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XC864 Flash Download Using Bootstrap Loader

Microcontrollers

Never stop thinking

Edition 2008-08

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Version	Subjects (major changes since last revision)
V 1.0	Initial release for XC864

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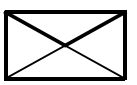


1 Introduction

A built-in bootstrap loader (BSL) is implemented in the XC800 family to provide a mechanism to load data / code into the internal memory of the device (XRAM or FLASH) via a UART interface. In variants that support external memory, it is also possible to load data / code to the external memory.

The protocol used in the XC800 family is standard, although there might be a slight variation due to different structures of the flash memory.

1.1 Overview

This document provides a cookbook on the BSL mode for XC864. It will show detailed steps on flash downloading.

The XC864 devices use the LIN protocol in BSL mode including the Fast LIN option as described below.

The user's manual contains detailed information about the BSL mode protocol.

This example code is additionally provided for reference. Although the code has been tested, there is no warranty provided.

There are four files containing the example code:

xc800_bsl.cpp	: code that contains the API for BSL mode
xc800_bsl.h	: corresponding header file
xc800.cpp	: main example code on how to use the API
xc800_verify.h	: verification code to be loaded into XRAM

These files can be compiled in Visual C 6.0.

Please note that the example code also provides routines for other devices of the XC800 family. Thus routines dedicated to the XC864 device are indicated by the "_xc864" suffix.

In order to run the example code, the PC host needs to be connected to a starterkit with a UART cable

The following files may also be included for tips and recommendations:

(Please note that these files are optional)

verify_lin.a51	: assembly code that can be downloaded to verify the content of the flash.
verify_lin.hex	: hex file generated from the above assembly code.

2 Supported BSL Mode in XC864

In order to gain access to the **BSL mode**, the chip must be **reset with MBC and TMS pins pulled low externally**.

The following hardware pins are used:

P1.0: Used as RXD (IN)

P1.1: Used as TXD (OUT)

Note: Please refer to chapter 7.2.3 in the user's manual for detailed information on the booting scheme and entering BSL mode.

2.1 LIN Mode

To enter the LIN BSL mode, the following steps have to be done by the PC Host:

1. Send the **bsl_lin_header()** instruction to initialize LIN communication.

   Parameter to be used:

bslHeader.NAD	= 0x7F
bslHeader.startAddr	= 0xF000
bslHeader.mode	= 0
bslHeader.fastLin	= 1 (to enter the Fast LIN mode)
bslHeader.baudrate	= <baud rate>

   Wait for 9 bytes acknowledgement (embedded inside the function).

   The routine will check that the **second byte** has a value of **0x55** to indicate a success.

   Fast LIN BSL is an enhanced feature in the XC864 device, supporting higher baud rates of up to 115200[1)] bit/second.

   When Fast LIN BSL mode is entered, the microcontroller will **switch to the BSL UART protocol** at the calculated baud rate. The microcontroller will stay at FAST LIN BSL and the **communication structure will be the same as in UART BSL mode**.

2. Send the **bsl_erase_flash_xc864()** instruction to erase the flash memory.

   All sectors of the flash memory will be erased.

   The flash erase will commence before the acknowledgement is sent from the microcontroller. Hence, there is a waiting time for about **100 ms**.

   Wait for 1 byte acknowledgement: 0x55 (embedded inside the function).

1) This is higher than the Standard LIN, which supports only baud rates of up to 20 kbit/second.

3. Send the **bsl_uart_header()** instruction.

   Parameter to be used:

   bslHeader.mode = 2

   bslHeader.dataLength = 32[1)]

   bslHeader.startAddr[2)] = <Starting Address - must by 32-byte aligned>

   Wait for 1 byte acknowledgement: 0x55 (embedded inside the function).

   Details about the header block and the type of acknowledgement is described in **Section 5.4** or in chapter 15 of the user's manual.

4. Send the **bsl_uart_data()** instruction.

   Parameter to be used:

   bslData.dataLength = 32

   bslData.cDataArray = <Pointer to the Data Array>

   It is recommended to send **only 32 bytes** of data for flash programming at once.

   The flash programming will commence before the acknowledgement is sent from the microcontroller. Hence, there is a waiting time for about **2 ms**.

   Wait for 1 byte acknowledgement: 0x55 (embedded inside the function).

5. Repeat data sending until all data is sent (**if and only if the address is continuous**).
6. Send the **bsl_uart_eot()** instruction.

   This routine must have an empty data buffer (when this API is used for flash download).

   Parameter to be used:

   bslEOT.dataLength = 32

   bslEOT.lastCodeLength = 0[3)]

   Wait for 1 byte acknowledgement: 0x55 (embedded inside the function).

7. Complete the flash download by repeating step 3 to step 6 (in case of a discontinous address).

Note: Step2 - Step6 are performed in the bsl_file_download_xc864() function (see API in chapter 4).

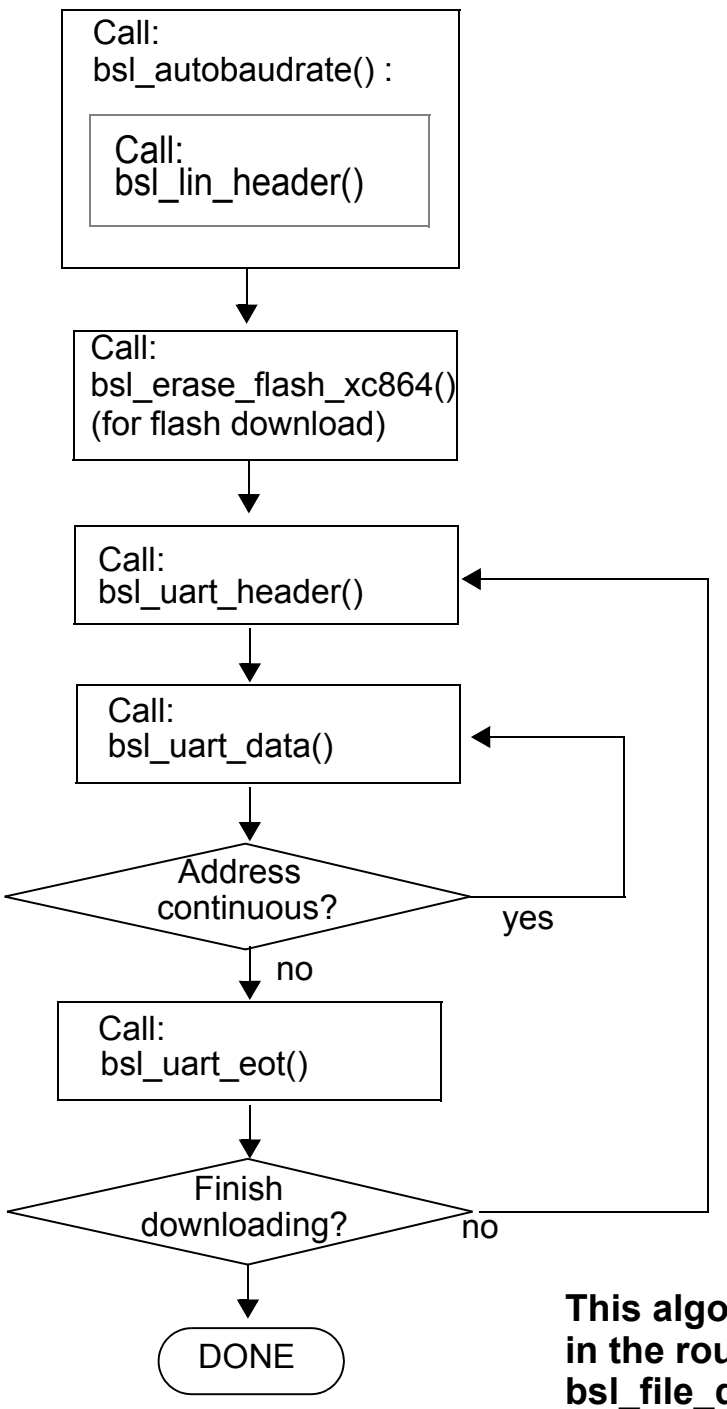
1) The data length for flash programming is 32 bytes (1 wordline). No crossing of a wordline boundary is allowed (see **Section 5.2**).

2) The Starting Address is set to 0x0000 by default.

3) In this example code all the program code bytes are transmitted in data blocks.

Note: ***The XC864 device uses a single wire connection. The HOST will receive its sent bytes as an echo from the device immediately after sending. This echo must be taken care of.***

2.2 BSL Diagram for Code Download



This algorithm is used in the routine: bsl_file_download_xc864()

3 Flash Protection and Unprotection

XC864 allows the flash to be protected by password after the download.

After the flash protection is done, no further flash downloading is possible. External access to the device, including the flash, will be blocked depending on the selected password.

In contrary to other devices of the XC800 family, the protection scheme for the XC864 device underlies certain conditions in terms of re-entering BSL mode:

1. **In order to re-enter BSL mode of the flash protected device, the LSB of the selected password must be set to 1. Otherwise user mode will be entered immediately. Re-entering BSL mode is no longer possible.**

2. **The NAC (no activity count) of the device must be programmed with a valid value (01h - 0Ch). The programming procedure of the NAC is decribed below. In this example code the NAC is set to the maximum value of 0Ch.**

After a hardware reset, NAC indicates the delay duration (multiplication of 5 ms) before jumping to user mode. If a valid LIN header frame is received within this delay period, the device will enter BSL mode. Due to the maximum value of 0Ch for NAC, the maximum delay period is 60ms (0Ch * 5ms) as shown in this example code.

For NAC (and NAD) programming the last 9 bytes of the flash memory are reserved. When LSB of the password is 1, LIN BSL routine will call a subroutine at address **0FF7h** to obtain the valid parameter values. The user has to ensure that the addresses **0FF7h to 0FFFh** are programmed with specified values, shown in **Table 3-1**. Default values are used if the parameters are not within the valid range.

The respective bytes are programmed using the normal flash programming procedure. The example code uses the function **bsl_file_download_xc864()** to program these bytes.

After a hardware reset, the example code has to send a LIN header frame within less than 60ms to enter BSL mode.

Table 3-1

Flash Address	Parameter/ Instruction	Value	Criteria / Range	Default values
0FF7h	MOV R6, #xx	7Eh		
0FF8h	NAC	**	01h - 0Ch	FFh (invalid)
0FF9h	MOV R7, #xx	7Fh		
0FFAh	NAD	**	01h - FFh	7Fh (valid)
0FFBh	RET	22h		
0FFCh	NAC	**	01h - 0Ch	FFh (invalid)
0FFDh	Not(NAC)[1)]	**	FEh - F3h	00h
0FFEh	NAD	**	01h - FFh	7Fh (valid)
0FFFh	Not(NAD)[1)]	**	FEh - 00h	80h

1) In order to ensure the validity of the 2 parameters, the inverted values need to be programmed together with the actual values.

The function **bsl_file_download_xc864()** ensures that the last 9 bytes of the flash memory are always specified respectively. User code in this address range will be overwritten.

Please refer to chapter 7.2.3 in the user's manual for further information about the conditions on how to enter user and BSL mode.

After downloading and NAC programming is done, the following instruction can be send:

1. Send **bsl_uart_header()** instruction.

   Parameter to be used:

   bslHeader.mode = 6

   bslHeader.password = <1-byte password, LSB=1>

When flash is not protected yet, the microcontroller will enable the flash protection scheme and the password will be stored.

When flash is already protected, the microcontroller will deactivate all flash protection, if the user-password matches the stored password. The **flash block will be automatically erased** and the stored password will be reset.

4 API Description of XC800_BSL

4.1 Data Type Structure in XC800_BSL

```
typedef struct BSL_HEADER {
    unsigned char NAD;              //  NAD for LIN.
    unsigned char mode;             //  0  = Download to XRAM
                                        1  = Run from XRAM (0xF000)
                                        2  = Download to FLASH
                                        3  = Run from FLASH (0x0000)
                                        4  = Erase Flash
                                        6  = Password protect/unprotect
    unsigned int  startAddr;        //  Starting Address for mode 0 and 2.
    unsigned char dataLength;       //  UART Mode:
                                         Data Byte Length to be
                                         written in a subsequent
                                         DATA Block.
                                        LIN Mode:
                                         The number of subsequent data
                                         blocks that will be sent.
    unsigned char fastLIN;          //  Only for LIN mode (0 = Normal
                                        LIN, 1 = Fast LIN)
    unsigned short password;        //  1 byte password to protect
                                        or unprotect flash (Mode 6 only)
    DWORD            dwBaudrate;    //  Baud rate (Only necessary for
                                        LIN Mode)
    unsigned char singlewire;       //  Set to 1 if single wire connection
                                        is used.
    unsigned char waitNoResponse;   //  Only for LIN mode.
                                        If set to 1, it will not wait for
                                        the acknowledge
    unsigned char ucDeviceType;     //  Specify the device type
} BSL_HEADER;

typedef struct BSL_DATA {
    unsigned char NAD;              //  NAD for LIN.
    unsigned char *cDataArray;      //  Pointer to the data to be loaded.
    unsigned char dataLength;       //  Data Byte Length to be loaded (MUST
                                        be the same value as in BSL HEADER)
    DWORD         dwBaudrate;       //  Baud rate (Only necessary for LIN
                                        Mode)
    unsigned char singlewire;       //  Set to 1 if single wire connection
                                        is used.
} BSL_DATA;
```

```
typedef struct BSL_EOT {
    unsigned char NAD;              //  NAD for LIN.
    unsigned char *cDataArray;      //  Pointer to the data to be loaded.
    unsigned char lastCodeLength;   //  Data Byte Length to be loaded
                                        (lastCodeLength < dataLength).
    unsigned char dataLength;       //  Data Byte Length as stated in BSL
                                        HEADER
    DWORD         dwBaudrate;       //  Baud rate (Only necessary for LIN
                                        Mode)
    unsigned char singlewire;       //  Set to 1 if single wire connection
                                        is used.
} BSL_EOT;


typedef struct BSL_DOWNLOAD {
    char *hexFileName;              //  Hex File Name.
    unsigned eraseFlash;            //  0 = Flash will NOT be erased before
                                            downloading
                                    //  1 = Flash  will  be  erased  before
                                            downloading
    unsigned eraseOnly;             //  0 = Flash will be downloaded after
                                            erasing.
                                    //  1 = Flash  will  NOT  be  downloaded
                                            after erasing.
    unsigned verbose;               //  0 = No message will be displayed.
                                    //  1 = (Default)  Message  will  be
                                            displayed.
    unsigned *xram_valid;           //  0 = No  Download  to  externally
                                            mapped XRAM is done
                                    //  1 = Download to externally mapped
                                            XRAM is done
    unsigned char singleWire;       //  Set to 1 if single wire connection
                                        is used.
    unsigned char ucDeviceType;     //  Specify the device type
} BSL_DOWNLOAD;


typedef struct BSL_ERASE {
    unsigned bankNumber;            //  Bank Number to indicate the bank to
                                        be erased.
    unsigned sectorNumber;          //  Sector Number to indicate the
                                        sector to be erased.
    unsigned char option;           //  Not used for XC864
    unsigned char singleWire;       //  Set to 1 if single wire connection
                                        is used.
    unsigned char ucDeviceType;     //  Specify the device type
} BSL_ERASE;
```

```
typedef struct AUTO_BAUDRATE {
    unsigned char detection;       //  Detection Mode:
                                   //  0 = UART Mode (No Auto Detection)
                                       1 = LIN  Mode (No Auto Detection)
                                       2 = Auto Detection Mode
                                        Byte 0x80 will be send first
                                        and wait for 10ms.
                                        If no response, then proceed
                                        with LIN auto detection.
    unsigned char mode;            //  Same as BSL HEADER
    unsigned char fastLIN;         //  Only for LIN mode (0 = Normal LIN,
                                       1 = Fast LIN)
    DWORD         dwBaudrate;      //  Baud rate
    unsigned char singleWire;      //  Set to 1 if single wire connection
                                       is used.
    unsigned char waitNoResponse;  //  Only for LIN mode.
                                       If set to 1, it will not wait for
                                       the acknowledge
    unsigned char nac;             //  no activity count
    unsigned char nad;             //  NAD for LIN mode
    bool bLIN;                     //  Set to “true“ if LIN device
    bool bReset;                   //  enable reset by bsl_autobaudrate()
    unsigned char ucDeviceType;    //  Specify the device type
} AUTO_BAUDRATE;
```

4.2 Function Prototypes in XC800_BSL

```
/*-------------------------------------------------------------------
Function Name          : bsl_init_uart()
Description            : Responsible to initialize the UART Port (COM
                         PORT)
                         Following actions are done:
                         -) Initialize the chosen COM PORT with the
                         selected baud rate
                         -) Return the hComm handle.
                       The parameter *uiError will be updated accordingly.
Function Called        : None
Input Parameter        : *cPortName     => Port Name (e.g: "COM1", "COM2"
                                            etc)
                         dwBaudrate     => Baud rate
Output Parameter       : *hComm         => Valid Communication Handle
                         *uiError       => Error Code
Return Value           : None
-------------------------------------------------------------------*/
```

```
/*-------------------------------------------------------------------
Function Name         : bsl_autobaudrate()
Description           : Sending the first byte for auto baud rate
                        detection.
                        If UART or LIN auto detection is enabled, the
                        function will first send byte: 0x80 to detect if
                        it is UART or not.  If there is no responds within
                        the specified time-out value, then send the first
                        LIN header (the chip must be reset again!!)
Function Called       : bsl_lin_header()
Input Parameter       : *hComm        => Communication Handle.
                        *autobaud     => AUTO_BAUDRATE structure.
Output Parameter      : *autobaud     => AUTO_BAUDRATE structure.
                        *uiError      => Error Code.
Return Value          : None
-------------------------------------------------------------------*/

/*-------------------------------------------------------------------
Function Name         : bsl_lin_header()
Description           : Sending the LIN Header Block.
Function Called       : None
Input Parameter       : *hComm        => Communication Handle.
                        bslHeader     => BSL_HEADER structure.
Output Parameter      : *uiError      => Error Code
Return Value          : None
-------------------------------------------------------------------*/

/*-------------------------------------------------------------------
Function Name         : bsl_erase_flash_xc864()
Description           : Responsible to erase the flash memory
Input Parameter       : *hComm        => Communication Handle.
                        bslErase      => BSL_ERASE Structure
Output Parameter      : *uiError      => Error Code
Return Value          : None
-------------------------------------------------------------------*/

/*-------------------------------------------------------------------
Function Name         : bsl_uart_header()
Description           : Sending the UART Header Block.
Function Called       : None
Input Parameter       : *hComm        => Communication Handle.
                        bslHeader     => BSL_HEADER structure.
Output Parameter      : *uiError      => Error Code
Return Value          : None
-------------------------------------------------------------------*/
```

```
/*---------------------------------------------------------------------
Function Name         : bsl_uart_data()
Description           : Sending the UART Data Block.
Function Called       : None
Input Parameter       : *hComm        => Communication Handle.
                        bslData       => BSL_DATA structure.
Output Parameter      : *uiError      => Error Code
Return Value          : None
---------------------------------------------------------------------*/

/*---------------------------------------------------------------------
Function Name         : bsl_uart_eot()
Description           : Sending the UART EOT Block.
Function Called       : None
Input Parameter       : *hComm        => Communication Handle.
                        bslEOT        => BSL_EOT structure.
Output Parameter      : *uiError      => Error Code
Return Value          : None
---------------------------------------------------------------------*/

/*---------------------------------------------------------------------
Function Name         : close_interface()
Description           : Responsible to close all of the communication
                        channel (UART or JTAG)
Function Called       : None
Input Parameter       : *hComm        => Communication Handle.
Output Parameter      : *uiError      => Error Code
Return Value          : None
---------------------------------------------------------------------*/

/*---------------------------------------------------------------------
Function Name         : file_download_xc864()
Description           : The function to download the hex file.
Function Called       : bsl_erase_flash_xc864(),bsl_uart_header()
                        bsl_uart_data(), bsl_uart_eot()
Input Parameter       : *hComm        => Communication Handle.
                        bslDownload   => BSL_DOWNLOAD structure.
                         .eraseFlash  => 0: Flash is not erased before
                                            downloading.
                                         1: Flash is erased before
                                            downloading.
                         .eraseOnly   => 0: Continue with flash download.
                                         1: Do not continue with flash
                                            download after erase.
Output Parameter      : *uiError      => Error Code
Return Value          : None
---------------------------------------------------------------------*/
```

```
/*-------------------------------------------------------------------
Function Name          : bsl_prepare_verification()
Description            : Loads the verification code to XRAM and
                         executes it.
Function Called        : bsl_uart_header(),bsl_uart_data(),
                         bsl_uart_eot()
Input Parameter        : *hComm         => Communication Handle.
                         autobaudrate   => AUTO_BAUDRATE structure.
Output Parameter       : *uiError       => Error Code
Return Value           : None
-------------------------------------------------------------------*/
```

5 Tips and Recommendations

5.1 Flash Verification

Since it is not possible to use BSL mode to read out the memory content, there is a need to download a verification program into XRAM and run it in order to verify the flash content. For this purpose, the file **verify_lin.a51** (**verify_lin.hex**) containing the verification code, is provided.

After downloading the hex file content into XRAM, the code will do the following:

1. Auto baud rate detection.

   HOST has to send bsl_autobaudrate() command.
2. Wait for the bsl_uart_header() from HOST.

   The header block contains the starting address for the verification.

   HOST has to send bsl_uart_header() instruction with MODE=2
3. Wait for the bsl_uart_data() from HOST.

   HOST will send data blocks containing the code that was downloaded to the flash before. The data bytes received from the HOST will be compared with the data bytes stored in the flash.
5. Step 3 will be repeated until all code in a continuous address space is verified. In case of a mismatch of received and stored data byte the microcontroller will send a verification error response as described below for each byte.
6. HOST has to send the bsl_uart_eot() instruction. **Important: the parameter lastCodeLength has to be 0.**
7. Complete the flash download by repeating Step 2 - Step 6 (in case of a discontinuous address). After completing the verification, HOST will reset the device and reinitialize the BSL mode.

In case of mismatch of received and stored data byte, the following response will be sent for each error byte:

```
Verification Error Byte    : 0xFC
High Byte Address          : 0xXX
Low Byte Address           : 0xXX
Actual Data Byte           : 0xXX
Expected Data Byte         : 0xXX
```

5.2 Flash / XRAM Memory Mapping

The XC864 device offers flash devices with 4 Kbytes of embedded flash memory. The flash bank is mapped to both address range 0000H – 0FFFH and A000H – AFFFH, physically there is only one 4 Kbytes flash bank.

The sectorization of the flash memory is shown in **Table 5-1** below. The flash memory is used for code and data storage.

A sector consists of 32-byte aligned wordlines.

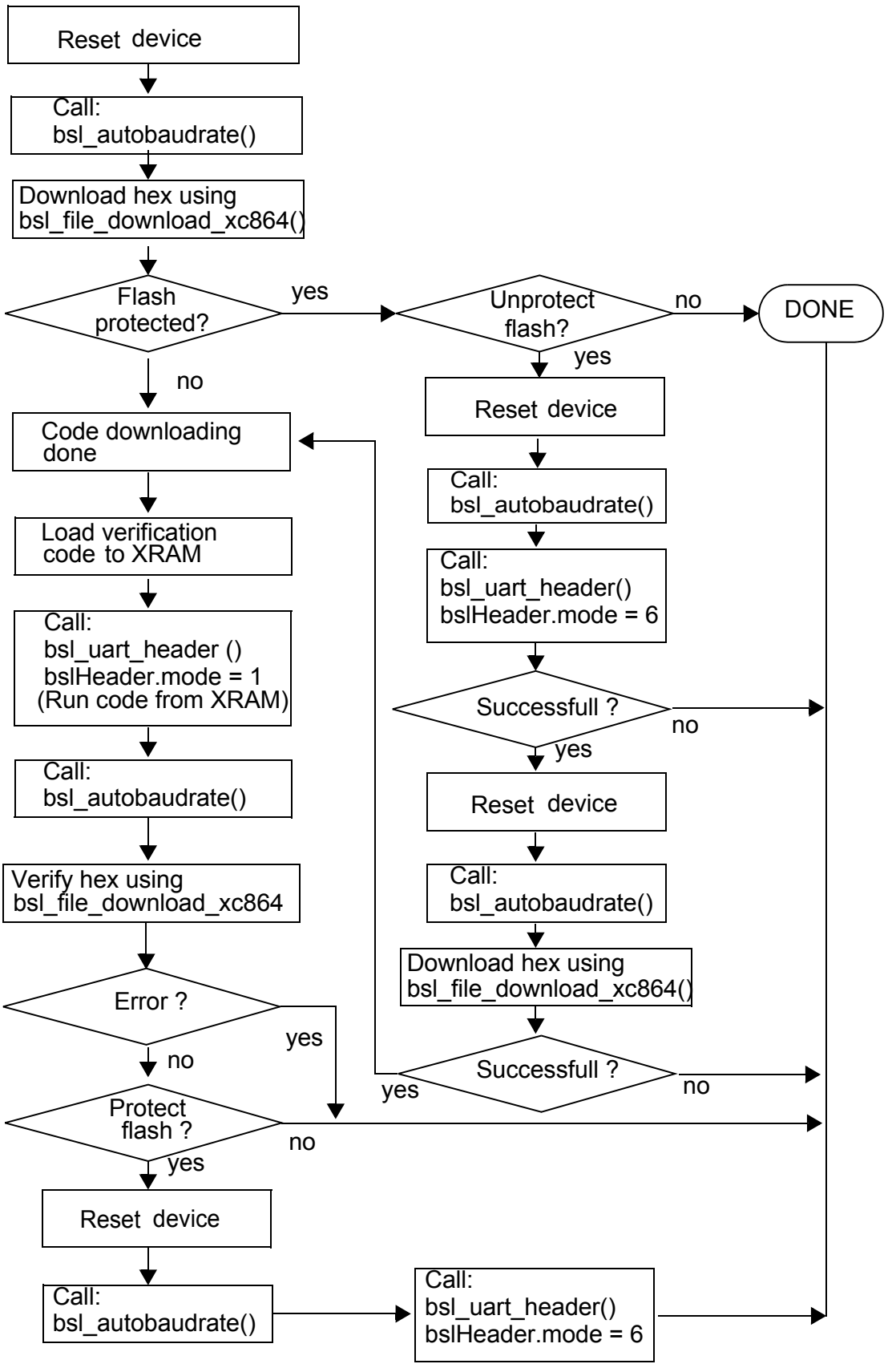
The flash is erased sector-wise.

.

Table 5-1 Flash Memory Mapping

SECTOR	Address Range	Size
0	0x0000 - 0x03FF	1 Kbytes
1	0x0400 - 0x07FF	1 Kbytes
2	0x0800 - 0x09FF	512 bytes
3	0x0A00 - 0x0BFF	512 bytes
4	0x0C00 - 0x0CFF	256 bytes
5	0x0D00 - 0x0DFF	256 bytes
6	0x0E00 - 0x0E7F	128 bytes
7	0x0E80 - 0x0EFF	128 bytes
8	0x0F00 - 0x0F7F	128 bytes
9	0x0F80 - 0x0FFF	128 bytes

5.3 Flow Chart of the Example Code



5.4 BSL Protocol Used

5.4.1 Flash / XRAM Code Download / Verification Using UART Protocol in Fast LIN Model

Header Block

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
TYPE (0)	**MODE**	**Start Address High**	**Start Address Low**	**Block Length**	**Not Used**	**Not Used**	**Checksum**

Data Block

Byte 0	Byte 1 - (Block_Length - 2)	Byte (Block_Length - 1)
TYPE (1)	**Program Codes ((Block_Length - 2) byte)**	**Checksum**

EOT Block

Byte 0	Byte 1	Byte 2 - ...	...	...
TYPE (2)	**Last_Codelength**	**Program Codes (Last_Codelength) byte**	**Not Used (Block_Length-3-Last_Codelength) byte**	**Checksum**

5.4.2 Flash Erasing Using UART

Header Block

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
TYPE (0)	**MODE (0x04)**	**Sector_P-FL0**	**Sector_P-FL1**	**Sector_P-FL2**	**Sector L_D-FL**	**Sector H_D-FL**	**Checksum**

5.4.3 Flash Protection / Unprotection Using UART

Header Block

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
TYPE (0)	**MODE (0x06)**	**Password**	**Not Used**	**Not Used**	**Not Used**	**Not Used**	**Checksum**

	Description
TYPE	0 = Header Block 1 = Data Block 2 = EOT Block
MODE	0 = Download to XRAM 1 = Execute code from XRAM (leave BSL mode) 2 = Download to flash 3 = Execute code from flash (leave BSL mode) 4 = Erase flash 6 = Flash protection / unprotection (leave BSL mode)
Start Address High / Low	16 bit starting address for programming.
Block Length	The number of bytes for the subsequent Data and EOT blocks (including Type and Checksum)
Program Codes	The bytes to be programmed into the memory.
LastCodeLength	Length of program code in the EOT block (not 32-byte aligned).
Password	The password for the protection / unprotection of flash (1 byte).
Sector_P-FL0	The sectors 0 to 2 of P-Flash Bank 0 are represented by bits 0 to 2[1)].
Sector_P-FL1	The sectors 0 to 2 of P-Flash Bank 1are represented by bits 0 to 2[1)].
Sector_P-FL2	The sectors 0 to 2 of P-Flash Bank 2are represented by bits 0 to 2[1)].
SectorL_D-FL	The sectors 0 to 7 of D-Flash Bank are represented by bits 0 to 7[1)].
SectorH_D-FL	The sectors 8 to 9 of D-Flash Bank are represented by bits 0 to 1[1)].
Response (Acknowledge Frame)	0x55 = OK 0xFE = Checksum Error 0xFD = Flash is protected 0xFC = Verification Error 0xFF = Block Error

1) Unwanted/ unselected bits should be cleared to 0.

5.4.4 LIN Auto Baud Rate Detection

Master Request Header + Command

Byte 0
SYN Break: 0x0 (Half baud rate)

==> Wait 700 µs (maximum)

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8	Byte9	Byte10
SYN Char (0x55)	**ID (0x3C)**	**NAD (0x7F)**	**0x00**	**0x00**	**0x00**	**0x00**	**0x00**	**0x00**	**Fast LIN 0x01**	**Check sum (0x80)**

==> Wait 10 ms

Slave Response Header

Byte 0
SYN Break: 0x0 (Half baud rate)

==> Wait 700 µs (maximum)

Byte 0	Byte 1
SYN Char (0x55)	**ID (0x7D)**

==> Wait 40 ms

==> Wait for Acknowledgement Frame (9 Bytes)

An **Acknowledgement Frame** can be always requested sending a **Slave Response Header** to the device.

LIN Acknowledgement Frame:

Byte0	Byte1	Byte2 - Byte7	Byte8
NAD	**Response**	**Not Used (6 bytes)**	**Checksum**

It is recommended to request an acknowledgement after each **Master Request Header** sent.

As described in the following sections, all commands to the device are sent via the **Master Request Header**.

5.4.5 Flash / XRAM Code Download / Verification Using LIN

Header Block

Byte 0

SYN Break: 0x0 (Half baud rate)

==> Wait 700 µs (maximum)

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8	Byte9	Byte10
SYN Char (0x55)	ID (0x3C)	NAD (0x7F)	TYPE (0x00)	MODE	Start Addr High	Start Addr Low	Data Count	Not Used	Fast LIN 0x01	Check sum

Data Block

Byte 0

SYN Break: 0x0 (Half baud rate)

==> Wait 700 µs (maximum)

Byte0	Byte1	Byte2	Byte3	Byte4 - Byte9	Byte10
SYN Char (0x55)	ID (0x3C)	NAD (0x7F)	TYPE (0x01)	Program Code (6 bytes)	Check sum

EOT Block

Byte 0

SYN Break: 0x0 (Half baud rate)

==> Wait 700 µs (maximum)

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5 - Byte8	Byte9	Byte10
SYN Char (0x55)	ID (0x3C)	NAD (0x7F)	TYPE (0x02)	Last Code Length	Program Code	Not Used	Check sum

5.4.6 Flash Erasing Using LIN

Header Block

Byte 0

SYN Break: 0x0 (Half baud rate)

==> Wait 700 µs (maximum)

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8	Byte9	Byte10
SYN Char (0x55)	ID (0x3C)	NAD (0x7F)	TYPE (0x00)	MODE (0x04)	Sector P-FL0	Sector P-FL1	Sector P-FL2	Sector L_D-FL	Sector H_D-FL	Check sum

5.4.7 Flash Protection / Unprotection Using LIN

Header Block

Byte 0

SYN Break: 0x0 (Half baud rate)

==> Wait 700 µs (maximum)

Byte0	Byte1	Byte2	Byte3	Byte4	Byte5	Byte6	Byte7	Byte8	Byte9	Byte10
SYN Char (0x55)	ID (0x3C)	NAD (0x7F)	TYPE (0x00)	MODE (0x06)	Pass-word	Not Used	Not Used	Not Used	Not Used	Check sum

***Note:** A Slave Response Header can be sent after each Master Request Block in order to request an Acknowledgement Frame from the device (see Section 5.4.4).*

***Note:** The only LIN frame used in this example code is the LIN "Auto baud rate Detection" frame (see Section 5.4.4) in order to enter Fast LIN BSL mode. The microcontroller will switch to the BSL UART protocol and the communication structure will be the same as in UART BSL mode.*

	Description
TYPE	0 = Header Block 1 = Data Block 2 = EOT Block
MODE	0 = Download to XRAM 1 = Execute Code from XRAM (leave BSL mode) 2 = Download to flash 3 = Execute Code from flash (leave BSL mode) 4 = Erase flash 6 = Flash Protection / unprotection
Fast LIN	0 = Disable Fast LIN BSL 1 = Enable and enter Fast LIN BSL mode (used in this example code)
Start Address High / Low	16 bit starting address for programming.
Data Count	The number of data blocks to be subsequently sent during programming[1)].
Program Codes	The bytes to be programmed into the memory.
LastCodeLength	Length of program code in the EOT block
Password	Password for protection / unprotection of flash.
Sector_P-FL0	The sectors 0 to 2 of P-Flash Bank 0 are represented by bits 0 to 2[2)].
Sector_P-FL1	The sectors 0 to 2 of P-Flash Bank 1are represented by bits 0 to 2[1)].
Sector_P-FL2	The sectors 0 to 2 of P-Flash Bank 2are represented by bits 0 to 2[1)].
SectorL_D-FL	The sectors 0 to 7 of D-Flash Bank are represented by bits 0 to 7[1)].
SectorH_D-FL	The sectors 8 to 9 of D-Flash Bank are represented by bits 0 to 1[1)].
Response (Acknowledge Frame)	0x55 = OK 0xFE = Checksum Error 0xFD = Flash is protected 0xFC = Verification Error 0xFF = Block Error

1) The length of program code in the data block is fixed to 6 bytes.

2) Unwanted/ unselected bits should be cleared to 0.

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