HY16F Series
ISP Bootloader Instruction Manual

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1. Introduction

HY16F series allow user to configure flash memory. To add a Boot code in the memory begging, it is Bootloader code. Provide for user to do on-line update program, it also be called ISP(In-System Programming). User use HY16F Bootloader GUI throught USB to UART brdige to update HY16F APP Flash. The funciton allows for all HY16F series.

In this artilce, we focus on introduction HY16F198B ISP Bootloader. First, HY16F198B have to pre-burn the UART Bootloader FW(4KB size) by using HY16F Mini Link or HY16F Writer in the memory begging. HYCON provide HY16F Bootloader GUI and UART Bootloader FW for user. User can use this platform easy to implement ISP on-line update program.

2. ISP Bootloader Introduction

2.1. Software Introduction

PC software : HY16F Bootloader GUI(Graphical User Interface) shows in figure1 and figure2. HY16F Bootloader GUI applies to HY16F series as below.
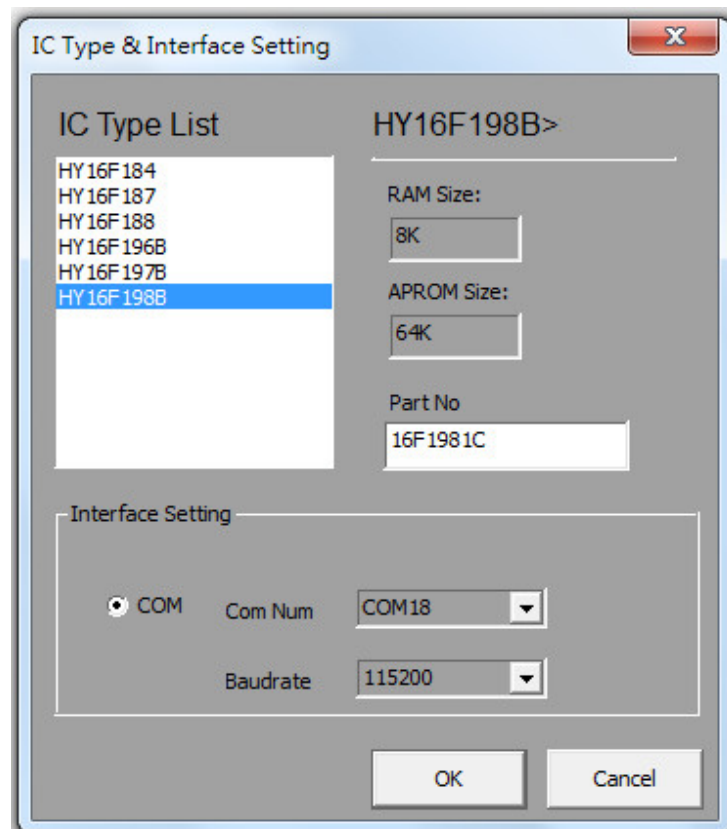HY16F184/HY16F187/HY16F188/HY16F196B/HY16F197B/HY16F198B

Figure1. HY16F Bootloader GUI - IC type list setting

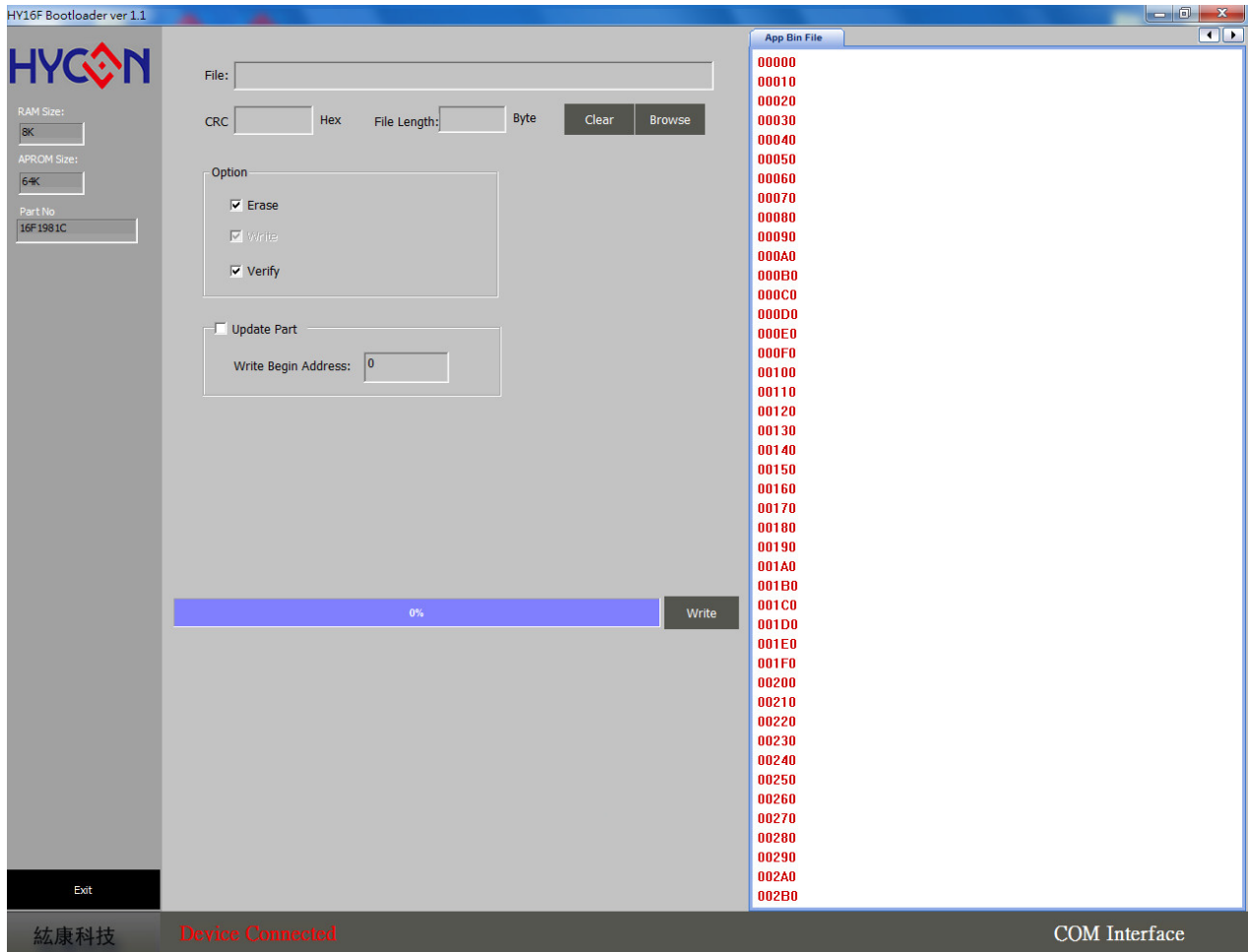After selecting HY16F IC type, below window will show up.

Figure 2. HY16F Bootloader GUI - control window

2.2. Software Installation

HY16F Bootloader V1.1 is mainly for AndeSight IDE compiler generated by the .bin file to burn. Minimum system requirements of operating HY16F Bootloader V1.1:

- **PC Hardware Requirement**:
  PC compatible with（PENTIUM®）system
  256MB Memory（recommend 512MB）
  500MB Hard disk

- **Operating System Support**:
  Windows XP (32 bit), Windows 7(32 bit/64 bit), Windows 8(32 bit/64 bit),
  Windows 10(64 bit)

- **Apply the following interface modes**:
  USB Port

- **Software Version Support**:
  HY16F Bootloader V1.1 above

- **Support Chip Product Model**:
  -HY16F18X product (HY16F184, HY16F187, HY16F188)
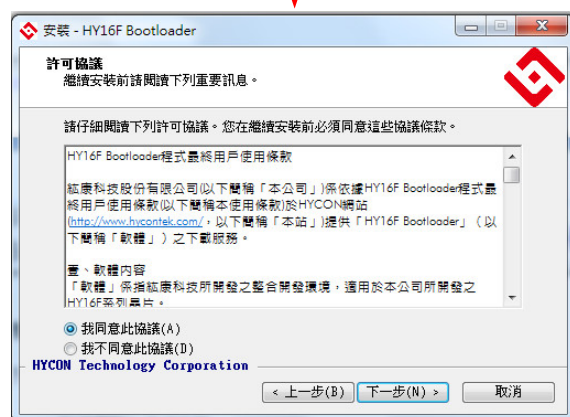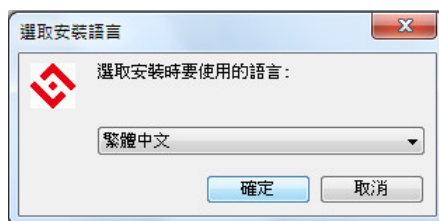 -HY16F19XB product（HY16F196B, HY16F197B, HY16F198B）

-**Program Version Compatibility:**
  Through the HY16F IDE software version compiled file (bin file), can be burned by HY16F Bootloader V1.1

-**HY16F Writer Software Installation Steps:**
  Refer to the figure3 in detail
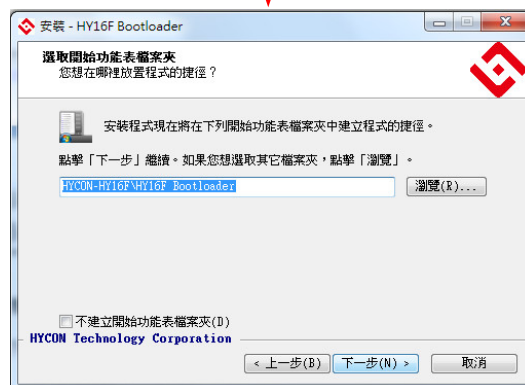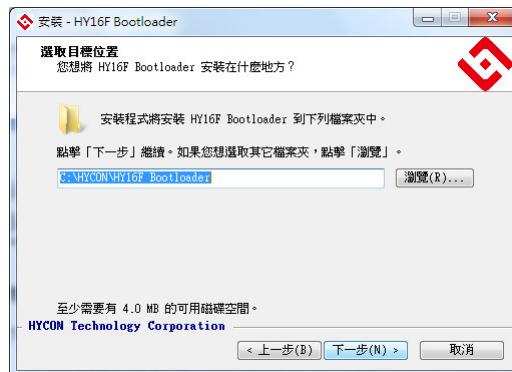
Figure3. Software installation steps

Note : For some Windows operating systems, installing the software on your computer requires administrator access.

2.3. Uninstall

Please go to the control panel(Windows) "Add or Remove Programs" to find HY16F Bootloader ver1.1 to select the removal program.

2.4. Software Operation

In this section, select the HY16F198B to do the software instructions.

Ⅰ）Set up the hardware environment, confirm the 3-pin connection correctly PT2.0(TX)/PT2.1(RX)/PT2.2(ISP_EN). And confirm that the chip had already burned the UART Bootloader FW.

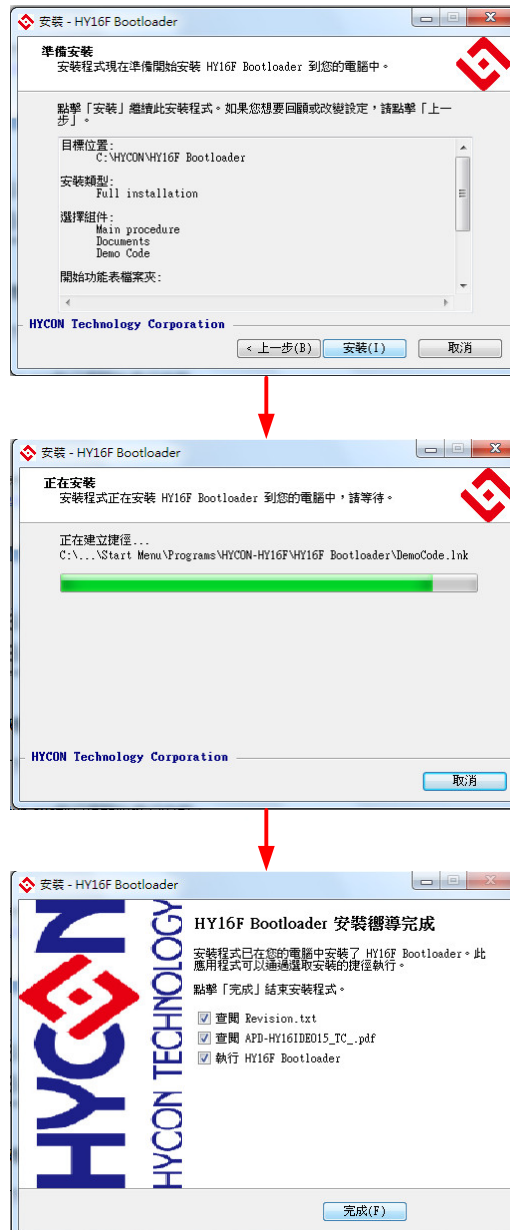Ⅱ）IC power on. Confirm that PT2.2(ISP_EN) is working on High status(VDD3V). Execute HY16F Bootloader V1.1, select HY16F series IC type and UART COM port number and UART baudrate. Click "Ok" button.
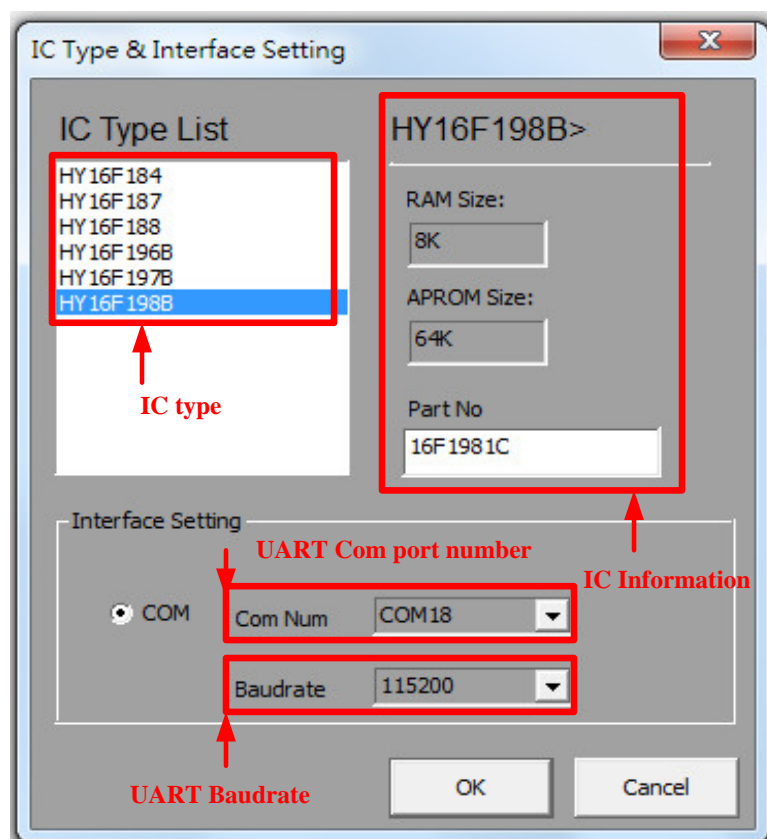
Figure4. HY16F series IC type list

III) After select the IC type and UART setting, click the "Ok" button. IC will auto do auto-baurdate calibration and connection. If auto-baudrate connection is success, that means UART communication normal. If auto-baudrate connection is failure, the pop-up message shows" Auto Detect Baudrate Fail". In this condition, user can RESET chip and re-open HY16F Bootloader V1.1 to try again.

IV) After enter the HY16F Bootloader GUI - control window, the selected IC information shows in the top left corner. In the bottom left corner shows"Device Conneted", otherwise it

shows "Device Disconneted".

V) Click "Browse" button and select the bin file. When bin file is loading success, it shows file path and file length information in the window. Note : the bin file can't exceed 60K bytes and bin file can't be used by other software at the same time.

VI) Option to modify "Write Begin Address". If select default setting "Write Begin Address" 0, the UART Bootloader will start from address 0x91000 to update APP flash bin.

VII) After load bin file, Enable the checkbutton "Erase" and "Verify".

VIII) Click"Write" button and start to burn FW. The progress bar displays the update status (unit :%). In the update processing, the verification is included. If update FW error, it displays the "Communication Error" or "Verify Error" information in the progress bar.

IX) User can click "Write" button continue to burn or click "Exit" button in the bottom left corner to leave HY16F Bootloader GUI.

Figure 5. Auto-baudrate detect failure
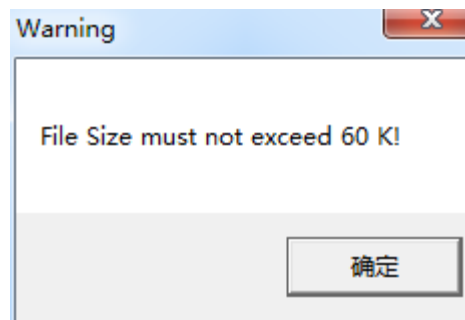
Figure 6. The bin file size exceed 60K bytes
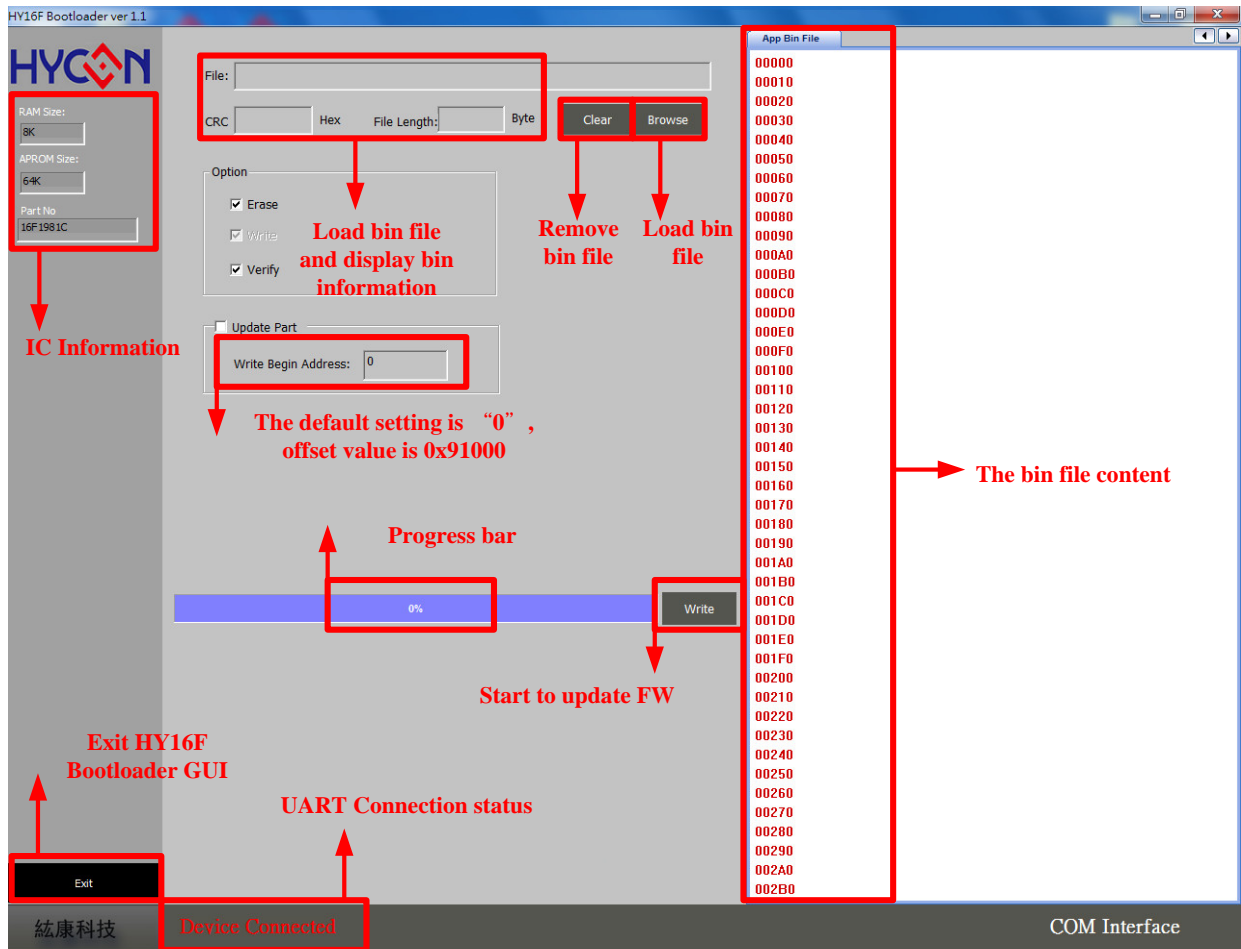
Figure 7. HY16F Bootloader GUI-control window

2.5. Hardware Description

The system connection architecture between control board and target board show on figure8. In this section, give as an example HY16F198B UART Bootloader FW. The default Bootloader communication pins are PT2.0(TX)/PT2.1(RX)/PT2.2(ISP_EN). User can modify Bootloader communication pins by UART_BootLoader.c.
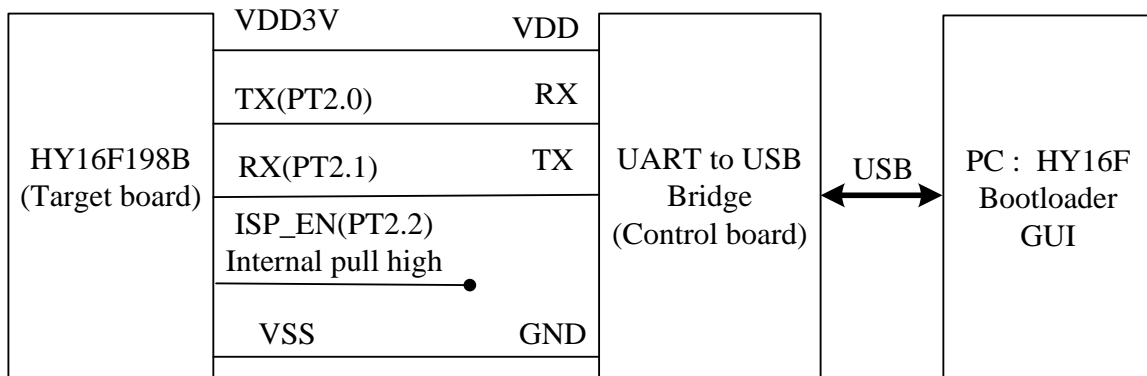
Figure8. System connection architecture

Hardware connection shows on figure9, the picture is HY16F198B starter kit. Follow the Step1~Step4, Step4 connect USB to PC. When IC power on, it will work on Bootloader Mode. Note : Please confirm that the HY16F198B had already burned the UART Bootloader FW, otherwise, it can't work on Bootloader Mode.

Figure 9. Hardware connection at bootloader mode

3. UART Bootloader FW Structure

3.1. Flash Memory Description

Start up code & UART Bootloader : Address 0x90000~0x91000, contains the interrupt handler stack and initialization action and UART Bootloader FW.

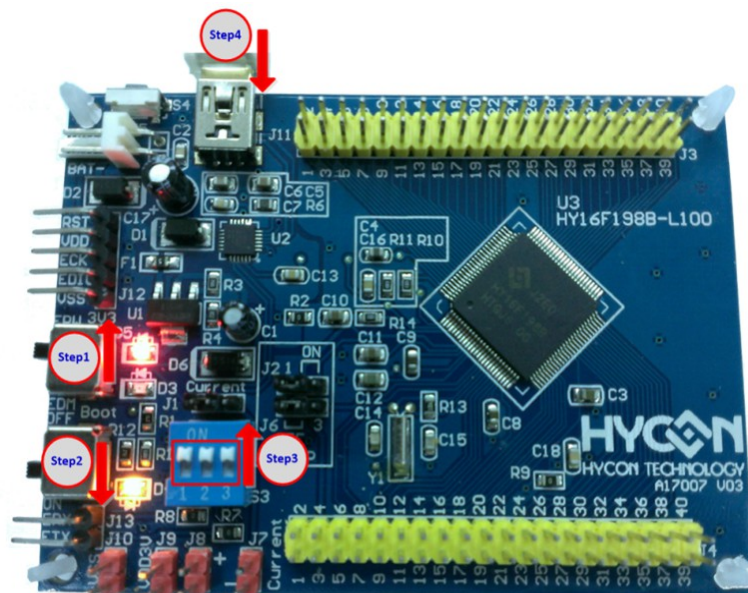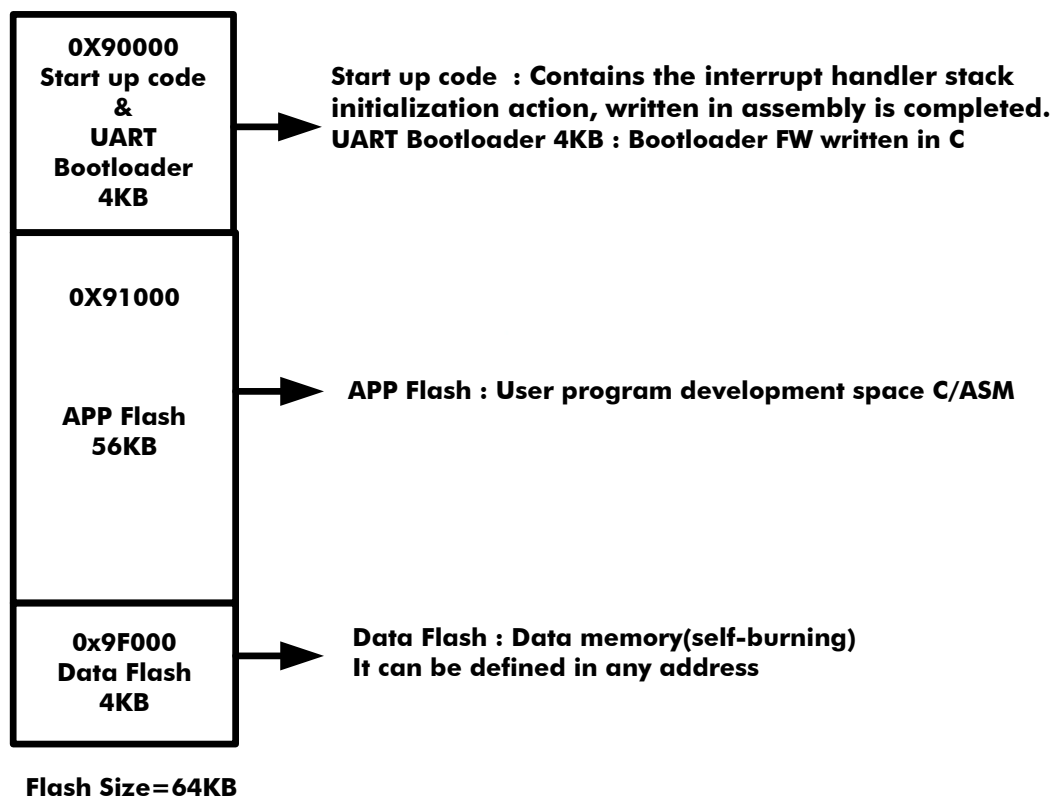APP Flash: User program development space, the default address is 0x91000. User can modify the address.

Data Flash : User self-burning the calibration parameters, the default address is 0x9F000. It can be defined in any address.

```
┌──────────────┐
│  0X90000     │      Start up code : Contains the interrupt handler stack
│ Start up code│      initialization action, written in assembly is completed.
│      &       │ ───▶ UART Bootloader 4KB : Bootloader FW written in C
│    UART      │
│ Bootloader   │
│    4KB       │
├──────────────┤
│  0X91000     │
│              │
│              │
│  APP Flash   │ ───▶ APP Flash : User program development space C/ASM
│    56KB      │
│              │
├──────────────┤
│  0x9F000     │      Data Flash : Data memory(self-burning)
│  Data Flash  │ ───▶ It can be defined in any address
│    4KB       │
└──────────────┘
  Flash Size=64KB
```

3.2. Programming Files

UART Bootloader documents：

1. UART_BootLoader.c / UART_BootLoader.h : UART Bootloader program, including UART TX/RX pin and ISP_EN pin and UART Bootloader protocol and UART handshank and so on.

2. ISR.c/ISR.h : include void HW0_INT(void) ~void HW8_INT(void) and tlb_exception_handler() functions definition.

3. ISP_Test.h: UART Bootloader related function and variable definition, including APP Flash start address.

4. main.c : User's main program area.

5. crt0.o : HY16F198B start up code

6. HY16F198B_ISP.LD : HY16F198B link file, user can configure the content to modify Data Flash start address.

3.3. UART Protocol

User can refer this section to customize Bootloader GUI by using UART protocol. Main program architecture has 3 layers. Bottom layer includes HY16F198B ROM function to do Flash Burn and Erase. Middle layer includes UART protocol, base on UART protocol and ISP command to do flash read/write.

HY16F198B support Flash ROM Function as below:

int ROM_BurnWord(unsigned int addr,unsigned int DelayTime,unsigned int data);

int ROM_BurnWordonly(unsigned int addr,unsigned int DelayTime,unsigned int data);

int ROM_BurnPage(unsigned int addr,unsigned int DelayTime,unsigned int * data);

int ROM_BurnPageWriteonly(unsigned int addr,unsigned int DelayTime,unsigned int * data);

int PageErase(unsigned int addr,unsigned int DelayTime);

int SectorErase(unsigned int addr,unsigned int DelayTime);

All functions description, please refer to the document "APD-HY16IDE007_SC".

3.3.1. Command Package

Sync Char1	Sync Char2	Command Code	Data Length	Payload	Check Sum
0x55	0xAA	1 Byte	1 Byte	Data number according to Length Field	1 Byte
		←Checksum calculation range→			

3.3.2. ISP Command(Host to Slave)

ISP Command	Command Code	Data Length	Payload
SECTOR_ERASE	0x92	0x2	<AddrH><AddrL>

ISP Command	Command Code	Data Length	Payload
PAGE_ERASE	0x93	0x2	<AddrH><AddrL>
WORDS_WRITE	0x94	0x2+N; N<= 0x20	<AddrH><AddrL> <Word$_0$><Word$_1$>......<Word$_{N-2}$><Word$_{N-1}$>
PAGE_WRITE	0x95	0x82	<AddrH><AddrL> <Word$_0$><Word$_1$>......<Word$_{30}$><Word$_{31}$>
WORDS_WRITE_ONLY	0x96	0x2+N; N<= 0x20	<AddrH><AddrL> <Word$_0$><Word$_1$>......<Word$_{N-2}$><Word$_{N-1}$>
PAGE_WRITE_ONLY	0x97	0x82	<AddrH><AddrL> <Word$_0$><Word$_1$>......<Word$_{30}$><Word$_{31}$>
ALL_ERASE	0x98	0x4	<AddrH><AddrL><Data_Lenght_H> <Data_Lenght_L><ExpectCS>
PAGES_READ_CHECKSUM	0x81	0x4	<AddrH><AddrL><NumPage> <ExpectCS>
SECTORS_READ_BLANK	0x82	0x3	<AddrH><AddrL><NumSector>

Note:<Word>=<Byte0MSB><Byte1><Byte2><Byte3LSB>

3.3.3. ISP Command(Slave to Host)

ISP ACK / NACK	Command Code	Data Length	Payload	Description
ACK_CMD_DONE	Return Host CMD Code	0x1	0xA4	Command Package is valid and has been executed.
ACK_PAGES_CS_TRUE	Return Host CMD Code	0x1	0xA5	For CMD 0x81: Expected Pages Checksum and Flash content is Consistent. For CMD 0x82: Expected Blank Sectors and Flash content is Consistent.
ACK_PAGES_CS_FAIL	Return Host CMD	0x1	0xA6	For CMD 0x81: Expected Pages Checksum and

	Code			Flash content is Inconsistent For CMD 0x82: Expected Blank Sectors and Flash content is Inconsistent
NACK_CHECKSUM_ERR	Return Host CMD Code	0x1	0xE1	Command Package is invalid due to Checksum inconsistent.
NACK_READ_ERR	Return Host CMD Code	0x1	0xE2	Command Package is invalid due to data length inconsistent.
NACK_HEADER_ERR	Return Host CMD Code	0x1	0xE3	Command Package is invalid due to Header differ from <0x55><0xAA>

3.4. ISP Functions

3.4.1. Peripheral Initial

After GPIO and UART initialization, execute UART auto-uaud rate and handshake program. When master connect with device(HY16F198B) successfully, master and device can do command package recevice and transmit.

unsignedchar ISP_GPIO_Init(void);

void ISP_UART_Init(void);

unsignedchar ISP_UART_ABR(void);

### 3.4.2. CMD Package Receive and Transmit

Command package receive/transmit

unsignedchar ISP_UART_Read(unsignedchar* ptr_data, unsignedint count);

void ISP_UART_Write(unsignedchar* ptr_data, unsignedint count);

3.4.3. CMD Execution and Checksum calculation

After receive command package, calculate and verify checksum, execute ISP command.

unsignedchar ISP_CMD(unsignedchar* ptr_data);

unsignedchar ISP_Checksum(unsignedchar* data,unsignedint len);

3.4.4. ISP Bootloader flowchart
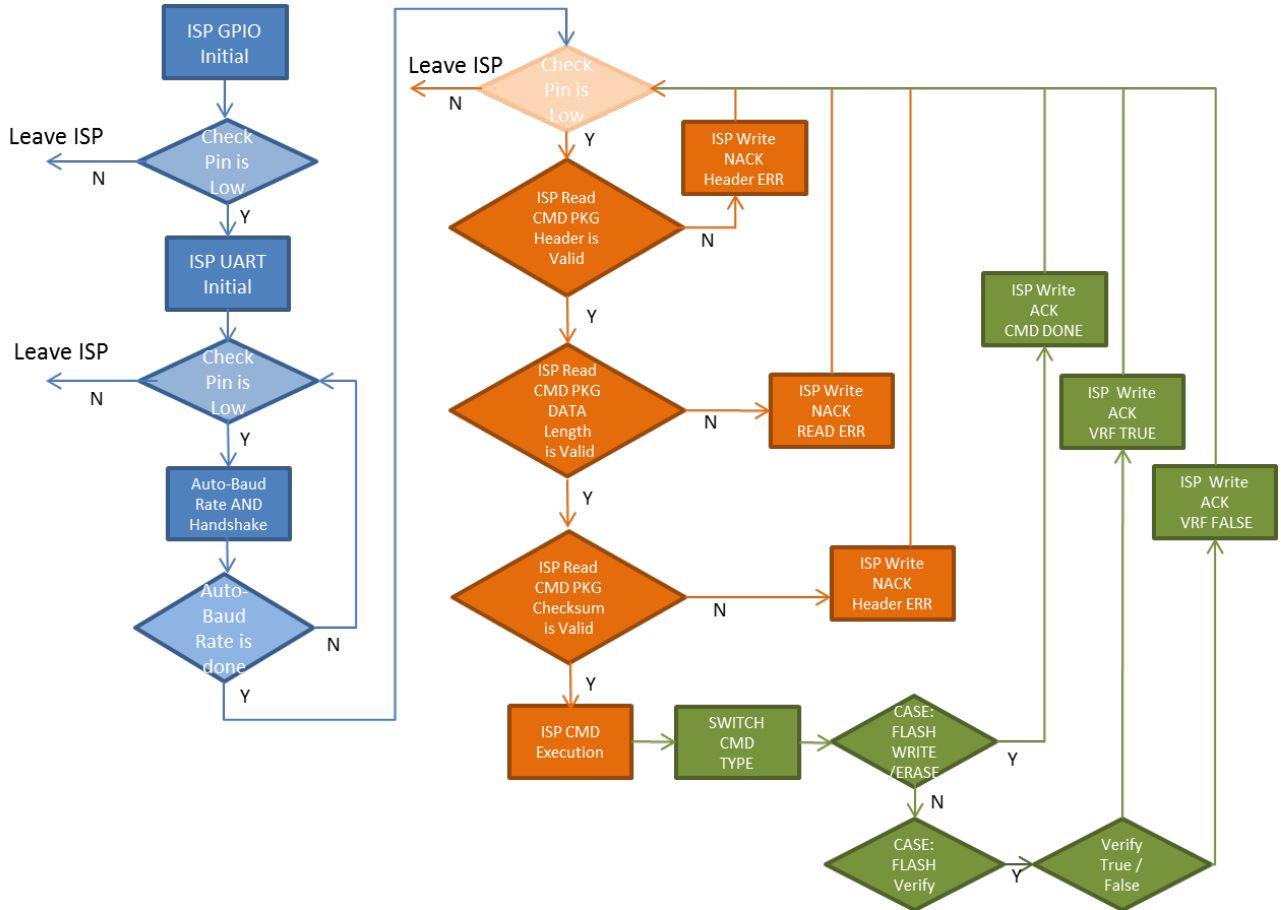
Description: in the above flowchart, bule color means ISP_EN pin check, orange color means UART Bootloader handshark check, green color means UART Bootloader Flash Wrtire programming

3.4.5. Checksum Calculation

The checksum algorithm is used by XOR, all variables are unsigned char. The initial calculation value is 0xFF, final return value will be checksum.

3.5. HY16F198B_UART_Boot_Style Description and Modification

First, enter the HYCON website to download and install HY16F Bootloader V1.1, and find out HY16F198B_UART_Boot_Style demo code, the default destination folder route is below.
C:\Program Files\HYCON\HY16F Bootloader\DemoCode\HY16F198B_UART_Boot_Style.

Second, for UART Bootloader developer, all user have to find out the project HY16F198B_UART_Boot_Style. Base on this project to develop the program and compile code in the future. After re-build and compile this project, the project generates 3 bin files. It includes the file name and date and checksum in the bin file.
The example below:

HY16F198B_UART_Boot_Style_APP-201708221106-0xcaff.bin	2017/8/22 上午 1...
HY16F198B_UART_Boot_Style_DATA-201708221106-0x7ff8.bin	2017/8/22 上午 1...
HY16F198B_UART_Boot_Style-201708221106-0x388a.bin	2017/8/22 上午 1...

(1) HY16F198B_UART_Boot_Style-201708221106-0x388a.bin means the start address from 0x90000. The bin file includes Bootloader FW and APP Flash and Data Flash. If the HY16F198B chip is empty, User have to burn the bin code into chip first, it makes chip to support UART Bootloader mode.
(2) HY16F198B_UART_Boot_Style_APP-201708221106-0xcaff.bin means the start address from 0x91000. It is APP Flash bin file. If the HY16F198B had already burned the UART Bootloader FW, user can burn APP Flash bin file by using HY16F Bootloader GUI.
(3) HY16F198B_UART_Boot_Style_DATA-201708221106-0x7ff8.bin means the start address from 0x9F000. It is Data Flash bin file. The defualet address is 0x9F000. It can be defined in any address. In common case, save the calibration parameters in the Data Flash.

In main.c, all interrupt service routine are defined in void HW0_INT(void) ~void HW8_INT(void), user can program the interrupt event at here. HYCON had already declared the interrupt function in the ISR.c file.

In UART_BootLoader.c, user can modify and define ISP pin check status and UART port. For example, the default setting PT2.0=TX, PT2.1=RX, if user would like to modify the UART PT1.4=TX, PT1.5=RX, user can find out the function "void ISP_UART_Init(void)", the function is UART related initialization. The function "unsigned char ISP_UART_ABR(void)" is related UART auto baudrate and handshark, user can modify the handshark protocol in

this function. The default ISP_EN pin is PT2.2 and high status to enter Bootloader Mode, user can modify and define to others pin or pin status judgement.

Note : please be understood that UART Bootloader will reduce 4K byte program flash size. In other words, 64K program flash only remains 60K program flash size(APP Flash+Data Flash) for user to develop the program. At the same time, user have to remain 3 pins on UART Bootloader communication PT2.0(TX)/PT2.1(RX)/PT2.2(ISP_EN). But once finish and leave UART Bootloader mode, User still can use these 3 pins to do other applications.

4. UART Bootloader FW Specification

Operating voltage：2.2~3.6V

Burning time：Considering UART baudrate speed is 115200

ROM_BurnPage, including Erase+ Page write time, it spends 30msec.

Each page has 128bytes, when burning 60K bytes flash, it totally spends
(61440/128)*30/1000=14.4s

5. Revisions

The following describes the major changes made to the document, excluding the punctuation and font changes.

Version	Page	Summary of Changes
V01	ALL	First version release