



Xcore MicroIII Series
Uncooled Thermal Imaging Module
Command Protocols
V1.0.5

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If you need the latest version of this manual, please contact us. IRay Photoelectric recommends that you use this manual under the guidance of professionals.

Version History

Version	Date	Description
V1.0.0	2019-06	Initial version
V1.0.1	2019-07	Modify the NUC correction command example; Change the name of palette
V1.0.2	2019-11	Add cursor position reading, LVCOMS digital video interface, display size setting, blind pixels, calibration related commands. Modify the electronic zoom commands and return commands of partial commands. Add temperature measurement commands.
V1.0.3	2020-03	Add commands of 4 parameters
V1.0.4	2020-08	Add Blackbody correction commands
V1.0.5	2021-11	Add commands of shutter correction, temperature scale and video source settings; Add commands of PN/SN query and analog video format settings.

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1. Serial Port Settings

Table1 Serial Port Settings

Baud Rate	Trans-format			Parity Check
	Data bits	Start Bits	Stop Bits	
115200bps	8	1	1	none

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

2. Command and Message Format of the Thermal Imaging Core

2.1 Receive Command Format of the Thermal Imaging Core

Table2 Receive Command Format of the Thermal Imaging Core (Take *Read FPA temperature* as an example)

Process Start	Byte Count	CW0	CW1	OW	PRM0	PRM1	...	PRM N	SC	Process End	
		Process Body									
0xAA	0x04	0x01	0xC3	0x00	none	none	none	none	0x72	0xEB	0xAA

Note:

- (1) All the format values described in Table2 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 Table5 to Table8;
- (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;

2.2 Return Command Format of the Thermal Imaging Core

Table3 Return Command Format of the Thermal Imaging Core (Take *Read FPA temperature* as an example)

Process start	Byte count	CW1	OW	RV	RV	...	RV	SC	Process end	
		Process body								
0x55	0x05	0xC3	0x33	0xCB	0x11	none	none	0x2C	0xEB	0xAA

Note:

- (1) Status information reflects command execution result;
- (2) CW and RV are described from Table5 to Table9. For the RV, the lower bit is in the front, as

Decimal 4725 is the hexadecimal number of 0x11CB, so the RV is 0xCB by 0x11;

(3) Byte count is the number of process body bytes;

(4) The OW (operation word) is fixed to 0x33;

(5) The process start is fixed to 0x55;

(6) The process end is fixed to 0xEB and 0xAA.

If two bytes of command words are 0xFF and the only one RV (returned value) is one of the values shown in Table 4, the command is error. Users can search for the cause of error by consulting Table 4.

Table4 Error list of RV

Returned value	Cause of Error
0xF1	Command sending overtime
0xFB	None of CW
0xFD	DRC SC error
0xFF	Process start 0xAA error

2.3 The Receiving Command and Status Information

Table5 Settings menu

Settings						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes Count
0x01	0x11	NUC	0x02	1	0x00: background correction (for imaging type) 0x01: shutter correction (for imaging type) 0x80: background correction (for temperature measurement type) 0x81: shutter correction (for temperature measurement type)	1
0x01	0x01	Auto NUC	0x01	1	0x00: off 0x01: on	1
0x01	0x03	Set interval time of auto NUC	0x01	1	0~255 minutes	1

0x01	0x04	Set interval temp. of auto NUC	0x01	1	0.0~25.5 °C (0.1°C/cnt)	1
0x01	0xC3	Read FPA temp.	0x00	0	none	2
0x01	0x7C	Read core temp.	0x00	0	none	2
0x01	0x7F	Save settings	0x02	0	none	1
0x01	0x82	Recovery default settings	0x02	0	none	1

Table6 Video Menu

Video settings						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes
0x01	0x44	Reticle moving	0x02	1	Bit7=0: short step Bit7=1: long step 0x06/0x86: up 0x07/0x87: down 0x08/0x88: left 0x09/0x89: right	1
				5	PRM1:0x05 means setting reticle position directly PRM 2: X axis coordinate low byte parameter PRM 3: X axis coordinate high byte parameter PRM 4: Y axis coordinate low byte parameter PRM 5: Y axis coordinate high byte	1
		Read reticle position	0x00	0	none	4
0x01	0x43	Reticle type	0x02	1	0x00: off 0x80: type1	1

Video settings						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes
					0x81: type 2 0x82: type 3 0x83: type 4	
0x01	0x5D	Video type	0x02	2	0x00 0x00: off 0x02 0x00: LVCOMS 0x03 0x00: LVDS 0x04 0x00: BT656 0x05 0x00: BT1120 0x05 0x80: CDS_2	1
0x01	0x5C	Video source	0x01	1	0x00: ORG 0x01: NUC 0x02: DRC 0x04: TEMP 0x05: DNS	1
0x01	0x3F	CVBS format	0x02	1	0x00: NTSC 0x01: PAL	1
0x01	0x4C	Image flip	0x01	1	bit0=1 off bit1=1 Horizontal bit2=1 Vertical bit3=1 Diagonal	1
0x01	0x40	Digital zoom	0x02	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 Please refer to the appendix for detailed formula.	1
0x01	0x3D	CVBS video on/off	0x02	1	0x00: off 0x01: on	1

Video settings						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes
0x01	0x3E	Video froze	0x02	1	0x00: off 0x01: on	1
0x01	0x4F	Video resolution	0x02	4	PRM1: width (low byte) PRM 2: width (high byte) PRM 3: high (low byte) PRM 4: high (high byte)	1
0x01	0x42	Palette	0x02	1	0x00: white Hot (default) 0x01: black Hot 0x02: rainbow 0x03: rainbow HC 0x04: iron 0x05: lava 0x06: sky 0x07: middle gray 0x08: red gray 0x09: purple orange 0x0A: special 1 0x0B: warning red 0x0c: ice fire 0x0d: blue red 0x0E: special 2 0x0F: gradient red 0x10: gradient green 0x11: gradient yellow 0x12: warning green 0x13: warning blue	1
0x01	0x4B	threshold value of alarm color	01	2	PRM1: threshold value PRM2: 0x00 alarm red 0x01 alarm green 0x02 alarm blue	1

Table7 AGC settings

AGC settings						
CW0	CW1	Meaning	OW	PRM Byte	PRM	RV Bytes
0x01	0x1F	AGC setting	0x01	1	0x00: manual	1
					0x01: auto0	
					0x02: auto1	
0x01	0x22	Contrast setting	0x01	1	contrast value (0-255)	1
0x01	0x23	Brightness setting	0x01	2	Brightness (0-511) PRM1: brightness (low byte) PRM2: brightness (high byte)	1
0x01	0x1A	DDE on/off	0x01	2	0: off 1: on	1
0x01	0x19	DDE level	0x01	1	Level range: 1-8	1
0x01	0x1B	Image filter on/off	0x01	2	0x00: off 0x01: on	1
0x01	0x2B	ROI	0x01	1	PRM 1: left-up X- low byte PRM 2: left-up X -high byte PRM 3: left-up Y -low byte PRM 4: left-up Y -high byte PRM 5: right-down X- low byte PRM 6: right-down X- high byte PRM 7: right-down Y -low byte PRM 8: right-down Y -high byte Please refer the appendix for detailed formula.	1

Table8 Advance settings

Advance settings						
CW0	CW1	Meaning	OW	PRM Bytes	CW0	CW1
0x01	0x77	Baud rate	0x02	1	0x02: 9600 0x04: 19200 0x08: 38400 0x40: 57600 0x10: 115200	1

Table 9 Functional Menu of Temperature Measurement Parameters

MicrolIII Temperature Measurement Parameters						
CW0	CW1	Meaning	OW	PRM Bytes	PRM	Returned Bytes
0x07	0x00	Temperature Measurement OSD enable /disable	0x01	1	0x00: disable 0x01: enable	1
0x07	0x01	Select Temperature Measurement Range	0x01	1	0x00: high gain 0x01: low gain 0x03: auto	1
0x07	0x02	Temperature Measurement Unit	0x01	1	0x00: Celsius 0x01: Kelvin 0x02: Fahrenheit	1
0x07	0x05	Read low-high gain threshold	0x00	1	0x00	2
		Set low-high gain threshold	0x01	2	Threshold=parameter/10, low bit in front	1
0x07	0x06	Read low-high gain percentage	0x00	1	0x00	3
		Set low-high gain percentage	0x01	1	Percentage=parameter/100	1
0x07	0x07	Read high-low gain threshold	0x00	1	0x00	2
		Set high-low gain threshold	0x01	2	Threshold=parameter/10, low bit in front	1

MicrolIII Temperature Measurement Parameters						
0x07	0x08	Read high-low gain percentage	0x00	1	0x00	3
		Set high-low gain percentage	0x01	1	Percentage=parameter/100	1
0x07	0x0f	Read reflected temperature	0x00	1	0x00	4
		Set reflected temperature	0x01	4	Temperature=parameter/10000 low bit in front	1
0x07	0x10	Read atmospheric temperature	0x00	1	0x00	4
		Set atmospheric temperature	0x01	4	Temperature=parameter/10000, Low bit in front	1
0x07	0x11	Read atmospheric transmissivity	0x00	1	0x00	4
		Set atmospheric transmissivity	0x01	4	Transmissivity=parameter/10000, low bit in front	1
0x07	0x12	Read emissivity	0x00	1	0x00	4
		Set emissivity	0x01	4	Emissivity=parameter/10000, low bit in front	1
0x07	0x13	Read distance	0x00	1	0x00	4
		Set distance	0x01	4	Distance=parameter/10000, Low bit in front	1
0x07	0x18	Environmental variable enable	0x01	1	0x00	1

Table 10 Functional Menu of Spot Temperature Measurement

Spot Temperature Measurement						
CW0	CW1	Meaning	OW	PRM Byte	PRM	Returned Bytes
0x07	0x80	spot temperature measurement enable/disable (support 10 spots)	0x01	2	PRM0: 0x00~0x09 stands for spot 1-10 PRM1: 0x00 disable 0x0 enable	1
0x07	0x82	select spot coordinate to read	0x00	1	PRM 0: 0x00~0x09 stands for spot 1-10	5
		Select spot coordinate to set	0x01	5	PRM 0: 0x00~0x09 stands for spot 1-10 PRM 1: low 8 bits of X –axis coordinates PRM2: high 8 bits of X –axis coordinates PRM3: low 8 bits of Y –axis coordinates PRM4: high 8 bits of Y –axis coordinates	1
0x07	0x83	Select spot temperature to read	0x00	1	PRM0: 0x00~0x09 stands for spot 1-10	5

Table 11 Functional Menu of Area/Line Temperature Measurement

Area/line temp. Measurement						
CW0	CW1	Meaning	OW	PRM Bytes	PRM	Returned Bytes
0x07	0x40	Area/Line enable/disable (support 12 areas/lines)	0x01	2	PRM 0: 0x00~0x0b stands for area/line 1-12 PRM1: 0x00 disable, 0x01 enable	1
0x07	0x41	Area/Line Selection	0x01	2	PRM 0: 0x00~0x0b stands for area/line 1-12 PRM 1: 0x00 stands for area,	1

Area/line temp. Measurement						
CW0	CW1	Meaning	OW	PRM Bytes	PRM	Returned Bytes
					0x01 stands for lines	
0x07	0x42	Read area/line coordinates	0x00	1	0x00	9
		Set area/line coordinates	0x01	9	PRM 0: 0x00~0x0b stands for area/line 1-12 PRM1: low 8 bits of X-axis(start point) PRM2: high 8 bits of X-axis(start point) PRM3: low 8 bits of Y-axis(start point) PRM 4: high 8 bits of Y-axis(start point) PRM5: low 8 bits of X-axis(end point) PRM 6: high 8 bits of X-axis(end point) PRM 7: low 8 bits of Y-axis(end point) PRM 8: high 8 bits of Y-axis(end point)	1
0x07	0x45	Read the Max. temp and coordinate of the area/line	0x00	1	PRM0: 0x00~0x0b stands for area/line 1-12	9
0x07	0x48	Read the Min. temp and coordinate of the area/line	0x00	1	PRM 0: 0x00~0x0b stands for area/line 1-12	9
0x07	0x4B	Read the central temp and coordinate of the area/line	0x00	1	PRM0: 0x00~0x0b stands for area/line 1-12	9
0x07	0x4C	Read the AVG. temp. and coordinate of the area/line	0x00	1	PRM 0: 0x00~0x0b stands for area/line 1-12	5

Table 12 Menu of Full Frame Temperature Measurement

Full Frame Temperature Measurement						
CW0	CW1	Meaning	OW	PRM Bytes	PRM	Returned Bytes
0x07	0x20	Isotherm enable /disable	0x01	1	0x00: disable 0x01: enable	1
0x07	0x24	Full-frame temperature measurement enable/disable	0x01	1	0x00: disable 0x01: enable	1
0x07	0x26	Max. temperature display enable/disable	0x01	1	0x00: disable 0x01: enable	1
0x07	0x28	Min. temperature display enable/disable	0x01	1	0x00: disable 0x01: enable	1
0x07	0x2b	Central spot temperature display enable/display	0x01	1	0x00: disable 0x01: enable	1
0x07	0x2a	Read the AVG. of the full frame	0x00	1	0x00	4
0x07	0x2d	Temperature alarm type	0x01	1	0x00: disable 0x01: below alarm 0x02: above alarm 0x03Above/below alarm	1
0x07	0x2e	Read low threshold of temperature alarm	0x00	1	0x00	4
		Set low threshold of temperature alarm	0x01	4	Temp=PRM/10, low bit in front	1
0x07	0x2f	Read high threshold of temperature alarm	0x00	1	0x00	4
		Set high threshold of temperature alarm	0x01	4	Temp=PRM/10, low bit in front	1
0x07	0x27	Read the Max. temp/coordinate of the full frame	0x00	1	0x00	8
0x07	0x29	Read the Min. temp/coordinate of the full frame	0x00	1	0x00	8

Full Frame Temperature Measurement						
CW0	CW1	Meaning	OW	PRM Bytes	PRM	Returned Bytes
0x07	0x2c	Read the central temp/coordinate of the full frame	0x00	1	0x00	8
0x07	0xf0	Temperature scale enable/disable	0x01	1	0x00: disable 0x01: enable	1
0x07	0x1d	Write low temperature threshold of temperature scale	0x01	4	Threshold=PRM/10000 low bit in front	1
		Read low temperature threshold of temperature scale	0x00	1	0x00	4
0x07	0x1e	Write high temperature threshold of temperature scale	0x01	4	Threshold=PRM/10000 low bit in front	1
		Write high temperature threshold of temperature scale	0x00	1	0x00	4

Table 13 Menu of Digital Video

Digital Video						
CW0	CW1	Meaning	OW	PRM Bytes	PRM	Returned Value
0x01	0x5D	Interface of digital video output	0x02	2	00 00: disable 02 00: LVCOMS 03 00: LVDS 04 00: BT.656 05 00: BT1120 05 80: CDS_2	1
0x01	0x5C	Date source of digital video	0x01	1	0x00: ORG 0x01: NUC 0x02: DRC 0x04: TEMP 0x05: DNS	1

Table 14 Menu of Calibration Function

Full Frame Temperature Measurement						
CW0	CW1	Meaning	OW	PRM Bytes	PRM	Returned Value
0x07	0x6E	Secondary Calibration (single point)	0x02	2	Temp=RPM	1
0x07	0x6F	Secondary Calibration (two points)	0x02	2	Temp=RPM	1
0x07	0x6A	Secondary Calibration enable and save	0x02	1	0x00	1
0x07	0x6B	Secondary Calibration Clear	0x02	1	0x00	1

Appendix 1 UART Commands List

Commands		The incoming message	Remark
NUC	Receive	For imaging type: AA 05 01 11 02 00 C3 EB AA (background correction) AA 05 01 11 02 01 C4 EB AA (shutter correction) For temperature measurement type: AA 05 01 11 02 80 43 EB AA (background correction) AA 05 01 11 02 81 44 EB AA (shutter correction)	No matter Auto NUC on or off, send background correction or shutter correction command to perform manual NUC.
	Return	55 04 11 33 01 9E EB AA	
Auto NUC	Receive	AA 05 01 01 01 01 B3 EB AA (on) AA 05 01 01 01 00 B2 EB AA (off)	
	Return	55 04 01 33 01 8E EB AA	
Read FPA Temp.	Receive	AA 04 01 C3 00 72 EB AA	For example: If the readout temp. is 47.55°C, the returned value is 47.55×100°C, that is 4755 in decimal, low byte returns first. If the temp. is below 0°C, the value will be returned as the complement code of current temp.
	Return	55 05 C3 33 CB 11 2C EB AA	
Read core temp.	Receive	AA 04 01 7C 00 2B EB AA	For example: If the readout temp. is 47.55°C, the returned value is 47.55×100°C, that is 4755 in decimal, low byte returns first.
	Return	55 05 7C 33 75 12 90 EB AA	

Commands		The incoming message	Remark
			If the temp. is below 0°C, the value will be returned as the complement code of current temp.
Save settings	Receive	AA 04 01 7F 02 30 EB AA	
	Return	55 04 7F 33 01 0C EB AA	
Restore to default settings	Receive	AA 05 01 82 02 00 34 EB AA	
	Return	55 04 82 33 01 0F EB AA	
Auto NUC interval time	Receive	AA 05 01 03 01 0A BE EB AA	For example: The interval time is 10 minutes (accurate to 1minute) of PRM is 0x0A. When auto NUC is enabled, the shutter correction interval can be set. For example, if the time interval is 10 min., then the sent parameter is 0x0A(the set accuracy is 1 minute).
	Return	55 04 03 33 01 90 EB AA	
Auto NUC interval temp.	Receive	AA 05 01 04 01 0F C4 EB AA	When the Auto NUC is enabled, temperature interval of shutter correction can be set. For example: 0x0F means the interval temp is $25/10 = 1.5^{\circ}\text{C}$
	Return	55 04 04 33 01 91 EB AA	
Digital Zoom	Receive	1.0 X: AA 0C 01 40 02 00 00 00 00 7F 02 FF 01 7A EB AA 2.0 X: AA 0C 01 40 02 A0 00 80 00 DF 01 7F 01 79 EB AA 3.0 X: AA 0C 01 40 02 D5 00 AB 00 A9 01 54 01 78 EB AA 4.0 X :AA 0C 01 40 02 F0 00 C0 00 8F 01 3F 01 79 EB AA	Let the detector array be W in width, H in height and m in magnification, that (accurate to 1 decimal) Left-up $X = \frac{W}{2} - \frac{W}{2 \cdot m}$ Left-up $Y = \frac{H}{2} - \frac{H}{2 \cdot m}$

Commands		The incoming message	Remark
		5.0 X: AA 0C 01 40 02 00 01 CD 00 7F 01 32 01 7A EB AA 6.0 X: AA 0C 01 40 02 0B 01 D5 00 74 01 29 01 79 EB AA 7.0 X: AA 0C 01 40 02 12 01 DB 00 6C 01 23 01 78 EB AA 8.0 X: AA 0C 01 40 02 18 01 E0 00 67 01 1F 01 7A EB AA	Right-down $X = \frac{W}{2} + \frac{W}{2 \cdot m} - 1$ Right-down $Y = \frac{H}{2} + \frac{H}{2 \cdot m} - 1$ The commands on the left take 640x512 as example.
	Return	55 04 40 33 01 CD EB AA	
Reticle	Receive	(off) AA 05 01 43 02 00 F5 EB AA (type1) AA 05 01 43 02 80 75 EB AA (type 2) AA 05 01 43 02 81 76 EB AA (type 3) AA 05 01 43 02 82 77 EB AA (type 4) AA 05 01 43 02 83 78 EB AA	
	Return	55 04 43 33 01 D0 EB AA	
Reticle moving	Receive	(up) short step: AA 09 01 44 02 06 00 00 00 00 00 EB AA Long step: AA 09 01 44 02 86 00 00 00 00 80 EB AA (down) short step: AA 09 01 44 02 07 00 00 00 00 01 EB AA Long step: AA 09 01 44 02 87 00 00 00 00 81 EB AA (left) short step: AA 09 01 44 02 08 00 00 00 00 02 EB AA Long step: AA 09 01 44 02 88 00 00 00 00 82 EB AA (right) short step: AA 09 01 44 02 09 00 00 00 00 03 EB AA Long step: AA 09 01 44 02 89 00 00 00 00 83 EB AA Move to the center 640*512: AA 09 01 44 02 05 40 01 00 01 41 EB AA	PRM bit8=1: long step

Commands		The incoming message	Remark
		720*576: AA 09 01 44 02 05 68 01 F0 00 58 EB AA	
	Return	55 04 44 33 01 D1 EB AA	
Reticle position	Receive	AA 09 01 44 02 05 64 00 64 00 C7 EB AA (position setting) AA 04 01 44 00 F3 EB AA (position reading)	PRM in 5 bytes. PRM1 fixed to 0x05, PRM2~3 is X axis coordinates, low byte is in front, PRM4~5 is Y axis coordinates, low byte is in front. In the example: X axis: 0x0064=100 Y axis: 0x0064=100
	Return	55 04 44 33 01 D1 EB AA (position setting) 55 07 44 33 68 01 20 01 5D EB AA (position reading)	
Palette	Receive	(WH) AA 05 01 42 02 00 F4 EB AA (BH) AA 05 01 42 02 01 F5 EB AA (Rainbow) AA 05 01 42 02 02 F6 EB AA (Rainbow HC) AA 05 01 42 02 03 F7 EB AA (Iron) AA 05 01 42 02 04 F8 EB AA (Lava) AA 05 01 42 02 05 F9 EB AA (Sky) AA 05 01 42 02 06 FA EB AA (Medium Gray) AA 05 01 42 02 07 FB EB AA (Gray-red) AA 05 01 42 02 08 FC EB AA (Purple orange) AA 05 01 42 02 09 FD ED AA (Special 1) AA 05 01 42 02 0A FE EB AA (warning red) AA 05 01 42 02 0B FF EB AA (Ice fire) AA 05 01 42 02 0C 00 EB AA (cyan-red) AA 05 01 42 02 0D 01 EB	Support CVBS and BT656 video only.

Commands		The incoming message	Remark
		AA (Special 2) AA 05 01 42 02 0E 02 EB AA (Gradient red) AA 05 01 42 02 0F 03 EB AA (Gradient green) AA 05 01 42 02 10 04 EB AA (Gradient blue) AA 05 01 42 02 11 05 EB AA (alarm green) AA 05 01 42 02 12 06 EB AA (alarm blue) AA 05 01 42 02 13 07 EB AA	
	Return	55 04 42 33 01 CF EB AA	
Threshold of warning color	Receive	(warning red, 0xF0 = 240) AA 06 01 4B 01 F0 00 ED EB AA (warning green, 0xF0 = 240) AA 06 01 4B 01 F0 01 EE EB AA (warning blue, 0x14 = 20) AA 06 01 4B 01 14 02 13 EB AA	0x00: warning red 0x01: warning green 0x02: warning blue
	Return	55 04 4B 33 01 D8 EB AA	
Digital video source	Receive	(ORG) AA 05 01 5C 01 00 0D EB AA (NUC) AA 05 01 5C 01 01 0E EB AA (DRC) AA 05 01 5C 01 02 0F EB AA (TEMP) AA 05 01 5C 01 04 11 EB AA (DNS) AA 05 01 5C 01 05 12 EB AA	
	Return	55 04 5C 33 01 E9 EB AA	
Digital video interface	Receive	(LVDS) AA 06 01 5D 02 03 00 13 EB AA (LVCOMS) AA 06 01 5D 02 02 00 12 EB AA (BT.656) AA 06 01 5D 02 04 00 14 EB	BT656, BT1120 and CDS-2 only supports DRC data source.

Commands		The incoming message	Remark
		AA (BT.1120) AA 06 01 5D 02 05 00 15 EB AA (CDS_2) AA 06 01 5D 02 05 80 95 EB AA (disable) AA 06 01 5D 02 00 00 10 EB AA	
	Return	55 04 5D 33 01 EA EB AA	
Image flip	Receive	(off) AA 05 01 4C 01 01 FE EB AA (left-right) AA 05 01 4C 01 02 FF EB AA (up-down) AA 05 01 4C 01 04 01 EB AA (mirror flip) AA 05 01 4C 01 08 05 EB AA	
	Return	55 04 4C 33 01 D9 EB AA	
Analog Video Format	Receive	(PAL) AA 05 01 3F 02 01 F2 EB AA (NTSC) AA 05 01 3F 02 00 F1 EB AA	
	Return	55 04 3F 33 01 CC EB AA	
PN Query	Receive	AA 04 01 70 00 1F EB AA	The returned PN code is ASCII code, which will return 00 if the returned bit is not enough.
	Return	55 17 70 33 4D 33 36 34 30 54 30 31 31 59 30 31 33 31 32 58 45 4E 4E 58 F0 EB AA (M3640T011Y01312XENNX)	
SN Query	Receive	AA 04 01 71 00 20 EB AA	The returned SN is ASCII code, which will returned 00 if the bit is not enough.
	Return	55 17 71 33 42 30 33 35 30 30 33 33 00 00 00 00 00 00 00 00 00 00 00 00 B0 EB AA (B0350033)	
CVBS video on/off	Receive	(on) AA 05 01 3D 02 01 F0 EB AA (off) AA 05 01 3D 02 00 EF EB AA	
	Return	55 04 3D 33 01 CA EB AA	
Video	Receive	(on) AA 05 01 3E 02 01 F1 EB AA	

Commands		The incoming message	Remark
Freeze		(off) AA 05 01 3E 02 00 F0 EB AA	
	Return	55 04 3E 33 01 CB EB AA	
Display size setting	Receive	AA 08 01 4F 02 D0 02 40 02 18 EB AA (720*576) AA 08 01 4F 02 80 02 00 02 88 EB AA (640*512)	384 only support 720*576
	Return	55 04 4F 33 01 DC EB AA	
AGC setting	Receive	(manual) AA 05 01 1F 01 00 D0 EB AA AA (auto0) AA 05 01 1F 01 01 D1 EB AA (auto1) AA 05 01 1F 01 02 D2 EB AA	
	Return	55 04 1F 33 01 AC EB AA	
Contrast setting	Receive	AA 05 01 22 01 8B 5E EB AA	For example: Set the contrast to 139 (decimal), then send PRM 0x8B.
	Return	55 04 22 33 01 AF EB AA	
Brightness setting	Receive	AA 06 01 23 01 D0 00 A5 EB AA	For example: Set the manual brightness to 208(decimal), send PRM 0xD0, 0x00.
	Return	55 04 23 33 01 B0 EB AA	
DDE on/off	Receive	(on) AA 05 01 1A 02 01 CD EB AA (off) AA 05 01 1A 02 00 CC EB AA	
	Return	55 04 1A 33 01 A7 EB AA	
DDE mode setting	Receive	AA 05 01 19 01 03 CD EB AA	For example: If set DDE mode as 2, then send the PRM is 2+1=0x03.
	Return	55 04 19 33 01 A6 EB AA	
Image filter	Receive	(on) AA 05 01 1B 02 01 CE EB AA (off) AA 05 01 1B 02 00 CD EB AA	
	Return	55 04 1B 33 01 A8 EB AA	
ROI setting	Receive	AA 0C 01 2B 01 58 00 3C 00 28 01 EC 00 8C EB AA (Set) AA 04 01 2B 00 DA EB AA(Read)	For example: left-up x: 0x0058=88 left-up y: 0x003C=60 right-down x: 0x0128=296
	Return	55 04 2B 33 01 B8 EB AA (Set)	

Commands		The incoming message	Remark
		55 0B 2B 33 58 00 3C 00 28 01 EC 00 67 EB AA(Read)	right-down y: 0x00EC=236
Baud rate setting	Receive	(9600bps) AA 06 01 77 02 02 00 2C EB AA (19200bps) AA 06 01 77 02 04 00 2E EB AA (38400bps) AA 06 01 77 02 08 00 32 EB AA (57600bps) AA 06 01 77 02 40 00 6A EB AA (115200bps) AA 06 01 77 02 10 00 3A EB AA	
	Return	55 04 77 33 01 04 EB AA	
The cursor of bad pixels	Receive	appear: AA 05 01 43 02 C1 B6 EB AA disappear: AA 05 01 43 02 40 35 EB AA	
	Return	55 04 43 33 01 D0 EB AA	
Move the cursor of bad pixels	Receive	Up 1: AA 05 01 44 02 01 F7 EB AA Down 1: AA 05 01 44 02 02 F8 EB AA Left 1: AA 05 01 44 02 03 F9 EB AA Right 1: AA 05 01 44 02 04 FA EB AA Up 20: AA 05 01 44 02 81 77 EB AA Down 20: AA 05 01 44 02 82 78 EB AA Left 20 : AA 05 01 44 02 83 79 EB AA Right 20 : AA 05 01 44 02 84 7A EB AA	
	Return	55 04 44 33 01 D1 EB AA	
Scan bad pixels	Receive	AA 04 01 93 02 44 EB AA	
	Return	55 04 93 33 01 20 EB AA	
Bad pixels add/cancel	Receive	Add: AA 05 01 90 01 01 42 EB AA Cancel: AA 05 01 90 01 02 43 EB AA	
	Return	55 04 90 33 01 1D EB AA	
Save the	Receive	AA 05 01 90 01 05 46 EB AA	

Commands		The incoming message	Remark
bad pixel list	Return	55 04 90 33 01 1D EB AA	
Recover the bad pixel list	Receive	AA 05 01 90 01 06 47 EB AA	
	Return	55 04 90 33 01 1D EB AA	
Calibrate the K value of lens	Receive	Acquire low temperature data: AA 05 01 A0 01 0A 5B EB AA Acquire high temperature data: AA 05 01 A0 01 0B 5C EB AA Calculate: AA 05 01 A0 01 0C 5D EB AA Save: AA 05 01 A0 01 0D 5E EB AA Clear: AA 05 01 A0 01 0E 5F EB AA	
	Return	55 04 A0 33 01 2D EB AA	
Image non-uniformity calibration	Receive	Clear: AA 05 01 A1 01 02 54 EB AA Acquire: AA 05 01 A1 01 00 52 EB AA Save: AA 05 01 A1 01 01 53 EB AA	
	Return	55 04 A1 33 01 2E EB AA	

Appendix2 Temp. measuring command protocol

Command	The incoming message		Remark
Measuring OSD on/off	Receive	AA 05 07 00 01 00 B7 EB AA (off) AA 05 07 00 01 01 B8 EB AA (on)	
	Return	55 05 07 00 33 01 95 EB AA	
Temp. unit	Receive	AA 05 07 02 01 00 B9 EB AA (Celsius) AA 05 07 02 01 01 BA EB AA (Kelvin) AA 05 07 02 01 02 BB EB AA (Fahrenheit)	
	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	55 06 07 05 33 B0 04 4E EB AA (threshold is 120)	Return 2Bytes, low Byte is in the front. Temp.=return value/10, for example, 120.0 degrees: B0 04.
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. Temp.=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 00 00 FB EB AA (95%)	Return 3 Bytes. Percentage = returned 0/100+returned 1-2(low byte in front)/100000.
Set the percentage of low-high gain	Receive	AA 07 07 06 01 5F 00 00 1E EB AA (95%)	PRM 3 Bytes. Percentage = PRM0/100+PRM 1-2(low bit in front)/100000
	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. Temp.=return value/10.

Command	The incoming message		Remark
Set the threshold of high-low gain	Receive	AA 06 07 07 01 2C 01 EC EB AA (threshold is 30.0)	PRM 2Bytes, low Byte is in the front. Temp.=PRM/10.
	Return	55 05 07 07 33 01 9C EB AA	
Read the percentage of high-low gain	Receive	AA 05 07 08 00 00 BE EB AA	
	Return	55 07 07 08 33 0F 00 00 AD EB AA (15%)	Return 3 Bytes. Percentage = returned 0/100+returned 1-2(low bit in front)/100000
Set the percentage of high-low gain	Receive	AA 07 07 08 01 0F 00 00 D0 EB AA (set as 15%)	Return 3 Bytes. Percentage = returned 0/100+returned 1-2(low bit in front)/100000
	Return	55 05 07 08 33 01 9D EB AA	
Measuring temp. range	Receive	AA 05 07 01 01 00 B8 EB AA (high gain) AA 05 07 01 01 01 B9 EB AA (low gain) AA 05 07 01 01 03 BB EB AA (Auto)	Hight gain temp. measuring range -20~+150°C. Low gain temp. measuring range 0~+550°C. In Auto mode, the module will automatically select the temp. measuring range.
	Return	55 05 07 01 33 01 96 EB AA	
Read the reflect temp.	Receive	AA 05 07 0F 00 00 C5 EB AA	
	Return	55 08 07 0F 33 90 D0 03 00 09 EB AA (reflect temp. is 25°C)	Return 4 Bytes, low Byte is in the front. Temp.=returned value/10000.
Set the reflect temp.	Receive	AA 08 07 0F 01 E0 93 04 00 40 EB AA (reflect temp. is 30°C)	PRM 4 Bytes, low Byte is in the front. Temp.=returned value/10000.
	Return	55 05 07 0F 33 01 A4 EB AA	
Read the ambient temp.	Receive	AA 05 07 10 00 00 C6 EB AA	
	Return	55 08 07 10 33 90 D0 03 00 0A EB AA (ambient temp. is 25°C)	Return 4 Bytes, low Byte is in the front. Temp.=returned value/10000.

Command	The incoming message		Remark
Set the ambient temp.	Receive	AA 08 07 10 01 90 D0 03 00 2D EB AA (ambient temp. is 25°C)	PRM 4 Bytes, low Byte is in the front. Temp.=returned value/10000.
	Return	55 05 07 10 33 01 A5 EB AA	
Read the ambient transmissivity	Receive	AA 05 07 11 00 00 C7 EB AA	
	Return	55 08 07 11 33 94 11 00 00 4D EB AA (transmissivity is 0.45)	Return 4 Bytes, low Byte is in the front. Transmissivity = returned value/10000.
Set the ambient transmissivity	Receive	AA 08 07 11 01 94 11 00 00 70 EB AA (transmissivity is 0.45)	PRM 4 Bytes, low Byte is in the front. Transmissivity = returned value/10000.
	Return	55 05 07 11 33 01 A6 EB AA	
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. Emissivity = returned value/10000.
Set the emissivity	Receive	AA 08 07 12 01 48 26 00 00 3A EB AA	PRM 4 Bytes, low Byte is in the front. Emissivity = 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	PRM 4 Bytes, low Byte is in the front. Distance = returned value/10000.
	Return	55 05 07 13 33 01 A8 EB AA	
Environmental Variables Enable	Receive	AA 05 07 18 01 00 CF EB AA	
	Return	55 05 07 18 33 01 AD EB AA	

Command	The incoming message		Remark
Spot temperature measurement on/off	Receive	AA 06 07 80 01 00 01 39 EB AA (on) AA 06 07 80 01 00 00 38 EB AA (off)	PRM0: 0x00~0x09 stands for spot 1-10 PRM1: 0x01 ON 0x00 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: 0x00~0x09 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
Set the spot coordinates	Receive	AA 09 07 82 01 00 41 00 64 00 E2 EB AA	PRM0: 0x00~0x09 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 temp.	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℃)	Return0: 0x00~0x09 stands for spot1-10 Return1-4: temp./10, low Bytes in the front.

Command	The incoming message		Remark
Area/line measuring tools On/off	Receive	AA 06 07 40 01 00 01 F9 EB AA (on) AA 06 07 40 01 00 00 F8 EB AA (off)	PRM0: 0x00~0x0b stands for area/line 1-12. PRM1: 0x00 off 0x01 on
	Return	55 05 07 40 33 01 D5 EB AA	
Area or line	Receive	AA 06 07 41 01 00 00 F9 EB AA (Area) AA 06 07 41 01 00 01 FA EB AA (Line)	PRM0: 0x00~0x0b stands for area/line 1-12. PRM1: 0x00 Area, 0x01 Line
	Return	55 05 07 41 33 01 D6 EB AA	
Read the coordinates of area/line	Receive	AA 05 07 42 00 00 F8 EB AA	PRM0: 0x00~0x0b 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

Command	The incoming message		Remark
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	
Read the highest temp. and coordinates of area/line	Receive	AA 05 07 45 00 00 FB EB AA	PRM0: 0x00~0x0b 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 temp. of Area/line1 is 33.4°C, and the coordinate is (16,10))	Return 9 bytes; Return 0: number of Area/line Return 1-4: temp.*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 temp.	Receive	AA 05 07 48 00 00 FE EB AA	PRM0: 0x00~0x0b stands for area/line 1-12.

Command	The incoming message		Remark
and coordinates of area/line	Return	55 0D 07 48 33 00 42 01 00 00 2B 00 15 00 67 EB AA (The highest temp. 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: temp.*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 Temp. and coordinate of central spot of area/line	Receive	AA 05 07 4B 00 00 01 EB AA	PRM0: 0x00~0x0b 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 temp. of Area/line1 is 30.7°C, and the coordinate is (150,150))	Return 9 Bytes; Return 0: number of Area/line Return 1-4: temp.*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 average temp. of area/line	Receive	AA 05 07 4C 00 00 02 EB AA	PRM0: 0x00~0x0b stands for area/line 1-12.
	Return	55 09 07 4C 33 00 33 01 00 00 18 EB AA (The average temp. of Area/line1 is 30.7°C)	Return 5 Bytes; Return 0: number of Area/line Return 1-4: temp.*10, low Byte is in the font
Isotherm on/off	Receive	AA 05 07 20 01 01 D8 EB AA (on) AA 05 07 20 01 00 D7 EB AA (off)	

Command	The incoming message		Remark
	Return	55 05 07 20 33 01 B5 EB AA	
Temp. measuring of full frame on/off	Receive	AA 05 07 24 01 01 DC EB AA (on) AA 05 07 24 01 00 DB EB AA (off)	
	Return	55 05 07 24 33 01 B9 EB AA	
The highest temp. display on/off	Receive	AA 05 07 26 01 01 DE EB AA (on) AA 05 07 26 01 00 DD EB AA (off)	
	Return	55 05 07 26 33 01 BB EB AA	
The lowest temp. display on/off	Receive	AA 05 07 28 01 01 E0 EB AA (on) AA 05 07 28 01 00 DF EB AA (off)	
	Return	55 05 07 28 33 01 BD EB AA	
The central temp. display on/off	Receive	AA 05 07 2B 01 01 E3 EB AA (on) AA 05 07 2B 01 00 E2 EB AA (off)	
	Return	55 05 07 2B 33 01 C0 EB AA	
Temp. Alarm type	Receive	AA 05 07 2D 01 00 E4 EB AA (off) AA 05 07 2D 01 01 E5 EB AA (below alarm) AA 05 07 2D 01 02 E6 EB AA (above alarm) AA 05 07 2D 01 03 E7 EB AA (above/below alarm)	
	Return	55 05 07 2D 33 01 C2 EB AA	
Read Below Alarm Threshold	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℃)	Return 4 Bytes. Temp.=Returned value/10, low bit is in the front.
Set Below Alarm Threshold	Receive	AA 08 07 2E 01 C8 00 00 00 B0 EB AA (20.0℃)	PRM 4 Bytes. Temp.=Returned value/10, low Byte is in the front.
	Return	55 05 07 2E 33 01 C3 EB AA	

Command	The incoming message		Remark
Read Above Alarm Threshold	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℃)	Return 4 Bytes. Temp.=Returned value/10, low bit in front.
Set Above Alarm Threshold	Receive	AA 08 07 2F 01 90 01 00 00 7A EB AA (40.0℃)	PRM 4 Bytes. Temp.=Returned value/10, low bit in front.
	Return	55 05 07 2F 33 01 C4 EB AA	
Read average temp. of 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℃)	Return 4 Bytes. Temp.=Returned value/10, low bit in front.
Temperature scale 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 0x01: Success 0x00: Fail
Write Low temperature threshold of temperature scale	Receive	AA 08 07 1D 01 40 0D 03 00 27 EB AA (20.00℃)	Receive data = Actual data ×10000, low bit in front.
	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 (20.00℃)	Actual data = Return data(low bit in front)/10000
Write high temperature threshold of	Receive	AA 08 07 1E 01 80 1A 06 00 78 EB AA (40.00℃)	Receive data = actual data × 10000, low bit in front

Command	The incoming message		Remark
temperature scale	Return	55 05 07 1E 33 01 B3 EB AA	
Read high temperature threshold of temperature scale	Receive	AA 05 07 1E 00 00 D4 EB AA	
	Return	55 08 07 1E 33 80 1A 06 00 55 EB AA (40.00℃)	Actual data = Return data(low bit in front)/10000
	Return	55 04 5C 33 01 E9 EB AA	The parameter value is 2 bytes
	Return	55 04 5D 33 01 EA EB AA	
Secondary calibration(two point correction)	Receive	AA 06 07 6F 02 19 00 41 EB AA (25℃)	PRM 2 Bytes stands for the input target blackbody temp of the client software
	Return	55 05 07 6F 33 01 04 EB AA	
Secondary calibration(enable and save)	Receive	AA 05 07 6A 02 00 22 EB AA	Enable the parameters of secondary calibration, parameters of secondary calibration will be saved after power off
	Return	55 05 07 6A 33 01 FF EB AA	
Secondary calibration (Eliminate)	Receive	AA 05 07 6B 02 00 23 EB AA	Enable the original calibration parameter, the original calibration parameters will be saved after power off
	Return	55 05 07 6B 33 01 00 EB AA	
Read Blackbody	Receive	AA 05 07 7C 00 00 32 EB AA	1 byte parameter;

Command	The incoming message		Remark
correction enable/disable status	Return	55 05 07 7C 33 00 10 EB AA	0x01: enable; 0x00: disable.
Set Blackbody correction enable/disable status	Receive	AA 05 07 7C 01 00 33 EB AA	
	Return	55 05 07 7C 33 01 11 EB AA	
Read Blackbody temperature	Receive	AA 05 07 7D 00 00 33 EB AA	4 bytes parameters: Temp value=parameter value/10000, low bit in front. 0x0003D090=250000; 250000/10000=25℃
	Return	55 08 07 7D 33 90 D0 03 00 77 EB AA	
Set Blackbody temperature	Receive	AA 08 07 7D 01 80 1A 06 00 D7 EB AA	
	Return	55 05 07 7D 33 01 12 EB AA	
Read Blackbody coordinate	Receive	AA 05 07 7E 00 00 34 EB AA	8 bytes parameters, including the coordinates of left-up point and right- bottom point. Each coordinate occupies 2 bytes, the lower byte is ahead. Note: The size of rectangle should be smaller than 30 . 0x013E =318; 0x00FE=254 ; 0x0142 =322; 0x0102 = 258; Up-left (318, 322) , Bottom-Right (322, 258) .
	Return	55 0C 07 7E 33 3E 01 FE 00 42 01 02 01 9C EB AA	
Set Blackbody coordinate	Receive	AA 0C 07 7E 01 BE 00 8C 00 C8 00 96 00 E4 EB AA	
	Return	55 05 07 7E 33 01 13 EB AA	