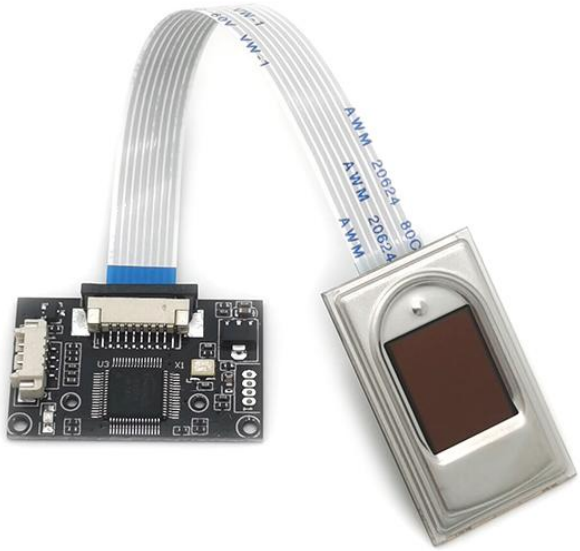
R306 Fingerprint Module

User Manual



Hangzhou Grow Technology Co., Ltd

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Preface & Declaration

Thank you for you selection of R306 Fingerprint Identification Module (Module) of GROW.

The Manual is targeted for hardware & software developing engineer, covering hardware interface, system resource, instruction system, installment information, etc. To ensure the developing process goes smoothly, it is highly recommended the Manual is read through carefully.

We will try our best to assure you the correctness of the Manual. However, should you find any problem or error with it, feel free to contact us or the sales representative of us. We would be very grateful.

Holding the principle of constantly improving and perfecting products, so both the module and contents of the Manual might subject to changes. Sorry for separate notice. You may visit our website or call us for the latest information.

www.hzgrow.com

Revised Version

Version Number	Date	Revise Content	Modifier
V1.1	2011.02	Establish	Grow Tech
V1.2	2022.08	1. Change control board size 2. Add Features and templates 3. Add GR_HighSpeedSearch command 4. Add GR_GenBinImage command 5. Add Operation Process command	Grow Tech

Catalog

I Introduction

Power	DC 4.2V-6.0V	**Interface**	UART(TTL logical level)/ USB 2.0
Working current	40mA	**Matching Mode**	1:1 and 1:N
Peak current	55mA	**Sensing Array**	152*200 pixels
Resolution	363 dpi	**Average searching time**	< 0.2s (1:1000)
Baud rate	(9600*N)bps, N=1～12 (default N=6）	**Character file size**	256 bytes
Image store time	<0.1s	**Template size**	512 bytes
Storage capacity	1000	**Security level**	5 (1, 2, 3, 4, 5(highest))
FAR	<0.0001%	**FRR**	<1%
Working environment	Temp: -20℃- +45℃	**Storage environment**	Temp: -40℃- +55℃
	RH: 10%-85%		RH: <85%
Window dimension	11mm*15mm	**Sensor Size**	33.4*20.4mm

Operation Principle

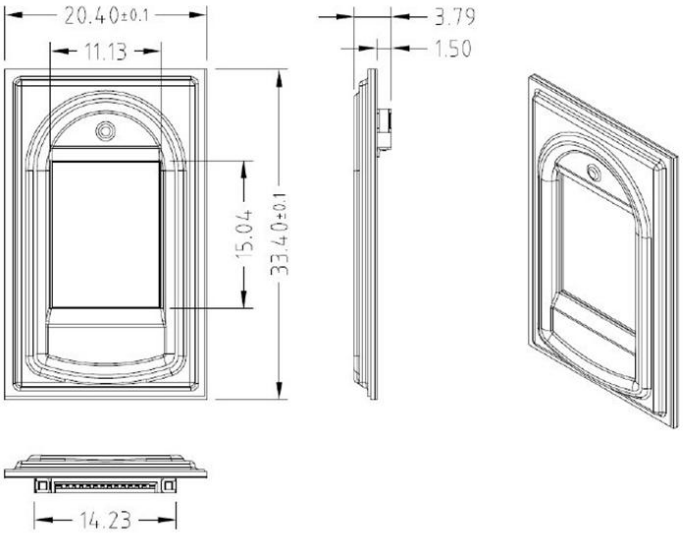
Fingerprint processing includes two parts: fingerprint enrollment and fingerprint matching (the matching can be 1:1 or 1:N).

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.

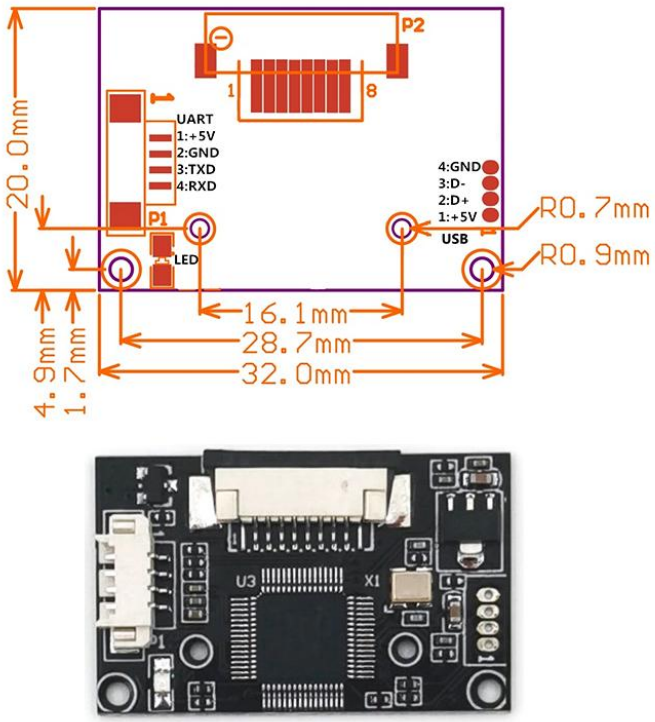
II Hardware Interface

Exterior Interface

Sensor Size: 33.4*20.4mm



Control board size：32.0*20.0mm



Serial Communication

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

Pin Nmuber	Name	Type	Function Description
1	Vin	in	Power input
2	GND	—	Signal ground. Connected to power ground
3	TD	out	Data output. TTL logical level
4	RD	in	Data input. TTL logical level

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.

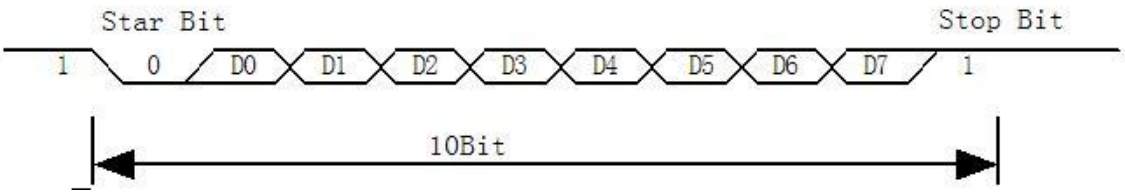
USB Communication

Pin Number	Name	Type	Function Description
1	Vin	in	Power input
2	D+	out	USB data output
3	D-	in	USB data input
4	GND	-	Signal ground

Serial communication protocol

The mode is semiduplex asychronism 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.

Electrical paramenter (All electrical level takes GND as reference)

Power supply

Item	Parameter			Unit	Note
	Min	Typ	Max		
Power Voltage (Vin)	3.6		6.0	V	Normal working value.
Maximum Voltage (Vin_{max})	－0.3		7.0	V	**Exceeding the Maximum rating may cause permant harm to the Module.**
Operation Current (Icc)	90	100	110	mA	
Peak Current (Ipeak)			150	mA	

TD（output, TTL logic level）

Item	Condition	Parameter			Unit	Note
		Min	Typ	Max		
V_{OL}	I_{OL}=－4mA			0.4	V	Logic 0
V_{OH}	I_{OH}= 4mA	2.4		**3.3**	V	Logic 1

RD（input, TTL logic level）

Item	Condition	Parameter			Unit	Note
		Min	Typ	Max		
V_{IL}				0.6	V	Loigc 0
V_{IH}		2.4			V	Logic 1
I_{IH}	V_{IH} =5V		1		mA	
	V_{IH} =3.3V		30		uA	
V_{Imax}		－0.3		5.5	V	**Maximum input voltage**

Ⅲ System Resources

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

Notepad

512-byte memory is set aside in flash for User's notepad. The notepad is divided into 16 pages logically, 32 bytes per page. The host can access any page by instruction GR_WriteNotepad or GR_ReadNotepad.
Note: when written, the whole page is taken as a whole and its former contents will be replaced.

Buffer

There are an image buffer and two 512-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 208*288 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.

Character file buffer

Character file buffer, CharBuffer1, CharBuffer2, can be used to store both character file and template file.

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.

System Configuration Parameter

To facilitate user's developing, Module opens part system parameters for use. And the basic instructions are SetSysPara & ReadSysPara. Both instructions take Parameter Number as

parameter.

When upper computer sends command to modify parameter, Module first responses with original configurations, then performs the parameter modification and writes configuration record into Flash. At the next startup, system will run with the new configurations.

Baud rate control (Parameter Number: 4)

The Parameter controls the UART communication speed of the Module. Its value is an integer N, N= [1, 12]. Corresponding 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 corresponding 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.

Features and templates

Fingerprint feature file occupies 256 bytes,including general information as well as minutiae information; Template file occupies 512 bytes, sum of two features files of the same fingerprint.

Feature file structure:

The minutiae number of a feature file is no more than 50. Of the total 256 bytes (size of feature file is 256 bytes) ,the first 56 bytes is the file header used for general information; The latter 200 bytes are to store minutiae information, 4 bytes for each minutiae.

File Header Format:

0~5 byte	6~39 byte	40~43 byte	44~55 byte
Symbol\Type\ Character quality Character Number\ Serial number	Background table: 34bytes	Two center coordinates	System reserved

Note:

1. **Flag:** 1 byte. Feature file flag. To distinguish the feature files generated by different sensors or algorithms. 0: the feature file is invalid or deleted. So no feature file can be stored to database when the flag is 0.
2. **Type:** 1 byte. Feature file type. 0: the file only contains file header;
   1: the file contains file header and reduced minutiae information.
   2: the file contains file header and complete minutiae information.
3. **Quality:** 1 byte. Quality of feature. Value range is 0~100 with the larger value indicating the higher feature quality.
4. **Number:** 1 byte. Minutiae number within the range of 5~50. Minimum of 5, maximum of 50.
5. **Serial number:** 2 bytes. Searching assistant.
6. **Background table:** 34 bytes. Zipped information of background table
7. **Singularity point coordinate:** 4 bytes. Includes (x, y) coordination information of the two centre points.
8. **System reserved bytes:** 12 bytes.

Feature Unit Structure (4 bytes):

31 23	22 14	13 5	4 1	0
x	y	Angle	Character point quality	Attribute

Ⅳ Communication Protocol

The protocol defines the data exchanging format when R30X 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.

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 (instruction/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 process, 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: command 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;
1Eh: Automatic enroll failed;
1Fh: Fingerprint database is full;
others: system reserved;

V Module Instruction System

R306 provide 25 instructions. Through combination of different instructions, application program may realize muti finger authentication functions. All commands/data are transferred in package format.

Instruction Table

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

System-related instructions

Verify password VfyPwd

Description: Verify Module's handshaking password.

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.

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.

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;

Input Parameter：none

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

Instruction 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

Instruction 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 successfully 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)

Instruction 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.

Input Parameter: none

Return Parameter: Confirmation code (1 byte)

Instruction 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.
Input Parameter: none
Return Parameter: Confirmation code (1 byte)
Instruction 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 Genchar

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)
Instruction 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)

Instruction 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)

Instruction 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 download character file or template DownChar

Description: to download character file or template from upper computer to the specified buffer of Module;

Input Parameter: BufferID (buffer number)

Return Parameter: Confirmation code (1 byte)

Instruction code: 09H

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	09H	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=0eH: fail to receive the following data packages.

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

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.

Instruction 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）

Instruction 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 finer;

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;

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. Also see R**eadNotepad;**

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; Also see **WriteNotepad**.

Input Parameter: none

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

Instruction 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;

High Speed Search HighSpeedSearch

Description: High-speed searching the whole or part of fingerprint database with the feature files in CharBuffer1 or CharBuffer2.If get, jump to the original page. The instruction will soon work out the searching result if the fingerprint really be in the database and with good quality.

Input Parameter: BufferID, StartPage, PageNum

Return Parameter: Confirmation code, Page number

Instuction code: 1bH

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	1bH	Buffer ID	Start Page	Page Num	sum

Comment：The BufferID in CharBuffer1 and CharBuffer2 are 1h and 2h.

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	Page Number	Score	Checksum
0xEF01	xxxx	07H	7	xxH	PageID	MatchScore	sum

Note: Confirmation code=00H: searching success;

Confirmation code=01H: error when receiving package;

Confirmation code=09H: searching failed, here the page number and score are "0";

Generate to Minutiae Fingerprint Image GenBinImage

Description: Processing the fingerprint image in image buffer and generate it to minutiae fingerprint image

Input Parameter: BinImgTpye

0：Binary images

1：Minutiae images without minutiae flag

2 or others：Minutiae images with minutiae flag

Return Parameter: Confirmation code

Instuction code: 1cH

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	Confirmation code	Target type	Checksum
0xEF01	xxxx	01H	04H	1cH	0/1/2	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=01H: error when receiving package;

Confirmation code=15H: invalid fingerprint images;

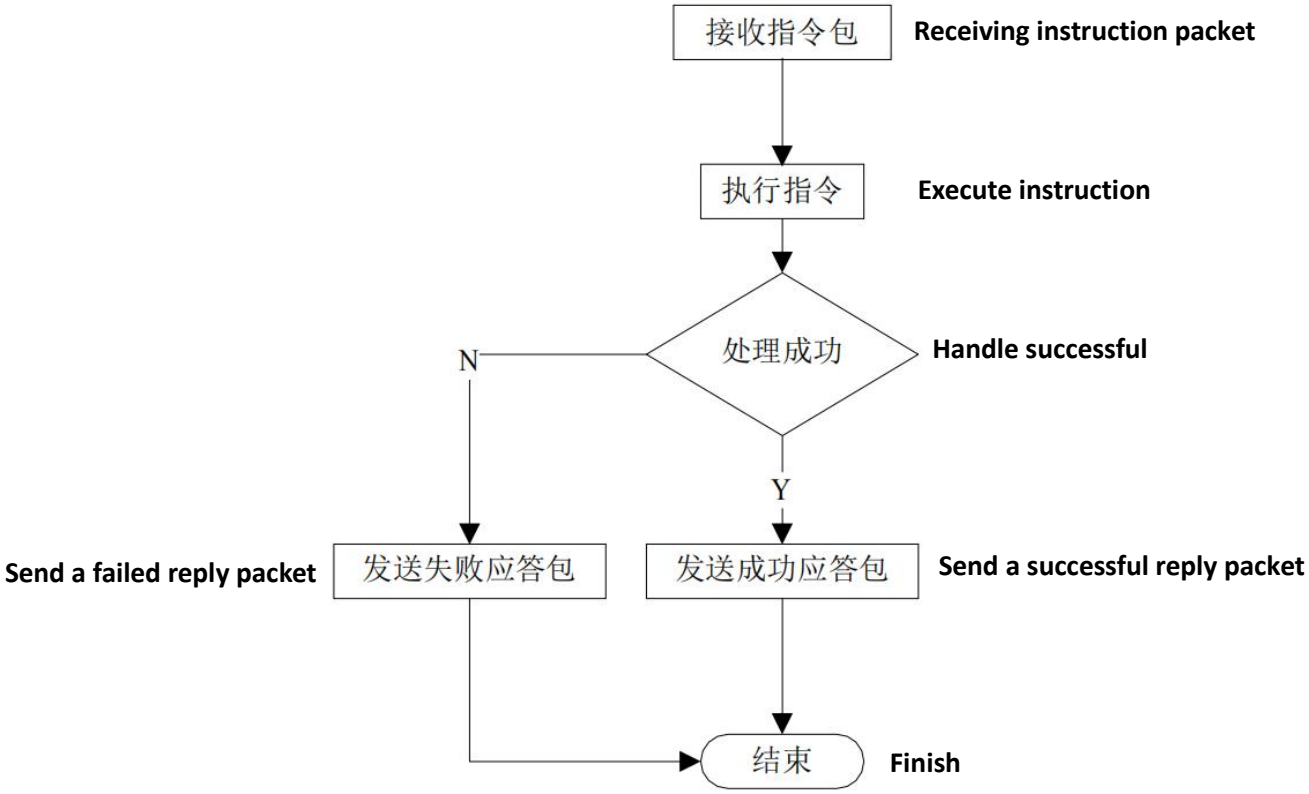
Confirmation code=07H: without enough feature information;

Confirmation code=06H: images with too low quality;

Ⅵ Operation Process

Basic Communication process

UART command package processing



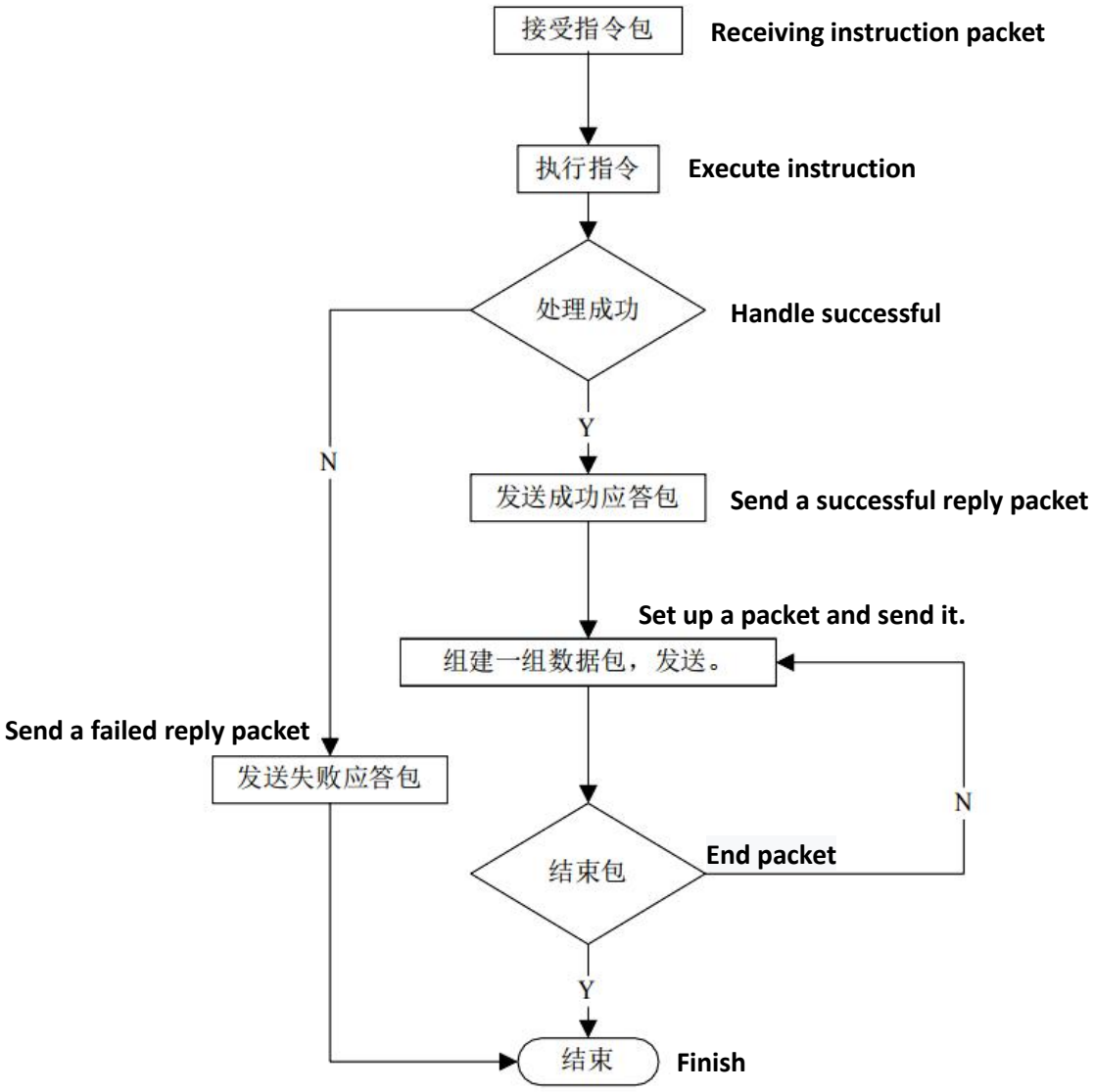
功能实现示例 1：UART命令包的处理过程

UART packet sending process

Before the data packet is transmitted through UART, the instruction packet of the transmitted data packet shall be received first, and the successful reply packet shall be sent after the transmission preparation is made, and the data packet shall be transmitted finally.Packet mainly includes: packet header, chip address, packet identity, packet length, data and checksum.

Packet identifiers of data packets are mainly divided into two types: 02H and 08H. 02H: packet with subsequent packets. 08H: the last packet, that is, the end packet.The data length is preset, which can be divided into 32, 64, 128 and 256.

For example, if the data length to be transmitted is 1K bytes and the preset data length in the data packet is 128 bytes, then the data of 1K bytes should be divided into 8 data packets for transmission.Each packet includes: 2 bytes header, 4 bytes chip address, 1 bytes packet identifier, 2 bytes packet length, 128 bytes data and 2 bytes check sum, each packet length is 139 bytes.In addition, among the 8 data packets, the packet id of the first 7 data packets is 02H, and that of the last ending data packet is 08H.Finally, it is important to note that if the end packet length does not reach 139 bytes, it will be transmitted at the actual length and not otherwise expanded to 139 bytes.



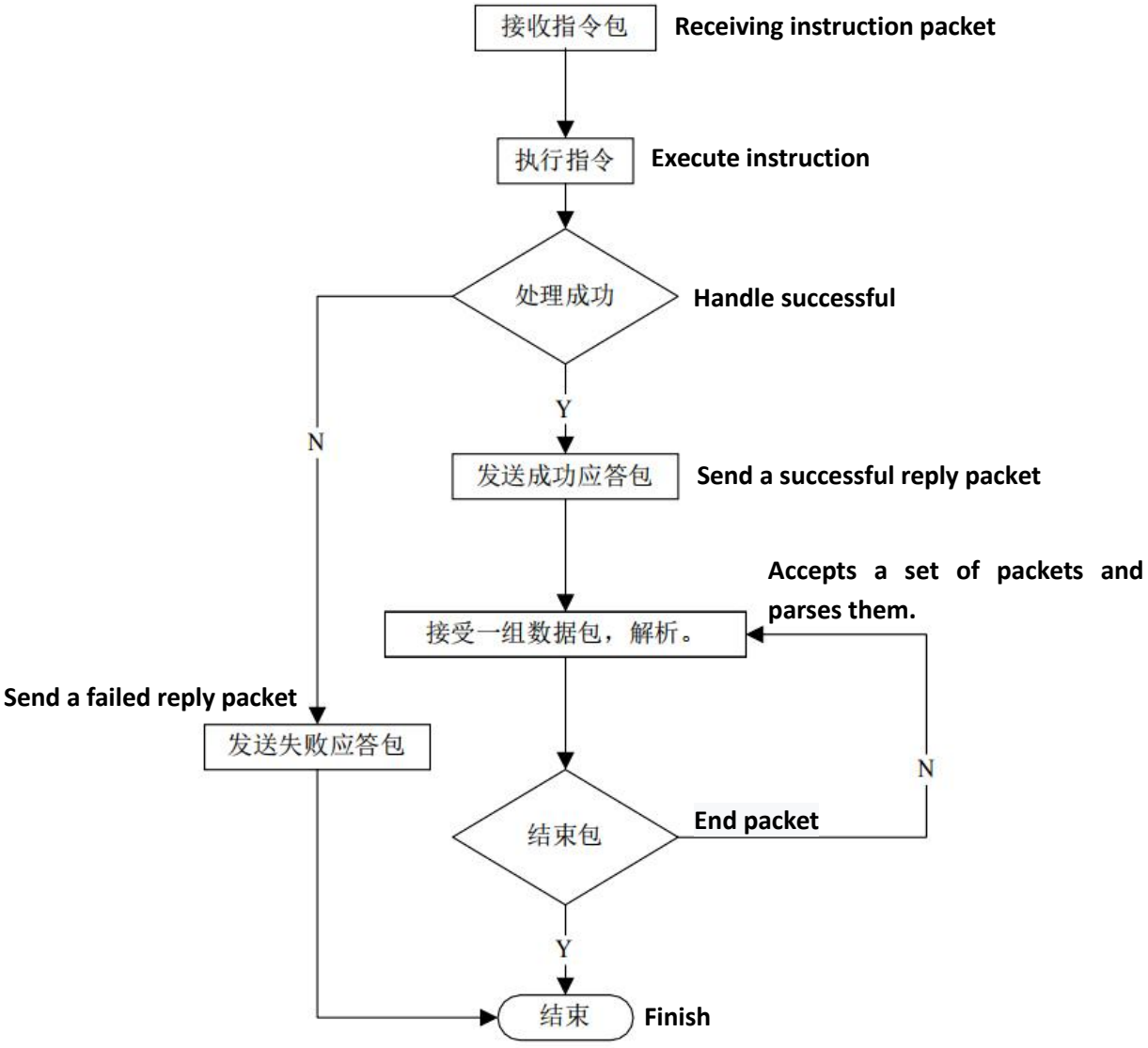
功能实现示例 2：UART 数据包的发送过程

UART packet receiving process

Before the data packet is transmitted through UART, the instruction packet of the transmitted data packet shall be received first, and the successful reply packet shall be sent after the transmission preparation is made, and the data packet shall be transmitted finally.Packet mainly includes: packet header, chip address, packet identity, packet length, data and checksum.

Packet identifiers of data packets are mainly divided into two types: 02H and 08H. 02H: packet with subsequent packets. 08H: the last packet, that is, the end packet.The data length is preset, which can be divided into 32, 64, 128 and 256.

For example, if the data length to be transmitted is 1K bytes and the preset data length in the data packet is 128 bytes, then the data of 1K bytes should be divided into 8 data packets for transmission.Each packet includes: 2 bytes header, 4 bytes chip address, 1 bytes packet identifier, 2 bytes packet length, 128 bytes data and 2 bytes check sum, each packet length is 139 bytes.In addition, among the 8 data packets, the packet id of the first 7 data packets is 02H, and that of the last ending data packet is 08H.Finally, it is important to note that if the end packet length does not reach 139 bytes, it will be transmitted at the actual length and not otherwise expanded to 139 bytes.

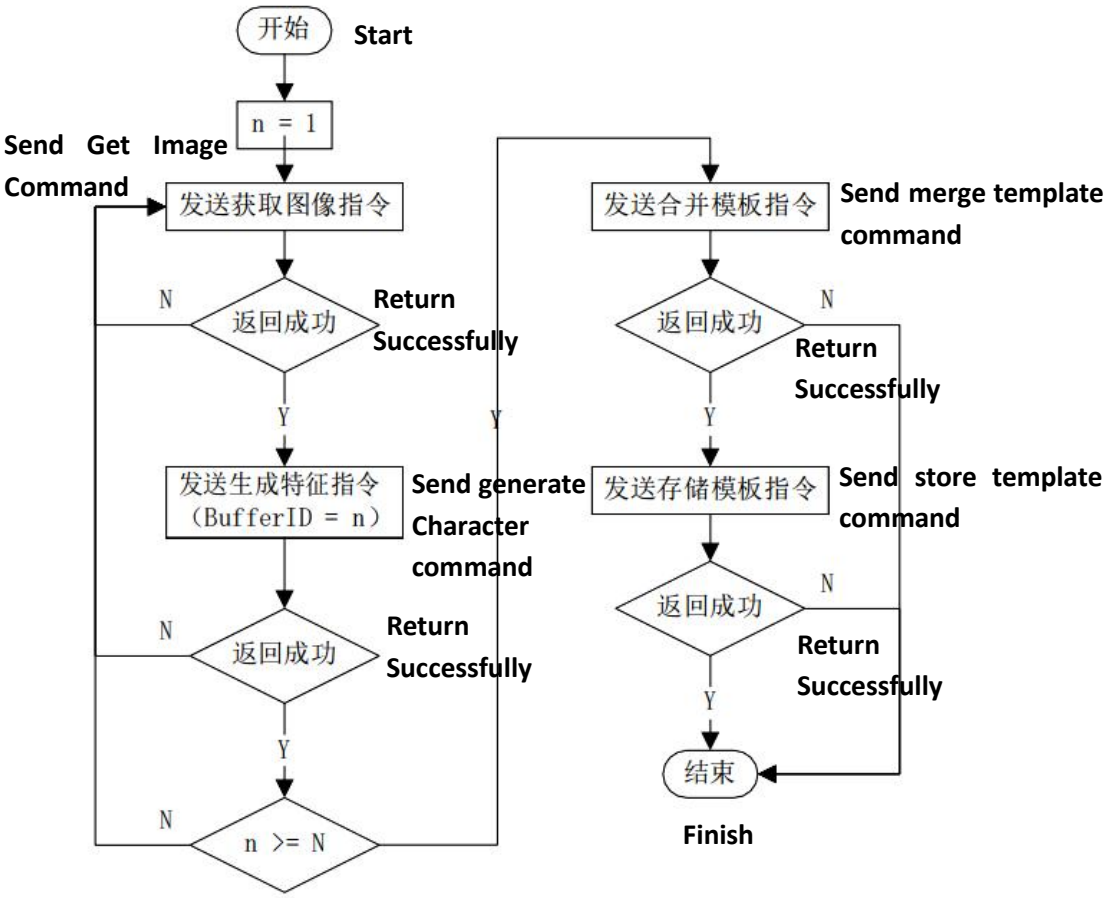


功能实现示例 3：UART 数据包的接收过程

General instruction communication flow

General Instruction Fingerprint Registration Process

The general instruction fingerprint registration process mainly includes: obtaining image for registration, generating feature, merging feature and storing template. Usually N=2.



功能实现示例 4：通用指令注册流程

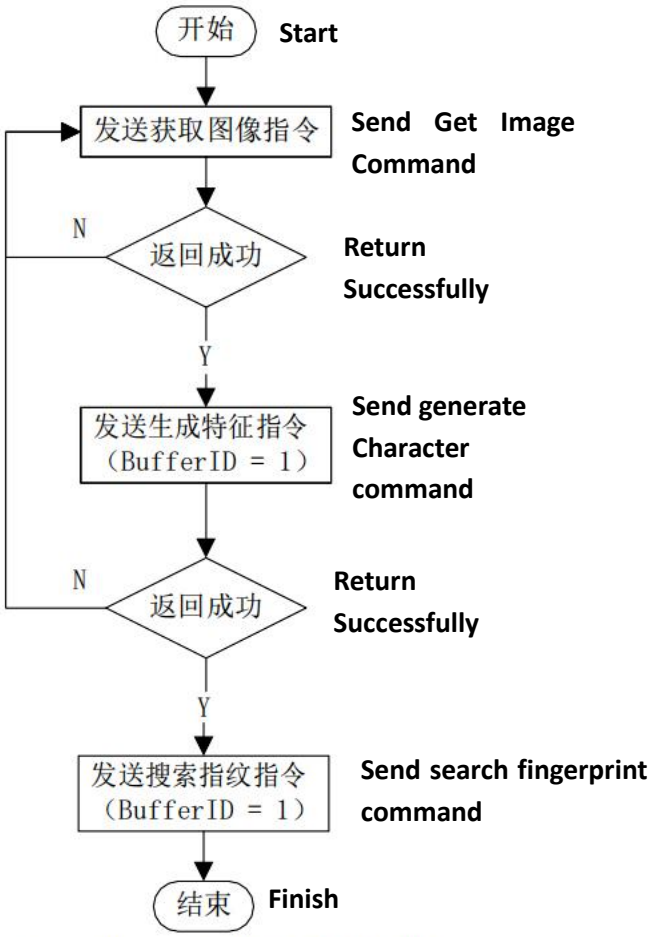
If the registration logic is set to 1, when register fingerprint, if the fingerprints currently collected are similar to those already collected,then the confirmation code in the generates characteristic instruction reply packet will not show success,but returns 28H, indicating that the current fingerprint feature is associated with the previous feature. It should be noted that the cross-correlation is only limited to fingerprints collected during the registration process in this time,and will not be compared with the fingerprints in the fingerprint database.

If the registration logic is set to 2, when register fingerprint,if the fingerprints currently collected are not similar to those already collected,then the confirmation code in the generates characteristic instruction reply packet will not show success,but returns 08H, indicating that the current fingerprint feature is not associated with the previous feature. It should be noted that the cross-correlation is only limited to fingerprints collected during the registration process in this time,and will not be compared with the fingerprints in the fingerprint database.

Whether 28H or 08H is returned, the current fingerprint feature has been extracted successfully. You can re-collect the image and generate features without changing the BufferID, or skip the BufferID of the current round and collect the fingerprint of the next round.

General Instruction Fingerprint Verification Process

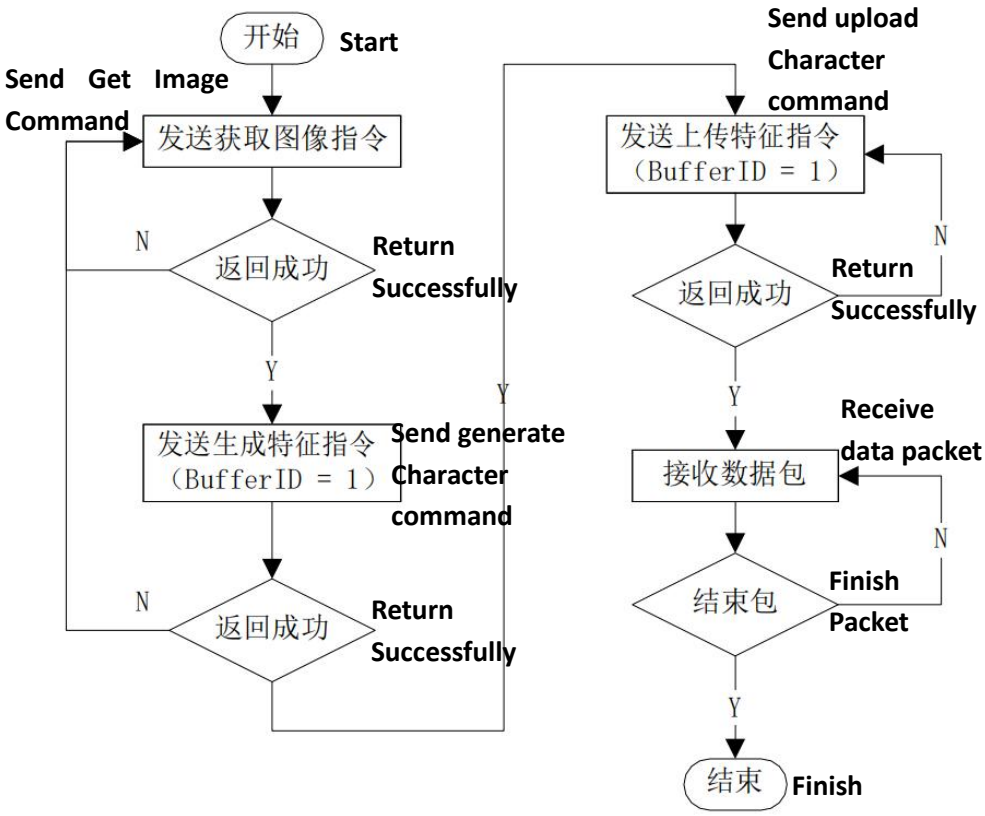
The general instruction fingerprint verification process mainly includes obtaining image, generating feature and searching fingerprint. The default value of BufferID is 1 for sending generated features and searching fingerprints.



功能实现示例 5：通用指令验证流程

Obtain fingerprint from sensor and generate features and upload to the master control

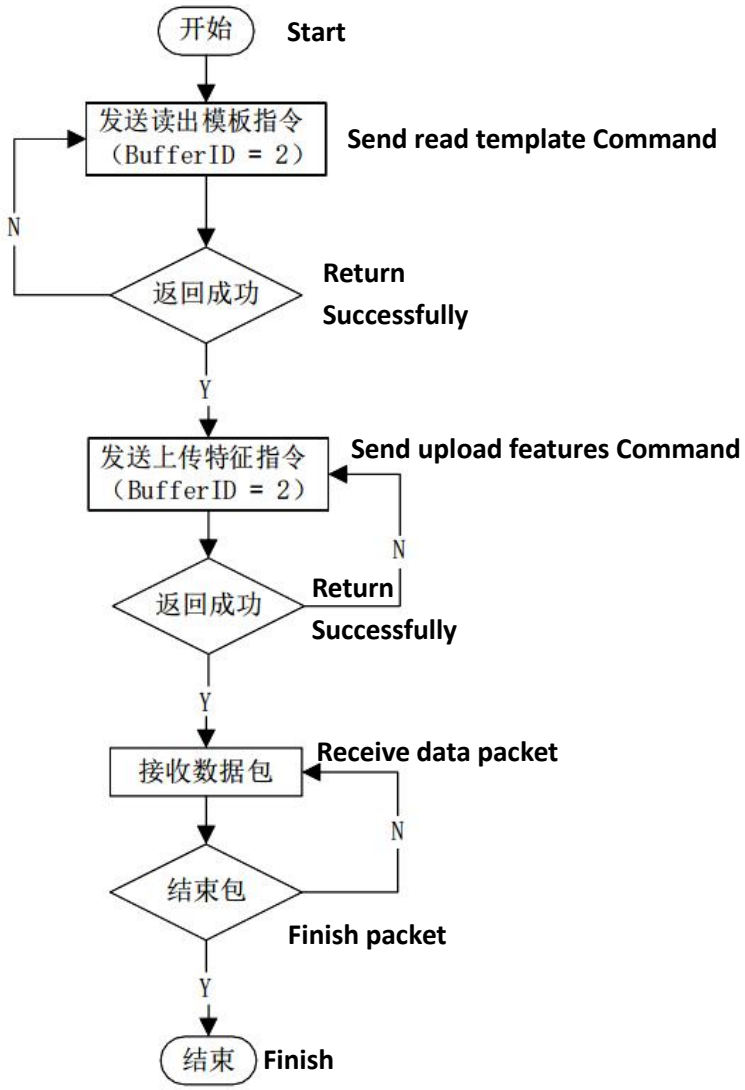
The whole process mainly includes: obtaining images for verification, generating features and uploading features. When sending generate features and upload features, BufferID is set to the default value 1. This function is supported when the encryption level is set to 0.



功能实现示例 6：从传感器获取指纹并生成特征后上传给主控

Upload a specified template from the Flash fingerprint library

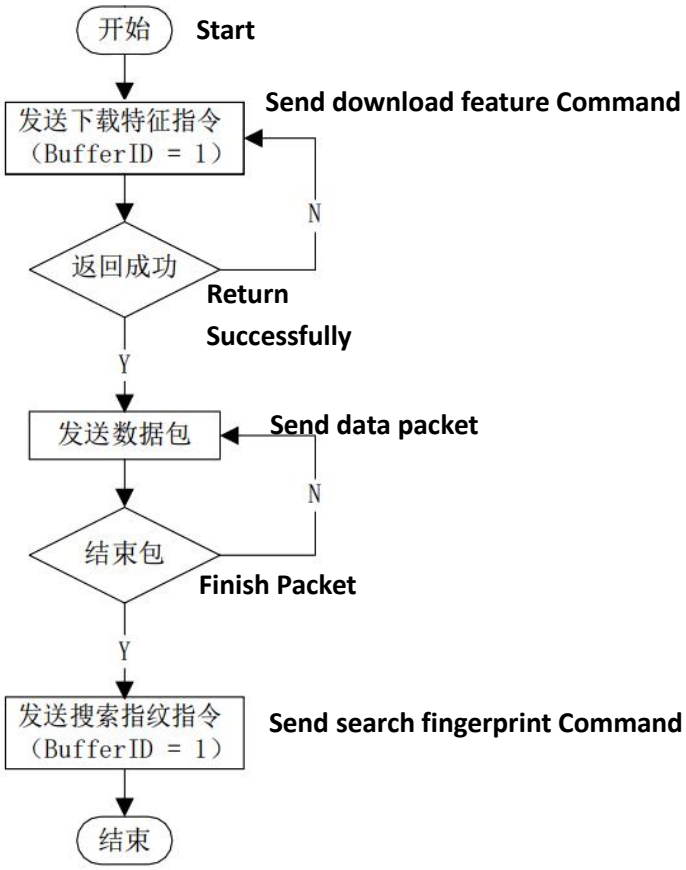
The whole process mainly includes: read templates and upload features. BufferID is set to 2 by default when sending read templates and upload features. This function is supported when the encryption level is set to 0.



功能实现示例 7：从 flash 指纹库中读取一个指定的模板上传

The master downloads a fingerprint feature and searches the fingerprint database with this feature

The whole process mainly includes downloading templates and searching for fingerprints. When downloading templates and searching fingerprints, BufferID is set to the default value 1. This function is supported when the encryption level is set to 0.



功能实现示例 8：主控下载一个指纹特征并以该特征搜索指纹库