AN4227
Application note

Audio hub demonstration kit supporting the MP45DT02, MP34DB01, and MP34DT01 microphones

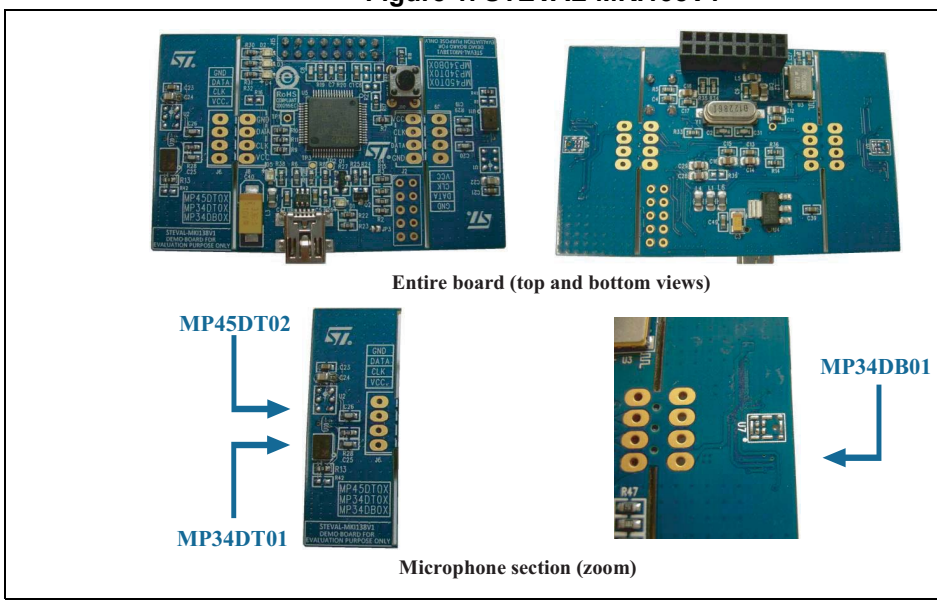
Introduction

This document provides a brief description of the audio hub demonstration board STEVAL-MKI138V1 available from *www.st.com* along with simple steps to use the board with the APWorkbench software tool.

The purpose of this board is twofold:

1. It can be used as an ***STSmartVoice interface***. In combination with this board (STEVAL-MKI126Vx), it manages the signal coming from the onboard microphones. The STSmartVoice board hosts up to six microphones and the STA321MPL microphone processor converts the PDM signals from them into the common I^2S audio format. (For additional details, please refer to AN4146 “STSmartVoice demonstration board STEVAL-MKI126Vx” available from *www.st.com*). Basically the audio hub, using the STM32F107RC microcontroller, is able to program the STA321MPL device via the I^2C and decodes the I^2S into a USB stream in order for the PC to manage the sound captured by the microphones. Multiple features for using the microphones on the STSmartVoice demonstration board are listed and accessible thanks to the APWorkbench software tool.
2. It can be used as a ***USB sound card***. As shown in *Figure 1*, the audio hub board hosts either the MP45DT02 or MP34DT01 (top-port digital microphones) and the MP34DB01 which is a bottom-port digital microphone. The board is able to host both types of microphones as shown below. The task of the STM32 microcontroller is to decode the PDM signals coming from the microphones and stream the audio via the USB.

Figure 1. STEVAL-MKI138V1

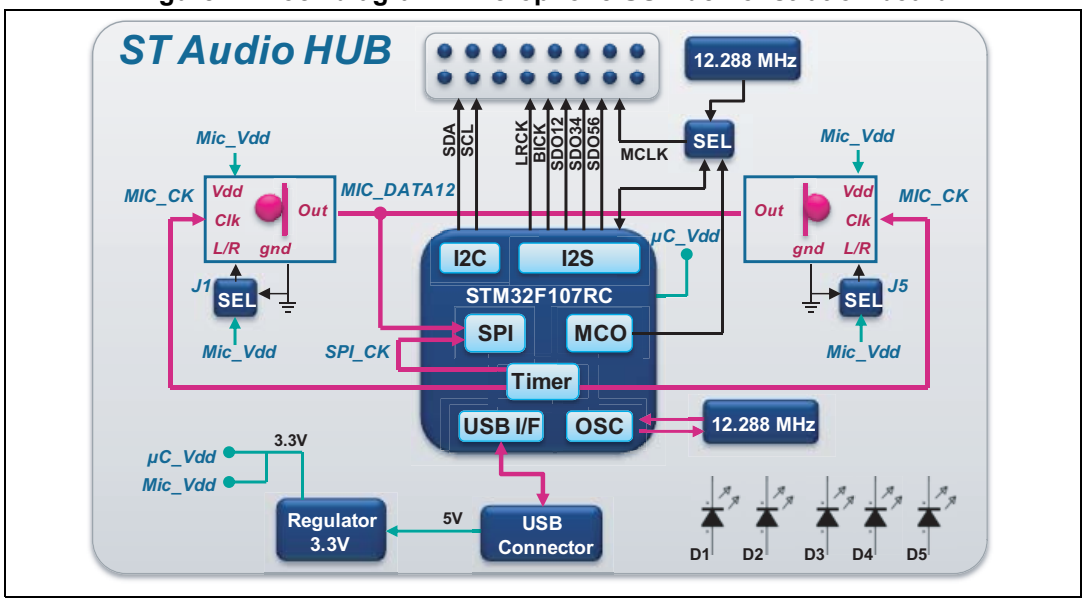


Contents

1 Hardware description

The connection is done through a USB cable that supplies the board and also streams the audio collected by the microphones to the PC.

Figure 2. Block diagram - microphone USB demonstration board



Referring to *Figure 2*:

- The supply section of the board is made up of one voltage regulator that steps down the 5 V of the USB connection to 3.3 V. The supply voltage ranges of the digital microphones are given below in *Table 1*.

Table 1. Supply voltage range of microphones

Part number	Min.	Typ.	Max.
MP45DT02	1.64	1.8	3.6
MP34DB01	1.64	1.8	3.6
MP34DT01	1.64	1.8	3.6

- Regarding the microphone sections, the MEMS outputs are a PDM signal, which is a high-frequency (1 to 3.25 MHz) stream of 1-bit digital samples. The “Functionality” section of each microphone datasheet (available on *www.st.com*) provides details concerning the connections of the microphone in single channel configuration or stereo configuration by setting the LR pin. This pin sets the validity of the output data on the high level of the clock or on the low level as shown in *Table 2*.

Table 2. L/R channel selection

L/R	Clock low	Clock high
GND	Data valid	High impedance
VDD	High impedance	Data valid

In this board the microphones are used in stereo configuration, so the two digital outputs are shorted (Mic_DATA12, refer to schematic) and the two MEMS LR pins must be respectively set one to GND and the other one to VDD. On the board, the resistors R1 and R13 already set the LR pin of the microphones, R1 and R42 give the user the possibility to change the MEMS polarity. Note that the PCB sections hosting the MEMS microphones are detachable. This option has been considered to let the user put the microphones in the desired position (i.e. for a display application in which the microphones are placed at the edges of the display).

- The hardware relative to the STM32F107RC microcontroller has been chosen to support both modes of usage listed above (either STSmartvoice interface or USB sound card).

  The board hosts two clock devices, the first one is a crystal quartz at 12.288 MHz and the other one is an active oscillator at 12.288 MHz as well. The first one, connected to the OSC_IN and OSC_OUT pins, serves to generate the entire internal clock of the microcontroller (STM32 clock tree). Once the clock tree has been set, all the internal peripherals of the microcontroller have their own clocks.

  If the ST audio hub is used as the STSmartVoice interface, the internal clock tree provides the clock for the USB, for the I^2C cell, for the I^2S cell and also provides the clock for the daughterboard through the MCO pin (12.288 MHz as well). The microcontroller is used to program the STA321MPL via I^2C and also is used to decode the I^2S coming from the daughterboard and to stream the audio via the USB. For this reason dedicated STM32 pins are connected to the connector physically interfacing the STSmartVoice board. An additional clock device (active oscillator) has been mounted for debugging purposes only. In the default configuration, the selector composed of R42, R21, and R17 is set to connect the MCLK trace to the MCO pin (refer to the schematic).

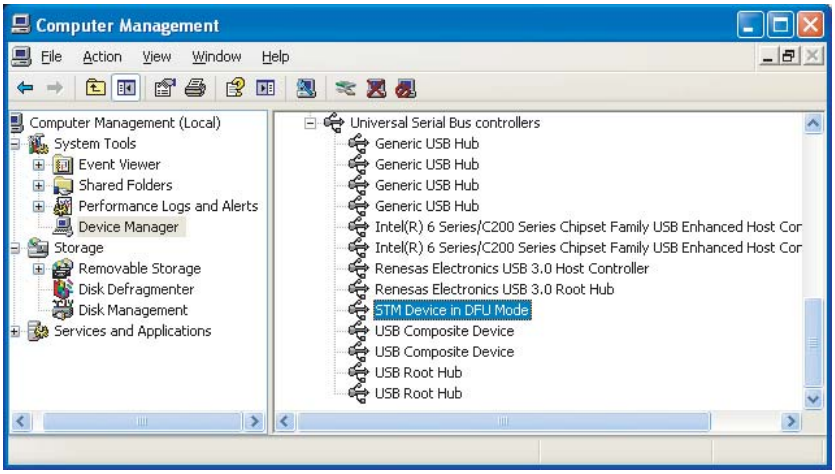
  If the ST Audio hub is used as a USB sound card, the clock tree is used to provide the MIC_CK and SPI_CK thanks to internal timers and a dedicated loop trace on the board (short between pin 21 and pin 27). The STM32 samples the output data of the microphones using the synchronous serial port (SPI1). The microphone signal MIC_DATA12 is a stereophonic signal and the SPI must be able to sample both channels. Since MIC_DATA12 is synchronous with its clock, SPI_CK must be doubled. Summarizing, the timer generates:

  – MIC_CK = 3.072 MHz
  – SPI_CK = 6.144 MHz

  The supported microcontroller USB interface allows streaming the audio on the USB peripheral, rendering this demonstration board compatible with any laptop or desktop.

- Some LEDs have been mounted on the board, thus allowing a real-time check of what the demonstration board is performing. LEDs D1 and D5 give feedback about the supply and successful enumeration while the purpose of D2, D3 and D4 is to check the status of the board. D2 and D3 will alternately blink while the STM32 is in DFU mode (before the dedicated firmware has been correctly loaded into the flash memory of the microcontroller). Checking the PC “Device Manager”, the STM device in DFU mode will appear (see *Figure 3* below).

Figure 3. Device manager when STM32 is in DFU mode



The audio hub boards are provided by ST with the firmware already loaded; the DFU section has been included to allow a firmware update by the user with no need for flash loader kits and is directly supported by the APWorkbench tool. The status of LEDs D1-D5 is summarized in the table below.

Table 3. LED status

D1	D2	D3	D4	D5
ON: USB enumeration successful	Blinking: DFU mode Off: Firmware correctly downloaded	Blinking: DFU mode Off: Firmware correctly downloaded	Off: Firmware correctly downloaded	ON: Board supplied

2 Software description (getting started with APWorkbench)

The firmware of the ST audio hub supports two different audio frameworks. In the first case the board can be used as the interface for the STSmartVoice, allowing the I^2C programming and the decoding of the I^2S coming from the daughterboard. When the board is used for this purpose, it will be recognized as "STAudioHub interface"[(a)]. The other possibility is the use of the board essentially as a PDM decoder that allows the couple of microphones on the board to be interfaced directly to the PC via the USB in which case the board will be recognized by the operative system as "STM32 Capture PDM mode".

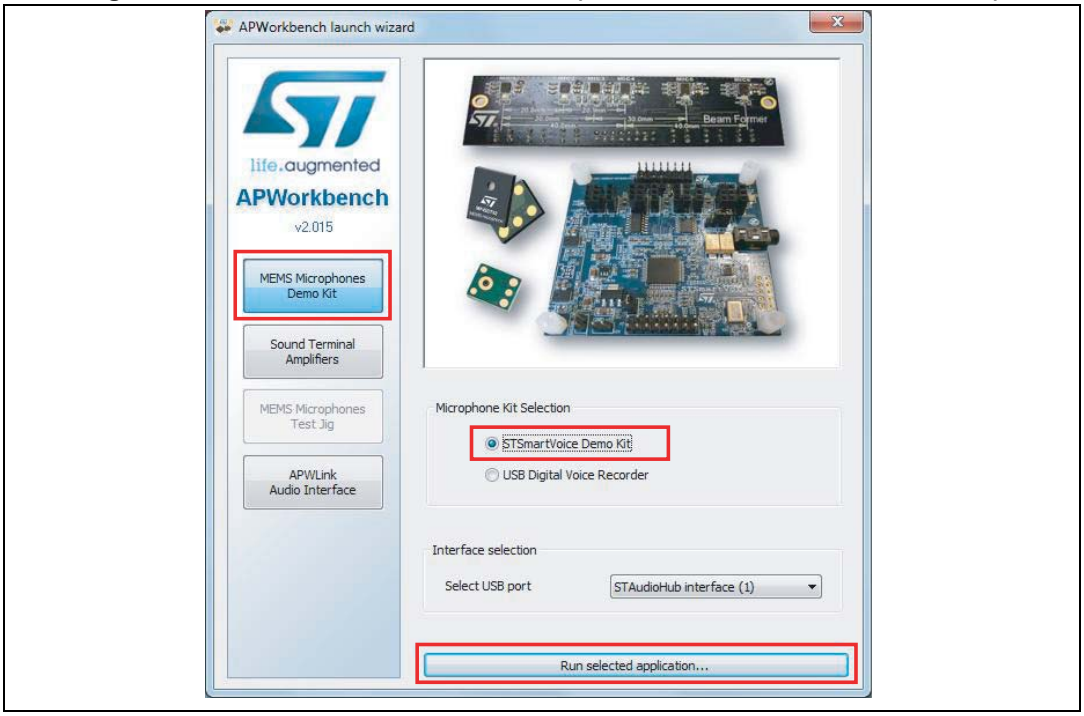
The APWorkbench tool allows choosing one of these modes by following these simple steps:

1. Run the tool
2. Click on the "MEMS Microphones Demo Kit" button
3. Select the mode in the "Microphone Kit selection" box
4. Click on the "Run Selected Application…" button

2.1 STSmartVoice interface

If the user wants to operate the board as the STSmartVoice interface, the corresponding mode must be selected as shown in *Figure 4*.

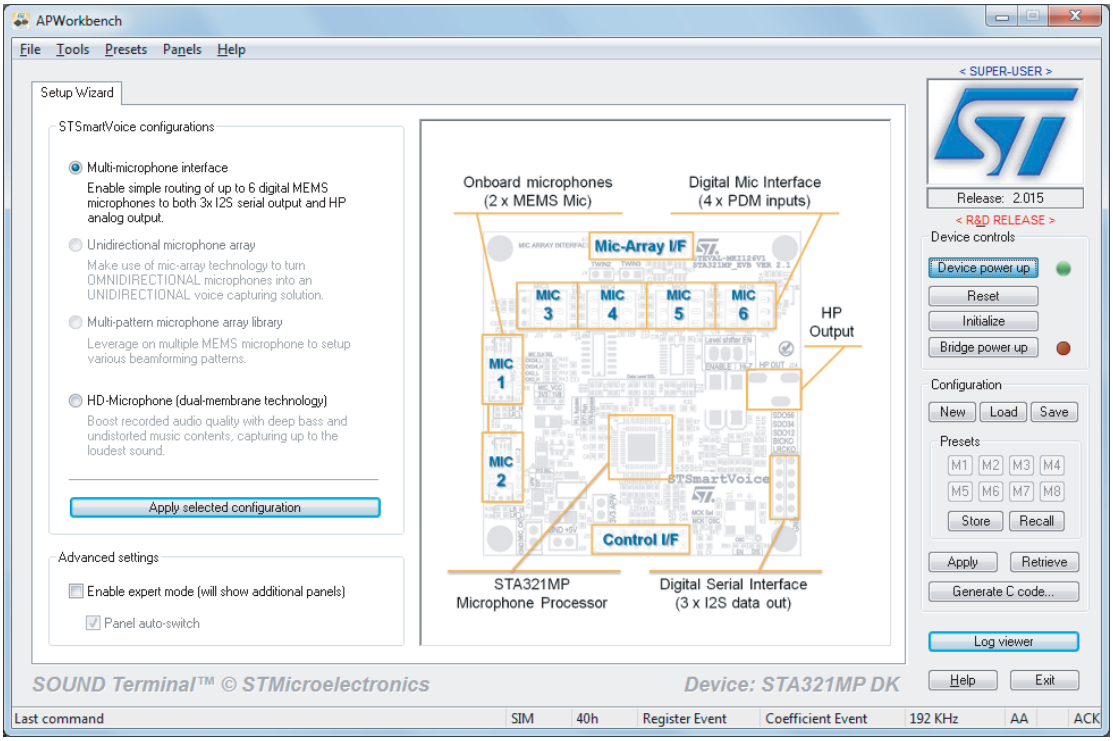
Figure 4. APWorkbench launch wizard (STSmartVoice demonstration kit)



a. APWorkbench is compatible with Windows XP, Windows Vista and Windows 7.

After this selection, the setup wizard panel of the STSmartVoice supported configurations will appear. For a detailed description of the meaning of the configurations listed in *Figure 5*, please refer to AN4146 "STSmartVoice demonstration board STEVAL-MKI126Vx" available on *www.st.com*.

Figure 5. STSmartVoice - setup wizard



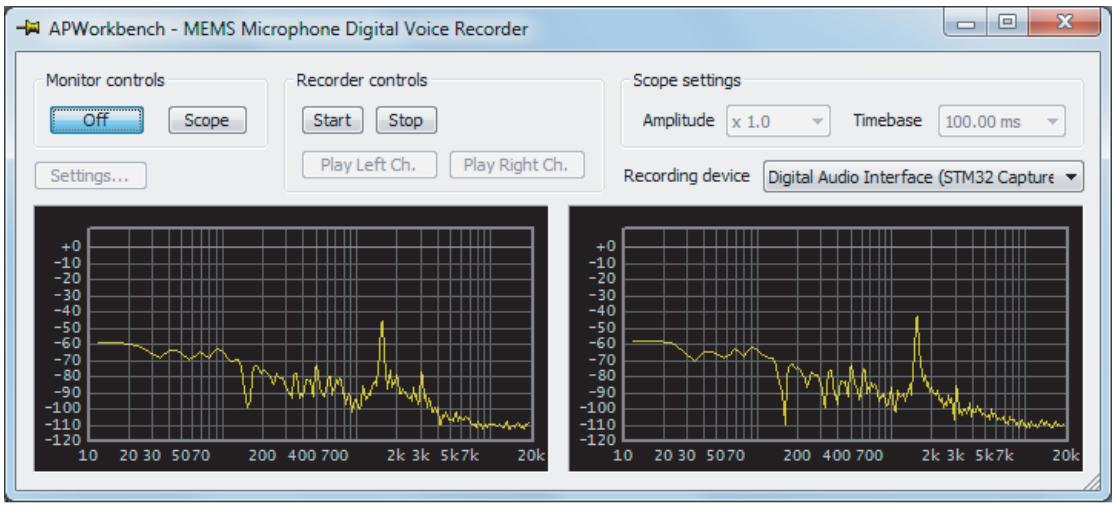
2.2 USB voice recorder

If the user wants to operate the board as a USB voice recorder, the proper mode must be selected as depicted in *Figure 6*.

Figure 6. APWorkbench launch wizard (USB digital voice recorder)

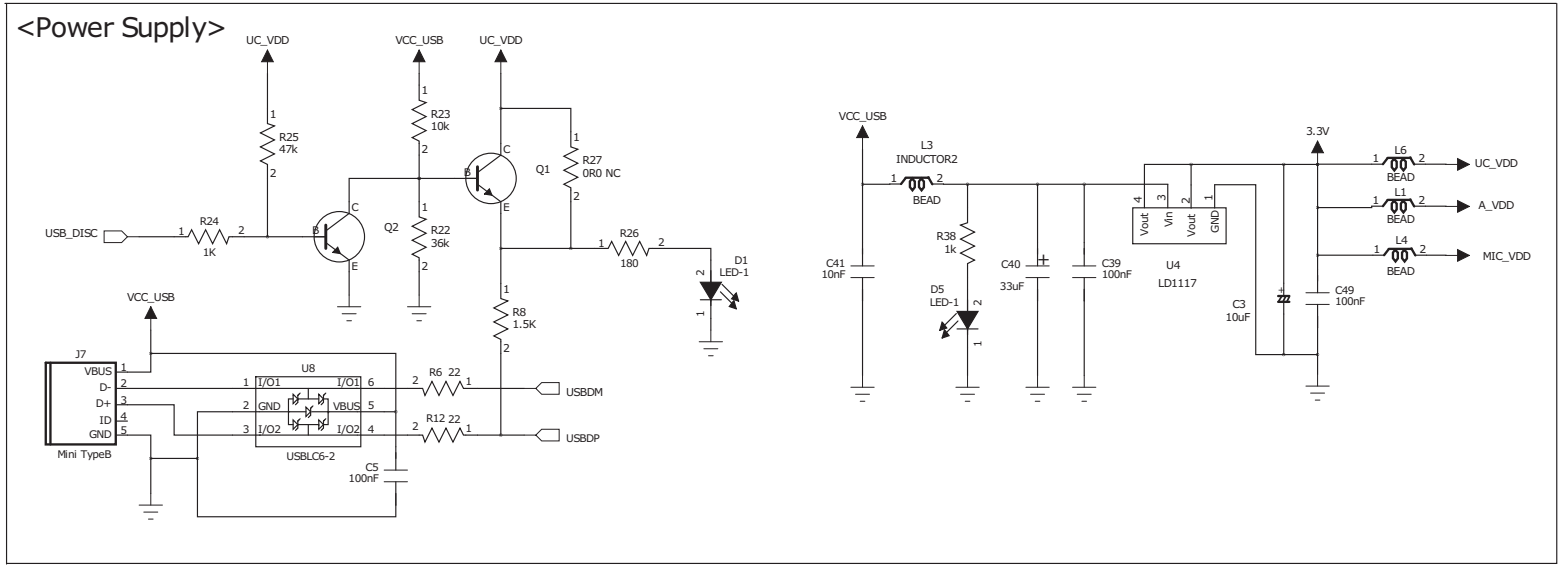
Once this selection has been run, a dedicated panel will appear. If the user wants to operate the board as a USB voice recorder, the tool shows the panel performing either FFT or scope monitoring. It is also possible to record the signal sensed by the microphones on the board.

Figure 7. USB voice recorder - FFT monitoring



Appendix A Schematics

Figure 8. Board schematic (power supply and JTAG connector)



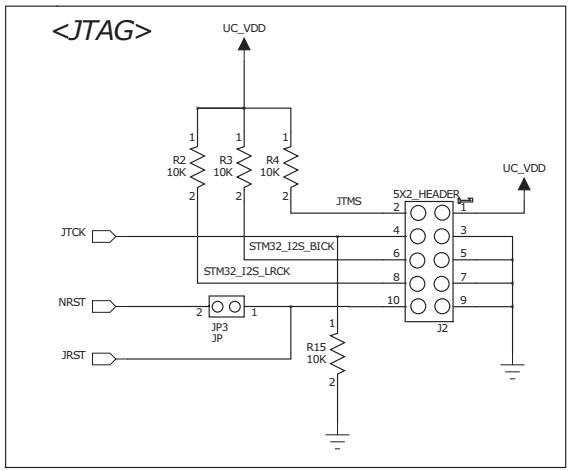
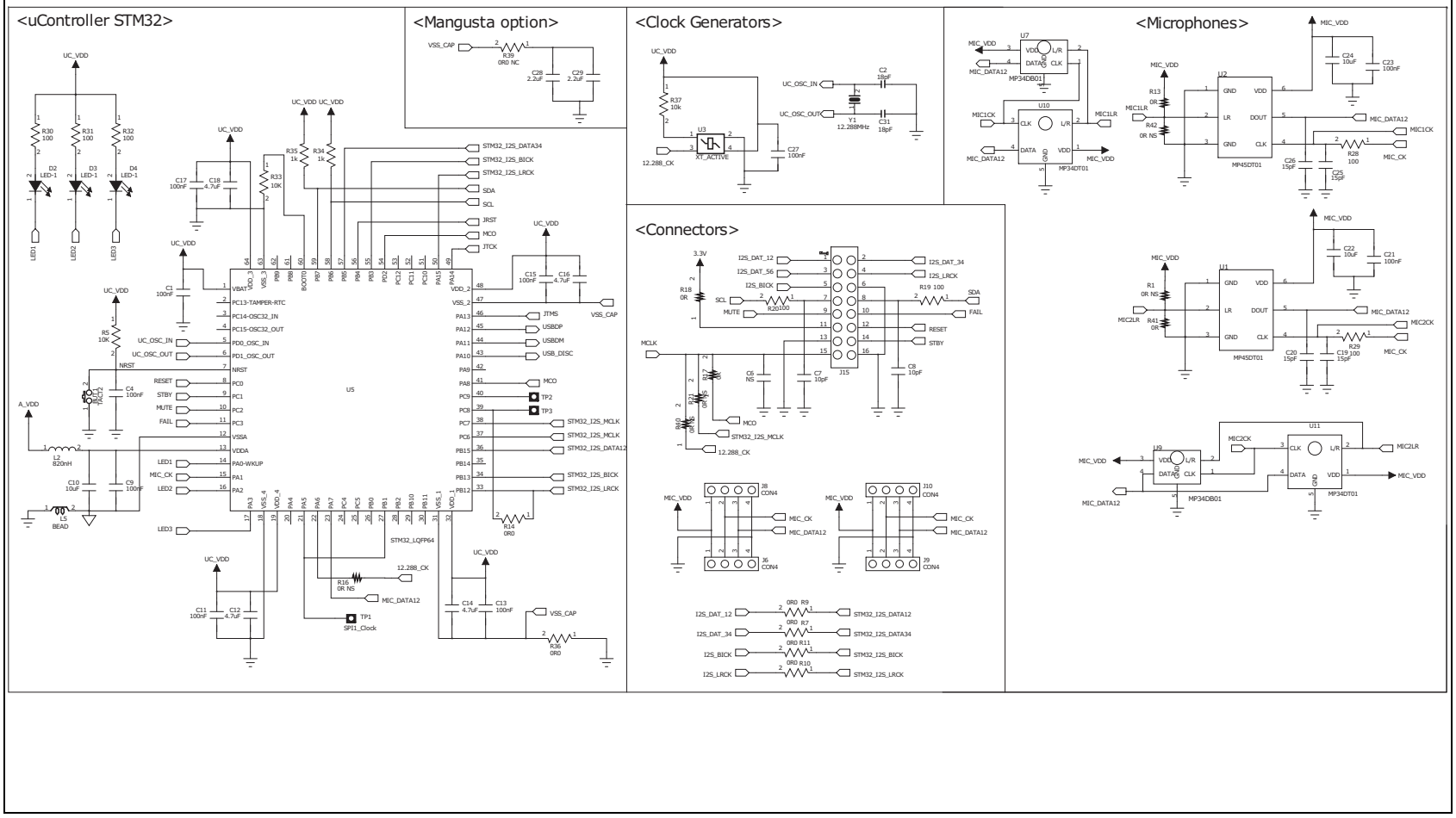


Figure 9. Board schematic (STM32 microcontroller, Mangusta option, clock generators, connectors, and microphones)



Appendix B Layout

Figure 10. Board layout - top view

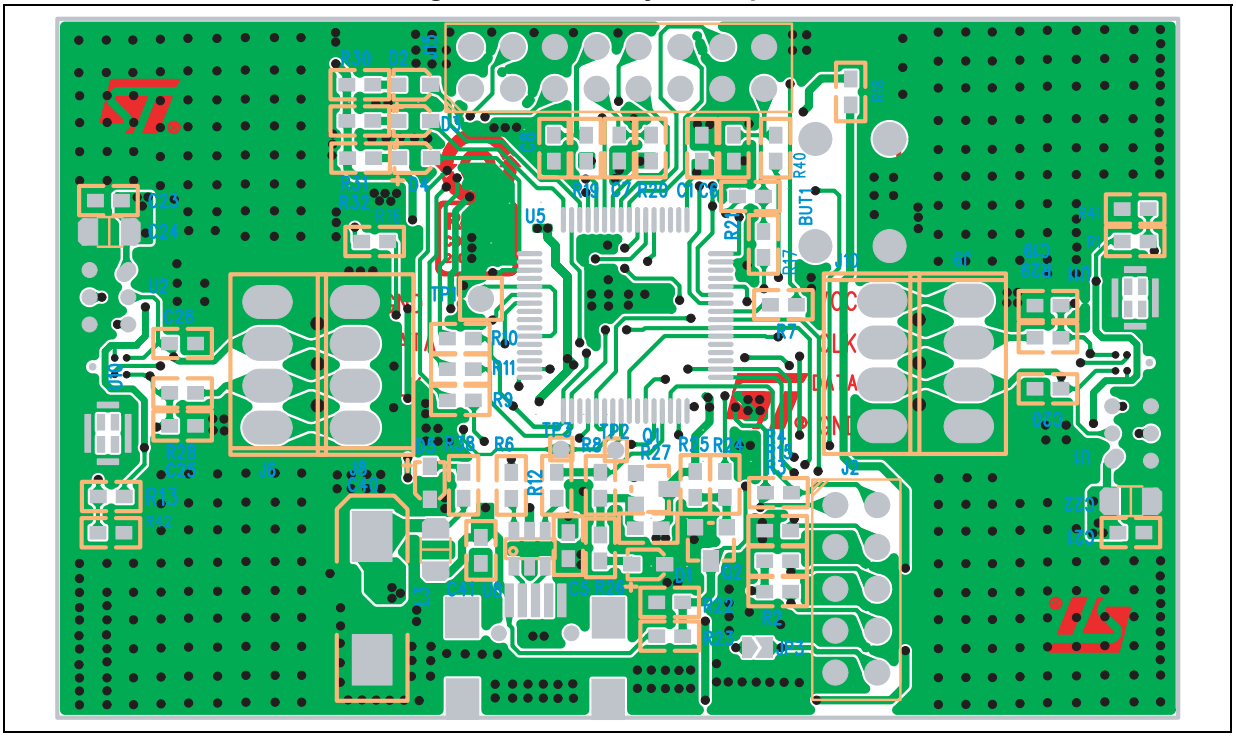
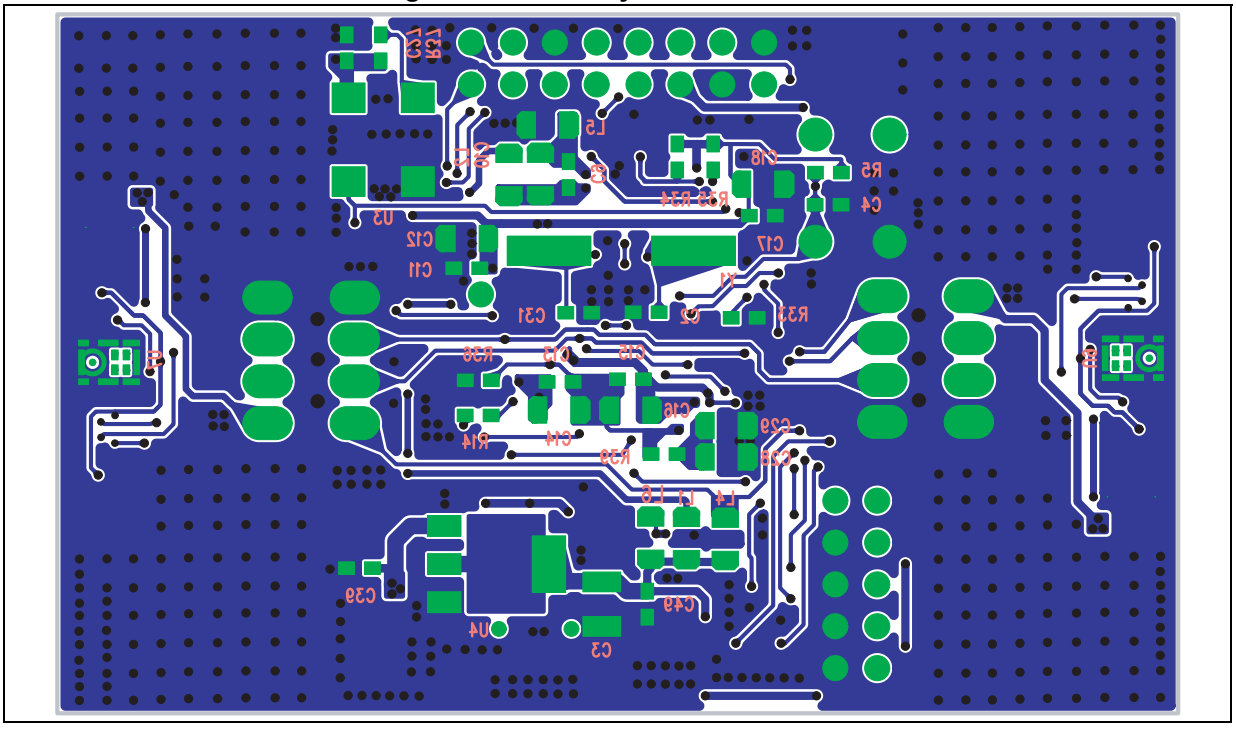


Figure 11. Board layout - bottom view



3 Revision history

Table 4. Document revision history

Date	Revision	Changes
22-Mar-2013	1	Initial release.