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Hitachi Finger Vein Authentication Device H2E

Serial Interface Specification

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All the information contained in this document is subject to change without prior notice.

Urban Planning and Development Systems Company,

Hitachi, Ltd.

Revision History

No.	Date	Chapter	Description	Remarks
2.0	Oct. 2, 2010	-	New release	Based on Japanese Ver. 2.00
2.1	June 17,2011	-	Added firmware version table	Based on Japanese Ver. 2.01

Firmware version

No.	Model name	Firmware version	Remarks
1	PCT-KCC5031/PCT-KCC9031	02-00	New release
2	PCT-KCC5031/PCT-KCC9031	02-01	Fixed wrong detection of flash ROM error (i.e. 7Ch).

1. Introduction

This document describes the communication and command interface of the embedded type Hitachi Finger Vein Authentication Device (hereafter referred to as "H2E"). H2E is able to store the template data of finger vein in either a non-volatile memory (i.e. flash ROM) or a volatile memory (i.e. SDRAM) installed inside the H2E itself. Therefore, the host system is not required to store the template data.

1.1 Scope of the document

Fig. 1-1 shows the scope of this document.

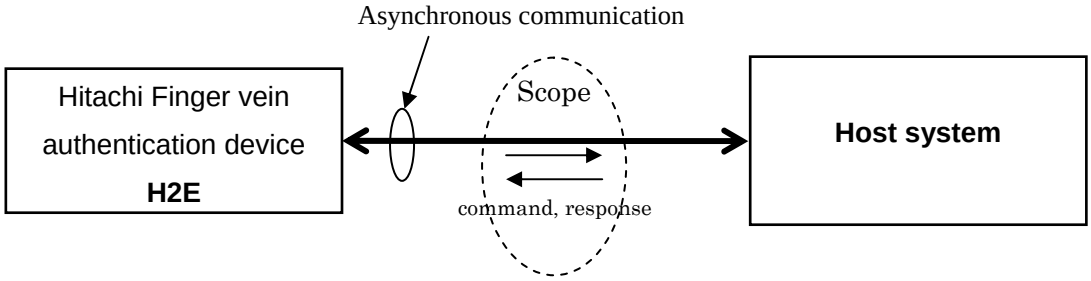


Fig.1-1 Scope of the document

1.2 Description

(1) A subscripted suffix “h” (e.g. “1234h”) means that the numeral is hexadecimal.

(2) Definition of symbols

No.	Symbol	Meaning
1	BYTE	8 bit unsigned integer
2	WORD	16 bit unsigned integer in big-endian format
3	DWORD	32 bit unsigned integer in big-endian format

The number in brackets after any of the symbols shown above represents the total length of data. For example, “BYTE[3]” means there are 3 bytes of data.

(3) A bit is shown as “bit”. The number after the “bit” will represent the numeral of the bit referred. The very right end bit is bit0. Counting right to left from bit0, the very left bit in the case of “BYTE” will be bit7, “WORD” will be bit15 and “DWORD” will be bit31. Therefore, the binary data “00100000” will be shown as “bit5 is ON”.

1.3 Related document

(1) Hitachi Finger Vein Authentication Device (PCT-KCC50*1/PCT-KCC90*1) Application Notes

2. Interface Specification

2.1 Communication specification

H2E communicates with the host system by an asynchronous serial interface. Table 1 shows the serial interface specification.

Table 1 Serial communication specification

No.	Item	Specification
1	Signal level	3.3V CMOS level
2	Speed	57,600bps or 19,200bps (Factory setting)
3	Flow control	None (The communication line consists of Tx and Rx only)
4	Parity	Odd
5	Data length	8 bit
6	Start bit length	1 bit
7	Stop bit length	1 bit
8	Character code	Binary
9	Synchronization method	Asynchronous communication

2.2 Communication protocol

(1) When powered on, the H2E becomes ready, and sends the following data to the host system. The host system is then permitted to communicate and send commands to H2E, after receiving this data.

Offset	Size	Description
0	BYTE	00h
1	WORD	0003h (Byte length of the following data, Big endian)
3	BYTE[3]	4Fh, 4Bh, 0Dh (“OK”CR (carriage return))

(2) If the host system and H2E are powered on at the same time, the host system may not receive the above command because of internal processing time required by the host system.

If there is no response for one second, the host system can check whether the H2E is ready or not by sending “Get Information” command described in 2.3.8.

(3) H2E will send an error message to the host system and clear all the commands received up to that point if H2E has not finish receiving all the command data within 1.2 seconds after receiving the first byte.

(4) The host system will not send out a new command until it receives the response from H2E.

(5) When H2E receives a command from the host system, it responses within 10 seconds to any command. Therefore the host system should judge that there is no response from H2E after waiting for 10 seconds.

(6) When H2E detects an abnormal state, it performs internal reset automatically and sends “OK”CR (carriage return) like right after power on. Therefore the host system must judge that an abnormal condition happened in H2E, when it received such a response other than right after power on.

2.3 Command format specification

2.3.1 Group of template data

(1) Template data of finger vein is specified by group number and template number, which are saved in the memory of H2E.

The data length of each number is 16 bit in big-endian format.

(2) The most significant bit of the group number means physical memory. The template data of group number 0000h through 7FFFh is stored in the non-volatile memory (i.e. flash ROM), while the template data of group number 8000h through FFFFh is stored in the volatile memory (i.e. SDRAM).

(3) The total number of template data, which can be stored in the memory is described in 2.3.6.

When 1:N verification is specified, the verification is executed in each respective group.

(4) The following is an example of the groupings. As of group number 0000h, you can see it containing several template data. The same template number cab be used if in different groups.

Group number	Memory	Template number
0000h	Flash ROM	0001h
		0020h
		0030h
		0032h
0202h	Flash ROM	0001h
8303h	SDRAM	0001h

Again, if the group number differs, the same template number may be used.

2.3.2 Template quality information

If an option bit is specified for “Enroll template data” command, the template quality information can be obtained. The template quality information is the number between 1 and 5 and which means how much the quality of the template data is appropriate for verification. The bigger number means the quality is better and appropriate for verification. Please refer to section 1.3 Related document in this document.

2.3.3 Verification level information

If an option bit is specified for “Verification” command, the verification level information can be obtained. The verification level is the number between 1 and 3 and which means how much the scanned finger is similar to the enrolled template data. The bigger number means the scanned finger is more similar to the enrolled template. Please refer to section 1.3 Related document in this document.

2.3.4 Command format

The following table shows the command format sent from the host system to H2E.

Table 2-2 command format

Offset	Size	Description
0	BYTE	Command code
1	WORD	Byte length of the following data (n). It must be specified by big-endian.
3	BYTE[n]	The following data

2.3.5 Response format

(1) The following table shows a general response data format sent from H2E to the host system.

Table 2-3 general response format

Offset	Size	Description
0	BYTE	Result 00h:Normal end 01h:Error
1	WORD	Byte length of the following data (n). It is described by big-endian.
3	BYTE[n]	The following data

(2) If a command is accepted, H2E sends responses in the following format. Other offsets may be added for some commands.

Table 2-4 Normal response format

Offset	Size	Description
0	BYTE	00h:Normal end
1	WORD	0000h (big endian)

(3) If an error occurs, H2E responds in the following response formats.

Table 2-5 Error response format

Offset	Size	Description
0	BYTE	01h:Error
1	WORD	0001h (big endian)
3	BYTE	Error code. Refer to 3. Error code list.

(4) Some commands has an option bit to send data when scan has been completed. The option is used to inform a user to remove his/her finger in case processing time is expected to be long. (e.g. N is big in 1:N verification. Enroll a template data in a group where many templates are already stored.)

The following table shows a response format of scanning completion.

Table 2-6 Response at scanning completion

Offset	Size	Description
0	BYTE	00h:
1	WORD	0001h (big endian)
2	BYTE	AAh

Even if the option bit is specified, H2E may not send the scanning completion response and send an error response in case scanning is not done. For example, a template was not found or command error occurred. Therefore software of the host system must be designed to treat any of the following cases if the option bit is specified.

(a) Scanning completion response + error response

(b) Scanning completion response + normal response

(c) Error response

2.3.6 Initialization of template area

Finger vein pattern is scanned, converted to template data and the template data is stored in Flash ROM or SDRAM in H2E. These areas need initialization prior to store template data shown in 2.3.14 “Initialize template data area” command.

Enroll mode must be specified to initialize template area. There are two commands shown as Table 2-7. N of 1:N verification and the maximum template number to be stored is different.

Table 2-7 Enrollment mode and maximum N of 1:N verification

No.	Enroll mode	Max. N	Max. Enroll template data	
			Flash ROM	SDRAM
1	C2h: Twice scanning and twice enrollment	15	360	15
2	C3h: Three times scanning and three times enrollment	10	230	10

In order to change enrollment mode, initialization is necessary. The template data enrolled by the other modes cannot be used.

2.3.7 Commands from Host system to H2E

The following table shows commands sent from the host system to H2E.

Table 2-8 Command list

No.	Command code	Function
1	12h	Get Information
2	13h	Hardware reset
3	14h	Release PASS_DRIVER
4	21h	Enroll template data
5	16h	Delete template data (Individual)
6	17h	Delete template data (Group)
7	18h	Initialize template area
8	19h	1:1 verification
9	1Ah	1:N verification (Group)
10	1Fh	1:N verification (All)
11	1Bh	Get group and template list
12	1Ch	Upload template data
13	1Dh	Download template data
14	1Eh	Set template ID
15	23h	Change template ID
16	20h	Check template data in flash ROM
17	22h	Set security level
18	24h	Set capture mode

2.3.8 Get information

This command is used to acquire information such as firmware version or serial number from H2E.

(1) Command format

Offset	Size	Description
0	BYTE	12h
1	WORD	0001h
3	BYTE	Indicates information to get 00h: Firmware version 01h: Serial number

(2) Normal response from H2E

Offset	Size	Description
0	BYTE	00h
1	WORD	n (Byte length of the following data, Big endian)
3	BYTE[n]	Information data

(3) Error response from H2E

Refer to Table 2-5.

(4) Format of information data

Information	Length (n)	Description
00h	13	“H2E/ver/VV/RR”, where “VV” means version, “RR” means revision. The other data is constant.
01h	12	This shows manufacturing serial number of H2E. This is described by 12 bytes character code. It does not include null-termination code.

H2E sends this response within 7ms after receiving the “Get information” command.

2.3.9 Hardware reset

This command is used to reset H2E.

(1) Command format

Offset	Size	Description
0	BYTE	13h
1	WORD	0000h

(2) Normal response from H2E

Refer to Table 2-4.

(3) Error response from H2E

Refer to Table 2-5.

2.3.10 Release PASS_DRIVER

This command is used to release PASS_DRIVER signal and make it open state (Hi-Z).

When a finger vein data is verified against the enrolled template data, PASS_DRIVER signal goes GND level. To verify the finger vein data, the “Verification” command is used.

The signal changes to open state within 3ms after receiving this command.

(1) Command format

Offset	Size	Description
0	BYTE	14h
1	WORD	0000h

(2) Normal response from H2E

Refer to Table 2-4.

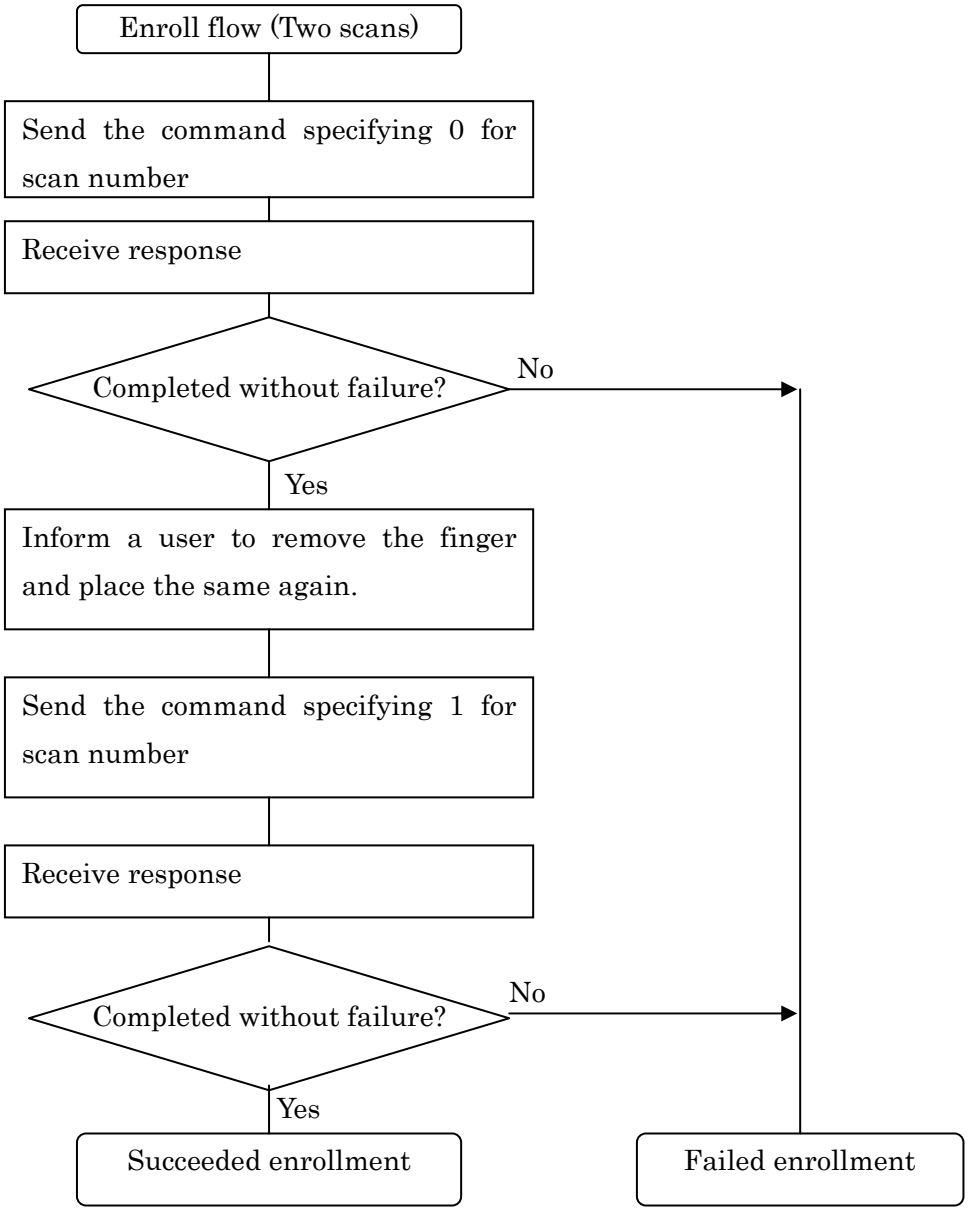
(3) Error response from H2E

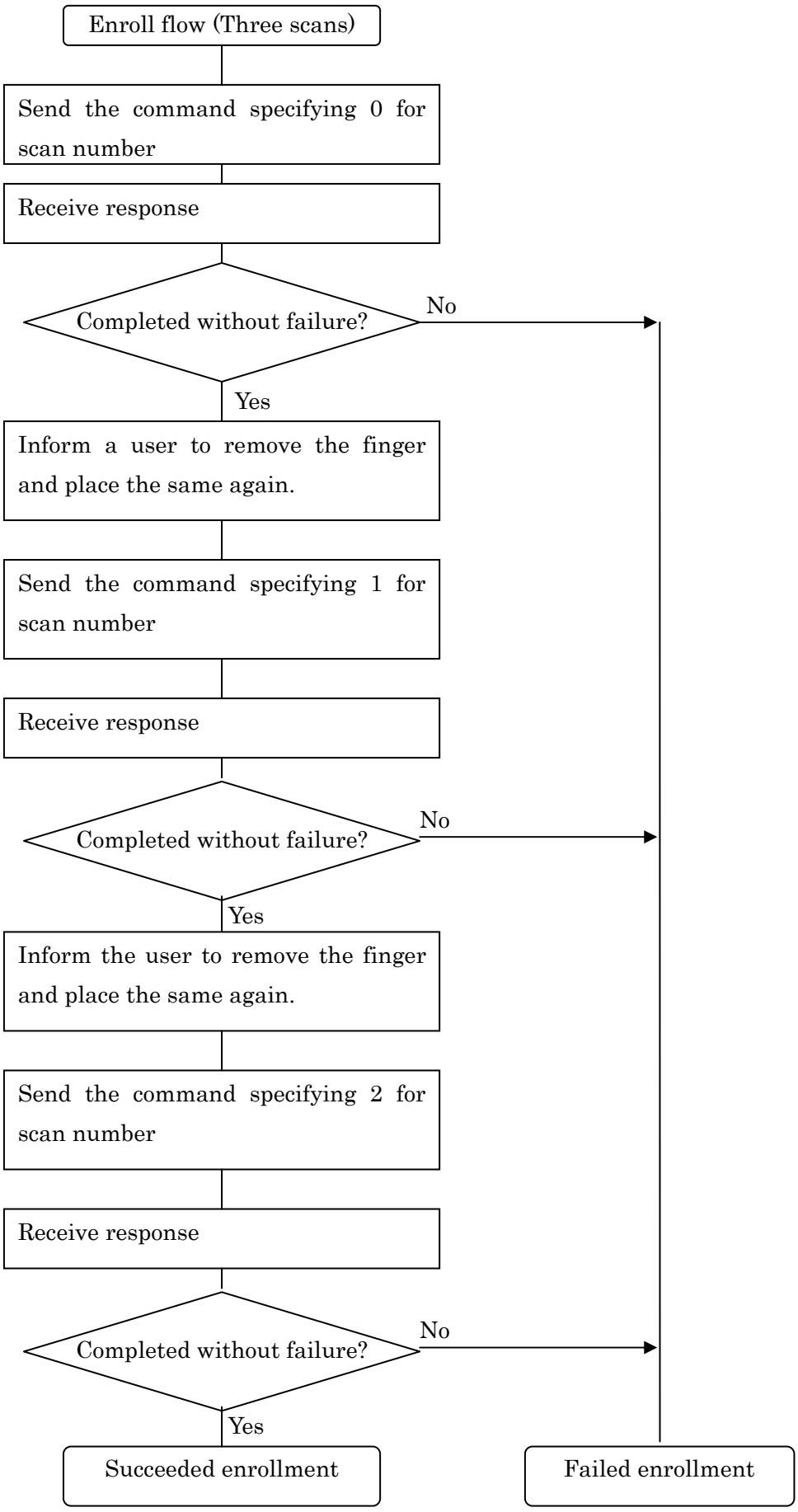
Refer to Table 2-5.

2.3.11 Enroll template data

This command is used to capture finger vein pattern, make template data, and store the data in the flash ROM or SDRAM of H2E. When stored, the template data will be stored and identified by a combination of a specified group number and a template number.

To enroll template data, two or three scans are necessary for a finger. The following flow chart shows how to enroll template data.




Enroll flow (Three scans)
Send the command specifying 0 for scan number
Receive response
Completed without failure?
No
Yes
Inform a user to remove the finger and place the same again.
Send the command specifying 1 for scan number
Receive response
Completed without failure?
No
Yes
Inform the user to remove the finger and place the same again.
Send the command specifying 2 for scan number
Receive response
Completed without failure?
No
Yes
Succeeded enrollment
Failed enrollment

The scan number must start from 0, the next is 1 for two scans, and 0 → 1→ 2 for three scans. After receiving response, a user must remove his/her finger once.

(1) Command format

Offset	Size	Description
0	BYTE	21h
1	WORD	0005h (Byte length of the following data, Big endian)
3	BYTE	bit 0 to 1:Scan number (0 to2) bit 2 :If this bit is ON, H2E sends response shown in Table 2-6 after scanning and sends response (2) or (3). If a scan is not executed, H2E does not send scan response. Refer to 2.3.5 (4) bit 3: OFF: Scan twice. ON: Scan three times. bit 4 to 6 must be kept OFF bit 7: ON Response with template quality information
4	WORD	Group number 0000h to 7FFFh: Template data stored in flash ROM 8000h to FFFFh: Template data stored in SDRAM
6	WORD	Template number (0000h to FFFFh)

(2) Normal response from H2E (Other than the last scan and template quality information bit is OFF)

Offset	Size	Description
0	BYTE	00h (Normal end)
1	WORD	0001h (Byte length of the following data, Big endian)
3	BYTE	55h

(3) Normal response from H2E (Other than the last scan and template quality information bit is ON)

Offset	Size	Description
0	BYTE	00h (Normal end)
1	WORD	0001h (Byte length of the following data, Big endian)
3	BYTE	55h
4	BYTE	Template quality between 1 to 5 (The best is 5)

(4) Normal response from H2E (The last scan and template quality information bit is OFF)

Offset	Size	Description
0	BYTE	00h (Normal end)
1	WORD	0005h (Byte length of the following data, Big endian)
3	BYTE	00h
4	WORD	Enrolled group number
6	WORD	Enrolled template number

(5) Normal response from H2E (The last scan and template quality information bit is ON)

Offset	Size	Description
0	BYTE	00h (Normal end)
1	WORD	0005h (Byte length of the following data, Big endian)
3	BYTE	Template quality between 1 to 5 (The best is 5)
4	WORD	Enrolled group number
6	WORD	Enrolled template number

(6) Error response from H2E

Offset	Size	Description
0	BYTE	01h (Error)
1	WORD	0005h (Byte length of the following data, Big endian)
3	BYTE	Error code. Refer to error code list.
4	WORD	Group number
6	WORD	Template number

2.3.12 Delete template data (Individual)

This command is used to delete a template data specified by the group number and the template number.

(1) Command format

Offset	Size	Description
0	BYTE	16h
1	WORD	0005h (Byte length of the following data, Big endian)
3	BYTE	00h
4	WORD	Group number 0000h to 7FFFh: Template data stored in flash ROM 8000h to FFFFh: Template data stored in SDRAM
6	WORD	Template number

(2) Normal response from H2E

Refer to Table 2-4.

(3) Error response from H2E

Refer to Table 2-5.

2.3.13 Delete template data (Group)

This command is used to delete template data specified by group number.

Command format

Offset	Size	Description
0	BYTE	17h
1	WORD	0003h (Byte length of the following data, Big endian)
3	BYTE	00h
4	WORD	Group number 0000h to 7FFFh: Template data stored in flash ROM 8000h to FFFFh: Template data stored in SDRAM

(2) Normal response from H2E

Refer to Table 2-4.

(3) Error response from H2E

Refer to Table 2-5.

2.3.14 Initialize template data area

This command is to delete all the template data and initialize template data storage area within the flash ROM or SDRAM. (See note 1) Time frame required to delete the template data stored in flash ROM is approximately six (6) seconds maximum.

(1) Command format

Offset	Size	Description
0	BYTE	18h
1	WORD	0002h (Byte length of the following data, Big endian)
3	BYTE	Storage area flag 01h: Delete all the template data stored in flash ROM. (See note 2) 02h: Delete all the template data stored in SDRAM. (See note 3and 4) 03h: Delete all the template data stored in both the flash ROM and in SDRAM.
4	BYTE	Specify enrollment mode. Refer to 2.3.11 for commands. Refer to Table 2-7 of 2.3.6 for value. C2h: Scan twice and enroll two templates. C3h: Scan three times and enroll three templates.

Note 1: The template data storage area is consists of flash ROM and SDRAM. If the flash ROM area is not initialized, template data cannot be written in both the flash ROM and in SDRAM.

Note 2: When the flash ROM area is initialized by specifying 01h to storage area flag, SDRAM area will be initialized as well if enrollment mode (refer to 2.3.6) is different from previous one. It includes when the flash ROM is not initialized.

Note 3: It is impossible to initialize only SDARM if flash ROM area is not initialized.

Note 4: When only SDRAM area is specified, it is impossible to initialize other than the current enroll mode.

(2) Normal response from H2E

Refer to Table 2-4.

(3) Error response from H2E

Refer to Table 2-5.

2.3.15 1:1 Verification

This command is used to verify the captured finger vein pattern against the enrolled template data identified by group number and template number. Maximum 6 enrolled templates can be specified.

A user must place the enrolled finger right after the command is issued.

Once verified, PASS_DRIVER signal goes GND level. To return it to open state, use the “Release PASS_DRIVER” command.

(1) Command format

Offset	Size	Description
0	BYTE	19h
1	WORD	1+4 x n (Byte length of the following data, Big endian) “n” is from 1 to 6.
3	BYTE	bit0～bit6 : must be kept OFF bit7: ON Response with velification level information
4	WORD	Group number 0000h to 7FFFh: Template data stored in flash ROM 8000h to FFFFh: Template data stored in SDRAM
6	WORD	Template number
7	(n-1) pairs of a group number and a template number are specified.	

(2) Normal response from H2E (Verification level information bit is OFF)

Offset	Size	Description
0	BYTE	00h (Normal end)
1	WORD	0002h (Byte length of the following data, Big endian)
3	BYTE	00h
4	BYTE	The index number of verified template. "0" means the first template was verified.

(3) Normal response from H2E (Verification level information bit is ON)

Offset	Size	Description
0	BYTE	00h (Normal end)
1	WORD	0002h (Byte length of the following data, Big endian)
3	BYTE	Verification level between 1 and 3 (The best is 3)
4	BYTE	The index number of verified template. "0" means the first template was verified.

(4) Error response from H2E

Refer to Table 2-5.

2.3.16 1:N Verification (Group)

This command is used to verify captured finger vein pattern against the template data identified by group number only. A user must place the enrolled finger right after the command is issued.

Plural groups can be specified. For example, [1Ah 00h, 0Bh, 00h, 22h, 22h, 11h, 11h, 44h, 44h, 55h, 55h, 33h, 33h] are sent, H2E will execute 1:N verification in a group by the order of 2222h, 1111h, 4444h, 5555h, 3333h. If plural groups are specified, H2E responds when the verification is succeeded and the rest of the groups are not verified. For example, if verification is succeeded in the group 2222h, H2E won't verify the group 1111h, 4444h, 5555h and 3333h.

When the verification succeeds, PASS_DRIVER signal goes GND level. To return it to open state, use the "Release PASS_DRIVER" command.

(1) Command format

Offset	Size	Description
0	BYTE	1Ah
1	WORD	1+2 x n (Byte length of the following data, Big endian)
3	BYTE	Option setting bit 0=ON: Send the response shown in the Table 2-6 after a scan is completed and sends response between (2) and (4). If the scan is not executed, scan end response will not be sent. (Refer to 2.3.5(4)) bit 1 to 6 must be kept OFF. bit7: ON Response with velification level information (The information is available when verification was succeeded)
4	WORD	Group number 0000h to 7FFFh: Template data stored in flash ROM 8000h to FFFFh: Template data stored in SDRAM

(2) Normal response from H2E (Verification level information bit is OFF)

Offset	Size	Description
0	BYTE	00h (Succeeded verification)
1	WORD	0005h (Byte length of the following data, Big endian)
3	BYTE	00h
4	WORD	Verified group number
6	WORD	Verified template number

(3) Normal response from H2E (Verification level information bit is ON)

Offset	Size	Description
0	BYTE	00h (Succeeded verification)
1	WORD	0005h (Byte length of the following data, Big endian)
3	BYTE	Verification level between 1 and 3 (The best is 3)
4	WORD	Verified group number
6	WORD	Verified template number

(4) Error response from H2E

Refer to Table 2-5.

2.3.17 1:N Verification (All)

This command is used to verify the captured finger vein pattern against all the template data in flash ROM and SDRAM. A user must place the enrolled finger right after the command is issued.

H2E can execute the command if the total enrolled template data in both flash ROM and SDRAM is less than max. N in Table 2-7. If it exceeds max. N, H2E responds an error.

When the verification succeeds, PASS_DRIVER signal goes GND level. To return it to open state, use the “Release PASS_DRIVER” command.

(1) Command format

Offset	Size	Description
0	BYTE	1Fh
1	WORD	0001h (Byte length of the following data, Big-endian)
3	BYTE	Option setting bit 0=ON: Send the response shown in the table 2-6 after a scan is completed and sends response (2) or (3). If the scan is not executed, scan end response will not be sent. (Refer to 2.3.5(4)) bit 1 to 6 must be kept OFF. bit7: ON Response with velification level information (The information is available when verification was succeeded)

(2) Normal response from H2E (Verification level information bit is OFF)

Offset	Size	Description
0	BYTE	00h (Succeeded verification)
1	WORD	0005h (Byte length of the following data, Big-endian)
3	BYTE	00h
4	WORD	Verified group number
6	WORD	Verified template number

(3) Normal response from H2E (Verification level information bit is ON)

Offset	Size	Description
0	BYTE	00h (Succeeded verification)
1	WORD	0005h (Byte length of the following data, Big-endian)
3	BYTE	Verification level between 1 to 3 (The best is 3)
4	WORD	Verified group number
6	WORD	Verified template number

(4) Error response from H2E

Refer to Table 2-5.

2.3.18 Get group and template list

This command is used to acquire the group number and template number list.

(1) Command format

Offset	Size	Description
0	BYTE	1Bh
1	WORD	0000h (Byte length of the following data, Big endian)

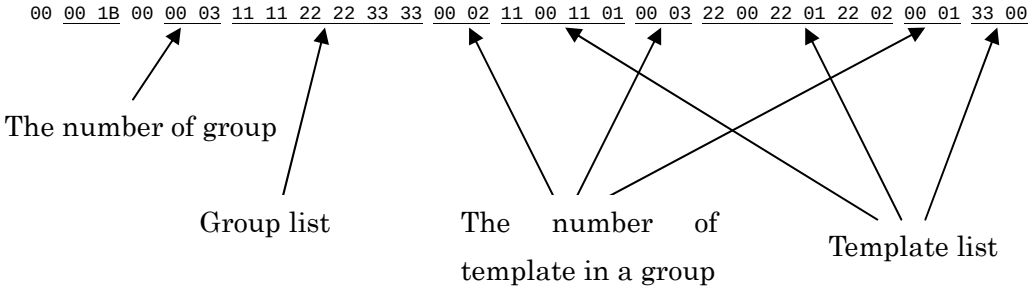
(2) Normal response from H2E

Offset	Size	Description
0	BYTE	00h
1	WORD	xxxxh (Byte length of the following data, Big endian) This number varies and depends on the enrolled template number.
3	BYTE	00h
4	WORD	**G**: Number of group
6	WORD[**G**]	Group number list consists of **G** groups. H2E transmits the enrolled group number by 2 bytes each.
6+(2 x **G**)	WORD	$\mathbf{T_0}$: The number of enrolled template data in a group
8+(2 x **G**)+2	WORD[$\mathbf{T_0}$]	Template number list in a group consists of $\mathbf{T_0}$ template data. H2E transmits the enrolled template number by 2 bytes each.
	WORD	$\mathbf{T_1}$: The number of enrolled template data in a group
	WORD[$\mathbf{T_1}$]	Template number list in a group consists of $\mathbf{T_1}$ template data. H2E transmits the enrolled template number by 2 bytes each.
		Repeat the data above

Example of the list

Group number	Template number
1111h	1100h
	1101h
2222h	2200h
	2201h
	2202h
3333h	3300h

If the template data is enrolled in H2E as above, H2E transmits the following data.



(3) Error response from H2E

Refer to Table 2-5.

2.3.19 Upload template data

This command is to upload the template data stored in H2E to the host system. The template data can be uploaded by identifying the template ID. The uploaded template data can be downloaded back to H2E by using the “Download template data” command. In this case, the same template ID must be identified and used for both data upload and data download. To set the template ID, refer to the “Set template ID” command. Although the setting of template ID is not always necessary, we recommend using an ID for security reasons.

Note: The template data will be encrypted regardless of whether setting or not setting a template ID.

(1) Command format

Offset	Size	Description
0	BYTE	1Ch
1	WORD	0005h (Byte length of the following data, Big-endian)
3	BYTE	00h
4	WORD	Group number 0000h to 7FFFh: Template data stored in flash ROM 8000h to FFFFh: Template data stored in SDRAM
6	WORD	Template number

(2) Normal response from H2E

In case of enroll mode C2h

Offset	Size	Description
0	BYTE	00h
1	WORD	0439h (Byte length of the following data, Big-endian)
3	BYTE	00h
4	BYTE[1072]	Template data
1076	DWORD	ADD check sum. Divide the uploaded template data into 4 byte data. Therefore the original BYTE[1072] template data will be divided into 268 data blocks. Add all 268 data blocks and store the least significant 32bit data from the calculation result.
1080	DWORD	XOR check sum. Divide the uploaded template data into 4 byte data. Therefore the original BYTE[1072] template data will be divided into 268 data blocks. Execute XOR all 268 data and store the result from the calculation result.

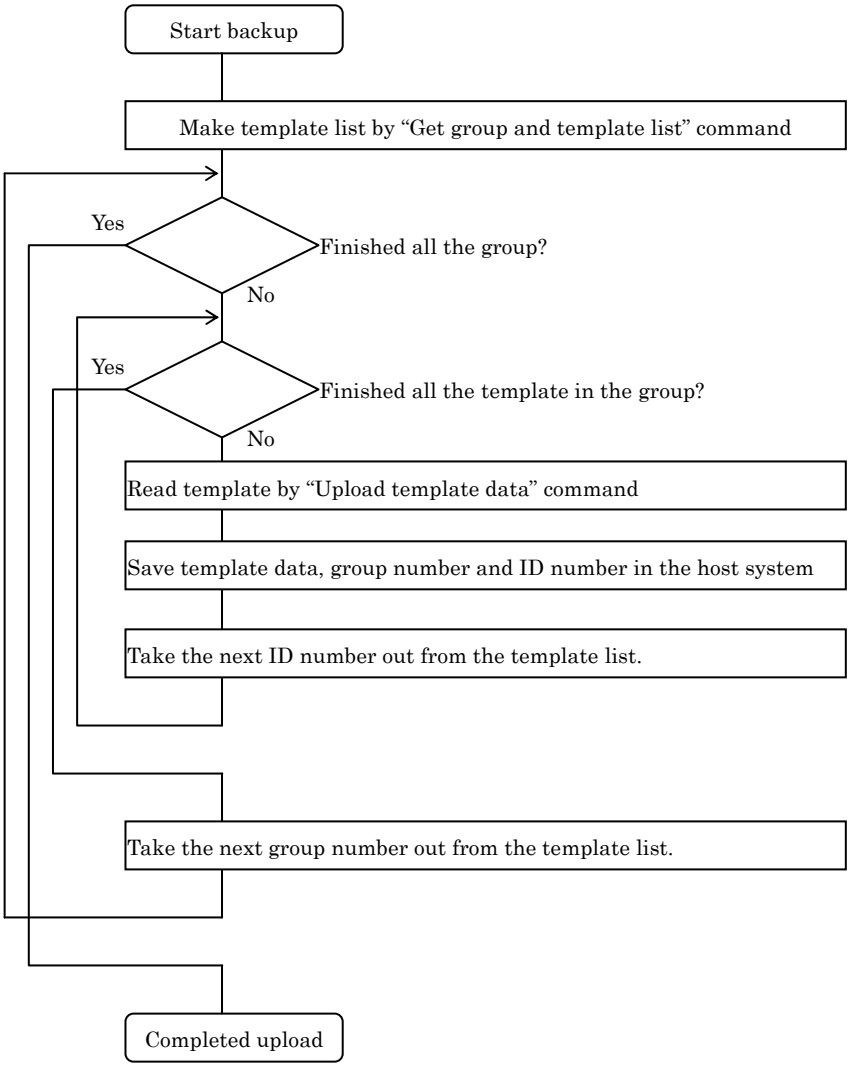
In case of enroll mode C3h

Offset	Size	Description
0	BYTE	00h
1	WORD	0639h (Byte length of the following data, Big-endian)
3	BYTE	00h
4	BYTE[1584]	Template data
1588	DWORD	ADD check sum. Divide the uploaded template data into 4 byte data. Therefore the original BYTE[1584] template data will be divided into 396 data blocks. Add all 396 data blocks and store the least significant 32bit data from the calculation result.
1592	DWORD	XOR check sum. Divide the uploaded template data into 4 byte data. Therefore the original BYTE[1584] template data will be divided into 396 data blocks. Execute XOR all 396 data and store the result from the calculation result.

(3) Error response from H2E

Refer to Table 2-5.

The following flow chart shows an example how to upload all the template data in H2E.



2.3.20 Download template data

This command is used to download template data from the host system back to H2E. If the template data in the system was uploaded to the host system by specifying the template ID, the same template ID must be set before downloading the template data back to H2E. To set the template ID, refer to the “Set template ID” command.

It is impossible to write template data if “enroll mode” does not match. The enroll mode is specified to initialize template storage area. For example, template data is uploaded after template area is initialized by enroll mode C2, it is impossible to write the template data if the template area is initialized by enroll mode C3.

(1) Command format

In case of enroll mode C2h

Offset	Size	Description
0	BYTE	1Dh
1	WORD	043Dh (Byte length of the following data, Big-endian)
3	BYTE	Option byte bit0: This is an option bit to check if the same finger is already enrolled. 0:Check 1: No check The other bit must be kept 0.
4	WORD	Group number 0000h to 7FFFh: Template data stored in flash ROM 8000h to FFFFh: Template data stored in SDRAM
6	WORD	Template number
8	BYTE[1072]	Template data, which is uploaded to the host system by using the “Upload template data” command.
1080	DWORD	ADD check sum. Divide the downloaded template data into 4 byte data. Therefore the original BYTE[1072] template data will be divided into 268 data blocks. Add all 268 data blocks and store the least significant 32bit data from the calculation result.
1084	DWORD	XOR check sum. Divide the downloaded template data into 4 byte data. Therefore the original BYTE[1072] template data will be divided into 268 data blocks. Execute XOR all 268 data and store the result from the calculation result.

In case of enroll mode C3h

Offset	Size	Description
0	BYTE	1Dh
1	WORD	063Dh (Byte length of the following data, Big-endian)
3	BYTE	Option byte bit0: This is an option bit to check if the same finger is already enrolled. 0:Check 1: No check The other bit must be kept 0.
4	WORD	Group number 0000h to 7FFFh: Template data stored in flash ROM 8000h to FFFFh: Template data stored in SDRAM
6	WORD	Template number
8	BYTE[1584]	Template data, which is uploaded to the host system by using the “Upload template data” command.
1592	DWORD	ADD check sum. Divide the downloaded template data into 4 byte data. Therefore the original BYTE[1584] template data will be divided into 396 data blocks. Add all 396 data blocks and store the least significant 32bit data from the calculation result.
1596	DWORD	XOR check sum. Divide the downloaded template data into 4 byte data. Therefore the original BYTE[1584] template data will be divided into 396 data blocks. Execute XOR all 396 data and store the result from the calculation result.

If bit0:0 is specified, it takes long time to write template data if a lot of template data already exist. It is recommended to initialize template area in advance and download data with bit0:1 if a lot of template data should be downloaded.

(2) Normal response from H2E

Refer to Table 2-4.

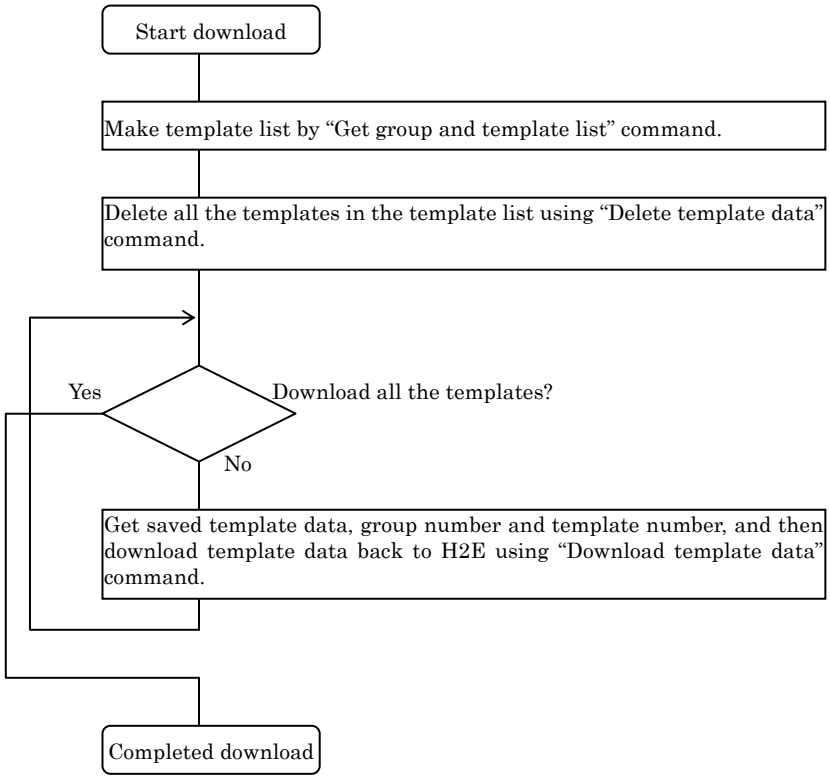
(3) Error response from H2E (If the same template or same finger was already enrolled in the specified group.)

Offset	Size	Description
0	BYTE	01h (Error)
1	WORD	0005h (Byte length of the following data, Big-endian)
3	BYTE	Error code (76h or 79h)
4	WORD	Group number where same template or same finger is enrolled.
5	WORD	Template number where same template or same finger is enrolled.

(4) Error response from H2E (Other than (3))

Refer to Table 2-5.

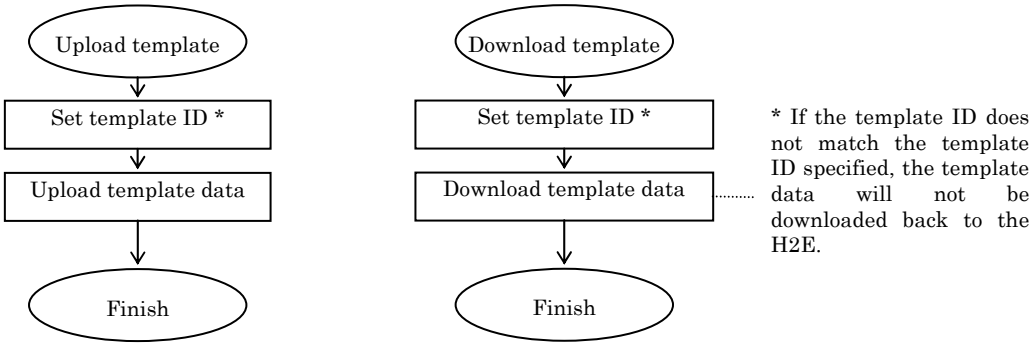
The following flow chart shows an example how to download all the template data back to H2E.



2.3.21 Set template ID

This command is used for security purposes to keep template data secure during uploading and downloading back the data between the host system and H2E. By using this command, if the template data in H2E is uploaded after setting template ID, the template data can only be downloaded back to H2E if the same template ID is specified.

The following flow chart shows how to download or upload the template data.



Note: Once the “Set template ID” command is executed, the template ID is applied for all “Upload template” or “Download template “ command thereafter.

The template ID is initialized to default status when hardware reset command is executed or when the power supply is turned off.

(1) Command format

Offset	Size	Description
0	BYTE	1Eh
1	WORD	0009h (Byte length of the following data, Big-endian)
3	BYTE	00h
4	BYTE[8]	Template ID consists of 8 bytes. If all bits of the data are “0”, it is treated as there is no template ID.

(2) Normal response from H2E

Refer to Table 2-4.

(3) Error response from H2E

Refer to Table 2-5.

2.3.22 Change template ID

Template data is specified by a group number and a template number. This command is to change these numbers. If the most significant bit of the group number is changed, storage area (i.e. flash ROM or SDARM) is changed. Refer to 2.3.1 for storage area.

(1) Command format

Offset	Size	Description
0	BYTE	23h
1	WORD	0009h (Byte length of the following data, Big-endian)
3	BYTE	00h
4	WORD	Current group number to be changed.
6	WORD	Current template number to be changed.
8	WORD	New group number
10	WORD	New template number

(2) Normal response from H2E

Refer to Table 2-4.

(3) Error response from H2E

Refer to Table 2-5.

2.3.23 Check template data in flash ROM

This command is to check if the template data in flash ROM is correct.

If the power supply of H2E is discontinued while saving template data in flash ROM, the template data may become invalid.

(1) Command format

Offset	Size	Description
0	BYTE	20h
1	WORD	0000h (Byte length of the following data, Big-endian)

(2) Normal response from H2E

Offset	Size	Description
0	BYTE	00h (Normal end)
1	WORD	0001h (Byte length of the following data, Big-endian)
3	BYTE	Enroll mode (Refer to 2.3.6) C2h: Scan twice and enroll two templates. C3h: Scan three times and enroll three templates. If the mode number is other than above, initialization may not be done correctly.

(3) Error response from H2E

Refer to Table 2-5.

2.3.24 Set security level

This command is to set security level for enrollment or verification. False Acceptance Rate and False Rejection Rate can be changed by setting the security level. The command enables to select the most appropriate level for each operating purpose, like strict security is necessary or easy operation is necessary.

(1) Command format

Offset	Size	Description
0	BYTE	22h
1	WORD	0001h (Byte length of the following data, Big-endian)
3	BYTE	Security level 00h:High, 01h:Mid-High, 02h:Middle, 03h:Mid-Low, 04h:Low

(2) Normal response from H2E

Refer to Table 2-4.

(3) Error response from H2E

Refer to Table 2-5.

2.3.25 Set capture mode

This command is to set capture mode for light condition where H2E is installed and used. There are two modes, normal mode and strong light mode. The normal mode is used when there is no strong light such as usage in a room. The default mode is normal.

(1) Command format

Offset	Size	Description
0	BYTE	24h
1	WORD	0001h (Byte length of the following data, Big-endian)
3	BYTE	Capture mode 00h: Normal mode 01h: Strong light mode

(2) Normal response from H2E

Refer to Table 2-4.

(3) Error response from H2E

Refer to Table 2-5.

3. Error code list

No.	Error code	Description of error and possible causes	
1	01h	Error	The command code or parameter is invalid
		Possible causes	(1) Sent command code is not supported. (2) The byte number followed by the command is wrong.
2	02h	Error	The length of the command parameter is invalid
		Possible causes	Command parameter may be incorrect.
3	04h	Error	Parity error or framing error occurred on serial communication.
		Possible causes	(1) Incorrect parameters set for serial communication specification. (2) Incorrect connection of the serial cable. (3) Noise effecting the serial cables.
4	05h	Error	The contents of template data is invalid
		Possible causes	The template ID to download template data is different from when it was uploaded.
5	06h	Error	Finger is not detected within a specific time frame.

		Possible causes	(1) The finger was not placed on the scanning device within 3 seconds after sending the “Verification” command. (2) The fingertip was not placed into the groove of H2E device.
6	07h	Error	Failed to control brightness of infrared LED in a specific time.
		Possible causes	(1) Items, such as bandages, covering the finger could have been interfering. (2) Object interference.
7	08h	Error	Finger not stably place during a specific time frame.
		Possible causes	(1) The host system not designed physically stable preventing stabile scanning process during verification. (2) Installed equipment vibration.
8	0Ah	Error	Verification failure (1:1 verification)
		Possible causes	(1) Finger position is different from when the finger was enrolled. (2) Finger was exceptionally pressed down onto the device during the scanning process. (3) Finger touching the scanning area when scanning.
9	0Bh	Error	Verification failure (1:N verification)
		Possible causes	Refer to error code 0Ah.
10	0Dh	Error	H2E could not receive total command in a specified time frame.
		Possible causes	(1) Incorrect command parameters. (2) The number of data followed by a command code is not described by big endian.
11	0Fh	Error	Verification or enrollment was cancelled because the quality of the scanned image was insufficient for enrollment or verification.
		Possible causes	(1) Finger was exceptionally pressed down onto the device. → Place the finer lightly. (2) The finger is dirty or has foreign object such as adhesive bandages. (3) Foreign object was attached on H2E.
12	70h	Error	Failed to erase a sector of a flash ROM.
		Possible causes	Device failure. → replace H2E.
13	71h	Error	Failed to store data into the flash ROM.

		Possible causes	Device failure. → replace H2E.
14	72h	Error	Specified template data does not exist.
		Possible causes	The template data does not exist. → Check by using the "Get group and template list" command.
15	73h	Error	The enrollment template number already exists in the specified group.
		Possible causes	Enroll the new template data after deleting existing one.
16	74h	Error	Capacity overflow of the template data.
		Possible causes	Storage of unnecessary template data.
17	75h	Error	The number of the template data in a group exceeded the limit.
		Possible causes	Storage of unnecessary template data in the group.
18	76h	Error	The finger vein data already exists in the group.
		Possible causes	Enrolled finger previously scanned.
19	77h	Error	Could not find encryption key
		Possible causes	Device failure. → replace H2E.
20	78h	Error	Checksum error
		Possible causes	(1) Checksum is incorrect. (2) Error during serial communication.
21	79h	Error	The downloading template data already exists in the same group.
		Possible causes	(1) Delete the existing template. (2) Download to another group.
22	7Ah	Error	Could not find group number
		Possible causes	The group does not exist in template data.
23	7Bh	Error	Capacity over flow of template data for 1:N verification.
		Possible causes	The "1:N Verification" command was sent when the template data in flash ROM exceeded max. N.
24	7Ch	Error	Invalid template data saved in flash ROM. There is invalid template data in flash ROM.

		Possible causes	The power supply of H2E may be discontinued while saving template data in flash ROM. → Delete all the template data and enroll template data again.
25	7Dh	Error	Different finger was placed in enroll template data command with plural scanning.
		Possible causes	User's error operation. → Place the same finger.
26	7Eh	Error	Invalid scanning number was specified in enroll command with plural scanning.
		Possible causes	Command parameter is incorrect.
27	7Fh	Error	The finger was not removed after completion of scanning in enroll template data command with plural scanning
		Possible causes	User's error operation. → Inform user to remove the finger.
28	80h	Error	Impossible to take image because of too strong outside light.
		Possible causes	Strong light.
29	82h	Error	The received command cannot be executed in the current enroll mode.
		Possible causes	Refer to 2.3.6 and 2.3.14.
30	83h	Error	Template storage area is not initialized in flash ROM.
		Possible causes	→ Initialize flash ROM with initialize command.

4. Remarks

4.1 Power cut during writing flash memory

The template data in flash ROM may become invalid when the power supply of H2E is discontinued while saving template data in flash ROM.

The “Check template data in flash ROM” command is used to check if the template data in flash ROM is correct. It is recommend for the host system to using this command to check template data.

The following table shows the commands that effect the data in the flash ROM.

No.	Command code	Function
1	16h	Delete template data (Individual)
2	17h	Delete template data (Group)
3	18h	Initialize template area
4	1Dh	Download template data
5	21h	Enroll template (Plural scan)
6	23h	Change template ID

4.2 Timeout of verification

If the scan is not completed within five seconds after enroll or verify command, H2E sends timeout error response.

4.3 How to check template quality without enrollment

If you want to know template quality without enrolling template data in H2E, please proceed the following procedure using “2.3.11 Enroll template data” command.

(1) Send Enroll template data command specifying 80h to offset 3. The group number and the template number can be any number.
(2) Receive the response with template quality information.
(3) Send Enroll template data command specifying FFh to offset 3. The group number and the template number can be any number.
(4) Receive the error response (Error code 01h).

Because of the failure command format described in (3), enrollment will not be executed.