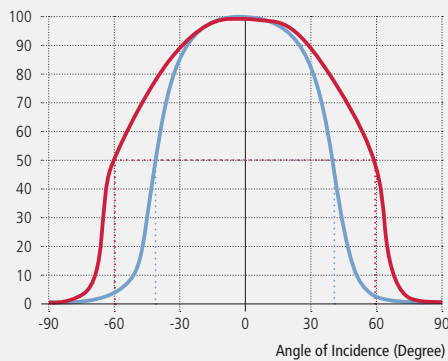
- Miniature TO-type metal housing
- Thermistor included

### Product Description

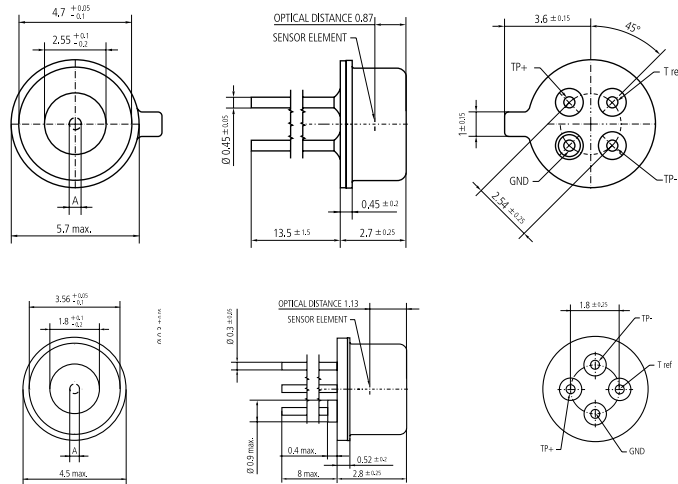
This is our range of miniature thermopile detectors tailored for infant ear thermometers. The TPD 0120 is the smallest detector in a 3.56 mm diameter TO-41 housing, the TPD 0122 is featured in a 4.7 mm diameter TO-46 type housing with a round window, which also serves as an aperture. Both types are equipped as standard with an internal thermistor as temperature reference for thermopile temperature compensation.

### Field of View

Relative Responsivity (%)



— TPD 0120 — TPD 0122



TPD 232

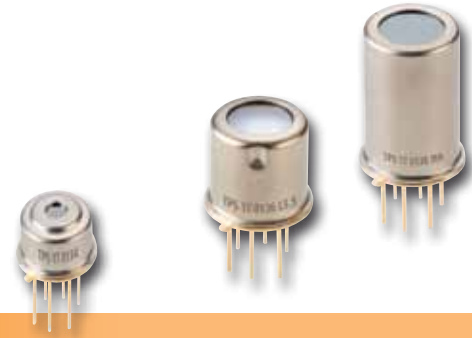
TPD 230

### TPD 0120, TPD 0122 Thermopile

Parameter	Symbol	0120	0122	Unit	Remark
Sensitive area	A	Ø 0.5	Ø 0.5	mm	Absorber area
Sensitive area	A	0.2	0.2	mm <sup>2</sup>	Absorber area
Thermopile resistance	R <sub>TP</sub>	85... 135	85... 135	kΩ	25° C
Responsivity	R	77	77	V/W	500° / 1Hz / without IR-filter
Sensitivity (T <sub>det</sub> 25° C / T <sub>obj</sub> 40° C)	S <sub>40</sub>	30	43	μV/K	With standard filter (LWP, cut-on 5.5 μm)
Sensitivity (T <sub>det</sub> 25° C / T <sub>obj</sub> 100° C)	S <sub>100</sub>	39	56	μV/K	With standard filter (LWP, cut-on 5.5 μm)
Time constant	t	15	15	ms	
Noise voltage	V <sub>N</sub>	42	42	nV / √Hz	25° C
Specific detectivity	D*	0.8	0.8	10 <sup>8</sup> cm <sup>2</sup> /Hz / W	25° C
Temp. coefficient of resistance	TC <sub>RTP</sub>	0.03	0.03	% / K	
Temp. coefficient of responsivity	TC <sub>R</sub>	-0.05	-0.05	% / K	
Field of view	FoV	82	120	Degrees	At 50 % intensity points
Thermistor resistance (25° C)	R <sub>25</sub>	100	100	kΩ	25° C
Thermistor BETA-value	β	3964	3964	K	Defined at 25° C / 100° C

# THERMOPILE SENSOR WITH INTEGRATED PROCESSING FOR NON-CONTACT TEMPERATURE MEASUREMENT

THERMOPILE SENSORS AND MODULES ■



## TPS 1T 0134 ,TPS 1T 0136 L5.5, TPS 1T 0136 IRA Thermopile Sensor (TPMI® Family)

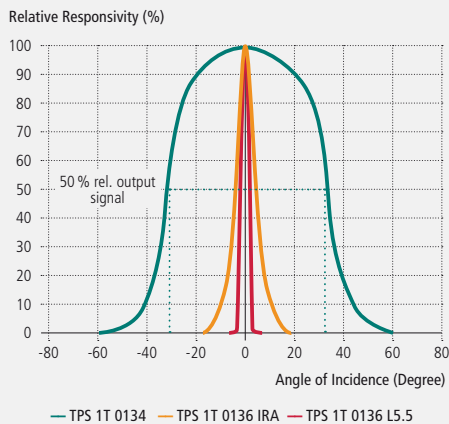
### Target Applications

- General purpose temperature monitoring

### Features and Benefits

- Internal signal processing
- Factory calibrated
- Optics available
- Ambient temperature compensation

### Field of View



### Filter



### Product Description

The TPS family, as a recent upgrade to our original and popular TPMTM thermopiles, senses the thermal radiation emitted by objects and converts this to an analog voltage. It is fully factory-calibrated for accurate signal output over a specific temperature range. Further, customers may program the unit individually via the serial interface. The internal digital signal processing and 8 bit resolution of the control registers and the E2PROM technology allow for adjustment and changing of the configuration to customer requirements.

The temperature accuracy of the fully adjustable integrated circuit outperforms discrete solutions. With the integration of thermopile and electronic circuits in compact TO-39 housing, the TPS is robust and insensitive to environmental influences like leakage currents on the parent PCB, relative humidity or electromagnetic interference.

The TPMTM sensor family includes the integrated ambient temperature compensation and the calibration to a certain temperature range. Customer specific modifications are possible. Thus, when ordering, the correct temperature range needs to be specified.

For requirements of defined spot sizes, we offer sensors with defined field of view obtained by apertures, internal lenses or integrated mirrors.

For amplification of the highly sensitive thermopile signal a high resolution programmable low noise amplifier is provided. An adjustable high precision ambient temperature sensor followed by a signal processor offers accurate compensation signals with polynomial characteristics perfectly matching the thermopile output to achieve an output signal which is closely linear with object temperature. Adding these signals will result in an ambient independent object temperature signal over a large temperature range. This range can be adapted and scaled to customer requirements by means of the flexible offset and post gain adjustment.

The two configurable comparators within the TPS can be used to allow the sensor to function as a temperature-dependent switch. Threshold temperatures and the amount of hysteresis for both comparators are freely programmable.

For the various object temperature ranges we offer the following pre-calibrated sensors:

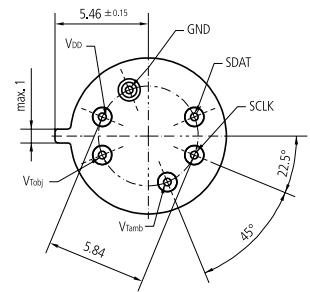
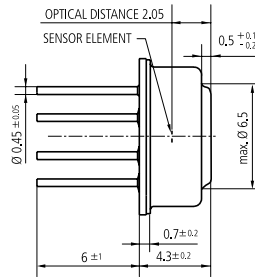
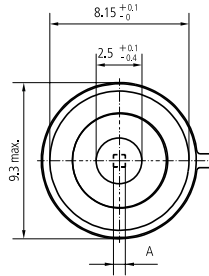
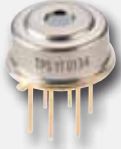
- -20 ... 60° C: TPS 1T 0134 OAA060
- -20 ... 60° C: TPS 1T 0236 IRA OAA060
- -20 ... 120° C: TPS 1T 0136 L5.5 OAA120
- -20 ... 120° C: TPS 1T 0136 L5.5 OAA120
- -20 ... 250° C: TPS 1T 0136 IRA OAA250

IRA = internal reflector. L5.5 = 5.5 mm focal length lens.

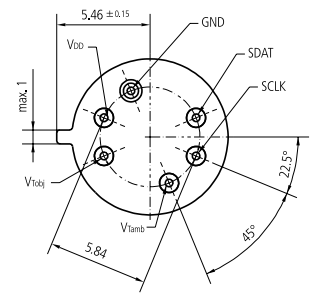
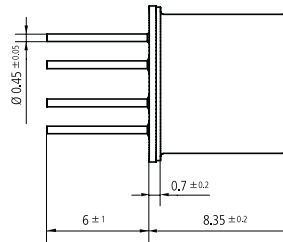
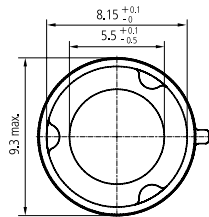
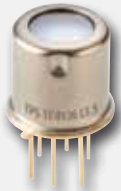
A temperature reference output is included. On request other object temperature ranges can be provided. The sensors can also be supplied as an "OBA" version without internal temperature compensation.



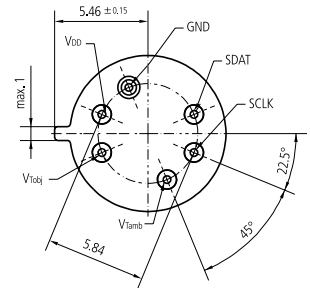
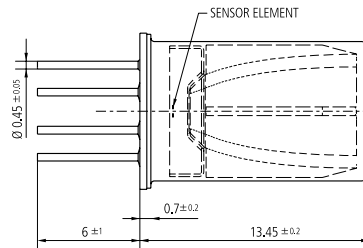
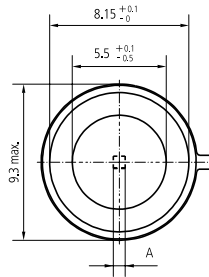
### TPS 1T 0134



### TPS 1T 0136 L5.5



### TPS 1T 0136 IRA



### TPS 1T 0134 ,TPS 1T 0136 L5.5, TPS 1T 0136 IRA Thermopile Sensor (TPMI® Family)

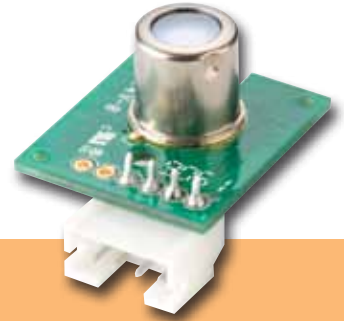
Parameter	Symbol	TPS 1T 0134	TPS 1T 0136 L5.5	TPS 1T 0136 IRA	Unit	Remark
Output voltage swing	$V_O$	0.25 ... ( $V_{DD} - 0.25$ )	0.25 ... ( $V_{DD} - 0.25$ )	0.25 ... ( $V_{DD} - 0.25$ )	V	
Resistive output load	$R_L$	50	50	50	k $\Omega$	min.
Object temp. accuracy		1.5	1.5	1.5	K	+/-
Response time	$t_{resp}$	100	100	100	ms	typ.
Sensitive area	A	Ø 0.5	Ø 0.5	Ø 0.5	mm	TPS 1T 01
Field of view	FoV	67	4.5	11	°	TPS 1T 01
Distance to spot size ratio		-	11:1	-		TPS 1T 01
Sensitive area	A	0.7 x 0.7	0.7 x 0.7	0.7 x 0.7	mm <sup>2</sup>	TPS 1T 02
Field of view	FoV	70	7	15	°	TPS 1T 02
Distance to spot size ratio		-	8:1	-		TPS 1T 02
Supply voltage	$V_{DD}$	4.5 ... 5.5	4.5 ... 5.5	4.5 ... 5.5	V	
Supply current	$I_{DD}$	1.5	1.5	1.5	mA	typ. ; $R_L > 1\text{ M}\Omega$
Operating temp. range		-25 ... +100	-25 ... +100	-25 ... +100	°C	
Storage temp. range		-40 ... +100	-40 ... +100	-40 ... +100	°C	
ESD tolerance		2.5	2.5	2.5	kV	Human body model
Soldering temp.		300	300	300	°C	max, 10 s





# THERMOPILE MODULE WITH INTEGRATED PROCESSING FOR TEMPERATURE MEASUREMENT

## TPM 1T 0136 L5.5, TPM 1T 0134 M(y) – Thermopile Module (TPMI®)



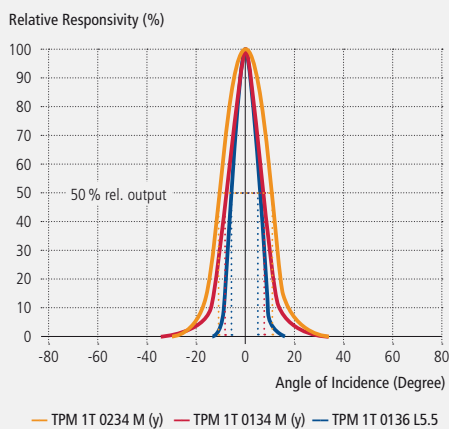
### Target Applications

- General purpose temperature monitoring

### Features and Benefits

- Internal signal processing
- Factory calibrated
- Lens or mirror optics
- Ambient temperature compensation

### Field of View



### Filter



### Product Description

The module range of Excelitas consists of a thermopile sensor mounted on a PCB with a connector. The PCB can also provide for optional features such as voltage regulation and a noise-reduction filter. The module includes the integrated temperature compensation for a defined temperature environment and the calibration to a certain object temperature range. Modules cannot be programmed individually at the customer site. Thus, when ordering, the correct ambient and object temperature ranges need to be specified.

For requirements of defined spot sizes, we offer sensors with a field of view defined by optical apertures, internal lenses or external mirror optics. The mirror orientation M(y) can be specified and a protective external filter may be supplied with the module.

The module types are available with different versions of pcb P(x). For the external mirror version, we supply the mirror in different viewing orientations M(y); y = L (left) / y = F (front) / y = R (right). Customization: As the modules are always calibrated to target temperature range customized versions are available.

For the various object temperature ranges we offer the following pre-calibrated modules:

External mirror types

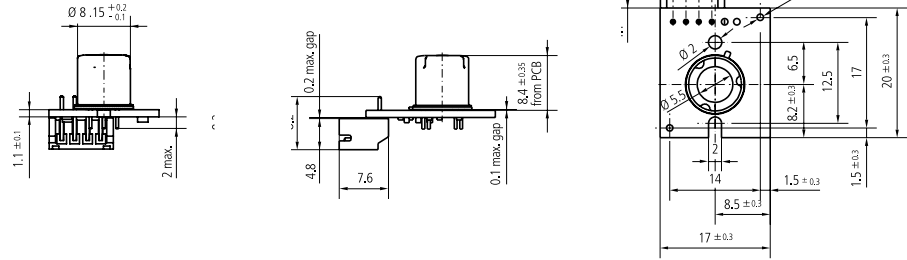
- -20 ... 60°C: TPM 1T 0234 OAA060 P(x) M(y)
- -20 ... 140°C: TPM 1T 0134 OAA140 P(x) M(y)
- -20 ... 250°C: TPM 1T 0134 OAA250 P(x) M(y)
- -20 ... 180°C: TPM 1T 0134 OAA180 P(x) M(y)

Integral lens types

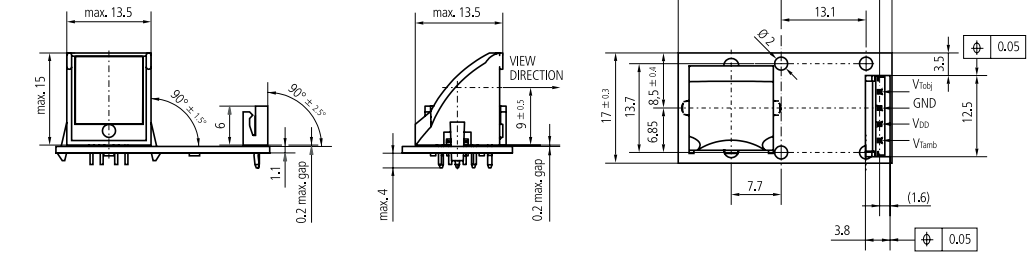
- -20 ... 60°C: TPM 1T 0236 L5.5 OAA060 P7
- -20 ... 120°C: TPM 1T 0136 L5.5 OAA120 P7
- -20 ... 180°C: TPM 1T 0136 L5.5 OAA180 P7
- -20 ... 250°C: TPM 1T 0136 L5.5 OAA250 P7
- -20 ... 300°C: TPM 1T 0136 L5.5 OAA300 P7

A temperature reference output is included. On request the modules can be supplied as an "OBA" version, which is calibrated but without internal temperature compensation. In this case the customer will do the temperature compensation externally with the use of the supplied reference output.

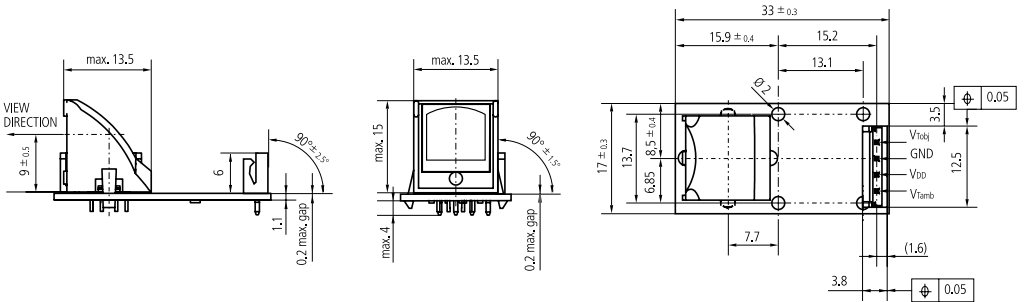
TPM 1T 0136 L5.5



TPM 1T 0134 P6 M(y)



TPM 1T 0134 P9 M(y)



TPM 1T 0136 L5.5, TPM 1T 0134 M(y) – Thermopile Module (TPM)<sup>®</sup>

Parameter	Symbol	TPM 1T 0136 L5.5	TPM 1T 0134 P6 M(y)	TPM 1T 0134 P9 M(y)	Unit	Remark
Output voltage swing	$V_O$	$0.25 \dots (V_{DD} - 0.25)$	$0.25 \dots (V_{DD} - 0.25)$	$0.25 \dots (V_{DD} - 0.25)$	V	
Resistive output load	$R_L$	50	50	50	k $\Omega$	min.
Object temp. accuracy		1.5	1.5	1.5	K	+ / -
Response time	$t_{resp}$	100	100	100	ms	typ.
Field of view		4.5	5.5	5.5	°	TPiS 1T 01
Distance to spot size ratio		11:1	-	-		TPiS 1T 01
Field of view	FoV	7	7	7	°	TPiS 1T 02
Distance to spot size ratio		8:1	-	-		TPiS 1T 02
Supply voltage	$V_{DD}$	4.5 ... 5.5	4.5 ... 5.5	4.5 ... 15*	V	* = Voltage regulator
Supply current	$I_{DD}$	1.5	1.5	1.7	mA	typ. ; $R_L > 1 \text{ M}\Omega$
Operating temp. range		-25 ... +100	-25 ... +100	-25 ... +100	°C	
Storage temp. range		-40 ... +100	-40 ... +100	-40 ... +100	°C	
ESD tolerance		2.5	2.5	2.5	kV	Human body model

# COOL EYE™ THERMOPILE ARRAY MODULES WITH INTEGRAL OPTICS FOR SAFETY AND SECURITY

COOL EYE THERMOPILE ARRAY MODULES ■



## TPiL 08T 2146 L3.9, TPiA 16T 4146 L3.9 Thermopile Array "Cool Eye"

### Target Applications

- Presence detection
- Non-contact temperature measurement
- Temperature dependent switch for alarm or thermostatic applications
- Household appliances like microwave oven, toaster, hair dryer

### Features and Benefits

- Digital SMBus interface
- Factory calibration
- Temperature signal
- Ambient temperature output signal
- Programmable emissivity
- Noise reduction filter
- Module with connector
- E2PROM configuration and data storage
- Optics included, various viewing angles
- Can be adapted to your specific requirements

### Product Description

With the Cool Eye™ family Excelitas offers thermopile arrays in various configurations. All are module types on a PCB with communication interface and a 4-pin connector. For line arrays, we offer 8 elements and 16 elements in two different lens configurations, with 3.9 mm focus and 5.5 mm focus. The spatial design provides for 4 x 4 elements and comes with recommended 3.9 mm or 5.5 mm focal length optics.

The thermopile line or array modules consist of a 1 x 8, 1 x 16 or 4 x 4 element thermopile chip connected to an integrated multiplexing and signal conditioning circuit, E2PROM and microcontroller with an integrated A/D converter for signal processing and interfacing. Lenses for different field of views are available on demand. The sensor is equipped with an internal reference temperature sensor for correct target temperature determination.

The temperature accuracy by digital signal processing in combination with the numeric ambient temperature compensation algorithm outperforms any discrete solution. The sensor module provides an output signal which is representing real temperature data for each pixel.

Customer specific modifications are possible.

For the various object temperature ranges we offer the following pre-calibrated modules:

#### L3.9 types

- 0...60°C: TPiL 08T 2146 L3.9 OAA060
- 0...60°C: TPiA 16T 4146 L3.9 OAA060

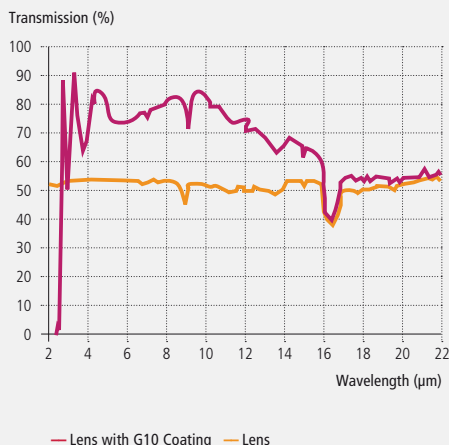
#### L5.5 types

- 0...150°C: TPiL 08T 2146 L5.5 OAA150
- 0...60°C: TPiA 16T 4146 L5.5 OAA060

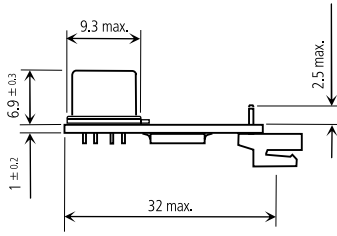
Customization: As the modules are always calibrated to target temperature range customized versions are available.

A temperature reference output is included. On request the modules can be supplied as an "OBA" version, which is calibrated but without internal temperature compensation. In this case the customer will do the temperature compensation externally with the use of the supplied reference output.

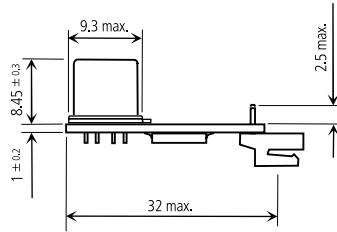
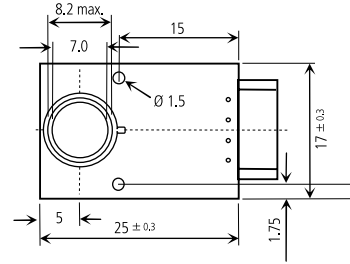
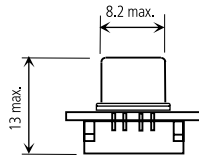
### Filter



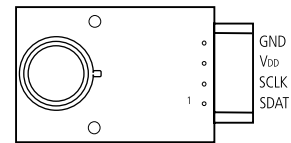
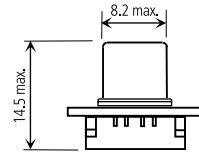




Dimensions TPiX YY L3.9

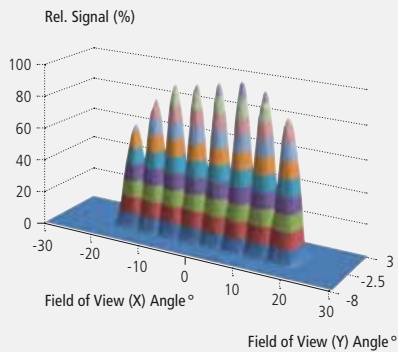


Dimensions TPiX YY L5.5

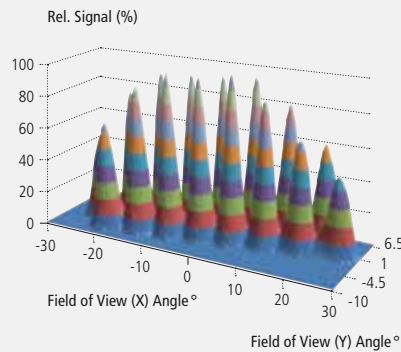


Connection Information for all TPiX Modules

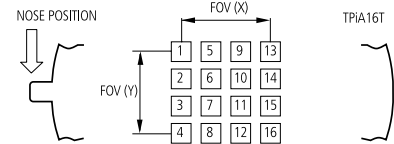
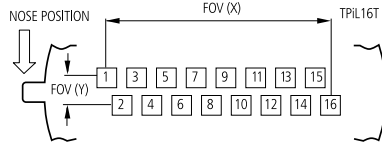
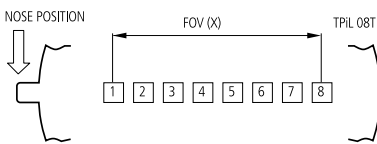
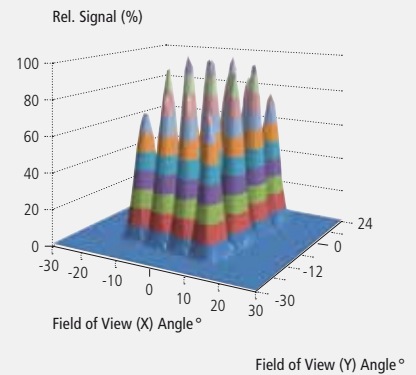
#### Field of View TPiL 08



#### Field of View TPiL 16T



#### Field of View TPiA 16T



#### TPiL 08T 2146 L3.9, TPiL 16T 3246 L3.9 G10 – Thermopile Line, TPiA 16T 4146 L3.9 Thermopile Array "Cool Eye "

Parameter	Symbol	TPiL 08 T	TPiL 16 T	TPiA 16 T	Unit	Remark
Storage temperature range			-40 ... +100		°C	
Operating temperature range			-25 ... +100		°C	
Supply voltage	V <sub>DD</sub>		4.5 ... 5.5		V	
Supply current	I <sub>DD</sub>		5		mA	typ.
Field of view X/L3.9	FOV <sub>X</sub>	50	49	30	°	Refer to FOV definitions
Field of view Y/L3.9	FOV <sub>Y</sub>	NA	6	22	°	Refer to FOV definitions
Field of view X/L5.5	FOV <sub>X</sub>	33	31	21	°	Refer to FOV definitions
Field of view Y/L5.5	FOV <sub>Y</sub>	NA	3.5	14	°	Refer to FOV definitions
Digital interface type			SMBus			
Object temperature accuracy		± 1.5			K	For calibration conditions
Signal refresh time	tp <sub>Xrefr</sub>	250	400	400	ms	All pixels and ambient temperature

## Handling and Precautions

### Humidity

All our IR-detectors shall not increase noise or decrease responsivity when exposed to  $\leq 95\%$  R.H. at  $30^\circ\text{C}$ . Operation below dew point (i.e. with condensation) might affect performance.

### Hermetic seal

All our IR-detectors are sealed to pass a He-leakage test with maximum leak rate of  $5 \times 10^{-8} \text{ mbar.l.s}^{-1}$ .

### Quality

Excelitas is a QS 9000 certified manufacturer with established SPC and TQM. Detector outgoing inspections include the parameters Responsivity, Match, Offset, Noise, Gross leak (Mil Std 883 method 1014C1). Individual data are not stored, statistical details can be disclosed on request.

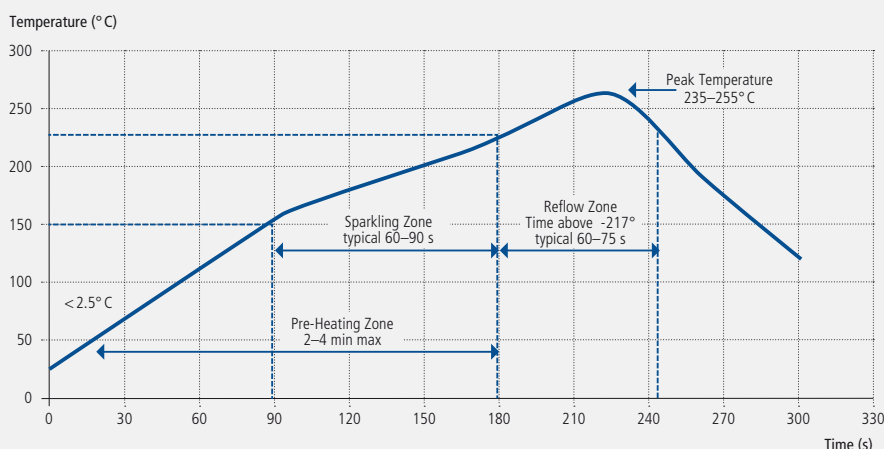
### Handling

Electrostatic charges may destroy the detector. We recommend applying precautions necessary for ESD devices to avoid damages. Do not apply physical force to detector leads. Do not expose detector to aggressive detergents such as freon, trichloroethylene, etc.

### Soldering conditions

Hand soldering and standard wave soldering process may be applied. Avoid heat exposure to the top and the window of the detector. Re-flow soldering is not recommended for all TO-housing types. Our new SMD types are designed for reflow-soldering in accordance with general practices for SMD.

### Typical Lead Free Reflow Profile



### Reliability Standards

#### International Electrotechnical Commission (IEC) Standards

IEC 60068-2-1	Environmental testing – Part 2: Tests. Tests A: Cold
IEC 60068-2-2	Environmental testing - Part 2: Tests. Tests B: Dry heat
IEC 60068-2-78	Environmental testing - Part 2-78: Tests - Test Cab: Damp heat, steady state
IEC 60068-2-14	Environmental testing - Part 2: Tests. Test N: Change of temperature

#### Joint Electron Devices Engineering (JEDEC) Standards

JESD-22	Series test methods
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#### US Military (MIL) Standards

MIL-STD-883	Test methods and procedures for microelectronics
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### 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 JEDEC (see table). For detailed information please contact Excelitas.

## Comparison of Current Thermopile Types to New Names and Features

Comparison Table					
	Current Type	New Type	Remark	Page	
Detectors	TPS 535	TPD 1T 0515	Equivalent	28	■
	TPS 735	TPD 1T 0625	Equivalent	28	■
	TPS 2734	TPD 2T 0625	Equivalent	29	■
	TPS 334	TPD 1T 0214	Equivalent	30	■
	TPS 534	TPD 1T 0514	Equivalent	30	■
	TPS 734	TPD 1T 0624	Equivalent	30	■
	TPS 336 IRA	TPD 1T 0216 IRA	Equivalent	31	■
	TPS 334 L5.5	TPD 1T 0216 L5.5	Equivalent	31	■
	TPS 333	TPD 333	Unchanged	32	■
	TPS 733	TPD 733	Unchanged	32	■
	TPS 230	TPD 230	Unchanged	35	■
	TPS 232	TPD 232	Unchanged	35	■
	TPS 23B	TPiD 23B	Unchanged	34	■
	TPS 33B	TPiD 33B	Unchanged	34	■
	TPS 23S	TPiD 1S 0121	Isothermal unchanged	33	■
Sensors	a2TPMI 23x	TPS 1T 0136 L5.5	Equivalent	36	■
	a2TPMI 23x	TPS 1T 0136 IRA	Equivalent	36	■
	a2TPMI 33x	TPS 1T 0236 L5.5	Equivalent	36	■
	a2TPMI 33x	TPS 1T 0236 IRA	Equivalent	36	■
	a2TPMI 23S	TPiS 1S 0133	SMD, Isothermal	38	■
	a2TPMI 23S FOV60	TPiS 1S 0133 FM	SMD, Isothermal	38	■
Modules	a2TPMI 23x L5.5 Px	TPM 1T 0136 L5.5	Equivalent	40	■
	a2TPMI 33x Px MLx	TPM 1T 0234 M(y)	Equivalent	40	■
Arrays	dTPLM 08A	TPL 8T 2146 L5.5	Unchanged	42	■
	dTPLM 16A	TPL 16T 3246 L5.5	Unchanged	42	■
	dTPAM 16A	TPA 16T 4146 L3.9	Unchanged	42	■

## Comparison of Analog to Digital Pyrodetectors

Selection Guide										
Digital Version			Analog Version			Market / Application			Features	
Type Name	Page		Type Name	Page		Automatic Light Switch	Burglar Alarm	Gas Detection	Window Size (mm²)	Package
PYD 1998	19	■	LHi 968	12	■	+	++	o	4.2 x 5.2	TO-5
PYD 1988	19	■	LHi 878	14	■	++	+	o	3.4 x 4.6	TO-5
PYD 1978	19	■	LHi 778	14	■	++	+	o	3.0 x 4.0	TO-5
PYQ 2898	20	■	LHi 1148, LHi 1128	13/ 16	■	+	++	o	4.2 x 5.2	TO-5
PYQ 5868	21	■	PYQ 1488	13	■	++	+	o	Hex	TO-5
PYQ 3828	-		PYS 3228, LHi 814	25	■	o	o	++	2.5 x 2.5	TO-5
PYS 3798	27	■	LHi 807	24	■	o	o	++	4.2 x 5.2	TO-5
PYD 5731	18	■	PYD 5131	17	■	++	+	o		TO-46
PYD 1096	22	■	Not applicable	-		++	o	o	4.2 x 5.2	TO-5
PYQ 1098	23	■	Not applicable	-		++	o	o	4.2 x 5.2	TO-5

+ Suited, ++ Best suited

