2048 InGaAs Linear Detector

User Manual

2048×1, 12.5μm, SWIR, Metal package



Introduction

The 2048 × 1 element InGaAs line detector is mainly composed of a low-noise readout circuit (ROIC), a P-I-N structure InGaAs photosensitive chip and a first-level thermoelectric cooler (TEC), and adopts a metal package. This user manual only describes the C type of this detector.

Detector main parameters

Optoelectronic Performance

Index name	Typical Value
Response spectrum range(μm)*1	0.95 ±0.05~1.7 ±0.05
Pixel filling rate(%)	100
Peak quantum efficiency(%)	≥65
Peak detection rate (cm· Hz/w)	$\geq 1\times10^{12}$
Peak sensitivity(A/W)	≥0.8

Effective pixel rate(%)*2	≥99	
Response non-uniformity(%)	<3	
Readout method	IWR 、ITR	
Readout rate(MHz)	1~11	
Maximum frame rate(fps)	40k	
Gain gear	4	
Saturation voltage(V)	2.0	
Integrating capacitance(fF)	Gain gear1：10 Gain gear 3：100	Gain gear2：20 Gain gear4：500

* 1 Focal plane temperature = 25℃

*2 Near the half-well, the deviation of the pixel response signal from the average value is less than the percentage of pixels within a certain range

Mechanical Performance

Index name	Typical Value
Length × Width × Heigh(mm)	51.3 ×28.2 ×9.8
Weight(g)	~38
focal plane scale	2048 × 1
Pixel center distance(μm)	12.5
Pixel size(μm)	12.5 × 12.5
Active area(mm)	12.8×0.025

Usage environment and power consumption parameters

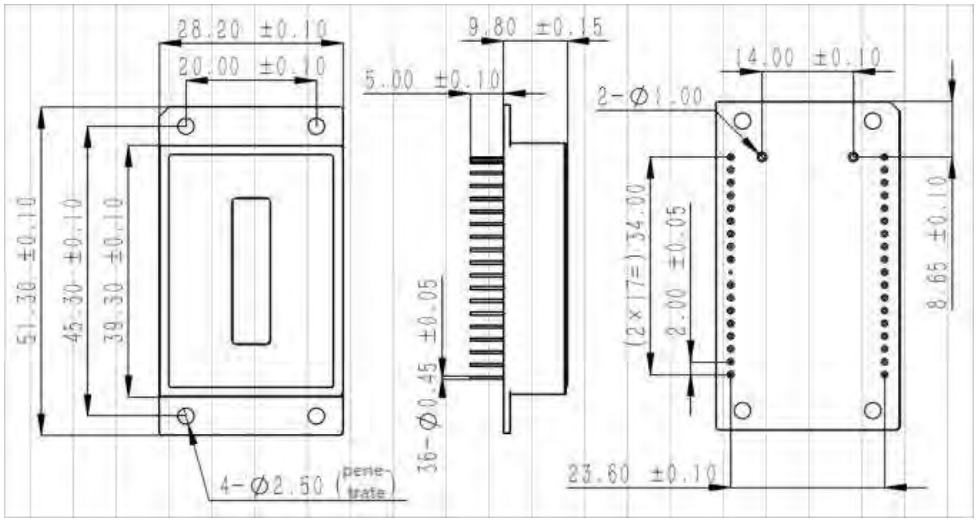
Index name	Typical Value
Operating temperature(℃)	-20~+60
Storage Temperature(℃)	-40~+70
Typical power(W)*1	<0.5

* 1 TEC is not turned on TEC ， Environmental temperature =25℃ ， clock frequency =1MHz ， VDDD=VDDA=3.3V ， VBOP=2.4V ，VBOUT=VREF=VNDET=2.4V

Mechanical parameters

This detector adopts a metal package and is filled with high-purity nitrogen at normal pressure. The metal shell is made of FeNiCoSi alloy, and the surface is electroplated with Ni layer. The window welding method is In system brazing, and the cover type is resistance welding. The overall dimensions of the detector are 51.3mm (L) × 28.2mm (W) × 9.8mm (H). There are 38 pins on the shell leading from the bottom, of which 36 Φ0.45mm pins are arranged in a bilateral "one" shape with a pin spacing of 2.00mm. They are used for the input of focal plane power and instructions, focal plane detection signals and temperature sensors. Electrical lead-out; 2 Φ1.00mm wires are used for the connection of thermoelectric coolers. Four Φ2.5mm through holes are distributed on both sides of the tube shell for fixing the detector. The pin near the missing corner is No. 1.

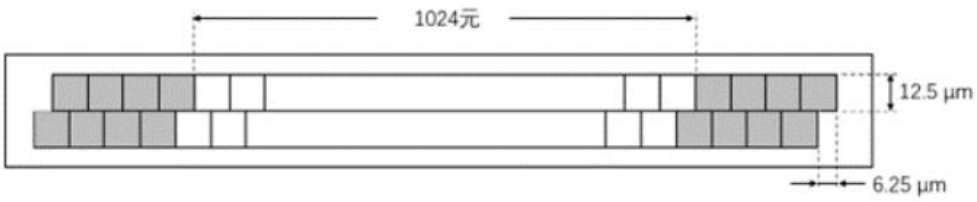
The appearance and dimensions of the mechanical interface are shown in the figure below



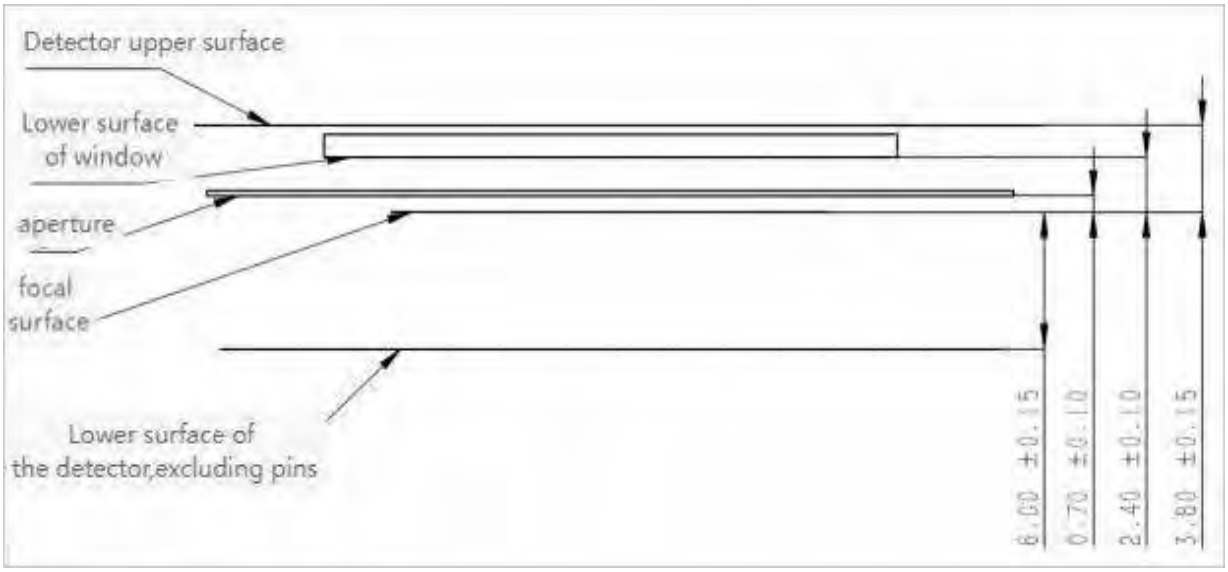
Optical Parameters

Optical structure

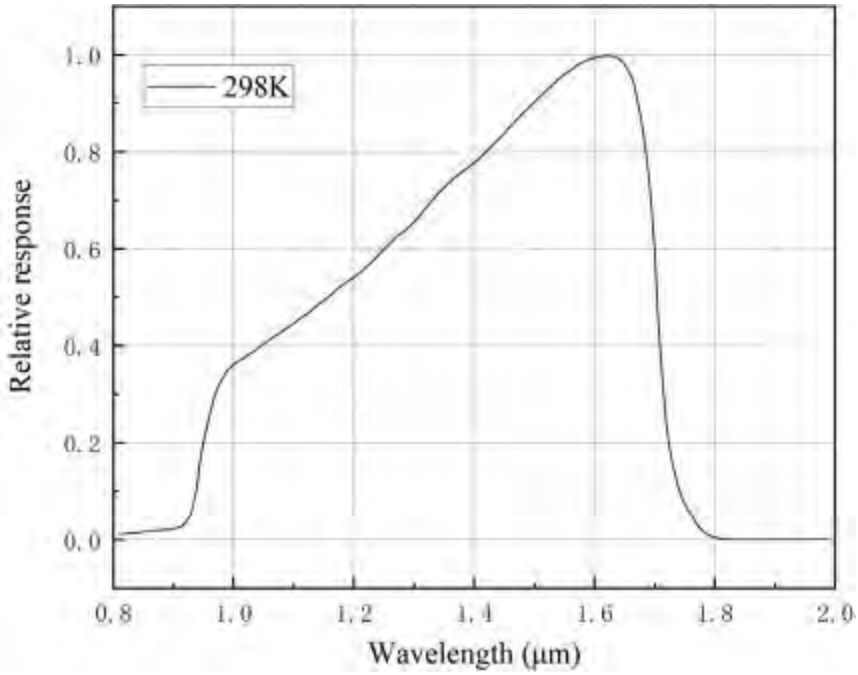
This detector uses a 1024×2 element InGaAs focal plane, with 4 redundant elements at each end of the detector, that is, the overall number of pixels is 1032×2. In actual use, it is recommended to use columns 5 to 1028. The pixel shape is square, the photosensitive size is 12.5μm × 12.5μm, the structure is arranged in a "-" shape, two rows of pixels are staggered, and the center distance of each row of pixels is 12.5μm. The structure is shown in the figure below.



The design distance value between the detector focal plane and the upper surface of the detector is 3.80±0.15mm, the design distance value from the lower surface of the window is 2.40±0.10mm, and the design distance value from the lower surface of the aperture is 0.70±0.15mm. The window material is sapphire, with a thickness of 1.00±0.05mm, and the surface is coated with AR film. The transmittance in the response band is >95%. The window light transmission area is 22.80mm×5.80mm, and the aperture light transmission size is 13.30mm×0.60mm. The center of the photosensitive surface is located at the center of the detector, the relative position offset is ≤0.05mm, and the relative rotation displacement is ≤0.02mm.

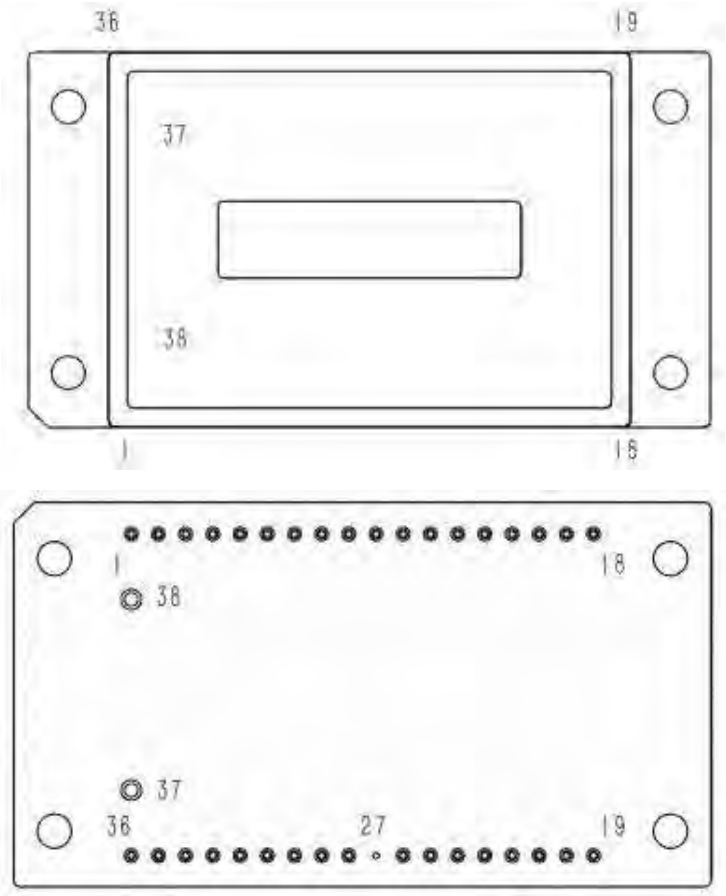


Response spectrum（Typical Value）



Electrical characteristic

Detector pin diagram



Detector pin description

Pin No.	Lead#	Pin function	Reference value
1	VDDA	Analog power supply	analog voltage 3.3V
2	SH3		
3	SH2	Sampling control signal, setting pixel integration time, changing readout method, specific methods can be found in the timing section	Digital voltage High 3.3V/Low 0V
4	SH1		
5	RESET	Reset the signal, control the length of the acquisition cycle of the circuit, and refer to the timing section for the control method	Digital voltage High 3.3V/Low 0V
6	VOUT5S		
7	VOUT5R		

8	VOUT6S		
9	VOUT6R	R is the reference signal, S is the output signal	
10	VOUT7S	Subtract the output signal from the reference signal of the same channel to obtain the actual detector response signal value	
11	VOUT7R		
12	VOUT8S		
13	VOUT8R		
14	VBOUT	Buffer bias, providing bias voltage for circuit buffers	analog voltage 2.4V
15	VBOP	Amplifier bias, providing bias voltage for signal amplifiers	analog voltage 2.4V
16	VREF	Reference voltage, providing a reference value for the output signal	analog voltage 2.4V
17/18	TS	temperature sensor	
19	GND	GND	
20	VNDET	Chip public N	analog voltage 2.4V
21	VBUF	Buffer bias, providing bias voltage to the overall buffer of the circuit	analog voltage 2.4V
22	VOUT4R		
23	VOUT4S		
24	VOUT3R	Same as 6~ 13	
25	VOUT3S		
26	VOUT2R		
27	CASE		
28	VOUT2S		
29	VOUT1R	Same as 6~ 13	
30	VOUT1S		
31	DSELUNIT	Trigger the pulse, and the circuit begins to collect signals	Digital voltage High 3.3V/Low 0V
32	DSELBUF	trigger pulse	Digital voltage High 3.3V/Low 0V
33	CLK	Clock, providing a time reference for circuit driven timing	Digital voltage High 3.3V/Low 0V
34	SELCAP0	Detector gain selection, controlling the output signal size of the detector, specific methods can be found in the timing section	Digital voltage High 3.3V/Low 0V

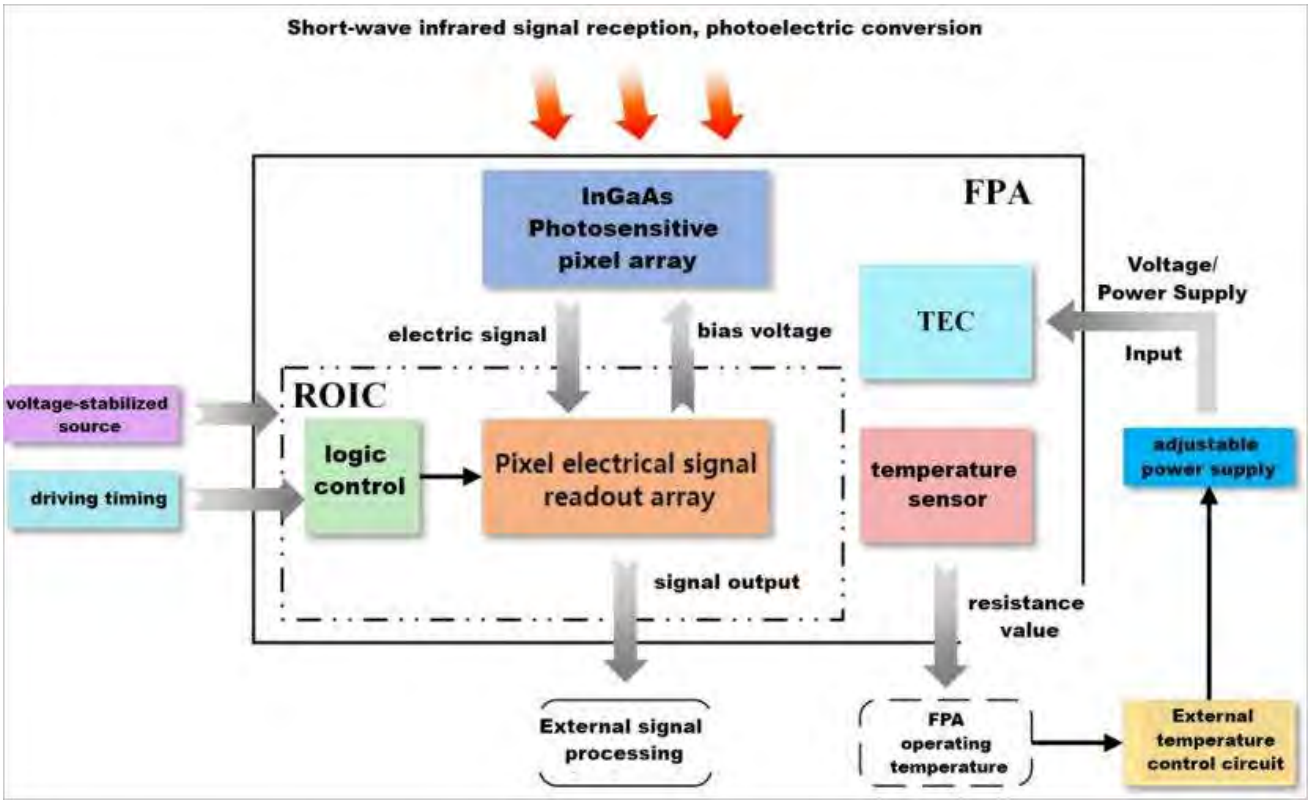
Pin No.	Lead#	Pin function	Reference value
35	SELCAP1	Detector gain selection, controlling the output signal size of the detector, specific methods can be found in the timing section	Digital voltage High 3.3V/Low 0V
36	VDDD	Digital circuit power supply, providing voltage to the digital circuit inside the detector	analog voltage 3.3V
37	TEC (-)	The input voltage of the thermoelectric cooler is cooling when the TEC (+) pin is connected to a high level, and heating when connected to a low level	
38	TEC (+)		

Notes:

The DC input directly affects the overall noise of the detector, so there are the following requirements for the ripple noise of the DC input power supply：

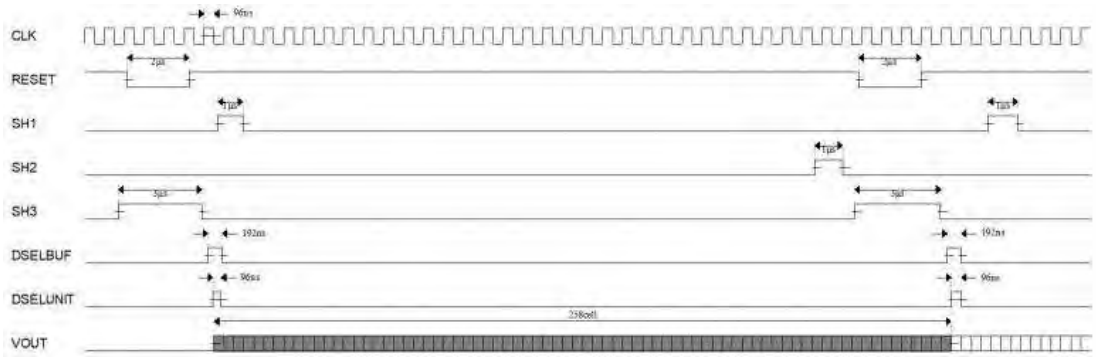
1) VDDA＜2mV
2) VDDD＜10mV
3) VREF 、VNDET＜0.3mV
4) VBOP 、VBOUT＜1mV

Schematic diagram of detector working principle and connection mode



Detector timing specification（IWR Mode）

The overall readout circuit drive timing pulse is shown as follows：



Overall timing requirements are as follows：

Name	High level width	Initial level	Rising edge moment
CLK	0.5CLK cycles	Low	3.0μs
RESET	Adjust based on integration time	High	1.5μs
SH1	1μs	Low	2.5μs
SH2	1μs	Low	22.5μs
SH3	3μs	Low	24.0μs
DSELBUF	192ns	Low	27.0μs
DSELUNIT	96ns	Low	27.1μs

Notes:

1. The CLK cycle and RESET high-level width can be set according to requirements. The recommended frequency range for CLK is 1-11 MHz, and the RESET low-level width cannot be less than 2 μ S;

2. In IWR mode, the relative positions of SH1, SH2, and SH3 cannot be changed, and the specific integration time of the detector is the time from the falling edge of SH1 to the falling edge of SH2 within the same RESET cycle;

3. The high level of DSELBUF needs to cover a complete high level of CLK, and the rising edge needs to be within the low level of CLK. It is recommended to set the rising edge at 1/2 of the low level of CLK;

4. The actual signal is read from the position of the first CLK rising edge after the rising edge of the DSELUNIT, and the reference signal R and output signal S are read sequentially until reaching the last CLK cycle before the rising edge of SH3;

5. If the width of the RESET high-level is not enough to read out all 1032 pixels, the next RESET high-level will still start reading from the first pixel, not from the pixel that has never been read out. If the width of the RESET high-level is too large, it will continue to be empty sampled after reading all 1032 pixels in the channel until the RESET low-level arrives for reset;

6. It is recommended to use digital input voltage for SH1, SH2, and SH3, which means maintaining a high level of 3.3 V/0 V consistently

Low level;

7. Detectors should take anti-static measures during transmission and use;

8. During the use of the detector, it is necessary to check the power supply connection status and strictly prohibit short circuits at the signal output end;

9. The photosensitive element has 2 rows, with 4 channels synchronously read out in each row. Each channel contains two output levels, VOUTR (reference level) and VOUTS (signal level). For example, four channels output data as follows:

Channel	Group1	Group2	Group3	Group4	……	Group255	Group256	Group257	Group258
VOUT1 R/S	A1	A2	A3	A4	……	A255	A256	A257	A258
VOUT2 R/S	B259	B260	B261	B262		B514	B515	B517	B516
VOUT3 R/S	C517	C518	C519	C520		C769	C770	C771	C774
VOUT4 R/S	D775	D776	D777	D778		D1029	D1030	D1031	D1032

The 258 sets of data output from 4 channels in each row can be concatenated into 1032 pieces of data. The concatenation method is as follows：

A1	…	A258	B259	…	B516	C517	…	C774	D775	…	D1032

Collect 1032 × 2-format signal data, with a middle area of 1024 × 2 is the effective pixel area, while the remaining areas are redundant pixel areas

	Columns 1~4	Columns 5~1028	Columns 1029~1032
Line1	Redundant area	Active imaging area	Redundant area
Line2	Redundant area	Active imaging area	Redundant area

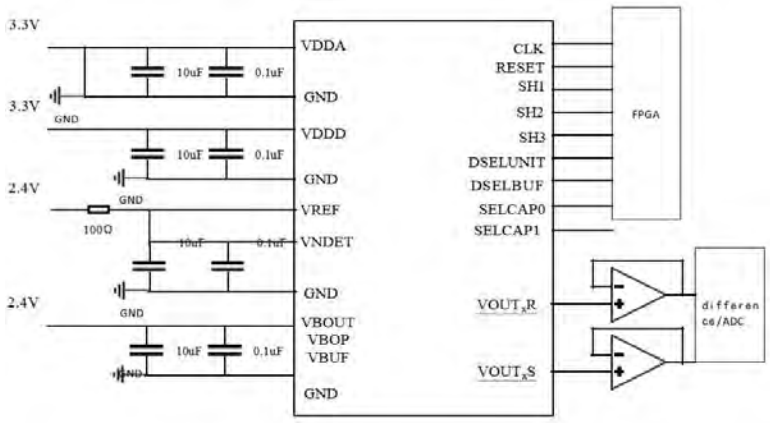
Collect 1032 × 2-format signal data, with a middle area of 1024 × 2 is the effective pixel area, and the remaining areas are redundant pixel areas. 1024 × After piecing together the data, 2048 is obtained × 1 Image

	Columns 1~4	**Columns 5~1028**	**Columns 1029~1032**
Line1	**Redundant area**	**Active imaging area**	**Redundant area**
Line2	**Redundant area**	**Active imaging area**	**Redundant area**

This detector has 4 gain levels, and it is recommended to use the highest gain level (level 1). The specific gain level and input voltage relationship are shown in the table below：

Gears	SELCAP0	SELCAP1	Gain
1	0	0	Hign
2	1	0	▌
3	0	1	▼
4	1	1	Low

Recommended circuit diagram for detector periphery



Thermal Parameters

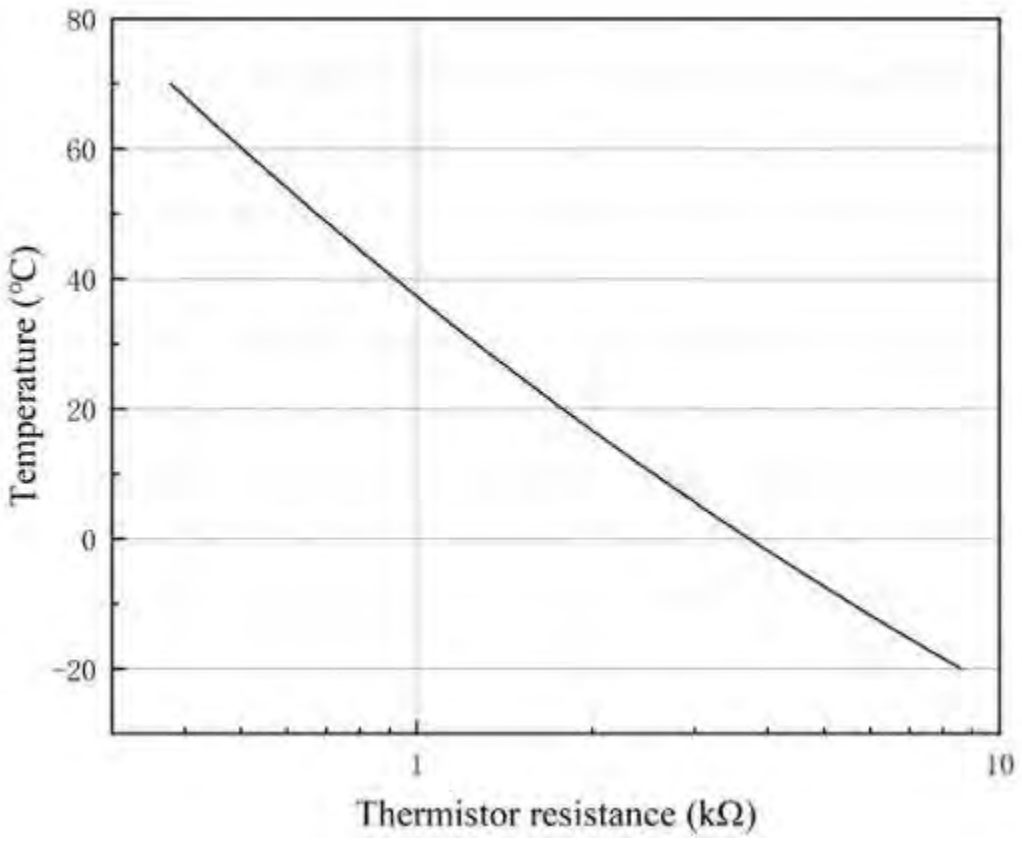
Characteristics of TEC

Integrated primary thermoelectric cooler (TEC) inside the detector ， The center of the heat dissipation surface is the center of the lower surface of the detector, and the heat dissipation area should be ≥ 20mm × 20mm, its performance parameters are shown in the table below：

Performance index	Numeric Value
Maximum load current allowed（ITEC-max/A）	8.5
The maximum load voltage allowed（VTEC-max/V）	4.3
Current impedance (including AC resistance)（ACR/Ω)	0.33-0.35

Temperature monitoring module characteristics

This detector uses a thermistor as a temperature sensor, and the relationship between the resistance value and temperature within the working temperature range is shown in the following chart：



Thermistor values correspond to typical values of temperature as shown in the following table：

Temperature(℃)	Value of resistance（kΩ）	Temperature(℃)	Value of resistance（kΩ）
-20	8.608	30	1.268
-15	6.909	35	1.077
-10	5.587	40	0.918
-5	4.549	45	0.786
0	3.729	50	0.674
5	3.075	55	0.581
10	2.55	60	0.502
15	2.126	65	0.435
20	1.782	70	0.378
25	1.5		

The corresponding relationship between the resistance value of a thermistor and temperature is as follows:

$$\frac{1}{(T1+273.15)}=\frac{\ln\left(\frac{R1}{R2}\right)}{B}+\frac{1}{(T2+273.15)}$$

T1 ： Test target temperature，Unit： ℃

T2 ： Reference point temperature, unit: ℃. The typical reference temperature within -20~70 ℃ is 10 or 40 ℃, and a reference temperature value close to the target temperature should be selected

R1: T1 corresponds to the thermistor resistance value, unit: k Ω

R2: The resistance value of the thermistor corresponding to T2, in k Ω

B: The thermal sensitivity coefficient, with a typical value of 3019.6 ± 60 for B10/40 within -20~70 ℃

Notes:

a) During the installation process of TEC, attention should be paid to the addition of new resistors introduced by the external electrical structure. If the added resistance exceeds 10% of the TEC resistance, the I-V curve needs to be recalibrated;

b) It is recommended to connect the TEC with a smaller resistance. If welding is required, short-circuit grounding protection is required. The welding temperature should be ≤ 250 ℃ and the welding time should be<10s

c) The relationship between temperature and resistance value in each node of the temperature monitoring module can be approximated as a first-order linear function, and the resistance value corresponding to the preset temperature can be estimated according to the demand.

d)Before starting the TEC, ensure that the temperature monitoring module is working properly, that the heat dissipation surface is in contact with the heat sink, that the heat dissipation surface is not smaller than the required area, and that the heat sink is working properly. Do not start the TEC when the heat dissipator is not installed or the heat sink is not working

e)When the TEC is turned on for the first time, the current or voltage should be gradually loaded starting from 0A or 0V, while the temperature changes are monitored until the preset temperature is reached

f)Since the performance of the detector is affected by temperature, the TEC should be turned on first until the temperature is stable, and then the detector is turned on. It is not recommended that the detector work in the environment of temperature change

g)When the detector is not working, the power supply to the TEC should be stopped to extend the service life of the TEC

h)The cooling and heating effects of the detector are related to the ambient temperature, power supply performance, and heat dissipation status. It is recommended to properly match the heat dissipation system according to the environment and the performance requirements of the detector.

Product support

Problem	Possible causes	solution
Abnormal output of detector VOUT signal	No power supply or abnormal power supply	Check if each power supply meets the electrical requirements in the user manual
	Timing exceptions	The timing pulse width of the detector needs to be modulated according to the recommendations in the user manual
Excessive noise in detector output signal	High power supply ripple noise	The ripple noise of DC power supply should be supplied according to the electrical requirements in the user manual
	High ambient temperature	Use in the right environment
	Thermoelectric refrigerator pin reverse connection	The temperature monitoring module detects whether there is a reverse connection