TP Gas Detector

Infrared Sensing Solutions

Product Specification

TPD 2T 0625 G2 G20 / 3176

Features

- G2 G20 filter
- Integrated 100 kΩ NTC
- Two separate TP channels
- Highly responsive TP pixels
- 87° field-of-view
- TO-39 metal housing for high EMI immunity

Applications

- Non-dispersive infrared (NDIR) gas sensing
- CO2 vs Reference channel

Two Channel High Sensitivity Thermopile

The TPD 2T 0625 G2 G20 is a 2 channel thermopile sensor with integrated optical filters for NDIR gas sensing applications.
It features two large area and highly sensitive thermopile pixels in one TO-39 package.

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Contents

1 Dimensions and Connections

Figure 1: Mechanical Dimensions (in mm) and Pin Configuration. A short description is given in table 1. .

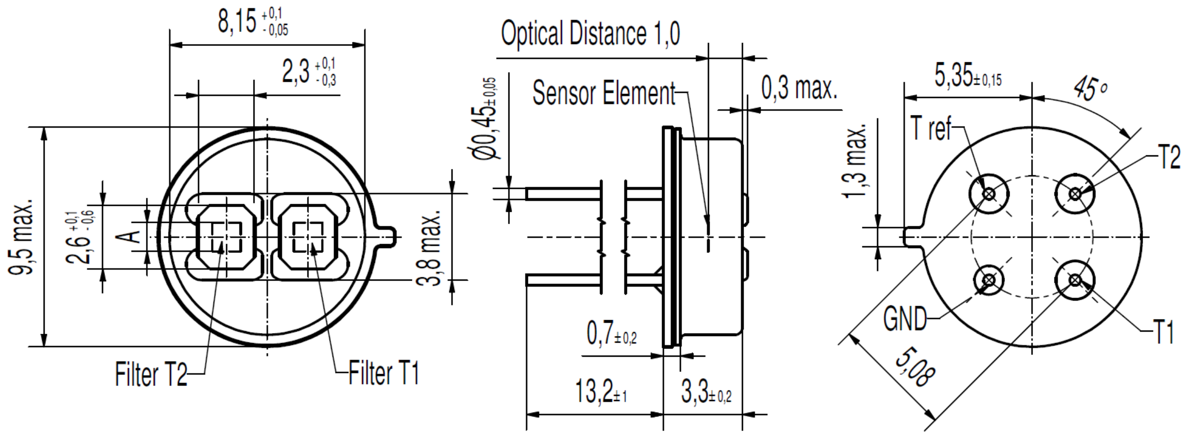

Table 1: Pin descriptions. Further explanations follow in this document.

Pin Symbol	Pin Name and short Functional Description.	Pin Type
T_{ref}	**NTC:** Reference package temperature sensor. The NTC is connected to GND.	NTC
T_1	**CH A:** Thermopile 1 output channel. The voltage reference is GND.	Output CH A
T_2	**CH B:** Thermopile 2 output channel. The voltage reference is GND.	Output CH B
GND	**Ground**: The ground (GND) reference for the power supply should be set to the host ground.	Reference

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2 Optical Characteristics

2.1 Field of View

Figure 2 illustrates the measurement of the sensor's field of view (FOV). A hot point like heat source radiates almost parallel infrared light in a distance to the sensor. The sensor's housing is rotated around its sensor plane in all directions while recording the sensor data. A typical measurement result is shown in figure 3. The result is normalized to the peak value of the measurement. The resulting parameters are depicted in table 2.

Figure 2: Illustration of the FOV measurement setup. For details see the text.

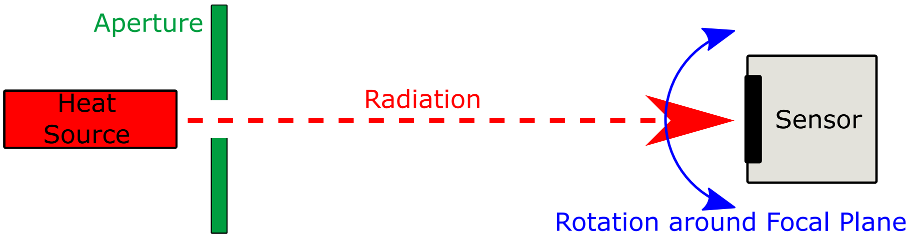

Figure 3: Typical FoV measurement result

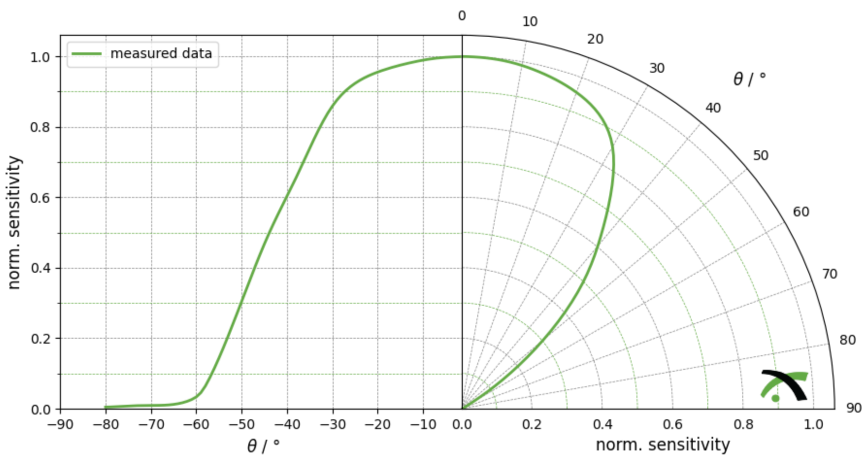

Table 2: Optical characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Remarks / Conditions
Field of View	FOV		87		°	at 50 % intensity
Optical Axis		−10	0	10	°	

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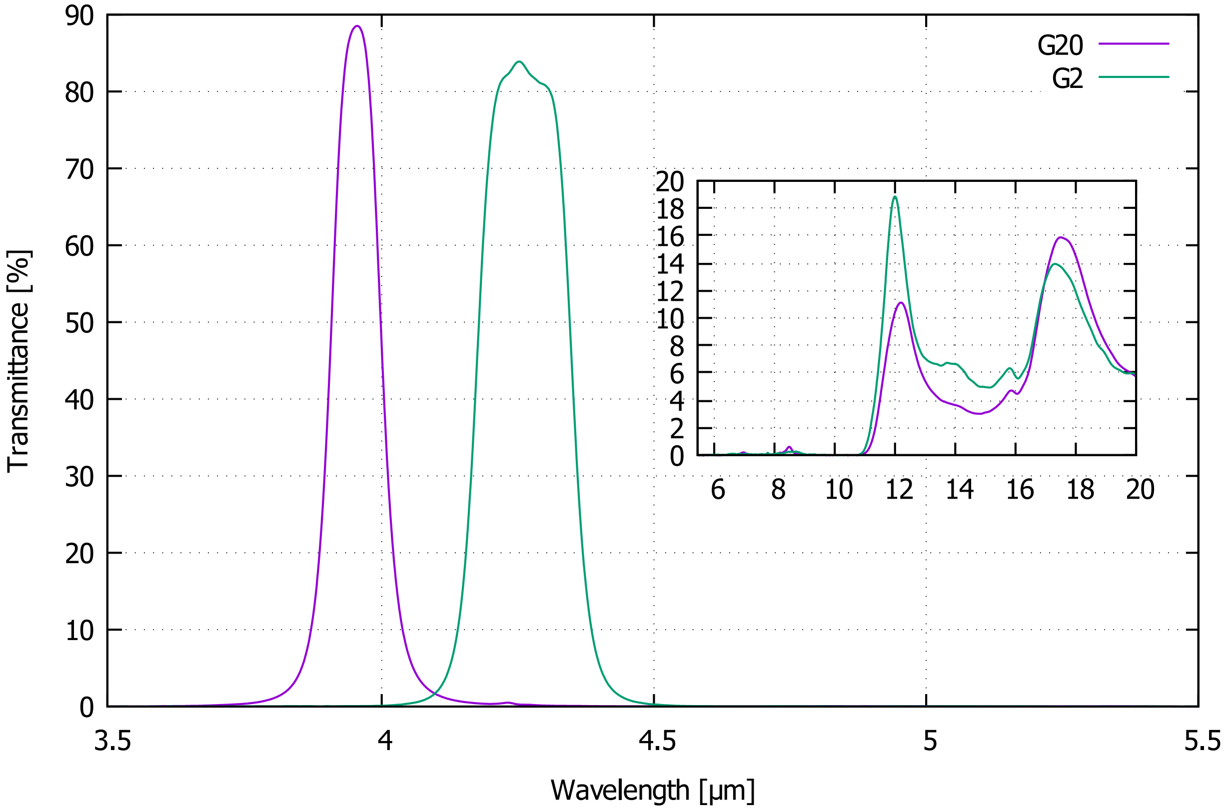
2.2 Filter Properties

Table 3: Filter properties

Property	Filter 1	Filter 2	Unit
Channel Number	**T1**	**T2**	
Filter Identifier	G20	G2	
Matched to gas	Reference	CO_2	
Center wavelength (CWL)	3.95 ± 0.04	4.26 ± 0.03	µm
Half power bandwidth (HPB)	0.10 ± 0.01	0.18 ± 0.02	µm
HPB / CWL	2.5	4.2	%
Peak transmittance	> 76	> 73	%
Average transmittance from visual to band pass region	< 0.1	≤ 0.1	%
Peak transmittance from visual to band pass region	-	≤ 1	%
Peak transmittance from band pass region to 10 µm	< 1	< 1	%
Average transmittance from 10 µm to 12 µm	< 5	≤ 5	%
Substrate material	Silicon	Silicon	

Figure 4: Filter transmittance, typical curve



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3 Absolute Maximum Ratings

Table 4: Maximum Ratings

Parameter	Symbol	Min	Max	Unit	Remarks / Conditions
Operating Temperature	T_0	−20	100	°C	Electrical parameters may vary from specified values in accordance with their temperature dependence
Storage Temperature	T_s	−40	100	°C	Avoid storage in humid environment

4 Device Characteristics

Device characteristics are given at 25 °C ambient temperature unless stated otherwise.

Table 5: Thermopile

Parameter	Symbol	Min	Typ	Max	Unit	Remarks / Conditions
Sensitive Area	A		1.44		mm^2	Absorber $1.2 \times 1.2\,mm^2$
Thermopile Resistance	R_{TP}	50		110	kΩ	
Sensitivity T1	S_{T1}	10		30	$\mu V\,K^{-1}$	$T_{Obj} = 500\,°C$
Sensitivity T2	S_{T2}	15		35	$\mu V\,K^{-1}$	$T_{Obj} = 500\,°C$
Noise Voltage	V_N		36		$nV/\sqrt{Hz}$	
Time constant	τ		27		ms	see sec. 4.2
Temperature Coefficient of Resistance	TC_{RTP}		0.03		$\%\,K^{-1}$	
Temperature Coefficient of Responsivity	TC_R		−0.05		$\%\,K^{-1}$	

Table 6: Ambient temperature sensor (NTC)

Parameter	Symbol	Min	Typ	Max	Unit	Remarks / Conditions
Thermistor Base Resistance	R_{25}	95	100	105	kΩ	See section 4.1
Thermistor β-Value	β	3952	3964	3976	K	See section 4.1

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4.1 Thermistor

The negative-temperature coefficient (NTC) reference temperature sensor follows a non-linear temperature dependence. For a temperature measurement of the component, you must calibrate the NTC in your device.
For highest accuracy measurements use the Steinhart-Hart equation.
The data provided here uses a simplified approach:

$$R = R_{25} \cdot \exp \beta(1/T - 1/T_{25}) \quad (1)$$

You can calibrate the NTC at only 2 calibration points when using this formula but consider the reduced accuracy as compared to the Steinhart-Hart equation.
Component specifications are calculated using this simplified approach. Table 6 provides you the specified limits according to this formula. Table 7 are the calculated values based on those limits and must be used for reference only.

Table 7: Tabulated Thermistor Data

T_{Sens}[°C]	R_{min}[Ω]	R_{nom}[Ω]	R_{max}[Ω]	T_{Sens}[°C]	R_{min}[Ω]	R_{nom}[Ω]	R_{max}[Ω]
-20	862756	921515	980460	50	34479	36451	38453
-15	655207	697928	740660	55	28615	30266	31944
-10	501697	533200	564640	60	23864	25252	26663
-5	387196	410735	434183	65	19994	21166	22357
0	301098	318896	336599	70	16827	17820	18830
5	235852	249430	262916	75	14221	15067	15927
10	186038	196504	206890	80	12068	12791	13526
15	147731	155875	163950	85	10286	10905	11534
20	118070	124460	130808	90	8796	9332	9872
25	**95000**	**100000**	**105000**	95	7550	8016	8481
30	76707	80830	84978	100	6504	6909	7314
35	62325	65710	69137	105	5623	5975	6327
40	50902	53713	56559	110	4877	5183	5492
45	41790	44136	46516	115	4242	4510	4783

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4.2 Time Constants

The thermopile output acts similar to a low pass filter. When using this model, we can determine the time constant τ of the thermopile output through the measurement of the response of the sensor to temperature changes while maintaining the sensor temperature constant.
The sensor responds to sudden object temperature changes of ΔT with an output change of ΔU. U_0 is the sensor output before the temperature change.
If the temperature increases ($\Delta T > 0 \Rightarrow \Delta U > 0$)

$$U(t) = U_0 + \Delta U \left(1 - \exp\left(-\frac{t}{\tau}\right)\right) \tag{2}$$

applies. After $t = \tau$ 63 % of ΔU are reached.
If the temperature decreases ($\Delta T < 0 \Rightarrow \Delta U < 0$)

$$U(t) = U_0 + \Delta U \left(\exp\left(-\frac{t}{\tau}\right)\right) \tag{3}$$

applies. After $t = \tau$ 37 % of ΔU are reached.
The temperature output can be regarded as stable after $(3-4)\tau$.
For a sinusoidaly modulated temperature change by ΔT of frequency f, the sensor's response would follow

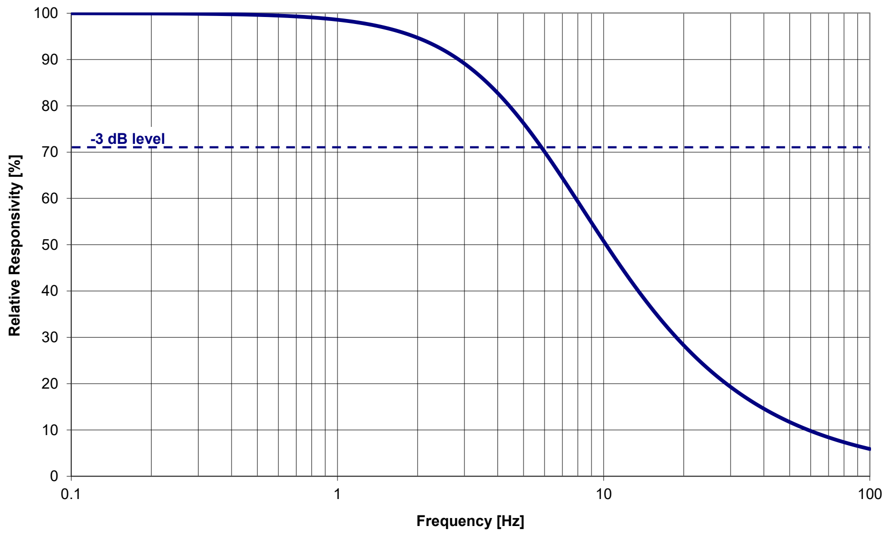
$$U(f) = U_0 + \frac{\Delta U}{\sqrt{1 + (2\pi f \tau)^2}} \tag{4}$$

according to the model of a low pass filter. The corner, or cut-off frequency f_{3dB} is the frequency where the amplitude ΔU drops to 71 % as compared to a DC signal. The cut-off frequency relates with τ as follows

$$\tau = \frac{1}{(2\pi f_{3dB})} \tag{5}$$

The frequency dependence is depicted in figure 5 for reference.

Figure 5: Calculated frequency dependence of part sensitivity



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5 Integration instructions and recommendations

5.1 Position

In order to obtain the highest possible performance it is possible to operate the sensor without a (protecting) front window. To measure an accurate gas concentrations no window between the sensor and the object must be used. Excelitas measurement values are only valid when the bare sensor is exposed to the object.
As the device is equipped with a highly sensitive infra-red detector, it is sensitive to any source of heat, direct or indirect. For a proper temperature measurement the device must be at the same temperature as the ambient. Sudden temperature changes will directly affect the behaviour of the sensor's performance.
We recommend to place strong EMI sources far apart and/or to shield those.

5.2 Soldering

For the soldering of the detectors within PCBs, the typically applied and recommended process is wave soldering. The recommended soldering temperature shall not exceed 300 °C with a maximum exposure time of 5 s.
Other soldering processes are also possible when maintaining similar temperature profiles. Temperatures higher than recommended may affect its performance. Any soldering process should be qualified to avoid damage to the sensor.

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6 Packaging

The Excelitas Technologies tube packaging system protects the product from mechanical and electrical damage and is designed for manual unloading. Figure 6 shows the basic outline.
The system consists of tubes which are protected against ESD (5). The devices are loaded sequentially and fixed with stoppers (4). Up to 50 parts are filled into one tube. In total up to 20 tubes are placed in one paper box (3) filled with protective sponges (8,9,10).
Information labels, ESD labels and bar-code Labels (7) are placed on the box. The label (7) contains the following Information:

- Producer = Excelitas Technologies
- Origin
- Product Name
- Full BAU (unique identification) number
- Batch Number
- Packaging Date

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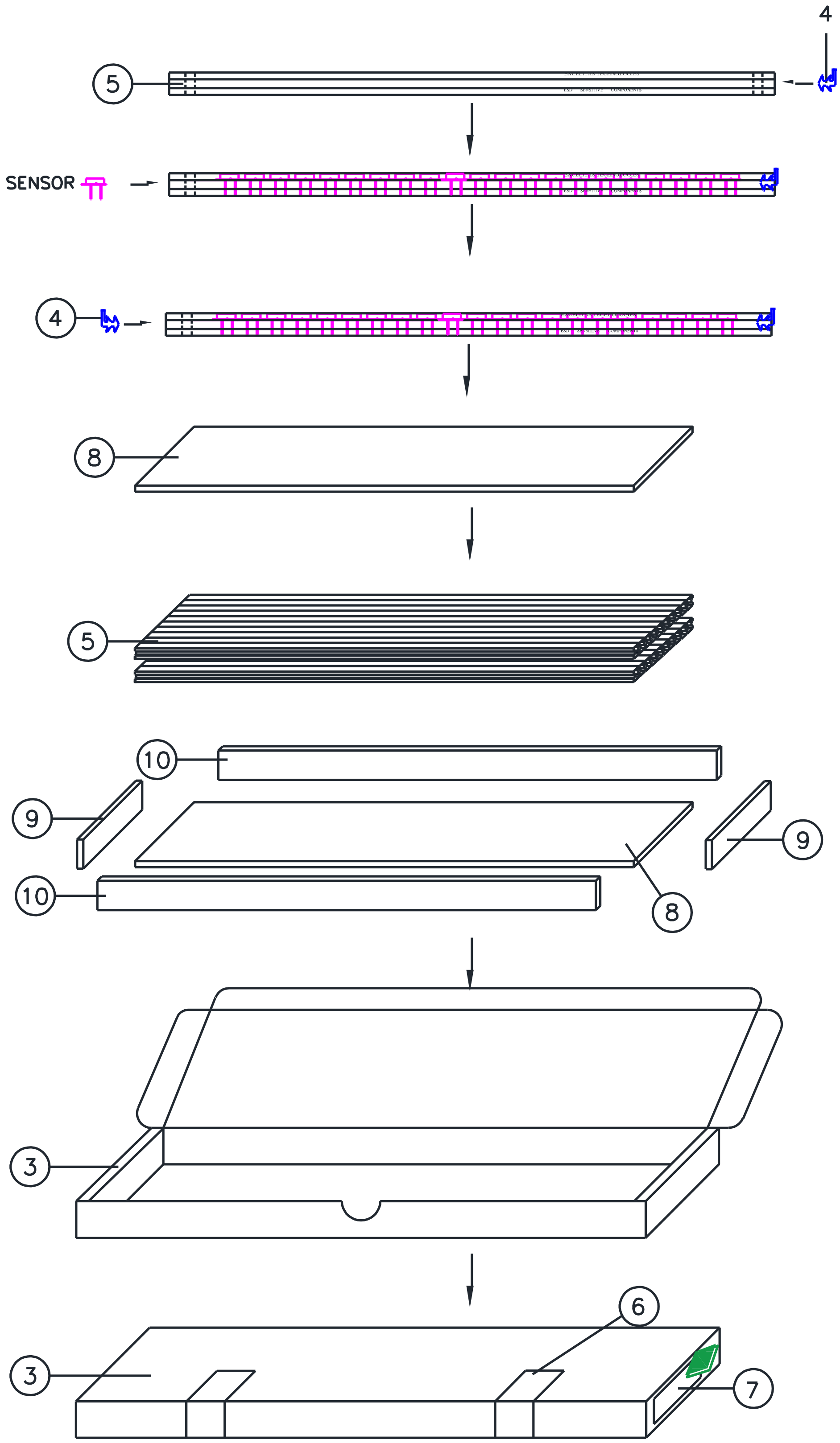
Figure 6: Information about the packaging of sensors.



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7 Statements

Quality Excelitas Technologies is a ISO 9001:2015 certified manufacturer with established SPC and TQM. Excelitas Technologies is certified for it's Environmental Management System according to ISO 14001:2015 and for the Occupational Safety and Health Management System according to ISO 45001:2018.
All devices employing PCB assemblies are manufactured according IPC-A-610 class 2 guidelines.
The infra-red detection product line is certified for ANSI/ESD S.20.20:2014.

Package This IR-detector is sealed to pass a He-leakage test with maximum leak rate of 1×10^{-8} mbar l s^{-1}.

Cleanliness Avoid touching the detector window. To clean windows, use only ethyl alcohol with a cotton swab when necessary. Do not expose detectors to aggressive detergents such as Freon, trichloroethylene, etc.

Tracability The marking of the detector includes the principal type, a 4 digit number that represents the Excelitas identification number. A 4 digit date code is provided in addition to that. It consists of the production year and week. The marking is printed on the top or side of the detector.

Moisture Sensitivity Level Moisture sensitivity level classification does not apply to TO-can products. Storage at high humidities should be avoided.

Electrostatic Discharge Performance All pins pass the electrostatic discharge sensitivity (ESD) test level 1 (±2 kV) according to IEC 61000-4-2. Please make sure not to confuse this norm with other norms such as ANSI/ESDA-JEDEC JS-001-2010 (Human Body Model), ESD DS5.3.1 (Charge Device Model) or ESD STM5.2 (Machine Model).

Mechanical Avoid mechanical stress on the housing and especially on the leads. Be careful when cutting or bending leads to avoid damage. Do not bend leads less than 5 mm from their base. Do not drop detectors on the floor.

RoHS This sensor is a lead-free component and complies with the current RoHS regulations, especially with existing road-maps of lead-free soldering.

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The Company's responsibility for damages will be limited to the repair or replacement of defective product. As with any semiconductor device, thermopile sensors or modules have a certain inherent rate of failure. To protect against injury, damage or loss from such failures, customers are advised to incorporate appropriate safety design measures into their product.

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