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.
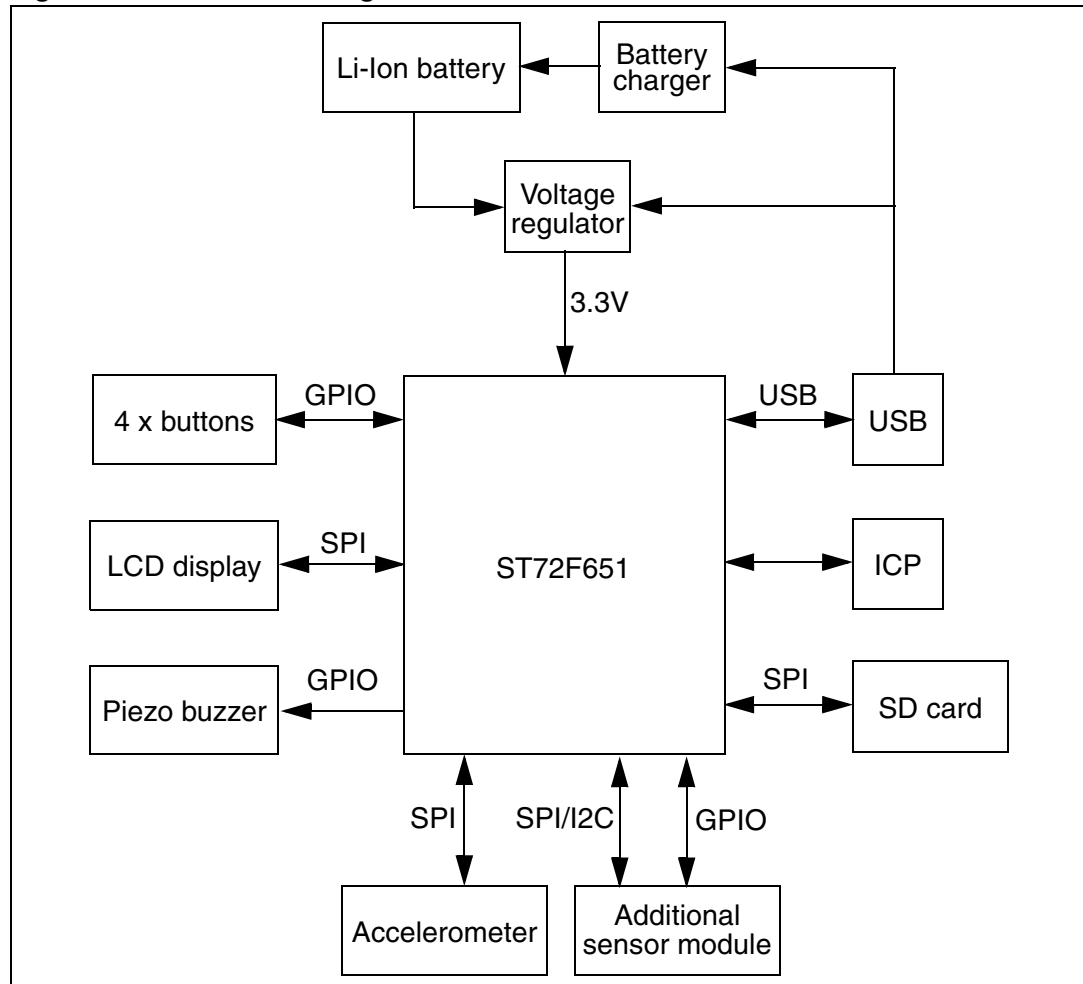
Figure 1.   The MuSA platform

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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.

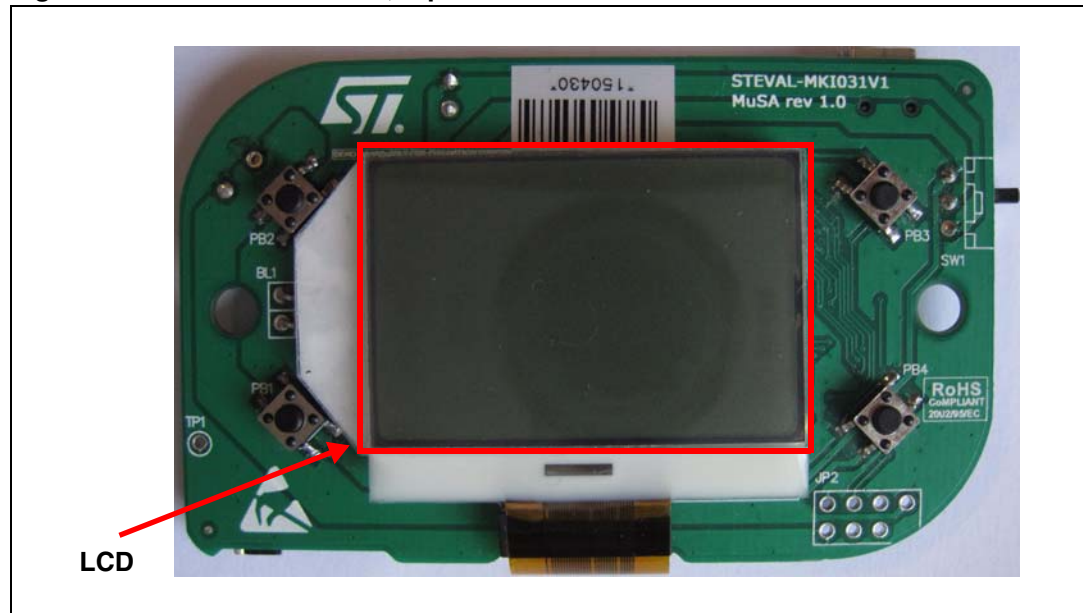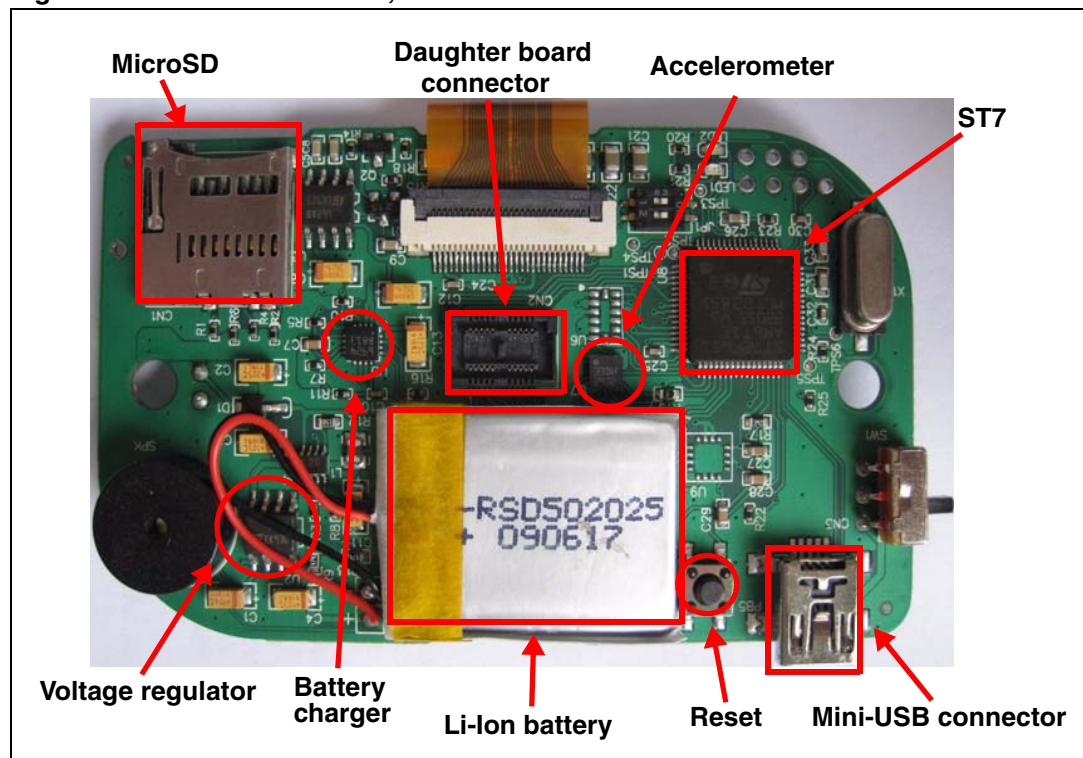**Figure 3.**   **MuSA main board, top side**

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.

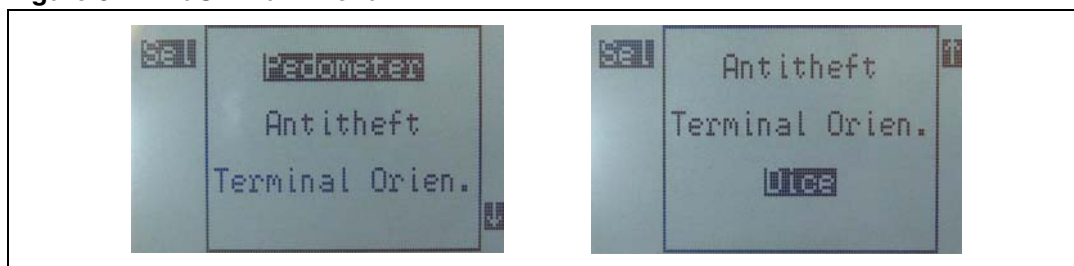**Figure 5.   MuSA start-up screen**

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 than 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.
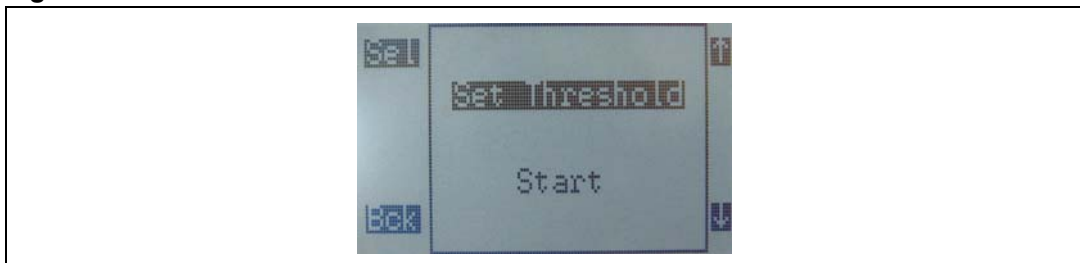
Press "Bck" to go back to the MuSA main menu.
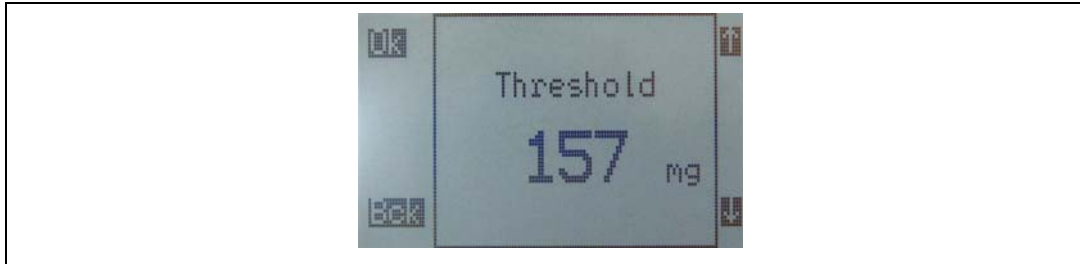
2.3 Antitheft

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
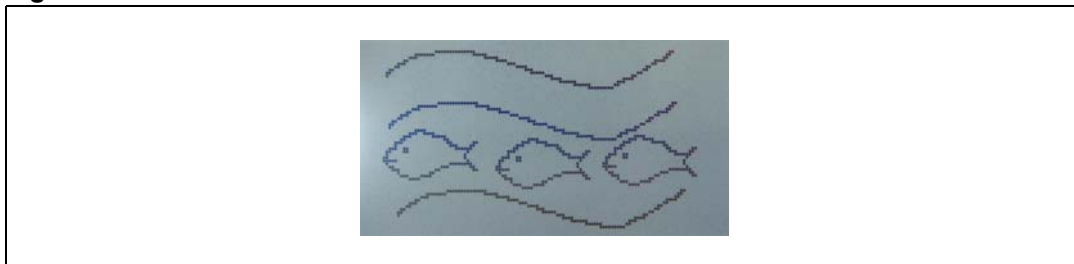
Figure 16. MuSA vertical
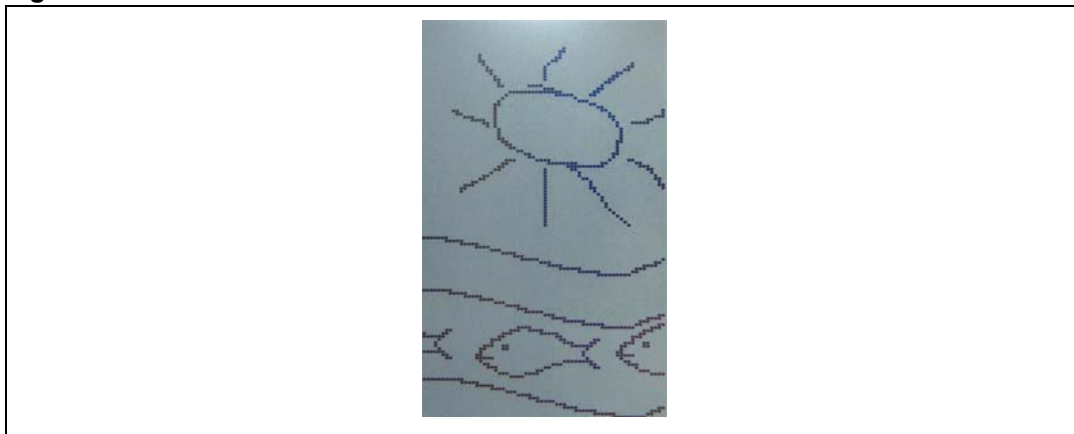
Press "Bck" to go back to the main menu.

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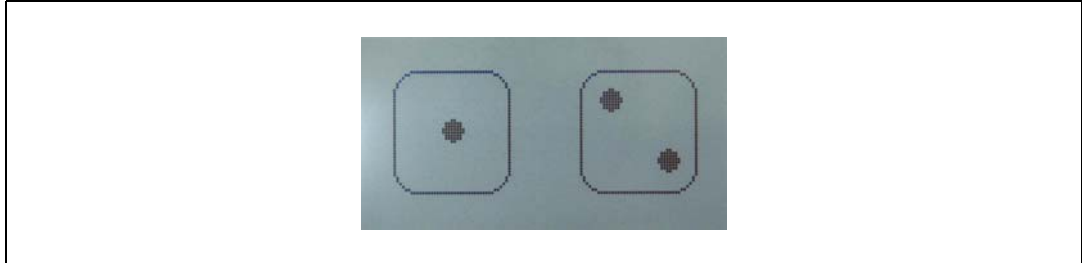
Press "Bck" to go back to the main menu.

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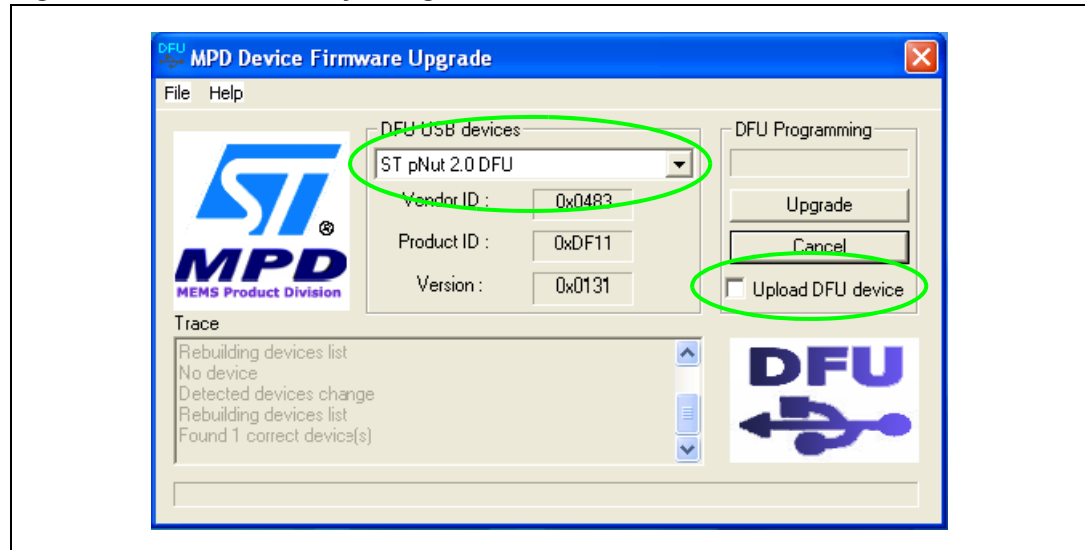
If it is the first time that this feature is used, it is necessary to install the DFU driver. It can be found in the Driver folder in MuSAFirmwareUpdate.zip.

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
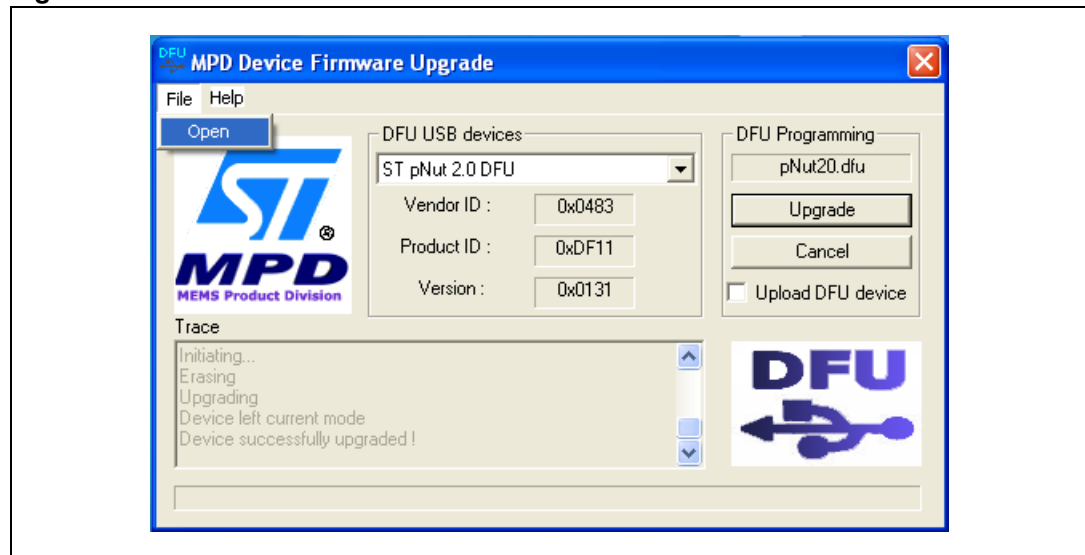
Figure 20. Flash erasing
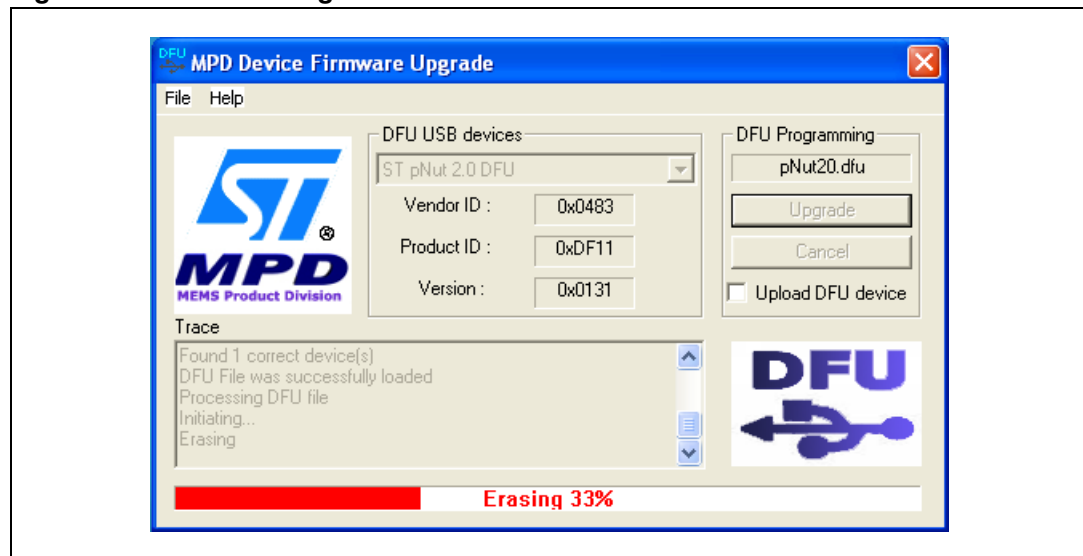
Figure 21. Flash upgrading
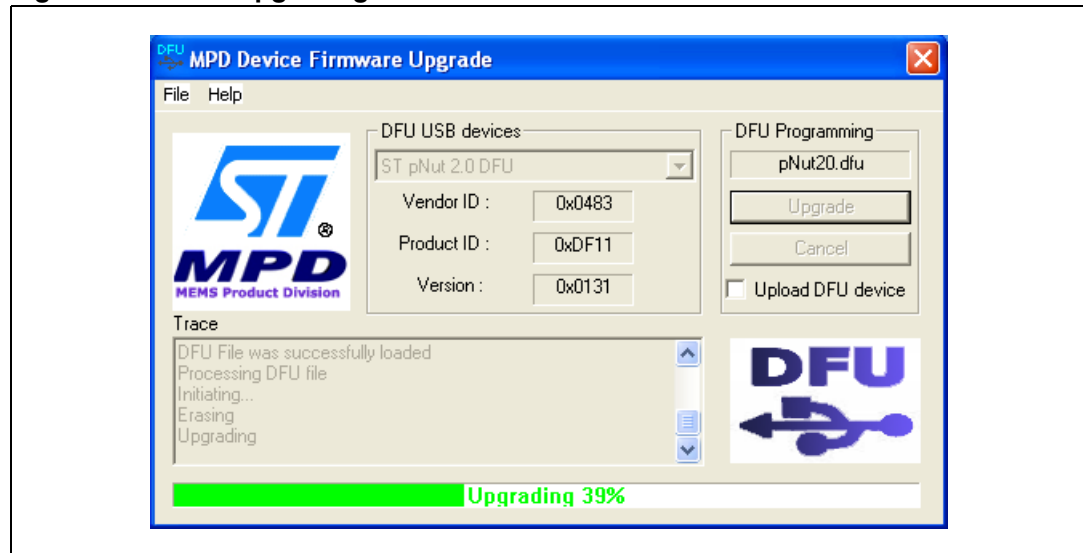
4 Recharging the MuSA

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

st7
st7.Sch

power
power.Sch

DFU
DFU.Sch

MEMS
MEMS.Sch

Display
Display.Sch

microSD
microSD.Sch

AM06934v1
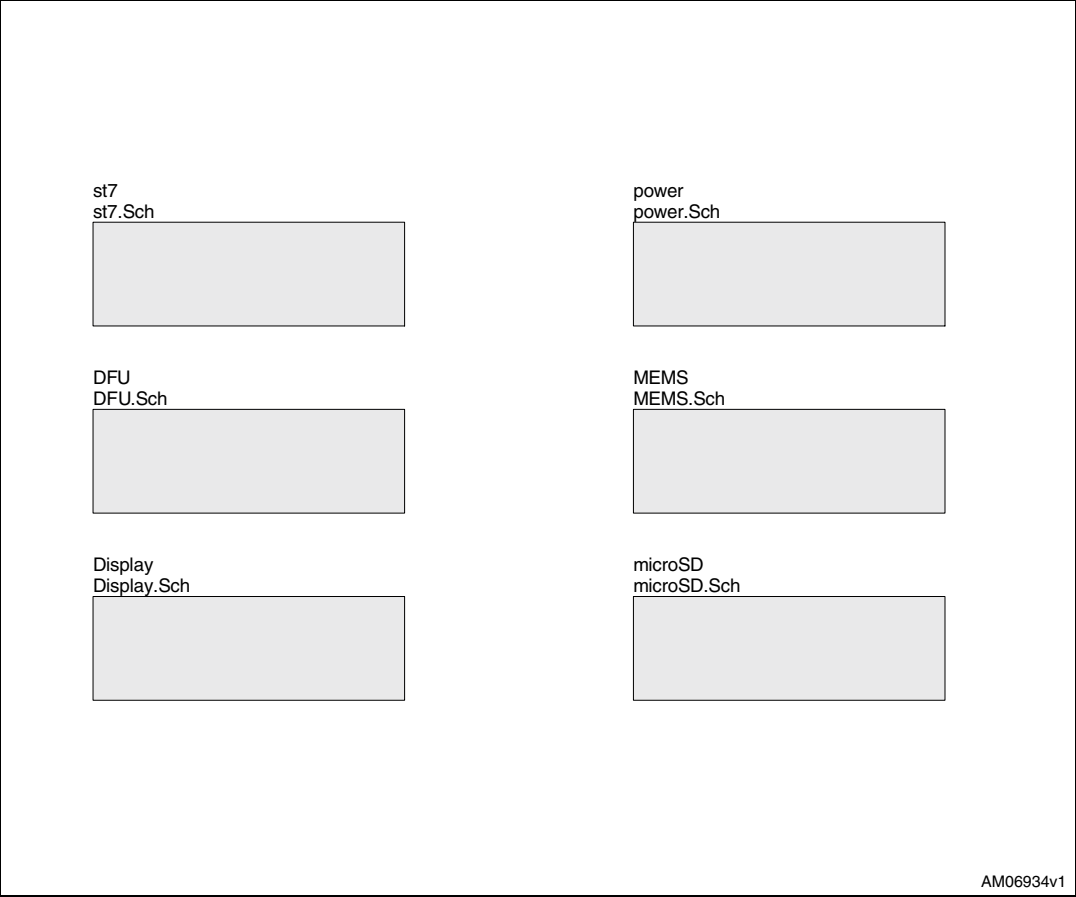
Figure 23.   MuSA schematics: ST7

AM06935v1

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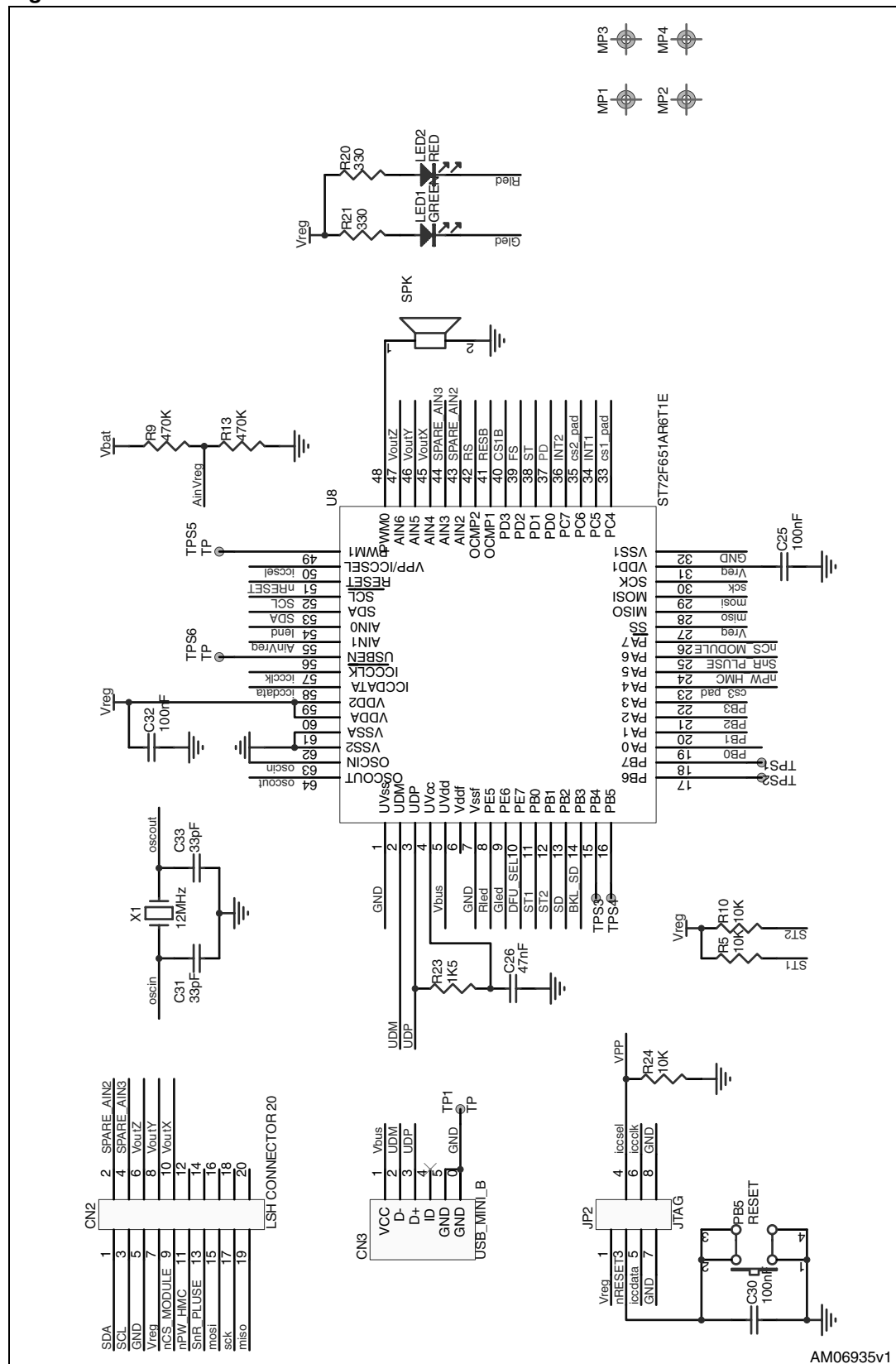
Figure 24. MuSA schematics: accelerometers

AM06936v1

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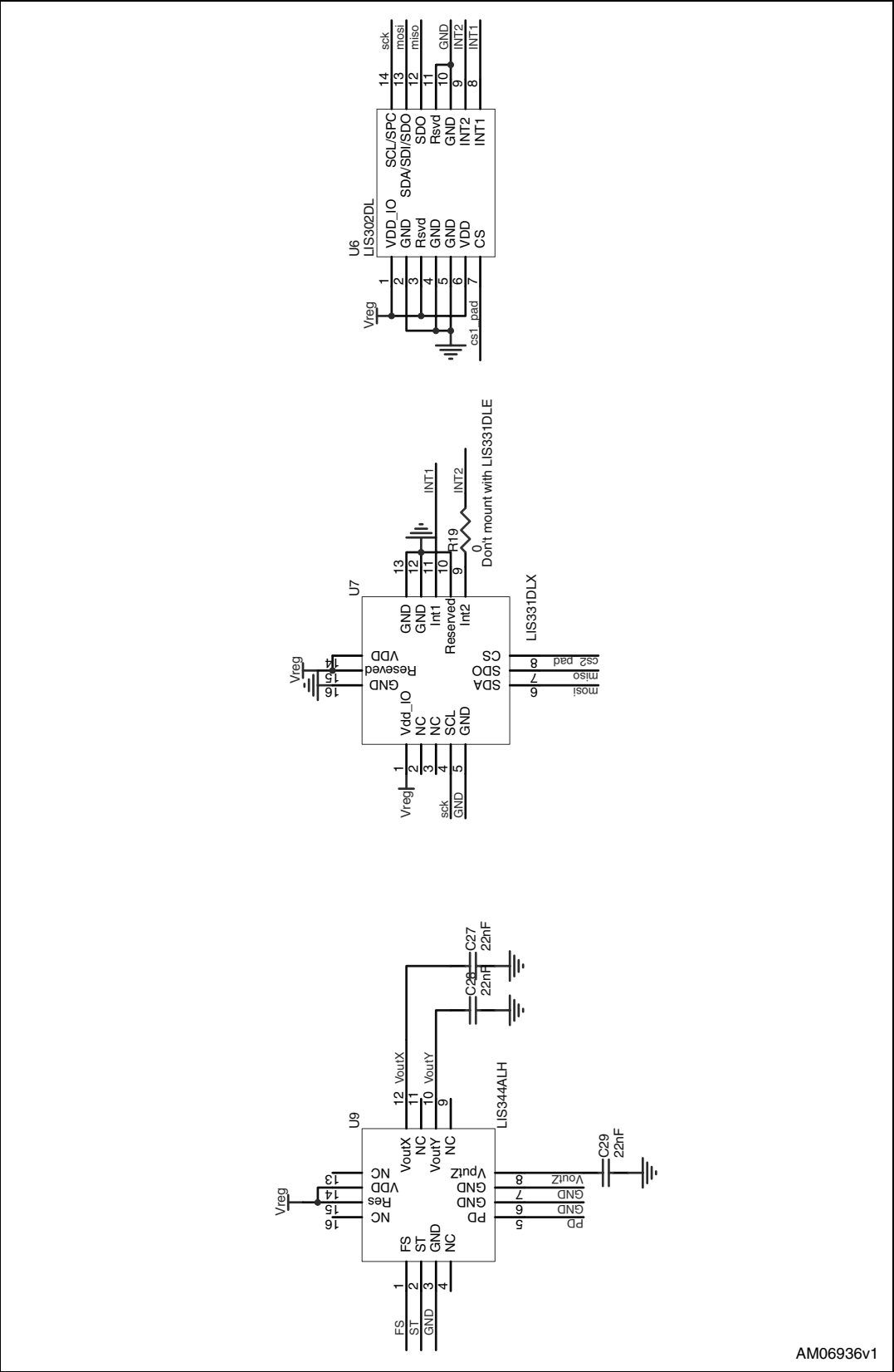
Figure 25. MuSA schematics: power supply

AM06937v1
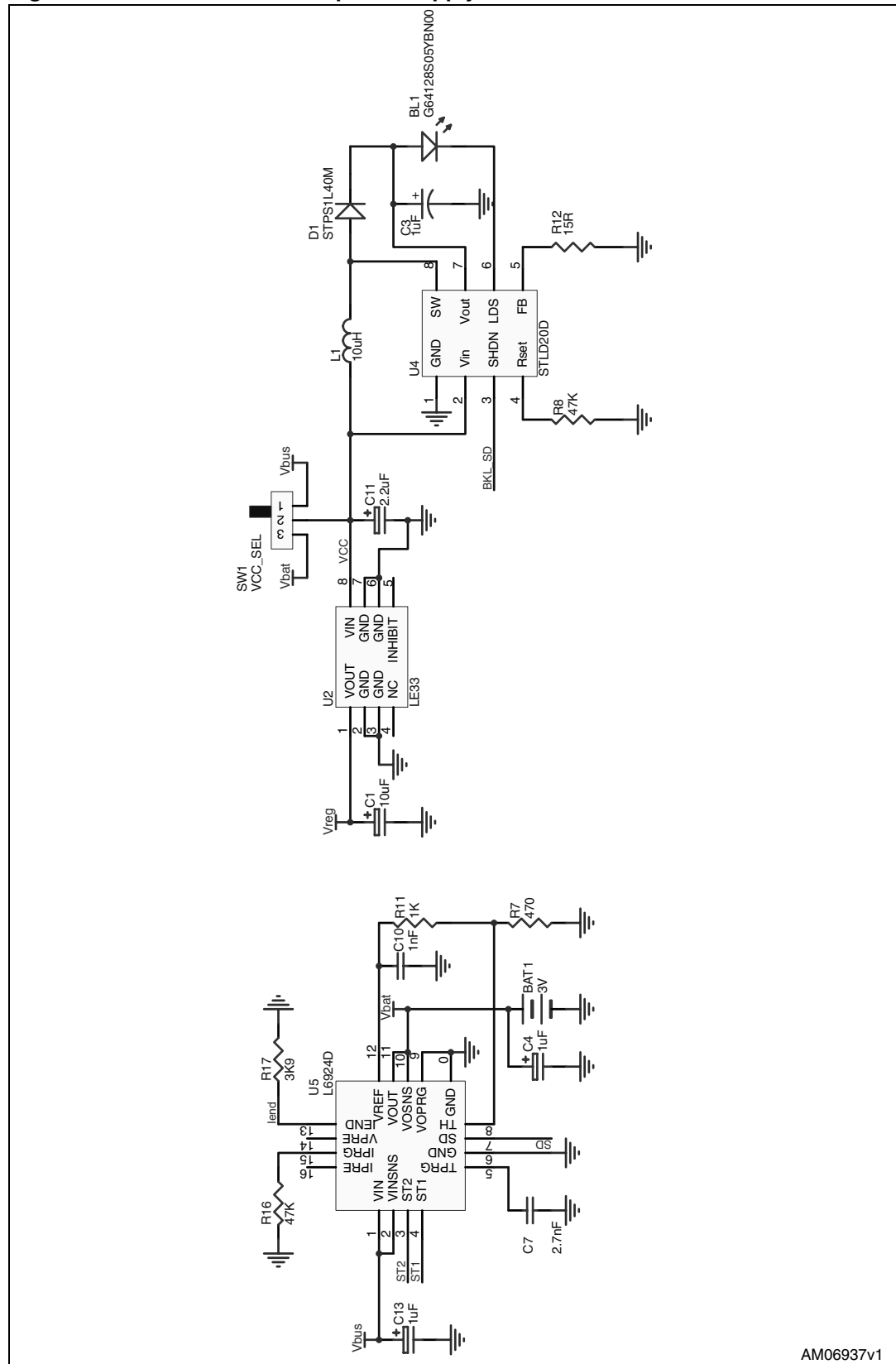
Figure 26. MuSA schematics: LCD

AM06938v1

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Figure 27.   MuSA schematics: microSD

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Figure 28.   MuSA schematics: DFU

AM06940v1
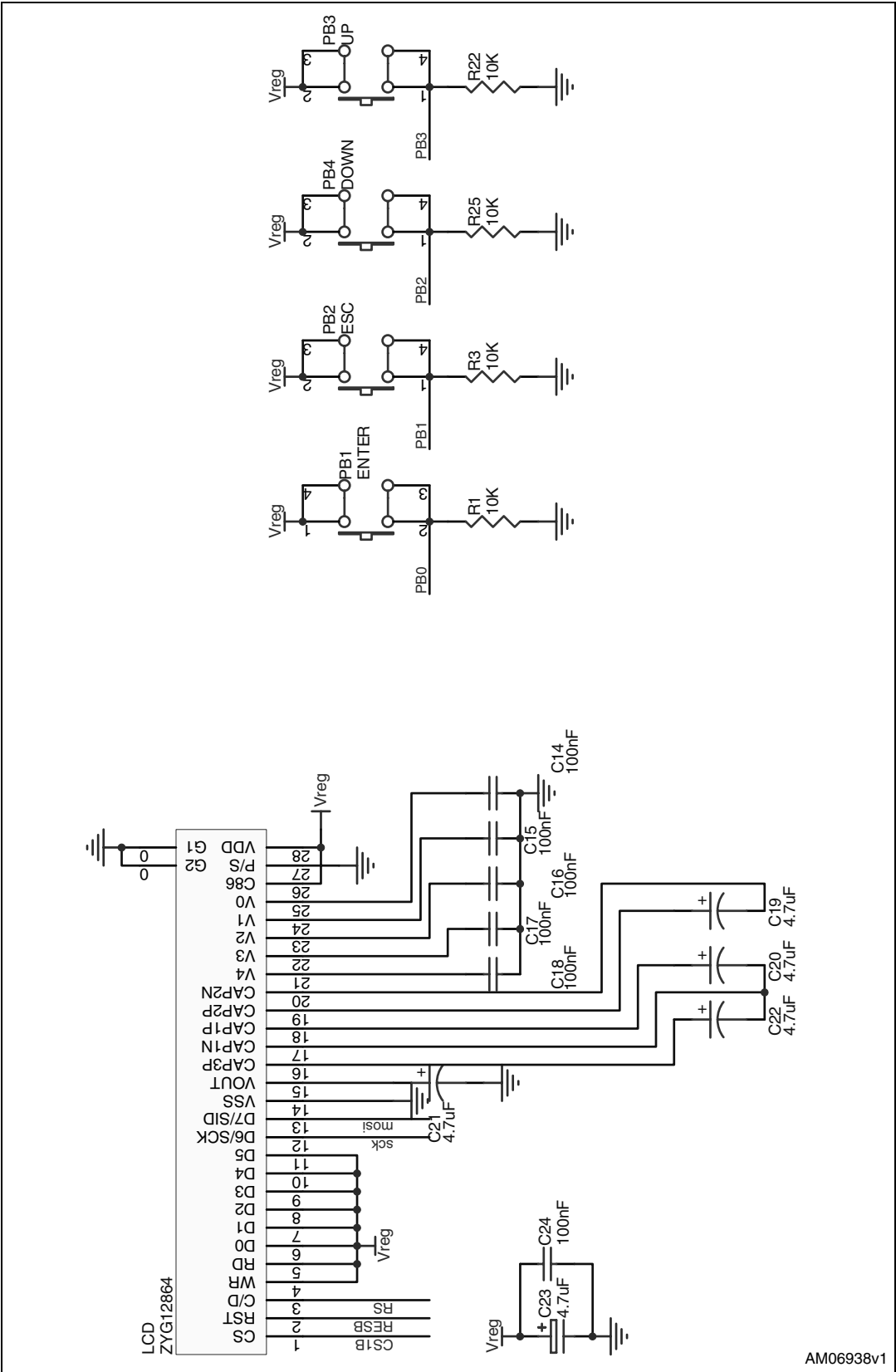
6 MuSA layout

Figure 29. MuSA layout: top layer

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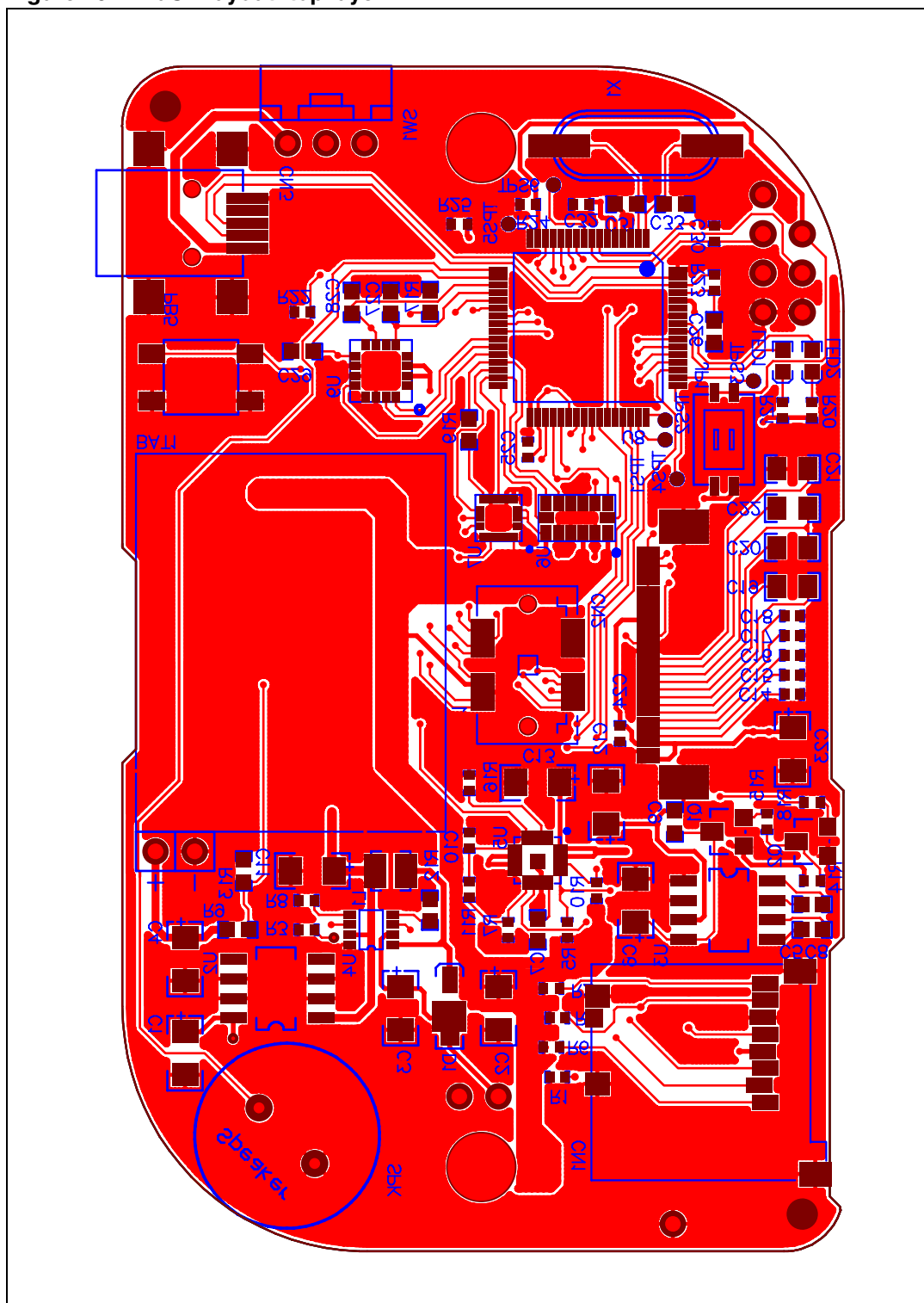
Figure 30. MuSA layout: bottom layer
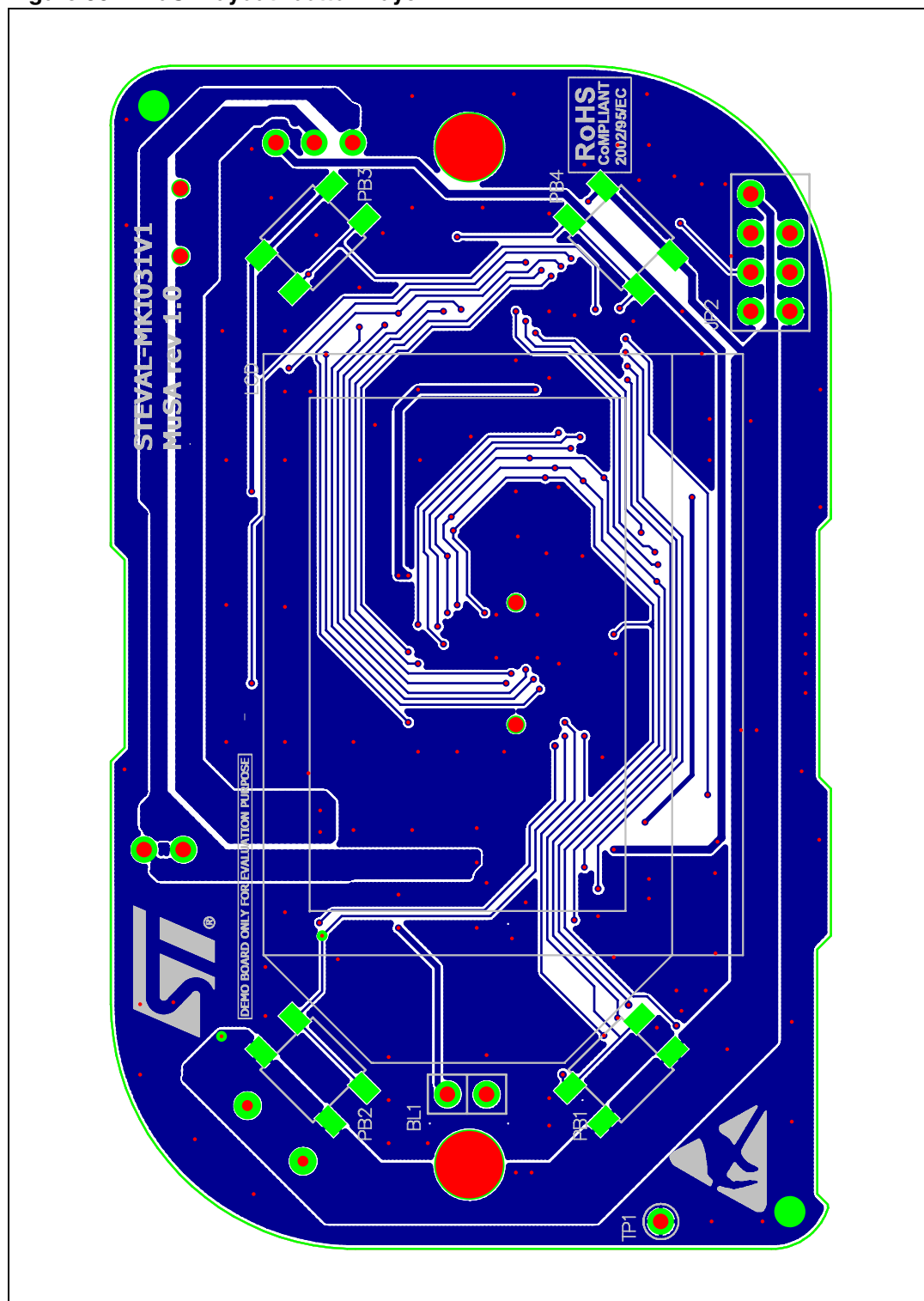
7 Revision history

Table 1. Document revision history

Date	Revision	Changes
06-Sep-2010	1	Initial release

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