

Digital Output Dual Element SMD Pyro

The PYD 2792 is a parallel opposed format, two elements detector based on fully RoHS compliant pyroelectric material. The signal is converted to a digital value using Sigma-Delta and DSP techniques. The data is accessed by the host system through a proprietary one-wire interface to enable advanced signal analysis with your own detection criteria.



Product Specification

Features

- Integrated digitization
- High responsivity pyroelectric elements
- Dual detector with $2 \times 1 \text{ mm}^2$ elements
- 146° field-of-view
- LCC SMD housing for re-flow soldering
- Best for advanced motion detection algorithms

Applications

- Long distance motion detection (with lens)
- Energy saving applications
- Intrusion alarms
- Horizontal mounting applications

Contents

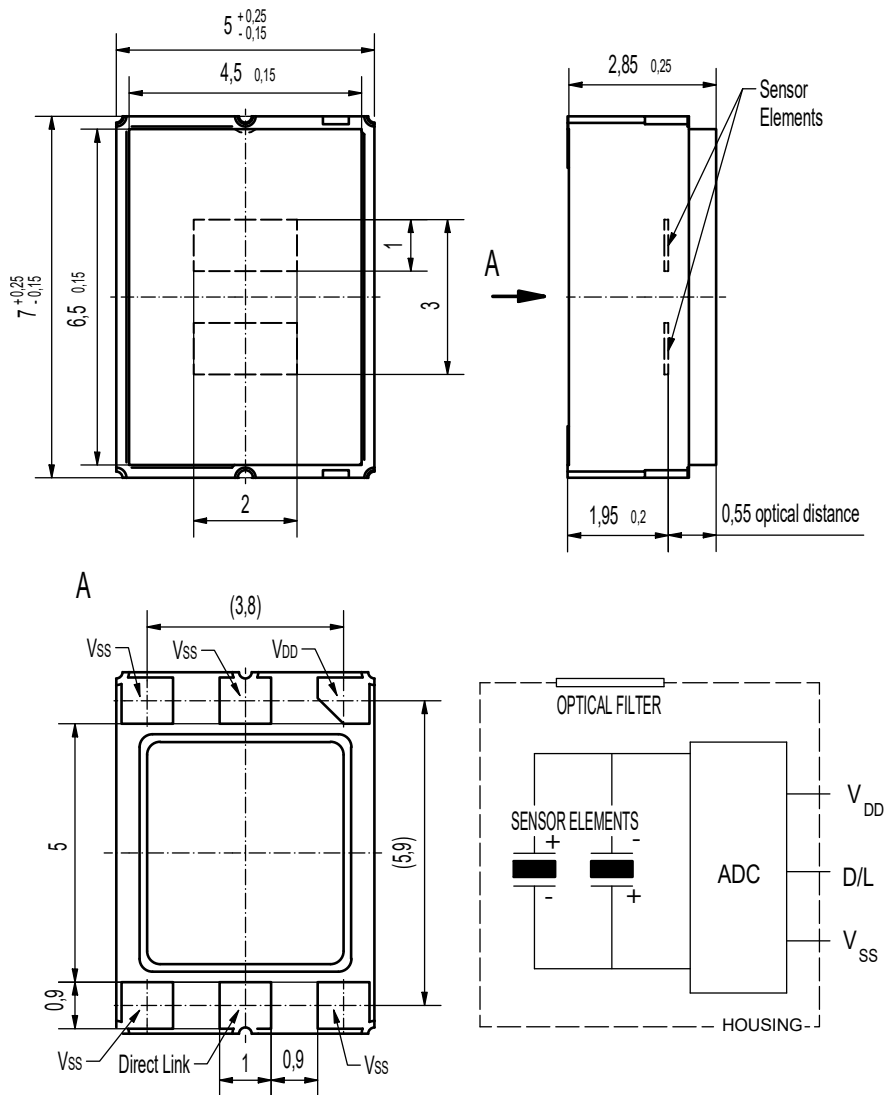
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1 Physical Characteristics

Table 1: Summary of physical characteristics. Parameters and data refer to an ambient temperature of $25 \pm 3^\circ\text{C}$.

Parameter	Symbol	Min	Typ	Max	Unit	Remarks/Conditions
Housing			LCC			see fig. 1
Field of View	FOV		146		$^\circ$	see sec. 1.2
Element Size			2×1		mm	see fig. 1
Spacing			1		mm	see fig. 1
Responsivity	R	3.0	3.7		kV W^{-1}	see sec. 1.1
Match	$(R_A - R_B)/R_A$			10	%	see sec. 1.1
Noise			30	90	μV_{pp}	see sec. 1.1
IR-Filter			Standard			see sec. 1.3

Figure 1: Dimensions and Connections. Explanations follow in this document.



1.1 Pyro-Electric Elements

The element configuration is shown in figure 1. It features a dual element configuration in a parallel opposed format. Its typical application is long distance, wall mounted, motion detection .

Figure 2: Test set up for the measurement of responsivity and match.

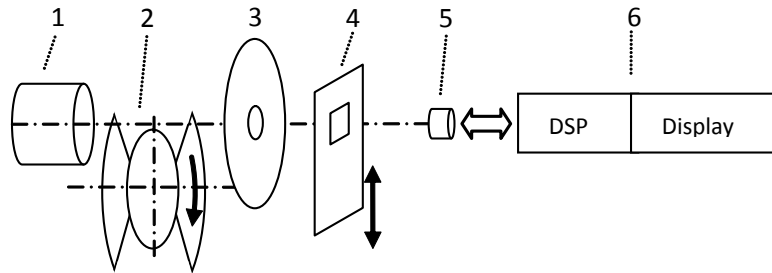
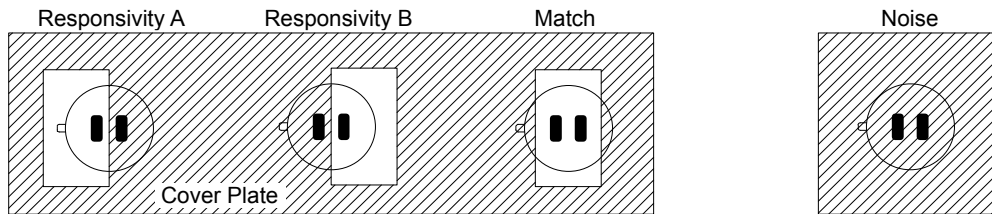


Figure 3: Masking of elements to test the electrical parameters.



The typical set-up for the measurement of responsivity and match is illustrated in figure 2. The black body (BB) radiator (1) is set to 373 K (100 °C). The signal is modulated by a rotating chopper (2). An aperture (3) is used to adjust the radiation flux. The cover plate (4) is masking the elements as shown in figure 3. The sensor (5) is interfaced to a signal processing chain (6). To measure noise, a bandpass filter in the range of 0.4 Hz to 10 Hz is applied.

Responsivity (R) and match are measured at a modulation frequency of 1 Hz.

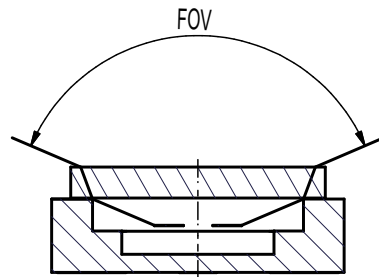
The match is defined by

$$\frac{\text{Match}}{R} \times 100 \quad (1)$$

Noise is measured shut from infra-red energy. The measurement is performed after a settling time of 10 min at an ambient temperature of 25 °C ± 3 °C. Noise is monitored for the duration of 600 s .

1.2 Optical Properties

Figure 4: Illustration for the definition of the horizontal field of view (FOV).



The horizontal field of view (FOV) as drawn to figure 4 is given as the geometrically unobstructed light path to both elements. The FOV of 146° is given for the optical light acceptance with the full so-called common mode suppression.

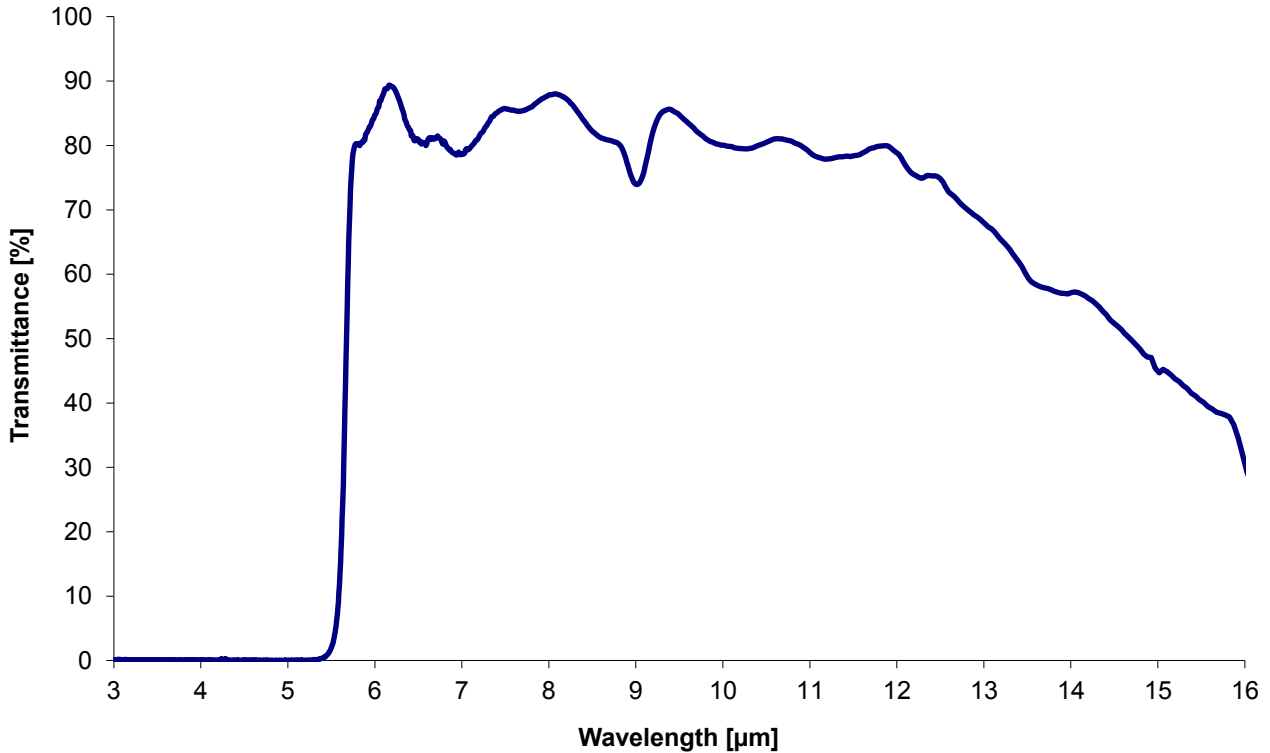
The optical distance as it is given in figure 1 represents the effective focal plane for the application specific optics. The optical distance is shorter than the geometrical due to refraction of light in the filter.

1.3 Filter Properties

Table 2: Filter properties

Parameter	Symbol	Min	Typ	Max	Unit	Remarks/Conditions
Average Filter Transmittance	T_A	77			%	$7.5\ \mu\text{m} < \lambda < 13.5\ \mu\text{m}$
Average Filter Transmittance	T_A			0.5	%	$\lambda < 5\ \mu\text{m}$
Cut-on Wavelength	$\lambda(5\%)$	5.2	5.5	5.8	μm	at 25 °C

Figure 5: Filter transmittance, typical curve



2 Electrical Characteristics

2.1 Absolute Maximum Ratings

Table 3: Absolute Maximum Ratings. Data applicable to operation at free-air temperature range.

Parameter	Symbol	Min	Typ	Max	Unit	Remarks/Conditions
Operating Voltage	V_{DD}	-0.3		3.6	V	
Current into any pin	I_{pin}	-100		100	mA	
Storage Temperature		-40		85	°C	< 60 % r.H.
Operating Temperature		-40		70	°C	

Stresses beyond the limits listed in table 3 may cause permanent damage to the device. Exposure to absolute maximum ratings for long time may affect the device reliability and may lead to deterioration of any parameter.

2.2 Electrical Data

Table 4: Electrical Data. Unless specified differently all data refers to $25 \pm 3^\circ\text{C}$.

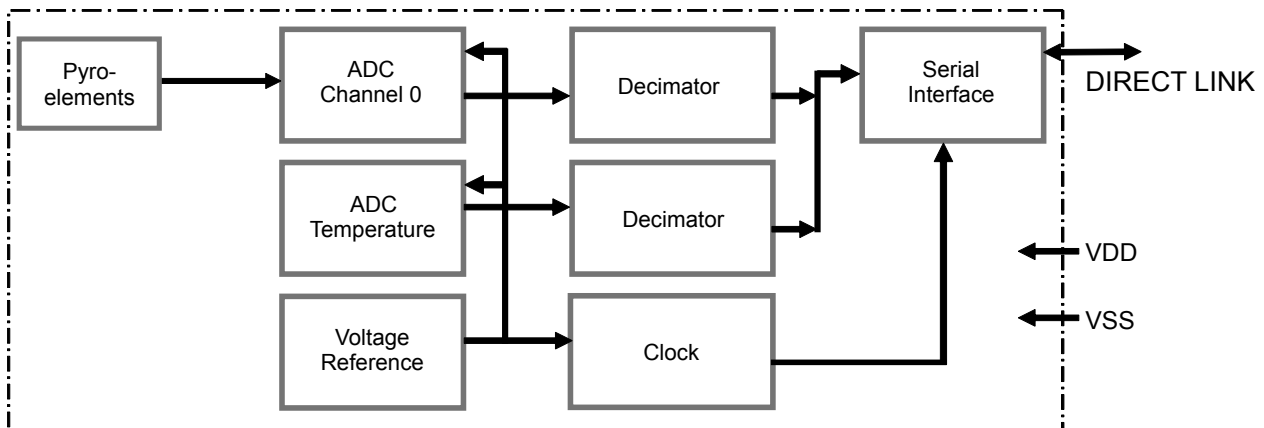
Parameter	Symbol	Min	Typ	Max	Unit	Remarks/Conditions
Operating Voltage	V_{DD}	1.8	3.3	3.6	V	
Supply Current	I_{DD}		5	7	μA	$V_{DD} = 3.3\text{ V}$, no load
Direct Link						
Input Low Voltage	V_{IL}			$0.2V_{DD}$	V	
Input High Voltage	V_{IH}	$0.8V_{DD}$			V	
Input Current ²	I_I	-1		1	μA	
Data Setup Time	t_{DS}	75		200	μs	Interrupt Readout Mode
Data Setup Time	t_{DS}	110		200	μs	Forced Readout Mode
Data Clock Low Time	t_{DL}	200		2000	ns	
Data Clock High Time	t_{DH}	200		2000	ns	
Data Bit Settling Time	t_{BS}			2	μs	$C_{LOAD} < 10\text{ pF}$
Sample Time	t_{SMPL}	2.0		14.6	ms	
Bit Time	t_{BIT}			25	μs	
ADC Resolution ¹			14		Bits	
PIR ADC Sensitivity			6.5		$\mu\text{V/Count}$	
PIR ADC Offset		6500	8192	9800	Counts	in stable condition
Sensitivity of T_{AMB}		72	80	88	Counts/K	
Counts at 25°C		4400	6700	9000	Counts	
LPF cutoff frequency	f_1		7		Hz	
Internal Clock Frequency	f_{CLK}	29	32	35	kHz	

¹ Effective ADC range is from 511 counts to $2^{14} - 511$ counts.

² Pull Up/Down resistors at Direct Link are not applicable.

2.3 Interface Overview

Figure 6: Block Diagram



The pyro-electric sensing elements are connected to a built-in IC, whose functions are shown in the block diagram 6. The DigiPyro™, contains pyro-electric elements, sensitive to IR radiation, and an ASIC for the digital signal processing within the sensor package. The ASIC includes an on-chip oscillator, a voltage reference, an analog-to-digital (ADC) converter for the pyroelements and an internal temperature sensor. A proprietary serial interface called "DIRECT LINK" is used to read the digitized data.

2.4 Direct Link Interface

The DIRECT LINK interface is a bi-directional one wire serial interface which is used to continuously retrieve data from the sensor.

Table 5: Content of the DIRECT LINK data stream when reading sensor out.

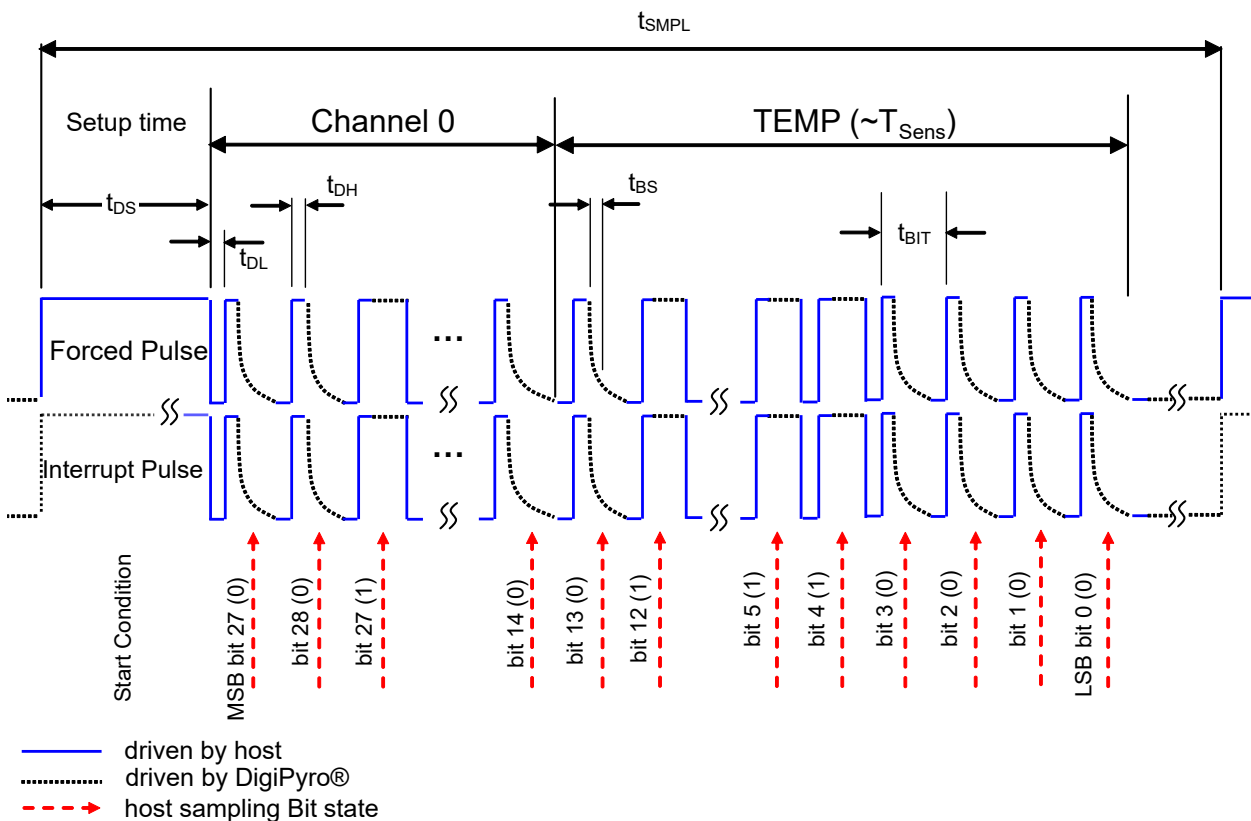
Bit#	Description	Size[bit]	Remarks
[27:14]	PIR (CH0) ADC counts	14	Value of PIR
[13:0]	Temperature ADC counts	14	Value of internal temperature reference

Out of Range The ASIC features an out of range detection. Should the signal of the pyroelectric sensor drop below 511 counts or exceed $2^{14} - 511$ counts the input will be shorted for a duration of about 16 ms in order to discharge the sensor. Out of range conditions may occur for example during strong sensor temperature gradients of more than 1 K min^{-1} .

ADC counts The data represents ADC counts after low-pass filtering and the reference temperature counts. The low-pass data and the reference temperature data is represented as 14 bit unsigned integer.

We recommend to implement a band pass filter on the hostsytem for the PIR data prior to further data analysis to remove the DC (offset) component.

Figure 7: Data Transmission Diagram



Timing The DIRECT LINK interface communication principle is sketched in figure 7. It can be divided into the start condition and the data stream after it.

The start condition for any communication is indicated by a LOW to HIGH transition of the DIRECT LINK line. That condition can be initiated either by the host system or the sensor. Initiating the condition with the host system is called "Forced Readout" mode. Initiating the condition with the sensor is called "Interrupt (driven) Readout" mode. The sensor will periodically initiate an "Interrupt Readout" if no "Forced Readout" is initiated by the host system. Details are described below.

Forced Readout The sensor is expecting the host system to initiate the communication. Forcing DIRECT LINK to HIGH for at least $t_{DS} = 110 \mu s$ and then pulling it to LOW will start the communication. The host system can resume with the **Readout of Bits**.

If the host system is not initiating the communication for a period of longer than $t_{SMPL} = 14.6 \text{ ms}$ the sensor will pull the line HIGH to initiate the "Interrupt Readout".

Interrupt Readout The sensor will drive the line typically every $t_{SMPL} = 16 \text{ ms}$ HIGH. The host system must then pull the line to LOW in order to start the communication with the sensor. The host system can proceed to the **Readout of Bits** not sooner than $75 \mu s$ after the Interrupt occurred and the DIRECT LINK was HIGH.

In order to recognize the interrupt by the sensor, the host system's connection to the DIRECT LINK line must have a high impedance (high Z) and be set to input.

The recommended readout mode is the "Forced Readout".

Readout of Bits The readout procedure is started by the forced or interrupt pulse. The DigiPyro™ waits for the next LOW to HIGH transition by the host system. The host system pulls the line HIGH and releases it (high impedance Z). The DigiPyro™ will pull the line LOW for a 0 bit state or keep it HIGH for a 1 bit state.

The time t_{BS} which the signal needs to settle to a LOW level depends on the capacitive load (e.g. PCB design) at the DIRECT LINK pin. Hence, it is recommended to start implementing the interface with t_{BIT} close to, but shorter than $25 \mu s$ to ensure proper LOW level settling. In next steps reduce t_{BIT} empirically to optimize for reliable data transmission at maximum transmission speed.

After reading the line state by the host system, the host pulls the line again LOW to initiate the next bit readout by a LOW to HIGH transition again. The sequence will be repeated until all bits are shifted out. After the last bit of bit[0] the host controller must force DIRECT LINK pin to LOW for at least $145 \mu s$ and subsequently release DIRECT LINK (High Z).

It has to be considered that t_{BIT} must not exceed $25 \mu s$ to avoid data corruption. Under no circumstances DIRECT LINK may be at LOW level for longer than $25 \mu s$. It is recommended that the total time to readout one data packet should not exceed $800 \mu s$ to ensure always latest values. In "Interrupt Mode" the total readout procedure must not exceed $t_{SMPL} < 14.6 \text{ ms}$.

It is allowed to cancel the readout at any position of the data stream. To terminate the readout, DIRECT LINK must be forced to LOW level for at least $145 \mu s$ and subsequently released to input (High Z).

In order to reduce settling effects, the data packets have to be read continuously with equal sampling intervals.

3 Handling, Operation and Precautions

3.1 Handling

Shelf Life The product can be stored for 12 months before usage at -10°C to 40°C (<60 % r.H. at 40°C non condensing).

Storage This device has a moisture sensitivity level of 3 according to IPC/JEDEC J-STD-20E. After opening moisture barrier bags, the humidity indicator card must be checked to be below 10 % when read at $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$. After opening the bag, parts may be stored at relative humidities below 10 %. Parts should be processed within less than 48 hours if moisture conditions are below $30^{\circ}\text{C}/60\%$ relative humidity. If conditions specified above are not met, parts must be baked for a minimum of 8 hours at 125°C prior to use.

ESD The ASIC was designed to withstand a discharge of up to 1.6 kV through a $1.5\text{ k}\Omega$ resistor in series according to the test method MIL-STD-883D / 3015.

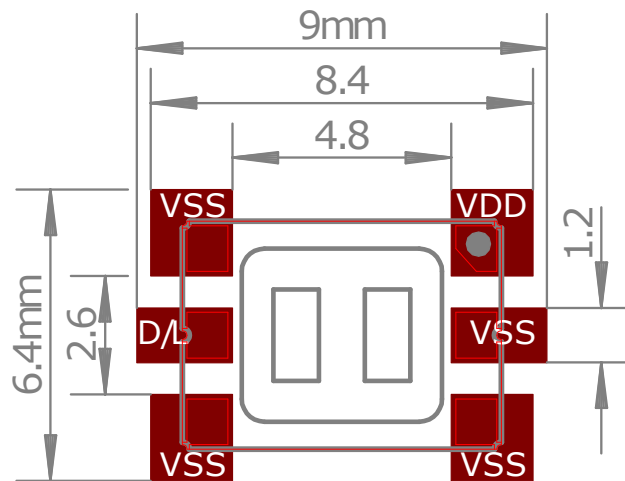
Handle the detectors as ESD sensitive devices and protect them from electrostatic discharges. Working areas should be conductive and grounded. When handling detectors, operators shall be grounded.

Mechanical Avoid mechanical stress on the housing and especially on the filter. Do not drop detectors on the floor.

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.

Footprint A proposal for a pad design is shown in drawing 8.

Figure 8: Proposal for pad dimensions in [mm]

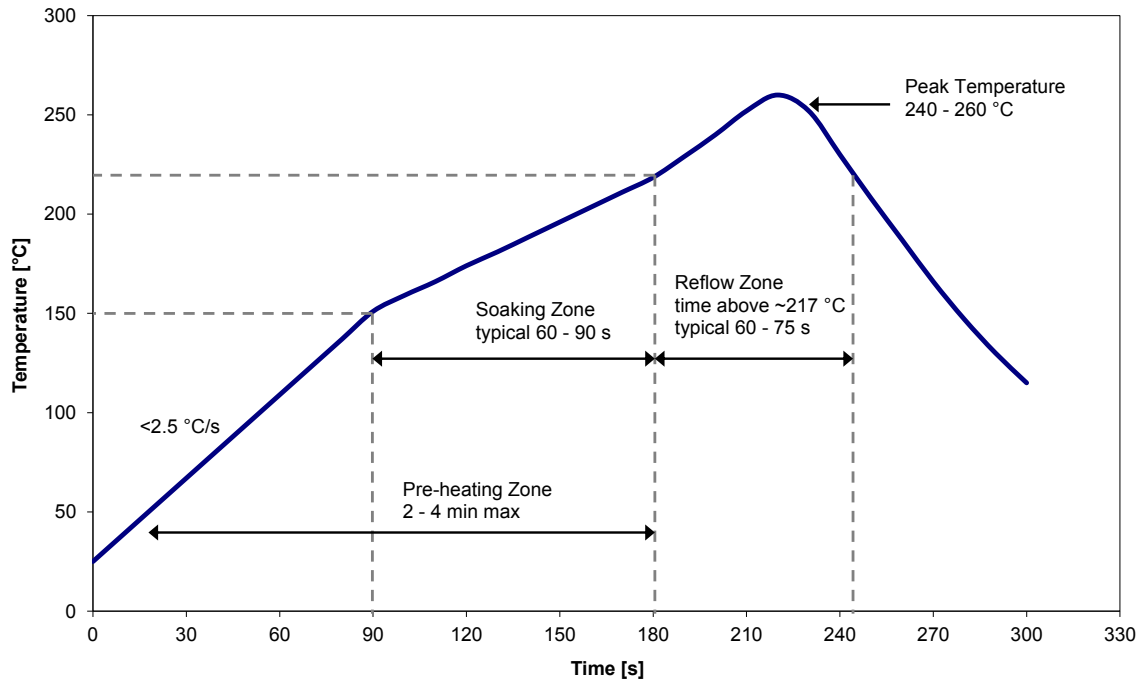


Soldering Conditions The SMD package allows for automated pick-and-place procedures combined with a lead-free automated re-flow soldering process. A typical lead-free soldering profile is shown in the graph 9.

3.2 Operation

Humidity The operation below the dew point may affect the performance.

Figure 9: Typical lead free soldering profile.



Temperature Strong temperature gradients above 1 K min^{-1} may affect the sensor's performance. Before taking a reading, during testing, and / or operation the unit has to become thermally stable (due to its nature as a thermal detector and the high sensitivity of the device).

All data is specified at room temperature. When operating at other temperatures within the specified operating range, parameters may vary. The detectors might operate outside the quoted range but may have degraded performance.

4 Quality and Statements

Quality Excelitas Technologies is a ISO 9001:2015 certified manufacturer with established SPC and TQM. Detector out-going inspections include the parameters responsivity, match, offset, noise, gross leak. Due to high level mass production, individual data is not stored. 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. This device has a moisture sensitivity level of 3 according to IPC/JEDEC J-STD-20E.

Safety Modern high-tech materials are applied in the production of our pyro-electric detectors. Some of these materials are sensitive to high temperature exposure or to specific forms of stress. Our parts are compliant with environmental regulations such as RoHS 2011/65/EU. For details please contact our local representatives. We recommend to always check your local regulations. Disposal shall only be carried out in accordance with the latest legislation and directives. In Europe, WEEE directives must be followed.

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5 Packaging Specification

5.1 General Information

The Excelitas Technologies Tape and Reel packing system protects the product from mechanical and electrical damage and is designed for automatic pick-and-place equipment.

The Tape and Reel packing system consists of a Carrier Tape sealed with a protective Cover Tape to hold the devices in place. The devices are loaded with leads down, into the carrier pockets. The tape is wound onto a plastic reel and the loose end of the carrier tape is kept in place by an additional protective band. The protective band also acts as an reinforcement of the plastic reel to avoid deformation after vacuuming. The conductive carrier tape, and antistatic coated transparent cover tape and reel provide ESD protection.

Information labels, ESD labels and bar-code labels (optional), desiccant, humidity indicator card, all are placed on each reel. Single reel of components are inserted into moisture barrier bag and then vacuumed, regardless of the specified MSL level. Additional Information labels are pasted on the vacuumed moisture barrier bags, which is then wrapped in bubble foil and then placed into boxes before shipping.

Excelitas Technologies' tape and reel specifications are in conformance with the EIA Standard 481 "Taping of Surface-Mount Components for Automatic Placement."

5.2 Carrier Tape

Figure 10 shows the basic outline and dimension labels of the carrier tape. Typically, the carrier tape is constructed from conductive Polystyrene (IV). The uniform film thickness t is 0.3 mm. The Reel size is 10 inches with a maximum quantity per reel of 500 pieces or 13 inches with a maximum quantity per reel of 1500 pieces.

Figure 10: Tape and reel specifications. Package dimensions are given in table 6

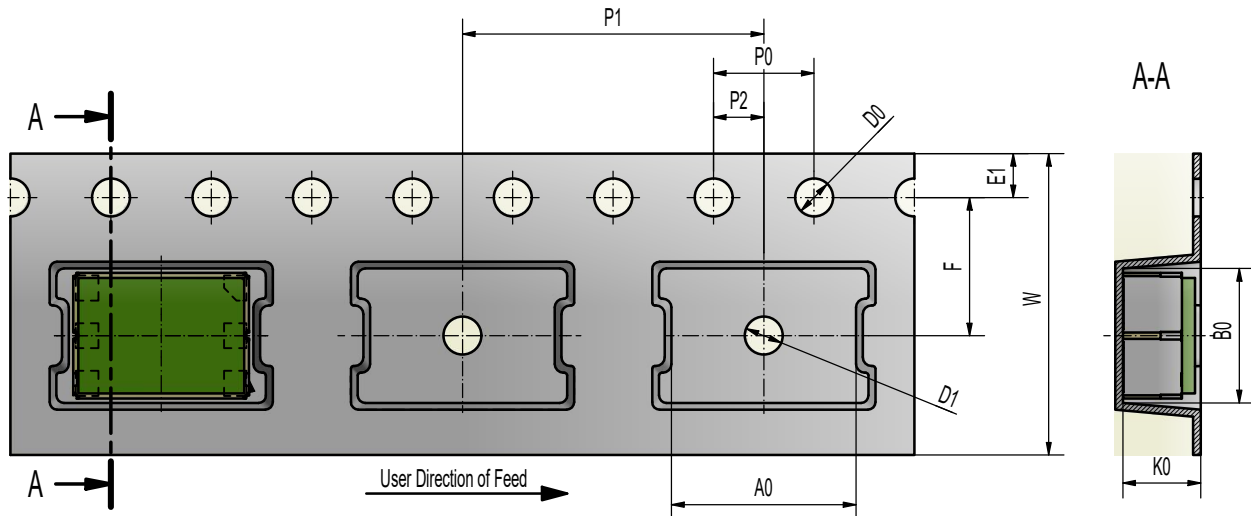


Table 6: Dimensions for figure 10 are given in [mm].

Device	A0	B0	E1	K0	F	P1	W	P0	P2	D0	D1	t
5.0 × 7.0	7.35	5.35	1.75	3.1	5.5	12	12	4.0	2.0	1.5	1.5	0.3

Figure 11: Packaging specifications

