



life.augmented

# UM2435

## User manual

### Bluetooth Low-Energy and 802.15.4 Nucleo pack based on STM32WB Series microcontrollers

## Introduction

The Nucleo pack (P-NUCLEO-WB55) with a Nucleo-68 board and a USB dongle provides an affordable and flexible way for users to try out new concepts and build prototypes using STM32WB microcontrollers with a 2.4 GHz radio interface.

This circuit block provides various combinations of performance, power consumption and features. A 2.4 GHz RF transceiver supporting Bluetooth® specification v5.0 and IEEE 802.15.4-2011 PHY and MAC is supported.

Arduino™ Uno V3 connectivity and ST morpho headers allow the user to easily expand the functionality of the Nucleo open development platform with a wide choice of specialized shields.

The boards are based on a multiprotocol wireless 32-bit microcontroller, based on an Arm® Cortex®-M4 with FPU, featuring Bluetooth® Low Energy and 802.15.4 radio solution.

The STM32 Nucleo-68 board does not require any separate probe, as it integrates the ST-LINK/V2-1 debugger/programmer. The board comes with the comprehensive free STM32 software libraries and examples available with the STM32Cube package.

The USB dongle can be programmed through USB BootLoad or USB DFU. It is also possible to debug/program it with an external STLink V2 (not delivered), using the SWD interface.

## Contents

<b>1</b>	<b>Features</b>	<b>6</b>
<b>2</b>	<b>Product marking</b>	<b>8</b>
<b>3</b>	<b>System requirements</b>	<b>8</b>
<b>4</b>	<b>Development toolchains</b>	<b>8</b>
<b>5</b>	<b>Demonstration software</b>	<b>8</b>
<b>6</b>	<b>Ordering information</b>	<b>9</b>
<b>7</b>	<b>Hardware layout and configuration</b>	<b>10</b>
7.1	Nucleo-68 board	10
7.2	USB dongle	19
7.3	Getting started	23
7.3.1	Conventions	23
7.3.2	Quick start	23
7.3.3	Default boards configuration	23
7.4	Embedded ST-LINK/V2-1	25
7.4.1	Drivers	25
7.4.2	ST-LINK/V2-1 firmware upgrade	26
7.5	Power supply and selection	27
7.5.1	External power supply input	27
7.5.2	External power supply output	31
7.5.3	Internal power supply	31
7.6	Programing/debugging when the power supply is not from USB ST-LINK (5V_ST_link)	31
7.7	OSC clock sources	32
7.7.1	LSE: OSC 32 kHz clock supply	32
7.7.2	OSC clock supply	32
7.8	Reset sources	33
7.9	Virtual COM port: LPUART/USART	33
7.10	LEDs	34

7.11	Push buttons .....	34
7.12	Current measurement .....	34
7.13	Jumper configuration .....	35
<b>8</b>	<b>Connectors .....</b>	<b>36</b>
8.1	USB ST-LINK micro-B connector CN15 .....	36
8.2	Arduino™ Uno revision 3 connectors .....	37
8.3	ST Morpho connectors CN7 and CN10 .....	40
8.4	Extension connectors CN1 and CN2 on USB dongle .....	41
<b>Appendix A</b>	<b>Nucleo-68 and USB dongle MCU IO assignment .....</b>	<b>42</b>
<b>9</b>	<b>Federal Communications Commission (FCC) and Industry Canada (IC) compliance statements .....</b>	<b>45</b>
9.1	FCC compliance statement .....	45
9.2	IC compliance statement .....	45
<b>10</b>	<b>Revision history .....</b>	<b>47</b>

## List of tables

Table 1.	Ordering information . . . . .	9
Table 2.	Example of codification . . . . .	9
Table 3.	Jumper and SB ON/OFF conventions . . . . .	23
Table 4.	Default jumper configuration . . . . .	24
Table 5.	Power sources . . . . .	27
Table 6.	SB25 bypass USB PWR protection . . . . .	31
Table 7.	LPUART1 and USART1 connections . . . . .	33
Table 8.	Configuration of jumpers and solder bridges . . . . .	35
Table 9.	USB STLINK micro-B pinout (connector CN15) . . . . .	36
Table 10.	Arduino™ connectors pinout . . . . .	38
Table 11.	IO assignment . . . . .	42
Table 12.	Document revision history . . . . .	47

## List of figures

Figure 1.	Nucleo-68 and USB dongle boards (top view on the left, bottom view on the right) . . . . .	7
Figure 2.	Nucleo-68 hardware block diagram . . . . .	10
Figure 3.	Nucleo-68 board (top view) . . . . .	11
Figure 4.	Nucleo-68 board (bottom view) . . . . .	12
Figure 5.	Nucleo-68 board mechanical drawing . . . . .	13
Figure 6.	Nucleo-68 board schematics . . . . .	14
Figure 7.	Nucleo-68 board schematics - RF part . . . . .	15
Figure 8.	Nucleo-68 board schematics - Connectors . . . . .	16
Figure 9.	Nucleo-68 board schematics - Power management . . . . .	17
Figure 10.	Nucleo-68 board schematics - ST-Link/V2-1 . . . . .	18
Figure 11.	USB dongle hardware block diagram . . . . .	19
Figure 12.	USB dongle board (top view) . . . . .	20
Figure 13.	USB dongle board (bottom view) . . . . .	20
Figure 14.	USB dongle mechanical drawing . . . . .	21
Figure 15.	USB dongle schematics . . . . .	22
Figure 16.	USB composite device . . . . .	25
Figure 17.	ST-LINK debugger: JP1 configuration for on-board MCU . . . . .	26
Figure 18.	JP1[7-8]: 5V_STL power source . . . . .	28
Figure 19.	JP1[3-4]: 5V_VIN power source . . . . .	29
Figure 20.	JP1[5-6]: 5V_USB_MCU power source . . . . .	30
Figure 21.	USB STLINK micro-B connector CN15 (front view) . . . . .	36
Figure 22.	Arduino™ connector . . . . .	37
Figure 23.	Arduino™ connector pinout . . . . .	38
Figure 24.	ST-Morpho connector pinout . . . . .	40
Figure 25.	Extension connectors pinout . . . . .	41

# 1 Features

The Nucleo-68 pack uses STM32WB 32-bit microcontrollers, based on Arm®<sup>(a)</sup> Cortex® processor(s).

## Nucleo-68

- STM32WB microcontroller in VFQFN68 package
- 2.4 GHz RF transceiver supporting Bluetooth® specification v5.0 and IEEE 802.15.4-2011 PHY and MAC
- Dedicated Arm® 32-bit Cortex® M0+ CPU for real-time Radio layer
- SMPS significantly reduces power consumption in Run mode
- Three user LEDs shared with Arduino™
- Four push-buttons
- 32.768 KHz LSE crystal oscillator
- 32 MHz crystal oscillator with integrated trimming capacitors
- Board expansion connectors:
  - Arduino™ Uno V3
  - ST Morpho
- Flexible board power supply: ST-LINK/V2-1 USB VBUS and external sources
- On-board ST-LINK/V2-1 debugger/programmer with USB re-enumeration capability: mass storage, virtual COM port and debug port
- Comprehensive free software libraries and examples available with a variety of examples, as part of the STM32Cube package
- Comprehensive free software libraries and examples available with the STM32Cube package
- Support of a wide choice of Integrated Development Environments (IDEs) including IAR™, Keil®, GCC-based IDEs, Arm® Mbed™

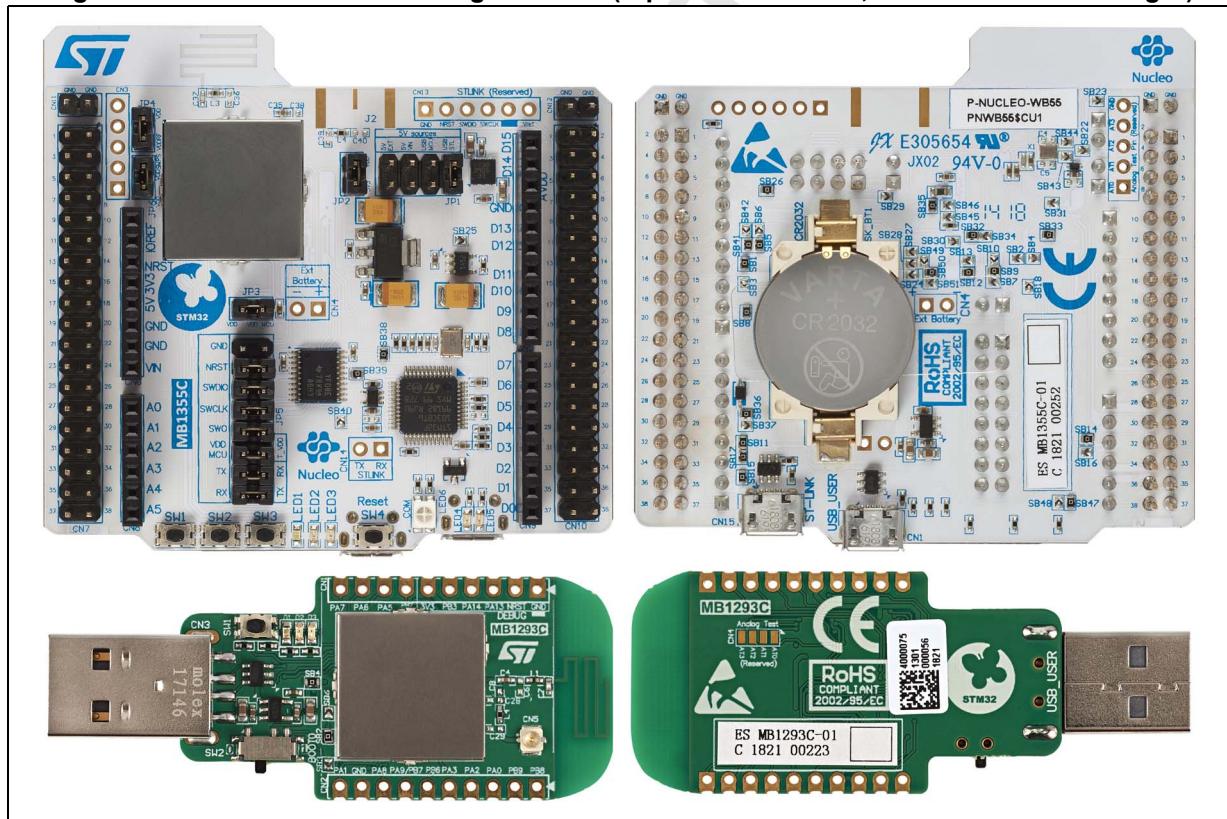


a. Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

### USB dongle

- STM32WB microcontroller in UFQFPN48 package
- 2.4 GHz RF transceiver supporting Bluetooth® specification v5.0 and IEEE 802.15.4-2011 PHY and MAC
- Dedicated Arm® 32-bit Cortex® M0+ CPU for real-time Radio layer
- SMPS significantly reduces power consumption in Run mode
- 32.768 KHz LSE crystal oscillator
- 32 MHz crystal oscillator with integrated trimming capacitors
- Full Bluetooth® solution with integrated PCB antenna for fast connection
- Switch for boot management
- User push button
- Three user LEDs

**Figure 1. Nucleo-68 and USB dongle boards (top view on the left, bottom view on the right)**



Note: Pictures are not contractual.

## 2 Product marking

Evaluation tools marked as “ES” or “E” are dedicated for evaluation purpose only, and not qualified to be used as reference design or in production. Any consequences deriving from such usage will not be at ST charge. In no event, ST will be liable for any customer usage of these engineering sample tools as reference design or in production.

“E” or “ES” marking examples of location:

- on the targeted MCU soldered on the board (for illustration of STM32WB marking, refer to the section “Package characteristics” of the datasheet)
- next to the evaluation tool ordering part number, stuck or silk-screen printed on the board.

## 3 System requirements

- Windows<sup>®</sup> OS (XP, 7, 8 or 10) or Linux 64-bit or Mac OS X
- USB Type-A to Micro-B cable

## 4 Development toolchains

- Arm<sup>®</sup> Keil<sup>®</sup>: MDK-Arm<sup>™</sup>(a)
- IAR<sup>™</sup>: EWARM<sup>(a)</sup>
- GCC-based IDEs including free SW4STM32 from AC6
- Arm<sup>®</sup> mbed<sup>™</sup> online

## 5 Demonstration software

The demonstration software is preloaded in the Flash memory of the STM32WB microcontroller for easy demonstration of the device peripherals in standalone mode.

The latest versions of the demonstration source code and associated documentation can be downloaded from the [www.st.com/stm32nucleo](http://www.st.com/stm32nucleo) webpage.

---

a. On Windows<sup>®</sup> only.

## 6 Ordering information

To order the Nucleo-68 board corresponding to the targeted STM32 MCU refer to [Table 1](#).

**Table 1. Ordering information**

Order code	Target MCU
P-NUCLEO-WB55	STM32WB55RG (Nucleo-68) STM32WB55CG (USB dongle)

The STM32WB55 codification is explained with an example in [Table 2](#).

**Table 2. Example of codification**

STM32WB55RG	Description
STM32WB	32-bit microcontroller, based on Arm® Cortex® processor(s)
WB	Wireless Bluetooth® and 802.15.4
55	Die 5, 1 Mbyte of Flash memory, 256 Kbytes of SRAM, full set of features
R	Number of pins (R = 68)
G	Memory size (G = 1 Mbyte)

## 7 Hardware layout and configuration

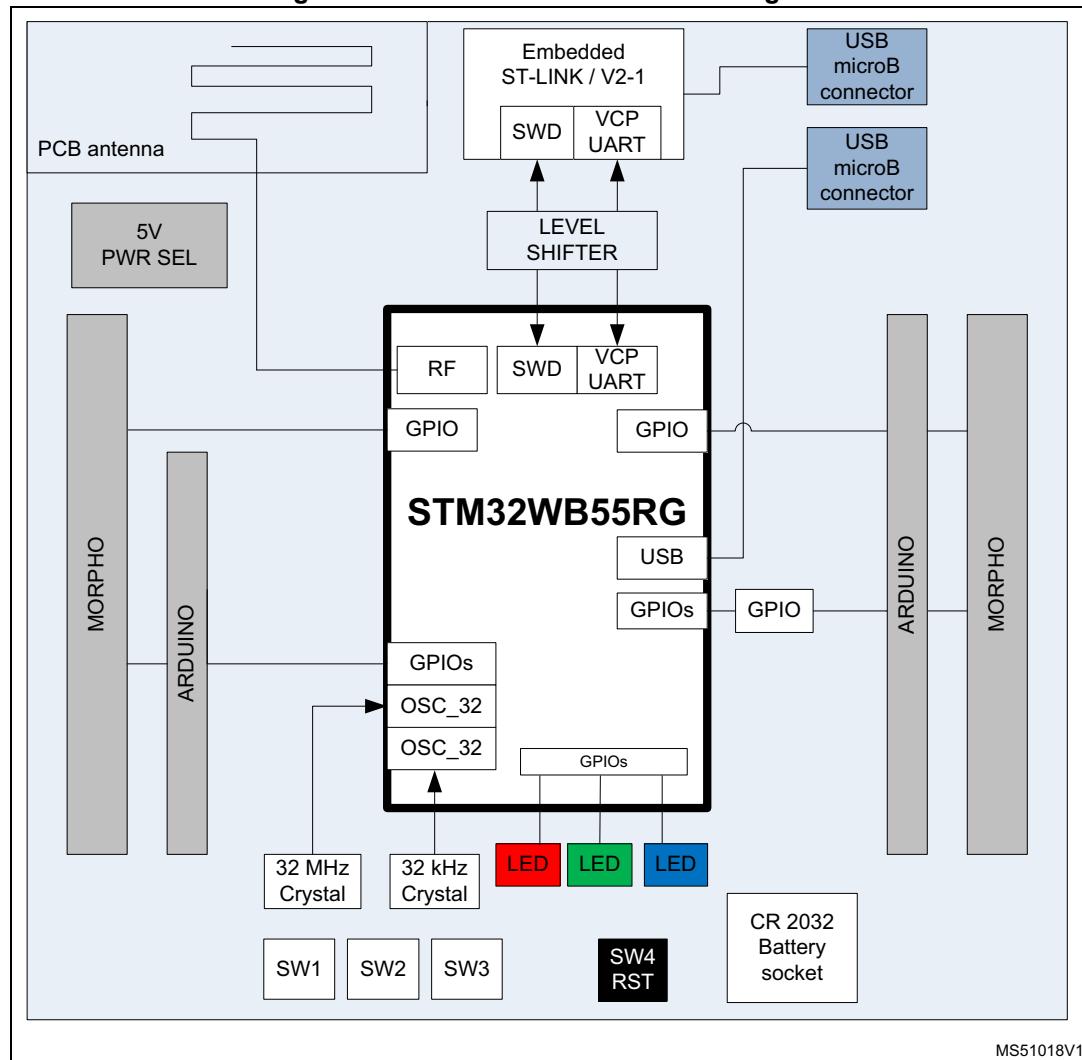
### 7.1 Nucleo-68 board

The Nucleo-68 board is designed around the STM32WB55RG microcontroller in a 68-pin VFQFPN68 package.

The hardware block diagram (see [Figure 2](#)) illustrates the connection between the MCU and peripherals (STLINK/V2-1, push buttons, LEDs, Arduino™ UNO V3 connectors and ST-Morpho connectors).

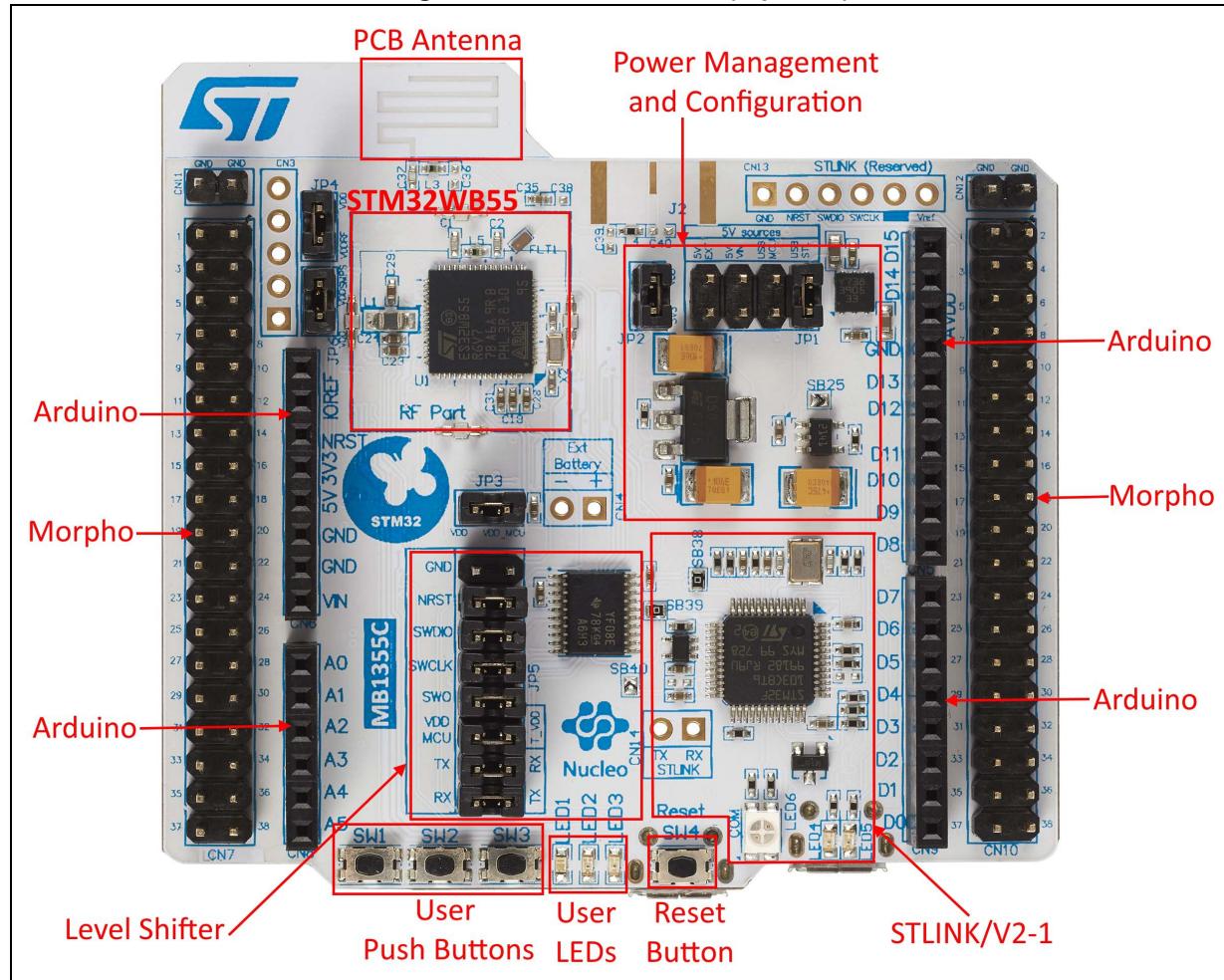
[Figure 3](#) and [Figure 4](#) help the user to locate these features on the board.

**Figure 2. Nucleo-68 hardware block diagram**

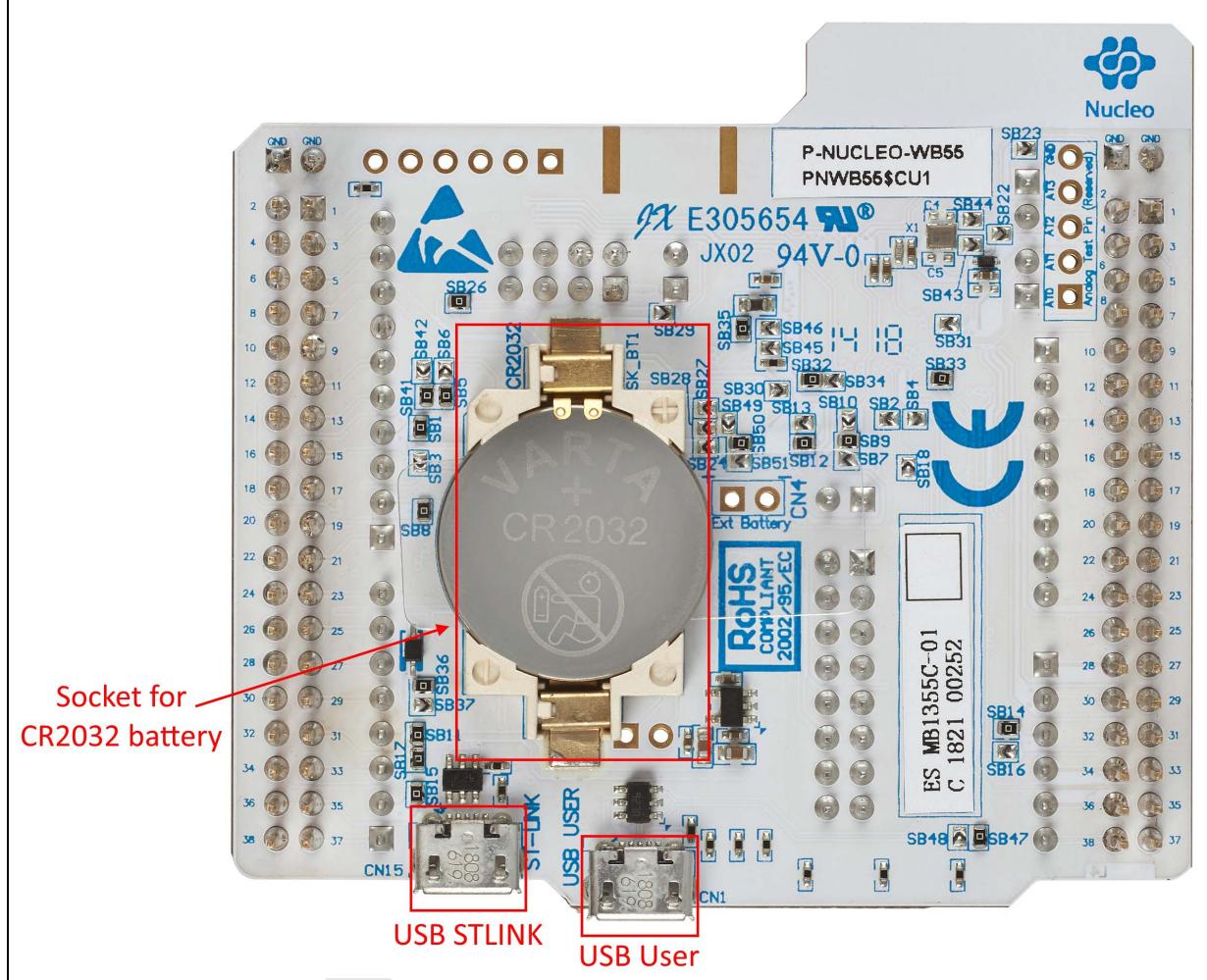


MS51018V1

Figure 3. Nucleo-68 board (top view)



**Figure 4. Nucleo-68 board (bottom view)**



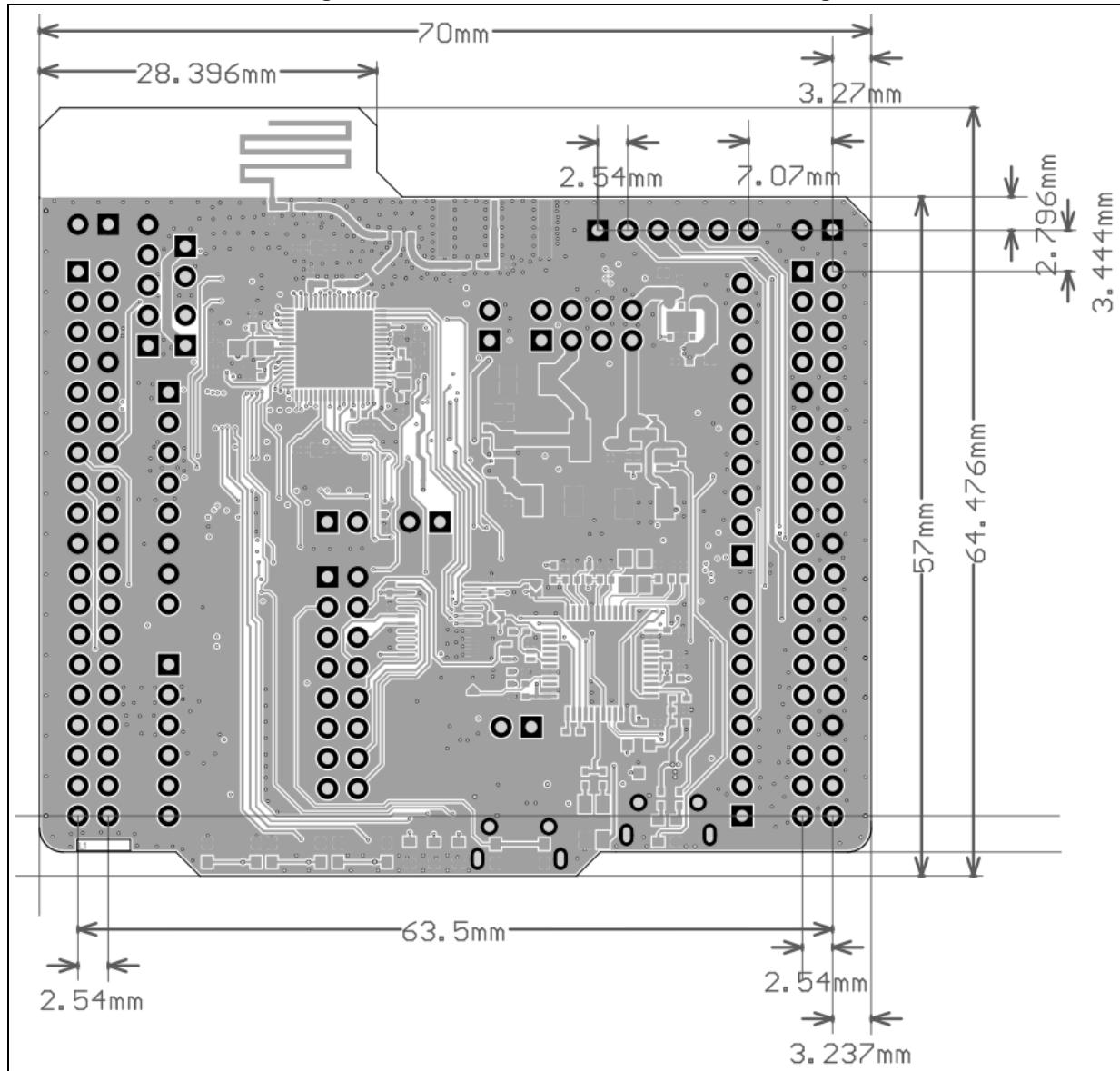
**Figure 5. Nucleo-68 board mechanical drawing**

Figure 6. Nucleo-68 board schematics

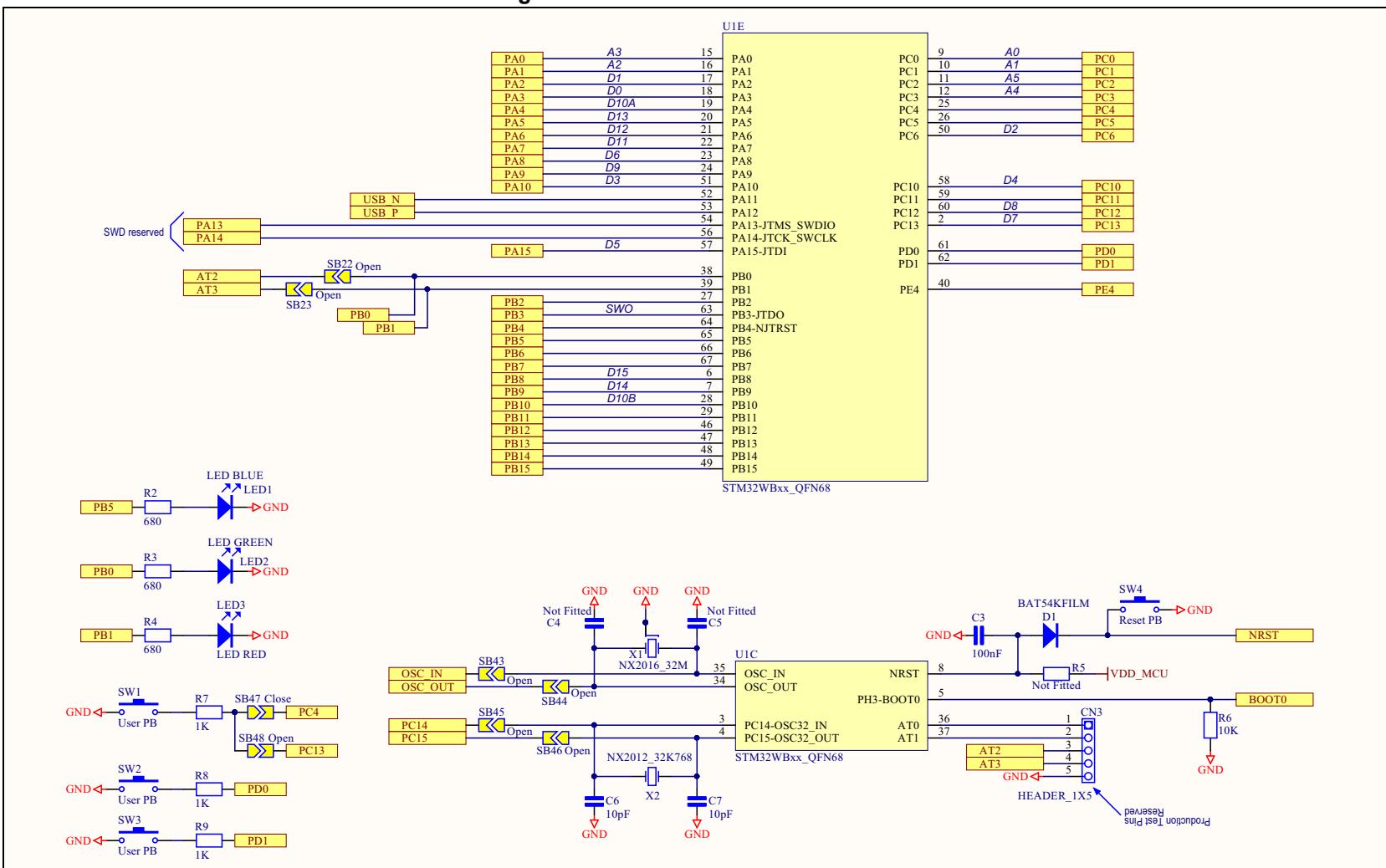


Figure 7. Nucleo-68 board schematics - RF part

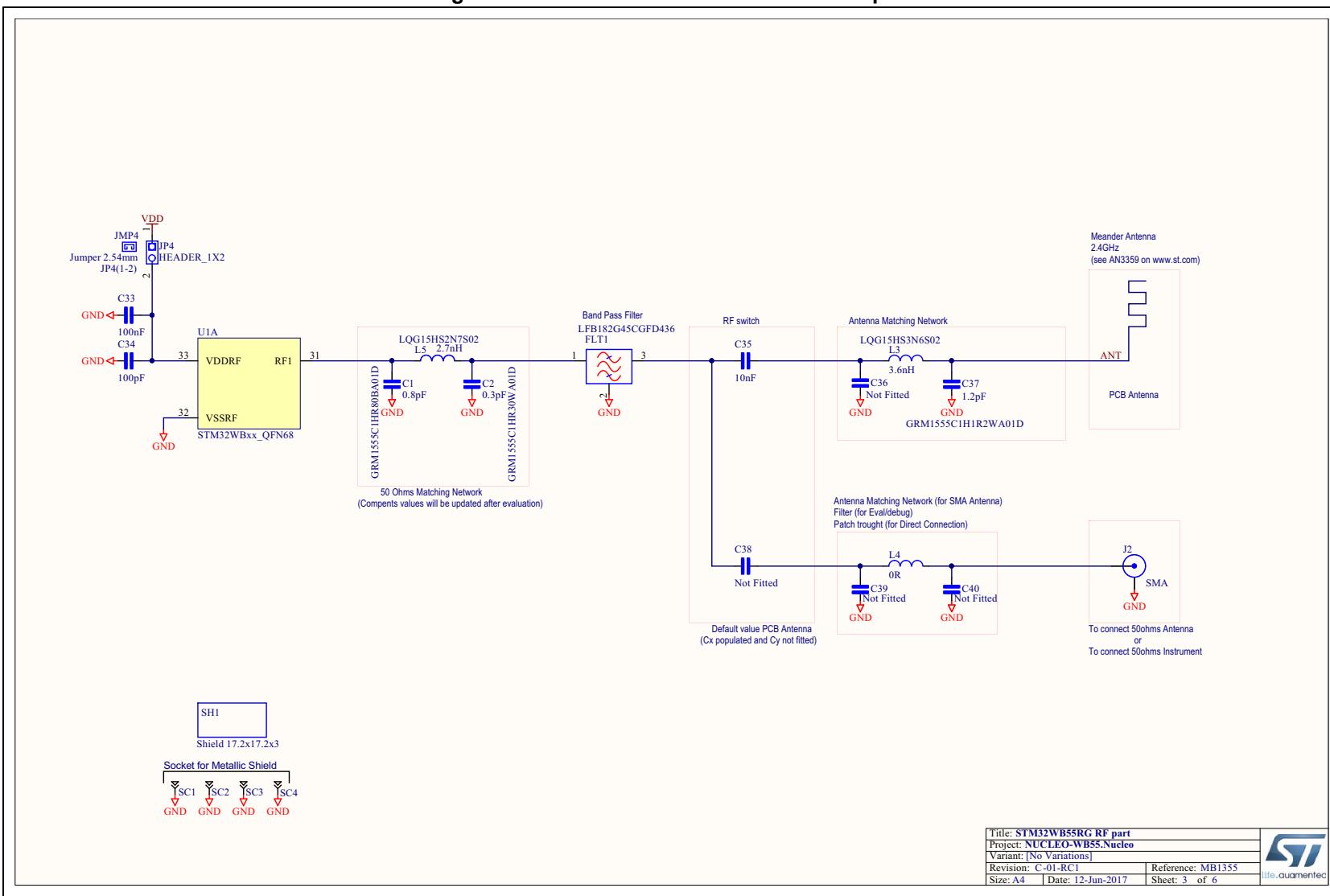


Figure 8. Nucleo-68 board schematics - Connectors

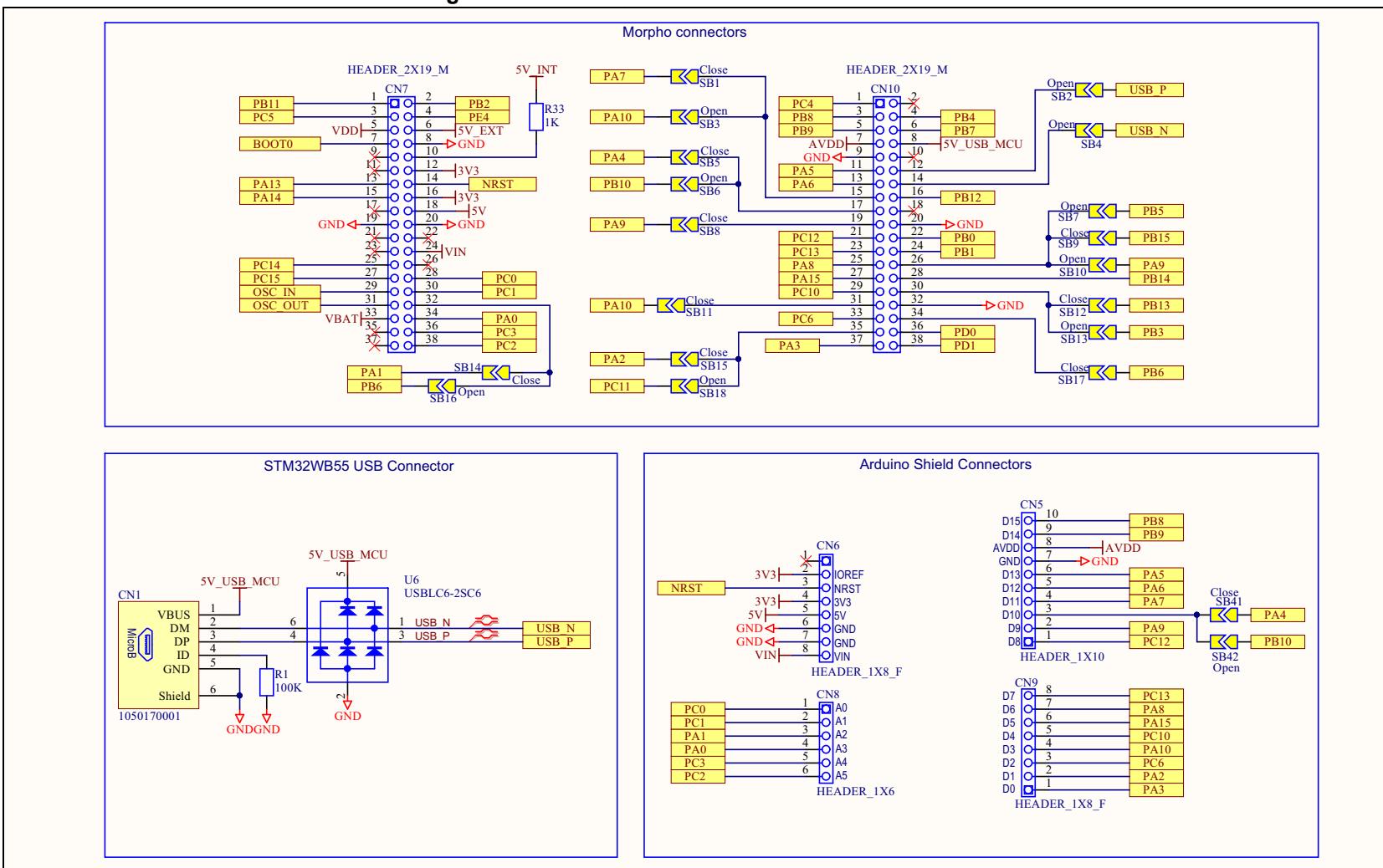
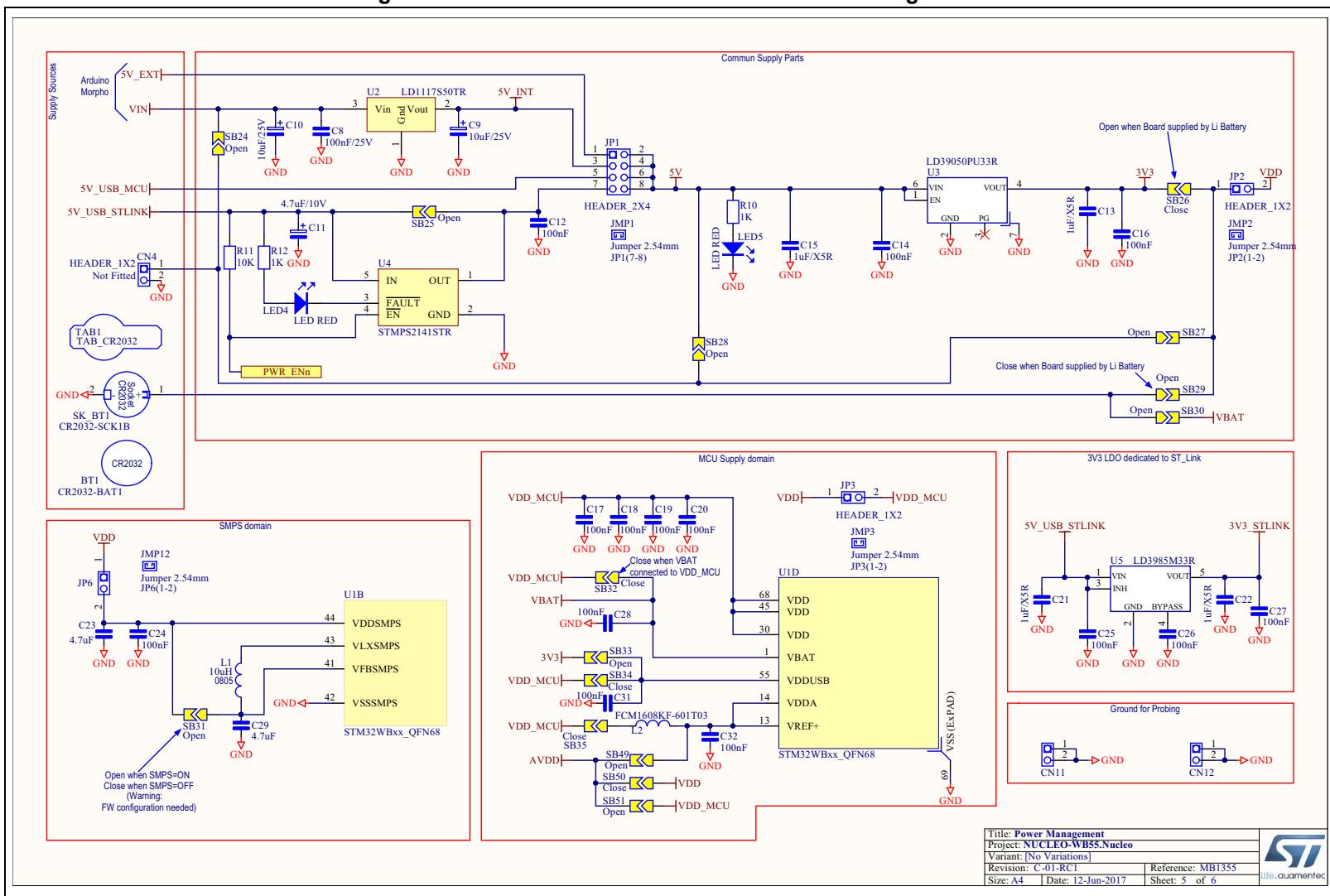
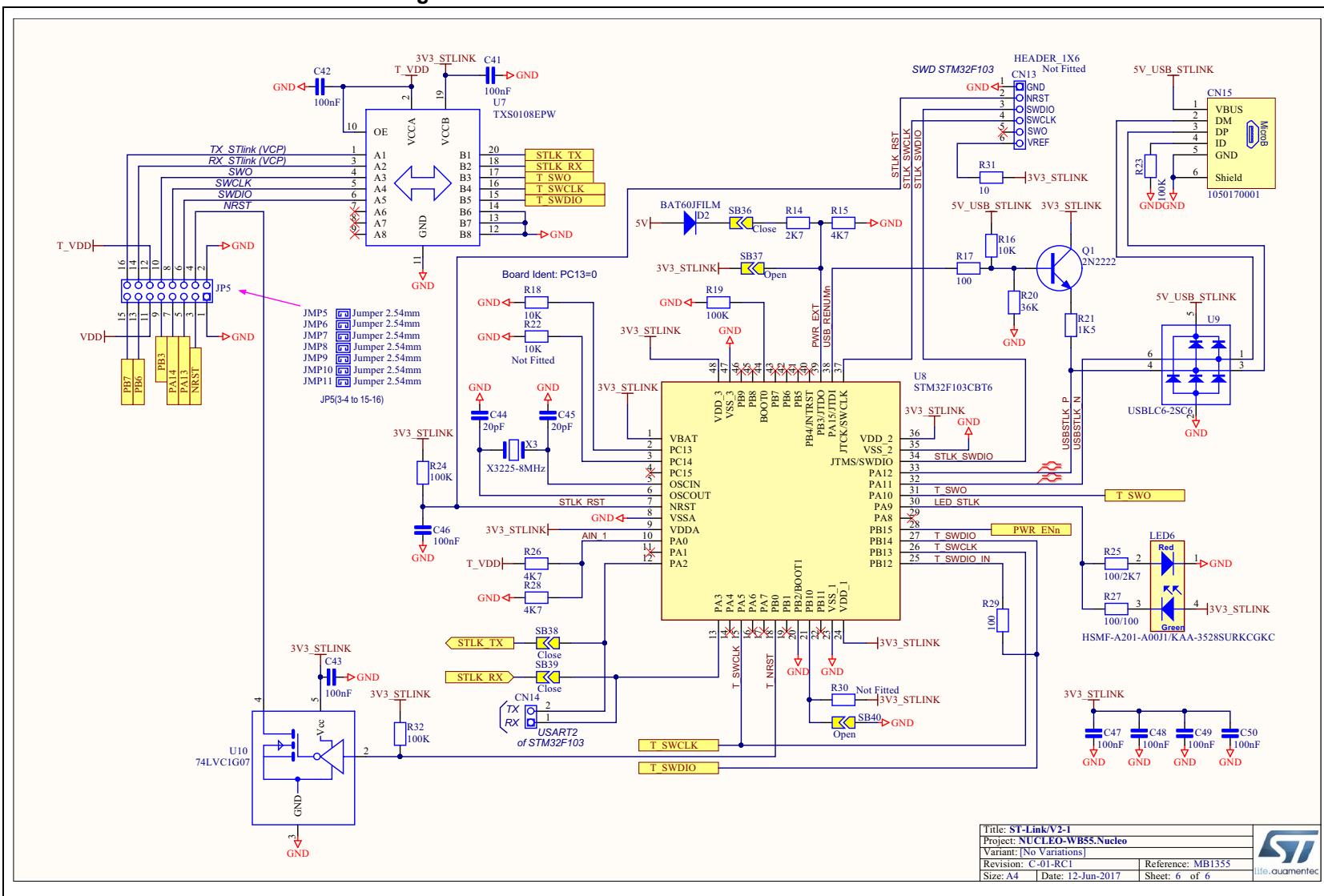


Figure 9. Nucleo-68 board schematics - Power management



Title:	ST-Link/V2-1
Project:	NUCLEO-WB55.Nucleo
Variant:	[No Variations]
Revision:	C-01-RC1
Size:	A4
Date:	12-Jun-2017
Reference:	MB1355
Sheet:	6 of 6



## 7.2 USB dongle

The USB dongle is designed around the STM32WB55CG microcontroller in a 48-pin UFQFPN48 package.

The hardware block diagram in [Figure 11](#) illustrates the connection between the MCU and the peripherals (STLINK/V2-1, push buttons, LEDs, Arduino™ UNO V3 connector and ST-Morpho connectors).

[Figure 12](#) and [Figure 13](#) help the user locate these features on the board.

**Figure 11. USB dongle hardware block diagram**

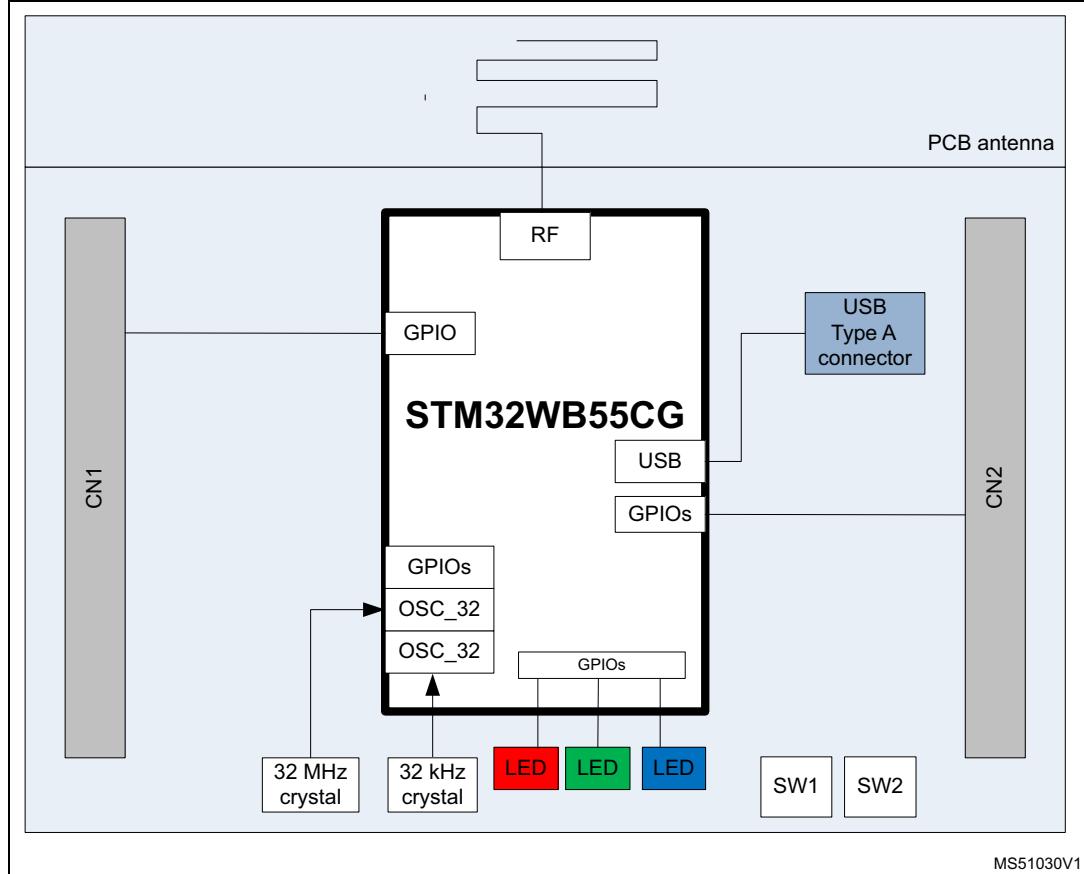


Figure 12. USB dongle board (top view)

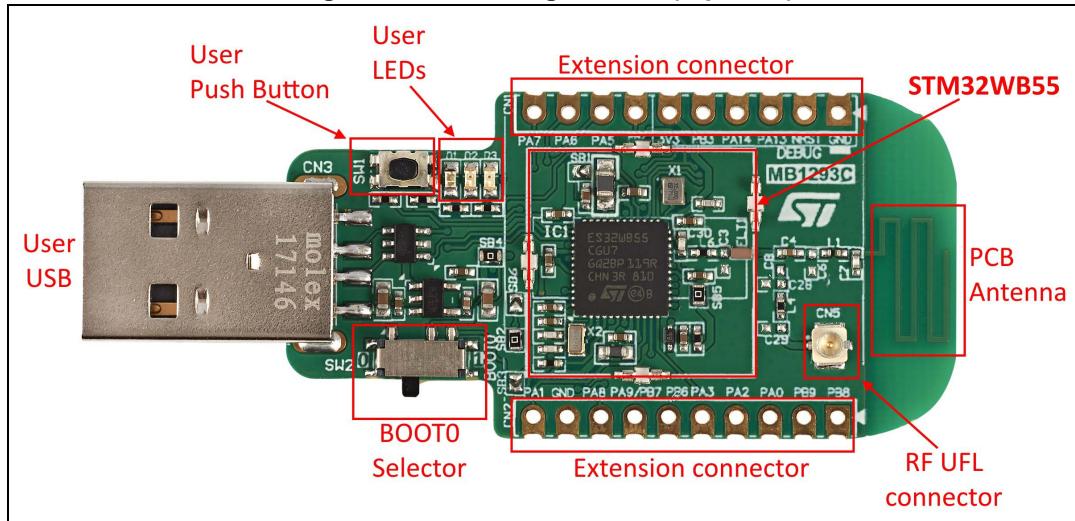
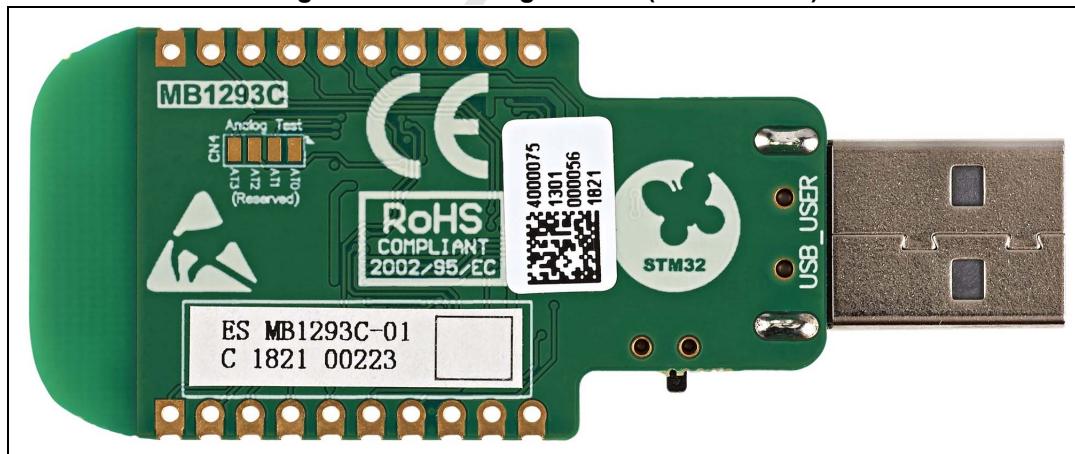
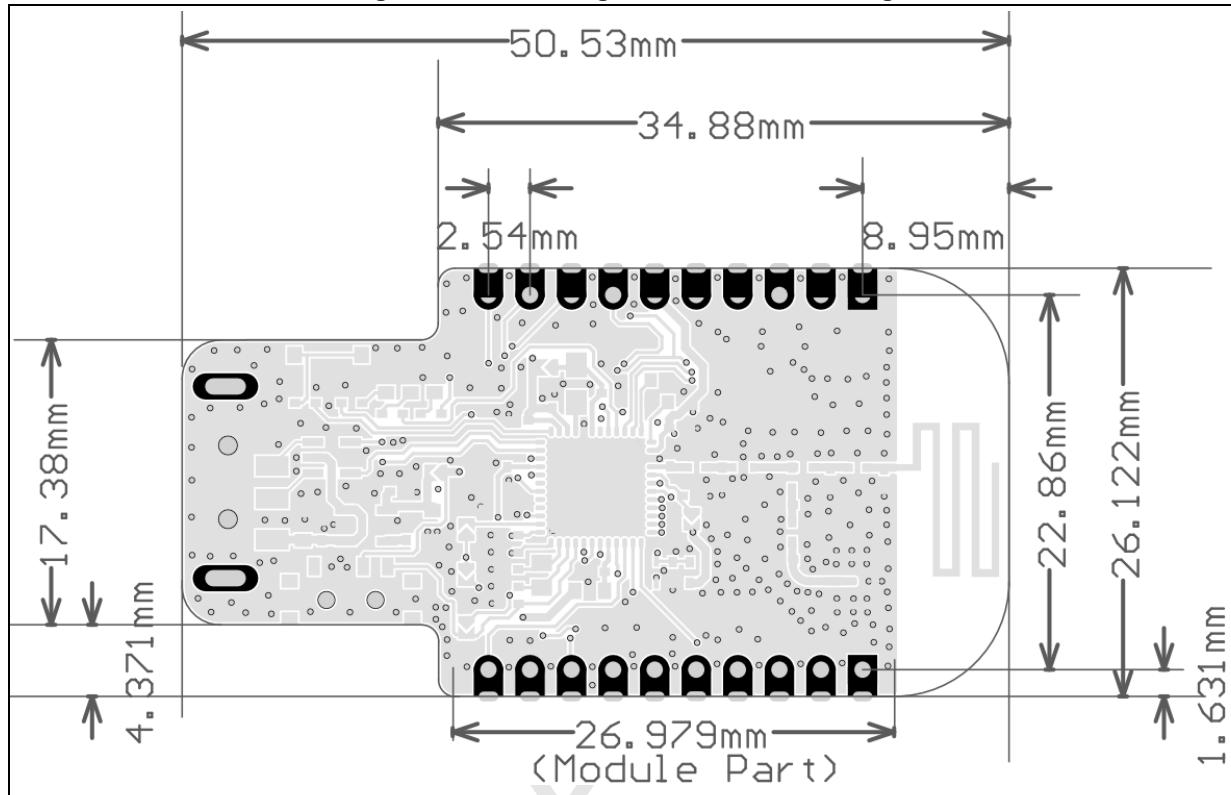
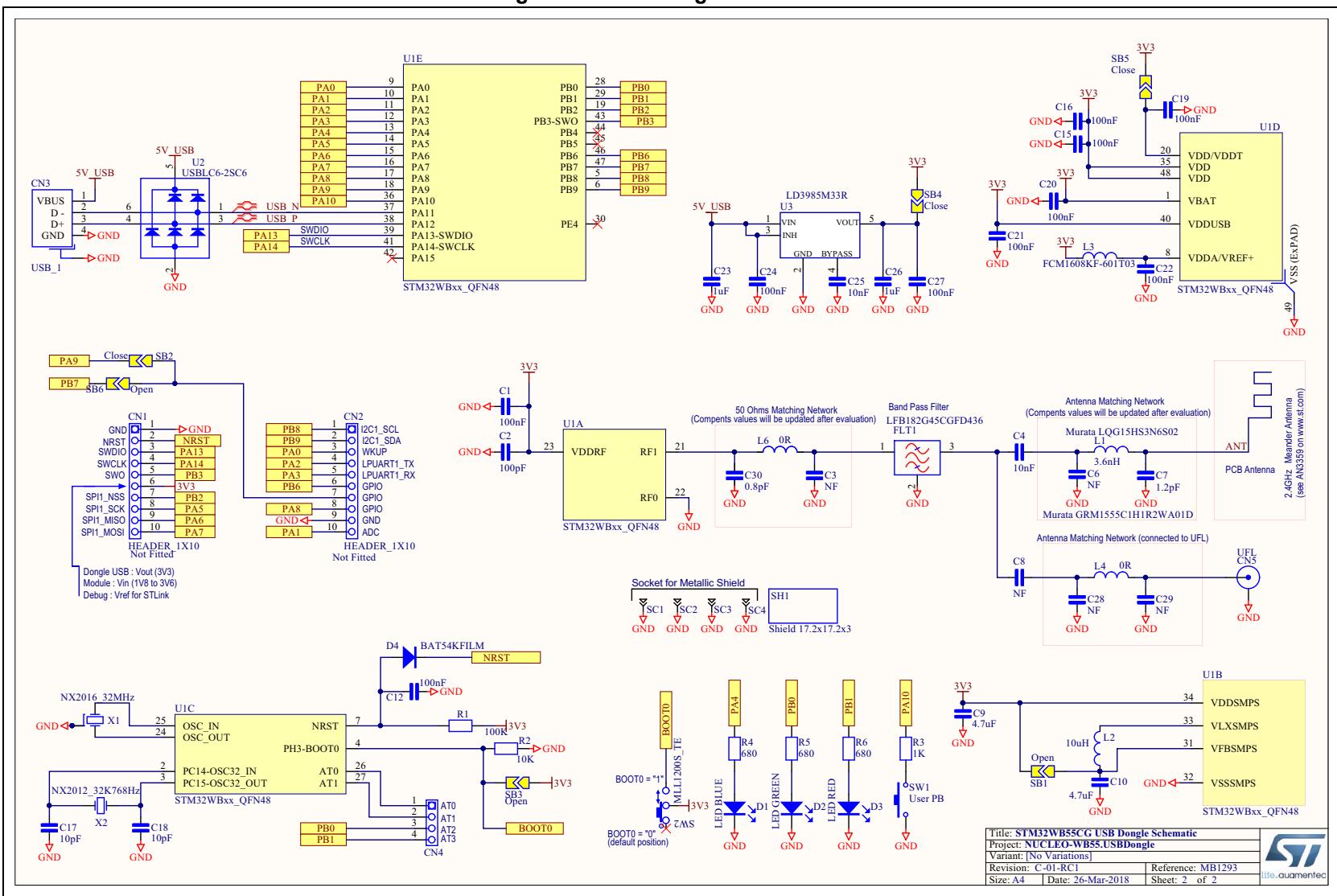


Figure 13. USB dongle board (bottom view)



**Figure 14. USB dongle mechanical drawing**



## 7.3 Getting started

### 7.3.1 Conventions

*Table 3* provides the definition of some conventions used in this document.

**Table 3. Jumper and SB ON/OFF conventions**

Convention	Definition
Jumper JPx ON	Jumper fitted
Jumper JPx OFF	Jumper not fitted
Jumper JPx [1-2]	Jumper to be fitted between Pin 1 and Pin 2
Solder bridge SBx ON	SBx connections closed by a $0\ \Omega$ resistor
Solder bridge SBx OFF	SBx connections left open

### 7.3.2 Quick start

The pack board is a low-cost and easy-to-use development kit to quickly evaluate and start a project based on an STM32WB microcontroller featuring a 2.4 GHz RF transceiver supporting Bluetooth® specification v5.0 and IEEE 802.15.4-2011 PHY and MAC in a VFQFPN68 or UFQFPN48 package.

1. Before installing and using the product, accept the Evaluation Product License Agreement from [www.st.com/stm32nucleo](http://www.st.com/stm32nucleo).
2. For correct identification of all device interfaces from the host PC, install the Nucleo USB driver available on [www.st.com/stm32nucleo](http://www.st.com/stm32nucleo), prior to connect the board.
3. Set correctly the jumper JP1 ([7-8] on USB STL).
4. Plug the Nucleo USB ST-LINK connector (P2P server) and USB dongle (P2P client) to power sources. On the P2P server, you will see a blinking LED for approximately 1 minute.
5. Once the P2P client is powered, push the SW1 button to start scanning (it will automatically connect to the P2P server).
6. Once connected, the green LED blinks for each connection interval. The P2P client searches for the P2P service, LEDs and buttons characteristics, and enables notification.
7. Pushing the SW1 button toggles the blue LED on the remote device.
8. Pushing the SW2 button on the Nucleo Board changes the connection interval (50 ms, 1 s). The effect is visible directly on the green LED of the Nucleo board.
9. The demonstration software and several software examples that make it possible to use the STM32 Nucleo and USB dongle features are available at [www.st.com/stm32nucleo](http://www.st.com/stm32nucleo).
10. Develop your own application using available examples.

### 7.3.3 Default boards configuration

By default the board is set in SMPS mode. It is possible to set the board In LDO mode, see [Section 7.13: Jumper configuration](#).

Moreover, the board embeds a level shifter, which allows the user to debug the firmware even if the target (STM32WB55) is supplied by a low-level voltage (1.8 to 3.3 V). There is no jumper on the USB dongle.

The default jumper configuration and the  $V_{DD} = 1.8$  V setting is done according to [Table 3](#).

**Table 4. Default jumper configuration**

Jumper	Definition	Default position	Comment
JP1	Power selection	ON [7-8]	5 V from ST-LINK
JP2	$I_{DD}$ measurement	ON	$V_{DD}$ current measurement
JP3	$I_{DD}$ measurement	ON	MCU $V_{DD}$ current measurement
JP4	RF power	ON	Possibility of isolating RF power
JP5	Level shifter	All ON, except [1-2] that is OFF	Level shifter
JP6	$VDD\_IN\_SMPS$	ON	$V_{DD}$ SMPS

## 7.4 Embedded ST-LINK/V2-1

The ST-LINK/V2-1 programming and debugging tool is integrated on the Nucleo board.

The new features supported on ST-LINK/V2-1 are:

- USB software re-enumeration
- Virtual Com port interface on USB
- Mass storage interface on USB
- USB power management request for more than 100 mA on USB

The following features are no longer supported on ST-LINK/V2-1:

- SWIM interface
- Application voltage lower than 3 V (a level shifter is needed to support it)

For all general information concerning debugging and programming features common between V2 and V2-1 versions, refer to UM1075 “ST-LINK/V2 in-circuit debugger/programmer for STM8 and STM32”, available on [www.st.com](http://www.st.com).

Nucleo-68 optional configuration for ST-LINK:

- The Nucleo-68 board is divided in two parts: ST-Link part and target MCU part. The PCB area dedicated to the first one can be cut to reduce board size. In this case the second part can only be powered by VIN, E5V and 3.3V on ST Morpho connectors, or VIN and 3.3V on Arduino™ connectors.
- It is still possible to use the ST-Link part to program the main MCU using wires between SWD connector and SWD signals available on ST Morpho connectors.

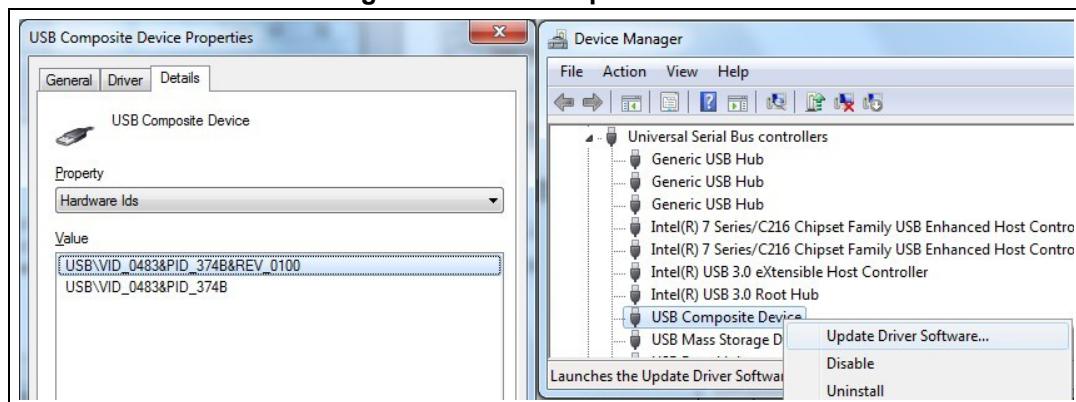
### 7.4.1 Drivers

Before connecting the Nucleo board to a Windows® PC (XP, 7, 8 or 10) via USB, a driver for the ST-LINK/V2-1 (available on [www.st.com](http://www.st.com)) must be installed.

If the Nucleo board is connected to the PC before the driver is installed, some interfaces may be declared as “unknown” in the PC device manager. In this case the user must install the driver files, and update the driver of the connected device from the device manager.

*Note:* Use preferably the “USB Composite Device” handle for a full recovery.

Figure 16. USB composite device



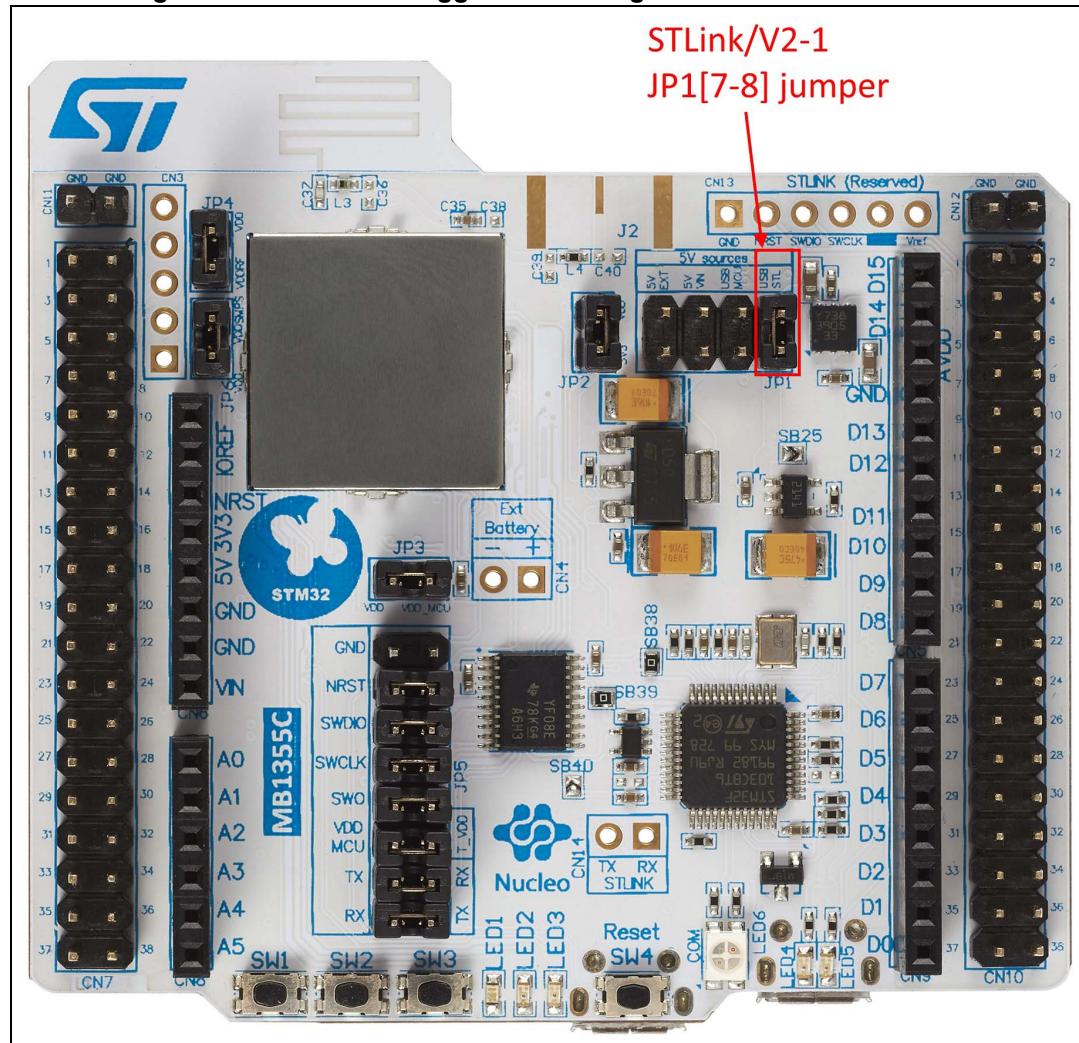
### 7.4.2 ST-LINK/V2-1 firmware upgrade

The ST-LINK/V2-1 embeds a firmware upgrade mechanism for *in-situ* upgrade through the USB port. As the firmware may evolve during the life time of ST-LINK/V2-1 (for example new functionality, bug fixes, support for new microcontroller families), it is recommended to check for updates on [www.st.com](http://www.st.com) before starting to use the Nucleo-68 board.

#### Using the ST-LINK/V2-1 to program/debug and supply the on-board MCU

To program the on-board STM32WB55, plug in the jumper JP1[7-8] connector, as shown in [Figure 17](#).

Figure 17. ST-LINK debugger: JP1 configuration for on-board MCU



## 7.5 Power supply and selection

### 7.5.1 External power supply input

The Nucleo-68 board is designed to be powered by several DC power supplies. It is possible to configure it to use any of the following power supplies by setting Jumper JP1:

- 5V\_ST\_LINK from STLINK USB connector (this is the default configuration)
- VIN (7 to 12 V) from Arduino™ connector or external connector CN4
- 5V\_EXT from ST-Morpho connector
- 5V\_USB from MCU USB (USB user)
- CR032 battery

The power supply capabilities are summarized in [Table 5](#).

**Table 5. Power sources**

Input name	Connector	Voltage range	Maximum current	Limitations
5V_USB_STLINK	CN15	4.75 to 5.25 V	500 mA	Maximum current depends upon the USB wall charger used to power the Nucleo-68 board
5V_USB_USER	CN1			Maximum current depends upon USB enumeration: – 100 mA without enumeration – 500 mA with enumeration
VIN	CN6 Pin 8 CN4 (SB24 on)	7 to 12 V	800 mA	From 7 to 12 V only Input current capability linked to input voltage: – 800 mA when $V_{in} = 7\text{ V}$ – 450 mA when $7\text{ V} < V_{in} < 9\text{ V}$ – 300 mA when $9\text{ V} < V_{in} < 10\text{ V}$ – < 300 mA when $V_{in} > 10\text{ V}$
5V_EXT	CN7 PIN6	4.75 to 5.25 V	500 mA	-
CR032 battery	SK_BT1	-	230 mAh	-

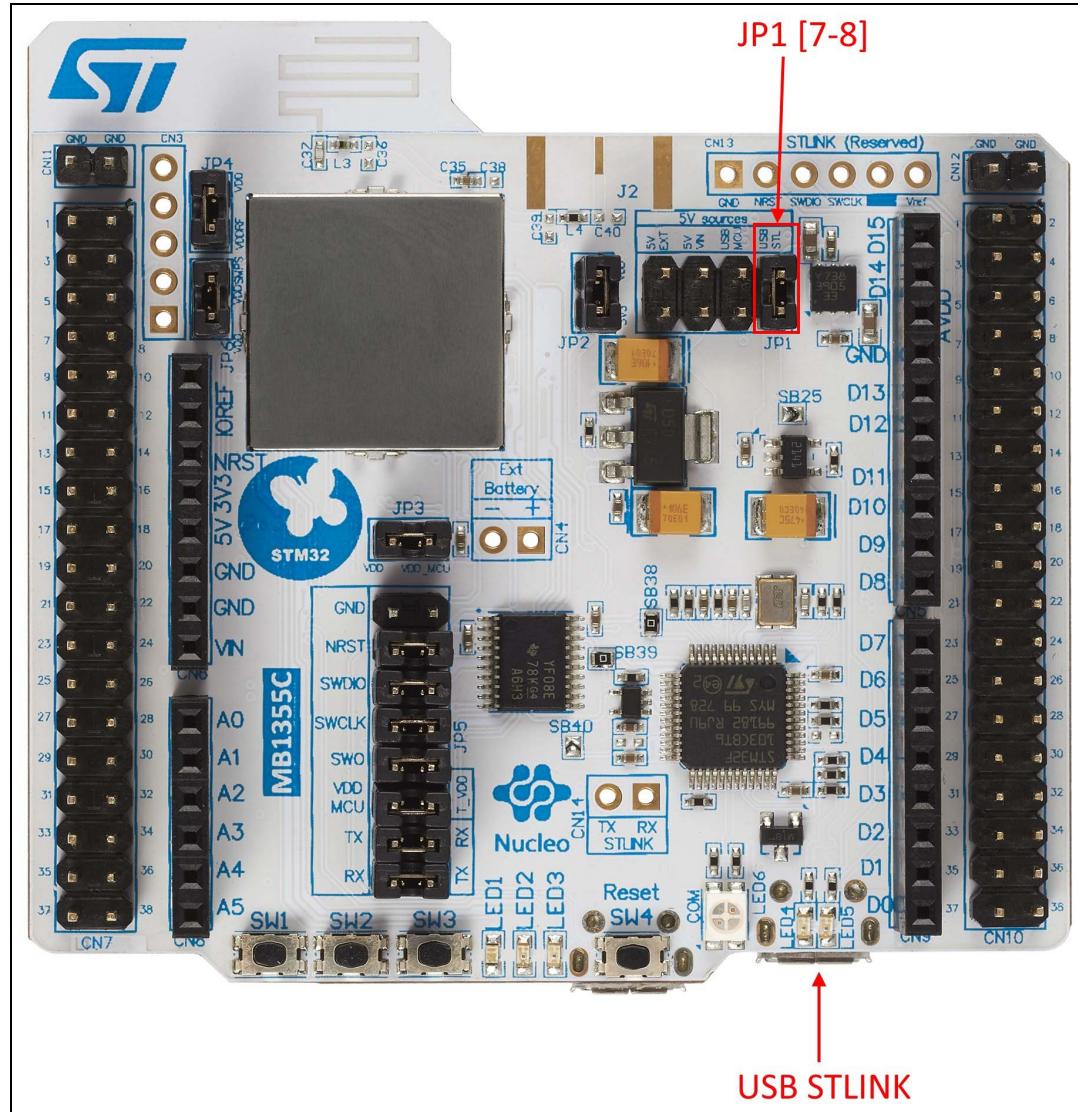
5V\_USB\_STLINK is a DC power with limitation from ST-LINK USB connector (USB type microB connector of ST-LINK/V2-1). In the default setting JP1 needs to be on pin [7-8] to select 5V\_USB\_STLINK power source on silkscreen of JP1. If the USB enumeration succeeds, the 5V\_ST\_LINK power is enabled by asserting the PWR\_ENn signal from STM32F103CBT6. This pin is connected to a power switch (STMP2141STR), which powers the board. This power switch also features a current limitation to protect the PC in case of currents exceeding 750 mA.

The Nucleo board and the shield on it can be powered from ST-LINK USB connector CN15, but only ST-LINK circuit has the power before USB enumeration, because the host PC only provides 100 mA to the board at that time. During the USB enumeration, Nucleo board needs 500 mA from the host PC. If the host is able to provide the required power, the enumeration finishes by a “SetConfiguration” command and then, the power transistor STMP2141STR is switched ON, the red LED (LED5) is turned ON, and the Nucleo board

and its shield can use up to 500 mA. If the host is unable to provide the requested current, the enumeration fails. Therefore the power switch STMPS2141STR remains OFF and the MCU is not powered. As a consequence LED5 remains turned OFF. In this case it is mandatory to use an external power supply.

In this configuration JP1[7-8] must be connected as in [Figure 18](#).

**Figure 18. JP1[7-8]: 5V\_STL power source**

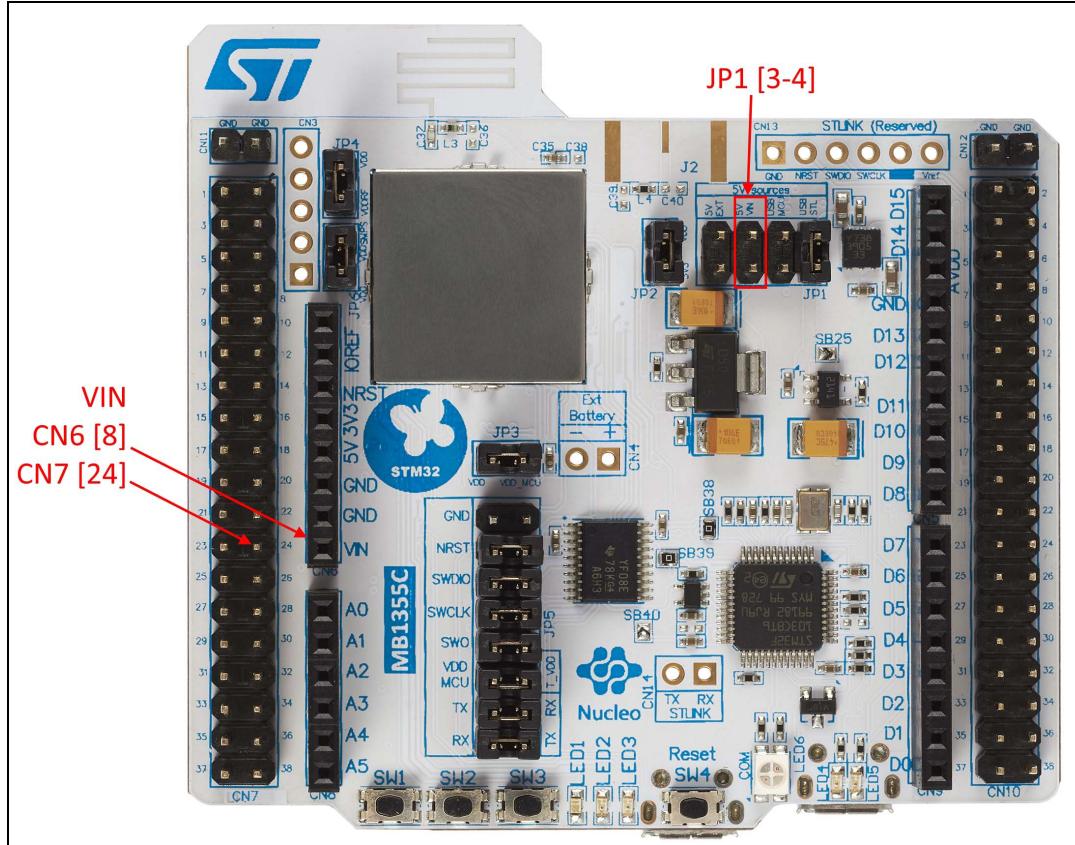


VIN is the 7 to 12 V DC power from ARDUINO™ CN8 pin 8 named VIN on Arduino™ connector silkscreen, or from Morpho connector CN7-24, or from external connector CN4.

In this case JP1 has to be on pin [3-4] to select VIN power source on silkscreen of JP1. The DC power can come from the power supply through the Arduino™ UNO V3 battery shield (compatible with Adafruit® PowerBoost 500 Shield).

In this configuration JP1[3-4] must be connected as shown in [Figure 19](#).

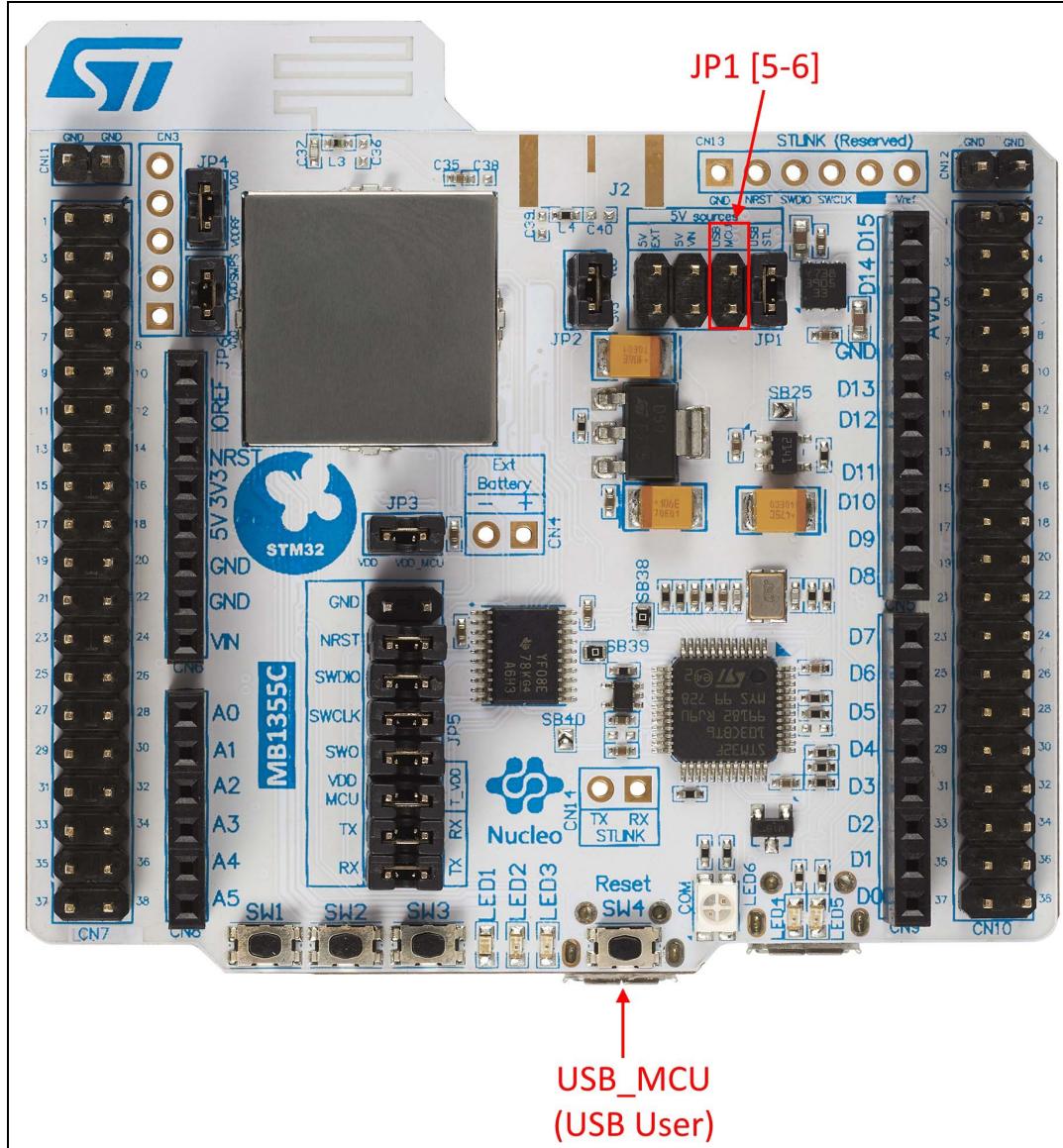
**Figure 19. JP1[3-4]: 5V\_VIN power source**



- The board can be also supplied by the USB User (5V\_USB MCU)
- No debug is possible on this USB port

In the 5V\_USB\_MCU configuration JP1 [5-6] must be connected as shown in [Figure 20](#).

**Figure 20. JP1[5-6]: 5V\_USB\_MCU power source**



**Caution:** A solder bridge (SB25) can be used (not an ST recommended setting) to bypass the USB PWR protection STMPs2141STR. SB25 can be set only if the board is powered by USB PC and maximum current consumption on 5V\_STLINK doesn't exceed 100 mA (including an extension board or Arduino™ Shield). In such condition USB enumeration will always succeed since no more than 100 mA is requested to the PC. Possible configurations of SB25 are summarized in [Table 6](#).

**Table 6. SB25 bypass USB PWR protection**

Default position	Power supply	Allowed current
OFF (not soldered)	USB PWR through CN15	500 mA max (limited by STMPS2141STR)
ON (soldered)		500 mA max
OFF (not soldered)	VIN or E5V PWR	No limitation
ON (soldered)		Forbidden configuration <sup>(1)</sup>

1. SB25 must be removed when the board is powered by 5V\_EXT (CN7 pin 6) or by VIN (CN6 pin 8).

**Caution:** If the maximum current consumption by the Nucleo and its extension boards exceeds 500 mA it is recommended to power the board using an external power supply connected to E5V or VIN.

### 7.5.2 External power supply output

5V: when the Nucleo board is powered by USB, VIN or 5V\_EXT, the 5V (CN6 pin 5 or CN7 pin 18) can be used as output power supply for an Arduino™ shield or an extension board. In this case, the maximum current specified in [Table 5](#) needs to be respected.

3V3 on CN6 pin 4 or CN7 pin 16 can be used as power supply output. The current is limited by the maximum capability of the regulator U3 (LD39050PUR33 from STMicroelectronics), that is 500 mA for the Nucleo board and its shield.

### 7.5.3 Internal power supply

The device allows the application to meet the tight peak current requirements imposed by the use of standard coin cell batteries. When the high efficiency embedded SMPS step-down converter is used, the RF front end consumption ( $I_{tmax}$ ) is reduced.

It is possible to be also in LDO mode by changing the firmware, SB31 needs to be closed.

## 7.6 Programming/debugging when the power supply is not from USB ST-LINK (5V\_ST\_link)

VIN or 5V\_EXT can be used as external power supply if the current consumption of Nucleo and extensions boards exceeds the allowed current on USB. In this condition it is still possible to use the USB for communication for programming or debugging only.

In this case it is mandatory to power the board first using VIN or 5V\_EXT, then connecting the USB cable to the PC. The enumeration succeeds thanks to the external power source.

The following power sequence procedure must be respected:

1. Configure jumper JP1 to select between VIN or 5V\_EXT, see [Section 7.3.1](#)
2. Be sure that SB37 is removed
3. Connect the external power source to VIN or E5V
4. Power ON the external power supply  $7 \text{ V} < \text{VIN} < 12 \text{ V}$  to VIN, or 5 V for 5V\_EXT
5. Check that the green LED is turned ON
6. Connect the PC to USB connector CN15

If this sequence is not respected, the board may be powered by VBUS first from STLINK, with some risks:

- If more than 500 mA are needed by the board, the PC may be damaged, or the current can be limited by the PC: as a consequence the board will be not correctly powered.
- 500 mA is requested by enumeration (since SB37 must be OFF), this request can be rejected and enumeration won't succeed, consequently the board will be not powered (LED5 remains OFF).

In some cases it can be interesting to use the 3V3 (CN6 pin 4 or CN7 pin 16) directly as power input, for instance when the 3.3 V is provided by an extension board. When Nucleo is powered by 3V3, the ST-LINK is not powered, thus programming and debug features are unavailable.

## 7.7 OSC clock sources

- LSE: 32.768 kHz external oscillator, for accurate RTC and calibration with other embedded RC oscillators
- HSE: high quality 32 MHz external oscillator with trimming, needed by the RF subsystem

### 7.7.1 LSE: OSC 32 kHz clock supply

There are three ways to configure the pins corresponding to low-speed clock (LSE):

1. LSE on-board oscillator X2 crystal (default configuration) 32.768 kHz, 7 pF, 20 ppm. Refer to application note AN2867 "Oscillator design guide for STM8AF/AL/S and STM32 microcontrollers", available on [www.st.com](http://www.st.com). It is recommended to use NX2012SA manufactured by NDK.
2. Oscillator from external to PC14 input: from external oscillator through pin 25 of CN7 connector. The following configuration is needed:
  - SB45 and SB46 ON
  - X2, C6 and C7 removed
3. LSE not used: PC14 and PC15 are used as GPIOs instead of low speed clock. The following configuration is needed:
  - SB45 and SB46 ON
  - X2, C6 and C7 removed

### 7.7.2 OSC clock supply

The HSE on board oscillator 32 MHz X1 crystal is provided for RF activities with tuning capacitors. Refer to STM32 microcontroller datasheets, and to AN2867 for oscillator design. It is recommended to use NX2016SA 32 MHz EXS00A-CS06654 manufactured by NDK. SB44 and SB43 must be open.

## 7.8 Reset sources

The reset signal of Nucleo board is active low and the reset sources include:

- Reset button SW4
- Embedded ST-LINK/V2-1
- Arduino™ UNO V3 connector from CN6 pin 3
- ST-Morpho connector CN7 pin 14

## 7.9 Virtual COM port: LPUART/USART

LPUART or USART interface of STM32 Microcontroller on the Nucleo-68 board can be connected to STLINK/V2-1 MCU or on Shields on ST-Morpho connectors and Arduino™ UNO V3 connectors.

The LPUART/USART selection can be changed by setting related solder bridges.

Refer to [Table 7](#) for the UART/LPUART connection to interfaces VCP or Arduino™ UART.

**Table 7. LPUART1 and USART1 connections**

SB	Features
SB15 ON SB18 OFF	LPUART1 (PA2/PA3) connected to Arduino™ and Morpho connector
JP5[15-16] ON JP5[13-14] ON SB38 ON SB39 ON	USART1 (PB6/PB7) connected to STLINK VCP

## 7.10 LEDs

Three LEDs on the top side of the Nucleo board help the user during the application development.

- LED6 COM: LED6 is a bi-color LED, whose default status is Red, turns to Green to indicate that communication is in progress between the PC and the ST-LINK/V2-1, as follows:
  - Slow blinking Red / OFF: at power-on, before USB initialization
  - Fast blinking Red / OFF: after the first correct communication between PC and ST-LINK/V2-1 (enumeration)
  - Red ON: when initialization between PC and ST-LINK/V2-1 is successfully finished
  - Green ON: after successful target communication initialization
  - Blinking Red / Green: during communication with target
  - Green ON: communication finished and OK
  - Orange ON: Communication failure
- LED4: 5V\_USB: this red LED switches ON when over-current is detected (more than 500 mA is requested) on USB VBUS. In this case it is recommended to supply the board by E5V or VIN, or in USB\_CHARGER mode.
- LED5: 5V\_PWR: this red LED indicates that MCU part is powered and 5 V power is available.

Three user LEDs are also available, they are LED1, LED2 and LED3.

## 7.11 Push buttons

Four buttons are available on the Nucleo board.

- SW1, SW2, SW3 USER: button for User and Wake-Up function is connected to the I/O PC13 of the STM32 MCU. When the button is pressed the logic state is “1”, otherwise the logic state is “0”. Wake-Up is available on SW1, SB48 must be ON and SB47 OFF.
- SW4 RESET: button is connected to NRST, is used to RESET the STM32. When the button is pressed the logic state is “0”, otherwise the logic state is “1”.

## 7.12 Current measurement

Jumper JP2 allows the user to measure the power consumption, by removing the jumper and connecting an ammeter.

## 7.13 Jumper configuration

Jumper default position are listed in [Table 4](#). [Table 8](#) summarizes the other settings and configurations.

**Table 8. Configuration of jumpers and solder bridges**

Supply source		JP1 (1-2)	JP1 (3-4)	JP1 (5-6)	JP1 (7-8)	SB24	SB26	SB27	SB28	SB29
USB connector	STLink (default)	Open	Open	Open	Closed	Open	Closed	Open	Open	Open
	STM32WB55 (user USB)	Open	Open	Closed	Open	Open	Closed	Open	Open	Open
5V from Morpho shield (5V_EXT)		Closed	Open	Open	Open	Open	Closed	Open	Open	Open
5V from Arduino™ shield (5V)		Open	Open	Open	Open	Open	Closed	Open	Open	Open
VIN from Arduino™ shield		Open	Closed	Open	Open	Open	Closed	Open	Open	Open
External power supply on CN4	1.8 to 3.3 V	Open	Open	Open	Open	Open	Open	Closed	Open	Open
	5 to 7 V	Open	Open	Open	Open	Open	Closed	Open	Closed	Open
	7 to 12 V	Open	Closed	Open	Open	Closed	Closed	Open	Open	Open
CR2032 battery		Open	Open	Open	Open	Open	Open	Open	Open	Closed

## 8 Connectors

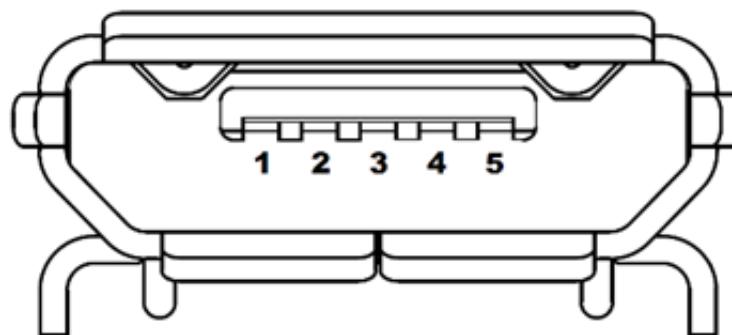
Eight connectors are implemented on the Nucleo board:

- CN15: ST-LINK USB connector
- CN5, CN6, CN8 and CN9 for Arduino™ Uno V3 connector
- CN7 and CN10 for ST-Morpho connector
- CN1: USB User connector.

### 8.1 USB ST-LINK micro-B connector CN15

The USB connector CN15 is used to connect the embedded ST-LINK/V2-1 to the PC for programming and debugging the Nucleo microcontroller.

**Figure 21. USB STLINK micro-B connector CN15 (front view)**



The related pinout for USB STLINK connector is detailed in [Table 9](#).

**Table 9. USB STLINK micro-B pinout (connector CN15)**

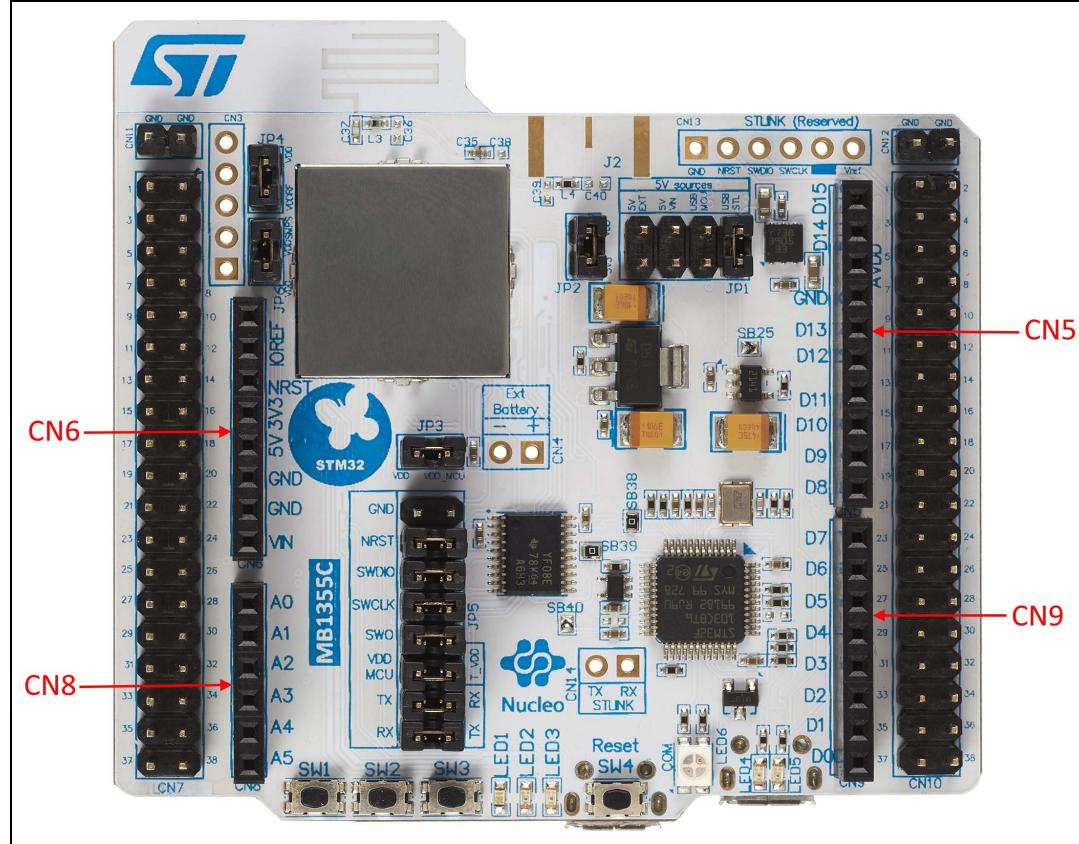
Pin number	Pin name	Signal	STM32 pin	Function
1	VBUS	5V_STLINK / 5V_USB_CHG	-	5 V power
2	DM (D-)	STLINK_USB_D_N	PA11	USB differential pair M
3	DP (D+)	STLINK_USB_D_P	PA11	USB differential pair M
4	ID	-	-	-
5	GND	-	-	GND

## 8.2 Arduino™ Uno revision 3 connectors

The Arduino™ connectors CN5, CN6 CN8 and CN9 are female connectors compatible with Arduino™ standard. Most shields designed for Arduino™ fit to the Nucleo board.

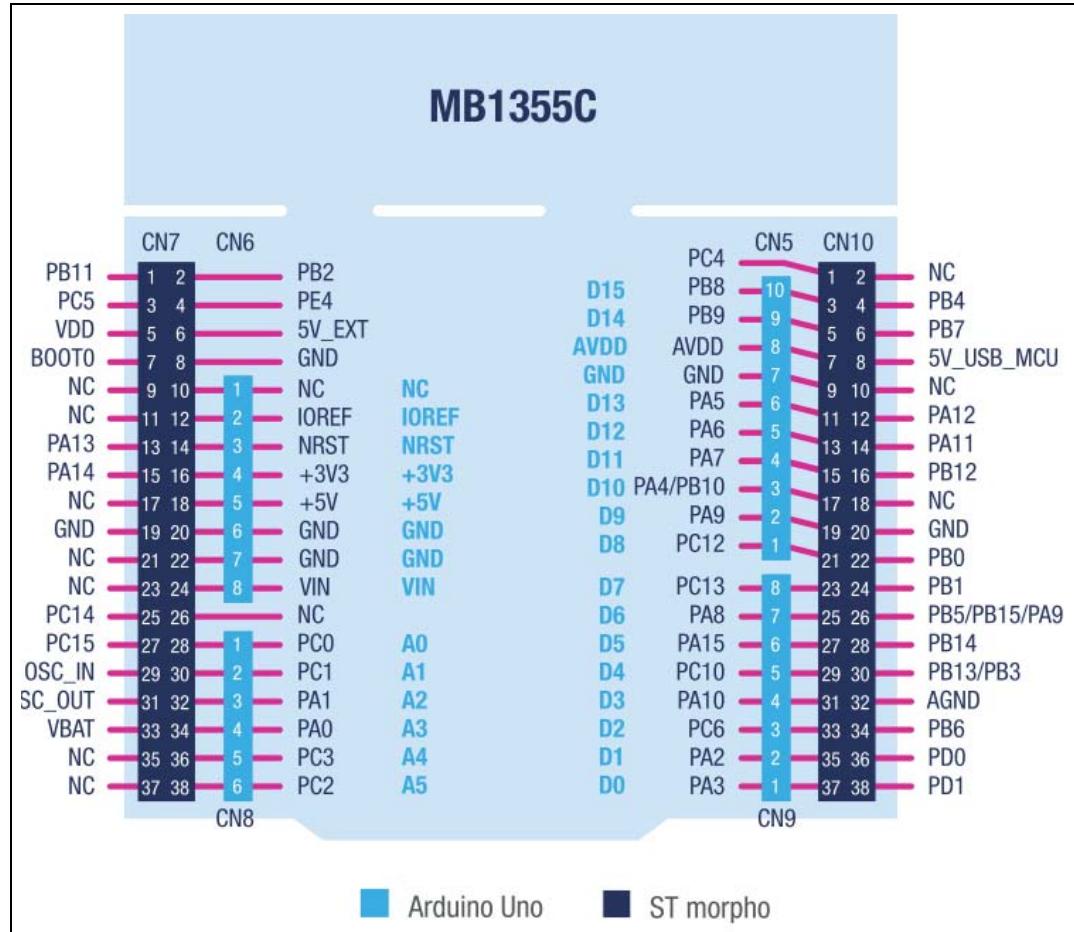
The Arduino™ connectors on the Nucleo board support the Arduino™ Uno revision 3.

Figure 22. Arduino™ connector



The related pinout for Arduino™ connector is detailed in [Figure 23](#) and [Table 10](#).

**Figure 23. Arduino™ connector pinout**



**Table 10. Arduino™ connectors pinout**

Connector	Pin number	Pin name	Signal	STM32 pin	Function
CN6	1	NC	-	-	Reserved for test
	2	IOREF	-	-	IO reference
	3	NRST	NRST	NRST	RESET
	4	3V3	-	-	3V3 input/output
	5	5V	-	-	5V output
	6	GND	-	-	GND
	7	GND	-	-	GND
	8	VIN	-	-	7-12V power input

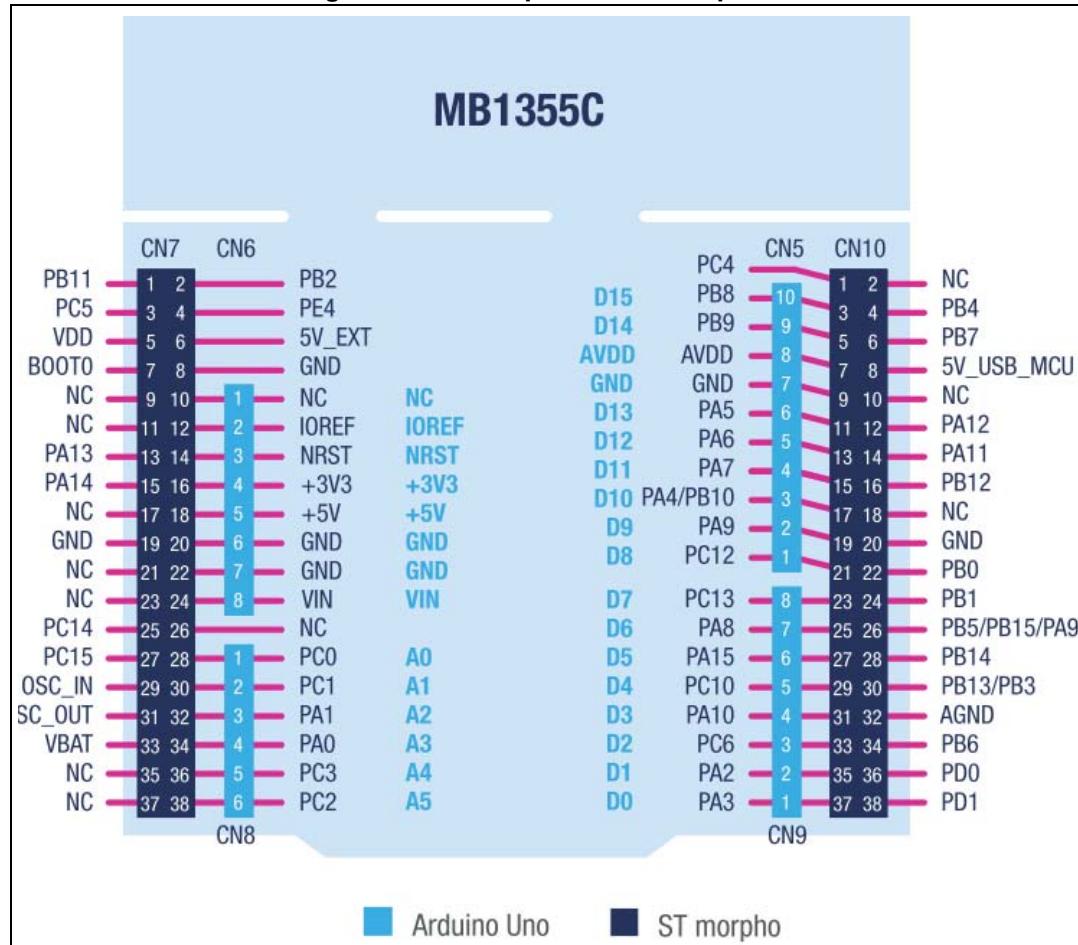
**Table 10. Arduino™ connectors pinout (continued)**

Connector	Pin number	Pin name	Signal	STM32 pin	Function
CN8	1	A0	ADC	PC0	ADC1_IN1
	2	A1	ADC	PC1	ADC1_IN2
	3	A2	ADC	PA1	ADC1_IN5
	4	A3	ADC	PA0	ADC1_IN6
	5	A4	ADC	PC3	ADC1_IN4
	6	A5	ADC	PC2	ADC1_IN3
CN5	10	SCL/D15	ARD_D15	PB8	I2C1_SCL
	9	SDA/D14	ARD_D14	PB9	I2C1_SDA
	8	AVDD	VREF+/VDDA	-	VREF+/VDDA
	7	GND	-	-	GND
	6	SCK/D13	ARD_D13	PA5	SPI1_SCK
	5	MISO/D12	ARD_D12	PA6	SPI1_MISO
	4	PWM/MOSI/D11	ARD_D11	PA7	TIM1_CH1N/SPI1_MOSI
	3	PWM/CS/D10	ARD_D10	PA4/PB10	TIM2_CH3 on PB10 /SPI_NSS on PA4
	2	PWM/D9	ARD_D9	PA9	TIM17_CH1
	1	D8	ARD_D8	PC12	IO
CN9	8	D7	ARD_D7	PC13	IO
	7	D6	ARD_D6	PA8	TIM1_CH1
	6	D5	ARD_D5	PA15	TIM2_CH1
	5	D4	ARD_D4	PC10	IO
	4	D3	ARD_D3	PA10	TIM1_CH3
	3	D2	ARD_D2	PC6	IO
	2	D1	ARD_D1	PA2	LPUART1_TX
	1	D0	ARD_D0	PA3	LPUART1_RX

### 8.3 ST Morpho connectors CN7 and CN10

The ST-Morpho connectors CN7 and CN10 are male pin headers accessible on both sides of the board. All signals and power pins of the MCU are available on Morpho connectors. These connectors can also be probed by an oscilloscope, logical analyzer or voltmeter.

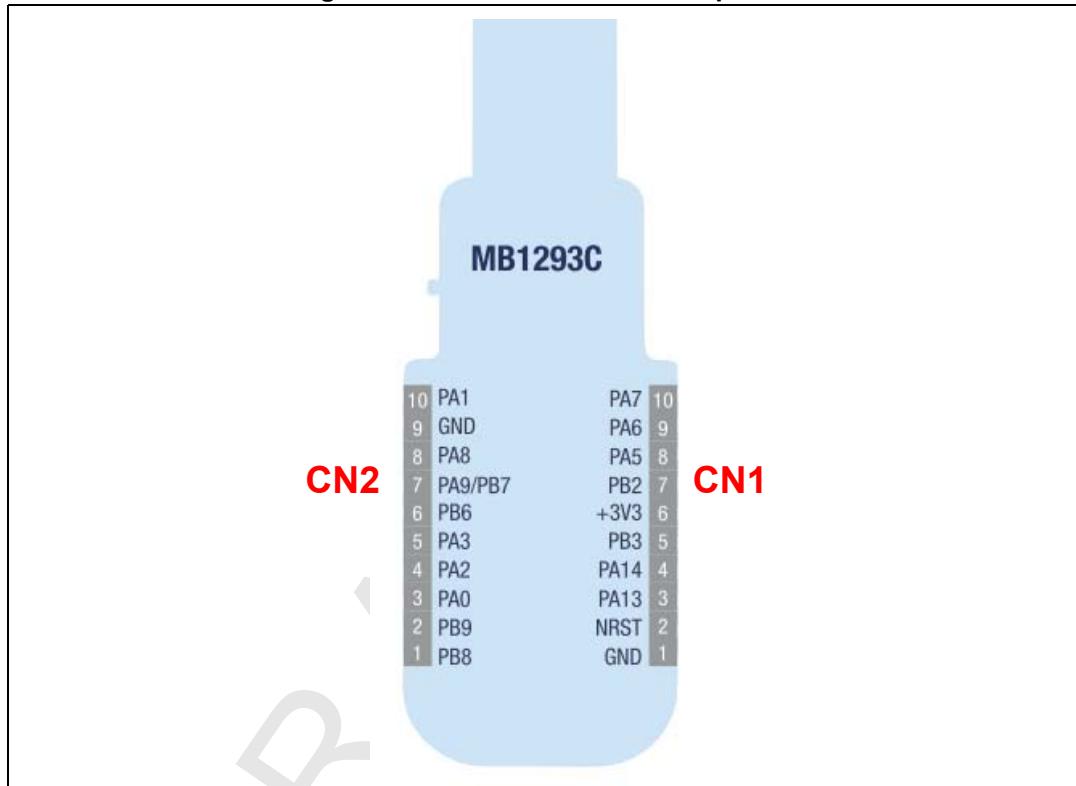
Figure 24. ST-Morpho connector pinout



## 8.4 Extension connectors CN1 and CN2 on USB dongle

The related pinout and the MCU assignment for the Extension connectors are detailed in [Figure 25](#).

**Figure 25. Extension connectors pinout**



## Appendix A Nucleo-68 and USB dongle MCU IO assignment

Table 11. IO assignment

Pin number		Pin name (function after reset)	Nucleo-68 QFN68 (MB1355C)				USB dongle QFN48 (MB1293C)		
UFQFPN48	VQFPN68		Arduino™	Morpho	Debug	Other functions	Extension connectors	Debug	Other functions
-	2	PC13	D7	CN10-23	-	Push button 1 (SW1 alternate)	-	-	-
24	34	OSC_OUT	-	CN7-31	-	-	-	-	-
25	35	OSC_IN	-	CN7-29	-	-	-	-	-
2	3	PC14-OSC32_IN	-	CN7-25	-	-	-	-	-
3	4	PC15-OSC32_OUT	-	CN7-27	-	-	-	-	-
4	5	PH3-BOOT0	-	CN7-7	-	BOOT0	-	-	BOOT0
5	6	PB8	D15(I2C1_SCL, GPIO)	CN10-3	-	-	CN2-1 (I2C1_SCL)	-	-
6	7	PB9	D14 (I2C1_SDA, GPIO)	CN10-5	-	-	CN2-2 (I2C1_SDA)	-	-
7	8	NRST	-	CN7-14	-	-	CN1-2	-	-
9	15	PA0	A3	CN7-34	-	-	CN2-3 (WKUP1)	-	-
10	16	PA1	A2	CN7-32A	-	-	CN2-10 (ADC)	-	-
11	17	PA2	D1 (LPUART1_TX, GPIO)	CN10-35A	-	-	CN2-4 (LPUART1_TX)	-	-
12	18	PA3	D0 (LPUART1_RX, GPIO)	CN10-37	-	-	CN2-5 (LPUART1_RX)	-	-
13	19	PA4	D10A (SPI1_NSS)	CN10-17A	-	-	-	-	LED1
14	20	PA5	D13 (SPI1_SCK)	CN10-11	-	-	CN1-8 (SPI1_SCK)	-	-

Table 11. IO assignment (continued)

Pin number		Pin name (function after reset)	Nucleo-68 QFN68 (MB1355C)				USB dongle QFN48 (MB1293C)		
			Arduino™	Morpho	Debug	Other functions	Extension connectors	Debug	Other functions
15	21	PA6	D12 (SPI1_MISO)	CN10-13	-	-	CN1-9 (SPI1_MISO)	-	-
16	22	PA7	D11 (SPI1_MOSI, PWM)	CN10-15A	-	-	CN1-10 (SPI1_MOSI)	-	-
17	23	PA8	D6 (PWM)	CN10-25	-	-	CN2-8 (GPIO)	-	-
18	24	PA9	D9 (PWM)	CN10-19 CN10-26B	-	-	-	-	-
-	25	PC4	-	CN10-1	-	Push button 1 (SW1)	-	-	-
-	26	PC5	-	CN7-3	-	-	-	-	-
19	27	PB2	-	CN7-2	-	-	CN1-7 (SPI1_NSS)	-	-
-	28	PB10	D10B (PWM)	CN10-17B	-	-	CN2-7	-	Push button 1 (SW1)
-	29	PB11	-	CN7-1	-	-	-	-	-
28	38	PB0	-	CN10-22	-	LED2 (GREEN)	-	-	LED2
29	39	PB1	-	CN10-24	-	LED3 (RED)	-	-	LED3
30	40	PE4	-	CN7-4	-	-	-	-	-
-	46	PB12	-	CN10-16	-	-	-	-	-
-	47	PB13	-	CN10-30A	-	-	-	-	-
-	48	PB14	-	CN10-28	-	-	-	-	-
-	49	PB15	-	CN10-26A	-	-	-	-	-
-	50	PC6	D2	CN10-33	-	-	-	-	-
-	51	PA10	D3 (PWM)	CN10-31 CN10-15B	-	-	-	-	-
37	52	PA11	-	CN10-14	-	USB_DM	USB_DM	-	-
38	53	PA12	-	CN10-12	-	USB_DP	USB_DP	-	-
39	54	PA13	-	CN7-13	SWDIO	-	CN1-3	SWDIO	-

Table 11. IO assignment (continued)

		Pin number	Pin name (function after reset)	Nucleo-68 QFN68 (MB1355C)				USB dongle QFN48 (MB1293C)		
UFQFPN48	VQFPN68			Arduino™	Morpho	Debug	Other functions	Extension connectors	Debug	Other functions
41	56	PA14	-	CN7-15	SWCLK	-		CN1-4	SWCLK	-
42	57	PA15	D5 (PWM)	CN10-27	-	-	-	-	-	-
-	58	PC10	D4	CN10-29	-	-	-	-	-	-
-	59	PC11	-	CN10-35B	-	-	-	-	-	-
-	60	PC12	D8	CN10-21	-	-	-	-	-	-
-	61	PD0	-	CN10-36	-	Push button 2 (SW2)	-	-	-	-
-	62	PD1	-	CN10-38	-	Push button 3 (SW3)	-	-	-	-
43	63	PB3	-	CN10-30B	SWO	-	CN1-5	SWO	-	-
44	64	PB4	-	CN10-4	-	-	-	-	-	-
45	65	PB5	-	CN10-26C	-	LED1 (BLUE)	-	-	-	-
46	66	PB6	-	CN10-34 CN7-32B	STLK_RX		CN2-6 (GPIO)	-	-	-
47	67	PB7	-	CN10-6	STLK_TX		CN2-7 (GPIO)	-	-	-

## 9 Federal Communications Commission (FCC) and Industry Canada (IC) compliance statements

### 9.1 FCC compliance statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Please take attention that changes or modification not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

*Note:*

*This product has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This product generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this product does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:*

- *Reorient or relocate the receiving antenna.*
- *Increase the separation between the equipment and receiver.*
- *Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.*
- *Consult the dealer or an experienced radio/TV technician for help.*

This equipment complies with FCC/IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

### 9.2 IC compliance statement

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions:

1. this device may not cause interference, and
2. this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radioexempts de licence. L'exploitation est autorisée aux deux conditions suivantes :

1. l'appareil ne doit pas produire de brouillage, et
2. l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain

## Federal Communications Commission (FCC) and Industry Canada (IC) compliance statements

---

should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

This equipment complies with FCC/IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

Ce matériel est conforme aux limites de dose d'exposition aux rayonnements, FCC / CNR-102 énoncée dans un autre environnement. cette équipement devrait être installé et exploité avec distance minimale de 20 cm entre le radiateur et votre corps.

DRAFT

## 10 Revision history

Table 12. Document revision history

Date	Revision	Changes
28-Sep-2018	1	Initial release.
dd-Mar-2019	2	Added <a href="#"><u>Section 9: Federal Communications Commission (FCC) and Industry Canada (IC) compliance statements</u></a> and its subsections.

DRAFT

**IMPORTANT NOTICE – PLEASE READ CAREFULLY**

STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, enhancements, modifications, and improvements to ST products and/or to this document at any time without notice. Purchasers should obtain the latest relevant information on ST products before placing orders. ST products are sold pursuant to ST's terms and conditions of sale in place at the time of order acknowledgement.

Purchasers are solely responsible for the choice, selection, and use of ST products and ST assumes no liability for application assistance or the design of Purchasers' products.

No license, express or implied, to any intellectual property right is granted by ST herein.

Resale of ST products with provisions different from the information set forth herein shall void any warranty granted by ST for such product.

ST and the ST logo are trademarks of ST. All other product or service names are the property of their respective owners.

Information in this document supersedes and replaces information previously supplied in any prior versions of this document.

© 2019 STMicroelectronics – All rights reserved