TSD305-1C55

DIGITAL TEMPERATURE SENSOR

Product Description

The TSD is a contactless temperature measurement system located in a TO5 package. The TSD includes an infrared sensor (thermopile) and a sensor signal conditioner.

The TSD can be interfaced to any microcontroller by an I^2C interface. This microcontroller has to calculate the temperature results based on the ADC values and the calibration parameters

Features

- 0°C … +100°C measurement range
- Small size
- Up to ±1°C accuracy
- I^2C Interface
- Low current consumption
- Operating Temperature Range: -10°C … +85°C

Applications

- Contactless temperature measurement
- Climate control
- Industrial process control
- Household applications

ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings are limiting values of permitted operation and should never be exceeded under the worst possible conditions either initially or consequently. If exceeded by even the smallest amount, instantaneous catastrophic failure can occur. Even if the device continues to operate satisfactorily, its life may be considerably shortened.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage	V_{DD}	---	-0.3	---	+3.63	V
Storage temperature	T_{stor}	dry	-20	---	+85	°C
Voltage at supply and IO pins	V_{DD} V_{IO}	---	-0.5	---	V_{DD} +0.5	V
Current into supply and IO pins	I_{IN}	---	-100	---	100	mA
ESD rating	ESD	Human Body Model	-2	---	+2	kV
Humidity	Hum	---	Non condensing			---

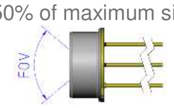
OPERATING CONDITIONS

If not otherwise noted, 3.3V supply voltage is applied.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Operating supply voltage	V_{DD}	stabilized, 100nF	1.68	---	3.6	V
VDD rise time	t_{VDD}	---	---	---	200	µs
Operating temperature	T_{op}	---	-20	---	+85	°C
Object temperature range	T_{OBJ}	---	0	---	+100	°C
Resolution	RES	---	---	---	0.1	°C
Supply Current	I_{VDD}	Active state, average	---	1050	1500	µA
		Sleep state, idle current	---	20	25	nA
Serial data clock I2C	F_{SCL}	---	---	---	3.4	MHz
Self heating	SH	1 sample/s, still air, 60s	---	---	+0.2	°C
VDD capacitor	C_{VDD}	Place close to the sensor	---	100	---	nF

THERMOPILE COMPONENT

If not otherwise noted, 3.3V supply voltage is applied.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Absorber area	A	---	0.8 x 0.8			mm
Field of view	FOV	At 50% of maximum signal 	---	88	---	deg
Filter transmission range	LWP	Long wave pass	>5.5			µm

ANALOGUE TO DIGITAL CONVERTER

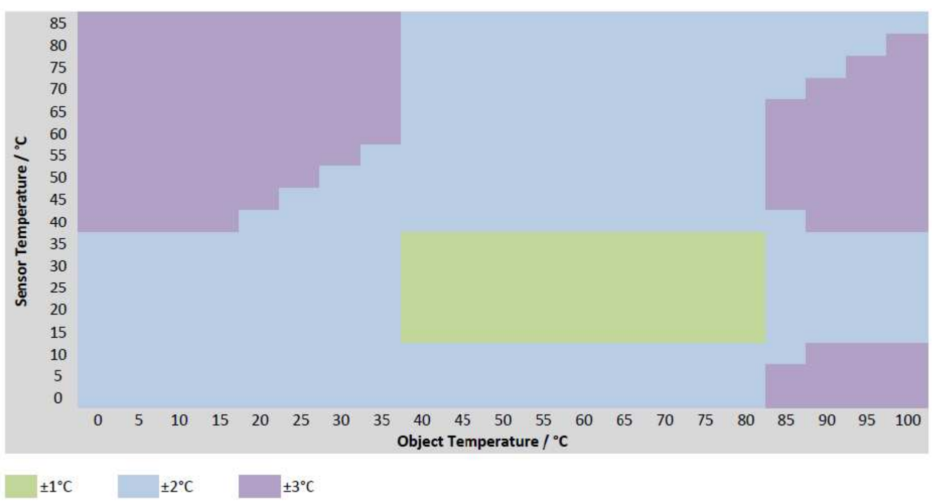
Parameter	Symbol	Condition	Min	Typ	Max	Unit
Resolution	ADC_{RES}	---	---	16	---	bit
Conversion time	t_{CONV}	---	---	44.8	59.2	ms
Rise time	t_{63}	Including rise time of sensor element	---	---	44.8	ms
Resolution internal temperature sensor	ITS_{RES}	---	---	0.003	---	K/LSB

TOLERANCES

If not otherwise noted, 3.3V supply voltage is applied. T_{sen} = sensor temperature, T_{obj} = object temperature

Parameter	Symbol	Sensor Temo	Object Temp	Max	Unit
Accuracy Standard Temp 1)	ACC_S	+15°C < T_{sen} < +35°C	+40°C < T_{obj} < +80°C	±1	°C
Accuracy Extended Temp. 1 2)	ACC_{E1}	Complete range	+40°C < T_{obj} < +80°C	±2	°C
		+15°C < T_{sen} < +35°C	Complete range		
Accuracy Extended Temp. 2 2)	ACC_{E3}	Complete range	Complete range	±3	°C

Other temperature ranges and accuracies are available on request.
1) Proved while production
2) Proved by design



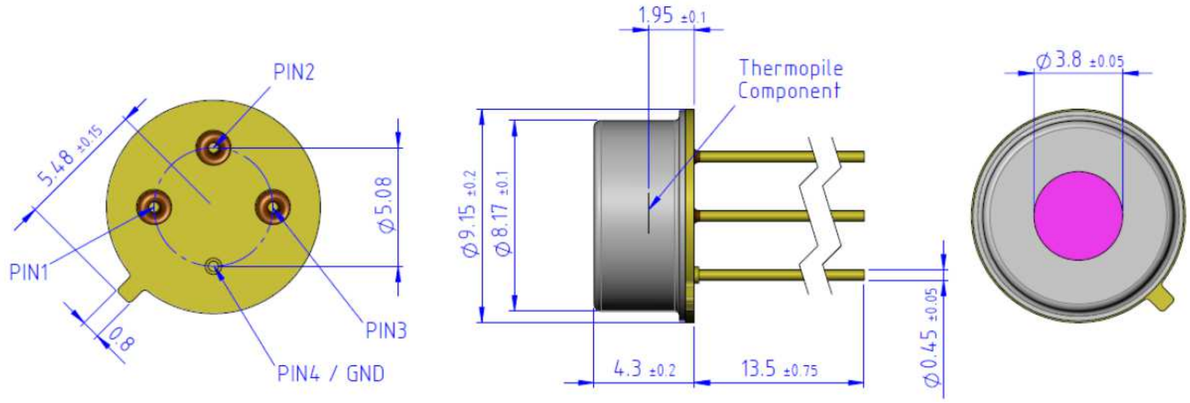
Typical accuracy performance

POWER & RESET

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Start up time	t_{STA1}	V_{DD} ramp up to interface communication	---	---	1	ms
	t_{STA2}	V_{DD} ramp to first ADC measurement	---	---	2.5	ms
Wake up time	t_{WUP1}	Sleep to active state interface communication	---	---	0.5	ms
	t_{WUP2}	Sleep to first ADC measurement	---	---	2	ms
Power down time for reset	t_{RESET}	VDD_{low}	3	---	---	µs
VDD low level	VDD_{low}	---	0	---	0.2	V
VDD rising slope	SR_{VDD}	---	10	---	---	V/ms

DIMENSIONS

If not specified, all tolerances according DIN ISO 2768-m.



PIN FUNCTION TABLE

Pin	Name	Type	Function
1	SCL	DI	I²C Clock
2	SDA	DIO	I²C Data
3	V_{DD}	P	Supply Voltage
4	V_{SS}	P	Ground

I²C INTERFACE

An I²C communication message starts with a start condition and it is ended by a stop condition.

Most commands consist of two bytes: the address byte and command byte.

I²C ADRESS

The standard I²C address is 0x00 (0b0000000X).

- X = 0: I²C Write
- X = 1: I²C Read

STATUS BYTE

Each return starts with a status byte followed by the requested data word.

Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Meaning	---	---	Busy	---	---	Memory Error	---	---

- Busy: 1 = Sensor is busy. The requested data is not available yet.
- Memory Error: 1 = Memory integrity check failed. Memory was changed after factory calibration.

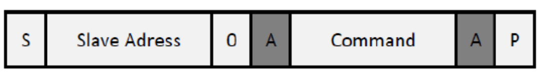
COMMANDS

Note: Each return starts with a status byte followed by the requested data word.

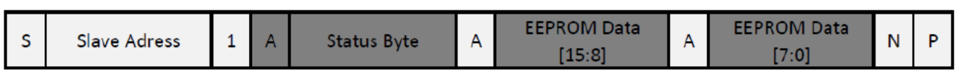
Command	**Return**	**Description**
0x00 … 0x39	16 bit EEPROM data	Read data from EEPROM address (0x00 … 0x39) matching the command
0xAF	24 bit object temperature ADC, 24 bit sensor temperature ADC	Measure object temperature and sensor temperature ADC 16 times and calculates mean value. Store data in output buffer.

Read EEPROM

Write Command:

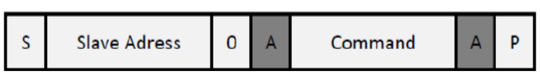


Read EEPROM Data:

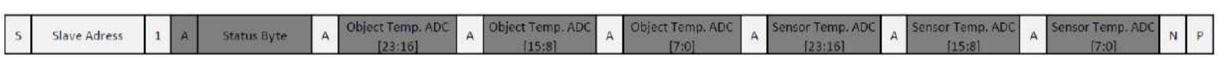


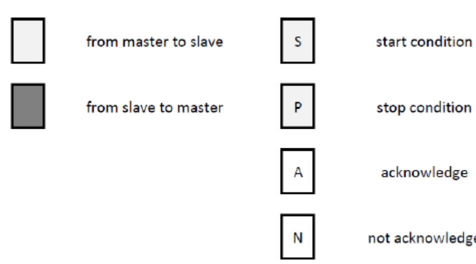
Perform Measurement and Read ADC Data

Write Command:



Read ADC Data:





EEPROM CONTENT

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x00	0	Lot Nr.	---	UINT16	15001	YY WWW
0x01	1	Serial Number	---	UINT16	12345	Number
0x02 ... 0x19	2 ... 25	Factory Calibration Data	---	---	---	---
0x1A	26	Min. Sensor Temp. / °C	T_{SenMin}	SINT16	0xFFEC	-20°C
0x1B	27	Max. Sensor Temp. / °C	T_{SenMax}	SINT16	0x0055	+85°C
0x1C	28	Min. Object Temp. / °C	T_{ObjMin}	SINT16	0x0000	0°C
0x1D	29	Max. Object Temp. / °C	T_{ObjMax}	SINT16	0x0064	100°C
0x1E	30	Temperature Coefficient	TC	IEEE 754 H-Word	0xBB96	-0.0046
0x1F	31			IEEE 754 L-Word	0xBB99	
0x20	32	Reference Temperature	T_{REF}	IEEE 754 H-Word	0x41D7	26.93
0x21	33			IEEE 754 L-Word	0x70A4	
0x22	34	Compensation Coefficient k4	$k4_{comp}$	IEEE 754 H-Word	0x3A07	5.161E-04
0x23	35			IEEE 754 L-Word	0x4C8C	
0x24	36	Compensation Coefficient k3	$k3_{comp}$	IEEE 754 H-Word	0x3F10	5.639E-01
0x25	37			IEEE 754 L-Word	0x5CEC	
0x26	38	Compensation Coefficient k2	$k2_{comp}$	IEEE 754 H-Word	0x4367	2.311E+02
0x27	39			IEEE 754 L-Word	0x0D1F	
0x28	40	Compensation Coefficient k1	$k1_{comp}$	IEEE 754 H-Word	0x4724	4.207E+04
0x29	41			IEEE 754 L-Word	0x5A6F	
0x2A	42	Compensation Coefficient k0	$k0_{comp}$	IEEE 754 H-Word	0xC9A0	-1.312E+06
0x2B	43			IEEE 754 L-Word	0x254D	
0x2C	44	Not used	---	---	---	---
0x2D	45			---	---	
0x2E	46	ADC → T Coefficient k4	$k4_{Obj}$	IEEE 754 H-Word	0x944B	-1.029E-26
0x2F	47			IEEE 754 L-Word	0xD24F	
0x30	48	ADC → T Coefficient k3	$k3_{Obj}$	IEEE 754 H-Word	0x2052	1.787E-19
0x31	49			IEEE 754 L-Word	0xF1C2	
0x32	50	ADC → T Coefficient k2	$k2_{Obj}$	IEEE 754 H-Word	0xABE5	-1.631E-12
0x33	51			IEEE 754 L-Word	0x991B	
0x34	52	ADC → T Coefficient k1	$k1_{Obj}$	IEEE 754 H-Word	0x3797	1.802E-05
0x35	53			IEEE 754 L-Word	0x2BBF	
0x36	54	ADC → T Coefficient k0	$k0_{Obj}$	IEEE 754 H-Word	0x41D7	2.693E+01
0x37	55			IEEE 754 L-Word	0x6DBA	
0x38	56	Status	---	UINT16	TBD	---

NUMBER FORMAT

UINT16

- Description: Unsigned integer
- Bits 16
- Min (dec/hec/bin) 0 / 0x0000 / 0b0000 0000 0000 0000
- Max (dec/hec/bin) 65,535 / 0xFFFF / 0b1111 1111 1111 1111

SINT16

- Description: Signed integer
- Bits 16
- Min (dec/hec/bin) - 32,768 / 0x8000 / 0b1000 0000 0000 0000
- Max (dec/hec/bin) 32,767 / 0x7FFF / 0b0111 1111 1111 1111

FLOAT IEEE 754

- Description: Float
- Bits 32
- Min (dec/hec/bin) -1.4E-45 / 0x80000001 / 0b1000 0000 0000 0000 0000 0000 0000 0001
- Max (dec/hec/bin) 3.403E38 / 0x7f800000 / 0b0111 1111 1000 0000 0000 0000 0000 0000
- Example: H-Word 0x3DCC
  L-Word 0xCCCD
  → 0b0011 1101 1100 1100 1100 1100 1100 1101
  → 0.1

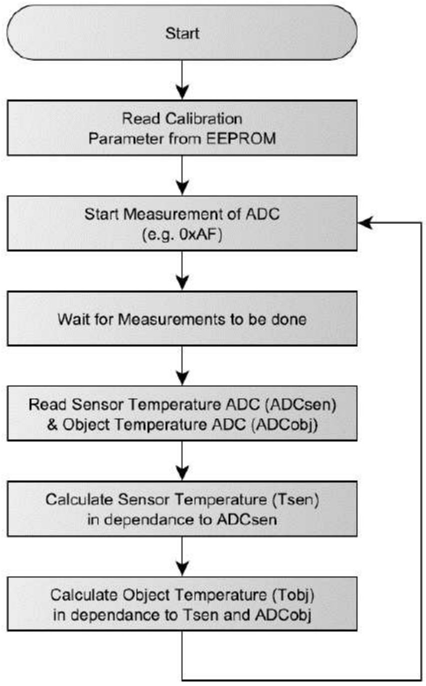
FLOAT IEEE 754 Conversions

The two integer words can easily be converted to a floating-point number by using a union consisting of an integer array and a float.

```
void main(void)
{
   union
   {
         unsigned int iValue[2];    // 16bit unsigned integer
         float fValue;              // float IEEE 754
   } MyUnion;

   while(1)
   {
         MyUnion.iValue[1] = 0x3dcc;
         MyUnion.iValue[0] = 0xcccd;
         //MyUnion.fValue = 0.1;
   }
}
```

TEMPERATURE CALCULATION



SENSOR TEMPERATURE

The sensor temperature T_{Sen} is calculated from the corresponding 24 bit ADC value ADC_{sen}.

Name	Description	Format	Range	
			Min	Max
ADC_{sen}	ADC Sensor Temperature	INT24	0	16,777,216

ADC_{sen} is scaled to cover the complete sensor temperature range from T_{SenMin} to T_{SenMax}.

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Value	Max
0x1A	26	Min. Sensor Temp. / °C	T_{SenMin}	SINT16	0xFFEC	-20°C
0x1B	27	Max. Sensor Temp. / °C	T_{SenMax}	SINT16	0x0055	+85°C

Formula:

$$T_{sen} = ADC_{sen} / 2^{24} \times (T_{SenMax} - T_{SenMin}) + T_{SenMin}$$

Example:

$$ADC_{sen} = 6{,}364{,}157$$

$$T_{sen} = 6{,}364{,}157 / 224 \times [+85°C - (-20°C)] + (-20°C) = \underline{19.83°C}$$

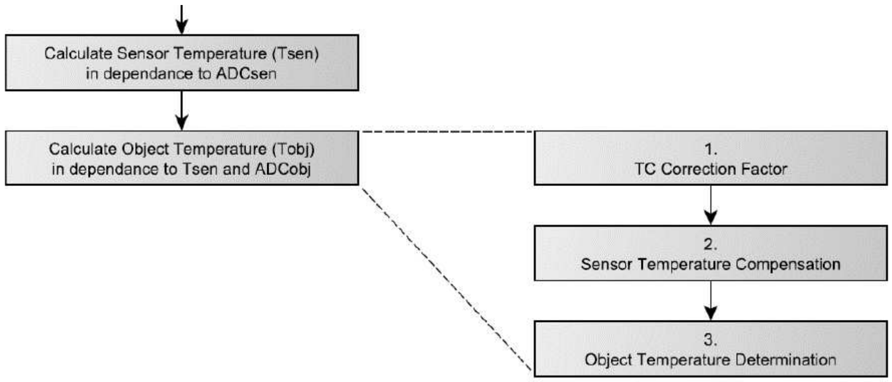
OBJECT TEMPERATURE

The object temperature T_{obj} is calculated in dependence of the sensor temperature T_{sen} and ADC_{Obj}.

ADC_{obj} is shifted by 2^{23} in order to provide unsigned integer values for positive and negative measurement values.

Name	Description	Format	Range	
			Min	Max
ADC_{obj}	ADC Object Temperature Shifted by 2^{23} (0 is represented by 8,388,608)	INT24	0	16,777,216

The process consists of three successive steps.



TC Correction Factor

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x1E	30	Temperature Coefficient	TC	IEEE 754 H-Word	0xBB96	-0.0046
0x1F	31			IEEE 754 L-Word	0xBB99	
0x20	32	Reference Temperature	T_{REF}	IEEE 754 H-Word	0x41D7	+26.93
0x21	33			IEEE 754 L-Word	0x70A4	

Formula:

TCF = $1 + [(T_{sen} - T_{ref}) \times TC]$

Example:

T_{sen} = +19.83°C

T_{ref} = +26.93°C

TC = -0.0046

TCF = $1 + [(19.83 - 26.93) \times -0.0046]$

= <u>1.0327</u>

Temperature Compensation

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x22	34	Compensation Coefficient k4	$k4_{comp}$	IEEE 754 H-Word	0x3A07	5.161E-04
0x23	35			IEEE 754 L-Word	0x4C8C	
0x24	36	Compensation Coefficient k3	$k3_{comp}$	IEEE 754 H-Word	0x3F10	5.639E-01
0x25	37			IEEE 754 L-Word	0x5CEC	
0x26	38	Compensation Coefficient k2	$k2_{comp}$	IEEE 754 H-Word	0x4367	2.311E+02
0x27	39			IEEE 754 L-Word	0x0D1F	
0x28	40	Compensation Coefficient k1	$k1_{comp}$	IEEE 754 H-Word	0x4724	4.207E+04
0x29	41			IEEE 754 L-Word	0x5A6F	
0x2A		Compensation Coefficient k0	$k0_{comp}$	IEEE 754 H-Word	0xC9A0	-1.312E+06
0x2B				IEEE 754 L-Word	0x254D	

Formula:

$$\text{Offset} = k4_{comp} \times Tsen^4 + k3_{comp} \times Tsen^3 + k2_{comp} \times Tsen^2 + k1_{comp} \times Tsen + k0_{comp}$$

$$\text{Offset}_{TC} = \text{Offset} \times TCF$$

Example:

T_{sen} = +19.83°C

$k4_{comp}$ ... $k0_{comp}$ See table above

$$\text{Offset} = 5.161 \cdot 10^{-4} \times 19.83^4 + 5.639 \cdot 10^{-1} \times 19.83^3 + 2.311 \cdot 10^{2} \times 19.83^2 + 4.207 \cdot 10^{4} \times 19.83 + -1.312 \cdot 10^{6}$$

$$= -382{,}399$$

$$\text{Offset}_{TC} = -382{,}399 \times 1.0327$$

$$= -394{,}904$$

Object Temperature Determination

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x2E	46	ADC → T Coefficient k4	$k4_{Obj}$	IEEE 754 H-Word	0x944B	-1.029E-26
0x2F	47			IEEE 754 L-Word	0xD24F	
0x30	48	ADC → T Coefficient k3	$k3_{Obj}$	IEEE 754 H-Word	0x2052	1.787E-19
0x31	49			IEEE 754 L-Word	0xF1C2	
0x32	50	ADC → T Coefficient k2	$k2_{Obj}$	IEEE 754 H-Word	0xABE5	-1.631E-12
0x33	51			IEEE 754 L-Word	0x991B	
0x34	52	ADC → T Coefficient k1	$k1_{Obj}$	IEEE 754 H-Word	0x3797	1.802E-05
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0x36	54	ADC → T Coefficient k0	$k0_{Obj}$	IEEE 754 H-Word	0x41D7	2.693E+01
0x37	55			IEEE 754 L-Word	0x6DBA	

Formula:

$ADC_{Comp} = Offset_{TC} + ADC_{Obj} - 2^{23}$

$ADC_{CompTC} = ADC_{Comp} / TCF$

$$T_{Obj} = k4_{Obj} \times ADC_{CompTC}^4 + k3_{Obj} \times ADC_{CompTC}^3 + k2_{Obj} \times ADC_{CompTC}^2 + k1_{Obj} \times ADC_{CompTC} + k0_{Obj}$$

Example:

$ADC_{Obj} =$ 10,738,758

$k4_{Obj}$ ... $k0_{Obj}$ See table above

$ADC_{Comp} =$ = -394,904 + 10,738,758 – 8,388,608
= 1,955,246

$ADC_{CompTC} =$ = 1,955,246 / 1.0327
= 1,893,334

$$T_{Obj} = -1.029 \cdot 10^{-26} \times 1{,}893{,}334^4 + 1.787 \cdot 10^{-19} \times 1{,}893{,}334^3 + -1.631 \cdot 10^{-12} \times 1{,}893{,}334^2 + 1.802 \cdot 10^{-5} \times 1{,}893{,}334 + 2.693 \cdot 10$$

$= \underline{56.28°C}$

ORDER INFORMATION

Further customer specific adaptations are available on request. Please refer to the table below for part name, description and order information.

Part Number	Part Desription	Comment
G-TPMO-101	TSD305-1C55 Digital Thermopile Sensor	TO5, I^2C Interface, 0°C … +100°C

EMC

Due to the use of these modules for OEM application no CE declaration is done. Especially line coupled disturbances like surge, burst, HF etc. cannot be removed by the module due to the small board area and low price feature. There is no protection circuit against reverse polarity or over voltage implemented. The module will be designed using capacitors for blocking and ground plane areas in order to prevent wireless coupled disturbances as good as possible.

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TSD305-2C55

DIGITAL TEMPERATURE SENSOR

Product Description

The TSD is a contactless temperature measurement system located in a TO5 package. The TSD includes an infrared sensor (thermopile) and a sensor signal conditioner.

The TSD can be interfaced to any microcontroller by an I^2C interface. This microcontroller has to calculate the temperature results based on the ADC values and the calibration parameters

Features

- 0°C … +300°C measurement range
- Small size
- I^2C Interface
- Low current consumption
- Operating Temperature Range: -10°C … +85°C

Applications

- Contactless temperature measurement
- Climate control
- Industrial process control
- Household applications

ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings are limiting values of permitted operation and should never be exceeded under the worst possible conditions either initially or consequently. If exceeded by even the smallest amount, instantaneous catastrophic failure can occur. Even if the device continues to operate satisfactorily, its life may be considerably shortened.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage	V_{DD}	---	-0.3	---	+3.63	V
Storage temperature	T_{stor}	dry	-20	---	+85	°C
Voltage at supply and IO pins	V_{DD} V_{IO}	---	-0.5	---	V_{DD} +0.5	V
Current into supply and IO pins	I_{IN}	---	-100	---	100	mA
ESD rating	ESD	Human Body Model	-2	---	+2	kV
Humidity	Hum	---	Non condensing			---

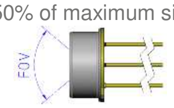
OPERATING CONDITIONS

If not otherwise noted, 3.3V supply voltage is applied.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Operating supply voltage	V_{DD}	stabilized, 100nF	1.68	---	3.6	V
VDD rise time	t_{VDD}	---	---	---	200	µs
Operating temperature	T_{op}	---	-20	---	+85	°C
Object temperature range	T_{OBJ}	---	0	---	+300	°C
Resolution	RES	---	---	---	0.1	°C
Supply Current	I_{VDD}	Active state, average	---	1050	1500	µA
		Sleep state, idle current	---	20	25	nA
Serial data clock I2C	F_{SCL}	---	---	---	3.4	MHz
Self heating	SH	1 sample/s, still air, 60s	---	---	+0.2	°C
VDD capacitor	C_{VDD}	Place close to the sensor	---	100	---	nF

THERMOPILE COMPONENT

If not otherwise noted, 3.3V supply voltage is applied.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Absorber area	A	---	0.8 x 0.8			mm
Field of view	FOV	At 50% of maximum signal 	---	88	---	deg
Filter transmission range	LWP	Long wave pass	>5.5			µm

ANALOGUE TO DIGITAL CONVERTER

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Resolution	ADC_{RES}	---	---	16	---	bit
Conversion time	t_{CONV}	---	---	44.8	59.2	ms
Rise time	t_{63}	Including rise time of sensor element	---	---	44.8	ms
Resolution internal temperature sensor	ITS_{RES}	---	---	0.003	---	K/LSB

TOLERANCES

If not otherwise noted, 3.3V supply voltage is applied. T_{sen} = sensor temperature, T_{obj} = object temperature

Parameter	Symbol	Sensor Temo	Object Temp	Max	Unit
Accuracy Standard Temp 1)	ACC_S	+10°C < T_{sen} < +40°C	+170°C < T_{obj} < +190°C	±1.5	%FS
Accuracy Extended Temp. 2)	ACC_{E1}	Complete range	Complete range	±2.5	%FS

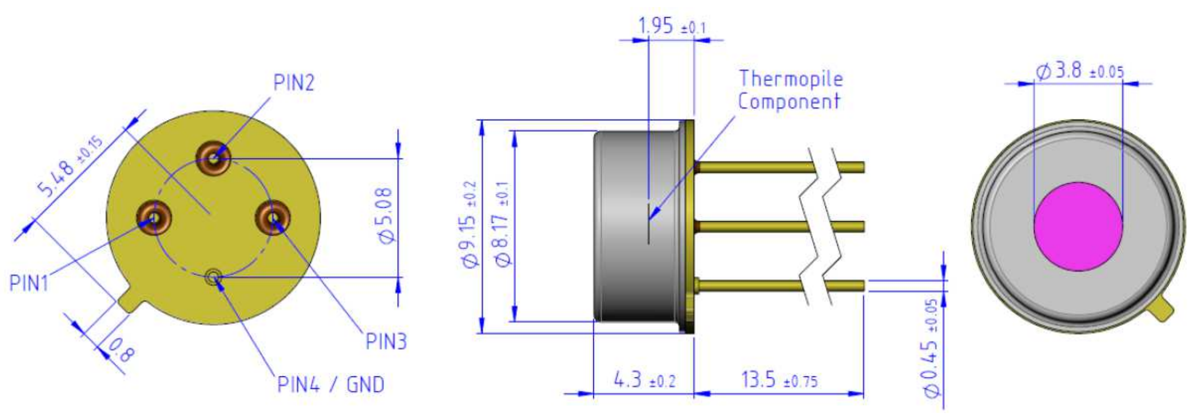
Other temperature ranges and accuracies are available on request.
1) Proved while production
2) Proved by design

POWER & RESET

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Start up time	t_{STA1}	V_{DD} ramp up to interface communication	---	---	1	ms
	t_{STA2}	V_{DD} ramp to first ADC measurement	---	---	2.5	ms
Wake up time	t_{WUP1}	Sleep to active state interface communication	---	---	0.5	ms
	t_{WUP2}	Sleep to first ADC measurement	---	---	2	ms
Power down time for reset	t_{RESET}	VDD_{low}	3	---	---	µs
VDD low level	VDD_{low}	---	0	---	0.2	V
VDD rising slope	SR_{VDD}	---	10	---	---	V/ms

DIMENSIONS

If not specified, all tolerances according DIN ISO 2768-m.



PIN FUNCTION TABLE

Pin	Name	Type	Function
1	SCL	DI	I^{2}C Clock
2	SDA	DIO	I^{2}C Data
3	V_{DD}	P	Supply Voltage
4	V_{SS}	P	Ground

I^{2}C INTERFACE

An I^{2}C communication message starts with a start condition and it is ended by a stop condition.

Most commands consist of two bytes: the address byte and command byte.

I^{2}C ADRESS

The standard I^{2}C address is 0x00 (0b0000000X).

- X = 0: I^{2}C Write
- X = 1: I^{2}C Read

STATUS BYTE

Each return starts with a status byte followed by the requested data word.

Bit	7	6	5	4	3	2	1	0
Meaning	---	---	Busy	---	---	Memory Error	---	---

- Busy: 1 = Sensor is busy. The requested data is not available yet.
- Memory Error: 1 = Memory integrity check failed. Memory was changed after factory calibration.

COMMANDS

Note: Each return starts with a status byte followed by the requested data word.

Command	Return	Description
0x00 … 0x39	16 bit EEPROM data	Read data from EEPROM address (0x00 … 0x39) matching the command
0xAF	24 bit object temperature ADC, 24 bit sensor temperature ADC	Measure object temperature and sensor temperature ADC 16 times and calculates mean value. Store data in output buffer.

Read EEPROM

Write Command:

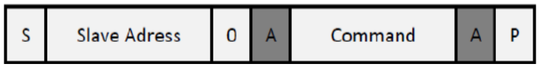
S	Slave Adress	0	A	Command	A	P

Read EEPROM Data:

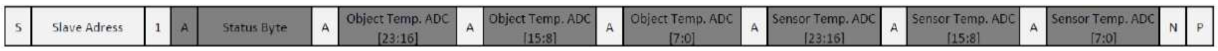
S	Slave Adress	1	A	Status Byte	A	EEPROM Data [15:8]	A	EEPROM Data [7:0]	N	P

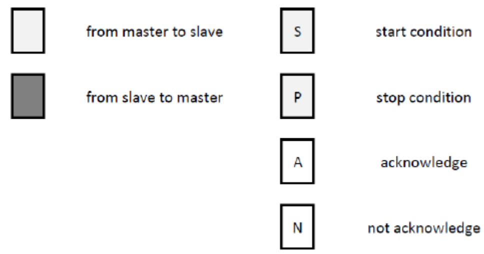
Perform Measurement and Read ADC Data

Write Command:



Read ADC Data:





EEPROM CONTENT

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x00	0	Lot Nr.	---	UINT16	15001	YY WWW
0x01	1	Serial Number	---	UINT16	12345	Number
0x02 ... 0x19	2 ... 25	Factory Calibration Data	---	---	---	---
0x1A	26	Min. Sensor Temp. / °C	T_{SenMin}	SINT16	0xFFEC	-20°C
0x1B	27	Max. Sensor Temp. / °C	T_{SenMax}	SINT16	0x0055	+85°C
0x1C	28	Min. Object Temp. / °C	T_{ObjMin}	SINT16	0x0000	0°C
0x1D	29	Max. Object Temp. / °C	T_{ObjMax}	SINT16	0x0064	100°C
0x1E	30	Temperature Coefficient	TC	IEEE 754 H-Word	0xBB96	-0.0046
0x1F	31			IEEE 754 L-Word	0xBB99	
0x20	32	Reference Temperature	T_{REF}	IEEE 754 H-Word	0x41D7	26.93
0x21	33			IEEE 754 L-Word	0x70A4	
0x22	34	Compensation Coefficient k4	$k4_{comp}$	IEEE 754 H-Word	0x3A07	5.161E-04
0x23	35			IEEE 754 L-Word	0x4C8C	
0x24	36	Compensation Coefficient k3	$k3_{comp}$	IEEE 754 H-Word	0x3F10	5.639E-01
0x25	37			IEEE 754 L-Word	0x5CEC	
0x26	38	Compensation Coefficient k2	$k2_{comp}$	IEEE 754 H-Word	0x4367	2.311E+02
0x27	39			IEEE 754 L-Word	0x0D1F	
0x28	40	Compensation Coefficient k1	$k1_{comp}$	IEEE 754 H-Word	0x4724	4.207E+04
0x29	41			IEEE 754 L-Word	0x5A6F	
0x2A	42	Compensation Coefficient k0	$k0_{comp}$	IEEE 754 H-Word	0xC9A0	-1.312E+06
0x2B	43			IEEE 754 L-Word	0x254D	
0x2C	44	Not used	---	---	---	---
0x2D	45			---	---	
0x2E	46	ADC → T Coefficient k4	$k4_{Obj}$	IEEE 754 H-Word	0x944B	-1.029E-26
0x2F	47			IEEE 754 L-Word	0xD24F	
0x30	48	ADC → T Coefficient k3	$k3_{Obj}$	IEEE 754 H-Word	0x2052	1.787E-19
0x31	49			IEEE 754 L-Word	0xF1C2	
0x32	50	ADC → T Coefficient k2	$k2_{Obj}$	IEEE 754 H-Word	0xABE5	-1.631E-12
0x33	51			IEEE 754 L-Word	0x991B	
0x34	52	ADC → T Coefficient k1	$k1_{Obj}$	IEEE 754 H-Word	0x3797	1.802E-05
0x35	53			IEEE 754 L-Word	0x2BBF	
0x36	54	ADC → T Coefficient k0	$k0_{Obj}$	IEEE 754 H-Word	0x41D7	2.693E+01
0x37	55			IEEE 754 L-Word	0x6DBA	
0x38	56	Status	---	UINT16	TBD	---

NUMBER FORMAT

UINT16

- Description: Unsigned integer
- Bits 16
- Min (dec/hec/bin) 0 / 0x0000 / 0b0000 0000 0000 0000
- Max (dec/hec/bin) 65,535 / 0xFFFF / 0b1111 1111 1111 1111

SINT16

- Description: Signed integer
- Bits 16
- Min (dec/hec/bin) - 32,768 / 0x8000 / 0b1000 0000 0000 0000
- Max (dec/hec/bin) 32,767 / 0x7FFF / 0b0111 1111 1111 1111

FLOAT IEEE 754

- Description: Float
- Bits 32
- Min (dec/hec/bin) -1.4E-45 / 0x80000001 / 0b1000 0000 0000 0000 0000 0000 0000 0001
- Max (dec/hec/bin) 3.403E38 / 0x7f800000 / 0b0111 1111 1000 0000 0000 0000 0000 0000
- Example: H-Word 0x3DCC
  L-Word 0xCCCD
  → 0b0011 1101 1100 1100 1100 1100 1100 1101
  → 0.1

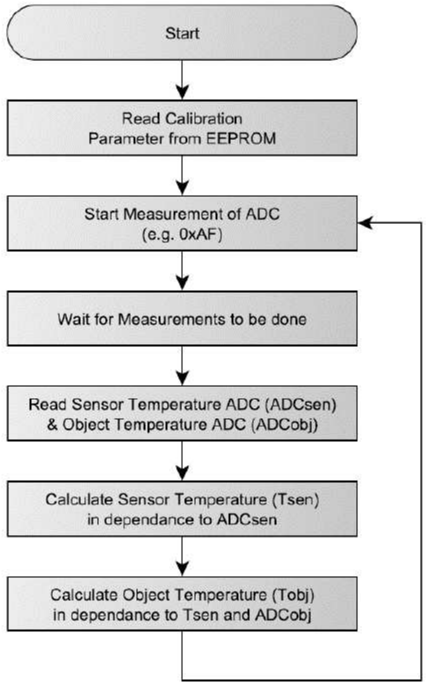
FLOAT IEEE 754 Conversions

The two integer words can easily be converted to a floating-point number by using a union consisting of an integer array and a float.

```
void main(void)
{
   union
   {
          unsigned int iValue[2];     // 16bit unsigned integer
          float fValue;               // float IEEE 754
   } MyUnion;

   while(1)
   {
          MyUnion.iValue[1] = 0x3dcc;
          MyUnion.iValue[0] = 0xcccd;
          //MyUnion.fValue = 0.1;
   }
}
```

TEMPERATURE CALCULATION



SENSOR TEMPERATURE

The sensor temperature T_{Sen} is calculated from the corresponding 24 bit ADC value ADC_{sen}.

Name	Description	Format	Range	
			Min	Max
ADC_{sen}	ADC Sensor Temperature	INT24	0	16,777,216

ADC_{sen} is scaled to cover the complete sensor temperature range from T_{SenMin} to T_{SenMax}.

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Value	Max
0x1A	26	Min. Sensor Temp. / °C	T_{SenMin}	SINT16	0xFFEC	-20°C
0x1B	27	Max. Sensor Temp. / °C	T_{SenMax}	SINT16	0x0055	+85°C

Formula:

$$T_{sen} = ADC_{sen} / 2^{24} \times (T_{SenMax} - T_{SenMin}) + T_{SenMin}$$

Example:

$$ADC_{sen} = 6{,}364{,}157$$

$$T_{sen} = 6{,}364{,}157 / 224 \times [+85°C - (-20°C)] + (-20°C) = \underline{19.83°C}$$

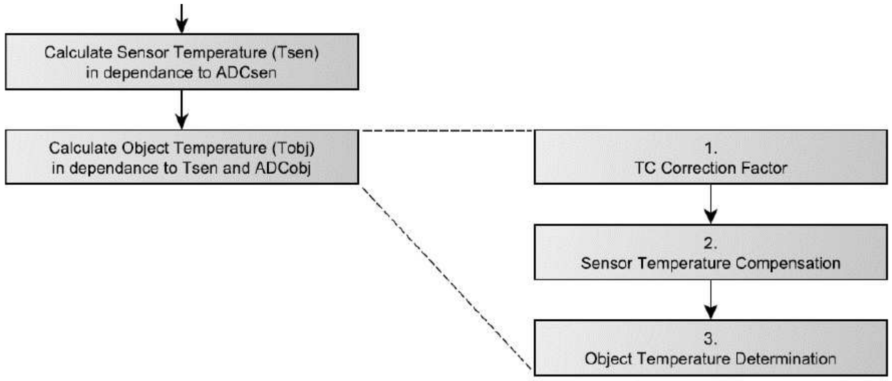
OBJECT TEMPERATURE

The object temperature T_{obj} is calculated in dependence of the sensor temperature T_{sen} and ADC_{Obj}.

ADC_{obj} is shifted by 2^{23} in order to provide unsigned integer values for positive and negative measurement values.

Name	Description	Format	Range	
			Min	Max
ADC_{obj}	ADC Object Temperature Shifted by 2^{23} (0 is represented by 8,388,608)	INT24	0	16,777,216

The process consists of three successive steps.



TC Correction Factor

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x1E	30	Temperature Coefficient	TC	IEEE 754 H-Word	0xBB96	-0.0046
0x1F	31			IEEE 754 L-Word	0xBB99	
0x20	32	Reference Temperature	T_{REF}	IEEE 754 H-Word	0x41D7	+26.93
0x21	33			IEEE 754 L-Word	0x70A4	

Formula:

$TCF = 1 + [(T_{sen} - T_{ref}) \times TC]$

Example:

$T_{sen} =$ +19.83°C

$T_{ref} =$ +26.93°C

$TC =$ -0.0046

$TCF = 1 + [(19.83 - 26.93) \times -0.0046]$

$= \underline{1.0327}$

Temperature Compensation

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x22	34	Compensation Coefficient k4	$k4_{comp}$	IEEE 754 H-Word	0x3A07	5.161E-04
0x23	35			IEEE 754 L-Word	0x4C8C	
0x24	36	Compensation Coefficient k3	$k3_{comp}$	IEEE 754 H-Word	0x3F10	5.639E-01
0x25	37			IEEE 754 L-Word	0x5CEC	
0x26	38	Compensation Coefficient k2	$k2_{comp}$	IEEE 754 H-Word	0x4367	2.311E+02
0x27	39			IEEE 754 L-Word	0x0D1F	
0x28	40	Compensation Coefficient k1	$k1_{comp}$	IEEE 754 H-Word	0x4724	4.207E+04
0x29	41			IEEE 754 L-Word	0x5A6F	
0x2A		Compensation Coefficient k0	$k0_{comp}$	IEEE 754 H-Word	0xC9A0	-1.312E+06
0x2B				IEEE 754 L-Word	0x254D	

Formula:

$$\text{Offset} = k4_{comp} \times Tsen^4 + k3_{comp} \times Tsen^3 + k2_{comp} \times Tsen^2 + k1_{comp} \times Tsen + k0_{comp}$$

$$\text{Offset}_{TC} = \text{Offset} \times \text{TCF}$$

Example:

$T_{sen} =$ +19.83°C

$k4_{comp}$ ... $k0_{comp}$ See table above

$$\text{Offset} = 5.161 \cdot 10^{-4} \times 19.83^4 + 5.639 \cdot 10^{-1} \times 19.83^3 + 2.311 \cdot 10^2 \times 19.83^2 + 4.207 \cdot 10^4 \times 19.83 + -1.312 \cdot 10^6$$

$$= -382{,}399$$

$$\text{Offset}_{TC} = -382{,}399 \times 1.0327$$

$$= -394{,}904$$

Object Temperature Determination

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x2E	46	ADC → T Coefficient k4	$k4_{Obj}$	IEEE 754 H-Word	0x944B	-1.029E-26
0x2F	47			IEEE 754 L-Word	0xD24F	
0x30	48	ADC → T Coefficient k3	$k3_{Obj}$	IEEE 754 H-Word	0x2052	1.787E-19
0x31	49			IEEE 754 L-Word	0xF1C2	
0x32	50	ADC → T Coefficient k2	$k2_{Obj}$	IEEE 754 H-Word	0xABE5	-1.631E-12
0x33	51			IEEE 754 L-Word	0x991B	
0x34	52	ADC → T Coefficient k1	$k1_{Obj}$	IEEE 754 H-Word	0x3797	1.802E-05
0x35	53			IEEE 754 L-Word	0x2BBF	
0x36	54	ADC → T Coefficient k0	$k0_{Obj}$	IEEE 754 H-Word	0x41D7	2.693E+01
0x37	55			IEEE 754 L-Word	0x6DBA	

Formula:

$ADC_{Comp} = Offset_{TC} + ADC_{Obj} - 2^{23}$

$ADC_{CompTC} = ADC_{Comp} / TCF$

$$T_{Obj} = k4_{Obj} \times ADC_{CompTC}^4 + k3_{Obj} \times ADC_{CompTC}^3 + k2_{Obj} \times ADC_{CompTC}^2 + k1_{Obj} \times ADC_{CompTC} + k0_{Obj}$$

Example:

$ADC_{Obj} =$ 10,738,758

$k4_{Obj} \ldots k0_{Obj}$ See table above

$ADC_{Comp} = -394{,}904 + 10{,}738{,}758 - 8{,}388{,}608 = 1{,}955{,}246$

$ADC_{CompTC} = 1{,}955{,}246 / 1.0327 = 1{,}893{,}334$

$$T_{Obj} = -1.029\cdot10^{-26} \times 1{,}893{,}334^4 + 1.787\cdot10^{-19} \times 1{,}893{,}334^3 + -1.631\cdot10^{-12} \times 1{,}893{,}334^2 + 1.802\cdot10^{-5} \times 1{,}893{,}334 + 2.693\cdot10$$

$= \underline{56.28°C}$

ORDER INFORMATION

Further customer specific adaptations are available on request. Please refer to the table below for part name, description and order information.

Part Number	Part Desription	Comment
G-TPMO-102	TSD305-2C55 Digital Thermopile Sensor	TO5, I^2C Interface, 0°C … +300°C

EMC

Due to the use of these modules for OEM application no CE declaration is done. Especially line coupled disturbances like surge, burst, HF etc. cannot be removed by the module due to the small board area and low price feature. There is no protection circuit against reverse polarity or over voltage implemented. The module will be designed using capacitors for blocking and ground plane areas in order to prevent wireless coupled disturbances as good as possible.

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te.com/sensorsolutions

Measurement Specialties, Inc., a TE Connectivity company.

TSD305

DIGITAL TEMPERATURE SENSORS

Product Description

The TSD Series are digital thermopile sensors in a TO5 package. The TSD sensors include an infrared sensor (thermopile) and a sensor signal conditioner.

The TSD sensors can be interfaced to any microcontroller by an I^2C interface. This microcontroller has to calculate the temperature results based on the ADC values and the calibration parameters

Features

- 0°C … up to +300°C measurement ranges
- Small size
- Small field of view available
- Up to ±1°C accuracy
- I^2C Interface
- Low current consumption
- Operating Temperature Range: -10°C … +85°C

Applications

- Contactless temperature measurement
- Climate control
- Industrial process control
- Household applications

ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings are limiting values of permitted operation and should never be exceeded under the worst possible conditions either initially or consequently. If exceeded by even the smallest amount, instantaneous catastrophic failure can occur. Even if the device continues to operate satisfactorily, its life may be considerably shortened.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Supply voltage	V_{DD}	---	-0.3	---	+3.63	V
Storage temperature	T_{stor}	dry	-20	---	+85	°C
Voltage at supply and IO pins	V_{DD} V_{IO}	---	-0.5	---	V_{DD} +0.5	V
Current into supply and IO pins	I_{IN}	---	-100	---	100	mA
ESD rating	ESD	Human Body Model	-2	---	+2	kV
Humidity	Hum	---	Non condensing			---

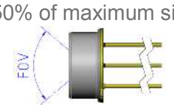
OPERATING CONDITIONS

If not otherwise noted, 3.3V supply voltage is applied.

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Operating supply voltage	V_{DD}	stabilized, 100nF	1.68	---	3.6	V
VDD rise time	t_{VDD}	---	---	---	200	µs
Operating temperature	T_{op}	---	-20	---	+85	°C
Resolution	RES	---	---	---	0.1	°C
Supply Current	I_{VDD}	Active state, average	---	1050	1500	µA
		Sleep state, idle current	---	20	25	nA
Serial data clock I2C	F_{SCL}	---	10	100	400	kHz
Self-heating	SH	1 sample/s, still air, 60s	---	---	+0.2	°C
VDD capacitor	C_{VDD}	Place close to the sensor	---	100	---	nF

THERMOPILE COMPONENT

If not otherwise noted, 3.3V supply voltage is applied.

Parameter	Symbol	Condition	Sensor	Min	Typ	Max	Unit
Absorber area	A	---	---	0.8 x 0.8			mm
Field of view	FOV	At 50% of maximum signal 	TSD305-1C55 TSD305-2C55 TSD305-3C55	---	88	---	deg
			TSD305-1SL10	---	10	---	deg
Filter transmission range	---	Long wave pass	TSD305-1C55 TSD305-2C55 TSD305-3C55	>5.5			µm
		Silicon lens, no coating	TSD305-1SL10	≥1.1			µm

ANALOGUE TO DIGITAL CONVERTER

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Resolution	ADC_{RES}	---	---	16	---	bit
Conversion time	t_{CONV}	---	---	44.8	59.2	ms
Rise time	t_{63}	Including rise time of sensor element	---	---	44.8	ms
Resolution internal temperature sensor	ITS_{RES}	---	---	0.003	---	K/LSB

OBJECT TEMPERATURE RANGE

Parameter	Symbol	Sensor	Min	Typ	Max	Unit
Object temperature range [1]	T_{OBJ}	TSD305-1C55 TSD305-3C55	0	---	+100	°C
		TSD305-2C55 TSD305-1SL10	0	---	+300	°C

[1] Other temperatures on request

TOLERANCES

If not otherwise noted, 3.3V supply voltage is applied. T_{sen} = sensor temperature, T_{obj} = object temperature

Parameter	Symbol	Sensor Temperature	Sensor	Object Temperature	Max	Unit
Accuracy Standard Temp [1]	ACC_S	+15°C < T_{sen} < +35°C	TSD305-1C55 TSD305-3C55	+40°C < T_{obj} < +80°C	±1	%FS
			TSD305-2C55 TSD305-1SL10	+170°C < T_{obj} < +190°		
Accuracy Extended Temp. 1 [2]	ACC_{E1}	Complete range	TSD305-1C55 TSD305-3C55	+40°C < T_{obj} < +80°C	±2	%FS
		+15°C < T_{sen} < +35°C		Complete range		
		Complete range	TSD305-2C55 TSD305-1SL10	+170°C < T_{obj} < +190°		
		+15°C < T_{sen} < +35°C		Complete range		
Accuracy Extended Temp. 2 [2]	ACC_{E3}	Complete range	TSD305-1C55 TSD305-2C55 TSD305-3C55 TSD305-1SL10	Complete range	±3	%FS

Other temperature ranges and accuracies are available on request.
[1] Ideal, proved by production
[2] Ideal case by design

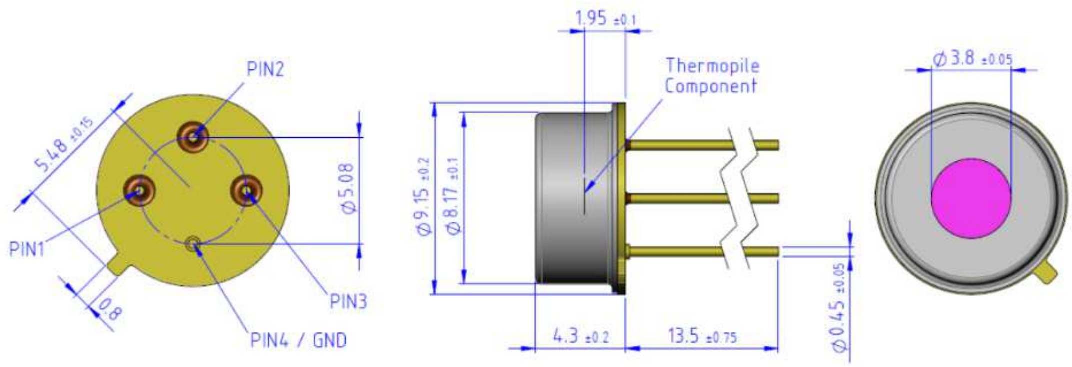
POWER & RESET

Parameter	Symbol	Condition	Min	Typ	Max	Unit
Start up time	t_{STA1}	V_{DD} ramp up to interface communication	---	---	1	ms
	t_{STA2}	V_{DD} ramp to first ADC measurement	---	---	2.5	ms
Wake up time	t_{WUP1}	Sleep to active state interface communication	---	---	0.5	ms
	t_{WUP2}	Sleep to first ADC measurement	---	---	2	ms
Power down time for reset	t_{RESET}	VDD_{low}	3	---	---	µs
VDD low level	VDD_{low}	---	0	---	0.2	V
VDD rising slope	SR_{VDD}	---	10	---	---	V/ms

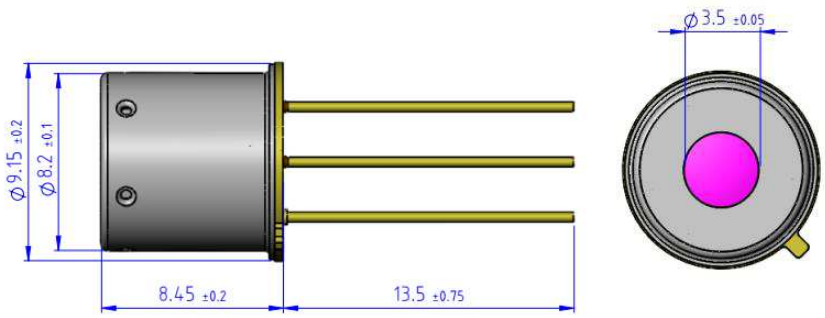
DIMENSIONS

If not specified, all tolerances according DIN ISO 2768-m.

TSD305-1C55
TSD305-2C55
TSD305-3C55



TSD305-1SL10



PIN FUNCTION TABLE

Pin	Name	Type	Function
1	SCL	DI	I^2C Clock
2	SDA	DIO	I^2C Data
3	V_{DD}	P	Supply Voltage
4	V_{SS}	P	Ground

I²C INTERFACE

An I^2C communication message starts with a start condition and it is ended by a stop condition.

Most commands consist of two bytes: the address byte and command byte.

I²C ADRESS

The standard I^2C address is

Sensor	I2C Address Hex	I2C Address Bin
TSD305-1C55 **TSD305-2C55** **TSD305-1SL10**	0x00	0b0000000X
TSD305-2C55	0x1E	0b0011110X

- X = 0: I^2C Write
- X = 1: I^2C Read

STATUS BYTE

Each return starts with a status byte followed by the requested data word.

Bit	**7**	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Meaning	---	---	Busy	---	---	Memory Error	---	---

- Busy: 1 = Sensor is busy. The requested data is not available yet.
- Memory Error: 1 = Memory integrity check failed. Memory was changed after factory calibration.

COMMANDS

Note: Each return starts with a status byte followed by the requested data word.

Command	**Return**	**Description**
0x00 … 0x39	16 bit EEPROM data	Read data from EEPROM address (0x00 … 0x39) matching the command
0xAF	24 bit object temperature ADC, 24 bit sensor temperature ADC	Measure object temperature and sensor temperature ADC 16 times and calculates mean value. Store data in output buffer.

Read EEPROM

Write Command:

S	Slave Adress	0	A	Command	A	P

Read EEPROM Data:

S	Slave Adress	1	A	Status Byte	A	EEPROM Data [15:8]	A	EEPROM Data [7:0]	N	P

Perform Measurement and Read ADC Data

Write Command:

S	Slave Adress	0	A	Command	A	P

Read ADC Data:

S	Slave Adress	1	A	Status Byte	A	Object Temp. ADC [23:16]	A	Object Temp. ADC [15:8]	A	Object Temp. ADC [7:0]	A	Sensor Temp. ADC [23:16]	A	Sensor Temp. ADC [15:8]	A	Sensor Temp. ADC [7:0]	N	P

☐	from master to slave	S	start condition
■	from slave to master	P	stop condition
		A	acknowledge
		N	not acknowledge

EEPROM CONTENT

Address / hex	Address / dec	Description	Name	Format	Example	
					Content	Value
0x00	0	Lot Nr.	---	UINT16	15001	YY WWW
0x01	1	Serial Number	---	UINT16	12345	Number
0X02	2	I^2C Address Valid range: 0x00 … 0x7F, 0x04 … 0x07 are reserved	I^2CAdd	UINT16	0x00	0
0x03 ... 0x19	2 ... 25	Factory Calibration Data	---	---	---	---
0x1A	26	Min. Sensor Temp. / °C	T_{SenMin}	SINT16	0xFFEC	-20°C
0x1B	27	Max. Sensor Temp. / °C	T_{SenMax}	SINT16	0x0055	+85°C
0x1C	28	Min. Object Temp. / °C	T_{ObjMin}	SINT16	0x0000	0°C
0x1D	29	Max. Object Temp. / °C	T_{ObjMax}	SINT16	0x0064	100°C
0x1E	30	Temperature Coefficient	TC	IEEE 754 H-Word	0xBB96	-0.0046
0x1F	31			IEEE 754 L-Word	0xBB99	
0x20	32	Reference Temperature	T_{REF}	IEEE 754 H-Word	0x41D7	26.93
0x21	33			IEEE 754 L-Word	0x70A4	
0x22	34	Compensation Coefficient k4	$k4_{comp}$	IEEE 754 H-Word	0x3A07	5.161E-04
0x23	35			IEEE 754 L-Word	0x4C8C	
0x24	36	Compensation Coefficient k3	$k3_{comp}$	IEEE 754 H-Word	0x3F10	5.639E-01
0x25	37			IEEE 754 L-Word	0x5CEC	
0x26	38	Compensation Coefficient k2	$k2_{comp}$	IEEE 754 H-Word	0x4367	2.311E+02
0x27	39			IEEE 754 L-Word	0x0D1F	
0x28	40	Compensation Coefficient k1	$k1_{comp}$	IEEE 754 H-Word	0x4724	4.207E+04
0x29	41			IEEE 754 L-Word	0x5A6F	
0x2A	42	Compensation Coefficient k0	$k0_{comp}$	IEEE 754 H-Word	0xC9A0	-1.312E+06
0x2B	43			IEEE 754 L-Word	0x254D	
0x2C	44	Not used	---	---	---	---
0x2D	45			---	---	
0x2E	46	ADC → T Coefficient k4	$k4_{Obj}$	IEEE 754 H-Word	0x944B	-1.029E-26
0x2F	47			IEEE 754 L-Word	0xD24F	
0x30	48	ADC → T Coefficient k3	$k3_{Obj}$	IEEE 754 H-Word	0x2052	1.787E-19
0x31	49			IEEE 754 L-Word	0xF1C2	
0x32	50	ADC → T Coefficient k2	$k2_{Obj}$	IEEE 754 H-Word	0xABE5	-1.631E-12
0x33	51			IEEE 754 L-Word	0x991B	
0x34	52	ADC → T Coefficient k1	$k1_{Obj}$	IEEE 754 H-Word	0x3797	1.802E-05
0x35	53			IEEE 754 L-Word	0x2BBF	
0x36	54	ADC → T Coefficient k0	$k0_{Obj}$	IEEE 754 H-Word	0x41D7	2.693E+01
0x37	55			IEEE 754 L-Word	0x6DBA	
0x38	56	Status	---	UINT16	TBD	---

CHANGE OF I^2C ADDRESS

The I^2C address of each TSD can be modified to use multiple TSDs on one I^2C bus. The used I^2C address is configured via an EEPROM address. Power needs to be cycled to active an updated I^2C address.

Command	Return	Description
0x00 … 0x39	16 bit EEPROM data	Read data from EEPROM address (0x00 … 0x39) matching the command
0x40 … 0x79	---	Write data from EEPROM address (0x00 … 0x39).
0x90	---	Calculate and write memory checksum (CRC). If the CRC is valid, then the “Memory Error” status bit is set to 0.

The commands to read and write the EEPROM are shown below. After changing the I²C address, the checksum needs to be recalculated to reset the Memory Error bit.

NUMBER FORMAT

UINT16

- Description: Unsigned integer
- Bits 16
- Min (dec/hec/bin) 0 / 0x0000 / 0b0000 0000 0000 0000
- Max (dec/hec/bin) 65,535 / 0xFFFF / 0b1111 1111 1111 1111

SINT16

- Description: Signed integer
- Bits 16
- Min (dec/hec/bin) - 32,768 / 0x8000 / 0b1000 0000 0000 0000
- Max (dec/hec/bin) 32,767 / 0x7FFF / 0b0111 1111 1111 1111

FLOAT IEEE 754

- Description: Float
- Bits 32
- Min (dec/hec/bin) -1.4E-45 / 0x80000001 / 0b1000 0000 0000 0000 0000 0000 0000 0001
- Max (dec/hec/bin) 3.403E38 / 0x7f800000 / 0b0111 1111 1000 0000 0000 0000 0000 0000
- Example: H-Word 0x3DCC
  L-Word 0xCCCD
  → 0b0011 1101 1100 1100 1100 1100 1100 1101
  → 0.1

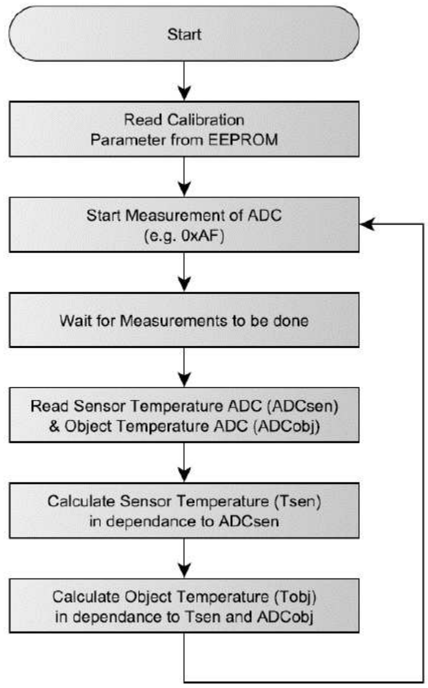
FLOAT IEEE 754 Conversions

The two integer words can easily be converted to a floating-point number by using a union consisting of an integer array and a float.

```
void main(void)
{
   union
   {
         unsigned int iValue[2];    // 16bit unsigned integer
         float fValue;              // float IEEE 754
   } MyUnion;

   while(1)
   {
         MyUnion.iValue[1] = 0x3dcc;
         MyUnion.iValue[0] = 0xcccd;
         //MyUnion.fValue = 0.1;
   }
}
```

TEMPERATURE CALCULATION



SENSOR TEMPERATURE

The sensor temperature T_{Sen} is calculated from the corresponding 24 bit ADC value ADC_{sen}.

Name	Description	Format	Range	
			Min	Max
ADC_{sen}	ADC Sensor Temperature	INT24	0	16,777,216

ADC_{sen} is scaled to cover the complete sensor temperature range from T_{SenMin} to T_{SenMax}.

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Value	Max
0x1A	26	Min. Sensor Temp. / °C	T_{SenMin}	SINT16	0xFFEC	-20°C
0x1B	27	Max. Sensor Temp. / °C	T_{SenMax}	SINT16	0x0055	+85°C

Formula:

$$T_{sen} = ADC_{sen} / 2^{24} \times (T_{SenMax} - T_{SenMin}) + T_{SenMin}$$

Example:

$ADC_{sen} = 6{,}364{,}157$

$T_{sen} = 6{,}364{,}157 / 224 \times [+85°C - (-20°C)] + (-20°C) = \underline{19.83°C}$

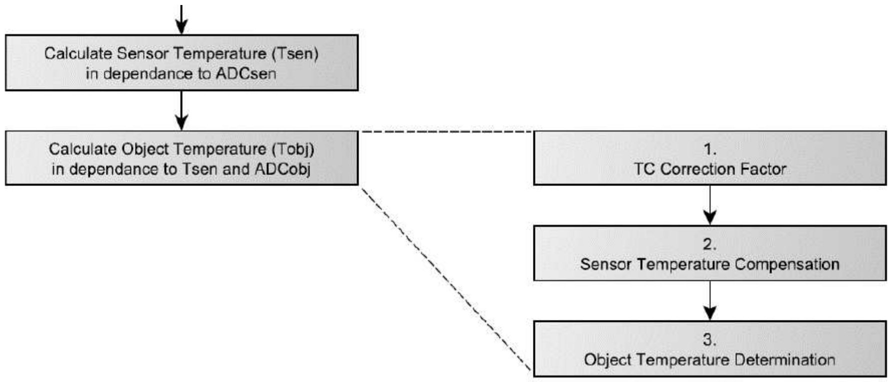
OBJECT TEMPERATURE

The object temperature T_{obj} is calculated in dependence of the sensor temperature T_{sen} and ADC_{Obj}.

ADC_{obj} is shifted by 2^{23} in order to provide unsigned integer values for positive and negative measurement values.

Name	Description	Format	Range	
			Min	Max
ADC_{obj}	ADC Object Temperature Shifted by 2^{23} (0 is represented by 8,388,608)	INT24	0	16,777,216

The process consists of three successive steps.



TC Correction Factor

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x1E	30	Temperature Coefficient	TC	IEEE 754 H-Word	0xBB96	-0.0046
0x1F	31			IEEE 754 L-Word	0xBB99	
0x20	32	Reference Temperature	T_{REF}	IEEE 754 H-Word	0x41D7	+26.93
0x21	33			IEEE 754 L-Word	0x70A4	

Formula:

TCF = $1 + [(T_{sen} - T_{ref}) \times TC]$

Example:

T_{sen} = +19.83°C

T_{ref} = +26.93°C

TC = -0.0046

TCF = $1 + [(19.83 - 26.93) \times -0.0046]$

= $\underline{1.0327}$

Temperature Compensation

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x22	34	Compensation Coefficient k4	$k4_{comp}$	IEEE 754 H-Word	0x3A07	5.161E-04
0x23	35			IEEE 754 L-Word	0x4C8C	
0x24	36	Compensation Coefficient k3	$k3_{comp}$	IEEE 754 H-Word	0x3F10	5.639E-01
0x25	37			IEEE 754 L-Word	0x5CEC	
0x26	38	Compensation Coefficient k2	$k2_{comp}$	IEEE 754 H-Word	0x4367	2.311E+02
0x27	39			IEEE 754 L-Word	0x0D1F	
0x28	40	Compensation Coefficient k1	$k1_{comp}$	IEEE 754 H-Word	0x4724	4.207E+04
0x29	41			IEEE 754 L-Word	0x5A6F	
0x2A		Compensation Coefficient k0	$k0_{comp}$	IEEE 754 H-Word	0xC9A0	-1.312E+06
0x2B				IEEE 754 L-Word	0x254D	

Formula:

$$\text{Offset} = k4_{comp} \times Tsen^4 + k3_{comp} \times Tsen^3 + k2_{comp} \times Tsen^2 + k1_{comp} \times Tsen + k0_{comp}$$

$$\text{Offset}_{TC} = \text{Offset} \times TCF$$

Example:

T_{sen} = +19.83°C

$k4_{comp}$ … $k0_{comp}$ See table above

$$\text{Offset} = 5.161\cdot10^{-4} \times 19.83^4 + 5.639\cdot10^{-1} \times 19.83^3 + 2.311\cdot10^2 \times 19.83^2 + 4.207\cdot10^4 \times 19.83 + -1.312\cdot10^6 = -382{,}399$$

$$\text{Offset}_{TC} = -382{,}399 \times 1.0327 = -394{,}904$$

Object Temperature Determination

Adress / hex	Adress / dec	Description	Name	Format	Example	
					Content	Value
0x2E	46	ADC → T Coefficient k4	$k4_{Obj}$	IEEE 754 H-Word	0x944B	-1.029E-26
0x2F	47			IEEE 754 L-Word	0xD24F	
0x30	48	ADC → T Coefficient k3	$k3_{Obj}$	IEEE 754 H-Word	0x2052	1.787E-19
0x31	49			IEEE 754 L-Word	0xF1C2	
0x32	50	ADC → T Coefficient k2	$k2_{Obj}$	IEEE 754 H-Word	0xABE5	-1.631E-12
0x33	51			IEEE 754 L-Word	0x991B	
0x34	52	ADC → T Coefficient k1	$k1_{Obj}$	IEEE 754 H-Word	0x3797	1.802E-05
0x35	53			IEEE 754 L-Word	0x2BBF	
0x36	54	ADC → T Coefficient k0	$k0_{Obj}$	IEEE 754 H-Word	0x41D7	2.693E+01
0x37	55			IEEE 754 L-Word	0x6DBA	

Formula:

$ADC_{Comp} = Offset_{TC} + ADC_{Obj} - 2^{23}$

$ADC_{CompTC} = ADC_{Comp} / TCF$

$$T_{Obj} = k4_{Obj} \times ADC_{CompTC}^4 + k3_{Obj} \times ADC_{CompTC}^3 + k2_{Obj} \times ADC_{CompTC}^2 + k1_{Obj} \times ADC_{CompTC} + k0_{Obj}$$

Example:

$ADC_{Obj} =$ 10,738,758

$k4_{Obj} \ldots k0_{Obj}$ See table above

$ADC_{Comp} =$ = -394,904 + 10,738,758 – 8,388,608
= 1,955,246

$ADC_{CompTC} =$ = 1,955,246 / 1.0327
= 1,893,334

$$T_{Obj} = -1.029 \cdot 10^{-26} \times 1{,}893{,}334^4 + 1.787 \cdot 10^{-19} \times 1{,}893{,}334^3 + -1.631 \cdot 10^{-12} \times 1{,}893{,}334^2 + 1.802 \cdot 10^{-5} \times 1{,}893{,}334 + 2.693 \cdot 10$$

= <u>56.28°C</u>

Example Code

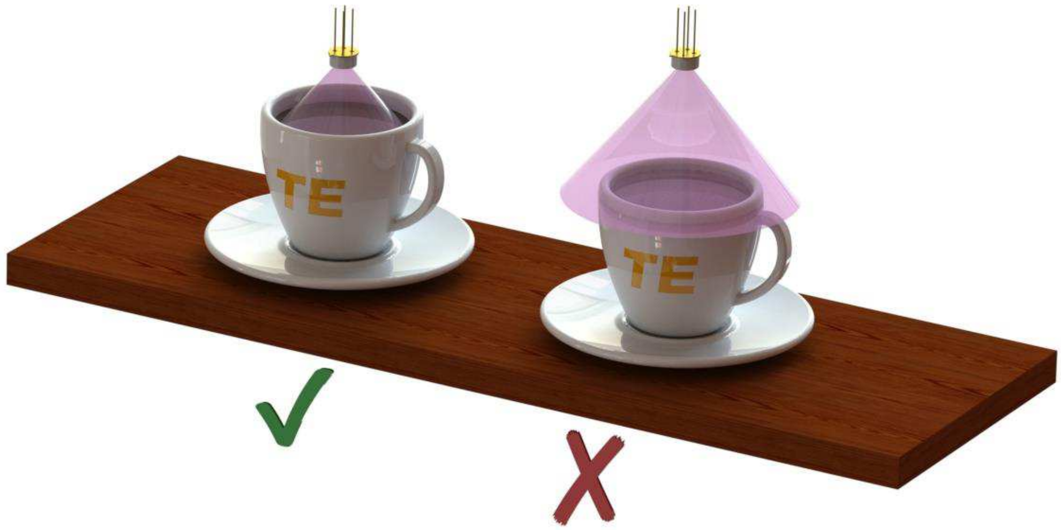
This example code is meant to illustrate the basic procedure to determinate the measured sensor and object temperatures with respect to TSD digital thermopile sensors. This code needs to be modified with respect to the compiler used.

```
//*********************************************************************************//
// File: TSD_Temperature_Determination_Example.c //
// Date: 01.11.2016 //
// Description: This example code is meant to illustrate the basical procedure //
// to determinat the measured sensor and object temperatures with //
// respect to TSD digital thermopile sensors. //
// This code is not meant to work or to be compiled. //
//*********************************************************************************//
void TSD_Determinate_Temperature(void)
{
        signed int siMinObjTemp, siMaxObjTemp, siMinSenTemp, siMaxSenTemp;
        float fTC, fTref, fK4com, fK3com, fK2com, fK1com, fK0com, fK4obj, fK3obj,
        fK2obj, fK1obj, fK0obj;
        float fTsen, fTobj;
        float fTCF, fOffset, fADCcomp;
        signed long slADC_Object, slADC_Sensor;
        // Read Temperature Range Minimum & Maximum
        siMinSenTemp = (signed int)Read_EE_UInt(26);
        siMaxSenTemp = (signed int)Read_EE_UInt(27);
        siMinObjTemp = (signed int)Read_EE_UInt(28);
        siMaxObjTemp = (signed int)Read_EE_UInt(29);
        // Read all necessary coefficients from the memory, float tye
        fTref = Read_EE_Float(32);
        fTC = Read_EE_Float(30);
        fTref = Read_EE_Float(32);
        fK4com = Read_EE_Float(34);
        fK3com = Read_EE_Float(36);
        fK2com = Read_EE_Float(38);
        fK1com = Read_EE_Float(40);
        fK0com = Read_EE_Float(42);
        fK4obj = Read_EE_Float(46);
        fK3obj = Read_EE_Float(48);
        fK2obj = Read_EE_Float(50);
        fK1obj = Read_EE_Float(52);
        fK0obj = Read_EE_Float(54);
        // Read ADC Values for Object Temp. & Sensor Temp.
        Read_ADC_Values(&slADC_Object, &slADC_Sensor);
        // Calculate Sensor Temp. (slADC_Sensor, Minimum & Maximum Sensor Temp.), Page 8
        fTsen = (float)slADC_Sensor / 16777216.0 * (siMaxSenTemp - siMinSenTemp) + siMinSenTemp;
        // Calculate TC Correction Factor (Temp. Coefficient & Reference Temp.), Page 9fTCF = 1.0
        + ((fTsen - fTref) * fTC);
        // Calculate Offset Value, Page 10
        fOffset = fOffset + fK4com * fTsen * fTsen * fTsen * fTsen;
        fOffset = fOffset + fK3com * fTsen * fTsen * fTsen;
        fOffset = fOffset + fK2com * fTsen * fTsen;
        fOffset = fOffset + fK1com * fTsen;
        fOffset = fOffset + fK0com;
        fOffset = fOffset * fTCF;
        // Align ADC Value for Object Temperature, Page 11
        slADC_Object = slADC_Object - 8388608;
        // Calculate Object Temperature, Page 11
        fADCcomp = (float)slADC_Object + fOffset;
        fADCcomp = fADCcomp / fTCF;
        fTobj = fTobj + fK4obj * fADCcomp * fADCcomp * fADCcomp * fADCcomp;
        fTobj = fTobj + fK3obj * fADCcomp * fADCcomp * fADCcomp;
        fTobj = fTobj + fK2obj * fADCcomp * fADCcomp;
        fTobj = fTobj + fK1obj * fADCcomp;
        fTobj = fTobj + fK0obj;
        // Resulting Sensor Temperature = fTsen
        // Resulting Object Temperature = fTobj
 }
```

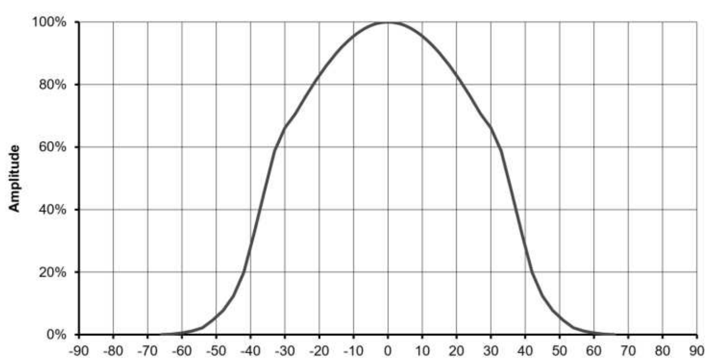
APPLICATION NOTES

FIELD OF VIEW

The thermopile's field of view must be directed to the object surface of interest. The distance to the surface or the surface diameter must be adjusted to ensure that the complete sensors field of view is covered by the object, see example on the left in the picture below.

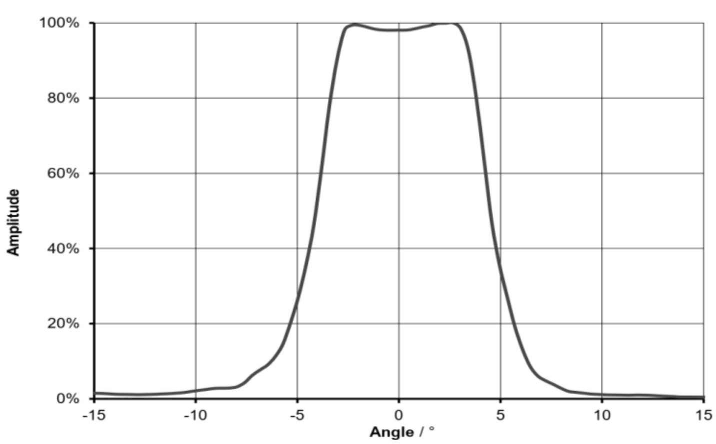


TSD305-1C55
TSD305-2C55



Distance / mm	Min. Diameter / mm
10	24
20	43
30	62
40	82
50	101
100	198
200	391
300	584
400	777
500	970

TSD305-1SL10



Distance / mm	Min. Diameter / mm
10	6
20	8
30	10
40	11
50	13
100	22
200	39
300	57
400	74
500	92

DIRECT SUNLIGHT

Sun light radiation which is transmitted through a glass window may influence the measurement accuracy. To avoid this, the thermopile sensor is equipped with a long wavelength filter. Due to not ideal filter characteristics a small portion of radiation will be added to the radiation of the object. In case of direct sunlight exposure this error can be up to +0.2°C.

TOUCHING THE SENSORS CAP

User should avoid touching the sensors cap. There will still be a measurement deviation after changing the sensors temperature rapidly.

EMISSIVITY

Every object is transmitting infrared energy in dependence to its temperature. The emissivity is the ratio of the radiated power by an object to the radiation of an ideal black body. Common materials like liquids, clothes, human skin, foods have emissivity factors >0.90 and therefore they can be measured very accurately without adopting the sensors specification.

To compensate the measurement for an object with significant low emissivity, ADC_{obj} needs to be adjusted.

Name	Description	Format	Range	
			Min	Max
ADC_{obj}	ADC Object Temperature Shifted by 2^{23} (0 is represented by 8,388,608)	INT24	0	16,777,216

Formula:

ADC_{Corr} = $(ADC_{Obj} - 2^{23}) / 0.9$

Example:

ADC_{Obj} = 10,738,758

$Emissivity_j$ 0.9 (90%)

ADC_{Corr} = = 2,611,278

Material	Emissivity
Aluminum	
Polished	0.10 – 0.05
Oxidized	0.10 – 0.40
Rough	0.10 – 0.30
Anodized	0.60 – 0.95
Asphalt	0.90 – 1.00
Brass	
Polished	0.05
Oxidized	0.50 - 0.60
Burnished	0.30
Ceramic	0.90 – 0.95
Copper	
Polished	0.10
Oxidized	0.20 – 0.80
Foods	0.85 – 1.00
Gold	0.05
Glass	
Plate	0.90 – 0.95
Fused quartz	0.75

Material	Emissivity
Human Skin	0.99
Iron	
Polished	0.20
Oxidized	0.50 - 0.95
Rusted	0.50 – 0.70
Paint	
Aluminum paint	0.50
Bronze paint	0.80
On metal	0.60 – 0.90
On plastic, wood	0.80 – 0.95
Paper	0.85 – 1.00
Plastic	0.95 – 1.00
Stainless Steel	
Polished	0.10 – 0.15
Oxidized	0.45 - 0.95
Water	
Liquid	0.90 – 0.95
Ice	0.95 – 1.00
Snow	0.80 – 1.00

ORDER INFORMATION

Further customer specific adaptations are available on request. Please refer to the table below for part name, description and order information.

Part Number	Part Desription	Comment
G-TPMO-101	TSD305-1C55 Digital Thermopile Sensor	TO5, I^2C Interface, 0°C … +100°C
G-TPMO-102	TSD305-2C55 Digital Thermopile Sensor	TO5, I^2C Interface, 0°C … +300°C
G-TPMO-103	TSD305-3C55 Digital Thermopile Sensor	TO5, I^2C Interface Add=0x1E, 0°C … +300°C
G-TPMO-104	TSD305-1SL10 Digital Thermopile Sensor	TO5, FOV=10°, I^2C Interface, 0°C … +300°C

EMC

Due to the use of these modules for OEM application no CE declaration is done. Especially line coupled disturbances like surge, burst, HF etc. cannot be removed by the module due to the small board area and low price feature. There is no protection circuit against reverse polarity or over voltage implemented. The module will be designed using capacitors for blocking and ground plane areas in order to prevent wireless coupled disturbances as good as possible.

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TSEV0108L39

Thermopile Sensor Module

SPECIFICATIONS

- **Contact less Temperature Measurement**
- **8 Measurement Pixels**
- **Wide Supply Voltage Range**
- **Digital Interface Bus (SPI)**

TSEV0108L39 is a contact-less temperature measuring system for OEM use based on the detection of infrared radiation

TSEV0108L39 is equipped with an infrared sensor (Thermopile) in front. In this version a Thermopile Array, ***including 8 pixels***, is used. It has to be pointed at the target object

The basic working principle is:

- Detection of infrared radiation with a Thermopile sensor
- Determination of sensor temperature using a thermistor
- Calculation of ambient and object temperature using a processing unit
- Providing the temperatures at digital output bus (SPI like Interface)

FEATURES

-20°C – +120°C Measurement Range
4V – 16V Supply Voltage Range
Up to 2°C Accuracy

APPLICATIONS

Contact less Temperature Measurement
Microwave Oven
Climate Control

ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings are limiting values of permitted operation and should never be exceeded under the worst possible conditions either initially or consequently. If exceeded by even the smallest amount, instantaneous catastrophic failure can occur. And even if the device continues to operate satisfactorily, its life may be considerably shortened.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	V_{cc}	Measured versus GND	-0.3		16	V
Operating Temperature	T_{op}		-10		+85	°C
Storage Temperature	T_{stor}		-30		+85	°C
Humidity	Hum_L	-30°C - +50°C			85	%
Humidity	Hum_H	+50°C - +85°C			50	%

SENSOR CHARACTERISTICS

If not otherwise noted, 25°C ambient temperature, 5V supply voltage were applied.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Total Field of View	T_FOV	Over all 8 Pixels		40		°
Individual Field of View	P_FOV	Field of View of one Pixel		3.5		°
Focal length	f			3.9	mm	

OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply voltage	V_{cc}	Measured versus GND	4	5	6	V
Supply Current	I	Full ambient temp. range, no output load		10	15	mA
Humidity	Hum_L	-30°C - +50°C			85	%
Humidity	Hum_H	+50°C - +85°C			50	%

INTERFACE CHARACTERISTICS

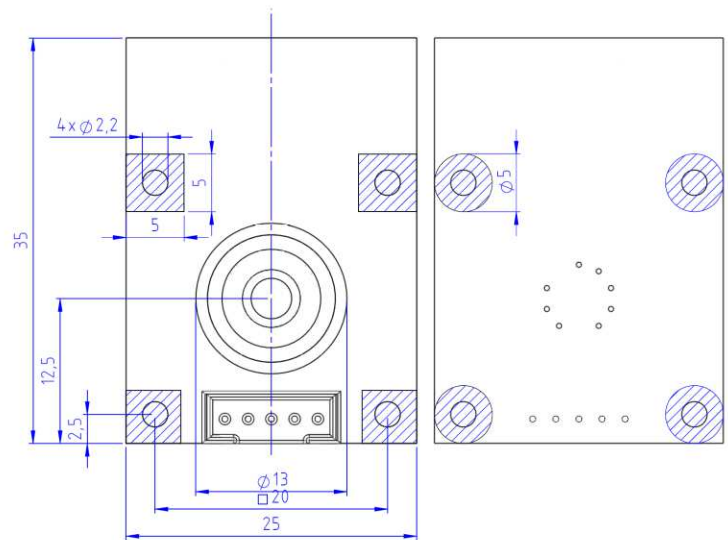
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Clock Rate (SPI)	F_{SPI}			100		kHz
Data Output Rate (New Measurement Data of all 8 Pixels available)	Fout			1		Hz

OPERATIONAL CHARACTERISTICS

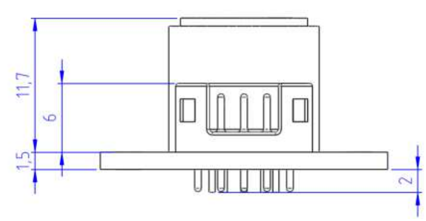
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Object Temperature Range	T_{obj}		-20		+120	°C
Ambient Temperature Range	T_{amb}		0		+85	°C
Resolution	Res				0.1	°C
Standard Start-Up Time	t_{Start}	Time from turning on supply to first measurement		3	5	s
Accuracy tolerance when Tambient = 25°C ±5°C	ΔT	-5°C < T_{object} < +5°C		±2[1)]		°C
		Outside above range		±4[1)]		°C

[1)] Valid for a distance of 100mm and black body size of 150mm x 150mm

MECHANICAL DIMENSIONS



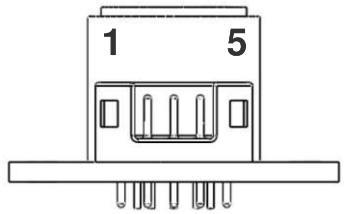
Only use hatched areas for mechanical assembly (screws, nuts, etc).



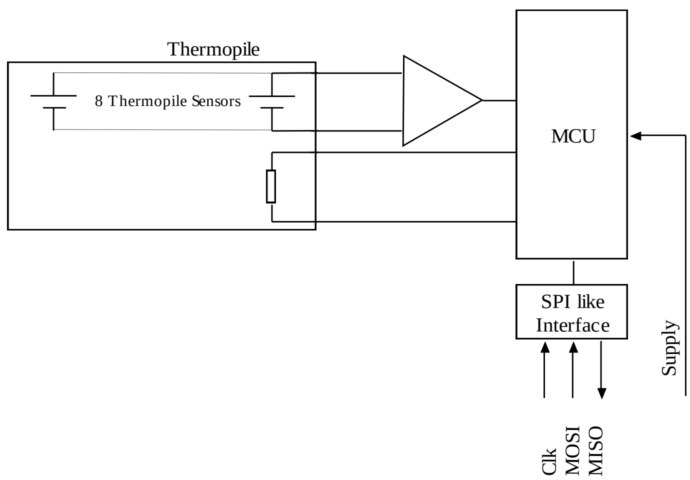
TERMINALS

Connector: JST B5B-PH-K-S(LF)(SN)

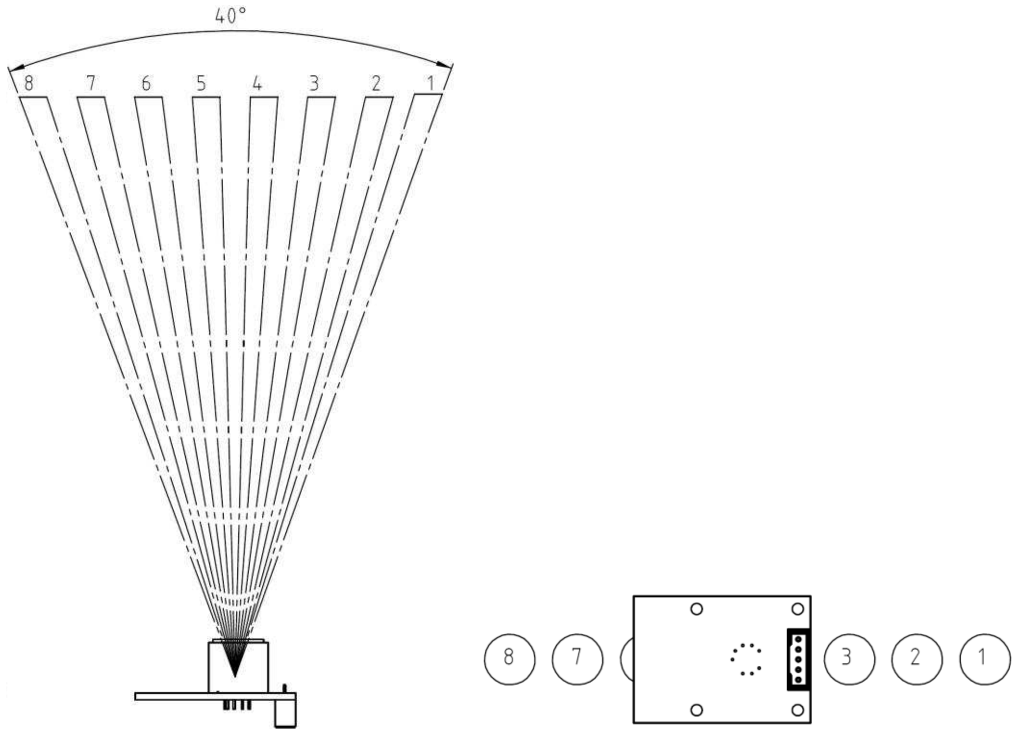
Pin	Name	Desription	Type
1	GND	Supply Ground	Supply
2	MISO	Data Out	Output
3	MOSI	Data In	Input
4	CLK	Clock	Input
5	VDD	Supply Voltage	Supply



BLOCK DIAGRAM



FIELD OF VIEW



ANGLE OF PIXELS

1	2	3	4	5	6	7	8
19,03	13,84	8,41	2,82	-2,82	-8,41	-13,84	-19,03

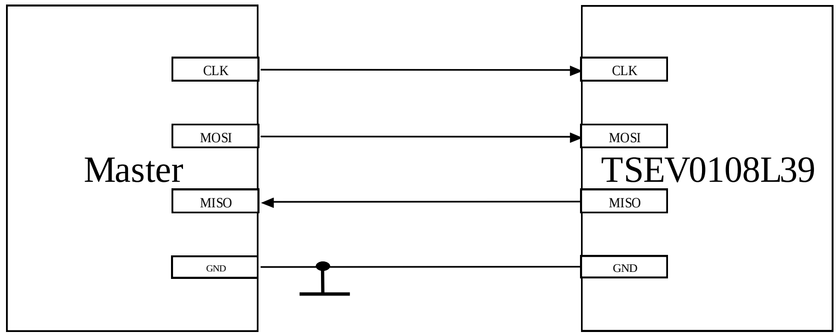
FUNCTION

SPI INTERFACE

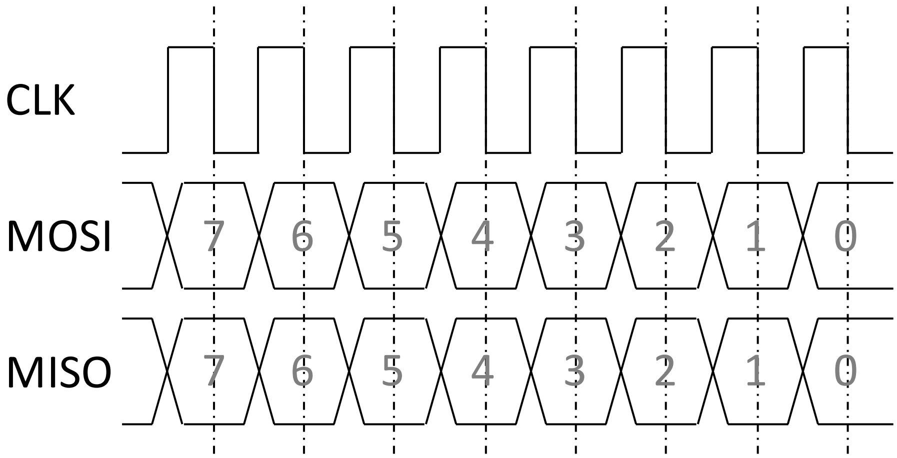
PHYSICAL INTERFACE PARAMETERS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Baudrate	FSPI		10		200	kHz
Data Bits				8		
Edge				Rising		
Chip Select				No		
Input Voltage Low					0.8	V
Input Voltage High			2.8		***3.6***	V
Output Current High		@ 2.8V	1			mA
Output Current Low		@ 0.8V	1			mA

SPI CONNECTION



SPI SIGNAL TIMING DESCRIPTION



INTERNAL RESET

The internal SPI status is reset to idle state if one of the following conditions occur:

- 100ms without receiving data
- Reset due to cycling of supply voltage

FILTER CIRCUITRY

Capacitors are added to the following lines in to reduce noise/spikes in order to provide stable SPI transmission even in EMC affected environment:

- CLK
- MOSI

A **10nF capacitor** is added parallel to ground potential.

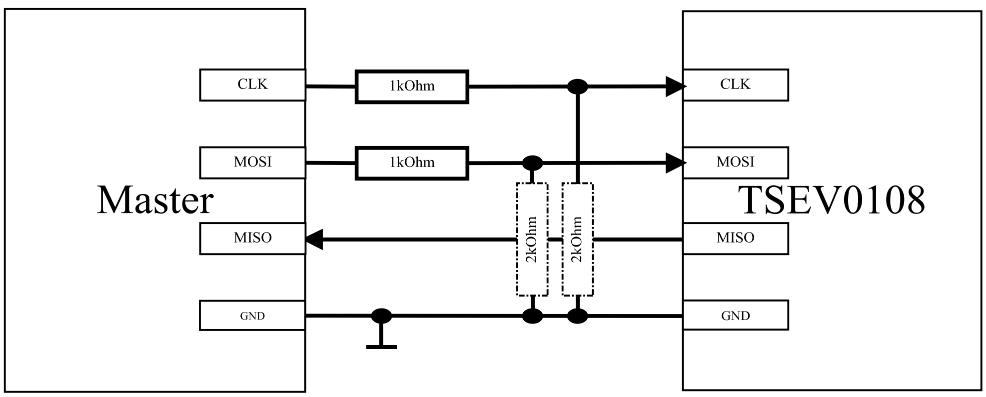
SPI SIGNAL SEQUENCE

Reading Temperature of Pixel 1

Nr.	MOSI	MISO	Direction	Description
1	0xA1	---	M → S	Sending Command (See Command Reference)
Wait at least 150us to arrange temperature data				
2	0XFF	0xXX	M ← S	Receiving High Byte (Send 0xFF while receiving)
Wait at least 150us to arrange temperature data				
3	0XFF	0xXX	M ← S	Receiving Low Byte (Send 0xFF while receiving)

EXAMPLE FOR 5V SPI INTERFACE LINE

The sensor cannot be connected directly to a SPI interface with 5V levels. Therefore the following circuitry is suggested. The Baud rate should be limited to 20kHz.



AMBIENT AND OBJECT MEASUREMENT

Please refer following table for SPI commands to read object temperature and ambient temperature. Both values are transmitted in tenth of degrees.

All temperature read outs are to be interpreted as twos complement.

Com	Description	Reply	Bytes
0xA0	Sensor Temperature	Sensor temperature in tenth of degrees Celsius	2
0xA1	Temperature Pixel 1	Temp. at pixel position 1 in tenth of degree Celsius	2
0xA2	Temperature Pixel 2	Temp. at pixel position 2 in tenth of degree Celsius	2
0xA3	Temperature Pixel 3	Temp. at pixel position 3 in tenth of degree Celsius	2
0xA4	Temperature Pixel 4	Temp. at pixel position 4 in tenth of degree Celsius	2
0xA5	Temperature Pixel 5	Temp. at pixel position 5 in tenth of degree Celsius	2
0xA6	Temperature Pixel 6	Temp. at pixel position 6 in tenth of degree Celsius	2
0xA7	Temperature Pixel 7	Temp. at pixel position 7 in tenth of degree Celsius	2
0xA8	Temperature Pixel 8	Temp. at pixel position 8 in tenth of degree Celsius	2

EXAMPLE OF TEMPERATURE CALCULATION

For reading object temperature of pixel 3 send: 0xA3

Return values i.e.:

Byte(0) = 0x02

Byte(1) = 0xB0

Temperature T_{obj} = (256 * Byte(0) + Byte(1)) / 10 = (256 * 2 + 11) / 10 = 52,3°C

OUT OF TEMPERATURE RANGE INDICATION

Com	Description	Reply	Bytes
0xA0	Sensor Temperature < 0°C	0x8001	2
0xA0	Sensor Temperature > 85°C	0x8002	2
0xA1 – 0xA8	Pixel Temperature < -20°C	0x8003	2
0xA1 – 0xA8	Pixel Temperature > +120°C	0x8004	2

ORDER INFORMATION

Please order this product using following:

Part Number	Part Description
G-TPMO-014	TSEV0108L39

EMC

Due to the use of these modules for OEM application no CE declaration is done.

Especially line coupled disturbances like surge, burst, HF etc. cannot be removed by the module due to the small board area and low price feature. There is no protection circuit against reverse polarity or over voltage implemented.

The module will be designed using capacitors for blocking and ground plane areas in order to prevent wireless coupled disturbances as good as possible

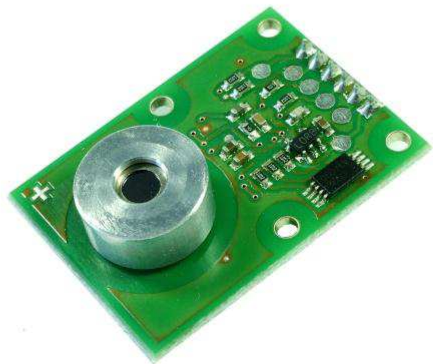
DEFINITIONS AND DISCLAIMERS

- Application information – Applications that are described herein for any of these products are for illustrative purpose only. MEAS Deutschland GmbH makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.
- Life support applications – These products are not designed for use in life support appliances, devices, or systems where malfunctions of these products can reasonably be expected to result in personal injury.
  MEAS Deutschland GmbH customers using or selling this product for use in such applications do so at their own risk and agree to fully indemnify MEAS Deutschland GmbH for any damages resulting from such improper use or sale

NORTH AMERICA
Measurement Specialties, Inc.,
a TE Connectivity Company
910 Turnpike Road
Shrewsbury, MA 01545
Tel: 1-508-842-0516
Fax: 1-508-842-0342
Sales email:
temperature.sales.amer@meas-spec.com

EUROPE
Measurement Specialties (Europe), Ltd.,
a TE Connectivity Company
Deutschland GmbH
Hauert 13
44277 Dortmund
Tel: +49 (0) 231/9740-0
Fax: +49 (0) 231/9740-20
Sales email:
info.de@meas-spec.com

ASIA
Measurement Specialties (China), Ltd.,
a TE Connectivity Company
No. 26 Langshan Road
Shenzhen High-Tech Park (North)
Nanshan District, Shenzhen 518057
China
Tel: +86 755 3330 5088
Fax: +86 755 3330 5099
Sales: pfg.cs.asia@meas-spec.com



TSEV01S01C90

SPECIFICATIONS

- **Contact less Temperature Measurement**
- **Small Size**
- **Heat Spreader improves Accuracy**
- **Wide Supply Voltage Range**
- **Digital Interface Bus (SPI)**
- **Connector**

The TSEV01S01C90 is a contact-less temperature measuring system for OEM use based on the detection of infrared radiation.

The TSEV01S01C90 is equipped with an infrared sensor (Thermopile) in front. The Thermopile Sensor has to be pointed at the target object.

The basic working principle is:

- Detection of infrared radiation with a Thermopile sensor, which turns incoming radiation to an analogue voltage
- Determination of sensor temperature using a thermistor
- Calculation of ambient and object temperature using a processing unit
- Providing the ambient and objects temperature at digital output bus (SPI)

The TSEC01S01C is suitable for a wide range of application where non-contact temperature measurement and high accuracy are required

FEATURES

0°C – 100°C Measurement Range
Small Size
Up to 1°C Accuracy
2mA Current Consumption

APPLICATIONS

Contact less Temperature Measurement
Climate Control
Industrial Process Control
Household Applications

ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings are limiting values of permitted operation and should never be exceeded under the worst possible conditions either initially or consequently. If exceeded by even the smallest amount, instantaneous catastrophic failure can occur. And even if the device continues to operate satisfactorily, its life may be considerably shortened.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	Vccmax	Stabilized supply voltage	-0.3		16	V
Operating Temperature	Topmax		-10		85	°C
Storage temperature	Tstor		-40		85	°C
Humidity	HumL	-40°C - +50°C			85	%
Humidity	HumH	+50°C - +85°C			50	%

OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	Vcc	Stabilized supply voltage	3.3		16	V
Operating Temperature Range	Top		0		85	°C
Emission Coefficient	ε		0.98			

SENSOR CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Field of View	FOV	Total field of view at 50% signal level		90		°
Wavelength Range	S		5.0 (cut on)			µm

OPERATIONAL CHARACTERISTICS

If not otherwise noted, 5V supply voltage and object with ε =0.98 were applied.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Object Temperature Range	Tobj		0		100	°C
Resolution	Res				0.02	°C
Supply Current[1)]	I	No output load		2		mA
Data Output Rate	Fout			1		Hz
Standard Start-Up Time	tStart				3	s

TOLERANCES

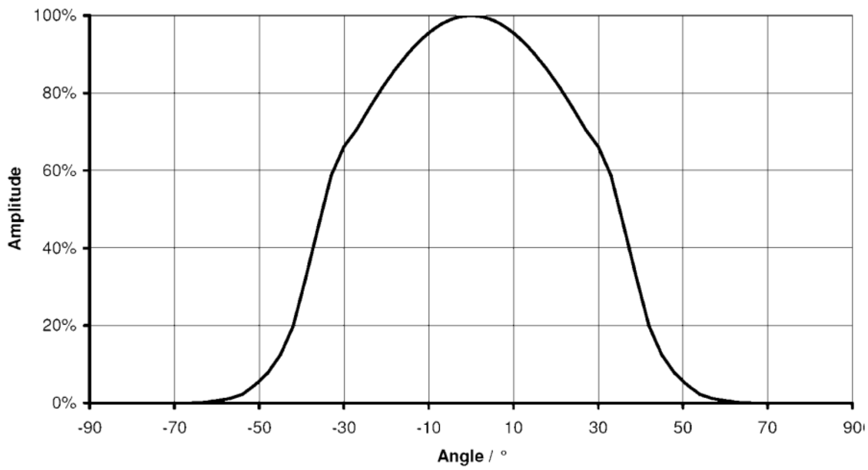
If not otherwise noted, 5V supply voltage and object with ε =0.98 were applied.

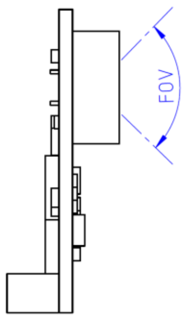
Parameter	Symbol	Sensor Temp.	Object Temp.	Max	Unit
Accuracy Standard Temp [1)]	AccS	$15 < T_{sen} < 35$	$40 < T_{obj} < 80$	1	°C
Accuracy Extended Temp. 1 [2)]	AccE1	$T_{sen} < 15$, $T_{sen} > 35$	$40 < T_{obj} < 80$	2	°C
Accuracy Extended Temp. 2 [2)]	AccE2	$15 < T_{sen} < 35$	$T_{obj} < 40$, $T_{obj} > 80$	2	°C
Accuracy Extended Temp. 3 [2)]	AccE3	$T_{sen} < 15$, $T_{sen} > 35$	$T_{obj} < 40$, $T_{obj} > 80$	3	°C

OTHER TEMPERATURE RANGES AND ACCURACIES ARE AVAILABLE ON REQUEST.

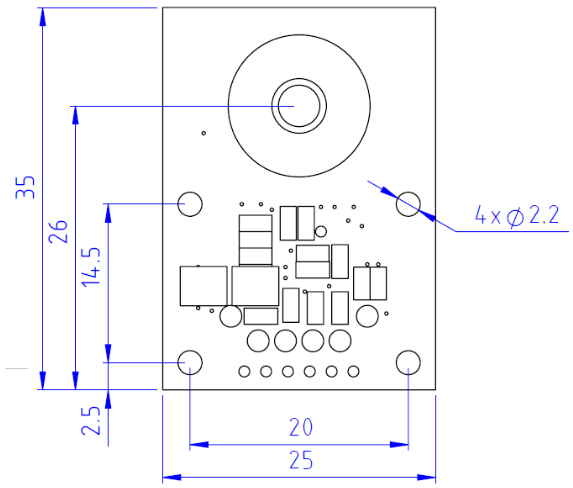
[1)] Proved while production
[2)] Proved by design

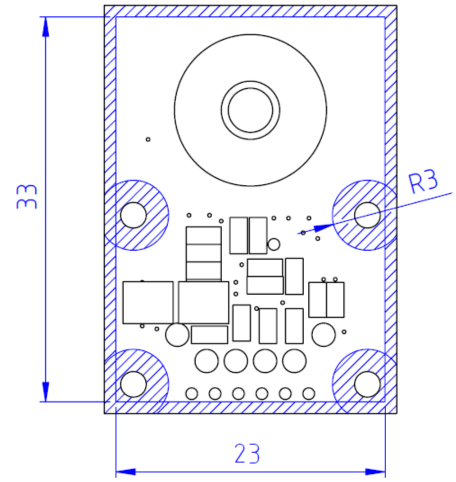
SENSOR FIELD OF VIEW



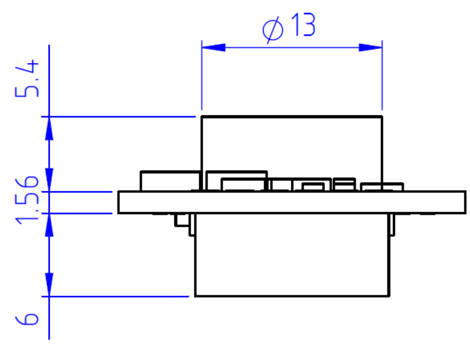


MECHANICAL DIMENSIONS





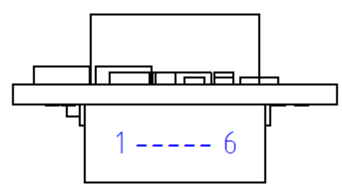
Only use hatched areas for mechanical assembly (screws, nuts, etc).



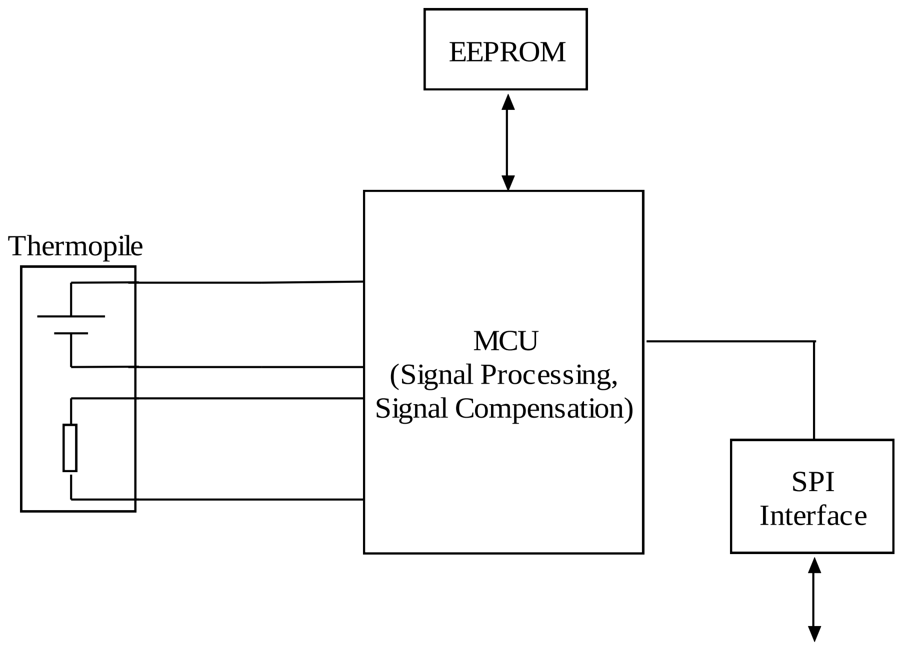
TERMINALS

Connector: JST PHR-6

Pin	Name	Description	Type
1	VDD	Supply Voltage	Supply
2	GND	Ground	Supply
3	SCL	SPI Clock	Interface
4	MISO	SPI Master In /	Interface
5	MOSI	SPI Master Out /	Interface
6	SCE	SPI Chip Enable	Interface



BLOCK DIAGRAM



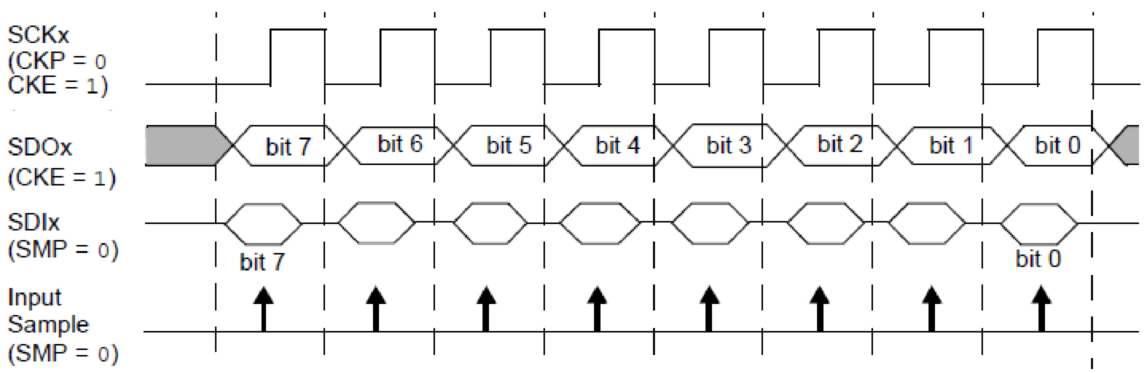
INTERFACE

PARAMETER

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Baudrate	FSPI		10		100	kHz
Data Bits				8		
Chip Select				Yes		
Input Voltage Low					0.9	V
Input Voltage High		Vcc = 3.3V	2.1			V
Output Voltage Low		1mA			0.3	V
Output Voltage High		Vcc = 3.3V, 1mA	3.0			V

SIGNAL DESCRIPTION

- SCE (Chip Select) 0 = Enable, 1 = Disable
- CKP 0
- CKE 1



SAMPLE CODE

Sample Code for sending 8 bits and reading 8 bits while sending 8 clocks.

```
// Setting directions
        TRISC4 = 1;     // SDI = Input
        TRISC5 = 0;     // SDO = Output
        TRISC3 = 0;     // SCL = Output
// Reset SPI Lines
        RC5 = 0;// SDO
        RC3 = 0;// SCL
        for (c = 0; c < 8; c++)
        {
                cReceive = cReceive << 1;       // Shift Receive Register
                RC3 = 0;                        // SCL = 0
                RC5 = (cTransmit >> (7 - c));   // Outupt next Bit on SDO
                RC3 = 1;                        // SCL = 1
                cReceive = cReceive | RC4;              // Input next Bit on SDI
        }
        RC3 = 0;
        RC5 = 0;
        return cReceive;
```

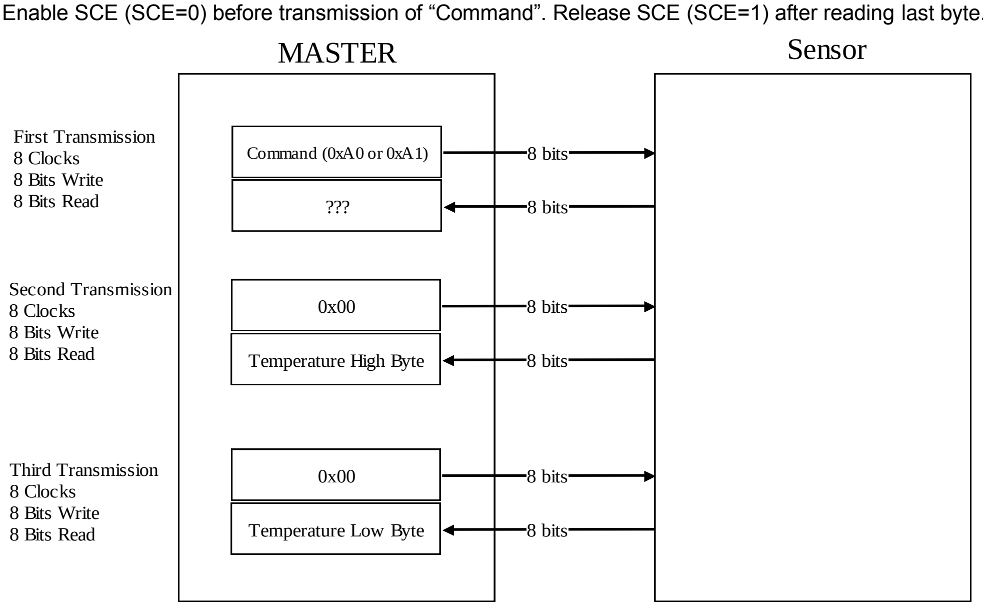
AMBIENT AND OBJECT TEMPERATUREMEASUREMENT

Please refer following table for SPI commands to read object temperature and ambient temperature. Both values are transmitted in hundredth of degrees.

Com	Description	Reply	Bytes
0xA0	Sensor Temperature	Sensor temperature in hundredth of degrees Celsius	2
0xA1	Object Temperature	Object temperature in hundredth of degrees Celsius	2

SEQUENCE OF TRANSMISSION

Enable SCE (SCE=0) before transmission of “Command”. Release SCE (SCE=1) after reading last byte.



EXAMPLE OF TEMPERATURE CALCULATION

For reading object temperature send: 0xA1
Return values i.e.:

Byte(0) = ??? discard reading
Byte(1) = 0x1A (=26)
Byte(2) = 0xB0 (=176)
Tobj = (256 * Byte(1) + Byte(2)) / 100 = (256 * 26 + 176) / 100 = 68.32°C

NAMING CONVENTION

TSEV01 S 01 B 10

Series
Interface (S = SPI, I = I^2C)
Variant (01, 02, ...)
Option (B = Basic, C = Comfort)
Field of View at 50% Signal Level (5°, 10°, ...)

ORDER INFORMATION

Please order this product using following:

Part Number	Part Description
G-TPMO-022	TSEV01S01C90

EMC

Due to the use of these modules for OEM application no CE declaration is done.
Especially line coupled disturbances like surge, burst, HF etc. cannot be removed by the module due to the small board area and low price feature. There is no protection circuit against reverse polarity or over voltage implemented.
The module will be designed using capacitors for blocking and ground plane areas in order to prevent wireless coupled disturbances as good as possible.

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- Life support applications – These products are not designed for use in life support appliances, devices, or systems where malfunctions of these products can reasonably be expected to result in personal injury.
  MEAS Deutschland GmbH customers using or selling this product for use in such applications do so at their own risk and agree to fully indemnify MEAS Deutschland GmbH for any damages resulting from such improper use or sale

NORTH AMERICA

Measurement Specialties, Inc.,
a TE Connectivity Company
910 Turnpike Road
Shrewsbury, MA 01545
Tel: 1-508-842-0516
Fax: 1-508-842-0342
Sales email:
temperature.sales.amer@meas-

EUROPE

Measurement Specialties (Europe), Ltd.,
a TE Connectivity Company
Deutschland GmbH
Hauert 13
44277 Dortmund
Tel: +49 (0) 231/9740-0
Fax: +49 (0) 231/9740-20
Sales email:
info.de@meas-spec.com

ASIA

Measurement Specialties (China), Ltd.,
a TE Connectivity Company
No. 26 Langshan Road
Shenzhen High-Tech Park (North)
Nanshan District, Shenzhen 518057
China
Tel: +86 755 3330 5088
Fax: +86 755 3330 5099
Sales: pfg.cs.asia@meas-spec.com

TSEV01S01C10

SPECIFICATIONS

- **Contact less Temperature Measurement**
- **Small Size**
- **Heat Spreader improves Accuracy**
- **Wide Supply Voltage Range**
- **Digital Interface Bus (SPI)**
- **Connector**
- **Small Field of View**

The TSEV01S01C10 is a contact-less temperature measuring system for OEM use based on the detection of infrared radiation.

The TSEV01S01C10 is equipped with an infrared sensor (Thermopile) in front. The Thermopile Sensor has to be pointed at the target object.

The basic working principle is:

- Detection of infrared radiation with a Thermopile sensor, which turns incoming radiation to an analogue voltage
- Determination of sensor temperature using a thermistor
- Calculation of ambient and object temperature using a processing unit
- Providing the ambient and objects temperature at digital output bus (SPI)

The basic thermopile sensor module is suitable for a wide range of application where non-contact temperature measurement and high accuracy are required

FEATURES

0°C – 300°C Measurement Range
Small Size
Up to 2°C Accuracy
2mA Current Consumption

APPLICATIONS

Contact less Temperature Measurement
Climate Control
Industrial Process Control
Household Applications

ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings are limiting values of permitted operation and should never be exceeded under the worst possible conditions either initially or consequently. If exceeded by even the smallest amount, instantaneous catastrophic failure can occur. And even if the device continues to operate satisfactorily, its life may be considerably shortened.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	Vccmax	Stabilized supply voltage	-0.3		16	V
Operating Temperature	Topmax		-10		85	°C
Storage temperature	Tstor		-40		85	°C
Humidity	HumL	-40°C - +50°C			85	%
Humidity	HumH	+50°C - +85°C			50	%

OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	Vcc	Stabilized supply voltage	3.3		16	V
Operating Temperature Range	Top		0		85	°C
Emission Coefficient	ε		0.98			

SENSOR CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Field of View	FOV_{10}	Total field of view at 10% signal level		14		°
Field of View	FOV_{50}	Total field of view at 50% signal level		10		°
Wavelength Range	S		Silicon, no coating			µm

OPERATIONAL CHARACTERISTICS

If not otherwise noted, 5V supply voltage and object with ε =0.98 were applied.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Object Temperature Range	Tobj		0		300	°C
Resolution	Res				0.1	°C
Supply Current[1)]	I	No output load		2		mA
Data Output Rate	Fout			1		Hz
Standard Start-Up Time	tStart				3	s

TOLERANCES

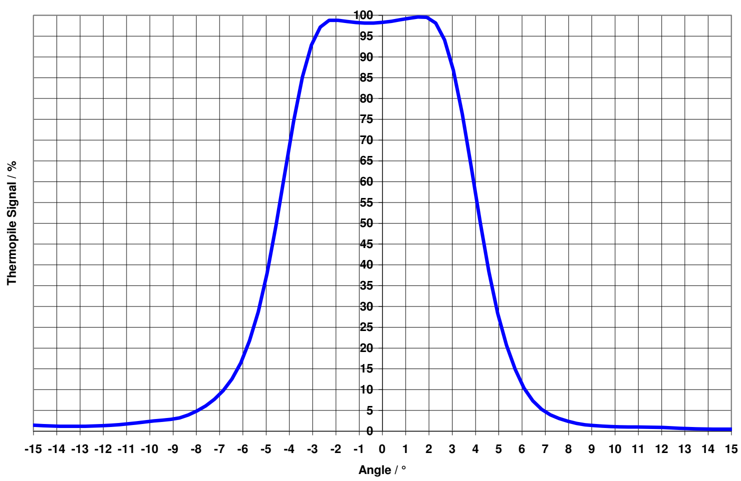
If not otherwise noted, 3.3V supply voltage and object with ε =0.98 were applied.

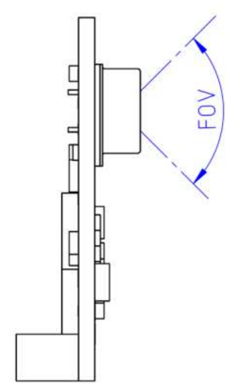
Parameter	Symbol	Sensor Temp.	Object Temp.	Max	Unit
Standard Temp [1) 3)]	AccS	$15 < T_{sen} < 35$	$170 < T_{obj} < 190$	2	°C
Extended Temp. 1 [2) 3)]	AccE1	$T_{sen} < 15$, $T_{sen} > 35$	$170 < T_{obj} < 190$	3	°C
Extended Temp. 2 [2) 3)]	AccE2	$15 < T_{sen} < 35$	$T_{obj} < 170$, $T_{obj} > 190$	3	°C
Extended Temp. 3 [2) 3)]	AccE3	$T_{sen} < 15$, $T_{sen} > 35$	$T_{obj} < 170$, $T_{obj} > 190$	4	°C

OTHER TEMPERATURE RANGES AND ACCURACIES ARE AVAILABLE ON REQUEST.

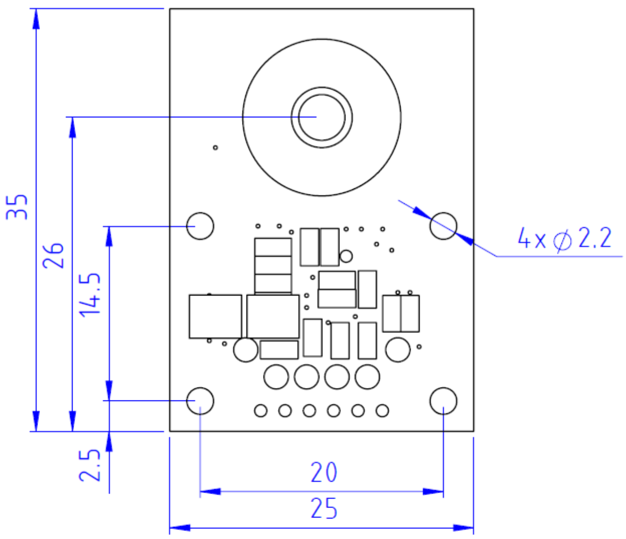
1) Proved while production
2) Proved by design
3) Valid for a distance of 100mm and black body size of 150mm x 150mm

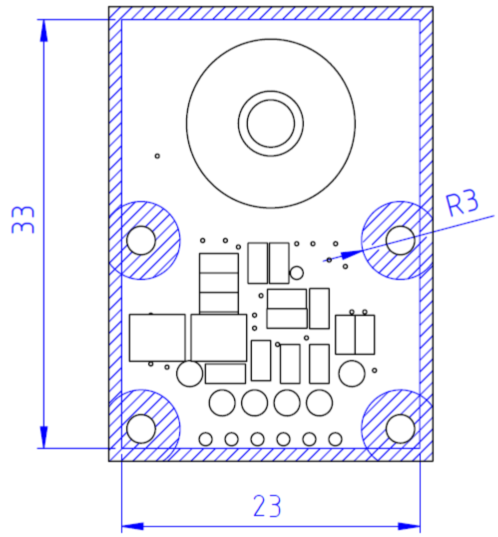
SENSOR FIELD OF VIEW



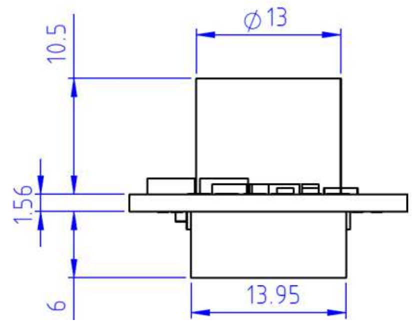


MECHANICAL DIMENSIONS





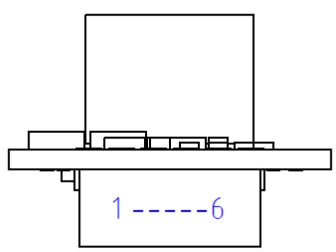
Only use hatched areas for mechanical assembly (screws, nuts, etc).



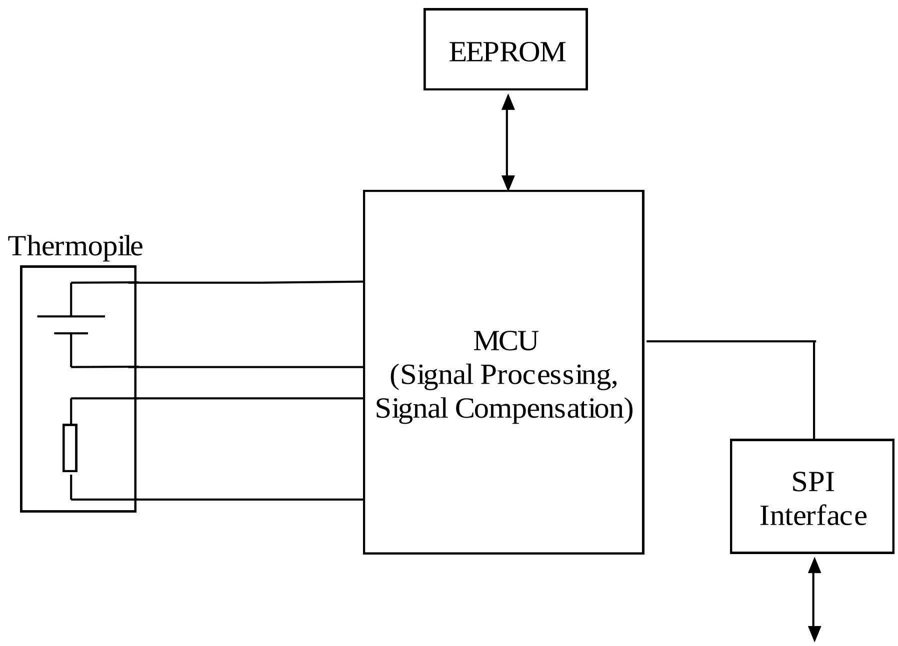
TERMINALS

Connector: JST PHR-6

Pin	Name	Description	Type
1	VDD	Supply Voltage	Supply
2	GND	Ground	Supply
3	SCL	SPI Clock	Interface
4	MISO	SPI Master In /	Interface
5	MOSI	SPI Master Out /	Interface
6	SCE	SPI Chip Enable	Interface



BLOCK DIAGRAM



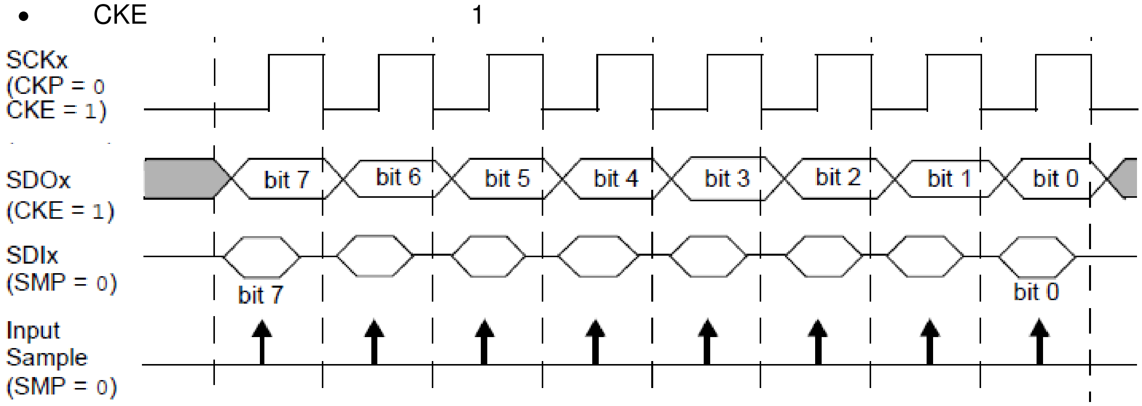
INTERFACE

PARAMETER

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Baudrate	FSPI		10		100	kHz
Data Bits				8		
Chip Select				Yes		
Input Voltage Low					0.9	V
Input Voltage High		Vcc = 3.3V	2.1			V
Output Voltage Low		1mA			0.3	V
Output Voltage High		Vcc = 3.3V, 1mA	3.0			V

SIGNAL DESCRIPTION

- SCE (Chip Select) 0 = Enable, 1 = Disable
- CKP 0
- CKE 1



SAMPLE CODE

Sample Code for sending 8 bits and reading 8 bits while sending 8 clocks.

```
// Setting directions
        TRISC4 = 1;        // SDI = Input
        TRISC5 = 0;        // SDO = Output
        TRISC3 = 0;        // SCL = Output
// Reset SPI Lines
        RC5 = 0;// SDO
        RC3 = 0;// SCL
        for (c = 0; c < 8; c++)
        {
                cReceive = cReceive << 1;           // Shift Receive Register
                RC3 = 0;                            // SCL = 0
                RC5 = (cTransmit >> (7 - c));       // Outupt next Bit on SDO
                RC3 = 1;                            // SCL = 1
                cReceive = cReceive | RC4;                  // Input next Bit on SDI
        }
        RC3 = 0;
        RC5 = 0;
        return cReceive;
```

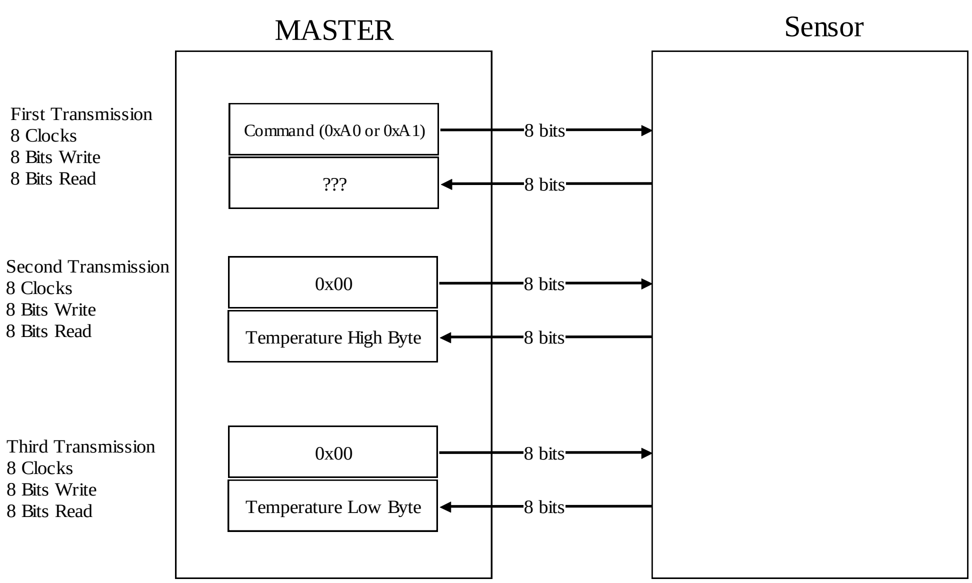
AMBIENT AND OBJECT TEMPERATUREMEASUREMENT

Please refer following table for SPI commands to read object temperature and ambient temperature. Both values are transmitted in hundredth of degrees.

Com	Description	Reply	Bytes
0xA0	Sensor Temperature	Sensor temperature in hundredth of degrees Celsius	2
0xA1	Object Temperature	Object temperature in hundredth of degrees Celsius	2

SEQUENCE OF TRANSMISSION

Enable SCE (SCE=0) before transmission of “Command”. Release SCE (SCE=1) after reading last byte.



EXAMPLE OF TEMPERATURE CALCULATION

For reading object temperature send: 0xA1

Return values i.e.:

Byte(0) = ???	discard reading
Byte(1) = 0x1A	(=26)
Byte(2) = 0xB0	(=176)

Tobj = (256 * Byte(1) + Byte(2)) / 100 = (256 * 26 + 176) / 100 = 68.32°C

NAMING CONVENTION

TSEV01 S 01 B 10

- Series — TSEV01
- Interface (S = SPI, I = I^2C) — S
- Variant (01, 02, ...) — 01
- Option (B = Basic, C = Comfort) — B
- Field of View at 50% Signal Level (5°, 10°, ...) — 10

ORDER INFORMATION

Please order this product using following:

Part Number	Part Description
G-TPMO-023	TSEV01S01C10

EMC

Due to the use of these modules for OEM application no CE declaration is done.

Especially line coupled disturbances like surge, burst, HF etc. cannot be removed by the module due to the small board area and low price feature. There is no protection circuit against reverse polarity or over voltage implemented.

The module will be designed using capacitors for blocking and ground plane areas in order to prevent wireless coupled disturbances as good as possible.

DEFINITIONS AND DISCLAIMERS

- Application information – Applications that are described herein for any of these products are for illustrative purpose only. MEAS Deutschland GmbH makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.
- Life support applications – These products are not designed for use in life support appliances, devices, or systems where malfunctions of these products can reasonably be expected to result in personal injury.
  MEAS Deutschland GmbH customers using or selling this product for use in such applications do so at their own risk and agree to fully indemnify MEAS Deutschland GmbH for any damages resulting from such improper use or sale.

NORTH AMERICA

Measurement Specialties, Inc.,
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Fax: +49 (0) 231/9740-20
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Nanshan District, Shenzhen 518057
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TSEV01S01C05

SPECIFICATIONS

- **Contact less Temperature Measurement**
- **Small Size**
- **Heat Spreader improves Accuracy**
- **Wide Supply Voltage Range**
- **Digital Interface Bus (SPI)**
- **Connector**
- **Small Field of View**
- **Improved constancy of output signal over distance**

The TSEV01S01C05 is a contact-less temperature measuring system for OEM use based on the detection of infrared radiation.
The TSEV01S01C05 is equipped with an infrared sensor (Thermopile) in front. The Thermopile Sensor has to be pointed at the target object.
The basic working principle is:

- Detection of infrared radiation with a Thermopile sensor, which turns incoming radiation to an analogue voltage
- Determination of sensor temperature using a thermistor
- Calculation of ambient and object temperature using a processing unit
- Providing the ambient and objects temperature at digital output bus (SPI)

The thermopile sensor module is suitable for a wide range of application where non-contact temperature measurement and high accuracy are required.

FEATURES

0°C – 300°C Measurement Range
Small Size
Up to 2°C Accuracy
2mA Current Consumption
Improved constancy of output signal over distance

APPLICATIONS

Contact less Temperature Measurement
Climate Control
Industrial Process Control
Household Applications

ABSOLUTE MAXIMUM RATINGS

Absolute maximum ratings are limiting values of permitted operation and should never be exceeded under the worst possible conditions either initially or consequently. If exceeded by even the smallest amount, instantaneous catastrophic failure can occur. And even if the device continues to operate satisfactorily, its life may be considerably shortened.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	Vccmax	Stabilized supply voltage	-0.3		+16	V
Operating Temperature	Topmax		-10		+85	°C
Storage temperature	Tstor		-40		+85	°C
Humidity	HumL	-40°C - +50°C			85	%
Humidity	HumH	+50°C - +85°C			50	%

OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	Vcc	Stabilized supply voltage	+3.3		+16	V
Operating Temperature Range	Top		-10		+85	°C
Emission Coefficient	ε		0.98			

SENSOR CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Field of View	FOV 10	Total field of view at 10% signal level		8		°
Field of View	FOV 50	Total field of view at 50% signal level		5		°
Wavelength Range	S		Silicon, no coating			µm

OPERATIONAL CHARACTERISTICS

If not otherwise noted, 5V supply voltage and object with ε =0.98 were applied.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Object Temperature Range	Tobj		0		300	°C
Resolution	Res				0.1	°C
Supply Current[1)]	I	No output load		2		mA
Data Output Rate	Fout			1		Hz
Standard Start-Up Time	tStart				3	s

TOLERANCES

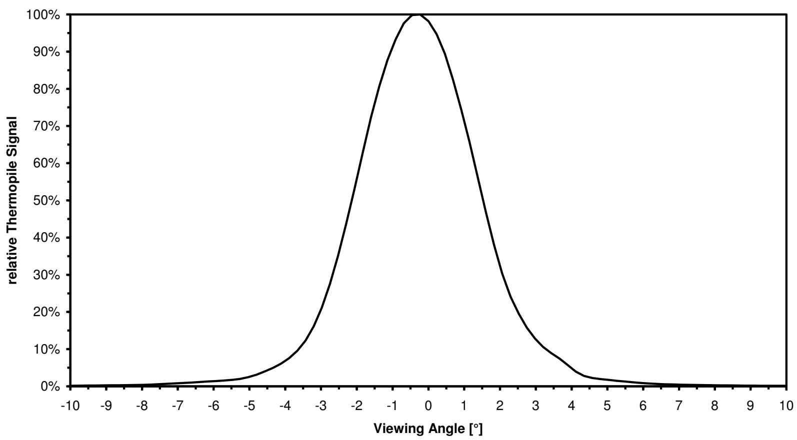
If not otherwise noted, 5V supply voltage and object with ε =0.98 were applied.

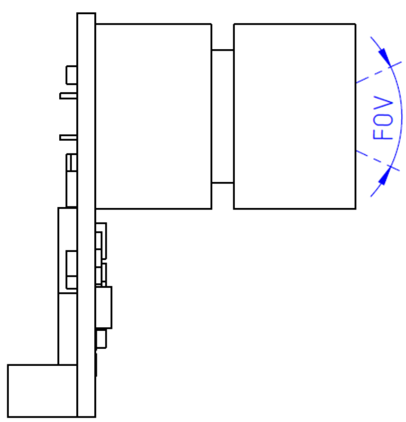
Parameter	Symbol	Sensor Temp.	Object Temp.	Max	Unit
Standard Temp [1) 3)]	AccS	$15 < T_{sen} < 35$	$160 < T_{obj} < 200$	2	°C
Extended Temp. 1 [2) 3)]	AccE1	$T_{sen} < 15$, $T_{sen} > 35$	$160 < T_{obj} < 200$	3	°C
Extended Temp. 2 [2) 3)]	AccE2	$15 < T_{sen} < 35$	$T_{obj} < 160$, $T_{obj} > 200$	3	°C
Extended Temp. 3 [2) 3)]	AccE3	$T_{sen} < 15$, $T_{sen} > 35$	$T_{obj} < 160$, $T_{obj} > 200$	4	°C

OTHER TEMPERATURE RANGES AND ACCURACIES ARE AVAILABLE ON REQUEST.

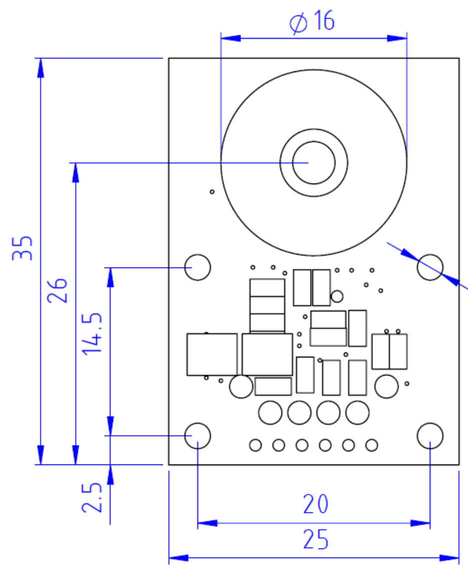
[1)] Proved while production
[2)] Proved by design
[3)] Valid for a distance of 100mm and black body size of 150mm x 150mm

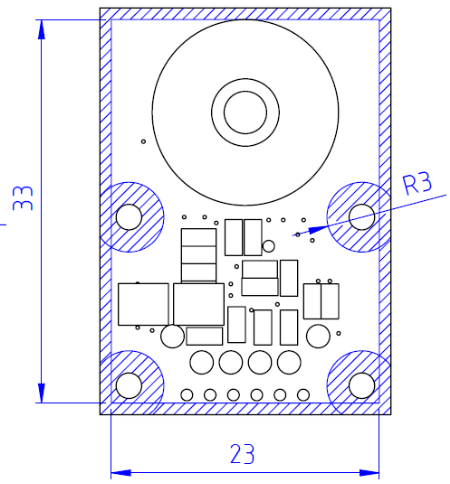
SENSOR FIELD OF VIEW



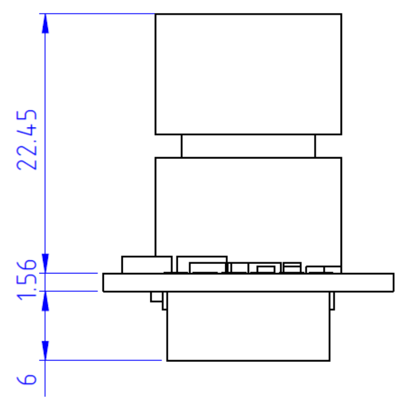


Mechanical Dimensions





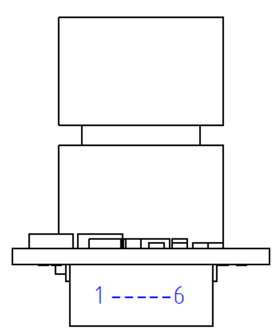
Only use hatched areas for mechanical assembly (screws, nuts, etc).



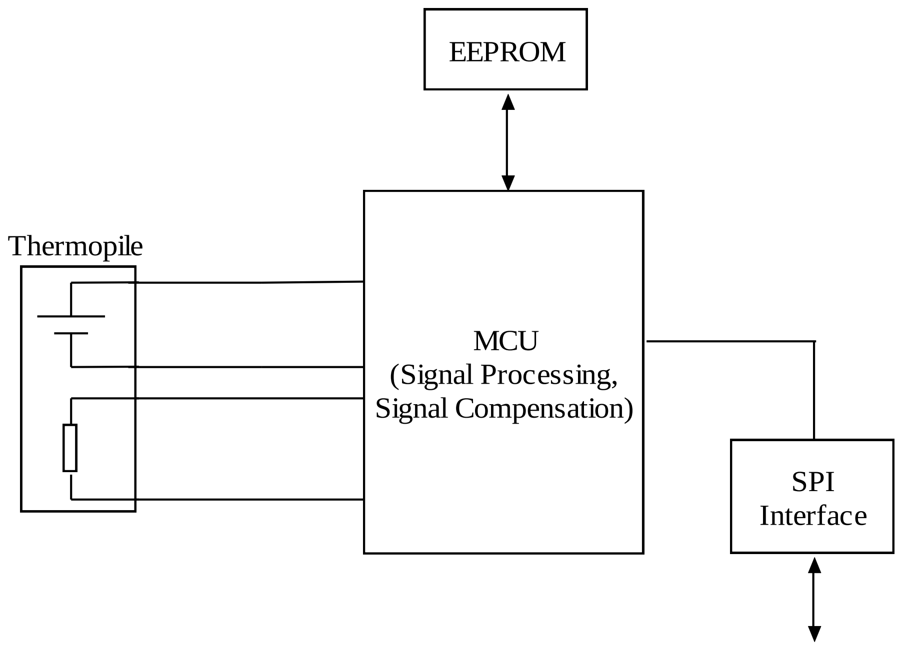
TERMINALS

Connector: JST PHR-6

Pin	Name	Description	Type
1	VDD	Supply Voltage	Supply
2	GND	Ground	Supply
3	SCL	SPI Clock	Interface
4	MISO	SPI Master In /	Interface
5	MOSI	SPI Master Out /	Interface
6	SCE	SPI Chip Enable	Interface



BLOCK DIAGRAM



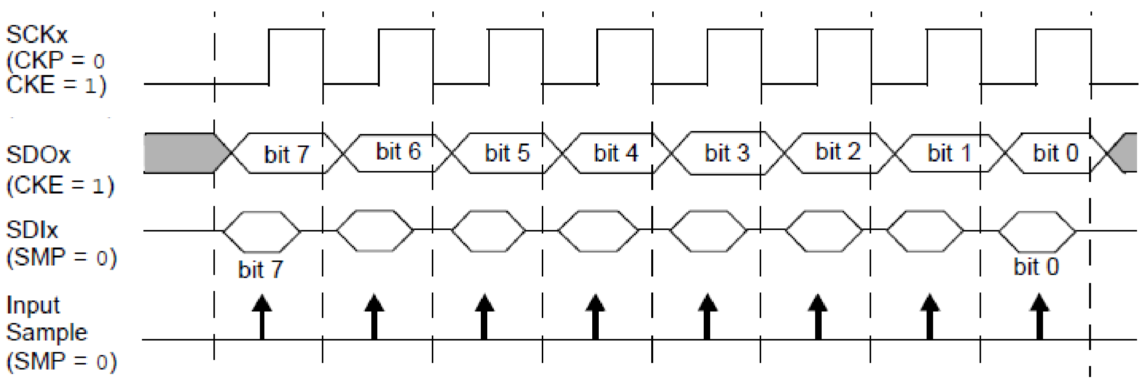
INTERFACE

PARAMETER

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Baudrate	FSPI		10		100	kHz
Data Bits				8		
Chip Select				Yes		
Input Voltage Low					0.9	V
Input Voltage High		Vcc = 3.3V	2.1			V
Output Voltage Low		1mA			0.3	V
Output Voltage High		Vcc = 3.3V, 1mA	3.0			V

SIGNAL DESCRIPTION

- SCE (Chip Select) 0 = Enable, 1 = Disable
- CKP 0
- CKE 1



SAMPLE CODE

Sample Code for sending 8 bits and reading 8 bits while sending 8 clocks.

```
// Setting directions
        TRISC4 = 1;        // SDI = Input
        TRISC5 = 0;        // SDO = Output
        TRISC3 = 0;        // SCL = Output
// Reset SPI Lines
        RC5 = 0;// SDO
        RC3 = 0;// SCL
        for (c = 0; c < 8; c++)
        {
                cReceive = cReceive << 1;          // Shift Receive Register
                RC3 = 0;                           // SCL = 0
                RC5 = (cTransmit >> (7 - c));      // Outupt next Bit on SDO
                RC3 = 1;                           // SCL = 1
                cReceive = cReceive | RC4;                 // Input next Bit on SDI
        }
        RC3 = 0;
        RC5 = 0;
return cReceive;
```

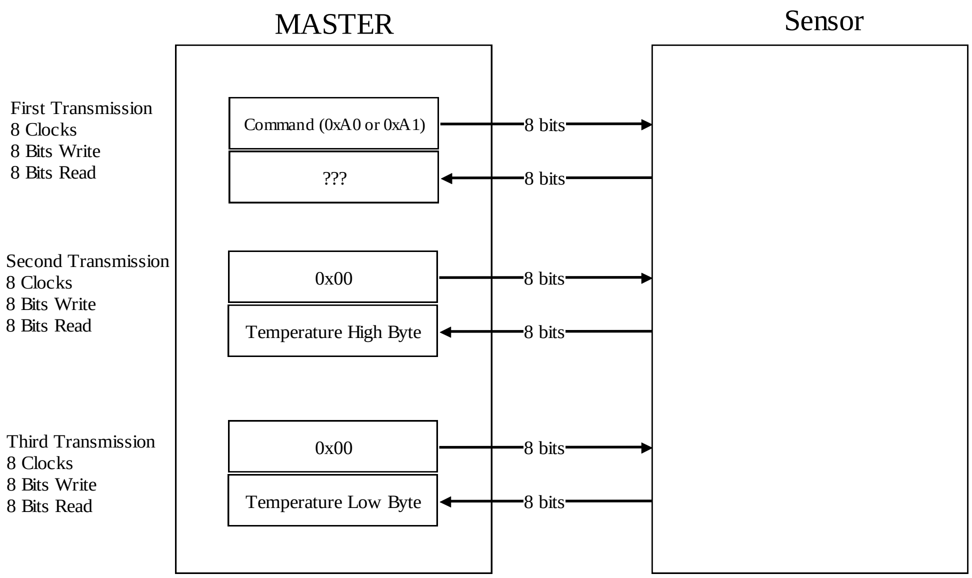
AMBIENT AND OBJECT TEMPERATUREMEASUREMENT

Please refer following table for SPI commands to read object temperature and ambient temperature. Both values are transmitted in hundredth of degrees.

Com	Description	Reply	Bytes
0xA0	Sensor Temperature	Sensor temperature in hundredth of degrees Celsius	2
0xA1	Object Temperature	Object temperature in hundredth of degrees Celsius	2

SEQUENCE OF TRANSMISSION

Enable SCE (SCE=0) before transmission of “Command”. Release SCE (SCE=1) after reading last byte.



EXAMPLE OF TEMPERATURE CALCULATION

For reading object temperature send: 0xA1

Return values i.e.:

Byte(0) = ???	discard reading
Byte(1) = 0x1A	(=26)
Byte(2) = 0xB0	(=176)

Tobj = (256 * Byte(1) + Byte(2)) / 100 = (256 * 26 + 176) / 100 = 68.32°C

NAMING CONVENTION

TSEV01 S 01 B 10

- Series — TSEV01
- Interface (S = SPI, I = I²C) — S
- Variant (01, 02, ...) — 01
- Option (B = Basic, C = Comfort) — B
- Field of View at 50% Signal Level (5°, 10°, ...) — 10

ORDER INFORMATION

Please order this product using following:

Part Number	Part Description
G-TPMO-025	TSEV01S01C05

EMC

Due to the use of these modules for OEM application no CE declaration is done.

Especially line coupled disturbances like surge, burst, HF etc. cannot be removed by the module due to the small board area and low price feature. There is no protection circuit against reverse polarity or over voltage implemented.

The module will be designed using capacitors for blocking and ground plane areas in order to prevent wireless coupled disturbances as good as possible.

Definitions and Disclaimers

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  MEAS Deutschland GmbH customers using or selling this product for use in such applications do so at their own risk and agree to fully indemnify MEAS Deutschland GmbH for any damages resulting from such improper use or sale.

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TE.com/sensorsolutions

TPT300V

IR Pyrometer

Key Features

- **Contactless Temperature Measurement**
- **High Accuracy**
- **Wide Temperature Range**
- **Digital and Analogue Interface**
- **Industrial Usage (IP65)**

TPT300V is a contactless temperature measuring system - called pyrometer - based on the detection of infrared radiation. TPT300V is equipped with a lens and an infrared sensor (Thermopile) in front. It has to be pointed at the target object.
The basic working principle is:

- Detection of infrared radiation with a Thermopile sensor
- Further analogue signal processing
- Calculation of the objects temperature using a microcontroller
- Providing the objects temperature at digital or analogue output

The main fields of applications are temperature measuring in industrial applications i.e. at moving or inaccessible parts

FEATURES

- 0°C – 300°C Measurement Range
- 9V – 24V Supply Voltage Range
- RS232 Interface & Analogue Voltage Output
- IP65 protected

APPLICATIONS

- Contactless Temperature Measurement
- Industrial Process Control

ABSOLUTE MAXIMUM RATINGS

- Absolute maximum ratings are limiting values of permitted operation and should never be exceeded under the worst possible conditions either initially or consequently. If exceeded by even the smallest amount, instantaneous catastrophic failure can occur. And even if the device continues to operate satisfactorily, its life may be considerably shortened.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	Vcc	Measured versus GND	-1		28	V
Storage Temperature	Tstor		-20		85	°C

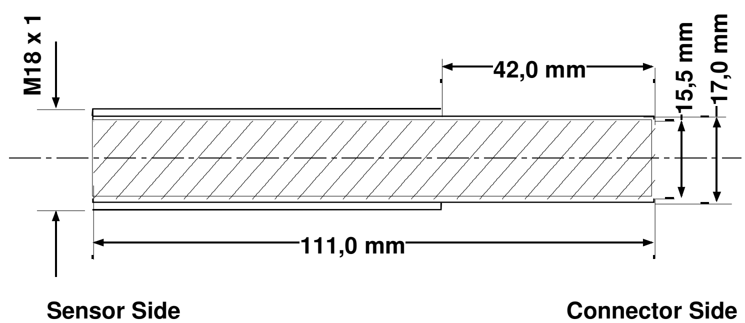
OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply Voltage	Vcc	Measured versus GND	9		24	V
Supply Current	I	Full ambient temp. range, no output load		22		mA
Thermal Emission Coefficient of Object	ε	Adjustable via RS232	10		100	%
Field of View	FOV			±5		°
Digital Output Rate		Adjustable	0.1		10	Hz
Digital Output Settings			9600 Baud, 8 Bit, No Parity, 1 Stop Bit			

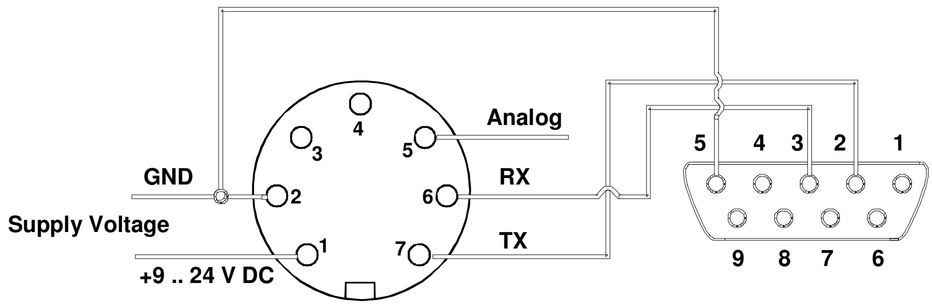
OPERATING CHARACTERISTICS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Object Temperature Range	Tobj	Digital output Analog output	0 12		300 288	°C
Ambient Temperature Range	Tamb		0		85	°C
Spectral Sensitivity	S		8		14	µm
Accuracy of Target Temp. Measuring	Acc_1	Tambient = 25°C	± 1% of Full Scale Range resp. ± 3°C			°C
Accuracy of Target Temp. Measuring	Acc_2	Full ambient temp. range	± 1.5% of Full Scale Range resp. ± 4.5°C			°C
Resolution Digital	Res		0.3			°C
Analog Output Characteristics			T[°C] x 5V/300°C			V
Analog Output Range			0.2 – 4.8			V
Resolution Analog			0.3			°C
Analog Output Source Resistance			40			Ω
Housing			Stainless steel			
Protection class			IP 65			

MECHANICAL DIMENSIONS



TERMINALS



Binder connector series 712

DSUB 9 connector (female)

Please take care: pin numbers are marked on the Binder and on most DSUB connectors!

Pin	Symbol	Description	Typ
1	+VS	Supply Voltage	Supply
2	GND	Ground potential	Supply
3	NC		
4	NC		
5	AN	Analog Output (Voltage)	Analog Output
6	RX	Receive Data (RS232)	Digital Input/Output
7	TX	Transmit Data (RS232)	Digital Input/Output

FUNCTION

RS232 PROTOCOL

Fixed RS232 settings: 9600 Baud, 8 Bit, No Parity, 1 Stop Bit

TPT MODES

There are two modes implemented in TPT sensors: the Free Running mode and the On Request mode.
In the Free Running mode the sensor cyclically sends measuring results via RS232. In this mode no further communication (for instance changing sensor parameters) is possible. The only telegram which is accepted in this mode is the “Set On Request Mode” telegram, which stops sensor output.
In On Request mode the sensor only sends data via RS232 after user has sent any request telegram. Only in this mode the changing of sensor parameters is possible.
NOTE: Updating the analog output is directly correlated with updating the RS232 output. Only if output data are sent via RS232 the analog output is updated. Two cases are possible: the “Request Result Data” telegram causes updating serial and analog output and - on the other hand - the cyclically sending data in Free Running Mode.

FACTORY SETTINGS

After delivery following parameters are set:

Parameter	Default Setting
Output Mode	Free Running
Output Format	Object and Ambient Temperature
Output Rate	100ms
Emissivity	98%

COMMANDS

command	to the sensor	sensor response	explanation
Request Software Version and Serial Number	„V“	“HL-Planartechnik “ “TPT V2.2 yywwnnn-2” *<CR> <LF>*	Manufacturer company, software version, serial number with yy =Year, ww = weak of year, nnn = consecutive number, -2 = product code for TPT300V
Set Output Mode “Free Running”	“F”	“F”	“Free Running” mode is active
Set Output Mode “On Request”	“f”	“f”	“On Request” mode is active
Set Output Format “Object and Ambient Temperature”	“I”	“I”	Format “Object and Ambient Temperature” is active
Set Output Format “Object Temperature”	“i”	“i”	Format “Object Temperature” is active
Set Emissivity Factor	“e” <Emissivity>	“e” <Emissivity>	Emissivity in percentage (10..100), 1 Byte Binary-Format,
Read Emissivity Factor	“E”	“99”	Answer Emissivity in percentage (10..100); ASCII-Format
Request Result Data (While Output Format “Object and Ambient Temperature”)	“R“	*“+255:+784” <CR> <LF>*	With +255 = sensor temperature in tenth of degree C (1-3 digit with sign) +784 = object temperature in tenth of degree C (1-4 digit with sign);
Request Result Data (While Output Format “Object Temperature”)	“R“	*“+784” <CR> <LF>*	With +784 = object temperature in tenth of degree C (1-4 digit with sign)
Software Reset	“q“	-	No Echo. It takes about 1 second until software reset is done and sensor acts normal (as after power-up)
Set Output Data Rate for Output Mode “Free Running”	“O” “(Data Rate Code)”	“O” “(Data Rate Code)”	(Note 1), ASCII-Format

“” = ASCII-Format, <> = Binary-Format, <CR>= Carriage Return, <LF> = Line Feed
No reset is necessary to activate the new settings.

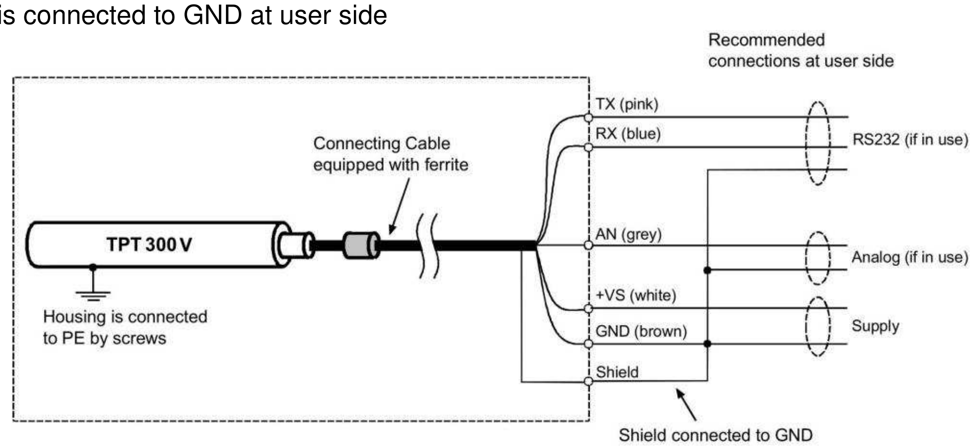
Note 1:

Data Rate Code	Output Data Rate
“0”	100 ms
“1”	500 ms
“2”	1000 ms
“3”	5000 ms
“4”	10000 ms

CE CONFORMITY

The sensor meets the normative requirements for use in industrial environment. The complete compliance with the norm is given under following conditions:

- Housing is connected to PE by screws
- Meas connecting cable is used
- Shield is connected to GND at user side



If the user intends to employ his own connecting cable, it is recommended to equip this cable with a ferrite near the sensor. A suitable type is Würth #74271112.

TECHNICAL CONTACT INFORMATION

ORDERING INFORMATION

Part No.	Part Description
G-TPSY-002	TPT300V

Convenient cable on request

NORTH AMERICA
Measurement Specialties, Inc.,
a TE Connectivity Company
910 Turnpike Road
Shrewsbury, MA 01545
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