

XGZT2613 Thermopile Sensor (I2C)

● Product brief

XGZT2613 is a high-precision digital infrared thermopile products used for a variety of non-contact temperature measurement Application in medical&healthcare、 consumer electronics、 Industrial etc,. The sensor include MEMS thermopile sensor chip、 NTC thermistor and specialized signal conditioning ASIC chip. The ASIC chip is equipped with 24 bits Sigma-Delta high precision ADC, low noise instrument amplifier PGA and interface circuit.



● Product features:

- Standard I²C interface
- High-precision digital temperature measuring sensor
- Temperature calibrated, easy to implement
- Direct temperature measurement without peripheral circuits
- MEMS thermopile technology
- High response rate, and a fast response time
- A 5.5 μ m long-pass filter
- TO-46 metal tube shell package

● Applied range:

- Intelligent wearable devices
- Intelligent household electrical appliance
- Industrial temperature monitoring
- Non-contact human surfaces temperature measurement
- Intelligent temperature sensing and control

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1. Absolute Maximum Rating Value

Table 1. Absolute maximum rating value

Parameter	Symbol	Min.value	Typical value	Max.value	Unit	Remarks
Supply voltage	V DD	-0.3		4.2	V	
Digital output voltage		-0.3		VDDIO+0.3	V	
ESD protect	H BM		±2		k V	
Store humidity				40%	RH	
Storage temperature		-40		100	°C	

2. Performance Parameters

Table 2. Sensor performance parameters

Parameter	Symbol	Min.value	Typical value	Max.value	Unit	Remarks
Chip size			1.12×1.12		mm ²	
Sensitive area			0.7 ×0.7		mm ²	
Angle of field			60~90		°	
Working temperature			-30 ~ 90		°C	
Supply voltage		2.3	3.3	3.6	V	
Operating current(Typ. application mode)	I avdd		733	800	μA	Default configuration
	I sleep		5		μA	
Standby current (25°C)		100			nA	
ADC resolution ratio			24		Bit	
Temperature measurement range		0		150	°C	Object Temp. application
		28		42		Human body Temp. application
Temperature measurement accuracy			±2(To ≤100°C) ± 3% reading (To> 100°C)		°C	Object Temp. application
			±0.3			Human body Temp. application

VCC = 3.3 V without specified conditions, ambient temperature 25°C, and PGA gain 64x.

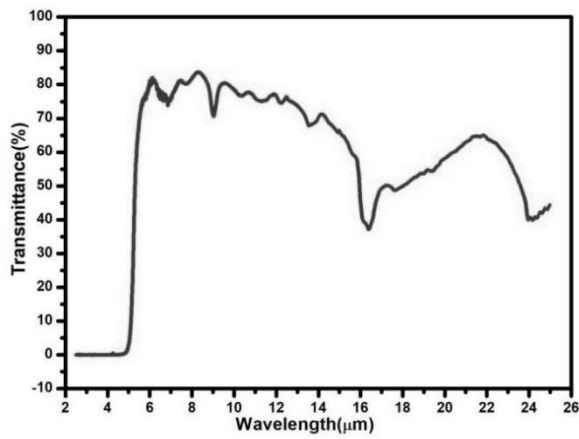


Figure 1. The transmission spectrum of the filter

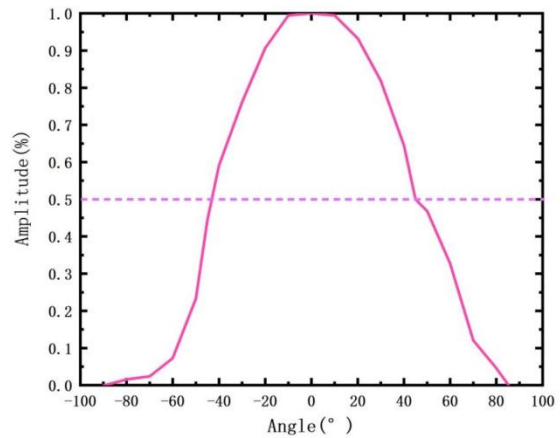
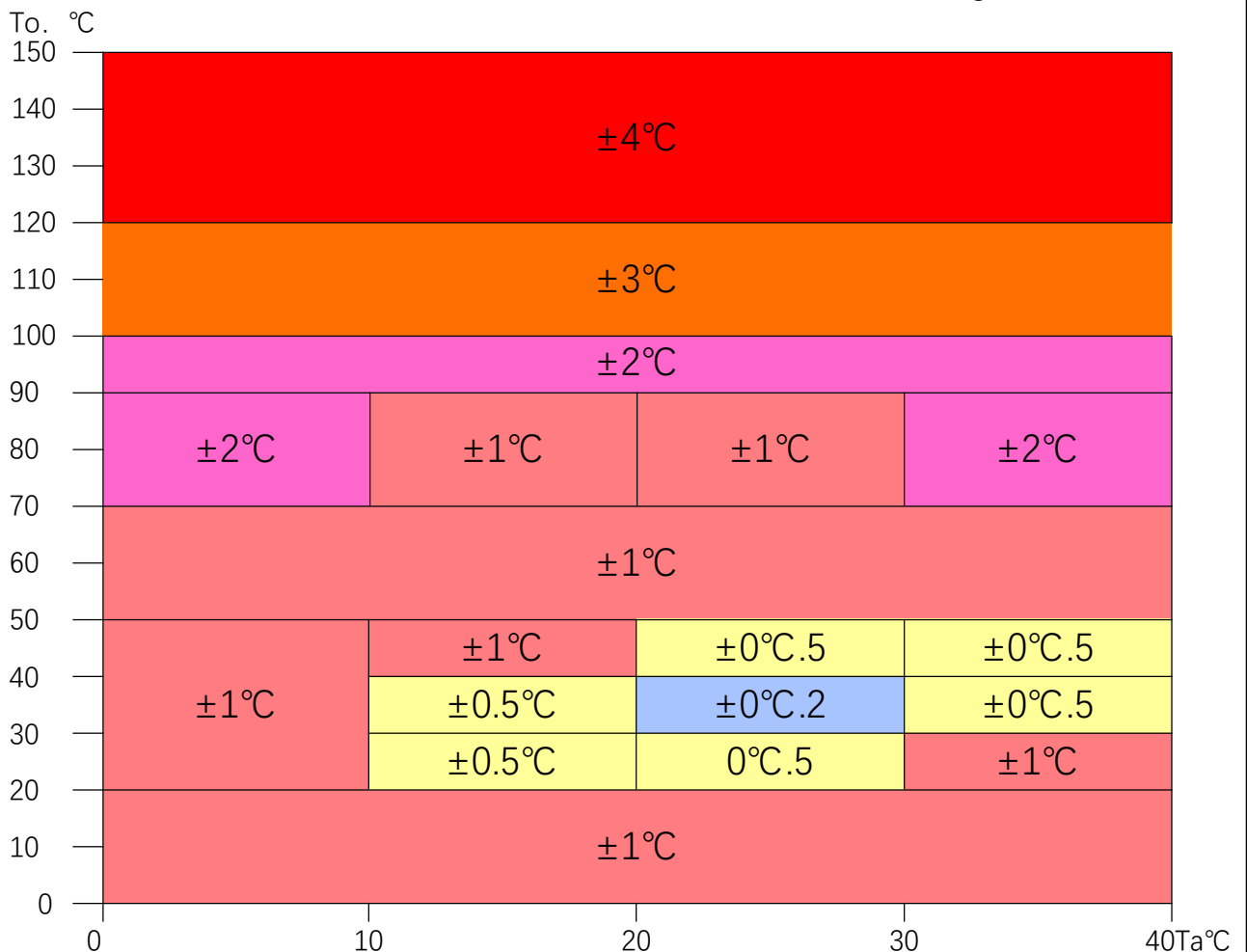


Figure 2. Field of view angle of the sensor

XGZT2613 Standard temperature accuracy index

All accuracy specifications were measured under stable isothermal and complete FOV conditions. T_a between 0°C and 40°C and T_o between 0°C and 150°C is shown in the following chart.

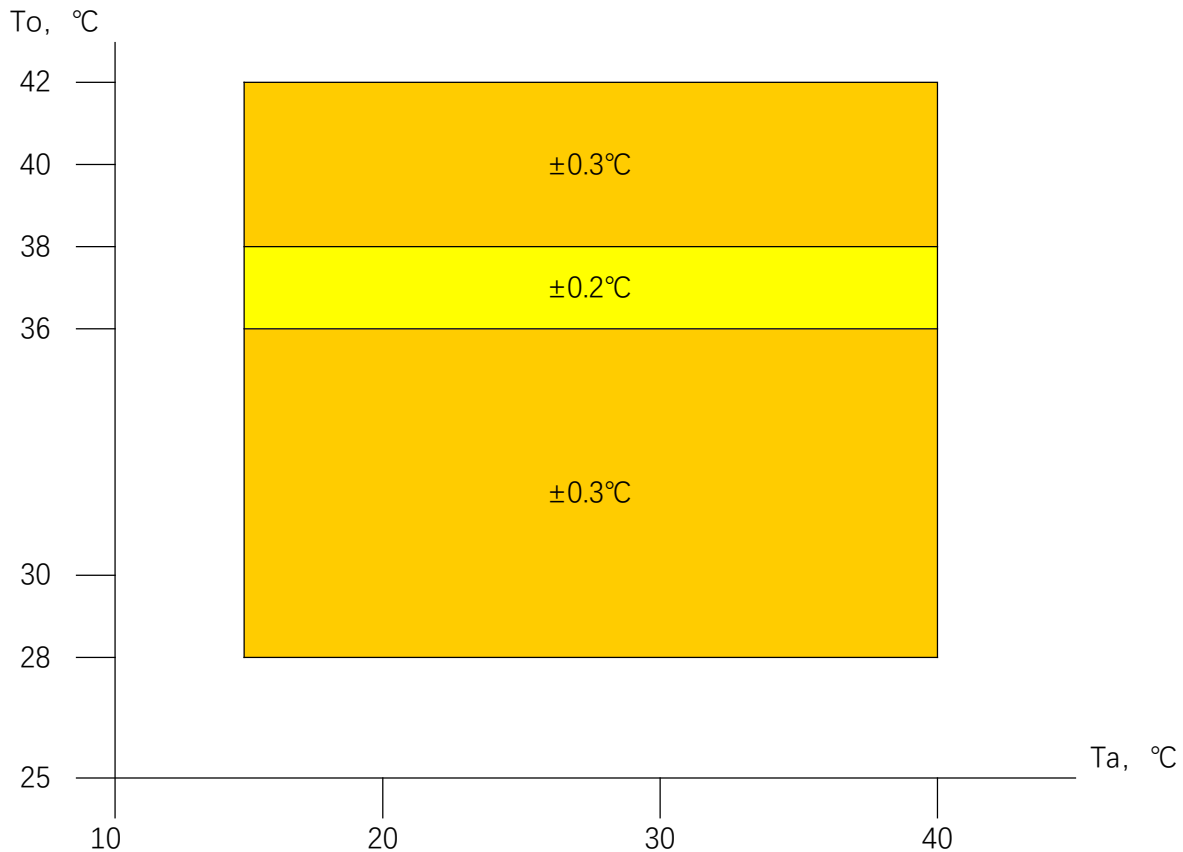


All the data are tested under typical conditions: the voltage is 3.3V, the distance between the sensor and the measured target is 2cm, the temperature target is standard black body furnace, and the corresponding ambient temperature is realized by changing the temperature of the ambient box. All precision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

Figure 3. Standard accuracy of the XGZT2613 (T_a , T_o)

XGZT2613 Medical temperature accuracy index

All accuracy specifications were measured under stable isothermal and complete FOV conditions T_a between 0°C and 40°C and T_o between 0°C and 150°C is shown in the following chart.



All the data are tested under typical conditions: the voltage is 3.3V, the distance between the sensor and the measured target is 2cm, the temperature target is standard black body furnace, and the corresponding ambient temperature is realized by changing the temperature of the ambient box.

All precision specifications are only applicable to stable isothermal conditions, and the sensor accuracy does not represent the final product accuracy.

Figure 4. Medical accuracy of XGZT2613 (T_a , T_o)

In the application design, the key is to understand that the accuracy given in FIGS. 3 and 4 only ensures that the sensor has this accuracy under thermal equilibrium conditions (there is no temperature difference on the sensor package). If there is a temperature difference on the sensor package, the measurement accuracy will be affected. Can cause the sensor packaging temperature difference, such as the hot (or cold) components on the bottom or side of the sensor, or the sensor is very close to the measured object, the measured object will locally heat the sensor.

3. Universal Register

Table 3. Universal registers

ADD	Description	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default
0x00	Soft Reset	W			SOFTRESET			SOFTRESET			0x00
0x02	Data_ready	R					Temp_rdy		To_drdy	Ta_drdy	0x00
0x03	Data_ready	R			To_raw_drdy	Ta_raw_drdy					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 data 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 common register, which automatically recovers to 0.

Reg0x02

Temp _ rdy: 1, the data preparation for Tobj after the DSP algorithm.

To _ drdy: 1, the data of To voltage values are ready.

Ta _ drdy: 1, data ready after ambient temperature (internal temperature sensor) calibration.

Reg0x03

To _ raw _ drdy: 1, To raw data was prepared prior to calibration.

Ta _ raw _ drdy: 1, the raw data is prepared before the calibration of the ambient temperature (internal temperature sensor).

Reg0x10-Reg0x12

Data_out: target temperature, output after DSP algorithm processing, output is 2 decimal complement. $DATA1/2^{14}$ (°C)

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: calibrated external ambient temperature (internal temperature sensor) data with an output of 2 decimal complement. $TEMP/2^{14}$ (°C)

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: the raw data of the To voltage value before calibration, the output is 2 decimal complement.

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, and exit 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

Table 4. EEPROM register

ADD	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_dither_en	SERIAL_filter_en					VT_scale		
0x95	Sensor_Config	RW			Gain_P<2:0>			OSR_P<2:0>			
0x97	BPS_Config	RW					RES_DAC<3:0>				

Reg0x92

Chip _ Address <6:0>: I can be configured²Address of C; I²The common 7-bit address of C is always 0x7F.

Reg0x93

FILT _ COEF <2:0>: IIR filter coefficient.

000 Disable IIR filter; 001 suppress 17% signal; 010 inhibit 25% signal;

01150% of signal; 10063%; 10175% of signal;

110 inhibited 88% of the signal; 111 inhibited 94% of the signal.

output_mode <1:0> : 00: I²C , 01: PWM , 10: Relay , 11: I²C 。 EEPROM Latch after loading.

Changes to that value will only take effect if the value is programmed to EEPROM and then reset the chip.

OSR _ T <1:0>: The OSR used for ambient temperature measurements.

000:512X , 011:1024X , 010:2048X , 011:4096X , 100:128X , 101:256X , 110:110:8192X , 11:16384X 。

Reg0x94

The adc _ dither _ en: 1, enabling the internal ADC jitter.

SERIAL_filter_en: 1, enabling I²C The input de-noise 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 over-sampling 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 Communication

The digital device provides an used for serial communication I²C protocol. The communication protocol is selected based on the CSB status.

I²C bus uses SCL and SDA as signal lines and both lines are externally connected to VDDIO, via the pull-up resistance, to maintain at high level when the bus is idle. The I²C of the digital device address can be configured by Chip _ Address of register 0x92, The universal distribution 7-bit address of I²C is 0x7F, as shown in the table below.

Table 5. I²C Device distribution address

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	W/R
1	1	1	1	1	1	1	0/1

Table 6. I²C Bus line characteristics of SDA and SCL

symbol	parameter	least value	crest value	unit
f_{SCL}	The SCL clock frequency		400	k H z
t_{LOW}	Low-level cycle of the SCL clock	1.3		μ s
t_{HIGH}	High-level cycle of the SCL clock	0.6		μ s
$t_{SU;DAT}$	The SDA establishment time	100		n s
$t_{HD;DAT}$	SDA hold time	0.0		μ s
$t_{SU;STA}$	Establishment time of the repeat start conditions	0.6		μ s
$t_{HD;STA}$	Starting condition holding time	0.6		μ s
$t_{SU;STO}$	Stop the condition for the establishment time	0.6		μ s
t_{BUF}	The interval between the two communications	1.3		μ s
t_r	Time of rise of the SDA and SCL signals		300	ns
t_f	Time of decline in SDA and SCL signals		300	ns

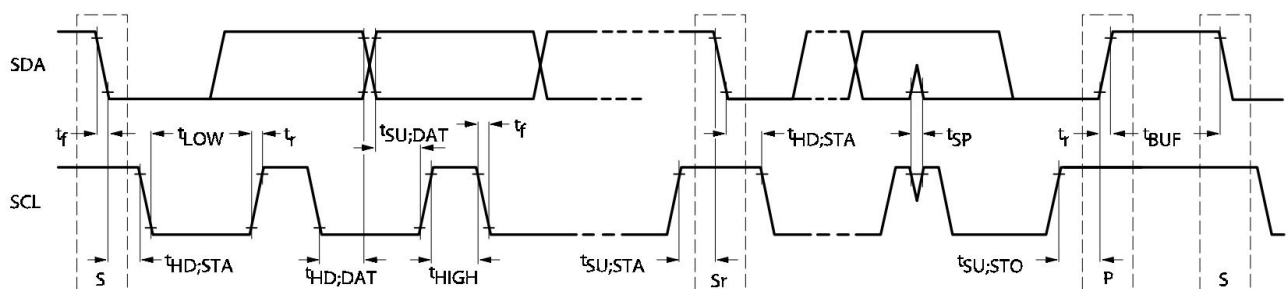


Figure 5. I²C sequence chart

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

When the SCL is at the high level and the SDA is at the descending edge, mark I²C Data communication begins. I²C The main device sends the address from the device (7 bits) successively, and then selects the read / write operation to the control bit R / W. When this address is identified from the device, a response signal is generated and the SDA is pulled down at the ninth SCL (ACK) cycle.

SCL is at high level and SDA is at rising edge, marking I²C End of data communication. Data transmitted by the SDA must remain stable when the SCL is high. The value of the SDA transmission can only be changed if the SCL is low.

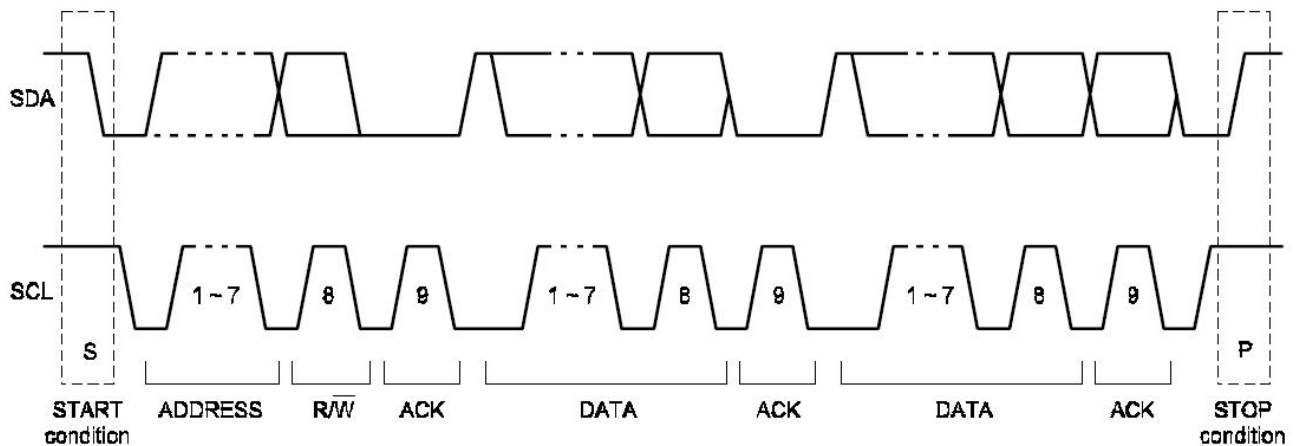


Figure 6. I²C protocol

6. General Application Circuit

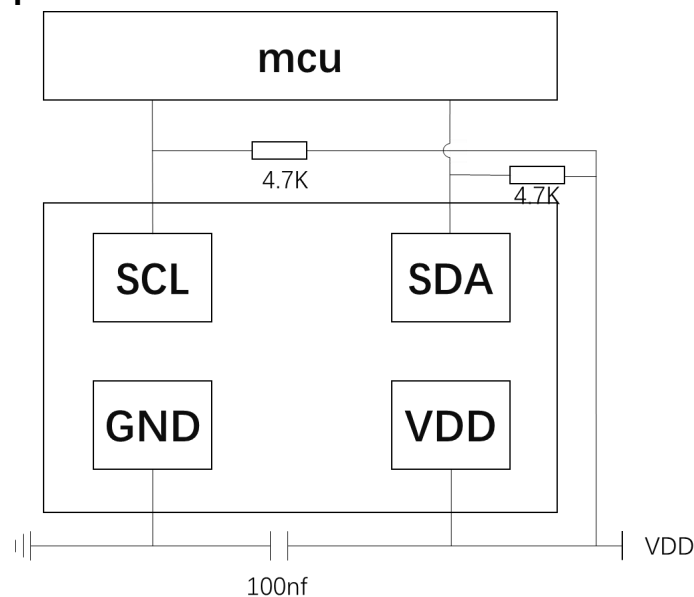


Figure 7. General application circuit

7. Mechanical specifications

1. Definition and Specification

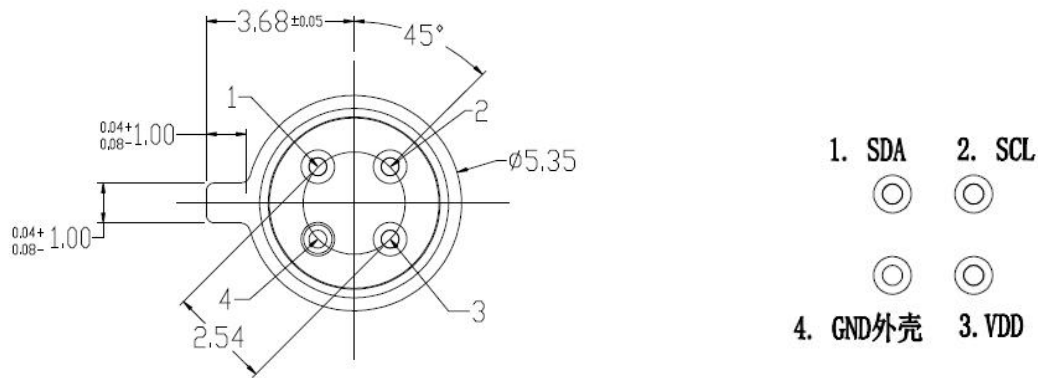


Figure 8. Basal base view

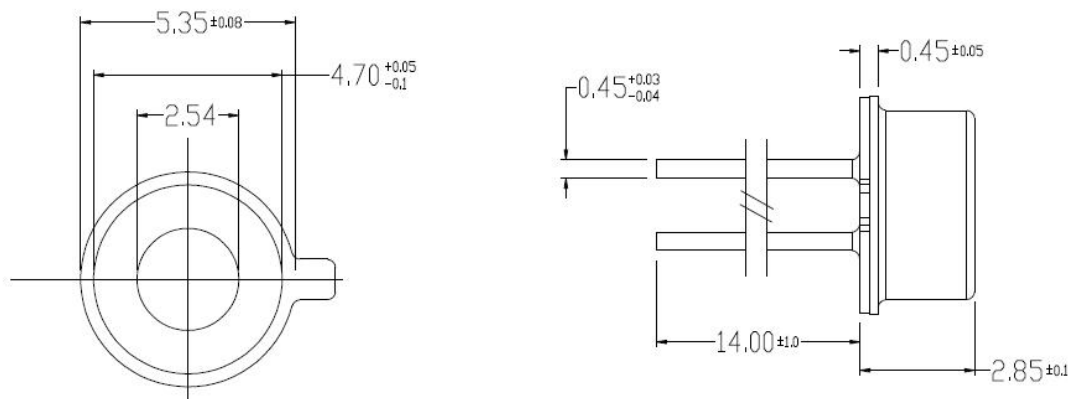
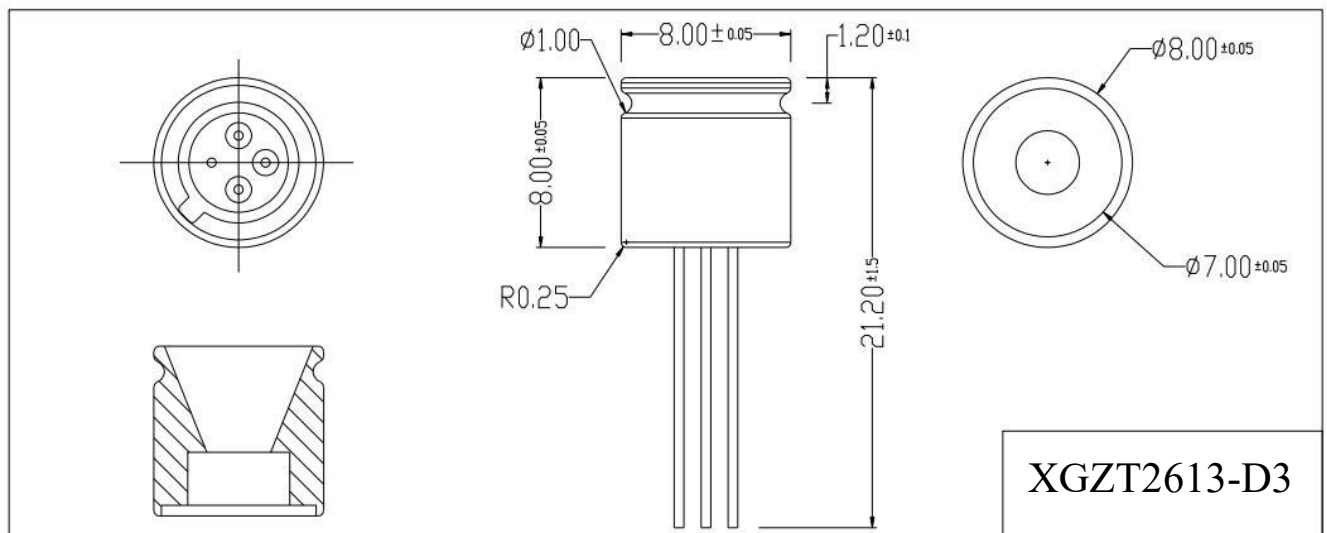
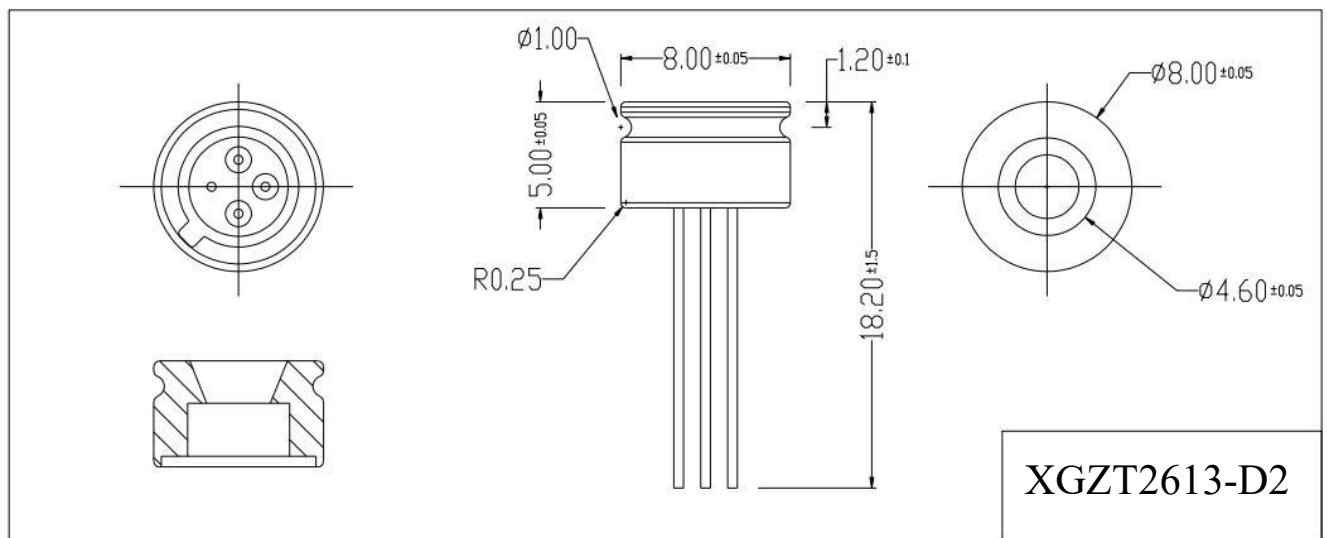
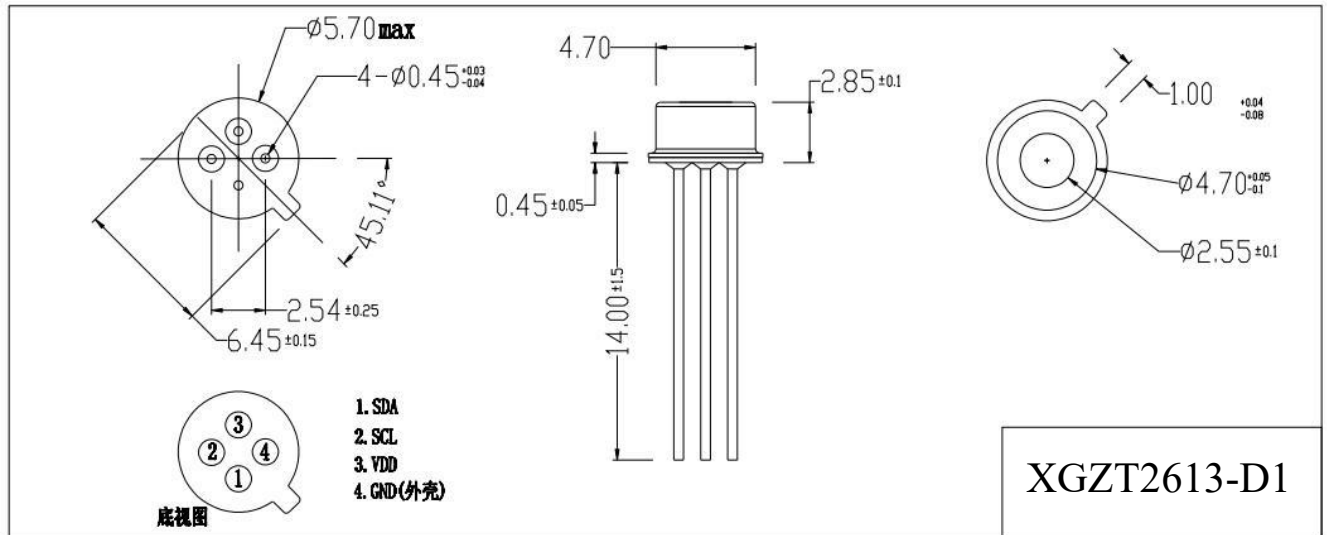


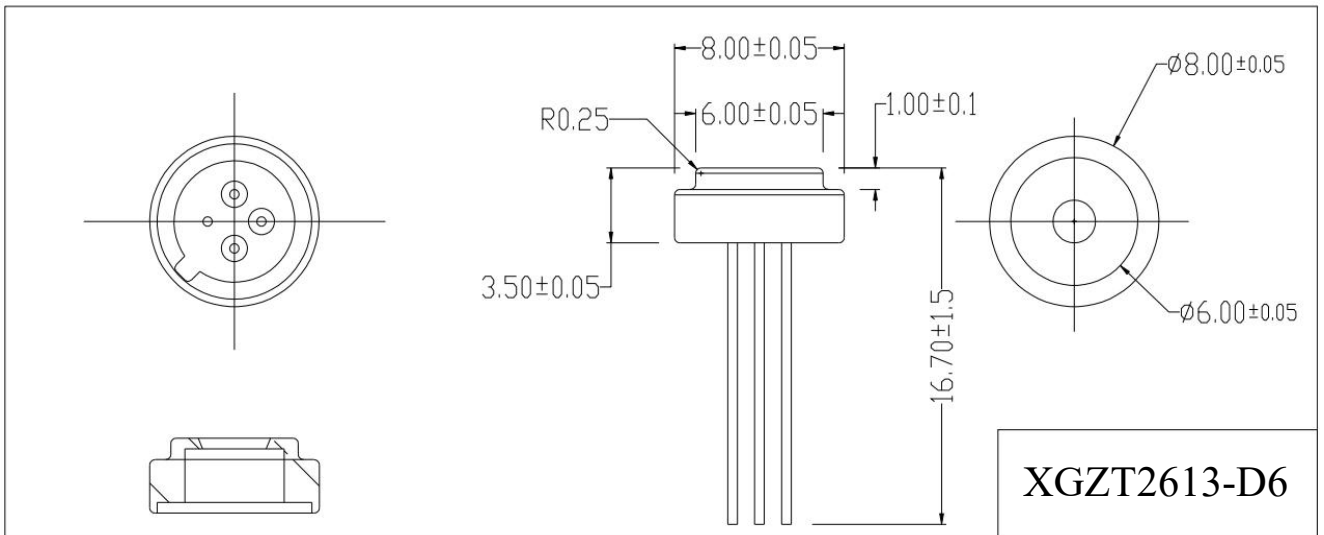
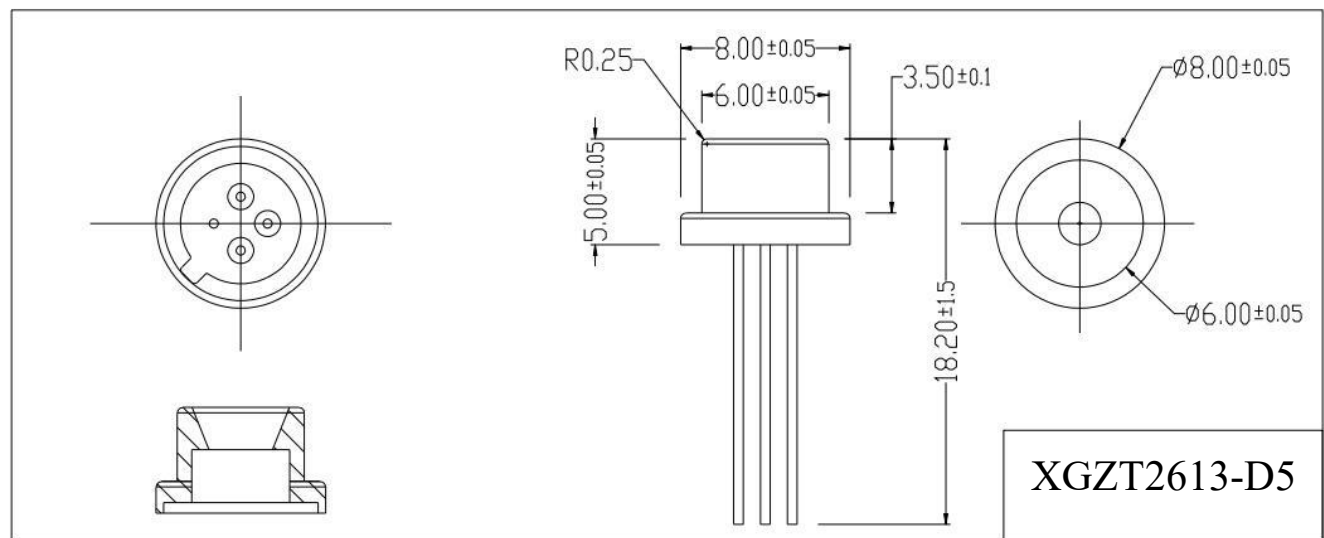
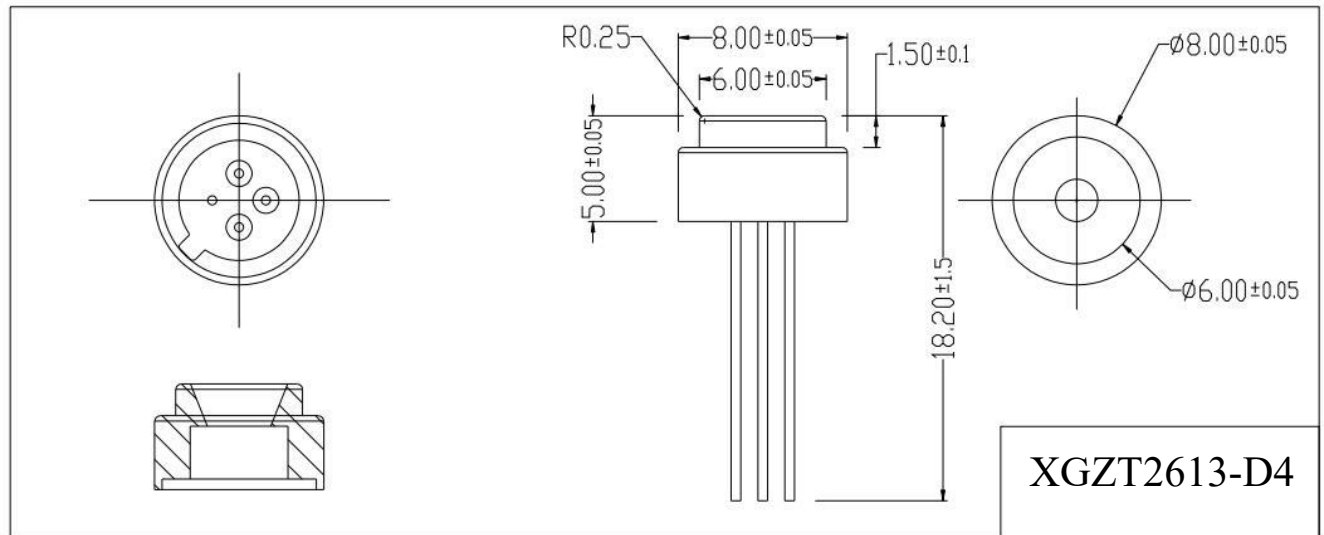
Figure 9. Matrix contour dimensions

Table 7. Pin definitions

order number	symbol	definition
1	S DA	Serial data input / output (I ² C Data)
2	S CL	Serial Clock input (I ² C Clock)
3	VDD	Core-chip power supply (Supply Voltage)
4	G ND	G ROUND(Ground)

2、Outline dimension





8. Recommended Reflow Curve

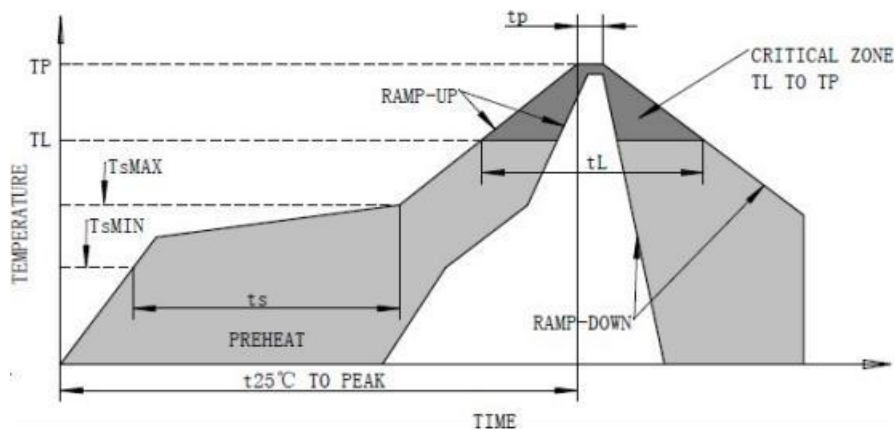


Figure 10. Recommended distribution curve of lead-free solder reflow temperature

Table 8. Distribution parameters of recommended lead-free solder reflow temperature curve

Average ramp-up rate(TsMAX to TP)	3°C /seconds max.
Preheat	
-Temperature Min.(TsMIN)	150°C
-Temperature Max.(TsMAX)	200°C
-Time(TsMIN to TsMAX)(Ts)	60~80seconds
Time maintained above:	
-Temperature(TL)	217°C
-Time(tL)	60~150seconds
Peak temperature(TP)	260 °C
Time of actual peak temperature(TP, within 5°C)	20-40 seconds
Peak temperature(TP)	245 °C
Ramp-down rate	Max 6°C /seconds
Time from 25°C to Peak temperature	8 minutes Max

Average warming rate (T_{sMAX} arrive T_p)		Maximum 3°C / s
Preheat	minimum temperature (T_{sMIN})	150°C
	maximum temperature (T_{sMAX})	200°C
	time (T_{sMIN} arrive T_{sMAX}) (t_s)	60-180 s
Time above the temperature	temperature (T_L)	217°C
	time (t_L)	60-150 s
Peak temperature (T_p)		260°C
Time within 5°C around the peak temperature		20-40 s
Average cooling rate (T_p arrive T_{sMAX})		Maximum 6°C / s
Time from 25°C to the peak temperature		Maximum 8 min

Note: After reflow welding, it is recommended to put the tube flat for 5 minutes before moving the PCBA, otherwise the sensor pipe cap is at risk of falling off.

9. Other Suggestions

1. Pressure and electrostatic discharge exceeding the absolute maximum rating may damage the sensor, please take appropriate precautions. Do not allow the sensor to contact the corrosive detergent, the light 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, moisture, dustproof and static.

3. Before applying the company's products to some special circumstances (i. e., improper operation will directly affect the semiconductor life or cause physical damage), we should consult CFSensor and agents in advance. The Company will not assume any responsibility for the unauthorized operations.

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