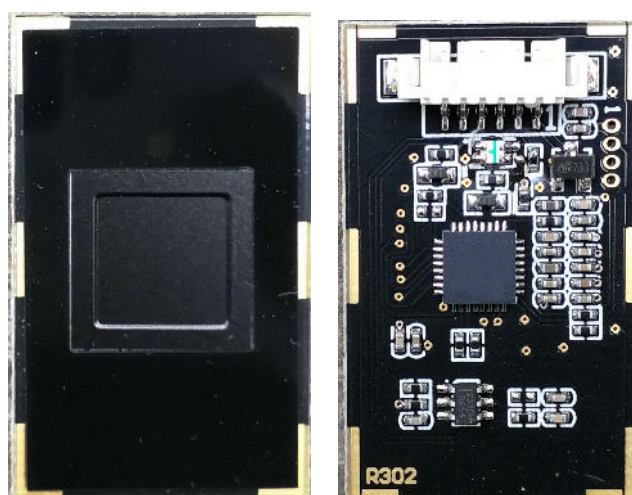


# R302 Fingerprint Module User Manual



**Hangzhou Grow Technology Co., Ltd.**

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## Preface & Declaration

Thank you for your selection of R302 Fingerprint Identification Module of GROW.

The Manual is targeted for hardware & software development engineer, covering module function, hardware and software interface etc. To ensure the developing process goes smoothly, it is highly recommended the Manual is read through carefully.

Because of the products constantly upgraded and improved, module and the manual content may be changed without prior notice. If you want to get the latest information, please visit our company website ([www.hzgrow.com](http://www.hzgrow.com)).

We have been trying our best to ensure you the correctness of the Manual. However, if you have any question or find errors, feel free to contact us or the authorized agent. We would be very grateful.

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# I Introduction

|                               |                                     |                            |                                  |
|-------------------------------|-------------------------------------|----------------------------|----------------------------------|
| <b>Power</b>                  | DC 4.2V-6.0V                        | <b>Interface</b>           | UART(TTL logical level)/ USB 2.0 |
| <b>Working current</b>        | Typical: 40mA<br>Peak:50mA          | <b>Matching Mode</b>       | 1:1 and 1:N                      |
| <b>Baud rate</b>              | (9600*N)bps,<br>N=1~6 (default N=6) | <b>Template size</b>       | 512 bytes                        |
| <b>Image acquiring time</b>   | <0.2s                               | <b>Image resolution</b>    | 508dpi                           |
| <b>Sensing Array</b>          | 160*160 pixel                       | <b>Detection Area</b>      | 8 * 8 mm                         |
| <b>Storage capacity</b>       | 150                                 | <b>Security level</b>      | 5 (1, 2, 3, 4, 5(highest))       |
| <b>FAR</b>                    | <0.001%                             | <b>FRR</b>                 | <0.1%                            |
| <b>Average searching time</b> | < 50ms (1:500)                      | <b>Starting time</b>       | <250ms                           |
| <b>Working environment</b>    | Temp: -10℃- +50℃                    | <b>Storage environment</b> | Temp: -40℃- +85℃                 |
|                               | RH: 10%-85%                         |                            | RH: <85%                         |

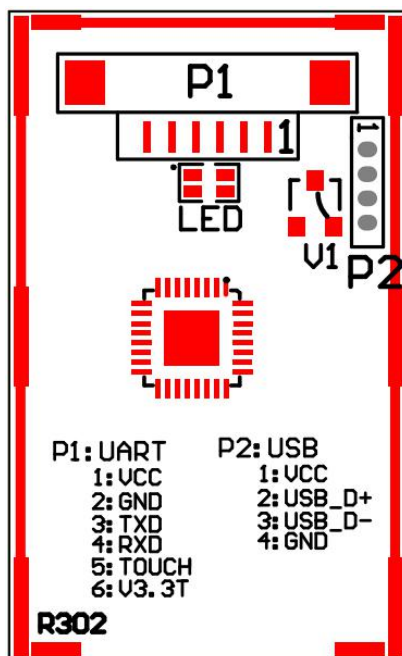
## Operation Principle

Fingerprint processing includes two parts: fingerprint enrollment and fingerprint matching (the matching can be 1:1 or 1:N).

When enrolling, user needs to enter the finger two times. The system will process the two time finger images, generate a template of the finger based on processing results and store the template. When matching, user enters the finger through optical sensor and system will generate a template of the finger and compare it with templates of the finger library. For 1:1 matching, system will compare the live finger with specific template designated in the Module; for 1:N matching, or searching, system will search the whole finger library for the matching finger. In both circumstances, system will return the matching result, success or failure.

## II Hardware Interface

### Exterior Interface



Size: 33.4\*20.4\*1.0 mm

### Serial Communication

When the FP module communicates with user device, definition of J1 is as follows:

|   | Name  | Type | Pin NmFunction Description                             |
|---|-------|------|--|
| 1 | 5V    | in   | Power input (DC4.2V - 6V)                              |
| 2 | GND   | -    | Signal ground. Connected to power ground               |
| 3 | TXD   | out  | Data output. TTL logical level                         |
| 4 | RXD   | in   | Data input. TTL logical level                          |
| 5 | Touch | out  | Finger detection signal (maximum output current: 50mA) |
| 6 | 3.3VT | in   | Finger detection power (DC3.3V - 5V、about 5uA)         |

### Hardware connection

Via serial interface, the Module may communicate with MCU of 3.3V or 5V power: TD (pin 3 of P1) connects with RXD (receiving pin of MCU), RD (pin 4 of P1) connects with TXD (transferring pin of MCU). Should the upper computer (PC) be in RS-232 mode, please add level converting circuit, like MAX232, between the Module and PC.

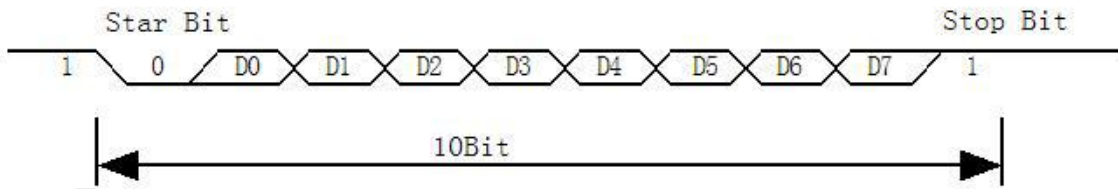
## USB Communication

| Pin Nnumber | Name | Type | Function Description |
|-------------|------|------|----------------------|
| 7           | Vin  | in   | Power input          |
| 8           | D+   | out  | USB data output.     |
| 9           | D-   | in   | USB data input.      |
| 10          | GND  | —    | Signal ground.       |

### Serial communication protocol

The mode is semiduplex asynchronism serial communication. And the default baud rate is 57600bps. User may set the baud rate in 9600~115200bps.

Transferring frame format is 10 bit: the low-level starting bit, 8-bit data with the LSB first, and an ending bit. There is no check bit.



### Reset time

At power on, it takes about 200ms for initialization. During this period, the Module can't accept commands for upper computer.

## III System Resources

To address demands of different customer, Module system provides abundant resources at user's use.

### Notepad

The system sets aside a 512-bytes memory (16 pages\* 32 bytes) for user's notepad, where data requiring power-off protection can be stored. The host can access the page by instructions of PS\_WriteNotepad and PS\_Read Notepad.

Note: when write on one page of the pad, the entire 32 bytes will be written in wholly covering the original contents.

### Buffer

There are an image buffer and two 496-byte-character-file buffer within the RAM space of the module. Users can read & write any of the buffers by instructions.

Note: Contents of the above buffers will be lost at power-off.

## Image buffer

ImageBuffer serves for image storage and the image format is 192\*192 pixels.

When transferring through UART, to quicken speed, only the upper 4 bits of the pixel is transferred (that is 16 grey degrees). And two adjacent pixels of the same row will form a byte before the transferring. When uploaded to PC, the 16-grey-degree image will be extended to 256-grey-degree format. That's 8-bit BMP format.

When transferring through USB, the image is 8-bit pixel, that's 256 grey degrees.

## Fingerprint Library

System sets aside a certain space within Flash for fingerprint template storage, that's fingerprint library. Contents of the library remain at power off.

Capacity of the library changes with the capacity of Flash, system will recognize the latter automatically. Fingerprint template's storage in Flash is in sequential order. Assume the fingerprint capacity N, then the serial number of template in library is 0, 1, 2, 3 ... N. User can only access library by template number.

## Baud rate control (Parameter Number: 4)

The Parameter controls the UART communication speed of the Modul. Its value is an integer N, N= [1, 12]. Cooresponding baud rate is 9600\*N bps.

## Security Level (Parameter Number: 5)

The Parameter controls the matching threshold value of fingerprint searching and matching. Security level is divided into 5 grades, and cooresponding value is 1, 2, 3, 4, 5. At level 1, FAR is the highest and FRR is the lowest; however at level 5, FAR is the lowest and FRR is the highest.

## Data package length (Parameter Number: 6)

The parameter decides the max length of the transferring data package when communicating with upper computer. Its value is 0, 1, 2, 3, corresponding to 32 bytes, 64 bytes, 128 bytes, 256 bytes respectively.

## System status register

System status register indicates the current operation status of the Module. Its length is 1 word, and can be read via instruction *ReadSysPara*. Definition of the register is as follows:

|             |          |   |            |     |      |      |
|-------------|----------|---|------------|-----|------|------|
| Bit Num     | 15       | 4 | 3          | 2   | 1    | 0    |
| Description | Reserved |   | ImgBufStat | PWD | Pass | Busy |

Note:

Busy: 1 bit. 1: system is executing commands; 0: system is free;

Pass: 1 bit. 1: find the matching finger; 0: wrong finger;



PWD: 1 bit. 1: Verified device's handshaking password.

ImgBufStat: 1 bit. 1: image buffer contains valid image.

## Module password

At power-on reset, system first checks whether the handshaking password has been modified. If not, system deems upper computer has no requirement of verifying password and will enter into normal operation mode. That's, when Module password remains the default, verifying process can be jumped. The password length is 4 bytes, and its default factory value is 0FFH, 0FFH, 0FFH, 0FFH. Should the password have be modified, *refer to instruction SetPwd*, then Module (or device) handshaking password must be verified before the system enter into normal operation mode. Or else, system will refuse to execute and command.

The new modified password is stored in Flash and remains at power off.

## Module address

Each module has an identifying address. When communicating with upper computer, each instruction/data is transferred in data package form, which contains the address item. Module system only responds to data package whose address item value is the same with its identifying address.

The address length is 4 bytes, and its default factory value is 0xFFFFFFFF. User may modify the address via instruction *SetAdder*. The new modified address remains at power off.

## Random number generator

Module integrates a hardware 32-bit random number generator (RNG) (without seed). Via instruction *GetRandomCode*, system will generate a random number and upload it.

# IV Communication Protocol

The protocol defines the data exchanging format when R302 series communicates with upper computer. The protocol and instruction sets apples for both UART and USB communication mode. For PC, USB interface is strongly recommended to improve the exchanging speed, especially in fingerprint scanning device.

## 5.1 Data package format

When communicating, the transferring and receiving of command/data/result are all wrapped in data package format.

### Data package format

|        |       |                    |                |  |          |
|--------|-------|--------------------|----------------|--|----------|
| Header | Adder | Package identifier | Package length | Package content<br>(instuction/data/Parameter) | Checksum |
|--------|-------|--------------------|----------------|--|----------|

### Definition of Data package

| Name | Symbol | Length | Description |
|------|--------|--------|-------------|
|------|--------|--------|-------------|

|                    |        |         |  |  |
|--------------------|--------|---------|--|--|
| Header             | Start  | 2 bytes | Fixed value of 0xEF01; High byte transferred first.  |  |
| Adder              | ADDER  | 4 bytes | Default value is 0xFFFFFFFF, which can be modified by command. High byte transferred first and at wrong adder value, module will reject to transfer.   |  |
| Package identifier | PID    | 1 byte  | 01H  | Command packet;  |
|                    |        |         | 02H  | Data packet; Data packet shall not appear alone in executing processs, must follow command packet or acknowledge packet. |
|                    |        |         | 07H  | Acknowledge packet;  |
|                    |        |         | 08H  | End of Data packet.  |
| Package length     | LENGTH | 2 bytes | Refers to the length of package content (command packets and data packets) plus the length of Checksum( 2 bytes). Unit is byte. Max length is 256 bytes. And high byte is transferred first. |  |
| Package contents   | DATA   | —       | It can be commands, data, command's parameters, acknowledge result, etc. (fingerprint character value, template are all deemed as data);   |  |
| Checksum           | SUM    | 2 bytes | The arithmetic sum of package identifier, package length and all package contents. Overflowing bits are omitted. high byte is transferred first.   |  |

## Check and acknowledgement of data package

**Note: Commands shall only be sent from upper computer to the Module, and the Module acknowledges the commands.**

Upon receipt of commands, Module will report the commands execution status and results to upper computer through acknowledge packet. Acknowledge packet has parameters and may also have following data packet. Upper computer can't ascertain Module's package receiving status or command execution results unless through acknowledge packet sent from Module. Acknowledge packet includes 1 byte confirmation code and maybe also the returned parameter.

*Confirmation code's definition is :*

00h: commad execution complete;

01h: error when receiving data package;

02h: no finger on the sensor;

03h: fail to enroll the finger;

06h: fail to generate character file due to the over-disorderly fingerprint image;

07h: fail to generate character file due to lackness of character point or over-smallness of fingerprint image

08h: finger doesn't match;

09h: fail to find the matching finger;

0Ah: fail to combine the character files;

0Bh: addressing PageID is beyond the finger library;

0Ch: error when reading template from library or the template is invalid;

0Dh: error when uploading template;



- 0Eh: Module can't receive the following data packages.
- 0Fh: error when uploading image;
- 10h: fail to delete the template;
- 11h: fail to clear finger library;
- 13h: wrong password!
- 15h: fail to generate the image for the lackness of valid primary image;
- 18h: error when writing flash;
- 19h: No definition error;
- 1Ah: invalid register number;
- 1Bh: incorrect configuration of register;
- 1Ch: wrong notepad page number;
- 1Dh: fail to operate the communication port;
- others: system reserved;

## V Module Instruction System

R30X series provide 23 instructions. Through combination of different instructions, application program may realize muti finger authentication functions. All commands/data are transferred in package format. *Refer to 5.1 for the detailed information of package.*

### System-related instructions

#### Verify password VfyPwd

Description: Verify Module's handshaking password. (Refer to 4.6 for details)

Input Parameter: PassWord (4 bytes)

Return Parameter: Confirmation code (1 byte)

Instruction code: 13H

Command (or instruction) package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes | 1 byte           | 4 byte   | 2 bytes  |
|---------|----------------|--------------------|---------|------------------|----------|----------|
| Header  | Module address | Package identifier |         | Instruction code | Password | Checksum |
| 0xEF01  | xxxx           | 01H                | 07H     | 13H              | PassWord | sum      |

Acknowledge package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
|---------|----------------|--------------------|----------------|-------------------|----------|
| Header  | Module address | Package identifier | Package Length | Confirmation code | Checksum |
| 0xEF01  | xxxx           | 07H                | 03H            | xxH               | sum      |

Note: Confirmation code = 00H: Correct password;

Confirmation code = 01H: error when receiving package;

Confirmation code = 13H: Wrong password;

## Set password SetPwd

Description: Set Module's handshaking password. (Refer to 4.6 for details)

Input Parameter: PassWord (4 bytes)

Return Parameter: Confirmation code (1 byte)

Instruction code: 12H

Command (or instruction) package format:

|         |                |                    |                |                  |          |          |
|---------|----------------|--------------------|----------------|------------------|----------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 4 byte   | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Password | Checksum |
| 0xEF01  | xxxx           | 01H                | 07H            | 12H              | PassWord | sum      |

Acknowledge package format:

|         |                |                |                   |          |
|---------|----------------|----------------|-------------------|----------|
| 2 bytes | 4 byte         | 2 bytes        | 1 byte            | 2 bytes  |
| Header  | Module address | Package length | Confirmation code | Checksum |
| 0xEF01  | xxxx           | 03H            | xxH               | Sum      |

Note: Confirmation code=00H: password setting complete;

Confirmation code=01H: error when receiving package;

## Set Module address SetAdder

Description: Set Module address. (Refer to 4.7 for address information)

Input Parameter: None;

Return Parameter: Confirmation code (1 byte)

Instruction code: 15H

Command (or instruction) package format:

|         |                         |                    |                |                  |                    |          |
|---------|-------------------------|--------------------|----------------|------------------|--------------------|----------|
| 2 bytes | 4bytes                  | 1 byte             | 2 bytes        | 1 byte           | 4 bytes            | 2 bytes  |
| Header  | Original Module address | Package identifier | Package length | Instruction code | New Module address | Checksum |
| 0xEF01  | xxxx                    | 01H                | 07H            | 15H              | xxxx               | sum      |

Acknowledge package format:

|         |                    |                    |                |                   |          |
|---------|--------------------|--------------------|----------------|-------------------|----------|
| 2 bytes | 4bytes             | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
| Header  | New Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | xxxx               | 07H                | 07H            | xxH               | Sum      |

Note: Confirmation code=00H: address setting complete;

Confirmation code=01H: error when receiving package;

## Set module system's basic parameter SetSysPara

Description: Operation parameter settings. (Refer to 4.4 for more information)

Input Parameter: Parameter number;

Return Parameter: Confirmation code (1 byte)

Instruction code: 0eH

Command (or instruction) package format:

|         |                |                    |                |                  |                  |          |          |
|---------|----------------|--------------------|----------------|------------------|------------------|----------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 1byte            | 1byte    | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Parameter number | Contents | Checksum |
| 0xEF01  | Xxxx           | 01H                | 05H            | 0eH              | 4/5/6            | xx       | sum      |

Acknowledge package format:

|         |                |                    |                |                   |          |
|---------|----------------|--------------------|----------------|-------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | Xxxx           | 07H                | 03H            | xxH               | Sum      |

Note: Confirmation code=00H: parameter setting complete;  
 Confirmation code=01H: error when receiving package;  
 Confirmation code=1aH: wrong register number;

## Port Control Control

Description:

For UART protocol, it control the “on/off” of USB port;

For USB protocol, it control the “on/off” of UART port;

Input Parameter: control code

Control code ”0” means turns off the port;

Control code ”1” means turns on the port;

Return Parameter: confirmation code;

Instruction code: 17H

Command (or instruction) package format:

|         |              |                    |                |                  |              |          |
|---------|--------------|--------------------|----------------|------------------|--------------|----------|
| 2 bytes | 4bytes       | 1 byte             | 2 bytes        | 1 byte           | 1byte        | 2 bytes  |
| Header  | Chip address | Package identifier | Package length | Instruction code | Control code | Checksum |
| 0xEF01  | xxxx         | 01H                | 04H            | 17H              | 0/1          | sum      |

Acknowledge package format:

|         |              |                    |                |                   |          |
|---------|--------------|--------------------|----------------|-------------------|----------|
| 2 bytes | 4bytes       | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
| Header  | Chip address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | xxxx         | 07H                | 03H            | xxH               | sum      |

Note: Confirmation code=00H: Port operation complete;  
 Confirmation code=01H: error when receiving package;  
 Confirmation code=1dH: fail to operate the communication port;

## Read system Parameter ReadSysPara

Description: Read Module’s status register and system basic configuration parameters; (Refer to 4.4 for system configuration parameter and 4.5 for system status register) .

Input Parameter: none

Return Parameter: Confirmation code (1 byte) + basic parameter (16bytes)

Instuction code: 0fH

Command (or instruction) package format:

|         |        |        |         |        |         |
|---------|--------|--------|---------|--------|---------|
| 2 bytes | 4bytes | 1 byte | 2 bytes | 1 byte | 2 bytes |
|---------|--------|--------|---------|--------|---------|

|        |                |                    |                |                  |          |
|--------|----------------|--------------------|----------------|------------------|----------|
| Header | Module address | Package identifier | Package length | Instruction code | Checksum |
| 0xEF01 | Xxxx           | 01H                | 03H            | 0fH              | sum      |

Acknowledge package format:

|         |                |                    |                |                   |                      |          |
|---------|----------------|--------------------|----------------|-------------------|----------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 16 bytes             | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | Basic parameter list | Checksum |
| 0xEF01  | xxxx           | 07H                | 3+16           | xxH               | See following table  | sum      |

Note: Confirmation code=00H: read complete;

Confirmation code=01H: error when receiving package;

| Name                   | Description                        | Offset (word) | Size (word) |
|------------------------|------------------------------------|---------------|-------------|
| Status register        | Contents of system status register | 0             | 1           |
| System identifier code | Fixed value: 0x0009                | 1             | 1           |
| Finger library size    | Finger library size                | 2             | 1           |
| Security level         | Security level (1, 2, 3, 4, 5)     | 3             | 1           |
| Device address         | 32-bit device address              | 4             | 2           |
| Data packet size       | Size code (0, 1, 2, 3)             | 6             | 1           |
| Baud settings          | N (baud = 9600*N bps)              | 7             | 1           |

## Read valid template number      **TempleteNum**

Description: read the current valid template number of the Module

Input Parameter: none

Return Parameter: Confirmation code (1 byte), template number:N

Instuction code: 1dH

Command (or instruction) package format:

|         |                |                    |                |                  |          |
|---------|----------------|--------------------|----------------|------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Checksum |
| 0xEF01  | xxxx           | 01H                | 0003H          | 1dH              | 0021H    |

Acknowledge package format:

|         |                |                    |                |                   |                 |          |
|---------|----------------|--------------------|----------------|-------------------|-----------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes         | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | Template number | Checksum |
| 0xEF01  | xxxx           | 07H                | 5              | xxH               | N               | sum      |

Note: Confirmation code=00H: read complete;

Confirmation code=01H: error when receiving package;

## Fingerprint-processing instructions

### To collect finger image      **GenImg**

Description: detecting finger and store the detected finger image in ImageBuffer while returning successfull confirmation code; If there is no finger, returned confirmation code

would be “can’t detect finger”.

Input Parameter: none

Return Parameter: Confirmation code (1 byte)

Instuction code: 01H

Command (or instruction) package format:

|         |                |                    |                |                  |          |
|---------|----------------|--------------------|----------------|------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Checksum |
| 0xEF01  | Xxxx           | 01H                | 03H            | 01H              | 05H      |

Acknowledge package format:

|         |                |                    |                |                   |          |
|---------|----------------|--------------------|----------------|-------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | Xxxx           | 07H                | 03H            | xxH               | Sum      |

Note: Confirmation code=00H: finger collection success;

Confirmation code=01H: error when receiving package;

Confirmation code=02H: can’t detect finger;

Confirmation code=03H: fail to collect finger;

## Upload image      UpImage

Description: to upload the image in Img\_Buffer to upper computer. Refer to 1.1.1 for more about image buffer.

Input Parameter: none

Return Parameter: Confirmation code (1 byte)

Instuction code: 0aH

Command (or instruction) package format:

|         |                |                    |                |                  |          |
|---------|----------------|--------------------|----------------|------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Checksum |
| 0xEF01  | Xxxx           | 01H                | 03H            | 0aH              | 000eH    |

Acknowledge package format:

|         |                |                    |                |                   |          |
|---------|----------------|--------------------|----------------|-------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | Xxxx           | 07H                | 03H            | xxH               | sum      |

Note 1: Confirmation code=00H: ready to transfer the following data packet;

Confirmation code=01H: error when receiving package;

Confirmation code=0fH: fail to transfer the following data packet;

2: Module shall transfer the following data packet after responding to the upper computer.

## Download the image      DownImage

Description: to download image from upper computer to Img\_Buffer. Refer to 1.1.1 for more about the image buffer.

Input Parameter: none



Return Parameter: Confirmation code (1 byte)

Instuction code: 0bH

Command (or instruction) package format:

|         |                |                    |                |                  |          |
|---------|----------------|--------------------|----------------|------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Checksum |
| 0xEF01  | Xxxx           | 01H                | 03H            | 0bH              | 000fH    |

Acknowledge package format:

|         |                |                    |                |                   |          |
|---------|----------------|--------------------|----------------|-------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | Xxxx           | 07H                | 03H            | xxH               | sum      |

Note: 1: Confirmation code=00H: ready to transfer the following data packet;

Confirmation code=01H: error when receiving package;

Confirmation code=0eH: fail to transfer the following data packet;

2: Module shall transfer the following data packet after responding to the upper computer.

Data package length must be 64, 128, or 256.

## To generate character file from image **Img2Tz**

Description: to generate character file from the original finger image in ImageBuffer and store the file in CharBuffer1 or CharBuffer2.

Input Parameter: BufferID (character file buffer number)

Return Parameter: Confirmation code (1 byte)

Instuction code: 02H

Command (or instruction) package format:

|         |                |                    |                |                  |               |          |
|---------|----------------|--------------------|----------------|------------------|---------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 1 byte        | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Buffer number | Checksum |
| 0xEF01  | xxxx           | 01H                | 04H            | 02H              | BufferID      | sum      |

Note: BufferID of CharBuffer1 and CharBuffer2 are 1h and 2h respectively. Other values (except 1h, 2h) would be processed as CharBuffer2.

Acknowledge package format:

|         |                |                    |                |                   |          |
|---------|----------------|--------------------|----------------|-------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | xxxx           | 07H                | 03H            | XxH               | sum      |

Note: Confirmation code=00H: generate character file complete;

Confirmation code=01H: error when receiving package;

Confirmation code=06H: fail to generate character file due to the over-disorderly fingerprint image;

Confirmation code=07H: fail to generate character file due to lackness of character point or over-smallness of fingerprint image;

Confirmation code=15H: fail to generate the image for the lackness of valid primary image;

## To generate template RegModel

Description: To combine information of character files from CharBuffer1 and CharBuffer2 and generate a template which is stroed back in both CharBuffer1 and CharBuffer2.

Input Parameter: none

Return Parameter: Confirmation code (1 byte)

Instuction code: 05H

Command (or instruction) package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 2 bytes  |
|---------|----------------|--------------------|----------------|------------------|----------|
| Header  | Module address | Package identifier | Package length | Instruction code | Checksum |
| 0xEF01  | xxxx           | 01H                | 03H            | 05H              | 09H      |

Acknowledge package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
|---------|----------------|--------------------|----------------|-------------------|----------|
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | xxxx           | 07H                | 03H            | xxH               | sum      |

Note: Confirmation code=00H: operation success;

Confirmation code=01H: error when receiving package;

Confirmation code=0aH: fail to combine the character files. That's, the character files don't belong to one finger.

## To upload character or template UpChar

Description: to upload the character file or template of CharBuffer1/CharBuffer2 to upper computer;

Input Parameter: BufferID (Buffer number)

Return Parameter: Confirmation code (1 byte)

Instuction code: 08H

Command (or instruction) package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 1 byte        | 2 bytes  |
|---------|----------------|--------------------|----------------|------------------|---------------|----------|
| Header  | Module address | Package identifier | Package length | Instruction code | Buffer number | Checksum |
| 0xEF01  | xxxx           | 01H                | 04H            | 08H              | BufferID      | sum      |

Note: BufferID of CharBuffer1 and CharBuffer2 are 1h and 2h respectively. Other values (except 1h, 2h) would be processed as CharBuffer2.

Acknowledge package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
|---------|----------------|--------------------|----------------|-------------------|----------|
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | xxxx           | 07H                | 03H            | xxH               | sum      |

Note 1: Confirmation code=00H: ready to transfer the following data packet;

Confirmation code=01H: error when receiving package;

Confirmation code=0dH: error when uploading template;

2: Module shall transfer following data packet after responding to the upper computer.;

3: The instruction doesn't affect buffer contents.

## To store template Store

Description: to store the template of specified buffer (Buffer1/Buffer2) at the designated location of Flash library.

Input Parameter: BufferID(buffer number), PageID (Flash location of the template, two bytes with high byte front and low byte behind)

Return Parameter: Confirmation code (1 byte)

Instruction code: 06H

Command (or instruction) package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 1 byte        | 2 bytes         | 2 bytes  |
|---------|----------------|--------------------|----------------|------------------|---------------|-----------------|----------|
| Header  | Module address | Package identifier | Package length | Instruction code | buffer number | Location number | Checksum |
| 0xEF01  | xxxx           | 01H                | 06H            | 06H              | BufferID      | PageID          | sum      |

Note: BufferID of CharBuffer1 and CharBuffer2 are 1h and 2h respectively. Other values (except 1h, 2h) would be processed as CharBuffer2.

Acknowledge package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
|---------|----------------|--------------------|----------------|-------------------|----------|
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | Xxxx           | 07H                | 03H            | xxH               | sum      |

Note: Confirmation code=00H: storage success;

Confirmation code=01H: error when receiving package;

Confirmation code=0bH: addressing PageID is beyond the finger library;

Confirmation code=18H: error when writing Flash.

## To read template from Flash library LoadChar

Description: to load template at the specified location (PageID) of Flash library to template buffer CharBuffer1/CharBuffer2

Input Parameter: BufferID(buffer number), PageID (Flash location of the template, two bytes with high byte front and low byte behind)。

Return Parameter: Confirmation code (1 byte)

Instruction code: 07H

Command (or instruction) package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 1 byte        | 2 bytes     | 2 bytes  |
|---------|----------------|--------------------|----------------|------------------|---------------|-------------|----------|
| Header  | Module address | Package identifier | Package length | Instruction code | buffer number | Page number | Checksum |
| 0xEF01  | xxxx           | 01H                | 06H            | 07H              | BufferID      | PageID      | sum      |

Note: BufferID of CharBuffer1 and CharBuffer2 are 1h and 2h respectively. Other values (except 1h, 2h) would be processed as CharBuffer2.

Acknowledge package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
|---------|----------------|--------------------|----------------|-------------------|----------|
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | xxxx           | 07H                | 03H            | XxH               | sum      |

Note: Confirmation code=00H: load success;



Confirmation code=01H: error when receiving package;

Confirmation code=0cH: error when reading template from library or the readout template is invalid;

Confirmation code=0BH: addressing PageID is beyond the finger library;

## To delete template **DeletChar**

Description: to delete a segment (N) of templates of Flash library started from the specified location (or PageID);

Input Parameter: PageID (template number in Flash), N (number of templates to be deleted)

Return Parameter: Confirmation code (1 byte)

Instuction code: 0cH

Command (or instruction) package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 2 bytes     | 2bytes                            | 2 bytes  |
|---------|----------------|--------------------|----------------|------------------|-------------|-----------------------------------|----------|
| Header  | Module address | Package identifier | Package length | Instruction code | Page number | number of templates to be deleted | Checksum |
| 0xEF01  | Xxxx           | 01H                | 07H            | 0cH              | PageID      | N                                 | sum      |

Acknowledge package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
|---------|----------------|--------------------|----------------|-------------------|----------|
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | Xxxx           | 07H                | 03H            | xxH               | sum      |

Note: Confirmation code=00H: delete success;

Confirmation code=01H: error when receiving package;

Confirmation code=10H: faile to delete templates;

## To empty finger library **Empty**

Description: to delete all the templates in the Flash library

Input Parameter: none

Return Parameter: Confirmation code (1 byte)

Instuction code: 0dH

Command (or instruction) package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 2 bytes  |
|---------|----------------|--------------------|----------------|------------------|----------|
| Header  | Module address | Package identifier | Package length | Instruction code | Checksum |
| 0xEF01  | Xxxx           | 01H                | 03H            | 0dH              | 0011H    |

Acknowledge package format:

| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
|---------|----------------|--------------------|----------------|-------------------|----------|
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | Xxxx           | 07H                | 03H            | xxH               | sum      |

Note: Confirmation code=00H: empty success;

Confirmation code=01H: error when receiving package;

Confirmation code=11H: fail to clear finger library;

## To carry out precise matching of two finger templates Match

Description: to carry out precise matching of templates from CharBuffer1 and CharBuffer2, providing matching results.

Input Parameter: none

Return Parameter: Confirmation code (1 byte), matching score.

Instuction code: 03H

Command (or instruction) package format:

|         |                |                    |                |                  |          |
|---------|----------------|--------------------|----------------|------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Checksum |
| 0xEF01  | Xxxx           | 01H                | 03H            | 03H              | 07H      |

Acknowledge package format:

|         |                |                    |                |                   |                |          |
|---------|----------------|--------------------|----------------|-------------------|----------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes        | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | Matching score | Checksum |
| 0xEF01  | Xxxx           | 07H                | 05H            | XxH               | XxH            | sum      |

Note 1: Confirmation code=00H: templates of the two buffers are matching!

Confirmation code=01H: error when receiving package;

Confirmation code=08H: templates of the two buffers aren't matching;

2: The instruction doesn't affect the contents of the buffers.

## To search finger library Search

Description: to search the whole finger library for the template that matches the one in CharBuffer1 or CharBuffer2. When found, PageID will be returned.

Input Parameter: BufferID, StartPage (searching start address), PageNum (searching numbers)

Return Parameter: Confirmation code (1 byte), PageID (matching templates location)

Instuction code: 04H

Command (or instruction) package format:

|         |                |                    |                |                  |               |           |           |          |
|---------|----------------|--------------------|----------------|------------------|---------------|-----------|-----------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 1 byte        | 2 bytes   | 2 bytes   | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | buffer number | Parameter | Parameter | Checksum |
| 0xEF01  | xxxx           | 01H                | 08H            | 04H              | BufferID      | StartPage | PageNum   | sum      |

Note: BufferID of CharBuffer1 and CharBuffer2 are 1h and 2h respectively. Other values (except 1h, 2h) would be processed as CharBuffer2.

Acknowledge package format:

|         |                |                    |                |                   |         |            |          |
|---------|----------------|--------------------|----------------|-------------------|---------|------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes | 2 bytes    | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | 页码      | 得分         | Checksum |
| 0xEF01  | xxxx           | 07H                | 7              | xxH               | PageID  | MatchScore | sum      |

Note 1: Confirmation code=00H: found the matching finger;

Confirmation code=01H: error when receiving package;

Confirmation code=09H: No matching in the library (both the PageID and matching score are 0);

2: The instruction doesn't affect the contents of the buffers.

## Other instructions

### To generate a random code      **GetRandomCode**

Description: to command the Module to generate a random number and return it to upper computer; Refer to 4.8 for more about Random Number Generator;

Input Parameter: none

Return Parameter: Confirmation code (1 byte)

Instruction code: 14H

Command (or instruction) package format:

|         |                |                    |                |                  |          |
|---------|----------------|--------------------|----------------|------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Checksum |
| 0xEF01  | xxxx           | 01H                | 03H            | 14H              | 0018H    |

Acknowledge package format:

|         |                |                    |                |                   |               |          |
|---------|----------------|--------------------|----------------|-------------------|---------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 4 bytes       | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | Random number | Checksum |
| 0xEF01  | xxxx           | 07H                | 07H            | xxH               | xxxx          | sum      |

Note: Confirmation code=00H: generation success;

Confirmation code=01H: error when receiving package;

### To write note pad      **WriteNotepad**

Description: for upper computer to write data to the specified Flash page (refer to 4.1 for more about Note pad). Also see **ReadNotepad**;

Input Parameter: NotePageNum, user content (or data content)

Return Parameter: Confirmation code (1 byte)

Instruction code: 18H

Command (or instruction) package format:

|         |                |                    |                |                  |             |              |          |
|---------|----------------|--------------------|----------------|------------------|-------------|--------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 1byte       | 32 bytes     | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Page number | Data content | Checksum |
| 0xEF01  | xxxx           | 01H                | 36             | 18H              | 0~15        | content      | sum      |

Acknowledge package format:

|         |                |                    |                |                   |          |
|---------|----------------|--------------------|----------------|-------------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | Checksum |
| 0xEF01  | xxxx           | 07H                | 03H            | xxH               | sum      |

Note: Confirmation code=00H: write success;

Confirmation code=01H: error when receiving package;

## To read note pad **ReadNotepad**

Description: to read the specified page's data content; Refer to 4.1 for more about user note pad.

Also see **WriteNotepad**.

Input Parameter: none

Return Parameter: Confirmation code (1 byte) + data content

Instuction code: 19H

Command (or instruction) package format:

|         |                |                    |                |                  |             |          |
|---------|----------------|--------------------|----------------|------------------|-------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte           | 1byte       | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Instruction code | Page number | Checksum |
| 0xEF01  | xxxx           | 01H                | 04H            | 19H              | 0~15        | xxH      |

Acknowledge package format:

|         |                |                    |                |                   |              |          |
|---------|----------------|--------------------|----------------|-------------------|--------------|----------|
| 2 bytes | 4bytes         | 1 byte             | 2 bytes        | 1 byte            | 32bytes      | 2 bytes  |
| Header  | Module address | Package identifier | Package length | Confirmation code | User content | Checksum |
| 0xEF01  | xxxx           | 07H                | 3+32           | xxH               | User content | sum      |

Note: Confirmation code=00H: read success;

Confirmation code=01H: error when receiving package;

## Instruction Table

### Classified by functions

| type                   | num | code | description                                      | Type                   | num | Code | description                                  |
|------------------------|-----|------|--|------------------------|-----|------|--|
| System-related         | 1   | 13H  | To verify password                               | Fingerprint processing | 13  | 08H  | to upload template                           |
|                        | 2   | 12H  | To set password                                  |                        | 14  | 09H  | To download template                         |
|                        | 3   | 15H  | To set device address                            |                        | 15  | 06H  | To store template;                           |
|                        | 4   | 0EH  | To set system Parameter                          |                        | 16  | 07H  | to read/load template                        |
|                        | 5   | 17H  | Port control                                     |                        | 17  | 0CH  | to delete tempates                           |
|                        | 6   | 0FH  | To read system Parameter                         |                        | 18  | 0DH  | to empty the library                         |
|                        | 7   | 1DH  | To read finger template numbers                  |                        | 19  | 03H  | Carry out precise matching of two templates; |
| Fingerprint processing | 8   | 01H  | Collect finger image                             | others                 | 20  | 04H  | Search the finger library                    |
|                        | 9   | 0AH  | To upload image                                  |                        |     |      |  |
|                        | 10  | 0BH  | To download image                                |                        | 21  | 14H  | to get random code                           |
|                        | 11  | 02H  | To generate character file from image            |                        | 22  | 18H  | to write note pad                            |
|                        | 12  | 05H  | To combine character files and generate template |                        | 23  | 19H  | To read note pad                             |

## Classified by instruction code

| code | identifier | Description                                      | Code | Identifier    | Description                     |
|------|------------|--|------|---------------|---------------------------------|
| 01H  | GenImg     | Collect finger image                             | 0DH  | Empty         | to empty the library            |
| 02H  | Img2Tz     | To generate character file from image            | 0EH  | SetSysPara    | To set system Parameter         |
| 03H  | Match      | Carry out precise matching of two templates;     | 0FH  | ReadSysPara   | To read system Parameter        |
| 04H  | Serach     | Search the finger library                        | 12H  | SetPwd        | To set password                 |
| 05H  | RegModel   | To combine character files and generate template | 13H  | VfyPwd        | To verify password              |
| 06H  | Store      | To store template;                               | 14H  | GetRandomCode | to get random code              |
| 07H  | LoadChar   | to read/load template                            | 15H  | SetAdder      | To set device address           |
| 08H  | UpChar     | to upload template                               | 17H  | Control       | Port control                    |
| 09H  | DownChr    | to download template                             | 18H  | WriteNotepad  | to write note pad               |
| 0AH  | UpImage    | To upload image                                  | 19H  | ReadNotepad   | To read note pad                |
| 0BH  | DownImage  | To download image                                | 1BH  | HiSpeedSearch | Search the library fastly       |
| 0CH  | DeletChar  | to delete tempates                               | 1DH  | TempleteNum   | To read finger template numbers |

## VII Reference Circuit

