UM1959
User manual

Mezzanine board with STM32F446 MCU

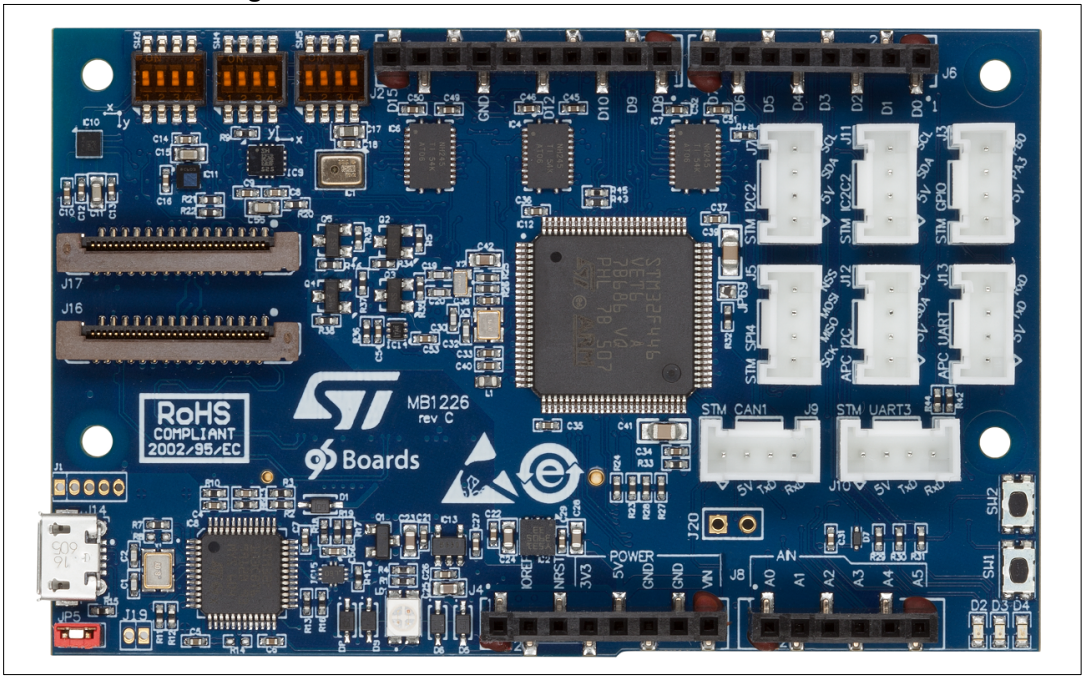
Introduction

The STM32F446 Mezzanine board (B-F446E-96B01A) brings environmental awareness to prototype systems and expands the features of the 96Boards CE cards, such as DragonBoard™ 410c.

The capabilities of this Mezzanine board are seamlessly extended through its Arduino™ Uno revision 3 and Grove connectors.

An embedded ST-LINK/V2-1 debugger facilitates software development and programming and gives a direct access to the ARM® mbed™ online resources (see http://mbed.org).

Figure 1. STM32F446 Mezzanine board



1. Picture is not contractual.

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1 Features

- Based on STM32F446 MCU, ARM® Cortex® -M4 180 MHz in LQFP100 package
- Compliant with the 96Boards CE standard
- Two types of extension resources:
  - 96Boards high/low-speed connectivity
  - Arduino™ Uno revision 3 and Grove connectivity
- ARM® mbed™ -enabled (see http://mbed.org), planned for the first quarter of the 2016
- Integrated MEMS sensors:
  - LSM6DS3H: 3D accelerometer / 3D gyroscope
  - LIS3MDL 3-axis magnetometer
  - LPS22HB barometer
  - MP34DT01-M microphone
- On-board ST-LINK/V2-1 debugger/programmer
- USB re-enumeration capability:
  - Virtual com port
  - Mass storage
  - Debug port
- Supported by wide choice of integrated development environments (IDEs) including IAR™, Keil®, GCC-based IDEs, ARM® mbed™ online

2 Product marking

Evaluation tools marked as “RevA” or “RevB” on board (A1 or A2) and “ES” on the blister insert card, are not yet qualified and therefore not ready to be used as reference design or in production. Any consequences deriving from such usage will not be at ST charge. In no event, will ST be liable for any customer usage of these engineering sample tools as reference design or in production.

3 Quick start

The STM32F446 Mezzanine board can directly be plugged on a 96Boards CE card (such as the DragonBoard 410c) or simply be used in stand-alone mode.

Before installing and using the product, accept the Evaluation Product License Agreement from the www.st.com/epla webpage.

For more information about the STM32F446 Mezzanine board and to access the demonstration software, visit the www.st.com/stm32evaltools website. For more information about the 96Boards information visit the www.96boards.org website.

3.1 Getting started

Provide a 5V power supply through a Grove or Arduino Uno revision 3 power connector and the three LEDs will start to blink alternatively.

3.2 Hardware layout and configuration

The board can be configured with different options. In the default configuration, the STM32 controls all the MEMS sensors. The on-board level shifter makes it easy to select the application processor (APC) from the 96Boards beneath, irrespective of different voltage supplies. The APC can take partial or full control of the sensors. Various bus and GPIO configurations are available. A UART is available for establishing an inter-processor communication channel between the STM32 and the APC. *Figure 2* shows the hardware block diagram of the STM32F446 Mezzanine board. *Figure 3* and *Figure 4* show the features of the STM32F446 Mezzanine board.

Figure 2. Hardware block diagram

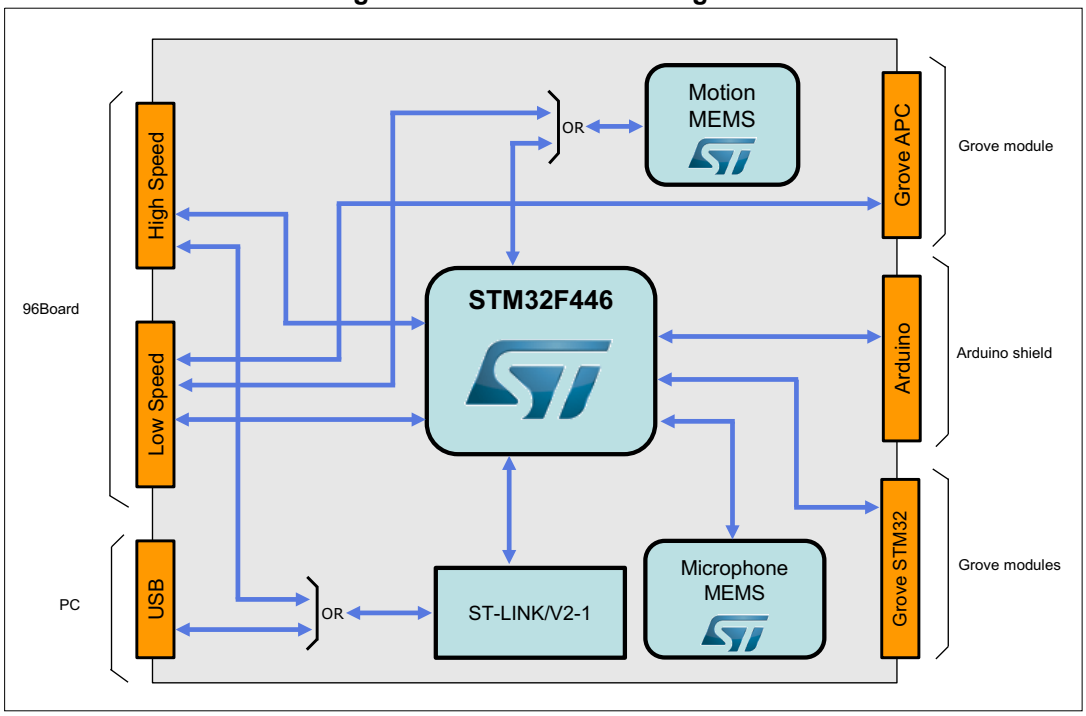
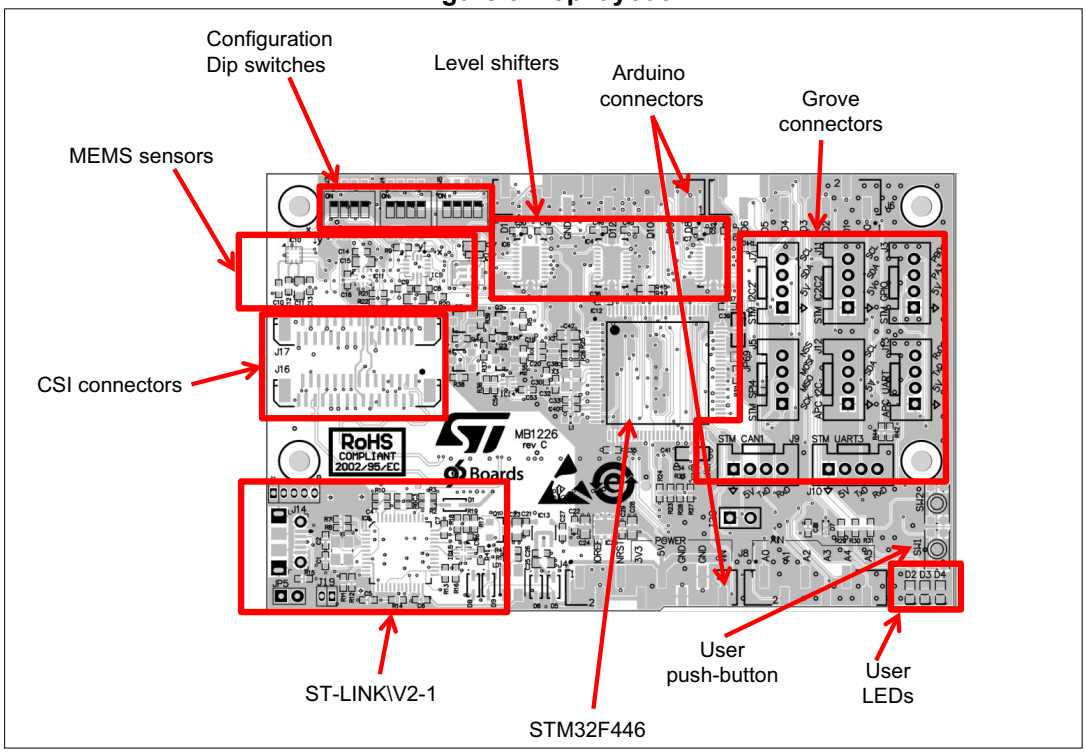
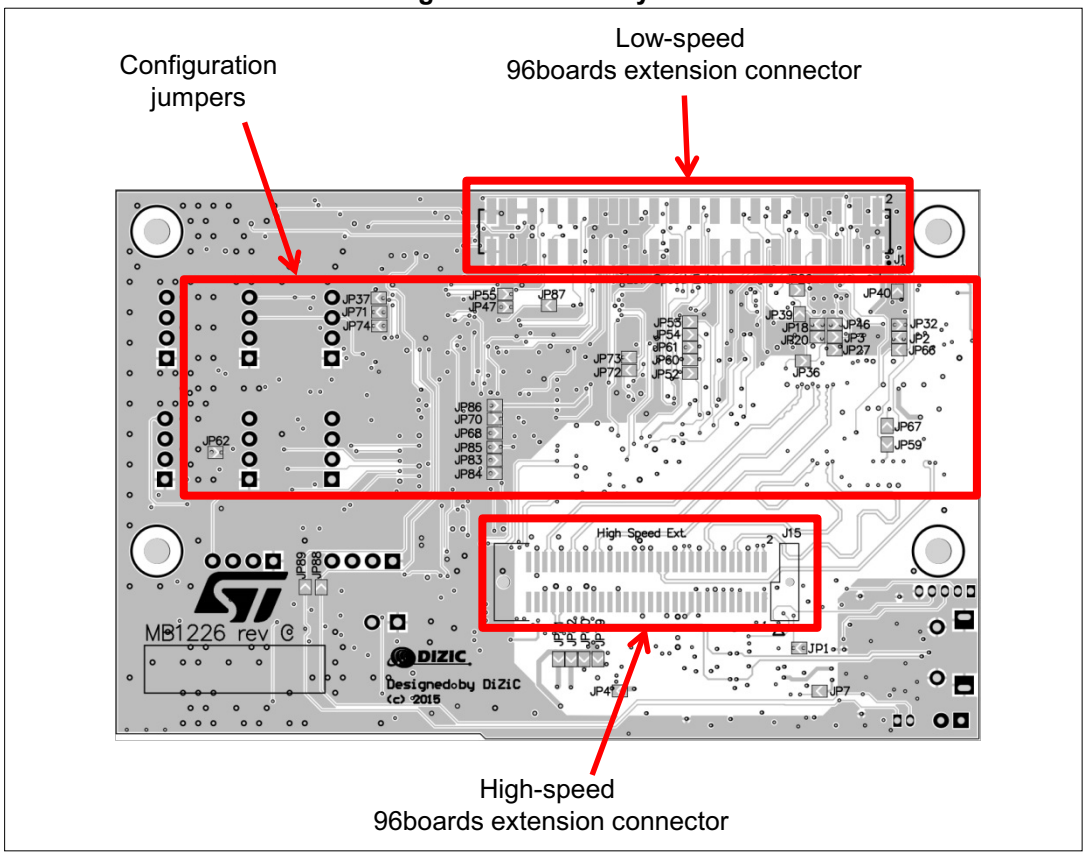


Figure 3. Top layout



Most of the configuration options are available through the solder bridges located on the back side of the board.

Figure 4. Bottom layout



3.3 Default setup

The solder bridges depicted with a red mark are closed by default when the board is manufactured (see *Figure 5* and *Figure 6*).

Figure 5. Top default settings

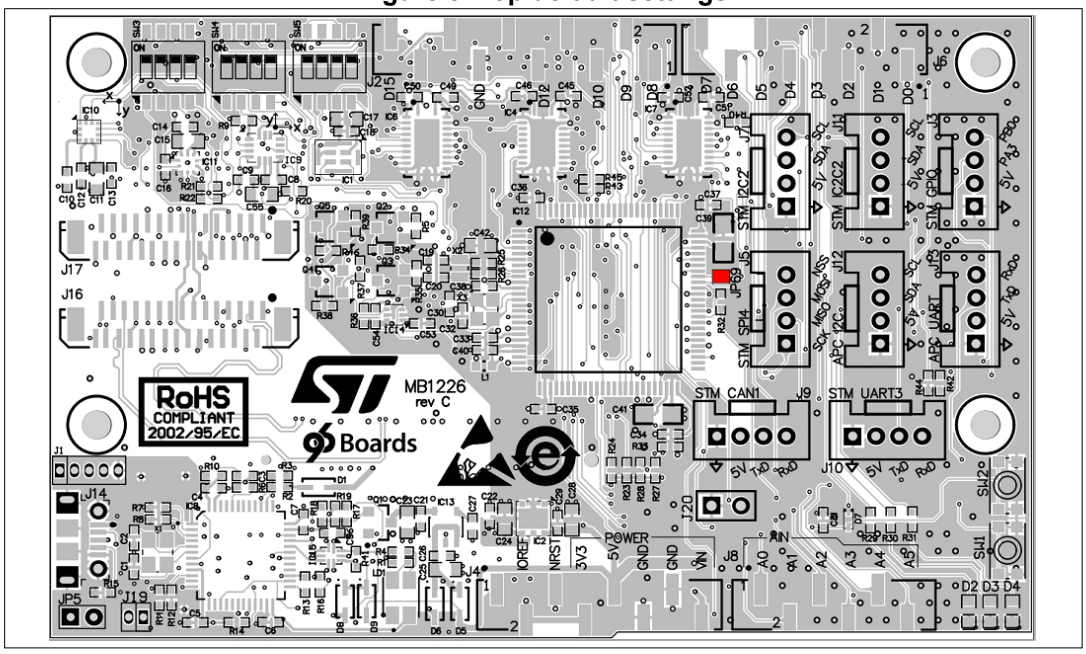
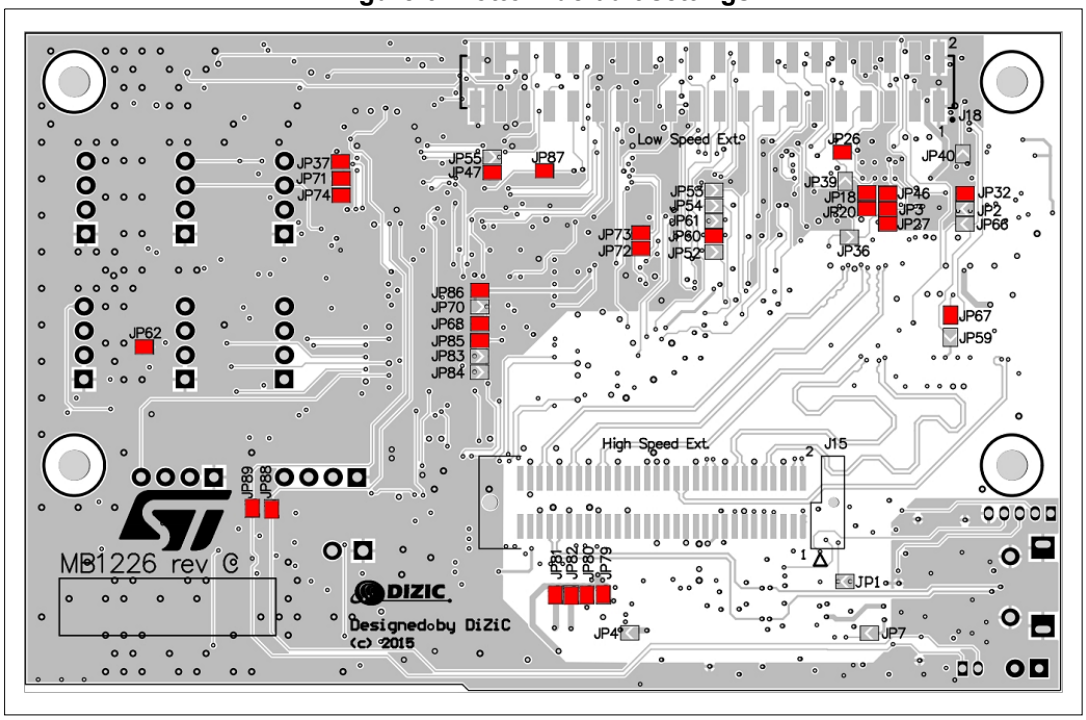


Figure 6. Bottom default settings



3.4 Power supply

The power supply is provided either by the 96Boards or by an external +5V source, connected through a Grove or Arduino Uno revision 3 connector in standalone mode.

Several solder bridges can be used to measure power consumption or to select powered ICs.

Figure 7. Power supply block diagram

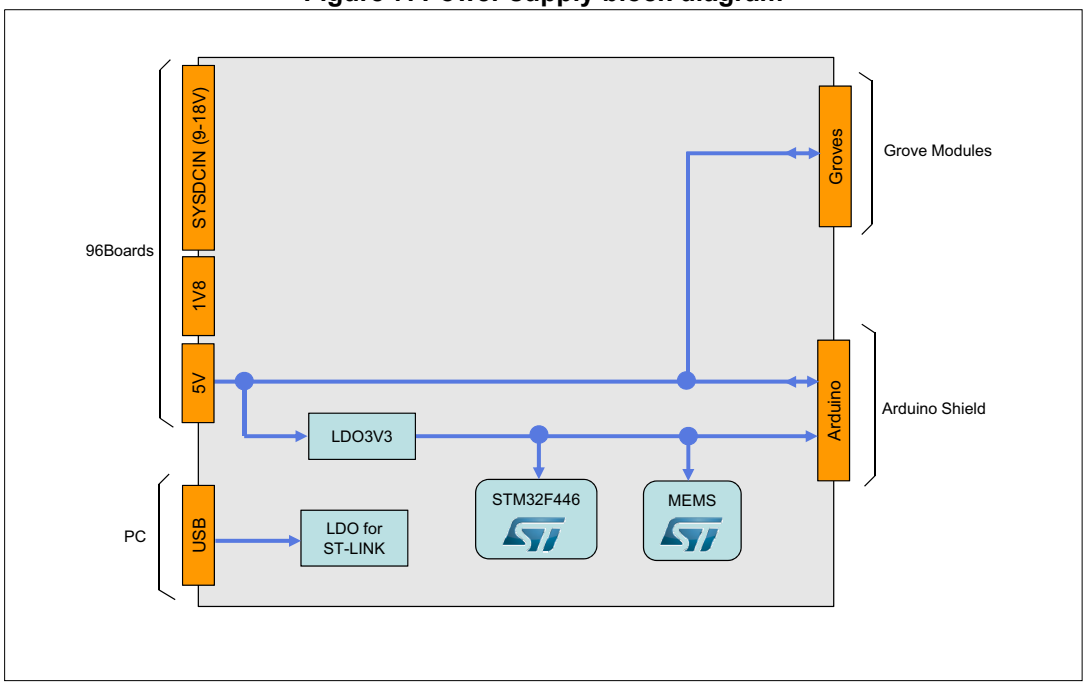
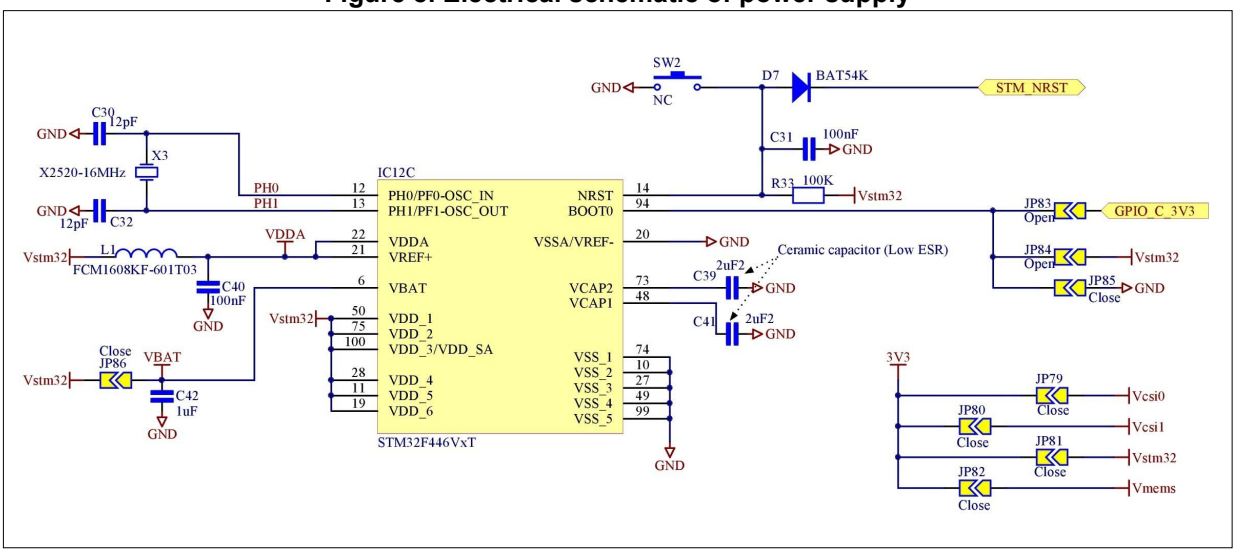


Figure 8. Electrical schematic of power supply



4 On-board programming and debugging

An ST-LINK/V2-1 debugger/programmer is integrated on the STM32F446 Mezzanine board to facilitate software development (no need for an external probe). The ST-LINK/V2-1 supports SWD debug, virtual com port as well as drag-and-drop programming through mass-storage. For detailed information about debugging and programming features, refer to *ST-LINK/V2 in-circuit debugger/programmer for STM8 and STM32* user manual (UM1075) available on *www.st.com*.

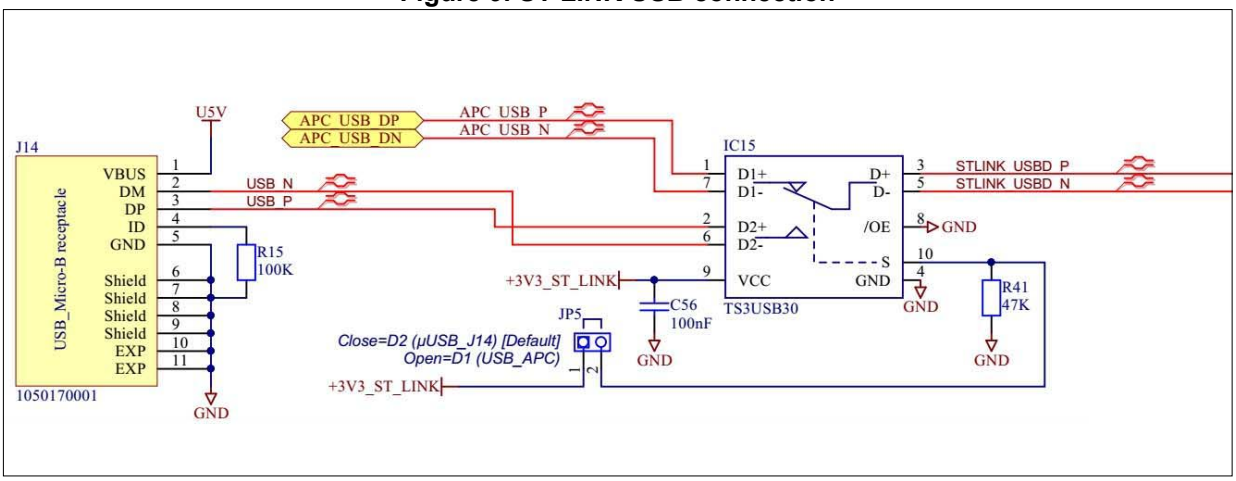
By default the programming tools are available from the micro USB connector CN1 connected to an external PC.

Alternatively the APC can be used to control the ST-LINK/V2-1.

Table 1. Solder bridge on ST-LINK/V2-1

Bridge	State	Description
JP5	Open	STLINK connected to APC High Speed connector (J15)
	Close	STLINK connected to µUSB connector (CN1)

Figure 9. ST-LINK USB connection



5 User interface

Basic information can be provided from the board, thanks to a push button and three signaling LEDs.

5.1 Push buttons

SW1 USER: the user button is connected to the I/O PD13 of the STM32.

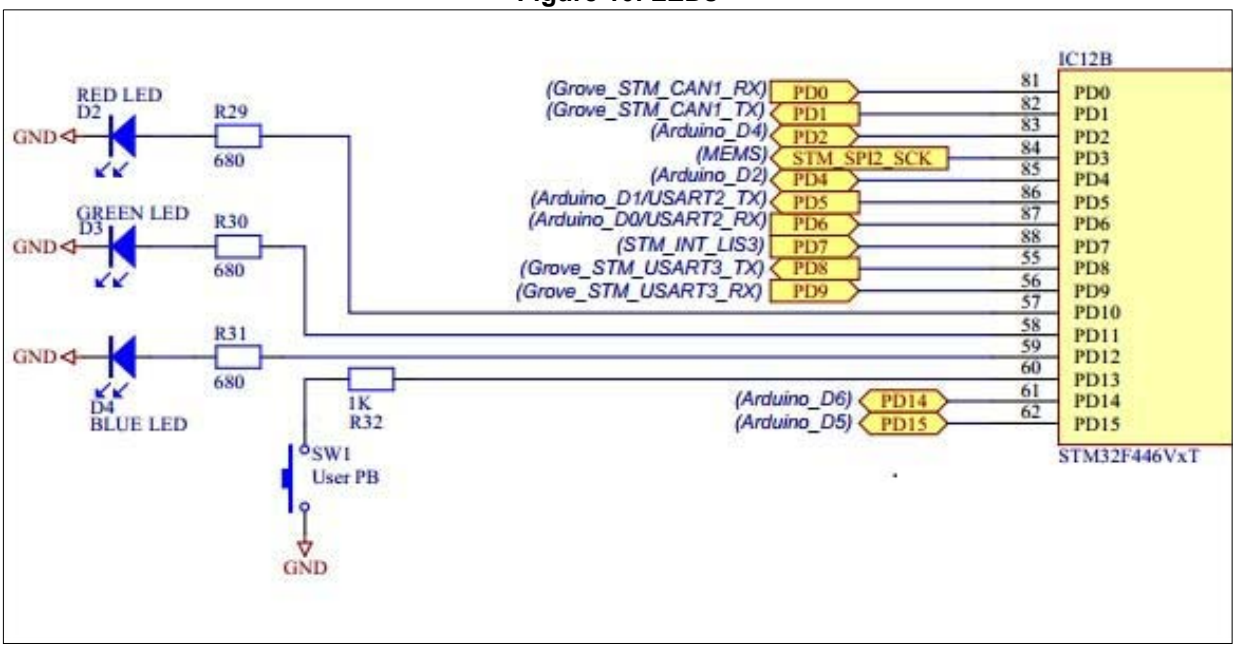
SW2 RESET: this push button (not soldered) connects to NRST and is used to reset the STM32.

Note: There is no external pull-up for this push button. So, it is necessary to enable the internal pull-up.

5.2 LEDs

Three LEDs (green, blue, red) can be used to signal information to an end user. Each LED is lighted on when a high signal is provided from the STM32 GPIO control pin.

Figure 10. LEDs



6 Inter-processor communication

The STM32 communicates with the 96Boards APC main processor through a UART bus.

Table 2. Solder bridge configuration

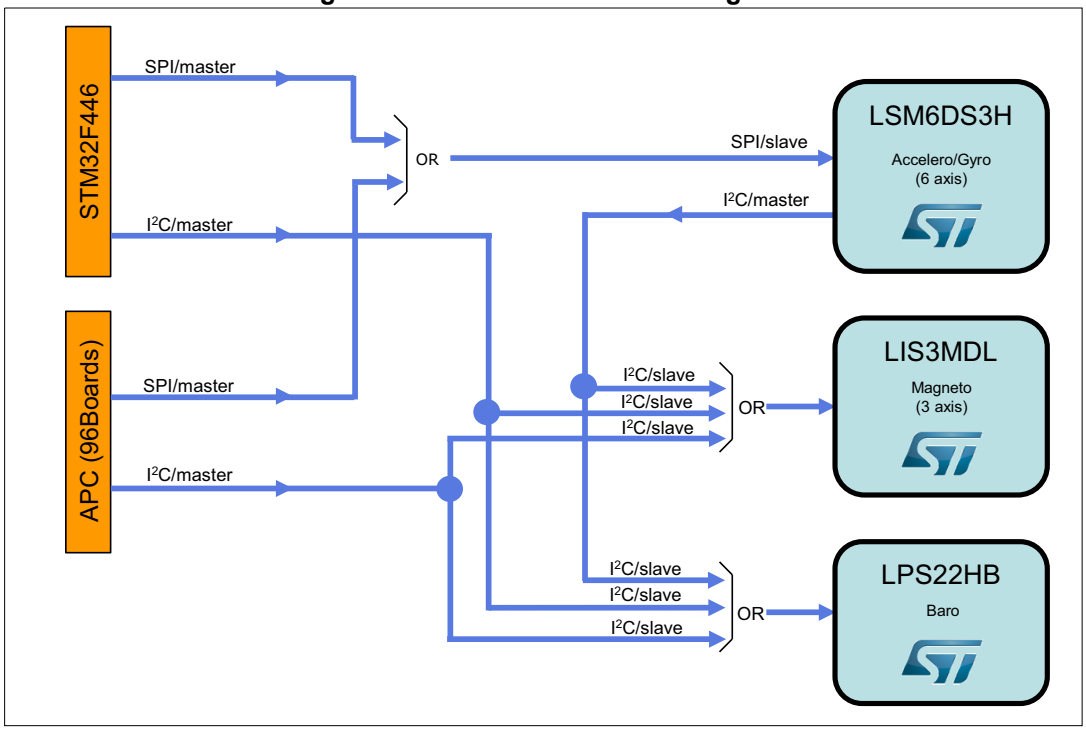
Bridge	State (1)	Description
JP71	Open	No signal connected
	Close	STM32_USART1_TX to PC_UART0_RxD
JP72	Open	No signal connected
	Close	STM32_USART1_RX to PC_UART0_TxD
JP73	Open	No signal connected
	Close	STM32_USART1_CTS to APC_UART0_RTS
JP74	Open	No signal connected
	Close	STM32_USART1_RTS to APC_UART0_CTS

1. The default JPxx state is shown in bold. Close means that a solder joint has been put on JPxx in order to close the bridge.

7 Sensors

The on-board MEMS sensors provide inertial and environmental sensing capabilities, which are used by the STM32 or the APC main processor. The STM32F446 Mezzanine board includes a 3D accelerometer/3D gyroscope (LSM6DS3H), a 3-axis magnetometer (LIS3MDL), a pressure sensor (LPS22HB) and a microphone (MP34DT01-M). The sensors interface by default with the STM32 via the I²C and SPI buses.

Figure 11. Motion MEMS block diagram



7.1 Sensors bus selection

Table 3. DIP switches configuration for STM32 or APC using SPI bus

Bridge	State(1)	Description
SW3A	**Open**	No signal connected
	Close (ON)	STM_SPI2_NSS1 to LMS6DS3H
SW3B	**Open**	No signal connected
	Close (ON)	STM_SPI2_SCK to LMS6DS3H
SW3C	**Open**	No signal connected
	Close (ON)	STM_SPI2_MOSI to LMS6DS3H
SW3D	**Open**	No signal connected
	Close (ON)	STM_SPI2_MISO to LMS6DS3H

Table 3. DIP switches configuration for STM32 or APC using SPI bus (continued)

Bridge	State(1)	Description
SW4A	Open	No signal connected
	Close (ON)	APC_SPI0_CS0 to LMS6DS3H
SW4B	Open	No signal connected
	Close (ON)	APC_SPI0_SCLK to LMS6DS3H
SW4C	Open	No signal connected
	Close (ON)	APC_SPI0_DOUT to LMS6DS3H
SW4D	Open	No signal connected
	Close (ON)	APC_SPI0_DIN to LMS6DS3H

1. The default SWxx state is shown in bold. Close means that a solder joint has been put on SWxx in order to close the bridge.

Table 4. DIP switches configuration for STM32 or APC using I^2C bus

Bridge	State(1)	Description
SW5A	Open	No signal connected
	Close (ON)	SCL connected to APC I2C.
SW5B	Open	No signal connected
	Close (ON)	SDA connected to APC I2C.
SW5C	**Open**	No signal connected
	Close (ON)	SCL connected to STM32 I2C.
SW5D	**Open**	No signal connected
	Close (ON)	SDA connected to STM32 I2C.

1. The default SWxx state is shown in bold. Close means that a solder joint has been put on SWxx in order to close the bridge.

7.2 MEMS bus configuration

Table 5. Solder bridge configuration for STM32 or APC using MEMS Interruption

Bridge	State(1)	Description
JP2	Open	No signal connected
	Close	INT1 of LSM6DS3H connected to STM32
JP3	Open	No signal connected
	Close	INT1 of LSM6DS3H connected with DRDY of LIS3MDL to STM32 or APC
JP18	Open	No signal connected
	Close	INT1 of LSM6DS3H connected to STM32

Table 5. Solder bridge configuration for STM32 or APC using MEMS Interruption

Bridge	State[1]	Description
JP20	Open	No signal connected
	Close	INT1 of LSM6DS3H connected to APC
JP32	Open	No signal connected
	Close	INT of LIS3MDL connected to STM32
JP36	**Open**	No signal connected
	Close	DRDY of LIS3MDL connected to STM32
JP37	Open	No signal connected
	Close	DRDY of LIS3MDL connected to APC
JP46	Open	No signal connected
	Close	INT1 of LPS22HB connected to STM32
JP47	Open	No signal connected
	Close	INT1 of LPS22HB connected to APC

1. The default JPxx state is shown in bold. Close means that a solder joint has been put on JPxx in order to close the bridge.

Table 6. Solder bridge configuration for LIS3MDL I2C bus

Bridge	State[1]	Description
JP26	Open	No signal connected
	Close	SCL of LIS3MDL connected to LSM3DSH Master I2C.
JP27	Open	No signal connected
	Close	SDA of LIS3MDL connected to LSM3DSH Master I2C.
JP39	**Open**	No signal connected
	Close	SCL of LIS3MDL connected to STM32 or APC I2C.
JP40	**Open**	No signal connected
	Close	SDA of LIS3MDL connected to STM32 or APC I2C.

1. The default JPxx state is shown in bold. Close means that a solder joint has been put on JPxx in order to close the bridge.

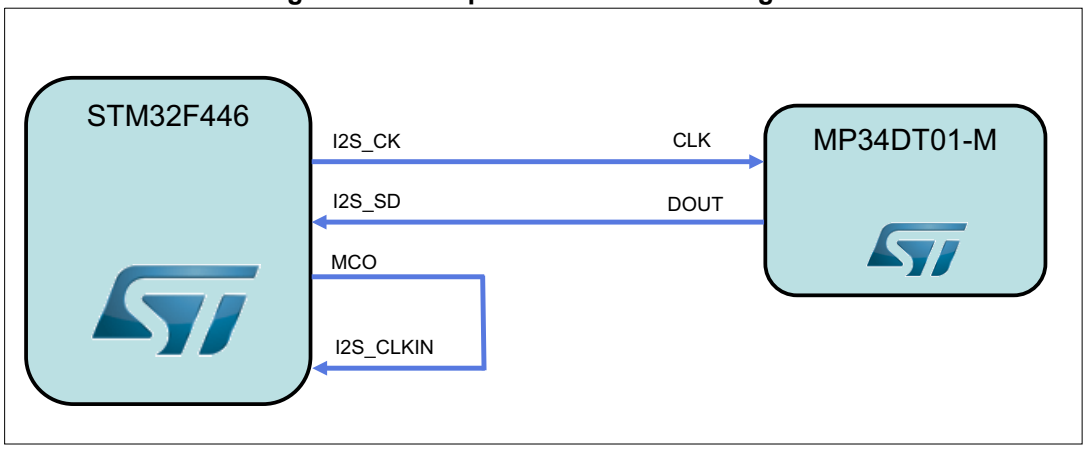
7.3 Microphone

Table 7. Solder bridge configuration

Bridge	State [1]	Description
JP69	Open	No signal connected
	Close	STM32_I2S2_CKIN

1. The default JPxx state is shown in bold. Close means that a solder joint has been put on JPxx in order to close the bridge.

Figure 12. Microphone MEMS block diagram



8 High-speed extension connector

The STM32F446 Mezzanine board is connected to the 96Boards with two connectors. The first is the high-speed extension (HSE) connector, grouping all the fast signals.

Table 8. P1 60-pin female header(1)

Pin No	Signal	Pin No	Signal
1	nc (default), SPI1_DOUT	2	CSI0_C+
3	-	4	CSI0_C-
5	-	6	GND
7	nc (default), SPI1_CS	8	CSI0_D0+
9	nc (default), SPI1_SCLK	10	CSI0_D0-
11	nc (default), SPI1_DIN	12	GND
13	GND	14	CSI0_D1+
15	CSI0_MCLK	16	CSI0_D1-
17	CSI1_MCLK	18	GND
19	GND	20	CSI0_D2+
21	-	22	CSI0_D2-
23	-	24	GND
25	GND	26	CSI0_D3+
27	-	28	CSI0_D3-
29	-	30	GND
31	GND	32	I2C2_SCL
33	-	34	I2C2_SDA
35	-	36	-
37	GND	38	-
39	-	40	GND
41	-	42	CSI1_D0+
43	GND	44	CSI1_D0-
45	-	46	GND
47	-	48	CSI1_D1+
49	GND	50	CSI1_D1-
51	USB_D+	52	GND
53	USB_D-	54	CSI1_C+
55	GND	56	CSI1_C-
57	-	58	GND
59	-	60	-

1. nc means: not connected

Table 9. Solder bridge configuration for high-speed extension connector

Bridge	State (1)	Description
JP52	**Open**	No signal connected
	Close	APC_SPI1_DOUT data out signal is connected
JP53	**Open**	No signal connected
	Close	APC_SPI1_CS chip select signal is connected
JP54	**Open**	No signal connected
	Close	APC_SPI1_SCLK serial clock chip select signal is connected
JP55	**Open**	No signal connected
	Close	APC_SPI1_DIN data in signal is connected

1. The default JPxx state is shown in bold. Close means that a solder joint has been put on JPxx in order to close the bridge.

Details on the second connector are given in *Section 10*.

9 Camera connectors

Two MIPI CSI ports are available with different interface capability: the CSI0 port (1-4 lanes camera) and the CSI1 port (1-2 lanes camera).

Table 10. CSI flex cable connector pins

CSI0 30 pins flex cable connector		CSI130 pins flex cable connector	
Pin No	**Signal**	**Pin No**	**Signal**
1	GND	1	GND
2	CSI0_C-	2	CSI1_C-
3	CSI0_C+	3	CSI1_C+
4	GND	4	GND
5	CSI0_D1-	5	CSI1_D1-
6	CSI0_D1+	6	CSI1_D1+
7	GND	7	GND
8	CSI0_D0-	8	CSI1_D0-
9	CSI0_D0+	9	CSI1_D0+
10	GND	10	GND
11	CSI0_MCLK	11	CSI1_MCLK
12	VCSI0(+3V3)	12	VCSI1(+3V3)
13	I2C2_SCL	13	I2C2_SCL
14	I2C2_SDA	14	I2C2_SDA
15	GPIO_J	15	GPIO_L
16	GND	16	GND
17	+5V	17	+5V
18	GND	18	GND
19	nc (default), GPIO_A	19	nc (default), GPIO_A
20	GPIO_I(default), nc	20	GPIO_K (default), nc
21	+1V8	21	+1V8
22	SYSDCIN	22	SYSDCIN
23	GND	23	GND
24	GND	24	GND
25	CSI0_D2+	25	-
26	CSI0_D2-	26	-
27	GND	27	GND
28	CSI0_D3+	28	-

Table 10. CSI flex cable connector pins (continued)

CSI0 30 pins flex cable connector		CSI130 pins flex cable connector	
Pin No	**Signal**	**Pin No**	**Signal**
29	CSI0_D3+	29	-
30	GND	30	GND

Table 11. Solder bridge configuration for CSI0

Bridge	State(1)	Description
JP59	**Open**	No signal connected
	Close	GPIO_A
JP60	Open	No signal connected
	Close	GPIO_I

1. The default JPxx state is shown in bold. Close means that a solder joint has been put on JPxx in order to close the bridge.

Table 12. Solder bridge configuration for CSI1

Bridge	State(1)	Description
JP66	**Open**	No signal connected
	Close	GPIO_A
JP67	Open	No signal connected
	Close	GPIO_K

1. The default JPxx state is shown in bold. Close means that a solder joint has been put on JPxx in order to close the bridge.

10 Low-speed extension connector

The second connector used with the 96Boards CE card is the low-speed extension (LSE) connector. It groups all the power supplies, low-speed interfaces, GPIOs and the auxiliary signals.

Table 13. J4 40 pins 2x20 male header description

Pin No	Signal	Pin No	Signal
1	GND	2	GND
3	APC_UART0_CTS	4	-
5	APC_UART0_TxD	6	PE1 (RST_BTN_N)
7	APC_UART0_RxD	8	SPI0_SCLK
9	APC_UART0_RTS	10	SPI0_DIN
11	APC_UART1_TxD	12	SPI0_CS0
13	APC_UART1_RxD_1V8b (default)	14	SPI0_DOUT
15	APC_I2C0_SCL	16	-
17	APC_I2C0_SDA	18	-
19	APC_I2C1_SCL	20	-
21	APC_I2C1_SDA	22	-
23	GPIO-A	24	GPIO-B
25	GPIO-C	26	STM_RST
27	APC_SPI0_CS1	28	GPIO-F
29	GPIO-G	30	GPIO-H
31	GPIO-I	32	GPIO-J
33	GPIO-K	34	GPIO-L
35	+1V8	36	SYS_DCIN
37	+5V	38	SYS_DCIN
39	GND	40	GND

Table 14. Solder bridge configuration for low-speed extension connector

Bridge	State (1)	Description
JP61	**Open**	No signal connected
	Close	APC_UART1_RxD_1V8a
JP62	Open	No signal connected
	Close	APC_UART1_RxD_1V8b

1. The default JPxx state is shown in bold. Close means that a solder joint has been put on JPxx, to close the bridge.

11 Arduino connectors

The CN5, CN6, CN8 and CN9 female connectors support Arduino Uno revision 3 connectivity. Most shields designed for Arduino Uno revision 3 fit to the STM32F446 Mezzanine board.

Table 15. J4 Power pins description

Pin	Arduino Uno revision 3 pin name	STM32 signal	Description
1	nc	-	Not connected
2	IOREF	VDD	+3.3 V reference
3	Reset	NRST	STM32 reset
4	+3V3	VDD	+3.3 V input/output
5	+5V	-	+5 V output
6	GND	GND	Ground
7	GND	GND	Ground
8	VIN	-	Not connected

Table 16. J8 AIN pin description

Pin	Arduino Uno revision 3 pin name	STM32 signal	Description
1	A0	PA1	STM32 ADC123_IN1
2	A1	PA2	STM32 ADC123_IN2
3	A2	PC3	STM32 ADC123_IN13
4	A3	PC2	STM32 ADC123_IN12
5	A4	PB1	STM32 ADC12_IN9
6	A5	PC0	STM32 ADC123_IN10

Table 17. J2 pin description

Pin	Arduino Uno revision 3 pin name	STM32 signal	Description
1	D8	PE3	-
2	D9	PB4	
3	D10	PE4	
4	D11	PE6	
5	D12	PE5	
6	D13	PE2	
7	GND	GND	Ground

Table 17. J2 pin description (continued)

Pin	Arduino Uno revision 3 pin name	STM32 signal	Description
8	AREF	VDDA	AVDD
9	D14	PC12	STM32_I2C2_SDA
10	D15	PB10	STM32_I2C2_SC

Table 18. J6 pin description

Pin	Arduino Uno revision 3 pin name	STM32 signal	Description
1	D0	PD6	STM32_USART2_RX
2	D1	PD5	STM32_USART2_TX
3	D2	PD4	-
4	D3	PC8	
5	D4	PD2	
6	D5	PD15	
7	D6	PD14	
8	D7	PE15	

12 Grove connectors

The STM32F446 Mezzanine board includes eight Grove connectors, which carry a +5 V power supply (to the exception of connector J5). Several different interfaces are supported by GPIO lines such as I^2C, SPI, UART and CAN buses, which provide plenty of possibilities to control external extension boards.

Warning: **On the revision A of the STM32F446 Mezzanine board, the silkscreen of the pinout is not correct on the Grove connectors (error on pin number allocation). Nevertheless, the allocation of the electric signals is correct. So, it is possible to connect Grove modules on these connectors without any risk or problem. The Grove connectors are fully operational.**

Table 19. J3 STM32 GPIO pin description

Pin	Signal	Type	Description
1	GND	Power	Ground
2	+5V	Power	+5 V power supply
3	PA3	I/O	A00 [STM32_ADC123_IN3]
4	PB0	I/O	A01 [STM32_ADC12_IN8)

Table 20. J5 STM32 SPI4 pin description

Pin	Signal	Type	Description
1	PE11	O	STM32_SPI4_NSS
2	PE14	O	STM32_SPI4_MOSI
3	PE13	I	STM32_SPI4_MISO
4	PE2	O	STM32_SPI4_SCK

Table 21. J7 STM32 I2C2 pin description

Pin	Signal	Type	Description
1	GND	Power	Ground
2	+5V	Power	+5 V power supply
3	PC12	I/O	STM32 I2C2_SDA
4	PB10	O	STM32 I2C2_SCL

Table 22. J9 STM32 CAN1 pin description

Pin	Signal	Type	Description
1	GND	Power	Ground
2	+5V	Power	+5 V power supply
3	PD1	O	STM32_CAN1_TX
4	PD0	I	STM32_CAN1_RX

Table 23. J10 STM32 UART3 pin description

Pin	Signal	Type	Description
1	GND	Power	Ground
2	+5V	Power	+5 V power supply
3	PD8	O	STM32_USART3_TX
4	PD9	I	STM32_USART3_RX

Table 24. J11 STM32 I2C2 UART5 pin description

Pin	Signal	Type	Description
1	GND	Power	Ground
2	+5V	Power	+5 V power supply
3	PC12	I/O	STM32_I2C2_SDA
4	PB10	O	STM32_I2C2_SCL

Table 25. J12 APC I^2C pin description

Pin	Signal	Type	Description
1	GND	Power	Ground
2	+5V	Power	+5 V power supply
3	SDA	I/O	APC_I2C1_SDA
4	SCL	I/O	APC_I2C1_SCL

Table 26. J13 APC UART pin description

Pin	Signal	Type	Description
1	GND	Power	Ground
2	+5V	Power	+5 V power supply
3	TxD	I/O	APC_I2C1_TxD
4	RxD	I/O	APC_I2C1_RxD

13 References

[1] 96Boards Consumer Edition, Version 1.0, January 2015, Linaro Ltd

[2] Sensors: the following datasheets are available from the *www.st.com* website:

- LSM6DS3H: *iNEMO inertial module: always-on 3D accelerometer and 3D gyroscope* (DS11273)
- LIS3MDL: *Digital output magnetic sensor: ultra-low-power, high-performance 3-axis magnetometer* (DS9463)
- LPS22HB: *MEMS nano pressure sensor: 260-1260 hPa absolute digital output barometer* (DS10677)
- MP34DT01-M: *MEMS audio sensor omnidirectional digital microphone* (DS10384)

14 Revision history

Table 27. Document revision history

Date	Revision	Changes
07-Jan-2016	1	Initial version.
2-Feb-2017	2	Updated: – *Figure 1: STM32F446 Mezzanine board* – *Section 1: Features*: MEMS sensors list – *Figure 3: Top layout*, *Figure 4: Bottom layout*, *Figure 5: Top default settings*, *Figure 6: Bottom default settings* – *Table 1: Solder bridge on ST-LINK/V2-1*, *Figure 9: ST-LINK USB connection* – *Figure 10: LEDs* – *Section 7: Sensors* – *Figure 11: Motion MEMS block diagram* – *Table 24: J11 STM32 I2C2 UART5 pin description* – *Section 13: References*. Added: *Section 9: Camera connectors*. Removed: – *Section 5.1*: table *Push button solder bridge configuration* – *Section 5.2*: table *LEDs solder bridge configuration*