UG_N32G05x Series MCU BOOT User Guide

Introduction

The usage guide mainly describes the BOOT interface instructions of N32G05x series MCU, which is easy to download and develop by using the Nations technology BOOT loader.

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

Content

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

1 BOOT brief introduction

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

This document describes in detail the function, implementation and introduction of BOOT of N32G05x series chips. The maximum Main FLASH storage area of N32G05X series chips is 128KB, and the maximum Data FLASH storage area is 8KB.

1.1 BOOT function definition

- **User program download function**
  - Support UART (UART1, default PA9/PA10, can be configured as PB10/PB11, PD10/PD11, PA2/PA3 through option byte USER6 [1:0], baud rate negotiation);
  - Support download data CRC32 verification;
  - Support plaintext download
  - Support FLASH partitioning;
  - Supports power-on BOOT self-verification.
  - Support jumping to the Main flash/SRAM user area for execution
  - Support software reset chip operation.

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

2 BOOT process and command processing

The firmware program BOOT of N32G05X series chips supports downloading user programs and data through the UART interface. The following describes the related command processing flow.

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	Description
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_FLASH_ERASE	0x30	Erase FLASH
CMD_FLASH_DWNLD	0x31	Download user programs to FLASH
CMD_DATA_CRC_CHECK	0x32	CRC verification 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 the partition USERX size and set the partition USERX size
CMD_SYS_RESET	0x50	The system reset
CMD_APP_GO	0x51	Jump to the user area to execute the program

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 parameters.

Upper and lower instruction data structures

1. Upper instruction structure:

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

CMD_H represents the first-level command field, CMD_L represents the second-level command field; LEN represents the length of the transmitted data; Par represents the 4-byte command parameter; DAT represents the specific data sent by the upper layer command to the lower layer;

2. Lower level response structure：

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

CMD_H represents the first-level command field, CMD_L represents the second-level 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 layer responds to the upper layer; CR1+CR2

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Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

represents the return to the upper layer Command execution result, if the first-level and second-level command fields of the command sent by the upper layer do not belong to any command, BOOT replies with CR1=0xBB and CR2 = 0xCC.

Command 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, STA1=0xAA, STA2=0x55. Used for the chip to identify the host computer to send the serial data stream.

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

2. The upper computer receives the lower-layer response:

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

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

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

2.1.3 Command Examples

The following table selects one command for each command type as an example for reference. For detailed instructions on commands, please refer to the Command Description section.

command name	Command Example	Command structure (2)							
		STA1	STA2	CMD_H	CMD_L	LEN[1:0]	Par[3:0]	DAT	XOR
CMD_SET_BR	Set serial port baud rate to 4800	AA	55	01	00	00,00	00,00,12, C0	empty (1)	2C
CMD_GET_INF	Read chip information	AA	55	10	00	00,00	00,00,00, 00	empty (1)	EF
CMD_FLASH_ERASE	Erase DATA FLASH page 0	AA	55	30	03	00,00	00,00,01, 00	empty (1)	CD
CMD_FLASH_DWNLD	Download DATA FLASH page 0 16 bytes	AA	55	31	03	24,00	00,10,FF, 1F	32 0x00，C8,22,2D,55	8B
CMD_DATA_CRC_CHECK	CRC check DATA FLASH page 0	AA	55	32	03	18,00	00,10,FF, 1F	16 0x00，Actual CRC value of 4 bytes，	XOR value based on

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

								00,02,00,00	CRC value
CMD_OPT_RW	Get option bytes	AA	55	40	00	0E,00	00,00,00,00	14 个 0x00	B1
CMD_USERX_OP	Read USER1 configuration	AA	55	41	00	00,00	00,00,00,00	empty (1)	BE
CMD_SYS_RESET	Software reset boot program	AA	55	50	00	00,00	00,00,00,00	empty (1)	AF
CMD_APP_GO	Jump to Main FLASH	AA	55	51	00	00,00	00,00,00,00	empty (1)	AE

Note:

1. Empty means no data

2. For a detailed explanation of upper level instructions, please refer to the Command Description chapter

2.2 Command description

2.2.1 CMD_SET_BR

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

Upper-level instructions:

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							
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 ~ 923.076Kbps, the default baud rate is 9600bps; baudrate = (Par[0] << 24) +(Par[1] << 16) + (Par[2] << 8) + Par[3].
- Reserved value: 0x00;

Lower layer response:

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0

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Tel：+86-755-86309900
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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):

Clock parameters	**Baud rate**											
(MHz)	**2400**	**4800**	**9600**	**14400**	**19200**	**38400**	**57600**	**115200**	**128000**	**256000**	**576000**	**923076**
HSI	√	√	√	√	√	√	√	√	√	√	√	√

2.2.2 CMD_GET_INF

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

Upper-level instructions:

Bit / Byte	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 sent							
4~7(Par)	Reserved							
(DAT)	None							

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

Lower layer response:

Bit / Byte	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x10 Level-1 command field							

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Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

1(CMD_L)	0x00 Level-2 command field
2~3 (LEN)	The length of the 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 instruction (CMD_H).
- LEN is the data length: 0x33(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).
- DAT[0] : 0x0B, chip model index
- DAT[1]: 0xXY, BOOT version number (BCD code)

  0x10: indicates the command set version used by BOOT, indicating that the command set version 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, see the user manual).
  2) DAT[19-30] : 12Byte Chip ID(UID) (for details, see the user manual).
  3) DAT[31~34] : 4Byte DBGMCU_IDCODE (for details about DBGMCU_IDCODE, see 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 bit (0xA0, 0x00).
  2) Return failure: status flag bits (0xB0, 0x00).

2.2.3 CMD_FLASH_ERASE

BOOT provides the function of erasing FLASH on a page by page basis, with the page address number and number provided by the user. The erased FLASH space cannot exceed the entire FLASH space, and at least one page (512Byte) must be erased.

Upper-level instructions:

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 sent (0)							
4~7(Par)	Page address number 2 bytes: 0~255 Page number 2 bytes :1~256							

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

- CMD_L: erases the partition number

  1) 0x00=USER1;(After partition sealing, it can be erased, but non erasable can be achieved through FLASH sealing. Please refer to section 2.2.7 for details)

  2) 0x01=USER2;(After partition sealing, it can be erased, but non erasable can be achieved through FLASH sealing. Please refer to section 2.2.7 for details)

  3) 0x02=USER3;(After partition sealing, it can be erased, but non erasable can be achieved through FLASH sealing. Please refer to section 2.2.7 for details)

  4) 0x03=Data FLASH

  5) 0x04=SRAM; Support address range 0x20001000~0x2003FFF. The SRAM erase operation does not actually perform any operation and returns OK directly.

- LEN Send data length: 0x10(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).

- The erase address and range consist of four bytes in the Par field

  - Par[0~1] : page address number 2 bytes (0~255)

    Page address number = Par [0] + Par [1]<<8;

  - Par[2~3] : Page number 2 bytes (1~256)

    Page number = Par [2] + Par [3]<<8;

  - The header address of page 0 is 0x0800_0000. The number of subsequent pages is incremented by 1, and the header address is incremented by 0x200.

    Such as:

    The header address of page 1 is 0x0800_0000 + 1*0x200 = 0x0800_0200

    The header address of page 2 is 0x0800_0000 + 2*0x200 = 0x0800_0400

  - 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*0x200) ~ (0x0800_0000 + 1*0x200 + 2*0x200). 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)

Lower layer response:

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 sent							
(DAT)	None							

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Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
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4(CR1)	Status byte 1
5(CR2)	Status byte 2

- LEN Send 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 command execution:
  1. Return success: status flag bit (0xA0, 0x00).
  2. Return failure: status flag bits (CR1, CR2).
     (1) (0xB0, 0x00) : Return failure;
     (2) (0xB0, 0x31) : The erased FLASH page is protected by WRP;
     (3) (0xB0, 0x32) : Erase FLASH page is protected by partition;
     (4) (0xB0, 0x33) : Erase FLASH page range across partitions;
     (5) (0xB0, 0x34) : The FLASH address range is out of bounds (that is, it exceeds the size of the entire FLASH/SRAM);
     (6) (0xB0, 0x37) : Failed to erase the FLASH.
     (7) (0xB0, 0x42) : FLASH sealing error, FLASH has been sealed, erasing FLASH failed;

2.2.4 CMD_FLASH_DWNLD

This command provides users with the ability to download code to a specified FLASH. The data length must be aligned with 16 bytes (if it is insufficient, 0x00 will be automatically added to the upper computer), all of which are provided by upper level commands. Write plaintext to FLASH.

Upper-level instructions:

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: download partition number
  1) 0x00=USER1;(After the partition is sealed, it cannot be downloaded to prevent users from downloading illegal code and reading the code in the sealed area)
  2) 0x01=USER2;(After the partition is sealed, it cannot be downloaded to prevent users from downloading

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

illegal code and reading the code in the sealed area)

3) 0x02=USER3;(After the partition is sealed, it cannot be downloaded to prevent users from downloading illegal code and reading the code in the sealed area)

4) 0x03=Data FLASH

5) 0x04=SRAM; Support address range 0x20001000~0x2003FFF.

- LEN send data length: 0xXX(LEN[0]), 0xXX(LEN[1]), LEN = LEN[0] + (LEN[1]<<8)
- Par [0 ~ 3] : download the starting address of the FLASH, synthetic rules to Address = Par[0] | Par[1]<<8 | Par[2]<<16 | Par[3]<<24.
- DAT[0~15] : reserve(0).
- DAT[16~16 +N] : download specific data, 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

Lower layer response:

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(LEN)	Length of data sent							
(DAT)	None							
3(CR1)	Status byte 1							
4(CR2)	Status byte 2							

- LEN Send 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 command execution:

  1. Download success: status flag bit (0xA0, 0x00).
  2. Download failed: status flag bit (CR1, CR2).

     (1) (0xB0, 0x00) : Return failure;

     (2) (0xB0, 0x31) : The downloaded FLASH address is protected by WRP;

     (3) (0xB0, 0x32) : The downloaded FLASH address is protected by partition;

     (4) (0xB0, 0x33) : Download FLASH address range across partitions;

     (5) (0xB0, 0x34) : Download FLASH address range is out of bounds (refers to the size of the entire FLASH/SRAM);

     (6) (0xB0, 0x35) : Download FLASH start address is not 16 bytes aligned;

     (7) (0xB0, 0x36) : The downloaded FLASH data length is not a multiple of 16;

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
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Nanshan District, Shenzhen, 518057, P.R.China

(8) (0xB0, 0x37) : Programming FLASH fails;

(9) (0xB0, 0x42) : FLASH sealing error, FLASH has been sealed, erasing FLASH failed;

2.2.5 CMD_DATA_CRC_CHECK

This command is used to verify whether the downloaded data is correct. Considering the factors of download speed and the relatively low probability of download failure, a unified CRC check is performed after the data download is completed. The upper level instructions need to provide the CRC value, start address, and length of the download data.

CRC verification cannot be performed under MMU sealing conditions.

Upper-level instructions:

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 sent							
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 512B)							

- CMD_L: Check partition number
  1) 0x00=USER1;(After sealing the partition, verification cannot be performed)
  2) 0x01=USER2;(After sealing the partition, verification cannot be performed)
  3) 0x02=USER3;(After sealing the partition, verification cannot be performed)
  4) 0x03=Data FLASH
  5) 0x04=SRAM; Support address range 0x20001000~0x2003FFF.
- 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] : reserve(0);
- DAT [] 16 ~ 19: check the starting address, the synthesis rules to Address = DAT[16] | DAT[17]<<8 | DAT[18]<<16 | DAT[19]<<24, the Address is only within the scope of the FLASH;
- DAT [20 to 23] : check length, its synthesis rules for CRC_LEN = DAT[20] | DAT[21]<<8 | DAT[22]<<16 | DAT[23]<<24, CRC_LEN is only within the effective range, length is larger than 512B, and is a multiple of 16;

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

Lower layer response:

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

- LEN Send 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 command execution:

1. Check succeeded: status flag bit (0xA0, 0x00).
2. Check failure: status flag bits (CR1, CR2)
   (1) (0xB0, 0x00) : Return failure;
   (2) (0xB0, 0x32) : CRC check addresses are protected by partitions;
   (3) (0xB0, 0x33) : CRC check address range is across partitions;
   (4) (0xB0, 0x34) : CRC check address range is out of bounds (Refers to exceeding the entire FLASH size);
   (5) (0xB0, 0x35) : CRC check address is not 16-byte alignment;
   (6) (0xB0, 0x36) : the CRC check length is not a multiple of 16, or the CRC check length is less than 512B.
   (7) (0xB0, 0x38) : CRC check fails;

The CRC32 model is as follows:

The CRC software implementation code is as follows:

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

```
u32 CRC32_Calculate(u32* data,u32 len)
{
    u32 crc=0xffffffff, xbit=0,data0=0,i=0,j=0;
    u32 polynomial = 0x04c11db7;
    for(i=0;i<len;i++)
    {
        xbit = 0x80000000;
        data0 = *data++;
        for(j=0;j<32;j++)
        {
            if(crc & 0x80000000)
            {
                crc= (crc<<1)^polynomial;
            }
            else
            {
                crc<<=1;
            }

            if(data0 & xbit)
            {
                crc ^= polynomial;
            }
            xbit >>= 1;
        }
    }
    return crc;
}
```

2.2.6 CMD_OPT_RW

This command is used for option byte read and write (including read protection level, FLASH page write protection, Data0/1 configuration, User configuration). When a partition is configured, BOOT will downgrade the read protection level from L1 to L0. The downgrade after the partition is sealed will only cause the unsealed area to be completely erased, and the sealed area of the partition will not be erased.

Note: BOOT V1.0 version does not allow MMU partition sealing and downgrading of read protection.

Upper-level instructions:

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 sent							
4~7(Par)								
8~23(DAT)	Option byte configures 14 bytes							

- CMD_L Level-2 command field:

  1) 0x00: Gets option bytes.

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2) 0x01: Configuration option byte.

3) 0x02: Configuration option byte, reset again.

- LEN Send data length: 0x10(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).
- DAT[0~15] : Option bytes configures 14 bytes
  - RDP、USER1、USER2、USER3、USER4、USER5、USER6、Data0、Data1、WRP0、WRP1、WRP2、WRP3、RDP2;

    1) CMD_L = 0x00: all values are 0x00.

    2) CMD_L = 0x01/0x02: Configuration option bytes are the values to be written.

Lower layer response:

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 sent							
4~19(DAT)	Option byte configures 16 bytes							
20(CR1)	Status byte 1							
21(CR2)	Status byte 2							

- LEN Send data length: 0x10(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).
- DAT[0~13] : The current option byte configuration is 16 bytes
  - RDP、USER1、USER2、USER3、USER4、USER5、USER6、Data0、Data1、WRP0、WRP1、WRP2、WRP3、RDP2;
- Status bytes (CR1 and CR2) are divided into the following types according to command execution:

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

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

     2) (0xB0, 0x39) : Partitions have been configured and the read protection level cannot be reduced from L1 to L0.

2.2.7 CMD_ USERX_OP

This command is used to read or configure the size of partitions USER1/2/3. After partition configuration is completed, the corresponding partition will automatically enable sealing. The size of partitions USER1/2/3 can only be configured once.

Suggested configuration process for users:

If it is necessary to divide into two zones, the USER3 size and USER2=0KB (automatic sealing after configuration)

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

need to be configured. If it is necessary to seal USER1 as well, configure USER1 again. The size of USER1+USER2+USER3 must be the size of the entire FLASH;

If you need to divide into three zones, first configure USER3 (automatic sealing after configuration), and then configure USER2 (automatic sealing after configuration). If it is necessary to seal USER1 as well, configure USER1 again. The size of USER1+USER2+USER3 must be the size of the entire FLASH.

The partition configuration operation is shown in the following table:

Situation description	Partition setting order	FLASH space size related to permission management (1)			describe
		user1	user2	user3	
No partition, default is that the user1 area is not sealed	-	-	-	-	The size of the user1 area is flash_size, and there is no access permission management function
No partition, USER1 partition is sealed	user1	user1_size	-	-	The size of the user1 area is flash_size
Two partitions, USER1 unsealed and USER3 sealed	user3→user2	-	0	user3_size	The sum of space sizes for user1 and user3 is flash_size, and user1 does not have access permission management functionality
Two partitions, USER1 sealed and USER3 sealed	user3→user2→user1	user1_size	0	user3_size	The sum of the space sizes of user1 and user3 is flashsize
Three partitions, USER1 unsealed, USER2&USER3 partitions sealed	user3→user2	-	user2_size	user3_size	The sum of space sizes for user1, user2, and user3 is flashsize, and user1 does not have access permission management functionality
Three partitions, all sealed	user3→user2→user1	user1_size	user2_size	user3_size	The sum of space sizes for user1, user2, and user3 is flashsize
Describe： 1. The FLASH space related to permission management refers to the FLASH main storage area space that has been set to partition size.					

Upper-level instructions:

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Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

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 USER1/2/3							
	Par [1] : Partition USER1/2/3 size							
	Par [2] : reserve(0)							
	Par [3] : reserve(0)							
DAT	None							

- CMD_L Level-2 command field:

  1) 0x00: Read partition USER1/2/3 size configuration.

  2) 0x01: Configure partition USER1/2/3 size.

  3) 0x02：FLASH（main flash and data flash）seal.

  Note: CMD_L=0x02, Par [0~3] are all reserved and can be fully written as 0; FLASH sealing non partition sealing refers to disabling BOOT write and erase operations on the main flash and data flash areas.

- LEN Send data length: 0x00(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).
- Par[0] : Partition number

  1) 0x00: partition USER1.

  2) 0x01: partition USER2.

  3) 0x02: partition USER3.

- Par [1] :

  1) CMD_L = 0x00:0x00.

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

  The input range for USER1 partition size is 0x0: 4KB, 0x1: 8KB... 0x1F: 128KB (default),

  The input range for USER2 partition size is 0x0: 0KB (default) 0x1: 4KB... 0x1E: 120KB,

  The input range for USER3 partition size is 0x0: 0KB (default) 0x1: 4KB... 0x1F: 124KB,

  USER1 + USER2 + USER3 = 128KB； Automatically seal the user area after configuring the size of USER1/2/3.

  Partition size and address determined

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Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

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 128K, the end address is 0x0800_0000 + 32*0x1000 - 1 = 0x0801_FFFF).

If USER1 is partitioned, the partition address of USER1 ranges from 0x0800_0000 ~ (0x0800_0000 + USER1_Size*0x1000 - 1).

If USER3 is partitioned, the partition address of USER3 ranges from (0x0802_0000 – USER3_Size*0x1000) ~ 0x0801_FFFF (For example, the end address of FLASH is 0x0801_FFFF).

The partition address of USER2, with the first address being the last address of USER1 and the last address being the first address of USER3. If USER1 does not have a partition, the first address of USER2 needs to be determined by USER2_Size

- Par [2] :Reserve(0).
- Par [3] : Reserve(0);

Lower layer response:

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(DAT)	DAT[0] : partition USER1/2/3							
	DAT[1] : partition USER1/2/3 size							
	DAT [2] : Sealing status							
	DAT [3] : 0x00							
8(CR1)	Status byte 1							
9(CR2)	Status byte 2							

- LEN Send data length: 0x02(LEN[0]), 0x00(LEN[1]), LEN = LEN[0] + (LEN[1]<<8).

  Note: CMD_L=0x02, DAT [0~3] is meaningless

- DAT[0] : Partition number

  1) 0x00: partition USER1.
  2) 0x01: partition USER2.
  3) 0x02: partition USER3.

- DAT[1] : Read the current partition USER1/2/3 size

  USER1 Partition size output range: 0x0(4KB), 0x1(8KB)... 0 x1F(128 KB, default).

  USER2 Partition size output range: 0x0(0KB, default), 0x1(4KB)... 0 x1E(120 KB).

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Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
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USER2 Partition size output range: 0x0(0KB, default), 0x1(4KB)... 0 x1F(124KB).

USER1 + USER2 + USER3 = 128KB.

- DAT [2].

  1) 0x55 (unsealed), 0xAA (sealed)

- DAT [3] :0x00

- 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:

     (1) (0xB0, 0x00) : Return failure;

     (2) (0xB0, 0x3A) : The partition size has been configured and cannot be configured again.

     (3) (0xB0, 0x3B) : The partition size is incorrectly configured, USER1 + USER2 + USER3 = FLASH capacity.

     (4) (0xB0, 0x3C) : Partition configuration order incorrect, USER1 or USER3 must be configured first.

2.2.8 CMD_SYS_RESET

This command is used to reset the BOOT program.

Upper-level instructions:

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							
4~7(Par)	Reserved							
(DAT)	None							

- Reserved value: 0x00;

Lower layer response:

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							

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Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
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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).

2.2.9 CMD_APP_GO

This command is used to jump to the USER1 reset program entry address (0x0800-0000) after BOOT downloads the application program to FLASH, or to jump to the SRAM reset program entry address (the entry address location is determined by the user's actual download) after BOOT downloads the application program to SRAM. SRAM supports user use of address range 0x20001000~0x2003FFF.

USER1 partition sealing cannot execute jump to Flash.

Upper-level instructions:

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x51 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							

- CMD_L：Jump partition number

1. 0x00 = Flash；
2. 0x01~0x03，Reserve
3. 0x04 = SRAM；Support address range 0x20001000~0x2003FFF。

- LEN Sending data length：0x00(LEN[0])、0x00(LEN[1])，LEN = LEN[0] + (LEN[1]<<8)
- Par[0~3]：The starting address of the jump, the synthesis rule is Address = Par[0] | Par[1]<<8 | Par[2]<<16 | Par[3]<<24。
- Reserve：0x00；

Lower layer response:

Byte \ Bit	b7	b6	b5	b4	b3	b2	b1	b0
0(CMD_H)	0x51 Level-1 command field							
1(CMD_L)	0x00 Level-2 command field							

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Tel：+86-755-86309900
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Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
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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).

2.3 Returns the status word description

2.3.1 Returns the success status word

Return success: status flag bit (0xA0, 0x00). Indicates that the command issued by the upper layer 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 Returns the failure status word

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

2.3.3 Return other status words

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

(1) (0xB0, 0x30) : Erase/download FLASH page protected by RDP;

(2) (0xB0, 0x31) : Erased/downloaded FLASH page is protected by WRP;

(3) (0xB0, 0x32) : Erase/download /CRC check address is protected by partition;

(4) (0xB0, 0x33) : erase/download /CRC check address range across partitions;

(5) (0xB0, 0x34) : The address range of erase/download /CRC is out of bounds (refers to the size of the entire flash/sram);

(6) (0xB0, 0x35) : The start address of erase/download /CRC is not 16 bytes aligned;

(7) (0xB0, 0x36) : The length of the downloaded /CRC data is not a multiple of 16.Data length indicates the length of erasing flash/sram, or the length of downloading code to FLASH/SRAM, or the length of checking FLASH CRC values; The CRC check length in the code is less than 512B;

(8) (0xB0, 0x37) : Failed to erase/download FLASH/SRAM programming;

(9) (0xB0, 0x38) : CRC check failed.

(10) (0xB0, 0x39) : Partitions have been configured and the read protection level cannot be changed from L1 to L0.

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Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
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(11) (0xB0, 0x3A) : The partition has been configured and cannot be configured again.

(12) (0xB0, 0x3B) : Partition size configuration error, must satisfy USER1 + USER2 + USER3 = FLASH capacity.

(13) (0xB0, 0x3C) : Partition configuration order incorrect, USER1 or USER3 must be configured first.

(14) (0xB0, 0x42) : FLASH sealing error, FLASH has been sealed, erasing/downloading FLASH failed;

(15) (0xB0, 0x43) : BOOT power on self verification error;

(16) (0xBB, 0xCC) : Upper-layer send commands Level-1 and level-2 command fields do not belong to any command.

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

3 BOOT Instructions

3.1 Upper computer control process

The upper computer supports users to erase the FLASH area, download user codes, and verify the integrity of downloaded codes.

Download user code in plaintext on the upper computer.

The upper computer supports users to read and configure the size of partitions USER1/2/3. After the user has configured the partition size, it cannot be modified again.

The upper computer supports users to update option byte reading and modification.

The upper computer supports software reset commands and execution commands to jump to the USER1/SRAM reset program entry address.

Enter BOOT: Enter BOOT, you can interact with PC TOOL through UART1 interface at this time.

Chip firmware integrity check: If you choose to start from the system storage area, BOOT automatically performs integrity self-checking. If the check fails, it will enter an infinite loop, and subsequent functions cannot be used..

Command set interaction: The PC TOOL sends 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) Erase FLASH;
3) Download user programs to FLASH;
4) CRC check downloaded user program;
5) Read/configure option bytes (including read protection level, FLASH page write protection, Data0/1 configuration, USER configuration);
6) Get partition USERX size, set partition USERX size;
7) System reset, you can reset the BOOT program to run again;
8) Jump to the entry address of the reset program for USER1/SRAM, and then to the entry address of the reset program for downloading the USER1/SRAM partition code.

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

4 Version history

Version	The revision date	Remark
V1.0.0	2024/5/14	Initial release
V1.0.1	2024/6/11	1. Add a partition sealing operation table 2. Add FLASH sealing description 3. Add L1 downgrade operation description

Nations Technologies Inc.
Tel：+86-755-86309900
Email：info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China

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Nations Technologies Inc.
Tel: +86-755-86309900
Email: info@nationstech.com
Address: Nations Tower, #109 Baoshen Road, Hi-tech Park North.
Nanshan District, Shenzhen, 518057, P.R.China