User Guide

Series MCU BOOT User Guide

Introduction

The MCU BOOT user guide mainly describes the BOOT interface instructions of N32G430 series MCU, which is easy to download and develop by using the NSING Technologies BOOT loader.

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Content

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1 BOOT Brief Introduction

The firmware program of the chip, namely BOOT, mainly provides functions such as user program download, API.

This document describes in detail the function, implementation and usage of BOOT for N32G430 series chip. The maximum Flash storage area of N32G430 series chip is 64KB.

1.1 BOOT Function Definition

- **User program download function**
  - Supports USART (USART1, using GPIO as PA9-TX, PA10-RX, baud rate negotiation)
  - Supports CRC32 verification for download data
  - Supports encrypted download (AES-128 ECB)
  - Supports key authentication for Flash partition and partition erasure during download
  - Supports partition key update
  - Supports self-verification on power-on BOOT
  - Supports software reset chip operation

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2 BOOT Process and Command

The firmware program BOOT of N32G430 series chips supports downloading user programs and data through the USART interface. The following describes the related BOOT process and command.

2.1 Commands and Data Structures

2.1.1 The List of Commands

Table 2-1 Command Definition

Name of the Command	The Key Value	Descriptions
CMD_SET_BR	0x01	Set the baud rate of the serial port (valid only when serial ports are used)
CMD_GET_INF	0x10	Read chip model index, BOOT version number, chip ID
CMD_GET_RNG	0x20	Get random number
CMD_KEY_UPDATE	0x21	Update the encryption download key or partition authentication key
CMD_FLASH_ERASE	0x30	Erase Flash,
CMD_FLASH_DWNLD	0x31	Download user programs to Flash
CMD_DATA_CRC_CHECK	0x32	CRC check for download user program
CMD_OPT_RW	0x40	Read/configure option bytes (including read protection level, Flash page write protection, Data0/1 configuration, USER configuration)
CMD_USERX_OP	0x41	Get/set the partition USERX size
CMD_SYS_RESET	0x50	The system reset

2.1.2 The Data Structure

Here are some conventions explained below, where "<>" represents fields that must be included, and "()" represents fields that are included according to different commands.

Command and response data structures

1. Upper level command data structure:

<CMD_H + CMD_L + LEN + Par> + (DAT).

CMD_H represents the level 1 command field; CMD_L represents the level 2 command field; LEN represents the length of the transmitted data; Par represents the 4-byte command parameter; DAT represents the specific received data transmitted by the upper level command to the lower level.

2. Lower level response data structure:

< CMD_H + CMD_L + LEN > + (DAT) + <CR1+CR2>.

CMD_H represents the level 1 command field; CMD_L represents the level 2 command field; the lower-level command field is the same as the corresponding upper-level command field; LEN represents the length of the transmitted data; DAT represents the specific data that the lower level

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responds to the upper level; CR1+CR2 represents the return to the upper level Command execution result, and if the level 1 and level 2 command fields of the command transmitted by the upper level do not belong to any command, BOOT responds with CR1=0xBB and CR2 = 0xCC.

Command and response data structures supported by the serial port

1. The upper computer sends the upper-layer command:

STA1 + STA2 + {upper instruction structure} + XOR.

STA1 and STA2 are the starting bytes of the command sent by the serial port, where STA1=0xAA, STA2=0x55. Those bytes are used for the chip to identify the host computer to transmit the serial data stream.

XOR represents the XOR value of the previous command byte (STA1 + STA2 + {upper instruction structure}).

2. The lower level response data structure:

STA1 + STA2 + {lower response structure} + XOR.

STA1 and STA2 are the starting bytes of the command sent by the serial port, where STA1=0xAA, STA2=0x55. Those bytes are used for the host computer to identify the chip to transmit serial data stream

XOR represents the XOR value of the previous command byte (STA1 + STA2 + {lower response structure}).

2.2 Command Description

2.2.1 CMD_SET_BR

This command is used to modify the serial port baud rate.

The upper level command:

Table 2-2 Upper Command of CMD_SET_BR

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x01 Level-1 command field							
1(CMD_L)	0x00 Level-2 command field							
2~3(LEN)	Length of data: 0x00,0x00							
4~7(Par)	Par[0~3] : Set baud rate parameters							
(DAT)	None							

- Par[0~3], the serial port baud rate negotiation setting value can be set to the maximum, and the setting range is 2.4Kbps ~ 4Mbps, the default baud rate is 9600bps

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- Reserved value: 0x00

The lower level response:

Table 2-3 Lower Response of CMD_SET_BR

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x01 Level-1 command field							
1(CMD_L)	0x00 Level-2 command field							
2~3(LEN)	Length of data sent: 0x00,0x00							
(DAT)	None							
4(CR1)	Status byte 1							
5(CR2)	Status byte 2							

- Status bytes (CR1 and CR2) are divided into the following types according to command execution:
  1) Return success: status flag bit (0xA0, 0x00)
  2) Return failure: status flag bits (0xB0, 0x00)

The following are the baud rate values supported by baud rate negotiation (√ means supported, / means not supported):

Table 2-4 Baud Rate Configuration Value

The Clock Parameters (MHz)		Baud Rate															
		2400	4800	9600	14400	19200	38400	57600	115200	128000	256000	576000	923076	1000000	2000000	3000000	4000000
HSE	4	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	6	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	/
	8	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	16	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	24	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	/
	32	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
HSI		√	√	√	√	√	√	√	√	√	√	√	√	/	/	/	/

2.2.2 CMD_GET_INF

The command reads the BOOT version number, chip model index, chip ID, and chip serialization information.

The upper level command:

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Table 2-5 Upper Command of CMD_SET_BR

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x10 Level-1 command field							
1(CMD_L)	0x00 Level-2 command field							
2~3 (LEN)	Length of data							
4~7(Par)	Reserved							
(DAT)	None							

- Reserved value: 0x00
- LEN is data length: 0x00(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] +(LEN[1]<<8).

The lower level response:

Table 2-6 Lower Response of CMD_SET_BR

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x10 Level-1 command field							
1(CMD_L)	0x00 Level-2 command field							
2~3 (LEN)	Length of data							
4~54(DAT)	BOOT version, chip model index, and chip ID							
55(CR1)	Status byte 1							
56(CR2)	Status byte 2							

- The procedure byte (CMD_H) corresponds to the upper level command (CMD_H).
- LEN is the data length: 0x33(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).
- DAT[0] : 0x05, chip model index
- DAT[1]: 0xXY, BOOT version number (BCD code)
    - For example, DAT[1] = 0x10 indicates that the BOOT command set version number of V1.0 is used
- DAT[2] : BOOT command set version
- DAT[3~50] 48Byte

1) DAT[3~18] : 16Byte UCID (for details about the UCID, refer to the user manual)

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2) DAT[19-30] : 12Byte Chip ID(UID) (for details, refer to the user manual)

3) DAT[31~34] : 4Byte DBGMCU_IDCODE (for details about DBGMCU_IDCODE, refer to the user manual)

4) DAT[35~50] : 16Byte chip model

- Status bytes (CR1 and CR2) are divided into the following types according to command execution:

1) Return success: status flag bits (0xA0, 0x00)

2) Return failure: status flag bits (0xB0, 0x00)

2.2.3 CMD_KEY_RNG

Gets the random number of the key that the user needs to verify.

The upper level command:

Table 2-7 Upper Command of CMD_KEY_RNG

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x20 Level-1 command field							
1(CMD_L)	0x00 Level-2 command field							
2~3(LEN)	Length of data sent							
4~7(Par)	Reserved							
(DAT)	None							

- Reserved value: 0x00
- LEN is data length: 0x00(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)

The lower level response:

Table 2-8 Lower Response of CMD_KEY_RNG

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x20 Level-1 command field							
1(CMD_L)	0x00 Level-2 command field							
2~3(LEN)	Length of data							

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4~19(DAT)	16Bytes pseudo-random number
20(CR1)	Status byte 1
21(CR2)	Status byte 2

- LEN is data length: 0x10(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).
- 16Byte pseudo-random number is generated by software algorithm.
- Status bytes (CR1 and CR2) are divided into the following types according to execution status of the command:
  1) Return success: status flag bits (0xA0, 0x00).
  2) Return failure: status flag bits (0xB0, 0x00).

2.2.4 CMD_KEY_UPDATE

Users can update the encrypted download key and partition authentication key. Before updating, they need to use CMD_KEY_RNG to obtain a random number. The random number is used to generate the 16-byte old key authentication value by the host computer, and then send it to BOOT through commands such as CMD_KEY_UPDATE. The authentication value verifies whether the old key is correct, thereby confirming whether to update the key. The new key needs to be decrypted with the old key.

The upper level command:

Table 2-9 Upper Command of CMD_KEY_UPDATE

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x21 Level-1 command field							
1(CMD_L)	Level-2 command field: KEY index ID							
2~3(LEN)	Length of data sent							
4~7(Par)	Reserved value: 0x00							
8~55(DAT)	DAT[0~15] : 16Bytes old key authentication value							
	DAT[16-31] : 16Bytes new key authentication value							
	DAT[32 to 47] : CRC32 check encrypted value 4Bytes (old key value + new key value)CRC32 check value + 12Bytes fill the value 0x00 Then encrypt 16Bytes of data with the old key							

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- CMD_L: indicates the key index ID that needs to be updated

  ID(0x00-0x01) : key index ID,0x00 indicates partition 1, 0x01 indicates partition 3
- LEN Send data length: 0x30(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)
- Reserved value: 0x00
- DAT[32~47] : CRC32 check value
- DAT[0~15] : the 16-bit random number obtained by the host computer with CMD_KEY_RNG and the authentication value generated by the old key
- DAT[16-31] : New key is encrypted with old key, and BOOT is decrypted with old key and then save new key

The lower level response:

Table 2-10 Lower Response of CMD_KEY_UPDATE

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x21 Level-1 Command field							
1(CMD_L)	Level-2 command field: key ID							
2~3(LEN)	Length of data							
(DAT)	1byte, the maximum number of updates is 12							
4(CR1)	Status byte 1							
5(CR2)	Status byte 2							

- LEN is data length: 0x01(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)
- DAT[0] : 1byte, the maximum number of updates is 12, sharing between two partitions. When 0x0D is returned, no further updates are allowed, with the first time ireturning 0x02
- Status bytes (CR1 and CR2) are divided into the following types according to execution status of the command:

  1. Return success: status flag bits (0xA0, 0x00)
  2. Return failure: status flag bits (CR1, CR2)

     (1) (0xB0, 0x00) : return failure

     (2) (0xB0, 0x10) : key index ID range error

     (3) (0xB0, 0x11) : new key CRC check error

     (4) (0xB0, 0x20) : old key authentication failed

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(5) (0xB0, 0x3F) : failed to update the management information

2.2.5 CMD_FLASH_ERASE

BOOT provides the function of erasing Flash in units of pages. CMD_KEY_RNG needs to be used to obtain a random number before erasing authentication. The page address number and page number to be erased are provided by the user. The erased Flash space cannot exceed the entire Flash space, and must erase at least 1 page (512Byte).

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The upper level command:

Table 2-11 Upper Command of CMD_FALSH_ERASE

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x30 Level-1 command field							
1(CMD_L)	0x00 Level-2 command field							
2~3(LEN)	Length of data (0)							
4~7(Par)	Page address number 2 bytes: 0~255 Page number 2 bytes :1~256							
8~23(DAT)	DAT[0:15] : 16 bytes key authentication value for USER1/3 partition authentication							

- CMD_L: the partition number to be erased
  1) 0x00=USER1
  2) 0x02=USER3
- LEN is data length: 0x10(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)
- The address and range of Flash to be erased consist of four bytes in the Par field
- Par[0~1] : 2 bytes for page address number (0~255)

  Page address number = Par [0] + Par [1]<<8
- Par[2~3] : 2 bytes for page number (1~256)

  Page number = Par [2] + Par [3]<<8
- The header address of page 0 is 0x0800_0000. The address of subsequent pages is incremented by 1, and the header address is incremented by 0x800

  For example:

  The header address of page 1 is 0x0800_0000 + 1*0x800 = 0x0800_0800

  The header address of page 2 is 0x0800_0000 + 2*0x800 = 0x0800_1000
- The entire address range erased

  For example: the page address number is 0x01, and the page number is 0x02

  Erasing address range:

  (0x0800_0000 + 1*0x800) ~ (0x0800_0000 + 1*0x800 + 2*0x800). That is (the header address of the page address number) ~ (the header address of the page address number + the number of pages * the size of the page)

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- DAT[0:15], key authentication value of 16 byte partition authentication:
- If partition authentication is not enabled, it can be set to any value. The BOOT program will not use this value.

The lower level response:

Table 2-12 Lower Response of CMD_FLASH_ERASE

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x30 Level-1 command field							
1(CMD_L)	Level-2 command field: Erase area							
2~3(LEN)	Length of data							
(DAT)	None							
4(CR1)	Status byte 1							
5(CR2)	Status byte 2							

- LEN is data length: 0x00(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).
- Status bytes (CR1 and CR2) are divided into the following types according to execution status of the command:

  1. Return success: status flag bit (0xA0, 0x00)
  2. Return failure: status flag bits (CR1, CR2)

     (1) (0xB0, 0x00): return failure

     (2) (0xB0, 0x20): key authentication fails

     (3) (0xB0, 0x30): the erased Flash page is protected by RDP

     (4) (0xB0, 0x31): the erased Flash page is protected by WRP

     (5) (0xB0, 0x32): erase Flash page is protected by partition

     (6) (0xB0, 0x33): erase Flash page range across partitions

     (7) (0xB0, 0x34): the Flash address range is out of bounds (that is, it exceeds the size of the entire FLASH)

     (8) (0xB0, 0x37): failed to erase the Flash

     (9) (0xB0, 0x3F): failed to update the management information

2.2.6 CMD_FLASH_DWNLD

This command allows users to download code into the specified Flash. Before authentication

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download, encryption download, or authentication encryption, CMD_KEY_RNG is used to obtain random numbers. Data length must be 16 bytes aligned (less than 16 bytes automatically added 0x00 by the upper computer). Data are all provided by upper level commands. For partition authentication and encryption download, partition number must be provided. The data encrypted during download needs to be decrypted into plaintext using the encryption download key (corresponding to partition authentication key) before being written to FLASH.

The upper level command:

Table 2-13 Upper Command of CMD_FLASH_DWNLD

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x31 Level-1 command field							
1(CMD_L)	Level-2 command field: Download partition number							
2~3(LEN)	Length of data sent							
4~7(Par)	Start address for downloading the Flash							
8~23(DAT)	DAT[0:15] : 16 bytes key authentication value for USER1/3 partition authentication							
24~(24+N)(DAT)	DAT[16~16+N] : specific data to be downloaded							
(24+N+1)~(24+N+4)(DAT)	DAT[16+N+ 1-16 +N+4] : specifies the 4-byte CRC32 check value of data							

- CMD_L: partition to be downloaded
  1) 0x00 = USER1
  2) 0x02 = USER3
- LEN is data length: 0xXX(LEN[0]), 0xXX(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)
- Par [0 ~ 3]: the starting address of the for downloading Flash, and synthetic rules is Address = Par[0] | Par[1]<<8 | Par[2]<<16 | Par[3]<<24
- DAT[0~15]: key authentication value of 16-byte partition authentication, encryption download key and partition authentication key are the same!
  1) If partition authentication is not enabled, it can be set as all 0x00
- DAT[16~16 +N]: specific data to be downloaded, and the total number of data is N+1
  1) USART: up to 128 bytes, 16<=N+1<=144. N+1 must be a multiple of 16
- DAT[16+N+1~16+N+4]: 4Byte CRC32 check value of unencrypted data

The lower level response:

Table 2-14 Lower Response of CMD_FLASH_DWNLD

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0

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0(CMD_H)	0x31 Level-1 command field
1(CMD_L)	Level-2 command field: Download partition number
2(LEN)	Length of data
(DAT)	None
3(CR1)	Status byte 1
4(CR2)	Status byte 2
5(XOR)	XOR operation result

- LEN is data length: 0x00(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).
- Status bytes (CR1 and CR2) are divided into the following types according to execution state of the command:

  1. Download success: status flag bits (0xA0, 0x00).
  2. Download failed: status flag bits (CR1, CR2).
     (1) (0xB0, 0x00): return failure
     (2) (0xB0, 0x20): key authentication fails
     (3) (0xB0, 0x21): the number of key authentication failures exceeds the limit
     (4) (0xB0, 0x30): the downloaded Flash address is protected by RDP
     (5) (0xB0, 0x31): the downloaded Flash address is protected by WRP
     (6) (0xB0, 0x32): the downloaded Flash address is protected by partition
     (7) (0xB0, 0x33): download Flash address range across partitions
     (8) (0xB0, 0x34): download Flash address range is out of bounds (refers to the size of the entire FLASH)
     (9) (0xB0, 0x35) : download Flash start address is not 16 bytes aligned
     (10) (0xB0, 0x36) : the downloaded Flash data length is not a multiple of 16
     (11) (0xB0, 0x37) : programming Flash fails
     (12) (0xB0, 0x3F) : failed to update the management information

2.2.7 CMD_DATA_CRC_CHECK

This command is used to check whether the downloaded data is correct. Considering the download speed and low probability of download failure, the CRC check is performed after the downloaded data is complete. The upper level command must provide the CRC value, start address, and check length of the downloaded data. Before CRCcheck, CMD_KEY_RNG is used to obtain a random number.

The upper level command:

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Table 2-15 Upper Command of CMD_DATA_CRC_CHECK

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x32 Level-1 command field							
1(CMD_L)	Level-2 command field: Parity partition number							
2~3(LEN)	Length of data							
4~7(Par)	32-bit CRC check value							
8~23(DAT)	DAT[0~15] : 16 bytes key authentication value of USER1/3 partition authentication							
24~27(DAT)	DAT[16 to 19] : check start address							
28~31(DAT)	DAT[20~23] : check length (unit: byte, minimum length 2KB)							

- CMD_L: partition number to be checked to
  1) 0x00 = USER1
  2) 0x02 = USER3
- LEN Send data length: 0x18(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)
- Par [0~3]: 32 bit CRC check value, the synthetic rules for CRC32 = Par[0] | Par[1]<<8 | Par[2]<<16 | Par[3]<<24
- DAT[0~15]: key authentication value for partition authentication
- DAT [16~19]: check the starting address, the synthesis rules to Address = DAT[16] | DAT[17]<<8 | DAT[18]<<16 | DAT[19]<<24. Note that the Address is only within the scope of theFlash
- DAT [20~23]: check length, its synthesis rules is for CRC_LEN = DAT[20] | DAT[21]<<8 | DAT[22]<<16 | DAT[23]<<24, CRC_LEN is only within the effective range, and length is larger than 2 KB, and is a multiple of 16

The lower level response:

Table 2-16 Lower Response of CMD_DATA_CRC_CHECK

Byte / Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x32 Level-1 command field							
1(CMD_L)	Level-2 command field: Parity partition number							
2~3(LEN)	Length of data							

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(DAT)	None
4(CR1)	Status byte 1
5(CR2)	Status byte 2

- LEN is data length: 0x00(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)
- Status bytes (CR1 and CR2) are divided into the following types according to execution status of the command:

  1. Check success: status flag bits (0xA0, 0x00).
  2. Check failure: status flag bits (CR1, CR2)
     (1) (0xB0, 0x00): return failure
     (2) (0xB0, 0x20): CRC check key authentication fails
     (3) (0xB0, 0x21): The number of CRC check key authentication failures exceeds the limit
     (4) (0xB0, 0x32): CRC check addresses are protected by partitions
     (5) (0xB0, 0x33): CRC check address range is across partitions
     (6) (0xB0, 0x34): CRC check address range is out of bounds (Refers to exceeding the entire Flash size)
     (7) (0xB0, 0x35): CRC check address is not 16-byte alignment
     (8) (0xB0, 0x36): the CRC check length is not a multiple of 16, or the CRC check length is less than 2KB
     (9) (0xB0, 0x38): CRC check fails
     (10) (0xB0, 0x3F): failed to update the management information

2.2.8 CMD_OPT_RW

This command is used for option byte read and write (including read protection level, Flash page write protection, Data0/1 configuration, and USER configuration).When a partition is configured, BOOT does not allow to change the read protection level from L1 to L0. This will cause mass erase in the user area.

The upper level command:

Table 2-17 Upper Command of CMD_OPT_RW

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x40 Level-1 command field							
1(CMD_L)	Level-2 command field							

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2~3(LEN)	Length of data
4~7(Par)	
8~23(DAT)	Option byte configures 16 bytes

- CMD_L Level-2 command field:
  1) 0x00: gets option bytes
  2) 0x01: configure option byte
  3) 0x02: configure option byte, then reset
- LEN is data length: 0x10(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)
- DAT[0~15] : 16 bytes for option bytes configuration
- RDP, nRDP, USER, nUSER, Data0, nData0, Data1, nData1, WRP0, nWRP0, WRP1, nWRP1, RDP2, nRDP2, USER2, nUSER2
  1) CMD_L = 0x00: all values are 0x00
  2) CMD_L = 0x01/0x02: configures option bytes as the values to be written

The lower level response:

Table 2-18 Lower Response of CMD_OPT_RW

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x40 Level-1 command field							
1(CMD_L)	Level-2 command field							
2~3(LEN)	Length of data							
4~19(DAT)	16 bytes for Option byte configuration							
20(CR1)	Status byte 1							
21(CR2)	Status byte 2							

- LEN is data length: 0x10(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)
- DAT[0~15] : The current 16 bytes of option byte configuration
  - RDP, nRDP, USER, nUSER, Data0, nData0, Data1, nData1, WRP0, nWRP0, WRP1, nWRP1, RDP2, nRDP2, USER2, nUSER2
- Status bytes (CR1 and CR2) are divided into the following types according to execution status of the command:
  1. Return success: status flag bits (0xA0, 0x00)
  2. Check failure: status flag bits (CR1, CR2)

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1) (0xB0, 0x00): return failure
2) (0xB0, 0x39): partitions have been configured and the read protection level cannot be reduced from L1 to L0

2.2.9 CMD_USERX_OP

This command is used to read or configure the USER1/3 partition size. After the partition configuration is complete, the corresponding partition is automatically enabled and sealed. The USER1/3 partition size can be configured only once.

The recommended configuration process is as follows:

1. If need to divide two areas, it is sufficient to configure USER3 (automatic sealing is complete).If want to also seal USER1, configure USER1 again. The size of USER1 + USER3 must be the size of the entire Flash

The upper level instructions:

Table 2-19 Upper Command of CMD_USERX_OP

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x41 Level-1 command field							
1(CMD_L)	Level-2 command field							
2~3(LEN)	Length of data sent							
4~7(Par)	Par[0]: partition USER1/3							
	Par [1]: partition USER1/3 size							
	Par [2]: partition authentication key index ID							
	Par [3]: partition authentication and encryption download enable configuration							
DAT	None							

- CMD_L Level-2 command field:
  1) 0x00: Read partition USER1/3 size configuration
  2) 0x01: Configure partition USER1/3 size, key ID, partition authentication/encrypted download enable
- LEN is data length: 0x00(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)
- Par[0] : Partition number
  1) 0x00: partition USER1
  2) 0x02: partition USER3
- Par [1]:
  1) CMD_L = 0x00:0x00

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2) CMD_L = 0x01: partition USER1/3 size configuration

Input range for partition size: 0x1(2KB)... 0x07(14KB), 0x20(64KB), USER1+ USER3 = 64KB; The user area USER1/3 size is automatically sealed after configuration

The start address of the partition is 0x0800_0000, and the end address of the partition is the start address plus the total Flash capacity (for example, if the Flash capacity is 64K, the end address is 0x0800_0000 + 64/2*0x800 = 0x0800_FFFF)

If USER1 is partitioned, the partition address of USER1 ranges from 0x0800_0000 ~ (0x0800_0000 + USER1_Size*0x800)

If USER3 is partitioned, the partition address of USER3 ranges from (0x0801_0000 – USER3_Size*0x800) ~ 0x0800_FFFF (for example, the end address of Flash is 0x0800_FFFF)

- Par [2] :

1) CMD_L = 0x00: 0xFF

2) CMD_L = 0x01: 0x00~0x01 is encrypted download/partition authentication key index ID; 0xFF indicates that the index ID is not configured. If the corresponding USERX is not configured with an ID, the value of Par[3] is not judged

- Par [3] :

Enable configuration of partition authentication and encrypted download, 0xXY

- X = 0: disable partition authentication, can be configured to 1
- X = 1: enable partition authentication, cannot be set to 0
- Y = 0: disable encrypted download, can be configured to 1
- Y = 1: enable encrypted download, cannot be set to 0

1) CMD_L = 0x00: read status, retain value 0x00

2) CMD_L = 0x01: configuration status, configuration value 0xXY

The lower level response:

Table 2-20 Lower Response of CMD_USERX_OP

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x41 Level-1 command field							
1(CMD_L)	Level-2 command field							
2~3(LEN)	Length of data							
4~7(DAT)	DAT[0] : partition USER1/3							
	DAT[1] : partition USER1/3 size							

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	DAT [2] : partition authentication key index ID configuration status
	DAT [3] : read partition authentication and encryption download enable configuration
8(CR1)	Status byte 1
9(CR2)	Status byte 2

- LEN is data length: 0x02(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).
- DAT[0]: Partition number
  1) 0x00: partition USER1.
  2) 0x02: partition USER3.
- DAT[1]: Read the current partition USER1/3 size

  Partition size output range: 0x0(0KB), 0x1(2KB)... 0x07 (14 KB), 0 x20 (64 KB).

  0x0 indicates that the partition size is not configured. USER1 + USER3 = 64KB.
- DAT[2].
  1) 0x00, the ID has been configured.
  2) 0xFF, the ID is not configured
- DAT[3]:

  Read partition authentication and encryption download enable configuration, 0xXY
  - X = 0: Disable partition authentication, can be configured to 1
  - X = 1: Enable partition authentication, cannot be set to 0
  - Y = 0: Disable encrypted download, can be configured to 1
  - Y = 1: Enable encrypted download, cannot be set to 0
- Status bytes (CR1 and CR2) are divided into the following types according to execution status of the command:
  1) Return success: status flag bits (0xA0, 0x00)
  2) Return failure: status flag bits (0x70, 0x00)
     (1) (0xB0, 0x00): return failure
     (2) (0xB0, 0x10): the key index ID range is incorrect
     (3) (0xB0, 0x3A): the partition size has been configured and cannot be configured again
     (4) (0xB0, 0x3B): the partition size is incorrectly configured, USER1 + USER3 = Flash capacity, and the minimum configuration of USER1/3 is 0x01 (2KB)
     (5) (0xB0, 0x3D): the partition key index ID fails to be configured or has been configured
     (6) (0xB0, 0x3E): the configuration of partition authentication and encryption download fails

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or has been configured

(7) (0xB0, 0x3F): Failed to update the management information

2.2.10 CMD_SYS_RESET

This command is used to reset the BOOT program.

The upper-level command:

Table 2-17 Upper Command of CMD_SYS_RESET

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x50 Level-1 command field							
1(CMD_L)	0x00 Level-2 command field							
2~3(LEN)	Length of data							
4~7(Par)	Reserved							
(DAT)	None							

- Reserved value: 0x00

The lower level response:

Table 2-18 Lower Response of CMD_SYS_RESET

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x50 Level-1 command field							
1(CMD_L)	0x00 Level-2 command field							
2~3(LEN)	Length of data sent							
(DAT)	None							
4(CR1)	Status byte 1							
5(CR2)	Status byte 2							

- Status bytes (CR1 and CR2) are divided into the following types according to command execution:
  1) Return success: status flag bit (0xA0, 0x00)
  2) Return failure: status flag bits (0xB0, 0x00)

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2.3 The Explanation of Response Status Bytes

2.3.1 The Success Status Bytes

Return success: status flag bits (0xA0, 0x00). Indicates that the command issued by the upper level is executed successfully, and returns a success status word.

Contains the success return value of the read, update, configure, and other commands.

2.3.2 The Failure Status Bytes

Return failure: status flag bits (0xB0, 0x00). Indicates that the command issued by the upper level fails to execute due to other reasons (command reception format error or timeout, etc.), and the failure status bytes is returned.

2.3.3 Other Status Bytes

The following return status bytes also indicates failure. The second byte indicates a different error type.

(1) (0xB0, 0x10): key index id range error

(2) (0xB0, 0x11): new key CRC check error

(3) (0xB0, 0x20): key authentication fails

(4) (0xB0, 0x21): the number of key authentication failures exceeds the limit (The maximum number of key authentication failures is 16, and the number of times are shared with the two partitions are shared)

(5) (0xB0, 0x30): erase/download FLASH page protected by RDP

(6) (0xB0, 0x31): erased/downloaded FLASH page is protected by WRP

(7) (0xB0, 0x32): erase/download /CRC check address is protected by partition

(8) (0xB0, 0x33): erase/download /CRC check address range across partitions

(9) (0xB0, 0x34): the address range of erase/download /CRC is out of bounds (refers to the size of the entire flash)

(10) (0xB0, 0x35): the start address of erase/download /CRC is not 16 bytes aligned

(11) (0xB0, 0x36): the length of the downloaded /CRC data is not a multiple of 16.Data length indicates the length of erasing flash, or the length of downloading code to FLASH, or the length of checking FLASH CRC values

(12) (0xB0, 0x37): failed to erase/download FLASH programming

(13) (0xB0, 0x38): CRC check failed

(14) (0xB0, 0x39): partitions have been configured and the read protection level cannot be changed from L1 to L0

(15) (0xB0, 0x3A): the partition has been configured and cannot be configured again

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(16) (0xB0, 0x3B): partition size configuration error, must satisfy USER1 + USER3 = FLASH capacity

(17) (0xB0, 0x3E): the configuration of partition authentication and encryption download fails or has been configured

(18) (0xB0, 0x3F): failed to update the management information

(19) (0xBB, 0xCC): level 1 and level 2 command fields transmit from upper level do not belong to any command

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3 BOOT Commands

3.1 Host Computer Control Process

Upper computer supports user erasing Flash area, user code downloads, and download code integrity check. By reading partition information, the upper computer automatically identifies the address range of erasing, downloading and checking entered by the user.

The upper computer supports users to choose whether to enable encryption download to protect user code.

The upper computer supports the user to read and configure the partition USER1/3 size. The partition size cannot be changed after being configured.

The upper computer supports users to update the security key (used for partition authentication and encryption download).

The upper computer supports user update option byte for reading and modification.

Enter BOOT: Upon entering BOOT mode, communication can be established with PC TOOL through USART1 interface.

Chip firmware integrity check: If booting from the system memory area, BOOT automatically performs integrity self-checking. If the check fails, it will enter a deadlock loop, and subsequent functions cannot be used.

Command set interaction: The PC TOOL transmits different commands based on the command set supported by the BOOT to use corresponding functions.

1) Read BOOT version number, chip model index, chip ID
2) Get 16byte random number
3) Update the security key (for partition authentication and encrypted download)
4) Erase Flash
5) Download user programs to Flash
6) CRC check downloaded user program
7) Read/configure option bytes (including read protection level, Flash page write protection, Data0/1 configuration, USER configuration)
8) Get partition USERX size, set partition USERX size
9) System reset, BOOT program can be reset to run again

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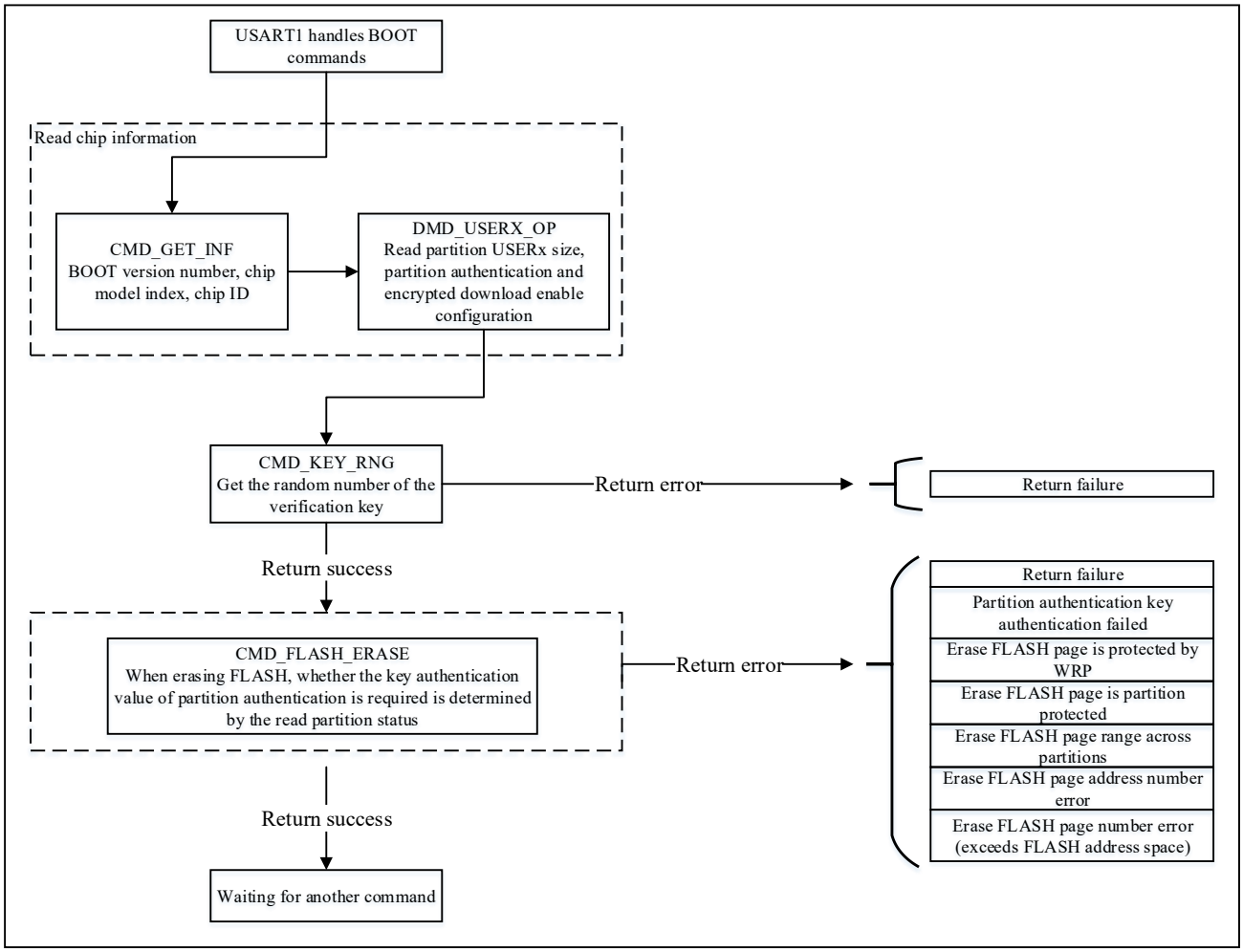
3.1.1 Flowchart for Erasing Command

Figure 3-1 Flowchart for Erasing Command



3.1.2 Flowchart for Download Command

Before partition authentication encrypted downloads, obtain a random number. The host computer uses this random number to generate the key authentication value of 16-byte USER1/3 partition authentication. In the case of continuous download, the random number used in the subsequent download command is generated by the random number deriving algorithm of the first time instead of obtaining a new random number.

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Figure 3-2 Flowchart for Downloading Command

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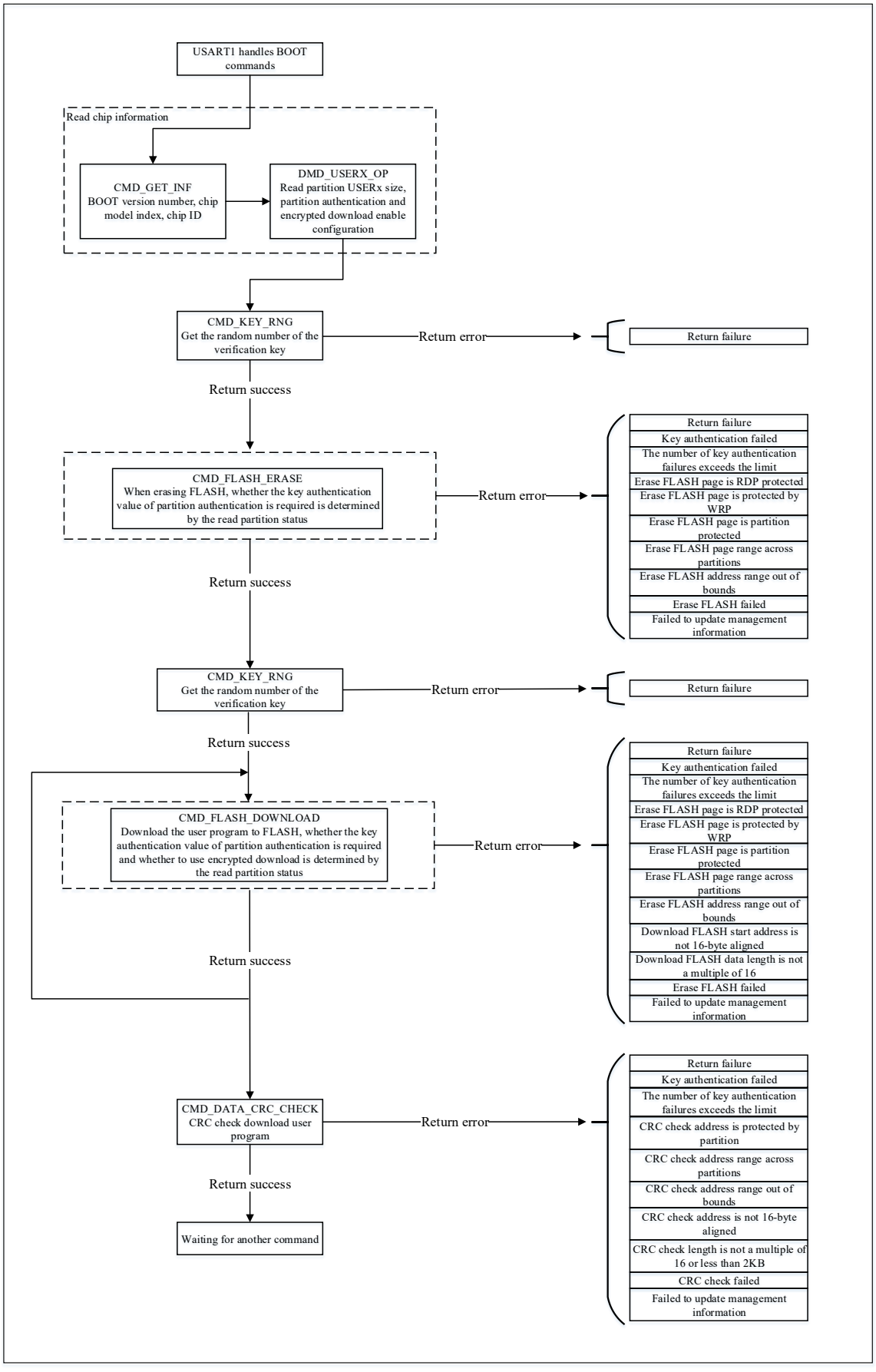

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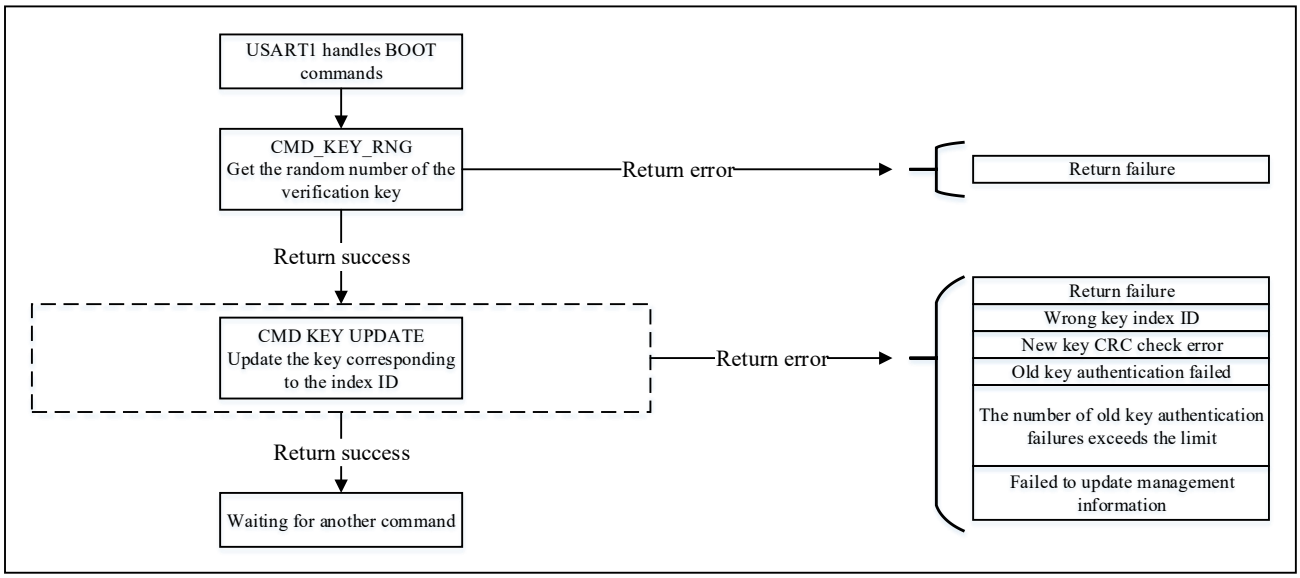
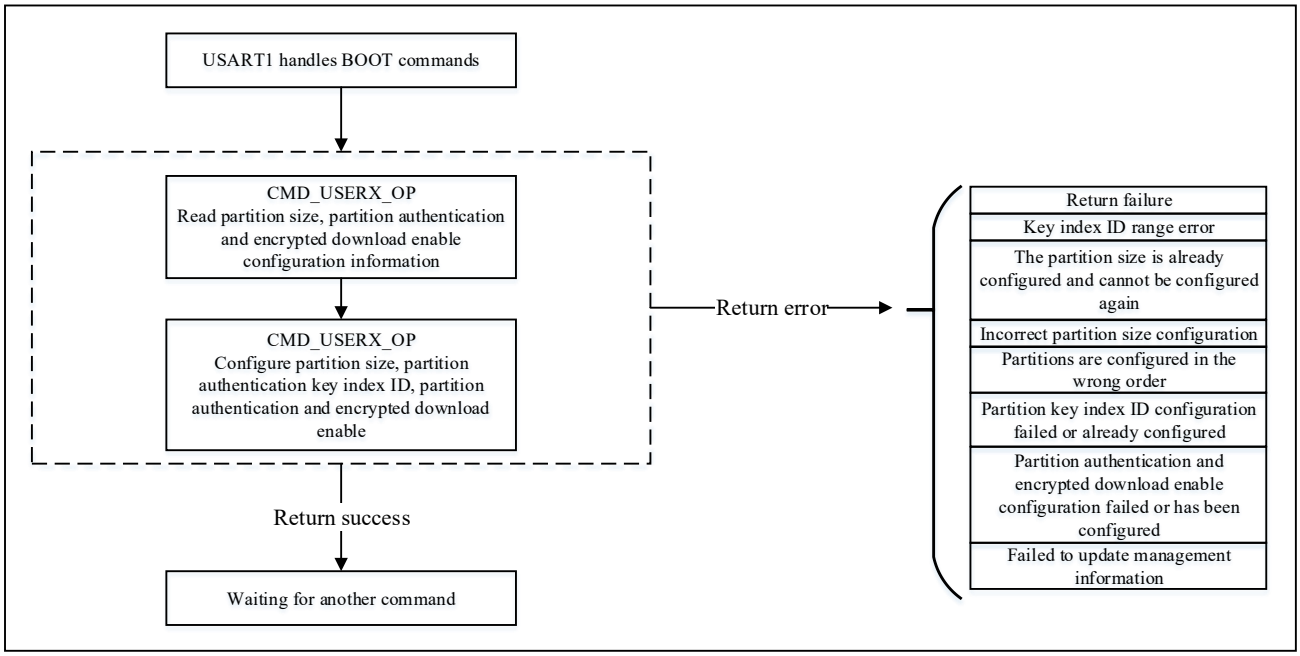
3.1.3 Flowchart for Updating Key Command

Figure 3-3 Flowchart for Updating Key Command



3.1.4 Flowchart for Partition Operation Command

Figure 3-4 Flowchart Partition Operation Command



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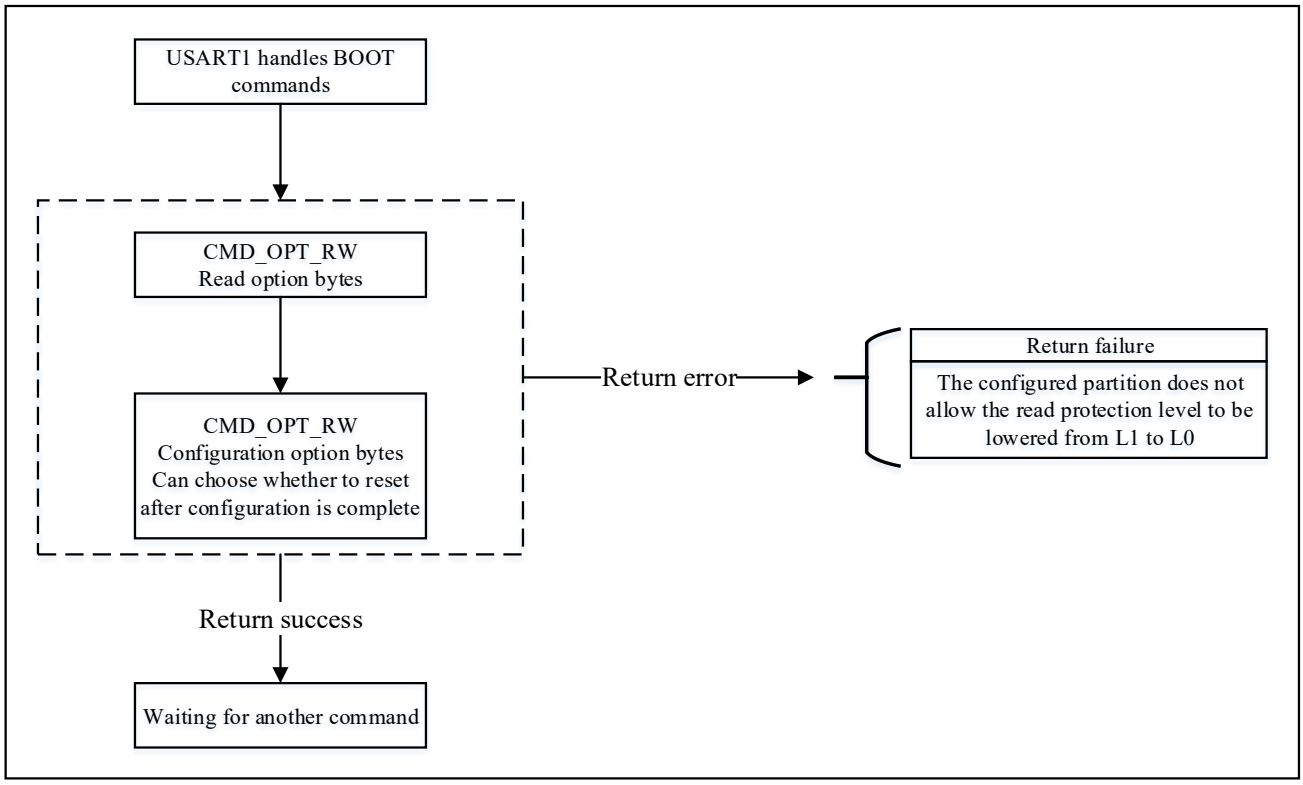
3.1.5 Flowchart for Option Byte Read/Write Command

Figure 3-5 Flowchart for Option Byte Read/Write Command



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4 Version History

Version	Date	Changes
V1.0	2022.3.24	Initial release

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