SL-W-TRS-5.5Dx

Digital Infrared Thermopile Sensor

SL-W-TRS-5.5Dx is a series of high-precision digital output differential infrared thermopile sensors for various non-contact temperature measurement products and industries, including MEMS thermopile sensor chips, NTC thermistors and professional signal conditioning ASIC chips. The ASIC chip is equipped with a 24-bit Sigma-Delta high-precision ADC, a low-noise instrument amplifier PGA and an interface circuit. This series consists of six models D1-D6, which are composed of a substrate sensor (D1) and a substrate sensor + optical cup, and are suitable for temperature measurement applications in medical, student cards, electronic sentinels and other products.

Features

- High-precision digital temperature sensor
- Easy to implement, no temperature calibration required by the user
- Directly output the measured temperature without external circuits
- MEMS Thermopile Technology
- High response rate, fast response time
- 5.5 μm Long pass filter window
- Standard I^2C interface
- TO-46 Metal tube package

Application

- Smart wearable devices
- Smart phone
- Smart home appliances
- Industrial Temperature Monitoring
- Non-contact surface body temperature measurement
- Intelligent temperature sensing and control

1.Absolute maximum ratings

List 1. Absolute maximum ratings

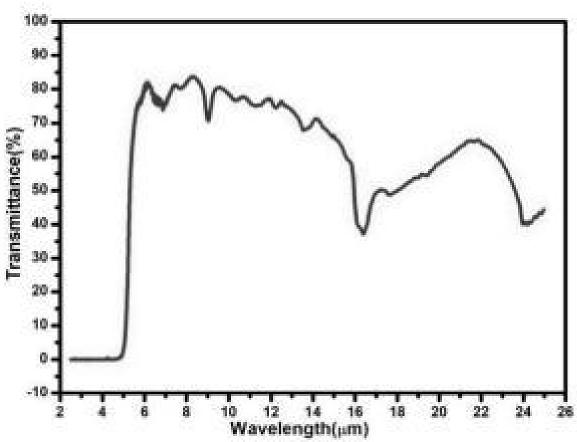
Parameter	Symbol	Min	Typ	Max	Unit	Remark
Supply voltage	VDD	-0.3		4.2	V	
Digital output voltage		-0.3		VDDIO+0.3	V	
ESD protection	HBM		±2		kV	
Storage humidity				40%	RH	
Storage temperature		-40		100	℃	

2.Performance parameters

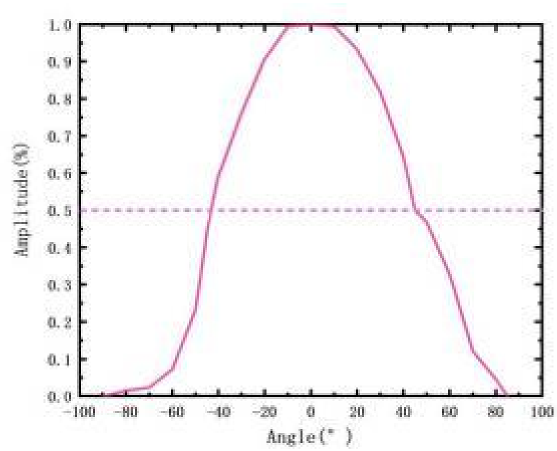
List 2. Sensor performance parameters

Parameter	Symbol	Min	Typ	Max	Unit	Remark
Chip size			1. 12×1. 12		mm^2	
Sensitive areas			0.7 ×0.7		mm^2	
Field of view			60~90		°	
Operating temperature			-30 ~ 90		℃	
Supply voltage		2.3	3.3	3.6	V	
Typical application mode operating current	Iavdd		733	800	μA	default setting
	Isleep		5		μA	
Standby current (25℃)		100			nA	
ADC resolution			24		Bit	
Temperature measurement range		0		150	℃	Application of measuring object temperature
		28		42		Temperature measurement application
Temperature measurement accuracy			±2（To≤100℃) ±3% swot (To>100℃)		℃	Material temperature application
			±0.3			Body temperature application

The conditions unless otherwise specified are VCC = 3.3V, test environment temperature 25 °C, PGA gain 64x.



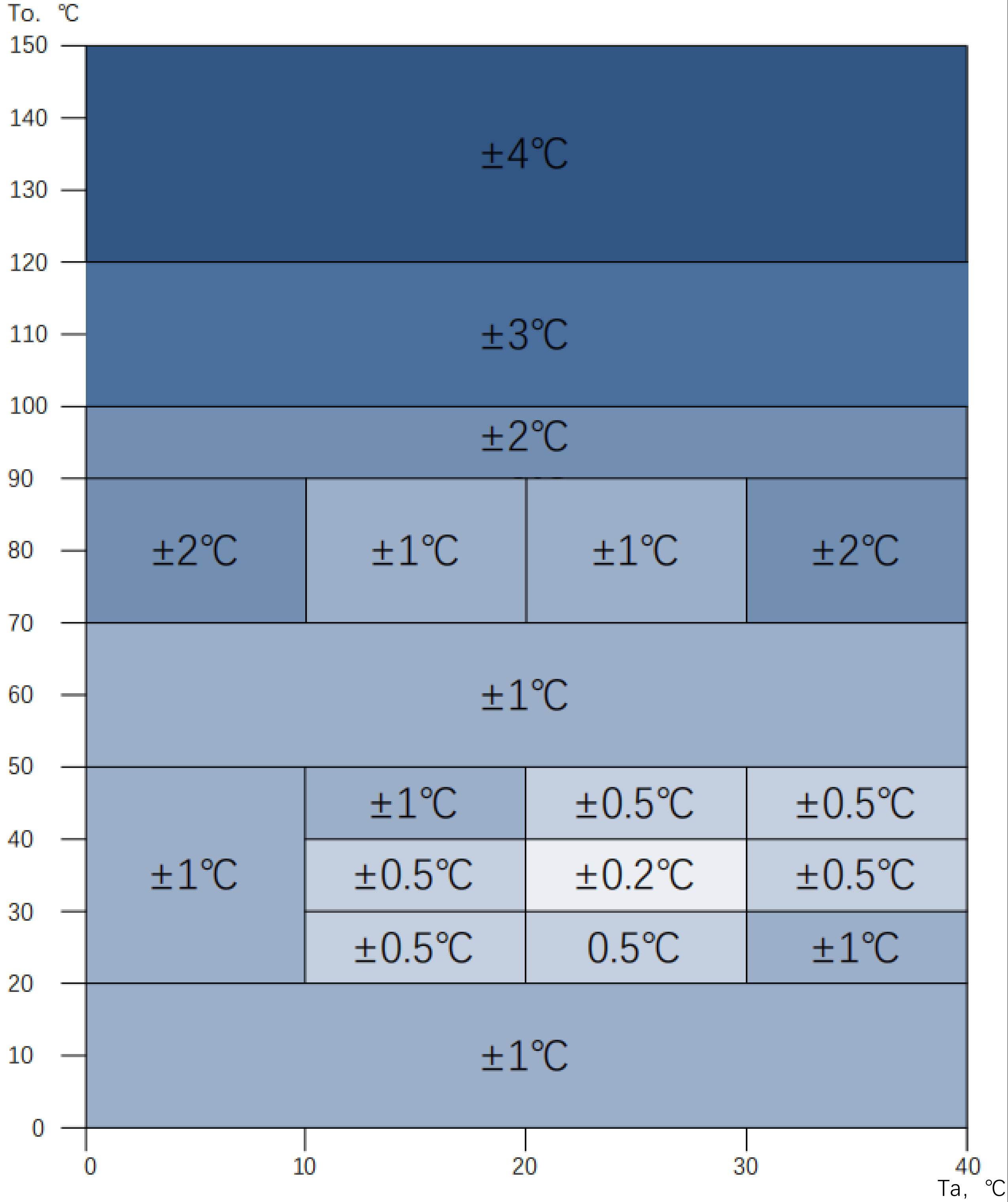
Picture 1. Transmission spectrum of the filter



Picture 2. Sensor field of view

SL-W-TRS-5.5D Standard temperature accuracy index

All accuracy specifications are measured under stable isothermal conditions and with the object under test completely covering the sensor's FOV. The accuracy is shown in the following graph for Ta between 0°C and 40 °C and To between 0°C and 150°C.

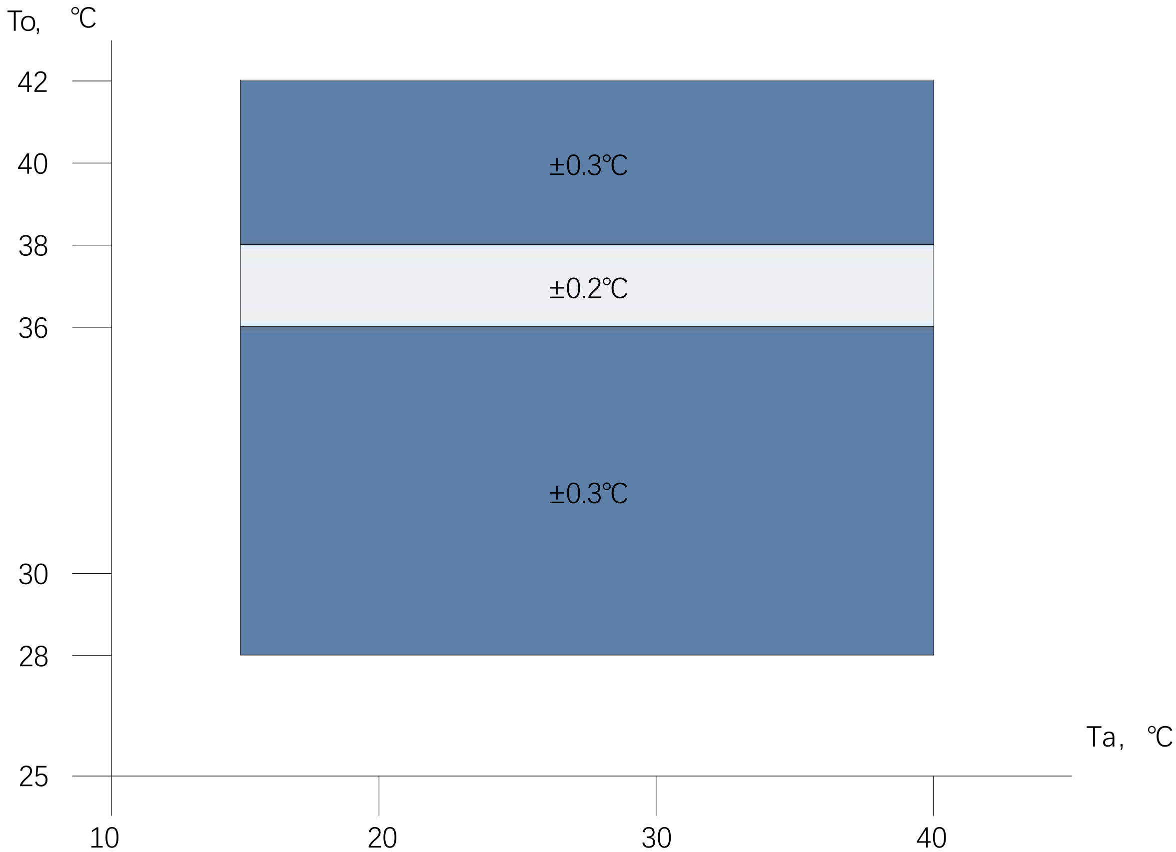


All data are tested under typical conditions: voltage is 3.3V, the distance between the sensor and the target is 2cm, the temperature measurement target is a standard black body furnace, and the corresponding ambient temperature is achieved by changing the temperature of the environmental chamber. All accuracy specifications are only applicable under stable isothermal conditions, and the sensor accuracy does not represent the final product accuracy.

Picture 3. SL- W-TRS-5.5D（Ta,To）standard accuracy

SL-W -TRS-5.5D Medical temperature accuracy indicators

All accuracy specifications are measured under stable isothermal conditions and with the object under test completely covering the sensor's FOV.
When Ta is between 15°C and 40°C and To is between 28°C and 42°C, the accuracy is shown in the following graph.



All data are tested under typical conditions: voltage is 3.3V, the distance between the sensor and the target is 2cm, the temperature measurement target is a standard black body furnace, and the corresponding ambient temperature is achieved by changing the temperature of the environmental chamber.
All accuracy specifications are only applicable under stable isothermal conditions, and the sensor accuracy does not represent the final product accuracy.

Picture 4. SL-W-TRS-5.5D（Ta,To）medical precision

In application design, it is important to understand that the accuracy given in Figures 3 and 4 is only guaranteed under thermal equilibrium conditions and isothermal conditions (no temperature difference on the sensor package). If there is a temperature difference on the sensor package, the measured accuracy will be affected. Conditions that can cause temperature differences in the sensor package, such as hotter (or colder) components on the bottom or side of the sensor, or the sensor is very close to the object being measured, which will locally heat the sensor.

3.General registers

List 3. general registers

Address	Description	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default
0x00	Soft Reset	W			SOFTRE SET			SOFTR ESET			0x00
0x02	Data_ready	R					Temp_rd y		To_drd y	Ta_drd y	0x00
0x03	Data_ready	R			To_raw_ drdy	Ta_raw_d r dy					0x00
0x10	Object temp out Tobj after DSP and IIR filter	R	data1_out<23:16>								0x00
0x11		R	data1_out<15:8>								0x00
0x12		R	data1_out<7:0>								0x00
0x16	Ambient temp out (internal temperature sensor) Ta datal after calibration	R	temp_value<23:16>								0x00
0x17		R	temp_value <15:8>								0x00
0x18		R	temp_value <7:0>								0x00
0x22	To raw data before calibration	R	data_raw_out<23:16>								0x00
0x23		R	data_raw_out<15:8>								0x00
0x24		R	data_raw_out<7:0>								0x00
0x30	CMD	RW			sleep_en	clk_mode	mode_en	mode_sel<2:0>			0x00

Reg0x00
Soft_reset: 1 : Reset the general register. After the reset is completed, this bit automatically returns to 0.
Reg0x02
Temp_rdy: 1, Tobj The data is ready after being processed by DSP algorithm.
To_drdy: 1, To voltage value after calibrated data is ready.
Ta_drdy: 1, The data after calibration of ambient temperature (internal temperature sensor) is ready.
Reg0x03
To_raw_drdy: 1, To raw data are prepared before calibration.
Ta_raw_drdy: 1, Prepare raw data before calibrating the ambient temperature (internal temperature sensor).
Reg0x10-Reg0x12
Data_out: The target temperature is output after being processed by the DSP algorithm and the output is a 2's complement code. DATA1/2^14 （℃）
Data_MSB<23:16> = 0x10<7:0>, Data_ CSB<15:8> = 0x11<7:0>, Data_ LSB<7:0> = 0x12<7:0>.
Reg0x16-Reg0x18
Temp_Value: The data of external ambient temperature (internal temperature sensor) after calibration is output as 2's complement code. TEMP/2^14 （℃）
Temp_MSB<23:16> = 0x16<7:0>, Temp_ CSB<15:8> = 0x17<7:0>, Temp_ LSB<7:0> = 0x18<7:0>.
Reg0x22-Reg0x24
Data_raw_out: To The original data of voltage value before calibration is output as 2's complement code.
Data_Raw_MSB<23:16> = 0x22<7:0>, Data_Raw_CSB<15:8> = 0x23<7:0>, Data_Raw_LSB<7:0> = 0x24<7:0>.
Reg0x30
Sleep_en: 1, Enter sleep mode; 0, Quit sleep mode.
Clk_mode: 1, 600KHz; 0, 1.2MHz
Mode_en: 1, start FSM;
Mode_sel<2:0>: 000/001: continuous conversion (Ta-To);

4.EEPROM register

List 4. EEPROM register

Address	Description	R/ W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	
0x92	Chip_Address	RW		Chip_Address<6:0>							
0x93	Sys_config	RW	FILT_COEF<2:0>			output_mode<1:0>		OSR_T<2:0>			
0x94	Sys_config	RW	adc_dith er en	SERIAL_f ilter_en					VT_scale		
0x95	Sensor_Config	RW			Gain_P<2:0>			OSR_P<2:0>			

Reg0x92
Chip_Address<6:0>: The I^2C address can be configured; the wildcard 7-bit address of I^2C is always 0x7F.
Reg0x93
FILT_COEF<2:0>: IIR filter coefficients. 000 disables the IIR filter; 001 suppresses 17% of the signal; 010 suppresses 25% of the signal; 011 suppresses 50% of the signal; 100 suppresses 63% of the signal; 101 suppresses 75% of the signal; 110 suppresses 88% of the signal; 111 suppresses 94% of the signal.

output_mode <1:0> ： 00: I2C **，** 01: PWM. 10: Relay, 11: I2C. EEPROM load and latch.
Changes to this value will only take effect when the value is programmed into the EEPROM and then the chip is reset.
OSR_T<1:0>: For ambient temperature measurement OSR.
000:512X， 011:1024X， 010:2048X， 011:4096X， 100:128X， 101:256X， 110:110:8192X， 11:16384X。
Reg0x94
adc_dither_en: 1, Enable ADC internal dithering.
SERIAL_filter_en: 1, Enables the I^2C input de-noising filter.
VT_SCALE: 1 'b0:±16 mv;1 'b1:±128 mv
Reg0x95
Gain_P<2:0>: Set the gain of the sensor signal acquisition channel. 000: gain=8 , 001: gain=12 , 010: gain=16, 011: gain=32 , 100: gain=48 , 101: gain=64 , 110: gain=96 , 111: gain=128.
OSR_P<2:0>: Set the oversampling rate of the sensor signal acquisition channel.000:512X, 011:1024X, 010:2048X ，011:4096X, 100:128X, 101:256X, 110:110:8192X, 111:16384X。
Reg0x97
RES_DAC<3:0>: 4'b1101 5/16*AVDD recommended value

5.Digital communications

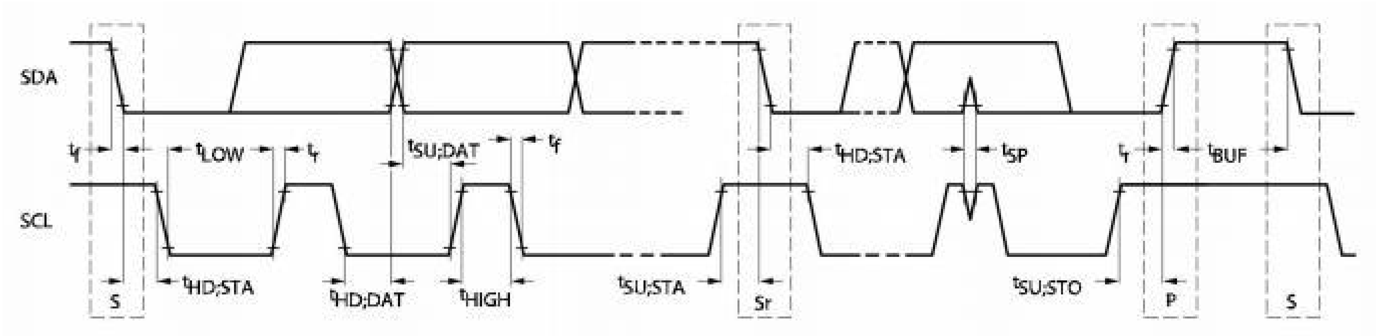
This digital device provides the I²C communication protocol for serial communication. The choice of communication protocol is based on the CSB state.
The I²C bus uses SCL and SDA as signal lines, both of which are externally connected to VDDIO through pull-up
resistors so that they remain high when the bus is idle. The I²C device address of the digital device can be configured through the Chip_Address register 0x92.
There is also a wildcard 7-bit address of 0x7F for the I²C bus,as shown in the following table.

List 5. I²C device wildcard address

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	W/R
1	1	1	1	1	1	1	0/1

List 6. I²C Bus Device SDA and SCL Bus Line Characteristics

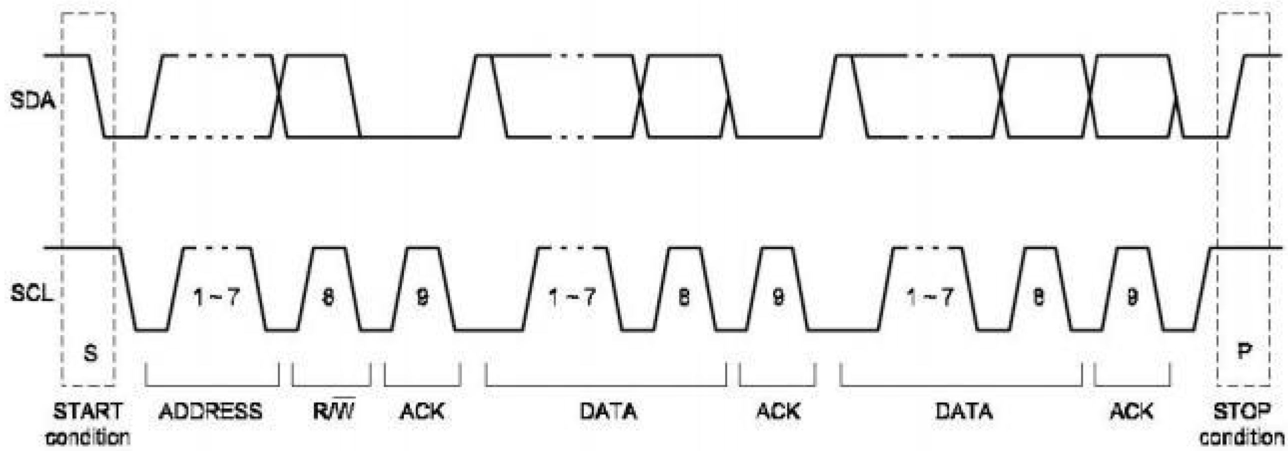
Symbol	Parameter	Min	Max	Unit
f_{SCL}	SCL Clock frequency		400	kHz
t_{LOW}	SCL The low period of the clock	1.3		μs
t_{HIGH}	SCL High period of the clock	0.6		μs
$t_{SU;DAT}$	SDA Build time	100		ns
$t_{HD;DAT}$	SDA Keep time	0.0		μs
$t_{SU;STA}$	Setup time for repeated start condition	0.6		μs
$t_{HD;STA}$	Start condition hold time	0.6		μs
$t_{SU;STO}$	Stop condition setup time	0.6		μs
t_{BUF}	The interval between two communications	1.3		μs
tr	Rise time of SDA and SCL signals		300	ns
tf	Fall time of SDA and SCL signals		300	ns



Picture 5. I²C Timing diagram

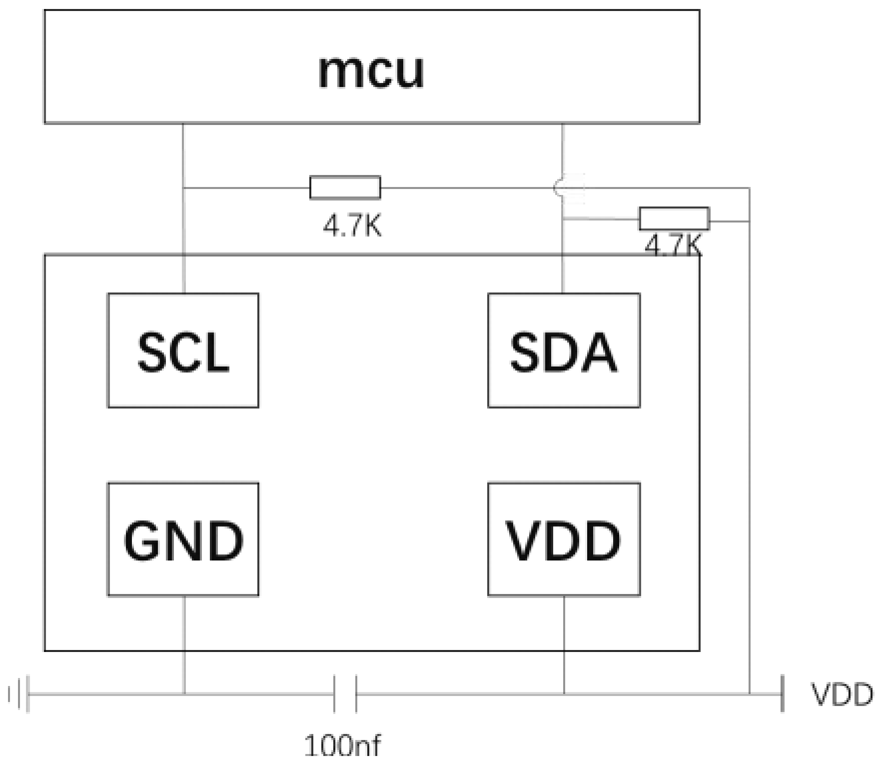
The I²C communication protocol has special bus signal conditions. The start (S) condition, stop (P) condition and binary data condition are shown in the figure below.

When SCL is at a high level and SDA is at a falling edge, it marks the start of I2C data communication. The I2C master device sends the address of the slave device (7 bits) in sequence, followed by the direction control bit R/W to select the read/write operation. When the slave device recognizes this address, it generates an acknowledge signal and pulls SDA low in the ninth SCL (ACK) cycle.
SCL is at a high level and SDA is at a rising edge, marking the end of I2C data communication. When SCL is high, the data transmitted by SDA must remain stable. The value transmitted by SDA can only be changed when SCL is low.



Picture 6. I^2C Communication protocol

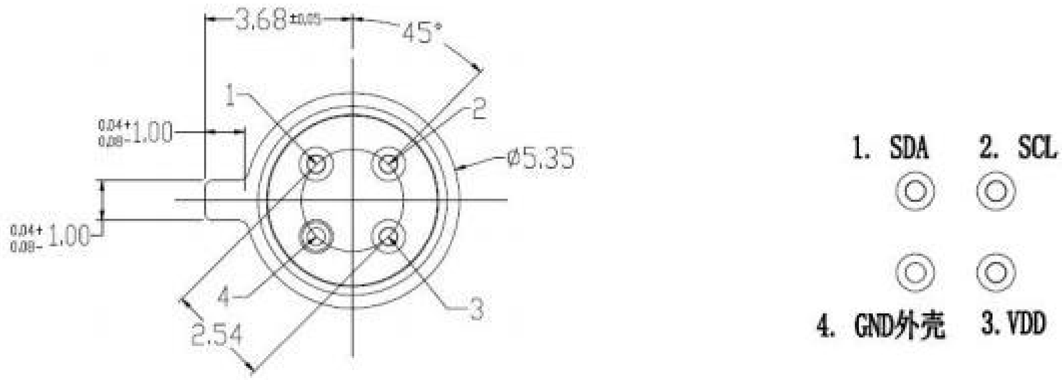
6.General application circuit



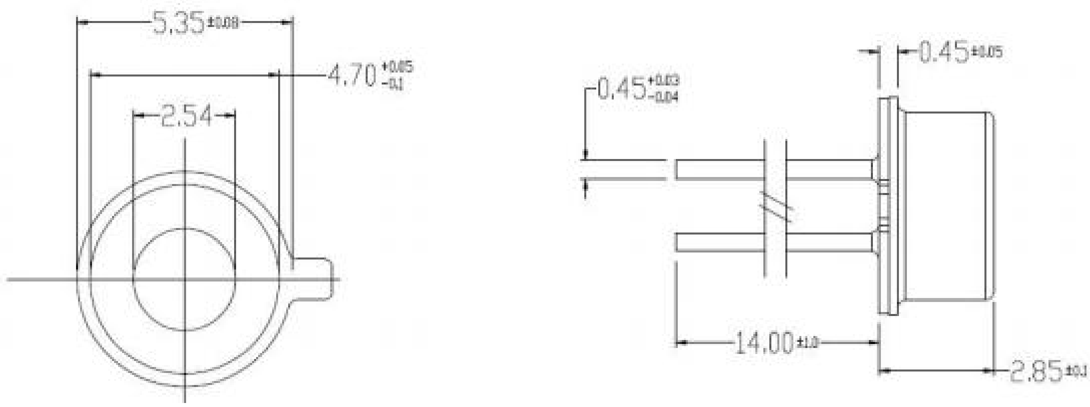
Picture 7. General application circuit

7.Mechanical specifications

1.Definition and size of base pins



Picture 8. Base bottom view

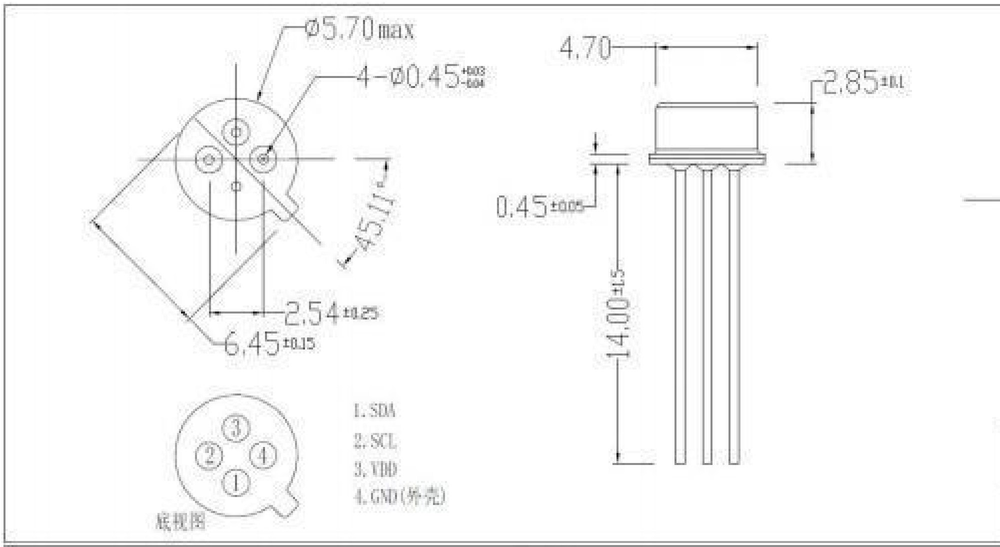


Picture 9. Base body dimensions

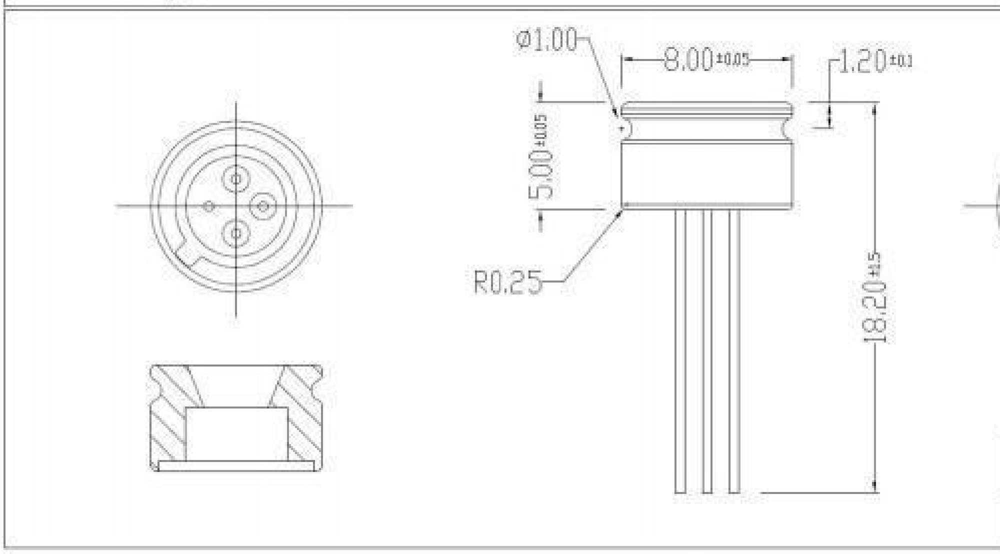
List 7. Pin definition

Serial number	Symbol	Definition
1	SDA	Serial data input/output (I^2C Data)
2	SCL	Serial clock input(I^2C Clock)
3	VDD	Core chip power supply (Supply Voltage)
4	GND	GROUND(Ground)

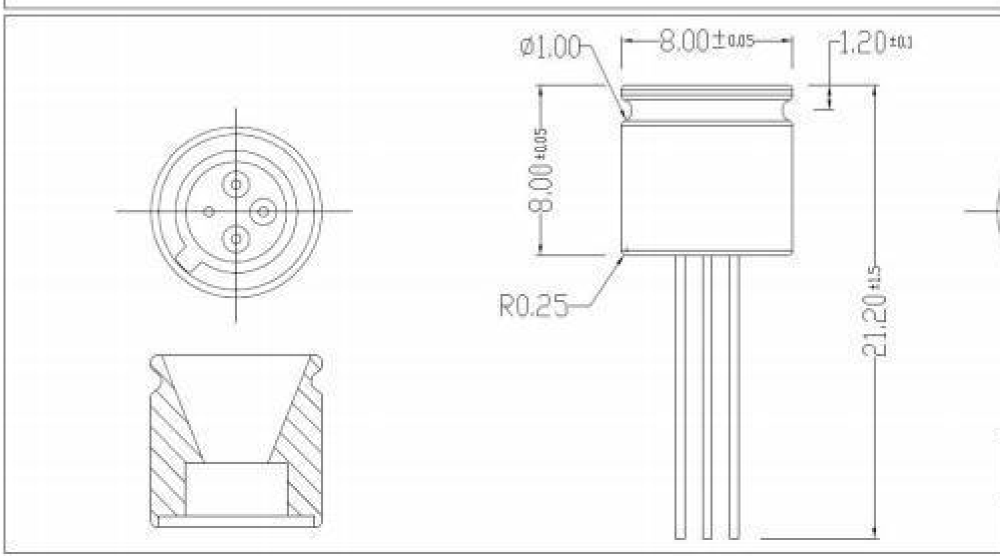
2. Dimensions



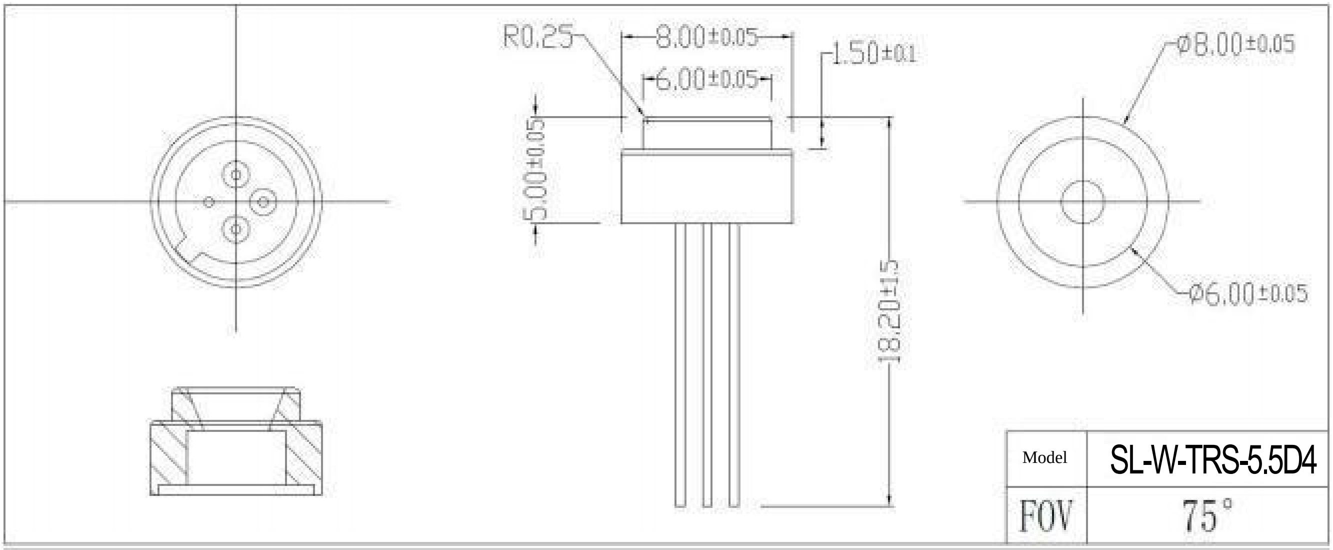
Model	SL-W-TRS-5.5D1
FOV	90°



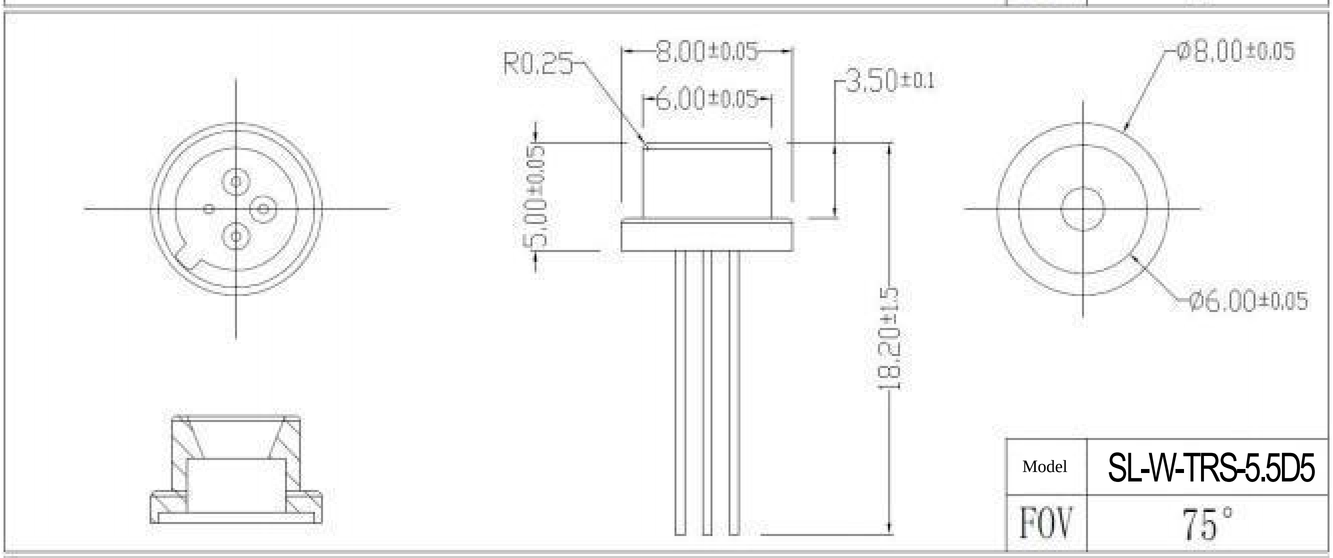
Model	SL-W-TRS-5.5D2
FOV	75°



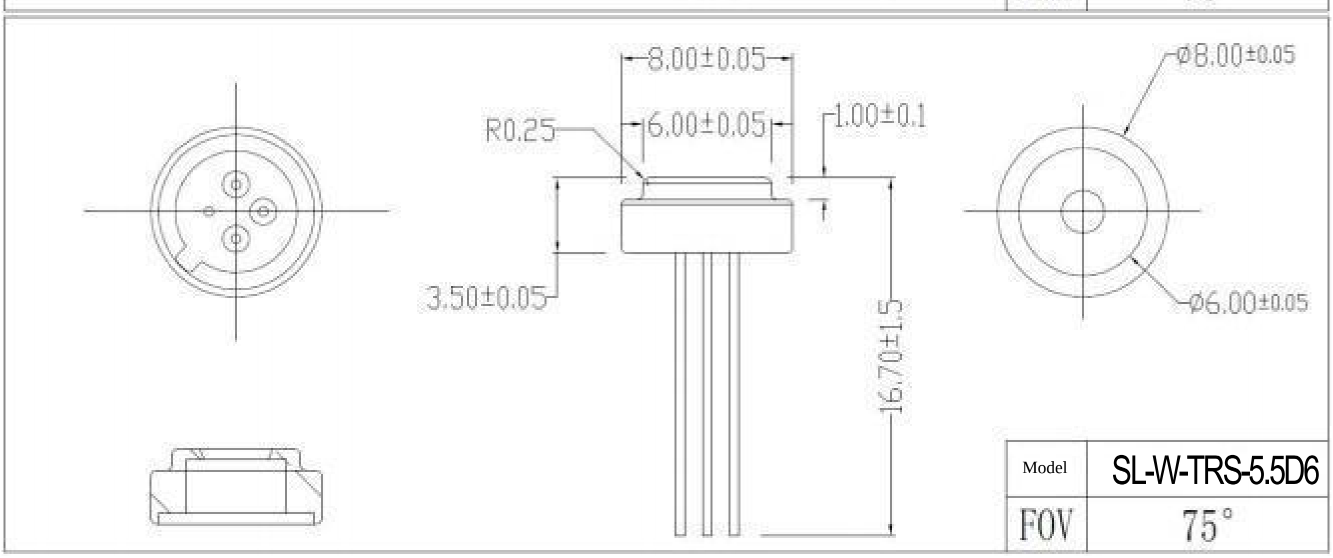
Model	SL-W-TRS-5.5D3
FOV	60°



Model	SL-W-TRS-5.5D4
FOV	75°

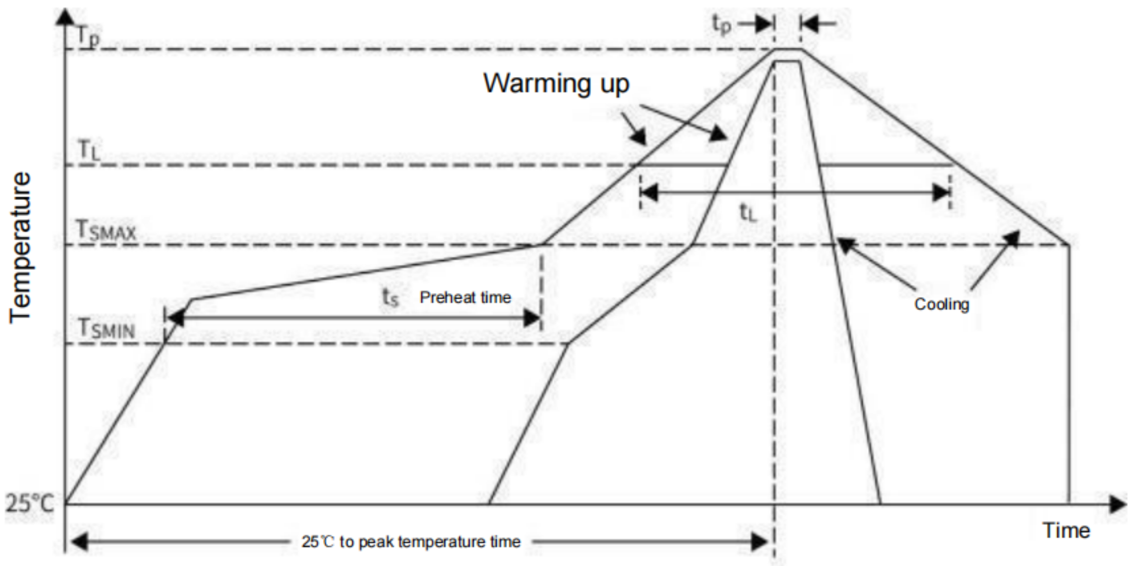


Model	SL-W-TRS-5.5D5
FOV	75°



Model	SL-W-TRS-5.5D6
FOV	75°

8.Recommended reflow profile



Picture 10. Recommended lead-free solder reflow temperature profile distribution diagram

List 8. Recommended lead-free solder reflow temperature curve distribution parameter table

Curve characteristics		Lead free
Average heating rate（T_{SMAX} to T_P)		Maximum 3℃/s
Preheat	Minimum temperature (T_{SMIN})	150℃
	Maximum temperature (T_{SMAX})	200℃
	Time(T_{SMIN} to T_{SMAX})(t_S)	60-180 s
Time to reach above temperature	Temperature (T_L)	217℃
	Time (t_L)	60-150 s
Peak temperature(T_P)		260℃
Time within 5℃ of the peak temperature		20-40 s
Average cooling rate (T_P to T_{SMAX})		Maximum 6℃/s
Time from 25℃ to peak temperature		Longest 8 min

Note: After reflow soldering, it is recommended to place it flat and let it stand for 5 minutes before moving the PCBA otherwise the sensor cap may fall off.

9.Other suggestions

1. Pressure and electrostatic discharge exceeding the absolute maximum rating may damage the sensor. Please take appropriate handling precautions. Do not allow the sensor to contact corrosive cleaners. The optical window can be cleaned with alcohol and cotton swabs.
2. The sensor should be stored in a well-sealed environment and pay attention to moisture, humidity, shock, dust, and anti-static.
3. Before applying our products to some special situations (i.e. improper operation will directly affect the life of the semiconductor or cause physical damage),
you should consult our company and representatives in advance.
Our company will not assume any responsibility for unauthorized operations.