规 格 书

SPECIFICATION FOR APPROVAL

客户名称: CUSTOMER:	
日 期: DATE:	2023-04-29
产品名称: PART NAME:	温补型数字热释电火焰传感器 Temp-Comp. Digital Passive InfraRed Flame Sensor
产品型号: PART NO. :	S001F24A51
客户型号: CUSTOMER PART NO. :	
件编号: DOCUMENT NO. :	
版 本: REVISION:	A/4

客户确认APPROVED BY:
确认编号APPROVED NO.:

拟 制 Prepared by	审 核 Checked by	批 准 Approved by

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1.Overview



The S001F24A51 integrated pyroelectric flame sensor utilizes a new environmentally friendly lithium tantalate ($LiTaO_3$) single-crystal material for its sensing element. It is a 4-pin digital PIR flame sensor that integrates a digital signal conditioning chip (IC) with the sensing element within an electromagnetic shielding cover. The probe communicates bidirectionally with an external controller to configure various operational states. The sensing element couples the detected flame flicker signal into the digital signal conditioning IC through a very high-impedance differential input circuit. The digital IC chip converts the signal into a digital format via a 14-bit ADC, facilitating subsequent signal processing and logic control.Configurations such as detection sensitivity (trigger threshold), blind time after trigger reset, signal pulse counting time window, algorithms, and the selection of three operating modes can be implemented by the external controller (μC) through the single-wire communication interface (SERIN) to configure internal registers. During routine continuous flame sensing, the μC does not need to remain active (it can enter standby mode to save power). Only when the digital probe detects a flame flicker signal meeting the pre-configured trigger conditions does the internal conditioning IC send an interrupt wake-up command to the μC via the INT/DOCI interface, prompting the μC to activate and execute subsequent control actions. Depending on the configured operating mode, the μC can also periodically or forcibly read the digital flame signal value from the probe through the DOCI port, and then determine follow-up actions based on its programmed algorithm.Thanks to the power-efficient interrupt wake-up mechanism, this digital sensing system is ideal for applications with high energy-saving requirements, particularly battery-powered scenarios, making it the most energy-efficient sensing control solution available.

2.Characteristic

1.Digital signal processing with bidirectional communication to the controller;

2.Configurable detection trigger conditions and support for three different operating modes, enabling open flame monitoring results output and ADC-filtered flame signal data output;

3.Built-in second-order Butterworth bandpass filter for the infrared sensor, shielding input interference from other frequencies;

4.The infrared signal conditioning circuit is fully encapsulated within an electromagnetic shielding cover, with only power and digital interface pins exposed, providing exceptional resistance to radio frequency interference;

5.The system's operational mechanism is deeply optimized for power efficiency, making it suitable for battery-powered devices;

6.Power supply voltage and on-chip temperature detection;

7.Operates with quick stabilization after a self-check during power-up;

8.Utilizes eco-friendly $LiTaO_3$ sensing material, strictly complying with RoHS environmental requirements without the need for exemptions or RoHS certification.

3.Application

1. Various open flame monitors;

2. Fire detectors;

3. Internet of Things flame sensing equipment;

4. Fire alarms for homes, industrial plants, and factories.

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4. Performance parameters

4.1 Maximum Ratings

Electrical overstress exceeding the parameters in the table below may cause permanent damage to the device. Operation beyond the maximum rated conditions may affect the reliability of the device.

Parameter	Symbol	Min.	Max.	Unit	
Supply voltage	VDD	-0.3	3.6	V	25℃
Pin voltage	Vnto	-0.3	Vdd ＋ 0.3	V	25℃
Pin current	Into	-100	100	mA	Single time ,single pin
Storage temperature	TST	-30	70	℃	< 60% R.H
Operating temperature	Toper	-20	55	℃	

4.2 Electrical Characteristics (Typical test conditions: TAMB=+25℃, VDD=+3V)

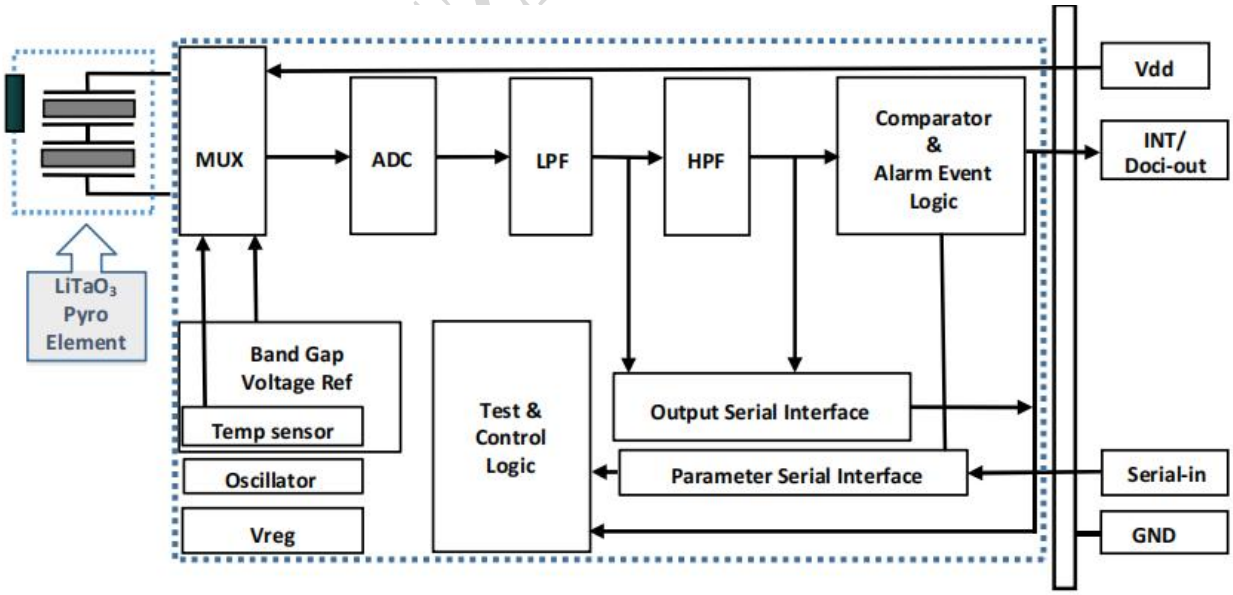
Parameter	Symbol	Min.	Typical	Max.	Unit	Note
Working conditions						
Operating voltage	VDD	1.5	3	3.6	V	
Working current, Vreg on	IDD1		5	6.0	μA	This product is not suitable
Operating current, Vreg off	IDD		3	3.5	μA	Applicable to this product Vdd = 3V, no load
Input parameters SERIN						
Input low voltage	VIL	- 0.3		0.2Vdd	V	
Input high voltage	VIH	0.8Vdd		0.3 + Vdd	V	Max V < 3.6V
Input current	Ii	-1		1	μA	Vss<Vin<Vdd
Digital clock low level time	tL	200		0.1/ FCLK	nS/μS	Typical: 1-2μS
Digital clock high level time	tH	200		0.1/ FCLK	nS/μS	Typical: 1-2μS
Data bit writing time	tBW	2/FCLK - tH		3/FCLK-- tH	μS	Typical: 80-90μS
Write timeout	tWA	16/FCLK		17/FCLK	μS	
Output pin INT/DOCI-OUT						
Input low voltage	VIL	- 0.3		0.2Vdd	V	
Input high voltage	VIH	0.8Vdd		0.3 + Vdd	V	Max V < 3.6V
Input current	IDI	-1		1	μA	Vss<Vin<Vdd
Data readable setup time	TDS	4/FCLK		5/FCLK	μS	
Data bit preparation time	TBs			1	μS	CLOAD < 10pF
Forced reading settling time	TFR	4/FCLK			μS	
Interrupt clear time	TCL	4/FCLK			μS	
Digital clock low level time	TL	200		0.1/ FCLK	nS/μS	Typical: 1-2μS
Digital clock high level time	TH	200		0.1/ FCLK	nS/μS	Typical: 1-2μS
Bit data read time	Tbit			24	μS	Typical: 20-22μS
Reading timeout	TRA	4/FCLK			μS	
DOCI pull-down duration	TDU	32/FCLK			μS	For data update
Input PIRIN/NPIRIN						
PIRIN/NPIRIN to Vss Input Impedance		30		60	GΩ	-60mV<Vin<60mV

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Input resistance differential value		60		120	GΩ	-60mV<Vin<60mV
PIRIN Input voltage range		-53		+53	mV	
Resolution/step size		6	6.5	7	μV/Count	
ADC output range		511		2^14-511	Counts	
ADC Bias		7150	8130	9150	Counts	
ADC Temperature Coefficient		-600		600	ppm/K	
ADC Input noise RMS valueF = 0.1Hz...10Hz			39	91	μVpp	f = 0.09...7Hz
Supply voltage measurement						
ADC Output range		2^13		2^14-511	Counts	
Voltage resolution		590	650	720	μV/Count	
ADC Bias @ 3V			12600		Counts	about ±10% offset

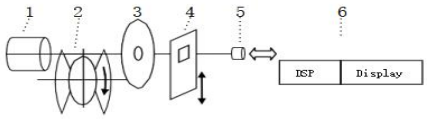
Temperature measurement (single point calibration required)						
Resolution			80		Counts/K	
ADC output range		511		2^14-511	Counts	
Bias value @ 298K			8130		Counts	about ±10% offset
Oscillators and filters						
Low pass filter cutoff frequency		FCLK*1.41/2048/π			Hz	2nd order BW
High pass filter cutoff frequency		FCLK*P*1.41/32768/π			Hz	2nd order BW P = 1 or 0.5
On-chip oscillator frequency	Fosci	60	64	72	kHz	
System clock	FCLK		Fosci/2		kHz	

4.3 Internal Function Block Diagram

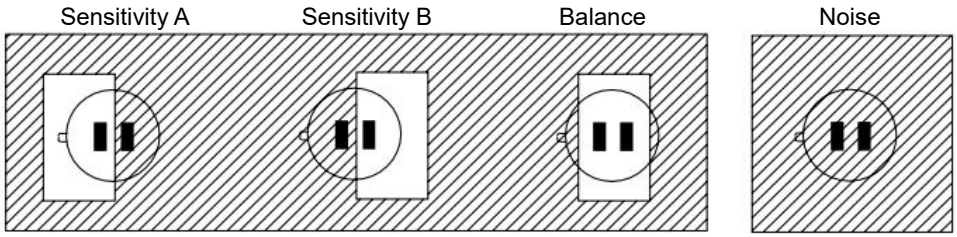


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4.4 Test Method

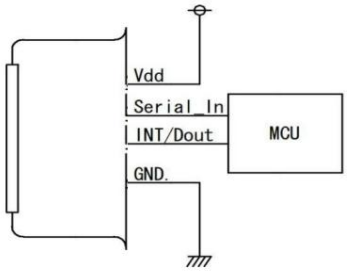


1: Blackbody 500K
2: 1Hz chopper
3: Grating Ø4mm
4: Baffle
5: PIR
6: Digital signal



Parameter	Symbol	Typical	Min.	Max.	Unit	Note
Sensitivity	Vp-p	450	360		uV	
noise	Vp-p	26		39	uV	

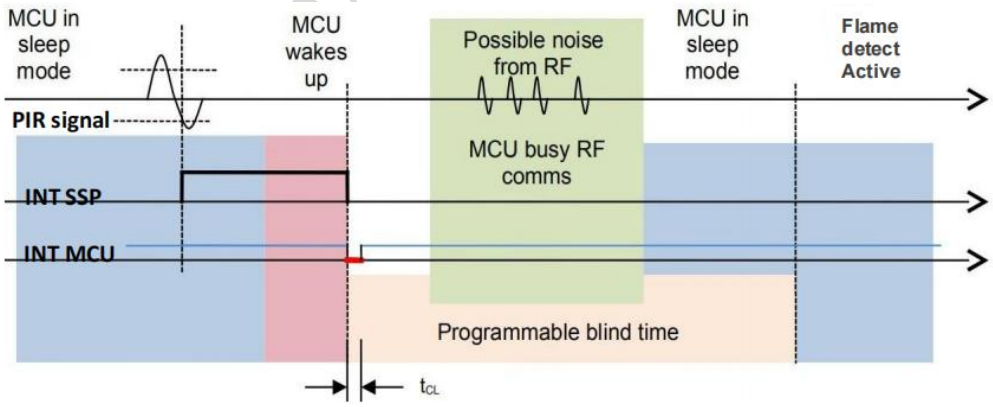
4.5 PIN Definition



4.6 Output trigger or alarm event logic

The output signal of the bandpass or lowpass (depending on the configuration) filter is calculated. When the flame signal value level exceeds the pre-configured sensitivity threshold, an internal pulse is generated. When the signal changes sign (or does not need to change sign) and exceeds the set threshold again, a second pulse is calculated. The conditions for output triggering or fire alarm, such as the number of pulses and the counting time window in which the pulse occurs, are configurable. If the previous event is cleared by resetting the interrupt, the detection stops for the next configurable blind lock time. This feature is very important to prevent self-excited false triggering in application scenarios that require high sensitivity to detect fire alarms.

The interrupt will be cleared by driving a low level "0" for at least 120μs (tCL); the processor can then switch the port back to a high impedance state.



Flame Detection and Trigger Clearing Timing Diagram

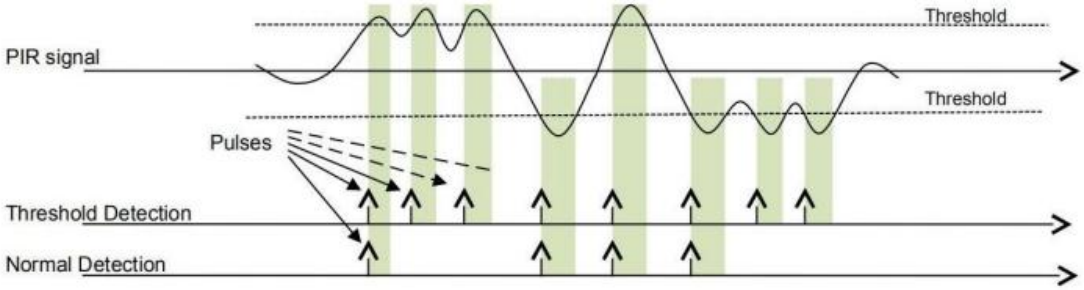
4.7 Serial interface and configurable register function description

The configuration of the conditioning IC control algorithm is achieved by programming the conditioning IC related registers through the SERIN pin of the controller, using a simple clock data single-wire communication protocol. The configured data of the conditioning IC is read out by the controller using the INT/DOCI pin, using a similar clock data single-wire output protocol. When SERIN is at a low

level for at least 16 system clocks (and Vdd is in the normal range), the conditioning IC inside the probe begins to accept new data.

The following parameters can be configured and adjusted through the conditioning IC registers:

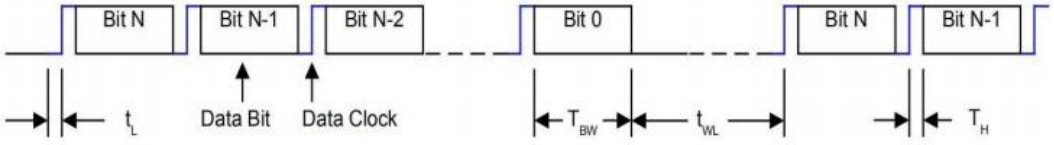
1). Sensitivity [8-bits]
Sensitivity/detection threshold is defined by register value; register configuration step is 6.5μV, threshold = register value * 6.5μV.
2). Blind lock time [4-bits]
After the interrupt output reset switches back to 0, the masking time of ignoring flame detection:
Range: 0.5s ~ 8s, blind lock time = register value * 0.5s + 0.5s.
3). Pulse count in flame detection [2-bits]
Range: 1 ~ 4 pulses with (or without) sign change, number of pulses = register value + 1.
4). Window time in flame detection [2-bits]
Range: 2s ~ 8s, window time = register value * 2s + 2s.
5). Flame detection start [1-bit]
0 = disable (off), 1 = enable.
6). Interrupt source [1-bit]
The interrupt source can be selected between flame detection logic output or ADC output data filter extraction. If the extraction filter is selected, an interrupt is generated every 16 milliseconds, transmitting a frame of valid raw data.
0 = flame detection, 1 = filter raw data output.
All interrupt outputs can be turned off by setting the interrupt source to flame detection (R6=0) and turning off the flame detection function (R5=0), and the controller can only pull the timing to force the reading.
7). ADC source selection [2-bits]
Multiplex ADC resources. The selectable sources for the input of the ADC are as follows:
PIR signal BFP, output = 0 PIR signal LPF, output = 1 power supply voltage = 2
On-chip temperature = 3
*For flame detection mode, "0" or "1" must be selected.
8). Built-in Pyro sensor regulator enable control (2.2V) [1-bit]
Provides a regulated 2.2V on the VREG output: 0 = Enable, 1 = Disable (disable); "1" must be selected to disable VREG when configuring this product.
9). Start self-test [1-bit]:
It takes 2 seconds to complete the PIR self-test procedure at startup; the self-test function starts with a jump from 0 to 1; it must be configured as 0 in the application and cannot be changed in the middle.
10). Sample capacitance value or high-pass cutoff frequency selection [1-bit]:
For different sizes of thermal ceramic sensors, different sample capacitors can be selected for thermal ceramic testing; the HPF high-pass cutoff frequency can be configured in the application. 0 = 0.4Hz, 1 = 0.2Hz
11). Short-circuit the two input terminals of PIR [1-bit]
1 = Short-circuit (measure ADC zero offset), 0 = Normal use; must be configured as 0 in the application
12). Flame detection pulse metering algorithm mode [1-bit]
1 = Direct pulse counting, 0 = The signs of adjacent pulses must be reversed to count



Two modes of flame detection pulse metering algorithm

4.8 SERIN Communication Protocol for Configuration Registers

The configuration data is written serially by the controller to the internal conditioning IC of the probe through SERIN. The external controller must generate a 0 to 1 transition at the SERIN input and then write the value (0/1) bit by bit; the "0" and "1" time of the transition can be very short (one instruction cycle of the controller). The write data bit length TBW requires at least two system clocks (tbit) of the conditioning IC and no more than three system clocks (tbit) of the conditioning IC. The 25-bit register data must be written in full at one time; when the data bit is interrupted for more than 16 times the system clock (tWL) during the transmission process, the last incomplete data received is latched into the internal register. When it is interrupted for more than 5 times the system clock (tWL), the register may have entered the latched state and cannot continue to be written.

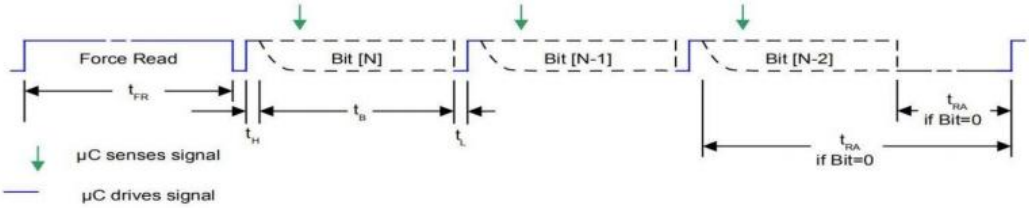


Bit-No	register	Note
[24:17]	[7:0] Sensitivity	The detection threshold is defined and can be adjusted in steps of 6.5μV.
[16:13]	[3:0] Interrupt blind lock time	Configurable time (0.5s ~ 8s); is the blind lock period after the interrupt output is reset
[12:11]	[1:0] Pulse counter	The number of pulses within the specified time window that triggers the alarm event
[10:9]	[1:0] Window time	Within the configured time window (2s ~ 8s), if the number of pulses measured reaches the pre-configured value, an alarm event will be triggered.
[8]	[0]Start flame detector	0 = Disable, 1 = Enable
[7]	[0]Interrupt Sources	0 = flame detection status, 1 = filter original output status
[6:5]	[1:0] ADC/Filtered voltage source	0 = PIR (BPF)；1 = PIR (LPF)； 2 = Supply voltage (LPF); 3 = Temperature sensor (LPF)
[4]	[1]Regulator shutdown or enable	0 = on; 1 = off. This bit must be configured to '1' to turn it off.
[3]	[0]Start self-test	0 to 1 transition starts the PIR self-test procedure. Write 0 in the application.
[2]	[0]Self-check capacitor size or HPF	1 = 2 * Self-test default capacitance; High-pass HPF cutoff frequency can be configured in the application: 0 = 0.4Hz, 1 = 0.2Hz
[1]	Short the two input terminals of PIR	1 = short circuit (measure ADC zero offset); 0 = normal use
[0]	Mode selection for pulse metering algorithms	1 = pulses are counted directly; 0 = only reverse pulses can be counted

Register values and corresponding parameters

4.9 DOCI-OUT communication protocol for data reading

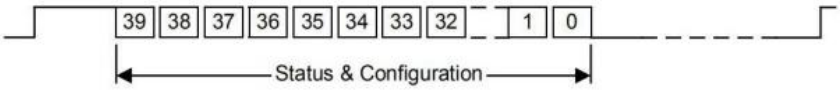
The serial output of the conditioning IC to the controller is used as an interrupt output to indicate a fire alarm; when used as a serial output, the status and configuration data can be read from the conditioning IC. The control timing when used as a serial output is as follows: The controller must hold or force DOCI at a high level for more than 4 device clock cycles (tFR) and then read the data bits as described in the timing diagram below. The reading can be terminated at any time by forcing the DOCI pin to be "0" for at least 4 system clock cycles. After reading the data, the μC should pull DOCI low and keep it low for more than 32 times the system clock to ensure that the internal register data of the probe is updated in time.



Control timing of the DOCI interface when the bidirectional interface INT/DOCI transmits data

The interrupt source for the DOCI/INT output can be selected between the ADC filter data reading and the flame detection logic output value. If the ADC output is selected, the probe will generate an interrupt every 512 system clocks (reminding the μC to read). The PIR signal voltage and all internal data can be read through the DOCI interface. The probe will no longer generate interrupt output during the reading process. Due to priority, the order of the data is fixed. The device first outputs the PIR voltage value, and then outputs the status and configuration data information. The μC reading process can be terminated at any time without reading all the data.

The status and configuration data format is as follows:



Bit-No	Register	remark
[39]	PIR Out of range indication	0 indicates out of range, and the sensitive element is automatically short-circuited at both ends for discharge.
[38:25]	[13:0]PIR voltage output	The output voltage value of the LPF or BPF, 6.5 μV per step, depends on the configuration.
[24:17]	[7:0] sensitivity	The detection threshold is defined and adjusted in accordance with 6.5μV each step
[16:13]	[3:0] Interrupt blind lock time.	Configurable time (0.5s ~ 8s); it is the masking period after the interrupt output reset ('H' to 'L').
[12:11]	[1:0] Pulse Counter.	The number of pulses within a specified time window that trigger a fire alarm event.
[10:9]	1:0] Window Time	In the specified time window (2s ~ 8s), the number of pulses measured reaches the pre-configured value will trigger the fire alarm
[8]	[0]Starting flame detector	0 = disable，1 = Enable.
[7]	[0]interrupt source	0 = Flame detection condition，1 = Filter original output state
[6:5]	[1:0] ADC/Filter voltage source	0 = PIR (BPF)；1 = PIR (LPF)； 2 = Power voltage (LPF)；3 = On - chip temperature(LPF)
[4]	[1]The voltage regulator is turned off or enabled	0 = On / 1 = Off; this bit must be configured as '1' to turn off.
[3]	[0]Start self-testing	A transition from 0 to 1 initiates the PIR self - check program; write '0' in the application.
[2]	[0]Self - check capacitance size or HPF (High - Pass Filter)	1 = 2 * self - check default capacitance; In the application, the cut - off frequency of the high - pass filter (HPF) can be configured: 0 = 0.4Hz, 1 = 0.2Hz
[1]	Short - circuit the two input terminals of the PIR.	1 = short-circuit (measure ADC zero bias); 0 = Normal usage
[0]	Pulse metering algorithm mode selection	1= direct pulse counting; 0= Only the reverse pulse can count

Register value and corresponding parameters

4.10 Calculation of measurement data

4.10.1. PIR output signal voltage measurement

a) Low pass filter LPF output;

ADC source [6:5] must be switched to PIR input, and digital LPF output needs to be selected (register configuration = 1). VPIR = (ADC_out - ADC_offset) * 6.5μV

b) Band pass filter BPF output;

ADC source [6:5] must be switched to PIR input, and digital LPF&HPF (i.e. BPF) output needs to be selected (register configuration = 0). VPIR = ADC_out * 6.5μv.

4.10.2. Power supply voltage measurement

ADC source [6:5] must be switched to chip power supply (register configuration = 2). VDD = (ADC_out - ADC_offset) * 650μV.

4.10.3. On-chip temperature measurement

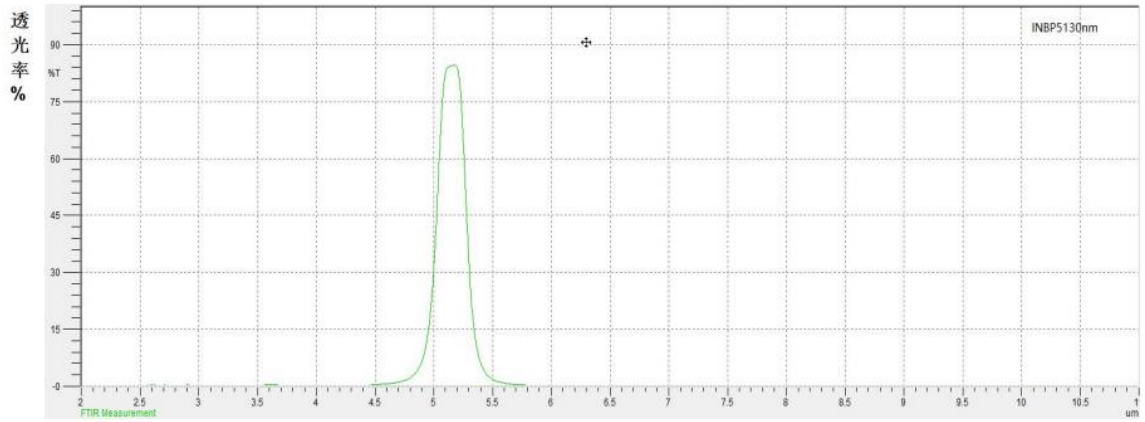
ADC source [6:5] must be switched to temperature sensor (register configuration = 3).

Temperature = Tcal + [ADC_out - ADC_offset(Tcal)] / 80 * counts/K ADC_offset = ADC value @ VIN = 0, typical value = 2^13,

ADC_offset(Tcal) = ADC value at defined ambient temperature, typical value = 8130 @ 298k.

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5. Window lens size, transmission spectrum and viewing angle

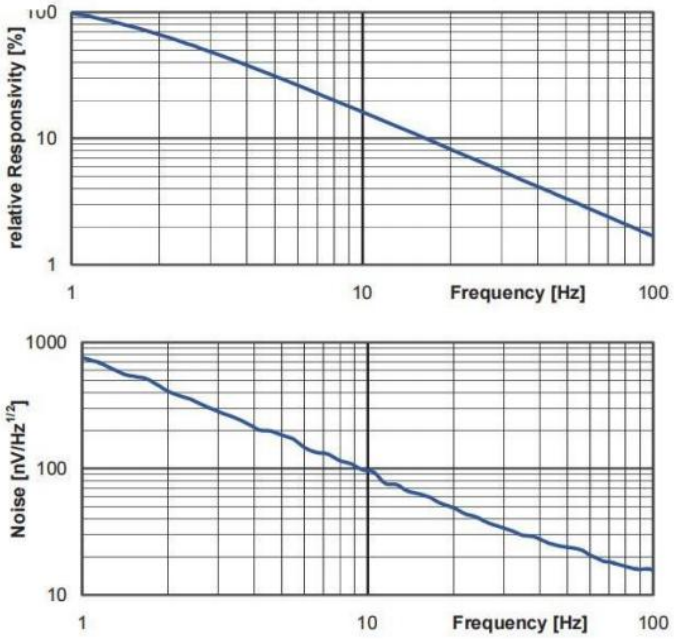


Central wavelength(nm)	Half-peak width (nm)	Peak transmittance	Cut-off range (nm)
4130±40	600±40	≥85%	UV~11000（≤1%）

Optical size:

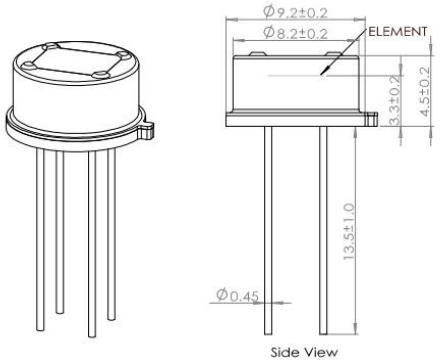
Parameter Item	numeric value	Unit
window size	5.2*4.2	mm^2
Sensitive element area	2*1.5	mm^2
Transmittable center wavelength	5.09~5.17	μm
Detection Angle	100	Deg.

Frequency response：



6. Dimensions and silk screen

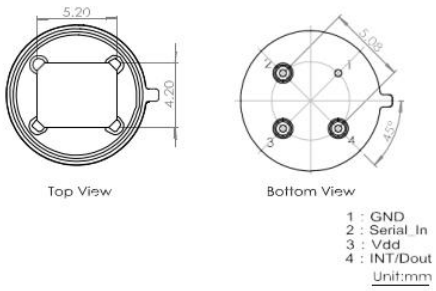
Window size: B: 5.2 x 4.2mm



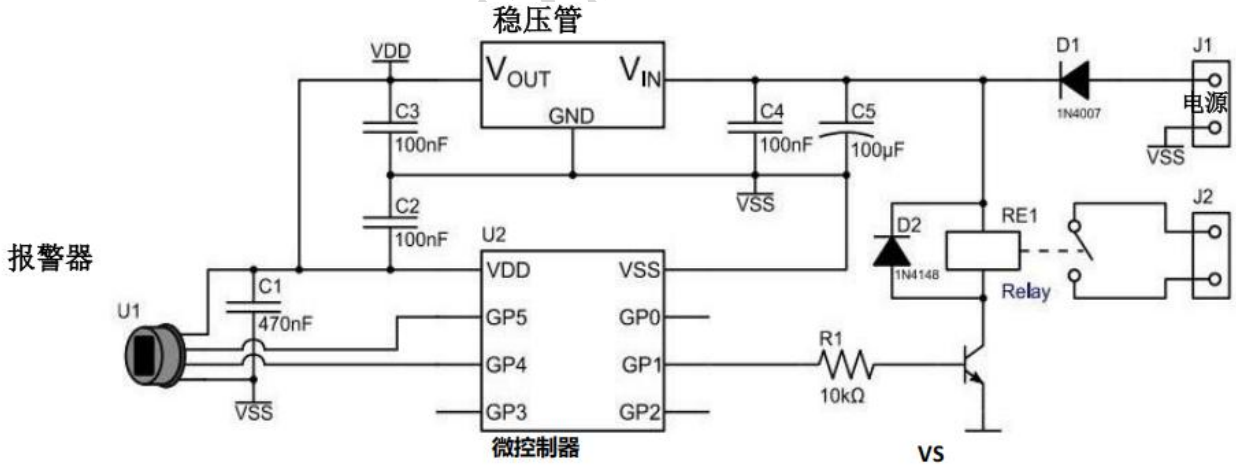
Silk screen:

First line: Product model

Second line: YYWW (production date)



7. Typical application circuit



8. Notes

S001F24A51 is a digital pyroelectric infrared sensor that detects flickering flame signals. It may not be able to detect heat sources other than flames or temperature changes and movement without heat sources. Please pay attention to the following matters:

8.1 Pyroelectric infrared detectors are typical AC working devices. When the target is stationary and the temperature remains unchanged, the pyroelectric infrared detector has no signal output. Only when there is transient target movement, temperature change, or modulation with a chopper, will there be a signal output.

8.2 During the operation, use and storage of pyroelectric infrared detectors, rapid temperature changes should be avoided. The detector can only maintain normal operation when the temperature change rate is less than 1℃/minute. If the detector heats up too quickly, it may cause damage to the lithium tantalate sheet.

8.3 Pyroelectric infrared detectors are piezoelectric and are very sensitive to sound, electromagnetic waves, and vibration. When using pyroelectric infrared detectors, proper shock absorption and shielding are necessary.

8.4 When welding the pyroelectric infrared detector, it is recommended to weld at a position above 4mm, the welding time should be as short as possible, and the root of the pin should be clamped with tweezers to help dissipate heat and prevent damage to the sensitive element of the detector. Prevent the components from falling. Spare components should be stored dry.

8.5 When operating the pyroelectric infrared detector, due to the contact of the hand, especially after welding, the temperature of the pyroelectric infrared detector is changed. Therefore, when the detector is restarted, it is necessary to wait for a period of time until the temperature of the detector is balanced before resuming normal operation. After the detector is heated, the power is turned on immediately. At this time, the detector may be in the cut-off state.

Do not touch the window directly with your hands or hard objects. Keep the window clean. If there is dirt, wipe it gently with an alcohol cotton ball.

9. Remark

The company reserves the right to update this specification periodically without prior notice to customers.

10. Regarding the manufacturer - HW INDUSTRIAL CO.,LTD

HW INDUSTRIAL CO.,LTD is a high-tech enterprise that integrates research and development, production, sales, and after-sales service. We have been focusing on infrared PIR and flame and microwave induction technology for more than ten years. We specialize in providing a variety of sensor components, sensitive electronic devices, intelligent electronic devices, and other series of products, such as pyroelectric infrared probes , flame sensor and their supporting ICs and Fresnel lenses; Infrared sensing module; Flame sensor module,Microwave induction module; Audio players, and can provide technical development and design, customized processing, and technical support for products. Our products are widely used in lighting fixtures, public security, advertising and media, traffic safety, and more.

Please recognize our brand [HW].

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