PLUG Series
Product Specification v2.0
(Observation type & Thermography type)

User Instructions

Precautions for safe use

This content is to ensure that the user uses the product properly to avoid danger or property damage. Before using this product, please read the instructions carefully and properly keep it for future reference.

As shown below, the precautions are divided into two parts, i.e., "warnings" and "cautions":

Warning: Ignoring a warning may result in death or serious injury.

Caution: Ignoring a caution may result in injury or property damage.

Warning Instructions to ensure the users to avoid potential dangers may result in death or serious injury.	**Caution** Instructions to ensure the users to avoid potential dangers may result in injury or property damage.

Warnings

- Install and use this product in strict accordance with all relevant national and local electrical safety regulations.
- Use power adapters supplied by legitimate manufacturers, power supply of the module: DC5V/2A.
- Do not connect multiple modules to a power adapter (overload of the adapter may result in excessive heat or fire).
- Power off the module during wiring, disassembly and other operations, do not allow live operation.
- Immediately power off the module off in the event of smoke, stench or noise during its use, and contact the distributor or service center to deal with related matters.
- If the equipment does not work properly, please contact the store where you purchased the equipment or the nearest service center. Do not disassemble or modify the equipment in any way. (We are not liable for any problems arising from unauthorized modification or repair).

Cautions

- Do not drop any object on the equipment or vigorously shake the equipment, and keep the equipment away from magnetic field interference. Avoid installing the equipment to a place where the surface vibrates or is subject to impact. (Ignoring this may damage the equipment).
- Do not use the equipment in environment with high temperature (higher than 70℃) or low temperature (lower than -40℃) or high humidity (higher than 95%).
- Do not expose the module to objects giving out bright light, such as sun, otherwise the module will be damaged.
- Do not place the equipment in a location under direct sunlight or a poorly ventilated location, or near heat source such as heater or heating (ignoring this may cause a fire hazard).
- Do not frequently power on/off the machine, turn it on at least 30 seconds after it is turned off, otherwise the module life will be affected.
- Do not hot swap the 50pin interface, which will cause damage to the module.
- Do not touch the surface coating of the module lens directly with your hand, or scratch the lens with a hard object, which may lead to blurred imaging, affecting image quality.
- Use sufficiently soft dry cloth or other alternatives to wipe the lens surface to clean the module. Do not use alkaline detergent.

Disclaimer

Please ensure that you have read and fully understand the product instructions and the statement before using this product. You should install and use this product in strict accordance with the product instructions. If the user fails to strictly follow the instructions to install and use this product, it may bring great inconvenience to use, and may even cause property damage and personal injury. We assume no legal responsibility for any property damage and personal injury arising from improper installation or improper use of the product.

Service Principle

The series of products enjoy one-month replacement and one-year warranty. The specific service principle shall follow the provisions on the attached warranty card to perform warranty services. For products that have been discontinued, obsolescence or sold at a discount, the execution time shall follow written documents such as the notice of company.

Document Version

Date	Version	changes	author
2017/09/	V1.0	/	WEN
2018/10	V1.2	/	TED
2020/01	V2.0	/	WEN

This document is the property of Wuhan Global Sensor Technology Co. Ltd which reserves the final right to interpret it. Prior notice will not be given in case of any parameters updating due to product iteration.

Table of contents

1 PRODUCT OVERVIEW 6
1.1 PRODUCT DESCRIPTION 6
1.2 PRODUCT CONFIGURATION 7
1.2.1 Technical specification — PLUG612(Observation type) 7
1.2.2 Technical specification — PLUG612R(Thermography type) 8
1.2.3 Optical configuration 9
1.3 DESCRIPTION OF PC CONTROL SOFTWARE 9
1.4 UNPACKING 9
2 ELECTRICAL INTERFACE INSTRUCTIONS 10
2.1 INPUT POWER REQUIREMENTS 10
2.2 HARDWARE INTERFACE 10
2.3 DETAILS OF DIGITAL VIDEO 13
2.3.1 Parallel 8-bit（CMOS8） 16
2.3.2 Parallel 16-bit（CMOS16） 22
2.3.3 Description of BT.656 data 28
2.3.4 LVDS 30
3 OPTIONAL ACCESSORIES 31
3.1 VPC EXPANSION BOARD 31
3.1.1 Description of the functions 31
3.1.2 Application instruction for VPC board 31
4 ICC CONTROL SOFTWARE 32
4.1 INSTALLATION INSTRUCTIONS 32
4.2 INTERCONNECTION BETWEEN MODULE AND PC CONTROL SOFTWARE 37
4.3 OPERATION INSTRUCTIONS OF PC CONTROL SOFTWARE 40
4.3.1 Status 40
4.3.2 Settings 41
4.3.3 Video 43
4.3.3.1 Setting interface of analog video 43
4.3.3.2 The digital video 46
4.3.3.3 Algorithm 50
4.3.4 Advanced Application 55
4.3.4.1 Focus setting interface 55
4.3.4.2 Defective pixel correction interface 57
4.3.4.3 Menu OSD 59
4.3.4.4 Non-uniformity calibration (K) 59
4.3.4.5 Hot tracking 60
4.3.5 Thermography 67
4.3.5.1 parameter setting 67
4.3.5.2 Blackbody correction interface 70

5 FREQUENTLY ASKED QUESTIONS (FAQ) 71
6 SPECIFICATION OF SERIAL COMMUNICATION PROTOCOL 73
6.1 OVERVIEW 73
6.2 MODULE CONNECTION PROTOCOL 74
6.2.1 Downlink protocol 74
6.2.1.1 Control command 75
6. 2. 1. 1. 1 Setup page 76
6. 2. 1. 1. 2 Video page 77
6. 2. 1. 1. 3 Advanced application page 81
6. 2. 1. 1. 4 Temperature measurement page 87
6.2.1.2 Query command 89
6.2.2 Uplink protocol 89
6.2.2.1 Handshake return 89
6.2.2.2 Query return 92
6. 2. 2. 2. 1 Status page 97
6. 2. 2. 2. 2 Setup page 98
6. 2. 2. 2. 3 Video page 99
6. 2. 2. 2. 4 Advanced application page 104
6. 2. 2. 2. 5 Thermography page 111
7 MECHANICAL INTERFACE SPECIFICATION 114
7.1 THE STRUCTURE OF BARE PLUG MODULE 114
7.2 THE STRUCTURE OF BARE PLUG MODULE WITH M34 LENS ADAPTER RING 115
7.3 PLUG TRIPOD INTERFACE（OPTIONAL） 116

1 Product Overview

1.1 Product description

PLUG series core is a high-resolution general-purpose uncooled infrared thermal module, characterized with large area array, high resolution, impact and vibration resistant and good scalability. As a basic thermal imaging module, it provides various industry standard interfaces, which will facilitate secondary development for OEM customers. It offers standard professional thermal imaging solutions for many applications, such as power monitoring, industrial maintenance, security and outdoor sports.

The basic framework of the PLUG module is shown in Figure 1-1.

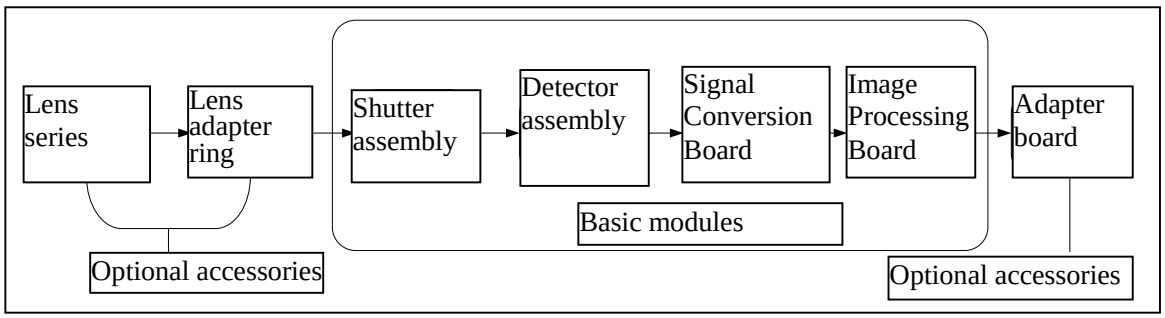


Figure 1-1 Basic framework of PLUG module

The basic core module is the basic unit of the core, which mainly completes the basic imaging functions of the infrared thermal module, including the shutter assembly, the detector assembly, the image processing assembly and the power supply unit. The shutter assembly uses an electromagnetic valve shutter, which has the advantages of good uniformity and short response time. The detector assembly includes infrared detector, PCB and inter-board connector. The signal conversion board is used to realize basic signal processing circuits and time-series transmission channels. The image processing board is mainly used to complete the image processing, analog video and digital video output, as well as power supply of the whole system.

1.2 Product configuration

1.2.1 Technical specification — PLUG612(Observation type)

Detector: uncooled vanadium oxide, 640x512

Pixel pitch: 12um; Spectral: 8~14um; NETD: ≤ 40mk@f1.0

Output: supports analog video and digital video

Analog video: CVBS, 75Ω characteristic impedance

The PAL system (9Hz/25Hz/50Hz) and NTSC system (9Hz/30Hz/60Hz), switchable

Digital video:

Support 8bit,14bit,16bit parallel CMOS, resolution: 640x512

Support BT.656(8bit, interleaved), resolution: 720x576,720x480

Support LVDS(14bit) digital interface, resolution: 640x512

Control communication: RS232-TTL

Boot time: ≤10S, Boot screen supports customization

Support image zoom, rollover, enhancement and pseudo-color

Support SDK for secondary development and function expansion

Physical properties

lens: 24mm, etc

Dimension: 44.5mm*44.5mm*36.1mm(excluding lens)

Assembly interface: M2 x 0.4, 2pc / side, 3 sides in total

Electrical properties

Power supply: DC 4-6V, typical power consumption ≤ 2W @ 5V @23 ± 3℃

Extension board: VPC board

Working temperature: -40℃ to +70℃, humidity 0% to 80%RH

Storage temperature: -45℃ to +85℃, humidity 0% to 85%RH

Impact and vibration resistance: 200g/11ms/ sawtooth, 4.3g/3 axis /8 hours

ROHS Certification

1.2.2 Technical specification — PLUG612R(Thermography type)

Detector: uncooled vanadium oxide, 640x512

Pixel pitch: 12um; Spectral: 8~14um; NETD: ≤ 40mk@f1.0

Output: supports analog video and digital video

Analog video: CVBS, 75Ω characteristic impedance

The PAL system (9Hz/25Hz/50Hz) and NTSC system (9Hz/30Hz/60Hz) , switchable

Digital video:

Support 8bit, 14bit, 16bit parallel CMOS, resolution: 640x512

Support BT.656(8bit, interleaved), resolution: 720x576,720x480

Support LVDS(14bit) digital interface, resolution: 640x512

Control communication: RS232-TTL

Boot time: ≤20S, Boot screen supports customization

Support image zoom, rollover, enhancement and pseudo-color

Support SDK for secondary development and function expansion

Physical properties

lens: 24mm, etc

Dimension: 44.5mm*44.5mm*36.1mm(excluding lens)

Assembly interface: M2 x 0.4, 2pc / side, 3 sides in total

Electrical properties

Power supply: DC 4-6V, typical power consumption ≤ 2.2W @ 5V @23 ± 3℃

Extension board: VPC board

Environmental properties

Working temperature: -40℃ to +70℃, humidity 0% to 80%RH

Storage temperature: -45℃ to +85℃, humidity 0% to 85%RH

Impact and vibration resistance: 200g/11ms/ sawtooth, 4.3g/3 axis /8 hours

ROHS Certification

Thermography: Only 25hz/30hz versions are currently supported

Temperature accuracy：±2℃或±2%(maximum value) in case of 23℃±3℃

Temperature range：two kinds of range(-20℃~+150℃，-20℃~+550℃) can be chosen, Specific requirements can be customized.

1.2.3 Optical configuration

The optical configuration of the PLUG module is shown in Table 1-1.

Table 1-1 Optical configuration

Focal length	Coating	Resolution	f/#	FOV (H×V, ±5%)	Weight (Module+Lens)
24mm (Athermal)	AR	640×512@12um	1.0	**18.1°x14.5°**	**≤140g**

Note:
The gray fraction is in design.
Lenses series of PLUG612 support front lens IP67.
AR stand for anti-reflection film. DLC stand for Hardcarbon film.

1.3 Description of PC control software

Infrared Camera Controller enables online control of the PLUG series.

The PC control software can be used in windows 7/8/10/XP and other operating systems.

Support Chinese/English language.

The ICC installation contains the driver for USB serial driver CP2102.

The typical baud rate is 115200.

1.4 Unpacking

The standard configuration chassis contains a module, a product certificate and accessories.

The module shall be unpacked and used in environment with good electrostatic protection as it contains electrostatic sensitive electronic components. The module shall be put in an antistatic bag to avoid electrostatic damage.

The packing box shall be filled with foam material to prevent damage to the module during transport.

2 Electrical interface instructions

2.1 Input power requirements

The steady-state power consumption of PLUG612 module ≤ 2W@5V, 23±3℃,25Hz.

The steady-state power consumption of PLUG612R module ≤ 2.2W@5V, 23±3℃,25Hz.

When starting up PLUG module, the transient power consumption ≤ 6W@6s;

When compensating the shutter, the transient power consumption ≤ 4W@1s;

Insufficient power supply may cause abnormality in startup and operation.

When using VPC or CAMERALINK expansion board, the power supply voltage range of the module is: DC:4V-6V. This voltage refers to the voltage supplied to the circuit board. In practical application, please consider the influence of line loss and reserve sufficient margin.

2.2 Hardware Interface

The external interface of bare PLUG module is 50PIN interface which includes functions of power input/ output, digital/analog video output, RS232-TTL serial port and independent IO etc.

The external interface model of module is:DF12B-50DS-0.5V (86), (HRS, male connector). The recommended external interface model is：DF12B (5.0)-50DP-0.5V (86), (HRS, female connector).

The position of HRS 50-PIN interface on the circuit board and the pin sequence are shown in Fig. 2-1, XS1. The dimension unit in Fig. 2-1 is mm; relative to the upper left positioning hole center, the coordinate of the first pin center for 50Pin base is (10.7, -0.73).

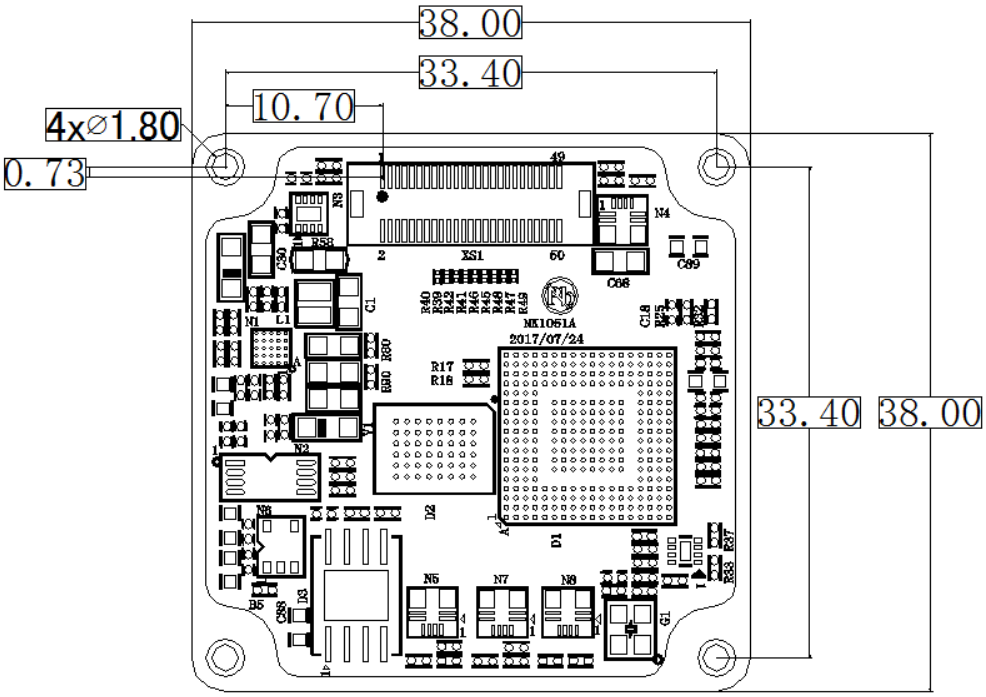


Fig. 2-1 The coordinate diagram of HRS 50-PIN interface

The definition of HRS 50-PIN external interface is shown in Table 2-1.

Table 2-1 The definition of 50-PIN interface

S/N	Signal definition	Signal direction	Level	Description
1	UART0_TXD	O	H 3.3V/L 0V	Send UART0 (core port, the same below)
2	UART0_RXD	I	H 3.3V/L 0V	Receive UART0
3	DIGITAL_HS	O	H 3.3V/L 0V	Digital signal line synchronization
4	DIGITAL_VS	O	H 3.3V/L 0V	Digital signal field synchronization
5	DGND	GND	0V	Power ground
6	DGND	GND	0V	Power ground
7	SCL2/UART1_RX	I/O	H 3.3V/L 0V	SCL2/UART1_RX
8	SDA2/UART1_TX	I/O	H 3.3V/L 0V	SDA2/UART1_TX
9	CLKP_PHY	O	LVDS	LVDS clock +
10	CLKN_PHY	O	LVDS	LVDS clock -
11	SYNCP_PHY	O	LVDS	Synchronizing signal+
12	SYNCN_PHY	O	LVDS	Synchronizing signal-
13	DATAP0_PHY	O	LVDS	LVDS data 0+
14	DATAN0_PHY	O	LVDS	LVDS data 0-
15	DATAP1_PHY	O	LVDS	LVDS data 1+
16	DATAN1_PHY	O	LVDS	LVDS data 1-
17	DGND	GND	0V	Power ground
18	DGND	GND	0V	Power ground
19	DATA_OUT15	O	H 3.3V/L 0V	Digital video signal
20	DATA_OUT13	O	H 3.3V/L 0V	Digital video signal
21	DATA_OUT14	O	H 3.3V/L 0V	Digital video signal
22	DATA_OUT12	O	H 3.3V/L 0V	Digital video signal
23	DATA_OUT11	O	H 3.3V/L 0V	Digital video signal
24	DATA_OUT10	O	H 3.3V/L 0V	Digital video signal
25	DATA_OUT9	O	H 3.3V/L 0V	Digital video signal
26	DATA_OUT8	O	H 3.3V/L 0V	Digital video signal
27	DGND	GND	H 3.3V/L 0V	Digital video signal
28	DGND	GND	H 3.3V/L 0V	Digital video signal
29	DATA_OUT7	O	H 3.3V/L 0V	Digital video signal
30	DATA_OUT6	O	H 3.3V/L 0V	Digital video signal
31	DATA_OUT5	O	H 3.3V/L 0V	Digital video signal
32	DATA_OUT4	O	H 3.3V/L 0V	Digital video signal
33	DATA_OUT3	O	H 3.3V/L 0V	Digital video signal
34	DATA_OUT2	O	H 3.3V/L 0V	Digital video signal
35	DATA_OUT1	O	H 3.3V/L 0V	Digital video signal
36	DATA_OUT0	O	H 3.3V/L 0V	Digital video signal
37	DGND	GND	0V	Power ground
38	DGND	GND	0V	Power ground
39	DATA_OUT_CLK	O	0V	Clock signal
40	EXT_SYNC	I/O	0V	External synchronizing signal
41	DGND	GND	0V	Power ground
42	DGND	GND	0V	Power ground
43	VIDEO_OUT	O	0-1V	Analog video signal output
44	VIDEO_AGND	GND	0V	Analog video ground
45	DGND	GND	0V	Power ground
46	3V3_OUT	POWER-OUT	3.3V	Power output
47	DGND	GND	0V	Power ground
48	POWER_IN	POWER-IN	4-6V	Power input
49	DGND	GND	0V	Power ground

50	POWER_IN	POWER-IN	4-6V	Power input

Note: The signal direction “O” stands for the output, “I” stands for the input and “NC” stands for suspend.

The digital signal Y8/Y16/ BT.656 / BT.601 hardware physical interface is compatible, and the digital signal output type can be switched by ICC control software.

When customers use external synchronous signal, the pin must connect 10 kΩ resistance and drop down to GND.

The multiplex digital signal hardware interface is shown in Table 2-2

Table 2-2 The definition of digital port

Signal definition	**Interface S/N**	**Output type of digital port**		
		Parallel port 8bit	Parallel port 16bit	BT.656
DATA_OUT_CLK	39	Y8_CLK	Y16_CLK	BT656_CLK
EXT_SYNC	40	EXT_SYNC	EXT_SYNC	/
DATA_OUT0	36	Y8_D0	Y16_D0	BT656_D0
DATA_OUT1	35	Y8_D1	Y16_D1	BT656_D1
DATA_OUT2	34	Y8_D2	Y16_D2	BT656_D2
DATA_OUT3	33	Y8_D3	Y16_D3	BT656_D3
DATA_OUT4	32	Y8_D4	Y16_D4	BT656_D4
DATA_OUT5	31	Y8_D5	Y16_D5	BT656_D5
DATA_OUT6	30	Y8_D6	Y16_D6	BT656_D6
DATA_OUT7	29	Y8_D7	Y16_D7	BT656_D7
DATA_OUT8	26	/	Y16_D8	/
DATA_OUT9	25	/	Y16_D9	/
DATA_OUT10	24	/	Y16_D10	/
DATA_OUT11	23	/	Y16_D11	/
DATA_OUT12	22	/	Y16_D12	/
DATA_OUT13	20	/	Y16_D13	/
DATA_OUT14	21	/	Y16_D14	/
DATA_OUT15	19	/	Y16_D15	/
DIGITAL_VS	4	Y8_FIELD_VALID	Y16_FIELD_VALID	/
DIGITAL_HS	3	Y8_LINE_VALID	Y16_LINE_VALID	/

Notes:

Y16 data are parallel 16bit data, Y16_D0 stands for low order, and Y16_D15 stands for high order. Such raw data are not subject to dimming.

Y8 data are parallel 8bit data, Y8_D0 stands for low order, and Y8_D7 stands for high order. Such data are subject to dimming.

The BT.656 interface outputs data in the standard BT.656 format, interlaced. See ITU-R Recommendation ITU-R BT.656-5(12/2007) for details. In present, support two kinds of resolution:720x576(valid resolution 640*512, centered windowing), 720x480(valid resolution 640*480, centered windowing and clipping). BT656 digital port does not support external synchronization.

BT.601 interface (YUV format), 16bit parallel data: D15~D8 is Y signal, D7~D0 is UV data;

EXT_SYNC: Only for external synchronization requirements, not necessary digital port signal, support external synchronization input and external synchronization output mode, when do not use the external synchronization interface, be sure to turn off the external synchronization function.

2.3 Details of digital video

PLUG module supports multiple digital video format output; the output video clock is related to the system, frame frequency and CMOS interface bit width. The specific list is as follows:

Table 2-3 Overview of digital video clock（Unit：MHz）

Data source	resulotion	640*512							
	Frame rate	25Hz		30Hz		50Hz		60Hz	
	CMOS	16bit	8bit	16bit	8bit	16bit	8bit	16bit	8bit
Y16		13.5	27	13.5	27	27	54	27	54
Y16+para.		13.5	27	13.5	27	27	54	27	54
YUV422		13.5	27	13.5	27	27	54	27	54
YUV422+para.		13.5	27	13.5	27	27	54	27	54
Y16+YUV422		27	54	27	54	(This function is not supported)			
Y16+para.+YUV422		27	54	27	54				
BT656		/	27	/	27	/	27	/	27
LVDS		94.5 (Serial transmit clock)				(This function is not supported)			
备注		1. BT656 25/50Hz Digital video resolution is 720*576，valid is 640*512 2. BT656 30/60Hz Digital video resolution is 720*480，valid is 640*480 3. The alignment phase of the output data with the output clock can be configured with serial port instructions 4. 50/60Hz（TBD）							

The data format is as follows:

Y16

- CMOS16：Y16[15:0], Y16[15:0], etc
- CMOS8(MSB)：Y16[15:8],Y16[7:0], Y16[15:8],Y16[7:0],etc
- CMOS8(LSB)：Y16[7:0],Y16[15:8], Y16[7:0],Y16[15:8],etc

YUV422

- CMOS16：YCb[15:0],YCr[15:0], YCb[15:0],YCr[15:0],etc
- CMOS8(MSB)：Y[7:0],Cb[7:0],Y[7:0],Cr[7:0],Y[7:0],Cb[7:0],Y[7:0],Cr [7:0],etc
- CMOS8(LSB)：Cb[7:0],Y[7:0], Cr[7:0],Y[7:0], Cb[7:0],Y[7:0], Cr[7:0],Y[7:0], etc

Note：

1.CMOSx use x physical channel for data transmission;

2.Patameter line format：

- CMOS16：Head1[15:0], Head2[15:0],Para1[15:0]，Para2[15:0]…Para40[15:0]，End1[15:0]，End2[15:0]；
- CMOS8(MSB)：Head1[15:8] ,Head1 [7:0], Head2[15:8] ,Head2 [7:0],Para1[15:8] ,Para1[7:0] ,Para2[15:8] ,Para2[7:0] …Para40[15:8] ,Para40[7:0] End1[15:8],End1[7:0] ,End2[15:8],End2[7:0]；
- CMOS8(LSB)：Head1[7:0], Head1 [15:8], Head2[7:0], Head2 [15:8], Para1[7:0], Para1[15:8] , Para2[7:0] ,Para2[15:8] …Para40[7:0] ,Para40[15:8] End1[7:0],End1[15:8] ,End2[7:0],End2[15:8]；

Tab 2-3b Digital video overview index table

Data Format	Bits	Data source	Std	Frame Rate(Hz)	Resolution	Data stream	Table	Figure	Figure
BT601 (line, filed, Data)	CMOS8	Y16		60	640x512	MSB/LSB	Tab. 2-4b	Fig. 2-3	Fig. 2-2a
BT601 (line, filed, Data)	CMOS8	Y16		25	640x512	MSB/LSB	Tab. 2-4a	Fig. 2-3	Fig. 2-2a
BT601 (line, filed, Data)	CMOS8	Y16		30	640x512	MSB/LSB	Tab. 2-4a	Fig. 2-3	Fig. 2-2a
BT601 (line, filed, Data)	CMOS8	YUV422		50	640x512	MSB/LSB	Tab. 2-4b	Fig. 2-4	Fig. 2-2a
BT601 (line, filed, Data)	CMOS8	YUV422		25	640x512	MSB/LSB	Tab. 2-4a	Fig. 2-4	Fig. 2-2a
BT601 (line, filed, Data)	CMOS8	YUV422		30	640x512	MSB/LSB	Tab. 2-4a	Fig. 2-4	Fig. 2-2a
BT601 (line, filed, Data)	CMOS8	YUV422		60	640x512	MSB/LSB	Tab. 2-4b	Fig. 2-4	Fig. 2-2a
BT601 (line, filed, Data)	CMOS8	Y16+YUV422		25	640x1024	MSB/LSB	Tab. 2-4c	Fig. 2-3 2-4	Fig. 2-2b
BT601 (line, filed, Data)	CMOS8	Y16+YUV422		30	640x1024	MSB/LSB	Tab. 2-4c	Fig. 2-3 2-4	Fig. 2-2b
BT601 (line, filed, Data)	CMOS8	Y16+ Para.		50	640x513	MSB/LSB	Tab. 2-5b	Fig. 2-6	Fig. 2-5a
BT601 (line, filed, Data)	CMOS8	Y16+ Para.		60	640x513	MSB/LSB	Tab. 2-5b	Fig. 2-6	Fig. 2-5a
BT601 (line, filed, Data)	CMOS8	Y16+ Para.		25	640x513	MSB/LSB	Tab. 2-5a	Fig. 2-6	Fig. 2-5a
BT601 (line, filed, Data)	CMOS8	Y16+ Para.		30	640x513	MSB/LSB	Tab. 2-5a	Fig. 2-6	Fig. 2-5a
BT601 (line, filed, Data)	CMOS8	YUV422 + Para.		50	640x513	MSB/LSB	Tab. 2-5b	Fig. 2-7	Fig. 2-5a
BT601 (line, filed, Data)	CMOS8	YUV422 + Para.		60	640x513	MSB/LSB	Tab. 2-5b	Fig. 2-7	Fig. 2-5a
BT601 (line, filed, Data)	CMOS8	YUV422 + Para.		25	640x513	MSB/LSB	Tab. 2-5a	Fig. 2-7	Fig. 2-5a

Data Format	Bits	Data source	Std	Frame Rate(Hz)	Resolution	Data stream	Table	Figure	Figure
BT601 (line, filed, Data)	CMOS8	YUV422 + Para.		30	640x513	MSB/LSB	Tab. 2-5a	Fig. 2-7	Fig. 2-5a
BT601 (line, filed, Data)	CMOS8	Y16+YUV422+ Para.		25	640x1025	MSB/LSB	Tab. 2-5c	Fig. 2-6 2-7	Fig. 2-5b
BT601 (line, filed, Data)	CMOS8	Y16+YUV422+ Para.		30	640x1025	MSB/LSB	Tab. 2-5c	Fig. 2-6 2-7	Fig. 2-5b
BT601 (line, filed, Data)	CMOS16	Y16		50	640x512		Tab. 2-6b	Fig. 2-9	Fig. 2-8a
BT601 (line, filed, Data)	CMOS16	Y16		60	640x512		Tab. 2-6b	Fig. 2-9	Fig. 2-8a
BT601 (line, filed, Data)	CMOS16	Y16		25	640x512		Tab. 2-6a	Fig. 2-9	Fig. 2-8a
BT601 (line, filed, Data)	CMOS16	Y16		30	640x512		Tab. 2-6a	Fig. 2-9	Fig. 2-8a
BT601 (line, filed, Data)	CMOS16	YUV422		50	640x512		Tab. 2-6b	Fig. 2-10	Fig. 2-8a
BT601 (line, filed, Data)	CMOS16	YUV422		25	640x512		Tab. 2-6a	Fig. 2-10	Fig. 2-8a
BT601 (line, filed, Data)	CMOS16	YUV422		30	640x512		Tab. 2-6a	Fig. 2-10	Fig. 2-8a
BT601 (line, filed, Data)	CMOS16	YUV422		60	640x512		Tab. 2-6b	Fig. 2-10	Fig. 2-8a
BT601 (line, filed, Data)	CMOS16	Y16+YUV422		25	640x1024		Tab. 2-6c	Fig. 2-9 2-10	Fig. 2-8b
BT601 (line, filed, Data)	CMOS16	Y16+YUV422		30	640x1024		Tab. 2-6c	Fig. 2-9 2-10	Fig. 2-8b
BT601 (line, filed, Data)	CMOS16	Y16+ Para.		50	640x513		Tab. 2-7b	Fig. 2-12	Fig. 2-11a
BT601 (line, filed, Data)	CMOS16	Y16+ Para.		60	640x513		Tab. 2-7b	Fig. 2-12	Fig. 2-11a
BT601 (line, filed, Data)	CMOS16	Y16+ Para.		25	640x513		Tab. 2-7a	Fig. 2-12	Fig. 2-11a
BT601 (line, filed, Data)	CMOS16	Y16+ Para.		30	640x513		Tab. 2-7a	Fig. 2-12	Fig. 2-11a
BT601 (line, filed, Data)	CMOS16	YUV422 +Para.		50	640x513		Tab. 2-7b	Fig. 2-13	Fig. 2-11a
BT601 (line, filed, Data)	CMOS16	YUV422 +Para.		60	640x513		Tab. 2-7b	Fig. 2-13	Fig. 2-11a
BT601 (line, filed, Data)	CMOS16	YUV422 +Para.		25	640x513		Tab. 2-7a	Fig. 2-13	Fig. 2-11a
BT601 (line, filed, Data)	CMOS16	YUV422 +Para.		30	640x513		Tab. 2-7a	Fig. 2-13	Fig. 2-11a
BT601 (line, filed, Data)	CMOS16	Y16+YUV422+ Para.		25	640x1025		Tab. 2-7c	Fig. 2-12 2-13	Fig. 2-11b
BT601 (line, filed, Data)	CMOS16	Y16+YUV422+ Para.		30	640x1025		Tab. 2-7c	Fig. 2-12 2-13	Fig. 2-11b

Data Format	Bits	Data source	Std	Frame Rate(Hz)	Resolution	Data stream	Table	Figure	Figure
BT656 (CMOS8, Interleaved)	CMOS8	YUV422	P	25	720x576		Tab. 2-8 2-9	Fig. 2-14	
BT656 (CMOS8, Interleaved)	CMOS8	YUV422	N	30	720x480		Tab. 2-8 2-9	Fig. 2-14	

2.3.1 Parallel 8-bit (CMOS8)

2.3.1.1 CMOS8 without parameter line

The timing parameters of parallel 8bit digital video (without parameter line)are shown in Table 2-4. The table 2-4a & 2-4b are applicable to data sources as Y16 and YUV422, the table 2-4c is applicable to Y16 + YUV422.

Table 2-4a Digital port 8bit sequence parameters 1

Video format	25Hz （Y16/YUV422）			30Hz （Y16/YUV422）		
Description	Typical value	Unit	Remarks	Typical value	Unit	Remarks
Resolution	640×512			640×512		
NW	640			640		
NH	512			512		
DIGITAL_CLK	27	MHz		27	MHz	
TLine	64	us	1728 CLK	63.55..	us	1716 CLK
TLine_Valid	47.407..	us	1280 CLK	47.407..	us	1280 CLK
TLine_Blank	16.592..	us	448 CLK	16.148..	us	436 CLK
TPixel	0.037..	us	1 CLK	0.037..	us	1 CLK
TStart	1.333..	us	36 CLK	1.333..	us	36 CLK
TFrame	40ms	ms	625 Line	33.366..	ms	525 Line
TField_Valid	32.768	ms	512 Line	32.54	ms	512 Line
TField_Blank	7.232	ms	113 Line	0.826	ms	13 Line

Tab.2-4b Digital port 8bit sequence parameters 2

Video format	50Hz (Y16/YUV422)			60Hz (Y16/YUV422)		
Description	Typical value	Unit	Remarks	Typical value	Unit	Remarks
Resolution	640×512			640×512		
NW	640			640		
NH	512			512		
DIGITAL_CLK	54	MHz		54	MHz	

TLine	32	us	1728 CLK	31.77..	us	1716 CLK
TLine_Valid	23.703..	us	1280 CLK	23.703..	us	1280 CLK
TLine_Blank	8.296..	us	448 CLK	8.074..	us	436 CLK
TPixel	0.0185..	us	1 CLK	0.0185..	us	1 CLK
TStart	0.666..	us	36 CLK	0.666..	us	36 CLK
TFrame	20ms	ms	625 Line	16.6833..	ms	525 Line
TField_Valid	16.384	ms	512 Line	16.27022	ms	512 Line
TField_Blank	3.616	ms	113 Line	0.4131	ms	13 Line

Tab.2-4c Digital port 8bit sequence parameters 3

Video Format	**25Hz（Y16+YUV422）**			**30Hz（Y16+YUV422）**		
Description	Typical Value	Unit	Remarks	Typical Value	Unit	Remarks
Resolution	640*1024			640*1024		
NW	640			640		
NH	1024			1024		
DIGITAL_CLK	54	MHz		54	MHz	
TLine	32	us	1728 CLK	31.77..	us	1716 CLK
TLine_Valid	23.703..	us	1280 CLK	23.703..	us	1280 CLK
TLine_Blank	8.296..	us	448 CLK	8.074..	us	436 CLK
TPixel	0.0185..	us	1 CLK	0.0185..	us	1 CLK
TStart	0.666..	us	36 CLK	0.666..	us	36 CLK
TFrame	40ms	ms	1250 Line	33.366..	ms	1050 Line
TField_Valid	32.768	ms	1024 Line	32.54	ms	1024 Line
TField_Blank	7.232	ms	226 Line	0.826	ms	26 Line

The frame timing sequence for Y16/YUV422 is shown in Fig.2-2a. The frame timing sequence for Y16+YUV422 is shown in Fig.2-2b;

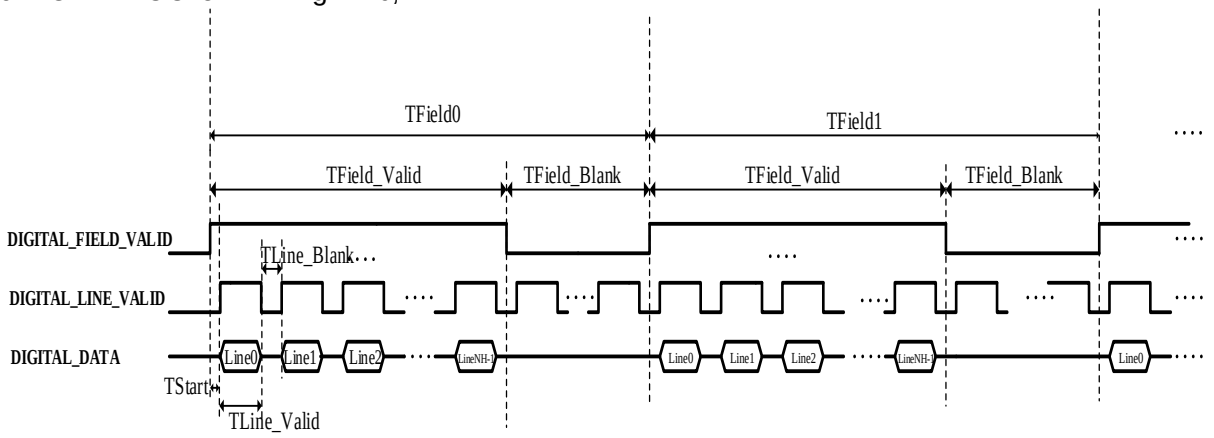


Fig. 2-2a Y16/YUV422(without parameter line) frame sequence diagram

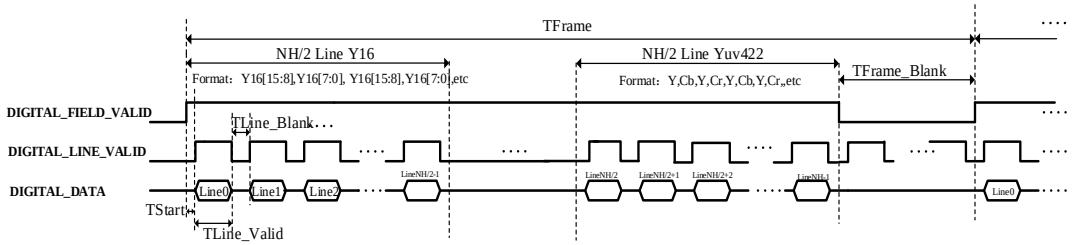


Fig. 2-2b Y16+YUV422(without parameter line) frame sequence diagram

The timing sequence of parallel 8bits for data source Y16 is shown in Fig. 2-3.

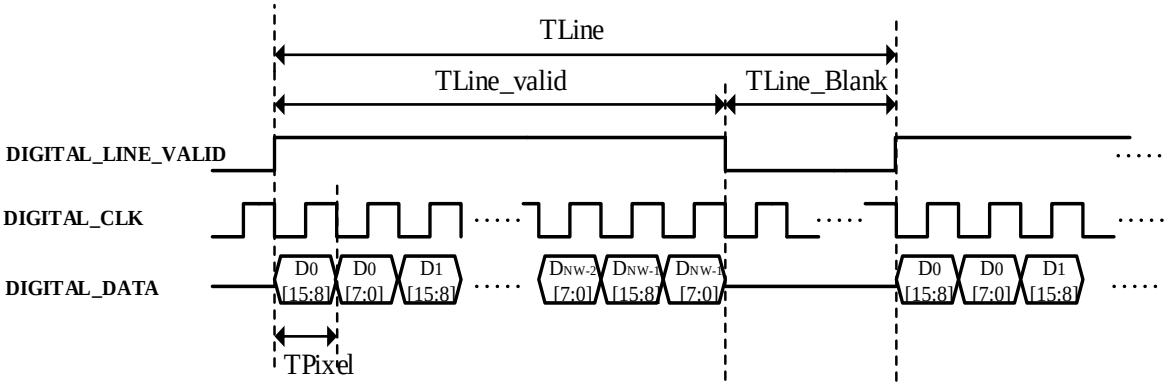


Fig. 2-3a Y16 (MSB) timing sequence diagram

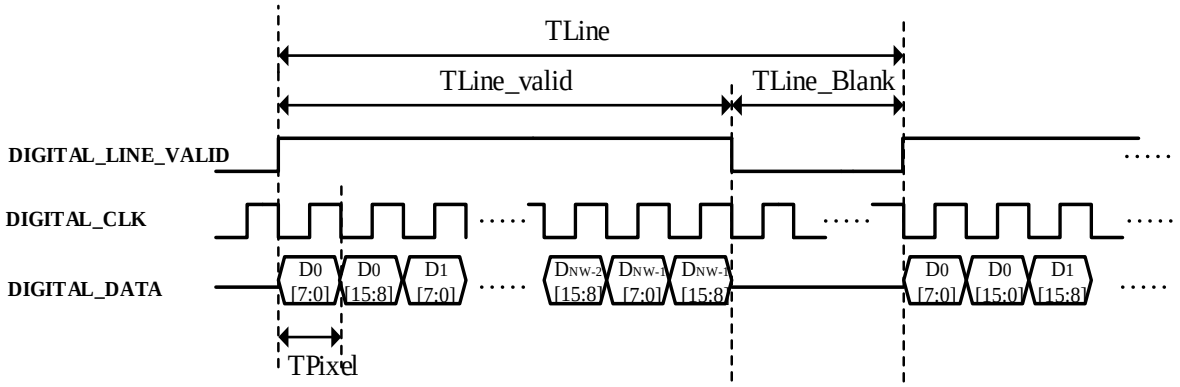


Fig. 2-3b Y16 (LSB) timing sequence diagram

The timing sequence of parallel 8bits for data source YUV422 is shown in Fig. 2-4.

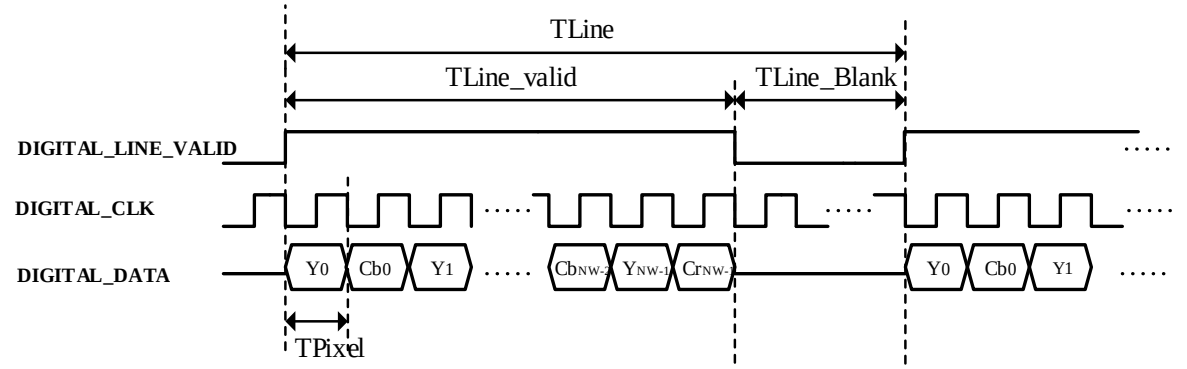


Fig. 2-4a YUV422 (MSB) timing sequence diagram

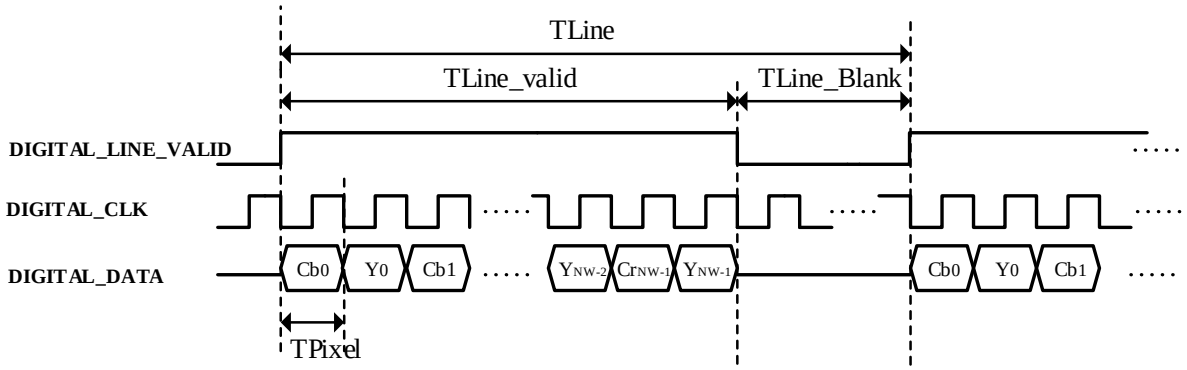


Fig. 2-4b YUV422 (LSB) timing sequence diagram

The timing sequence of parallel 8bits for data source Y16+YUV422 is shown as same as Y16 & YUV422

2.3.1.2 CMOS8 with parameter line

Parallel 8-bit digital video timing parameters (with parameter line) are shown in Table 2-5. The table 2-5a & 2-5b are applicable to data sources as Y16 and YUV422, the table 2-5c is applicable to Y16 + YUV422.

Table 2-5a Digital port 8bit sequence parameters 1(with parameter line)

Video format	25Hz （Y16/YUV422）			30Hz （Y16/YUV422）		
Description	Typical value	Unit	Description	Typical value	Unit	Description
Resolution	640×513			640×513		
NW	640			640		
NH	513		With a line parameter	513		With a line parameter
DIGITAL_CLK	27	MHz		27	MHz	
TLine	64	us	1728 CLK	63.55..	us	1716 CLK
TLine_Valid	47.407..	us	1280 CLK	47.407..	us	1280 CLK
TLine_Blank	16.592..	us	448 CLK	16.148..	us	436 CLK
TPixel	0.037..	us	1 CLK	0.037..	us	1 CLK
TStart	1.333..	us	36 CLK	1.333..	us	36 CLK
TFrame	40ms	ms	625 Line	33.366..	ms	525 Line
TField_Valid	32.832	ms	513 Line	32.604	ms	513 Line
TField_Blank	7.168	ms	112 Line	0.7626	ms	12 Line

Table 2-5b Digital port 8bit sequence parameters 2(with parameter line)

Video format	50Hz （Y16/YUV422）			60Hz （Y16/YUV422）		
Description	Typical value	Unit	Description	Typical value	Unit	Description
Resolution	640×513			640×513		
NW	640			640		
NH	513		With a line parameter	513		With a line parameter
DIGITAL_CLK	54	MHz		54	MHz	
TLine	32	us	1728 CLK	31.77..	us	1716 CLK
TLine_Valid	23.703..	us	1280 CLK	23.703..	us	1280 CLK
TLine_Blank	8.296..	us	448 CLK	8.074..	us	436 CLK
TPixel	0.0185..	us	1 CLK	0.0185..	us	1 CLK
TStart	0.666..	us	36 CLK	0.666..	us	36 CLK
TFrame	20ms	ms	625 Line	16.6833..	ms	525 Line
TField_Valid	16.416	ms	513 Line	16.302	ms	513 Line
TField_Blank	3.584	ms	112 Line	0.3813	ms	12 Line

Tab 2-5c Digital port 8bit sequence parameter 3(with parameter line)

Video format	**25Hz （Y16+YUV422）**			**30Hz （Y16+YUV422）**		
Description	Typical Value	Unit	Description	Typical Value	Unit	Description
Resolution	640*1025			640*1025		
NW	640			640		
NH	1025		With a line parameter	1025		With a line parameter
DIGITAL_CLK	54	MHz		54	MHz	
TLine	32	us	1728 CLK	31.77..	us	1716 CLK
TLine_Valid	23.703..	us	1280 CLK	23.703..	us	1280 CLK
TLine_Blank	8.296..	us	448 CLK	8.074..	us	436 CLK
TPixel	0.0185..	us	1 CLK	0.0185..	us	1 CLK
TStart	0.666..	us	36 CLK	0.666..	us	36 CLK
TFrame	40ms	ms	1250 Line	33.366..	ms	1050 Line
TField_Valid	32.8	ms	1025 Line	32.572	ms	1025 Line
TField_Blank	7.2	ms	225 Line	0.794	ms	25 Line

The frame timing sequence of parallel 8bits for Y16/YUV422 with parameter line is shown in Fig.2-5a.The frame timing sequence of parallel 8bits for Y16+YUV422 with parameter line is shown in Fig.2-5b.

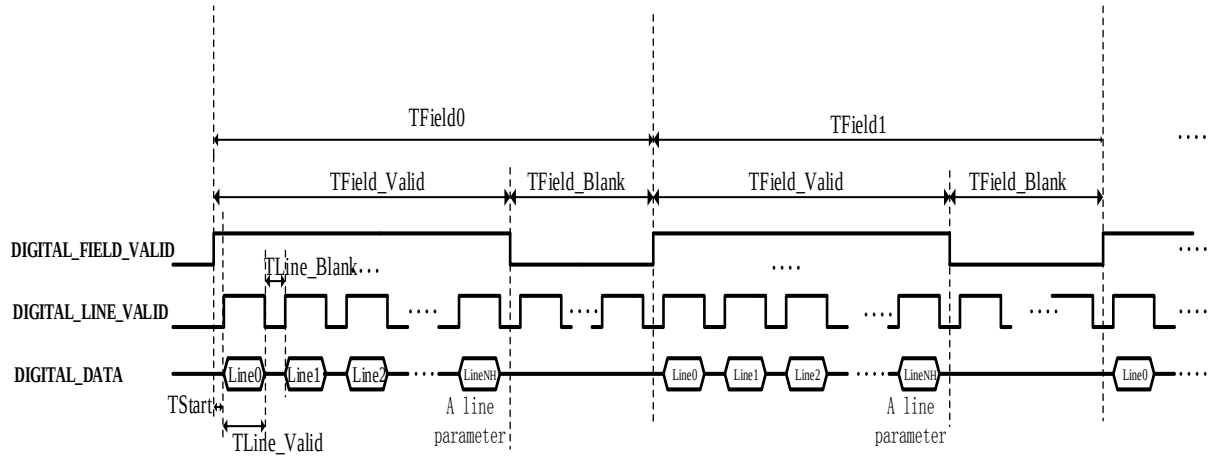


Fig. 2-5a Y16/YUV422+parameter frame sequence diagram

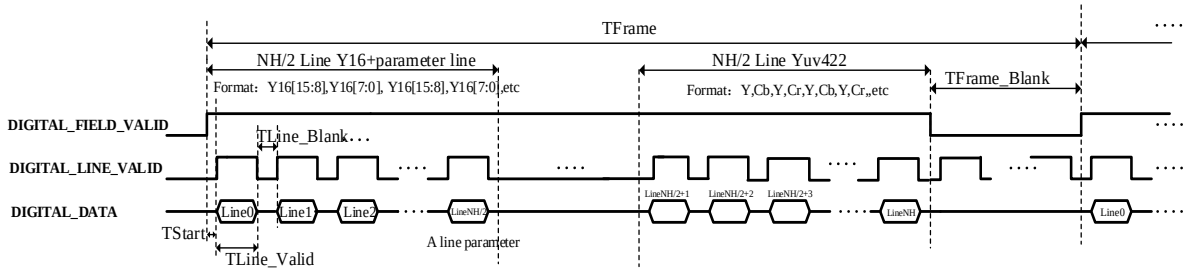


Fig. 2-5b Y16+YUV422+parameter frame sequence diagram

The timing sequence of parallel 8bits for data source Y16+parameters is shown in Fig.2-6.

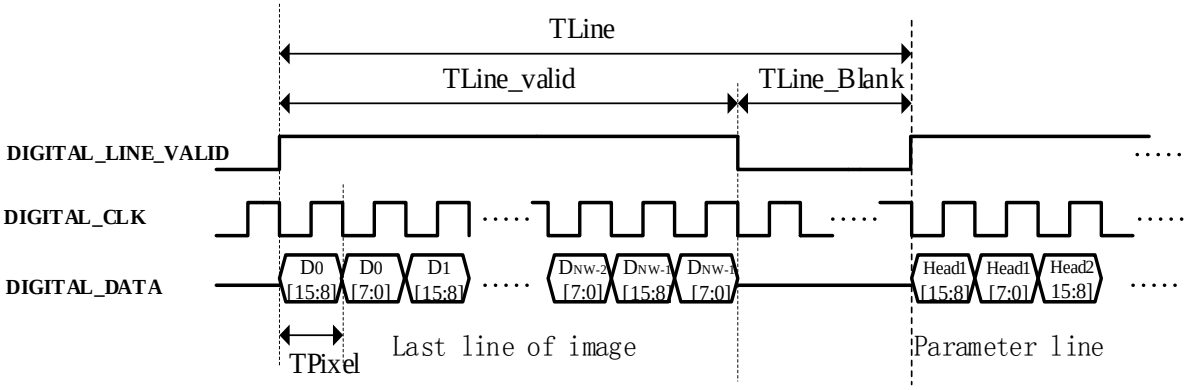


Fig. 2-6a Y16 + parameter (MSB) timing sequence diagram

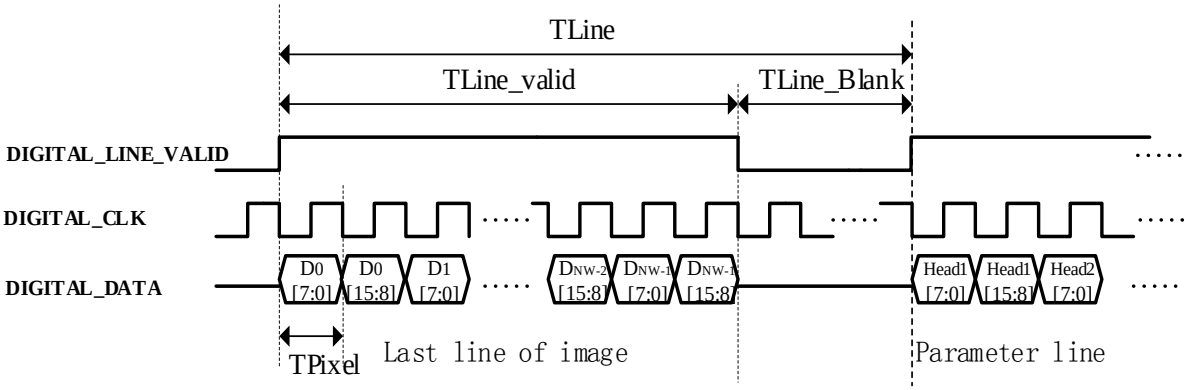


Fig. 2-6b Y16+ parameter (LSB) timing sequence diagram

The timing sequence of parallel 8bits for data source YUV422+parameters is shown in Fig.2-7.

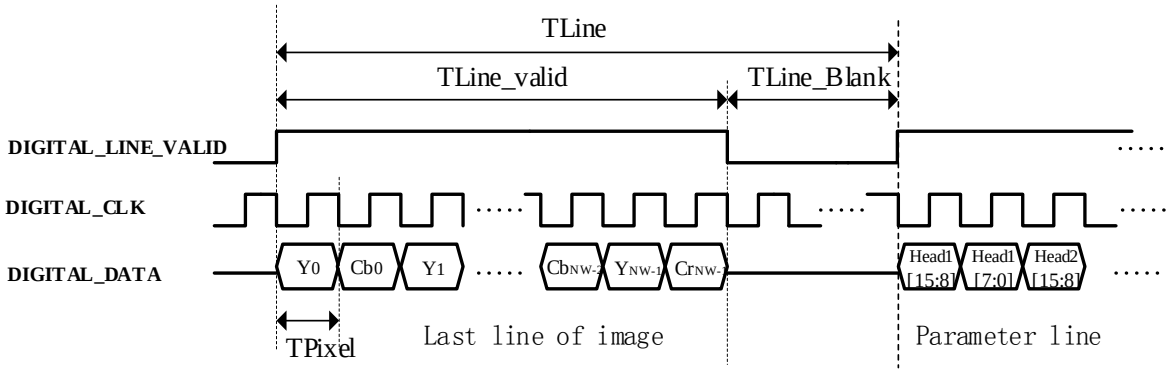


Fig.2-7a YUV422+parameter (MSB) timing sequence diagram

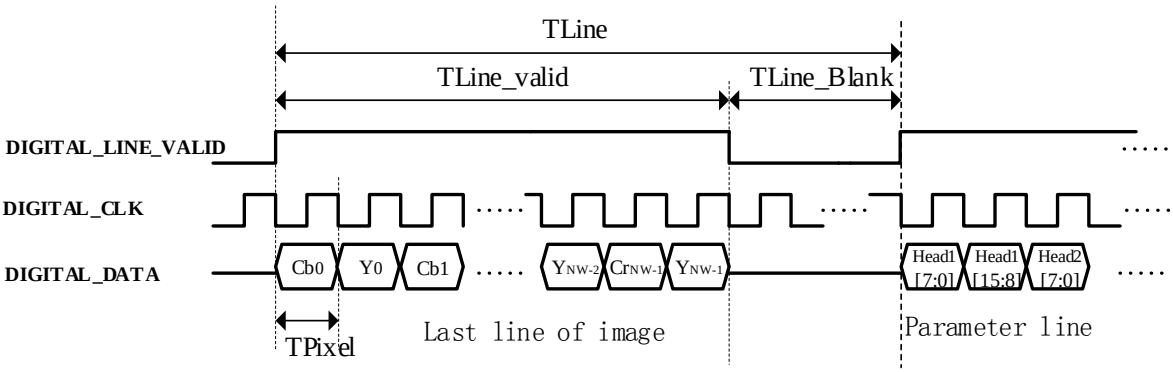


Fig. 2-7b YUV422+parameter(LSB) timing sequence diagram

The timing sequence of parallel 8bits for data source Y16+YUV422 is shown as same as Y16 & YUV422

2.3.2 Parallel 16-bit (CMOS16)

2.3.2.1 CMOS16 without parameter line

The timing parameters of parallel 16bit digital video are shown in Table 2-6. The table 2-6a & 2-6b are applicable to data sources as Y16 and YUV422, the table 2-6c is applicable to Y16 + YUV422.

Table 2-6a Digital port 16bit sequence parameters 1

Video format	**25Hz (Y16/YUV422)**			**30Hz (Y16/YUV422)**		
Description	Typical value	Unit	Remarks	Typical value	Unit	Remarks
Resolution	640×512			640×512		
NW	640			640		
NH	512			512		
DIGITAL_CLK	13.5	MHz		13.5	MHz	
TLine	64	us	864 CLK	63.55..	us	858 CLK
TLine_Valid	47.407..	us	640 CLK	47.407..	us	640 CLK
TLine_Blank	16.592..	us	224 CLK	16.148..	us	218 CLK
TPixel	0.074..	us	1 CLK	0.074..	us	1 CLK

TStart	1.333..	us	18 CLK	1.333..	us	18 CLK
TFrame	40ms	ms	625 Line	33.366..	ms	525 Line
TField_Valid	32.768	ms	512 Line	32.54	ms	512 Line
TField_Blank	7.232	ms	113 Line	0.826	ms	13 Line

Table 2-6b Digital port 16bit sequence parameters 2

Video format（data source）	**50Hz (Y Y16/YUV422)**			**60Hz (Y16/YUV422)**		
Description	Typical value	Unit	Remarks	Typical value	Unit	Remarks
Resolution	640×512			640×512		
NW	640			640		
NH	512			512		
DIGITAL_CLK	27	MHz		27	MHz	
TLine	32	us	864 CLK	31.77..	us	858 CLK
TLine_Valid	23.703..	us	640 CLK	23.703..	us	640 CLK
TLine_Blank	8.296..	us	224 CLK	8.074..	us	218 CLK
TPixel	0.037..	us	1 CLK	0.037..	us	1 CLK
TStart	0.666..	us	18 CLK	0.666..	us	18 CLK
TFrame	20ms	ms	625 Line	16.6833..	ms	525 Line
TField_Valid	16.384	ms	512 Line	16.27022	ms	512 Line
TField_Blank	3.616	ms	113 Line	0.4131	ms	13 Line

Tab 2-6c Digital port 16bit sequence parameter 3(without parameter line)

Video format	**25Hz （Y16+YUV422）**			**30Hz （Y16+YUV422）**		
Description	Typical Value	Unit	Remarks	Typical Value	Unit	Remarks
Resolution	640*1024			640*1024		
NW	640			640		
NH	1024			1024		
DIGITAL_CLK	27	MHz		27	MHz	
TLine	32	us	864 CLK	31.77..	us	858 CLK
TLine_Valid	23.703..	us	640 CLK	23.703..	us	640 CLK
TLine_Blank	8.296..	us	224 CLK	8.074..	us	218 CLK
TPixel	0.037..	us	1 CLK	0.037..	us	1 CLK
TStart	0.666..	us	18 CLK	0.666..	us	18 CLK
TFrame	40ms	ms	1250 Line	33.366..	ms	1050 Line
TField_Valid	32.768	ms	1024 Line	32.54	ms	1024 Line
TField_Blank	7.232	ms	226 Line	0.826	ms	26 Line

The frame timing sequence of parallel 16bits for Y16/YUV422 is shown in Fig.2-8a. The frame timing sequence of parallel 16bits for Y16+YUV422 is shown in Fig.2-8b.

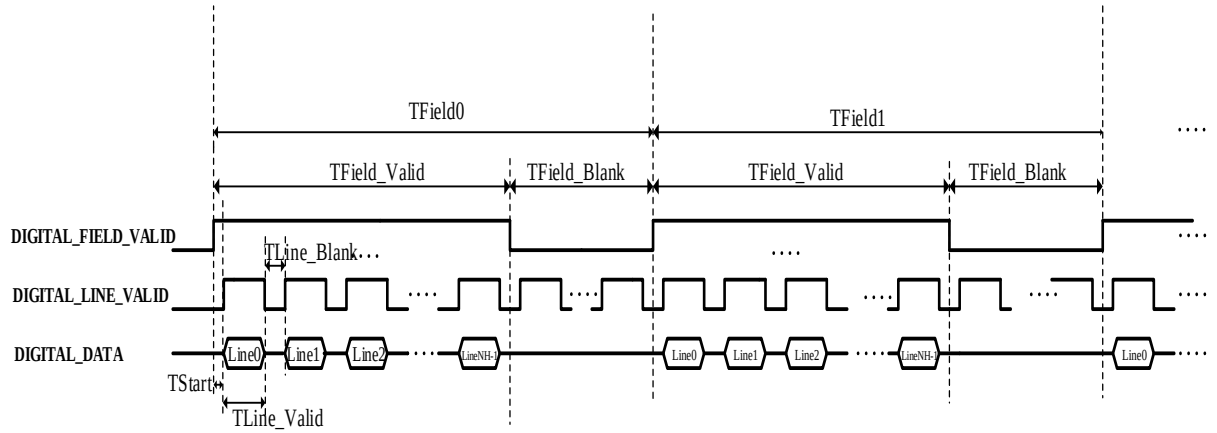


Fig.2-8a CMOS16, parallel 16bit without parameter line frame timing sequence diagram

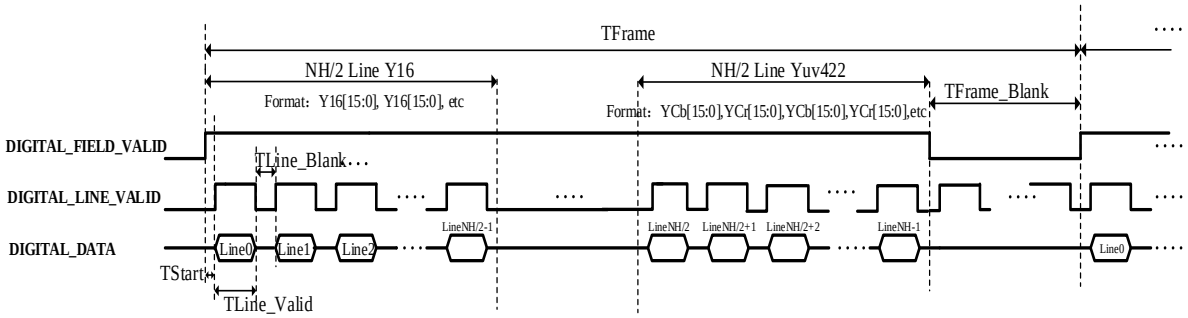


Fig.2-8b Y16+YUV422 without parameter line frame timing sequence diagram

The timing sequence of parallel 16bits for data source Y16 is shown in Fig.2-9.

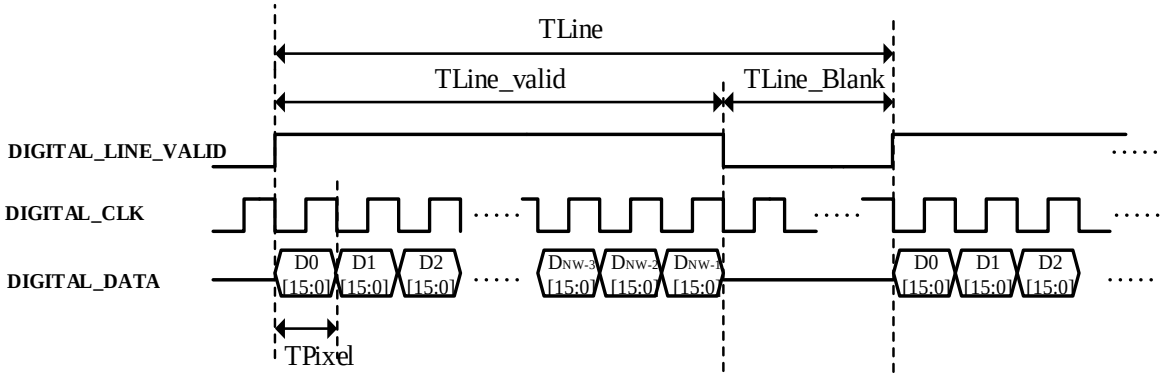


Fig.2-9 CMOS16, Y16 timing sequence diagram

The timing sequence of parallel 16bits for data source YUV422 is shown in Fig.2-10.

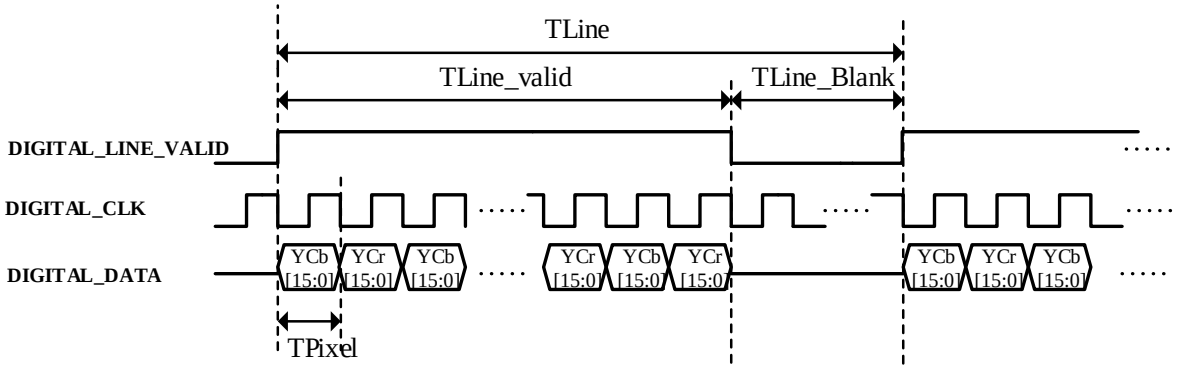


Fig.2-10 CMOS16, YUV422 timing sequence diagram

The timing sequence diagram of parallel 16bits for data source Y16+YUV422 without parallel line is as same as Y16 & YUV422.

2.3.2.2 CMOS16 with parameter line

Parallel 16bit digital video (including parameter line) timing parameters are shown in Table 2-7, the timing of table 2-7a,2-7b are apply to the data source is Y16, YUV422.the timing of table 2-7c is apply to the data source is Y16+YUV422.

Table2-7a Digital port 16bit sequence parameters (with parameter line)1

Video format	**25Hz (Y16/YUV422)**			**30Hz (Y16/YUV422)**		
Description	Typical value	Unit	Description	Typical value	Unit	Description
Resolution	640*513			640*513		
NW	640			640		
NH	513		With a line parameter	513		With a line parameter
DIGITAL_CLK	13.5	MHz		13.5	MHz	
TLine	64	us	864 CLK	63.55..	us	858 CLK
TLine_Valid	47.407..	us	640 CLK	47.407..	us	640 CLK
TLine_Blank	16.592..	us	224 CLK	16.148..	us	218 CLK
TPixel	0.074..	us	1 CLK	0.074..	us	1 CLK
TStart	1.333..	us	18 CLK	1.333..	us	18 CLK
TFrame	40ms	ms	625 Line	33.366..	ms	525 Line
TField_Valid	32.832	ms	513 Line	32.604	ms	513 Line
TField_Blank	7.168	ms	112 Line	0.7626	ms	12 Line

Table2-7b Digital port 16bit sequence parameters (with parameter line)2

Video format	**50Hz (Y16/YUV422)**			**60Hz (Y16/YUV422)**		
Description	Typical value	Unit	Description	Typical value	Unit	Description
Resolution	640*513			640*513		

NW	640			640		
NH	513		With a line parameter	513		With a line parameter
DIGITAL_CLK	27	MHz		27	MHz	
TLine	32	us	864 CLK	31.77..	us	858 CLK
TLine_Valid	23.703..	us	640 CLK	23.703..	us	640 CLK
TLine_Blank	8.296..	us	224 CLK	8.074..	us	218 CLK
TPixel	0.037..	us	1 CLK	0.037..	us	1 CLK
TStart	0.666..	us	18 CLK	0.666..	us	18 CLK
TFrame	20ms	ms	625 Line	16.6833..	ms	525 Line
TField_Valid	16.416	ms	513 Line	16.302	ms	513 Line
TField_Blank	3.584	ms	112 Line	0.3813	ms	12 Line

Tab. 2-7c Digital port 16bit sequence parameters (with parameter line)3

Video format	**25Hz（Y16+YUV422）**			**30Hz（Y16+YUV422）**		
Description	Typical value	Unit	Description	典型值	Unit	Description
Resolution	640*1025			640*1025		
NW	640			640		
NH	1025		With a line parameter	1025		With a line parameter
DIGITAL_CLK	27	MHz		54	MHz	
TLine	32	us	864 CLK	31.77..	us	858 CLK
TLine_Valid	23.703..	us	640 CLK	23.703..	us	640 CLK
TLine_Blank	8.296..	us	224 CLK	8.074..	us	218 CLK
TPixel	0.037..	us	1 CLK	0.037..	us	1 CLK
TStart	0.666..	us	18 CLK	0.666..	us	18 CLK
TFrame	40ms	ms	1250 Line	33.366..	ms	1050 Line
TField_Valid	32.8	ms	1025 Line	32.572	ms	1025 Line
TField_Blank	7.2	ms	225 Line	0.794	ms	25 Line

The frame timing sequence of parallel 16bits for Y16/YUV422 with parameter line is shown in Fig.2-11a.

The frame timing sequence of parallel 16bits for Y16+YUV422 with parameter line is shown in Fig.2-11b.

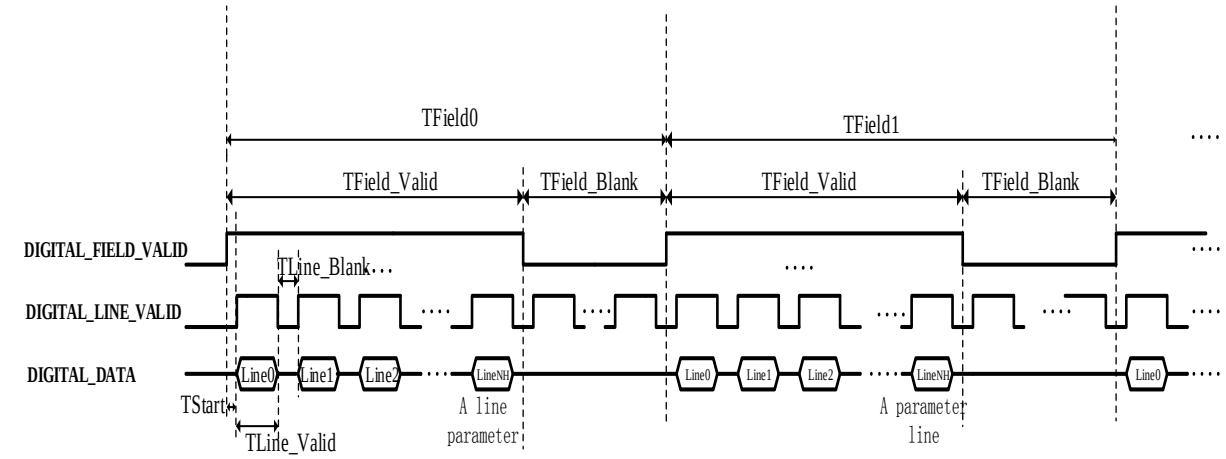


Fig.2-11a Y16/YUV422+parameter frame timing sequence diagram

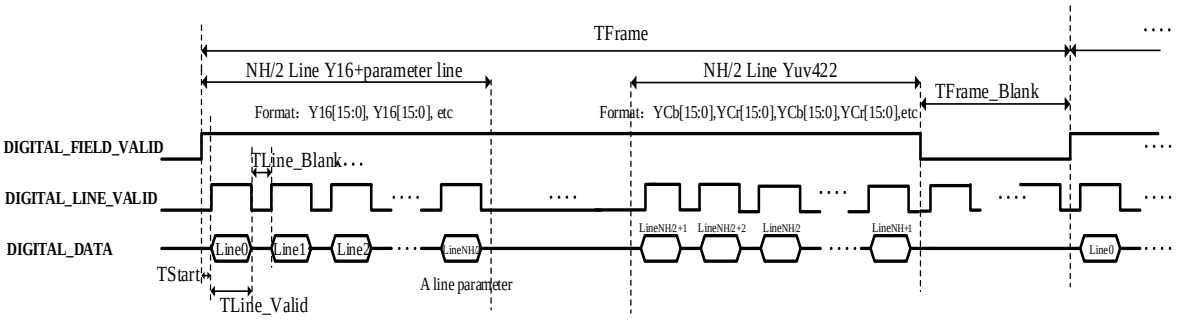


Fig.2-11b Y16+YUV422+parameter frame timing sequence diagram

The timing sequence of parallel 16bits for Y16 with parameter line is shown in Fig.2-12.

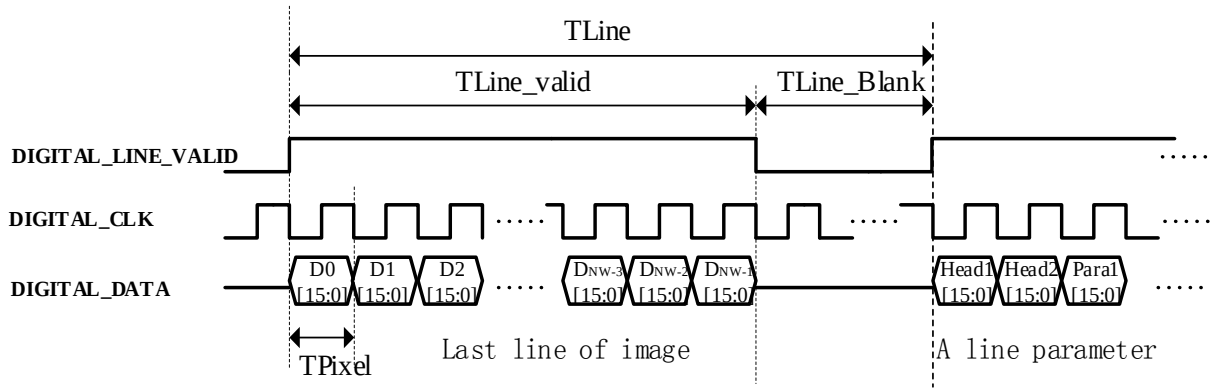


Fig.2-12 CMOS16 Y16+parameter timing sequence diagram

The timing sequence of parallel 16bits for YUV422 with parameter line is shown in Fig.2-13.

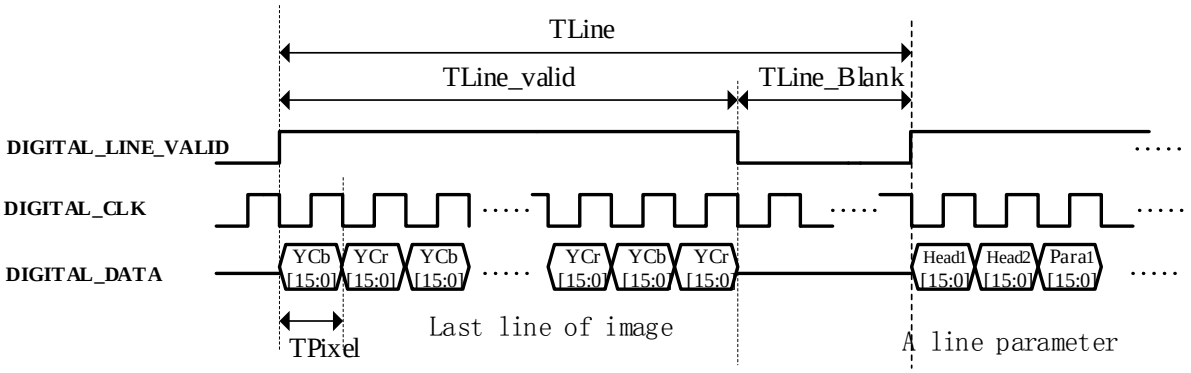


Fig.2-13 CMOS16, YUV422+parameter timing sequence diagram

The timing sequence diagram of parallel 16bits for data source Y16+YUV422 with parallel line is as same as Y16 & YUV422.

2.3.3 Description of BT.656 data

The BT.656 interface output data in standard BT.656 format. For details, see the ITU-R standard Recommendation ITU-R BT.656-5(12/2007),8bits, interleaved.

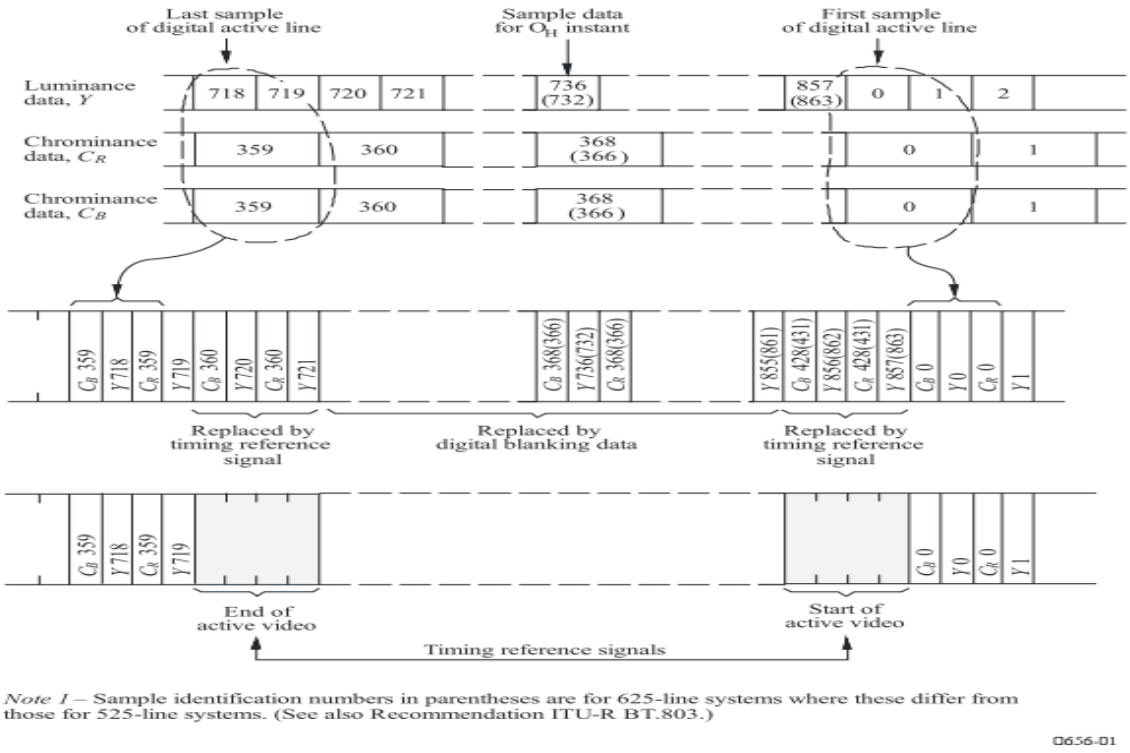
1) Data format: Cb, Y, Cr, Y, Cb, Y, Cr, Y, etc;

2) Clock frequency:

System	resolution	Data clock	Remark
PAL	720×576	27MHz	Effective image resolution is 640×512
NTSC	720×480	27MHz	Effective image resolution is 640×480

3) Data timing: BT.656 format is to insert the line header and footer information into the common digital data stream, with the header information as the start of active video (SAV) and the footer information as the end of active video (EAV), as shown in Fig. 2-14, Table 2-8 and Table 2-9.

FIGURE 1
Composition of interface data stream



Note 1 – Sample identification numbers in parentheses are for 625-line systems where these differ from those for 525-line systems. (See also Recommendation ITU-R BT.803.)

0656-01

Fig.2-14 BT.656 data format

Table 2-8 Details of SAV and SEV in BT.656 format

Data bit number	First word (FF)	Second word (00)	Third word (00)	Fourth word (XY)
7(MSB)	1	0	0	1
6	1	0	0	F
5	1	0	0	V
4	1	0	0	H
3	1	0	0	P3
2	1	0	0	P2
1	1	0	0	P1
0	1	0	0	P0

Note：

F: 0 odd field; 1 even field

V: 0 field effective; 1 field blanking

H: 0 SAV; 1 EAV

P0, P1, P2, P3: Protection bits

Table 2-9 Protection bit in BT.656 format

Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Byte
MSB	F	V	H	P3	P2	P1	P0	
1	0	0	0	0	0	0	0	0x80
1	0	0	1	1	1	0	1	0x9D
1	0	1	0	1	0	1	1	0xAB
1	0	1	1	0	1	1	0	0xB6
1	1	0	0	0	1	1	1	0xC7
1	1	0	1	1	0	1	0	0xDA
1	1	1	0	1	1	0	0	0xEC
1	1	1	1	0	0	0	1	0xF1

2.3.4 LVDS

Digital video 14bit LVDS output. LVDS output adopts 4 pairs of differential pair, respectively as follows:

1. LVDS_CLK: serial LVDS clock, 7 times the data clock;

2. LVDS_SYNC: row field synchronization signal, the beginning of field synchronization is 0x70, the data valid is 0x64, and the data invalid is 0x60;

3. LVDS_DATA0: low 7 bits of 14bit data;

4. LVDS_DATA1: high 7 bits of 14bit data.

Specific row field coding sequence is shown in the figure below:

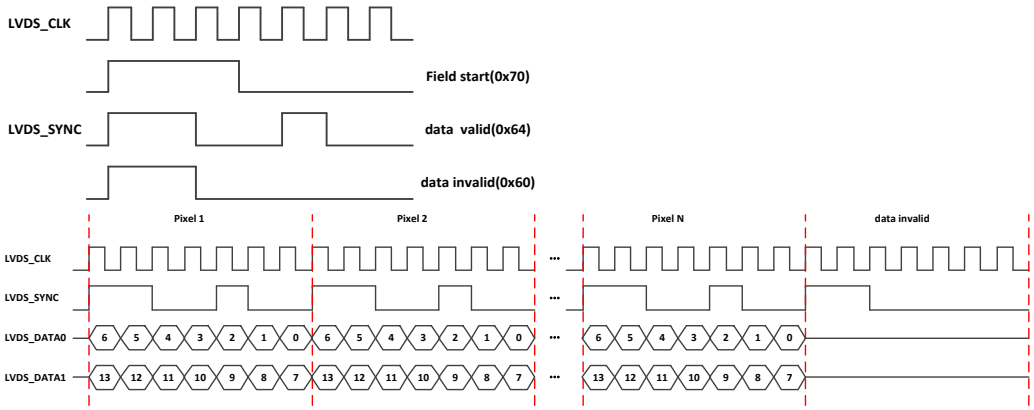


Fig.2-15 LVDS data format

3 Optional Accessories

tripod

hoop

lens

VPC borad

Adapter +Video cable + Micro USB cable

3.1 VPC expansion board

3.1.1 Description of the functions

- Standard 5-PIN Micro USB interface:
- Steady current ≤ 400mA@5V, transient starting current ≤1A@5V.
- Baud rate at serial port: 115200.
- MCX analog video interface, 75Ω characteristic impedance.
- Hot swap protection.

3.1.2 Application instruction for VPC board

VPC board has two external interfaces: analog video interface and Micro USB interface.

The user can use the optional video extension cable for the application of external analog video, with one terminal (MCX terminal) connected to the module and the other terminal connected to the AV interface of monitor.

The user can also use the optional USB cable or mobile phone USB cable with rated current over 1A , with one terminal connected to the Micro USB interface of the module and the other terminal connected to the USB interface of the computer.

After the ICC control software is installed on the computer, the connection between the module and the ICC software can be realized through the USB cable. For the installation instructions of the ICC control software, please refer to ICC related instructions .

4 ICC control software

4.1 Installation instructions

This chapter mainly describes the installation method, steps and precautions of the infrared module software to achieve the normal use of the installed software.

1.Firstly, double-click the application installation file setup.exe for installation to pop up an installation window, click the button "Next" for installation at the next step, as shown in Figure 4-1.

Figure 4-1 Software installation interface 1

2.Click the button "Next" to pop up a window for selection of installation path and the installation object. After selecting the file installation path and object, click the button "Next" to proceed to the next step, as shown in Figure 4-2.

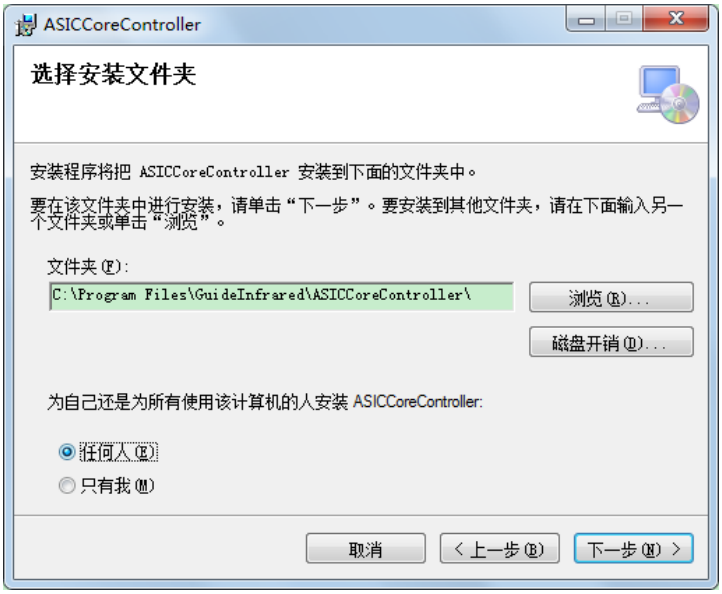


Figure 4-2 Software installation interface 2

3.In the new pop-up window, click the button "Next" to proceed to the next step, as shown in Figure 4-3.

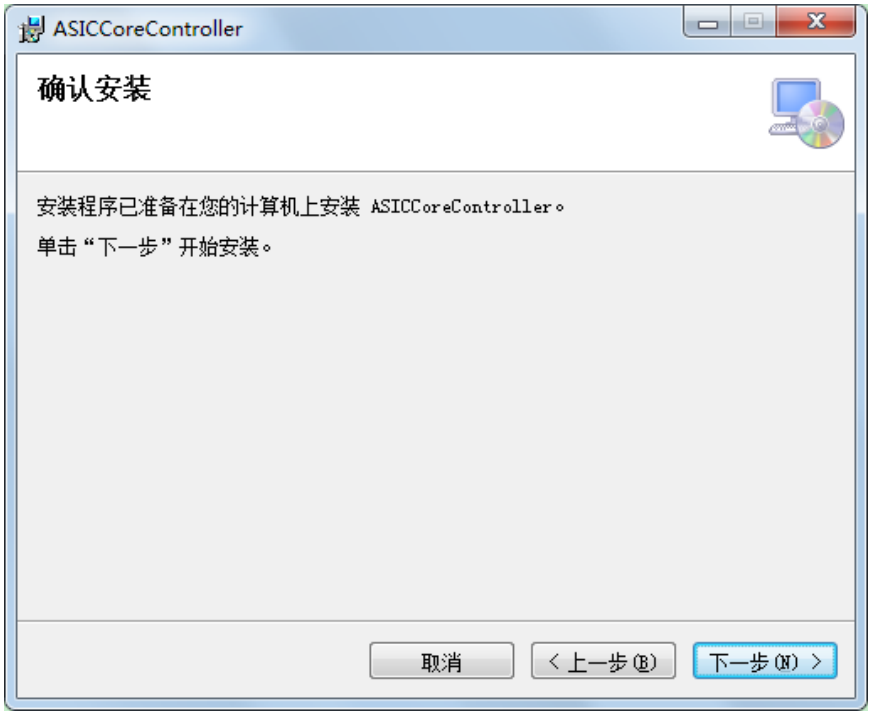


Figure 4-3 Software installation interface 3

4.During installation, the installation progress interface will appear, please wait for the installation to complete, as shown in Fig. 4-4.

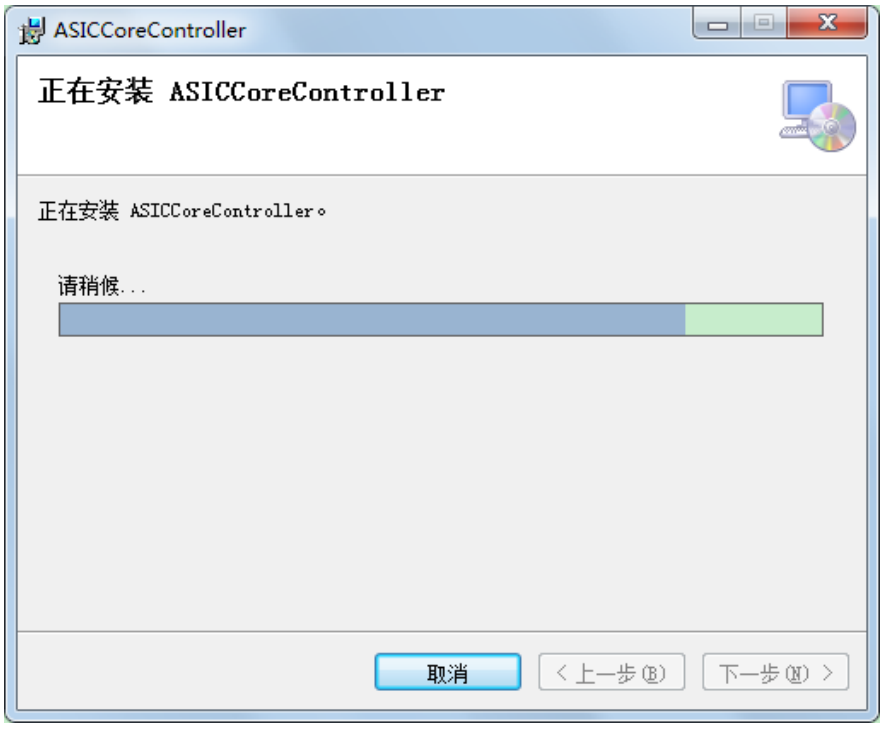


Figure 4-4 Software installation interface 4

5. After the installation, two windows will pop up, one is the window for installation complete, and other one is window for USB driver, as shown in Figure 4-5 and Figure 4-6 respectively.

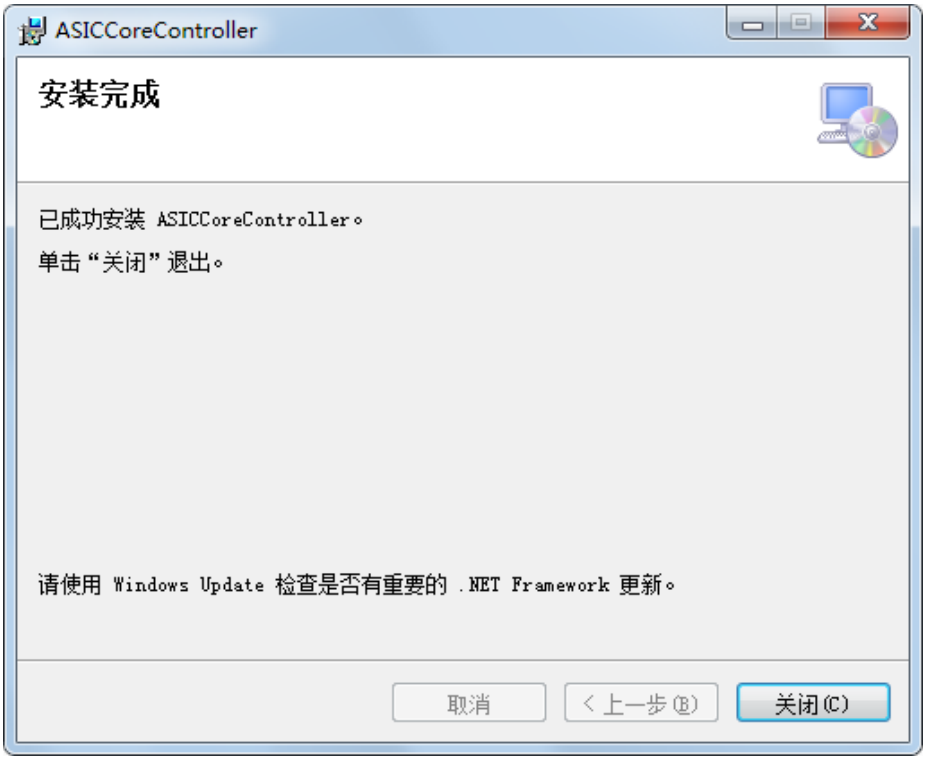


Figure 4-5 Pop-up window for software installation complete

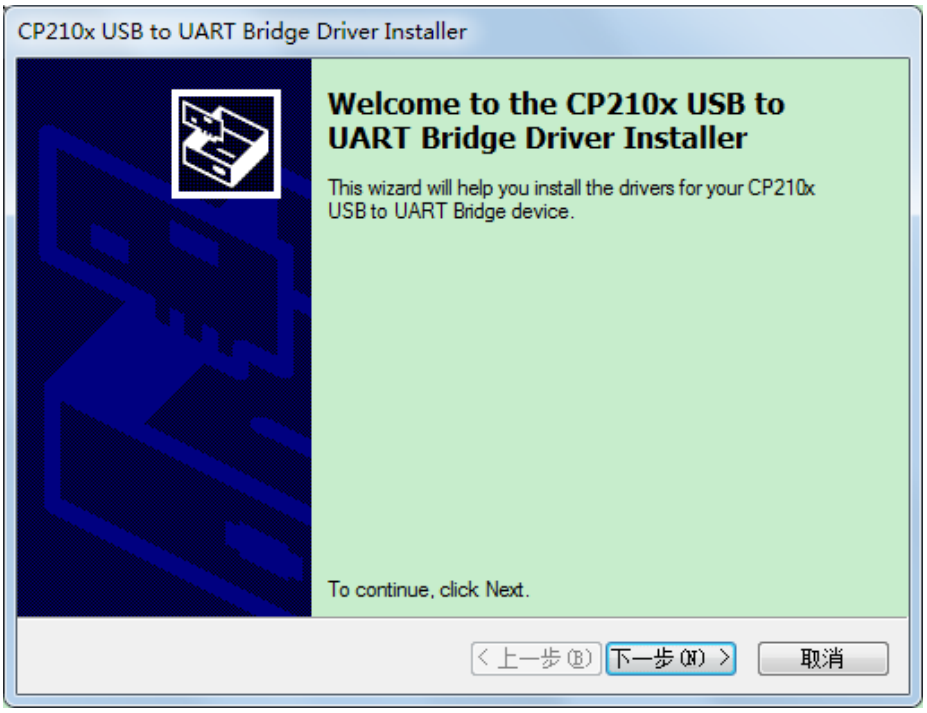


Figure 4-6 Pop-up window for USB driver installation

6. Click the button "Close" in Figure 4-5 to complete the module software installation, and then click the button "Next" in Figure 4-6 for USB driver installation, at which time, an agreement selection window as shown in Figure 4-7 will pop up.

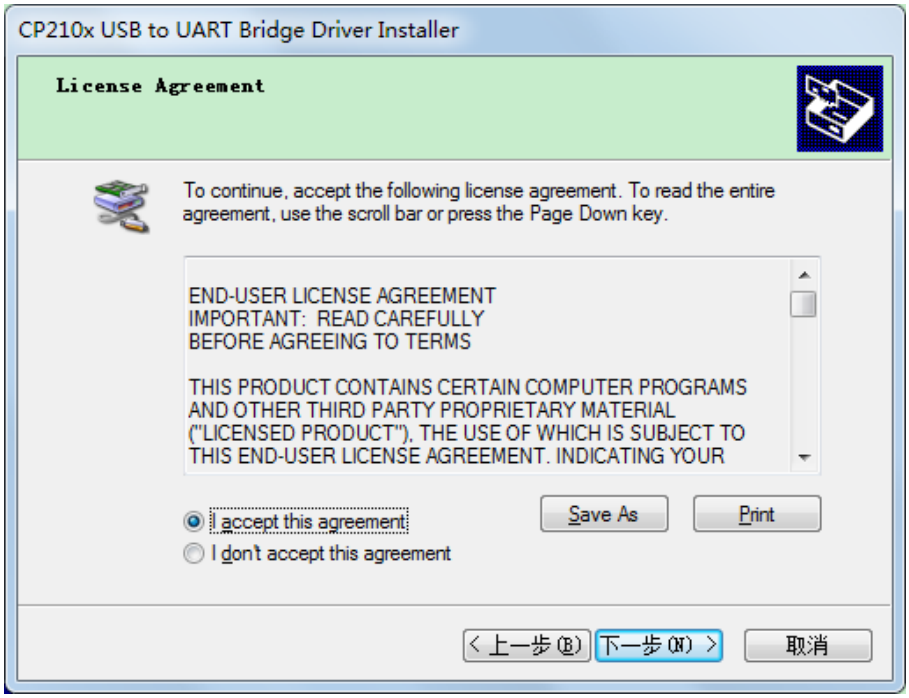


Figure 4-7 Agreement selection window

7. Select the button "I accept this agreement" and click the button "Next" to continue the installation.

8. During installation, the installation progress interface will appear, please wait for the installation to complete, as shown in Fig. 4-8.

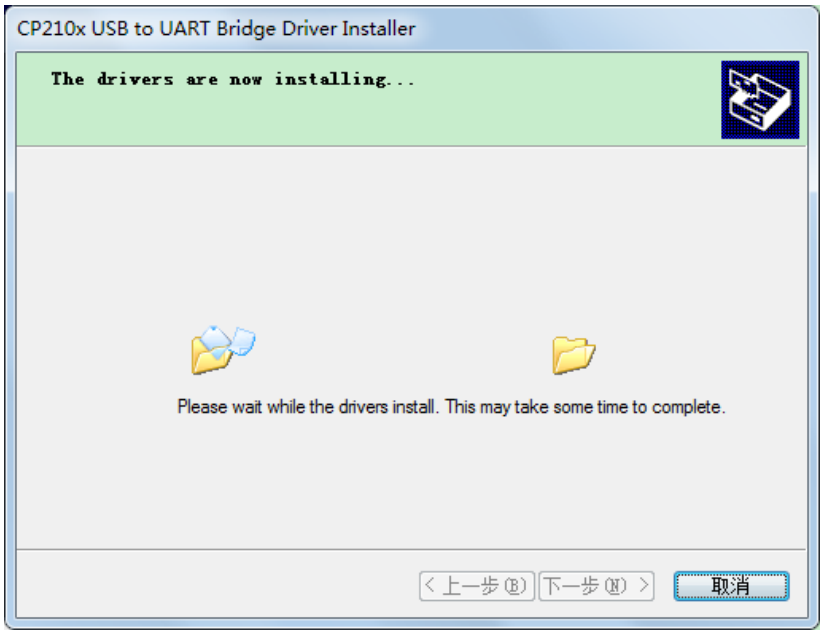


Figure 4-8 Installing window

9. Upon USB driver installation, an installation complete window as shown in Figure 4-9 will pop up.

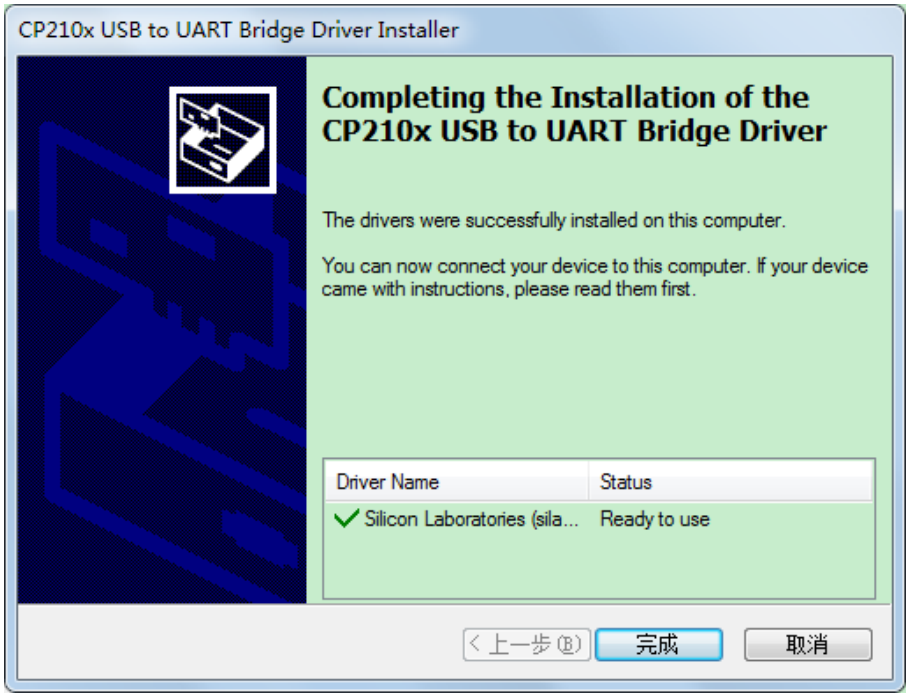


Figure 4-9 Pop-up window for USB installation complete

10. Click the botton ”Finish”, installation complete, quit the installation.

4.2 Interconnection between module and PC control software

This chapter describes how to use the infrared module software to connect the PC and the module through a USB data wire.

1. Click the desktop icon or click the " ASIC Core Controller " in "Start" to start the infrared module software.

2. When the software is opened for the first time, the connection wizard interface is an English interface by default, the upper left corner shows that the current connection status is "NotConnected", and the upper right corner shows the software version number, as shown in Figure 4-10.

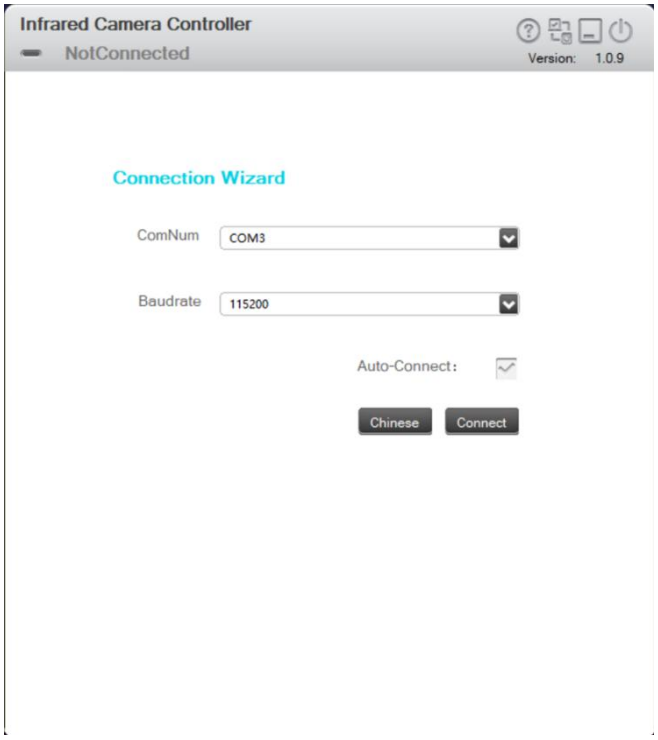


Figure 4-10 Connection wizard interface

3. Click the icon in the upper left corner to display the software instructions;

Click the icon to switch to the connection wizard interface;

Click the icon to hide the window in the taskbar;

Click the icon to close the software.

4. Click the icon to select the serial number and baud rate, and click the to set whether automatic connection is used for the next software startup, as shown in figures 4-11, 4-12 and 4-13.

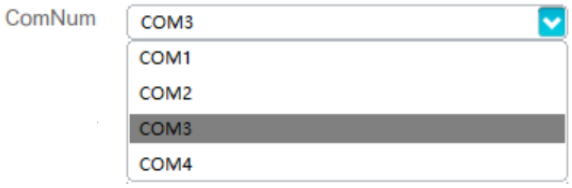


Figure 4-11 Selection of connection serial number

Figure 4-12 Selection of connection baud rate

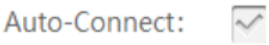


Figure 4-13 Setting of automatic connection

If it is set as automatic connection, the module will not enter the connection wizard interface but directly enter the next interface at the next software startup, but the previous software language version is still kept unchanged.

5. Click "Chinese" to select the Chinese language version, or click "English" to select the English version, the connection wizard interface in English is shown in figure 4-14.

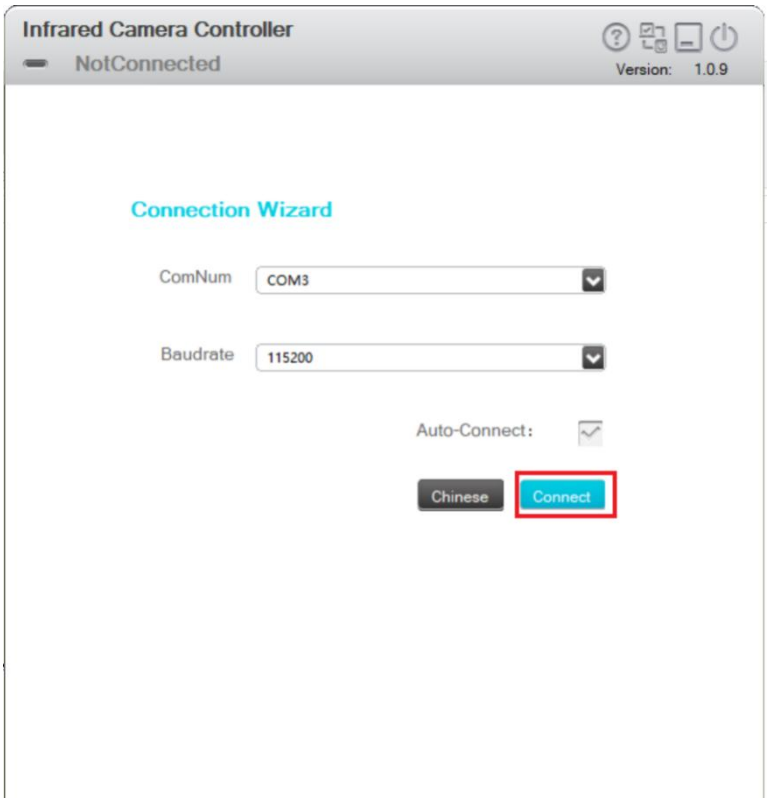


Figure 4-14 Connection wizard interface in English

6. Click the button "Connect" to connect the module, as shown in Figure 4-15. If the module is currently connected, click the icon to switch to the connection wizard interface, and then click "Disconnect" to disconnect the module. The upper left corner shows the current connection status "DisConnect", as shown in Figure 4-16.

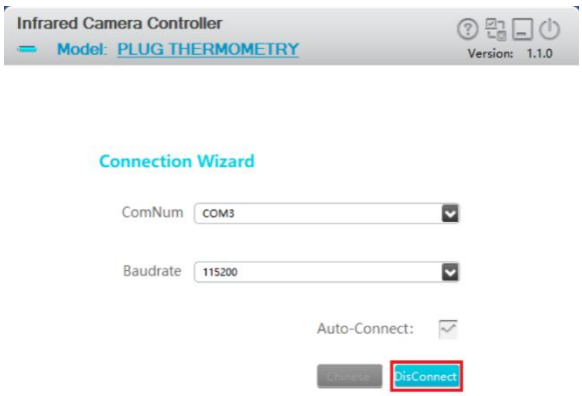


Figure 4-15 Module connection

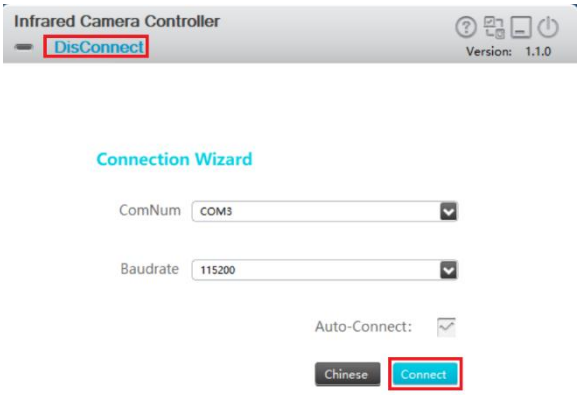


Figure 4-16 Module disconnection

4.3 Operation instructions of PC control software

After the module and PC control software are connected successfully, the module enters the operation interface. The functions and operation method of the interface will be described in the following section.

4.3.1 Status

This chapter mainly describes the parameters and performance status of the module connected at present.

1. Click the "Connect" to communicate with the module successfully, and then allow the software to enter the module status interface. The upper left corner of the interface shows the current connection status and module type, as shown in Figure 4-17.

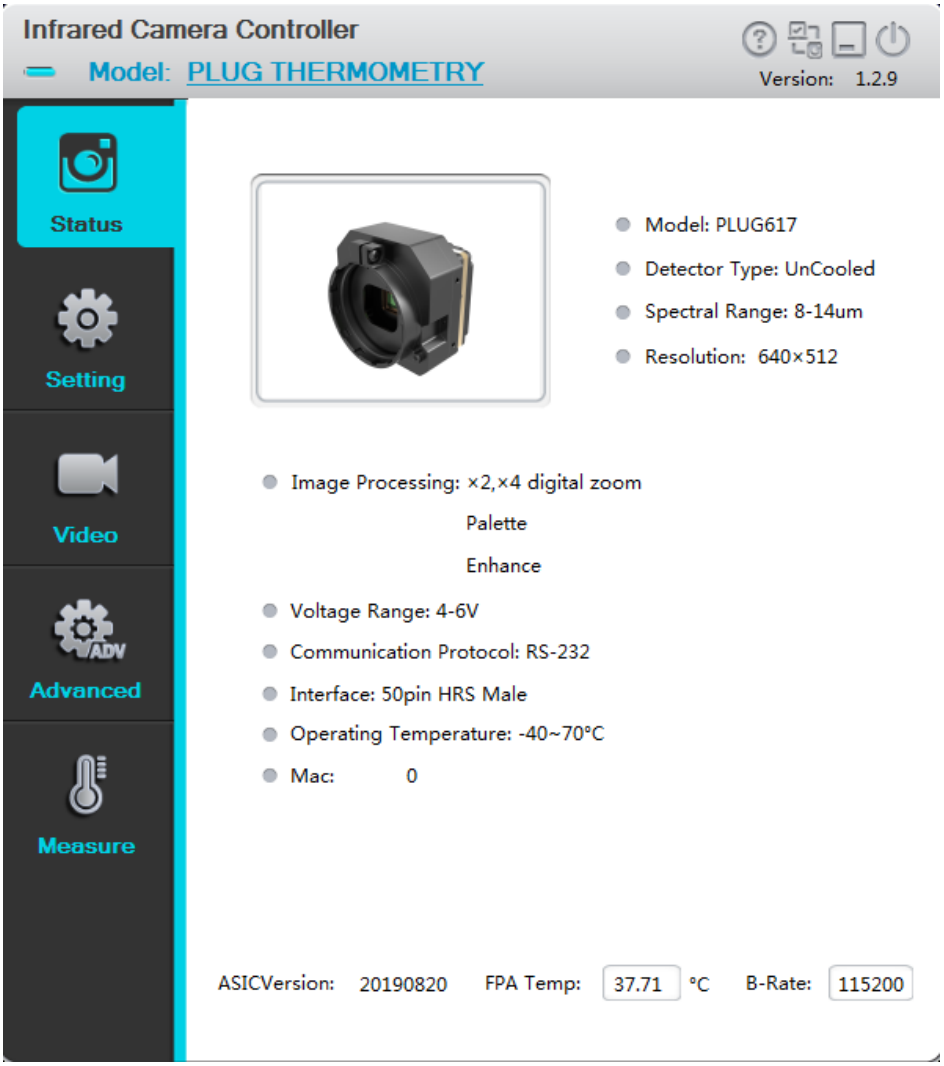


Figure 4-17: Module status interface

2. The interface shows the module information, including name, shape, detector type, wavelength, resolution, function, input voltage, communication protocol and machine code., etc. The program version number, focal plane array temperature, and current communication baud rate of the slave are also displayed at the bottom of the interface.

4.3.2 Settings

This chapter mainly describes the setting of the shutter including compensation interval time, Image mode including image freeze, all kinds of test image.

Click the setting menu on the left side of the interface to enter the module settings interface as shown in Figure 4-18.

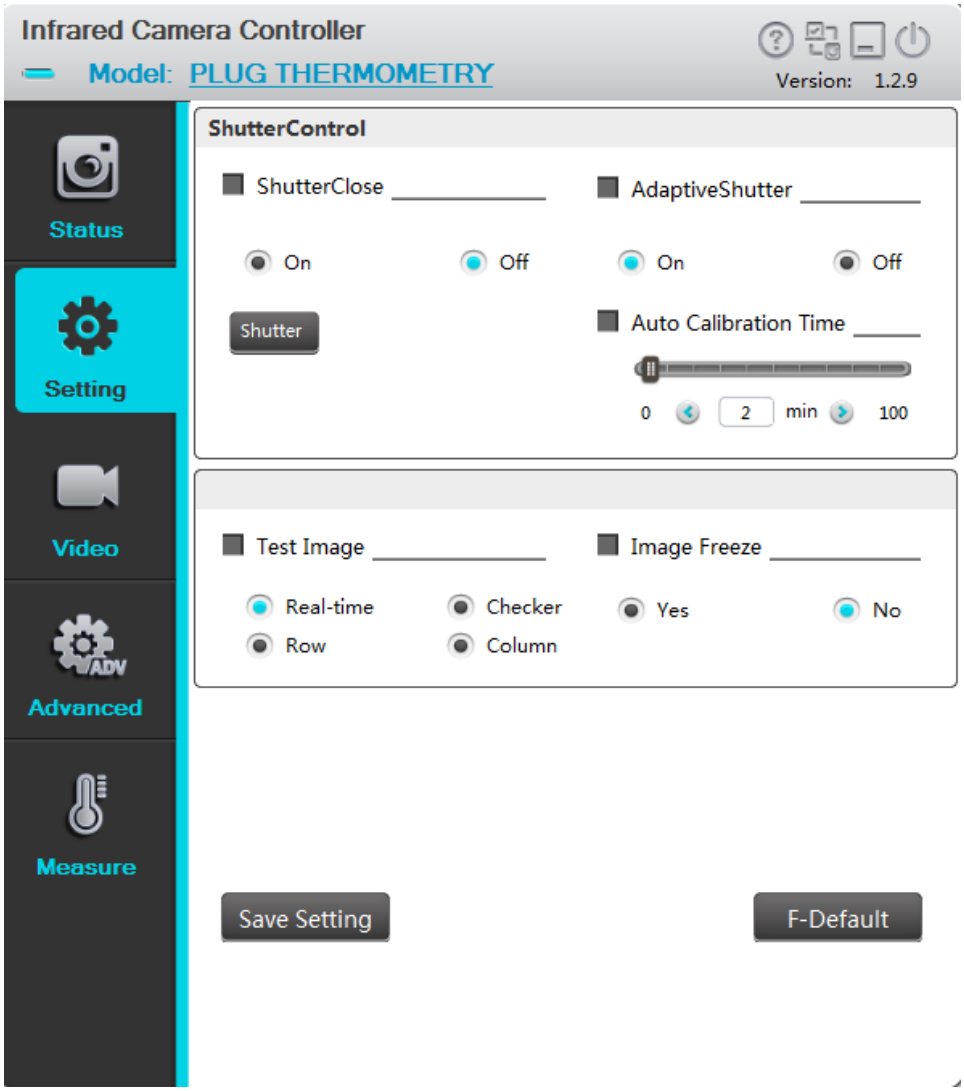


Figure 4-18 Module settings interface

Automatic compensation time: Set the time interval (in minutes) of automatically opening the shutter. When the module is just started and the focal plane temperature is not stable, the time interval may be short. After the focal plane temperature is stable, you can extend the time interval properly.

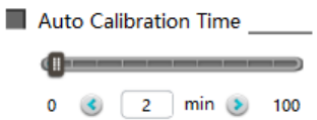
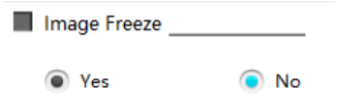
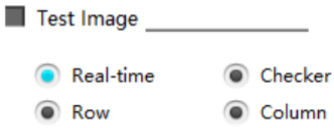


Image freeze: For the analog video scene of interest, you can select “Yes” to freeze the infrared scene image. Then the infrared image of the analog video output will not change as the scene does, allowing users to watch the scene of interest. You can choose “No” to unfreeze, to observe real-time changes in the scene.



Test screen: The module provides four models of image displays, including real-time image and three

test patterns; the test patterns include checkerboard pattern, horizontal scanning pattern and vertical scanning pattern.



Save settings: After using the Infrared Camera Controller ICC to change the module mode and parameter values, click the button "Save Settings" to save the current configuration as the new power-on default. When powering on the module at the next time, the module will be configured with the new power-on default. If you do not save the settings, the change made by ICC is only valid for the current stage, and the module will be configured based on the previous default at the next boot.

Factory reset: Press the button “Factory Reset” to restore module's all configurations to the factory defaults.

4.3.3 Video

This section describes the parameters adjustment and image processing of analog video, digital video and other related algorithms in detail.

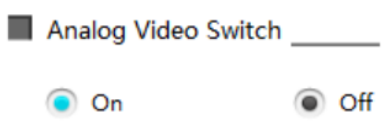
4.3.3.1 Setting interface of analog video

Click the video menu on the left side of the interface, and enter the analog video setting interface, as shown in Fig. 4-19.

Figure 4-19 The setting interface of analog video

The analog video page mainly includes: analog video switch, system selection, frame rate setting, polarity/pseudo-color, mirror and zoom setting.

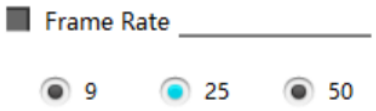
Analog video switch: If the analog video display is not needed in the application, you can set the switch “off” to turn off the analog video to reduce 200mW power consumption. The is “on” by default.



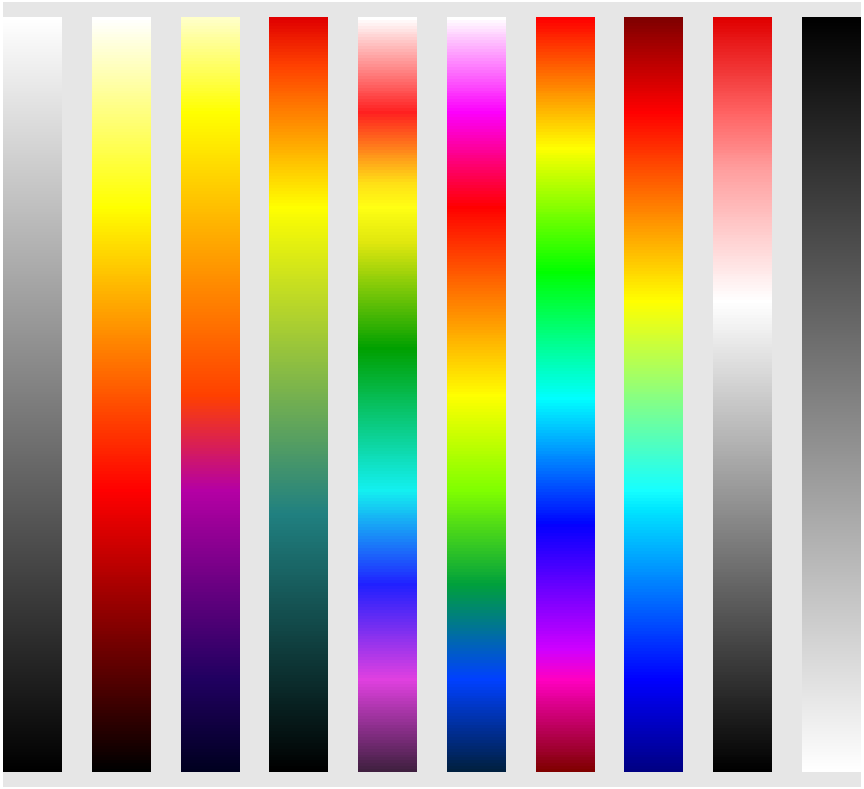
Video system: Choose the video system to output. The module provides two video systems: PAL (video resolution 720×576, valid resolution 640×512) and NTSC (video resolution 720×480, valid resolution 640×480). Different output systems correspond to different digital and analog video frame rate. After

changing the video system, the module needs to be restarted after shut down.

Frame rate: Select the frame rate of the analog video output for the module. If the module is working under PAL system, the frame rate of the analog video can be set to 25Hz and 9Hz. If the module is working under NTSC system, the frame rate of the analog video can be set to 30Hz and 9Hz. The lower the frame rate is, the lower the frequency needed to discover analog video motion is.



Polarity: The module detects and images the temperature, and maps the temperature to the range between 0 and 255. In black white mode, the gray scale 0 is shown as solid black and the gray scale 255 is shown as white. In the gray scale range of 0~255, color mapping can be performed through the internal lookup table, and different lookup table represent different ribbons. The modes black hot (darker represents hotter) and white hot (whiter represents hotter) are often selected, and such simple temperature black white mapping is also known as polarity. Color mapping can also be performed through the color lookup table. The module provides totally nine color mapping, including white hot and black hot, which are suitable for analog and digital video.



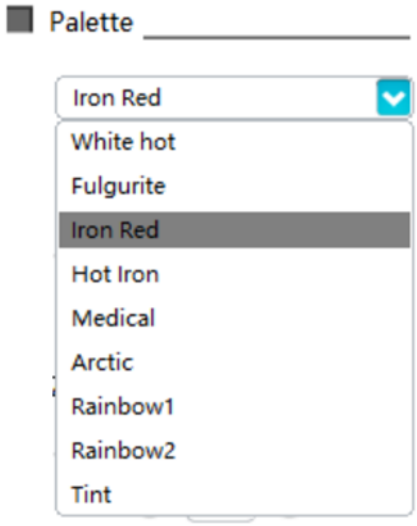
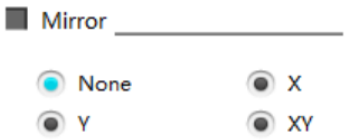


Fig. 4-20 Pseudo-color table

Mirroring: As module can provide four image mirroring modes, and you can choose any one to change the direction of the image for digital and analog video.



None: Keep the direction of outputting original image by the detector unchanged.

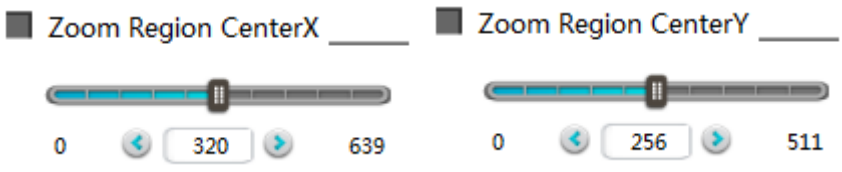
X: Mirror the original image horizontally. Map the pixels in the upper right corner of the detector to the upper left corner of the output video. When you need a horizontal mirroring scene or set the up and down direction of the module oppositely, you can choose the mirroring mode X.

Y: Mirror the original image vertically. Map the pixels in the upper left corner of the detector to the lower left corner of the output video. When you need a vertical mirror scene or set the up and down direction of the module oppositely, you can choose the mirroring mode Y.

XY: Mirror the original image horizontally and vertically at the same time. Map the pixels in the upper left corner of the detector to the lower left corner of the output video. When you need a diagonal mirroring scene, you can select the mirroring mode XY.

Zoom in: This infinite zoom function supports 1~8 times magnification configuration; the amplification precision is 0.125 times and the amplification factor is the 1/8 of setting value. For example, when the setting value is 8, the amplification factor is 1, which is the original image; if setting value is 64, the amplification factor is 8.

The X/Y coordinates of the center point in zoom area: This option can set the coordinates of the center point in zoom area, so that the user can zoom in precisely on any area of interest in the analog video image.



4.3.3.2 The digital video

Click digital video menu at the bottom of Fig. 4-19, and enter the digital video setting interface, as shown in Fig. 4-21.

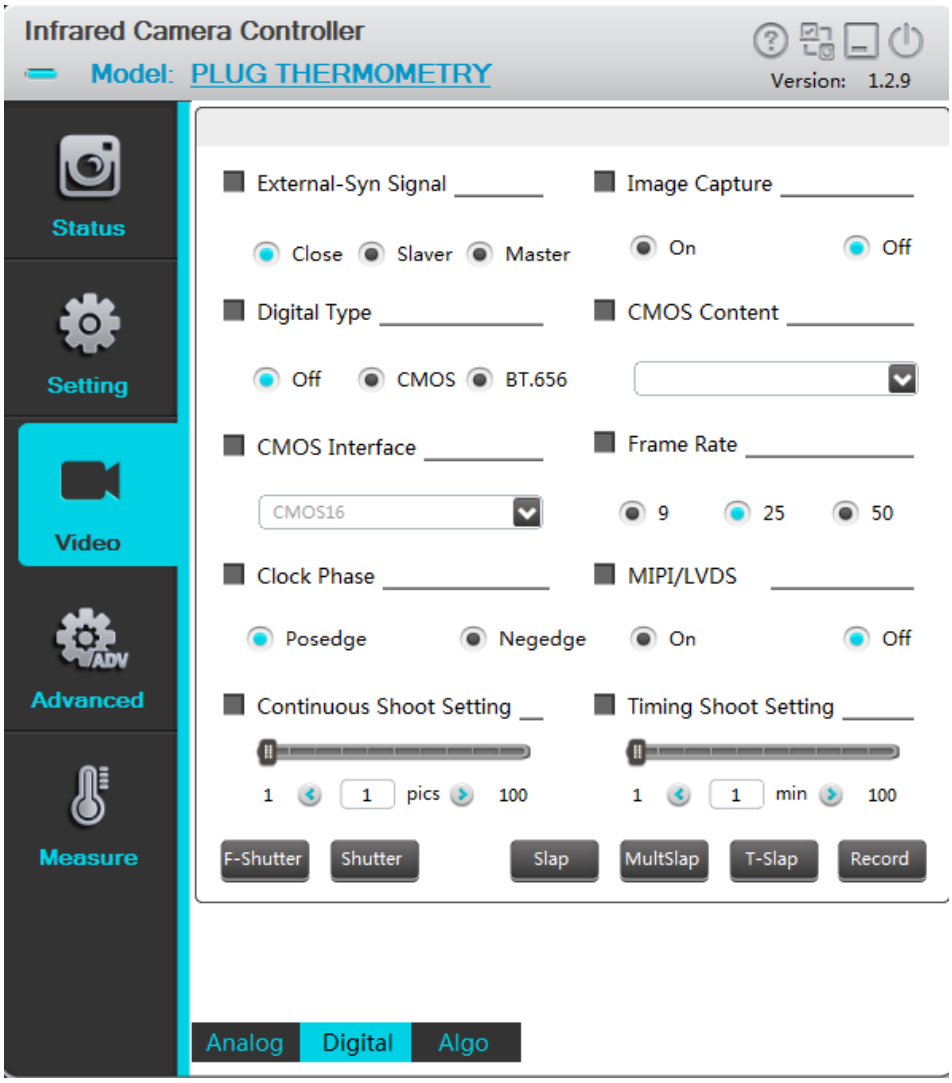
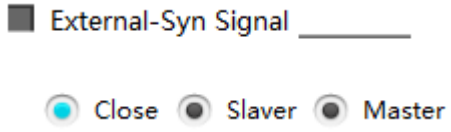


Figure 4-21 The setting interface of digital video

Digital video page is mainly used to achieve the related settings of digital video, such as external synchronization (slave mode) switch, digital port switch, digital port type, CMOS content, CMOS interface, digital frame rate and LVDS switch .

External synchronization: external synchronization (slave mode) switch of the module. (This function is unavailable by ICC PC control software, Please send related command by customer's platform.）



Slave: When the module is working, start external synchronization mode. If the external synchronization trigger signal is detected, that is, output video according to the external synchronization signal after the end of the current field. If the external synchronization signal is not detected, execute it in the last cycle.

The external synchronization signal EXT_SYNC of PLUG612 module must meet the following requirements, as shown in the figure below. If the given external synchronization signal EXT_SYNC does not meet the requirements, it can cause module abnormal working state.

1) The period of external synchronization signal EXT_SYNC is 40ms, the error accuracy is±0.1%, that is, the period is controlled within (40±0.04)ms.

2) External sync signal EXT_SYNC high level duration must be ≥64us.

3) External synchronization input signal only supports 25Hz synchronization, so video output should be set to 25Hz.

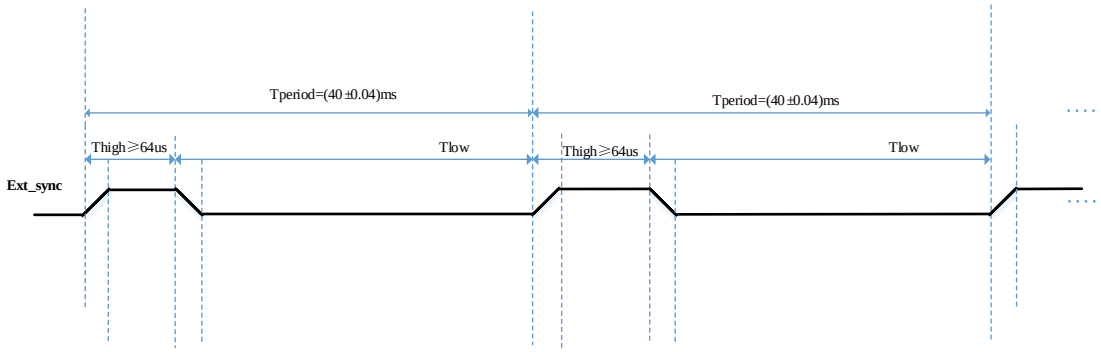
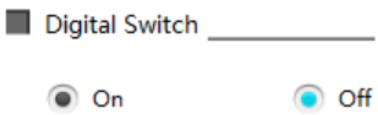


Fig. 4-22 External synchronization sequence diagram

Close: The module works in internal sync mode and outputs analog video normally.

Master: Output field period signals which can be used for external synchronization

Cameralink Switch: CameraLink digital port switch Settings. When CameraLink digital video is not required, it can be set to "off".



If the digital video acquisition channel connection is effective, such as CameraLink channel or USB channel, after setting the digital port type, CMOS content and CMOS interface, select “On”, a real-time video display window will be popped up, as shown in Fig. 4-23.

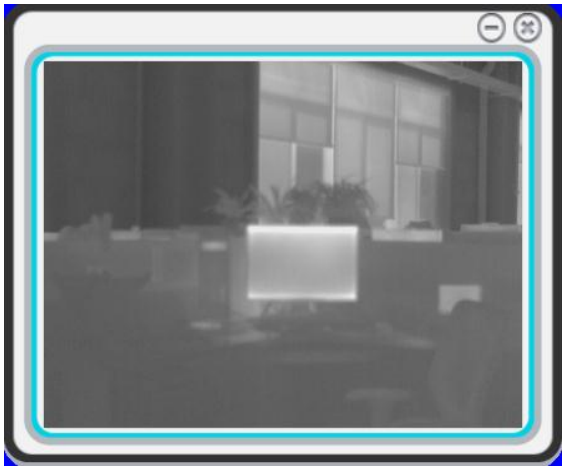
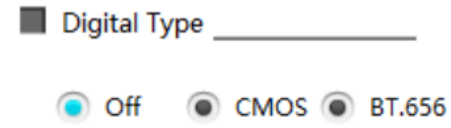


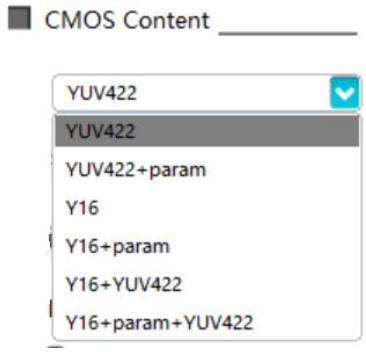
Fig. 4-23 Digital port real-time video

Digital port type: select the output format of digital parallel port, including CMOS and BT.656. If the digital port is needed to output BT.656, select "BT.656" in this item and set the digital port switch to “On”.

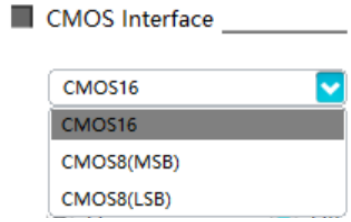
If choosing to output CMOS contents, you need to configure the CMOS content and CMOS interface options.



CMOS content: To select CMOS content. The CMOS content can only be configured when the digital port type option is “CMOS”. CMOS content can be set as follows, and please refer to Section 2.3 for the digital port output timing. Each time you change the CMOS content, reopen the digital port for the changes to take effect.



CMOS interface: To select CMOS interface. The CMOS content can only be configured when the digital port type option is “CMOS”. The CMOS interface selection is as follows, and please refer to Section 2.3 for the digital port output timing. Except for the interface CMOS16, the other two interfaces can’t support the real time video display.

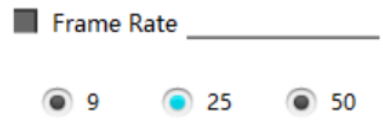


Frame rate: To set the digital video CMOS type output frame rate.

If the Firmware version is 25/30hz, the frame rate of digital video can be set to 30Hz, 25Hz and 9Hz.

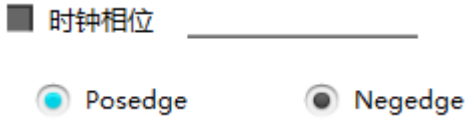
If the Firmware version is 50/60hz , the frame rate of digital video can be set to 60Hz, 50Hz and 9Hz.

The smaller the frame frequency setting of digital video is, the smaller the frame frequency of the field synchronization signal can be detected..



Clock alignment phase: Set the data of the output digital port of the module aligned with the output clock edge, which is valid for parallel digital port and LVDS digital port.

If rising edge alignment is set in module, the back-end receiving device needs to sample at the falling edge, If falling edge alignment is set, the back-end receiving device needs to sample as rise edge.



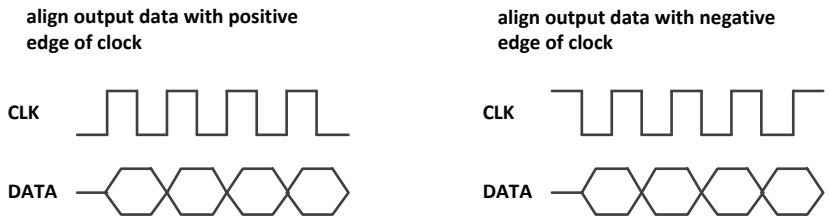
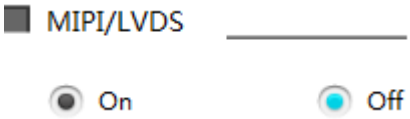
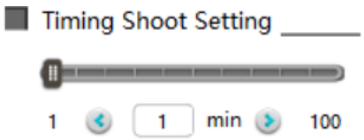


Fig. 4-24 the output data is phase aligned with the output clock

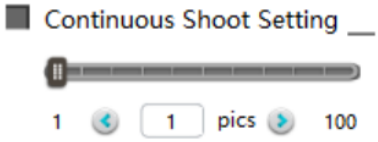
MIPI/LVDS: LVDS switch setting. When setting to “On”, the module will output standard LVDS timing from the fixed interface. The default setting is “Off”.



Time-lapsed photography interval: Set the time interval for the software to take photos of the captured video in unit of min.



Number of continuous shooting: Set the number of pictures taken from the captured video by the software.

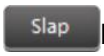


Scene compensation: Click the button

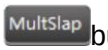
to capture the current scene data for non-uniformity correction.

Shutter compensation: Click the button

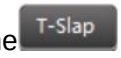
to control the shutter close and to collect the shutter data for non-uniformity correction.

Shooting: Click the 

button to take a screenshot of the current scene, and the picture is named after the current time and saved in the selected folder. The format of saved photo files is bmp or raw, based on the digital port.

Continuous shooting: Click the 

button to take a continuous picture of the video. According to the number value set by the "number of continuous shooting", take pictures of the current scene. The picture is named after the current time and saved in the selected folder. The format of saved photo files is bmp or raw, based on the digital port.

Time-lapsed photography: Click the 

button for timed photographing. The module will take pictures with the time interval you’ve set. The picture is named after the current time and saved in the selected folder. The format of saved photo files is bmp or raw, based on the digital port.

Video: Click the

button to begin videoing after the button brightens; click again, the button returns to normal state and it will stop videoing; Video files are named after the current time and saved in the selected folder. The format of saved video files is avi or raw, based on the digital port.

4.3.3.3 Algorithm

Click the algorithm menu at the bottom of Fig.4-19, and enter the algorithm setting interface 1, as shown in Fig. 4-25.

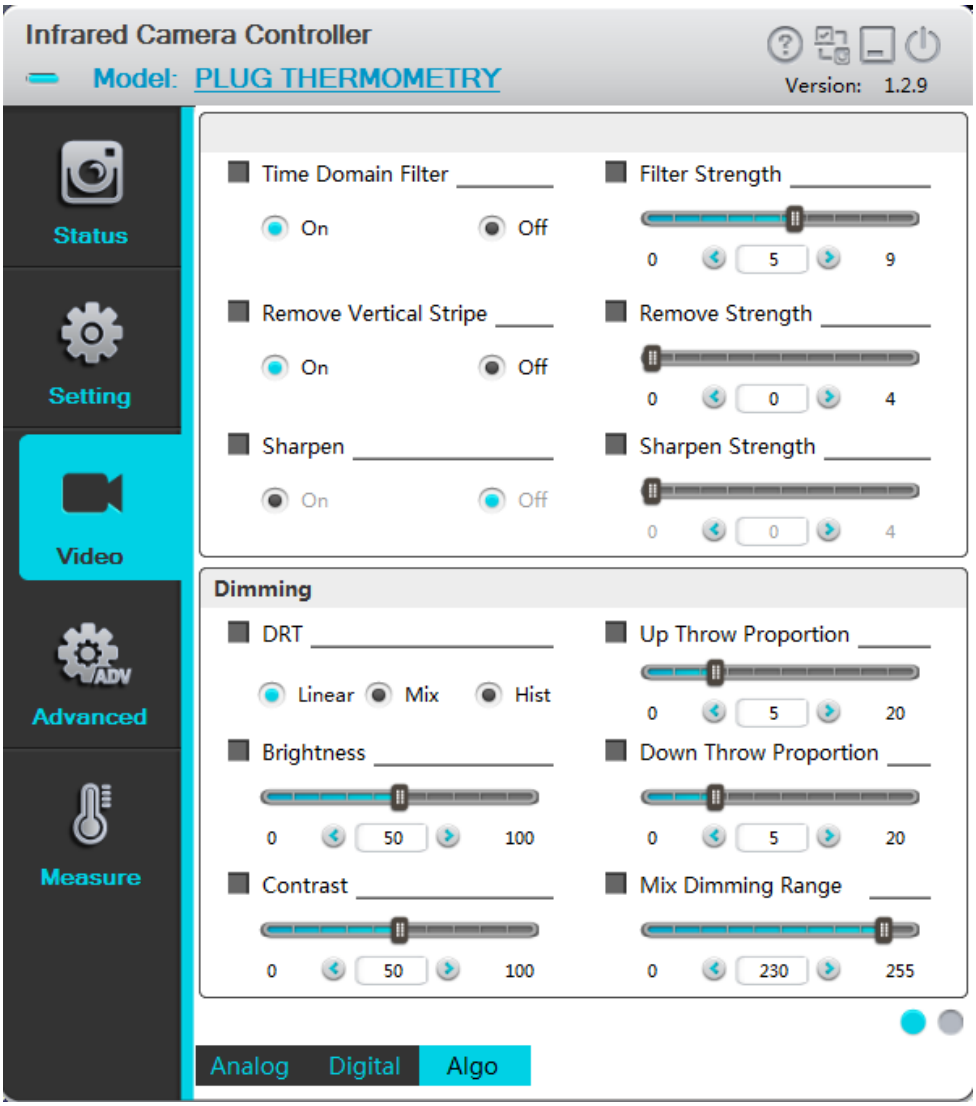
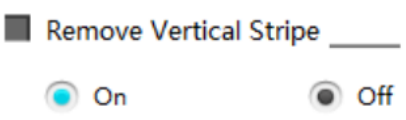


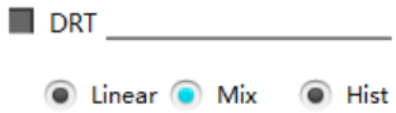
Fig. 4-25 The algorithm setting interface 1

Time-domain filtering: Set the intensity of random noise in filtered infrared image sequences. The range of random noise filtering intensity is 0-9. The larger the value is, the greater the filtering degree is, the smoother the image will be, the more obvious the smear side effects will be.

Removal of vertical stripe: Remove non-uniformity noise at the column direction in the infrared image sequence.



DRT dimming: Dynamic Range Transform. In order to render optimal image effects in different scenes, the module provides three dimming algorithms: linear dimming, histogram dimming and mixed dimming.



Linear dimming: Under the linear dimming mode, brightness and contrast are automatically optimized by linear transformation function based on image information statistics, to achieve dynamic range compression of image data.

Fig. 4-26a Effect picture of linear dimming

Histogram dimming: Under the histogram dimming mode, the grayscale value of the image pixels is non-linearly mapped according to the cumulative probability of occurrence of the pixel gray level, to realize the dynamic range compression of the image data and achieve the dimming effect.

Fig. 4-26b Effect picture of histogram dimming

Mixed dimming: Under the mixed dimming mode, the weight of linear dimming and histogram dimming is adaptively adjusted according to the statistical information of the image, to automatically adjust the image performance based on different scenes.

Fig. 4-26c Effect picture of mixed dimming

Proportion of upper throwing point: Under the linear dimming mode, the proportion of throwing point affects the mapping range of the original data and controls the ratio of pixels with saturated brightness in the image. The larger the proportion of upper throwing point is, the greater the contrast of the dimming result will be, and the more details lost due to image saturation.

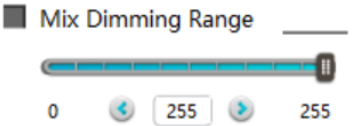
Proportion of down throwing point: Under the linear dimming mode, the proportion of throwing point controls the mapping range of the original data and the ratio of bright saturated pixels in the image. The larger the proportion of down throwing point is, the greater the contrast of the dimming result will be, and the more details lost due to image saturation.

Brightness: Reflect the overall brightness of the image and adjust as a percentage. The larger the value is, the brighter the image will be.

Contrast: Reflect the overall size of the image contrast and adjust as a percentage. The larger the value is, the stronger the contrast will be.

Note. When Y8 correction is in automatic mode, brightness and contrast cannot be adjusted; When Y8 correction is in manual mode, brightness contrast can be adjusted.

The mapping range of mixed dimming: Under the mixed dimming mode, it reflects the overall grayscale value mapping range after image dimming. The larger the value is, the higher the overall brightness of the image will be.



Click the rightmost button at the right bottom of the algorithm setting menu to switch to the algorithm setting interface 2, as shown in Fig. 4-27.

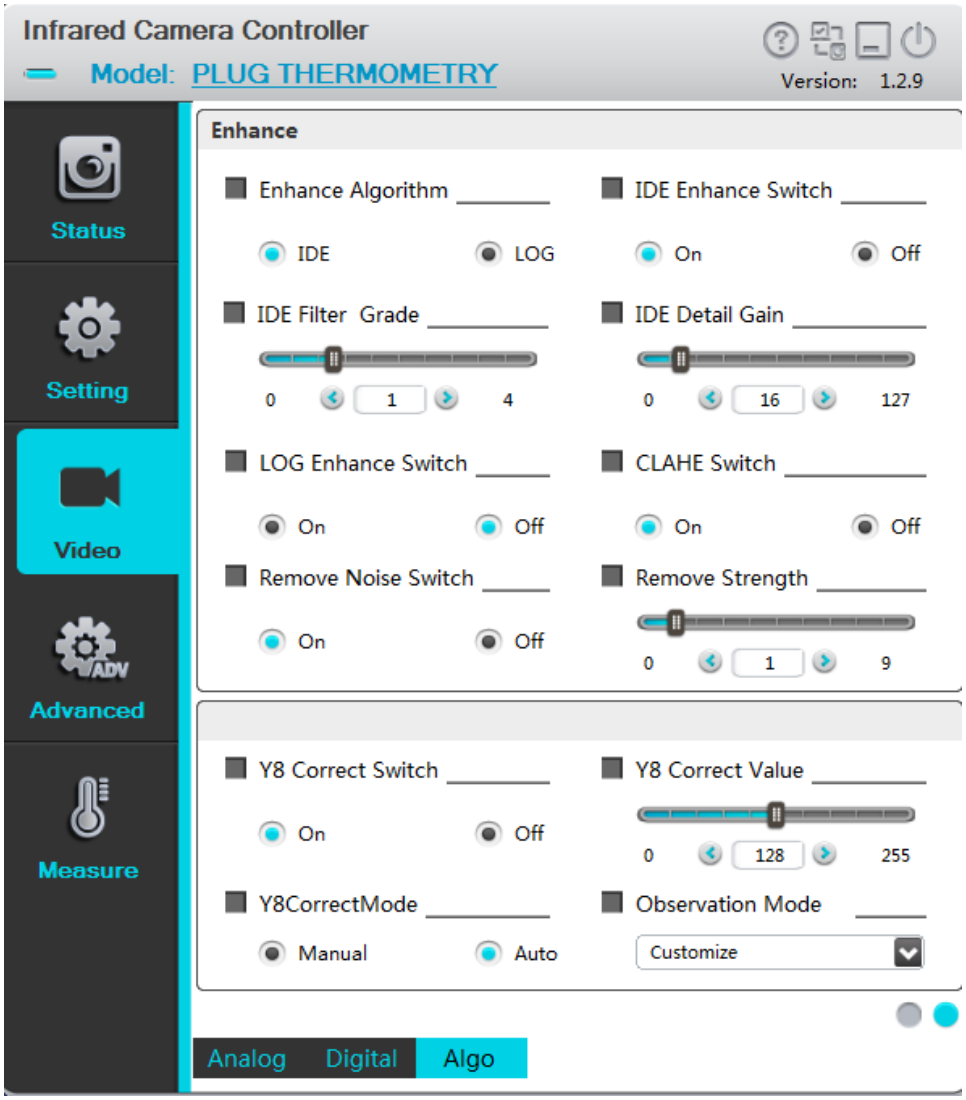
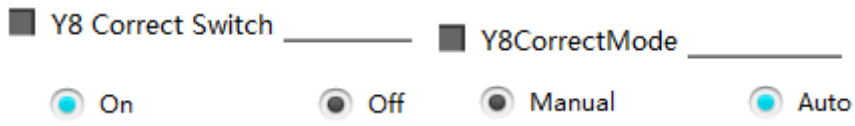


Fig. 4-27 Algorithm setting interface 2

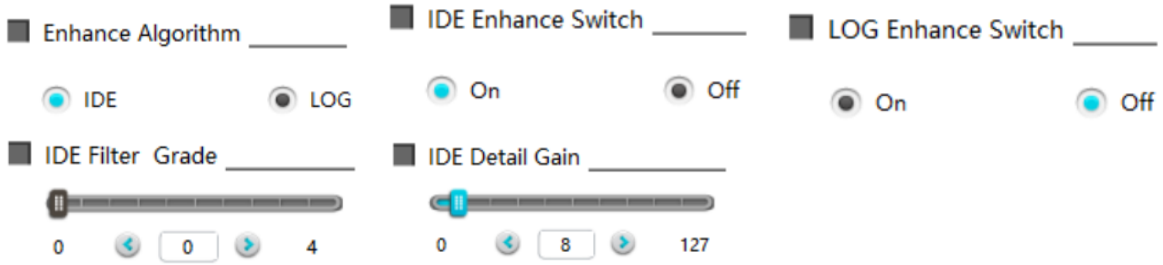
Y8 Correction: the switch of Y8 Correction;

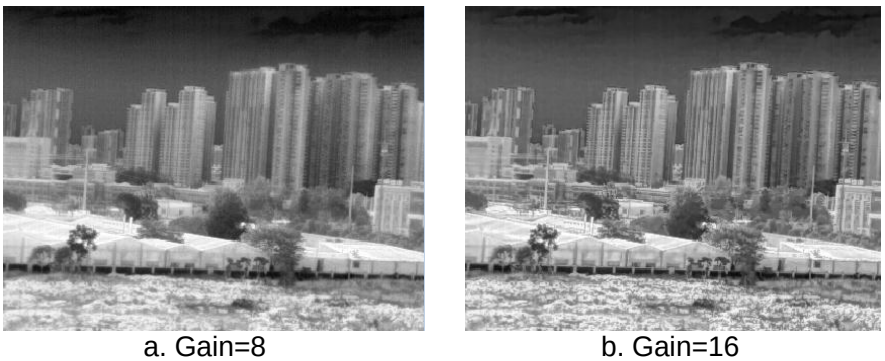
Y8 Correction Mode: When Y8 correction is in automatic mode, brightness and contrast cannot be adjusted; When Y8 correction is in manual mode, brightness contrast can be adjusted.



Enhance algorithm: enhance image detail information. Only support IDE (Image Detail Enhance) .

IDE algorithm adjustable parameters: IDE filtering level control to extract the level of detail, the larger the parameters, the richer the details; IDE detail gain control at different detail levels, the higher the value of detail enhancement, the more obvious the image detail enhancement, the detail gain range is 0-64.





a. Gain=8 b. Gain=16

Fig. 4-28 Different parameter comparison of detail gain

Block histogram: Enhance the local contrast of the image

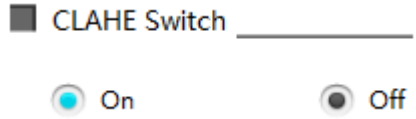


Fig.4-29 block histogram effect

Denoising: spatial noise reduction, parameters adjustable : denoising intensity, the larger the parameter value, the smoother the spatial noise.

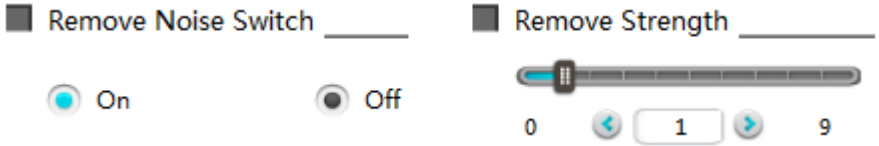


Fig . 4-30 spatial noise reduction effect

4.3.4 Advanced Application

This chapter focuses on the advanced application operation of the module, including focusing, defective pixel treatment, menu superposition and so on.

4.3.4.1 Focus setting interface

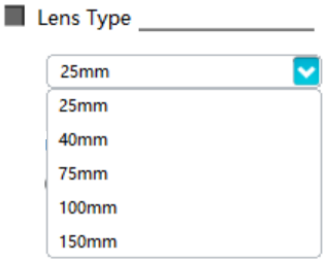
Click the advanced application menu at the left of interface, and enter the focus setting interface of advanced application, as shown in Fig. 4-31.

This page mainly focus on the electric lens and updating program.

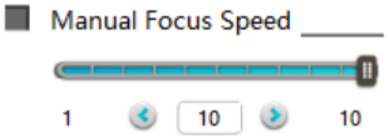
Fig. 4-31 Advanced application interface

On the focusing interface, the electric DC focusing lens is mainly configured, including selection of lens type and parameters required to be set for the motor in each lens: manual focusing speed, statistic frame number of automatic focusing, Max automatic focusing speed and Min automatic focusing speed. These parameters are set only when the user needs to configure the electric DC focusing lens himself. When the motor driven board is used, the focusing can be controlled via near, far and automatic focusing keys.

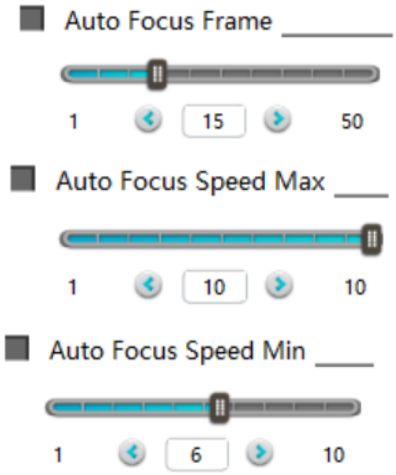
Lens type: if the module needs to support the electric DC focusing lens with various focal lengths, the lens type shall be selected according to the lens and the parameters of motor in the lens shall be set.



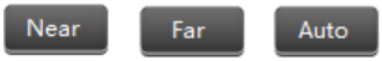
Manual focusing speed: After the user configures the electric DC focusing lends himself, this parameter shall be set firstly to test the min speed allowing the normal rotation of motor.



Automatic focusing parameter: if automatic focusing speed is required after the user configures the electric DC focusing lens, the following parameters shall be set: statistic frame number of automatic focusing, Max automatic focusing speed and Min automatic focusing speed. Please refer to Operating Instructions of Automatic Focusing Test for further details.



Focusing: in case of electric focusing lens, the “Near focus” or “Far focus” key can be long pressed to drive the motor run and perform electric focusing. Focusing will stop when the key is up. Image can be focused automatically to clear by pressing “Automatic focusing” key.



Updating program: Loading ". dat "file and select update type. Don’t switch off during the updating program process

Fig. 4-32 Serial port update

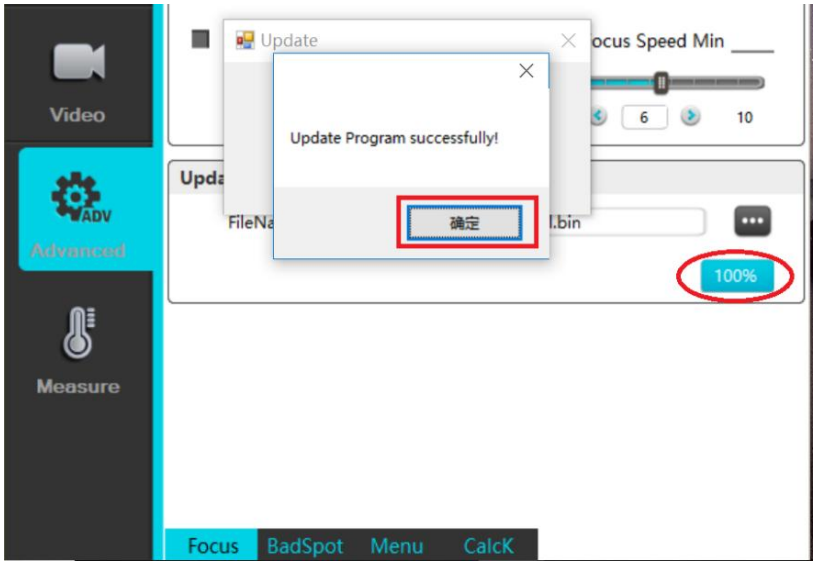


Fig. 4-33 Serial port update successful upgrade prompt screen

4.3.4.2 Defective pixel correction interface

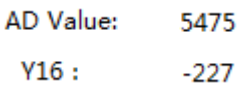
Click the “Defective pixel” menu on the interface as shown in Fig. 4-31, and enter the defective pixel correction interface of advanced application as shown in Fig. 4-34.

Fig. 4-34 Defective pixel correction interface

On the defective pixel correction interface, imaging effects of the abnormal pixel of images can be corrected.

Cursor: Analog video cursor display switch. Cursor will be displayed at the corresponding location on the analog video when it is on. The cursor can be moved by adjusting the coordinates X and Y, or moved continuously via the arrow keys on keyboard. The AD sampling value of current coordinate point can also be displayed in real time.

AD value: display the AD sampling value of current coordinate to determine whether the current pixel is defective.



Y16: Displays the value of Y16 at the current coordinate

Coordinate X/Y: display the values of coordinate X/Y at current cursor location. The cursor can be moved continuously via Up and Down keys on the interface or arrow keys on the keyboard.

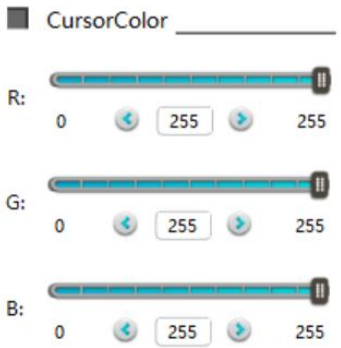
Adding defective pixels: For the defective pixels of the detector pixel, you can move the cursor to a defective pixel, and click the "Add Defective Pixel" button to replace the selected defective pixel with a new pixel to improve image quality.

Saving defective pixels: After addition and replacement of the defective pixels / defective rows / defective columns, you can click “Save Defective Pixel” button to save the defective pixels, and the module will remember the positions of the saved defective pixels and replace them when you reboot the machine. Without saving the new defective pixels, the changes made through ICC are only valid in the current stage and the original defective pixels will be displayed at the same positions when you reboot the machine.

Add defective rows: Adds the rows where the cursor on as defective pixels, complete the whole row of defective pixels replacement.

Add defective columns: Adds the columns where the cursor on as defective pixels, complete the whole column of defective pixels replacement.

Cursor color: Customizable.



4.3.4.3 Menu OSD

Unavailable for the moment

4.3.4.4 Non-uniformity calibration (K)

Click the “K” font area on the interface as shown in Fig.4-31, and enter the Non-uniformity calculation function interface of advanced application as shown in Fig. 4-35.

Shutter compensation: control shutter closure to collect shutter data for non-uniform correction.

BL compensation: collect data of low temperature uniform surface for non-uniform correction and K process calculation.

BH compensation: collect data of high temperature uniform surface for non-uniform correction and K process calculation.

Calculation K: according to the collected high and low temperature data, start the calculation of non-uniform coefficient K value.

Save K: saves the current K value from DDR to FLASH.

Load K: load the saved K value in the FLASH to DDR.

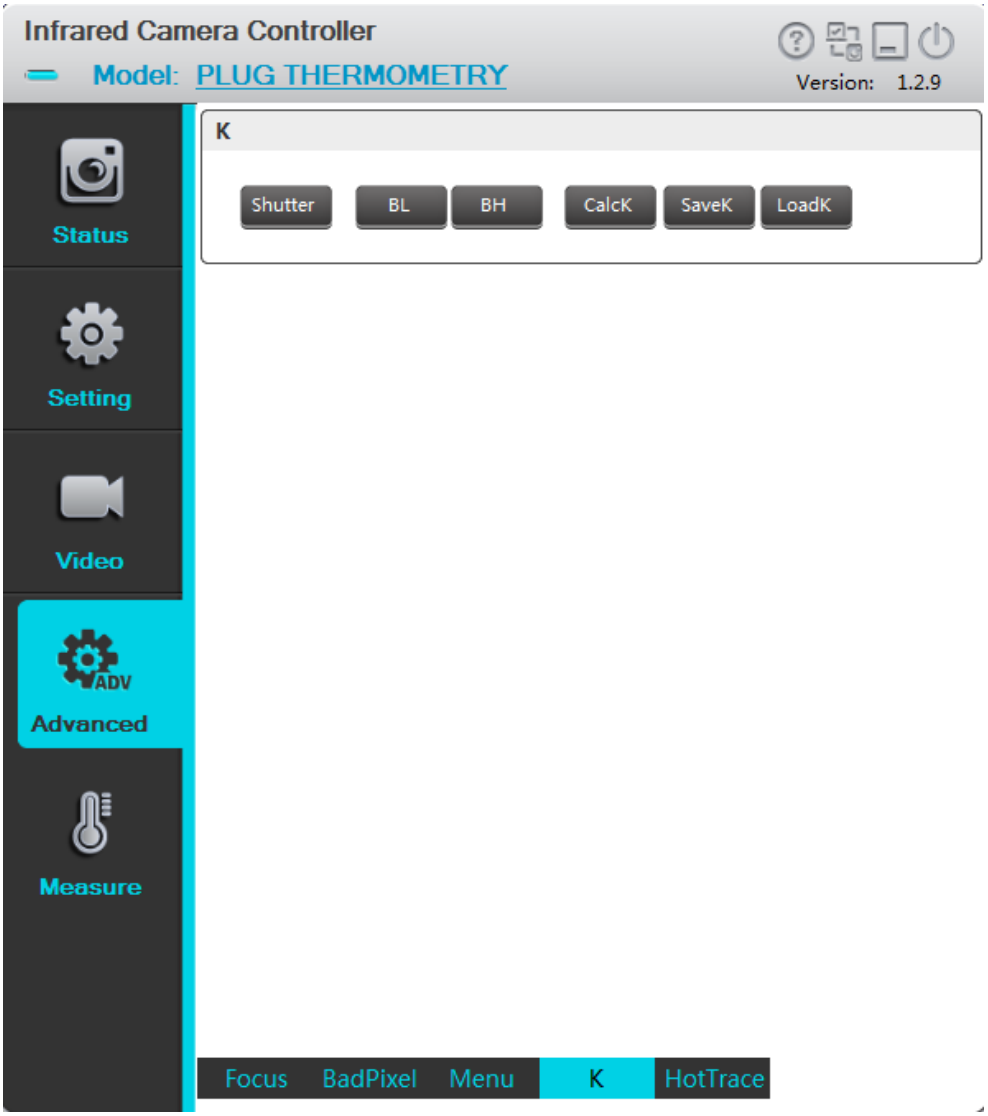


Fig. 4-35 NUC K processing interface

4.3.4.5 Hot tracking

Click the font area of "hot trace" in the interface of Fig. 4-31 and the software enters the interface of hot analysis in advanced applications. The first page of hot analysis is shown in Fig. 4-36.

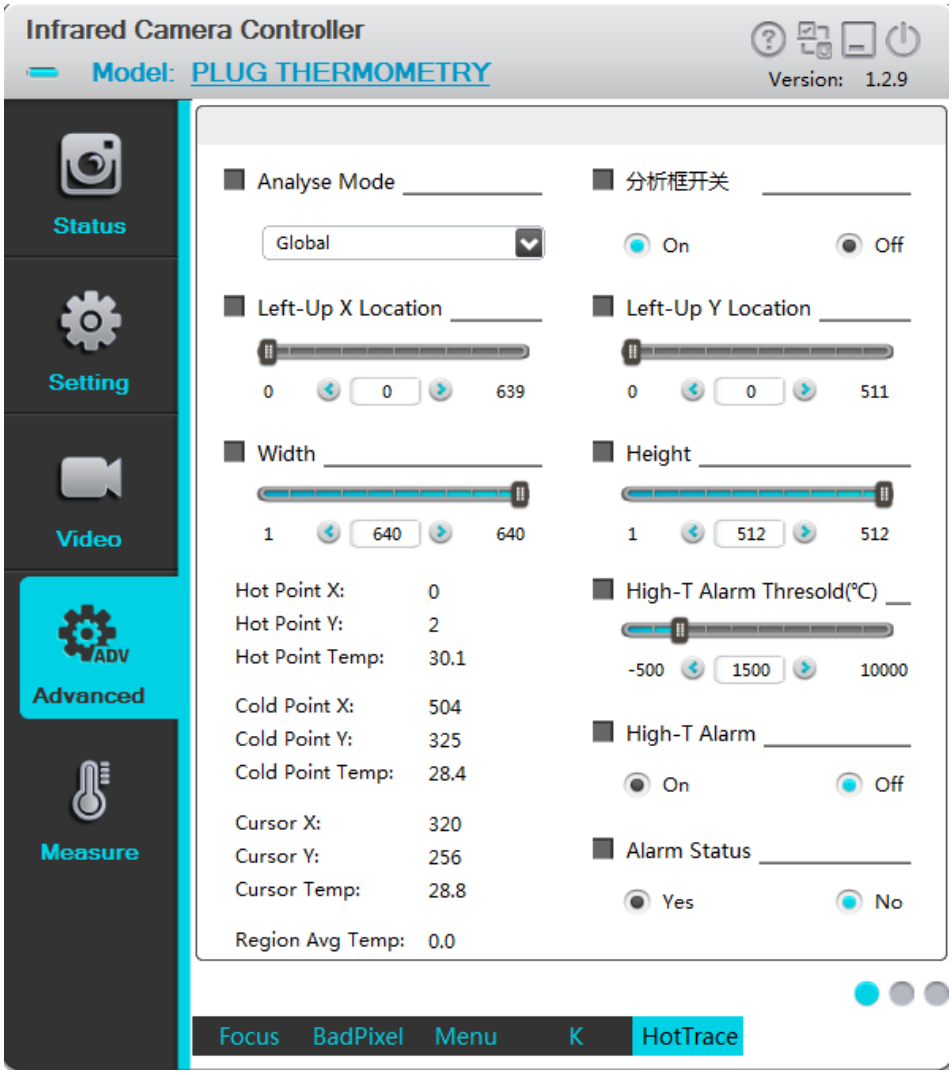


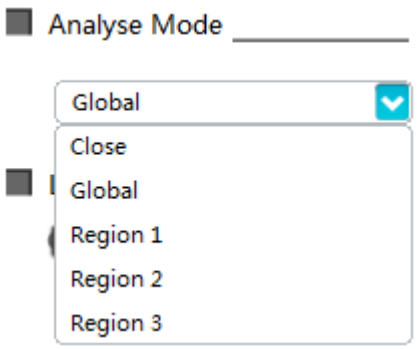
Fig. 4-36 page 1 of Hot tracking

Analysis mode: region analysis mode selection

Full screen: display the maximum, minimum, cursor and average value of the full screen.

Region: when selecting the region, the upper left coordinates X and Y of the region and the width W and height H of the region can be set. The setting range of W is 1~640 and that of H is 1~512. The default upper-left coordinate of the three regions is (0,0), and up to three regions are supported for analysis.

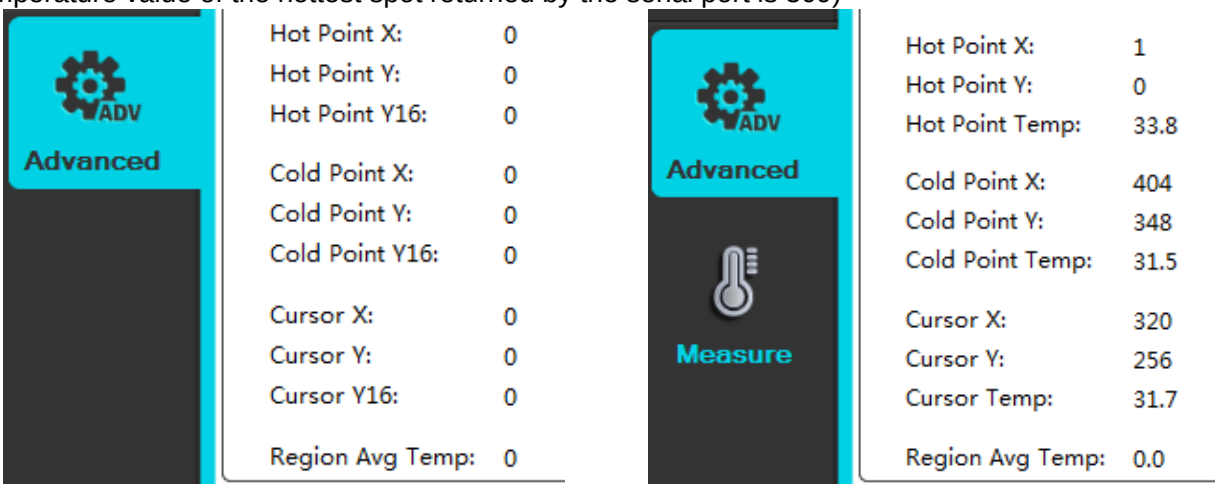
Turn off: turn off area analysis



In the three regions of analysis mode, only one region can be selected for setting each time, but the parameters of three regions are independent. Three areas can not be displayed at the same time, also

can not track or thermometry simultaneously. The area box displays off when you select analysis mode as off or full screen. After resetting the starting coordinates and width and height of the area, the area box displays the position, area tracking or thermometry immediately.

Analysis results display: the module is immediately tracked whether it is set to full screen or area. On software to switch page or send the hot tracking first page query command, then get the tracked result, as shown in fig. 4-37, for observation module, can get the Y16 value of hottest spots, coldest spots, the cursor spots and their corresponding coordinate position, the last item is regional average Y16 value,for thermometry module, you can get the temperature of hottest spots, coldest spots and cursor spots and their corresponding coordinates position, the last item is the average temperature for area (please note that the temperature value from machines response page query command is the real-time temperature * 10, as shown below, for example, when display the hottest spot temperature is 30.9 degrees, The temperature value of the hottest spot returned by the serial port is 309)



a) Observation type b) Thermography type

Fig. 4-37 result of area analysis

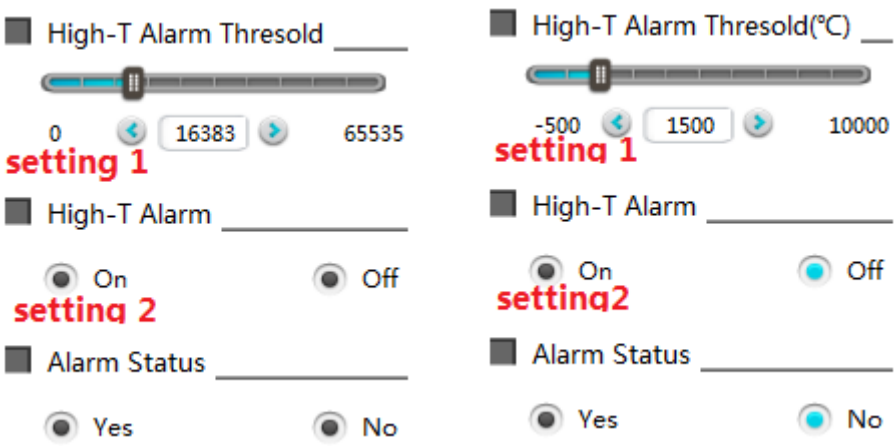
High temperature alarm: high temperature alarm threshold can be set.

For observation module:

High temperature alarm threshold setting, as shown in fig. 4-38 ,the default value is 16383 (the maximum value of the imaging range). This setting item can be set according to the analysis mode. For example, the region 1 can be set to 10000, region 2 set to 12000, and the threshold value of region 1 and region 2 can be stored and used independently.

Recommended alarm threshold setting method : if the environment temperature T0 is known, The average Y16 can be supposed to Y0, that can be approximated to the corresponding temperature T0, if want to set the temperature of T1 as over temperature alarm temperature, and the corresponding Y1 set formula Y1 = Y0 + K * (TI - T0), for observation module, K value can be observed by two known temperature target through simple calculation, use cursor spot aim the two known temperature target (target temperature T1, T2), obtain the cursor point Y16 value Y1, Y2, K = (Y2 - Y1)/(T2 - T1).

At this time, switch on the high temperature alarm , as shown in setting 2 of Fig. 4-38. The module start hot tracking, and when the hot spot Y16 is greater than the high temperature alarm threshold, the module takes the initiative to send the uplink protocol on the first page of hot spot tracking. When there is an alarm or no alarm detected for the first time, the uplink protocol of this page will be consecutive sent 3 times. If an alarm is detected continuously, the uplink protocol will be sent once at a time.



a) Observation type b) Thermography type

Fig. 4-38 temperature alarm setting

For thermometry module:

High temperature alarm threshold setting, as shown in fig. 4-38 ,the default value is 10000 , it means alarm only if it exceeds 1000℃. This setting item can be set according to the analysis mode. For example, the region 1 can be set to 10000, region 2 set to 8000, and the threshold value of region 1 and region 2 can be stored and used independently. This setting item is the temperature threshold, the setting value is related to the temperature measurement range.

Recommended method for setting alarm threshold: after setting the interest area or full screen, the temperature value can be obtained according to the tracking result or query shown in FIG. 4-37 , that is, the temperature value of the hottest spot can be obtained, and the temperature threshold can be directly set based on the tracking result (FIG. 4-38, setting 1).

At this time, switch on the high temperature alarm , as shown in setting 2 of Fig. 4-38. The module start hot spot tracking, and when the hottest spot is greater than the high temperature alarm threshold, the module takes the initiative to send the uplink protocol on the first page of hot spot tracking. When there is an alarm or no alarm detected for the first time, the uplink protocol of this page will be consecutive sent 3 times. If an alarm is detected continuously, the uplink protocol will be sent once at a time.

After setting the high temperature alarm threshold, it is necessary to switch on the high temperature alarm at the same time, so that the module can actively upload the alarm status and other information (hot tracking first page uplink protocol).

The second page of hot spot analysis is shown in fig. 4-39

Fig. 4-39 page 2 of Hot tracking

The hottest spot switch: control the location of the hottest spot and whether the cursor is displayed on the image.
The coldest spot switch: controls the position of the coldest spot and whether the cursor is displayed on the image.
The hottest spot cursor color: sets the display color of the hottest spot cursor on the image.
The coldest spot cursor color: sets the display color of the coldest spot cursor on the image.

Hotspot tracking upper limit and lower limit: used to filter some abnormal ultra-high temperature or ultra-low temperature objects that may cause false alarm in some scenes.

For the observation module, take the hottest spot as an example, when the hottest spot Y16 is greater than the high temperature alarm threshold and less than the upper limit of hot spot tracking, the alarm will be actived. This setting is not recommended by general customers, and the setting value cannot exceed 16383.

For the thermometry module, take the hottest spot as an example. When the temperature of the hottest spot is greater than the high temperature alarm threshold and less than the upper limit of hot spot tracking, the alarm will be actived. This setting item is the temperature threshold, when the setting value is 10000, it means the threshold value is 1000℃, and its range is related to the temperature measurement range, which is not recommended by general customers.

The third page of hotspot analysis is shown in fig. 4-40

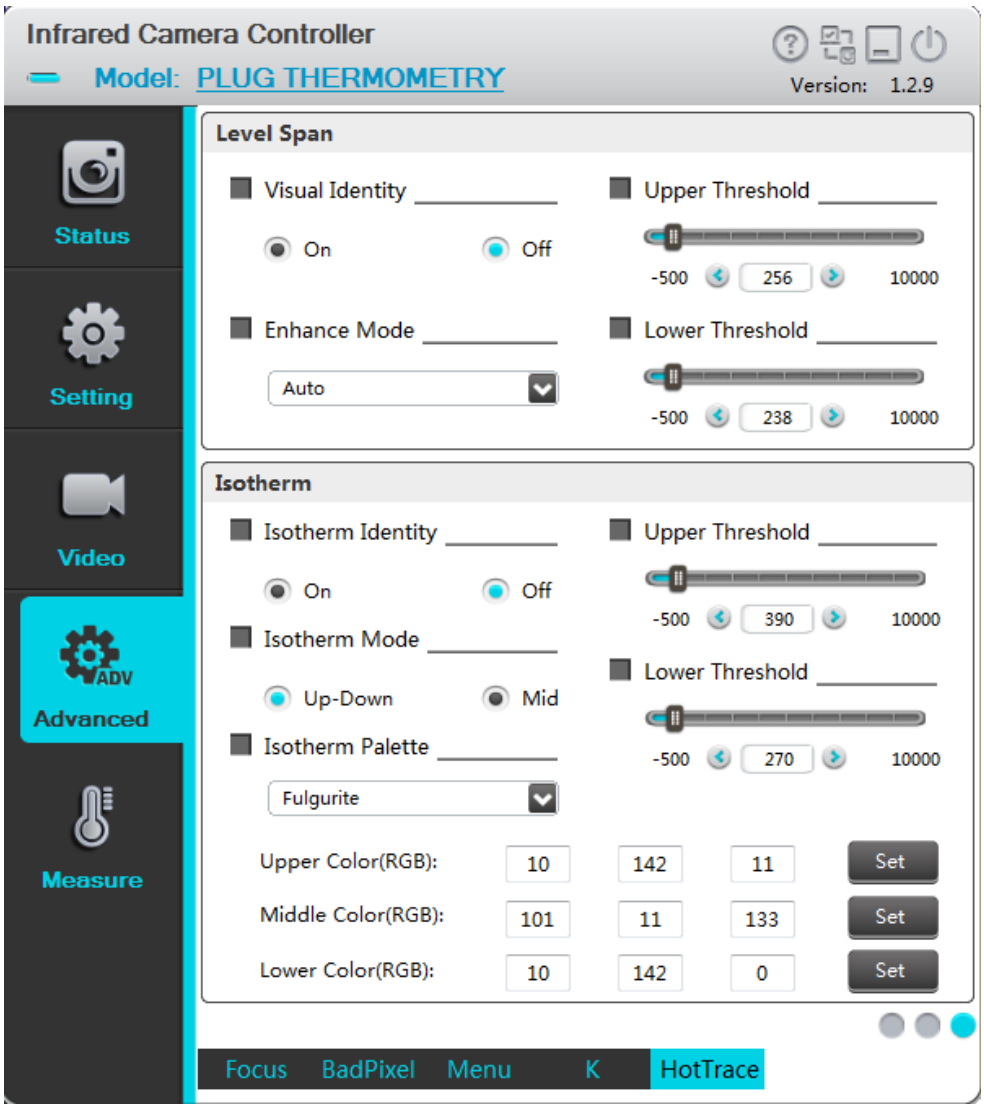
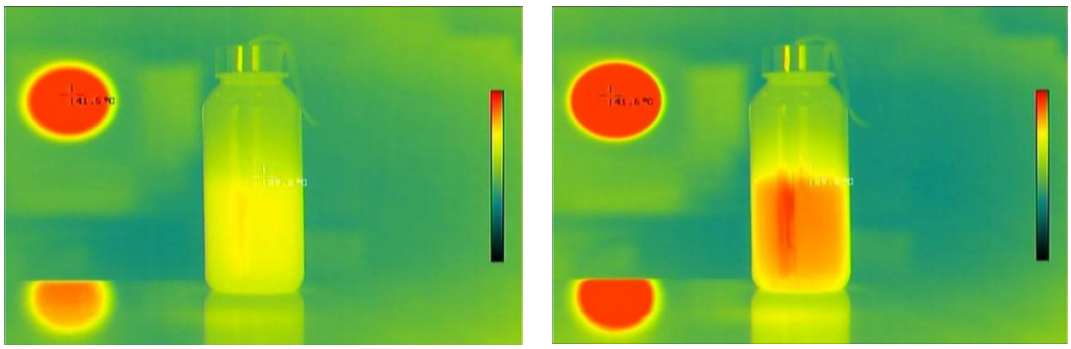


Fig. 4-40 page 3 of Hot tracking

Pseudo-color vision enhancement: improve the mapping relationship of dimming (DRT) by manually adjusting the attention temperature range or Y16 data area, allocate more gray levels to the attention temperature or Y16 range and reduce the gray distribution outside the range, so as to achieve the effect of highlighting the focus area.

Enhancement mode:
Automatic: calculate the grayscale distribution automatically according to the temperature or Y16 range of the scene.
Semi-automatic: base on the cursor spot temperature or Y16, set the focus range to [cursor spot temperature - lower limit, cursor spot temperature + upper limit] or [cursor spot Y16 - lower limit, cursor spot Y16 + upper limit] , and adjust dynamically with the center point as the reference point.
Manual: for observation type, adjust the gray distribution by input the upper limit and lower limit of concerned Y16 ; For the thermometry type, the gray distribution is adjusted through the input of the upper limit and lower limit of the concerned temperature.



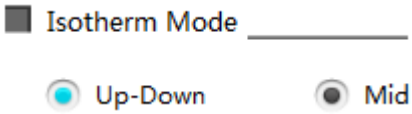
(a) (b)

Fig. 4-41 pseudo color vision enhancement

Take temperature measurement as an example, as shown in Fig. 4-41. Fig. A shows pseudo-color image in automatic mode. The highest temperature of the scene is black body at 41℃, and the temperature of the central water cup is about 29℃, In manual mode, the upper limit threshold was adjusted to 31℃, and the lower limit threshold was adjusted to 26℃. The pseudo-color enhancement effect for the concerned temperature range was shown in figure b.

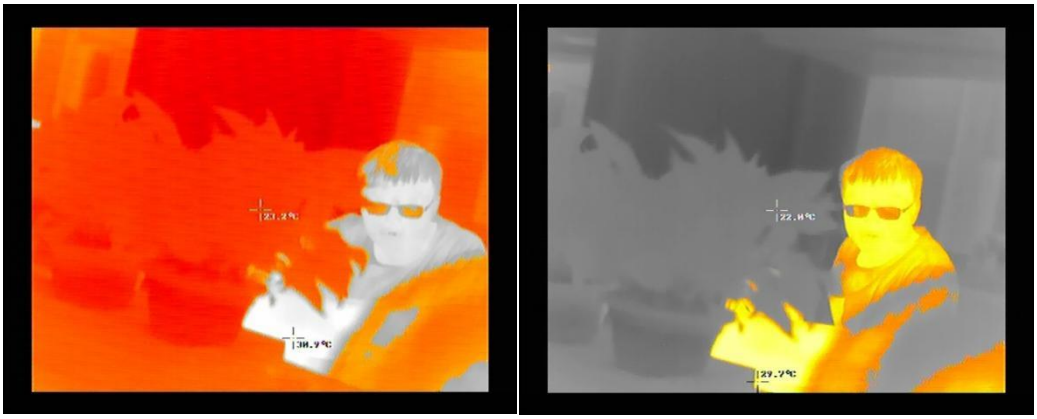
Isothermals: in grayscale image, the temperature interval or Y16 interval to be concerned should be highlighted with pseudo-color.

Isothermal model:



Up-Down: in this mode, pseudo-color is used to highlight the areas where the temperature or Y16 is higher than the upper limit threshold, and pseudo-color is used to highlight the areas where the temperature or Y16 is lower than the lower limit. The upper isotherm or lower isotherm mode can be realized by adjusting the threshold value.

Middle: In this mode, the areas where temperature or Y16 is larger than the upper threshold and smaller than the lower limit are highlighted with pseudo-color.



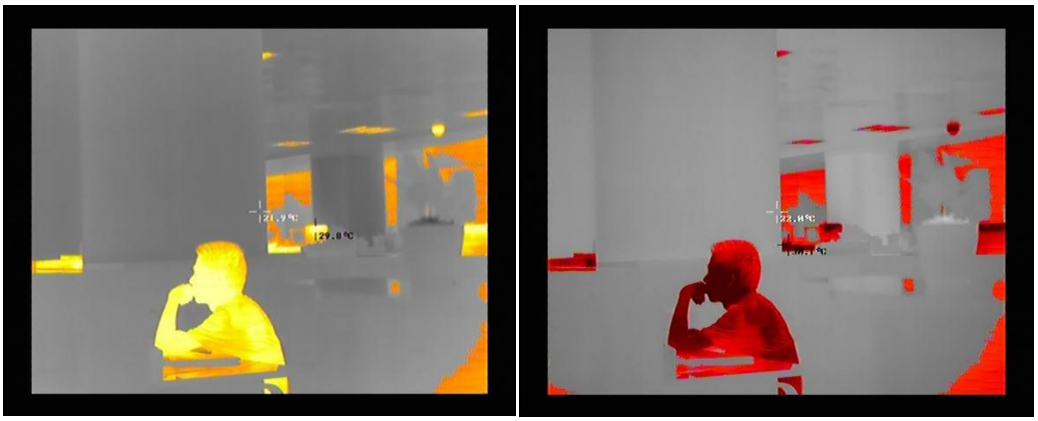
(a) (b)

Fig. 4-42 Isothermals

Take the thermography type as an example, the upper limit threshold is 39.0℃, the lower limit threshold is 29.0℃, FIG. a shows the upper and lower isothermal mode, and the scene beyond 29~39℃ is represented by fulgurite pseudo-color. FIG. b shows the scene in the medium isotherm mode within 29~39℃ represented by fulgurite pseudo-color.

Isothermal color: isothermal pseudo-color can be selected by isothermal pseudo-color belt selection command. Currently, 10 isothermal pseudo-colors including white hot, fulgurite, iron red, hot iron, medical treatment, arctic, rainbow 1, rainbow 2, trace red and black hot are supported by default.

Isothermal polarity: when the isotherm function is switch on, setting the polarity pseudo-color on the page invalid, but the black/white polarity of the isotherm can be changed by sending black and white pseudo-color modes.



(a) (b)

Fig. 4-43 Isotherm polarity switching

Taking thermography type as an example, the upper limit threshold is 39.0℃, the lower limit threshold is 29.0℃, and FIG. a shows the white-hot Fulgurite isotherm. FIG.b shows the black-hot Fulgurite isotherm.

4.3.5 Thermography

On the parameters setting interface, the parameters related to temperature measurement is mainly configured, including distance, emissivity, temperature measurement range, temperature show and temperature correction settings., etc.

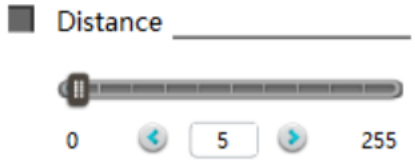
4.3.5.1 parameter setting

Click the "parameter setting" interface, as shown in FIG. 4-44.

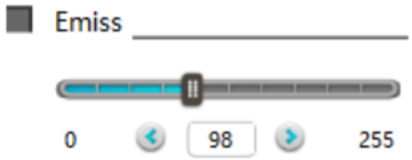
FIG. 4-44 Thermography interface

Thermography interface mainly includes distance, emissivity, temperature measurement range, humidity, restore factory value, and save Settings.

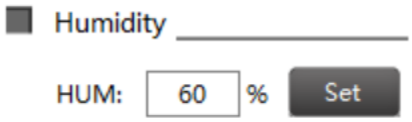
Distance ： Customizable is available, the typical distance is 5M.



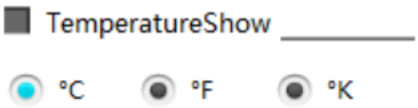
Emissivity：customizable from 0 to 100, typical radiation rate is 98 (effective value is 0.98)

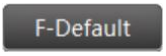


Humidity: customizable from 0~100%, the typical data is 80%.



Temperature Show：switch of temperature units, the degree Celsius、degree Fahrenheit and degree Kelvin can be freely switched between each other.



Factory reset: Press the button “Factory Reset” 

to restore module's all configurations to the factory defaults.

Save settings: After using the Infrared Camera Controller ICC to change the module mode and parameter values, click the button "Save Settings"

to save the current configuration as the new power-on default. When powering on the module at the next time, the module will be configured with the new power-on default. If you do not save the settings, the change made by ICC is only valid for the current stage, and the module will be configured based on the previous default at the next boot.

4.3.5.2 Blackbody correction interface

Click the “Regulate” (Blackbody correction) menu on the interface as shown in Fig.4-30, and enter the blackbody correction interface of thermography application as shown in Fig.4-31.

Fig.4-31 blackbody correction interface

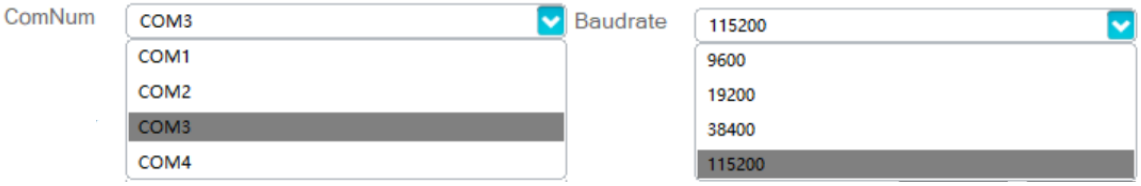
For the use of black body correction page, please refer to the secondary calibration guidance.

5 Frequently asked questions (FAQ)

5.1: Prepare for demonstration?

5.2: How to choose the correct serial number to connect?

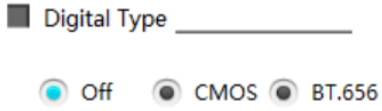
Answer: the solution is: After successful software installation, enable the device manager of the computer, and double-click "Port" to display the serial number to be connected by the module, Silicon Labs CP210x USB to UART Bridge (COM3). Select the appropriate serial number from the connection interface for use in connection. The typical connection baud rate is 115200.



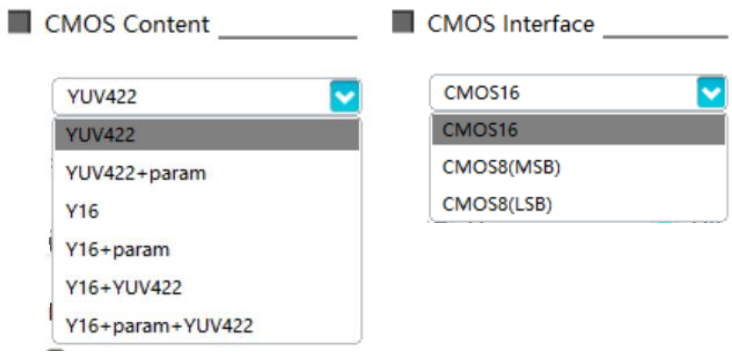
5.3: How to use digital port format?

Answer:

A. There are two kinds of digital video format can be chosen, CMOS or BT.656.



B. If you select the CMOS format, you need to select additional CMOS content and CMOS interface type to use normally.



C. If the BT.656 format is selected, the core will automatically switch to the BT656 format data matching the corresponding frame frequency and video format;

More BT.656 information can refer to the section “2.3.3 Description of BT.656 data”.

5.4: If the video capture card is installed, why real-time video display is unavailable when interface CMOS8 (MSB) or CMOS8 (LSB) is selected?

Answer: Except for interface CMOS16, the other two interfaces do not support real time video display.

5. 5: Emissivity of common materials

Material	Emissivity	Material	Emissivity
Brass mirror	0.03	Bright paint(All colour)	0.90
Polished aluminum or aluminum foil	0.09	Stone	0.92
Pebble	0.28~0.04	Concrete	0.94
Gold-plated copper	0.30	Dark paint	0.95
Solder coated copper	0.35	Water	0.95~0.96
Wood	0.78	Smooth black paint	0.96~0.98
Paper	0.80~0.95	Bark	0.98
Bitumen	0.85	Ice	0.98
Sheet metal	0.88~0.90	Skin	0.98

6 Specification of Serial Communication Protocol

6.1 Overview

This chapter describes the applicable scope and format of serial protocol of PLUG module.

1. Serial port (typical baud rate of 115200) is applied to realize the control and communication of host computer of IR module.

2. Detailed protocol contents are defined.

3. The format of basic frame is as shown in Table 5-1.

Table 5-1 Serial port data format

<table>
<tr><td colspan="2">Frame header</td><td colspan="3">To start the communication frame, two bytes, specified data [55] [AA].</td></tr>
<tr><td colspan="2">Data length</td><td colspan="3">Total number of bytes (including command word and data) of all command segments of the whole command frame, one byte;</td></tr>
<tr><td rowspan="6">Command segment</td><td>Functional classification</td><td colspan="3">Attribute of current menu.</td></tr>
<tr><td>Page</td><td colspan="3">Page number of the current menu attribute.</td></tr>
<tr><td rowspan="4">Option</td><td colspan="3">Option in current page, one byte; the highest order bit is used for marking the read-write.</td></tr>
<tr><td>bit[7]</td><td>bit[6:0]</td><td>Function</td></tr>
<tr><td rowspan="2">1(RD)</td><td>80</td><td>Query current page</td></tr>
<tr><td>xx</td><td>Read a register</td></tr>
<tr><td>0(WR)</td><td>xx</td><td>Write a register</td></tr>
<tr><td>Command word</td><td colspan="3">Value of the register, four bytes (32 bits)</td></tr>
<tr><td colspan="2">XOR checkout</td><td colspan="3">The XOR checkout words of data length byte and all bytes of command segments;</td></tr>
<tr><td colspan="2">Frame end</td><td colspan="3">To end the communication frame, one byte, specified data [F0]</td></tr>
</table>

6.2 Module connection protocol

If the software is started for the first time, select the COM port and baud rate and click CONNECT connection. The host sends a connection command, and the slave gives a response to the received query command after receiving the connection command. After receiving the response command, the host analyzes and displays the connection.

The working process as shown in Fig. 5-1.

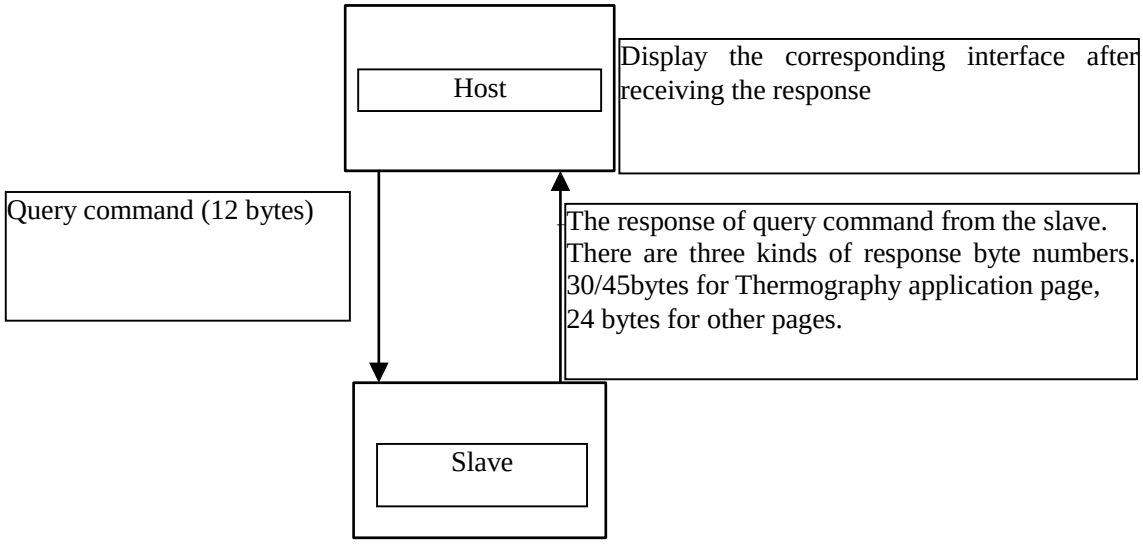


Fig. 5-1 The working process

6.2.1 Downlink protocol

There is only one type of command format of host computer, as shown in Table 5-2.

Table. 5-2 type of command format of host computer

Frame header		Length	Effective command words				Check bit	Frame end
			Functional category	Page	Option	Command word		
2 bytes		1 byte	1 byte	1 byte	1 byte	4 bytes	1 byte	1 byte
00-01		02	03	04	05	06~09	0A	0B
55	AA	07	00	00	0x/8x	00	XX	F0

The option part has 1 byte and the highest bit is used to identify the read-write operation.

The highest bit 1 represents read operation of host computer;

The highest bit 0 represents write operation of host computer;

The option of individual register begins with 0x01.

eg：

Query command: 55 AA + 07 + 00 + 00 + 80 + xxxxxxxx + XX + F0

It is used to inquire the register status of option 1 on the page 00 with function 00, in which, the command word part is invalid and any fixed value can be used.

The format of return command is same as that of query command. Place the query result 0x01020304 in the command word part, such as:

Query feedback command: 55 AA + 13+ 00 + 00 + xx…… + XX + F0

Write operation command: 55 AA + 07 + 00 + 00 + 01 + 01020304 + XX + F0

It is used to write 0x01020304 into the register of option 1 on the page 00 with function 00.

6.2.1.1 Control command

The control command format is as shown in Table 5-3.

Table 5-3 Control command format

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x07	The length is 7	Command length
Byte3	0x00	Status page	Functional classification
	0x01	Setup page	
	0x02	Video page	
	0x03	Application page	
	0x04	Temperature measurement page	
	0xA0	/	
Byte4	0x00	Page 1	Page
	0x01	Page 2	
	0x02	Page 3	
Byte5	0x01~0x07F	Option	ID number of command word
Byte6	0x00	Command high [31:24]	Command word
Byte7	0x00	Command low [23:16]	
Byte8	0x00	Command low [15:8]	
Byte9	0x00	Command low [7:0]	
Byte10	0xXX	XOR checkout	Check bit
Byte11	0xF0	Frame end	Frame end

6. 2. 1. 1. 1 Setup page

All operation commands of the function setting page: (55 AA 07 01 00 + option + command word (4 bytes) + XOR +F0). The command contents are specified as in Table 5-4.

Table 5-4 Operation commands of setup page

Option content	Option	Command word	Operation content	Operation command
Automatic compensation time (min)	0x01	00 00 00 xx	0~100	55 AA 07 01 00 01 00 00 00 xx XOR F0
Image freezing	0x02	00 0000 00	Not freezing	55 AA 07 01 00 02 00 00 00 00 04 F0
		00 0000 01	Freezing	55 AA 07 01 00 02 00 00 00 01 05 F0
Test Screen Switching	0x03	00 00 00 00	Real image	55 AA 07 01 00 03 00 00 00 00 05 F0
		00 00 00 01	Chess pattern	55 AA 07 01 00 03 00 00 00 01 04 F0
		00 00 00 02	Row gradients pattern	55 AA 07 01 00 03 00 00 00 02 07 F0
		00 00 00 03	Column gradients pattern	55 AA 07 01 00 03 00 00 00 03 06 F0
Save settings	0x04	00 00 00 01	Setting	55 AA 07 01 00 04 00 00 00 01 03 F0
Restore to factory default	0x05	00 00 00 01	Setting	55 AA 07 01 00 05 00 00 00 01 02 F0
Module restart	0x06	/	/	Not supported
temperature calibration	0x07	00 00 00 00	off	55 AA 07 01 00 07 00 00 00 00 01 F0
		00 00 00 01	on	55 AA 07 01 00 07 00 00 00 01 00 F0
Shutter control option	0x08	/	/	Not supported
Shutter manual control command	0x08	00 00 00 00	Shutter close	55 AA 07 A0 02 08 00 00 00 00 AD F0
		00 00 00 01	Shutter open	55 AA 07 A0 02 08 00 00 00 01 AC F0
Gain control (Observation type)	0x09	00 00 00 00	Standard	55 AA 07 01 00 09 00 00 00 00 0F F0
		00 00 00 01	Low noise	55 AA 07 01 00 09 00 00 00 01 0E F0

Note:

Timing compensation operation content 0 means timing compensation function is off, 1~100 means 1min~100min.

6. 2. 1. 1. 2 Video page

(1) Analog Video page

All operation command formats of the analog video page: (55 AA 07 02 00 + option + command word (4 byte) + XOR + F0). See Table 5-5 for details.

Table 5-5 Operation commands of analog video page

Option content	Option	Command word	Operation content	Operation command
Analog video switch	0x01	00 00 00 00	Off	55 AA 07 02 00 01 00 00 00 00 04 F0
		00 00 00 01	On	55 AA 07 02 00 01 00 00 00 01 05 F0
Video system switching	0x02	00 00 00 00	P:768x576	/ (This function is not supported)
		00 00 00 01	N:640x480	/ (This function is not supported)
		00 00 00 02	P:720x576	55 AA 07 02 00 02 00 00 00 02 05 F0
		00 00 00 03	N:720x480	55 AA 07 02 00 02 00 00 00 03 04 F0
Frame rate setting P-system : 50/25/9 N-system : 60/30/9	0x03	00 00 00 00	50/60Hz	55 AA 07 02 00 03 00 00 00 00 06 F0
		00 00 00 01	25/30Hz	55 AA 07 02 00 03 00 00 00 01 07 F0
		00 00 00 02	9Hz	55 AA 07 02 00 03 00 00 00 02 04 F0
Pseudo-color	0x04	00 00 00 00	White hot	55 AA 07 02 00 04 00 00 00 00 XOR F0
		00 00 00 01	Fulgurite	55 AA 07 02 00 04 00 00 00 01 XOR F0
		00 00 00 02	Iron Red	55 AA 07 02 00 04 00 00 00 02 XOR F0
		00 00 00 03	Hot Iron	55 AA 07 02 00 04 00 00 00 03 XOR F0
		00 00 00 04	Medical	55 AA 07 02 00 04 00 00 00 04 XOR F0
		00 00 00 05	Arctic	55 AA 07 02 00 04 00 00 00 05 XOR F0
		00 00 00 06	Rainbow 1	55 AA 07 02 00 04 00 00 00 06 XOR F0
		00 00 00 07	Rainbow 2	55 AA 07 02 00 04 00 00 00 07 XOR F0
		00 00 00 08	Tint	55 AA 07 02 00 04 00 00 00 08 XOR F0
		00 00 00 09	Black hot	55 AA 07 02 00 04 00 00 00 09 XOR F0
Mirror image	0x05	00 00 00 00	N/A	55 AA 07 02 00 05 00 00 00 00 00 F0
		00 00 00 01	Mirror X	55 AA 07 02 00 05 00 00 00 01 01 F0
		00 00 00 02	Mirror Y	55 AA 07 02 00 05 00 00 00 02 02 F0
		00 00 00 03	Mirror XY	55 AA 07 02 00 05 00 00 00 03 03 F0
EZOOM		00 00 00 xx	8~64(the effective value range 1	55 AA 07 02 00 06 00 00 00 xx XOR F0

			to 8)	
Coordinate X of the center of zoomed area	0x07	00 00 xxxx(MSB)	0~width-1	55 AA 07 02 00 07 00 00 xx xx XOR F0
Coordinate Y of the center of zoomed area	0x08	00 00 xxxx(MSB)	0~height-1	55 AA 07 02 00 08 00 00 xx xx XOR F0
Hotspot track switch	0x09	/	/	This page is not supported

Note:

EZOOM magnification of the operation content N need to be a multiple of 8, the actual effective value is N/8 times.

(2) Digital Video page

All operation command formats of the digital video page: (55 AA 07 02 01 + option + command word (4 byte) + XOR + F0) See Table 5-6 for details.

Table 5-6 Operation commands of digital video page

Option content	Option	Command word	Operation content	Operation command
External synchronization switch	0x01	00 00 00 00	Slave mode-Off	55 AA 07 02 01 01 00 00 00 00 05 F0
		00 00 00 01	Slave mode-On	55 AA 07 02 01 01 00 00 00 01 04 F0
		00 00 00 02	Master mode	55 AA 07 02 01 01 00 00 00 02 07 F0
Digital port type	0x02	00 00 00 00	Off	55 AA 07 02 01 02 00 00 00 00 06 F0
		00 00 00 01	BT.656	55 AA 07 02 01 02 00 00 00 01 07 F0
		00 00 00 02	CMOS	55 AA 07 02 01 02 00 00 00 02 04 F0
CMOS content selection	0x03	00 00 00 00	YUV422	55 AA 07 02 01 03 00 00 00 00 07 F0
		00 00 00 01	YUV422_ parameter line	55 AA 07 02 01 03 00 00 00 01 06 F0
		00 00 00 02	YUV16	55 AA 07 02 01 03 00 00 00 02 05 F0
		00 00 00 03	YUV16_ parameter line	55 AA 07 02 01 03 00 00 00 03 04 F0
		00 00 00 04	Y16_YUV422	55 AA 07 02 01 03 00 00 00 04 03 F0
		00 00 00 05	Y16_parameter	55 AA 07 02 01 03 00 00 00 05 02 F0

			line_ YUV422	
CMOS interface type	0x04	00 00 00 00	CMOS16	55 AA 07 02 01 04 00 00 00 00 00 F0
		00 00 00 01	CMOS8 (MSB first)	55 AA 07 02 01 04 00 00 00 01 01 F0
		00 00 00 02	CMOS8 (LSB first)	55 AA 07 02 01 04 00 00 00 02 02 F0
Frame rate setting P-system 50/25/9 N-system 60/30/9	0x05	00 00 00 00	50/60Hz	55 AA 07 02 01 05 00 00 00 00 01 F0
		00 00 00 01	25/30Hz	55 AA 07 02 01 05 00 00 00 01 00 F0
		00 00 00 02	9Hz	55 AA 07 02 01 05 00 00 00 02 03 F0
LVDS switch	0x06	00 00 00 00	Off	55 AA 07 02 01 06 00 00 00 00 02 F0
		00 00 00 01	On	55 AA 07 02 01 06 00 00 00 01 03 F0
Scene compensation	0x07	00 00 00 01	Compensation	55 AA 07 02 01 07 00 00 00 01 02 F0
Shutter compensation	0x08	00 00 00 01	Compensation	55 AA 07 02 01 08 00 00 00 01 0D F0
Digital port output clock phase	0x09	00 00 00 00	Rising edge alignment	55 AA 07 02 01 09 00 00 00 00 0D F0
		00 00 00 01	Fall edge alignment	55 AA 07 02 01 09 00 00 00 01 0C F0

(3) Algorithm setting page

All operation command formats of the algorithm setting page:

(55 AA 07 02 02 + option + command word (4 byte) + XOR+ F0).

See Table 5-7 for details.

Table 5-7 Operation commands of algorithm setting page

Option content	Option	Command word	Operation content	Operation command
Time-domain filtering switch	0x01	00 00 00 00	Off	55 AA 07 02 02 01 00 00 00 00 06 F0
		00 00 00 01	On	55 AA 07 02 02 01 00 00 00 01 07 F0
Filtering strength	0x02	00 00 00 00	Level 0	55 AA 07 02 02 02 00 00 00 00 05 F0
		00 00 00 01	Level 1	55 AA 07 02 02 02 00 00 00 01 04 F0
		00 00 00 02	Level 2	55 AA 07 02 02 02 00 00 00 02 07 F0
		00 00 00 03	Level 3	55 AA 07 02 02 02 00 00 00 03 06 F0

		00 00 00 04	Level 4	55 AA 07 02 02 02 00 00 00 04 01 F0
		00 00 00 05	Level 5	55 AA 07 02 02 02 00 00 00 05 00 F0
		00 00 00 06	Level 6	55 AA 07 02 02 02 00 00 00 06 03 F0
		00 00 00 07	Level 7	55 AA 07 02 02 02 00 00 00 07 02 F0
		00 00 00 08	Level 8	55 AA 07 02 02 02 00 00 00 08 0D F0
		00 00 00 09	Level 9	55 AA 07 02 02 02 00 00 00 09 0C F0
Vertical strip removal switch	0x03	00 00 00 00	Off	55 AA 07 02 02 03 00 00 00 00 04 F0
		00 00 00 01	On	55 AA 07 02 02 03 00 00 00 01 05 F0
Vertical strip strength	0x04	/	/	Not supported
Sharpening switch	0x05	/	/	Not supported
Sharpening strength	0x06	/	/	Not supported
Dimming mode	0x07	00 0000 00	Linear	55 AA 07 02 02 07 00 00 00 00 00 F0
		00 0000 01	Platform	55 AA 07 02 02 07 00 00 00 01 01 F0
		00 0000 02	Hybrid	55 AA 07 02 02 07 00 00 00 02 02 F0
Proportion of upper throwing point	0x08	00 0000 xx	0~20	55 AA 07 02 02 08 00 00 00 xx XOR F0
Proportion of lower throwing point	0x09	00 0000 xx	0~20	55 AA 07 02 02 09 00 00 00 xx XOR F0
Brightness	0x0a	00 0000 xx	0~100	55 AA 07 02 02 0a 00 00 00 xx XOR F0
Contrast	0x0b	00 0000 xx	0~100	55 AA 07 02 02 0b 00 00 00 xx XOR F0
Hybrid dimming mapping range	0x0c	00 0000 xx	0~255	55 AA 07 02 02 0c 00 00 00 xx XOR F0
Y8 correction switch	0x0d	00 00 00 00	Off	55 AA 07 02 02 0d 00 00 00 00 0A F0
		00 0000 01	On	55 AA 07 02 02 0d 00 00 00 01 0B F0
Y8 correction expectation	0x0e	/	/	Not supported
Enhancement selection	0x0f	/	/	Not supported
IDE enhancement switch	0x10	00 00 00 00	Off	55 AA 07 02 02 10 00 00 00 00 17 F0
		00 00 00 01	On	55 AA 07 02 02 10 00 00 00 01 16 F0

IDE filtering level	0x11	00 0000 00	Level 0	55 AA 07 02 02 11 00 00 00 00 16 F0
		00 0000 01	Level 1	55 AA 07 02 02 11 00 00 00 01 17 F0
		00 0000 02	Level 2	55 AA 07 02 02 11 00 00 00 02 14 F0
		00 0000 03	Level 3	55 AA 07 02 02 11 00 00 00 03 15 F0
		00 0000 04	Level 4	55 AA 07 02 02 11 00 00 00 04 12 F0
IDE detail gain	0x12	00 00 00 xx	0~64	55 AA 07 02 02 12 00 00 00 xx XOR F0
LOG enhancement switch	0x13	/	/	Not supported
Y8 correction mode	0x14	00 00 00 00	Automatic	55 AA 07 02 02 14 00 00 00 00 13 F0
		00 00 00 01	Manual	55 AA 07 02 02 14 00 00 00 01 12 F0
Block histogram	0x15	00 00 00 00	Off	55 AA 07 02 02 15 00 00 00 00 12 F0
		00 00 00 01	On	55 AA 07 02 02 15 00 00 00 01 13 F0
Noise removal switch	0x16	00 00 00 00	Off	55 AA 07 02 02 16 00 00 00 00 11 F0
		00 00 00 01	On	55 AA 07 02 02 16 00 00 00 01 10 F0
Noise removal level	0x17	00 00 00 00	Level 0	55 AA 07 02 02 17 00 00 00 00 10 F0
		00 00 00 01	Level 1	55 AA 07 02 02 17 00 00 00 01 11 F0
		00 00 00 02	Level 2	55 AA 07 02 02 17 00 00 00 02 12 F0
		00 00 00 03	Level 3	55 AA 07 02 02 17 00 00 00 03 13 F0
		00 00 00 04	Level 4	55 AA 07 02 02 17 00 00 00 04 14 F0
		00 00 00 05	Level 5	55 AA 07 02 02 17 00 00 00 05 15 F0
		00 00 00 06	Level 6	55 AA 07 02 02 17 00 00 00 06 16 F0
		00 00 00 07	Level 7	55 AA 07 02 02 17 00 00 00 07 17 F0
		00 00 00 08	Level 8	55 AA 07 02 02 17 00 00 00 08 18 F0
		00 00 00 09	Level 9	55 AA 07 02 02 17 00 00 00 09 19 F0

6. 2. 1. 1. 3 Advanced application page

1）Focusing page

All operation command formats of the focusing page: (55 AA 07 03 00 + option + command word (4 byte) + XOR + F0). See Table 5-8 for details.

Table 5-8 Operation commands of focusing page

Option content	Option	Command word	Operation content	Operation command
Lens selection (to be added or deducted based on product planning)	0x01	00 00 00 00	19mm	55 AA 07 03 00 01 00 00 00 00 05 F0
		00 00 00 01	25mm	55 AA 07 03 00 01 00 00 00 01 04 F0
		00 00 00 02		55 AA 07 03 00 01 00 00 00 02 07 F0
		00 00 00 03		55 AA 07 03 00 01 00 00 00 03 06 F0
		……	……	
Manual focusing speed	0x02	00 0000 xx	1~10	55 AA 07 03 00 02 00 00 00 xx XOR F0
Automatic statistics of automatic focusing	0x03	00 0000 xx	1~50	55 AA 07 03 00 03 00 00 00 xx XOR F0
MAX automatic focusing speed	0x04	00 0000 xx	1~10	55 AA 07 03 00 04 00 00 00 xx XOR F0
MIN automatic focusing speed	0x05	00 0000 xx	1~10	55 AA 07 03 00 05 00 00 00 xx XOR F0
Focus mode	0x06	00 00 00 00	Stop	55 AA 07 03 00 06 00 00 00 00 02 F0
		00 00 00 01	Manual far focus	55 AA 07 03 00 06 00 00 00 01 03 F0
		00 00 00 02	Manual near focus	55 AA 07 03 00 06 00 00 00 02 00 F0
		00 00 00 03	Automatic focusing	55 AA 07 03 00 06 00 00 00 03 01 F0

2）Defective pixel page

All operation command formats of the defective pixel page: (55 AA 07 03 01 + option + command word (4 byte) + XOR + F0). See Table 5-9 for details.

Table 5-9 Operation commands of defective pixel page

Option content	Option	Command word	Operation content	Operation command
Cross cursor switch	0x01	00 00 00 00	Off	55 AA 07 03 01 01 00 00 00 00 04 F0
		00 00 00 01	On	55 AA 07 03 01 01 00 00 00 01 05 F0

Cursor coordinate X	0x02	00 00 xxxx	0~width-1	55 AA 07 03 01 02 00 00 xx xx XOR F0
Cursor coordinate Y	0x03	00 00 xxxx	0~height-1	55 AA 07 03 01 03 00 00 xx xx XOR F0
Display of AD value				
Defective pixel addition	0x04	00 00 00 01	Defective pixel addition	55 AA 07 03 01 04 00 00 00 01 00 F0
		00 00 00 02	Defective row addition	55 AA 07 03 01 04 00 00 00 02 03 F0
		00 00 00 03	Defective column addition	55 AA 07 03 01 04 00 00 00 02 03 F0
Defective pixel saving	0x05	00 00 00 01	Setting	55 AA 07 03 01 05 00 00 00 01 01 F0
Cursor color R	0x06	00 00 00 xx	Red component	55 AA 07 03 01 06 00 00 00 xx XOR F0
Cursor color G	0x07	00 00 00 xx	Green Component	55 AA 07 03 01 07 00 00 00 xx XOR F0
Cursor color B	0x08	00 00 00 xx	Blue component	55 AA 07 03 01 08 00 00 00 xx XOR F0

3）Menu function page

Not supported

4）Hots tracking page 1 (region analysis)

All operation command formats of the menu page: (55 AA 07 03 03 + option + command word (4 byte) + XOR+ F0). See Table 5-10 for details.

Table 5-10 Operation commands of menu function page

Option content	Optio	Command	Operation	Operation command

	n	word	content	
Anaysis Mode	0x01	00 00 00 00	Anaysis Off	55 AA 07 03 03 01 00 00 00 00 06 F0
		00 00 00 01	Full screen anaysis	55 AA 07 03 03 01 00 00 00 01 07 F0
		00 00 00 02	Region 1	55 AA 07 03 03 01 00 00 00 02 04 F0
		00 00 00 03	Region 2	55 AA 07 03 03 01 00 00 00 03 05 F0
		00 00 00 04	Region 3	55 AA 07 03 03 01 00 00 00 04 02 F0
Region upper left corner coordinate X	0x02	00 00 xx xx	Region analysis (0~639)	55 AA 07 03 03 02 00 00 xx xx XOR F0
Region upper left corner coordinate Y	0x03	00 00 xx xx	Region analysis (0~511)	55 AA 07 03 03 03 00 00 xx xx XOR F0
Region width W	0x04	00 00 xx xx	Region analysis 1~640	55 AA 07 03 03 04 00 00 xx xx XOR F0
Region height H	0x05	00 00 xx xx	Region analysis 1~512	55 AA 07 03 03 05 00 00 xx xx XOR F0
Region frame color	0x06	00 00 00 xx	Component R(0~255)	55 AA 07 03 03 06 00 00 00 xx XOR F0
	0x07	00 00 00 xx	Component G(0~255)	55 AA 07 03 03 07 00 00 00 xx XOR F0
	0x08	00 00 00 xx	Component B(0~255)	55 AA 07 03 03 08 00 00 00 xx XOR F0
High temperature alarm switch	0x09	00 00 00 00	High temperature alarm off	55 AA 07 03 03 09 00 00 00 00 0E F0
		00 00 00 01	High temperature alarm on	55 AA 07 03 03 09 00 00 00 01 0F F0
High temperature alarm threshold	0x0a	00 00 xx xx	Note①	55 AA 07 03 03 0a 00 00 xx xx XOR F0

Note:

①Observation type setting range 0 to 65535,Thermography type setting range -50.0℃ to 1000.0℃, magnify 10 times transmission.

5) Hotspot tracking page 2 (Hot tracking)

Hotspot tracking page all operation commands:55 AA 07 03 04 + option + command word (4 byte) +XOR + F0

Fig5-11 Hotspot tracking page operating command

Option content	Option	Command word	Operation content	Operation command
cursor switch	0x01	00 00 00 00	The hottest spot cursor off	55 AA 07 03 04 01 00 00 00 00 01 F0
		00 00 00 01	The hottest spot cursor on	55 AA 07 03 04 01 00 00 00 01 00 F0
	0x02	00 00 00 00	The coldest spot cursor off	55 AA 07 03 04 02 00 00 00 00 02 F0
		00 00 00 01	The coldest spot cursor on	55 AA 07 03 04 02 00 00 00 01 03 F0
Hot spot tracking upper limit	0x03	00 00 xx xx	Note①	55 AA 07 03 04 03 00 00 xx xx XOR F0
Hotspot tracking lower limit	0x04	00 00 xx xx		55 AA 07 03 04 04 00 00 xx xx XOR F0
The hottest spot cursor color	0x05	00 00 00 xx	Component R(0~255)	55 AA 07 03 04 05 00 00 00 xx XOR F0
	0x06	00 00 00 xx	Component G(0~255)	55 AA 07 03 04 06 00 00 00 xx XOR F0
	0x07	00 00 00 xx	Component B(0~255)	55 AA 07 03 04 07 00 00 00 xx XOR F0
The coldest spot cursor color	0x08	00 00 00 xx	Component R(0~255)	55 AA 07 03 04 08 00 00 00 xx XOR F0
	0x09	00 00 00 xx	Component G(0~255)	55 AA 07 03 04 09 00 00 00 xx XOR F0
	0x0a	00 00 00 xx	Component B(0~255)	55 AA 07 03 04 0a 00 00 00 xx XOR F0

Note:

①Observation type setting range 0 to 65535,Thermography type setting range -50.0℃ to 1000.0℃, magnify 10 times transmission.

6) Hotspot tracking page 3 (pseudo-color vision enhancement)

Pseudo-color vision enhancement all operation commands: 55 AA 07 03 04 + option + command word (4 byte) +XOR + F0.

Fig.5-12 Pseudo-color vision enhancement operation commands

Option content	Option	Command word	Operation content	Operation command
Pseudo-color band switch（color bar）	0x01	00 00 00 00	Off	55 AA 07 03 05 01 00 00 00 00 00 F0
		00 00 00 01	On	55 AA 07 03 05 01 00 00 00 01 01 F0
Pseudo-color vision enhancement mode（level span）	0x02	00 00 00 00	Manual	55 AA 07 03 05 02 00 00 00 00 03 F0
		00 00 00 01	Semi-auto	55 AA 07 03 05 02 00 00 00 01 02 F0
		00 00 00 02	Automatic	55 AA 07 03 05 02 00 00 00 02 01 F0
Pseudo-color vision enhancement upper threshold	0x04	00 00 xx xx	Note①	55 AA 07 03 05 04 00 00 xx xx XOR F0
Pseudo-color vision enhancement Lower threshold	0x05	00 00 xx xx		55 AA 07 03 05 05 00 00 xx xx XOR F0
Isotherm switch（isotherm）	0x06	00 00 00 00	Off	55 AA 07 03 05 06 00 00 00 00 07 F0
		00 00 00 01	On	55 AA 07 03 05 06 00 00 00 01 06 F0
Isothermal model	0x07	00 00 00 00	Up and down Isothermal model	55 AA 07 03 05 07 00 00 00 00 06 F0
		00 00 00 01	Medium isotherm model	55 AA 07 03 05 07 00 00 00 01 07 F0
Upper limit of isotherm threshold	0x08	00 00 xx xx	Note①	55 AA 07 03 05 08 00 00 xx xx XOR F0
Lower limit of isotherm threshold	0x09	00 00 xx xx		55 AA 07 03 05 09 00 00 xx xx XOR F0
Isothermal pseudo-color band selection	0x0d	00 00 00 00	White heat	55 AA 07 03 05 0d 00 00 00 00 0C F0
		00 00 00 01	fulgurite	55 AA 07 03 05 0d 00 00 00 01 0D F0
		00 00 00 02	iron red	55 AA 07 03 05 0d 00 00 00 02 0E F0
		00 00 00 03	hot iron	55 AA 07 03 05 0d 00 00 00 03 0F F0

		00 00 00 04	medical treatment	55 AA 07 03 05 0d 00 00 00 04 08 F0
		00 00 00 05	arctic	55 AA 07 03 05 0d 00 00 00 05 09 F0
		00 00 00 06	Rainbow 1	55 AA 07 03 05 0d 00 00 00 06 0A F0
		00 00 00 07	Rainbow 2	55 AA 07 03 05 0d 00 00 00 07 0B F0
		00 00 00 08	Trace red	55 AA 07 03 05 0d 00 00 00 08 04 F0
		00 00 00 09	Black heat	55 AA 07 03 05 0d 00 00 00 09 05 F0

Note:

①Observation type setting range 0 to 65535,Thermography type setting range -50.0℃ to 1000.0℃, magnify 10 times transmission.

6. 2. 1. 1. 4 Temperature measurement page

1) Parameter setting page

All operation commands of the function parameter setting page：（55 AA 07 04 00 + option + command word (4 bytes) + XOR + F0）. The command contents are specified as shown in Table5-11.

Table 5-13 Operation commands of menu function page

Option content	Option	Command word	Operation content	Operation command
Distance setting	0x01	00 00 00 xx	0~100	55 AA 07 04 00 01 00 00 00 xx XOR F0
Emissivity setting	0x02	00 00 00 xx	0~100	55 AA 07 04 00 02 00 00 00 xx XOR F0
Measurement mode	0x03	00 00 00 00	Min + max temp.	55 AA 07 04 00 03 00 00 00 00 00 F0
		00 00 00 01	cursor spot+ max temp.	55 AA 07 04 00 03 00 00 00 01 01 F0
		00 00 00 02	min + cursor spot temp.	55 AA 07 04 00 03 00 00 00 02 02 F0
Temperature Show	0x04	00 00 00 00	degree Celsius	55 AA 07 04 00 04 00 00 00 00 07 F0
		00 00 00 01	degree Fahrenheit	55 AA 07 04 00 04 00 00 00 01 06 F0
		00 00 00 02	degree Kelvin	55 AA 07 04 00 04 00 00 00 02 05 F0
Factory reset	0x06	00 00 00 01	Setting	55 AA 07 04 00 06 00 00 00 01 04 F0
Reflected	0x07	00 00 xx xx	Setting	55 AA 07 04 00 07 00 00 xx xx XOR F0

setting				
Save settings	0x04	00 00 00 01	Setting	55 AA 07 01 00 04 00 00 00 01 03 F0
Humidity Save settings	0x08	00 00 00 xx	Setting	55 AA 07 04 00 08 00 00 00 xx XOR F0
Temperature measurement range	0x09	00 00 00 00	-40℃~+150℃，（factory default）	55 AA 07 04 00 09 00 00 00 00 0A F0
		00 00 00 01	-40℃~550℃	55 AA 07 04 00 09 00 00 00 01 0B F0

2) Thermography calibration page

Blackbody correction page

All operation commands of the function blackbody correction page：（55 AA 07 04 01 + option + command word (4 bytes) + XOR + F0）. See Table 5-14 for details.

Table5-14 Blackbody correction page operating command

Option content	Option	Command word	Operation content	Operation command
Area temperature switch	0x01	00 00 00 00	off	55 AA 07 04 02 01 00 00 00 00 00 F0
		00 00 00 01	on	55 AA 07 04 02 01 00 00 00 01 01 F0
The area selected command	0x02	00 00 00 01	Area one	55 AA 07 04 02 02 00 00 00 01 02 F0
		00 00 00 02	Area two	55 AA 07 04 02 02 00 00 00 02 01 F0
		00 00 00 03	Area three	55 AA 07 04 02 02 00 00 00 03 00 F0
the starting coordinate X	0x03	00 00 xx xx		55 AA 07 04 02 03 00 00 xx xx XOR F0
the starting coordinate Y	0x04	00 00 xx xx		55 AA 07 04 02 04 00 00 xx xx XOR F0
Region width	0x05	00 00 xx xx		55 AA 07 04 02 05 00 00 xx xx XOR F0
Region height	0x06	00 00 xx xx		55 AA 07 04 02 06 00 00 xx xx XOR F0
Area one temperature switch	0x07	00 00 00 00	off	55 AA 07 04 02 07 00 00 00 00 06 F0
		00 00 00 01	on	55 AA 07 04 02 07 00 00 00 01 07 F0
Area two temperature switch	0x08	00 00 00 00	off	55 AA 07 04 02 08 00 00 00 00 09 F0
		00 00 00 01	on	55 AA 07 04 02 08 00 00 00 01 08 F0
Area three temperature switch	0x09	00 00 00 00	off	55 AA 07 04 02 09 00 00 00 00 08 F0
		00 00 00 01	on	55 AA 07 04 02 09 00 00 00 01 09 F0

6.2.1.2 Query command

The query commands are as shown in Table 5-15.

Table 5-15 Query commands

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x07	Length is 7	Command length
Byte3	0x00	Status page	Functional classification
	0x01	Setup page	
	0x02	Video page	
	0x03	Application page	
	0x04	Measurement page	
Byte4	0x00	Page 1	Page
	0x01	Page 2	
	0x02	Page 3	
Byte5	0x80	Page query code	
Byte6	0x00	0x00	Command word (command word is invalid at query, and the default is 0x00)
Byte7	0x00	0x00	
Byte8	0x00	0x00	
Byte9	0x00	0x00	
Byte10	0xXX	XOR checkout	Check bit
Byte11	0xF0	Frame end	Frame end

6.2.2 Uplink protocol

6.2.2.1 Handshake return

If the slave computer requires a certain time in responding to the control of host computer, the slave computer will return the operation completion command upon its completion of response operation, so that the host computer can continue operation. If no return command is received within the agreed time, the prompt of operation failed will be displayed.

The return command format is as shown in Table 5-16.

Table 5-16 Return command format

Frame header	Length	Option	Checksum	Frame end

2 bytes		1 byte	1 byte	1 byte	1 byte
00-01		02	03	04	05
55	AA	01	xx	XX	F0

1. Confirm the command receiving: 55 AA 01 00 01 F0.

2. Receiving error, resending of command is requested: 55 AA 01 01 00 F0.

See Table 5-17 for details of return command.

Table 5-17 Return commands

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x01	Length is 1	Command length
Byte3	0x00	Receiving confirmation	Receiving confirmation
	0x01	Receiving error, resending of command is requested	Receiving error, resending of command is requested
	0x02	Save settings	Return to current option number upon the completion of response
	0x03	Restore factory settings	
	0x04	Restart	
	0x05	Scene compensation	
	0x06	Shutter compensation	
	0x13	BL compensation	
	0x14	BH compensation	
	0x15	Calculate K	
	0x16	Save K	
	0x17	Load K	
	0x18	Load initial K	
	0x25	Upload BL	
	0x26	Upload BH	
	0x28	Upload NUC	
	0x29	Temperature parameter restored to factory default successfully	
	0x1A	Upload B0	
	0x1B	Upload B1	

	0x1C	Upload B2	
	0x1D	Upload B3	
	0x1E	Upload B4	
	0x1F	Upload B5	
	0x20	Upload B6	
	0x21	Upload B7	
	0x22	Upload B8	
	0x23	Upload B9	
	0x24	Upload K	
	0x25	Upload BL	
	0x26	Upload BH	
	0x27	Upload NUC	
	0x50	Upload PROGRAM	
	0x51	Upload FILTER	
	0x52	Upload RMS	
	0x53	Upload IDE	
	0x54	Upload IMAGE_RGB	
	0x55	Upload SINGLE_TMP	
	0x56	Upload START_IMAGE_RGB	
	0x57	Upload START_IMAGE	
	0x58	Upload MENU_RGB	
	0x59	Upload MENU	
	0x5A	Upload LOG	
	0x5B	Upload HF_CURSOR	
	0x5C	Upload ZSP_PROGRAM	
	0x34	Program upgrading	
	0x39	Defective pixel saving	
	0x40	Defective pixel addition	
	0x47	Low temperature blackbody collection completed	

	0x41	High temperature blackbody collection completed	
	0x42	Two point calibration successful	
	0x43	Two point calibration failed	
	0x44	Single point collection completed	
	0x45	Single point calibration successful	
	0x46	Single point calibration failed	
	0xA0	The “start to upload” mark of asic	
	0xA1	The “upgrading failed” mark of asic	
	0xA2	asic starts to flash	
Byte4	0xXX	XOR checkout	Check bit
Byte5	0xF0	Frame end	Frame end

6.2.2.2 Query return

After receiving the query command, the slave computer will respond and return all information of the queried page to the host computer. The response command format of lower computer is consistent with the return command format at query. Query returns are generally 24 bytes, and the thermography application page has special 30, 45 bytes.

The format of 24\30\45 bytes query return commands are as shown in Table5-18、5-19、5-20.

Table 5-18 Format of 24-bytes query return command

Frame header		Length	Valid command word			Check bit	Frame end
			Functional classification	Page	Option		
2Byte		1Byte	1Byte	1Byte	17Byte	1Byte	1Byte
00-01		02	03	04	05~21	22	23
55	AA	13	00	00	0000000…	XX	55

Table 5-19 Format of 30-bytes query return command

Frame header		Length	Valid command word			Check bit	Frame end
			Functional classification	Page	Option		
2Byte		1Byte	1Byte	1Byte	23Byte	1Byte	1Byte
00-01		02	03	04	05~27	28	29
55	AA	19	00	00	00 00000…	XX	F0

Table 5-20 Format of 45-bytes query return command

Frame header		Length	Valid command word			Frame header	Length
			Functional classification	Page	Option		
2Byte		1Byte	1Byte	1Byte	38Byte	1Byte	1Byte
00-01		02	03	04	05~42	43	44
55	AA	28	00	00	00 00000…	XX	F0

Details of 24\30\45 bytes query response command of salve computer are described in Table 5-21, 5-22, 5-23.

Table 5-21 24-bytes query return command

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x13	Length is 19	Command length
Byte3	0x00	Status page	Functional classification
	0x01	Setup page	
	0x02	Video page	
	0x03	Advance setting page	
	0x04	Measurement page	
Byte4	0x00	Page 1	
	0x01	Page 2	
	0x01	Page 3	
Byte5	0x00	Command of option 1	
Byte6	0x00	Command of option 2	
Byte7	0x00	Command of option 3	
Byte8	0x00	Command of option 4	
Byte9	0x00	Command of option 5	
Byte10	0x00	Command of option 6	
Byte11	0x00	Command of option 7	
Byte12	0x00	Command of option 8	
Byte13	0x00	Command of option 9	
Byte14	0x00	Command of option 10	
Byte15	0x00	Command of option 11	

Byte16	0x00	Command of option 12	
Byte17	0x00	Command of option 13	
Byte18	0x00	Command of option 14	
Byte19	0x00	Command of option 15	
Byte20	0x00	Command of option 16	
Byte21	0x00	Command of option 17	
Byte22	0xXX	XOR checkout	Check bit
Byte23	0xF0	Frame end	Frame end

Table5-22 30-bytes query return command

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x19	Length is 25	Command length
Byte3	0x00	Status page	Functional classification
	0x01	Setup page	
	0x02	Video page	
	0x03	Advance setting page	
	0x04	Measurement page	
Byte4	0x00	Page 1	Page
	0x01	Page 2	
	0x01	Page 3	
Byte5	0x00	Command of option 1	Command word
Byte6	0x00	Command of option 2	
Byte7	0x00	Command of option 3	
Byte8	0x00	Command of option 4	
Byte9	0x00	Command of option 5	
Byte10	0x00	Command of option 6	
Byte11	0x00	Command of option 7	
Byte12	0x00	Command of option 8	

Byte13	0x00	Command of option 9	
Byte14	0x00	Command of option 10	
Byte15	0x00	Command of option 11	
Byte16	0x00	Command of option 12	
Byte17	0x00	Command of option 13	
Byte18	0x00	Command of option 14	
Byte19	0x00	Command of option 15	
Byte20	0x00	Command of option 16	
Byte21	0x00	Command of option 17	
Byte22	0x00	Command of option 18	
Byte23	0x00	Command of option 19	
Byte24	0x00	Command of option 20	
Byte25	0x00	Command of option 21	
Byte26	0x00	Command of option 22	
Byte27	0x00	Command of option 23	
Byte28	0xXX	XOR checkout	Check bit
Byte29	0xF0	Frame end	Frame end

Table5-23 45-bytes query return command

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x28	Length is 40	Command length
Byte3	0x00	Status page	Functional classification
	0x01	Setup page	
	0x02	Video page	
	0x03	Advance setting page	
	0x04	Measurement page	
Byte4	0x00	Page 1	Page
	0x01	Page 2	

	0x02	Page 3	
Byte5	0x00	Command of option 1	Command word
Byte6	0x00	Command of option 2	
Byte7	0x00	Command of option 3	
Byte8	0x00	Command of option 4	
Byte9	0x00	Command of option 5	
Byte10	0x00	Command of option 6	
Byte11	0x00	Command of option 7	
Byte12	0x00	Command of option 8	
Byte13	0x00	Command of option 9	
Byte14	0x00	Command of option 10	
Byte15	0x00	Command of option 11	
Byte16	0x00	Command of option 12	
Byte17	0x00	Command of option 13	
Byte18	0x00	Command of option 14	
Byte19	0x00	Command of option 15	
Byte20	0x00	Command of option 16	
Byte21	0x00	Command of option 17	
Byte22	0x00	Command of option 18	
Byte23	0x00	Command of option 19	
Byte24	0x00	Command of option 20	
Byte25	0x00	Command of option 21	
Byte26	0x00	Command of option 22	
Byte27	0x00	Command of option 23	
Byte28	0x00	Command of option 24	
Byte29	0x00	Command of option 25	
Byte30	0x00	Command of option 26	
Byte31	0x00	Command of option 27	
Byte32	0x00	Command of option 28	

Byte33	0x00	Command of option 29	
Byte34	0x00	Command of option 30	
Byte35	0x00	Command of option 31	
Byte36	0x00	Command of option 32	
Byte37	0x00	Command of option 33	
Byte38	0x00	Command of option 34	
Byte39	0x00	Command of option 35	
Byte40	0x00	Command of option 36	
Byte41	0x00	Command of option 37	
Byte42	0x00	Command of option 38	
Byte43	0xXX	XOR checkout	Check bit
Byte44	0xF0	Frame end	Frame end

6. 2. 2. 2. 1 Status page

Query response command contents of the status page are as shown in Table 5-24.

Table 5-24 Commands of status page

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x13	Length is 19	Command length
Byte3	0x00	Status page	Functional classification
Byte4	0x00	Page 1	Page number
Byte5	0x0A	PLUG612 Obervation type	ID number of module
	0x0B	PLUG612 Thermography type	
	Others	Reserved	
Byte6	0x00		ID number of communication object
Byte7	0x0D	Year (13)	

Byte8	0x06	Month (06)	Program version
Byte9	0x16	Day (22)	
Byte10	0x1E	Focal spot temperature high 8 bit	Focal plane temperature (precision: 0.01)
Byte11	0x00	Focal spot temperature low 8 bit	
Byte12	0x00	Video system	Video system
Byte13	0x08	640×512	ID number of resolution
	Others	Reserved	
Byte14	xx	Machine identification code [31:24]	
Byte15	xx	Machine identification code [23:16]	
Byte16	xx	Machine identification code[15:8]	
Byte17	xx	Machine identification code [7:0]	
Byte18~Byte21	0x00	Reserved	
Byte22	0xXX	Checksum	Check bit
Byte23	0xF0	Frame end	Frame end

6. 2. 2. 2. 2 Setup page

Query response command contents of the setup page are as shown in Table 5-25.

Table 5-25 Commands of setup page

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x13	Length is 19	Command length
Byte3	0x01	SETUP Status page	Functional classification
Byte4	0x00	Page 1	Page
Byte5	xx	Automatic compensation	Command of option 1

		time (xxmin)	
Byte6	0x00	Image not freezing	Command of option 2
	0x01	Image freezing	
Byte7	0x00	Real-time image	Command of option 3
	0x01	Checker board pattern	
	0x02	Row gradients	
	0x03	Line gradients	
Byte8	0x00	The rising of temperature calibration switch off	
	0x01	The rising of temperature calibration switch on	
Byte9	0x00	Shutter control mode	Not supported
Byte10	0x00	Shutter close off	
	0x01	Shutter close on	
Byte11	0x00	Standard mode	Observation type
	0x01	Low noise mode	
Byte12~ Byte21	0x00	Reserved	
Byte22	0xXX	Checksum	Check bit
Byte23	0xF0	Frame end	Frame end

6. 2. 2. 2. 3 Video page

Analog video page

Query response command contents of the analog video page are as shown in Table 5-26.

Table 5-26 Commands of analog video page

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header

Byte1	0xAA	Frame header byte 2	
Byte2	0x13	Length is 19	Command length
Byte3	0x02	Video page	Functional classification
Byte4	0x00	Analog video page (Page 1)	Page
Byte5	0x00	Analog video off	
	0x01	Analog video on	
Byte6	0x00	/	
	0x01	/	
	0x02	P-system 720x576	
	0x03	N-system 720x480	
Byte7 P-system 50/25/9 N-system 60/30/9	0x00	50/60Hz	
	0x01	25/30Hz	
	0x02	9Hz	
Byte8	xx	Pseudo-color	
Byte9	0x00	No	
	0x01	Mirror image in X direction	
	0x02	Mirror image in Y direction	
	0x03	Mirror images in X and Y directions	
Byte10	xx	EZOOM zoom factor 8~64	
Byte11	xx	Coordinate X [15:0] of the center of zoomed area	
Byte12	xx	Coordinate X [7:0] of the center of zoomed area	
Byte13	xx	Coordinate Y [15:0] of the center of zoomed area	
Byte14	xx	Coordinate Y [7:0] of the center of zoomed area	

Byte15	0x00	Hot track switch	Not supported
Byte16~ Byte21	0x00	Reserved	
Byte22	0xXX	Checksum	Check bit
Byte23	0xF0	Frame end	Frame end

Digital video page

Query response command contents of the digital video page are as shown in Table 5-27.

Table 5-27 Commands of digital video page

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x13	Length is 19	Command length
Byte3	0x02	Video page	Functional classification
Byte4	0x01	Digital video page (Page 2)	Page
Byte5	0x00	External synchronization enabling off	Command of option 1
	0x01	External synchronization enabling on	
Byte6	0x00	Digital port parallel off	Command of option 2
	0x01	Digital port BT.656	
	0x02	Digital port CMOS	
Byte7	0x00	YUV422	Command of option 3 Parallel output contents
	0x01	YUV422_ parameter line	
	0x02	YUV16	
	0x03	YUV16_ parameter line	
	0x04	Y16_YUV422	
	0x05	Y16_parameter line_ YUV422	
Byte8	0x00	CMOS16	Command of option 4 Parallel output interface
	0x01	CMOS8(MSB first)	

	0x02	CMOS8(LSB first)	type
Byte9	0x00	50/60Hz	Command of option 5
	0x01	25/30Hz	
	0x02	9Hz	
Byte10	0x00	Off	LVDS switch
	0x01	On	
Byte11	0x00	Rising edge alignment	Data lines are aligned with clocks
	0x01	Fall edge alignment	
Byte12~ Byte21	0x00	Reserved	
Byte22	0xXX	Checksum	Check bit
Byte23	0xF0	Frame end	Frame end

Algorithm control page 1

Query response command contents of the algorithm control page 1 are as shown in Table 5-28.

Table 5-28 Algorithm control page 1

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x13	Length is 19	Command length
Byte3	0x02	Video page	Functional classification
Byte4	0x02	Digital video page (Page 3)	Page
Byte5	0x00	Time-domain filtering off	
	0x01	Time-domain filtering on	
Byte6	0x00	Level 0	Filtering strength
	0x01	Level 1	
	0x02	Level 2	
	0x03	Level 3	
	0x04	Level 4	

	0x05	Level 5	
	0x06	Level 6	
	0x07	Level 7	
	0x08	Level 8	
	0x09	Level 9	
Byte7	0x00	Vertical strip removal off	
	0x01	Vertical strip removal on	
Byte8	0x00	Vertical strip removal strength	Not supported
Byte9	0x00	Sharpening switch	Not supported
Byte10	0x00	Sharpening strength	Not supported
Byte11	0x00	Linear	Dimming mode
	0x01	Platform	
	0x02	Hybrid	
Byte12	xx	Proportion of upper throwing point 0~20	
Byte13	xx	Proportion of lower throwing point 0~20	
Byte14	xx	Brightness	
Byte15	xx	Contrast	
Byte16	xx	Hybrid dimming mapping	
Byte17~ Byte21	0x00	Reserved	
Byte22	0xXX	Checksum	Check bit
Byte23	0xF0	Frame end	Frame end

Algorithm control page 2

Query response command contents of the algorithm control page 2 are as shown in Table 5-29.

Table 5-29 Algorithm control page 2

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header

Byte1	0xAA	Frame header byte 2	
Byte2	0x13	Length is 19	Command length
Byte3	0x02	Video page	Functional classification
Byte4	0x03	Digital video page (page 3)	Page
Byte5	0x00	Y8 correction off	
	0x01	Y8 correction on	
Byte6	0x00	Y8 correction expectation	Not supported
Byte7	0x00	Enhancement type	Not supported
Byte8	0x00	IDE enhancement off	
	0x01	IDE enhancement on	
Byte9	xx	IDE filtering level 0~4	
Byte10	xx	IDE detail gain 0~64	
Byte11	00	LOG enhancement switch	Not supported
Byte12	00	Y8 correction automatic mode	
	01	Y8 correction manual mode	
Byte13	00	Block histogram off	
	01	Block histogram on	
Byte14	00	Noise removal off	
	01	Noise removal on	
Byte15	0xXX	Noise removal level 0-9	
Byte16~Byte21	0x00	Reserved	
Byte22	0xXX	Checksum	Check bit
Byte23	0xF0	Frame end	Frame end

6. 2. 2. 2. 4 Advanced application page

(1)Focusing page

Query response command contents of the focusing page are as shown in Table 5-30.

Table 5-30 Commands of focusing page

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x13	Length is 19	Command length
Byte3	0x03	Application	Functional classification
Byte4	0x00	Focusing page (page 1)	Page
Byte5	xx	Lens type	Command of option 1
Byte6	xx	Manual focusing speed 1~10	Command of option 2
Byte7		Statistic frame number of automatic focusing 1~15	Command of option 3
Byte8	xx	Automatic focusing speed MAX1~10	Command of option 4
Byte9	xx	Automatic focusing speed MIN1~10	Command of option 5
Byte10~Byte21	0x00	Reserved	
Byte22	0xXX	Checksum	Check bit
Byte23	0xF0	Frame end	Frame end

(2)Defective pixel page

Query response command contents of the defective pixel page are as shown in Table 5-31.

Table 5-31 Commands of defective pixel page

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x13	Length is 19	Command length
Byte3	0x03	Application	Functional classification
Byte4	0x01	Defective pixel correction page (page 2)	Page
Byte5	0x00	Cross cursor off	

	0x01	Cross cursor on	
Byte6	xx	Cursor location X[15:8]	
Byte7	xx	Cursor location X[7:0]	
Byte8	xx	Cursor location Y[15:8]	
Byte9	xx	Cursor location Y[7:0]	
Byte10	xx	AD value of cursor point [15:8]	
Byte11	xx	AD value of cursor point [7:0]	
Byte12	xx	Cursor R component	
Byte13	xx	Cursor G component	
Byte14	xx	Cursor B component	
Byte15	0x00	Automatic defective pixel search	Not supported
Byte16	0x00	Automatic defective pixel search threshold [15:8]	Not supported
Byte17	0x00	Automatic defective pixel search threshold [7:0]	Not supported
Byte18	0x00	Automatic defective pixel search number [15:8]	Not supported
Byte19	0x00	Automatic defective pixel search number [7:0]	Not supported
Byte20	xx	Cursor point Y16 [15:8]	
Byte21	xx	Cursor point Y16 [7:0]	
Byte22	0xXX	Checksum	Check bit
Byte23	0xF0	Frame end	Frame end

(3)Menu function page

Not supported

(4)Hot tracking page 1 (regional analysis)

Table 5-32 regional analysis page command

Command word	Bytes	Parameter specification	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x28	Length 40	Command length
Byte3	0x03	Application	Functional classification
Byte4	0x04	regional analysis page （The fourth page）	Page number
Byte5	0x00	Close analysis	Option 1 command
	0x01	Full screen analysis	
	0x02	Region 1	
	0x03	Region 2	
	0x04	Region 3	
Byte6	xx	Upper left corner of regional Coordinate X[15：8]	Option 2 command
Byte7	xx	Upper left corner of regional Coordinate X[7:0]	
Byte8	xx	Upper left corner of regional Coordinate Y[15：8]	Option 3 command
Byte9	xx	Upper left corner of regional Coordinate Y[7:0]	
Byte10	xx	Upper left corner of regional Coordinate W[15：8]	Option 4 command
Byte11	xx	Upper left corner of regional Coordinate W[7:0]	
Byte12	xx	Upper left corner of regional Coordinate H[15：8]	Option 5 command
Byte13	xx	Upper left corner of regional Coordinate H[7:0]	
Byte14	xx	Region frame color component R	Option 6 command
Byte15	xx	Region frame color component G	Option 7 command
Byte16	xx	Region frame color	Option 8 command

		component B	
Byte17	0x00	High temperature alarm off	Option 9 command
	0x01	High temperature alarm on	
Byte18	xx	High temperature alarm threshold[15：8]	Option 10 command
Byte19	xx	High temperature alarm threshold[7：0]	
Byte20	0x00	Temperature does not exceed alarm threshold	
	0x01	Temperature exceeds alarm threshold	
Byte21	xx	The coldest spot coordinate X[15：8]	
Byte22	xx	The coldest spot coordinate X[7:0]	
Byte23	xx	The coldest spot coordinate Y[15：8]	
Byte24	xx	The coldest spot coordinate Y[7:0]	
Byte25	xx	The coldest spot temperature/Y16[15：8]	Observation type 0-65535, Thermography type-50℃ -1000℃, Magnify 10 times
Byte26	xx	The coldest spot temperature/Y16[7:0]	
Byte27	xx	The hottest spot coordinate X[15：8]	
Byte28	xx	The hottest spot coordinate X[7:0]	
Byte29	xx	The hottest spot coordinate Y[15：8]	
Byte30	xx	The hottest spot coordinate Y[7:0]	
Byte31	xx	The hottest spot temperature/Y16[15：8]	Observation type 0-65535, Thermography type-50℃ -1000℃, Magnify 10 times
Byte32	xx	The hottest spot temperature/Y16[7:0]	
Byte33	xx	Cursor spot coordinate X[15：8]	

Byte34	xx	Cursor spot coordinate X[7:0]	
Byte35	xx	Cursor spot coordinate Y[15：8]	
Byte36	xx	Cursor spot coordinate Y[7:0]	
Byte37	xx	Cursor spot temperature/Y16[15：8]	Observation type 0-65535, Thermography type-50℃ -1000℃, Magnify 10 times
Byte38	xx	Cursor spot temperature/Y16[7:0]	
Byte39	xx	Regional average temperature/Y16[15：8]	Observation type 0-65535, Thermography type-50℃ -1000℃, Magnify 10 times
Byte40	xx	Regional average temperature/Y16[7:0]	
Byte41	0x00	Reserved	
Byte42	0x00	Reserved	
Byte43	0xXX	Checksum	Check bit
Byte44	0xF0	Frame end	Frame end

(5)Hot tracking page 2 (Hot Tracking)

Table 5-33 Hots Tracking page command

Command word	Bytes	Parameter specification	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x13	Length 19	Command length
Byte3	0x03	Application	Functional classification
Byte4	0x05	Hot Tracking page （The fifth page）	Page number
Byte5	0x00	The hottest spot cursor off The hottest spot cursor off	Option 1 command
	0x01	The hottest spot cursor on The hottest spot cursor off	
	0x02	The hottest spot cursor off The hottest spot cursor on	
	0x03	The hottest spot cursor on The hottest spot cursor on	
Byte6	xx	Hot tracking upper limit value[15：8]	Option 2 command
Byte7	xx	Hot tracking upper limit value[7:0]	
Byte8	xx	Hot tracking lower limit value[15：8]	Option 3 command
Byte9	xx	Hot tracking lower limit	

		value[7:0]	
Byte10	xx	The hottest cursor spot color component R	
Byte11	xx	The hottest cursor spot color component G	
Byte12	xx	The hottest cursor spot color component B	
Byte13	xx	The coldest cursor spot color component R	
Byte14	xx	The coldest cursor spot color component G	
Byte15	xx	The coldest cursor spot color component B	
Byte16- Byte21	xx	Reserved	
Byte22	0xXX	Checksum	Check byte
Byte23	0XF0	Frame end	Frame end

(6)Hotspot tracking page 3 (Pseudo-color vision enhancement)

Table 5-34 Pseudo-color vision enhancement page command

Command word	Bytes	Parameter specification	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x19	Length 25	Command length
Byte3	0x03	Application	Functional classification
Byte4	0x06	Hot tracking page （The sixth page）	Page number
Byte5	0x00	Pseudo-color band off	Option 1 command
	0x01	Pseudo-color band on	
Byte6	0x00	Pseudo-color vision enhancement manual mode	Option 2 command
	0x01	Pseudo-color vision enhancement semi-automatic mode	
	0x02	Pseudo-color vision enhancement automatic mode	
Byte7	0x00	Reserved	Option 3 command
Byte8	xx	Pseudo-color vision enhancement upper threshold [15：8]	Option 4 command Observation type 0-65535, Thermography type-50℃ -1000℃, Magnify 10 times
Byte9	xx	Pseudo-color vision enhancement upper threshold[7:0]	
Byte10	xx	Pseudo-color vision enhancement lower threshold[15：8]	Option 5 command Observation type 0-65535, Thermography type-50℃ -1000℃, Magnify 10 times
Byte11	xx	Pseudo-color vision enhancement lower threshold[7:0]	
Byte12	0x00	Isotherm off	Option 6 command
	0x01	Isotherm on	
Byte13	0x00	Upper and lower isotherm display mode	Option 7 command
	0x01	Medium isotherm display	

		mode	
Byte14	xx	Upper limit of isotherm threshold[15:8]	Option 8 command Observation type 0-65535, Thermography type-50℃ -1000℃, Magnify 10 times
Byte15	xx	Upper limit of isotherm threshold[7:0]	
Byte16	xx	Lower limit of isotherm threshold[15:8]	Option 9 command Observation type 0-65535, Thermography type-50℃ -1000℃, Magnify 10 times
Byte17	xx	Lower limit of isotherm threshold[7:0]	
Byte18	0x00	Reserved	Option 10 command
Byte19	0x00	Reserved	
Byte20	0x00	Reserved	
Byte21	0x00	Reserved	Option 11 command
Byte22	0x00	Reserved	
Byte23	0x00	Reserved	
Byte24	0x00	Reserved	Option 12 command
Byte25	0x00	Reserved	
Byte26	0x00	Reserved	
Byte27	0x00	White heat	Option 13 command
	0x01	fulgurite	
	0x02	iron red	
	0x03	hot iron	
	0x04	medical treatment	
	0x05	arctic	
	0x06	Rainbow 1	
	0x07	Rainbow 2	
	0x08	Trace red	
	0x09	Black heat	
Byte28	0xXX	Checksum	Check byte
Byte29	0xF0	Frame end	Frame end

6. 2. 2. 2. 5 Thermography page

(1) Parameter setting page

Query response command contents of the temperature measurement page are as shown in Table 5-35.

Table5-35 Thermography function page 1 command

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x19	Length is 25	Command length
Byte3	0x04	Measurement page	Functional classification
Byte4	0x00	Page 1	Page number
Byte5	0-255	The value of distance setting	
Byte6	0-255	The value of emissivity setting	
Byte7	00	Minimum + maximum temperature	

		of current analysis object	
	01	Cross cursor spot+ maximum temperature	
	02	minimum + Cross cursor spot temperature	
Byte8	00	Temperature unit: ℃	
	01	Temperature unit: ℉	
	02	Temperature unit: °K	
Byte9	0x00	Reserved	
Byte10	0x00	Reserved	
Byte11	xx	Coordinate X [15:8] is based on byte7 value	The parameters(coordinate X, coordinate Y, temperature) of the first point are related to byte7 value: 00 means minimum temp. 01means cross cursor temp. 02 means Minimum temp. (actual temperature*10)
Byte12	xx	Coordinate X [7:0] is based on byte7 value	
Byte13	xx	Coordinate Y [15:8] is based on byte7 value	
Byte14	xx	Coordinate Y [7:0] is based on byte7 value	
Byte15	xx	The temperature[15 : 8] after calibration is based on byte7 value	
Byte16	xx	The temperature[7 : 0] after calibration is based on byte7 value	
Byte17	xx	Coordinate X [15:8] is based on byte7 value	The parameters(coordinate X, coordinate Y, temperature) of the second point are related to byte7 value : 00: Maximum temp. 01: Maximum temp. 02: Cross cursor temp. (actual temperature*10)
Byte18	xx	Coordinate X [7:0] is based on byte7 value	
Byte19	xx	Coordinate Y [15:8] is based on byte7 value	
Byte20	xx	Coordinate Y [7:0] is based on byte7 value	
Byte21	xx	The temperature[15 : 8] after calibration is based on setting of byte7 value	
Byte22	xx	The temperature[7 : 0] after calibration is based on setting of byte7 value	
Byte23	xx	Reflected temp[15 : 8]	
Byte24	xx	Reflected temp [7 : 0]	
Byte25	xx	Humidity value	

Byte26	xx	Temperature measurement range	
Byte27	0x00	Reserved	
Byte28	0xXX	XOR checkout	Check bit
Byte29	0xF0	Frame end	Frame end

(2) Blackbody correction page

Query response command contents of the blackbody correction page are as shown in Table 5-36.

Table 5-36 Thermography function page 2 command

Command word	Byte	Parameter description	Parameter type
Byte0	0x55	Frame header byte 1	Frame header
Byte1	0xAA	Frame header byte 2	
Byte2	0x19	Length is 25	Command length
Byte3	0x04	Measurement page	Functional classification
Byte4	0x01	Page 2	Page number
Byte5	xx	Low blackbody temperature [15:8]	
Byte6	xx	Low blackbody temperature [7:0]	
Byte7	xx	High blackbody temperature [15:8]	
Byte8	xx	High blackbody temperature [7:0]	
Byte9	xx	Single point blackbody temperature [15:8]	
Byte10	xx	Single point blackbody temperature [7:0]	
Byte11~ Byte27		Reserved	
Byte28	0xXX	XOR checkout	Check bit
Byte29	0xF0	Frame end	Frame end

Remark:

The "highest temperature", "lowest temperature", "central temperature" and "average temperature" mentioned in the above table are "10* actual temperature".

7 Mechanical interface specification

7.1 The structure of bare PLUG module

The structure of bare PLUG module is as shown in Fig. 7-1.

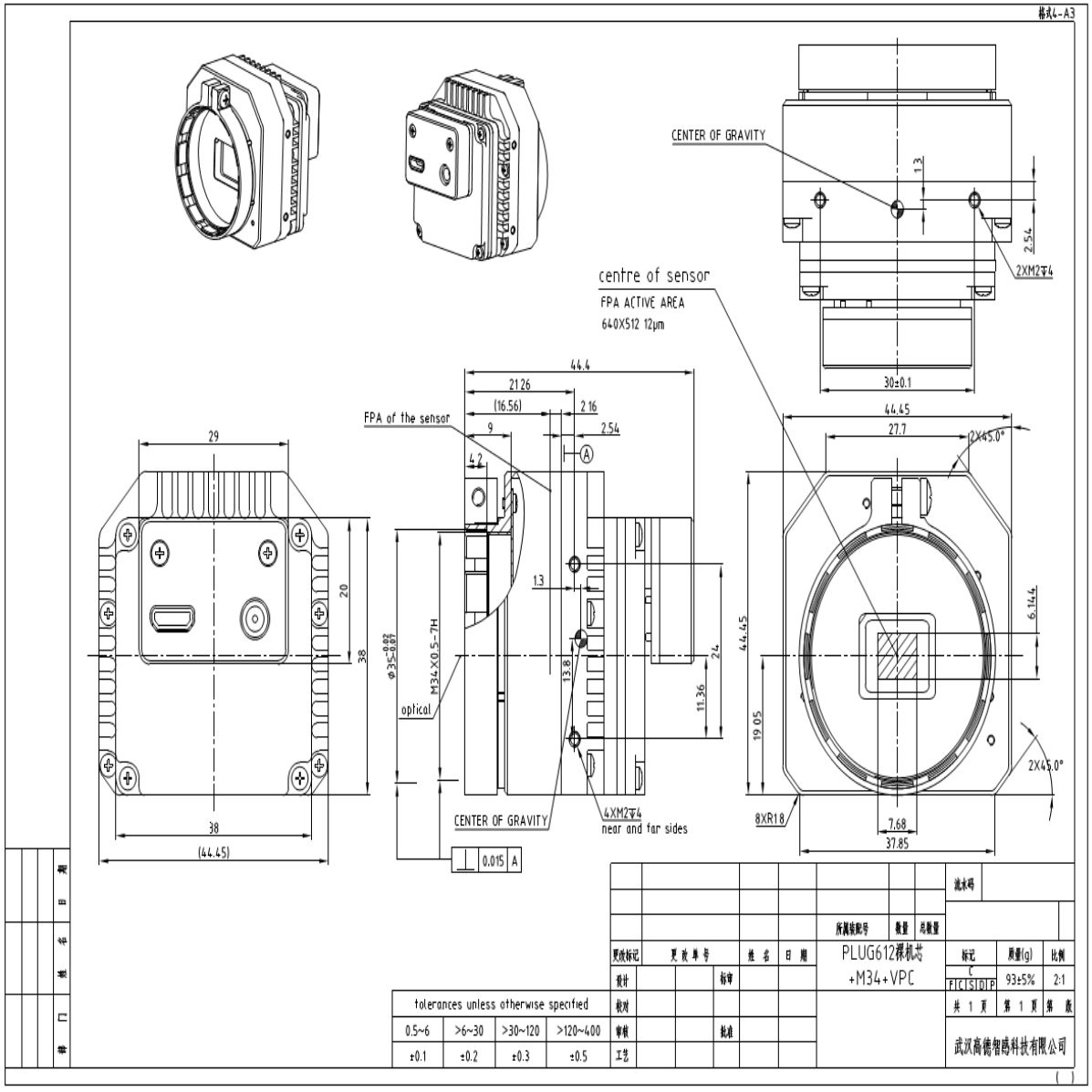


Fig. 7-1 Bare module structure diagram

7.2 The structure of bare PLUG module with M34 lens adapter ring

The structure of bare PLUG module with M34 lens adapter ring is as shown in Fig.7-2.

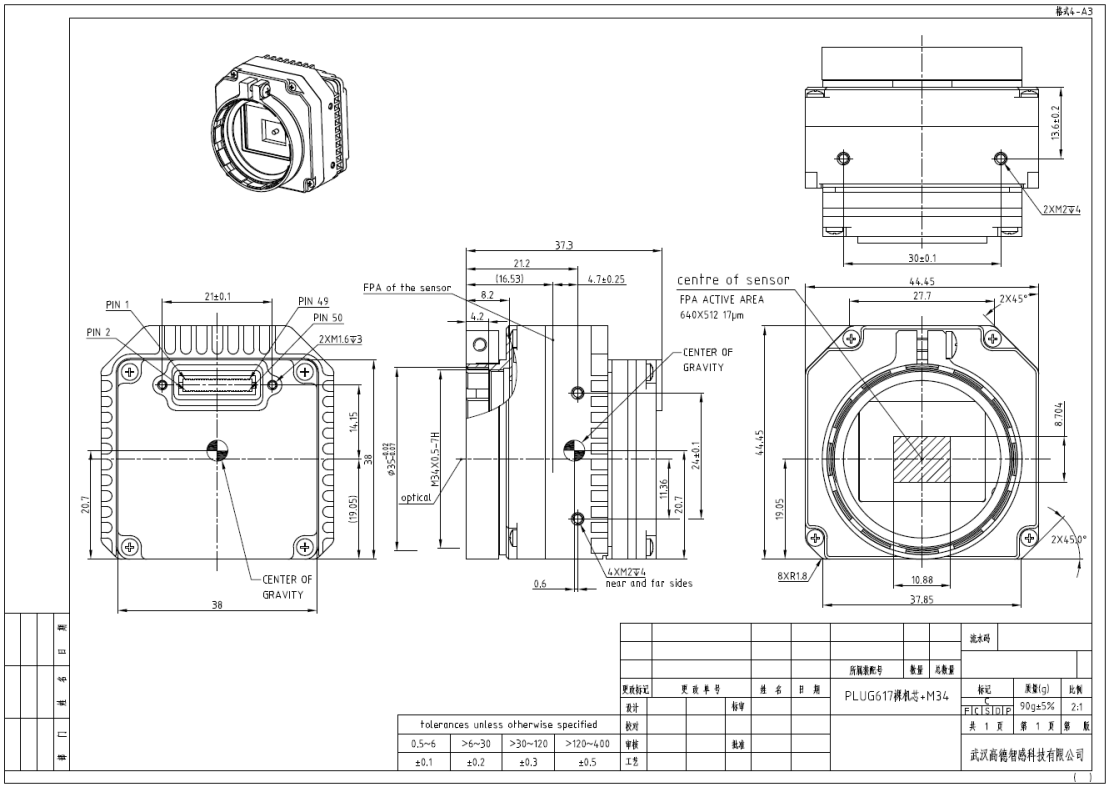


Fig. 7-2 Diagram of the structure with M34 lens adapter ring

7.3 PLUG Tripod interface (Optional)

The PLUG module is provided with an optional tripod adapter by which the module can be fixed on a general tripod. Its structure size is shown in Figure 7-3.

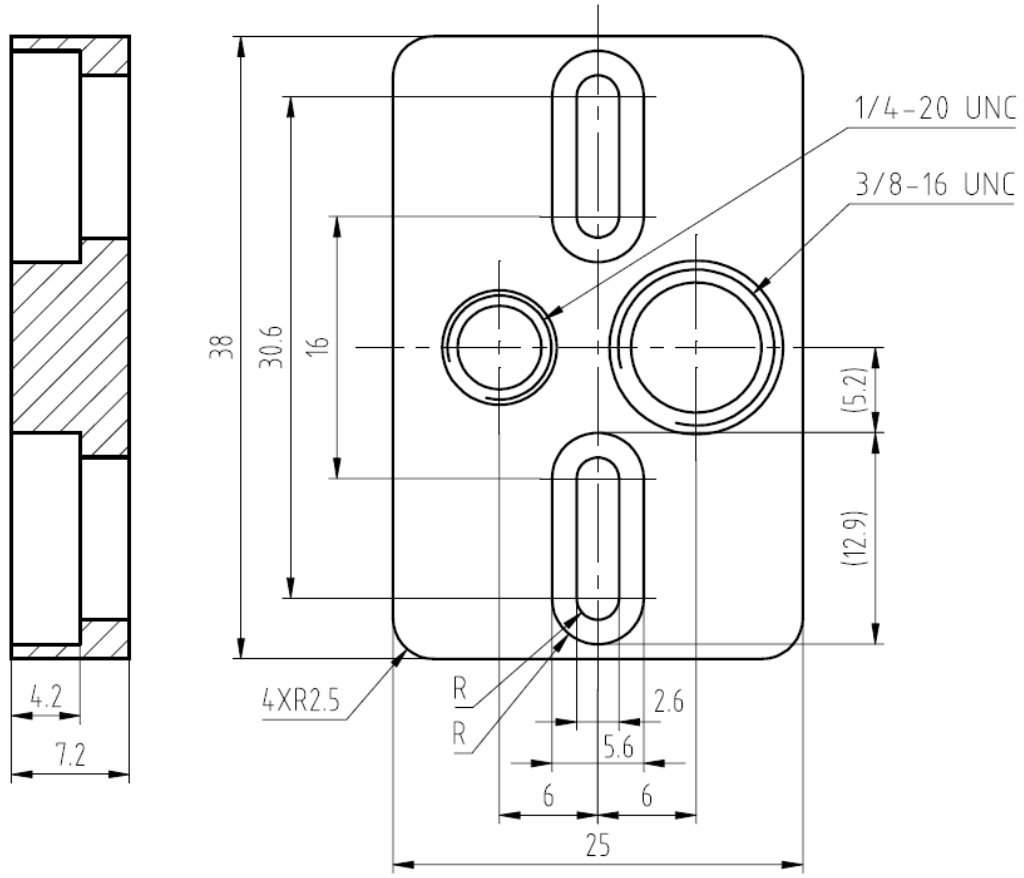


Figure 7-3 Structure diagram of tripod interface