



STM32F2xx 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 STM32F2xx 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 5**
 - 1.1 Principle 5
 - 1.2 IAP driver description 5

- 2 Running the IAP driver 8**
 - 2.1 HyperTerminal configuration 8
 - 2.2 Executing the IAP driver 8

- 3 IAP driver menu 9**
 - 3.1 Download image to the internal Flash memory 9
 - 3.2 Upload image from the internal Flash memory 10
 - 3.3 Execute the new program 10
 - 3.4 Disabling the write protection 10

- 4 STM32F2xx IAP implementation summary 12**

- 5 User program conditions 13**

- 6 Revision history 14**

List of tables

Table 1.	STM32F2xx IAP implementation	12
Table 2.	Revision history	14

List of figures

Figure 1.	Flowchart of the IAP driver	7
Figure 2.	COM port properties	8
Figure 3.	IAP driver menu when the STM32F2xx Flash memory is not protected.	9
Figure 4.	IAP Driver menu when the STM32F2xx Flash memory is write-protected	10
Figure 5.	Flash memory usage	13

1 IAP overview

STM32F2xx devices are implemented in the STMicroelectronics STM3220G-EVAL evaluation board.

1.1 Principle

You should program the IAP driver to the Flash memory base address via the JTAG/SWD interface using the development toolchain of your choice or the factory-embedded boot loader in the System memory area.

The IAP driver uses the USART to:

- Download a binary file from the HyperTerminal to the STM32F2xx's internal Flash memory.
- Upload the STM32F2xx'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 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 USART peripheral
- *ymodem.c*: It is used to receive/send the data from/to the HyperTerminal application using the YMODEM protocol^(a). In the event of a failure when receiving the data, 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 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 when the image file size is greater than the allowed memory space and when the user aborts the task.
- STM32F2xx Standard Peripherals Library.

a. The Ymodem protocol sends data in 1024-byte blocks. An error check is performed in data blocks transmitted to the STM32F2xx's internal RAM to compare the transmitted and received data. Blocks unsuccessfully received are acknowledged with a NAK (Negative Acknowledgement). For more details about the Ymodem protocol, refer to existing documentation.

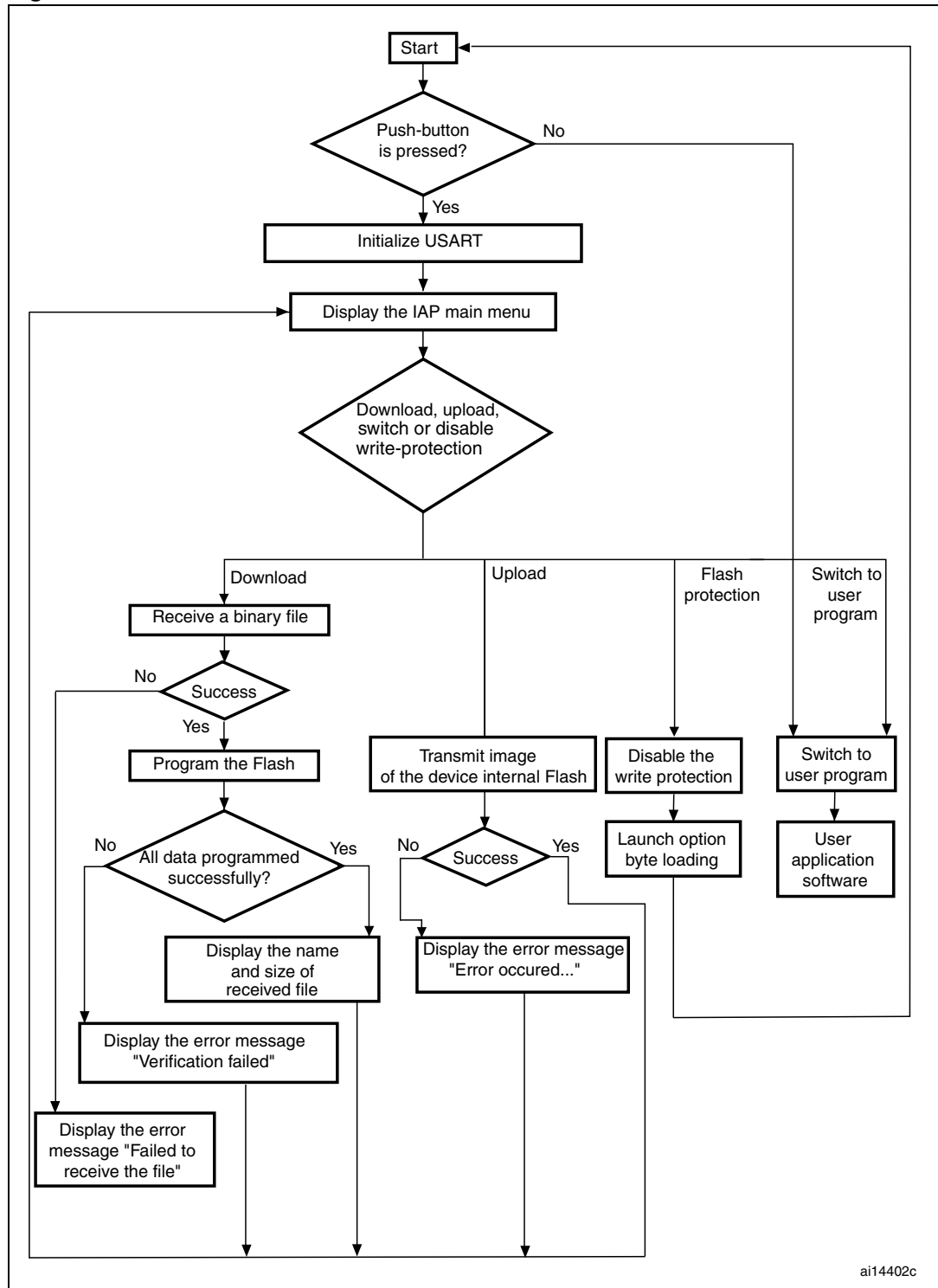
The user can choose to either go to the user application or execute the IAP for reprogramming purposes by pressing a push-button connected to a pin.

- 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.: STM32F2xx IAP implementation](#) for more details about the STM3220G-EVAL board push-button used to enter the IAP mode.

The IAP flowchart is shown in [Figure 1](#).

Figure 1. Flowchart of the IAP driver



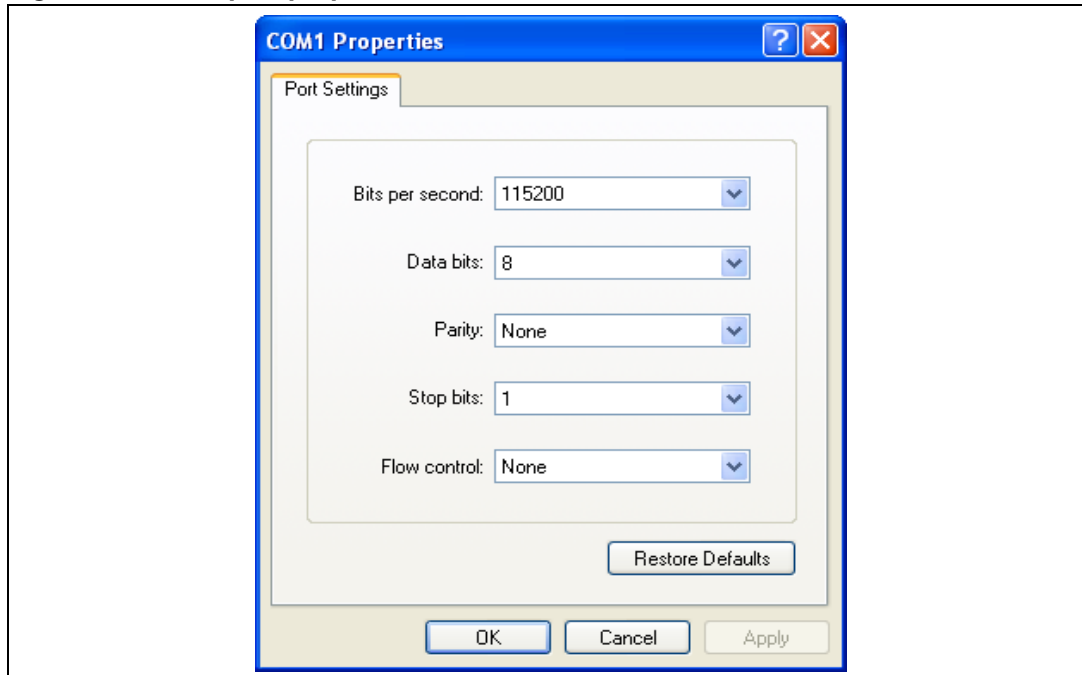
ai14402c

2 Running the IAP driver

2.1 HyperTerminal configuration

To use the IAP, the user must have a PC running HyperTerminal or other Terminal program that supports **ymodem protocol**. In this document the HyperTerminal is used. The following figure 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

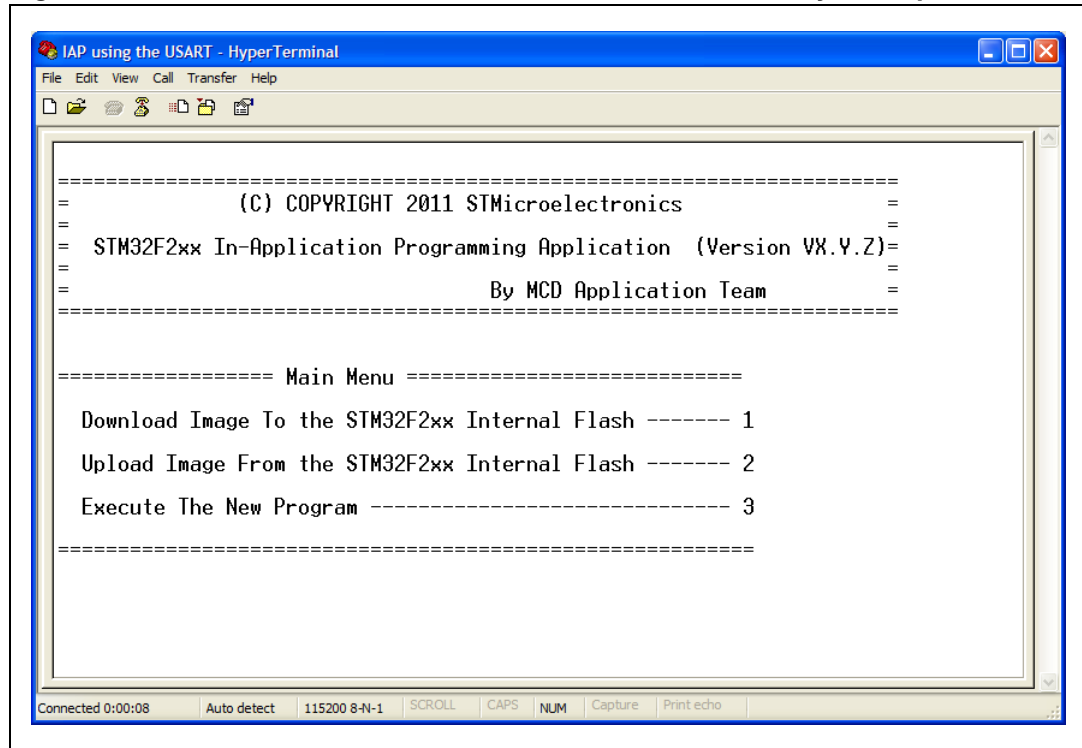
As an example in this application note, pressing the pin connected to the push-button allows the IAP driver to run.

By pressing the push-button at reset, the user can run the IAP driver to reprogram the STM32F2xx'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: STM32F2xx IAP implementation](#).

3 IAP driver menu

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

Figure 3. IAP driver menu when the STM32F2xx Flash memory is not protected



3.1 Download image to the internal Flash memory

To download a binary file via HyperTerminal to the STM32F2xx's internal Flash memory, do as follows:

1. Press **1** on the keyboard to select the **Download Image To the STM32F2xx 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 you want to download
4. From the protocol list, select the **Ymodem** protocol
5. Click on the **Send** button

As a result, the IAP driver loads the binary file into the STM32F2xx'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

To upload a copy of the internal Flash memory started from the user application address, do as follows:

1. Press 2 on the keyboard to select **Upload image from the STM32F2xx 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.

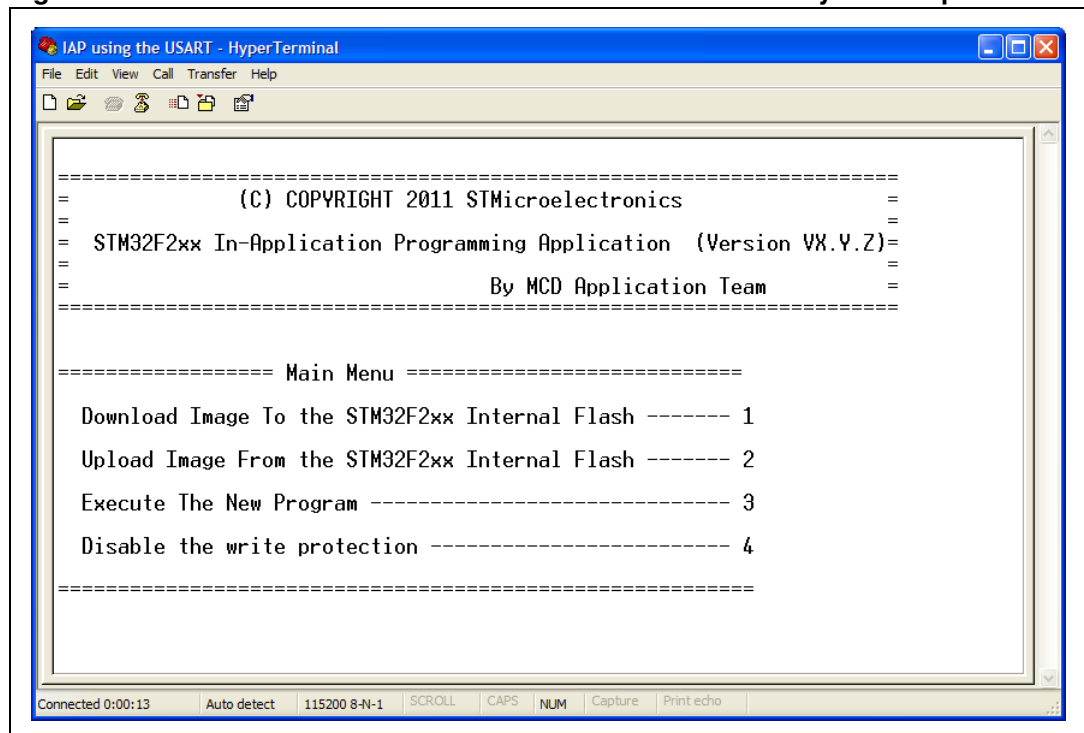
3.3 Execute the new program

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

3.4 Disabling the write protection

When the IAP starts, it checks the Flash memory pages where the user program is to be loaded to see if any are write-protected. If it is the case, the menu shown in [Figure 4](#) appears.

Figure 4. IAP Driver menu when the STM32F2xx Flash memory is write-protected



Prior to downloading the new program, the write protection must be disabled. To do so, press **4 (Disable the write protection)** on the keyboard. The 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 this application, the read protection is not supported, so the user has to verify that the Flash memory is not read-protected.

4 STM32F2xx IAP implementation summary

Table 1 provides a summary of the STM32F2xx IAP implementation.

Table 1. STM32F2xx IAP implementation

	Firmware			Hardware	
	The IAP program is located at 0x8000000. The Flash routines (program/erase) are executed from the Flash memory. The size of this program is about 8 Kbytes and programmed on:	The user application (image to be downloaded with the IAP) will be programmed starting from address 0x8004000 ⁽¹⁾ The maximum size of the image to be loaded is:	The image is uploaded with the IAP from the STM32F2xx internal Flash. The size of the image to be uploaded is:	Push-button (active level: high)	USART used
STM32F2xx devices (STM3220G-EVAL)	Sector 0	1008 Kbytes (Sector 1 - Sector 11)	1008 Kbytes (Sector 1 - Sector 11)	Key push-button connected to pin PG15	USART3

1. User application location address is defined in the *flash_if.h* file as: `#define APPLICATION_ADDRESS 0x8004000`. To modify it, change the default value to the desired one.

The STM32F2xx IAP package comes with:

- Source files and pre-configured projects for the IAP program (under Project\STM32F2xx_IAP directory)
- Source files and pre-configured projects that build the application to be loaded into Flash memory using the IAP (under Project\STM32F2xx_IAP\binary_template directory).

The readme.txt files provided within this package describes step by step how to execute this IAP application.

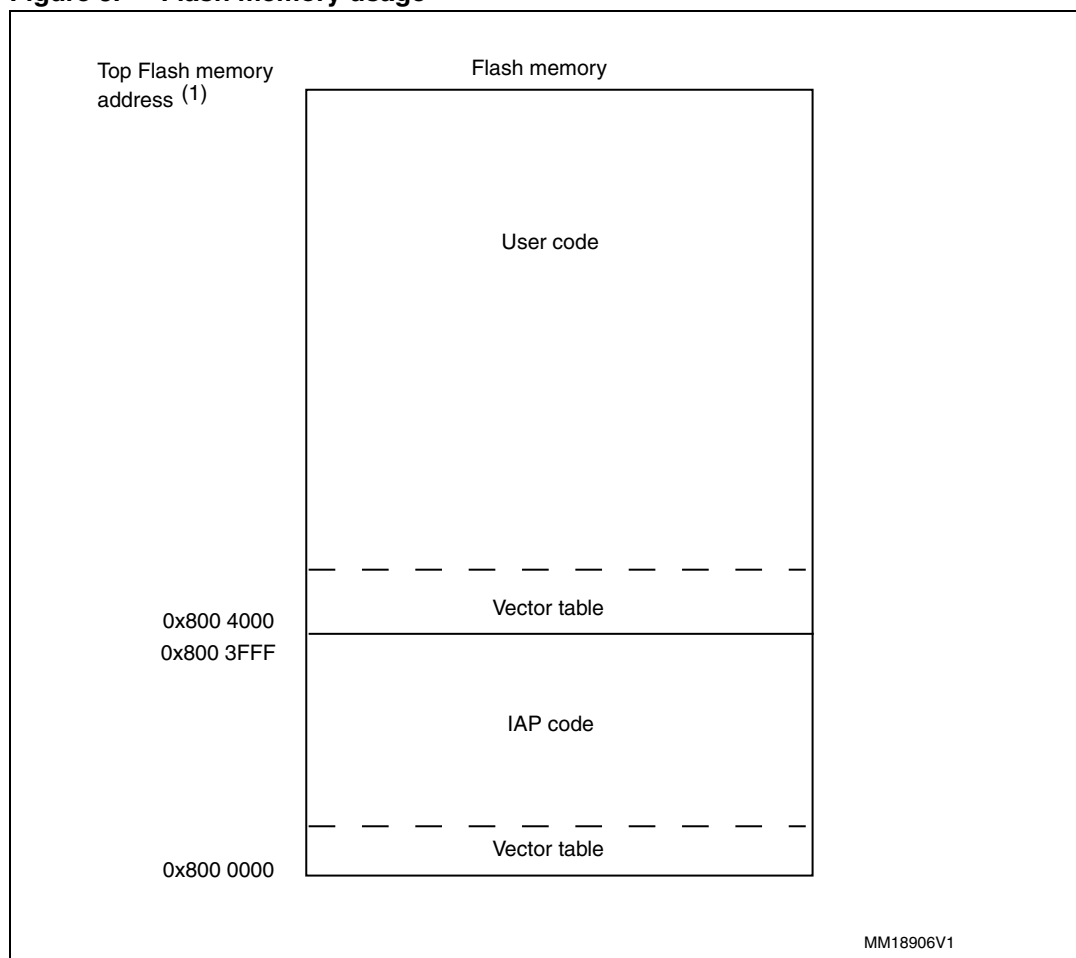
5 User program conditions

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

1. Set the program load address at 0x08004000, using your toolchain linker file
2. Relocate the vector table at address 0x08004000, using the “NVIC_SetVectorTable” function from the misc.h/c driver (under STM32F2xx_StdPeriph_Driver\inc) or by modifying the value of the constant “VECT_TAB_OFFSET” defined in the system_stm32f2xx.c file.”

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

Figure 5. Flash memory usage



1. Top Flash memory address is equal to: 0x080F FFFF for STM32F2xx devices

6 Revision history

Table 2. Revision history

Date	Revision	Changes
18-Apr-2011	1	Initial release.

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2011 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com