
STEVAL-MKI031V1 multi sensor application board (MuSA)

Introduction

The MuSA (multi sensor application board) platform is intended to be used to show the possible use of MEMS devices.

The platform is based on an ST7 8-bit microcontroller that handles the signal coming from the MEMS accelerometer on the board (LIS344ALH analog output and all the digital output in 3x3 mm and 3x5 mm packages can be mounted on the PCB).

The four buttons are used for the menu navigation.

A mini-USB connector is available to exchange data with the PC, depending on the specific application, and to recharge the internal Li-Ion battery.

Figure 1. The MuSA platform



Contents

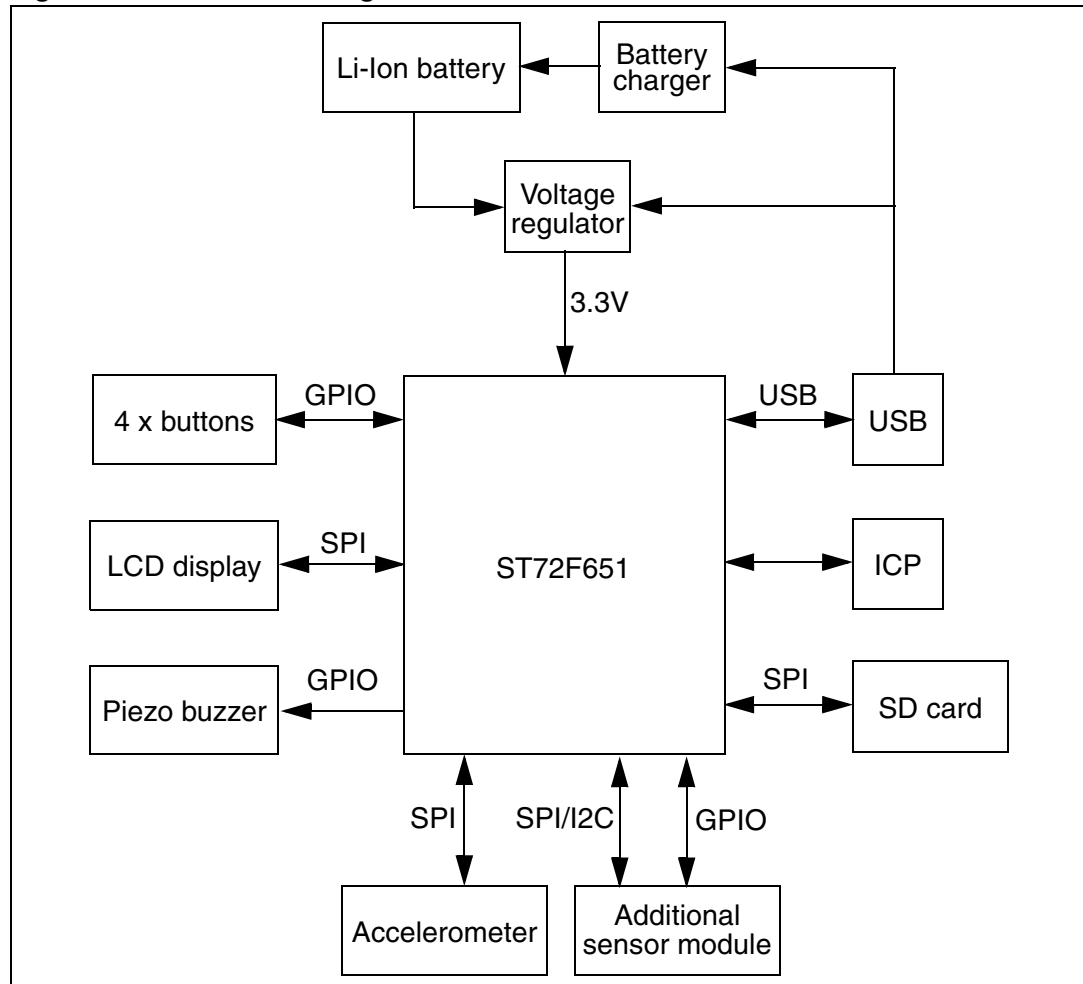
1	Platform description	4
2	Instructions	6
2.1	Main menu	6
2.2	Step counter	7
2.3	Antitheft	8
2.4	Terminal orientation	10
2.5	Dice	11
3	DFU	12
3.1	PC requirements	12
3.2	DFU procedure	12
4	Recharging the MuSA	15
5	MuSA schematics	16
6	MuSA layout	22
7	Revision history	24

List of figures

Figure 1.	The MuSA platform	1
Figure 2.	MuSA block diagram	4
Figure 3.	MuSA main board, top side	5
Figure 4.	MuSA main board, bottom side	5
Figure 5.	MuSA start-up screen	6
Figure 6.	MuSA main menu	6
Figure 7.	Pedometer main screen	7
Figure 8.	Pedometer main menu	7
Figure 9.	Pedometer setup menu	8
Figure 10.	Pedometer height menu	8
Figure 11.	Antitheft main menu	8
Figure 12.	Antitheft set up menu	9
Figure 13.	Alarm enabled	9
Figure 14.	Alarm	9
Figure 15.	MuSA horizontal	10
Figure 16.	MuSA vertical	10
Figure 17.	Dice main screen	11
Figure 18.	MuSA correctly recognized	12
Figure 19.	Select new firmware	13
Figure 20.	Flash erasing	14
Figure 21.	Flash upgrading	14
Figure 22.	MuSA schematics: building blocks	16
Figure 23.	MuSA schematics: ST7	17
Figure 24.	MuSA schematics: accelerometers	18
Figure 25.	MuSA schematics: power supply	19
Figure 26.	MuSA schematics: LCD	20
Figure 27.	MuSA schematics: microSD	21
Figure 28.	MuSA schematics: DFU	21
Figure 29.	MuSA layout: top layer	22
Figure 30.	MuSA layout: bottom layer	23

1 Platform description

Figure 2. MuSA block diagram



The platform can mount the LIS344ALH analog output accelerometer and all the digital output accelerometers in 3x3 mm and 3x5 mm packages that are connected to the micro through the SPI interface. The platform comes with the LIS331DLH mounted on the board.

A rechargeable Li-Ion battery ensures approximately 7 hours of operation. It can be recharged through the mini-USB connector using the internal battery charger.

A USB interface is available for the firmware upgrade (DFU) and for data exchanging with user developed software running on a host PC.

Interaction with the user is realized by means of 4 buttons, a black and white 128x64 LCD and a piezoelectric buzzer.

A microSD socket is available for data logging applications.

A multipole connector is available to expand the platform with sensor specific modules.

Figure 3. MuSA main board, top side

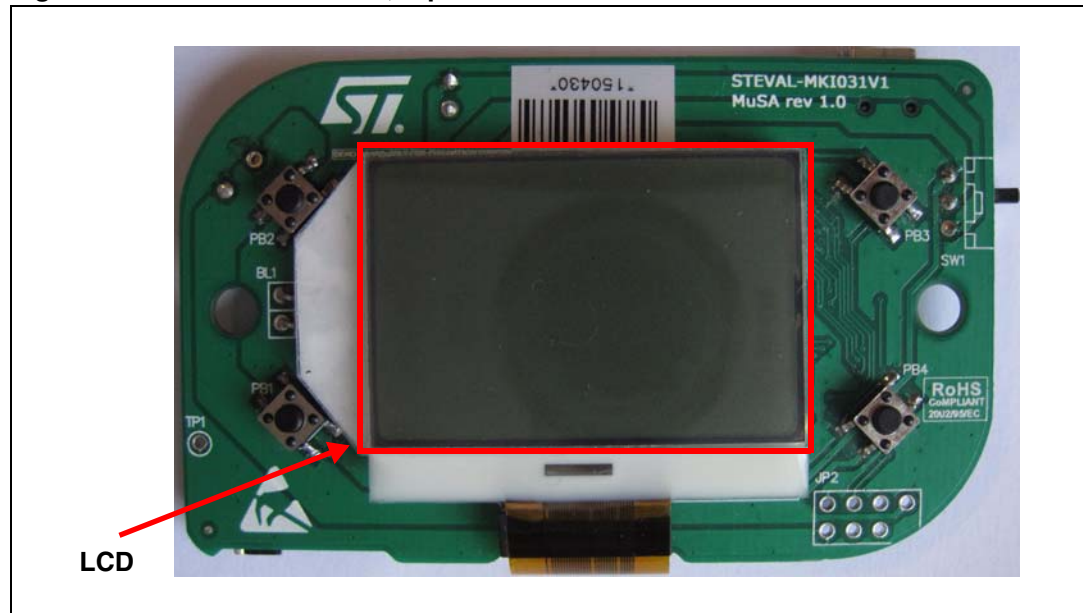
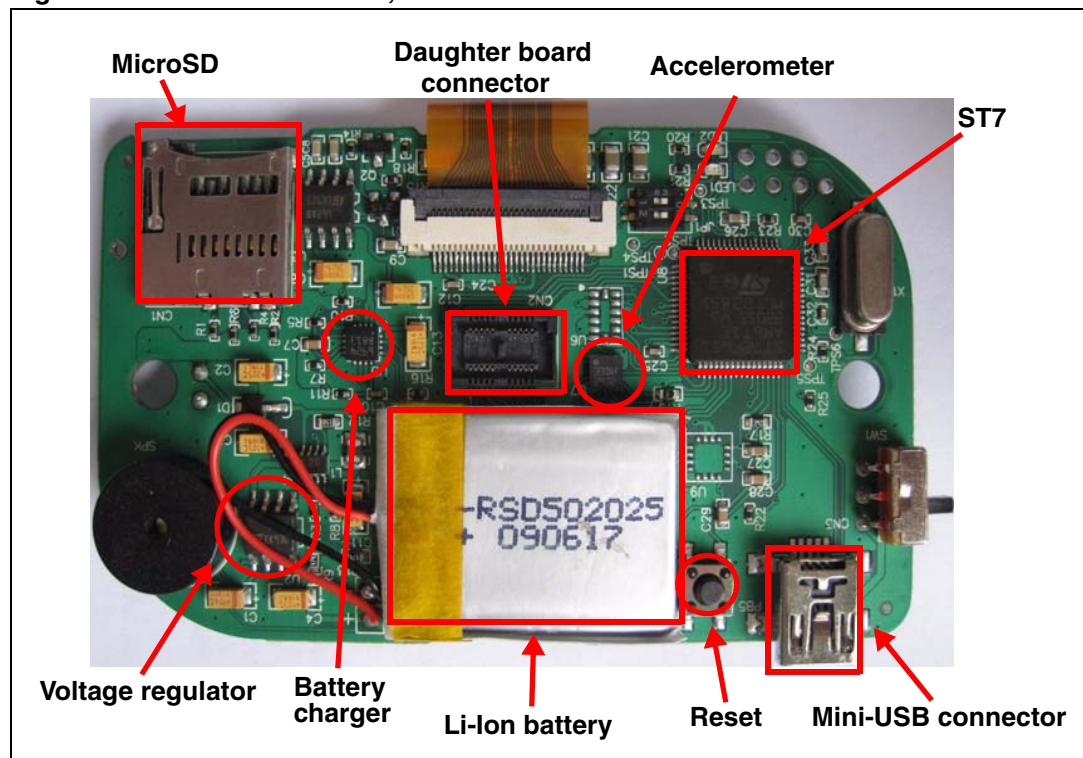


Figure 4. MuSA main board, bottom side



2 Instructions

Figure 5 shows the MuSA start-up screen. Press any key to go to the main menu.

Figure 5. MuSA start-up screen

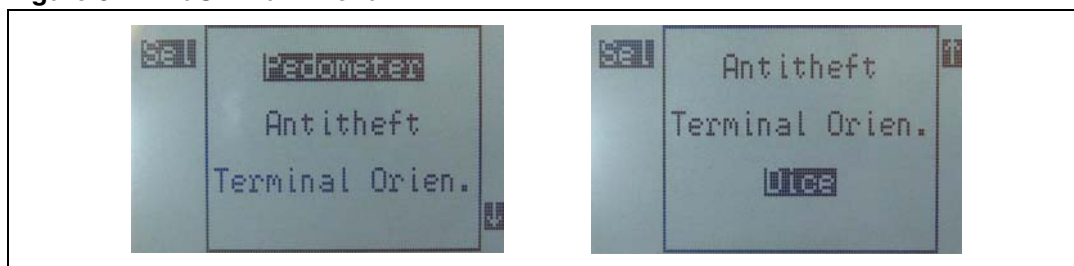


2.1 Main menu

Four buttons on the front panel (*Figure 5*) allow the user to navigate through the MuSA menus:

- Button 1: select (“Sel”/”Set”) or confirm (“Ok”)
- Button 2: go back (“Bck”)
- Button 3: move “Up” or increase value
- Button 4: move “Down” or decrease value

Figure 6. MuSA main menu



The main menu (*Figure 6*) gives access to four applications:

- Pedometer
- Antitheft
- Terminal Orientation
- Dice game

Use the Up/Down buttons to highlight the desired application in the list and then press “Sel” to run it.

2.2 Step counter

The algorithm running on the micro makes use of the acceleration data coming from the sensor to implement a pedometer: an instrument able to count steps and to estimate distance covered. The system has been designed to be worn on either the hip or arm.

The main features of the implemented algorithm are:

- Automatic detection of dominant axis for step detection
- Step-by-step adaptive threshold adjustment
- Step length changed continuously vs. detected activity
- Signal debouncing to handle stair cases
- Correct step counting when climbing the stairs
- Distance walked estimation
- Instant speed computation
- Calories burned computation
- Wear and go operating mode (step length derived from user height)

The main screen ([Figure 7](#)) reports information regarding steps and distance or speed and calories, selected using the two righthand buttons.

Figure 7. Pedometer main screen



Press Set to access the main menu ([Figure 8](#)). It has two items:

- Setup: to set user personal data
- Reset: to reset the algorithm and user data to default

Figure 8. Pedometer main menu



By selecting “Setup”, the user can select weight and height ([Figure 9](#)) to enter personal data using the arrows to increase or decrease the values ([Figure 10](#)). Press “Ok” to confirm or “Bck” to go back without modifying the value.

Figure 9. Pedometer setup menu**Figure 10. Pedometer height menu**

Press “Bck” to go back to the main menu of the Pedometer. Now the system is ready to be placed on the body (preferably on the hip or arm). Note that the user must take at least 8 steps before the data changes on the screen.

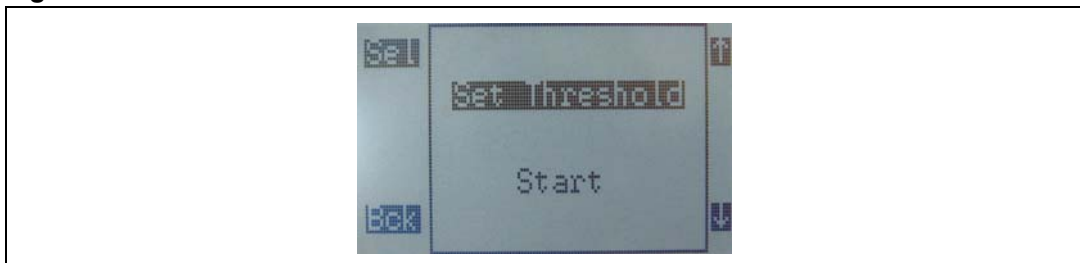
Press “Bck” to go back to the MuSA main menu.

2.3 Antitheft

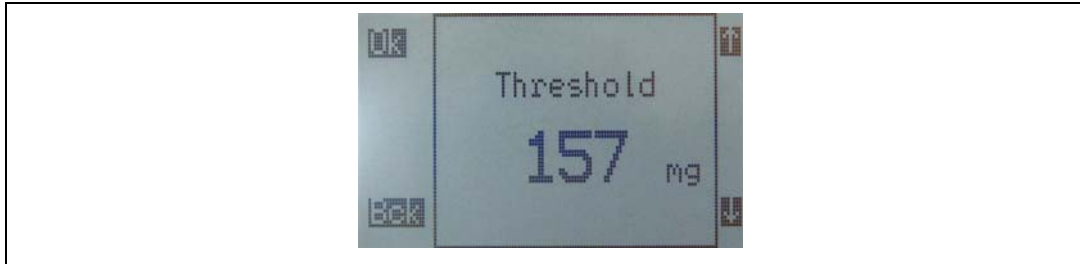
This application is intended to demonstrate the interrupt generation and high pass filtering features embedded in the LIS331DLH or LIS302DL. The accelerometer is configured to generate an interrupt (Wake-up interrupt) when the acceleration sensed on any axis is bigger than the selected threshold. Moreover, the internal high pass filter is enabled so as to delete the DC component of the acceleration: the device is configured to recognize when only the high-frequency component of the acceleration applied along either X, Y or Z axis exceeds the preset threshold. As the high pass filter is switched on, the demo works with the MuSA placed with any orientation.

The Antitheft main menu ([Figure 11](#)) has two items:

- Set threshold: to set the sensitivity to movements
- Start: to start the application

Figure 11. Antitheft main menu

Select “Set Threshold” to set up the threshold ([Figure 12](#)).

Figure 12. Antitheft set up menu

Press “Bck” to go back to main menu.

Select “Start” to enable the antitheft. It counts down from 3 to 0, to give the user time to position the platform. When the countdown reaches 0, a guard appears ([Figure 13](#)). Now the micro is waiting for the interrupt coming from the sensor.

Figure 13. Alarm enabled

If you touch or move the MuSA, the guard gets angry ([Figure 14](#)) and the MuSA beeps.

Figure 14. Alarm

Press “Bck” to go back to the main menu of the Antitheft.

2.4 Terminal orientation

In demo, the acceleration data coming from the sensor are used by the micro to rotate the image in the screen so that it is always horizontal regardless of the orientation of the MuSA ([Figure 15](#) and [Figure 16](#)).

Figure 15. MuSA horizontal

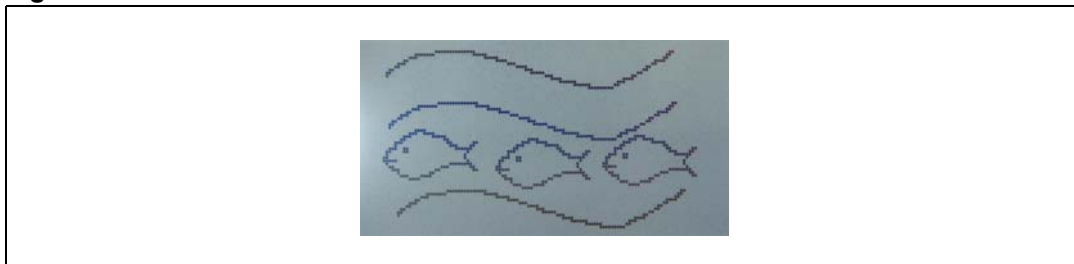
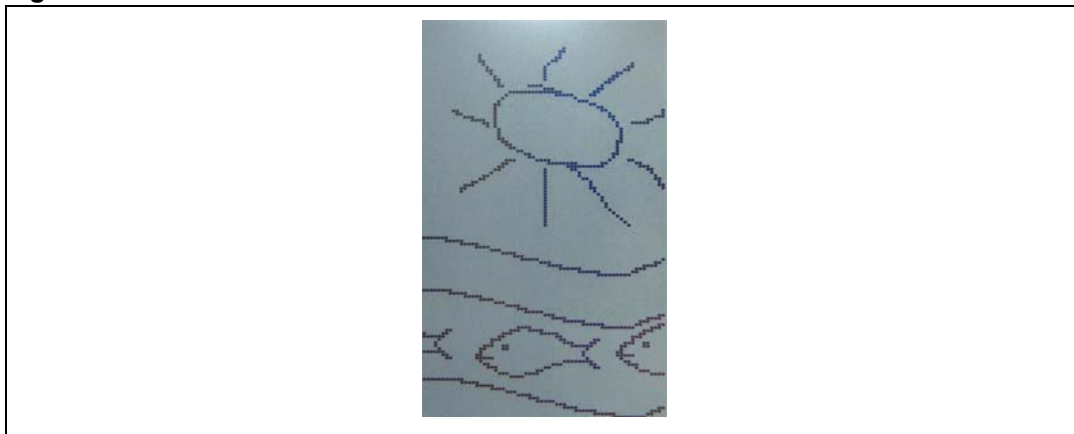


Figure 16. MuSA vertical

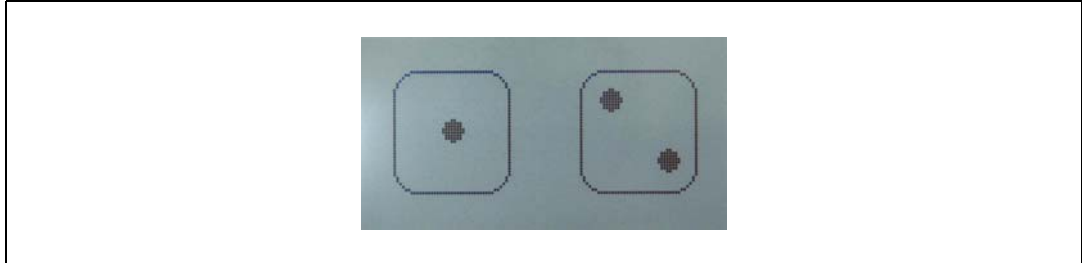


Press "Bck" to go back to the main menu.

2.5 Dice

This demo gives an example of how acceleration data, coming from the sensor, is used to implement a simple game. Two dice are on the screen. If the MuSA is shaken, the dice start spinning (numbers change). The harder the user shakes the MuSA, the longer the dice spin.

Figure 17. Dice main screen



Press “Bck” to go back to the main menu.

3 DFU

The MEMS device firmware update GUI is a graphical user interface that allows a common user to download and replace the firmware of a MEMS product division demonstration boards directly from a PC though the USB port.

MEMS demonstration boards which mount an ST7-USB microcontroller, have the capability of reprogramming an application though USB, in accordance with the DFU class specification defined by the USB Implementers Forum. This capability is useful because it allows the microcontroller to be reprogrammed directly in the field, and it is particularly well suited in USB applications, where the same USB connector can be used both for the standard operating mode and for the reprogramming process.

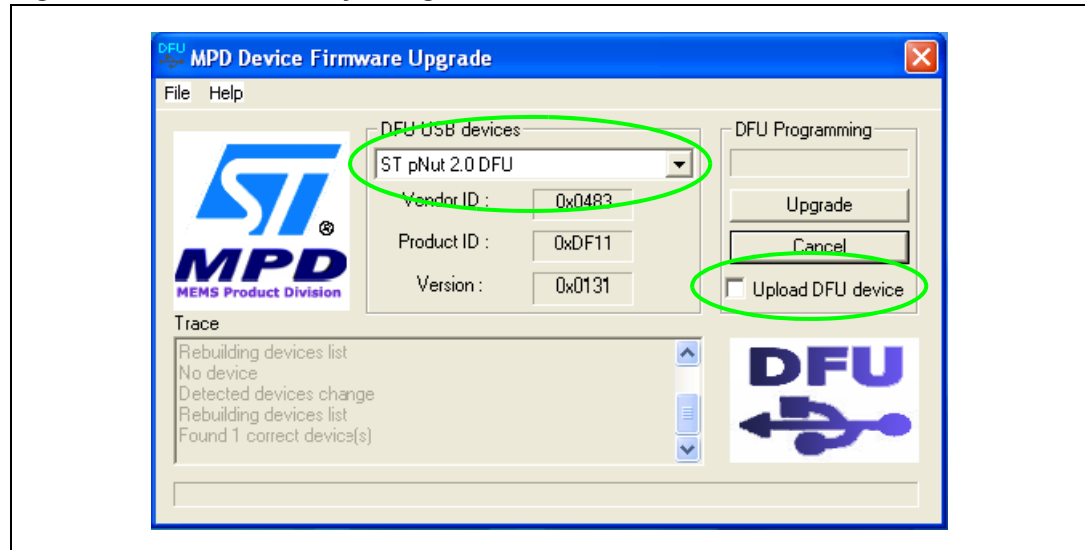
3.1 PC requirements

In order to use the device firmware upgrade (DFU) software with a Windows operating system, a recent version, such as Windows XP, Windows Vista or Windows7, must be installed on the PC.

3.2 DFU procedure

Run the DFUDEMO.exe file. To enter firmware update mode, the USB cable must be plugged into the MuSA, while pressing Button 2 ([Figure 5](#)).

Figure 18. MuSA correctly recognized



If it is the first time that this feature is used, it is necessary to install the DFU driver. It can be found in the Driver folder in MuSAFirmwareUpdate.zip.

If the driver is installed correctly, "ST MuSA 2.0 DFU" can be read in the DFU USB devices list ([Figure 18](#)).

To execute the firmware upgrade:

1. click on File > Open then select the correct directory where the “.dfu” file is downloaded and select it ([Figure 19](#));
2. click on “Upgrade”.
3. the internal flash memory is erased ([Figure 20](#));
4. and reflashed with the new firmware ([Figure 21](#)).

Once the procedure is finished, a windows message says that a USB device has not been recognized. The USB cable can be unplugged from the MuSA and used with the new firmware.

In case the user wants to back up the actual firmware before flashing the MuSA with a new one, “Upload DFU device” must be flagged ([Figure 18](#)) before clicking on “Upgrade”. The user is prompted to save the current firmware in the preferred directory before the erasing of the internal flash.

Figure 19. Select new firmware

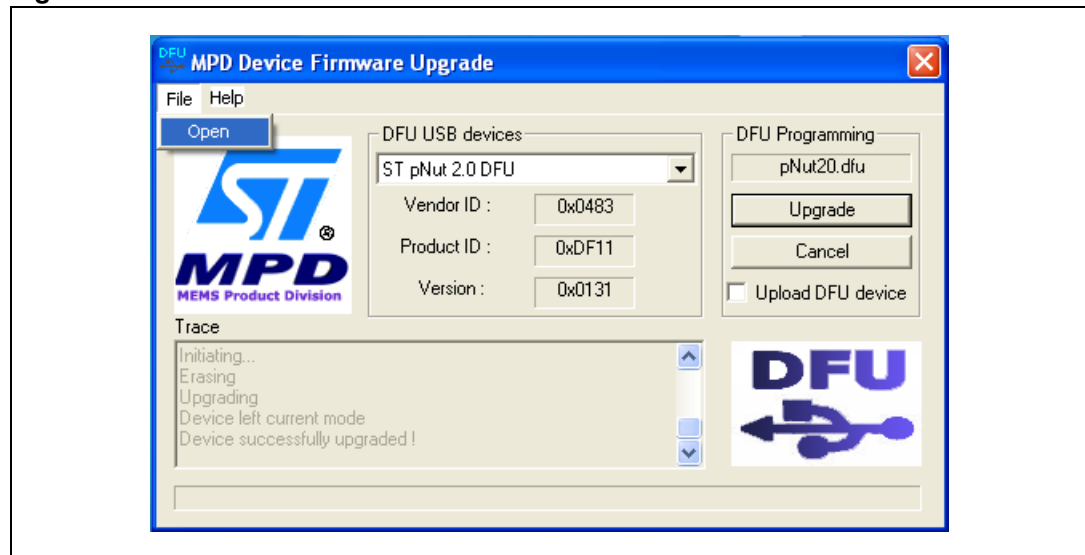


Figure 20. Flash erasing

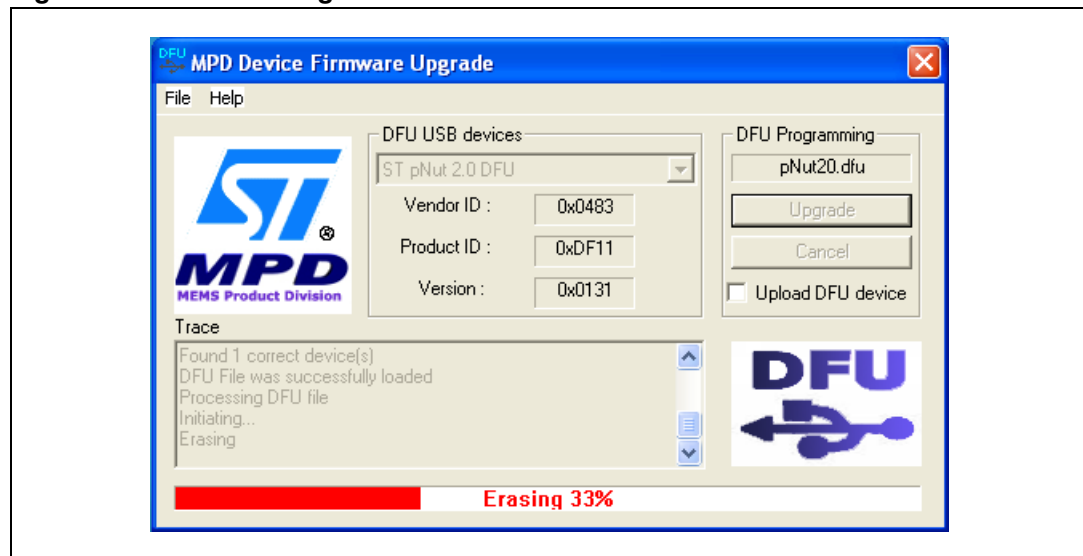
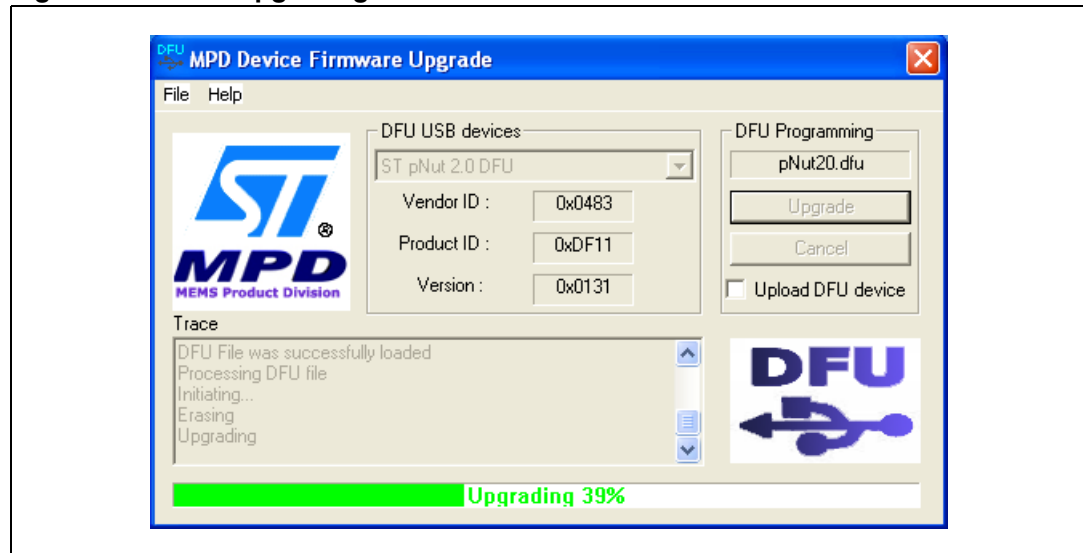


Figure 21. Flash upgrading



4 Recharging the MuSA

The MuSA can be recharged via the mini-USB cable connected to the USB port of the PC and the onboard battery charger.

Warning: When charging the battery, the MuSA must be **SWITCHED OFF** before plugging the USB cable into the PC. The MuSA automatically switches on after being plugged into the USB cable. Do not move the switch until the USB is powered.

5 MuSA schematics

Figure 22. MuSA schematics: building blocks

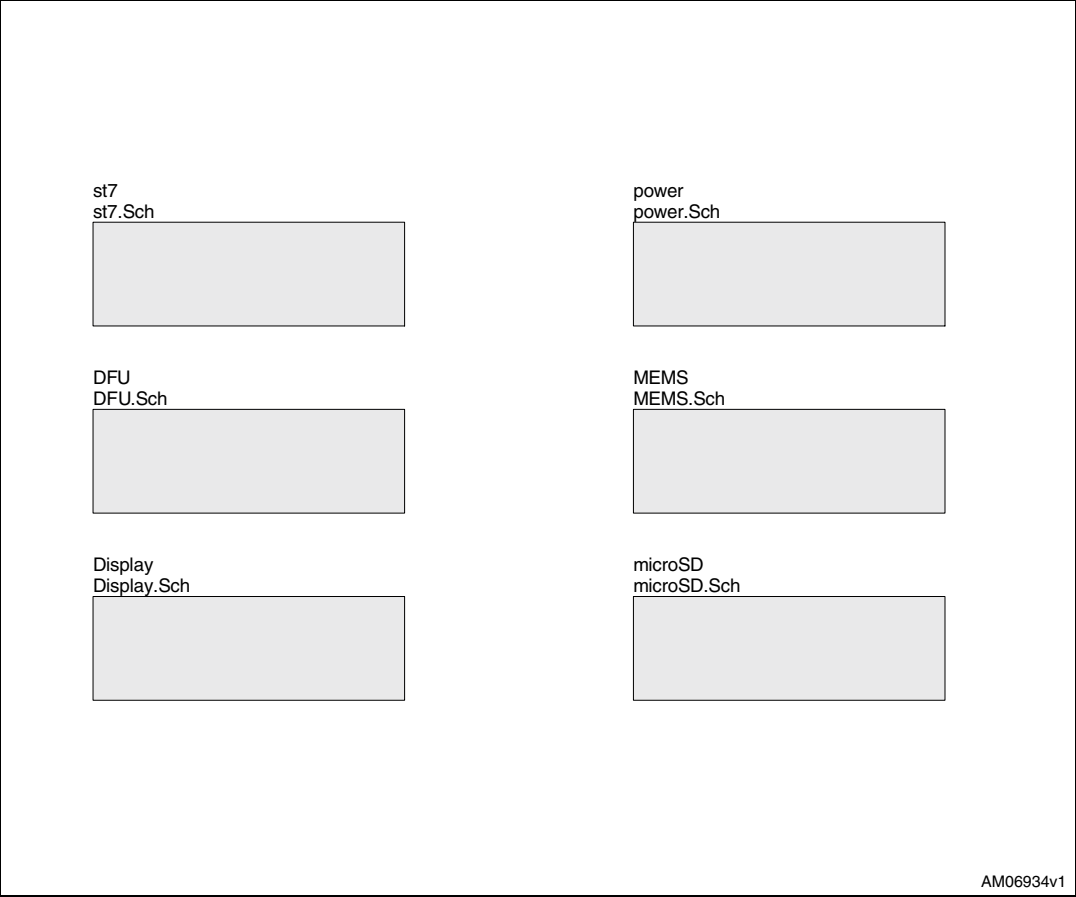


Figure 23. MuSA schematics: ST7

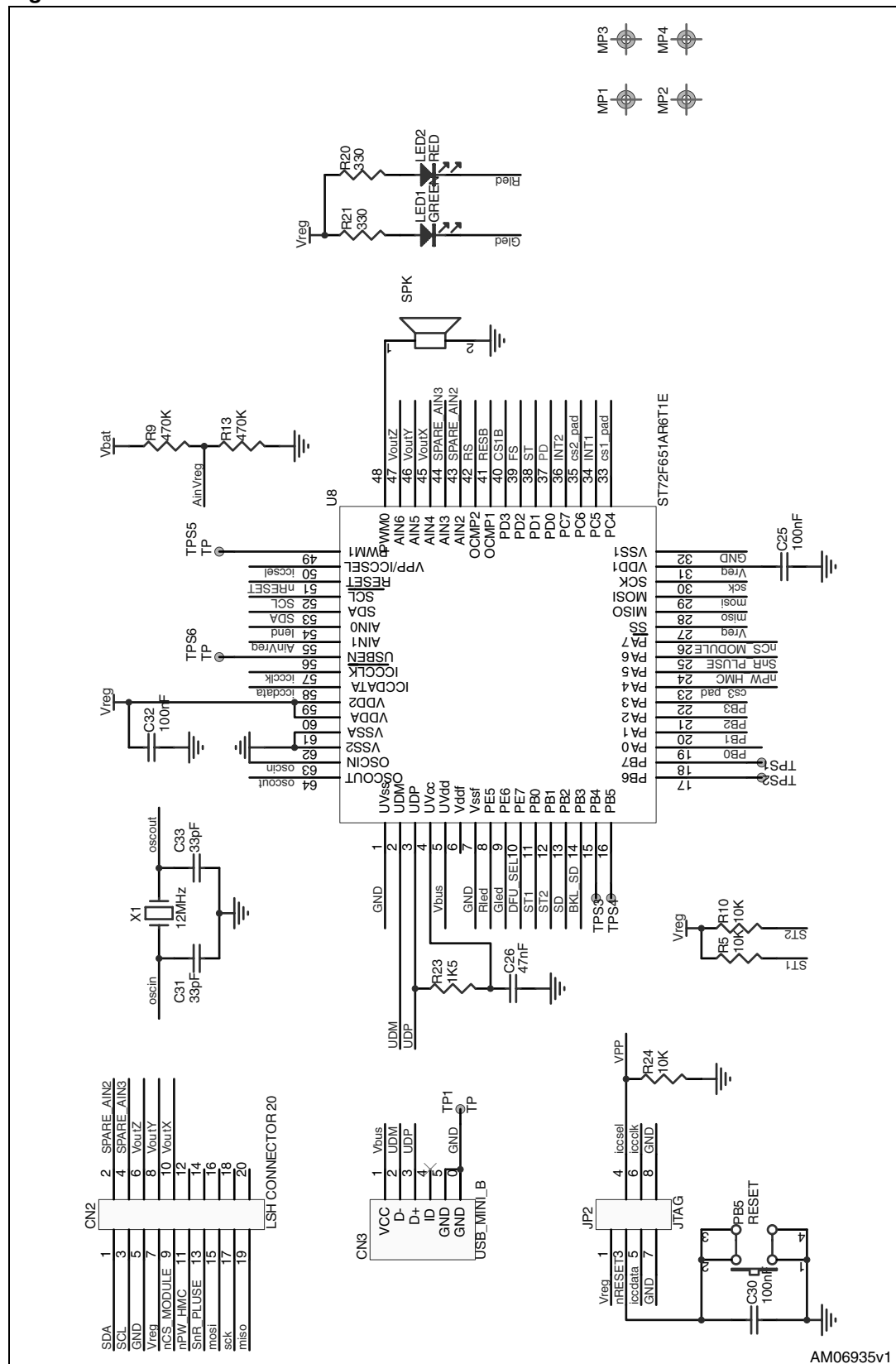


Figure 24. MuSA schematics: accelerometers

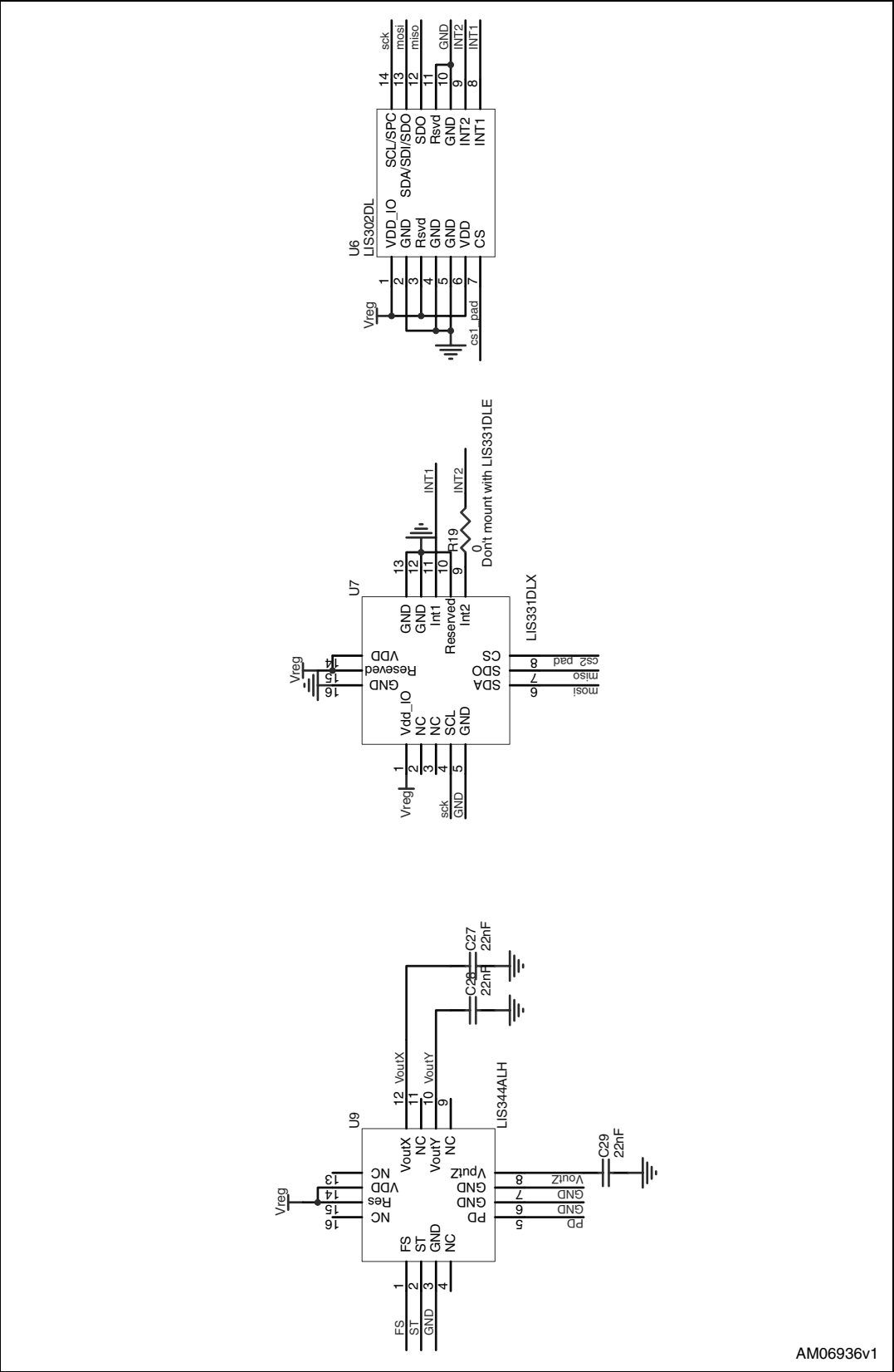


Figure 25. MuSA schematics: power supply

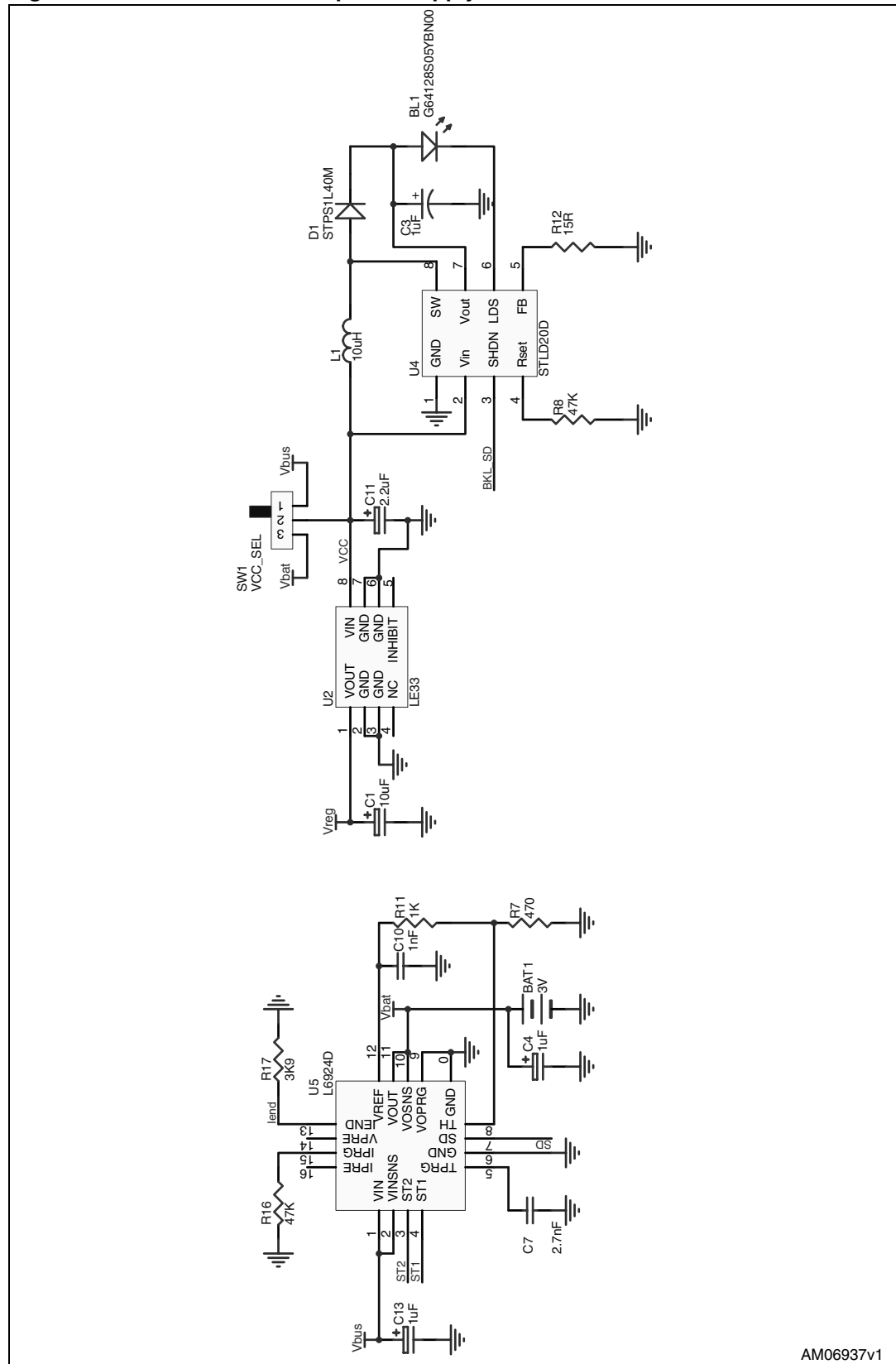
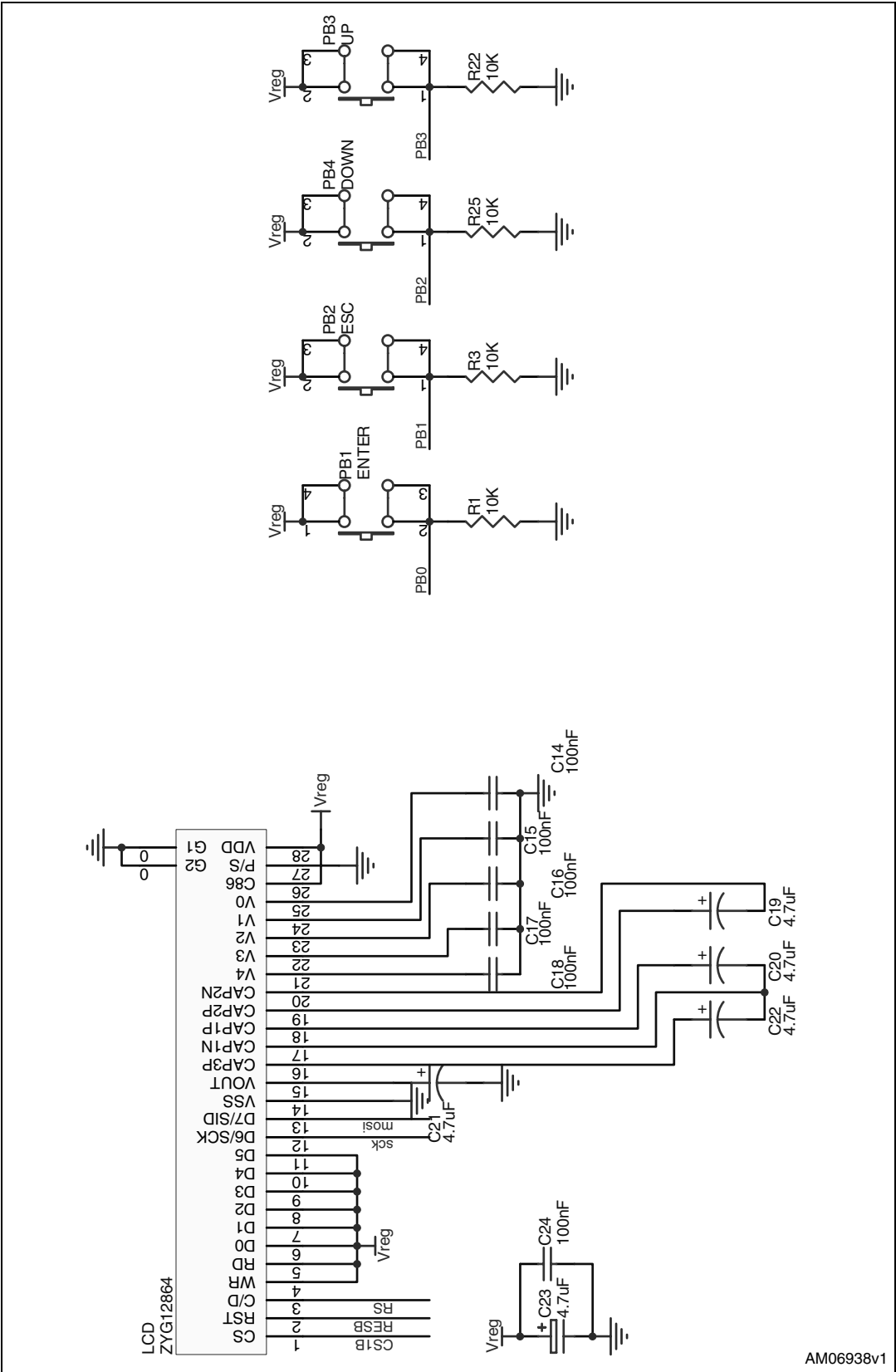


Figure 26. MuSA schematics: LCD



AM06938v1

6

Figure 29. MuSA layout: top layer

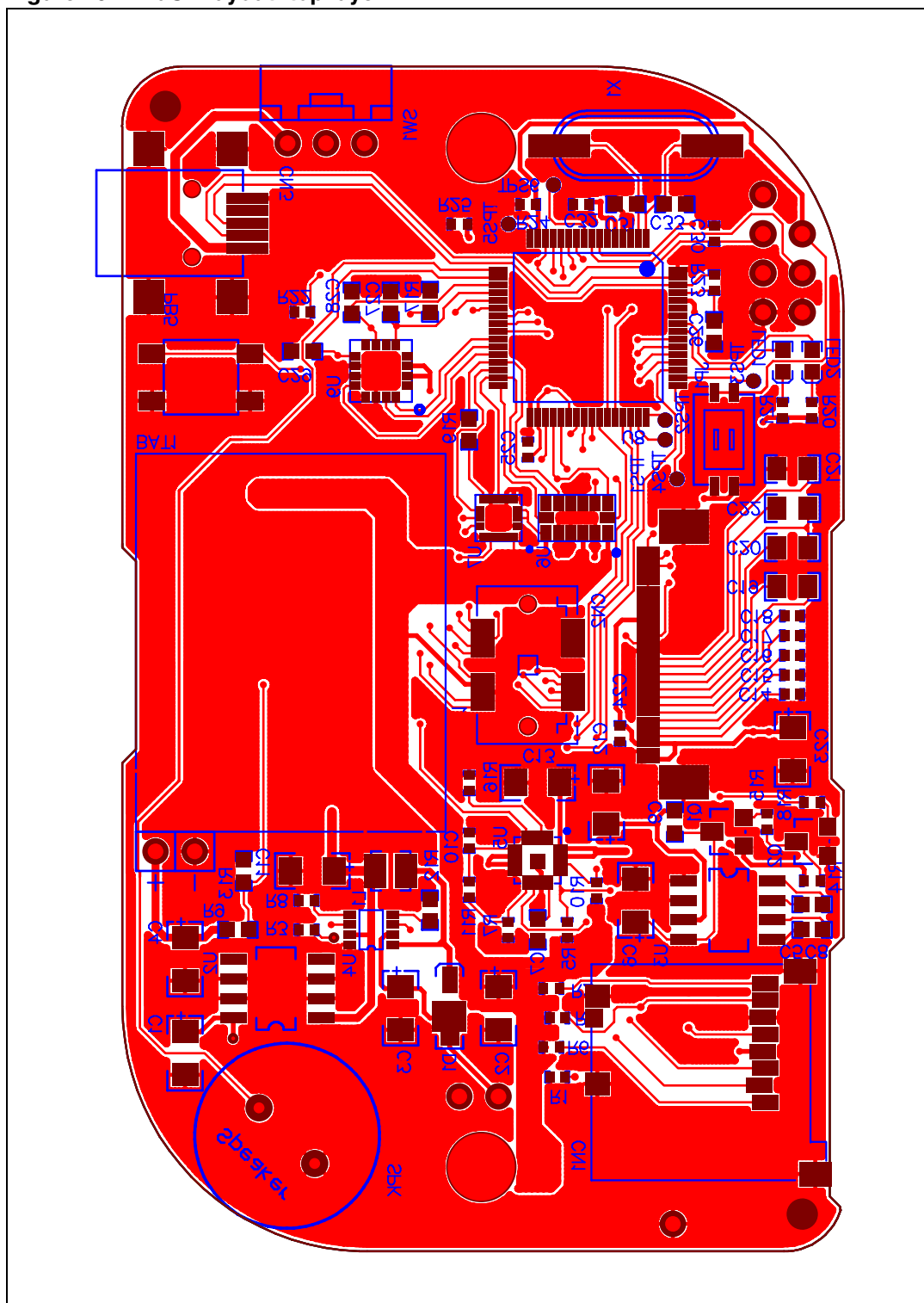
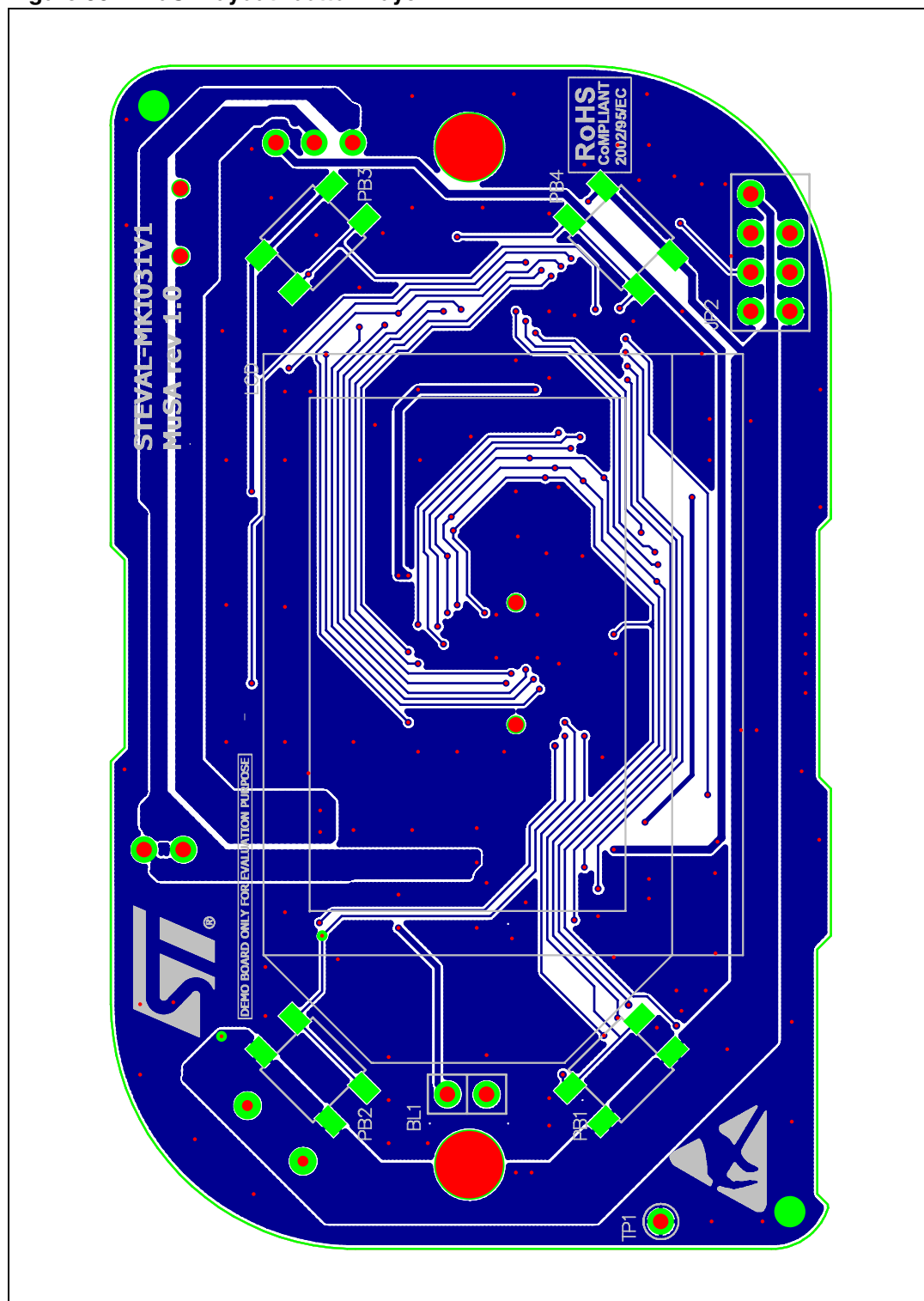


Figure 30. MuSA layout: bottom layer



7 Revision history

Table 1. Document revision history

Date	Revision	Changes
06-Sep-2010	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.

© 2010 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

