



DEVICE FIRMWARE UPGRADE (DFU) IMPLEMENTATION IN NON-USB APPLICATIONS

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1 INTRODUCTION

This application note describes how to implement the Device Firmware Upgrade (DFU) capability using a ST7 USB microcontroller like the ST72F62 or ST72F63B in a general purpose or 'non-USB' application. The term 'non-USB' is used here to contrast with 'USB application' which has a different DFU implementation (refer to AN1577). In the implementation described here, the USB interface is not used in the application. The application board is self powered and the on-chip USB interface is only used occasionally, as a maintenance utility port to upgrade the MCU firmware.

The USB cell is only activated when the USB cable is plugged-in. At this time the application is stopped and the microcontroller is seen as a USB device and enters the DFU process to erase and program the new firmware in Sector 1 and/or Sector 2. When the user removes the USB cable, the USB cell is switched-off and the main application is executed !

To illustrate this application note, a firmware example has been developed using a ST72F62 or a ST72F63B USB Low-Speed device. This firmware is based on the ST7 USB Low-Speed DFU Demo firmware.

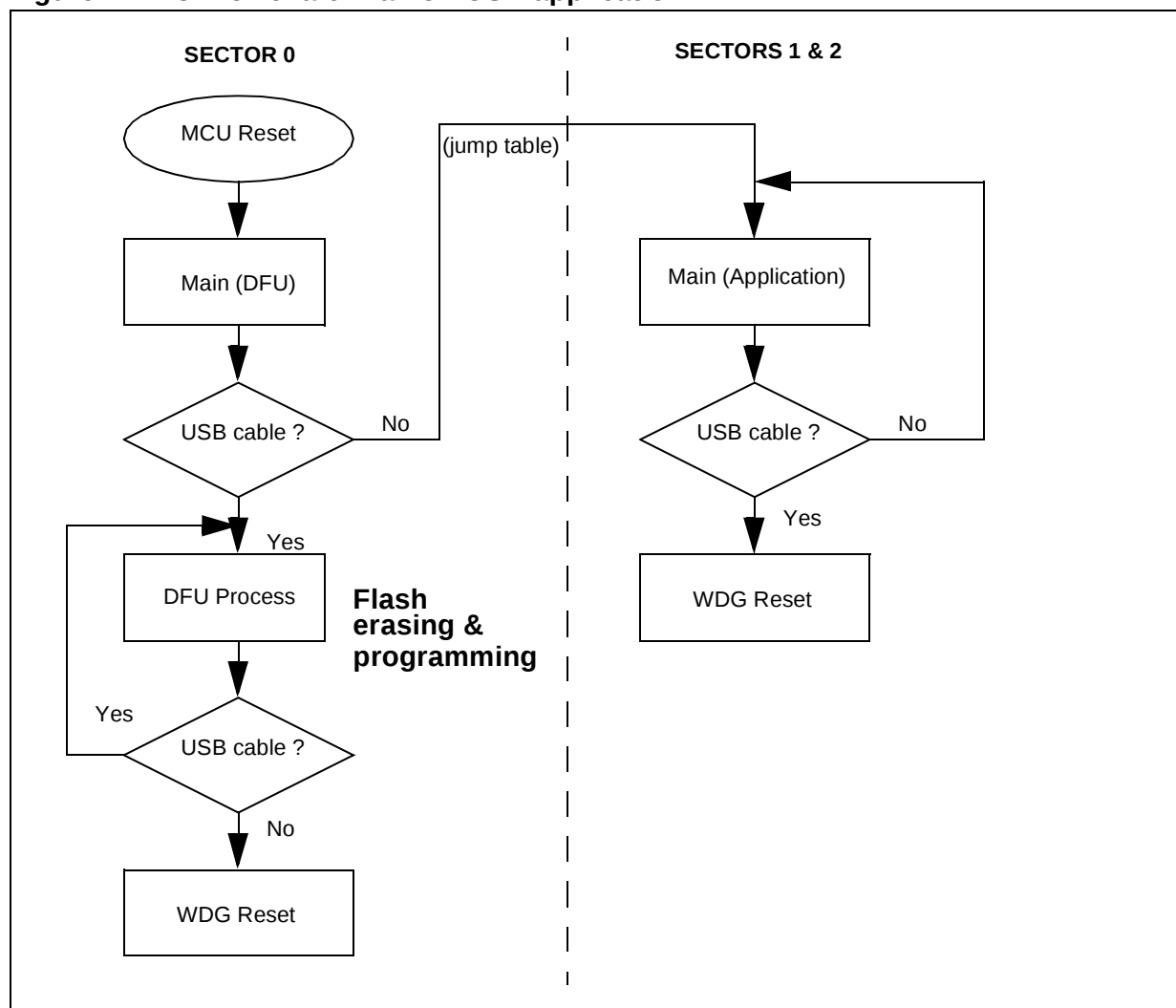
It is not necessary to know the USB cell to understand this application note. For more information about the USB DFU class, please refer to the Application Note AN1577.

2 DFU MECHANISM

2.1 OVERVIEW

As mentioned in the introduction, the microcontroller's USB cell is only used during the DFU upgrade process. This upgrade process takes place only when the USB cable is plugged-in. When the USB cable is removed the non-USB application is executed and the USB cell is switched off. The following figure explains this mechanism in detail.

Figure 1. DFU Flowchart in a non-USB application



As you can see, two separate firmware applications reside in different flash sectors and are selected by plugging a cable in the USB connector.

The first firmware application contains the USB Library, the DFU layer and the HDFlash driver. This firmware application must be placed in Sector 0. It is executed only when the USB cable is plugged-in. This firmware cannot be modified during the DFU process. When the Flash upgrade is finished, the firmware in Sector 0 continues execution until the USB cable is removed.

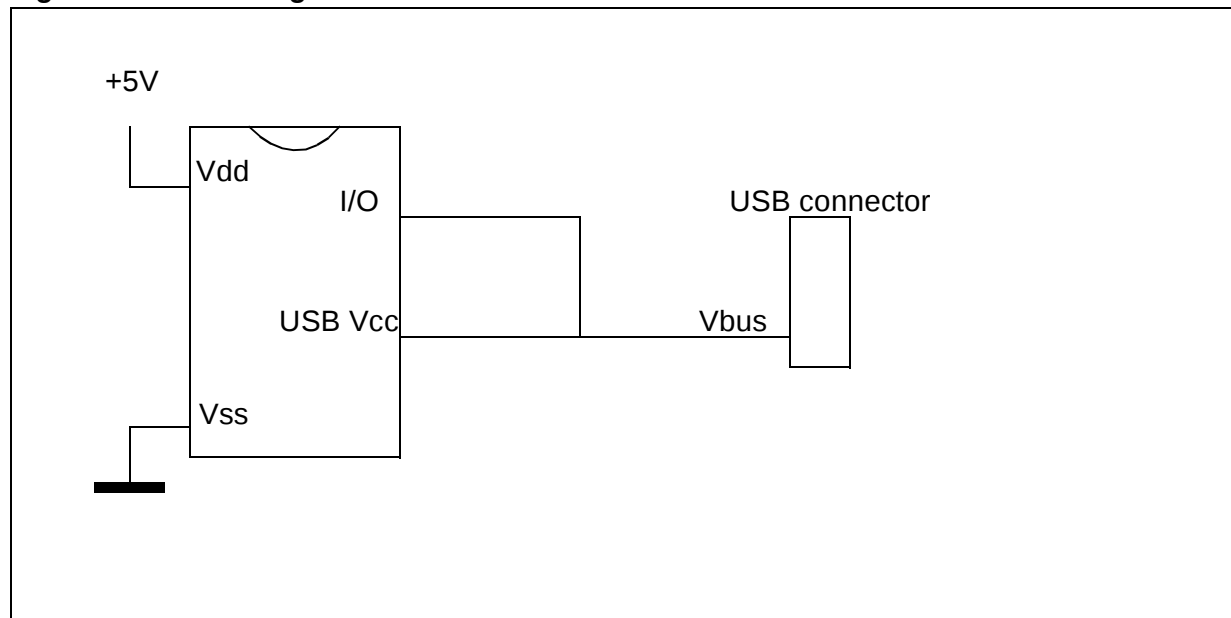
The second firmware application is the main application. It must be placed in Sectors 1 or 2 because it is modified during the DFU process. This firmware is executed only when the USB cable is not plugged into the board.

The DFU layer also allows you to upgrade only one sector. You can use this feature, for example, to store common data or code for any firmware loaded in Sector 2.

2.2 USB CABLE DETECTION

The detection of the USB cable is made through an I/O port configured in Input mode. This I/O is connected to the Vbus line on the USB connector. Detection can be done with interrupts or by polling. In our example, the polling method is used. This detection must be performed by both applications (main application and DFU).

Figure 2. Connecting an I/O Port to the Vbus line



2.3 TRANSITION BETWEEN USB AND APPLICATION

The transition between the application firmware and the DFU firmware is made only through an MCU reset. A software reset is performed using the Watchdog control register when the USB cable is detected.

The transition between the DFU firmware and the application firmware is made through a “Jump Table”. In fact, the DFU firmware only needs to know the address of the application main routine. This address is saved in the last bytes of Sector 1.

2.4 RAM

As the execution of the firmware in Sector 0 and Sectors 1 & 2 always starts after a MCU Reset, we have no RAM overlapping problem. Furthermore, as it is a non-USB application, there none of the USB Library functions are called by the main application. So, there is also no problem of parameter passing. This simplifies the RAM management a lot.

3 FIRMWARE

A specific firmware example has been developed to illustrate this application note: ST7 USB LS DFU Demo for non-USB applications.

This firmware has been created starting from the ST7 USB LS DFU Demo firmware, itself based on the ST7 USB LS Library and ST7 USB LS EvalKit.

The main changes concern the size optimization of the USB Library and the DFU layer in order to use a little space as possible in Sector 0. Currently the space required by the USB Library and the DFU layer is around 2 Kbytes. This optimization leaves 2 Kbytes of code for running the application during the DFU process or using it for code that does not need to be upgraded.

This firmware is compatible with Cosmic and Metrowerks compilers.

3.1 MAIN APPLICATION FUNCTION EXAMPLE

```
void main(void) {
    Init_Appli();
    while (1) {
        // MANDATORY: USED TO GO INTO DFU MODE WHEN THE USB CABLE IS PLUGGED
        if (ValBit(PBDR, 5)) { // Check if Vbus is present ?
            Stop_Appli();
            WDGCR = 0x80; // MCU Reset
        }
        else {
            Application();
        }
    } // End of while
} // End of main
```

3.2 DEVICE INFORMATION EXAMPLE

As the application is non-USB, we don't have the USB descriptors. The descriptors normally contain strings like: Manufacturer name, Product name, firmware version, ...

Because it is very useful to know which product is connected to the USB, a kind of string descriptor has been created in this project.

The principle is very simple: a fixed table contains the address and the size of these string descriptors (for example the Product name and its version). The host retrieves this information using a DFU_UPLOAD request. It is then possible to display these strings on a Graphical User Interface.

In the demo firmware this table has been placed at the end of Sector 1, it contains the following information: Jump to main function, product string address, product string length, version string address, version string length, flash size.

This is only an example and you can decide to create more strings or none.

4 GRAPHICAL USER INTERFACE

A specific GUI has been developed for this project. This GUI is only given as example.

Main features:

- Developed with Borland Delphi5
- Uses the ST7DFU.DLL developed by STMicroelectronics to access the DFU low level layer.
- Retrieves the string information described above.
- Reads and writes files in S19 format
- Selects Sector 1 and 2 independently.

5 RELATED DOCUMENTS & FIRMWARE

Table 1. External Documents

Name
Universal Serial Bus Specification, V1.1
Universal Serial Bus Device Class Specification for Device Firmware Upgrade, V1.0

Table 2. STM Documents

Name
ST7 Family Flash Programming Reference Manual
AN1575 "On-Board Programming Methods for XFlash and HDFlash ST7 MCUs"
AN1576 "In-Application Programming Drivers for XFlash and HD-Flash ST7 MCUs"
AN1577 "Device Firmware Upgrade implementation in ST7 USB devices"

Table 3. Firmware

Name
ST7 USB LS DFU Demo for non-UB application

6 TERMS AND ABBREVIATIONS

Table 4. Terms and Abbreviations

Term	Definition
DFU	Device Firmware Upgrade.
Firmware	Executable software stored in a write-able, nonvolatile memory on a USB device.
GUI	Graphical User Interface
Upgrade	(1) To overwrite the firmware of a device, (2) the act of overwriting the firmware of a device, (3) new firmware intended to replace a device's existing firmware.
Download	To transmit information from host to device.
Upload	To transmit information from device to host.

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