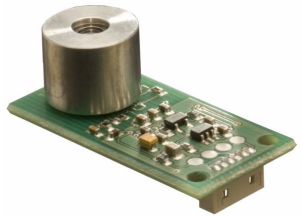
TSEV01CL55 Thermopile Sensor Module



- **Contact less Temperature Measurement**
- **High Accuracy**
- **Small Size**
- **Wide Supply Voltage Range**
- **Digital Interface Bus (I2C)**

DESCRIPTION

TSEV01CL55 is a contact-less temperature measuring system for OEM use based on the detection of infrared radiation.

TSEV01CL55 is equipped with an infrared sensor (Thermopile) in front. The Thermopile Sensor has to be pointed at the target object of interest.

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
- Further analogue signal processing and conditioning
- Calculation of ambient and object temperature using a processing unit
- Providing the ambient and objects temperature at digital output bus (I^2C)

The TSEV01CL55 is suitable for a wide range of application where non-contact temperature measurement is required.

The TSEV01CL55 is equipped with a silicon lens (back focal length = 5.5mm) to narrow the field of view.

I^2C pull-up resistors are provided on the sensor.

The I2C interface does not block the clock for clock-stretching.

FEATURES

- 0℃ – 300℃ Measurement Range
- 4V – 16V Supply Voltage Range
- Up to 1.5% Accuracy
- 2mA Current Consumption

APPLICATIONS

- Contact less Temperature Measurement
- Climate Control
- Industrial Process Control
- Household Applications

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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	-0.3		16	V
Operating Temperature	Top		-10		85	℃
Storage temperature	Tstor		-40		85	℃

OPERATING CONDITIONS

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Supply voltage	Vcc	Measured versus GND	4	5	16	V
Emission Coefficient	ε		0.95			

OPERATING CONDITIONS

If not otherwise noted, 25℃ ambient temperature, 5V supply voltage and object with ε =0.98 were applied.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Field of View	FOV			14[1)]		°
Supply Current	I	Full ambient temp. range, no output load	1	2	4	mA
Digital Output Clock Rate (I2C)	FI2C		20		50	kHz
Data Output Rate	Fout			1		Hz

[1)] Total field of view at 10% signal level

OPERATIONAL CHARACTERISTICS

If not otherwise noted, 25℃ ambient temperature, 5V supply voltage and object with ε =0.98 were applied.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Object Temperature Range	Tobj		0		300	℃
Ambient Temperature Range	Tamb		0		100	℃
Standard Start-Up Time	tStart			5		s
Stabilization Time	tStab			3		min
Accuracy offset – prior to thermal stability time	ΔT_{stab}			±2.5[2)]		%FS
Accuracy tolerance when 10℃ < Tambient < 40℃ and after 3 minutes stabilization time	ΔT	170℃ < T_{object} < 190℃		±1.5[2)]		%FS
		Outside above range		±2.5[2)]		%FS

[2)] The distance of sensor to measurement object has to be disclosed by customer in order to guaranty calibration accuracy.

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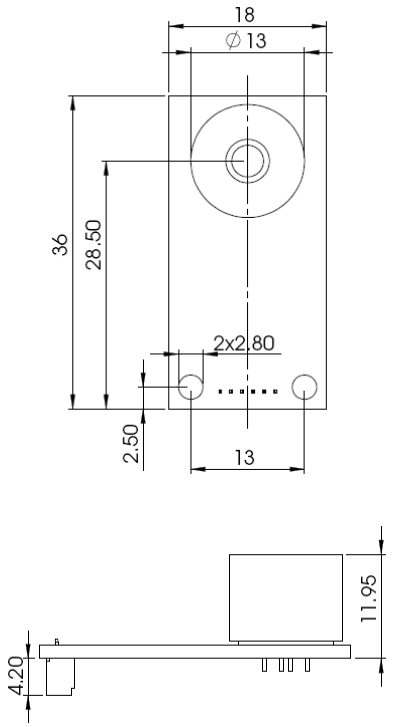
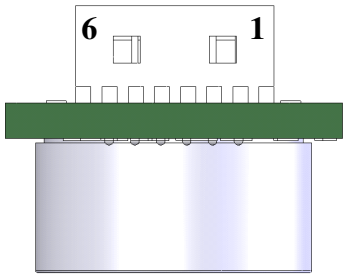
MECHANICAL DIMENSIONS



TERMINALS

Connector: Molex 51021-0600 (Farnell-In-One: 1012261, Digikey: WM1724-ND)

Pin	Name	Desription	Type
1	NC		
2	NC		
3	SDA	I^2C Data (3.6V)	Interface
4	SCL	I^2C Clock (3.6V)	Interface
5	GND	Ground	Supply
6	VCC	Supply Voltage (5V)	Supply



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BLOCK DIAGRAM

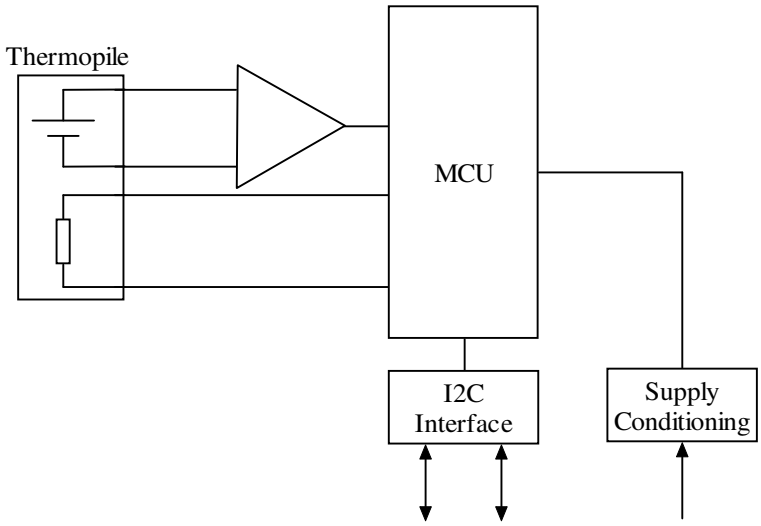
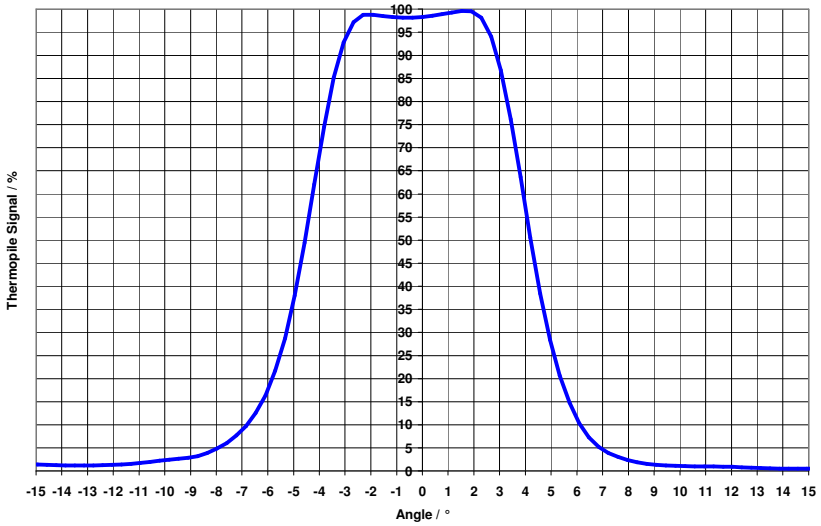


Figure n: Block diagram

FIELD OF VIEW



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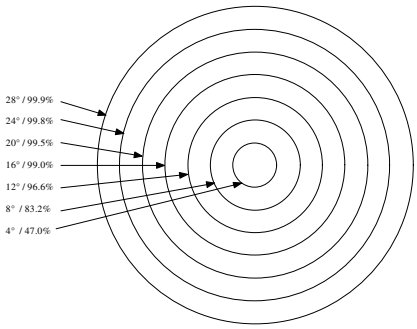
SIGNAL DISTRIBUTION

The non-ideal filter characteristics have to been considered for the correct measurement distance with respect to the measurement object surface size. To achieve most accurate measurement results, measurement object should at least cover 99% of the sensors field of view.



FUNCTION

I²C INTERFACE

This module is always operating in pure slave modus of a two wire interface similar to I²C. The typical baud rate of this device is 20kBit/s. The supported address length is seven bits. The I²C slave address is 54h.

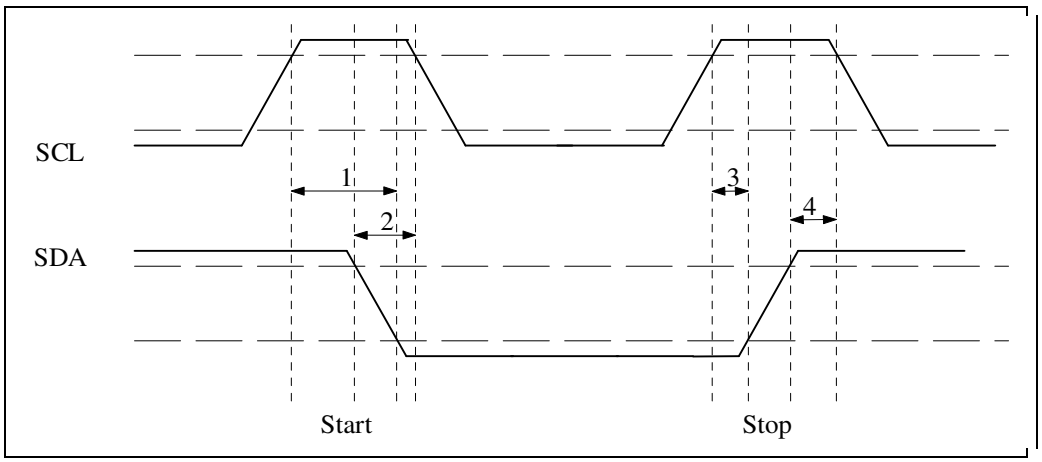
PHYSICAL INTERFACE PARAMETERS

Parameter	Min	Typical	Max	Unit
Baudrate	10	---	50	kBit/s
Address length	---	7	---	Bit
Address (standard)	---	54h	---	---
Input High Level	2	---	3.6	V
Input Low Level	---	---	1	V
Output High Level	2.5	---	---	V
Output Low Level	---	---	1	V

TIMING PARAMETERS

START/STOP

No.	Parameter	Description	Min	Typ	Max	Unit
1	TSU:STA	Start Setup Time	4.7	---	---	µs
2	THD:STA	Start Hold Time	4.0	---	---	µs
3	TSU:STO	Stop Setup Time	4.0	---	---	µs



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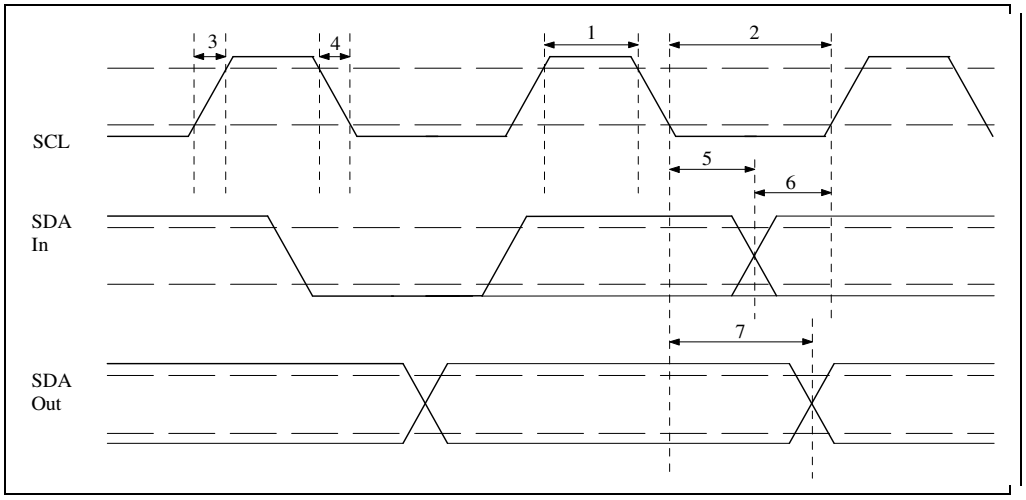
DATA

No	Parameter	Description	Min	Max	Unit
1	THIGH	Clock High Time	4.0	50	µs
2	TLOW	Clock Low Time	4.7	---	µs
3	TR	SDA & SCL Rise Time	---	1	µs
4	TF	SDA & SCL Fall Time	---	0.3	µs
5	THD:DAT	Data Input Hold Time	0.3	---	µs
6	TSU:DAT	Data Input Setup Time	0.25	---	µs
	TBUF	Bus Free Time	4.7	---	µs



I2C COMMAND REFERENCE

AMBIENT AND OBJECT MEASUREMENT

Please refer following table for I^2C commands to read object temperature and ambient temperature. Both values are transmitted in hundredth of degrees.

Command	Description	Reply	Bytes
0xB6	Read object temperature	Object temperature in hundredth of degree	2
0xB5	Read ambient temperature	Ambient temperature in hundredth of degree	2

EXAMPLE OF TEMPERATURE CALCULATION

For reading object temperature send: 0xB6

Return values i.e.: Byte(0) = 0x0E, Byte(1) = 0xAA

Temperature T_{obj} = (256 * Byte(0) + Byte(1)) / 100 = (256 * 14 + 170) / 100 = 37,54℃

OUT OF RANGE INDICATION

In case of ambient or object temperature over exceeding specified temperature ranges temperature outputs showing following data:

Command	Description	Reply	Bytes
0xB6	Object temperature > 50℃	0xFFF0	2
0xB6	Object temperature < 0℃	0xFFF1	2
0xB5	Ambient temperature > 85℃	0xFFFF	2
0xB5	Ambient temperature < 0℃	0xF000	2

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I2C TIMING REQUIREMENTS

The I2C hardware module was change with respect to the SCL “latch-up” issue. The modified I2C module will not pull down SCL to signal the master to wait for calculation of data anymore. Therefore the master has to add wait times to ensure that the slave will be able to organize the data.

For standard data transmission (like reading temperatures) 1ms of time is sufficient for the slave to arrange the data.

For more time demanding operations (like reading/writing the EEPROM) 10ms should be waited for slave to process data.

READING TEMPERATURE

I.e. object temperature.

WRITE SEQUENCE

Data	Direction
Start, Address (Write 0x54), Command (0xB6), Stop	Master → Slave

READ SEQUENCE

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (high byte of temperature)	Master ← Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (low byte of temperature)	Master ← Slave
Stop	Master → Slave

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SETTING EMISSIVITY

	EE = F * 256 **High Byte = EE / 256** **Low Byte = EE modulo 256**

i.e.: *Emissivity = 0.92*
EE = 278
High Byte = 1
Low Byte = 22

UNLOCK WRITE PROTECT

Write Sequence

Data	Direction
Start, Address (Write 0x54), Command (189d), Stop	Master → Slave

Read Sequence

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (0d)	Master ← Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (189d)	Master ← Slave
Stop	Master → Slave

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WRITING HIGH BYTE TO EEPROM

Send Command

Data	Direction
Start, Address (Write 0x54), Command (186d), Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (1d)	Master ← Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (186d)	Master ← Slave
Stop	Master → Slave

Send Location

Data	Direction
Start, Address (Write 0x54), Location (0d), Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (0d)	Master ← Slave
Stop	Master → Slave

Send Cell

Data	Direction
Start, Address (Write 0x54), **EEPROM Cell (24d)**, Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (24d)	Master ← Slave
Stop	Master → Slave

Send Data

Data	Direction
Start, Address (Write 0x54), High Byte of Emissivity (i.e. 1d), Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of ***10ms*** for slave to write to EEPROM and read back data	Master → Slave
Read data (1d)	Master ← Slave
Stop	Master → Slave

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WRITING LOW BYTE TO EEPROM

Send Command

Data	Direction
Start, Address (Write 0x54), Command (186d), Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (1d)	Master ← Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (186d)	Master ← Slave
Stop	Master → Slave

Send Location

Data	Direction
Start, Address (Write 0x54), Location (0d), Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (0d)	Master ← Slave
Stop	Master → Slave

Send Cell

Data	Direction
Start, Address (Write 0x54), **EEPROM Cell (25d)**, Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (24d)	Master ← Slave
Stop	Master → Slave

Send Data

Data	Direction
Start, Address (Write 0x54), High Byte of Emissivity (i.e. 22d), Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of ***10ms*** for slave to write to EEPROM and read back data	Master → Slave
Read data (22d)	Master ← Slave
Stop	Master → Slave

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READING HIGH BYTE FROM EEPROM

Send Command

Data	Direction
Start, Address (Write 0x54), Command (185d), Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (1d)	Master ← Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (185d)	Master ← Slave
Stop	Master → Slave

Send Location

Data	Direction
Start, Address (Write 0x54), Location (0d), Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (0d)	Master ← Slave
Stop	Master → Slave

Send Cell

Data	Direction
Start, Address (Write 0x54), **EEPROM Cell (24d)**, Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of ***10ms*** for slave to read data from EEPROM	Master → Slave
Read data (high byte)	Master ← Slave
Stop	Master → Slave

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READING HIGH BYTE FROM EEPROM

Send Command

Data	Direction
Start, Address (Write 0x54), Command (185d), Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (1d)	Master ← Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (185d)	Master ← Slave
Stop	Master → Slave

Send Location

Data	Direction
Start, Address (Write 0x54), Location (0d), Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of **1ms** for slave to arrange data	Master → Slave
Read data (0d)	Master ← Slave
Stop	Master → Slave

Send Cell

Data	Direction
Start, Address (Write 0x54), **EEPROM Cell (25d)**, Stop	Master → Slave

Data	Direction
Start, Address (Read 0x55)	Master → Slave
Master adds wait period of ***10ms*** for slave to read data from EEPROM	Master → Slave
Read data (low byte)	Master ← Slave
Stop	Master → Slave

CALCULATION OF EMISSIVITY

The Emissivity is calculated by:

EE	**= 256*High-Byte + Low-Byte**
Emissivity	**= 256 / EE**

i.e.:

High Byte	*= 1*
Low Byte	*= 22*
EE	*= 278*
Emissivity	*= 0.92*