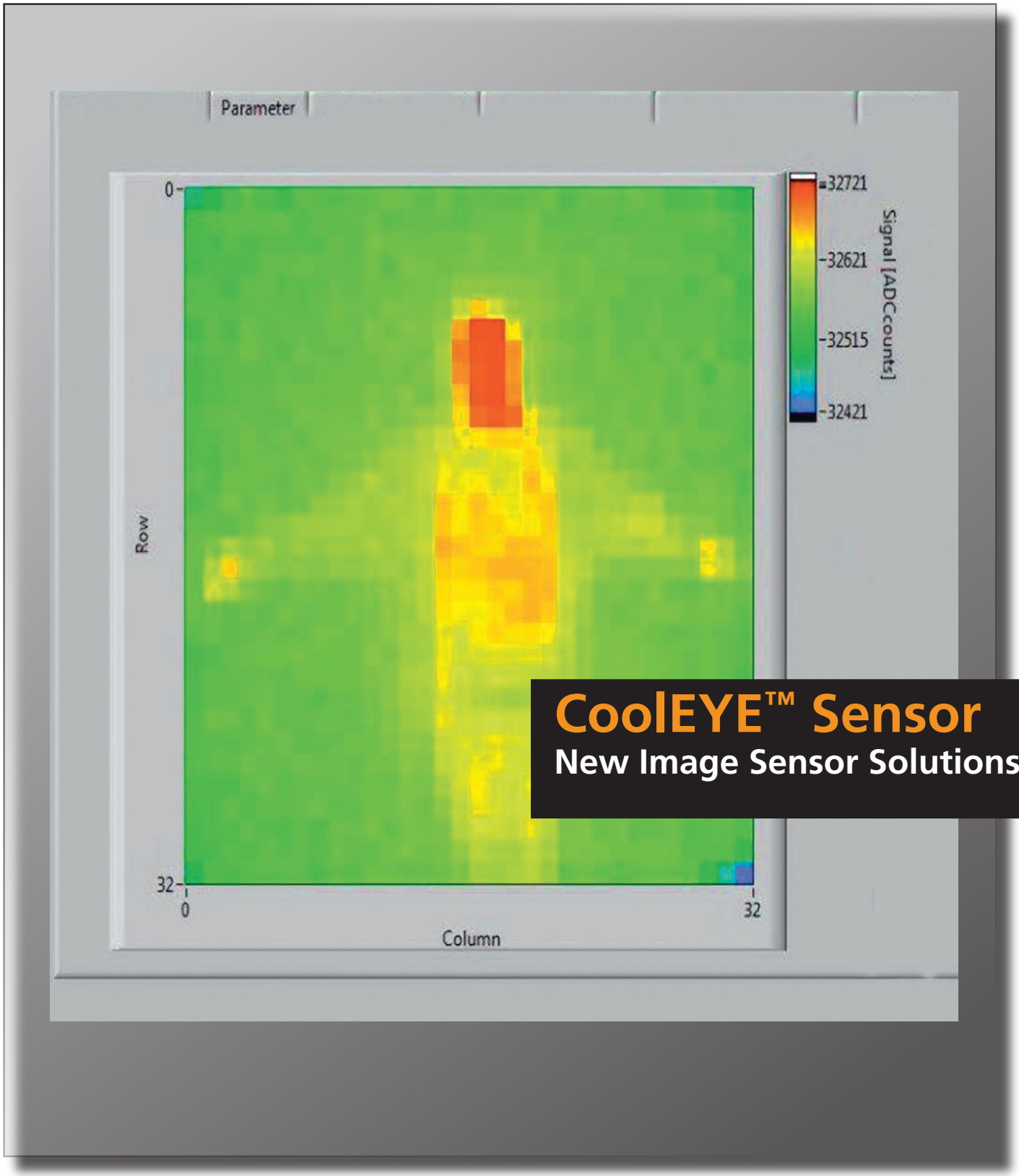
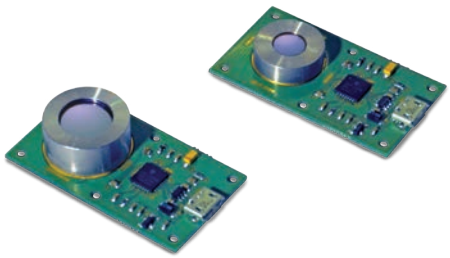


CoolEYE™ Sensor

New Image Sensor Solutions



For Temperature Measurement
and Presence Detection

EXCELITAS
TECHNOLOGIES®

Infrared Sensing Technologies

For Your Cutting-edge Applications.

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 contribute to safeguarding homes, saving energy, and providing comfort – each and every day. From motion and presence detection to gas detection, thermometry and indoor climate control applications, Excelitas' IR sensing technologies and our growing range of IR products are meeting your challenges. We are sensing what you need for your cutting-edge applications.

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

Our Infrared-Sensing Solutions provide:

- Excellent performance
- Strong reliability
- Innovative features

We support our products with:

- Applications expertise
- Customer-driven features and functions

WORLDWIDE COMMITMENT TO YOUR CHALLENGES

You can depend on Excelitas' world-class global network of production, R&D, and distribution centers located in 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 a collaborative partnership in which we are proactively communicating with you and refining the forecasts of your requirements to serve you better.

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 extensive applications expertise to respond to the most demanding detection requirements and to further anticipate your needs. Feel confident that you can discuss your requirements with our engineers. We thrive on addressing your challenges and will always try to provide you with sincere assistance based on our knowledge 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 systems 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 certification to major quality and environmental standards, which are subject to regular audits. All of our manufacturing facilities are state-of-the-art and have received certifications for ISO 9001, OHSAS 18001, NLF/ILO-OSH 2001.

Introduction to Low-resolution IR Imaging

The Thermopile Line Array Module family comprises of line sensors of 1x8-, 1x16- and 1x32-pixel. In addition we offer a spatial configuration of 4x4 pixels. All arrays are modular in design whereas the sensor offers an integrated lens and is mounted on a small PCB that provides the communication interface and connector. The modules use a common design concept: An Array Sensor is equipped with an internal temperature reference for correct target temperature determination and is connected to an integrated signal conditioning circuit. The signal is then fed to a microcontroller with an integrated E^2PROM on a small pcb. This µC is indispensable for the signal processing and interfacing. It further provides the digital output signal by SMBus representing real temperature data for each pixel.

Digital signal processing for temperature accuracy in combination with the numeric ambient temperature compensation algorithm, out performs any discrete solution. For many of our IR components we offer a patented ISOthermal concept which offers unusually high performance under thermal shock conditions.

Our new family of IR Image Sensors is based on high-performance Thermopile designs manufactured entirely in-house. It represents our approach of enabling high-volume applications at low cost. The IR Image Sensors provide spatial IR information without identification of objects and thus maintain people's privacy and data protection when monitoring areas. This approach is ideally suited for presence detection in smart homes, offices and hospitals.

Thermal Imaging Introduction

The CoolEYE™ IR Image Sensor family offers a range of low cost IR camera modules designed for sensing of IR radiation in the mid-infrared range with low resolution. The camera is equipped with single lens optics resulting in a field-of-view of approximately 45° to 60°. The image as well as the the spot size of a single pixel becomes larger as distance increases. As long as the measuring area is larger than the pixel area the measurement result is independent from the distance between camera and object.

The Imaging information is provided to the user by means of an USB interface which also powers the CoolEYE IR Image Sensor. The USB protocol delivers digital representation of uncalibrated and unprocessed TP signal voltage. The voltage signal is converted by a 16-Bit ADC.

The following formula describes the transformation of IR radiation into an electrical signal as per the Stefan-Boltzmann law.

Pixel Signal = ε *k*(Tobj^4-Tamb^4) +Voffset

with: ε = emmisivity of object
k = constant considering pixel sensitivity, optics, physical constants (S. Boltzmann)

Tobj = temperature of the object in the FoV of the thermopile pixel

Tamb = ambient temperature of the thermopile

Voffset = bias voltage and offset voltage from ADC input

The thermopile senses a temperature difference between the object temperature it is exposed to and its own (ambient) temperature. Depending on the sign of the temperature difference the thermopile provides either a positive or a negative output voltage. To allow processing of a bipolar signal with unipolar readout circuit the thermopile is biased.
The ADC sampling rate and data transmission rate of the CoolEYE IR Image Sensor is maximized to allow imaging at 10 frames per second for the largest imager size with 32x32 pixels. This complies with the thermal time constant of a thermopile pixel. If an application accepts slower frame rates it is recommendable to apply averaging of a certain number of consecutive frames to achieve better image quality with reduced noise.

The CoolEYE IR Image Sensor does not apply any signal processing and provides only raw data containing all the tolerances and imperfections that are inherent to thermopile technology, its fabrication, the signal processing as well as lens optics properties.

The CoolEYE IR Image Sensor will be calibrated during fabrication and individual calibration data for each pixel is stored in the Microcontroller. The calibration data can be read out via the USB interface and applied for signal processing in order to compensate for the effects of tolerances and to provide a homogenous and normalized signal for each individual pixel. The principle of signal processing is described in the following sections.

Offset Correction

Each individual Pixel has a certain Offset failure which is mainly caused by fabrication tolerances in thermopile resistance and due to offset currents and voltages of read out electronics. The following formula shows the offset correction principle that should be applied.

Offset corr Pix$_i$ Sig = Pixel$_i$ Signal - OffsCM - Offs$_i$

with:
i = Pixel-and Parameter-index
Offset corr Pixi Sig =Off set corrected Pixel$_i$ Signal
Offs$_i$ = Individual Off set Voltage of Pixel$_i$
OffsCM = Bias Voltage Level

Sensitivity Correction

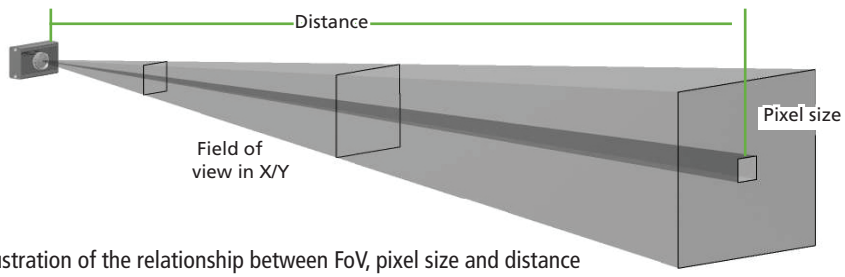
Each individual Pixel has a certain sensitivity range which is mainly caused due to fabrication tolerances, optical and detector material tolerances, as well as aberration effects of the optics. The following formula shows the sensitivity correction principle that is applied by the visualization software.

NormPixel$_i$ Sig = (Offset corrected Pixel$_i$ Signal)/Sensitivity$_i$

with:
NormPixel$_i$ Sig = Normalized Pixel$_i$ Signal
i = Pixel- and Parameter-index
Sensitivity$_i$ = Individual Pixel Sensitivity$_i$ in %

False Pixel Correction

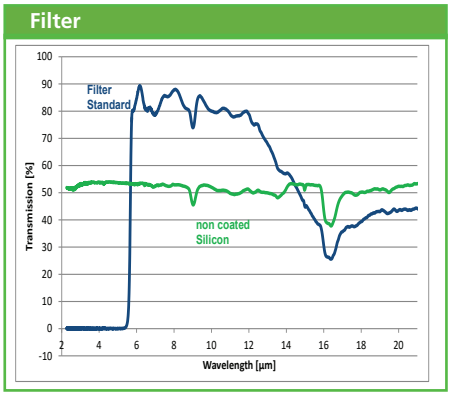
The imager can have up to 1.5 % of defective pixels. The indices of defective pixels that were found during production testing are stored on the CoolEYE IR Image Sensor. The defective Pixel information can be read out via the USB interface in order to replace missing signals from defective pixel with a signal that is interpolated from the neighboring pixels of the defective pixel.



Ilustration of the relationship between FoV, pixel size and distance

Lenses, Filters and Transmission

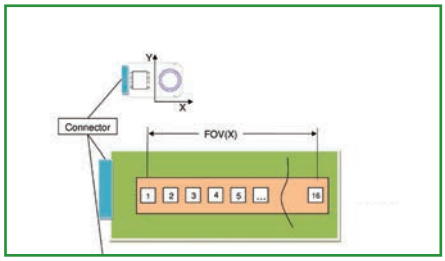
All IR Detectors, Sensors and Arrays need a special window that is transmissive in the working Infrared range. Most passive IR devices work in the mid-IR range which is above 5 µm. Thus we offer our products with either broad band window for low-cost applications or with coated IR filters. All arrays need a focussing lens close to the sensor. Excelitas offers array sensors with built-in lenses and with IR transmissive characteristics as shown above with filters.

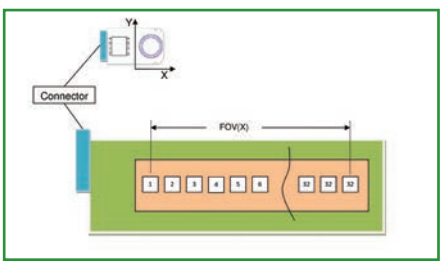


Depending on the lens applied, the arrays will offer different FoV. Several standard focal lenses will be available with our products to suit the application.

Field-of-View of Line Arrays

For the line array family presented herein, two types of lenses will be applicable. For measurement applications we offer L5.5 whereas for presence detection applications, where a wide FoV is desirable, L3.9 is applied. As to the field of view definitions see the diagram below.

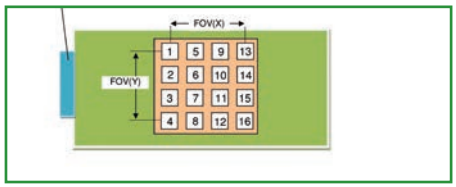


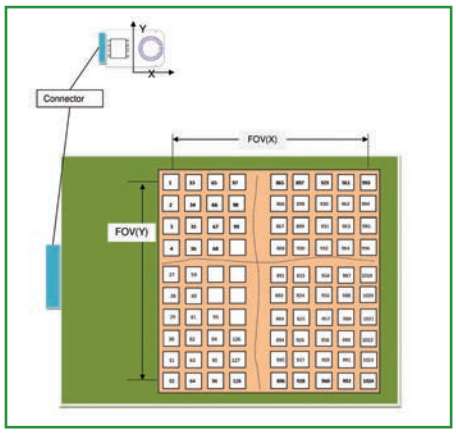


FoV for 2-Dimensional Arrays

The 2-dimensional array family presented herein is designed for the primary purpose of presence detection and automatic processing. Thus, sometimes lesser pixel number is better for fast and easy image processing.

As for FoV, the individual Array Module is equipped with an appropriate lens to enable a wide field-of-view. For the definitions see the diagrams below.





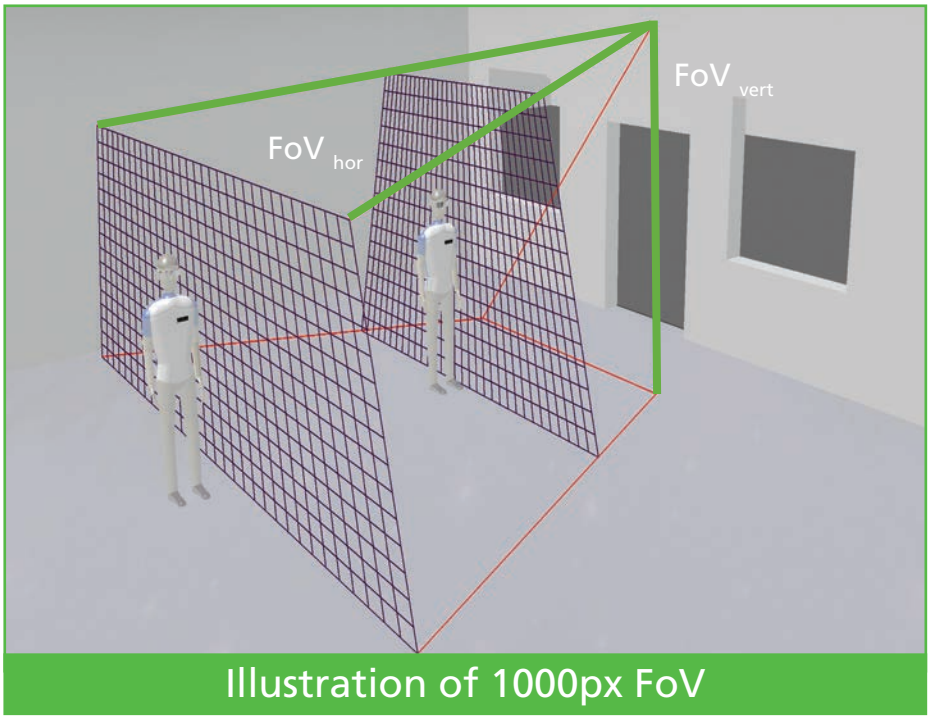
Pixel Number 2-Dimensional Arrays

IR Sensors and Arrays have been used in military applications for many years. Often, even cooled devices were applied to generate high-resolution images with a large number of pixels. Most familiar technology is the microbolometer. Devices are available now even as uncooled sensors, however, they always need an on-time calibration to present an accurate information.

For smart home presence detection those sensors will not be very useful. Too much processing power and slow response will be the downside of high-resolution Imagers.

Excelitas thus presents its family of CoolEYE arrays featuring a reduced number of pixels with high-temperature resolution. The applied technology will not rely upon on-time calibration. The 2-D array family presented herein is primarily designed for presence detection and automated processing. Thus, less pixel are better for faster image processing.

The illustration below shows the spatial resolution of 1000 pixels in a fairly wide FoV and distances up to 8m. We can recognize that in the full range the shape of human being may be recognized and detected with more than sufficient details.



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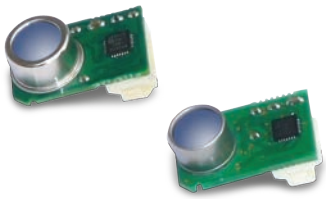


Thermopile Line Array

For Non-Contact Temperature Sensing

TPiL 8T 2246 L3.9, TPiL 16T 3x46 L3.9, TPL 32C 3343 L4.7 Line Arrays

Target Applications

- Non-Contact Temperature Measurement
- Household Appliances: Microwave Ovens
- Printer/Copier Applications

Features and Benefits

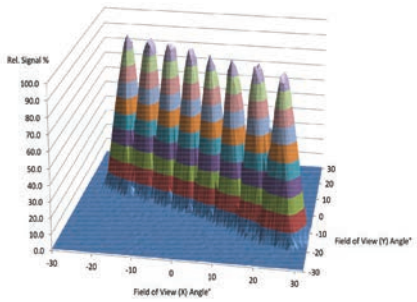
- Digital SMBus
- Factory Calibration
- Ambient Temperature Output
- Noise Reduction Filter

Product Description

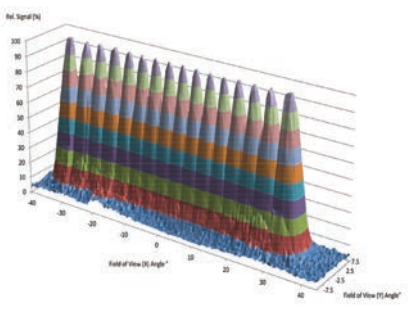
The Excelitas Thermopile Line Array family includes three major versions of modules for non-contact temperature measurement applications. All modules consist of an array sensor with multiplexed output signal which is transferred into a calibrated Signal by a microprocessor located on the modules board. The microprocessor also acts as the SMBus interface. All modules are supplied with connector.

The offerings include an 8-Element Line Array and a 16-Element Line Array for either 60°C max temperature or 120°C max target temperature and a 32-Element Line Array for max 60°C target temperatures. Customized versions are available upon request.

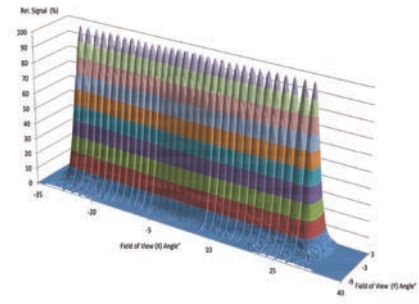
Field of View TPiL 8T 2246 L3.9

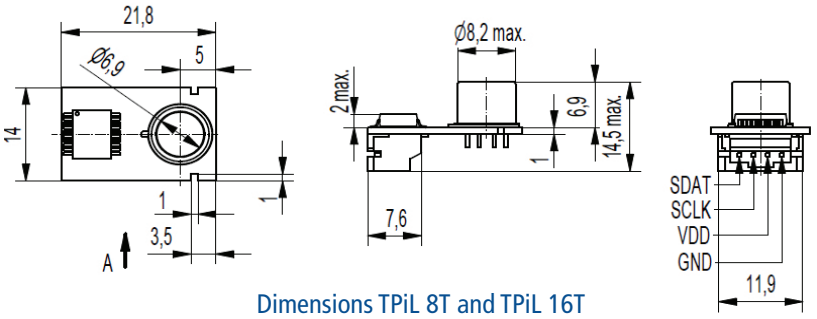


Field of View TPiL 16T 3446 L3.9

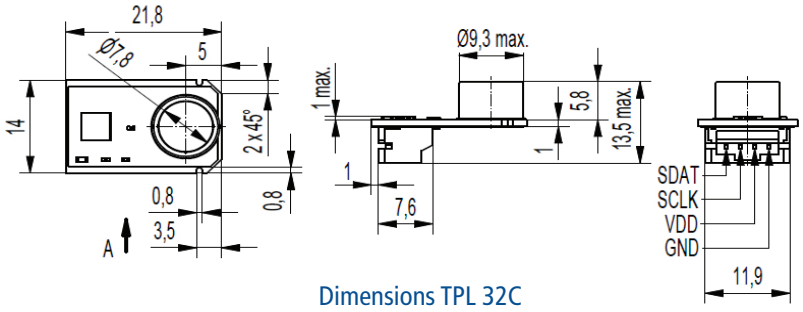


Field of View TPL 32C 3343 L4.7





Dimensions TPiL 8T and TPiL 16T



Dimensions TPL 32C

TPiL 8T 2246 L3.9, TPiL 16T 3x46 L3.9, TPL 32C 3343 L4.7

Parameter	Symbol	TPiL 8T 2246 L3.9	TPiL 16T 3446 L3.9	TPiL 16T 3546 L3.9	TPL 32C 3343 L4.7	Unit	Remark
Sensing Temp. Range		0....60	0...60	0...60	0...60	°C	only A60 Version
Sensing Temp. Range			0...120			°C	only A120 Version
Object Temp. Accuracy		+/- 1,5	+/- 1,5	+/- 1,5	+/- 1,5	°C	
Operating Temp. Range		-25...+100	-25...+100	-25...+100	-25...+100	°C	
Storage Temp. Range		-40...+100	-40...+100	-40...+100	-40...+100	°C	
Supply Voltage	V_{DD}	4,5...5,5	4,5...5,5	4,5...5,5	4,5...5,5	V	
Supply Current	I_{DD}	5	5	5	5	mA	typical
Field of View x direction	FoV_x	50	71	70	59	Degree	peak to peak
Field of View y direction	FoV_y	4	4	4	3	Degree	50% Line
Signal refresh time	$t_{refresh}$	250	400	400	380	ms	
Digital Interface		SMBus	SMBus	SMBus	SMBus		

EXCELITAS TECHNOLOGIES®

Thermopile Line Array

For Non-Contact Temperature Sensing

TPL 32C 3774 L4.7 Fast Line Array

Target Applications

- Non-Contact Temperature Measurement
- Smart Homes
- Scanning Presence Detection

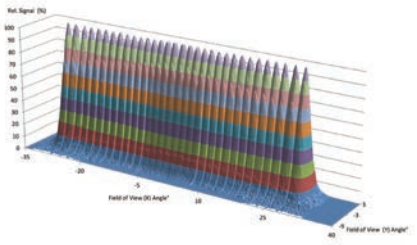
Features and Benefits

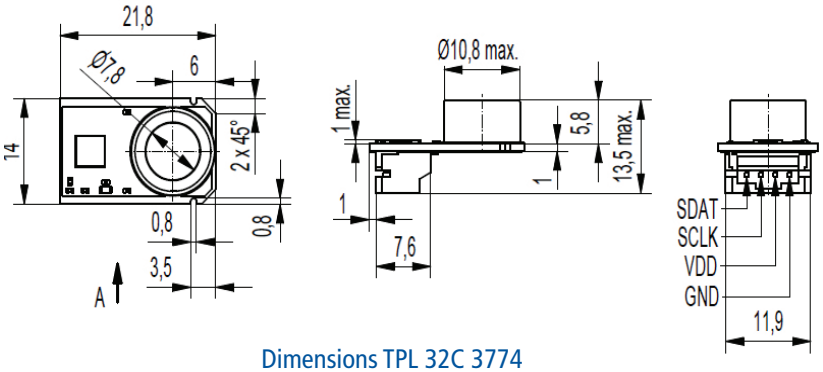
- Digital SMBus
- Factory Calibration
- Ambient Temperature Output
- Noise Reduction Filter

Product Description

This new Excelitas Thermopile Line Array represents the improved version of TPL 32C modules for non-contact temperature measurement and scanning applications. It is featured by parallel read out, and as such, is much faster in response. The new module consists of an improved Array Sensor and small microprocessor which provide a calibrated temperature output signal. The microprocessor also acts as the bus interface. The module is supplied with 4-pin connector. The new 32-Element Line array is designed to measure temperatures up to 60°C.

Field of View TPL 32C 3774 L4.7





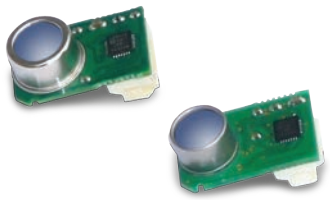
Dimensions TPL 32C 3774

TPL 32C 3774 L4.7

Parameter	Symbol	TPL 32C 3774 L4.7	Unit	Remark
Sensing Temperature Range		0...60	°C	only A60 Version
Object Temperature Accuracy		+/- 1,5	°C	
Operating Temperature Range		-25...+100	°C	
Storage Temperature Range		-40...+100	°C	
Supply Voltage	V_{DD}	4,5...5,5	V	
Supply Current	I_{DD}	20	mA	max
Field of View x direction	FoV_x	59	Degree	peak to peak
Field of View y direction	FoV_y	3	Degree	50% Line
Signal refresh time	$t_{refresh}$	100	ms	
Digital Interface		SMBus		

Thermopile Array

Temperature Sensing and Presence Detection



TPiA 4.4T 4146 L3.9 Spatial Array

Target Applications

- Non-Contact Temperature Measurement
- Smart Home Applications
- Presence Detection

Features and Benefits

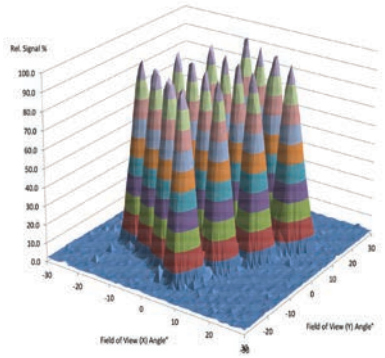
- Digital SMBus
- Factory Calibration
- Ambient Temperature Output
- Low Cost

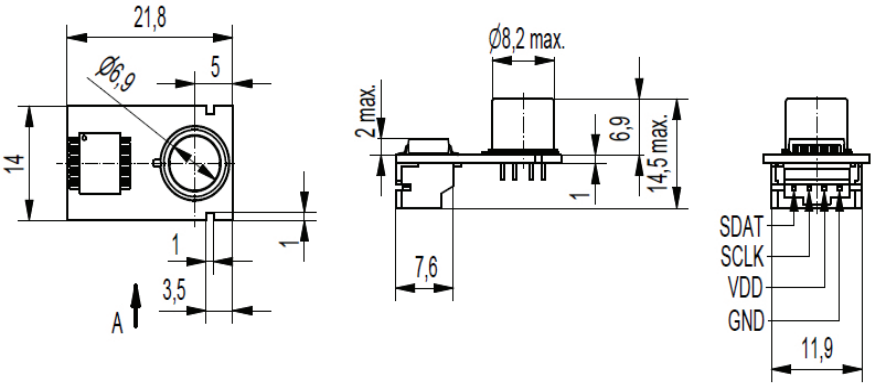
Product Description

This small Infrared Array Sensor offers 4 x 4 pixels. With this it offers the benefits of easy signal processing with spatial infrared imaging at low cost.

The module includes a small IR transmissive lens and the Thermopile Sensor. A microprocessor on the module board provides a calibrated signal and acts as the Bus interface. These new modules are supplied with a 4-pin connector.

Field of View TPiA 4.4T





TPiA 4.4T 4146 L3.9				
Parameter	Symbol		Unit	Conditions
Operation Conditions				
Operating Voltage	V_{DD}	4,5...5,5	V	
Supply Current	I_{DD}	5	mA	typ, V_{DD} 3V
Operating Temperature	T_o	-25...+100	°C	T_{obj} =25°C
Sensing Range		60	°C	
Optical Characteristics				
Field of View	FoV_x	30	Degree	peak to peak
Field of View	FoV_y	20	Degree	peak to peak
Spectral range				
Interface Characteristics				
Interface		SMBus		
Signal Refresh Time		400	ms	

Handling and Precautions

Humidity
All Excelitas IR-detectors shall not increase noise or decrease responsivity when exposed to <=95 % R.H. at 30° C. Operation below dew point (i.e. with condensation) might affect performance.

Hermetic seal
All Excelitas IR-detectors are sealed to pass a He-leakage test with maximum leak rate of 5 x 10^{-8} mbar l /s.

Quality
Excelitas is an ISO 9001-certified manufacturer with established SPC and TQM. Detector outgoing inspections include the parameters Responsivity, 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.

Avoid heat exposure to the top and the window of the part, and keep the window clean. When wiping window use cotton swap with clean alcohol. Do not expose detector to aggressive detergents such as freon, trichloroethylene, etc. Do not scrap the windows.

Since all arrays are supplied as modules with connectors, there is no need to solder the connections to the following circuitry. The modules have fixation holes for easy fixture with small screws to their carrier. Avoid physical stress to the boards when using screw type mounting.

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
US Military (MIL) Standards	
MIL-STD-883	Test methods and procedures for microelectronics

Reliability Standards
Excelitas' continuous reliability qualification and monitoring program ensures that all outgoing products meet quality and reliability standards. Tests are performed according to approved semiconductor device standards, such as

- IEC
- MIL, and JDEC (see table above).

For detailed information please contact Excelitas.

About Excelitas Technologies

Excelitas Technologies is a global technology leader focused on delivering innovative, customized solutions to meet the detection, lighting, optical, imaging, photonic and advanced electronic systems needs of OEM customers.

From safety and security applications to industrial, consumer, medical, analytical instrumentation, clinical diagnostics, and aerospace and defense applications, Excelitas Technologies is committed to enabling our customers' success in their end-markets.

Excelitas Technologies has approximately 7,000 employees in North America, Europe and Asia, serving customers across the world.

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