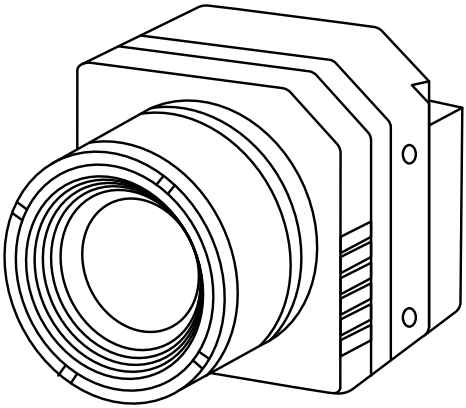
THERMAL CAMERA

TITAN 1280 & TITAN BB CORE

USER MANUAL



Shown with a 25 mm lens. Body style may vary.

PLEASE READ THIS MANUAL BEFORE SWITCHING THE UNIT ON.
IMPORTANT SAFETY INFORMATION INSIDE.

Revision: 07.2023-001

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Revision History

04.2022-001	Document created
06.2022-001	Added command protocols
07.2023-001	Added Titan BB specifications and table of contents

Contents

1. Disclaimers

1-1 Terms and Conditions

Warranty Terms and Condition of Sale are made available online at:

https://thermalcamera.com/support/terms-and-conditions-of-sale/

1-2 U.S. Government Regulations

This product may be subject to U.S. Export Regulations. Please send any inquiries to support@thermalcamera.com

1-3 Copyright

1-4 Quality Assurance

Thermal Camera is committed to a policy of continuous development; therefore we reserve the right to make changes and improvements on any of the products without prior notice.

1-5 Customer Help

For customer help, visit:

https://thermalcamera.com/support/

E-mail:

support@thermalcamera.com

2. User Notice

2-1 Calibration

Annual calibration to the thermal camera is recommended. Contact customer service to schedule maintenance.

2-2 Accuracy

For very accurate results, we recommend that you wait a minimum of 5 minutes after you have started the camera before measuring a temperature.

2-3 Cybersecurity

After the products are connected to the Internet, they may face risks including but not limited to network attacks, hacker attacks, virus infections, etc. The company will not be responsible for the abnormal operation of the products and any loss or liability caused therefrom shall be at your own risk.

2-4 Disposal of Electronic Waste

Electrical and electronic equipment (EEE) contains materials, components and substances that may be hazardous and present a risk to human health and the environment when waste electrical and electronic equipment (WEEE) is not handled correctly.

Equipment marked with the below crossed-out wheeled bin is electrical and electronic equipment. The crossed-out wheeled bin symbol indicates that waste electrical and electronic equipment should not be discarded together with unseparated household waste, but must be collected separately.

All local authorities have established collection schemes under which residents can dispose of equipment at a recycling center or other collection points, or WEEE will be collected directly from households. More detailed information is available from the administration of the relevant local authority. Always dispose of waste in accordance with local, state, and federal regulations.

2-5 Intended Use

Titan 1280 cores are highly accurate thermal imagers capable of capturing data in as little as 3 seconds. It supports full-screen temperature data output and features multiple image output interfaces. The Titan 1280 offers comprehensive analysis functions and can serve a wide range of temperature measurement applications.

Environment of use: industrial and petrochemical buildings, electrical plants, security rooms, science labs, environmental conservatories, among others.

You agree that this product is for civilian use only, and shall not use applications that may infringe the rights of third parties, medical and safety devices or other applications where product failure may lead to life-threatening or personal injury, as well as weapons of mass destruction, chemical and biological weapons, nuclear explosions, unsafe use of nuclear energy, dangerous or humanitarian purposes. Any loss or liability caused therefrom shall be at the your own risk.

2-6 Manual Update

The user manual will be updated from time to time. To access the latest manuals, translations of manuals, and notifications, go to:

https://thermalcamera.com/product-resources/

The manufacturer reserves the right to alter the specifications of the product without prior notification. The manufacturer allows himself the right to modify without any preliminary opinion the technical specifications of the product.

2-7 Scope of Application

Thermal Camera issues generic manuals that cover several cameras within a model line.

This means that this manual may contain descriptions and explanations that do not apply to your particular camera model. This manual may contain technical inaccuracies or typographical errors.

2-8 Authoritative Versions

The authoritative version of this publication is English. In the event of divergences due to translation errors, the English text has precedence.

Any late changes are first implemented in English. Other languages may or may not be available.

2-9 Training

To read about infrared training, visit:

https://infraredtraininginstitute.com/

3. Safety Information

- Operation is subject to the following two conditions: 1 This device may not cause harmful interference, and 2 this device must accept any interference received, including interference that may cause undesired operation.
- This device must be installed by qualified service personnel or system installation personnel.
- Do not disassemble or modify the thermal device. If the device operates abnormally, please contact the supplier and do not dismantle the device on your own.
- Do not point the imager (with or without the lens cover) at intensive energy sources, e.g. devices that emit laser radiation, or the sun. This can affect the accuracy of the camera, and cause damage to the detector.
- Do not use the imager in temperatures higher than 50 °C (122 °F) or lower than -15 °C (5 °F). High/low temperatures can cause damage to the device.
- Do not cut, alter, or place heavy items on the device. These actions may cause an electric short leading to fire or electrocution.
- Prior to start of the device, make sure that the power supply is properly connected. If the power supply is connected incorrectly, the device may be damaged.
- Do not put holes in the device with objects. Damage to the device may occur.
- Do not hit the device with a hammer or apply strong impacts or electric shocks to it. Damage to the device may occur.
- Do not put the device in or near a fire, stove or other high-temperature locations. Damage or ignition of the device may occur.
- Do not put the device in direct sunlight or other high-temperature locations. Damage or ignition of the device may occur.
- Do not get water or salt water on the device or permit the device to get wet. Damage to the device may occur.
- Remove any water or moisture on the device before you install it. Damage to the device may occur.
- If there are fluids on the device and the fluid gets into the eyes, do not rub the eyes. Flush well with water and immediately get medical care.
- Always dispose of device in accordance with local, state and federal regulations.
- Do not use the device if, when used, there is a smoke emitted from the device, the device feels excessively hot, changes color, changes shape, or is in an unusual condition. Speak with a sales office if one or more of these problems occurs.
- Do not use liquids to clean the electronics.
- Clean the case with a damp cloth and a weak soap solution. Do not use abrasives, isopropyl alcohol, or solvents to clean the case or lens/screen.

- Be careful when cleaning the infrared lens. Do not clean the infrared lens too vigorously. This can damage the anti-reflective coating.
- Avoid condensation. Taking the device from cold to hot will cause condensation in the thermal imager. To protect the device, power on the device and wait until it becomes warm enough for the condensation to evaporate.
- Keep device out of reach of children.
- This product is a precise electronic device that must be handled with care during use, storage, and transportation to prevent dangerous actions such as the device being hit by external force, or falling from heights.
- Transport: During transportation and storage the original packaging box must be used.
- Storage: If you do not use the imager for a long period of time, put the device in a cool and dry environment.
- It is recommended to calibrate the device(s) annually.

4. Technical Specifications

	Titan 1280
Pixel Resolution	1280 x 1024
Accuracy	± 2 °C (± 3.6 °F) or ± 2%
Temperature Range	Standard/Industrial: -20 °C to 150 °C (-4 °F to 302 °F)/ 0 °C to 500 °C (32 °F to 932 °F)
Operation Range	-40 °C to 80 °C (-40 °F to 176 °F)
Storage Range	-45 °C to 85 °C (-49 °F to 185 °F)
Detector Type	Uncooled VOx microbolometer
Pixel Pitch	12 µm
Spectral Band	8 µm to 14 µm
Frame Rate	30 Hz
Dimensions (without lens)	45 mm x 45 mm (W x H ± 0.5 mm) (1.77" x 1.77" (W x H ± 0.02")) [1]
Power	4V ~ 6V DC, < 2.3W [2]
Power Protection	Over-voltage; Under-voltage; Reverse Connection
Startup Time	≤15s
Weight (without lens)	< 150 g (5.29 oz) ± 3 g (0.11 oz)
Zoom	1.0X ~ 4.0X continuous zoom
Interface	RS-232, UART (3.3 V)
Extension Board	Cameralink; LVDS; USB3.0
Video	Digital: 14-bit or 16-bit LVCMOS; LVDS; BT.1120 [3]
Video Mirror	Horizontal; Vertical; Diagonal [4]
Image Polarity	White hot or black hot
Image Processing	Digital filter; Imaging denoising; Detail enhancement
Recticle	Reveal; Hidden; Shift
Pixel Operability	> 99 %
Shock	40 G
Vibration	4.3 G
Palette support [4]	
Internal non-uniformity correction (NUC)	
10 Fixed point measurements; Maximum/Minimum temperatures; Full frame measurement; Center point measurement; 12 Lines/Areas analysis; Isotherm analysis; Area of interest support; Level/Span adjustment; Brightness adjustment	

Note:

1. Dimensions without expansion board.
2. Wattage is based on tests without expansion boards. Typical working voltage is 4V DC. Expansion components support 5V ~ 24V DC.
3. 10-bit or 14-bit LVCMOS digital video is only available in Hirose 80 Pin Interface.
4. These functions are supported in analog video, BT.1120, BT.656, and LVDS DRC_Color.

	Titan Broadband (Titan BB)
Pixel Resolution	1280 x 1024
Accuracy	± 2 °C (± 3.6 °F) or ± 2%
Temperature Range	Standard/Industrial: -20 °C to 150 °C (-4 °F to 302 °F)/ 0 °C to 500 °C (32 °F to 932 °F)
Operation Range	-40 °C to 80 °C (-40 °F to 176 °F)
Storage Range	-45 °C to 85 °C (-49 °F to 185 °F)
Detector Type	Uncooled VOx microbolometer
Pixel Pitch	12 µm
Spectral Band	3 µm to 13.5 µm
Frame Rate	30 Hz
Dimensions (without lens)	45 mm x 45 mm (W x H ± 0.5 mm) (1.77" x 1.77" (W x H ± 0.02")) [1]
Power	4V ~ 6V DC, < 2.3W [2]
Power Protection	Over-voltage; Under-voltage; Reverse Connection
Startup Time	≤15s
Weight (without lens)	< 150 g (5.29 oz) ± 3 g (0.11 oz)
Zoom	1.0X ~ 4.0X continuous zoom
Interface	RS-232, UART (3.3 V)
Extension Board	Cameralink; LVDS; USB3.0
Video	Digital: 14-bit or 16-bit LVCMOS; LVDS; BT.1120 [3]
Video Mirror	Horizontal; Vertical; Diagonal [4]
Image Polarity	White hot or black hot
Image Processing	Digital filter; Imaging denoising; Detail enhancement
Recticle	Reveal; Hidden; Shift
Pixel Operability	> 99 %
Shock	40 G
Vibration	4.3 G
Palette support [4]	
Internal non-uniformity correction (NUC)	
10 Fixed point measurements; Maximum/Minimum temperatures; Full frame measurement; Center point measurement; 12 Lines/Areas analysis; Isotherm analysis; Area of interest support; Level/Span adjustment; Brightness adjustment	

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

Note:

1. Dimensions without expansion board.
2. Wattage is based on tests without expansion boards. Typical working voltage is 4V DC. Expansion components support 5V ~ 24V DC.
3. 10-bit or 14-bit LVCMOS digital video is only available in Hirose 80 Pin Interface.
4. These functions are supported in analog video, BT.1120, BT.656, and LVDS DRC_Color.

5. Lens Options and Model Numbers

5-1 Titan 1280

In the below model numbers XX = FOV (H).

- Model Number:
  - Industrial: ICITitan1280P-I-XX
  - Standard: ICITitan1280P-S-XX

Titan 1280 Lens Options					
Model No.	**Focal Length**	**F#**	**Focus Type**	**FOV (HxV)**	**IFOV**
ICITitan1280P-X-44	19 mm	1.0	Athermal	44°x35.8°	0.630 mrad
ICITitan1280P-X-50	17 mm	1.0	Athermal	50°x40°	0.710 mrad
ICITitan1280P-X-32	25 mm	1.0	Athermal	32°x27°	0.500 mrad
ICITitan1280P-X-16	50 mm	1.0	Athermal	16°x13.5°	0.250 mrad
ICITitan1280P-X-05	150 mm	1.0	Athermal	5°x3.7°	0.070 mrad

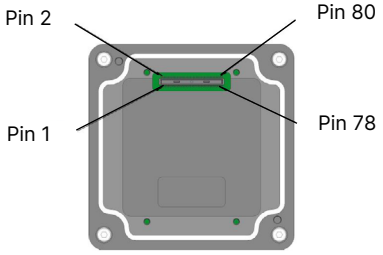
X = calibration type: Industrial or Standard

6. Structure

6-1 Pin Layout

The user interface component is an Hirose 60 pin DF12-60DS-0.5V(86) connector which includes the power supply interface, RS-232 serial communication interface, UART communication interface, BT-1120 digital video interface, 10-bit and 14-bit LVCMOS digital video interface. Users can adopt DF12(5.0)-60DP-0.5(86) to implement the connection between the thermal camera and user expansion boards.

Among the digital video interfaces, BT.656 and BT.1120 reuse interfaces of 10-bit or 14-it LVCMOS digital video. LVDS digital video has independent interfaces.



6-2 Pin Connector Interface Description

NO.	Name	Type	Description
1, 2, 3, 4,	Power Supply	Power	Power input (4 V ~ 6 V DC) [1]
9, 10, 11, 12, 13, 14, 78	--	--	Not available
15	RS-232_RX	Input	RS-232 Serial communication interface [2]
16	RS-232_TX	Output	
17	UART_RX	Input	Serial communication interface
18	UART_TX	Output	

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

CONTINUES

NO.	Name	Type	Description			
21	DV1	Output	14-Bit or 10-Bit LVCMOS Digital video	Data	BT.656 BT.1120 (3.3V)	Data
22	DV0			Data LSB		Data LSB
23	DV3			Data		Data
24	DV2			Data		Data
25	DV5			Data		Data
26	DV4			Data		Data
27	DV7			Data		Data MSB(BT.656)
28	DV6			Data		Data
29	DV9			Data MSB (10-bit)		Data
30	DV8			Data		Data
31	DV11			Data		Data
32	DV10			Data		Data
33	DV13			Data MSB (14-bit)		Data
34	DV12			Data		Data
35	DV15			--		Data Signal MSB (BT.1120)
36	DV14			--		Data
37	Line_Valid		Digital video	Line valid signal		Line valid signal
38	Frame_Valid			Frame valid signal		Frame valid signal
39	Clock			Clock signal		Clock signal
42	MOTOR_FP	Input	Motor interface (3.3V)			Reserved
44	MOTOR_FN					Reserved
46	MOTOR_ZP					Reserved
48	MOTOR_ZN					Reserved
50	MOTOR_SDA					Reserved
52	MOTOR_SCL					Reserved
43	GPIO2	Input/ Output	Input/Output (3.3V)			Reserved
45	GPIO3					Reserved
47	GPIO4					Reserved
48	GPIO5					Reserved
51	GPIO6					Reserved
53	GPIO7					Reserved
54	GPIO0					Reserved
66	GPIO1					Reserved
72	GPIO8	Input/ Output	Input/Output (1.8V)			Reserved
74	GPIO9					Reserved
60, 62, 64, 66	GPIO	Input/ Output	General Programmable Input/Output (2.5V)			Reserved

NO.	Name	Type	Description	
76	EXT_SYNC	Input	Input (3.3V)	Reserved (off by default)
57	LVDS_D4P	Output	LVDS (2.5V)	Data signal
59	LVDS_D4N			Data signal
61	LVDS_D3N			Data signal
63	LVDS_D3P			Data signal
65	LVDS_D2P			Data signal
67	LVDS_D2N			Data signal
69	LVDS_D1N			Data signal
71	LVDS_D1P			Data signal
75	LVDS_CLKP			Clock signal
77	LVDS_CLKN			Clock signal
5, 6, 7, 8, 19, 20, 40, 41, 55, 58, 68, 70, 73, 79, 80	GND	Power	Ground of power [3]	

Note:

1. Typical value of power supply is 4 V DC; here refers to the voltage value of the thermal camera connector, power setup time (10% ~ 90%) < 4 mS, peak current > 1.0 A, ripple and noise < 40 mVp-p. All these requirements shall be met when the power supply reaches to the connector on the core.
2. All the TX and RX of serial communication interfaces refer to the thermal camera's sending and receiving.
3. GND and VGND are shorted internally.

7. Digital Video

7-1 Digital Video

Among the digital video interfaces are LVCMOS, LVDS, BT.1120, BT.656, and CDS_2 digital video.

7-1-1 LVCMOS

The signals of LVCMOS video consist of a clock signal (Clock), a line valid signal (Line_Valid), a frame valid signal (Frame_Valid), and 14-bits data signals (DV0~DV13). There are two kinds of data formats which are 14-bits and 10-bits.

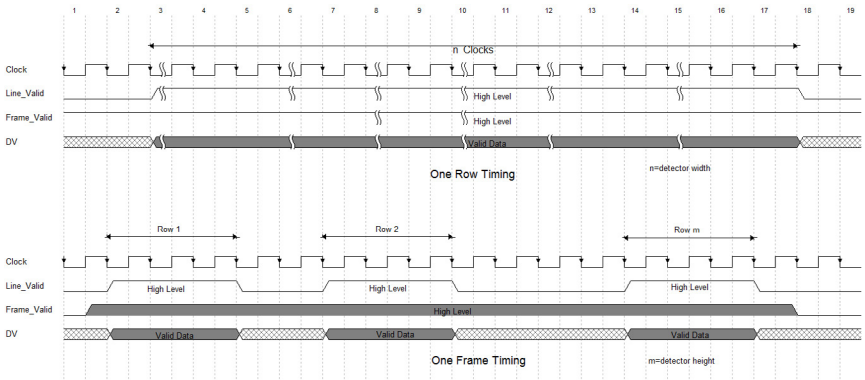
When original data (RAW) or temperature data (TMP) is selected, the data has 14 bits which are DV[13:0], among them, DV0 is LSB and DV13 is MSB. When data after image processing (DRC) is selected, the data has 10 bits which are DV[9:0], among them, DV0 is LSB, DV9 is MSB.

LVCMOS digital video can be enabled or disabled through control command. Original data (RAW), temperature data (TMP), or data after image processing (DRC) can be selected as output source when the LVCOMS digital video is enabled.

When the original data (RAW) and temperature data (TMP) are selected, function of polarity selection, digital zoom, digital detail enhancement, digital filter and imaging denoising, and temperature display are not supportable.

When data after image processing (DRC) is selected, function of digital zoom and temperature display are not supportable.

LVCMOS Clock Frequency	
Model	**Clock Frequency**
Titan 1280	45.00 MHz



Note:

1. It is recommended to sample DV data at the rising edge of clock.
2. The high level is valid for Line_Valid, Frame_Valid.
3. On a certain line, after the Line_Valid turns to be valid (logic '1') and lasts for n clocks, the data from column 1 to column n are valid.

7-1-2 LVDS_H

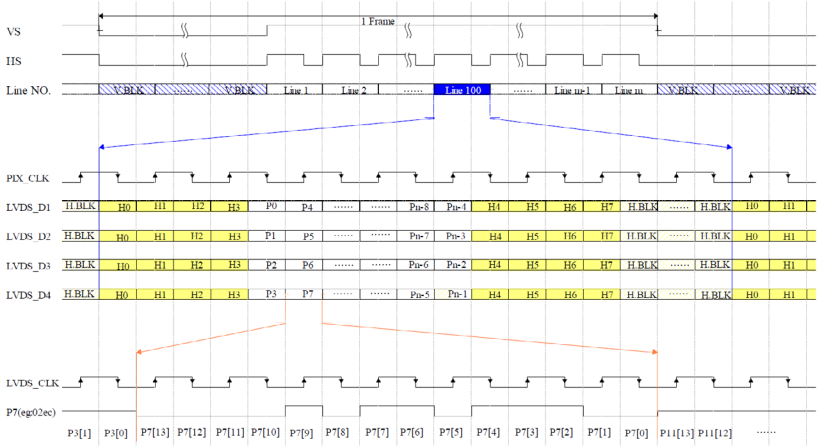
LVDS_H digital video includes one clock signal (LVDS_CLK) and four data signals (LVDS_DATA1, LVDS_DATA2, LVDS_DATA3 and LVDS_DATA4). It is convenient to be parsed by mainstream encode/decode chip.

LVDS_H digital video can be enabled or disabled by control command. When it is enabled, original data (RAW), temperature data (TMP), data after image processing(DRC, DRC_Gray, DRC_Color) can be selected.

When the original data (RAW) and temperature data (TMP) are selected, function of polarity selection, digital zoom, digital detail enhancement, digital filter and imaging denoising and temperature display are not supportable.

When data after image processing (DRC) is selected, function of digital zoom and temperature display are not supportable.

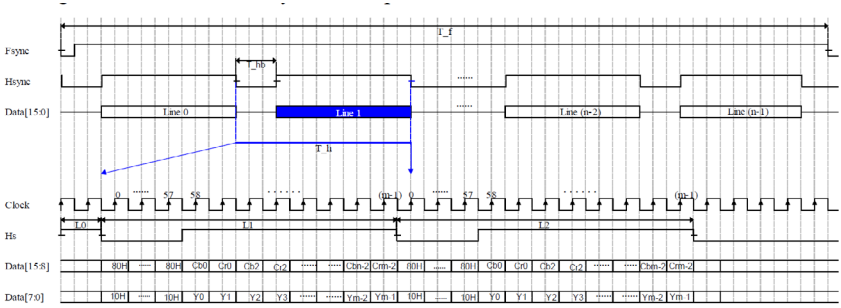
LVDS_H Clock Frequency	
Model	LVDS_CLK
Titan 1280	78.75MHz



Sync Code								
	H0	H1	H2	H3	H4	H5	H6	H7
BLANK LINE	3FFF	0000	0000	2AC0	3FFF	0000	0000	2D80
VALID LINE	3FFF	0000	0000	2000	3FFF	0000	0000	2740

7-1-3 BT.1120

BT.1120 digital video outputs signals line by line. It includes clock signals (Clock), line valid signal (Line_Valid), frame valid signal (Frame_Valid), and 16 data signals (DV0 - DV15). As shown:



When BT.1120 digital video is selected, the functions like digital zoom, menu display are not supportable.

7-1-4 BT.656

BT.656 digital video consists of one clock signal and eight data signals (DV0~DV7).

BT.656 digital video supports all the functions, which include brightness/contrast adjustment, polarity selection, palette selection, reticle controlling, digital zoom and video mirror. And the data source of BT.656 shall be the data after image processing (DRC).

7-1-5 CDS_2

CDS_2 digital video consists of a clock signal (Clock), a frame valid signal (Vsync), a line valid signal (Hsync), and 16-bits data signals (DATA).

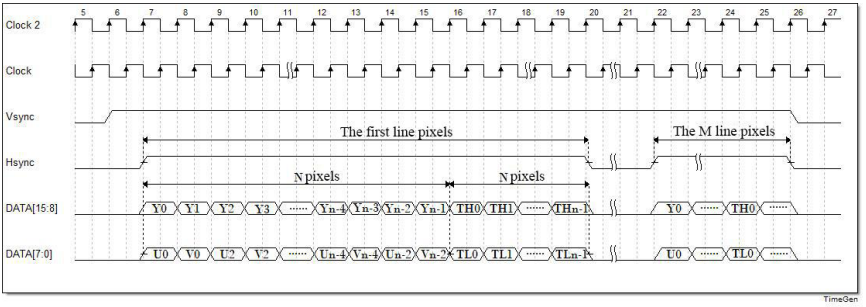
The digital video includes two parts. The first part is image data, in YUV422 format, the higher 8 bits data defines luminance, the lower 8 bits data defines chrominance, supporting color palette mapping; the followed part is temperature data, only 14 bits are valid bits, write ‘0’ to the highest 2 bits.

There are two kinds of sync for CDS_2: external sync and internal sync. The data is synchronized by Vsync signals and Hsync signals for external sync. The data is synchronized by adding sync codes for internal sync.

See next 2 pages.

7-1-5-1 External Sync

The data is synchronized by Vsync signals and Hsync signals for external sync.



Note:

1. Image data is in YUV format, the higher 8 bits are Y, lower 8bit are UV;
2. “T” standards for temperature data (valid bits of 14 bits, write ‘0’ to the highest 2 bits), “TH” standards for the higher 8 bits, “TL” standards for the lower 8 bits;
3. External synchronization signal, “Vsync” standards for frame sync signal, “Hsync” standards for line sync signals;
4. The amount of outputted data is 2 time of line array of detector, as 640×512 detector, each line data includes 640×2=1280 clocks (N=640), each frame includes 512 lines (M=512).

7-1-5-2 Internal Sync

The data is synchronized by adding sync codes for internal sync.

One Frame Data Format of CD_2 Video				
Invalid line reference number EAV 0xB6B6	Blanking 0x1080	Invalid line reference number SAV 0xABAB	Invalid data 0×1080	
Valid line reference number EAV 0×9D9D	Blanking 0x1080	Valid line reference number SAV 0×8080	Valid data area Image Data YCbYCr. The corresponding resolution is 384×288, 640×512, and 1280×1024.	Valid data area temperature data 14-bit. The corresponding resolution is 384×288, 640×512, and 1280×1024.
Invalid line reference number EAV 0xB6B6	Blanking 0x1080	Invalid line reference number SAV 0xABAB	Invalid data 0×1080	

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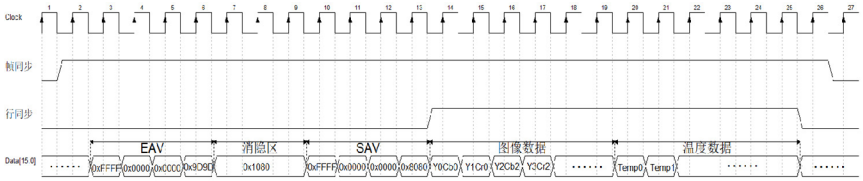
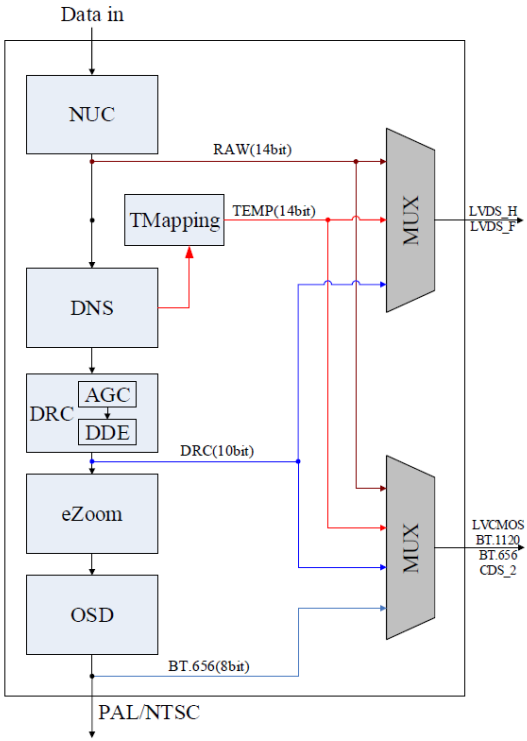
CDS_2 video includes internal sync and external sync, see the following image for the sequence format of CDS_2 video with one line valid data.



7-2 Data Processing



8. Temperature Measurement Functions

Titan 1280 supports full frame, area, line, and spot temperature measurement. The temperature can be read at any pixel through PC software. Spot, line, and area temperature measurement tools can be enabled or disabled independently except for the temperature measurement tools of the highest, lowest, average, and center spot. The OSD can be enabled or disabled.

8-1 Measurement Tools

Through the serial communication interface spot, line, area, and full frame temperature measurement tools can be enabled or disabled.

In the spot temperature measurement mode the core supports displaying the temperature value. Users can move the temperature measurement spots.

In the line temperature measurement mode, the core can calculate and display the maximum temperature value, minimum temperature value, and average temperature value. The position of two ends of line segment can be moved.

In the full frame and area temperature measurement modes the maximum temperature, minimum temperature, center temperature, and average temperature can be displayed. Analysis can be enabled or disabled. The area size and position can be adjusted through PC software. Up to 12 areas or lines are supported in the area temperature measurement mode.

Users can also configure temperature correction data through the serial communication interface.

Measurement Tool	Function	Operation
Spot analysis	10 fixed spots; Maximum/ minimum temperature spots capture; 1 center spot (only displayed on screen)	Moving spot position through serial command and displaying temperature value on screen.
Line analysis	12 Line/Rectangle analysis tools totally (only display on screen)	Adjusting the position of top left corner and bottom right corner and area size through serial command.
Area analysis		Adjusting the position of top left corner and bottom right corner and area size through serial command.
Isotherm analysis	1 isotherm analysis tools (only display on screen)	Adjusting isotherm upper and lower limit to set the isotherm area through serial command.

8-2 Real-time Temperature Data

Through serial output interface, the module output full frame temperature data in real time. Refer to **Section 7-1-1 LVCMOS** and **Section 7-1-2 LVDS_H** for the data format. The temperature is in Kelvin format.

There are two different kinds of data calculation format, for which the user can consult the detailed usage or switch method. The two different data calculation formats are as follows:

Format 1: Value =T x10

Format 2: Value = $\begin{cases} \text{T x10 - 7000, } 0 \le \text{Value} \le 7300 \\ \text{T x15 - 3300, } 7301 \le \text{Value} \le 16383 \end{cases}$

9. UART Command Protocols

9-1 Serial Port Settings

Baud Rate	Format			Check
115200 bps	8-bit data bits	1-bit data bit	1-bit stop bit	N

Note:

1. Start transmission from the Least Significant Bit (LSB) of each byte.

9-2 Camera Component Command and Information Format

9-2-1 Command Receiving Format

Format of Reading the FPA Height of Receiving Command											
Process Start	bytes	CW0	CW1	OW	PRM0	PRM1	...	PRMN	SC	Process End	
		Process Body									
0xAA	0x05	0x00	0x03	0x00	0x00	none	none	none	0xB1	0xEB	0xAA

Note:

1. All the format values described in Format of Reading the FPA Height of Receiving Command are hexadecimal bytes.
2. SC value is the sum of all the bytes before the SC byte Mod 256.
3. The command and parameter information is described from Status Menu table to Form9.
4. The process body byte count is the number of valid bytes from CW0 to SC.
5. Process start is fixed to 0xAA, process end is fixed to 0xEB and 0xAA.
6. BC of 0×00 is the command of Core settings, and BC of 0×07 is the command of temperature measuring.

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

9-2-2 Camera Component Status Information Format

Format of Status Information											
Process Start	bytes	CW0	CW1	OW	PRM0	PRM1	...	PRMN	SC	Process End	
		Process Body									
0x55	0x06	0x00	0x03	0x33	0x00	0x02	none	none	0x93	0xEB	0xAA

Note:

1. Status information reflects command execution result.
2. CW and RV are described from Status Menu table to Table 9. For the RV, the lower bit is in the front, as Decimal 512 is the hexadecimal number of 0×200, so the RV is 0×00 by 0×02.
3. Byte count is the number of process body bytes.
4. The OW (operation word) is fixed to 0×33.
5. The process start is fixed to 0×55.
6. The process end is fixed to 0xEB and 0xAA.
7. BC of 0×00 is the command of Core settings, and BC of 0×07 is the command of temperature measuring.

9-2-3 Error Codes

If two bytes of command words are 0xFF and the only one RV (returned value) is one of the values shown in Error List of RV table, the command is error. Users can search for the cause of error by consulting Error List of RV table.

Error List of RV	
Return Value	Cause of Error
0xF1	Command sending overtime
0xFB	None of CS
0xFD	DRC SC error
0cFF	Process start 0xAA error

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

9-2-4 Receiving Command and Status Information

Status Menu						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bystes Count
0x00	0x00	Read SN code	0x00	0	None	10
0x00	0x01	Read PN Num	0x00	0	None	20
0x00	0x02	Read FPA width	0x00	0	None	2
0x00	0x03	Read FPA height	0x00	0	None	2
0x00	0x04	Read FPA temperature	0x00	0	None	2

9-2-5 Setup Menu

Setup						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x00	0x05	Read camera temperature	0x00	0	None	2
0x00	0x11	Save settings	0x01	0	None	1
0x00	0x12	Restore factory defaults	0x02	0	None	1
0x00	0x13	Camera reboot	0x02	0	None	1
0x00	0x15	NUC	0x01	0	0x00: Manual 0x01: Auto (default)	1
		Read status of Auto NUC	0x00	0	None	1
0x00	0x16	Set manual NUC	0x01	1	0x00: external shutter correction 0x01: Background correction	1
0x00	0x17	Set the time interval for automatic NUC	0x01	1	Time range: 0 - 255	1
		Automatically set interval time of NUC	0x00	0	None	1
0x00	0x18	Set interval temperature of NUC	0x01	1	Temperature range: 0 - 255	1
		Automatically set interval temperature of NUC	0x00	0	None	1

9-2-6 Video Menu

Video						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x00	0x2A	Digital zoom	0x01	1	Refer to appendix	1
		Read digital zoom status	0x00	0	None	2
0×01	0x40	Magnification in any area	0x02	8	0x2A	0x2A
0x00	0x2C	Cross cursor movement (save)	0x02	8	Parameter 0: low byte of left-up, X coordinate; Parameter 1: high byte of left-up, X coordinate; Parameter 2:low byte of left-up, Y coordinate; Parameter 3: high byte of left-up, Y coordinate; Parameter 0: low byte of right bottom, X coordinate; Parameter 1: high byte of right bottom, X coordinate; Parameter 2:low byte of right bottom, Y coordinate; Parameter 3: high byte of right bottom, Y coordinate; Refer to appendix 1	1
0x00	0x30	Image flip	0x01	1	bit0=1 no-operation bit1=1 Horizontal bit2=1 Vertical bit3=1 Diagonal	1
		Read flip status	0x00	0	None	1

CONTINUES

Video						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x00	0x2D	Palette settings	0x01	1	0x00: White Hot (Default) 0x01: Black Hot 0x02: Blue Red yellow 0x03: Purple red yellow 0x04: blue green red 0x05: Rainbow 1 0x06: Rainbow 2 0x07: Black red 0x08: blackish green Red 0x09: BGR -pink 0x0A: mixed 0x0B: Red high-temperature	1
		Read	0x00	0	None	1
0x00	0x4B	Threshold setting for warning red/ green/blue	0x01	2	Parameter : Threshold, 0~255 Parameter 1: 0x00- warning red 0x00- warning green 0x00- warning blue	
0x00	0x32	Image freeze	0x02	1	0x00: Analog video active 0x01: Analog video freeze 0x02: digital video active 0x03: digital video freeze	1
0x00	0x33	Analog video Switch	0x02		0x00: Analog video off 0x01: Analog video on	1
0×00	0x42	ROI	0x01	8	PRM 0: left-up X- low byte PRM 1: left-up X- high byte PRM 2: left-up Y -low byte PRM 3: left-up Y -high byte PRM 4: right-down X- low byte PRM 5: right-down X- high byte PRM 6: right-down Y -low byte PRM 7: right-down Y -high byte	1

9-2-7 AGC Menu

AGC						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x00	0x3A	AGC Mode (savable)	0x01	1	0x00: Manually adjust	1
					0x01: Auto adjust 0 (default)	
					0x02: Auto adjust 1	1
		Read current mode	0x00	0	None	1
0x00	0x3B	Contrast Settings (savable)	0x01	2	Contrast (0-255)	2
		Read contrast	0x00	0	None	
0x00	0x40	Contrast set by step size	0x01	2	PRM0: 0x00 reduce contrast 0x01 increase contrast PRM1: Step (0-255)	1
0x00	0x3C	Brightness Settings (savable)	0x01	2	Brightness (0-511) PRM 0: low brightness bytes PRM 1: high brightness bytes	1
		Read the brightness	0x00	0	None	2
0x00	0x41	Brightness set by step size	0x01	2	PRM 1: 0x00 brightness minus 0x01 brightness plus PRM 2: step size (0-255)	1
0x00	0x31	Filter on/off	0x01	1	0x00: off 0x01: on	1
		Read image filter	0x00	0	None	1
0x00	0x3E	DDE switch (savable)	0x01	1	0: DDE on 1: DDE off	1
		Read DDE status	0x00	0	None	1

CONTINUES

AGC						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0×00	0x3F	DDE level (savable)	0x01	1	Limit: 0-7 (integer)	1
		Read DDE level	0x00	0	None	1

9-2-8 Advance Menu

Advance Menu						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x00	0x01	Set baud rate	0x02	2	PRM0: 0x00 Reserve PRM1: 0x02: 9600 0x04: 19200 0x08: 38400 0x10: 115200 (default) 0x40: 57600	1

9-2-9 Glare Protection

Glare Protection						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x01	0x01	Read glare protection status	0x00	1	0x00	1
		Set glare protection	0x01	4	PRM1: 00 glare protection is off 01 glare protection is on PRM2, PRM3: threshold (low byte first) PRM4: glare protection time.	

9-2-10 Temperature Measuring Functions Menu

Temperature Measuring Parameters						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x07	0x00	Measuring OSD on/off	0x01	1	0x00: off 0x01: on	1
0x07	0x00	Temperature measuring range	0x01	1	0x00: High Gain 0x01: Low Gain 0x03: Auto	1
0x07	0x02	Temperature unit	0x01	1	0x00: Celsius 0x01: Kelvin 0x02: Fahrenheit	1
0x07	0x05	Read low-high gain threshold value	0x00	1	0x00	2
		Set low-high threshold value	0x01	2	Threshold value = parameter/10, low byte is in the front	1
0x07	0x06	Read the percent of low-high gain	0x00	1	0x00	2
		Set the percent of low-high gain	0x01	2	Percent = parameter/10	1
0x07	0x07	Read high-low gain threshold value	0x00	1	0x00	2
		Set high-low gain threshold value	0x01	2	Threshold value = parameter/10, low byte is in the front	1
0x07	0x08	Read the percent of high-low gain	0x00	1	0x00	2
		Set the percent of high-low gain	0x01	2	Percent = parameter/100	1
0x07	0x0f	Read reflect temperature	0x00	1	0x00	4
		Set reflect temperature	0x01	4	Temp = parameter/10000, low byte is in the front	1
0x07	0x10	Read ambient temperature	0x00	1	0x00	4
		Set ambient temperature	0x01	4	Temp = parameter/10000, low byte is in the front	1

CONTINUES

9-2-11 Temperature Measuring Parameters

Temperature Measuring Parameters						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x07	0x11	Read ambient transmissivity	0x00	1	0x00	4
		Set ambient transmissivity	0x01	4	Transmissivity = parameter/10000, low byte is in the front	1
0x07	0x12	Read emissivity	0x00	1	0x00	4
		Read emissivity	0x01	4	Emissivity = parameter/10000, low byte is in the front	1
0x07	0x13	Read distance	0x00	1	0x00	4
		Set distance	0x01	4	Distance = parameter/10000, low byte is in the front	1
0x07	0x18	Environment variables take effect	0x01	1	0x00	1
0x07	0x80	Spot on/off (support 10 spots)	0x01	2	PRM0: 0x00~0x09 stands for spot 1-10 PRM1: 0x00 off 0x01 on	1
0x07	0x82	Read the spot coordinates	0x00	1	PRM0: 0x00~0x09 stands for spot 1-10	5
		Set the spot coordinates	0x01	5	PRM0: 0x00~0x09 stands for spot 1-10 PRM 1: Axis x-low 8 byte PRM 2: Axis x-high 8 byte PRM 3: Axis y-low 8 byte PRM 4: Axis y-high 8 byte	1
0x07	0x83	Read spot temperature value	0x00	1	PRM0: 0x00~0x09 stands for spot 1-10	5

9-2-12 Area/Line Temperature Measuring Tools Function

Measuring Tools Function						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x07	0x40	Area/line tools on/off (support 12 areas or lines)	0x01	2	PRM0: 0x00~0x0b stands for area/line 1-12 PRM1: 0x00 off, 0x01 on	1
0x07	0x41	Type of Area/Line tools	0x01	2	PRM0: 0x00~0x0b stands for area/line 1-12 PRM1: 0x00 area, 0x01 Line	1
0x07	0x42	Read coordinates of area/line	0x00	1	0x00	9
		Set coordinates of area/line	0x01	9	PRM0: 0x00~0x0b stands for area/line 1-12 PRM 1: Start axis X – low 8-byte PRM 2: Start axis X – high 8-byte PRM 3: Start axis Y – low 8-byte PRM 4: Start axis Y – high 8-byte PRM 5: End axis X – low 8-byte PRM 6: End axis X – high 8-byte PRM 7: End axis Y – low 8-byte PRM 8: End axis Y – high 8-byte	1
0x07	0x45	Read the spot temp value and coordinates of highest temp of area/line	0x00	1	PRM0: 0x00~0x0b stands for spot of area/line 1-12	9
0x07	0x48	Read the spot temp value and coordinates of lowest temp of area/line	0x00	1	PRM0: 0x00~0x0b stands for spot of area/line 1-12	9

CONTINUES

Measuring Tools Function						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x07	4B	Read the central spot temp value and coordinates of area/ line	0x00	1	PRM0: 0x00~0x0b stands for spot of area/line 1-1	9
0x07	0x4C	Read the average temp value of area/ line	0x00	1	PRM0: 0x00~0x0b stands for spot of area/line 1-12	5

9-2-13 Temperature Measuring of Full Frame Functions Menu

Temperature Measuring in Full Frame						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x07	0x2b	Central spot display on/off	0x01	1	0x00: off 0x01: on	1
0x07	0x2a	Read average temperature of whole image	0x00	1	0x00	4
0x07	0x2d	Measuring alarm type	0x01	1	0x00: off 0x01: lowest temp alarm 0x02: highest temp alarm 0x03: lowest & highest temp alarm	1
0x07	0x2e	Read threshold of lowest temperature alarm	0x00	1	0x00	4
		Set threshold of lowest temperature alarm	0x01	4	Temperature = parameter/10, low byte is in the front	1
0x07	0x2f	Read threshold of highest temperature alarm	0x00	1	0x00	4
		Set threshold of highest temperature alarm	0x01	4	Temperature = parameter/10, low byte is in the front	1
0x07	0x27	Read coordinates of highest temperature spot	0x00	1	0x00	8

CONTINUES

Temperature Measuring in Full Frame						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x07	0x29	Read coordinates of lowest temp spot	0x00	1	0x00	8
0x07	0x2c	Read temperature and coordinates of central spot	0x00	1	0x00	8
0x07	0xf0	Temperature width tensile on/off	0x00	1	0x00: off 0x01: on	1
0x07	0x1d	Write the threshold of low temperature width tensile	0x01	4	Temperature = parameter/10000, low byte is in the front	1
		Read the threshold of low temperature width tensile	0x00	1	0x00	4
0x07	0x1e	Write the threshold of high temperature width tensile	0x01	4	Temperature = parameter/10000, low byte is in the front	1
		Read the threshold of high temperature width tensile	0x00	1	0x00	4

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

9-2-14 Digital Video Functions Menu

Digital Video Functions						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x01	0x2F	Digital video output format type	0x00	2	PRM0: Select the digital video output format, supporting parallel data and serial data output together. 0x00: digital video output off 0x02: parallel LVCMOS video 0x03: serial LVDS video 0x04: parallel BT.656 video 0x05: parallel BT.1120 video 0x06 : LVDS and LVCMOS video output together 0x07: LVDS and BT.656 video output together 0x08 : LVDS and BT.1120 video output together When serial LVDS video outputting, the Bit1 & Bit4 of PRM1 definition is video type and palette type. -Bit4 is serial LVDS video type, Bit4=0 stands for LVDS_H video Bit4=1 stands for LVDS_F video -Bit1 is serial LVDS palette type only in the video source of DRC Bit1=0 stands for palette video Bit1=1 stands for gray scale video	1

CONTINUES

Digital Video Functions						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x00	0x2E	Digital video source	0x01	1	Only for LVCMOS and LVDS video ource. Low 4-byte for LVCMOS video source: 0xX2: DRC 0xX4: TEMP 0xX5: RAW High 4-byte for LVDS video source: 0x2X: DRC 0x4X: TEMP 0x5X: RAW	1

9-2-15 Calibration Menu

Calibration Menu						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x07	0x6E	Secondary calibration (single point correction)	0x02	2	Temperature = parameter	1
0x07	0x6F	Secondary calibration (two points correction)	0x02	2	Temperature = parameter	1
0x07	0x6A	Save secondary calibration	0x00	1	0x00	1
		Read secondary calibration status	0x00	1	0x00	1
0x07	0x6B	Clear secondary calibration	0x02	1	0x00	1

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

9-2-15 Digital Video Functions Menu

Digital Video Functions						
CW0	**CW1**	**Meaning**	**OW**	**PRM Byte**	**PRM**	**RV Bytes Count**
0x07	7c	Read temperature reference source calibrations status	0x00	1	0x00	1
		Set temperature reference source calibration status	0x01	1	0x00: off 0x01: on	1
0x07	7d	Rear temperature reference source temperature	0x00	1	0x00	1
		Set temperature reference source temperature	0x01	4	Temperature = parameter/10000, low byte in the front	1
0x07	7e	Read temperature reference source coordinate	0x00	1	0x00	8
		Set temperature reference source coordinate	0x01	8	PRM0: start axis X – low 8-byte PRM1 : start axis X – high 8-byte PRM2 : start axis Y – low 8-byte PRM3 : start axis Y – high 8-byte PRM4 : end axis X – low 8-byte PRM5 : end axis X – high 8-byte PRM6 : end axis Y – low 8-byte PRM7 : end axis Y – high 8-byte	1

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

9-2-16 Skin Temperature Measurement

Skin Temperature Measurement						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x07	0x72	Read skin temperature measurement status	0x00	1	0x00	1
		Set skin temperature measurement	0x01	1	0x00: off 0x01: on	1

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

10. User Expansion Boards

There are different user expansion boards for the Titan 1280 infrared thermal camera. The boards support multiple interfaces and serve many functions.

Model	Figure	Interface	Connector
Coming Soon		• Power supply: 5 V ~ 24 V DC, typical voltage: 12 V DC • USB Type C • Cameralink	• USB Type C • Cameralink connector
Coming Soon		• Power supply: 5 V ~ 24 V DC, typical voltage: 12 V DC • USB Type C	USB Type C
Coming Soon		• Power supply: 5 V ~ 24 V DC, typical voltage: 12 V DC • LVDS-H • RS232	Samtec: TFM-115-02-L-D-WT
Coming Soon		• Power supply: 5 V ~ 24 V DC, typical voltage: 12 V DC • Cameralink • RS232/RS422	Samtec: TFM-115-02-L-DH

11. Maintenance

11-1 Cleaning the Germanium Lens

Do not use corrosive chemicals on the optical glass components. The germanium window surface is coated with anti-reflection coating. Dust, grease, and fingerprints will produce harmful substances and lead to a decline in performance, or cause scratches. If dirt is found, please use the following methods:

1. Use a blown balloon or a soft brush to clean the lens surface to avoid dust particles scratching the anti-reflection film on lens surface during the wiping process.
2. Use a soft cotton cloth or lens wiping paper and dip in alcohol or lens wiping liquid. Gently wipe the lens surface from the middle to the edge, paying attention to not crack the lens, or use too much wiping liquid. If the lens is still not clean, replace the cloth and repeat operation.

11-2 Disinfecting the Camera Surface

Do not use corrosive cleaning solutions on the optical glass components. Do not get the electronics wet. It is recommended to disinfect the camera surface regularly with a non-corrosive sanitizing product. Follow the directions provided by the manufacturer of the cleaning solution. Adhere to the sanitation protocols and cleaning schedule set forth by the employer.

11-3 Device Calibration

It is recommended to have device(s) re-calibrated annually. Contact customer service to schedule maintenance.

11-4 Storage

When the equipment is not in use, the device should be placed in a dust-free and moisture-free environment with a stable temperature and humidity.

DO NOT USE CORROSIVE CLEANING SOLUTIONS ON THE OPTICAL GLASS COMPONENTS. DISINFECT THE CAMERA SURFACE REGULARLY WITH A NON-CORROSIVE SANITIZING PRODUCT.

CALIBRATE YOUR DEVICES ANNUALLY. CONTACT CUSTOMER SERVICE TO SCHEDULE MAINTENANCE.

12. Appendix 1 Core Command Protocols

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

Instruction		Camera Instructions Received	Note
Read SN code	Receive	AA 04 00 00 00 AE EB AA	Example: The SN code returned is the ASCII code of 010001, If the data length is not enough, the rest data position return '0x00'.
	Return	55 0D 00 00 33 30 30 31 30 30 30 31 00 00 00 00 B7 EB AA	
Read PN code	Receive	AA 04 00 01 00 AF EB AA	Example: The returned SN is the ASCII of Titan serial cores. If the data length is not enough, the rest data position return '0x00'.
	Return	55 18 00 01 33 4C 41 33 32 33 30 00 00 00 00 00 00 00 00 00 00 00 0000 F6 EB AA	
Read FPA width	Receive	AA 04 00 02 00 B0 EB AA	The return value is 2 bytes, with the low byte first. In the example, the return value is 0x80,0x01, indicating that the FPA width is 384.
	Return	55 06 00 02 33 80 01 11 EB AA	
Read FPA height	Receive	AA 04 00 03 00 B1 EB AA	The return value is 2 bytes, with the low byte first. In the example, the return value is 0x20,0x01, indicating that the FPA width is 768.
	Return	55 06 00 03 33 20 01 B2 EB AA	
Read FPA temperature	Receive	AA 04 00 04 00 B2 EB AA	Example: If the readout Temperature is 30.7°C, the returned value is 3070 (30.7x100°C, decimal), and low byte returns first. If the temperature is below 0°C, the returned value is the complement code of current temperature.
	Return	55 06 00 04 33 FE 0B 9B EB AA	
Read camera temperature	Receive	AA 04 00 05 00 B3 EB AA	Example: If the readout temperature is 10.7°C,the returned value is 1070 (10.7x100°C, decimal), and low byte returns first. If the temperature is below 0°C, the returned value is the complement code of current Temperature
	Return	55 06 00 05 33 37 04 CE EB AA	

CONTINUES

Instruction		Camera Instructions Received	Note
Save setting	Receive	AA 04 00 11 01 C0 EB AA	
	Return	55 05 00 11 33 01 9F EB AA	
Restore factory defaults	Receive	AA 04 00 12 02 C2 EB AA	
	Return	55 05 00 12 33 01 A0 EB AA	
NUC settings	Receive	Manual: AA 05 00 15 01 00 C5 EB AA Auto: AA 05 00 15 01 01 C6 EB AA	The default setting is Auto calibrating.
	Return	55 05 00 15 33 01 A3 EB AA	
Read NUC settings	Receive	AA 04 00 15 00 C3 EB AA	Core feedback value of 1-byte. 0x01 means Auto mode 0×00 means Manual mode
	Return	Manual: 55 05 00 15 33 00 A2 EB AA Auto: 55 05 00 15 33 01 A3 EB AA	
Manual NUC settings	Receive	Shutter calibration: AA 05 00 16 01 00 C6 EB AA Background calibration: AA 05 00 16 01 02 C8 EB AA	In any calibrations, send anyone of the commands to run the NUC calibrated.
	Return	55 05 00 16 33 01 A4 EB AA	
Auto NUC Interval settings	Receive	AA 05 00 17 01 0A D1 EB AA	In Auto NUC, the interval time can be set. Example: The interval time is 10 minute, then send the 0x0A (accurate to 1minute, 0x01).
	Return	55 05 00 17 33 01 A5 EB AA	
Read auto NUC timing	Receive	AA 04 00 17 00 C5 EB AA	0x01 means the interval time is 1 minute.
	Return	55 05 00 17 33 01 A5 EB AA	
Interval temperature Auto NUC setting	Receive	AA 05 00 18 01 14 DC EB AA	In Auto NUC, the interval temperature can be set. Example: 0x14 means the interval temperature is 20/10 =2°C.
	Return	AA 05 00 18 01 14 DC EB AA	
Read interval temperature of automatic NUC	Receive	AA 04 00 18 00 C6 EB AA	Core feedback value of 1-byte. Example: 0x14 means the interval temperature is 20/10 =2°C.
	Return	55 05 00 18 33 14 B9 EB AA	

CONTINUES

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

Instruction		Camera Instructions Received	Note
Digital zoom	Receive	1x: AA 0D 00 2A 01 00 00 00 00 00 7F 02 FF 01 63 EB AA 1.1x: AA 0D 00 2A 01 00 1D 00 17 00 61 02 E7 01 61 EB AA 1.2x: AA 0D 00 2A 01 00 35 00 2B 00 49 02 D4 01 62 EB AA 1.3x: AA 0D 00 2A 01 00 4A 00 3B 00 35 02 C3 01 62 EB AA 1.4x: AA 0D 00 2A 01 00 5B 00 49 00 23 02 B5 01 61 EB AA 1.5x: AA 0D 00 2A 01 00 6B 00 55 00 14 02 A9 01 62 EB AA 1.6x: AA 0D 00 2A 01 00 78 00 60 00 06 02 9E 01 61 EB AA 1.7x: AA 0D 00 2A 01 00 84 00 69 00 FB 01 95 01 61 EB AA 1.8x: AA 0D 00 2A 01 00 8E 00 72 00 F0 01 8D 01 61 EB AA 1.9x: AA 0D 00 2A 01 00 98 00 79 00 E7 01 85 01 61 EB AA 2.0x: AA 0D 00 2A 01 00 A0 00 80 00 DF 01 7F 01 62 EB AA 2.1x: AA 0D 00 2A 01 00 A8 00 86 00 D7 01 78 01 61 EB AA 2.2x: AA 0D 00 2A 01 00 AF 00 8C 00 D0 01 73 01 62 EB AA 2.3x: AA 0D 00 2A 01 00 B5 00 91 00 CA 01 6E 01 62 EB AA 2.4x: AA 0D 00 2A 01 00 BB 00 95 00 C4 01 69 01 61 EB AA 2.5x: AA 0D 00 2A 01 00 C0 00 9A 00 BF 01 65 01 62 EB AA 2.6x: AA 0D 00 2A 01 00 C5 00 9E 00 BA 01 61 01 62 EB AA 2.7x: AA 0D 00 2A 01 00 C9 00 A1 00 B5 01 5D 01 61 EB AA 2.8x: AA 0D 00 2A 01 00 CE 00 A5 00 B1 01 5A 01 62 EB AA 2.9x: AA 0D 00 2A 01 00 D2 00 A8 00 AD 01 57 01 63 EB AA 3.0x: AA 0D 00 2A 01 00 D5 00 AB 00 A9 01 54 01 62 EB AA	Let the detector array be W in width, H in height and m in magnification, that (accurate to 1 decimal) Left-up $X = \frac{W}{2} - \frac{W}{2 \times m}$ Left-up $Y = \frac{H}{2} - \frac{H}{2 \times m}$ Right-down $X = \frac{W}{2} + \frac{W}{2 \times m} - 1$ Right-down $Y = \frac{H}{2} + \frac{H}{2 \times m} - 1$ The commands on the left are as 640×512 as example.

CONTINUES

Instruction		Camera Instructions Received	Note
		3.1x: AA 0D 00 2A 01 00 D9 00 AD 00 A6 01 51 01 62 EB AA 3.2x:AA 0D 00 2A 01 00 DC 00 B0 00 A2 01 4E 01 61 EB AA 3.3x: AA 0D 00 2A 01 00 DF 00 B2 00 9F 01 4C 01 61 EB AA 3.4x: AA 0D 00 2A 01 00 E2 00 B5 00 9D 01 4A 01 63 EB AA 3.5x: AA 0D 00 2A 01 00 E5 00 B7 00 9A 01 48 01 63 EB AA 3.6x: AA 0D 00 2A 01 00 E7 00 B9 00 97 01 46 01 62 EB AA 3.7x: AA 0D 00 2A 01 00 EA 00 BB 00 95 01 44 01 63 EB AA 3.8x: AA 0D 00 2A 01 00 EC 00 BD 00 93 01 42 01 63 EB AA 3.9x: AA 0D 00 2A 01 00 EE 00 BE 00 91 01 40 01 62 EB AA 4.0x: AA 0D 00 2A 01 00 F0 00 C0 00 8F 01 3F 01 63 EB AA 4.1x: AA 0D 00 2A 01 13 F2 00 C2 00 8D 01 3D 01 75 EB AA 4.2x: AA 0D 00 2A 01 13 F4 00 C3 00 8B 01 3B 01 74 EB AA 4.3x: AA 0D 00 2A 01 13 F6 00 C4 00 89 01 3A 01 74 EB AA 4.4x: AA 0D 00 2A 01 13 F7 00 C6 00 87 01 39 01 74 EB AA 4.5x: AA 0D 00 2A 01 13 F9 00 C7 00 86 01 37 01 74 EB AA 4.6x: AA 0D 00 2A 01 13 FA 00 C8 00 84 01 36 01 73 EB AA 4.7x: AA 0D 00 2A 01 13 FC 00 CA 00 83 01 35 01 75 EB AA 4.8x: AA 0D 00 2A 01 13 FD 00 CB 00 81 01 34 01 74 EB AA 4.9x: AA 0D 00 2A 01 13 FF 00 CC 00 80 01 33 01 75 EB AA 5.0x: AA 0D 00 2A 01 13 00 01 CD 00 7F 01 32 01 76 EB AA 5.1x: AA 0D 00 2A 01 13 01 01 CE 00 7D 01 31 01 75 EB AA	

CONTINUES

Instruction		Camera Instructions Received	Note
		5.2x: AA 0D 00 2A 01 13 02 01 CF 00 7C 01 30 01 75 EB AA 5.3x: 0D 00 2A 01 13 04 01 D0 00 7B 01 2F 01 76 EB AA 5.4x: 0D 00 2A 01 13 05 01 D1 00 7A 01 2E 01 76 EB AA 5.5x: 0D 00 2A 01 13 06 01 D1 00 79 01 2D 01 75 EB AA 5.6x: 0D 00 2A 01 13 07 01 D2 00 78 01 2C 01 75 EB AA 5.7x: 0D 00 2A 01 13 08 01 D3 00 77 01 2B 01 75 EB AA 5.8x: 0D 00 2A 01 13 09 01 D4 00 76 01 2B 01 76 EB AA 5.9x: 0D 00 2A 01 13 0A 01 D5 00 75 01 2A 01 76 EB AA 6.0x: 0D 00 2A 01 13 0B 01 D5 00 74 01 29 01 75 EB AA 6.1x: 0D 00 2A 01 13 0C 01 D6 00 73 01 28 01 75 EB AA 6.2x: 0D 00 2A 01 13 0C 01 D7 00 72 01 28 01 75 EB AA 6.3x: 0D 00 2A 01 13 0D 01 D7 00 71 01 27 01 74 EB AA 6.4x: 0D 00 2A 01 13 0E 01 D8 00 71 01 27 01 76 EB AA 6.5x: 0D 00 2A 01 13 0F 01 D9 00 70 01 26 01 76 EB AA 6.6x: 0D 00 2A 01 13 10 01 D9 00 6F 01 25 01 75 EB AA 6.7x: 0D 00 2A 01 13 10 01 DA 00 6E 01 25 01 75 EB AA 6.8x: 0D 00 2A 01 13 11 01 DA 00 6E 01 24 01 75 EB AA 6.8x: 0D 00 2A 01 13 11 01 DA 00 6E 01 24 01 75 EB AA 6.9x: 0D 00 2A 01 13 12 01 DB 00 6D 01 24 01 76 EB AA 7.0x: 0D 00 2A 01 13 12 01 DB 00 6C 01 23 01 74 EB AA 7.1x: 0D 00 2A 01 13 13 01 DC 00 6C 01 23 01 76 EB AA	

CONTINUES

Instruction		Camera Instructions Received	Note
		7.2x: 0D 00 2A 01 13 14 01 DC 00 6B 01 22 01 75 EB AA 7.3x: 0D 00 2A 01 13 14 01 DD 00 6A 01 22 01 75 EB AA 7.4x: 0D 00 2A 01 13 15 01 DD 00 6A 01 21 01 75 EB AA 7.5x: 0D 00 2A 01 14 15 01 DE 00 69 01 21 01 76 EB AA 7.6x: 0D 00 2A 01 14 16 01 DE 00 69 01 20 01 76 EB AA 7.7x: 0D 00 2A 01 14 16 01 DF 00 68 01 20 01 76 EB AA 7.8x: 0D 00 2A 01 14 17 01 DF 00 68 01 1F 01 76 EB AA 7.9x: 0D 00 2A 01 14 17 01 E0 00 67 01 1F 01 76 EB AA 8.0x: 0D 00 2A 01 14 18 01 E0 00 67 01 1F 01 77 EB AA	
	Return	55 05 00 2A 33 01 B8 EB AA	
Magnification	Receive	AA 0C 01 40 02 64 00 64 00 C8 00 C8 00 51 EB AA	Left-up dot coordinate (100,100), right-bottom coordinate (200,200), area size should be larger than (Whole array)*1/8
	Return	55 04 40 33 01 CD EB AA	
Read digital zoom value	Receive	AA 04 00 2A 00 D8 EB AA	Return 2 bite, example: return 0×64, 0×00, means zoom time 100/100 = 1X
	Return	55 06 00 2A 33 64 00 1C EB AA	
Palette settings	Receive	White hot: AA 05 00 2D 01 00 DD EB AA Black hot: AA 05 00 2D 0101 DE EB AA BRY: AA 05 00 2D 01 02 DF EB AA PRY: AA 05 00 2D 01 03 E0 EB AA BGR: AA 05 00 2D 01 04 E1 EB AA Rainbow1: AA 05 00 2D 01 05 E2 EB AA Rainbow2: AA 05 00 2D 01 06 E3 EB AA Black-red: AA 05 00 2D 01 07 E4 EB AA Blackish green-red: AA 05 00 2D 01 08 E5 EB AA	

CONTINUES

Instruction		Camera Instructions Received	Note
		BGR-pink: AA 05 00 2D 01 09 E6 EB AA Mixed: AA 05 00 2D 01 0A E7 EB AA Red hot: AA 05 00 2D 01 0B E8 EB AA Icy red: AA 05 00 2D 01 0C E9 EB AA Black-red: AA 05 00 2D 01 0D EA EB AA Blue-red: AA 05 00 2D 01 0E EB EB AA Gradual red: AA 05 00 2D 01 0F EC EB AA Gradual green AA 05 00 2D 01 10 ED EB AA Gradual yellow blue: AA 05 00 2D 01 11 EE EB AA Warning green: AA 05 00 2D 01 12 EF EB AA Warning blue: AA 05 00 2D 01 13 F0 EB AA	
	Return	55 05 00 2D 33 01 BB EB AA	
Read the palette value	Receive	AA 04 00 2D 00 DB EB AA	0×00: white hot (default) 0×01: black hot 0×02: BRY 0×03: PRY 0×04: BGR 0×05: 1 rainbow 1 0×06: 2 rainbow 2 0×07: B-R 0×08: blackish green Red 0×09: BGR-pink 0×0A: mixed 0×0B: Red hot 0×0C: Icy red 0×0D: black-red 0×0E: blue-red 0×0F: Gradual red 0×10: Gradual green 0×11: Gradual yellow 0×12: Warning green 0×13: Warning blue

CONTINUES

Instruction		Camera Instructions Received	Note
Set threshold of warning red/green/ blue	Receive	Threshold of warning red 200: AA 06 01 4B 01 C8 00 C5 EB AA Threshold of warning green 200: AA 06 01 4B 01 C8 01 C6 EB AA Threshold of warning blue 80: AA 06 01 4B 01 50 02 4F EB AA	
	Return	55 04 4B 33 01 D8 EB AA	
AGC	Receive	Manual: AA 05 00 3A 01 00 EA EB AA Auto0: AA 05 00 3A 01 01 EB EB AA Auto1: AA 05 00 3A 01 02 EC EB AA	
	Return	55 05 00 3A 33 01 C8 EB AA	
Read AGC value	Receive	AA 04 00 3A 00 E8 EB AA	
	Return	Manual: 55 05 00 3A 33 00 C7 EB AA Auto0: 55 05 00 3A 33 01 C8 EB AA Auto1: 55 05 00 3A 33 02 C9 EB AA	
Contrast setting	Receive	AA 05 00 3B 01 82 6D EB AA	Example: Set the contrast to 130 (decimal), then send PRM 0×82.
	Return	55 05 00 3B 33 01 C9 EB AA	
Read contrast value	Receive	AA 04 00 3B 00 E9 EB AA	Return 1 Byte, 0×82 means the current manual AGC value is 130
	Return	55 05 00 3B 33 82 4A EB AA	
Set contrast by steps	Receive	AA 06 00 40 01 01 05 F7 EB AA	PRM0: 0×00 decrease, 0×01 increase; PRM1: step. Example shows contrast increasing 5 in manual AGC.
	Return	55 05 00 40 33 01 CE EB AA	
Brightness setting	Receive	AA 06 00 3C 01 2C 01 1A EB AA	Example: Set the brightness to 300 (decimal), send PRM 0×2C, 0×01.
	Return	55 05 00 3C 33 01 CA EB AA	

CONTINUES

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

Instruction		Camera Instructions Received	Note
Set brightness by steps	Receive	AA 06 00 41 01 01 05 F8 EB AA	PRM0: 0×00 decrease, 0×01 increase; PRM1: step. Example shows brightness increasing 5 in manual AGC.
	Return	55 05 00 41 33 01 CF EB AA	
Read brightness value	Receive	AA 04 00 3C 00 EA EB AA	Return 2 Bytes, Example: 0xF4,0×00 means brightness is 244.
	Return	55 06 00 3C 33 F4 00 BE EB AA	
Set DDE on/off	Receive	DDE on: AA 05 00 3E 01 01 EF EB AA DDE off: AA 05 00 3E 01 00 EE EB AA	
	Return	55 05 00 3E 33 01 CC EB AA	
Read DDE value	Receive	AA 04 00 3E 00 EC EB AA	
	Return	DDE on: 55 05 00 3E 33 01 CC EB AA DDE off: 55 05 00 3E 33 00 CB EB AA	
DDE range setting	Receive	AA 05 00 3F 01 03 F2 EB AA	Example shows DDE value set as 3.
	Return	55 05 00 3F 33 01 CD EB AA	
Read DDE range value	Receive	AA 04 00 3F 00 ED EB AA	Return 1 Byte, 0×02 means DDE level 2.
	Return	55 05 00 3F 33 02 CE EB AA	
Image flip	Receive	AA 05 00 30 01 01 E1 EB AA (no flip) AA 05 00 30 01 02 E2 EB AA (left-right flip) AA 05 00 30 01 04 E4 EB AA (up-down flip) AA 05 00 30 01 08 E8 EB AA (left up – right down flip)	
	Return	55 05 00 30 33 01 BE EB AA	
Analog video freeze	Receive	Frozen: AA 05 00 32 02 00 E3 EB AA Active: AA 05 00 32 02 01 E4 EB AA	
	Return	55 05 00 32 33 01 C0 EB AA	
Digital video freeze	Receive	Frozen: AA 05 00 32 02 02 E5 EB AA Active: AA 05 00 32 02 03 E6 EB AA	
	Return	55 05 00 32 33 01 C0 EB AA	
Analog video on/off	Receive	On: AA 05 00 33 02 01 E5 EB AA Off: AA 05 00 33 02 00 E4 EB AA	
	Return	55 05 00 33 33 01 C1 EB AA	

CONTINUES

Instruction		Camera Instructions Received	Note
ROI	Receive	AA 0C 00 42 01 64 00 64 00 F4 01 F4 01 AB EB AA	Example: Left-Up (100,100), Right-Down (500,500)
	Return	55 04 2B 33 01 B8 EB AA	
Image filtering setting	Receive	On: AA 05 00 31 01 01 E2 EB AA Off: AA 05 00 31 01 00 E1 EB AA	
	Return	55 05 00 31 33 01 BF EB AA	
Read the image filtering value	Receive	AA 04 00 31 00 DF EB AA	
	Return	On: 55 05 00 31 33 01 BF EB AA Off: 55 05 00 31 33 00 BE EB AA	
Digital video output settings	Receive	Off: AA 06 00 2F 02 00 00 E1 EB AA AA 06 00 2F 02 02 00 E3 EB AA (LVCMOS) AA 06 00 2F 02 03 00 E4 EB AA (LVDS) AA 06 00 2F 02 04 00 E5 EB AA (BT.656) AA 06 00 2F 02 05 00 E6 EB AA (BT.1120) AA 06 00 2F 02 06 00 E7 EB AA (LVDS & LVCMOS) AA 06 00 2F 02 07 00 E8 EB AA (LVDS & BT.656)	PRM0: Select the digital video output format, supporting parallel data and serial data output together. 0×00: digital video output off 0×02: parallel LVCMOS video 0×03: serial LVDS video 0×04: parallel BT.656 video 0×05: parallel BT.1120 video

CONTINUES

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

Instruction		Camera Instructions Received	Note
		AA 06 00 2F 02 08 00 E9 EB AA (LVDS & BT.1120) AA 06 00 2F 02 03 02 E6 EB AA (only LVDS_H video select palette) AA 06 00 2F 02 03 00 E4 EB AA (only LVDS_H video select gray scale) AA 06 00 2F 02 03 12 F6 EB AA (only LVDS_F video select palette) AA 06 00 2F 02 03 10 F4 EB AA (only LVDS_F video select gray scale)	0×06: LVDS and LVCMOS video output together 0×06： LVDS and LVCMOS video output together 0×07: LVDS and BT.656 video output together 0×08： LVDS and BT.1120 video output together When serial LVDS video outputting, the Bit1 & Bit4 of PRM1 definition is video type and palette type. -Bit4 is serial LVDS video type, Bit4=0 stands for LVDS_H video Bit4=1 stands for LVDS_F video -Bit1 is serial LVDS palette type only in the video source of DRC Bit1=0 stands for palette video Bit1=1 stands for gray scale video
	Return	55 05 00 2F 33 01 BD EB AA	
Digital video source	Receive	AA 05 00 2E 01 20 FE EB AA (LVDS-DRC) AA 05 00 2E 01 40 1E EB AA (LVDS-TEMP) AA 05 00 2E 01 50 2E EB AA (LVDS-RAW) Only LVCMOS video output, the video source is: AA 05 00 2E 01 02 E0 EB AA (LVCMOS-DRC) AA 05 00 2E 01 04 E2 EB AA (LVCMOS -TEMP) AA 05 00 2E 01 05 E3 EB AA (LVCMOS -RAW) LVDS DCR & LVCOMS DRC output together: AA 05 00 2E 01 22 00 EB AA	Only LVCMOS or LVDS video source selected. Low 4-byte shows the LVCMOS video source: 0xX2: DRC 0xX4: TEMP 0xX5: RAW High 4-byte shows the LVDS video source: 0×2X: DRC 0×4X: TEMP 0×5X: RAW
	Return	55 05 00 2E 33 01 BC EB AA	

CONTINUES

Instruction		Camera Instructions Received	Note
Baud rate setting	Receive	(115200bps)AA 06 00 14 02 00 10 D6 EB AA (9600bps) AA 06 00 14 02 00 02 C8 EB AA (19200bps) AA 06 00 14 02 00 04 CA EB AA (38400bps) AA 06 00 14 02 00 08 CE EB AA (57600bps) AA 06 00 14 02 00 40 06 EB AA	
	Return	55 05 00 14 33 01 A2 EB AA	
Read glare protection status	Receive	AA 05 01 08 00 00 B8 EB AA	
	Return	55 07 08 33 00 80 3E 07 5C EB AA	Return 4bytes
Set glare protection	Return	AA 08 01 08 01 00 80 3E 07 81 EB AA	00: Off 80 3E: 0×3E80, threshold16000 07: protection time 7s
	Return	55 04 08 33 01 95 EB AA	Return 1byte

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

13. Appendix 2 Temperature Measuring Command Protocol

Instruction		Camera Instructions Received	Note
Measuring OSD on/off	Receive	On: AA 05 07 00 01 00 B7 EB AA Off: AA 05 07 00 01 01 B8 EB AA	
	Return	55 05 07 00 33 01 95 EB AA	
Temperature unit	Receive	Celsius: AA 05 07 02 01 00 B9 EB AA Kelvin: AA 05 07 02 01 01 BA EB AA Fahrenheit: AA 05 07 02 01 02 BB EB AA	
	Return	55 05 07 02 33 01 97 EB AA	
Read the threshold of low-high gain	Receive	AA 05 07 05 00 00 BB EB AA	Return 2Bytes, low Byte is in the front. Temperature = return value/10. Example: 120.0 degrees: B0 04.
	Return	55 06 07 05 33 B0 04 4E EB AA (threshold is 120)	
Set the threshold of low-high gain	Receive	AA 06 07 05 01 B0 04 71 EB AA (threshold is 120)	PRM 2Bytes, low Byte is in the front. Temperature =PRM/10.
	Return	55 05 07 05 33 01 9A EB AA	
Read the percent of low-high gain	Receive	AA 05 07 06 00 00 BC EB AA	
	Return	55 07 07 06 33 5F F9 EB AA (percent is 95%)	Return 1 Byte. Percent = returned value/100.
Set the percent of low-high gain	Receive	AA 05 07 06 01 5F 1C EB AA (percent is 95%)	Return 1 Byte. Percent = returned value/100.
	Return	55 05 07 06 33 01 98 EB AA	
Read the threshold of high-low gain	Receive	AA 05 07 07 00 00 BD EB AA	
	Return	55 06 07 07 33 78 05 19 EB AA (threshold is 140.0)	Return 2Bytes, low Byte is in the front. Temperature = return value/10.
Set the threshold of high-low gain	Receive	07 07 33 78 05 19 EB AA (threshold is 140.0)	PRM 2Bytes, low Byte is in the front. Temperature =PRM/10.
	Return	55 05 07 07 33 01 9C EB AA	

CONTINUES

Instruction		Camera Instructions Received	Note
Read the percent of high-low gain	Receive	AA 05 07 08 00 00 BE EB AA	
	Return	55 05 07 08 33 0F AB EB AA (percent is 15%)	Return 1 Byte. Percent = returned value/100.
Set the percent of high-low gain	Receive	AA 05 07 08 01 0F CE EB AA (set percent is 15%)	Return 1 Byte. Percent = returned value/100.
	Return	55 05 07 08 33 01 9D EB AA	
Measuring temperature range	Receive	High: AA 05 07 01 01 00 B8 EB AA Low: AA 05 07 01 01 01 B9 EB AA Auto: AA 05 07 01 01 03 BB EB AA	Hight gain temperature measuring range -20~+150°C. Low gain temperature measuring range 0~+550°C. In Auto mode, the core will auto select the temperature measuring range.
	Return	55 05 07 01 33 01 96 EB AA	
Read the reflect temperature	Receive	AA 05 07 0F 00 00 C5 EB AA	
	Return	55 08 07 0F 33 90 D0 03 00 09 EB AA (reflect temperature is 25°C)	Return 4 Bytes, low Byte is in the front. Temperature =returned value/10000.
Set the reflect temperature	Receive	AA 08 07 0F 01 E0 93 04 00 40 EB AA (reflect temperature is 30°C)	PRM 4 Bytes, low Byte is in the front. Temperature =returned value/10000.
	Return	55 05 07 0F 33 01 A4 EB AA	
Read the ambient temperature	Receive	AA 05 07 10 00 00 C6 EB AA	
	Return	55 08 07 10 33 90 D0 03 00 0A EB AA (ambient temperature is 25°C)	Return 4 Bytes, low Byte is in the front. Temperature =returned value/10000.
Set the ambient temperature	Receive	AA 08 07 10 01 90 D0 03 00 2D EB AA (ambient temperature is 25°C)	Return 4 Bytes, low Byte is in the front. Temperature =returned value/10000.
	Return	55 05 07 10 33 01 A5 EB AA	
Read the ambient transmission	Receive	AA 05 07 11 00 00 C7 EB AA	
	Return	55 08 07 11 33 D0 DD 06 00 5B EB AA (transmissivity is 0.45)	Return 4 Bytes, low Byte is in the front. Transmissivity = returned value/10000.
Set the ambient transmission	Receive	AA 08 07 11 01 D0 DD 06 00 7E EB AA (transmissivity is 0.45)	Return 4 Bytes, low Byte is in the front. Transmissivity = returned value/10000.
	Return	55 05 07 11 33 01 A6 EB AA	

CONTINUES

Instruction		Camera Instructions Received	Note
Read the emissivity	Receive	AA 05 07 12 00 00 C8 EB AA	
	Return	55 08 07 12 33 48 26 00 00 17 EB AA (Emissivity: 0.98)	Return 4 Bytes, low Byte is in the front. Transmissivity = returned value/10000.
Set the emissivity	Receive	AA 08 07 12 01 48 26 00 00 3A EB AA	Return 4 Bytes, low Byte is in the front. Transmissivity = returned value/10000.
	Return	55 05 07 12 33 01 A7 EB AA	
Read the distance	Receive	AA 05 07 13 00 00 C9 EB AA	
	Return	55 08 07 13 33 60 EA 00 00 F4 EB AA (distance: 6.0)	Return 4 Bytes, low Byte is in the front. Distance = returned value/10000.
Set the distance	Receive	AA 08 07 13 01 60 EA 00 00 17 EB AA	Return 4 Bytes, low Byte is in the front. Distance = returned value/10000.
	Return	55 05 07 13 33 01 A8 EB AA	
Environment variable take effect	Receive	AA 05 07 18 01 00 CF EB AA	
	Return	55 05 07 18 33 01 AD EB AA	
Spot measuring tools on/off	Receive	On: AA 06 07 80 01 00 01 39 EB AA Off: AA 06 07 80 01 00 00 38 EB AA	PRM0: 0×00~0×09 stands for spot 1-10 PRM1: 0×01 ON 0×00 OFF
	Return	55 05 07 80 33 01 15 EB AA	
Read the spot coordinates	Receive	AA 05 07 82 00 00 38 EB AA	PRM0: 0×00~0×09 stands for spot 1-10
	Return	55 09 07 82 33 00 41 00 64 00 BF EB AA (coordinates: (65,100))	Return0: number of spot Return 1: low 8-bits of start x axis Return 2 : high 8-bits of start x axis Return 3: low 8-bits of start y axis Return 4: high 8-bits of start y axis

CONTINUES

Instruction		Camera Instructions Received	Note
Set the spot coordinates	Receive	AA 09 07 82 01 00 41 00 64 00 E2 EB AA	PRM0: 0×00~0×09 stands for spot1-10 PRM1: 8-bits of start x axis PRM 2: high 8-bits of start x axis PRM 3: low 8-bits of start y axis PRM 4: high 8-bits of start y axis
	Return	55 05 07 82 33 01 17 EB AA	
Read spot temperature	Receive	AA 05 07 83 00 00 39 EB AA	
	Return	55 09 07 83 33 00 65 01 00 00 81 EB AA (spot1, 35.7°C)	Return0: 0×00~0×09 stands or spot1-10 Return1-4: temperature/10, low Bytes in the front.
Area/line measuring tools on/off	Receive	On: AA 06 07 40 01 00 01 F9 EB AA Off: AA 06 07 40 01 00 00 F8 EB AA	PRM : 0×00~0×0b stands for area/line 1-12. PRM1: 0×00 off 0×01 on
	Return	55 05 07 40 33 01 D5 EB AA	
Choose area or line	Receive	Area: AA 06 07 41 01 00 00 F9 EB AA Line: AA 06 07 41 01 00 01 FA EB AA	PRM0: 0×00~0×0b stands for area/line 1-12. PRM1: 0×00 Area, 0×01 Line
	Return	55 05 07 41 33 01 D6 EB AA	

CONTINUES

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

Instruction		Camera Instructions Received	Note
Read the coordinates of area/line	Receive	AA 05 07 42 00 00 F8 EB AA	PRM0: 0×00~0×0b stands for area/line 1-12.
	Return	55 0D 07 42 33 00 64 00 64 00 C8 00 C8 00 36 EB AA	Return0 : stands for number of area/line Return 1: low 8-bits of start x axis Return 2: high 8-bits of start x axis Return 3: low 8-bits of start y axis Return 4: high 8-bits of start y axis Return 5: low 8-bits of end x axis Return 6: high 8-bits of end x axis Return 7: low 8-bits of end y axis Return 8: high 8-bits of end y axis
Set the coordinates of area/line	Receive	AA 0D 07 42 01 00 64 00 64 00 C8 00 C8 00 59 EB AA	PRM0: stands for number of area/line PRM 1: low 8-bits of start x axis PRM 2: high 8-bits of start x axis PRM 3: low 8-bits of start y axis PRM 4: high 8-bits of start y axis PRM 5: low 8-bits of end x axis PRM 6: high 8-bits of end x axis PRM 7: low 8-bits of end y axis PRM 8: high 8-bits of end y axis
	Return	55 05 07 42 33 01 D7 EB AA	

CONTINUES

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

Instruction		Camera Instructions Received	Note
Read the highest temperature and coordinates of area/line	Receive	AA 05 07 45 00 00 FB EB AA	PRM0: 0×00~0×0b stands for area/line 1-12
	Return	55 0D 07 45 33 00 4E 01 00 00 10 00 0A 00 4A EB AA (The highest temperature of Area/line1 is 33.4°C, and the coordinate is (16,10))	Return 9 bits; Return 0: number of Area/ line Return 1-4: temperature*10, low Byte is in the font Return 5-6: coordinate x, low Byte is in the font Return 7-8: coordinate y, low Byte is in the font
Read the lowest temperature and coordinates of area/line	Receive	AA 05 07 48 00 00 FE EB AA	PRM0: 0×00~0×0b stands for area/line 1-12
	Return	55 0D 07 48 33 00 42 01 00 00 2B 00 15 00 67 EB AA (The highest temperature of Area/line1 is 32.2°C, and the coordinate is (43,21))	Return 9 Bytes: Return 0: number of Area/ line Return 1-4: temperature*10, low Byte is in the font Return 5-6: coordinate x, low Byte is in the font Return 7-8: coordinate y, low Byte is in the font
Read temperature and coordinate of central spot	Receive	AA 05 07 4B 00 00 01 EB AA	PRM0: 0×00~0×0b stands for area/line 1-12
	Return	55 0D 07 4B 33 00 33 01 00 00 96 00 96 00 47 EB AA (The highest temperature f Area/line1 is 30.7°C, and the coordinate is (150,150))	Return 9 Bytes; Return 0: number of Area/ line Return 1-4: temperature*10, low Byte is in the font Return 5-6: coordinate x, low Byte is in the font Return 7-8: coordinate y, low Byte is in the font

CONTINUES

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

Instruction		Camera Instructions Received	Note
Read average temperature of area/line	Receive	AA 05 07 4C 00 00 02 EB AA	PRM0: 0×00~0×0b stands for area/line 1-12
	Return	55 09 07 4C 33 00 33 01 00 00 18 EB AA (The average temperature of Area/line1 is 30.7°C)	Return 5 Bytes; Return 0: number of Area/line Return 1-4: temperature*10, low Byte is in the font
Isotherm on/off	Receive	On: AA 05 07 20 01 01 D8 EB AA Off: AA 05 07 20 01 00 D7 EB AA	
	Return	55 05 07 20 33 01 B5 EB AA	
Temperature measuring of full frame on/off	Receive	On: AA 05 07 24 01 01 DC EB AA Off: AA 05 07 24 01 00 DB EB AA	
	Return	55 05 07 24 33 01 B9 EB AA	
The highest temperature display on/off	Receive	On: AA 05 07 26 01 01 DE EB AA Off: AA 05 07 26 01 00 DD EB AA	
	Return	55 05 07 26 33 01 BB EB AA	
The lowest temperature display on/off	Receive	On: AA 05 07 28 01 01 E0 EB AA Off: AA 05 07 28 01 00 DF EB AA	
	Return	55 05 07 28 33 01 BD EB AA	
The central temperature display on/off	Receive	On: AA 05 07 2B 01 01 E3 EB AA Off: AA 05 07 2B 01 00 E2 EB AA	
	Return	55 05 07 2B 33 01 C0 EB AA	
Temperature alarm type	Receive	AA 05 07 2D 01 00 E4 EB AA (off) AA 05 07 2D 01 01 E5 EB AA (alarm of low Temperature) AA 05 07 2D 01 02 E6 EB AA (alarm of high Temperature) AA 05 07 2D 01 03 E7 EB AA (alarm of low-high Temperature)	
	Return	55 05 07 2D 33 01 C2 EB AA	

CONTINUES

Instruction		Camera Instructions Received	Note
Read temperature alarm value	Receive	AA 05 07 2E 00 00 E4 EB AA	
	Return	55 08 07 2E 33 C8 00 00 00 8D EB AA (20.0°C)	Return 4 Bytes. Temperature =Returned value/10, low Byte is in the front.
Set temperature alarm value	Receive	AA 08 07 2E 01 C8 00 00 00 B0 EB AA (20.0°C)	Return 4 Bytes. Temperature =Returned value/10, low Byte is in the front.
	Return	55 05 07 2E 33 01 C3 EB AA	
Read temperature alarm of high-value	Receive	AA 05 07 2F 00 00 E5 EB AA	
	Return	55 08 07 2F 33 90 01 00 00 57 EB AA (40.0°C)	Return 4 Bytes. Temperature =Returned value/10, low Byte is in the front.
Set temperature alarm of high-value	Receive	AA 08 07 2F 01 90 01 00 00 7A EB AA (40.0°C)	Return 4 Bytes. Temperature =Returned value/10, low Byte is in the front.
	Return	55 05 07 2F 33 01 C4 EB AA	
Read the highest temperature/ coordinate in full frame	Receive	AA 05 07 27 00 00 DD EB AA	
	Return	55 0C 07 27 33 4E 01 00 00 5C 01 2D 00 9B EB AA (temperature 32.3°C; coordinate(348,45))	Return 8bytes; Return 0-3: Temperature *10,low bytes is in the front Return 4-5: coordinate x, low bytes is in the front Return 6-7: coordinate y, low bytes is in the front
Read the lowest temperature/ coordinate in full frame	Receive	AA 05 07 29 00 00 DF EB AA	
	Return	55 0C 07 29 33 CD 00 00 00 62 02 17 00 0C EB AA(Temperature 20.5°C;coordinate (610,23))	Return 8bytes; Return 0-3: Temperature *10,low bytes is in the front Return 4-5: coordinate x, low bytes is in the front Return 6-7: coordinate y, low bytes is in the front

CONTINUES

Instruction		Camera Instructions Received	Note
Read the central temperature/ coordinate in full frame	Receive	AA 05 07 2C 00 00 E2 EB AA	
	Return	55 0C 07 2C 33 F2 00 00 00 40 01 00 01 FB EB AA (temperature 24.2°C; coordinate (320,256))	Return 8bytes; Return 0-3: Temperature *10,low bytes is in the front Return 4-5: coordinate x, low bytes is in the front Return 6-7: coordinate y, low bytes is in the front
Read the average temperature/ coordinate full frame	Receive	AA 05 07 2A 00 00 E0 EB AA	
	Return	55 08 07 2A 33 43 01 00 00 05 EB AA (32.3°C)	Return 4 Bytes. Temperature = Returned value/10, low Byte is in the front.
Temperature width tensile on/off	Receive	On: AA 05 07 F0 01 01 A8 EB AA Off: AA 05 07 F0 01 00 A7 EB AA	
	Return	55 05 07 F0 33 01 85 EB AA	Return 1 byte 0×01: Success 0×00: Fail
Write low temperature threshold of temperature width tensile	Receive	AA 08 07 1D 01 40 0D 03 00 27 EB AA	Receive data = Actual data ×10000, low byte is ahead.
	Return	55 05 07 1D 33 01 B2 EB AA	
Read low temperature threshold of temperature width tensile	Receive	AA 05 07 1D 00 00 D3 EB AA	
	Return	55 08 07 1D 33 40 0D 03 00 04 EB AA	Actual data = Return data(low byte is ahead)/10000
Write high temperature threshold of temperature width tensile	Receive	AA 08 07 1E 01 80 1A 06 00 78 EB AA	Receive data = actual data × 10000, low byte is ahead
	Return	55 05 07 1E 33 01 B3 EB AA	
Set high temperature threshold of temperature width tensile	Receive	AA 05 07 1E 00 00 D4 EB AA	
	Return	55 08 07 1E 33 80 1A 06 00 55 EB AA	Actual data = Return data (low byte is ahead)/10000

CONTINUES

Instruction		Camera Instructions Received	Note
Read temperature imaging status	Receive	AA 05 07 71 00 00 27 EB AA	
	Return	55 05 07 71 33 XX sum EB AA	Return 1byte: temperature imaging 0×00: off; 0×01: on
Set temperature imaging	Receive	AA 05 07 71 01 01 29 EB AA	PRM 1byte 0×00: off; 0×01: on
	Return	55 05 07 71 33 01 sum EB AA	
Secondary calibration (single point calibration)	Receive	AA 06 07 6E 02 19 00 40 EB AA (25°C)	PRM: 2bytes
	Return	55 05 07 6E 33 01 03 EB AA	
Secondary calibration (two point calibration)	Receive	AA 06 07 6F 02 19 00 41 EB AA (25°C)	PRM: 2bytes
	Return	55 05 07 6F 33 01 04 EB AA	
Save secondary calibration	Receive	AA 05 07 6A 02 00 22 EB AA	The parameters for the second calibration are enabled, and it will be still used for power-off and restart.
	Return	55 05 07 6A 33 01 FF EB AA	
Read secondary calibration	Receive	AA 05 07 6A 00 00 20 EB AA	
	Return	55 05 07 6A 33 XX sum EB AA	Return 1byte 0×00: non-calibrated 0×01: calibrated
Clear secondary calibration	Receive	AA 05 07 6B 02 00 23 EB AA	The parameters for the second calibration are enabled, and it will be still used for power-off and restart.
Read temperature reference source calibration	Receive	AA 05 07 7C 00 00 32 EB AA	
	Return	55 05 07 7C 33 01 11 EB AA	Return 1byte: 0×01 on, 0×00 off
Set temperature reference source calibration	Receive	AA 05 07 7C 01 00 33 EB AA	0×01 on, 0×00 off
	Return	55 05 07 7C 33 01 11 EB AA	Return 1byte

CONTINUES

Instruction		Camera Instructions Received	Note
Read temperature reference source temperature	Receive	AA 05 07 7D 00 00 33 EB AA	
	Return	55 08 07 7D 33 80 1A 06 00 B4 EB AA 40°C	Return 4bytes
Set temperature reference source temperature	Receive	AA 08 07 7D 01 80 1A 06 00 D7 EB AA	Temperature = parameter/10000, low byte is in the front.
	Return	55 05 07 7D 33 01 12 EB AA	Return 1byte
Read temperature reference source coordinates	Receive	AA 05 07 7E 00 00 34 EB AA	
	Return	55 0C 07 7E 33 BE 00 8C 00 C8 00 96 00 C1 EB AA Upper left corner (190, 140,)bottom right corner (200, 150)	Return 8bytes
Set temperature reference source coordinate	Receive	AA 0C 07 7E 01 BE 00 8C 00 C8 00 96 00 E4 EB AA	Temperature reference source coordinate: The resulting frame is a square with sides not exceeding 30.
	Return	55 05 07 7E 33 01 13 EB AA	Return 1byte
Read skin temperature measurement status	Receive	AA 05 07 72 00 00 28 EB AA	
	Return	55 05 07 72 33 00 06 EB AA	Return 1byte; 0×01 on, 0×00 off
Set skin temperature measurement	Receive	AA 05 07 72 01 01 2A EB AA	0×01 on, 0×00 off
	Return	55 05 07 72 33 01 07 EB AA	Return 1byte

PLEASE READ AND UNDERSTAND THE TABLES BEFORE SWITCHING THE UNIT ON.

14. About Thermal Camera

Thermal Camera is a distributor of thermal camera cores. You can see our products and services used in industrial, commercial, and government applications worldwide.

Our knowledge and experience stems from years of using infrared imaging and temperature measurement instruments to provide solutions to: managers, engineers, scientists, inspectors and operators in space, power companies, medical, pulp and paper, food industry, research and development, and various process industries.

Thank you for your dedicated and continued support.

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