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HEIMANN Sensor

Thermopiles for TEMPERATURE and Gas Sensing

Including new DIGITAL output detectors & with OPERATING TEMP TO 180°C

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Heimann Thermopiles - how to select

Need to decide on ACTIVE AREA, NUMBER OF ELEMENTS, PACKAGE, AND FILTER/WINDOW.
OPTIONALLY add AMPLIFICATION (inside package or outside) and OPTICS (lens, mirror)

Chips

Active Area — **4 standard active areas are available.**

CODE >>	1	2	3	1C
AREA mm^2 (rectagular)	0.61x0.61	1.2x1.2	2.1x2.1	0.85x0.85
	small, low cost	large, high signal	largest, higher signal, higher cost	midsize
	used for temp sensing usually	used for gas sensing usually	used for gas sensing usually	temp or gas

Active area = area of highest absorption. Heimann's main advantage over competitors is small thermal time constant. The heat capacity of Heimann elements is small, which makes them fast.

Number of elements	single, dual and quad are standard. 3x3, 1x8 and 1x16 available as engineering samples	
Thermistors	CODE: second digit	*n* 1 = 100 kOhm thermistor; *n* 2 = 30 kOhm thermistor

Filters

Spectral Response — **A variety of filters are stocked**

Filters are chosen depending on the application

Application		Filter	
Temp measurement, short distance to target			5.5 micron LWP
Temp measurement, when distance to target makes atmospheric absorption significant			8 to 14 micron BP
Gas sensing	Gas	filter ctr_wl/HPBW (standard)	**Also Available**
	CO2	4.26/0.18 or 0.09	4.43/0.06 (band edge)
	CO	4.64/0.18	and per customer specification
	HC	3.4/0.19	
	Reference	3.91/0.09	
	others	customer specified	
	uncoated windows	uncoated Si, CaF, sapphire - yet might not always be in stock for all window sizes	

Packages

Sensor Packages

	Code	Type	Comment
HTS	A	TO-5 (TO-39)	2.5 mm dia aperture
HTS	B		3.8 mm dia aperture
HTS	C		3.5x3.5 mm aperture; not encouraged
HTS	D		customized product
HTS	I		internal FOV aperture
HTS	E		Dual aperture
HTS	Q		Quad aperture
HMS	M	TO-18 (TO-46)	with lens f=3mm
HMS	J / K	TO-18 (TO-46) Mini	J with tab, K no tab, "1" or "1C" or 2 chip only
HMS	Z	Baby	no tab, "1" chip only

Electronics

Sensor Modules with electronics	Code	customers can get the timing and protocol requirements for re-programming	
HTIA (typical application is temp measurement)		PCB type with chip-on-board , TO39 cap	**Analog single channel ASIC with EEPROM adjusted to customer requirements**
	B	external mirror optics	
	C	cap aperture 2.5mm dia , filter type typ. F5.5	
	D	internal mirror optics , typ. F5.5	
	E	lens optics focal length 4.4mm, typ. F5.5	
HIS 6PIN (typical aplication is temp of gas measurement)		TO39 housing	**Single channel ASIC with EEPROM adjusted to customer requirements**
	C	cap aperture 2.5mm dia , filter type typ. F5.5	
	E	lens optics focal length 3mm or 4.4mm	
HIS 4PIN (typical application is gas measurement)		TO39 housing	**Single channel ASIC with EEPROM max. amplification pref. for gas detection**
	A	cap aperture 2.5mm dia , filter type typically gas , typically chip type 2	

Infrared Measurement

Application Notes

Every object emits electromagnetic radiation, which wavelength spectrum is dependent on its temperature. For an object without “color”, which means that no wavelength is selectively emitted or absorbed, the radiation spectrum is completely determined by the temperature alone. In this case, the total radiation power P_{obj} emitted by an object of temperature T_{obj} can be expressed as

$$P_{obj} = \delta * \varepsilon * (_{Tobj})^4$$

with *s* being the Stefan-Boltzmann constant and *e* the so-called emission factor (or emissivity) of the object. In the ideal case *e* has the value 1 (black body). For many substances the emission factor lies in the range between 0.85 to 0.95. The above equation is called the Stefan-Boltzmann law. It integrates the total quantity of radiation over all wavelength.

The *net* power P_{rad} received by the thermopile is related to the object temperature T_{obj} and to the temperature of the thermopile chip itself. This value is generally referred as T_{amb}, the ambient temperature.

Therefore the total heat power *Prad* received from the object at temperature T_{obj} is given to

$$P_{rad} = K * (\varepsilon_{obj} * T_{obj}^4 - \varepsilon_{abs} * T_{amb}^4)$$

The empirical factor *K* is a constant device factor.

The thermopile sensor delivers an output signal proportional to the heat flux. The heat balance equation is the basis of any quantitative temperature measurement (S -> voltage sensitivity).

$$U_{TP} = S * P_{rad} = S * K * (\varepsilon_{obj} * T_{obj}^4 - \varepsilon_{abs} * T_{amb}^4)$$

It describes that the output voltage is a function of the object and the ambient temperature. For a fixed ambient, the theoretical output voltage of the thermopile chip is proportional to T_{obj}^4. The T^4-dependence is only valid, if the sensor senses the whole electromagnetic spectrum with the same sensitivity.

Since in all practical situations the thermopile sensor never senses over all wavelengths with the same sensitivity, the pure T^4-dependence will rarely be seen. The real dependency can be better described by a polynomial regression of many polynomial factors and coefficients.

The output voltage also varies with the ambient temperature. Any IR temperate measurement system needs therefore to compensate this effect.

There are two possible ways to realize the ambient temperature compensation of the output signal. The analog way by employing an analog circuit. The circuit is designed in a way, that a voltage is generated, which matches exactly the loss or gain in output voltage due to any ambient temperature change.

For high accuracy applications a digital (numerical) calculation method is needed. In this case, the two signals, thermopile voltage and temperature reference signal are derived separately and fed into a microcontroller system, where the necessary calculations are made. The ambient temperature compensation can be performed using look-up tables or polynomial regression equations as a function of the ambient temperature, thermopile output and as result the object temperature. The calculation is related to a defined emissivity. The emissivity variation can be considered by a factor.

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APPLICATION NOTE - NDIR Gas detection

Molecules like CO_2, CO, CH_4, NO, N_2O and many others show strong absorption lines in the mid IR region. The absorption of infrared radiation causes transitions between the vibrational-rotational energy levels of the molecule. The typical structure of such an absorption line can be seen in the calculated CO_2 spectrum of figure 1.

An NDIR (non-dispersive infrared) gas measurement set-up consists of an infrared radiation source, a gas sample cell including optical components, a gas specific filter which transmits only radiation corresponding to an absorption band or line of the gas in question and a suitable infrared sensor to detect this radiation.

The gas absorption is similar to a light barrier. If there is none of the specific gas between source and detector the measured signal remains stable and high. If gas molecules of the specific gas passes the area between source and detector the signal drops proportional to the gas concentration. The transmitted intensity is described by the law of Lambert and Beer, where I_0 is the initial intensity, k is the gas specific absorption coefficient, c is the gas concentration and l is the length of the absorption path.

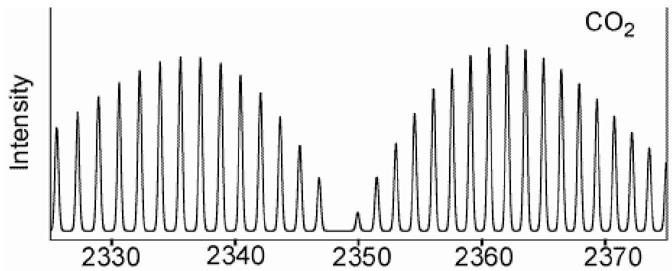

Fig.1:Calculated CO_2 absorption spectrum
(4,30 µm – 4,21 µm)

$$I = I_o \cdot e^{-k \cdot c \cdot l} \quad (1)$$

The infrared source can be a simple infrared lamp, a blackbody radiation source or an infrared diode-laser. The choice depends on the spectral characteristics and costs of the source in relation to the necessary resolution and sensitivity of the gas measurement.

The gas cell can be a single path cell of length l with reflective walls and additional optical components to concentrate the source radiation into the cell. Another possibility is a “White-cell” where the path length is increased by folding the rays with different mirrors or a multipass cell with an even higher number of reflections, increasing absorption due to the longer path length.

The infrared filter and filter specification (CWL = center wavelength at normal incidence, FWHM = full width at half maximum) are important parameters of the gas measurement set-up. In most of the cases this filter is integrated as window into the infrared sensor, making the sensor a gas specific sensor.

If filters are used at other than normal angle of incidence the shift in spectral characteristics has to be considered. All interference filters will shift to shorter wavelenth as the angle of incidence deviates from normal. The effect can be approximately calculated by the following formula with n being the index of refraction.[3]

$$\lambda_\Theta = \lambda_0 \cdot \frac{\sqrt{n^2 - \sin^2 \Theta}}{n} \quad (2)$$

With increasing temperature the interference filter transmission will shift to longer wavelength and with decreasing temperature to shorter wavelength. The temperature effect can be approximated by the following formula and is normally small (0.01-0.2nm/°C). [3]

$$\lambda_T = \lambda_0 + \Delta T \cdot \frac{\Delta\lambda}{1°C} \quad (3)$$

Thermopile infrared sensors create a voltage signal proportional to the received radiation. In addition, the signal voltage depends on the sensors own temperature. Equation 4 describes the basic function. T_{source} is the source or object temperature, T_{amb} the ambient or sensor temperature, K an apparatus constant and the exponent n depends on the actual filter characteristics (n=4 for a perfect “black” characteristic and unlimited wavelength range).

$$U \approx K \cdot (T^n_{source} - T^n_{amb=sensor}) \quad (4)$$

There are different NDIR methods used in practical applications. The two most important are single beam – single wavelength and single beam-dual wavelength. Figure 2 shows the schematic arrangements.

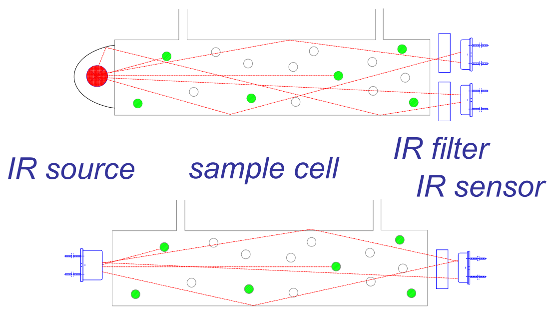

Fig 2: Schematic NDIR set-ups

Heimann normally supplies thermopiles with the filter built into the package cap as its window. In the dual wavelength set-up at top the spectral reference channel is normally well outside of the gas absorption wavelength, therefore the ratio of the two signals will be proportional to the gas concentration but independent of source variations or aging effects. In order to match the two wavelength channels further, the two sensor chips and two filters can be integrated together in one sensor housing. An example for such a dual channel infrared sensor is the Heimann Sensor HTS E21 F4.0/4.26 where "E" denotes the sensor type, "2" the sensor chip size, "1" a thermistor reference of 100kΩ and the two numbers following the letter F give the center wavelength of the the two gas filters. Up to 4 gas filters and 4 thermopiles are available in stahdard Heimann packages.

Anther approach to increasing sensor stability and ease of application for our customers is to integrate a sensor chip with an matched preamplifier in the form of an ASIC into the same TO housing. The Heimann ASIC has been specially developed to match the sensor chip parameters. The thermopile sensor acts as a voltage source with an internal resistance of about 85kΩ when the contact points of the thermoelements are heated by absorbed radiation energy. In a position close to this voltage source the sensor signal is then amplified to a level of several Volts. Of course the ASIC can be combined with different thermopile chip sizes and the TO39 header can be welded to different filter caps. In addition, the ASIC carries a temperature reference that delivers a linear output signal, e.g. 15mV/°C, for the ambient temperature. The voltage of this temperature reference and the radiation signal can be combined on chip to create a net output signal independent from ambient temperature. Table 1 summarizes typical output signals for the cases that the sensor faces a large blackbody source or the micromachined source EMIRS 200. Alternatively the knowledge of the ambient temperature can be used to calculate the effects of signal variation or filter wavelength shifts associated with changes of the ambient temperature. Since several ASIC parameters can be controlled externally there are different options how to use the ASIC. The integrated thermopile sensor can either be used with pre-set parameters, giving the system manufacturer a better and easier access to the gas-concentration proportional sensor signal and providing additional information on ambient temperature. The gas dependent signal output and temperature reference output are in a range that allows a direct connection to standard low-cost ADC and µC without further analog circuitry.

HIS integrated Sensor			fov 180° large blackbody 500K ambient 298K	dist. micromachined source to sensor =13 mm no optics source supply 5V
type	filter	gain	net output signal / V	
A11	CO2	900	1.39	
B11	CO2	900	3.32	
C11	CO2	900	3.41	
A11	CO2	3000		0.155
B11	CO2	3000		0.155
C11	CO2	3000		0.155
A21	CO2	300	1.18	
B21	CO2	300	2.71	
C21	CO2	300	2.91	
A21	CO2	3000		0.42
B21	CO2	3000		0.42
C21	CO2	3000		0.42

Table 1: Sensor output for different sources (no gas)

More Information in: Simon, Leneke, et al.: "Thermopile Sensors and IR Sources for Gas Detection with Improved Functionality"; Proceedings of Sensors Conference, Section B8.5; Nürnberg, 10.-12.05.2005

Gas	CWL/nm	Tol/%	Tol/nm	FWHM/nm	HPB Tol/nm
CH4	3300	2	66	160	20
HC	3375	1	34	190	10
CO2	4260	1	43	180	20
CO2	4270	1	43	90	20
CO2	4430	1	44	60	5
CO	4640	1	46	180	20
Ref	3910	2	78	90	20

Datasheet Integrated Sensor SMD
Type HCM Cx2 Fxxx

Features and Benefits

- Small size, low cost, integrated ASIC with analog outputs
- Surface mountable ceramic leadless chip carrier CLCC with 3.8mm
- Operating range 2.7V to 5.5V , -40°C to 120°C
- Sensor gain adjustable to 4300 or 2150 (preset 4300 with internal pull-up res.)
- Integrated linear temperature reference with a sensitivity of typical 16mV/°C
- Large variety of available filter types for different application

Ordering Information

HCM -> Heimann thermopile sensor and ASIC in a SMD ceramic carrier
Cx2 -> „C" ceramic carrier of 3.8mm ; „x" sensor chip (list) ; „2" ASIC STP1
Fxxx -> application-specific filter type (list)

Sensor Chip Selection

Parameter	*Sensor chip "1"*	*Sensor chip "2"*
Absorbing area	0.61x 0.61mm^2	1.2 x 1.2mm^2
Sensitivity	50 V/W	38 V/W
Voltage response	19 Vmm^2/W	55 Vmm^2/W
Resistance	85 kOhm	85 kOhms
Time constant	5ms	8ms

Filter Selection

Filter Type	*Application*	*Specification*
F4.26-180	CO_2 gas detection	NBP CWL 4.26µm HPB 180nm
F4.27-90	CO_2 gas detection	NBP CWL 4.27µm HPB 90nm
F4.43-60	CO_2 gas detection	NBP CWL 4.43µm HPB 60nm
F4.64-180	CO gas detection	NBP CWL 4.64µm HPB 180nm
F3.30-160	HC gas detection	NBP CWL 3.30µm HPB 160nm
F3.37-190	HC gas detection	NBP CWL 3.375µm HPB 190nm
F3.91-90	gas reference	NBP CWL 3.91µm HPB 90nm
F5.5	temperature detection	LWP Cut On 5.5µm
F8-14	temperature detection	BP HPP 8µm to 14µm

Please contact Heimann customer service for special filter requirements.

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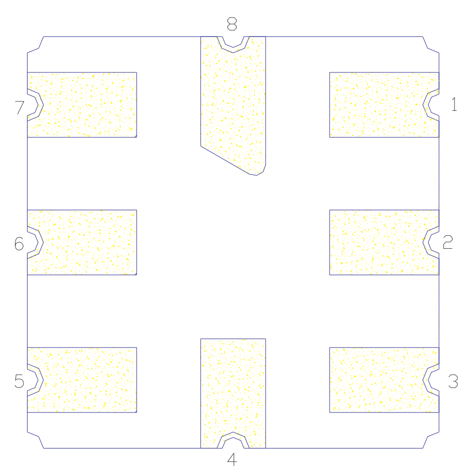
Operating Conditions

Parameter	*Typical Value*	*Unit*	*Condition*
Supply voltage VDD	(2.7).. 3 .. 5..(5.5)	V	+Vs
Supply voltage VSS	0	V	-Vs , Ground
Supply current	1	mA	Without load
Open loop gain	90	dB	
Low pass frequency	240	Hz	ASIC
PSRR	>40	dB	
Output voltage range	0.15 .. (VDD-0.15)	V	
Start up time after POR	Max. 0.5	sec	Electrical start up
Noise voltage input related	45	nV/√Hz	Output TPO; Sensor + ASIC
Zero input sensor signal	1.25	V	Output TPO
Sensor gain adjustment	4300 or 2150	V/V	Output TPO ; adjustable
Temp. ref. voltage at 25°C	1.45	V	Output TRO
Sensitivity temp. reference	16	mV/°C	Linear ; Output TRO
Field of view	120	degree	
Operating temperature	-40.. 120	°C	

Pin Assignment

Pin No.	*Sym bol*	*Description*
1	GAIN	Gain factor 4300 (Internal pull up or VDD on GAIN) Gain factor 2150 (VSS/GND on GAIN)
3	VDD	Positive supply voltage
4 / 8	VSS/ GND	Negative supply voltage / Ground (0V)
6	TPO	Analog temperature reference output voltage
7	TRO	Amplified thermopile sensor output voltage



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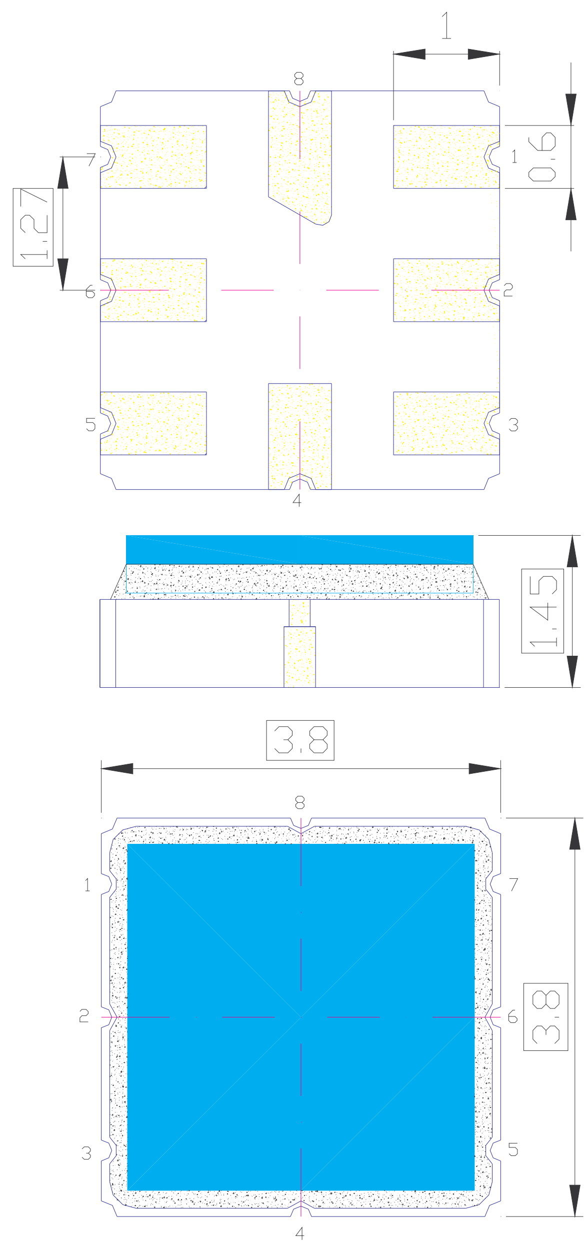
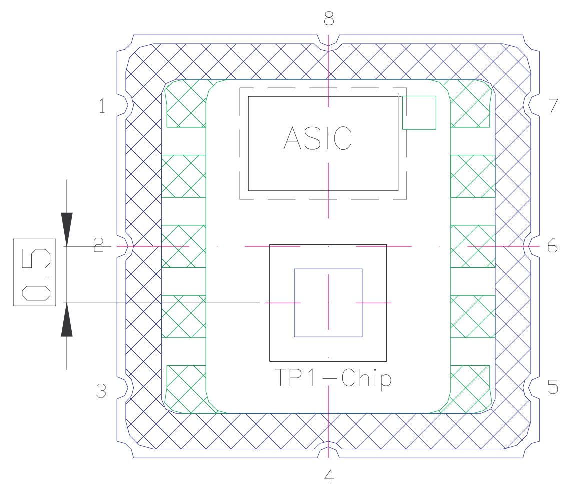
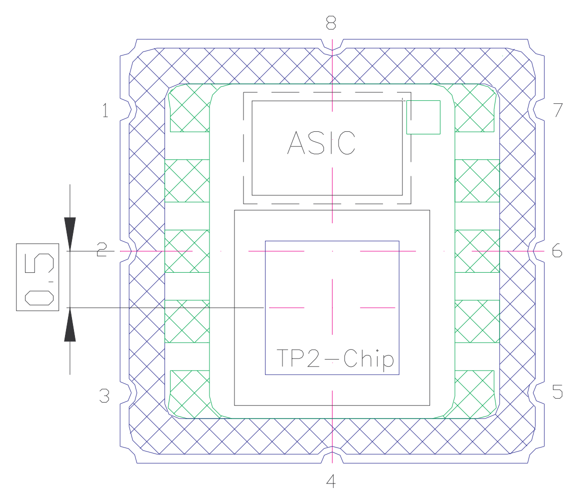
Dimensions



HCM C12 ..



HCM C22 ..



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Application Hints

Heimann integrated sensors are used for non-contact temperature measurements. A thermopile sensor and a signal conditioning circuit (ASIC) are integrated in the same housing. The thermopile sensor converts the temperature radiation of an object surface to an electrical signal (voltage) by thermocouples (Seebeck effect). The sensor output voltage is related to the object temperature and object emissivity (radiation) as well as to the sensor chip temperature (housing temperature) and surrounding temperature (radiation) by the following equation :

$$VS = K * \varepsilon * (TO^n - TS^n) \quad \text{at } TA=TS$$

VS -> sensor output voltage ; K -> constant apparatus factor ; ε -> object emissivity ; TO -> object temperature ; TA -> ambient (surrounding) temperature ; TS -> sensor (housing) temperature ; n -> exponent to describe the temperature dependency of the signal voltage
The low noise amplifier of the ASIC transforms the sensor signal to a suitable voltage range. A temperature related voltage provided by the ASIC can be used to compensate ambient temperature drift effects.

A gas concentration can be measured by monitoring the absorption of an infrared light beam. The base equation for gas concentration measurement in the infrared way is Beer's law :

$$I=I(0)*exp(-k*c*L)$$

I	-> radiant flux at the point of measurement
I(0)	-> base radiant flux of the test system without gas absorption
k	-> constant (gas and filter specific)
L	-> measuring distance
c	-> gas concentration

The radiant flux is proportional to the output voltage of the sensor module :

$$U/U(0) \sim I/I(0) .$$

A special infrared light source is used to generate the radiant heat. The infrared source needs to be pulsed to eliminate parasitic temperature influences.
Don't hesitate to contact HEIMANN Sensor for support to use our long-time experience in infrared sensors and sensor modules.

Liability

Changes or modifications at the product which haven't influence to the performance and/or quality of the device haven't to be announced to the customers in advance. Customers are requested to consult with Heimann Sensor representatives before the use of Heimann Sensor products in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage. The company or their representatives will not be responsible for damage arising from such use without prior approval.

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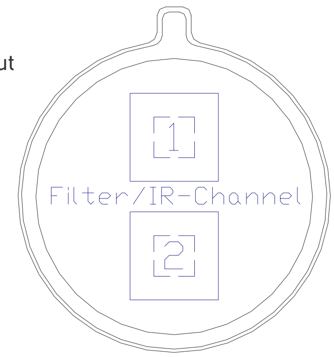
Preliminary Datasheet
Digital Sensor Module with 2 IR Channels
Type HID E2x Fyyy Fzzz

HEIMANN Sensor
HEIMANN SENSOR GMBH

Features and Benefits

- Thermopile Sensor with ASIC in TO-5 housing with 4 leads
- 2 IR channels with low noise chopper amplifiers and programmable gain
- Digital voltage output (via SMBus compatible RAM access) or PWM output
- 3V and 5V supply ranges available
- Complies with ROHS regulations



Ordering Information

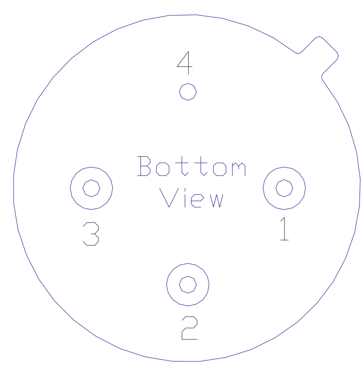
HID : Heimann thermopile sensors and ASIC in TO-5 housing
E2 : ->„E" cap with 2 filter openings ;
->„2" two thermopile sensors of type TP2
x : ASIC supply voltage ->„4" : 5V ; ->„5" : 3V
Fyyy : Filter 1 of IR channel 1, selection acc. to filter list
Fzzz : Filter 2 of IR channel 2, selection acc. to filter list

e.g. HID E24 F3.91-90 F4.26-180

Filter Selection (Please contact Heimann customer service for special filter requirements)		
Filter Type	*Application*	*Specification*
F5.30-180	NO gas detection	NBP CWL 5.30µm HPB 180nm
F4.64-180	CO gas detection	NBP CWL 4.64µm HPB 180nm
F4.43-60	CO2 gas detection	NBP CWL 4.43µm HPB 60nm
F4.26-180	CO2 gas detection	NBP CWL 4.26µm HPB 180nm
F4.27-90	CO2 gas detection	NBP CWL 4.27µm HPB 90nm
F3.91-90	gas reference	NBP CWL 3.91µm HPB 90nm
F3.37-190	HC gas detection	NBP CWL 3.375µm HPB 190nm
F3.30-160	HC gas detection	NBP CWL 3.30µm HPB 160nm

Pin Configuration

Pin	*Sym*	*Description*
1	SCL	Digital input , serial clock in SMBus compatible mode
2	VDD	Positive supply voltage
3	SDA / PWM	Digital I/O , data input /output in SMBus compatible mode (open drain), pulse width modulated temperature(s) in PWM mode
4	VSS	Negative supply voltage / Ground (0V) (connected to housing)



Maximum Ratings

Parameter	*Max. value*	*Unit*	*Condition*
Supply voltage 1 VDD	7	V	Type 5V
Supply voltage 2 VDD	5	V	Type 3V
Reverse voltage	0.4	V	Ground
ESD sensitivity	2	kV	Human body
Storage temperature	-40.. 125	°C	

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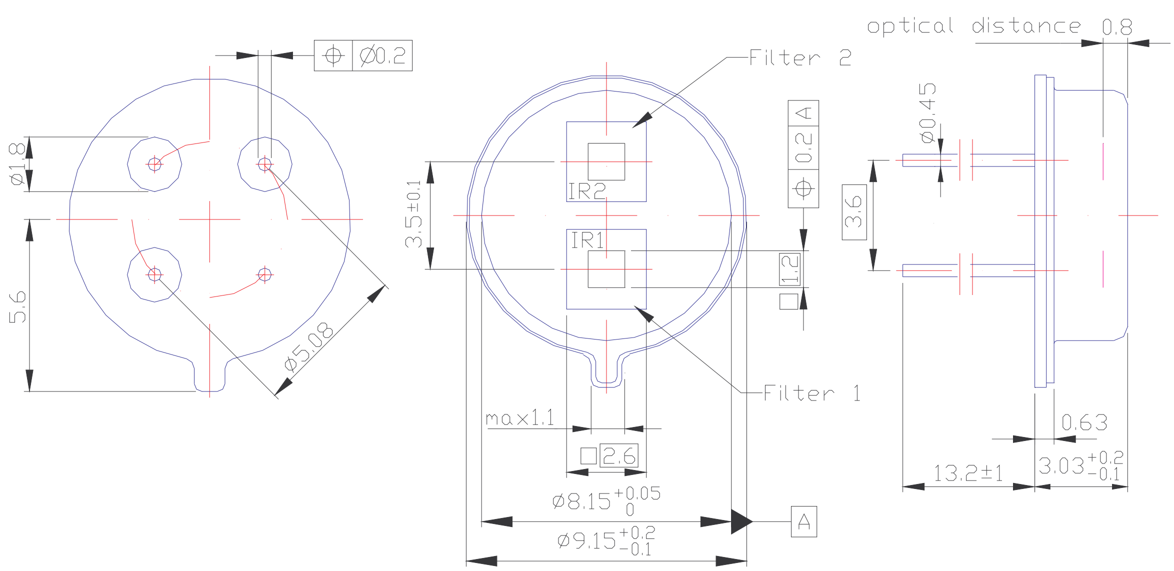
Preliminary Datasheet
Digital Sensor Module with 2 IR Channels
Type HID E2x Fyyy Fzzz

Operating Conditions

Parameter	*Typical Value*	*Unit*	*Condition*
Supply voltage 1 VDD	5	V	Preset option "x -> 4"
Supply voltage 2 VDD	3	V	Preset option "x -> 5"
Supply voltage VSS	0	V	Ground
Supply current	1	mA	Without load
Start up time after POR	0.15	sec	
Sensor absorbing area	1.2 x 1.2	mm²	Sensor type TP2
Sensitivity thermopile sensor	38	V/W	Sensor chip, 500K, 1Hz
Voltage response thermopile sensor	55	Vmm²/W	Sensor chip
Gain factor preset	100	V/V	Range 1 .. 100
IR output voltage range	-475 .. 475	mV	RAM cells V_{TP}
Voltage resolution	0.0145	mV/step	
Response time	8	ms	Sensor chip
Refresh rate	100 .. 250	ms	Temperature signal
Temperature sensor range	-40 .. +125	°C	RAM cell T_A
Operating temperature range	-40.. 125	°C	
Interface (EEPROM Configuration)	2-wire SMBus compatible, output preset to open drain NMOS		
	1-wire PWM output, 10 bit resolution, output configurable to push-pull or open drain		

Dimensional Drawings



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Datasheet Integrated Sensor TO46
Type HIM Jx2 Fxxx Gxxx

Features and Benefits

- Small size, low cost, integrated ASIC with analog outputs
- 4-pin metal housing TO46
- Operating range 2.7V to 5.5V , -40°C to 120°C
- Sensor gain preset to 4300 or 2150
- Integrated linear temperature reference with a sensitivity of typical 16mV/°C
- Large variety of available filter types for different application

Ordering Information

HIM -> Heimann thermopile sensor and ASIC in a TO46 housing
Jx2 -> „J" standard cap TO46 ; „x" sensor chip (list) ; „2" ASIC STP1
Fxxx -> application-specific filter type (list)
Gxxx -> sensor gain preset G2150 or G4300

Sensor Chip Selection		
Parameter	*Sensor chip "1"*	*Sensor chip "2"*
Absorbing area	0.61x 0.61mm²	1.2 x 1.2mm²
Sensitivity	50 V/W	38 V/W
Voltage response	19 Vmm²/W	55 Vmm²/W
Resistance	85 kOhm	85 kOhms
Time constant	5ms	8ms

Filter Selection		
Filter Type	*Application*	*Specification*
F4.26-180	CO_2 gas detection	NBP CWL 4.26µm HPB 180nm
F4.27-90	CO_2 gas detection	NBP CWL 4.27µm HPB 90nm
F4.43-60	CO_2 gas detection	NBP CWL 4.43µm HPB 60nm
F4.64-180	CO gas detection	NBP CWL 4.64µm HPB 180nm
F3.30-160	HC gas detection	NBP CWL 3.30µm HPB 160nm
F3.37-190	HC gas detection	NBP CWL 3.375µm HPB 190nm
F3.91-90	gas reference	NBP CWL 3.91µm HPB 90nm
F5.5	temperature detection	LWP Cut On 5.5µm
F8-14	temperature detection	BP HPP 8µm to 14µm

Please contact Heimann customer service for special filter requirements.

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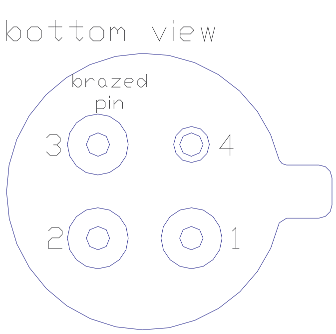
Fax 49 (0) 6123 60 50 39

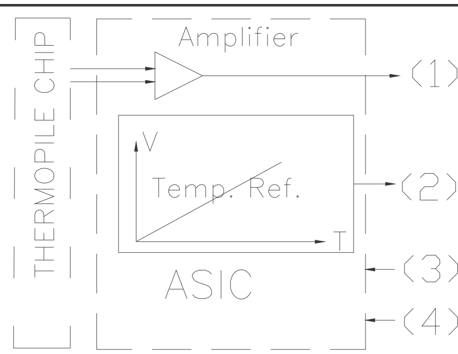
Operating Conditions

Parameter	*Typical Value*	*Unit*	*Condition*
Supply voltage VDD	(2.7).. 3 .. 5..(5.5)	V	+Vs
Supply voltage VSS	0	V	-Vs , Ground
Supply current	1	mA	Without load
Open loop gain	90	dB	
Low pass frequency	240	Hz	ASIC
PSRR	>40	dB	
Output voltage range	0.15 .. (VDD-0.15)	V	
Start up time after POR	Max. 0.5	sec	Electrical start up
Noise voltage input related	45	nV/√Hz	Output TPO; Sensor + ASIC
Zero input sensor signal	1.25	V	Output TPO
Sensor gain preset	4300 or 2150	V/V	Output TPO ; optional
Temp. ref. voltage at 25°C	1.45	V	Output TRO
Sensitivity temp. reference	16	mV/°C	Linear ; Output TRO
Field of view	70	degree	Sensor chip TP1
Operating temperature	-40.. 120	°C	

Pin Assignment

Pin No	*Symbol*	*Description*
1	VDD	Positive supply voltage
2	TPO	Amplified analog sensor output voltage
3	TRO	Analog temperature reference output voltage
4	VSS	Negative supply voltage / Ground (0V)





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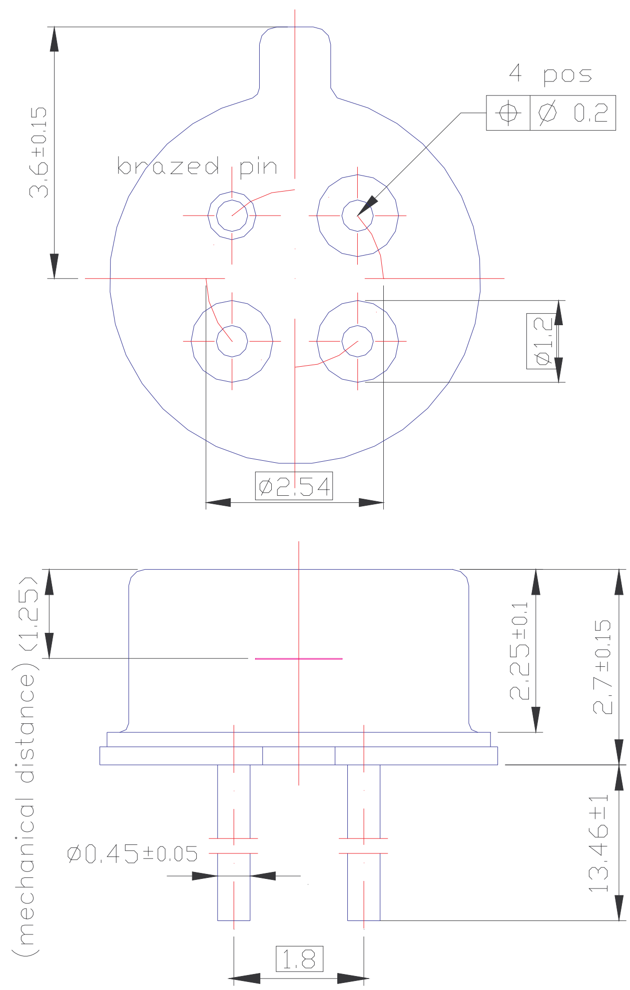
Dimensions



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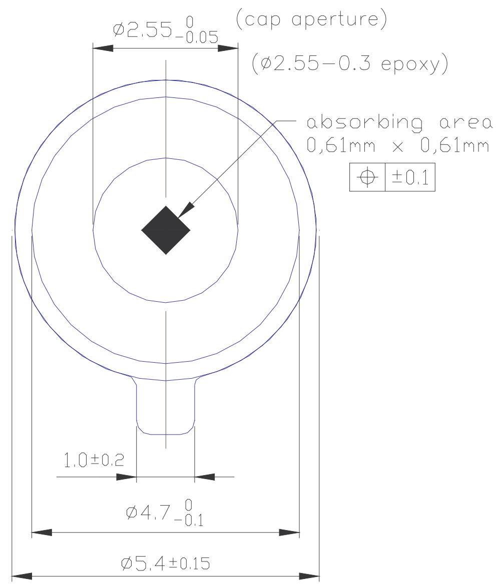
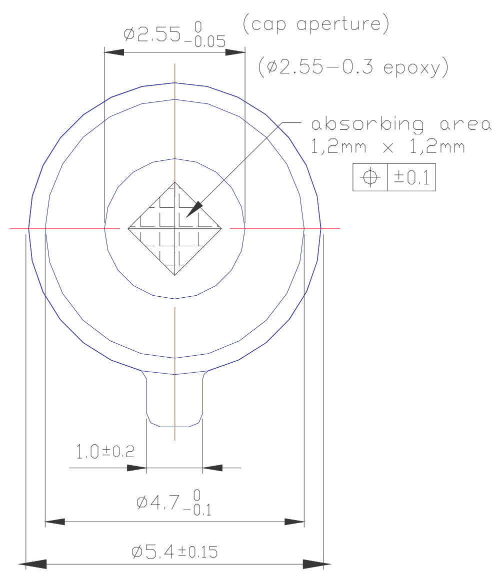


HIM J22 ..



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Application Hints

Heimann integrated sensors are used for non-contact temperature measurements. A thermopile sensor and a signal conditioning circuit (ASIC) are integrated in the same housing. The thermopile sensor converts the temperature radiation of an object surface to an electrical signal (voltage) by thermocouples (Seebeck effect). The sensor output voltage is related to the object temperature and object emissivity (radiation) as well as to the sensor chip temperature (housing temperature) and surrounding temperature (radiation) by the following equation :

$$VS = K * \varepsilon * (TO^n - TS^n) \quad \text{at } TA=TS$$

VS -> sensor output voltage ; K -> constant apparatus factor ; ε -> object emissivity ; TO -> object temperature ; TA -> ambient (surrounding) temperature ; TS -> sensor (housing) temperature ; n -> exponent to describe the temperature dependency of the signal voltage

The low noise amplifier of the ASIC transforms the sensor signal to a suitable voltage range. A temperature related voltage provided by the ASIC can be used to compensate ambient temperature drift effects.

A gas concentration can be measured by monitoring the absorption of an infrared light beam. The base equation for gas concentration measurement in the infrared way is Beer's law :

$$I=I(0)*\exp(-k*c*L)$$

I	-> radiant flux at the point of measurement
I(0)	-> base radiant flux of the test system without gas absorption
k	-> constant (gas and filter specific)
L	-> measuring distance
c	-> gas concentration

The radiant flux is proportional to the output voltage of the sensor module :

$$U/U(0) \sim I/I(0) .$$

A special infrared light source is used to generate the radiant heat. The infrared source needs to be pulsed to eliminate parasitic temperature influences.

Don't hesitate to contact HEIMANN Sensor for support to use our long-time experience in infrared sensors and sensor modules.

Liability

Changes or modifications at the product which haven't influence to the performance and/or quality of the device haven't to be announced to the customers in advance. Customers are requested to consult with Heimann Sensor representatives before the use of Heimann Sensor products in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage. The company or their representatives will not be responsible for damage arising from such use without prior approval.

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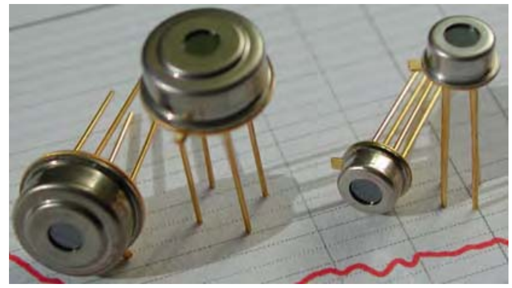
Integrated Sensors

HIS Series

HEIMANN Sensor
HEIMANN SENSOR GMBH

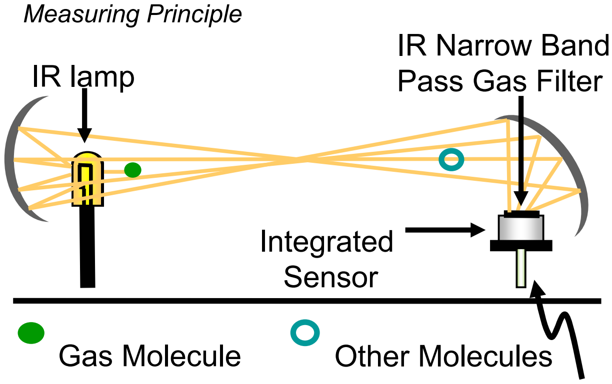
Integrated Sensor For NDIR Gas Detection

- Thermopile single sensor with integrated ASIC
- 2 analog outputs for amplified thermopile and reference signal
- Simple linear reference function for external compensation
- TO-5 or TO-18 metal housing with 4 connections
- Fast sensor response time of 8 msec typical
- Various types equipped with different filters available
- Gas types for NDIR gas detection CO_2, CO, NOx, HC, (H_2O)
- IR-Lamp or broadband IR-Source available

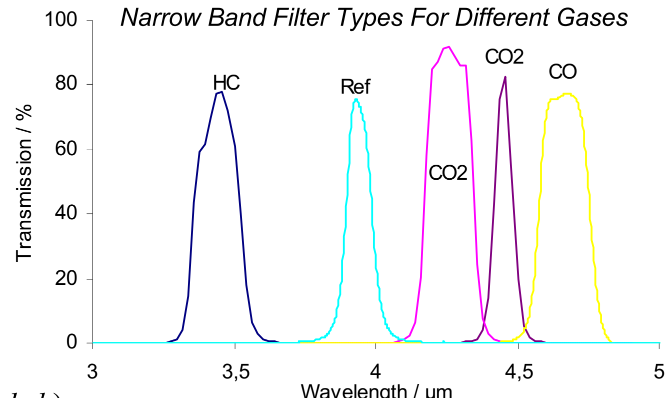


Parameter	*Typ. Value ASIC 1*	*Typ. Value ASIC 2*	*Unit*	*Condition*
supply voltage	5	3 or 5	V	VDD
supply current	1.7	1	mA	without load
output voltage range	0.3 .. VDD-0.3	0.3 .. VDD-0.3	V	
output load	> 20	> 20	kOhm	for optimal operation
thermopile amplification	5500	4000	V/V	
gradient temp. reference	15	15	mV/°C	linear ; 1.225V at 25°C
response time	8	8	ms	t /T=63% ; sensor
transmission range	filter list	filter list	µm	narrow band pass
sensor housing	TO-5	TO-5 or TO-18		
operating temperature	-40 to 120	-40 to 120	°C	

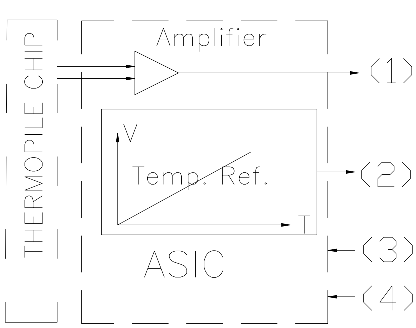
Measuring Principle



$$U \propto I = I_o \cdot \exp(-kcl)$$



Schematic



Pin Assignment

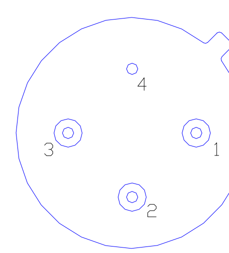
1: AOT –>Sensor

2: AOR ->Temp. Reference

3: VDD -> Supply Voltage

4: Vss -> Ground

TO Header Bottom Side



Package drawings TO-5 and TO-18
see HTS- and HMS series datasheet

Modifications reserved Rev.08 / 08.04.2008

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4-Pin Gas Sensor with Integrated Signal Conditioning

HEIMANN Sensor
HEIMANN SENSOR GMBH

Datasheet HEIMANN Sensor Integrated Module TO-Case for Gas Detection CO_2 - Type HIS A21 F4.26 4PIN

HEIMANN Sensor thermopile modules are designed for the non-contact temperature measurement based on infrared radiation. A thermopile sensor and a self-designed application specific integrated circuit (ASIC) is integrated in the sensor case. The ASIC is used for the sensor signal amplification and supplies a sensor temperature voltage.

Features of the specific sensor module type :

- **CO_2 detection by 4% grade infrared narrow band pass filter**
- **4-pin TO39-case**
- **Sensor amplification factor 5500**
- **Linear temperature reference with a sensitivity of 15mV/°C**

Field of View

parameter	*limits*			*unit*	*conditions*
	Min	*Typ*	*Max*		
field of view		70		degree	

Filter Specification

parameter	*minimum*	*typical*	*maximum*	*conditions*
Center wavelength (CWL) at 90° angle of incidence	4.21 µm	4.26 µm	4.31 µm	
Half power bandwidth (HPB)	160 nm	180 nm	200 nm	
Peak transmittance	70%			
Average transmittance from visual to band pass region			0.1%	
Peak transmission from visual to band pass region			1%	
Peak transmittance from band pass region to 8 µm			1%	
Base material		Silicon		

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4-Pin Gas Sensor with Integrated Signal Conditioning

HEIMANN Sensor
HEIMANN SENSOR GMBH

Datasheet HEIMANN Sensor Integrated Module TO-Case for Gas Detection CO_2 - Type HIS A21 F4.26 4PIN

Operating Conditions

Parameter	*Typical Value*	*Unit*	*Condition*
Supply voltage VDD	4.5 .. 5 .. 5.5	V	+Vs
Supply voltage VSS	0	V	-Vs , Ground
Supply current	1 .. 1.5 .. 2	mA	Without load
Output voltage range	0.3 .. VDD-0.3	V	
Start up time after POR	Max. 0.5	sec	Electrical start up
Sensor absorbing area	1.2 x 1.2	mm^2	Type TP2
Sensor amplification	5500		Output AOT
Response time sensor	10	msec	t/T = 63%
Temperature reference voltage at 25°C	1.225	V	output AOR
Sensitivity temperature reference	15	mV/°C	Linear ; output AOR
Operating temperature	-20.. 120	°C	

Pin / Device Configuration

Pin No.	*Symbol*	*Description*
1	AOT	Amplified analog sensor output voltage
2	AOR	Analog temperature reference output voltage
3	VDD	Positive supply voltage (+5V)
4	VSS	Negative supply voltage / Ground (0V)

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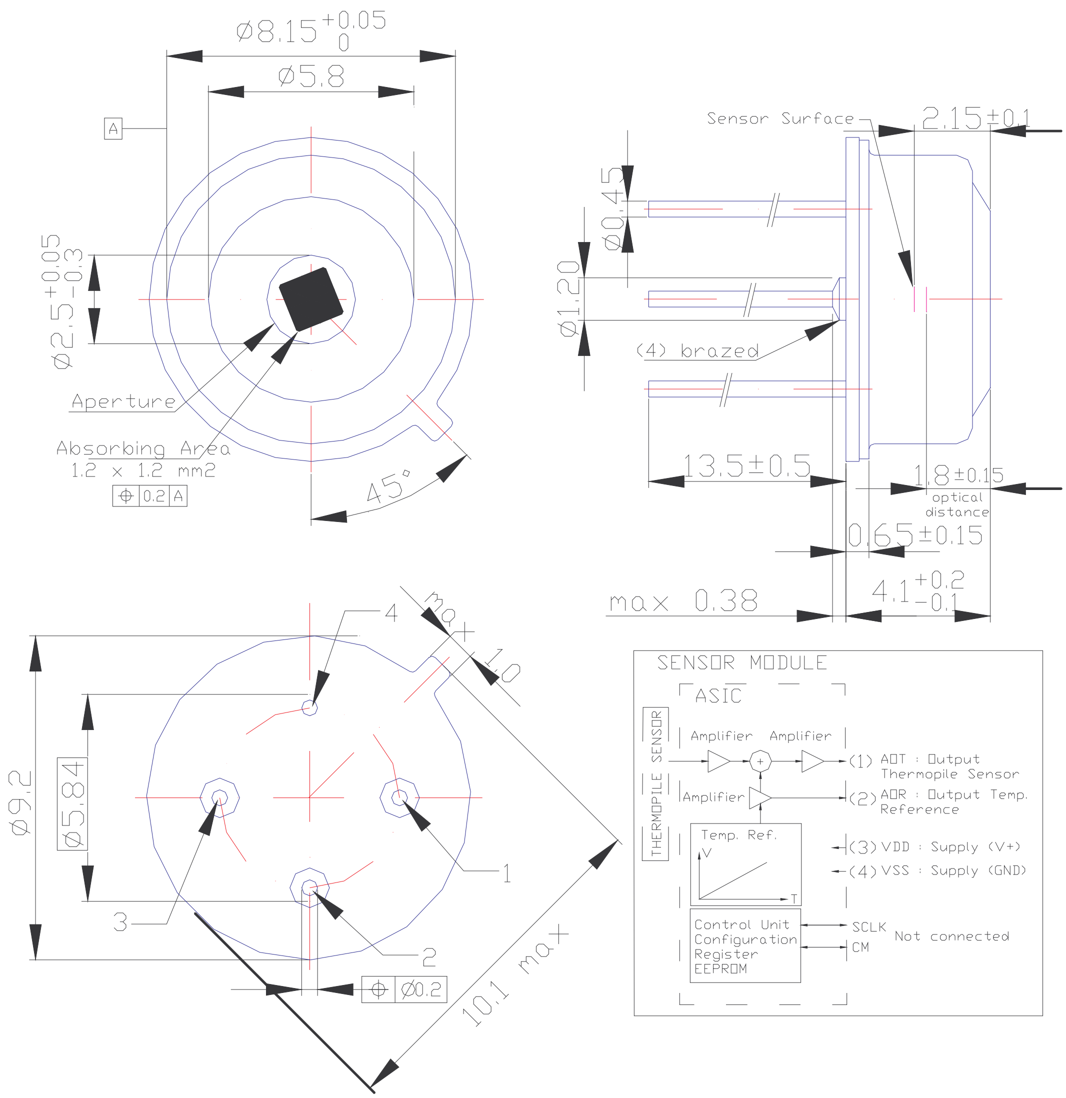
4-Pin Gas Sensor with Integrated Signal Conditioning

Datasheet HEIMANN Sensor Integrated Module TO-Case for Gas Detection CO_2 - Type HIS A21 F4.26 4PIN

Dimensions / Pin Assignment



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4-Pin Gas Sensor with Integrated Signal Conditioning

HEIMANN Sensor
HEIMANN SENSOR GMBH

Datasheet HEIMANN Sensor Integrated Module TO-Case for Gas Detection CO_2 - Type HIS A21 F4.26 4PIN

Application Hints

The gas concentration can be measured by monitoring the absorption of an infrared light beam. The base equation for gas concentration measurement in the infrared way is Beer's law :

I=I(0)*exp(-k*c*L)

I	-> radiant flux at the point of measurement
I(0)	-> base radiant flux of the test system without gas absorption
k	-> constant (gas and filter specific)
L	-> measuring distance
c	-> gas concentration

The radiant flux is proportional to the output voltage of the sensor module :

U/U(0) ~ I/I(0) .

A special infrared light source is used to generate the radiant heat. The infrared source needs to be pulsed to eliminate parasitic temperature influences.
The temperature reference output (housing temperature) of the sensor module can be used to compensate ambient temperature drift effects.
Don't hesitate to contact HEIMANN Sensor for support to use our long-time experience in infrared sensors and sensor modules.

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Liability

Changes or modifications at the product which haven't influence to the performance and/or quality of the device haven't to be announced to the customers in advance. Customers are requested to consult with Heimann Sensor representatives before the use of Heimann Sensor products in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage. The company or their representatives will not be responsible for damage arising from such use without prior approval.

6-Pin TO Sensor with Integrated Signal Conditioning

HEIMANN Sensor
HEIMANN SENSOR GMBH

Datasheet HEIMANN Sensor Integrated Module TO-Case Type HIS-Ax1-F8-14

General information about HIS models are described in

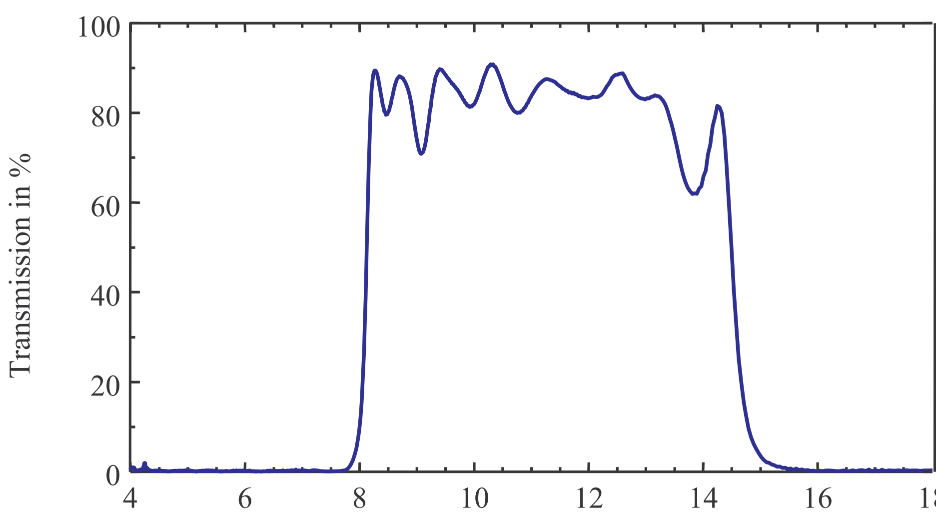
“General Datasheet HIS” .

Liability

Changes or modifications at the product which haven't influence to the performance and/or quality of the device haven't to be announced to the customers in advance. Customers are requested to consult with Heimann Sensor representatives before the use of Heimann Sensor products in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage. The company or their representatives will not be responsible for damage arising from such use without prior approval.

Filter Specification

parameter	*minimum*	*typical*	*maximum*
Cot on wavelength at half power point	7.8µm	8µm	8.2µm
Cut off wavelength at half power point	13.5µm	14µm	14.5µm
Average transmission from 9µm to 13µm	70%		
Average transmission from visual to band pass			1%
Average transmission from band pass to 20µm			1%



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6-Pin TO Sensor with Integrated Signal Conditioning

HEIMANN Sensor
HEIMANN SENSOR GMBH

Datasheet HEIMANN Sensor Integrated Module TO-Case Type HIS-Ax1-F8-14

Operating Conditions

Parameter	*Typical Value*	*Unit*	*Condition*
Supply voltage VDD	4.5 .. 5 .. 5.5	V	+Vs
Supply voltage VSS	0	V	-Vs , Ground
Supply current	1 .. 1.5 .. 2	mA	Without load
Output voltage range	0.3 .. VDD-0.3	V	
Start up time after POR	Max. 0.5	sec	Electrical start up
Sensor absorbing area	0.6 x 0.6	mm²	Type TP2
Sensor amplification	150 .. 5500		Output AOT , preadjusted
Response time sensor	5	msec	t/T = 63%
Temperature reference voltage at 25°C	1.225	V	Output AOR
Sensitivity temperature reference	15 (10 .. 16)	mV/°C	Linear ; output AOR ; not internal compensated (internal compensated)
Field of view	70	degree	
Operating temperature	-20.. 120	°C	

Pin / Device Configuration

Pin No.	*Symbol*	*Description*
1	VDD	Positive supply voltage (+5V)
2	VSS	Negative supply voltage / Ground (0V)
3	AOT	Amplified analog sensor output voltage
4	AOR	Analog temperature reference output voltage
5	SCLK	Adjustment mode only – serial clock input
6	CM	Adjustment mode only – programming mode selection

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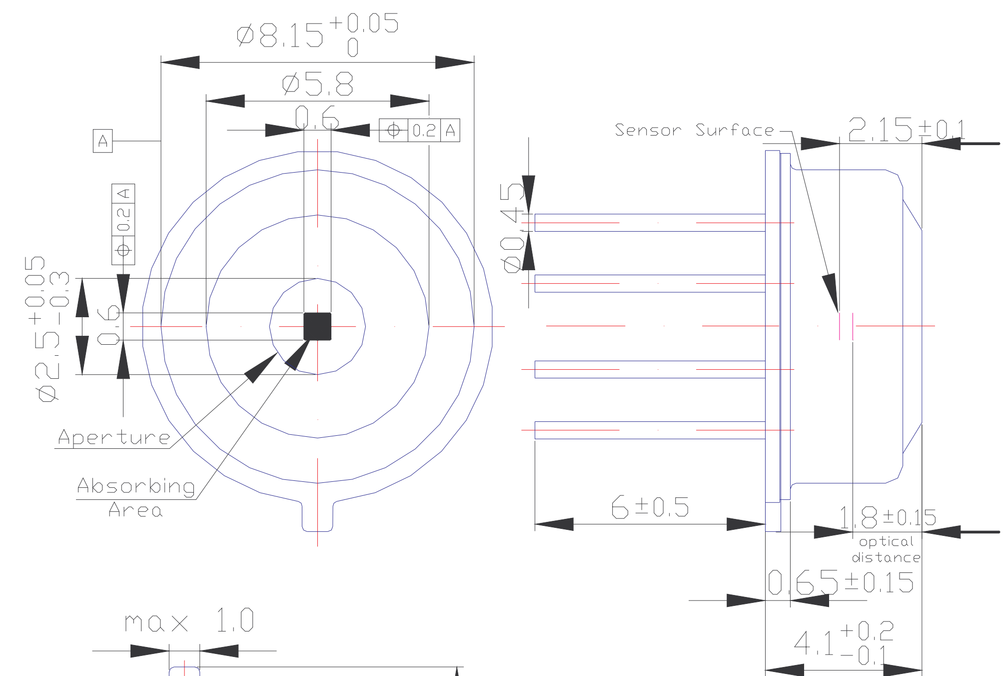
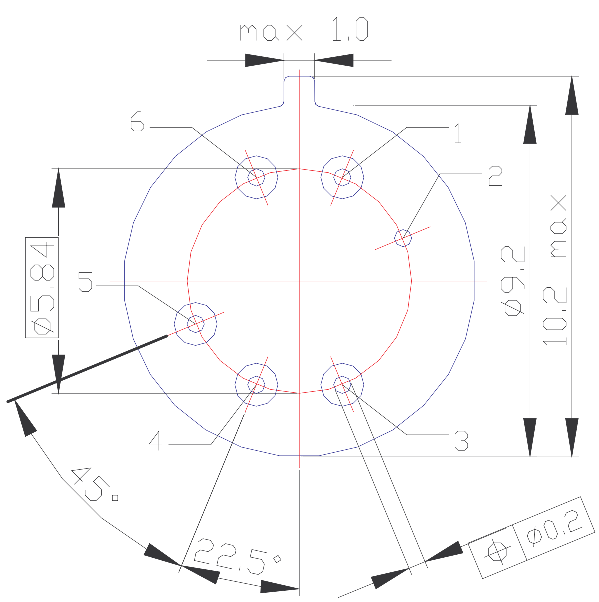
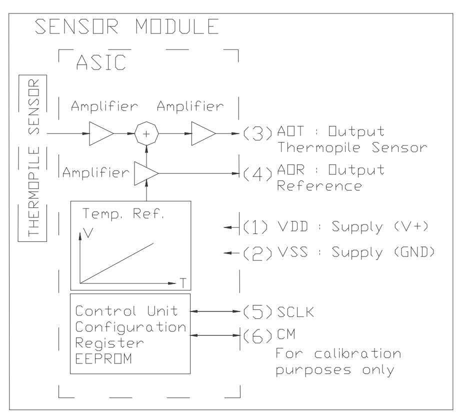
6-Pin TO Sensor with Integrated Signal Conditioning

Datasheet HEIMANN Sensor Integrated Module TO-Case Type HIS-Ax1-F8-14

Dimensions / Pin Assignment







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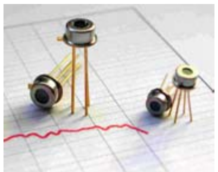
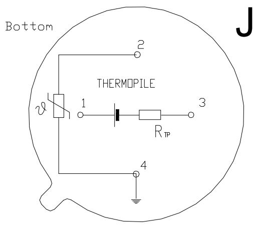


HMS Series

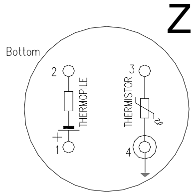
Miniature Thermopile Sensors for Remote Temperature Measurement and Gas Analysis

The HMS Series of CMOS compatible thermopile sensor chips in TO46 (or TO18) and even smaller transistor housings, features good sensitivity, small temperature coefficient of sensitivity as well as high reproducibility and reliability.
The smaller package sizes benefit applications in which sensor mounting is a critical parameter. Especially the ultra small HMS Z11 F5.5 sensor with high symmetry (no orientation tap) opens new design and application possibilities. The HMS M-types offers the possibility to integrate an infrared lens into a TO46 housing and to reduce the field of view accordingly. The smaller chip TP1 is well suited for temperature measurements which require a precise measuring spot whereas the chip type TP2 offers higher signal.

J, M



Z



Ordering Information:

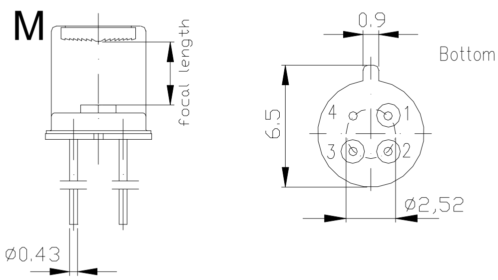
HMS / package shape / chip type / w/wo thermistor / F desired filter type,

e.g.: HMS J11 F5.5

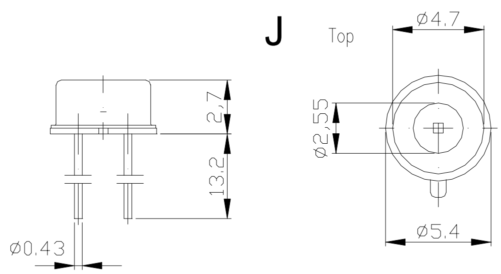
Parameter	HMS Z11	HMS J11	HMS J21	Unit
element size	0,61²	0,61²	1,2²	mm²
voltage response [1]	13	13	39	V mm²/W
sensitivity [1]	36	36	27	V/W
resistance R_{TP} [2]	86	86	84	k Ohm
TC of resistance R_{TP} [2]	0.02	0.02	0.02	% / K
noise [2]	38	38	37	nV/ $Hz^{½}$
detectivity [1,2]	5,6 10^7	5.6 10^7	8.7 10^7	cm $Hz^{½}$ / W
time constant	< 6	<6	10	ms
thermistor reference [2]	100	100	100	kOhm
temp.coeff.of thermistor B [3]	3940	3940	3940	K
field of view [4]	95	120	120	
operating temperature		-20...120		°C
storage temperature		-40...120		°C

1) filter type F5.5, Tobj=100°C, DC
2) at Tamb=25°C
3) 25°C, 50°C
4) degree at 50% signal level

M



J



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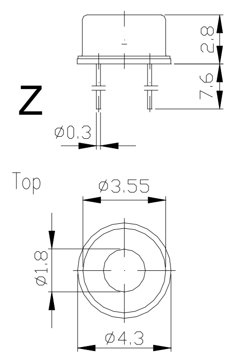
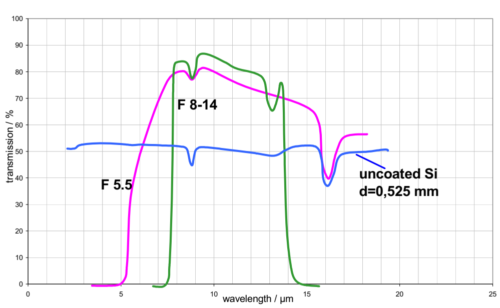
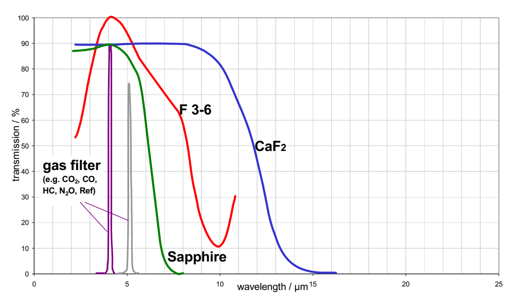


Filter types for temperature measurements



Filter types for Gas Analysis



Modifications reserved Rev.07 / 01.10.2004

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Specification Thermopile Sensor
HMS Z11 F5.5

Part No. 1018

R 04

Author(s):

W. Leneke, M. Simon

Revision History

Version	Date	Remarks
R 01	29.08.2005	1. Draft of HEIMANN Sensor GmbH
R 02	27.02.2006	Update packing
R 03	30.08.2006	Update drawing
R 04	15.12.2008	Update drawing

TABLE OF CONTENTS

1. Purpose, Scope

The new thermopile infrared sensor from Heimann Sensor, comprising a new type CMOS compatible sensor chip plus a thermistor reference chip, features good sensitivity, small temperature coefficient of sensitivity as well as high reproducibility and reliability. The sensor meets the requirements of the European Union RoHS (Regulation of Hazardous Substances) Directive.

The sensor will be available in standard transistor outline packages in different sizes, equipped with an IR transmitting filter window (transmission curve as shown below).

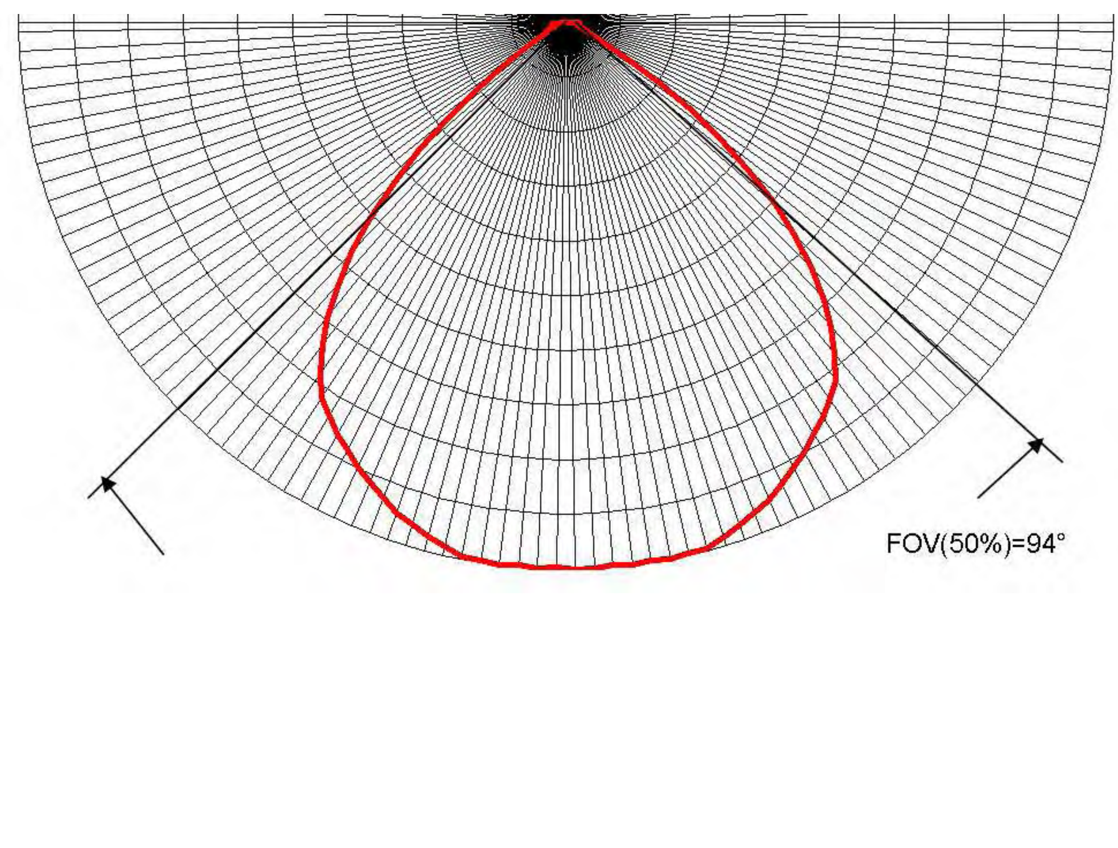
2. Absolute Maximum Ratings

Parameter	*Symbol*	*Limits*			*Units*	*Conditions*
		Min	*Typ.*	*Max*		
storage temperature		-40		100	°C	
operating temperature		-20		100	°C	

3. General and electro-optical Parameter Thermopile

Parameter	***Symbol***	***Limits***			***Units***	***Conditions***
		Min	*Typ.*	*Max*		
element size			0.6*0.6		mm^2	absorbing area
field of view	FOV		94		degree	50% intensity within FOV, see graph
resistance	R_{TS}	69	86	112	kΩ	-40℃ to 100℃
voltage response		9	11.5	16	Vmm^2/W	Filter F5.5, 100℃,1Hz
voltage sensitivity	S_V	25	35	45	V/W	Filter F5.5, 100℃,1Hz
time constant	τ		6	10	ms	
noise voltage	V_{RMS}		38		nV/√Hz	r.m.s., 25℃
detectivity	D^*		$5.6*10^7$		cm√Hz/W	Filter F5.5, 100℃,1Hz
Insulation resistance	R_{iso}	5			GΩ	10V, 25℃, 60% r.h., between pin 1 or 2 and 4 (ground)

Field Of View



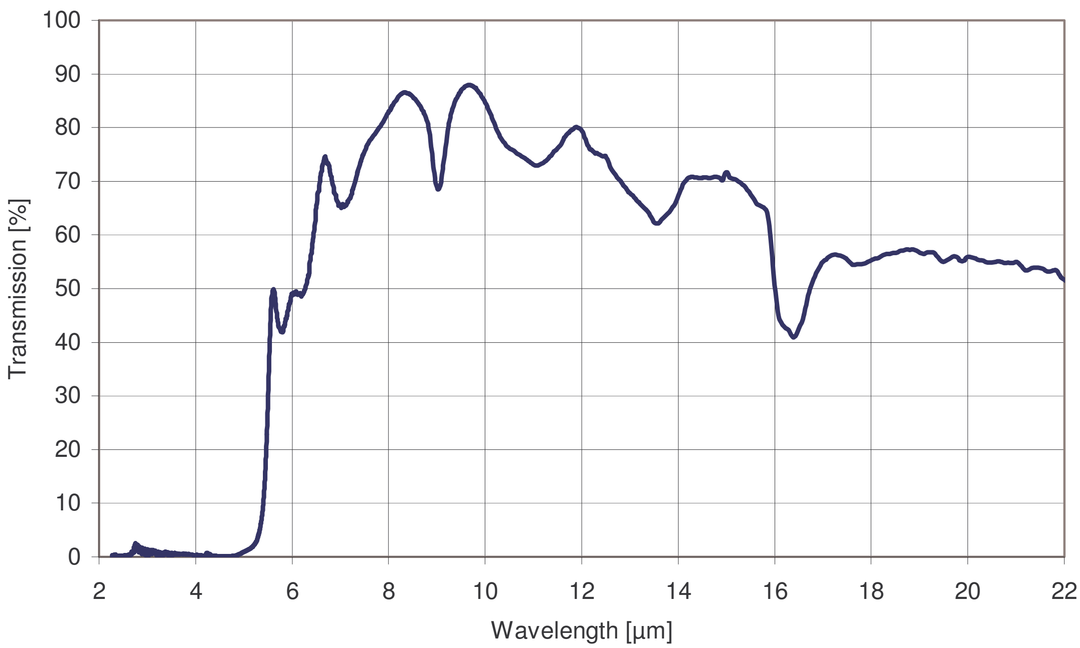
4. General and Electrical Parameter Thermistor

Type	**Thermistor 100kΩ**					
Parameter	***Symbol***	***Limits***			***Units***	***Conditions***
		Min	*Typ.*	*Max*		
resistance	R_{TH}	95	100	105	kΩ	25°C
BETA-value	β	3900	3940	3980	K	25°C/50°C

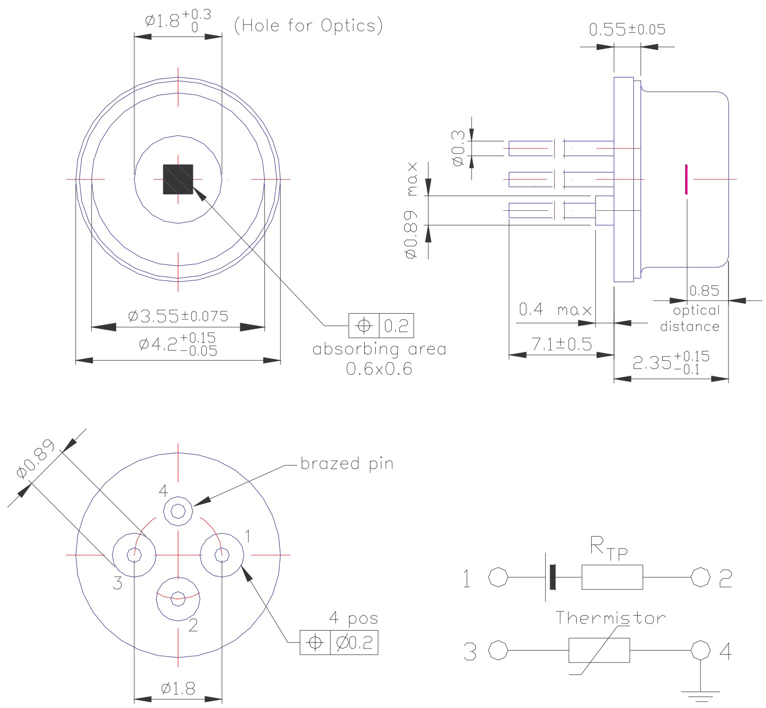
T / °C	***Rth_min / Ohm***	***Rth_nom / Ohm***	***Rth_max / Ohm***
-30	1557900	1655000	1753100
-25	1163320	1234000	1306680
-20	875826	928700	981974
-15	665010	704500	744190
-10	508730	538500	568370
-5	392108	414600	437292
0	304466	321700	338934
5	238072	251400	264728
10	187444	197800	208056
15	148568	156600	164632
20	118404	124800	131096
25	95000	100000	105000
30	76537	80630	84713
35	62032	65380	68738
40	50543	53310	56077
45	41386	43680	45984
50	34070	35980	37890
55	28174	29770	31366
60	23405	24750	26095
65	19536	20670	21804
70	16383	17340	18297
75	13788	14600	15422
80	11653	12350	13047
85	9890	10480	11080
90	8421	8930	9444
95	7197	7635	8076
100	6172	6551	6935

5. Filter Characteristics

Filter F5.5					
Parameter	*Limits*			*Units*	*Conditions*
	Min	*Typ*	*Max*		
average transmission	70			%	7.5µm to 13.5µm
average transmission			1	%	visual to 5µm
cut on	5.2	5.5	5.8	µm	25°C
filter thickness		0.525			
filter material	silicon coated				



6. Drawing and Pin Assignment

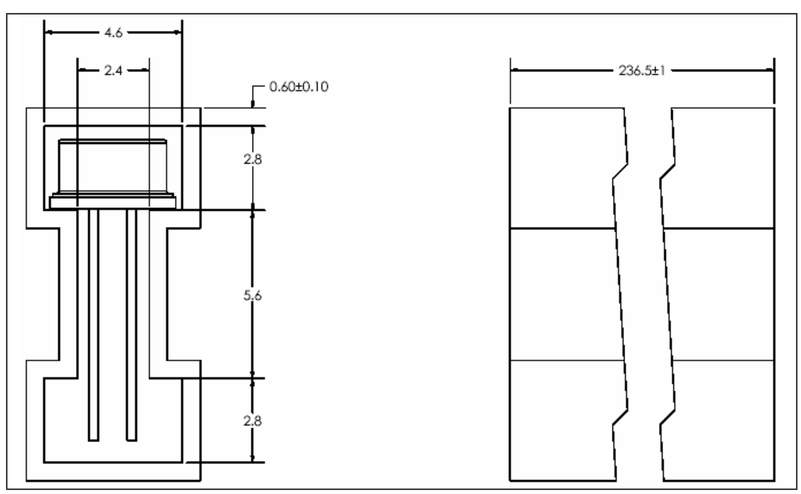


7. Packing

The thermopile sensors HMS Z11 F5.5 are packed in ESD save plastic packing tubes. Each packing tube contains 55 sensors and the tube ends are closed by soft rubber plugs.
Two labels stick on each packing tube:

HMS Z11 F5.5 / 55pcs. HEIMANN Sensor	**HLN 06034/09**
Sensor description / quantity / logo	**Lot number**

Main dimensions of packing tube



8. General Directions for Further Processing

Stresses above the absolute maximum ratings may cause damages to the device.
The sensor can be damaged by electrostatic discharges. Please take appropriate precautions for the handling.
Do not expose the sensors to aggressive detergents. Windows may be cleaned with alcohol and cotton swab.
Wave soldering may be applied by a maximum temperature of 280°C for a dwell time less than 10s. For hand soldering the maximum applicable temperature is 350°C for a dwell time less than 3s. The minimum distance between the housing body and the liquid solder should be for 280°C at least 0.6mm and for 350°C at least 1.5mm. Avoid heat exposure to the top and the window of the detector. Reflow soldering is not recommended.

9. Liability

Important product or process changes require a customer release. Changes or modifications at the product which haven't influence to the performance and/or quality of the device haven't to be announced to the customers in advance. Customers are requested to consult with Heimann Sensor representatives before the use of Heimann Sensor products in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage. The company or their representatives will not be responsible for damage arising from such use without prior approval.

HEIMANN Sensor
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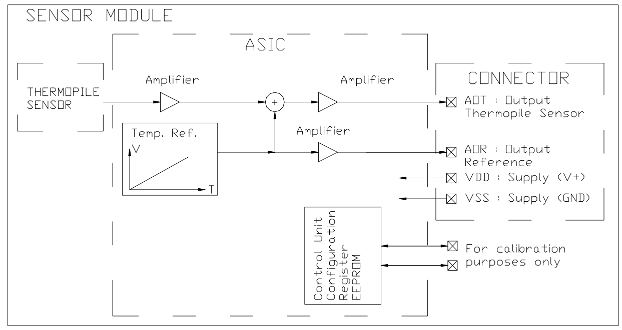
HTIA series with optics

Thermopile Modules for
Temperature measurement

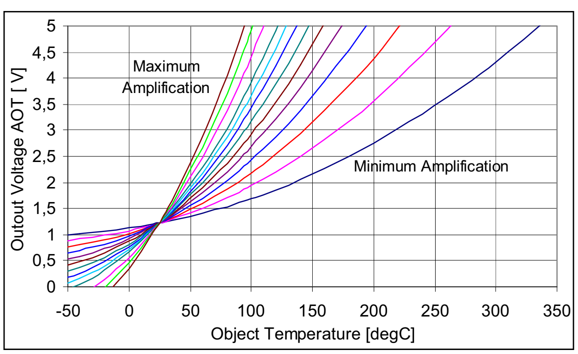
- **Thermopile sensor with integrated ASIC for signal processing**
- **2 analog outputs for thermopile and reference signal**
- **Simple linear reference function for external compensation**
- **Small size by COB technology**
- **Fast response time of 6 msec available**
- **Various optics and filter available**

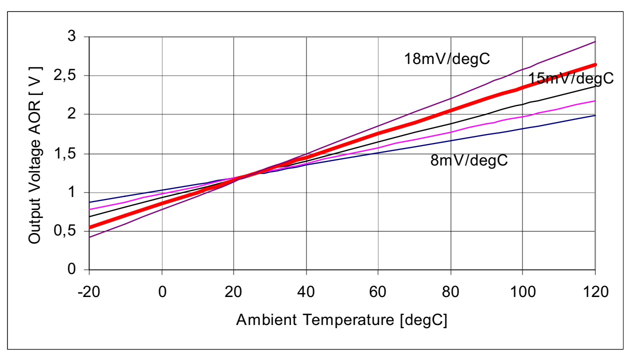


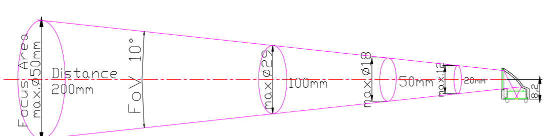
Ordering information for Modules:

Please specify:
- object temperature range
- ambient temperature range
- object (surface) emissivity
- required temperature accuracy and resolution
- required optics
- environmental conditions
- requested speed of response
- connector type and mounting

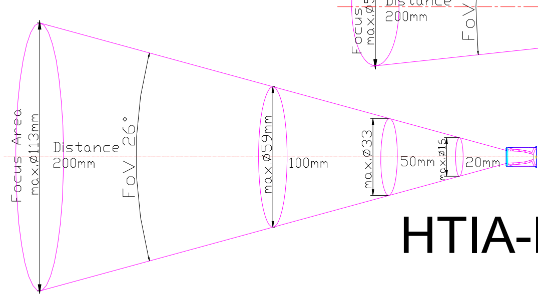
Parameter	Typical Value	Unit	Condition
supply voltage	5	V	VDD
supply current	1	mA	without load
output voltage range	0.3 ... (Vdd - 0.3)	V	
thermopile amplification	500 ... 5000		
object temperature range	-30 ... +500 (max)	°C	object emissivity 90%
gradient temp. reference	8 ... 18	mV/°C	at AOR
response time	6 ... 10	ms	t/T = 63%
operating temperature	-20 to 120	°C	



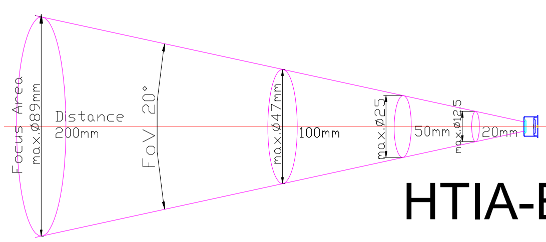




HTIA-B



HTIA-D



HTIA-E

Modifications reserved Rev.07 / 05.10.2004

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Fast Response

Small Size

HEIMANN Sensor

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Datasheet HEIMANN Sensor Integrated Module HTIA

Features

The HEIMANN Sensor thermopile module is designed for the non-contact temperature measurement of surfaces based on infrared radiation. A self-designed application specific integrated circuit is used for the sensor signal processing. The module can be supplied with or without internal compensation of the sensor-typical, physical-based ambient temperature drift.

The HEIMANN Sensor thermopile module HTIA-type-To can be supplied for different object temperature ranges characterized by the detectable object temperature „To". The "type" in the nomenclature describes the sizes, optics and filter characteristics of the different versions.

- Thermopile sensor with integrated ASIC for signal processing
- 2 analog outputs for thermopile and reference signal
- Simple linear reference function for external compensation
- Small size by COB technology
- Fast sensor response time of 5 msec
- Various optics and filter available

Characteristics

Parameter	*min/typ/max value*	*unit*	*condition*
supply voltage	4.5 .. 5 .. 5.5	*V*	*VDD*
supply current	1 .. 1.4 .. 2	*mA*	*without load*
output voltage range	0.3 .. VDD-0.3	*V*	
output resistance	< 10	*Ohm*	*f < 100Hz*
output load	> 20	*kOhm*	*for optimal operation*
thermopile amplification	150 .. 5500		
object temperature range	-30….+500 (1000)	*°C*	*dep. on meas.conditions*
gradient temp. reference	10 .. 15 .. 16	*mV/°C*	*linear function w/ 1.225V at 25°C*
response time	4 .. 5 .. 10	*ms*	*t /T=63% ; sensor*
transmission range	Typ. lwp cut on 5.5 (filter list)	*µm*	*long wavelength pass (options)*
operating temperature	-40 to 120	*°C*	

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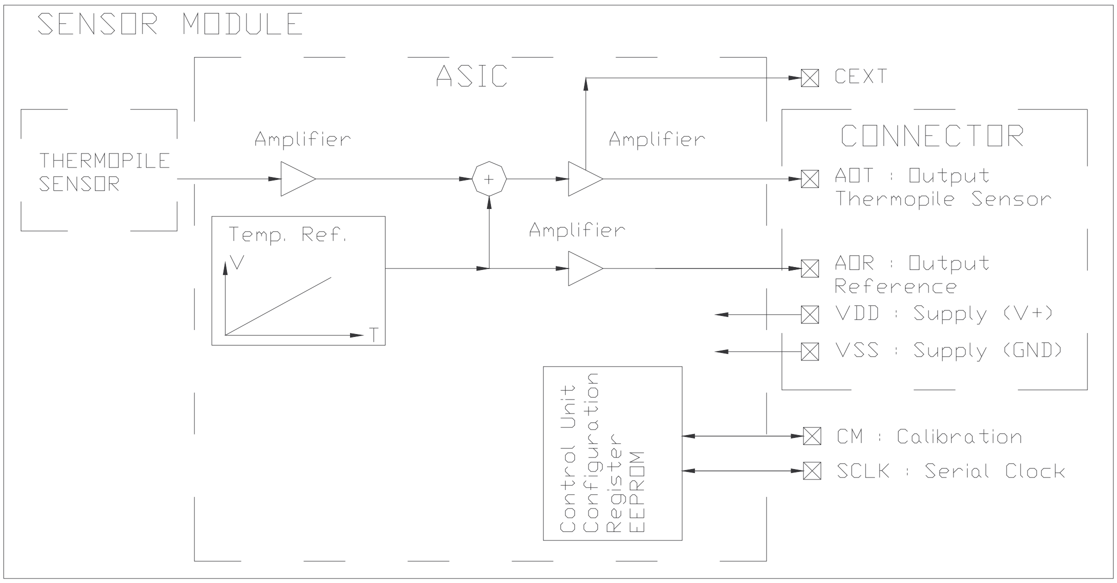
Schematic



connect	*description*
AOR	analog output – temperature reference (AORt) or voltage reference (AORv) / digital input – instructions, addresses, data
V+	power supply – positive supply voltage
AOT	analog output – object temperature related output voltage - AOTc (amplified thermopile signal internal compensated by the temperature reference) - AOTu (amplified thermopile signal) / digital output - data
V-	power supply – negative supply voltage , ground
CM	calibration mode – selection between analog and digital mode
SCLK	serial clock input
device	*description*
Cap C1	optional ; connected to V+ and V-
Cap C2	optional ; connected to CEXT – low pass filter for the output AOT

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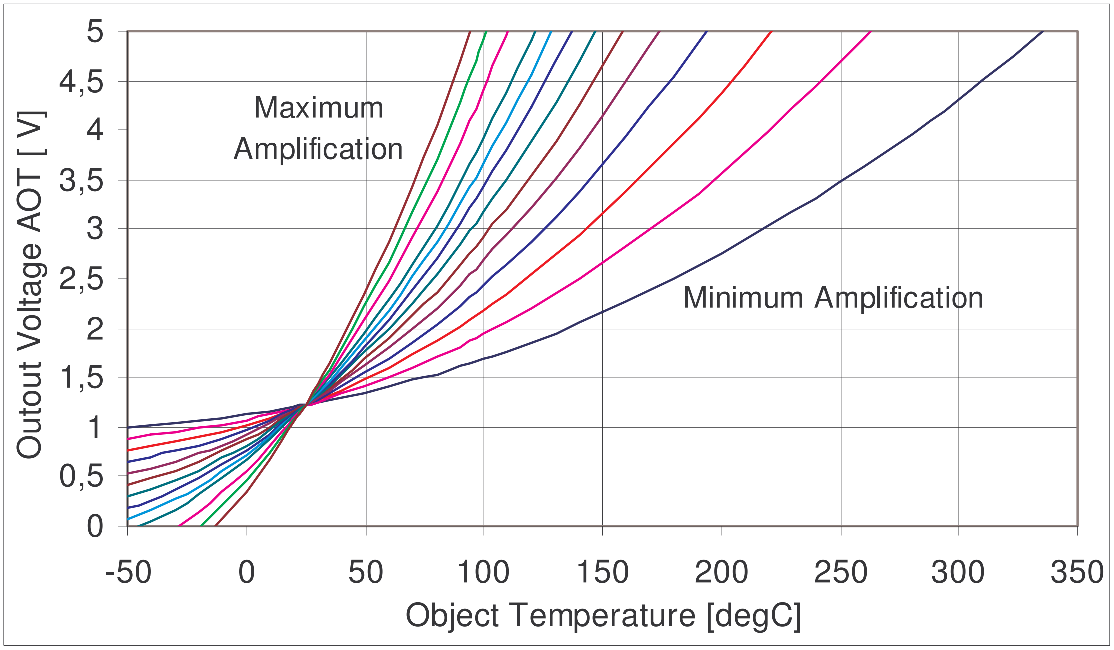
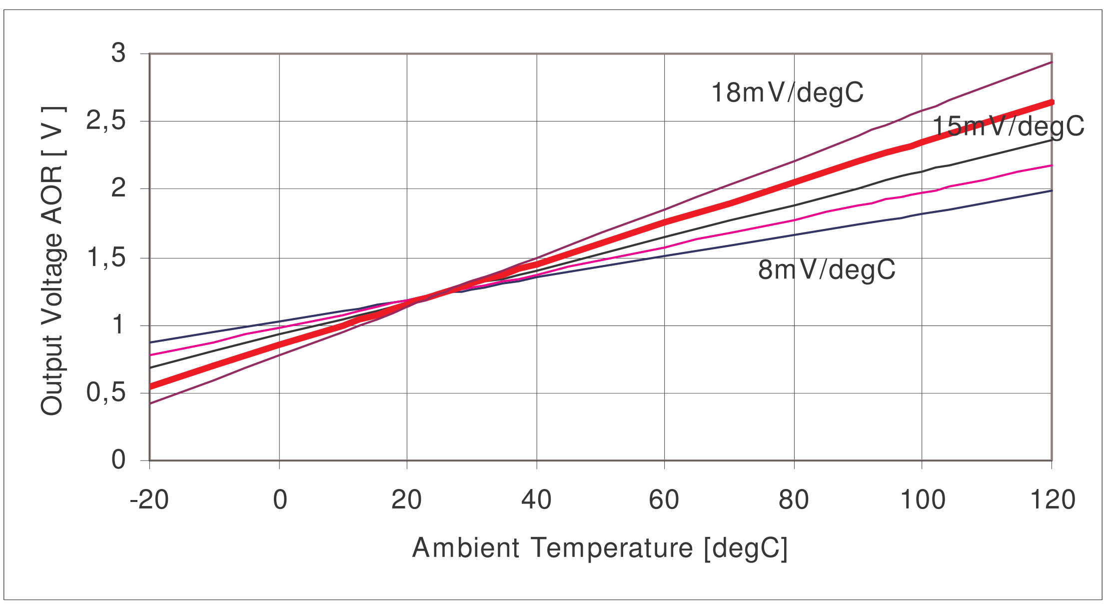
Sample Signal Characteristics Sensor Output AOT



Sample Signal Characteristics Reference Output AOT



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Datasheet HEIMANN Sensor Integrated Module HTIA

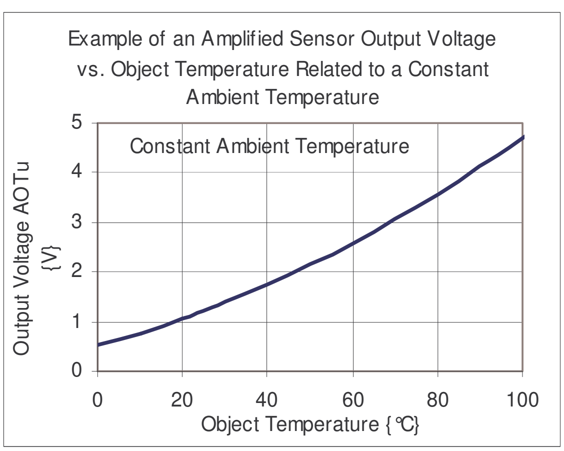
Application Hints – Temperature Calculation and Compensation

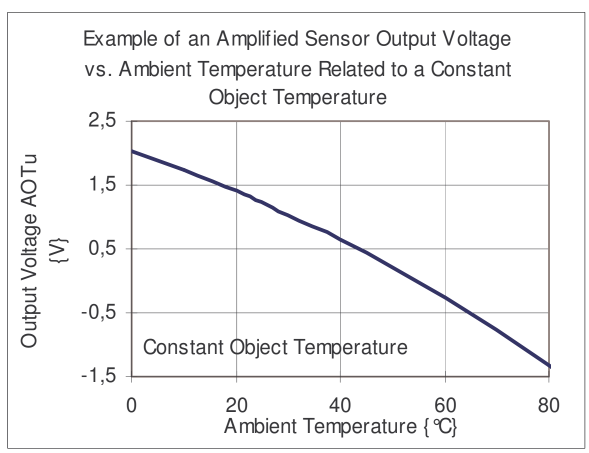
The HEIMANN Sensor integrated module HTIA consists of a fast response thermopile sensor and an ASIC as specific integrated circuit for the signal processing and on chip calibration.
The thermopile sensor converts the temperature radiation of an object surface to an electrical signal (voltage) by thermocouples (Seebeck effect). The sensor output voltage is related to the object temperature and emissivity (radiation) as well as to the sensor chip temperature (housing temperature) and surrounding temperature (radiation) by the following equation :

$$VS = K * \varepsilon * (TO^n - TS^n) \text{ at } TA=TS$$

VS -> sensor output voltage
K -> constant apparatus factor
ε -> object emissivity
TO -> object temperature
TA -> ambient (surrounding) temperature
TS -> sensor (housing) temperature
n -> exponent to describe the temperature dependency of the signal voltage

The equation is simplified by the hypothesis of equal ambient and sensor temperatures. The exponent „n" has the theoretical value of „4" based on physical laws. But in the application practice it is an empirically determined exponent value mostly in the range of 3 .. 4 . The knowledge of the housing temperature is necessary to get the right object temperature from the sensor voltage.





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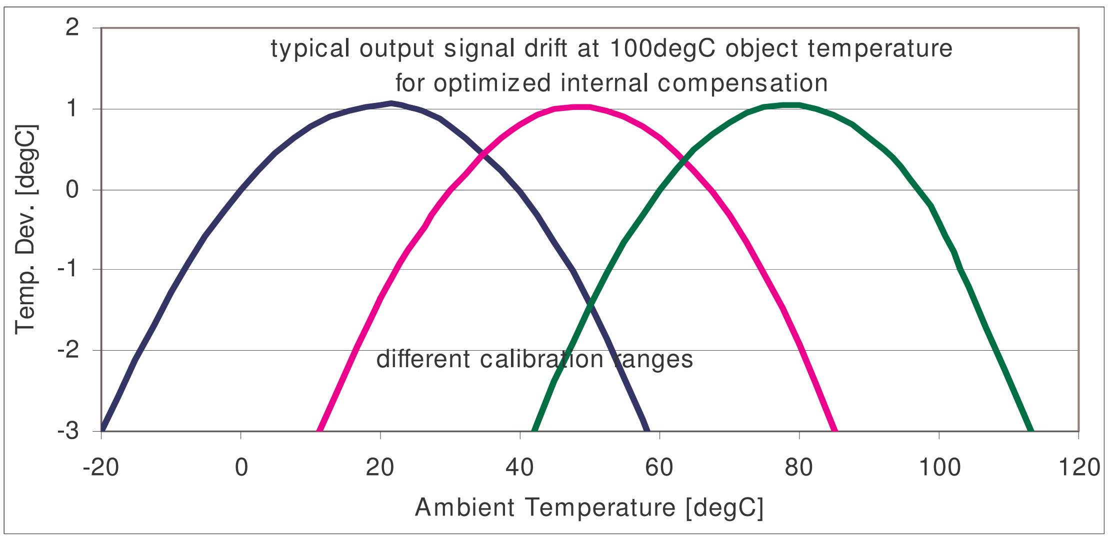
Datasheet HEIMANN Sensor Integrated Module HTIA

Application Hints – Temperature Calculation and Compensation

The integrated sensor module HTIA is designed to detect the housing temperature and to convert the temperature to a voltage.
By the multi-functionality of the integrated sensor module HTIA it is possible to use that voltage for an internal (on chip) ambient temperature compensation which makes the output voltage of the sensor module widely independent from ambient temperature variations within a range of about 40° C. The achievable accuracy is shown in the picture.



For higher accuracy requirements the multi-functional sensor module can output the amplified and calibrated sensor voltage separated from the linear on-chip temperature reference voltage. With it the ambient temperature compensation can be simply done combined with the object temperature calculation by the external microcontroller used in most applications. The following equations and procedures can be used for the calculation of the object temperature independent from the ambient temperature with sufficient accuracy for most applications.

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Datasheet HEIMANN Sensor Integrated Module HTIA

Application Hints – Temperature Calculation and Compensation

Base Function

Vobj (V):	sensor object voltage
K :	constant apparatus factor -> test certificate
ε :	emissivity of the object
Tobj (K):	object temperature (Kelvin)
Tamb (K):	sensor (ambient) temperature (Kelvin); The equation is simplified by the hypothesis of equal ambient Tamb and sensor temperatures Ts.
n:	exponent, empirically determined, in sensor practice mostly in the range 3 to 4 -> test certificate

$$V_{obj} = K * \varepsilon * \left(T_{obj}^{n} - T_{amb}^{n}\right)$$

Tamb=Tsensor

Experimental Determined Factors

In a first approximation the constant factor "K" and exponent "n" based on the Heimann Sensor measuring data can be used. In most cases an exponent of 4 is sufficient for the required temperature tolerance, which simplifies the calculation. The verification of the values is recommended by an application test.

$$K = \frac{V_{obj}}{\varepsilon * \left(T_{obj}^{n} - T_{s}^{n}\right)}$$

Function for Object Temperature Calculation with Temperature Compensation

$$T_{obj} = \sqrt[n]{\frac{V_{obj}}{K * \varepsilon} + T_{s}^{n}}$$

The uncompensated sensor output voltage *V(AOTu)*, measured at the output AOT, is containing the object signal value *Vobj* and the reference voltage *Vref* :

Vobj = V{AOTu} - Vref

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Datasheet HEIMANN Sensor Integrated Module HTIA

Application Hints – Temperature Calculation and Compensation

Internal temperature gradients generate additional offset voltages *Voffs* depending on application influences :

Vobj = V{AOTu} - Vref + Voffs

The temperature generated offset can be determined by an output signal test at Tobj = Tamb.
Calculation of the ambient (sensor) temperature using the sensor output AOR :

$Ts = 1/S_T * (V\{AORt\} – V\{AORt@25\}) + 298.15K$

Ts:	sensor temperature
S_T (V/K):	temperature sensitivity of the internal temperature reference -> test certificate
V{AORt} (V):	measured temperature output voltage at output AOR
V{AORt@25}(V):	temperature output voltage at 25° C (298.15K) -> test certificate

For first tests the object temperature calculation can be done by the mentioned calculation procedure using an application factor and exponent derived from the Heimann Sensor sample data and based on Heimann Sensor test equipment.
All test data are typical related to a defined emissivity of 100%. The emissivity variation can be considered by the factor **ε**.
Another ways for the object temperature calculation with ambient temperature compensation can be performed using look-up tables or polynomial regression equations.
But by the large number of physical affects influencing the non-contact temperature measurement, it is difficult to have the best initial adjustment for the different applications. In detail the measuring is influenced by the object emissivity and its variation, optical ratios (field of view, object size, measuring distances), the ambient and object temperature ranges, the adjustment of the ambient temperature compensation as well as unstable (dynamic) ambient temperature conditions. For that reason the object and ambient temperature to output voltage relation needs to be measured on application conditions.
For most applications an optimized solution can be found and fixed for a serial production. Don't hesitate to contact HEIMANN Sensor for support to use our long-time experience in infrared sensors and sensor modules.

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Application Hints – Handling

Thermal stress to the sensor module can cause temporary measuring deviations. That deviations are generated by internal temperature differences in the sensor package. The sensor detects the temperature differences until the system is thermal stabilized. Recommended measures to reduce the influence of temperature stress to the output signal are

- to fix the sensor module at the printed circuit board only
- to thermal isolate the sensor package to the environment
- to place the sensor chip far from parasitic thermal sources

Stresses above the absolute maximum ratings may cause damages to the device. Precautions should be taken to avoid voltages 0.3V beyond the supply voltages to all inputs and outputs, which may result in latch-up effects (low impedance state with excessive currents). A limitation of the input current to maximum 5mA can avoid latch-up effects.

The allowed duration of output short circuits are indefinite. Continuous short-circuits to ground might cause permanent damage to the device.

Reversed polarity of power supply may result in a destroyed unit.

Do not expose the sensors to aggressive detergents.

Windows may be cleaned with alcohol and cotton swab.

Capacitive loads which are applied directly to the outputs reduce the loop stability margin. A resistive isolation should be used If larger load capacitances must be driven.

The module can be damaged by electrostatic discharges. Please take appropriate precautions for the handling._

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Datasheet HEIMANN Sensor Integrated Module HTIA

Ordering Information

The sensor modules can be ordered by the following nomenclature :

HTIA-"type"+"U" or "C"-To , e.g. HTIA-DU-100

HTIA -> HEIMANN Sensor thermopile module with integrated circuit and analog outputs
type -> letter describing the size and optics according to the datasheet
"U" or "C" -> stands for separated or internal compensated output voltage AOT
To -> maximum object temperature describing the amplification adjustment
The long wavelength pass filter with 5.5µm cut on is used as standard filter type for all types.

Please give following information :
- object and ambient temperature ranges
- object (surface) emissivity
- required temperature accuracy and resolution
- required optics (field of view or object size and measuring distance)
- special environmental conditions
- requested speed of response
- different filter transmission

Don't hesitate to contact us , if the sensor modules show problems in your special application.

Liability Information

Changes or modifications at the product which haven't influence to the performance and/or quality of the device haven't to be announced to the customers in advance.

Customers are requested to consult with Heimann Sensor representatives before the use of Heimann Sensor products in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage. The company or their representatives will not be responsible for damage arising from such use without prior approval.

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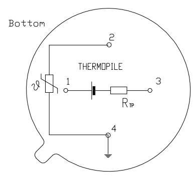
HTS Series

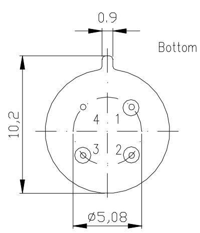
Thermopile Sensors for Remote Temperature Measurement and Gas Analysis

The HTS Series of CMOS compatible thermopile sensor chips in a TO39 size transistor housing, features good sensitivity, small temperature coefficient of sensitivity and high reproducibility and reliability.
The smallest chip TP1 is well suited for temperature measurements which require a precise measuring spot whereas the chip type TP3 is optimized for highest signal.

Additionally Heimann Sensor can offer integrated thermopile sensors (HIS series) combining a thermopile sensor chip with an ASIC in a TO39 housing.



$$R_{therm.ref}(T) = R_{25} \cdot e^{\left[B \cdot \left(\frac{1}{T} - \frac{1}{T_{25}}\right)\right]}$$



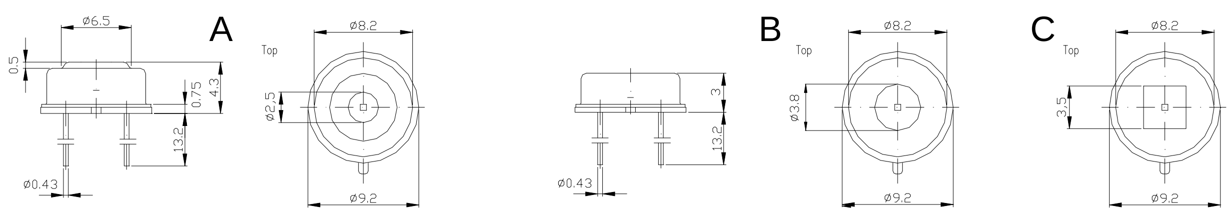
Parameter	HTS A11	HTS B21 C21	HTS B31 C31	Unit
element size	$0{,}61^2$	$1{,}2^2$	$2{,}1^2$	mm^2
voltage response [1]	13	39	74	V mm^2/W
sensitivity [1]	36	27	16	V/W
resistance R_{TP} [2]	86	84	88	kOhm
TC of resistance R_{TP} [2]	0.02	0.02	0.02	% / K
noise[2]	38	37	38	nV/ $Hz^{½}$
detectivity [1,2]	$5.6\ 10^7$	$8.7\ 10^7$	$9.1\ 10^7$	cm $Hz^{½}$ / W
time constant	6	10	18	ms
thermistor reference [2]	100	100	100	kOhm
temp. coeff. of thermistor B [3]	3940	3940	3940	K
field of view [4]	70	100	100	°
operating temperature		-20 ... 120		°C
storage temperature		-40 ... 120		°C

1) filter type F5.5, Tobj=100°C, DC
2) at Tamb=25°C
3) 25°C, 50°C
4) deg at 50% signal level

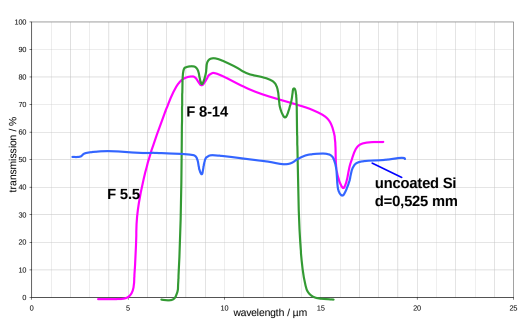
Ordering Information:

HTS / cap aperture / chip type / w/wo thermistor / F desired filter

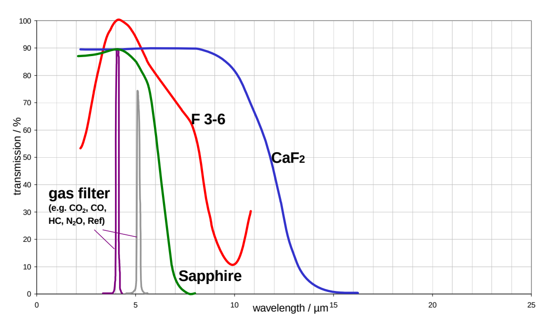
e.g.: HTS A11 F5.5



Filter types for temperature measurements



Filter types for Gas Analysis



Modifications reserved Rev.07 / 01.10.2004

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Specification Thermopile Sensor (preliminary)
HTS A10 F8-14-HT

Part No. 1050

R 01

Author(s):

W. Leneke, M. Simon

Revision History

Version	Date	Remarks
R 01	14.05.2008	Draft of HEIMANN Sensor GmbH

TABLE OF CONTENTS

1. Purpose, Scope

The new thermopile infrared sensor from Heimann Sensor, comprising a new type CMOS compatible sensor chip plus a thermistor reference chip, features good sensitivity, small temperature coefficient of sensitivity as well as high reproducibility and reliability. The sensor meets the requirements of the European Union RoHS (Regulation of Hazardous Substances) Directive.

The sensor will be available in a standard transistor outline package, equipped with an IR transmitting filter window (transmission curve as shown below).

2. Absolute Maximum Ratings

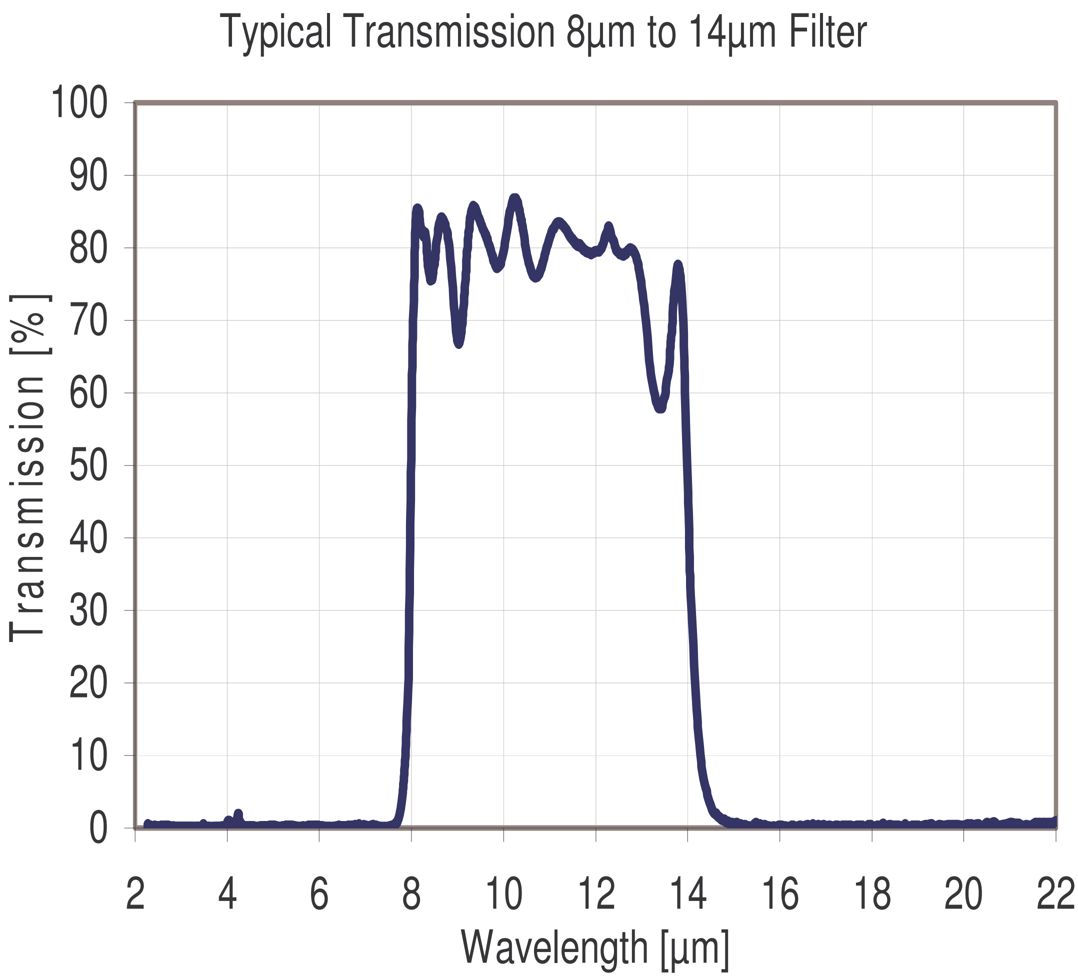
Parameter	*Symbol*	*Limits*			*Units*	*Conditions*
		Min	*Typ.*	*Max*		
storage temperature		-40		185	°C	
operating temperature		-20		180	°C	

3. General and Electrical Parameter Thermopile

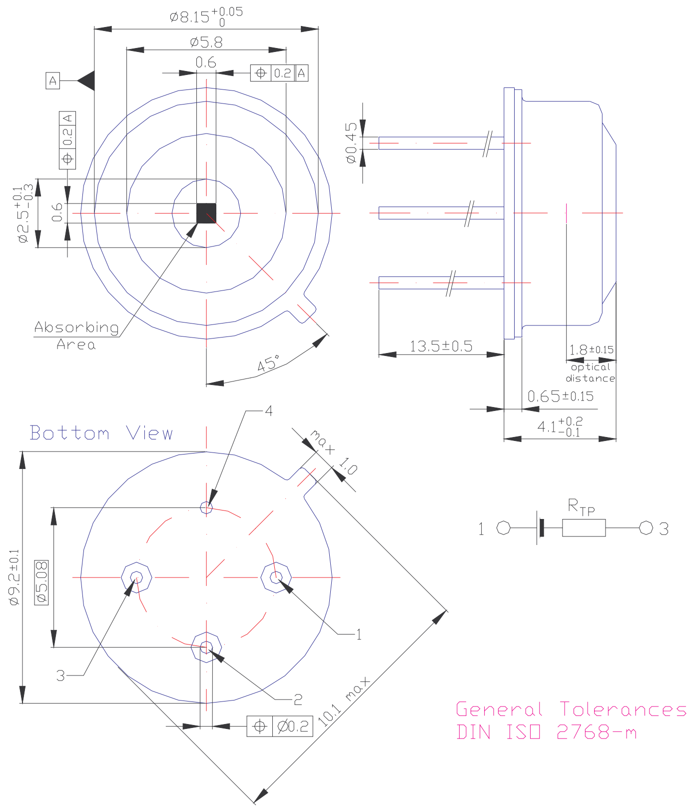
Parameter	*Symbol*	*Limits*			*Units*	*Conditions*
		Min	*Typ.*	*Max*		
filling gas						dry nitrogen
element size			0.6*0.6		mm^2	absorbing area
field of view			75			degree
resistance	R_{TS}	69	86	112	kΩ	-40°C to 185°C
signal voltage	Vs		600		µV	Filter F8–14 µm, T_{BB} 100°C, f = 4.5 Hz
time constant	τ		15		ms	t90
noise voltage	V_{RMS}		38		nV/√Hz	r.m.s., 25°C
detectivity	D^*		$2.9*10^7$		cm√Hz/W	Filter F8–14 µm

4. Filter Characteristics

Filter F8-14					
Parameter	*Limits*			*Units*	*Conditions*
	Min	*Typ*	*Max*		
average transmission	75			%	9µm to 13µm
average transmission			1	%	visual to pass, pass to 20µm
half power point on	7.8	8	8.2	µm	25℃
Half power point off	13.5	14	14.5	µm	25℃
filter thickness		0.525			
filter material	coated silicon				



5. Drawing and Pin Assignment



6. General Directions for Further Processing

Stresses above the absolute maximum ratings may cause damages to the device. The sensor can be damaged by electrostatic discharges. Please take appropriate precautions for the handling.
Do not expose the sensors to aggressive detergents. Windows may be cleaned with alcohol and cotton swab.
For hand soldering the maximum applicable temperature is 215°C for a dwell time less than 10s.
Any temperature above 215°C will lead to an irreversible damage of the thermopile sensor.
Avoid heat exposure to the top and the window of the detector. Reflow and wave soldering is not recommended.

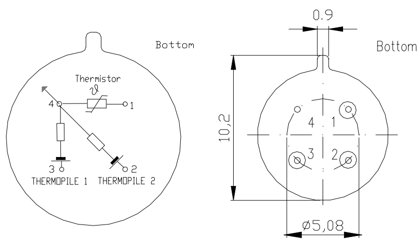
7. Liability

Important product or process changes require a customer release. Changes or modifications at the product which haven't influence to the performance and/or quality of the device haven't to be announced to the customers in advance. Customers are requested to consult with Heimann Sensor representatives before the use of Heimann Sensor products in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage. The company or their representatives will not be responsible for damage arising from such use without prior approval.

HTS i e Se s r

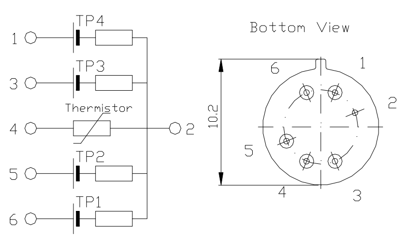
Thermopile Sensor for Gas Analysis

The HTS Multichannel Sensors comprise two or four independent sensor chips for a multichannel gas concentration measurement. Typically one to three of the optical channels contain a gas specific filter window and the other channel, equipped with a filter with center wavelength where no gas absorption occurs, serves as reference.
Of course we can also provide Multichannel Sensors with customer filters (thickness should be close to 0.5 mm).



Parameter	HTS Q21	HTS E21	HTS E31	Unit
num er of channels	4	2	2	
element size	$1,2^2$	$1,2^2$	$2,1^2$	mm^2
voltage response [1]	125	125	237	V mm^2/W
sensitivity [1]	86	86	51	V/W
resistance R_{TP} [2]	84	84	88	k Ohm
TC of resistance R_{TP} [2]	0.02	0.02	0.02	% / K
noise [2]	37	37	38	nV/ $Hz^{½}$
detectivity [1,2]	$2.7\ 10^8$	$2.7\ 10^8$	$2.9\ 10^8$	cm $Hz^{½}$ / W
time constant	10	10	18	ms
thermistor reference[2]	100	100	100	kOhm
temp. coeff. of thermistor B [3]	3940	3940	3940	K
operating temperature		-20..120		°C
storage temperature		-40..120		°C

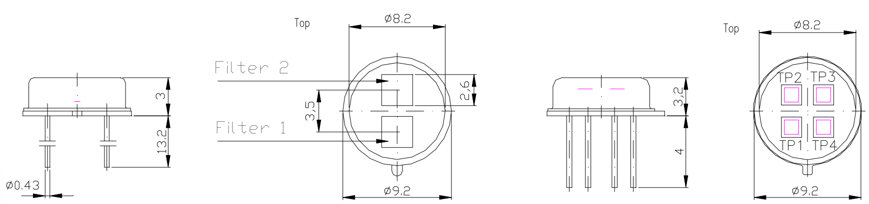
1) **without filter**, Tobj=500°C, DC
2) at Tamb=25°C
3) 25°C, 50°C

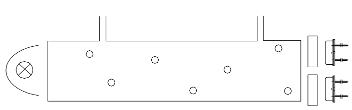


Ordering Information:

HTS / package type / chip type / w/wo thermistor / F desired filters

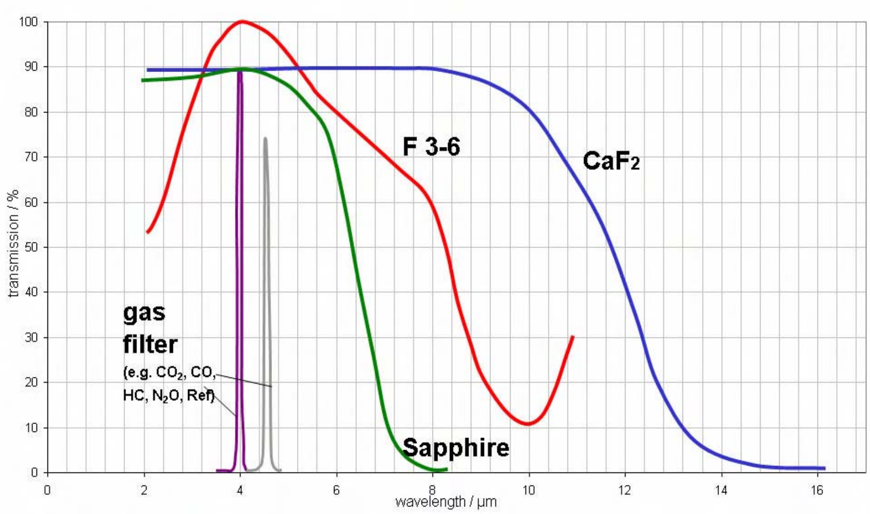
e.g.: HTS 21 F4.0 / F4.26





Please contact Heimann Sensor also for

- **IR lamps,**
- **light concentrators or**
- **high precision broad-band IR sources.**



Modifications reserved Rev.08 / 01.10.2004

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Specification Thermopile Sensor HTS-E21-F3.91/F4.26

R 0.1

Author(s):

W. Leneke, M. Simon

Revision History

Version	Date	Remarks
R 0.1	04.08.2005	1. Draft of HEIMANN Sensor GmbH

1. Purpose, Scope

The new thermopile infrared sensor from Heimann Sensor, comprising a new type CMOS compatible sensor chip plus a thermistor reference chip, features good sensitivity, small temperature coefficient of sensitivity as well as high reproducibility and reliability.

The sensor will be available in standard transistor outline packages in different sizes, equipped with an IR transmitting filter window (transmission curve as shown below).

2. Absolute Maximum Ratings

Parameter	*Symbol*	*Limits*			*Units*	*Conditions*
		Min	*Typ.*	*Max*		
storage temperature		-40		120	°C	
operating temperature		-20		120	°C	

3. General and Electrical Parameter Thermopile

Parameter	*Symbol*	*Limits*			*Units*	*Conditions*
		Min	*Typ.*	*Max*		
element size			1.2*1.2		mm^2	absorbing area
resistance	R_{TP}	69	84	112	kΩ	-40°C to 100°C
TC of resistance			0.02		%/K	25°C
signal voltage channel 3.9	V_S	60	90	115	µV	Heimann Sensor test set-up “F1”: IR source, 6V, 3Hz, distance 15mm
signal voltage channel 4.26	V_S	95	120	145	µV	Heimann Sensor test set-up “F1”: IR source, 6V, 3Hz, distance 15mm
noise voltage	V_{RMS}		37		nV/√Hz	r.m.s., 25°C
time constant	τ		10	13	ms	

4. General and Electrical Parameter Thermistor

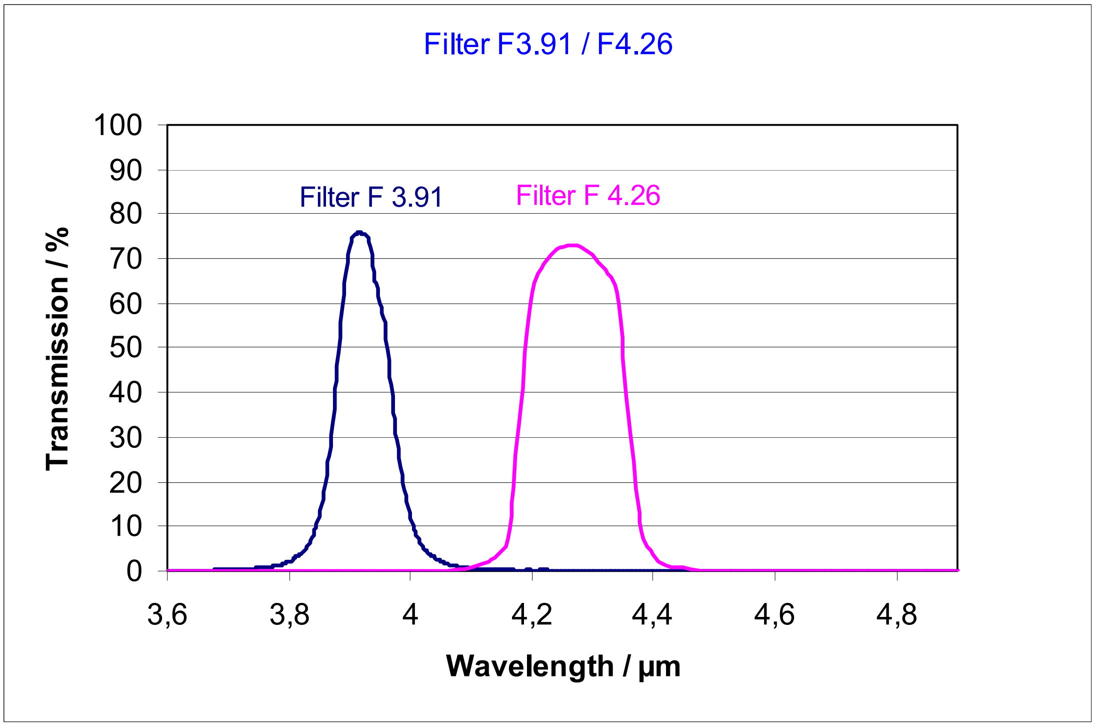
Type	Thermistor 100kΩ					
Parameter	*Symbol*	*Limits*			*Units*	*Conditions*
		Min	*Typ.*	*Max*		
resistance	R_{TH}	95	100	105	kΩ	25°C
BETA-value	β	3900	3940	3980	K	25°C/50°C

T / °C	*Rth_min / Ohm*	*Rth_nom / Ohm*	*Rth_max / Ohm*
-30	1557900	1655000	1753100
-25	1163320	1234000	1306680
-20	875826	928700	981974
-15	665010	704500	744190
-10	508730	538500	568370
-5	392108	414600	437292
0	304466	321700	338934
5	238072	251400	264728
10	187444	197800	208056
15	148568	156600	164632
20	118404	124800	131096
25	95000	100000	105000
30	76537	80630	84713
35	62032	65380	68738
40	50543	53310	56077
45	41386	43680	45984
50	34070	35980	37890
55	28174	29770	31366
60	23405	24750	26095
65	19536	20670	21804
70	16383	17340	18297
75	13788	14600	15422
80	11653	12350	13047
85	9890	10480	11080
90	8421	8930	9444
95	7197	7635	8076
100	6172	6551	6935

5. Filter Characteristics

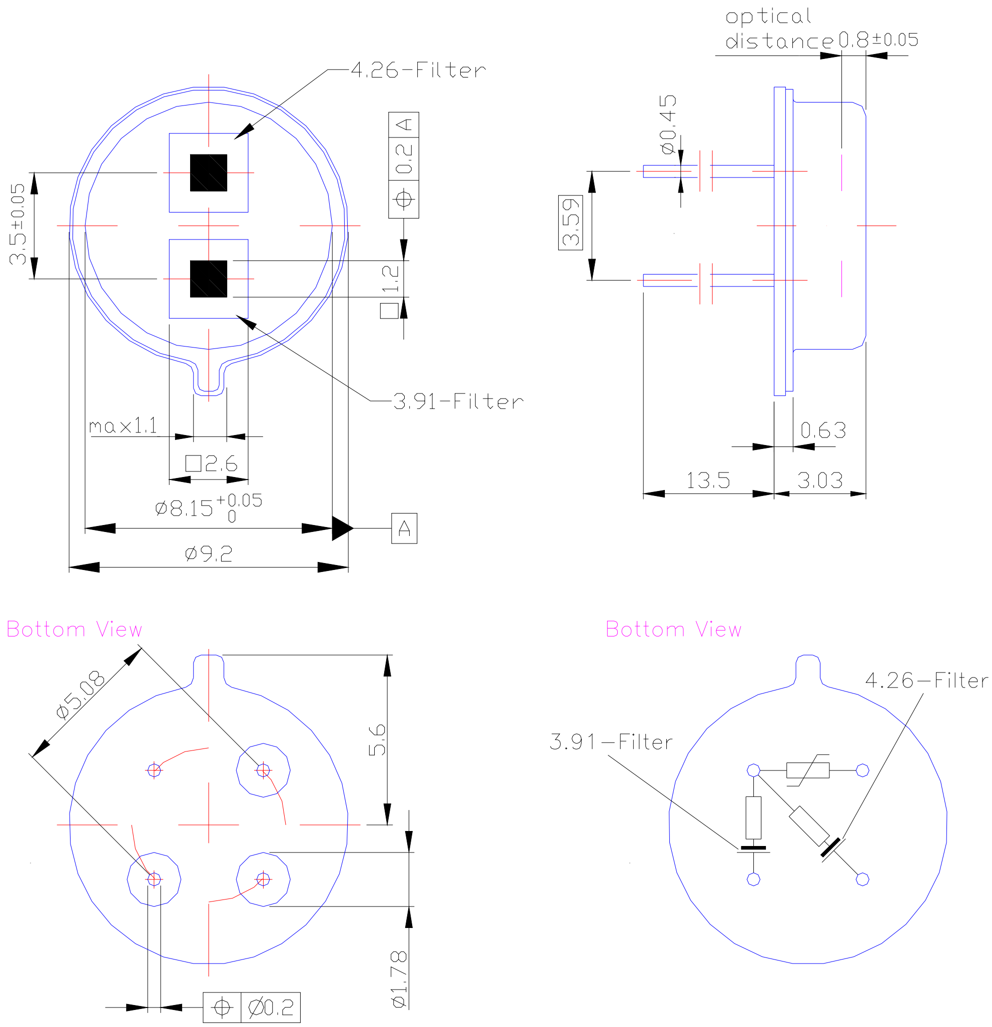
Filter F3.91					
Parameter	***Limits***			***Units***	***Conditions***
	Min	*Typ.*	*Max*		
Center wavelength (CWL)	3.87	3.91	3.95	µm	
Half power bandwidth (HPB)	70	90	110	nm	
HPB/CWL		2.3		%	
Peak transmittance	76			%	
Blocking		$T_{average}$ < 0.1%		%	from UV to band pass
		T_{peak} < 1%		%	from UV to band pass
		T_{peak} < 1%		%	from band pass to 12µm

Filter F4.26					
Parameter	***Limits***			***Units***	***Conditions***
	Min	*Typ.*	*Max*		
Center wavelength (CWL)	4.05	4.26	4.51	µm	
Half power bandwidth (HPB)	160	180	200	nm	
HPB/CWL		4.2		%	
Peak transmittance	73			%	
Blocking		$T_{average}$ < 0.1%		%	from UV to band pass
		T_{peak} < 1%		%	from UV to band pass
		T_{peak} < 1%		%	from band pass to 12µm



Filter F3.91 / F4.26
Filter F 3.91
Filter F 4.26
Transmission / %
100
90
80
70
60
50
40
30
20
10
0
3,6
3,8
4
4,2
4,4
4,6
4,8
Wavelength / µm

6. Drawing and Pin Assignment



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Specification Thermopile Sensor (preliminary)
HTS A10 F8-14-HT

Part No. 1050

R 01

Author(s):

W. Leneke, M. Simon

Revision History

Version	Date	Remarks
R 01	14.05.2008	Draft of HEIMANN Sensor GmbH

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Parameter	*Symbol*	*Limits*			*Units*	*Conditions*
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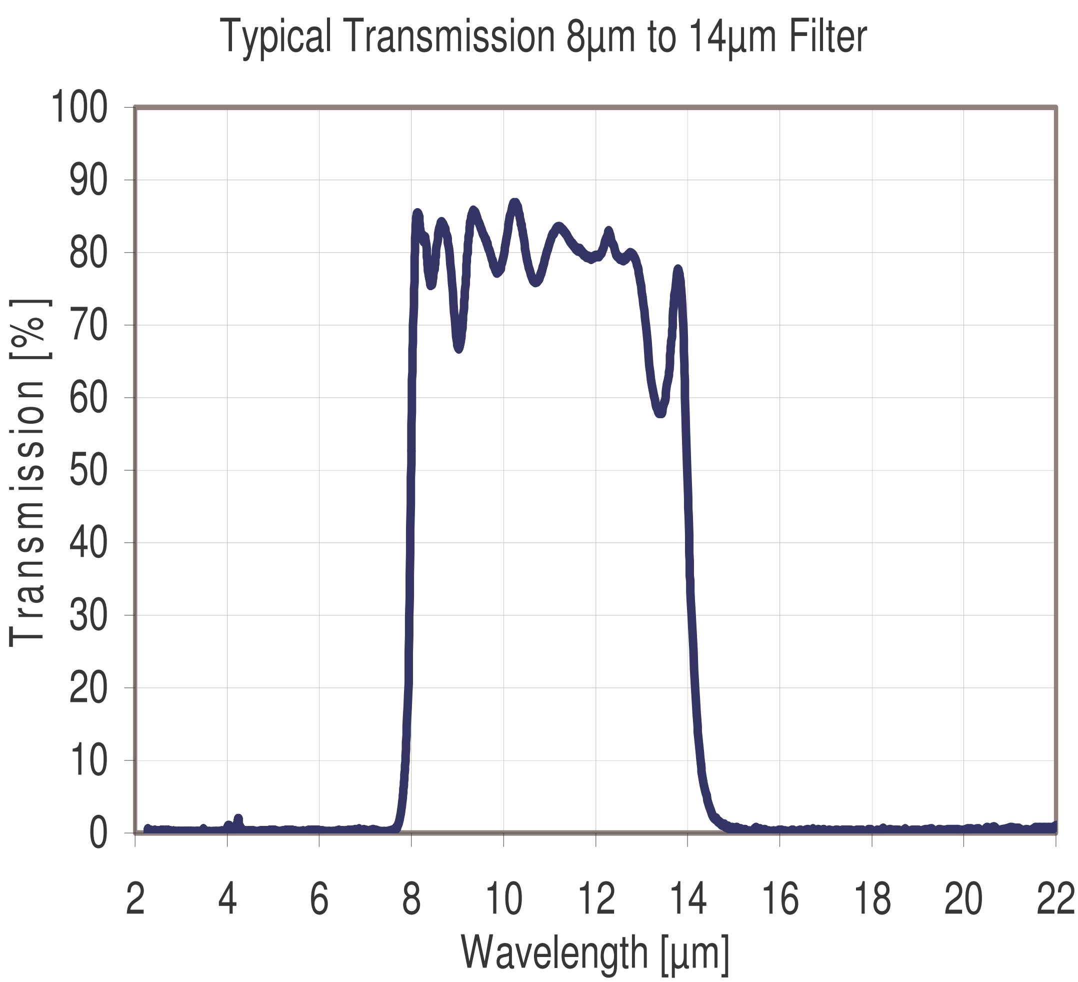
field of view			75			degree
resistance	R_{TS}	69	86	112	kΩ	-40°C to 185°C
signal voltage	Vs		600		µV	Filter F8–14 µm, T_{BB} 100°C, f = 4.5 Hz
time constant	τ		15		ms	t90
noise voltage	V_{RMS}		38		nV/√Hz	r.m.s., 25°C
detectivity	D^*		$2.9*10^7$		cm√Hz/W	Filter F8–14 µm

4. Filter Characteristics

Filter F8-14					
Parameter	*Limits*			*Units*	*Conditions*
	Min	*Typ*	*Max*		
average transmission	75			%	9µm to 13µm
average transmission			1	%	visual to pass, pass to 20µm
half power point on	7.8	8	8.2	µm	25°C
Half power point off	13.5	14	14.5	µm	25°C
filter thickness		0.525			
filter material	coated silicon				



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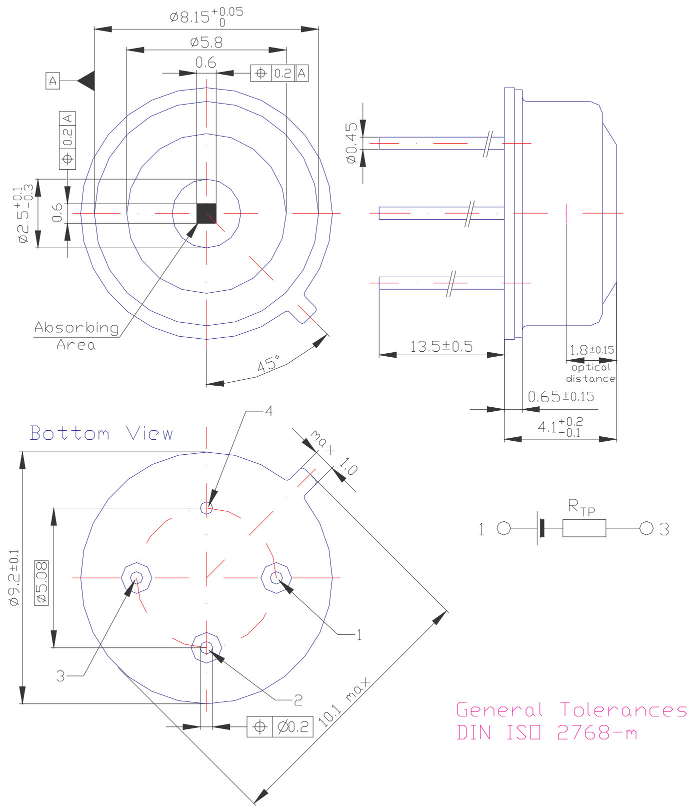

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