AN4065
Application note

STM32F0xx in-application programming using the USART

Introduction

An important requirement for most Flash-memory-based systems is the ability to update firmware when installed in the end product. This ability is referred to as in-application programming (IAP). The purpose of this application note is to provide general guidelines for creating an IAP application.

The STM32F0xx microcontroller can run user-specific firmware to perform IAP of the microcontroller-embedded Flash memory. This feature allows the use of any type of communication protocol for the reprogramming process. The USART is the example used in this application note.

Contents

1   IAP overview

STM32F0xx devices are implemented in the STMicroelectronics STM320518-EVAL evaluation board.

1.1   Principle

Program the IAP driver to the Flash memory base address via the serial wire debug (SWD) interface using the development toolchain of your choice or the factory-embedded bootloader in the system memory area.

The IAP driver uses the USART to:

●   Download a binary file from the HyperTerminal to the STM32F0xx's internal Flash memory.

●   Upload the STM32F0xx's internal Flash memory content (starting from the defined user application address) into a binary file.

●   Execute the user program.

1.2   IAP driver description

The IAP driver contains the following set of source files:

●   *main.c*: where the USART initialization and RCC configuration are set. A main menu is then executed from the *menu.c* file.

●   *menu.c*: contains the main menu routine. The main menu gives the options of downloading a new binary file, uploading the internal Flash memory, executing the binary file already loaded, and disabling the write protection of the pages where the user loads his binary file (if they are write protected).

●   *flash_if.c* contains write, erase and disable write protection of the internal Flash memory.

●   *common.c*: contains functions related to read/write from/to the USART peripheral

●   *ymodem.c*: is used to receive/send the data from/to the HyperTerminal application using the YMODEM protocol[a]. In the data receiving process fails, the "Failed to receive the file" error message is displayed. If the data is received successfully, it is programmed into the internal Flash memory from the appropriate address. A comparison between the internal RAM contents and internal Flash memory contents is performed to check the data integrity. If there is any data discrepancy, the "Verification failed" error message is displayed. Other error messages are also displayed, for example, when the image file size is greater than the allowed memory space and when the user aborts the task.

●   STM32F0xx Standard Peripherals Library.

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a.   The Ymodem protocol sends data in 1024-byte blocks. An error check is performed in data blocks transmitted to the STM32F0xx's internal RAM to compare the transmitted and received data. Blocks unsuccessfully received are acknowledged with an NAK (negative acknowledgement). For more details about the Ymodem protocol, refer to existing documentation.
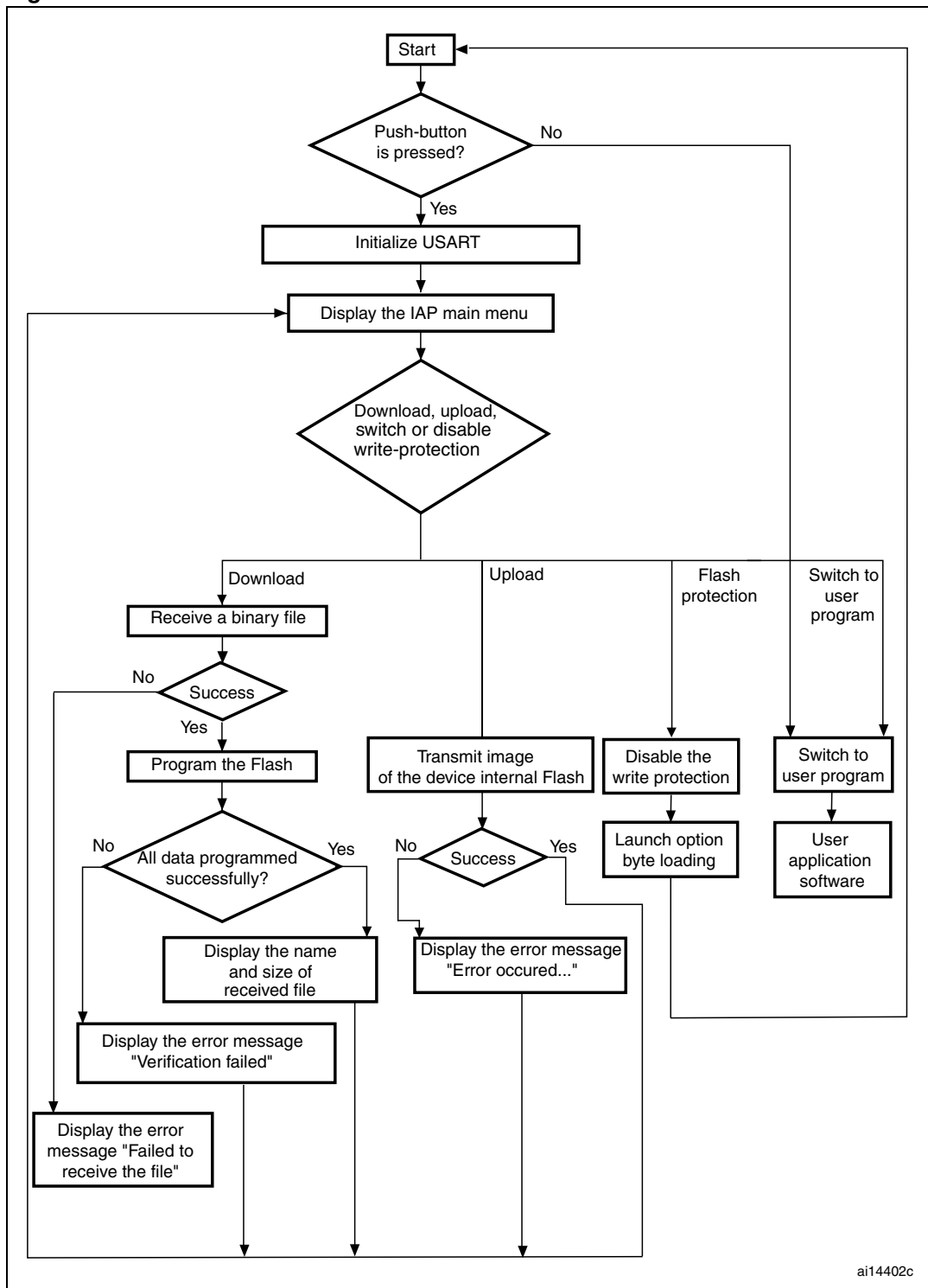
The user can choose to either go to the user application or execute the IAP for reprogramming purposes by pressing a push-button connected to a pin.

● Not pressing the push-button at reset switches to the user application

● Pressing the push-button at reset displays the IAP main menu

Refer to *Table 1: STM32F0xx IAP implementation* for more details about the STM320518-EVAL board push-button used to enter IAP mode.

The IAP flowchart is shown in *Figure 1*.

Figure 1.   Flowchart of the IAP driver

Start

Push-button is pressed? — No

Yes

Initialize USART

Display the IAP main menu

Download, upload, switch or disable write-protection

Download | Upload | Flash protection | Switch to user program

Receive a binary file

Success — No

Yes

Program the Flash

All data programmed successfully? — No / Yes

Transmit image of the device internal Flash

Success — No / Yes

Disable the write protection

Switch to user program

Display the name and size of received file

Display the error message "Error occured..."

Launch option byte loading

User application software

Display the error message "Verification failed"
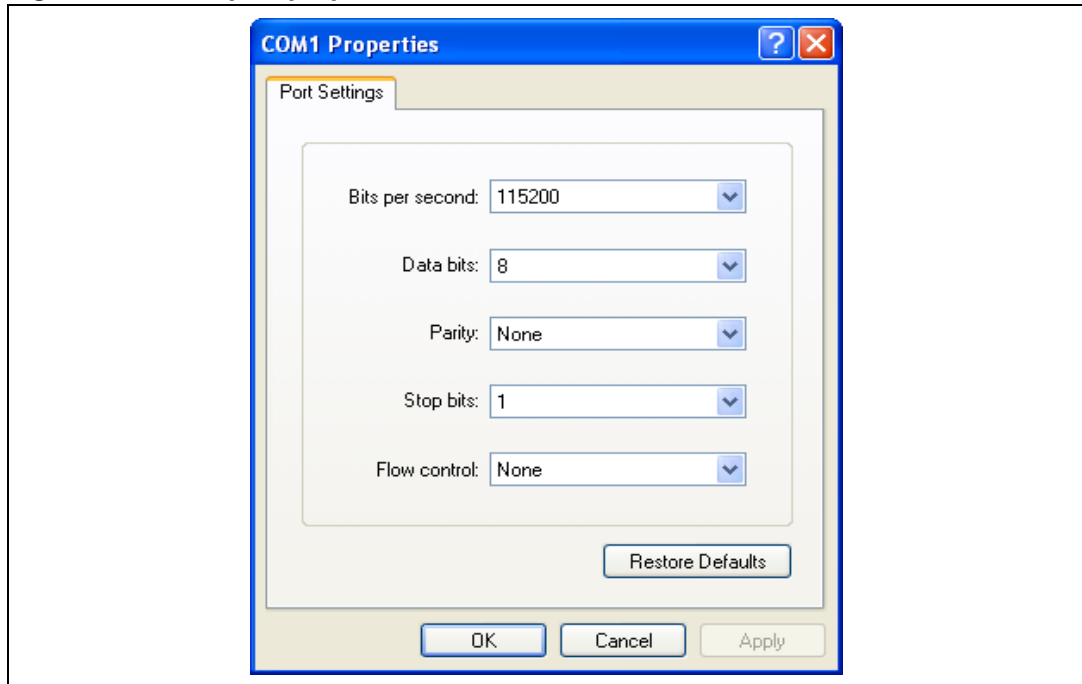
Display the error message "Failed to receive the file"

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2 Running the IAP driver

2.1 HyperTerminal configuration

To use the IAP, the user must have a PC running HyperTerminal or another terminal program that supports **ymodem protocol**. In this document, the HyperTerminal is used. *Figure 2* shows the HyperTerminal configuration.

Figure 2. COM port properties

Note: *The baud rate value of 115200 bps is used as an example.*

Care must be taken when selecting the system clock frequency. To guarantee successful communication via the USART, the system clock frequency in the end application must be such that a baud rate equal to 115200 bps can be generated.

2.2 Executing the IAP driver

As an example in this application note, pressing the pin connected to the push-button allows the IAP driver to run.

By pressing the push-button at reset, the user can run the IAP driver to reprogram the STM32F0xx's internal Flash memory. It is not mandatory to use the push-button; the user can apply a signal to this pin with respect to its active level. Refer to *Table 1: STM32F0xx IAP implementation*.

3 IAP driver menu

Running the IAP driver displays the following menu in the HyperTerminal window.

Figure 3.   IAP driver menu when the STM32F0xx Flash memory is not protected
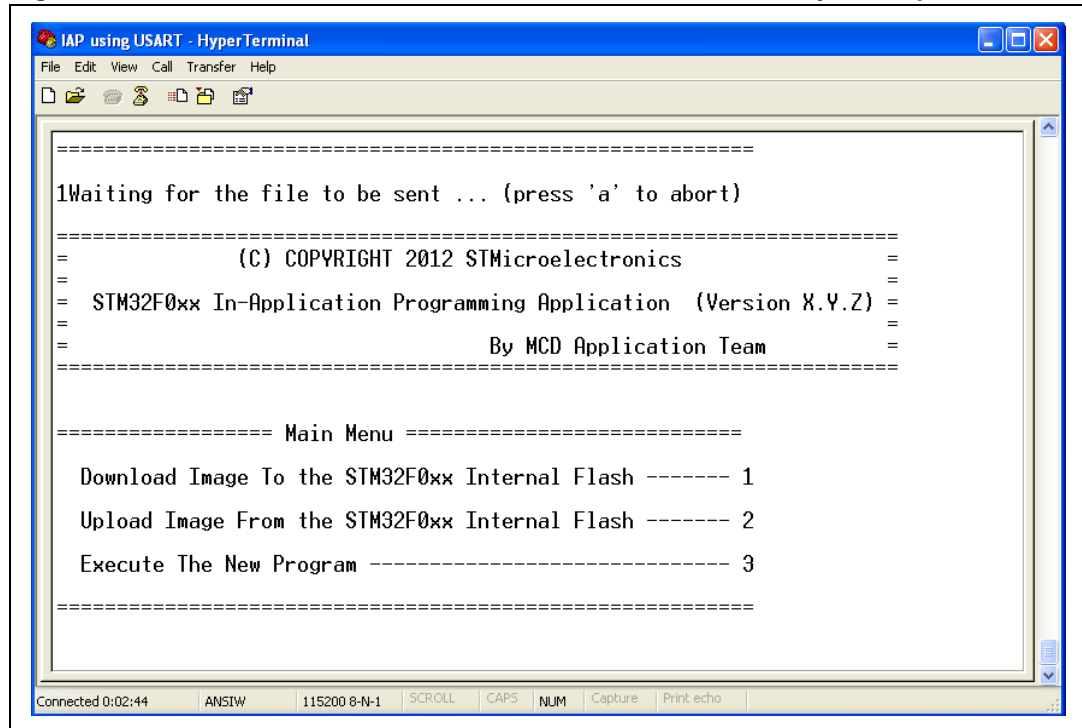
3.1 Download image to the internal Flash memory

Follow steps 1 to 5 below to download a binary file via the HyperTerminal to the STM32F0xx's internal Flash memory.

1. Press **1** on the keyboard to select the **Download Image to the STM32F0xx Internal Flash** menu.
2. Select **Send File** in the **Transfer** menu.
3. In the **Filename** field, type the name and the path of the binary file to be downloaded.
4. From the protocol list, select the **Ymodem** protocol.
5. Click on the **Send** button.

When these steps are executed, the IAP driver loads the binary file into the STM32F0xx's internal Flash memory from the defined base address and displays the binary file name and size in the HyperTerminal window.

3.2 Upload image from the internal Flash memory

Follow steps 1 to 5 below to upload a copy of the internal Flash memory started from the user application address.

1. Press 2 on the keyboard to select **Upload image from the STM32F0xx internal Flash** menu.
2. Select **Receive File** in the **Transfer** menu.
3. Select the directory to save the binary file.
4. From the protocol list, select the **Ymodem** protocol.
5. Click on the **Receive** button.

3.3 Execute the new program

Once the new program has been loaded, press **3** on the keyboard to select **Execute the New Program** menu and execute the code.

3.4 Disable the write protection

When IAP starts, it checks the Flash memory pages where the user program is to be loaded to see if any of them are write protected. If this is the case, the menu shown in *Figure 4* appears.

Figure 4.   IAP driver menu when the STM32F0xx Flash memory is write protected
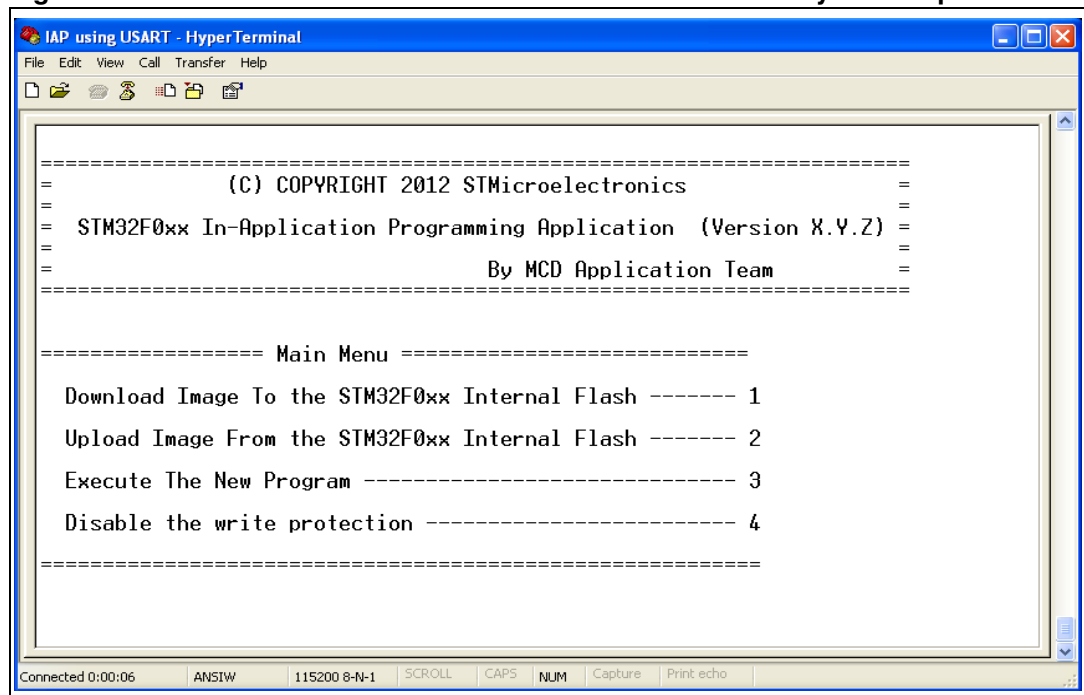
Prior to downloading the new program, the write protection function must be disabled. To do so, press **4** (**Disable the write protection**) on the keyboard. Write protection is disabled and a system reset is generated to reload the new option byte values. After resuming from reset, the menu shown in *Figure 3* is displayed if the key push-button is pressed.

Note: *In the current application, read protection is not supported, so the user has to verify that the Flash memory is not read-protected.*

4 STM32F0xx IAP implementation summary

Table 1 provides a summary of the STM320518-EVAL IAP implementation.

Table 1.   STM32F0xx IAP implementation

	Firmware			Hardware	
	IAP program is located at 0x8000000. Flash routines (program/erase) are executed from the Flash memory. Size of IAP program program is about 6 Kbytes.	User application (image to be downloaded with the IAP) is programmed starting from address 0x8003000[1]	Image is uploaded with IAP from STM32F0xx internal Flash	Push-button (active level: high)	USART used
STM32F0xx devices (STM320518-EVAL)	Sector 0 - Sector 1	52 Kbytes (Sector 3 - Sector 15)	52 Kbytes (Sector 3 - Sector 15)	Push-button connected to pin PB8	USART1

1. The user application location address is defined in the *flash_if.h* file as: `#define APPLICATION_ADDRESS 0x8003000`. To modify it, change the default value to the desired one.

The STM32F0xx IAP package comes with:

● Source files and preconfigured projects for the IAP program (see: Project\STM32F0xx_IAP directory)

● Source files and preconfigured projects that build the application to be loaded into Flash memory using the IAP (see: Project\STM32F0xx_IAP\binary_template directory).

The readme.txt files provided within this package describe, in a step by step fashion, how to execute the current IAP application.

5 User program conditions

The user application to be loaded into the Flash memory using IAP should be built with the following configuration settings:

1. Set the program load address at 0x08003000, using the toolchain linker file.
2. Relocate the vector table at address 0x20000000 (reserve 48 word starting in RAM @ 0x20000000).

An example application program to be loaded with the IAP application is provided with preconfigured projects.

Figure 5. Flash memory usage
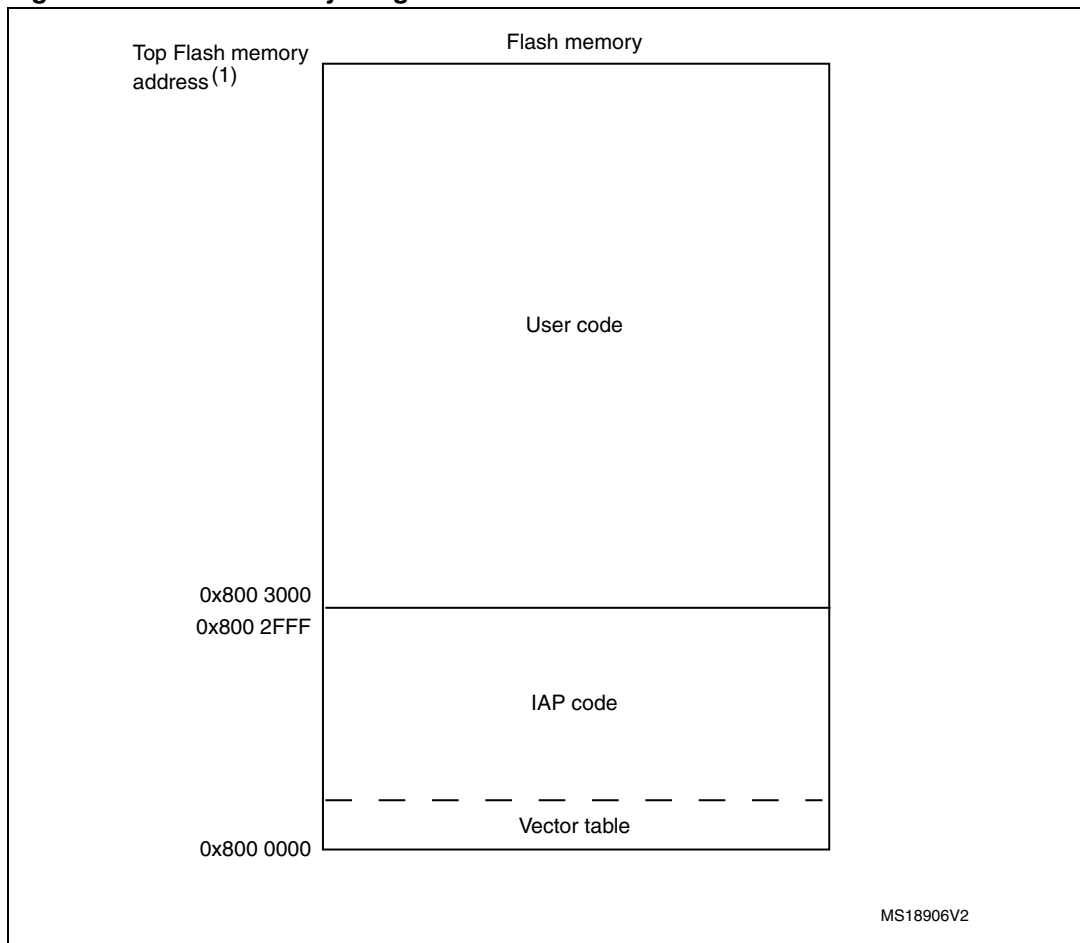
1. The top Flash memory address is 0x0800 7FFF for STM32F0xx devices

6 Revision history

Table 2. Document revision history

Date	Revision	Changes
03-May-2012	1	Initial release.

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