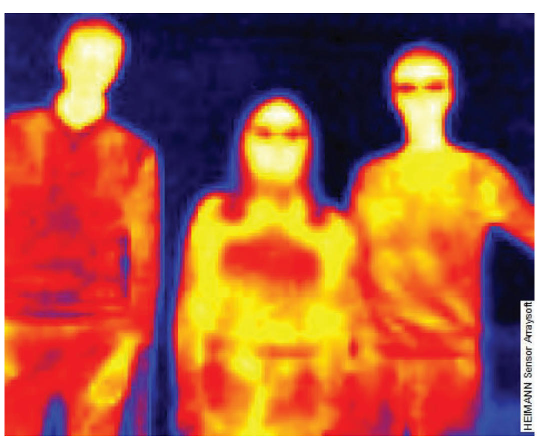
Boston Electronics

Infrared Detector Arrays
Low Cost Thermal Imaging



HEIMANN Sensor

www.boselec.com | boselec@boselec.com | shop.boselec.com | 617-566-3821

Infrared (IR) Imaging Arrays

Silicon-based thermopile IR arrays are the most affordable, robust thermal imaging sensors available. Thermopile imaging arrays, from our partner, Heimann Sensor, are more compact, affordable and scalable in production than other infrared imaging technologies. Heimann offers the worldwide first fully monolithic thermopile arrays in TO-8, TO-39 and TO-46 housing.

The sensors are available in a **variety of array formats**, packages **digital or analog output** and with **integrated lenses**. Thus, the sensors are tailored to your FOV requirements, without the need for expensive, bulky external optics. Further, they are **factory calibrated**, and do not need shutter or non-uniformity correction, thus greatly simplifying the design of your sensor system.

These devices are ideal for high volume applications including:

- surveillance,
- home and building control and automation,
- robotics,
- machine vision
- home security
- instrumentation
- fire monitoring
- anywhere compact, affordable thermal imaging is needed

A wide range of array configurations are available:

- 8x8d elements (digital)
- 16x4d elements (digital)
- 16x16d elements (digital)
- 32x31 elements (analog)
- 32x32d elements (digital)
- 80x64d elements (digital)

Applications Sets

Applications Sets are available for quick-start imaging capability, and allow fast implementation of your system design. These are turnkey kits ready to go out of the box. Application Sets include an IR-Camera with integrated Germanium Optics and an Ethernet interface. A windows-based visualization program allows control and visualization of the image and temperature data streams from up to four cameras.

The sets include:

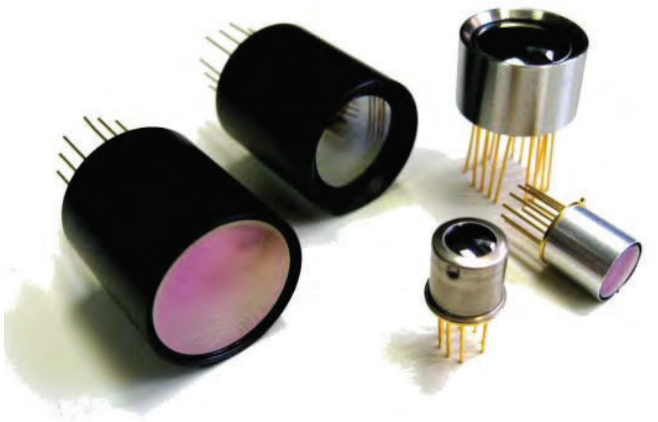
- IR-Camera (80x64d, digital interface or other formats – see catalog)
- Power Supply
- Tripod
- Cables
- Software

Heimann Sensor - Thermopile imaging arrays - Digital output (I2C or SPI)

Array	Package	Lens FL (mm)/f#	Lens material	Application Set (Ready to go, just add your PC)	Array only* Quantity			Array output
					2	20	200	
8x8	TO-46	2.1/0.8	Si	$277.00	$52.00	$31.60	$19.00	I2C
16x4	TO-39	2.1/0.8	Si	$277.00	$57.00	$39.30	$25.60	I2C
		3.6/0.9	Si	$277.00	$53.00	$36.50	$23.80	I2C
		5.5/1.1	Si	$277.00	$53.00	$36.50	$23.80	I2C
16x16	TO-39	2.1/0.8	Si	$277.00	$55.00	$37.10	$24.70	I2C
32x32	TO-39	1.6/0.8	Si	$277.00	$71.00	$62.80	$42.10	I2C
		2.1/0.8	Si	$277.00	$66.50	$50.10	$31.60	I2C
		4.0/0.7	Ge	$277.00	$104.00	$90.30	$60.20	I2C
		5.0/0.8	Ge	$277.00	$80.90	$60.60	$39.00	I2C
80x64	TO-8	3.9/0.8	Ge	$388.00	$268.00	$218.00	$162.30	SPI
		4.8/0.8	Ge	$388.00	$268.00	$218.00	$162.30	SPI
		10.0/0.7	Ge	$388.00	$268.00	$218.00	$162.30	SPI
		10/0.85	Ge/Si	$388.00	$164.00	$127.00	$96.40	SPI
		10.5/0.95	Ge	$388.00	$191.00	$149.00	$113.60	SPI
		21.5/0.9	Ge/Si	$388.00	$184.00	$141.00	$106.10	SPI
		33/1.1	Ge	$388.00	$223.00	$171.00	$125.40	SPI

* Calibrated array prices - uncalibrated arrays are available at lower prices

Field of View Calculation



The FOV can be easily calculated, according to the ray law

$$FOV = 2 \cdot arctan\left(\frac{N_{Col/Row} \cdot P}{2 \cdot f}\right)$$

f= focal length of the lens
P=Pitch of the sensitive elements
NCol/Row=Number of elements in Column or Row, depending if the FOV in horizontal or vertical direction should be calculated

Due to spherical aberrations we will provide detailed information concerning field curvature and distortion, if required.

If the application requires different types of coatings, we can also provide these, including LWP and band pass filters.

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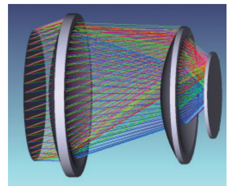

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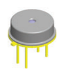
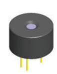
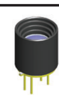
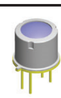
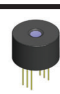
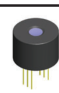
HTPA Series Standard Optics

	TO46	TO39			TO8
	HTPA 8x8d	HTPA 16x4d	HTPA 16x16d	HTPA 32x32d	HTPA 80x64d
IR L0.8/0.8[Si]F5.0 	47° X 47°				
IR L1.6/0.8[Si]F5.0 			54° X 54°	105° X 105°	
IR L1.8/0.7[Ge]ARC 				93° X 93°	
IR L2.1/0.8[Si]F5.0 	23° X 23°	120° X 30°	45° X 45°	90° X 90°	
IR L3.6/0.9[Si]uncoated 		60° X 15°			
IR L4.0/0.7[Ge]F7.7 				40° X 40°	
IR L5.0/0.85[Ge]F7.7 				33° X 33°	
IR L5.5/1.1[Si]uncoated 		35° X 9°			
IR L3.9/0.8[Ge]ARC 					120° X 90°
IR L4.8/0.8[Ge]ARC 					90° X 70°
IR L10/0.7[Ge]F7.7 					41° X 33°
IR L10/0.85[Ge/Si]F7.7 					38° X 32°
IR L10.5/0.95[Ge]F7.7 					39° X 31°
IR L21.5/0.9[Si/Ge]ARC 					19° X 15°

Modifications reserved Rev.15 / 04.042019

Overview Infrared Thermopile Array Sensors

HTPA Assortment

Uncalibrated Sensor	Calibrated Sensor	Module (UDP)	AppSet	FOV [°]	default FPS [Hz]	typical Hi, NETD[mK] @1Hz@25°C	typical UHi, NETD[mK] @1Hz@25°C*
HTPA8x8d							
HTPA8x8dR2L0.8/0.8F5.0HiS[Si]	HTPA8x8dR2L0.8/0.8F5.0HiC[Si]	HTPA8x8dR2L0.8/0.8F5.0HiM(UDP)[Si]	HTPA8x8dR2L0.8/0.8F5.0HiA[Si]	47 x 47	37	124	---
HTPA8x8dR2L2.1/0.8F5.0HiS[Si]	**HTPA8x8dR2L2.1/0.8F5.0HiC[Si]**	HTPA8x8dR2L2.1/0.8F5.0HiM(UDP)[Si]	**HTPA8x8dR2L2.1/0.8F5.0HiA[Si]**	23 x 23	37	127	---
HTPA16x4d							
---	**HTPA16x4R1L2.1EA**	HTPA16x4R1L2.1EA-M(UDP)	**HTPA16x4R1L2.1EA-A**	110 x 25	16	75	---
---	**HTPA16x4R1L3.6EA**	HTPA16x4R1L3.6EA-M(UDP)	**HTPA16x4R1L3.6EA-A**	60 x 15	16	125	---
---	**HTPA16x4R1L5.5EA**	HTPA16x4R1L5.5EA-M(UDP)	**HTPA16x4R1L5.5EA-A**	35 x 9	16	175	---
HTPA16x16d							
HTPA16x16dR1L1.6/0.8F5.0HiS[Si]	HTPA16x16dR1L1.6/0.8F5.0HiC[Si]	HTPA16x16dR1L1.6/0.8F5.0HiM(UDP)[Si]	HTPA16x16dR1L1.6/0.8F5.0HiA[Si]	54 x 54	17,5	160*	---
HTPA16x16dR1L2.1/0.8F5.0HiS[Si]	HTPA16x16dR1L2.1/0.8F5.0HiC[Si]	HTPA16x16dR1L2.1/0.8F5.0HiM(UDP)[Si]	HTPA16x16dR1L2.1/0.8F5.0HiA[Si]	45 x 45	17,5	160	---
HTPA32x32d							
Single Optics							
HTPA32x32dR2L1.6/0.8F5.0HiS[Si]	HTPA32x32dR2L1.6/0.8F5.0HiC[Si]	HTPA32x32dR2L1.6/0.8F5.0HiM(UDP)[Si]	HTPA32x32dR2L1.6/0.8F5.0HiA[Si]	105 x 105	8,3	340*	---
HTPA32x32dR2L2.1/0.8F5.0HiS[Si]	**HTPA32x32dR2L2.1/0.8F5.0HiC[Si]**	**HTPA32x32dR2L2.1/0.8F5.0HiM(UDP)[Si]**	**HTPA32x32dR2L2.1/0.8F5.0HiA[Si]**	90 x 90	8,3	329	---
HTPA32x32dR2L5.0/0.85F7.7eHiS	**HTPA32x32dR2L5.0/0.85F7.7eHiC**	**HTPA32x32dR2L5.0/0.85F7.7eHiM(UDP)**	**HTPA32x32dR2L5.0/0.85F7.7eHiA**	33 x 33	8,3	254	---
Dual Optics							
HTPA32x32dR2L1.8/0.7HiS	HTPA32x32dR2L1.8/0.7HiC	HTPA32x32dR2L1.8/0.7HiM(UDP)	HTPA32x32dR2L1.8/0.7HiA	93 x 93	8,3	160	---
HTPA32x32dR2L4.0/0.7F7.7HiS	HTPA32x32dR2L4.0/0.7F7.7HiC	HTPA32x32dR2L4.0/0.7F7.7HiM(UDP)	HTPA32x32dR2L4.0/0.7F7.7HiA	40 x 40	8,3	140	---
HTPA80x64d							
HTPA80x64dR2L3.9/0.8HiS	**HTPA80x64dR2L3.9/0.8HiC**	HTPA80x64dR2L3.9/0.8HiM(UDP)	**HTPA80x64dR2L3.9/0.8HiA**	120 x 90	9	260	87
HTPA80x64dR2L4.8/0.8HiS	**HTPA80x64dR2L4.8/0.8HiC**	HTPA80x64dR2L4.8/0.8HiM(UDP)	**HTPA80x64dR2L4.8/0.8HiA**	90 x 70	9	390	80
HTPA80x64dR2L10/0.7F7.7HiS	**HTPA80x64dR2L10/0.7F7.7HiC**	HTPA80x64dR2L10/0.7F7.7HiM(UDP)	**HTPA80x64dR2L10/0.7F7.7HiA**	41 x 33	9	233	70
HTPA80x64dR2L10/0.85F7.7HiS[Ge/Si]	HTPA80x64dR2L10/0.85F7.7HiC[Ge/Si]	HTPA80x64dR2L10/0.85F7.7HiM(UDP)[Ge/Si]	HTPA80x64dR2L10/0.85F7.7HiA[Ge/Si]	38 x 32	9	360*	120*
HTPA80x64dR2L10.5/0.95F7.7HiS	**HTPA80x64dR2L10.5/0.95F7.7HiC**	HTPA80x64dR2L10.5/0.95F7.7HiM(UDP)	**HTPA80x64dR2L10.5/0.95F7.7HiA**	39 x 31	9	333	115*
HTPA80x64dR2L21.5/0.9HiS[Ge/Si]	HTPA80x64dR2L21.5/0.9HiC[Ge/Si]	HTPA80x64dR2L21.5/0.9HiM(UDP)[Ge/Si]	HTPA80x64dR2L21.5/0.9HiA[Ge/Si]	19 x 15	9	400*	135*
HTPA80x64dR2L33/1.05HiS**	HTPA80x64dR2L33/1.05HiC**	HTPA80x64dR2L33/1.05HiM(UDP)**	HTPA80x64dR2L33/1.05HiA**	13 x 9	9	450*	150*

Standard parts with shorter delivery time
Avaiable parts in sample quantities
--- Parts not in assortment / not available
* estimated NETD
** on request

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Infrared Thermopile Array Sensors

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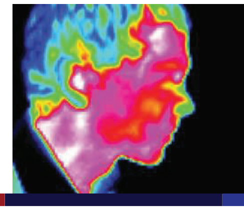

Picture of a face profile

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HTPA80x64d

Infrared Thermopile Array Sensors for Remote Temperature Measurement and Imaging Applications

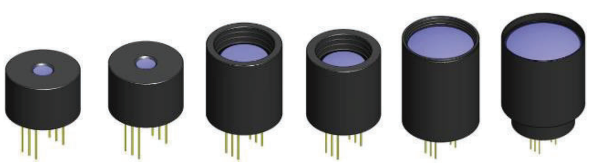
The HTPA80x64d is the bigger brother of the 32x32d infrared array sensor with a resolution of 80x64 pixel inside a TO8 housing.

Due to the digital SPI interface only 6 pins are needed. It has a built-in EEPROM to store all calibration data and a 16-bit ADC. The speed can be set internally via the sensor clock and ADC-resolution between 20 Hz (highest resolution) and 41 Hz (lower resolution).

Available Optics

Optic	L3.9	L4.8	L10	L10.5	L21.5	L33*
FoV [°]	120x90	90x70	41x33	39x31	19x15	12x9
Length of cap [mm]	12.6	14.6	25.7	24.1	35.8	46
Diameter of cap [mm]	20	20	23	23	28	37
F-number	0.8	0.8	0.7	0.95	0.9	1.05

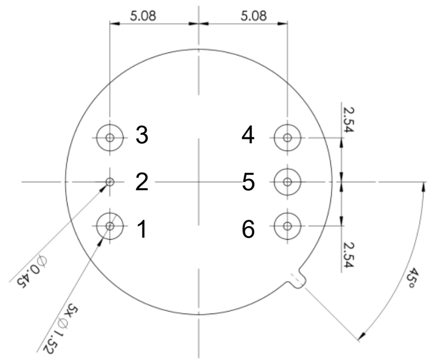
* Only on request



Pin Configuration (SPI)

Pin	Function
1	3.3 V Supply
2	Ground
3	EE_Enable
4	MISO
5	MOSI
6	SCLK

Dimensions



Characteristics

Parameter	Value	Tolerance	Unit
Supply voltage (DC)	3.3	+0.3/-0.0	V
Current consumption	26	+/-5.0	mA
Clock frequency (Sensor)	5	± 3	MHz
Ambient temperature range	-20 to 85		°C
Object temperature range	-20 to >1000		°C
Framerate (full frame)	1 to 41		Hz
Framerate (quarter frame)	4 to 164		Hz
NETD (best optics)	230/70*		mK@1Hz

*: NETD valid for UHi version

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Infrared Thermopile Array Sensors

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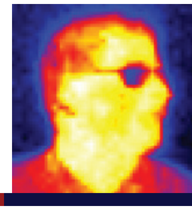

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Picture of a face profile,
taken with the HTPA32x32d L5.0

HTPA32x32d

Infrared Thermopile Array Sensors for Remote Temperature Measurement and Imaging Applications

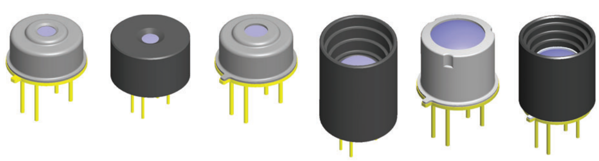
The HTPA32x32d is an infrared array sensor with a resolution of 32x32 pixel in a TO39 housing.

Due to the digital I²C interface only 4 pins are needed. It has a built-in EEPROM to store all calibration data and a 16-bit ADC. The speed can be set internally via the sensor clock and ADC-resolution between 15 Hz (highest resolution) and 27 Hz (lower resolution).

Available Optics

Optic	L1.6 [Si]	L1.8 [Ge]	L2.1 [Si]	L4.0 [Ge]*	L5.0 [Ge]*	L5.0 [Ge]**
FoV [°]	105	93	90	40	33	33
Length of cap [mm]	4.3	7.3	4.45	16.3	7.63	10.41
F-number	0.8	0.7	0.8	0.7	0.85	0.85

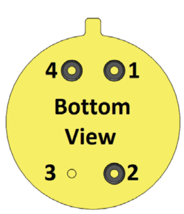
*: Ge optics ensure the best performance thus command a higher price.
**: Same optics but an external aperture for better performance is added.
Other optics are available upon request.



Pin Configuration*

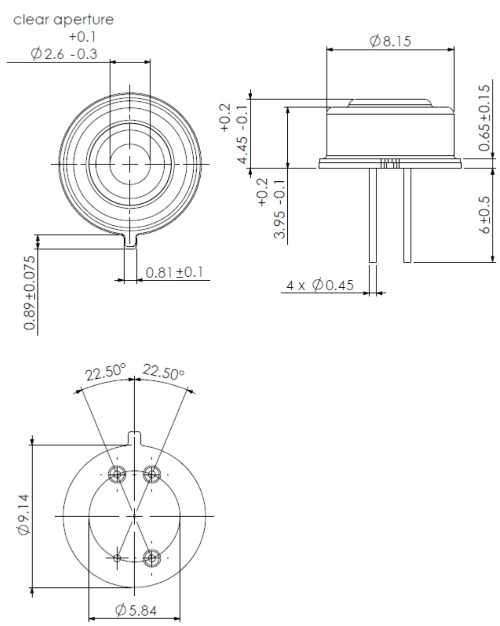
Pin	Function
1	Clock (I²C)
2	3.3 V Supply
3	Ground
4	SDA (I²C)

* HTPA32x32L2.1, TO39 housing (other optics are available)



Dimensions

HTPA32x32L2.1,TO39 housing



Characteristics

Parameter	Value	Tolerance	Unit
Supply voltage (DC)	3.3	+0.3/-0.0	V
Current consumption	5.5	± 1.0	mA
Clock frequency (Sensor)	5	± 3	MHz
Ambient temperature range	-20 to 85		°C
Object temperature range	-20 to >1000		°C
Framerate (full frame)	2 to 27		Hz
Framerate (quarter frame)	8 to 110		Hz
NETD (best optics)	140		mK@1Hz

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Infrared Thermopile Array Sensors

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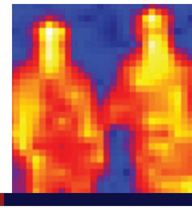

Picture of 2 persons

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HTPA16x16d

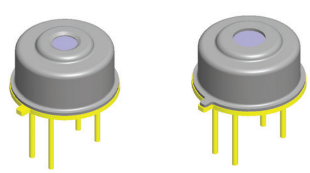
Infrared Thermopile Array Sensors for Remote Temperature Measurement and Imaging Applications

The HTPA16x16d is an infrared array sensor with a resolution of 16x16 pixel in a TO39 housing.
Due to the digital I^2C interface only 4 pins are needed. It has a built in EEPROM to store all calibration data and a 16-bit ADC. The speed can be set internally via the sensor clock and ADC-resolution between 40 Hz (highest resolution) and 70 Hz (lower resolution).

Available Optics

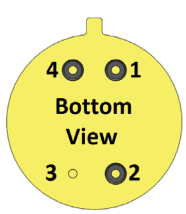
Optic	L1.6 [Si]	L2.1 [Si]
FoV [°]	54	45
Length of cap [mm]	4.3	4.45
F-number	0.8	0.8

Other optics are available upon request.



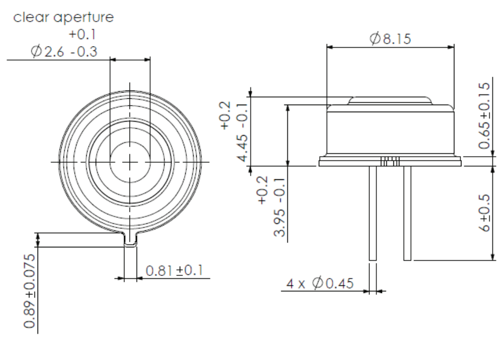
Pin Configuration

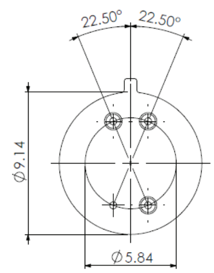
Pin	Function
1	Clock (I^2C)
2	3.3 V Supply
3	Ground
4	SDA (I^2C)



Dimensions

HTPA16x16L2.1,TO39 housing



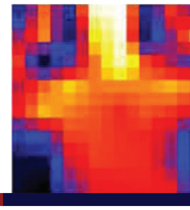


Characteristics

Parameter	Value	Tolerance	Unit
Supply voltage (DC)	3.3	+ 0.3/-0.0	V
Current consumption	3.5	± 1.0	mA
Clock frequency (Sensor)	5	± 3	MHz
Ambient temperature range	-20 to 85		°C
Object temperature range	-20 to >1000		°C
Framerate (full frame)	2 to 70		Hz
Framerate (half frame)	8 to 140		Hz
NETD	160		mK@1Hz

Modifications reserved Rev.04 / 04.04.2019

Infrared Thermopile Array Sensors



Picture of a person with raised arms

HTPA8x8d

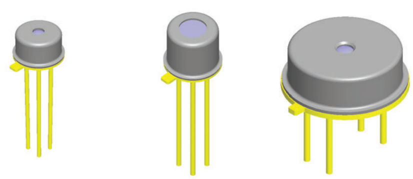
Infrared Thermopile Array Sensors for Remote Temperature Measurement and Imaging Applications

The HTPA8x8d is the world smallest infrared array sensor with a resolution of 8x8 Pixel inside a TO46 housing.
Due to the digital I²C interface only 4 pins are needed. It has a built-in EEPROM to store all calibration data and a 16-bit ADC. The speed can be set internally via the sensor clock and ADC-resolution between 89 Hz (highest resolution) and 160 Hz (lower resolution).

Available Optics

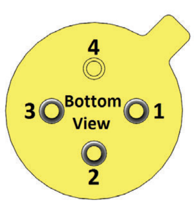
Optic	L0.8 (TO46)*	L2.1 (TO46)	L0.8 (TO39)
FoV [°]	47	23	47

* Only on request



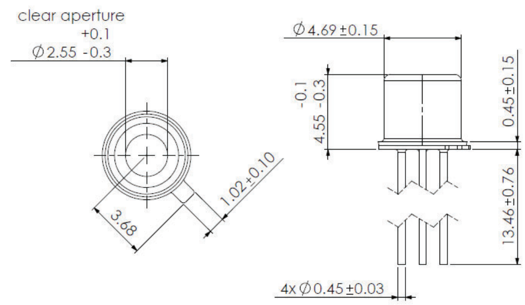
Pin Configuration

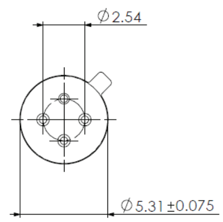
Pin	Function
1	SDA (I²C)
2	Clock (I²C)
3	3.3 V Supply
4	Ground



Dimensions

HTPA8x8L2.1,TO46 housing



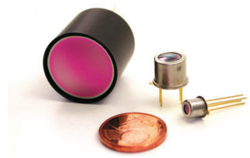


Characteristics

Parameter	Value	Tolerance	Unit
Suppy voltage (DC)	3.3	+ 0.3/-0.0	V
Current consumption	1.8	± 0.5	mA
Clock frequency (Sensor)	5	± 3	MHz
Ambient temperature range	-20 to 85		°C
Object temperature range	-20 to >1000		°C
Framerate	7 to 160		Hz
NETD	ca. 115		mK@1Hz

Modifications reserved Rev.08 / 04.04.2019

HEIMANN Sensor
HEIMANN SENSOR GMBH



Boston Electronics

Quick Start Application Set

Read-out Circuit for Instantaneous Sensor Evaluation

For thermal imaging and easy evaluation of our arrays, we designed an application set in a modular metal housing for better handling.

The modules field of view depends on the built-in lens and can be varied on demand. The object temperature range depends on the array type and lens.

For every array type we also provide a matching application set in our portfolio, which allows full sensor control. The application set processes the data and communicates via Ethernet/UDP to a PC. On PC side, the data stream can be visualized and logged with a Graphical User Interface. The given software allows the user to instantly start with sensor evaluation, measurements and testing.

Applications

- Person detection
- Fire detection
- Hotspot detection
- Energy management
- Security cameras
- Industrial process control
- Air condition control
- Position detection

Benefits

- Low-cost TO8/TO39/TO46 housing
- Resolutions 8x8d/ 16x16d/ 32x32d/ 80x64d/ 84x60d/ 120x84d available
- Low power consumption
- Short time constant
- High sensitivity of the system
- No need for shutter and thermal stabilization

Features

- Communications via UDP (Ethernet)
- False color images with auto scaling
- Selectable frame rate
- Data log mode
- Contrast adjustment
- Interpolation
- Temperature display
- Several lenses for different fields of view

Included in Delivery

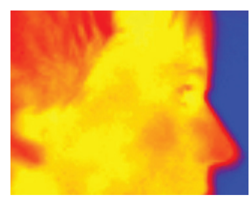
- Array module
- Interface cable
- USB cable for power supply
- Tripod
- Graphical User Interface (GUI) for visualization

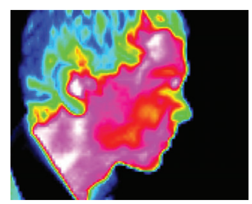
Module Dimensions

- Diameter 28 mm; length approx. 55 mm (length depends on chosen lens)

Setup

Thermal Imaging Pictures





Modifications reserved Rev.7 / 04.04.2019

HTPA Application Set


Picture of a face profile

Heimann Sensor ArraySoft v2

Graphical User Interface for HTPA Application Sets

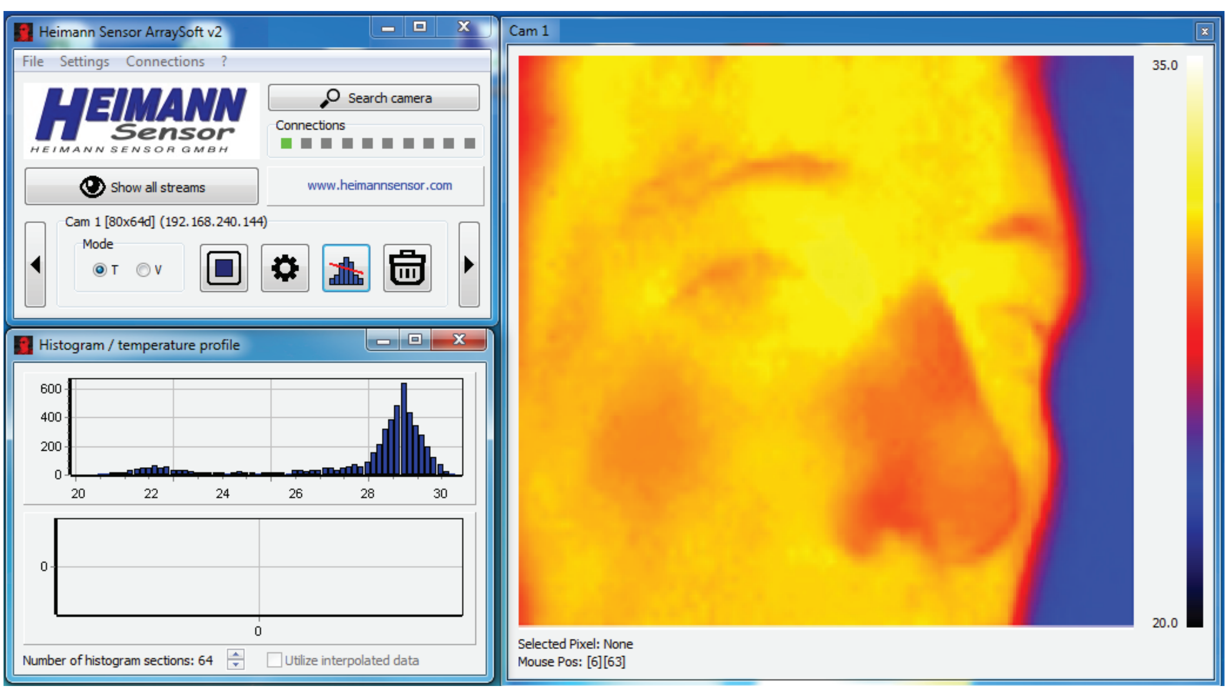
The HTPA Application Set comes with our new comprehensive Graphical User Interface (GUI) “ArraySoft v2”, which provides a lot of features and is constantly updated.

It can be used with our digital HTPA Application Sets and enables instant visualization of your measurement data and a quick start for feasibilty studies. Other applications are possible, too.

Features

- Many diverse and self designable color scales
- Auto and manual scaling (9 scaling modes)
- Temperature and voltage mode
- Data streaming into files
- AVI export
- Interpolation mode (up to 8x, bicubic/bilinear)
- Complete control of the device
- Multiple, sensor-type independent devices can be controlled
- The data stream of 10 devices can be displayed at the same time
- Histogram
- Selectable temperature or voltage profile
- Filter features: IIR, FIR, Median, adaptive averaging, averaging
- Minimum and Maximum Temperature / Voltage info
- Suitable for all digital HTPA types (8x8d to 120x84d)
- Frames per second indicator
- Alignment for offset corrected frames
- Temperatures in Kelvin, degree Fahrenheit or degree Celsius
- IR-Frame can be mirrored in both axis
- Single Pixel information accessible
- Temperature calculation based on object emissivity
- Screenshot ability (JPG or ASCII data)
- Make your own “thermal movie”
- Time lapse option for videos
- Alarm feature

Instant Visualization



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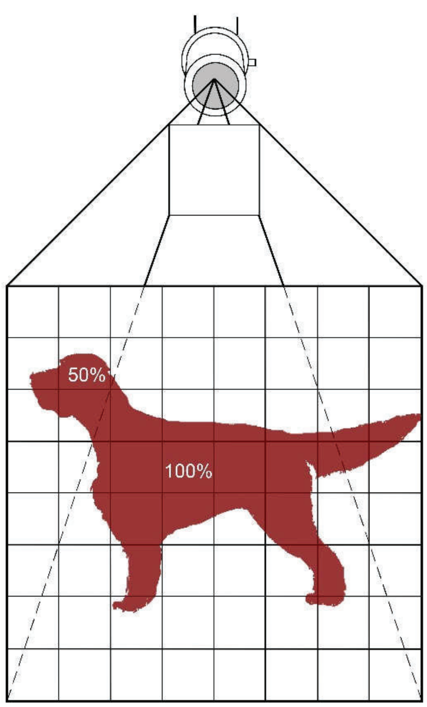
Basic expertise for spatial radiometric measurements

How to obtain the best visual performance for your IR image

An IR camera optics is usually described by the same parameters as optics for the VIS spectrum, the main difference between the two is the material: For IR optics usually Germanium, Silicon, Zinc Sulfide or Chalcogenide is used, since these materials show good transparency in the IR spectrum. The most common are Ge and Si, where Ge shows a better transparency but at the cost of higher price.

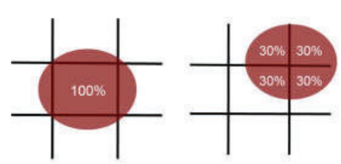
The two main parameters to describe the optic system is the focal length and the f-number. The focal length (f) determines in combination with the dimension of the focal plane area (FPA) the field of view (FOV) of the camera. The f-number (N) is the ratio of the focal length to the diameter of the entrance pupil (D). Since it is defined as N=f/D, the f-number gets smaller the larger the entrance aperture gets. The smaller the f-number, the more radiation can be received by the IR sensitive chip, resulting in a better signal to noise ratio (SNR). Low f-numbers of course require a lens system with larger diameters, resulting in a higher price of the system. Furthermore, the f-number also has an influence on the dynamic range (temperature measurement interval) of the IR camera: The lower the f-number, the more radiation will be detected by the IR sensitive pixel at the same object temperature, resulting in a smaller object temperature measurement range. The object temperature measurement range can be expanded by optical filters, which cut off certain parts of the IR spectrum. This allows good SNRs for lower object temperatures as well as increased measurement range.

The pixel pitch of a chip and the FOV of the optical system are the main parameters that determine the spatial resolution of the measured object. Usually, our standard optics set to infinity, which means that each object will generate a sharp image, if the distance between principal plane of the optics and the object is large enough. If the image of the object (or, more precise, the image of specific features and details of the object) gets smaller than the pixel pitch, the pixel will detect a mixed temperature of the object and the background. For a better explanation refer to the following image:



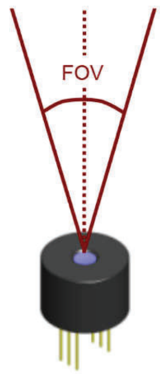
There are two pixels, where the filling factor of the dog versus the background is shown. For the 100% pixel the camera will detect the temperature of the specific part of the dog, but for the 50% filled pixel, the camera will measure the superposition of the dogs head temperature and the background. In example: If the dogs head temperature is 30°C and the background is 20°C, the camera will detect 25°C.

Therefore it can be seen, that small features of object may not be reliable detected under certain circumstances. This is of course true for every IR camera. Also, movement of an object may change the reading significantly, as shown here:



Position 1 Position 2

The ray law can coarsely determine the FOV of the camera:



$$FOV = 2 * arctan\left(\frac{P * n}{2 * f}\right)$$

P equals the pixel pitch, n the number of elements in the corresponding direction. This means the FOV can vary in x and y direction, if the number of elements is not equal in both directions. In example: An 80x64 thermopile array has a pixel pitch of 90µm. Combined with a 17mm focal length optics the FOV will result in 24° x 20°.

$$FOV = 2 * arctan\left(\frac{90\text{e-}6 * 80}{2 * 0.017}\right) = 23.9°$$

Note, that this formula does not work well for wide FOV optics, since the aberrations of the system can be not considered.

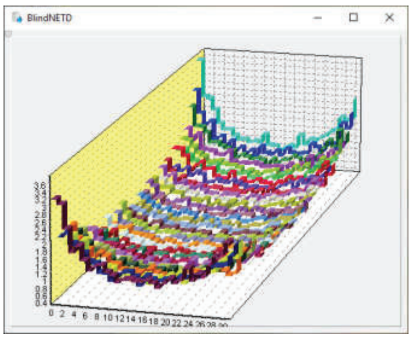
To determine if an image is large enough for a filling factor of 100% also the ray law can be used: The image size *I* can be easily calculated by I=(O*f)/d, where O is the object size, f the focal length and d the distance of the object. The image size divided by the pixel pitch results in the number of pixels illuminated. In example: A human with a shoulder width of 50 cm is 1.5 meters distant from an HTPA32x31L10. Therefore, f=0.01m, O=0.5m, d=1.5m I=3,33E-3m. With a pixel pitch of 220µm, this result in 15 pixels illuminated.

Tips and tricks for GUI design

How to obtain the best visual performance for your IR image

False color scaling limits:

These are the most important parameter and the first thing to look at. First thing is to understand the typical noise performance of the IR sensor. Since there is usually less signal on the outer pixels than on the central ones (due to vignetting and cos^4-law) but the electrical noise of each pixel is basically the same, pixels with larger distance from the center show generally a worse SNR. This effect leads to a higher NETD (**N**oise **E**quivalent **T**emperature **D**ifference) for the pixels in the corner of the FPA (**F**ocal **P**lane **A**rray). For the extreme wide angled lenses corner pixels maybe even do not get any signal, rendering these pixels blind. This means these pixel will show extremely high noise, which can be multitudes higher than the actual content of the frame. Please find here an actual NETD plot for each pixel of an HTPA32x32d with a wide FOV (**F**ield **o**f **V**iew) optics:



It can be seen, that the noise caused by the corner pixels is approximate 4 times higher than in the central area of the FPA. Therefore if your algorithm picks the minimum and maximum temperature in the frame and sets them to black respectively white (for a simple grey scale) the image will have a high flicker noise, since the corner values will shift the boundaries of the scale with each single frame. This leads to huge offset shifts of the color of the central pixels even if the scenery is timewise invariant.

Solutions for noise depression:

- Create the average of the i.e. three pixels with the lowest and highest reading and use that as the grey scale limits. This means that a small amount of pixels will be out of the scaling range, but the boundaries will be much more stable over time.
- Also, it is possible to use the average of the max/min reading in a moving average over time. This will decrease the noise on the boundaries as well.
- A combination of the two methods can be used as well. These two methods can be enabled with the "Smoothing" function in the Heimann Sensor GUI v2.
- Furthermore, a small hysteresis on the scaling algorithm also makes sense to avoid many dynamical changes of the content of the frame. If scale.max and scale.min is the actual max/min value of the scale and frame.max and frame.min are the values to be displayed this can be implemented like this:

```
bool ReScale=false;
if((scale.max>(frame.max+AUTOSCALEHYST))||(scale.max<(frame.max-AUTOSCALEHYST)))
    ReScale=true;
if((scale.min>(frame.min+AUTOSCALEHYST))||(scale.min<(frame.min-AUTOSCALEHYST)))
    ReScale=true;
```

  AUTOSCALEHYST is a value, which needs to be determined in dependency of the system. The Heimann GUI v2 usually uses 0.8 in most cases.

Tips and tricks for GUI design

How to obtain the best visual performance for your IR image

Furthermore, the way the boundaries of the false color scale are determined has a high influence on the image quality. Especially in very high contrast scenarios it might make sense to set the grey scale not to the min or max value of the frame content. In example if there are humans and very hot objects in the image but the focus of the application lies on the humans, the max boundary should be set to a value which is slightly higher than the body temperature of the humans.

Solutions for min/max determination

These depend strongly on your application. In most scenarios a simple detection as described above (combined with the "Smoothing") is the best approach. Please check the manual scaling methods in the GUI v2 to get an overview on possible solutions. In example for the above described method a dynamic minimum scale, but a fixed maximum at 37°C will help tremendously to shift the dynamic range of the image towards the humans.

Graphic improvements

Noise depression

The noise in the image can be decreased by the following methods:

- Moving average of the readings of each pixels over time.
  - Pro/Con: Decreases the noise, but has a tremendous effect on the bandwidth→slow. Recommended for static or slow changing scenarios
- Adaptive averaging: This is basically also a moving averaging of each pixel over time, but with the precondition that the actual difference of the reading to the pre-calculated average must be smaller than a given threshold to apply the new average. If the difference is larger, than the actual reading is displayed. Otherwise, the moving average is displayed. Check the "AdapAv" option in the filter settings of the Heimann GUI v2. The threshold can be set in this case with the slider, but for a single system it can be set i.e. to five times the NETD of the system. The average is calculated in the GUI for four frames, but of course different values can be used.
  - Pro/Con: Good noise depression, but can generate "ghosts" in the image. Dynamic influence on the bandwidth of each pixel, which cannot be predicted.
- Low pass filters: In the GUI there are two low pass filters implemented. One IIR (**I**nfinite **I**mpulse **R**esponse) and a FIR (**F**inite **I**mpulse **R**esponse) low pass filters. These can cut of high frequent noise. Both are designed to a cut-off frequency of 3Hz when input is driven with 10Hz. They utilize a second order Bessel window. Code for these can be found in the subfolder "CodeExamples" of the GUIv2 folder.
  - Pro/Con: Very good high frequency noise depression without the huge influence on the bandwidth (approx. -20dB at 4Hz, but around -80dB for 5Hz). Both filters create a significant group delay, approx. 130ms for the IIR and 1.5s (!) for the FIR. Needs huge amounts of memory →(TAP_NUM+1)*pixelcount of the device.

Tips and tricks for GUI design

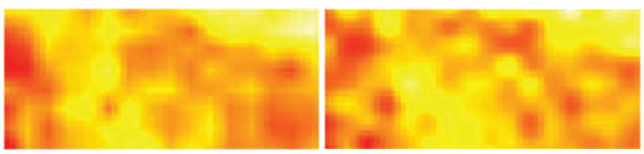
How to obtain the best visual performance for your IR image

- Median filter: Can be used to get rid of “salt and pepper noise” while it doesn’t matter if this is static (offset differences of the pixel) or dynamic noise. This is a simple sorting of the eight adjacent neighbours of each pixel and taking the median of these readings for the central pixel reading. If there are large contrasts in the respective pixels the contrast may be reduced by taking simply the median. Therefore the Heimann GUIv2 utilizes a threshold, which determines belwo which contrast ratios of the respective pixels the median should be applied. A careful design of this threshold will show good results
    - Pro/Con: No influence on the bandwidth, needs small processing power and almost no memory. May decrease contrast (blurry image) if applied uncareful and without threshold.

Interpolation

By using interpolation methods the resolution of the image can be enhanced. The easiest way to do this is the bilinear algorithm. Since this relatively trivial please refer to Wikipedia for this. Another way is the bicubic interpolation, which shows less artifacts but needs much more processing time. A bicubic interpolation algorithm can be found as plain c-code in the “CodeExamples” folder of the GUIv2 subfolder.

Bilinear algorithm (left) compared to the bicubic (right)



Cleaning and Handling of Sensors with Optical Elements

Cleaning of Filter with Isopropyl Alcohol or Acetone

This is the method most universally used for cleaning optical elements with or without coatings. Filters or lenses mounted in our sensors may be cleaned rubbing the surfaces lightly with a clean, soft, all-cotton cloth or cotton swab during immersion in solvent or simply moistened with the solvent. The parts are then immediately wiped dry with another clean, soft, all-cotton cloth or cotton swab.

Cleaning with Detergent and Water

A very mild, non-abrasive detergent (one which does not contain additives) and water may also be used for cleaning optical elements. In general, a detergent and water mixture is an excellent method for removing fingerprints and other smudges. The liquid detergent is first mixed with deionized water (proportions recommended by the manufacturer should be followed). The element is then washed, rinsed, and immediately wiped dry. Use a clean, soft cloth when cleaning and drying. If the part is allowed to dry in air, a permanent stain may result.

Please note:

- Do not use isopropyl alcohol or acetone or detergent if the elements will be mounted in an assembly with a finish which may be soluble by these solvents.
- Please avoid glass isolation being moistened by solvent.
- If the part is allowed to dry in air, a permanent stain may result.

Handling Advises

Sensors with optical elements deserve special consideration in their handling and care. Ordinarily, filters or lenses are cleaned and inspected prior to shipment. If proper care is exercised during handling cleaning should not be necessary prior to use.

- Wear gloves when handling a sensor or optical element. Lightweight nylon or cotton gloves which are relatively lint-free are recommended.
- Avoid touching the surface of filters and lenses.
- Protect devices from static discharge and static fields.
- Thermopile sensors are electrostatic sensitive devices. Sensors should be handled over an electrostatic protected work area.
- Precautions should be taken to avoid reverse polarity of power supply for sensors with integrated signal processing. Reversed polarity of power supply results in a destroyed unit.
- Sensors should rest preferably in a partitioned container where the mounted filters or lenses will be not coming into contact with other material.
- During storage optical surfaces should be covered to avoid contamination from the surrounding environment.
- A covered container can eliminate damage during transportation and storage.
- Sensors or optical elements should be stored in a restricted access area to eliminate handling by untrained personnel.
- Do not expose the sensors to aggressive detergents such as freon, trichlorethylen, etc.
- Avoid rotating the sensors when they are soldered into a PCB or something similar
- Shortening of the pins is not suggested. This may cause cracks in the glass of the pins and result in a leakage.
  - If this is necessary, a tool for this is recommended. Please contact Heimann Sensor for further information.

Soldering Recommendations

Attention: For all of our array sensors we give no guarantee on the calibration and its performance if the pins are shortened by the customer. Additionally we strongly recommend to not soldering the sensor with its back plate directly to a PCB. This will cause different thermal conductivity compared to air and the measurement results could get worse. Use a minimum gap between PCB and backplate of 2mm or more. The glass of the pins to the back plate can get damage by applying high temperatures (during soldering), which will lead into a lower temperature reading what cannot be repaired afterwards.

Manual Iron Soldering and Automatic Point-to-Point Iron Soldering

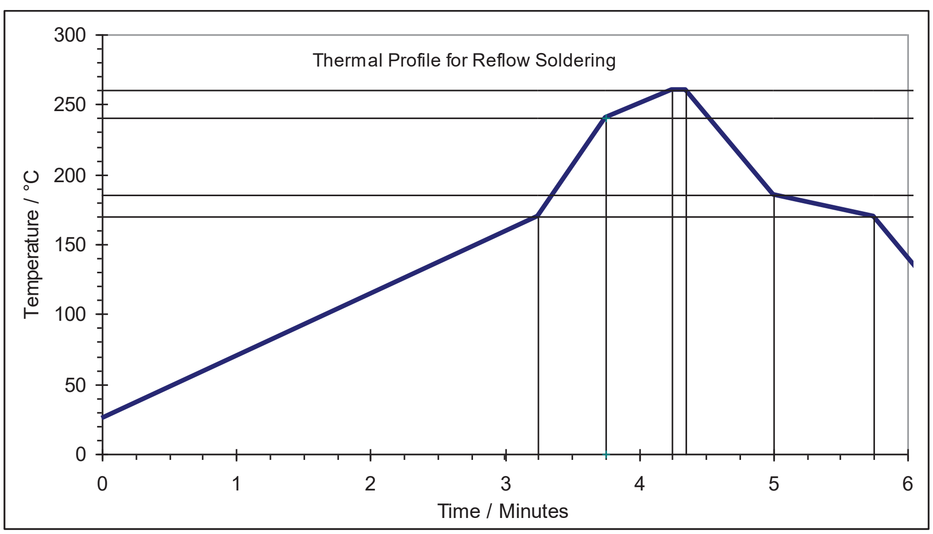
Manual Iron Soldering and Automatic Point-to-Point Iron Soldering methods are allowed for TO packages. It is recommended for through hole applications to shield the package body from soldering heat by PCB or similar.
The soldering iron temperature should be set as low as possible (maximum 350C) and should not exceed recommended soldering time (maximum 5 seconds).

Wave Soldering

Wave soldering is not recommended for Surface Mounted Device packages.
Wave soldering is allowed for through hole application. A pre-heating step is required and should be performed in accordance with international standard recommendations. For TO packaged products, during the pre-heat and soldering phase, the temperature of the body shall not exceed 170°C.

Reflow Soldering

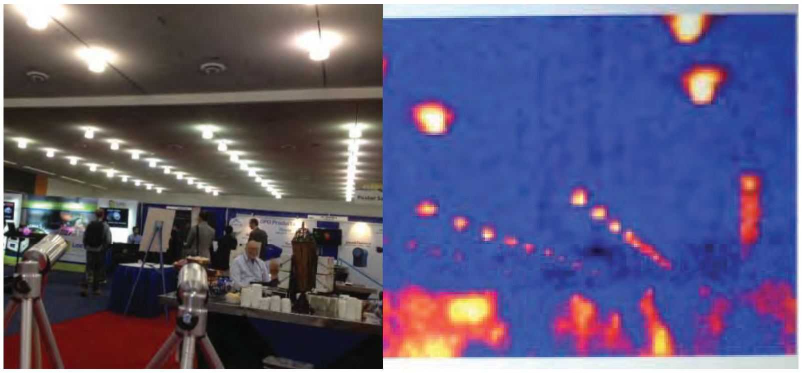
Reflow techniques can be used to solder Surface Mounted Device packages. Temperature profile should conform to those described in Jedec-020 standard (recommended reflow furnace profile below).
Reflow soldering creates a risk for exposing the sensor body to excessive temperatures around and above the TG of used epoxies. Process validation has been carried out by samples exposed to maximum temperature of below furnace profile.



Disclaimer

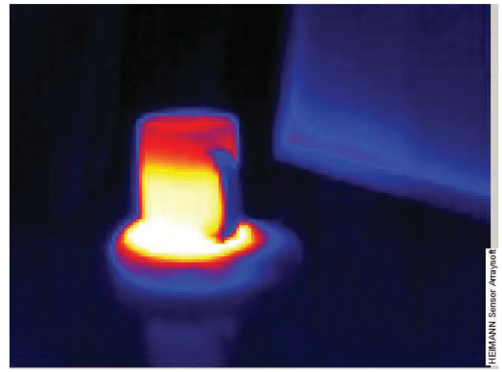
Although these Recommendations are presented in good faith and believed to be correct, Heimann Sensor makes no representations or warranties as to the completeness or accuracy of these recommendations. The recommendations therefore are supplied upon the express condition that the persons and/or

companies receiving them will make their own determination as to the suitability of these recommendations for the intended purposes prior to use.
In no event will Heimann Sensor be responsible for damages of any nature whatsoever resulting from the use of or reliance upon the recommendations.
No representations or warranties, either express or implied, of fitness for a particular purpose or of any other nature are made hereunder with respect to these recommendations.
Notwithstanding any other provision in these recommendations, the customer will remain solely responsible for its soldering process.

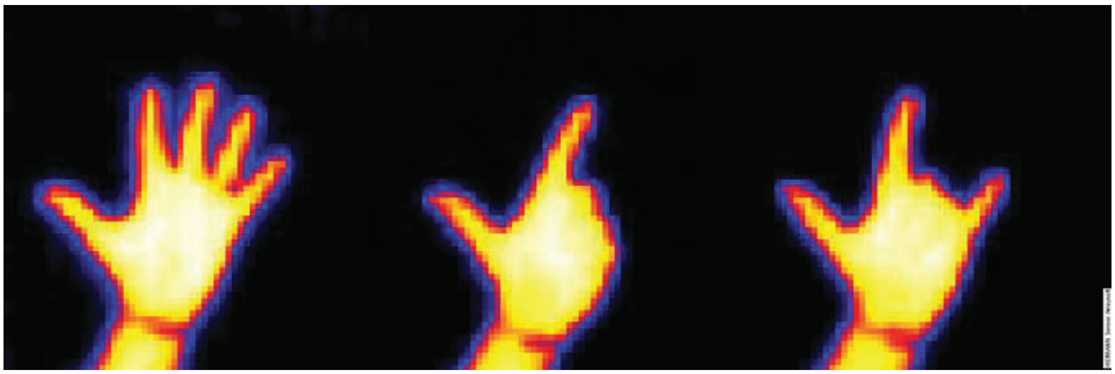


Visible camera HTPA 64x62

Exhibit hall

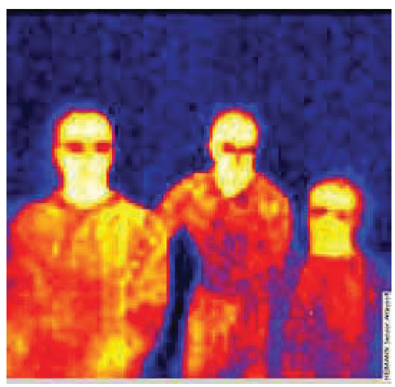


HTPA 82x62
Coffee mug on warmer



HTPA 32x31
Hand gesture recognition

HTPA 82x62
Hand with watch and ring



HTPA 64x62
Group photo

HTPA 64x62
Portrait of the boss

HTPA 82x62
Fever detection