L640

Uncooled Thermal Imaging Module

Product Manual

V1.0.1

Revision History

Version	Date	Comments
V1.0.0	2024-07	Initial Release
V1.0.1	2024-08	Add CDS3 video format

Table of Contents

1. Product Overview

L640 uncooled thermal imaging module is specially designed for the applications that are sensitive to SWaP. It is low in SWaP, supports a variety of serial communication interfaces, video output interfaces and optional lightweight infrared lenses. The L640 is suitable for miniaturized handheld devices, enhanced night vision goggles (ENVG), UAVs and Advanced Driving Assistant System (ADAS), which can support a comprehensive thermal imagery solution. The L640 radiometric products can be used in industrial temperature measurement, electric power temperature measurement, security & surveillance measurement, machine vision and other fields.

2. Lens Parameters

Table 2.1 Lens Specs

Array Format	E.F.L./F#	Focus Type	FOV (H×V)	IFOV
640×512	4.1mmF1.2	Athermalized	100°×82°	2.93mrad
	6.9mmF1.0		62.9°×50.4°	1.74mrad
	9.1mmF1.0		48.1°×38.4°	1.32mrad
	13mmF1.2		33.5°×26.9°	0.92mrad
	25mmF1.2		17.5°×14°	0.48mrad
	45mmF1.2		9.7°×7.8°	0.27mrad

3. Product Specs

Table 3.1 Product Performance Specs

Performance Index	640	640 (radiometric)
Detector Type	VOx Uncooled IRFPA	
Resolution	640×512	
Pixel Pitch	12μm	
Frame Rate	50Hz	25Hz
Spectral Range	8～14μm	
NETD	≤50mK@25℃, F#1.0	
Image Adjustment		
Brightness &Contrast Adjustment	Manual/Auto	
Polarity	Black-hot/white-hot	
Color Palettes	Support (1)	
Image Processing	Temperature control algorithm(w/o TEC)	
	DNR	

	DDE	
	Histogram equalization	
Image Mirror	Left-right/Up-down/Diagonal	
External Sync	10~50Hz, rising edge trigger	None
Power Supply(2)		
Power Supply Range	3.8～5.2VDC / 1.8V / 3.3V	
Typical Power Consumption @25℃	≤0.50W	≤0.40W
Interfaces(2)		
Digital Video	14Bit LVCMOS(1)	
	Progressive BT.656/BT.1120	CDS2/CDS3
	2lane MIPI(Raw8)	
Serial Communication Interfaces	UART(1.8V)	
Temperature Measurement Performance		
Temperature Measurement Range	————	-20℃～+150℃, 100℃～+650℃
Accuracy	————	±3℃ or ±3% of reading, the larger value shall prevail (±2℃ optional)
Physical Properties (W/o lens & Expansion component)		
Weight	8g	
Size	21mm × 21mm	
Environmental Adaptation		
Operating Temperature Range	-40℃～+80℃(-20℃～+60℃ for radiometric function)	
Storage Temperature Range	-45℃～+85℃	
Humidity	5～95%, no condensation	
Vibration(3)	6.06g, random vibration, all axial	
Shock(3)	80, 4ms, trailing edge sawtooth wave, 3-axis 6-direction	

Note:

(1) The color palettes, polarity and image mirror are unavailable for LVCMOS.

(2) The power supply and interface descriptions apply only to the factory state without extended components; for detailed functions of extended components, refer to User Extended Components Manual.

(3) It is necessary to equip with our company's standard expansion components.

4. User Interface Description

The Hirose 70PIN connector named DF40C-70DP-0.4V(51) is used on the imaging module, including power supply interfaces, UART interfaces, 14Bit LVCMOS digital video interfaces and other interfaces. Users can adopt Hirose 70Pin DF40HC(3.0)-70DS-0.4V(51) board-to-board connector to implement the connection between imaging module and user expansion components.

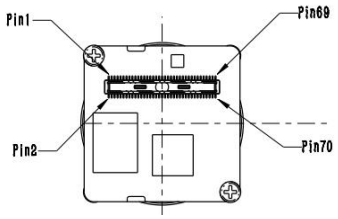


Figure 4.1 Hirose User Interface

4.1 Definition of Hirose 70-pin Connector

Table 4.1 Definition of Hirose 70-pin Connector(1)

Pin No.	Pin Name	Type	Descriptions		
1, 2, 3, 4	Main_Power	Input	Power: 3.8V~5.2V(2)		
9, 10, 12	VDD1V8	Input	Power: 1.8V(2)		
13, 15	VDD3V3	Input	Power: 3.3V(2)		
18	DV0	Output	14Bit or 8Bit LVCMOS digital video (1.8V)	Data signal LSB	CDS2/CDS3/ BT.1120/ Progressive BT.656 (1.8V)
19	DV1			Data signal	Data signal
20	DV2			Data signal	Data signal
21	DV3			Data signal	Data signal
22	DV4			Data signal	Data signal
23	DV5			Data signal	Data signal
24	DV6			Data signal	Data signal
25	DV7			Data signal MSB(8bit)	Data signal MSB (BT.656)
26	DV8			Data signal	CDS2/ BT.1120 /(1.8V)
27	DV9			Data signal	Data signal
28	DV10			Data signal	Data signal
29	DV11			Data signal	Data signal
30	DV12			Data signal	Data signal
31	DV13			Data signal	Data signal

Pin No.	Pin Name	Type	Descriptions			
				MSB(14bit)		
32	DV14			——		Data signal
33	DV15			——		Data signal MSB(CDS2 /BT.1120)
34	Line_Valid		Line Sync			
35	Frame_Valid		Frame Sync			
36	Clock		CLK signal			
39	MIPI_CLK+	Output	MIPI CLK (1.2V)			
41	MIPI_CLK-	Output				
45	MIPI_D0+	Output	MIPI Data(1.2V)			
47	MIPI_D0-	Output				
51	MIPI_D1+	Output				
53	MIPI_D1-	Output				
50	UART_TX	Output(3)	UART(1.8V)		Transmit Module	
52	UART_RX	Input/Output(3)			Receive Module	
40	EXT_SYNC	Input	External trigger (1.8V)			
42 (4)	Reserved OUT	Output	1.8V			
44, 46, 56, 57, 59, 60, 61, 62, 63, 64, 65, 66, 67, 70	——	——	NC, Suspend			
5, 6, 7, 8, 11, 14, 16, 17, 37, 38, 43, 48, 49, 54, 55, 58, 68, 69	GROUND					

Note:

(1) The pin assignment and pin description of the Hirose 70-pin connector are only applicable for default product w/o expansion board.

(2) The voltage values mentioned here all refer to the voltage at the core connector.

(3) The TX and RX in serial communication interface represent the send and receive of this module.

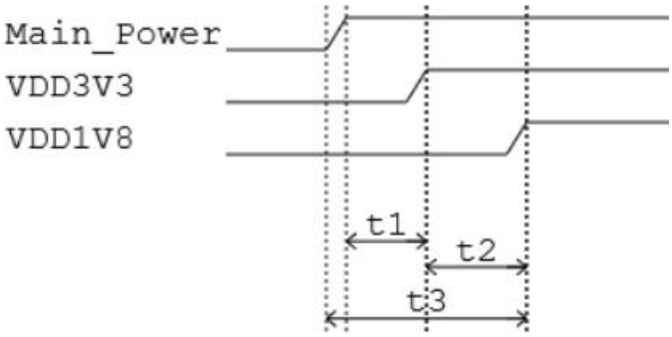
(4) The pin No. 42 can only output, which has pullup resistor inside.

4.2 Power Supply Requirement for Hirose 70-pin Connector

The thermal imaging module adopts multi-channel power supply, see the following figure for the tolerable noise and power-on timing:

Table 4.2 Description of Power Supply

Power Name	Power Supply Range	Max. Noise	Peak Current	Steady State Current (1)	Power Consumption (1)	Power on Timing
Main_Power	3.8V~5.2V	10mVP-P	400mA	≤60mA	280mW	See the following figure
VDD3V3	+3.3V	10mVP-P	250mA(2)	≤5mA	11mW	
VDD1V8(3)	+1.8V	1mVRMS (1Hz~50KHz)	150mA	≤27mA	50mW	



Time(t)	
t1	t1>2ms
t2	t2>0ms
t3	t3<10ms

Figure 4.2 Power on Timing of 70-Pin Connector

***Note**:*

(1) Both the steady current and power consumption are typical values at 25℃;

(2)The peak VDD3V3 is current when the module is performing shutter calibration;

(3) When VDD1V8 starts powering on, the power-on process of both the Main_Power and the VDD3V3 should finish and become stable, and the whole process should finish within 10ms;

4.3 Expansion Board List

Table 5 Expansion Board List

Model	Figure	Main Interface/Function	Fit Module
TLX02V110F014C		Power supply via USB, typical voltage 5 VDC Communication via USB Video via USB 2.0	640 / 640 Radiometric
TLX02V100F022C		Power supply via USB, typical voltage 5 VDC Communication via USB Video via USB 2.0	640 /640 Radiometric
TLX02V100F023C		Typical voltage 5VDC Communication via RS232 by default Analog video (PAL)	640/ 640 Radiometric

4.4 Parallel Digital Video Format

Table 4.4 Description of Digital Video Format

Video Format	LVCMOS		BT.656	BT.1120	CDS_2(1)	CDS_3(1)
Supported Models	Observation Type	Temperature Measurement Type	Observation Type	Observation Type	Temperature Measurement Type	Temperature Measurement Type
I/O Qty.	CLK(1) HSync(1) VSync(1) Data signal(16)		CLK(1) HSync(1) VSync(1) Data signal(8)	CLK(1) HSync(1) VSync(1) Data signal(16)	CLK(1) HSync(1) VSync(1) Data signal(16)	CLK(1) HSync(1) VSync(1) Data signal(8)
Progressive/ interlaced	Progressive					
CLK Frequency /MHz	37.5	37.5	37.5	37.5	37.5	37.5
External Sync	Yes					

Internal Reference Code	No		Yes	Yes	Yes	Yes
Data Format	RAW8/14		YUV422 2 CLKs for 1 pixel UY first, VY follow-up	YUV422 1 CLK for 1 pixel High 8-bit UV, low 8-bit Y	YUV422+TEMP 1CLK for 1 pixel High 8-bit Y, low 8-bit UV	YUV422+TEMP 2 CLKs for 1 pixel UY first, VY follow-up Low byte first and the high byte second for temperature data
Support Color Palettes/ Polarity	No		Yes	Yes	Yes	Yes
Image Data Source	NUC or DNS or DRC		DRC	DRC	DRC	DRC
Array Format (column×line)	640×512	1280×512	640×512	640×512	1280×512	2560×512

Note:

(1) The second half of each line of CDS_2/CDS_3 is 16-bit temperature data;

4.4.1 LVCMOS Timing

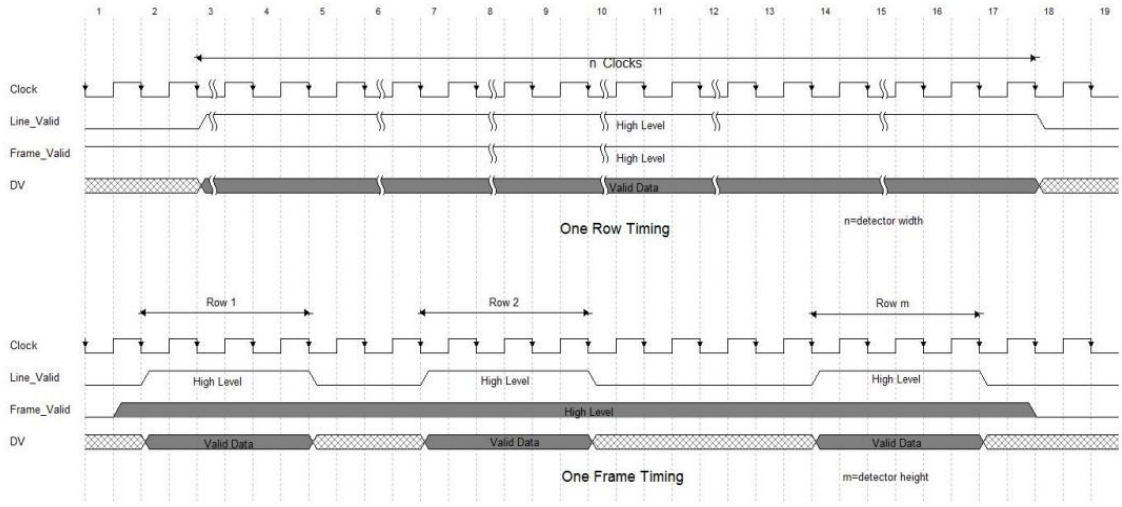


Figure 4.3 Timing of 14bit or 8bit LVCMOS Digital Video

Note：

(1) LVCMOS does not support change of color palettes and polarity;

4.4.2 Timing of Progressive BT.656

The video format of one frame output by the module is as shown in the table below:

Table 4.5 Video Frame Format

EAV in invalid line	Blanking 0x10 0x80	SAV in invalid line	Inactive data area 0x10 0x80
EAV in valid line	Blanking 0x10 0x80	SAV in valid line	Active image data 640*512 pixel/640*512*2 clk
EAV in invalid line	Blanking 0x10 0x80	SAV in invalid line	Inactive data area 0x10 0x80

In the table above, the top left corner represents the start of the frame, and the bottom right corner represents the end of the frame. The timing of one line is as follows:

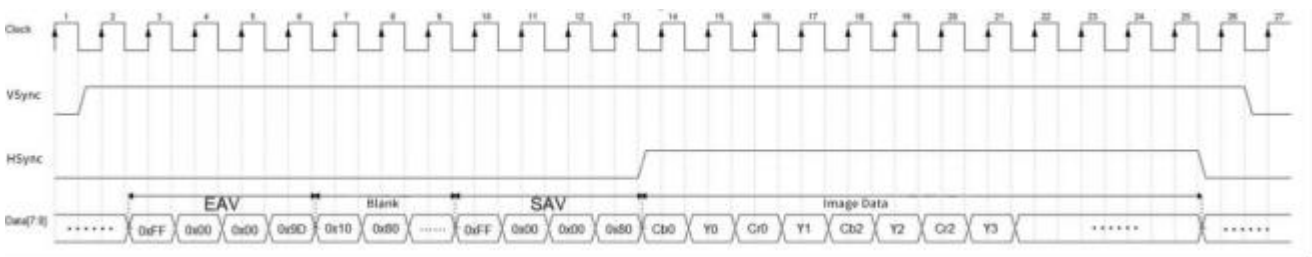


Figure 4.4 Timing of BT.656 Digital Video

Table 4.6 The Fourth Byte of The Reference Code

Position of Reference Code	Reference Code
EAV in invalid line	0xB6
SAV in invalid line	0xAB
EAV in valid line	0x9D
SAV in valid line	0x80

4.4.3 BT.1120 Timing

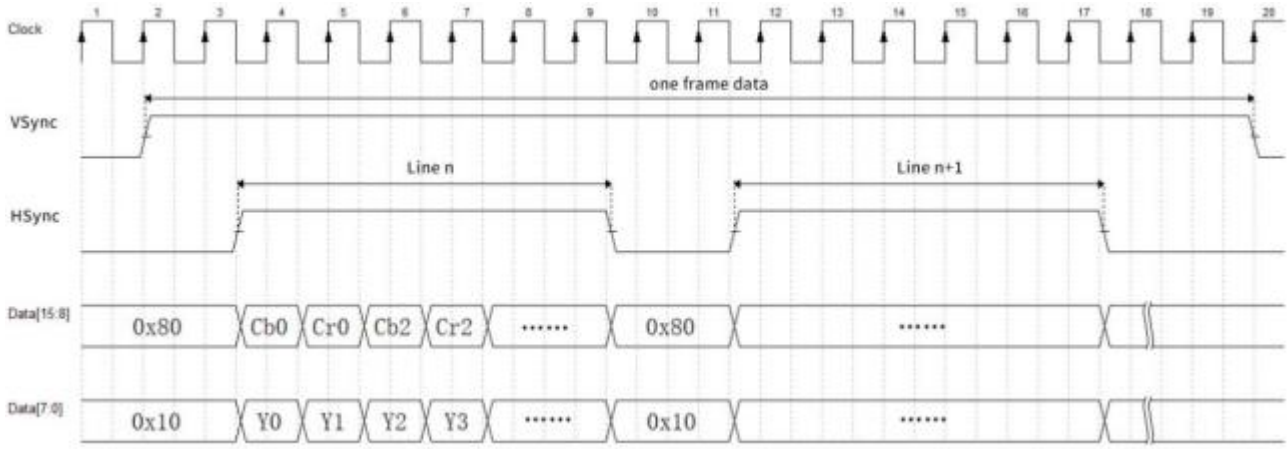


Figure 4.5 Timing of BT.1120 Digital Video in External Mode

Table 4.6 Timing of BT.1120 Digital Video in Internal Sync Mode

EAV in invalid line 0xB6B6	Blanking Area 0x8010	SAV in invalid line 0xABAB	Invalid data 0x8010
EAV in valid line 0x9D9D	Blanking Area 0x8010	SAV in valid line 0x8080	Valid data area CbYCrY The valid data area is 640*512 for thermal imaging modules with 640*512 array format. The valid data area is 384*288 for thermal imaging modules with 384*288 array format.
EAV in invalid line 0xB6B6	Blanking Area 0x8010	SAV in invalid line 0xABAB	Invalid data 0x8010

4.4.4 CDS2 Timing

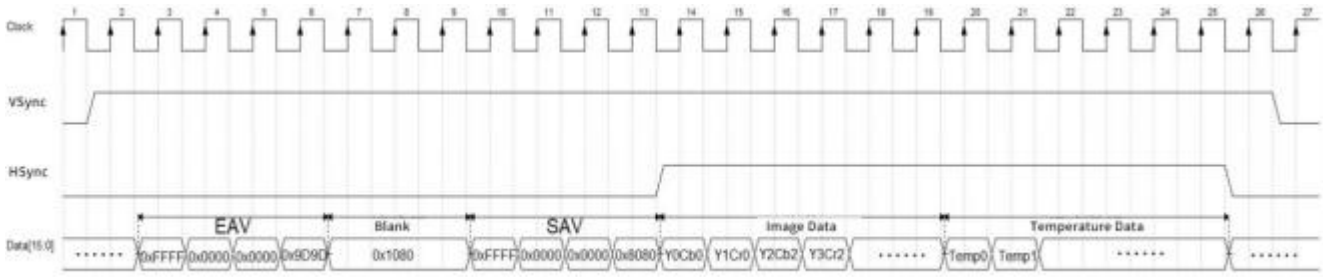


Figure 4.6 Timing of CDS2 Digital Video

Note:

(1)Temp refers to temperature data.(valid data bit is low 14-bit, fill up 0 for high 2-bit);

*(2)The output data is 2N,N refers to array width, take the thermal imaging module with 640*512 array format, it contains 640*2=1280 CLKs (N=640), 512 lines for each frame.(M=512, M refers to array height)*

4.4.5 CDS3 Video Format

The CDS3 video can output pseudo-color images. CDS3 does not require frame sync signals or line sync signals; it only requires one clock signal and eight data lines.

CDS3 video data is arranged in a progressive scan format. Each line of CDS3 video data includes three parts: the reference codes (EAV/SAV), the Blanking, and the Active Video. The video frame format output by the module is shown in the table below:

Table 4.7 The Video Frame Format

<table>
<tr><td>EAV in invalid line</td><td>Blanking
0x80 0x10</td><td>SAV
in invalid line</td><td colspan="2">Inactive data
0x80 0x10</td></tr>
<tr><td>EAV in valid line</td><td>Blanking
0x80 0x10</td><td>SAV
in valid line</td><td>Active image data
640*512
pixel/640*512*2
clk</td><td>Active temperature data
640*512
pixel/640*512*2 clk</td></tr>
<tr><td>EAV in invalid line</td><td>Blanking
0x80 0x10</td><td>SAV
in invalid line</td><td colspan="2">Inactive data
0x80 0x10</td></tr>
</table>

In the table above, the top left corner represents the start of the frame, and the bottom right corner represents the end of the frame. The CDS3 video does not use line or frame sync signals; instead, it uses reference codes (SAV or EAV) to indicate the start or end of a line or frame of data. The EAV indicates the start of the next line of data and the end of the previous line, while the SAV marks the beginning of the Active Video for the current line. Each reference code corresponds to 4 clock cycles, meaning each reference code contains 4 bytes. The first three bytes are fixed and are 0xFF, 0x00, and 0x00, respectively, while the content of the fourth byte depends on the position of the reference code. The content of the fourth byte in the reference code is shown in the table below:

Table 4.8 The Fourth Byte of the Reference Code

Position of Reference Code	Reference Code
EAV in invalid line	0xB6
SAV in invalid line	0xAB
EAV in valid line	0x9D

SAV in valid line	0x80

The data in both the Blanking and the Active Video are arranged in the sequence of Cb Y Cr Y. Cb, Cr, and Y are all 8 bits wide, each corresponding to one clock cycle. Therefore, one set of Cb Y Cr Y corresponds to the data of two pixels, which takes 4 clock cycles.

For the blanking and invalid data, Cb and Cr are fixed at 0x80, and Y is fixed at 0x10. In the image area of the Active Video, the chrominance Cb and Cr are both 8-bit values, and the luminance Y is an 8-bit grayscale value. In the temperature area of the Active Video, the chrominance Cb and Cr correspond to the lower 8 bits of the temperature data (TEMP[7:0]), and the luminance Y corresponds to the higher 8 bits of the temperature data (TEMP[15:8]).

The format and content of each line in the CDS3 video are shown in the table below:

Table 4.9 Video Data Format of One Line

	EAV				**Blanking**				**SAV**				**Active Video**							
													Image				**Temperature**			
Byte Count	4 Bytes				---				4 Bytes				640*2 Bytes				640*2 Bytes			
	FF	00	00	EVA	Cb	Y	Cr	Y	FF	00	00	SAV	Cb	Y	Cr	Y…	Cb	Y	Cr	Y…
Invalid Line	FF	00	00	B6	80	10	80	10	FF	00	00	AB	80	10	80	10	80	10	80	10
Valid Line	FF	00	00	9D	80	10	80	10	FF	00	00	80	Cb	Y	Cr	Y	TEMP [7:0]	TEMP [15:8]	TEMP [7:0]	TEMP [15:8]

4.5 MIPI Protocol

4.5.1 Brief Introduction on MIPI Protocol

This thermal camera module uses 2-lane MIPI, MIPI interface includes 1 pair of source-synchronized differential clocks, and 2 pairs of differential data lines. The clock signal enters the high-speed mode at the beginning of each frame, and quit the high-speed mode at the end of the frame. The inter-frame is in the low-power mode (the data and clock lines are both at 1.2V high level). The CLK frequency of L640 thermal camera module is 218MHz.

The data line sends a frame start packet at the beginning of each frame and a frame end packet at the end of the frame. Between the frame start packet and the end packet is long data packets with a total number of the array height (take 640*512 module for example, a total of 512 long packets), and each long packet of data contains one line of valid data.

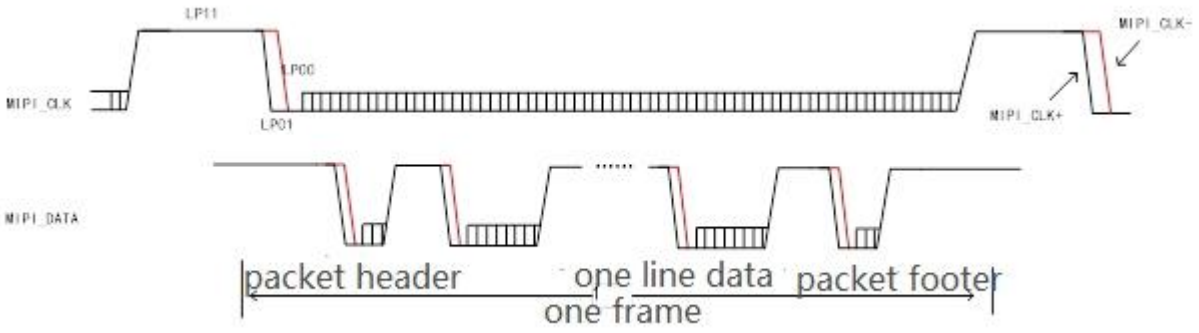


Figure 4.7 A Frame of Data

4.5.2 Introduction on Output of the Thermal Imaging Module

The thermal imaging module will output MIPI digital video after it is powered on, take 640*512 temperature measurement type as an example, output data format is RAW8(standard MIPI CSI-2 protocol), the array format should be set as (1280*2)*512, which should be spliced into 1280*512*16 bit data, low bit in front. The first 640*16 bit is image data (first UV then Y with color palettes), the last 640*16 bit is temperature data, as shown in figure 4.8.

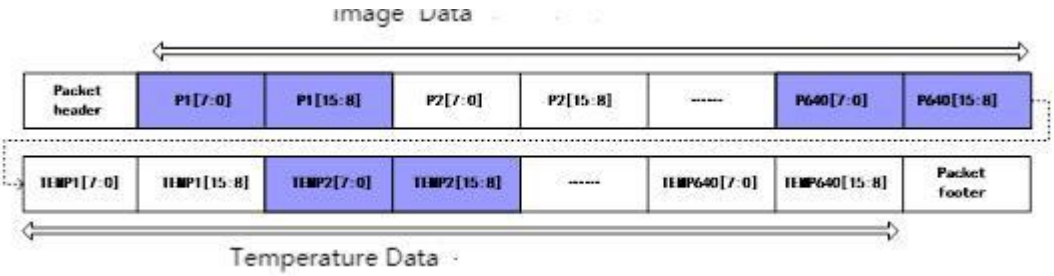


Figure 4.8 A Line of Valid Data

5. Dimension

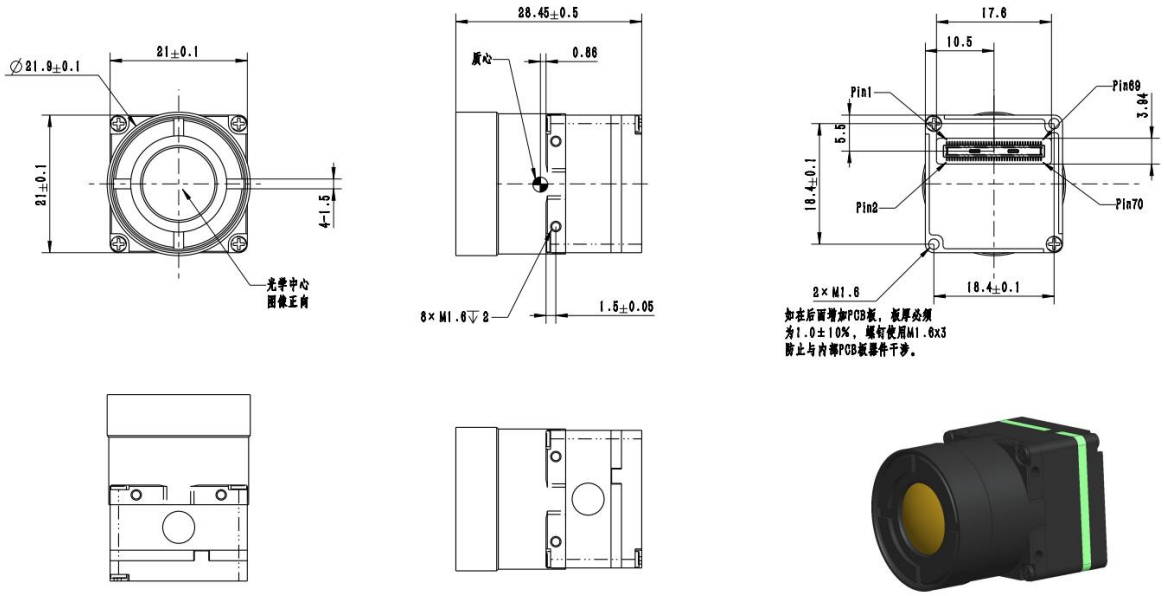


Figure 5.1 Dimension of Module with13mm F1.2 Lens

Different dimension for modules with differing lens and user expansion board, see the drawings for detailed dimension.

6. Cautions

To protect you and others from injury or to protect your equipment from damage, please read all the following information before using your equipment.

(1) The product shall not face towards the sun or other high-intensity radiation sources directly;

(2) The optimal environment temperature for operating is - 20 ℃ to 50 ℃;

(3) The detector window shall not be touched or hit with hands or other objects;

(4) The equipment and cables shall not be touched with wet hands;

(5) Please do not bend or damage cables;

(6) Scrubbing your equipment with diluents is prohibited;

(7) Do not unplug and plug cables when the power is on;

(8) Wrong cable should not be connected in case that brings damages to the equipment;

(9) Please pay attention to prevent static electricity;

(10) Please do not disassemble the equipment. If there is any fault, please contact us, and professional personnel will carry out maintenance.