



# Thermal Camera Module

HM-TM5X-XRG/C Series

UART/CVBS Communication Protocol Guide

## **PREFACE**

This manual is applicable to the thermal camera modules of HM-TM5X-XRG/C series, and introduces the UART serial communication and CVBS video communication protocols and related commands for this series of thermal camera modules.

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# 1 Introduction

## 1.1 Communication Protocols

The thermal camera modules support UART serial communication and CVBS video communication protocols.

### UART Serial Communication

Users can send commands to the thermal camera modules through serial port to control the modules to perform corresponding actions, such as image parameter settings, function adjustment, etc.

The data transmission and reception of serial communication shall follow the requirements of the communication packet format.

### CVBS Video Communication

Thermal images and video streams follow the CVBS video communication protocol. Video data is output as soon as the module is powered on (no enabling control).

## 1.2 Preparation

Users can connect the module ("device" end) to the device to be developed ("host" end) via the serial port.

Once the module is connected and powered on, it will send the image data to the host via the CVBS protocol. The host will parse the obtained data and then display the image or use it for other purposes.

Users can send serial port commands to the module through the host to control the module, such as setting image parameters.

## 2 Serial Communication

### 2.1 Introduction

The modules use UART (Universal Asynchronous Receiver/Transmitter) serial communication. The host (user-developed device) can send commands to the module through the serial port and control the module to perform the corresponding actions. Communication commands need to be sent in the specified packet format.

#### 2.1.1 Serial Communication Format

Before establishing communication with the host, you need to set the communication parameters on the host according to Table 2-1, which shows the serial communication format of the thermal camera modules.

Table 2-1 Serial Communication Format

Item	Description
Baud rate	115200 bps
Start	1 bit
Data	8 bits
End	1 bit
Check	NONE

#### 2.1.2 Data Transmitting and Receiving

##### Data Packet Transmitting

The serial communication packet of the thermal camera modules contains multiple fields, as shown in Figure 2-1.

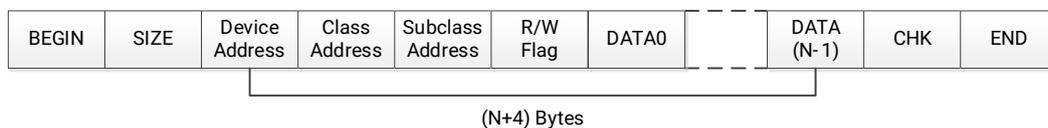


Figure 2-1 Transmitting Data Packet Fields

Table 2-2 describes the fields of the data packet.

Table 2-2 Definition of Transmitting Data Packet

Field	Bytes	Description	Value	Offset
BEGIN	1	Command packet starts.	0xF0	1

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Field	Bytes	Description	Value	Offset	
SIZE	1	Lenth of the command packet.	N+4 bytes, as shown in Figure 2-1.	2	
Device Address	1	Address of the module device.	0x36	3	
Class Address	1	Class address of the command.	See <b>Commands</b> for the details.	4	
Subclass Address	1	Subclass address of the command.	See <b>Commands</b> for the details.	5	
R/W Flag	1	Packet transmitting from host.	Read/Write Flag ● Write: 0x00 ● Read: 0x01	6	
		Packet feedback from device.	Normal return. 0x03 Return of error code. 0x04		
DATA	N	Packet transmitting from host.	Transmit the data content.	7~(N+6)	
		Packet feedback from device.	Feedback of normal commands		● Success: 0x01 ● Failed: No return
			Feedback of abnormal commands		● No command: 0x00, the command sent by the host does not belong to the commands of the module. ● Threshold exceeded: 0x01
			Data content		When a read command is received, the data content is returned.
CHK	1	Summation check.	After adding the fields: Device Address, Class Address, Subclass Address , R/W Flag and DATA, take the lower 8 bits.	(N+7)	
END	1	Command packet ends.	0xFF	(N+8)	

### Data Packet Receiving

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In the command packet the thermal camera module returns to the host, DATA0 is the high byte and DATA(N-1) is the low byte.

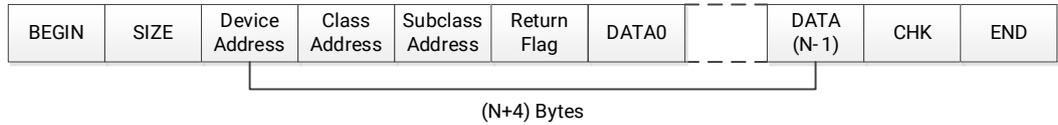


Figure 2-2 Receiving Data Packet Fields

Table 2-3 describes the fields of the data packet.

Table 2-3 Definition of Receiving Data Packet

Field	Bytes	Description	Value	Offset
BEGIN	1	Command packet starts.	0xF0	1
SIZE	1	Lenth of the command packet.	N+4 bytes, as shown in Figure 2-2.	2
Device Address	1	Address of the module device.	0x36	3
Class Address	1	Class address of the command.	See <b>Commands</b> for the details.	4
Subclass Address	1	Subclass address of the command.	See <b>Commands</b> for the details.	5
Return Flag	1	Return Flag.	0x03	6
DATA	N	DATA	See <b>Commands</b> for the details. Default: 0x00 (no data).	7~ (N+6)
CHK	1	Summation check.	After adding the fields: Device Address, Class Address, Subclass Address , Return Flag and DATA, take the lower 8 bits.	(N+7)
END	1	Command packet ends.	0xFF	(N+8)



### Note

- When the host sends a write command to the module, the module will return the actual executing state of the command after completely receiving it.
  - 0x01: indicates that a write command has been received, but does not mean that the command has been executed.
  - 0x00: indicates that the write command was not received.

- When the module receives a read command, it reads the contents in the register and returns it to the host according to the protocol, and the specific DATA analysis can be referred to Table 2-3.
- 

### Example of Serial Communication

This example is to "Set the brightness parameter of the thermal camera module to 100."

#### Steps

1. Query the Device Address, Class Address, Subclass Address and R/W Flag of the brightness setting command.

Query the serial communication command table in **Serial Communication Commands** to obtain the Device Address (0x36), Class Address (0x78), Subclass Address (0x02) and R/W Flag (write: 0x00) of the brightness setting command.

2. Calculate the field values: SIZE, DATA and CHK.
  - SIZE: N+4. The number of bytes for the DATA field of the brightness setting command is N=1, so the SIZE is 5 (0x05).
  - DATA: The hexadecimal value corresponding to the brightness of 100 is 0x64.
  - CHK: The summation  $0x(36+78+02+00+64)=0x114$ , take the lower 8 bits for the CHK field, that is 0x14.
3. Combining the above parameters, the host sends the command 0x F0 05 36 78 02 00 64 14 FF to the module.

Table 2-4 Host Transmitting Command to Set Brightness to 100

Field	BEGIN	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK	END
Host Transmitting	0xF0	0x05	0x36	0x78	0x02	0x00	0x64	0x14	0xFF

4. The module feeds back the command 0x F0 05 36 78 02 03 01 B4 FF.

Table 2-5 Module Feedback Command to Set Brightness to 100

Field	BEGIN	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK	END
Module Feedback	0xF0	0x05	0x36	0x78	0x02	0x03	0x01	0xB4	0xFF

- SIZE: N+4. The number of bytes for the DATA field of the brightness setting command is N=1, so the SIZE is 5 (0x05).
- DATA: The module receives the brightness setting command and returns 0x01.

- **CHK:** The summation  $0x(36+78+02+00+01)=0xB4$ , take the lower 8 bits for the CHK field, that is 0xB4.

5. Check whether the screen brightness changes to determine whether the setting is successful, or you can use the brightness query command to check it.

## 2.2 Commands

This section introduces the reading and writing rules for each command, interprets the information fed back from the module, and notes for the commands. For the complete list of commands, refer to **Serial Communication Commands**.

### 2.2.1 Reading the Model of the Module (Read-Only)

The host can read the model of the thermal camera module via this command. The hexadecimal data returned by the module needs to be converted to ASCII characters.

#### Commands and Parameters

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x74	0x02	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x74	0x02	0x03	The model of the module, needs to be converted to ASCII characters.	TBD

#### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.

### 2.2.2 Reading the FPGA Program Version Number (Read-Only)

The host can read the FPGA program version number of the module via this command.

#### Commands and Parameters

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Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x74	0x03	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x74	0x03	0x03	The FPGA program version number of the module, with the length of 3 bytes and the MSB is the high byte.	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The value of the DATA field is the version number of the FPGA program. The length is 3 bytes and the MSB is the high byte, e.g. 0x050112 represents 5.1.12.

### 2.2.3 Reading FPGA Program Compilation Time (Read-Only)

The host can read the FPGA program compilation time of the module via this command.

### Commands and Parameters

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x74	0x04	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x74	0x04	0x03	The compilation time of the FPGA program. The length is 4 bytes and the MSB is the high byte.	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The value of the DATA field is the compilation time of the FPGA program. The length is 4 bytes and the MSB is the high byte, e.g. 0x20140820 indicates that the compilation time is 20140820.

## 2.2.4 Reading the Module Software Version Number (Read-Only)

The host can read the software version number of the module via this command.

### Commands and Parameters

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x74	0x05	0x01	None.	TBD
Module Feedback	TBD	0x36	0x74	0x05	0x03	The software version number of the module. The length is 3 bytes and the MSB is the high byte.	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The value of the DATA field is the software version number of the module. The length is 3 bytes and the MSB is the high byte, e.g. 0x050112 represents 5.1.12.

## 2.2.5 Reading the Module Software Compilation Time (Read-Only)

The host can read the software program compilation time of the module via this command.

### Commands and Parameters

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x74	0x06	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x74	0x06	0x03	The software compilation time of the module. The length is 4 bytes and the MSB is the high byte.	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The value of the DATA field is the software version number of the module. The length is 4 bytes and the MSB is the high byte, e.g. 0x20140820 indicates that the compilation time is 20140820.

## 2.2.6 Reading the Camera Process Calibration Version Time

### (Read-Only)

The host can read the camera process calibration version time of the module via this command.

### Commands and Parameters

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x74	0x0B	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x74	0x0B	0x03	The camera process calibration version time of the module. The length is 4 bytes and the MSB is the high byte.	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The value of the DATA field is the camera process calibration version time of the module. The length is 4 bytes and the MSB is the high byte, e.g. 0x20170121 indicates the time is January 21, 2017.

## 2.2.7 Reading the ISP Parameter Version Number (Read-Only)

The host can read the ISP parameter version number of the module via this command.

### Commands and Parameters

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x74	0x0C	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x74	0x0C	0x03	4 bytes are valid.	TBD

### Command Descriptions

- Refer to ***Data Transmitting and Receiving*** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to ***Data Transmitting and Receiving***.
- The module returns the ISP parameter version number. The valid length is 4 bytes. E.g. if the ISP version number is 5, 0x00000005 is returned.

## 2.2.8 Manual Shutter Calibration (Write-Only)

This command is used to perform a manual shutter calibration for the module, known as Flat Field Calibration (FFC), which is used to correct the non-uniformity of the image and improve the image quality.

### Commands and Parameters

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x7C	0x02	0x00	None. 0x00 by default.	TBD
Module Feedback	0x05	0x36	0x7C	0x02	0x03	0x01	TBD

### Command Descriptions

- Refer to ***Data Transmitting and Receiving*** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to ***Data Transmitting and Receiving***.

## 2.2.9 Manual Background Correction (Write-Only)

This command is used to perform a background correction for the module. Background correction reduces the distortion of the background image to make it display normally.

### Commands and Parameters

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x7C	0x03	0x00	None. 0x00 by default.	TBD
Module Feedback	0x05	0x36	0x7C	0x03	0x03	0x01	TBD

### Command Descriptions

- Refer to ***Data Transmitting and Receiving*** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to ***Data Transmitting and Receiving***.

### 2.2.10 Vignetting Correction (Write-Only)

This command allows you to manually perform vignetting correction.

Vignetting correction is to correct image non-uniformity caused by the transmittance of the device's lens and internal radiation (pot lid defect) to make the image more uniform.

When using this function, you need to face the lens towards a uniform surface. Otherwise the current lens scene will be superimposed, which will affect the image display.

### Commands and Parameters

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x7C	0x0C	0x00	0x02: Vignetting Correction.	TBD
Module Feedback	0x05	0x36	0x7C	0x0C	0x03	0x01	TBD

### Command Descriptions

- Refer to ***Data Transmitting and Receiving*** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to ***Data Transmitting and Receiving***.

### 2.2.11 Automatic Shutter Control (Read/Write)

This command is used to switch the automatic shutter control mode of the module. 4 modes are selectable: automatic control off, timing control,

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temperature difference control and full-automatic control (default, 0x03). It is recommended to keep the default setting.

After setting the switching mode (timing, temperature control, full-automatic), the shutter is periodically closed according to the set conditions, which helps to improve the uniformity of the thermal imaging.

### Commands and Parameters

Write command of automatic shutter control.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x7C	0x04	0x00	0x00: Automatic control off 0x01: Automatic switching, timing control 0x02: Automatic switching, temperature difference control 0x03: Full-automatic control (Default)	TBD
Module Feedback	0x05	0x36	0x7C	0x04	0x03	0x01	TBD

Read command of automatic shutter control.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x7C	0x04	0x01	None. 0x00 by default.	TBD
Module Feedback	0x05	0x36	0x7C	0x04	0x03	0x00: Automatic control off 0x01: Automatic switching, timing control 0x02: Automatic switching, temperature difference control 0x03: Full-automatic control	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- There are 4 values for the DATA field.

- 0x00: The automatic shutter control is turned off.
- 0x01: The timing control is enabled, and the default shutter switching interval is 10 minutes, which is not recommended for users to modify. Refer to **Setting the Automatic Shutter Switching Interval**.
- 0x02: The temperature difference shutter control is turned on. The module automatically controls the shutter according to the temperature difference. No additional user setup is required.
- 0x03: Default setting. The timing control and temperature difference control for the shutter are turned on at the same time. The default shutter switching interval is 10 minutes, which is not recommended for users to modify. Refer to **Setting the Automatic Shutter Switching Interval**. The temperature difference control is controlled by the module and does not require user settings.

### 2.2.12 Setting the Automatic Shutter Switching Interval (Read/Write)

When the automatic shutter control is set to 0x01 or 0x03 (refer to **Automatic Shutter Control**), the automatic shutter switching interval can be adjusted as needed. The module will close the shutter at a set interval, 10 minutes by default, and it is not recommended to modify it.

#### Commands and Parameters

Write command of automatic shutter switching interval.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	TBD	0x36	0x7C	0x05	0x00	{DATA0,DATA1}: shutter interval, in minutes, valid for 2 bytes.	TBD
Module Feedback	0x05	0x36	0x7C	0x05	0x03	0x01	TBD

Read command of automatic shutter switching interval.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x7C	0x05	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x7C	0x05	0x03	{DATA0,DATA1}: shutter interval, in minutes, valid for 2 bytes.	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The shutter interval is in minutes, and 2 bytes are valid. The default setting is 10 minutes (0x00 0A)

### 2.2.13 Defective Pixel Correction (Write-Only)

Defective pixels are pixels on the detector that are insensitive to thermal radiation and cannot reflect the temperature changes of the measured target. During the integration of the module into the host, new dead pixels may arise that need to be corrected.

This module can correct defective pixels on the client software, as well as via serial port commands. The following describes how to correct defective pixels by using serial commands.

#### Steps

1. Turn on the cursor display: 0x F0 05 36 78 1A 00 0F D7 FF
2. Move the cursor to the defective pixel position. The cursor movement commands are as follows:
  - Cursor up: F0 05 36 78 1A 00 02 CA FF
  - Cursor up for N pixels: F0 05 36 78 1A 00 2N CHK FF (N is the step size, CHK is the check field)
  - Cursor down: F0 05 36 78 1A 00 03 CB FF
  - Cursor down for N pixels: F0 05 36 78 1A 00 3N CHK FF (N is the step size, CHK is the check field)
  - Cursor shifted left: F0 05 36 78 1A 00 04 CC FF
  - Cursor shifted left for N pixels: F0 05 36 78 1A 00 4N CHK FF (N is the step size, CHK is the check field)
  - Cursor shifted right: F0 05 36 78 1A 00 05 CD FF
  - Cursor shifted right for N pixels: F0 05 36 78 1A 00 5N CHK FF (N is the step size, CHK is the check field)
  - Cursor to the center: F0 05 36 78 1A 00 06 CE FF
3. Defective pixel correction: F0 05 36 78 1A 00 0D D5 FF



### Note

When a defective pixel appears in the image, you can use this command to add the pixel to the defective pixel sequence and the pixel will be removed in the image.

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4. Cancel defective pixel correction: F0 05 36 78 1A 00 0E D6 FF

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### Note

When a non-defective pixel is corrected and the pixel is mistakenly removed from the image, you can send this command to remove the pixel from the defective pixel sequence and restore it in the image.

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## Commands and Parameters

Turn on/off the cursor display.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x78	0x1A	0x00	0x00: Turn off the cursor display 0x0F: Turn on the cursor display	TBD
Module Feedback	0x05	0x36	0x78	0x1A	0x03	0x01	TBD

Move the cursor.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x78	0x1A	0x00	0x02: Cursor up 0x03: Cursor down 0x04: Cursor shifted left 0x05: Cursor shifted right 0x06: Cursor to the center 0x2N: Cursor up for N pixels (N: 0x1~0xF) 0x3N: Cursor down for N pixels (N: 0x1~0xF) 0x4N: Cursor shifted left for N pixels (N: 0x1~0xF) 0x5N: Cursor shifted right for N pixels (N: 0x1~0xF)	TBD
Module Feedback	0x05	0x36	0x78	0x1A	0x03	0x01	TBD

Add/remove a defective pixel.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x78	0x1A	0x00	0x0D: Add the pixel to the defective pixel table. 0x0E: Remove the pixel from the defective pixel table.	TBD
Module Feedback	0x05	0x36	0x78	0x1A	0x03	0x01	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.

## 2.2.14 Brightness Setting (Read/Write)

This command is used to set the image brightness, which can be set in the range of 0~100 (decimal), and the default value is 50 (0x32).

### Commands and Parameters

Write command of brightness setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x78	0x02	0x00	0~100, default 50 (decimal). Needs to be converted to hexadecimal value.	TBD
Module Feedback	0x05	0x36	0x78	0x02	0x03	0x01	TBD

Read command of brightness setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x78	0x02	0x01	None. 0x00 by default.	TBD
Module Feedback	0x05	0x36	0x78	0x02	0x03	0~100 (decimal). Needs to be converted to hexadecimal value.	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The value of DATA field is the brightness parameter that needs to be set or read, if the parameter is 100 (decimal), the value of DATA field is 0x64.

### 2.2.15 Contrast Setting (Read/Write)

Adjust the contrast of the module image or read the current contrast parameter of the module.

#### Commands and Parameters

Write command of contrast setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	TBD	0x36	0x78	0x03	0x00	0~100, default 50 (decimal). Needs to be converted to hexadecimal value.	TBD
Module Feedback	0x05	0x36	0x78	0x03	0x03	0x01	TBD

Read command of contrast setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x78	0x03	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x78	0x03	0x03	0~100 (decimal). Needs to be converted to hexadecimal value.	TBD

#### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The value of DATA field is the contrast parameter that needs to be set or read, if the parameter is 65 (decimal), the value of DATA field is 0x41.

## 2.2.16 Setting Image Detail Digital Enhancement (Read/Write)

This command is used to set the digital enhancement level of image details. The higher the enhancement level, the better the detail, but at the same time the image noise will be more pronounced.

### Commands and Parameters

Write command of digital enhancement setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	TBD	0x36	0x78	0x10	0x00	0~100, default 50 (decimal). Needs to be converted to hexadecimal value.	TBD
Module Feedback	0x05	0x36	0x78	0x10	0x03	0x01	TBD

Read command of digital enhancement setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x78	0x10	0x00	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x78	0x10	0x03	0~100 (decimal). Needs to be converted to hexadecimal value.	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The value of DATA field is the digital enhancement parameter that needs to be set or read, if the parameter is 65 (decimal), the value of DATA field is 0x41.

## 2.2.17 Setting Static Denoising Level (Read/Write)

This command is used to set the static denoising level of the image, which can reduce the image noise when the denoising level increases, but it also reduces the sharpness of the image, which needs to be adjusted according to the actual image effect.

## Commands and Parameters

Write command of denoising level setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	TBD	0x36	0x78	0x15	0x00	0~100, default 50 (decimal). Needs to be converted to hexadecimal value.	TBD
Module Feedback	0x05	0x36	0x78	0x15	0x03	0x01	TBD

Read command of denoising level setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x78	0x15	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x78	0x15	0x03	0~100 (decimal). Needs to be converted to hexadecimal value.	TBD

## Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The value of DATA field is the denoising level that needs to be set or read, if the parameter is 65 (decimal), the value of DATA field is 0x41.

### 2.2.18 Setting Dynamic Denoising Level (Read/Write)

This command is used to set the dynamic denoising level of the image, which can reduce the image noise when the denoising level increases, but it also reduces the sharpness of the image, which needs to be adjusted according to the actual image effect.

## Commands and Parameters

Write command of denoising level setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	TBD	0x36	0x78	0x16	0x00	0~100, default 50 (decimal). Needs to be converted to hexadecimal value.	TBD

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Module Feedback	0x05	0x36	0x78	0x16	0x03	0x01	TBD
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Read command of denoising level setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x78	0x16	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x78	0x16	0x03	0~100 (decimal). Needs to be converted to hexadecimal value.	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- The value of DATA field is the denoising level that needs to be set or read, if the parameter is 65 (decimal), the value of DATA field is 0x41.

## 2.2.19 Palette Setting (Read/Write)

Thermal images are based on infrared radiation intensity and have no color information. The image algorithms map a set of colors based on grayscale values, known as palettes. The module supports a variety of palettes for users to choose. White Hot (0x00) is set by default.

### Commands and Parameters

Write command of palette setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	TBD	0x36	0x78	0x20	0x00	0x00: White Hot 0x01: Black Hot 0x02: Fusion 1 0x03: Rainbow 0x04: Fusion 2 0x05: Iron Red 1 0x06: Iron Red 2 0x07: Dark Brown 0x08: Color 1 0x09: Color 2 0x0A: Ice and Fire 0x0B: Rain 0x0C: Green Hot 0x0D: Red Hot 0x0E: Deep Blue	TBD

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Module Feedback	0x05	0x36	0x78	0x20	0x03	0x01	TBD
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Read command of palette setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x78	0x20	0x01	None. 0x00 by default.	TBD
Module Feedback	TBD	0x36	0x78	0x20	0x03	0x00: White Hot 0x01: Black Hot 0x02: Fusion 1 0x03: Rainbow 0x04: Fusion 2 0x05: Iron Red 1 0x06: Iron Red 2 0x07: Dark Brown 0x08: Color 1 0x09: Color 2 0x0A: Ice and Fire 0x0B: Rain 0x0C: Green Hot 0x0D: Red Hot 0x0E: Deep Blue	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- White Hot (0x00) is set by default.
- Palette switching will take a while. You need to wait after sending the command to check the switching result.

### 2.2.20 Setting Image Mirroring (Read/Write)

Set the mirroring mode of the image, or read the current mirroring status of the module.

#### Commands and Parameters

Write command of image mirroring setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x70	0x11	0x00	0x00: No mirroring. 0x01: Horizontal mirroring	TBD

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						0x02: Vertical mirroring 0x03: Central mirroring	
Module Feedback	0x05	0x36	0x70	0x11	0x03	0x01	TBD

Read command of image mirroring setting.

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x70	0x11	0x01	None. 0x00 by default.	TBD
Module Feedback	0x05	0x36	0x70	0x11	0x03	0x00: No mirroring. 0x01: Horizontal mirroring 0x02: Vertical mirroring 0x03: Central mirroring	TBD

### Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- No mirroring (0x00) is set by default.

### 2.2.21 Setting Digital Zoom (Read/Write)

Set the digital zoom magnification of the image, or read the current zoom status of the module.

#### Commands and Parameters

To set the digital zoom magnification of the module image:

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
Host Transmitting	0x05	0x36	0x70	0x12	0x00	0x00: 1x magnification 0x01: 2x magnification 0x02: 4x magnification 0x03: 8x magnification	TBD
Module Feedback	0x05	0x36	0x70	0x12	0x03	0x01	TBD

To read the current digital zoom status of the module:

Field	SIZE	Device Address	Class Address	Subclass Address	Flag	DATA	CHK
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Host Transmitting	0x05	0x36	0x70	0x12	0x01	None. 0x00 by default.	TBD
Module Feedback	0x05	0x36	0x70	0x12	0x03	0x00: 1x magnification 0x01: 2x magnification 0x02: 4x magnification 0x03: 8x magnification	TBD

## Command Descriptions

- Refer to **Data Transmitting and Receiving** to edit commands or interpret feedback data.
- For the calculation of SIZE and CHK fields, refer to **Data Transmitting and Receiving**.
- 1x magnification (0x00) is set by default.

## 2.3 Reading Initialization State (Read-Only)

This command is used by the host to read the initialization state of the module.

When the module is in the initializing state, it is loading video streams. When the initialization is completed, video streams will be output.

### Commands and Parameters

Write command of image mirroring setting.

Field	Class Address	Subclass Address	Flag	DATA	Remarks
Host Transmitting	0x7C	0x14	0x00	0x00	
Module Feedback	0x7D	0x06	0x03	0x00: Loading 0x01: Video output	



#### Note

If the command is successfully executed, and the module feedback Flag field is "Normal return (0x03)", and DATA field is "0x00" (loading state) or "0x01" (video output state).

## 2.4 Serial Command Transmitting and Verification

For this module, usually after sending a command, the data returned by the module only indicates whether the command has been received, but not whether it has taken effect.

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For some image setting commands, you can check whether the commands take effect through the image changes. For the other commands, you need to send the read command of the corresponding function to query the device status.

The procedure is as follows.

### **Steps**

1. Send a write command.
2. Wait for the device to execute the command. The waiting time varies according to different commands.
3. Send the read command for the corresponding function.
4. Check the data returned by the module and check whether the parameters have been modified.



### **Note**

Do not send write commands to the module frequently, as it will freeze when exceeding the processing capacity.

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## 3 FAQ

Frequently asked questions about the device.

### **Why can't connect the module to the development tool or can't set parameters of the module?**

- Please check whether the serial port is properly connected with the module.
- Please check whether the baud rate and COM port of the connected module are selected correctly, and the corresponding COM port is also available on the PC.
- If you use USB to serial port, please confirm whether the USB to serial port driver is installed.

### **How to upgrade the module?**

Once the module has been connected to the development tool, use the upgrade function to upgrade the module.

## Appendix A Serial Communication Commands

Table 3-1 Information Query Commands

Command	Device Address	Class Address	Subclass Address	Flag	DATA	Remarks
Reading the Model of the Module	0x36	0x74	0x02	0x01	None	5 bytes valid. Return the model of the module.
Reading the FPGA Program Version Number	0x36	0x74	0x03	0x01	None	E.g. 0x050112 indicates 5.1.12. 5 is the major version, which is the 3 <sup>rd</sup> byte; 1 is the minor version, which is the 2 <sup>nd</sup> byte, 12 is the subdivided version, which is the 1 <sup>st</sup> byte. 3 bytes valid, MSB is the high byte.
Reading FPGA Program Compilation Time	0x36	0x74	0x04	0x01	None	4 bytes valid, MSB is the high byte. E.g. 0x20140820 means 20140820.
Reading the Module Software Version Number	0x36	0x74	0x05	0x01	None	Refer to <i>Reading the FPGA Program Version Number</i> above.
Reading the Module Software Compilation Time	0x36	0x74	0x06	0x01	None	Refer to <i>Reading FPGA Program Compilation Time</i> above.
Reading the Camera Process Calibration Version Time	0x36	0x74	0x0B	0x01	None	4 bytes valid, MSB is the high byte. E.g. 0x20170101 means 20170101.
Reading the ISP Parameter Version Number	0x36	0x74	0x0C	0x01	None	4 bytes valid. E.g. if the ISP version number is 5, 0x00000005 will be returned.

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Table 3-2 Function Setting Commands

Command	Device Address	Class Address	Subclass Address	Flag	DATA	Default
Manual Shutter Calibration	0x36	0x7C	0x02	0x00	Write-Only	
Manual Background Correction	0x36	0x7C	0x03	0x00	Write-Only	
Automatic Shutter Control	0x36	0x7C	0x04	0x00	0x00: Automatic control off 0x01: Automatic switching, timing control 0x02: Automatic switching, temperature difference control 0x03: Full-automatic control	0x03
Setting the Automatic Shutter Switching Interval	0x36	0x7C	0x05	0x00	The shutter interval is in minutes, and 2 bytes are valid. The default setting is 10 minutes (0x00 0A)	0x00 0A
Vignetting Correction	0x36	0x7C	0x0C	0x00	0x02: Vignetting Correction	
Brightness Setting	0x36	0x78	0x02	0x00	1 byte valid. Value range: 0~100, default 50 (decimal).	0x32
Contrast Setting	0x36	0x78	0x03	0x00	1 byte valid. Value range: 0~100, default 50 (decimal).	0x32
Setting Image Detail Digital Enhancement	0x36	0x78	0x10	0x00	1 byte valid. Value range: 0~100, default 50 (decimal).	0x32
Setting Static Denoising Level	0x36	0x78	0x15	0x00	1 byte valid. Value range: 0~100, default 50 (decimal).	0x32
Setting Dynamic Denoising Level	0x36	0x78	0x16	0x00	1 byte valid. Value range: 0~100, default 50 (decimal).	0x32

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Command	Device Address	Class Address	Subclass Address	Flag	DATA	Default
Defective Pixel Correction	0x36	0x78	0x1A	0x00	0x00: Turn off the cursor display 0x0F: Turn on the cursor display 0x02: Cursor up 0x03: Cursor down 0x04: Cursor shifted left 0x05: Cursor shifted right 0x06: Cursor to the center 0x0D: Add the pixel to the defective pixel table. 0x0E: Remove the pixel from the defective pixel table. 0x2N: Cursor up for N pixels (N: 0x1~0xF) 0x3N: Cursor down for N pixels (N: 0x1~0xF) 0x4N: Cursor shifted left for N pixels (N: 0x1~0xF) 0x5N: Cursor shifted right for N pixels (N: 0x1~0xF)	0x00
Palette Setting	0x36	0x78	0x20	0x00	0x00: White Hot 0x01: Black Hot 0x02: Fusion 1 0x03: Rainbow 0x04: Fusion 2 0x05: Iron Red 1 0x06: Iron Red 2	0x00

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Command	Device Address	Class Address	Subclass Address	Flag	DATA	Default
					0x07: Dark Brown 0x08: Color 1 0x09: Color 2 0x0A: Ice and Fire 0x0B: Rain 0x0C: Green Hot 0x0D: Red Hot 0x0E: Deep Blue	
Setting Image Mirroring	0x36	0x70	0x11	0x00	0x00: No mirroring. 0x01: Horizontal mirroring 0x02: Vertical mirroring 0x03: Central mirroring	0x00
Setting Digital Zoom	0x36	0x70	0x12	0x00	0x00: 1x magnification 0x01: 2x magnification 0x02: 4x magnification 0x03: 8x magnification	0x00

## Appendix B Revision History

Date	Changes
February 27, 2024	First Edition.

