Datasheet HEIMANN Sensor Integrated Module HIS

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 HIS-type can be supplied for different object temperature ranges characterized by the detectable temperature range „To" or adjusted to a defined amplification for gas detection applications. 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 or internal compensation
- TO39 metal housing for proper thermal shock behaviour
- Fast response time of 5 msec for sensor type 1 and 10msec for sensor type 2
- Various caps, 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	500 .. 5500		
object temperature range	-30….+500 (1000)	*°C*	*dep. on meas.conditions*
gradient temp. reference	10 .. 15 .. 16	*mV/°C*	*linear function* *1.225V at 25°C*
response time	4 .. 5 .. 10	*ms*	*t /T=63% ; sensor type 1*
operating temperature	-40 to 120	*°C*	

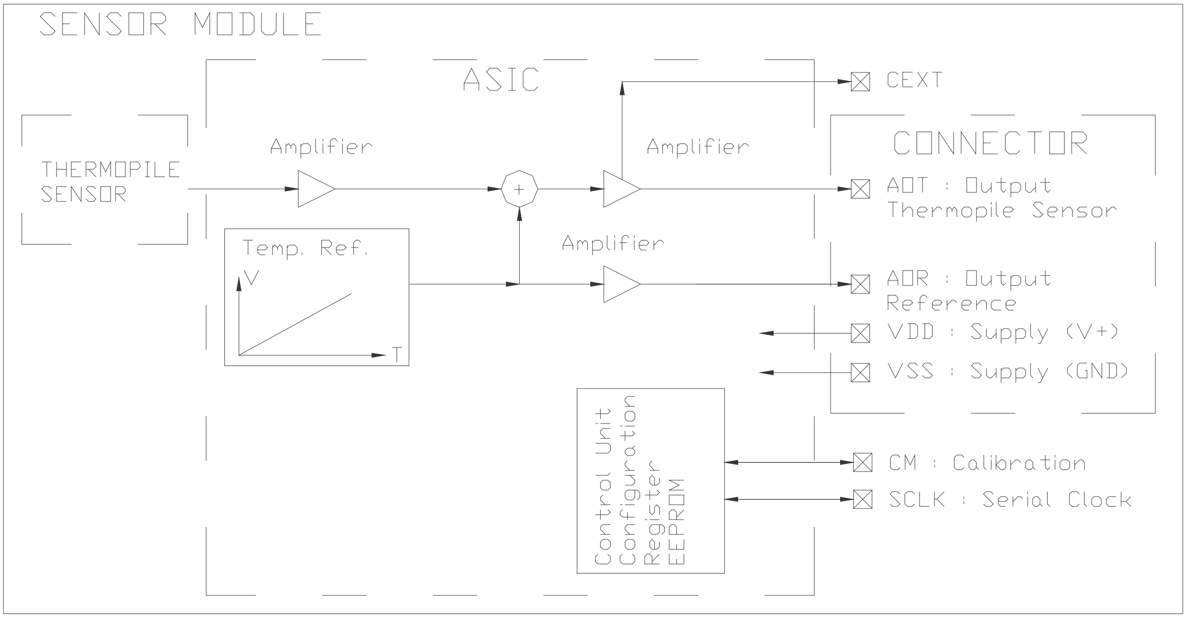
HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

Internet
www.heimannsensor.com
mail: info@heimannsensor.com

Datasheet HEIMANN Sensor Integrated Module HIS

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

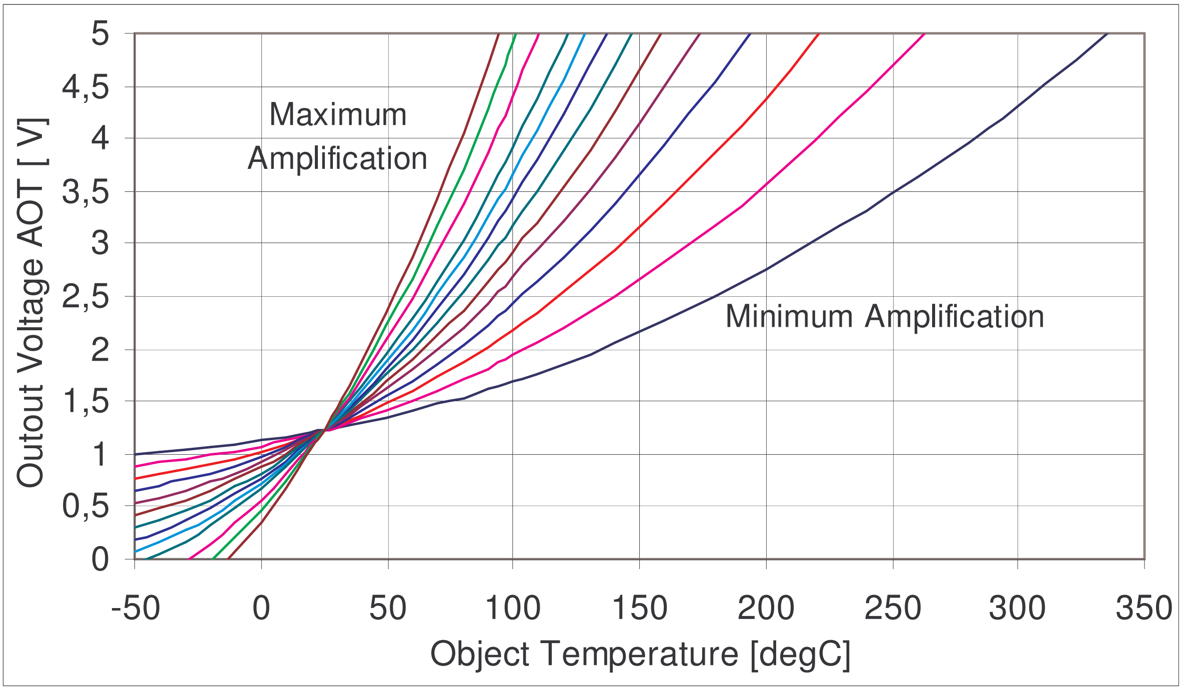
HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

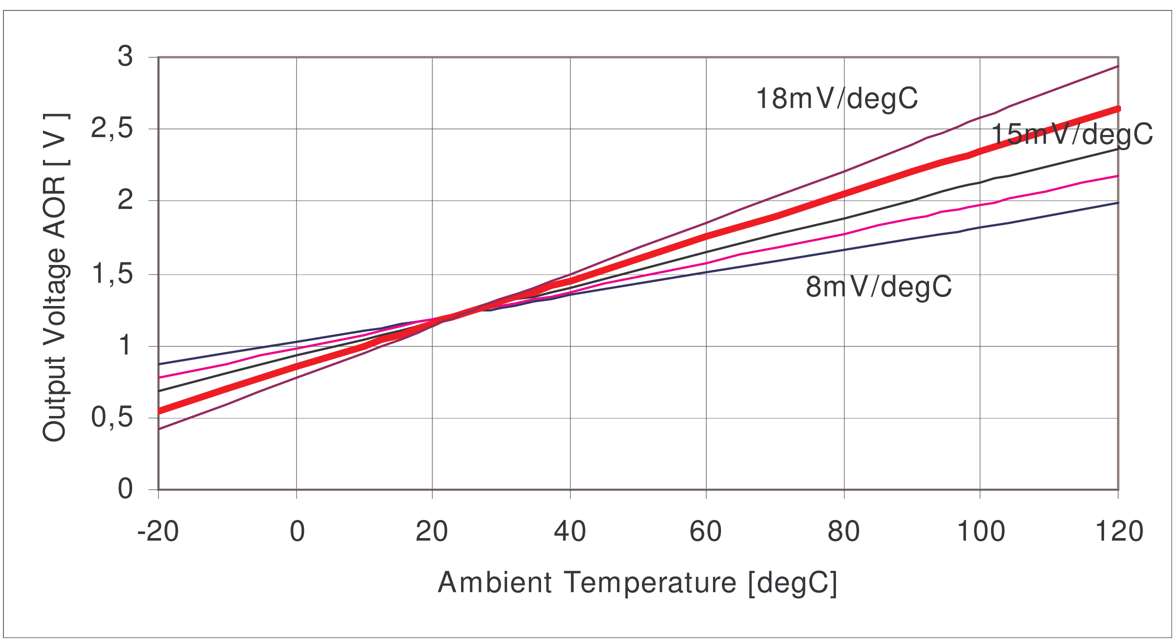
Internet
www.heimannsensor.com
mail: info@heimannsensor.com

Datasheet HEIMANN Sensor Integrated Module HIS

Sample Signal Characteristics Sensor Output AOT



Sample Signal Characteristics Reference Output AOT



HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

Internet
www.heimannsensor.com
mail: info@heimannsensor.com

Datasheet HEIMANN Sensor Integrated Module HIS

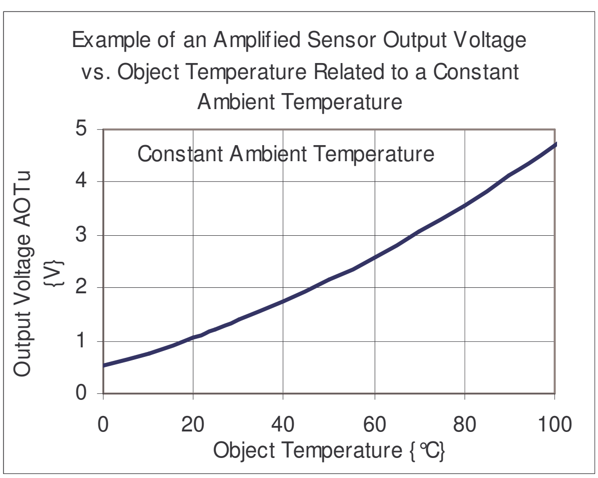
Application Hints – Temperature Calculation and Compensation

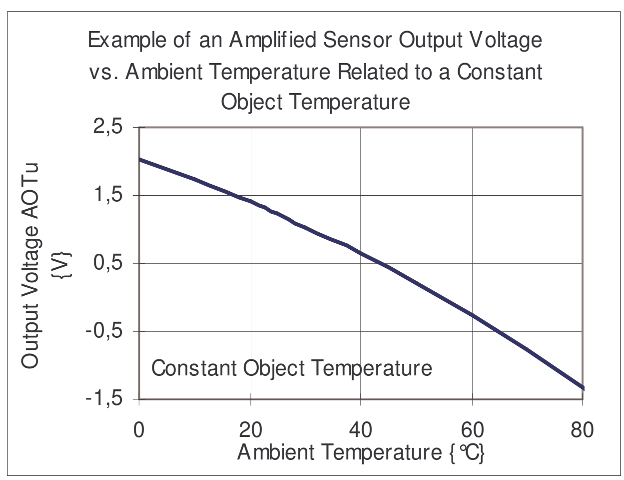
The HEIMANN Sensor integrated module HTIA consists of a fast response thermopile sensor and an ASIC as specific integrated circuit for the signal processing and on chip calibration.
The thermopile sensor converts the temperature radiation of an object surface to an electrical signal (voltage) by thermocouples (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.





HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

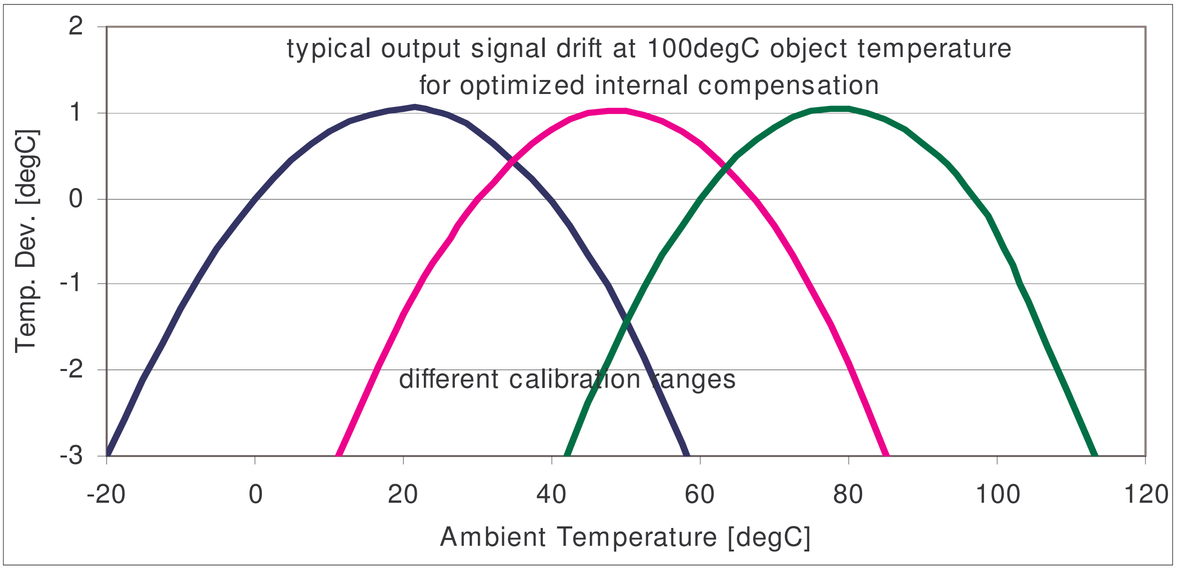
Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

Internet
www.heimannsensor.com
mail: info@heimannsensor.com

Datasheet HEIMANN Sensor Integrated Module HIS

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.

HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

Internet
www.heimannsensor.com
mail: info@heimannsensor.com

Datasheet HEIMANN Sensor Integrated Module HIS

Application Hints – Temperature Calculation and Compensation

<u>Base Function</u>

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

<u>Experimental Determined Factors</u>

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.

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

<u>Function for Object Temperature Calculation with Temperature Compensation</u>

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

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

HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

Internet
www.heimannsensor.com
mail: info@heimannsensor.com

Datasheet HEIMANN Sensor Integrated Module HIS

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 = 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.

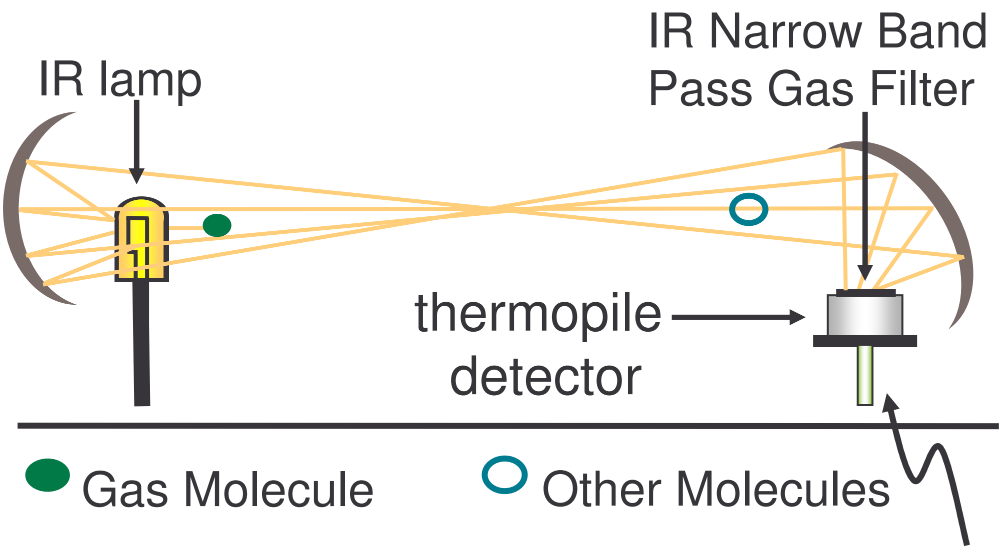
HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

Internet
www.heimannsensor.com
mail: info@heimannsensor.com

Datasheet HEIMANN Sensor Integrated Module HIS

Application Hints – Gas Detection



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

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.

HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

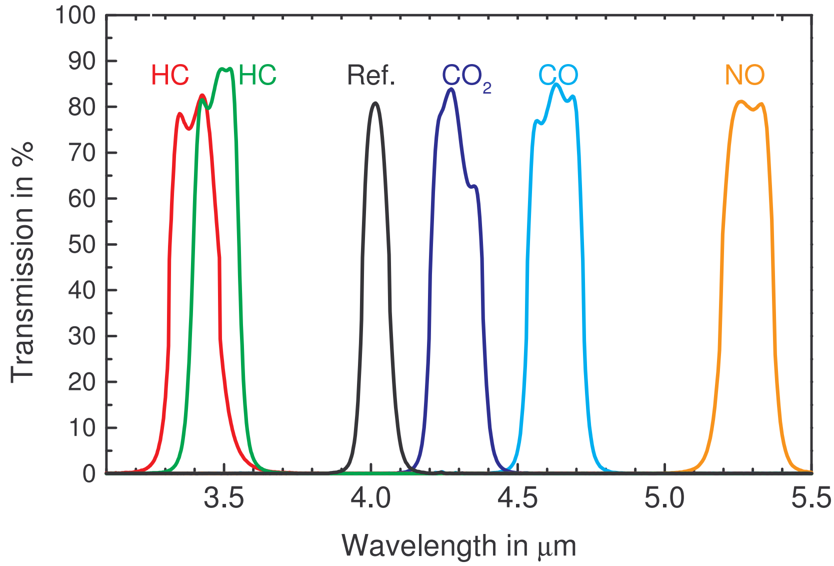
Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

Internet
www.heimannsensor.com
mail: info@heimannsensor.com

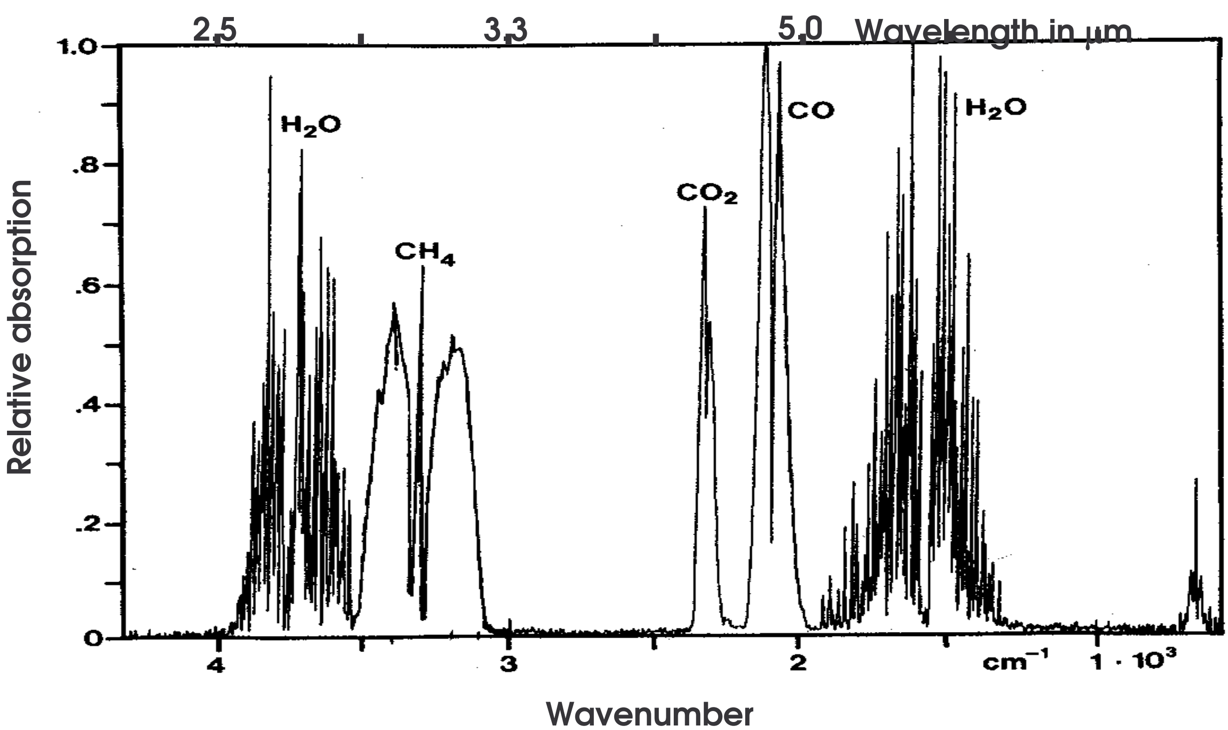
Datasheet HEIMANN Sensor Integrated Module HIS

Application Hints – Gas Detection

Available Infrared Filter for Gas Detection



Absorption Lines of Prominent Gases



HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

Internet
www.heimannsensor.com
mail: info@heimannsensor.com

Datasheet HEIMANN Sensor Integrated Module HIS

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 side wall of the header only
- to thermal isolate the sensor package to the environment
- to place the sensor 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._

HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

Internet
www.heimannsensor.com
mail: info@heimannsensor.com

Datasheet HEIMANN Sensor Integrated Module HIS

Ordering Information

The sensor modules can be ordered by the following nomenclature :
Temperature measurement : HIS-"type"+"U" or "C"-To , e.g. HTIA-DU-T100
Gas detection : HIS-"type" –"filter"-"pin number" , e.g. HIS A21 F4.26 4PIN

HIS -> HEIMANN Sensor thermopile module with integrated circuit and analog outputs in a TO39 package
type -> letter describing the cap, optics and sensor type (1,2 or 3)
"U" or "C" -> stands for separated or internal compensated output voltage AOT
To -> maximum object temperature describing the amplification adjustment
filter -> central wave length of the narrow band filter or gas type
Pin number -> for gas detection 4 or 6 pin sensors are available , 4 pin types are adjusted to max. sensor amplification of 5.500
The long wavelength pass filter with 5.5µm cut on is used as standard filter type for all temperature measurement 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.

HEIMANN Sensor GmbH
Grenzstr. 22
D-01109 Dresden

Contact / Customer Support
Phone 49 (0) 6123 60 50 30
Fax 49 (0) 6123 60 50 39

Internet
www.heimannsensor.com
mail: info@heimannsensor.com