

### Introduction

The STM32 Nucleo-64-P boards based on the MB1319 reference board (NUCLEO-L412RB-P, NUCLEO-L433RC-P and NUCLEO-L452RE-P) provide an affordable and flexible way for users to try out new concepts and build prototypes with the STM32 microcontroller and the external SMPS (switched mode power supply), which provides various combinations of performance, power consumption and features.

ARDUINO® Uno V3 connectivity and ST morpho headers provide an easy means of expanding the functionality of the Nucleo open development platform with a wide choice of specialized shields.

The STM32 Nucleo-64-P boards do not require any separate probe, as they integrate the ST-LINK/V2-1 debugger/programmer. The STM32 Nucleo-64-P boards come with the comprehensive free STM32 software libraries and examples that are available with the STM32Cube package.

Figure 1. Nucleo-64-P board (top view)

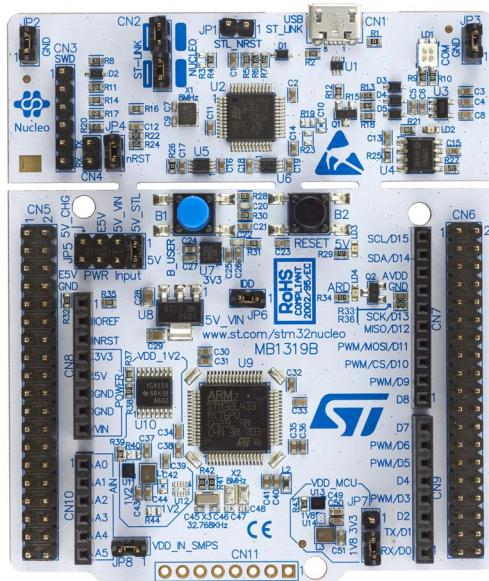
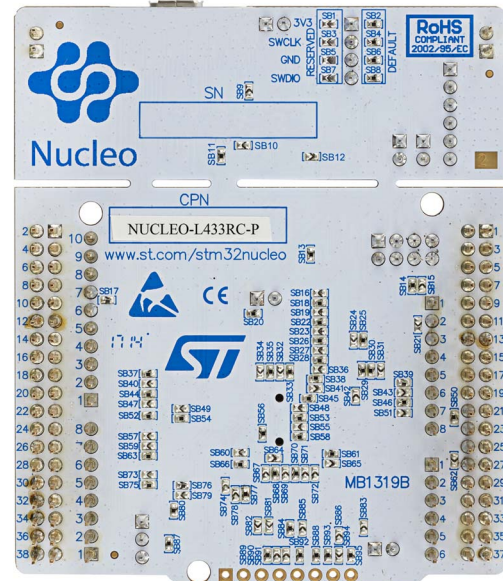


Figure 2. Nucleo-64-P board (bottom view)



Pictures are not contractual.



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# 1 Features

- Common features
  - STM32 microcontroller in LQFP64 package
  - SMPS: significantly reduces power consumption in Run mode
  - 32.768 kHz LSE crystal oscillator
  - One user LED shared with ARDUINO®
  - Two push-buttons: USER and RESET
  - ARDUINO® Uno V3 expansion connector
  - ST morpho expansion connector
  - External SMPS experimentation dedicated connector
  - Flexible board power supply: ST-LINK/V2-1 USB  $V_{BUS}$  or 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 the STM32Cube package
  - Support of a wide choice of Integrated Development Environments (IDEs) including IAR™, Keil® and STM32CubeIDE
- Board-specific feature
  - Arm® Mbed Enabled™<sup>(a)</sup> compliant

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## 2 Ordering information

To order an STM32 Nucleo-64-P board, refer to, refer to [Table 1](#). Additional information is available from the datasheet and reference manual of the target STM32.

**Table 1. Ordering information**

Order code	Board reference	Target STM32	Differentiating features
NUCLEO-L412RB-P	MB1319	STM32L412RBT6PU	-
NUCLEO-L433RC-P		STM32L433RCT6PU	Arm® Mbed Enabled™
NUCLEO-L452RE-P		STM32L452RET6PU	-

### 2.1 Product marking

Evaluation tools marked as "ES" or "E" are not yet qualified and therefore they are not ready to be used as a 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 STM32 that is soldered on the board (for illustration of STM32 marking, refer to the section "Package characteristics" of the STM32 datasheet at [www.st.com](http://www.st.com)).
- Next to the evaluation tool ordering part number, that is stuck or silk-screen printed on the board.

These boards feature a specific STM32 device version, which allows the operation of any bundled commercial stack/library available. This STM32 device shows a "U" marking option at the end of the standard part number and is not available for sales. In order to use the same commercial stack in his application, a developer may need to purchase a part number specific to this stack/library. The price of those part numbers includes the stack/library royalties.

## 2.2 Codification

The meaning of the codification is explained in [Table 2](#).

**Table 2. Codification explanation**

NUCLEO-XXYYRT-P	Description	Example: NUCLEO-L452RE-P
XX	MCU series in STM32 32-bit Arm Cortex MCUs	STM32L4 Series
YY	MCU product line in the series	STM32L452
R	STM32 package pin count	64 pins
T	STM32 Flash memory size: – B for 128 Kbytes – C for 256 Kbytes – E for 512 Kbytes	512 Kbytes
-P	STM32 has external SMPS function	External SMPS

This order code is mentioned on a sticker placed on the top or bottom side of the board.



## 3 Development environment

### 3.1 System requirements

- Windows® OS (7, 8 and 10), Linux® 64-bit or macOS®(a) (b)
- USB Type-A to Micro-B cable

### 3.2 Development toolchains

- IAR™ - EWARM<sup>(c)</sup>
- Keil® - MDK-ARM<sup>(c)</sup>
- STMicroelectronics - STM32CubeIDE
- Arm® Mbed™ online<sup>(d)</sup> (see [mbed.org](http://mbed.org))

### 3.3 Demonstration software

The demonstration software, included in the STM32Cube MCU Package corresponding to the on-board microcontroller, is preloaded in the STM32 Flash memory 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.

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b. All other trademarks are the property of their respective owners.

c. On Windows® only.

d. Refer to the [www.mbed.com](http://www.mbed.com) website and to the "Ordering information" section to determine which order codes are supported.

## 4 Conventions

[Table 3](#) provides the conventions used for the ON and OFF settings in the present document.

**Table 3. ON/OFF convention**

Convention	Definition
Jumper JPx ON	Jumper fitted
Jumper JPx OFF	Jumper not fitted
Jumper JPx [1-2]	Jumper should be fitted between Pin 1 and Pin 2
Solder bridge SBx ON	SBx connections closed by 0 ohm resistor
Solder bridge SBx OFF	SBx connections left open

In this document the references for all information that is common to all sale types, are “STM32 Nucleo-64-P board” and “STM32 Nucleo-64-P boards”.

## 5 Quick start

This section describes how to start a development quickly using the STM32 Nucleo-64-P board.

Before installing and using the product, accept the Evaluation Product License Agreement from the [www.st.com/epla](http://www.st.com/epla) webpage.

### 5.1 Getting started

The STM32 Nucleo-64-P board is a low-cost and easy-to-use development kit to quickly evaluate and start a development with an STM32 microcontroller in QFP64 package. To start using this board, follow the steps below:

1. Check the jumper position on the board, as shown in [Table 4: Default jumper settings](#).
2. For a correct identification of all device interfaces from the host PC, install the Nucleo USB driver available on the [www.st.com/stm32nucleo](http://www.st.com/stm32nucleo) webpage, prior to connecting the board.
3. To power the board connect the Nucleo-64-P board to a PC with a Type-A to Micro-B USB cable through USB connector CN1. As a result the green LED LD3 (5 V PWR) lights up, LD1 (COM) and green LED LD4 blink.
4. Press user button B1 (blue).
5. Observe that the blinking frequency of the three green LEDs LD4 changes, by clicking on the button B1.
6. The software demonstration and the several software examples, that allow the user to use the Nucleo features, are available at the [www.st.com/stm32nucleo](http://www.st.com/stm32nucleo) webpage.
7. Develop an application using the available examples.

## 6 Hardware layout and configuration

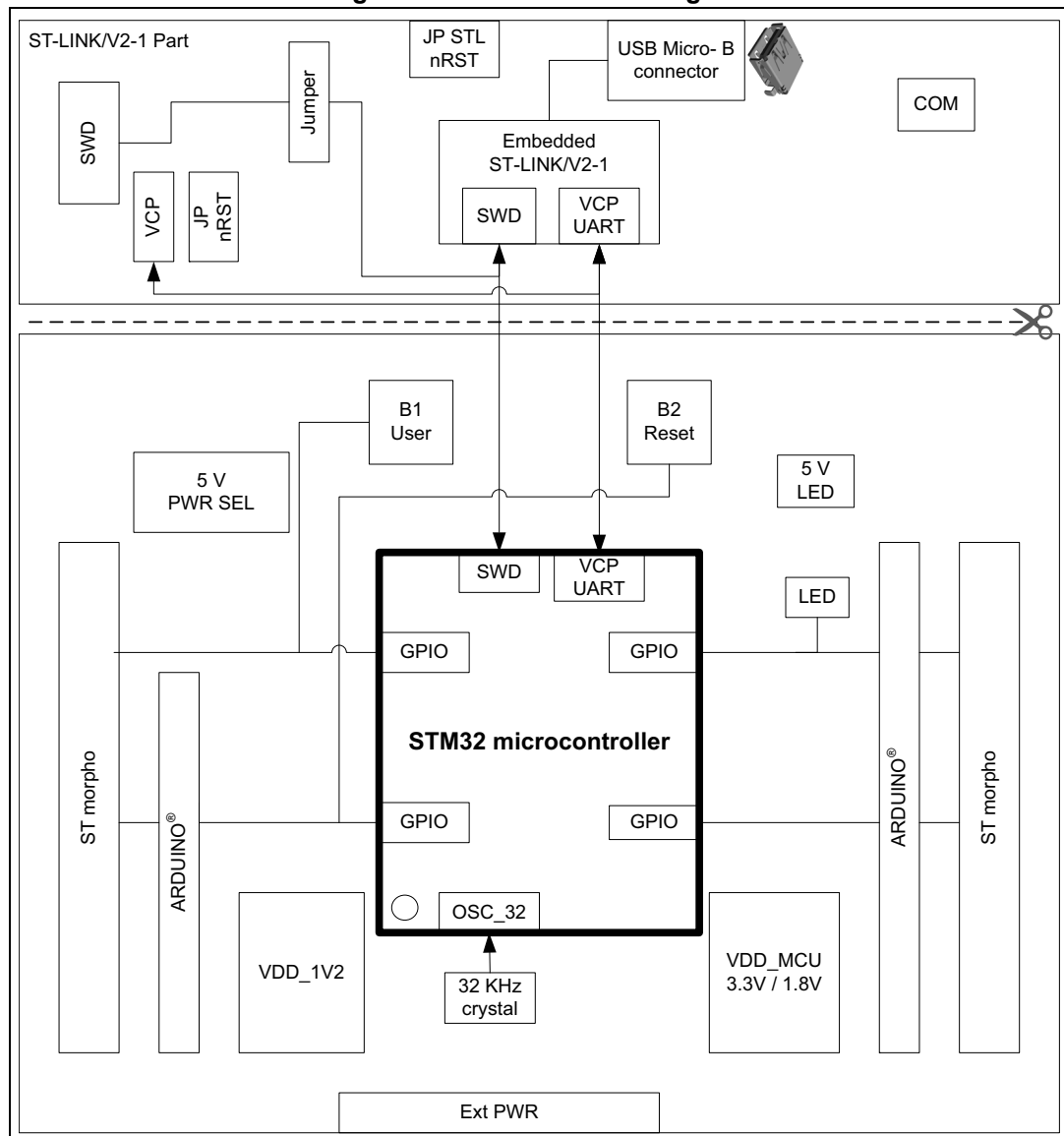
The STM32 Nucleo-64-P board is designed around the STM32 microcontrollers in a 64-pins LQFP package.

*Figure 3* illustrates the connection between the STM32 and the peripherals (ST-LINK/V2-1, push-buttons, LEDs, ARDUINO® Uno V3 connector and ST morpho connectors).

*Figure 4* and *Figure 5* show the location of these features on the STM32 Nucleo-64-P board.

The mechanical dimensions of the board are shown in *Figure 6*.

**Figure 3. Hardware block diagram**



## 6.1 STM32 Nucleo-64-P board layout

Figure 4. STM32 Nucleo-64-P board top layout

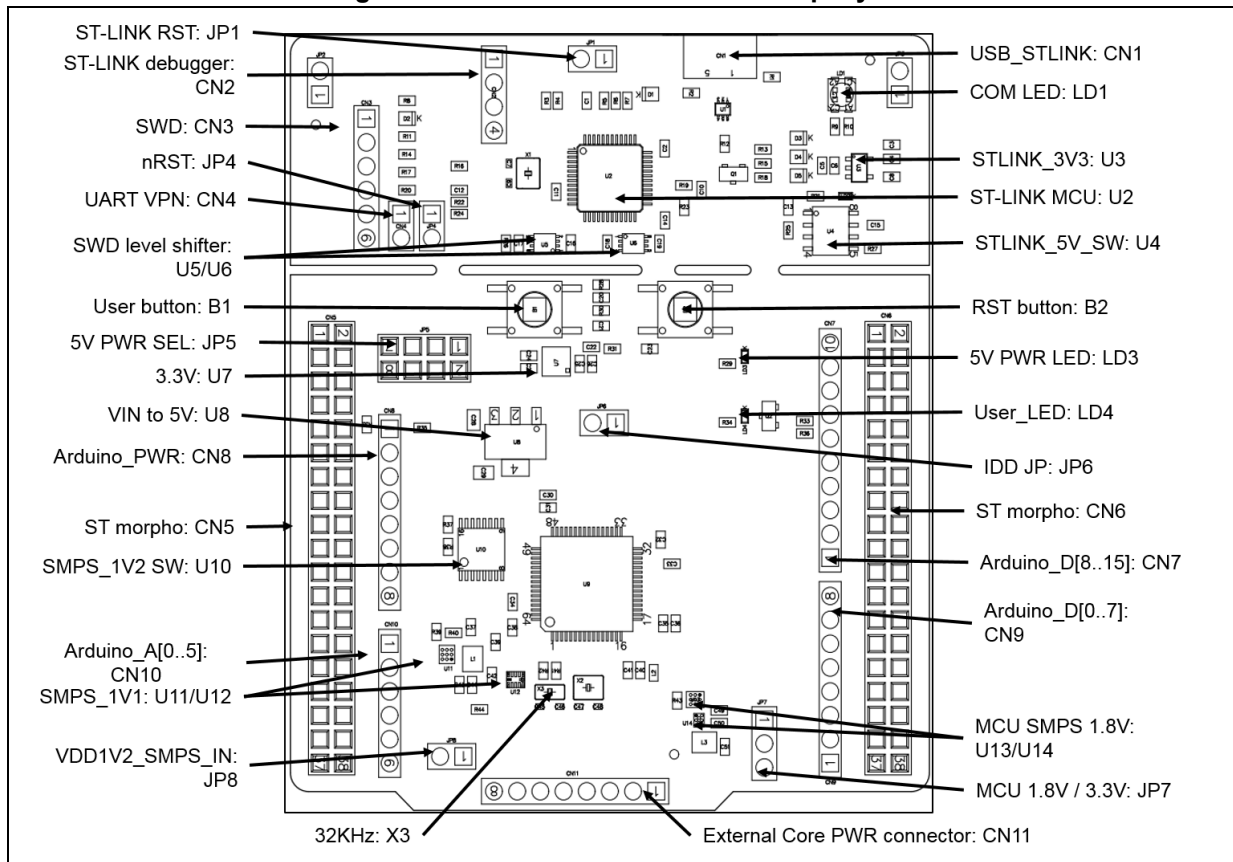


Figure 5. STM32 Nucleo-64-P board bottom layout

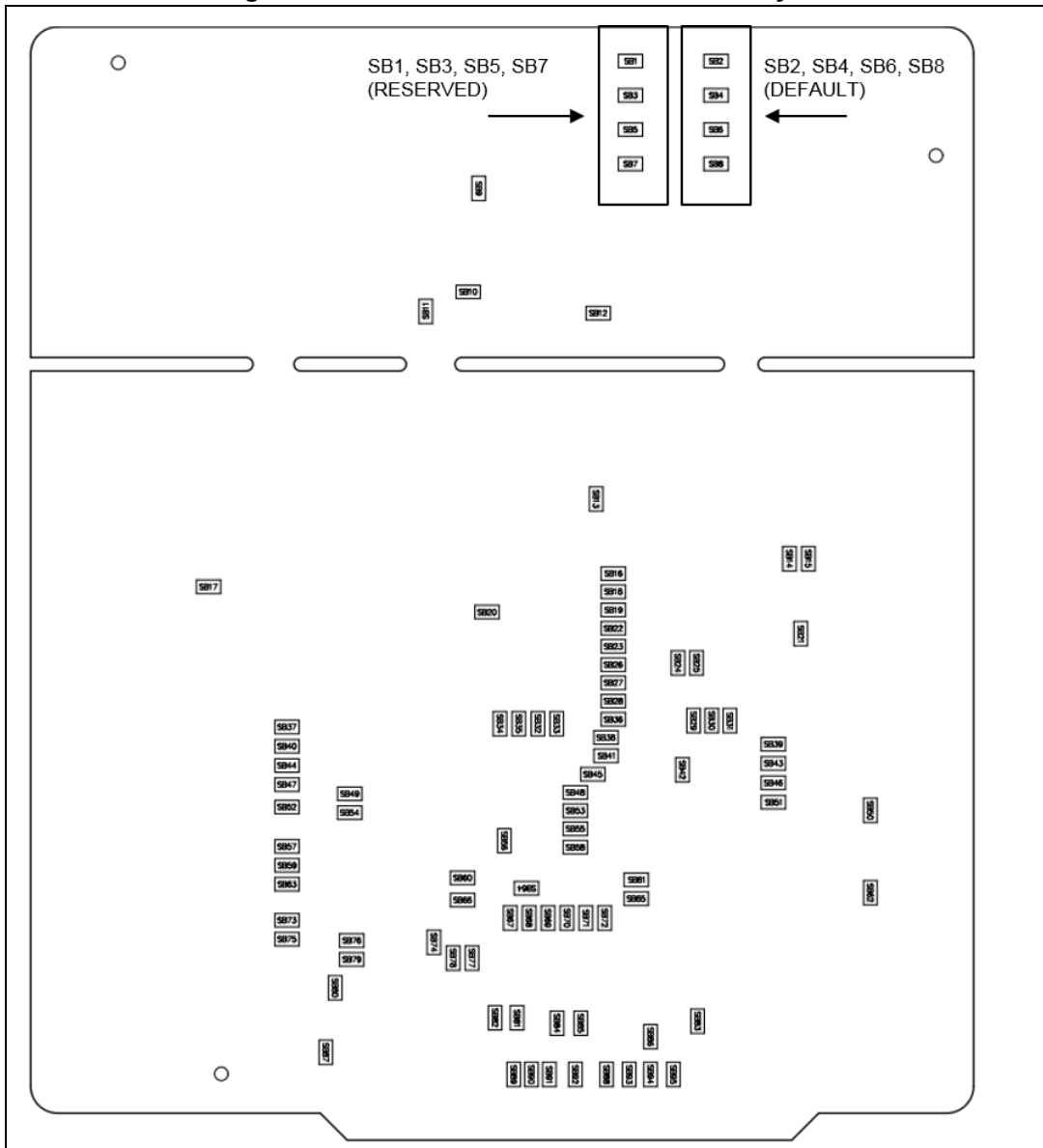




Table 4. Default jumper settings

Jumper	Definition	Default position	Comment
CN2	SWD interface	ON [1-2] ON[3-4]	On-board ST-LINK/V2-1 debugger
JP1	STLK_RST	OFF	-
JP4	T_NRST	ON	-
JP5	5 V Power selection	ON [1-2]	5 V from ST-LINK
JP6	I <sub>DD</sub> measurement	ON	STM32 V <sub>DD</sub> current measurement
JP7	V <sub>DD_MCU</sub>	ON [1-2] (default)	V <sub>DD_MCU</sub> voltage selection 3.3 V
		ON [2-3] (optional)	V <sub>DD_MCU</sub> voltage selection 1.8 V
JP8	V <sub>DD_IN_SMPS</sub>	ON	V <sub>DD_1V2</sub> SMPS input power supply

### 6.3 Cuttable PCB

An STM32 Nucleo-64-P board is divided into two parts: ST-LINK and target STM32. The ST-LINK part of the PCB can be cut out to reduce the board size. In this case the remaining target STM32 part can only be powered by V<sub>IN</sub>, E5V and 3.3 V on the ST morpho connector CN5, or by V<sub>IN</sub> and 3.3 V ARDUINO<sup>®</sup> connector CN8.

It is still possible to use the ST-LINK part to program the STM32, using wires between the CN3 and SWD available signals on the ST morpho connector (SWCLK CN5 pin 17, SWDIO CN5 pin 15 and NRST CN5 pin 14, same I/O level as V<sub>DD\_MCU</sub>).

### 6.4 Embedded ST-LINK/V2-1

The ST-LINK/V2-1 programming and debugging tool is integrated on the STM32 Nucleo-64-P board.

For information about debugging and programming features, refer to *ST-LINK/V2 in-circuit debugger/programmer for STM8 and STM32* User manual (UM1075) at the [www.st.com](http://www.st.com) website.

The changes versus ST-LINK/V2 version are listed below.

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 100mA power on USB

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

- SWIM interface
- Application voltage lower than 3 V (need to add level shifter to support it)



The embedded ST-LINK/V2-1 can be used in two different ways according to the jumper states (refer to [Table 5](#)):

- Program/debug the STM32 on board,
- Program/debug an STM32 in an external application board using a cable connected to SWD connector.

**Table 5. ST-LINK jumper configuration**

CN	Definition	Default position	Comment
CN3	T_SWCLK / T_SWDIO	ON [1-2] ON [3-4]	ST-LINK/V2-1 functions enabled for on-board programming (default)
	T_SWCLK / T_SWDIO	OFF [1-2] OFF [3-4]	ST-LINK/V2-1 functions enabled from external connector (SWD supported)

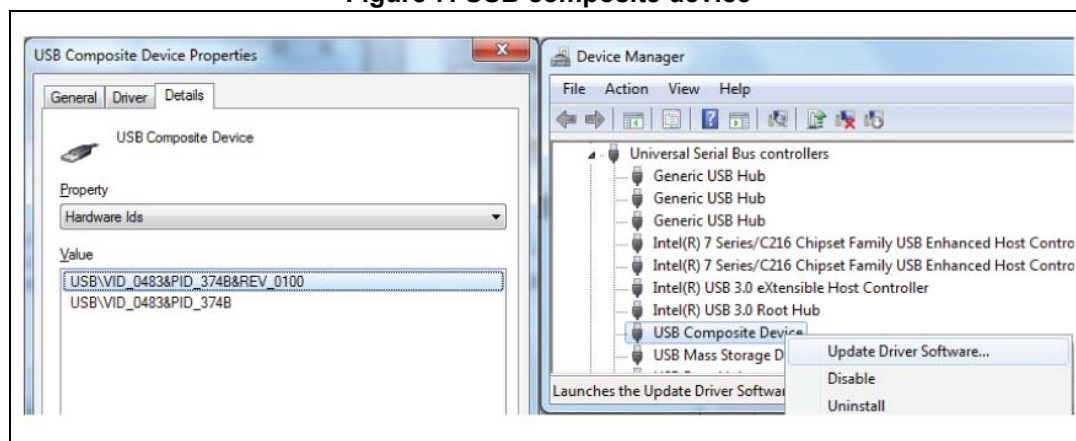
### 6.4.1 Drivers

Before connecting the STM32 Nucleo-64-P board to a Windows® PC (XP, 7, 8 and 10) through USB, install the driver for the ST-LINK/V2-1 that is available at the [www.st.com](http://www.st.com) website.

In case the STM32 Nucleo-64-P board is connected to the PC before installing the driver, the PC device manager may report some Nucleo interfaces as “Unknown”. To recover from this situation, after installing the dedicated driver, the association of “Unknown” USB devices found on the STM32 Nucleo-64-P board to this dedicated driver, must be updated in the device manager manually.

*Note: It is recommended to proceed by using USB Composite Device, as shown in [Figure 7](#).*

**Figure 7. USB composite device**



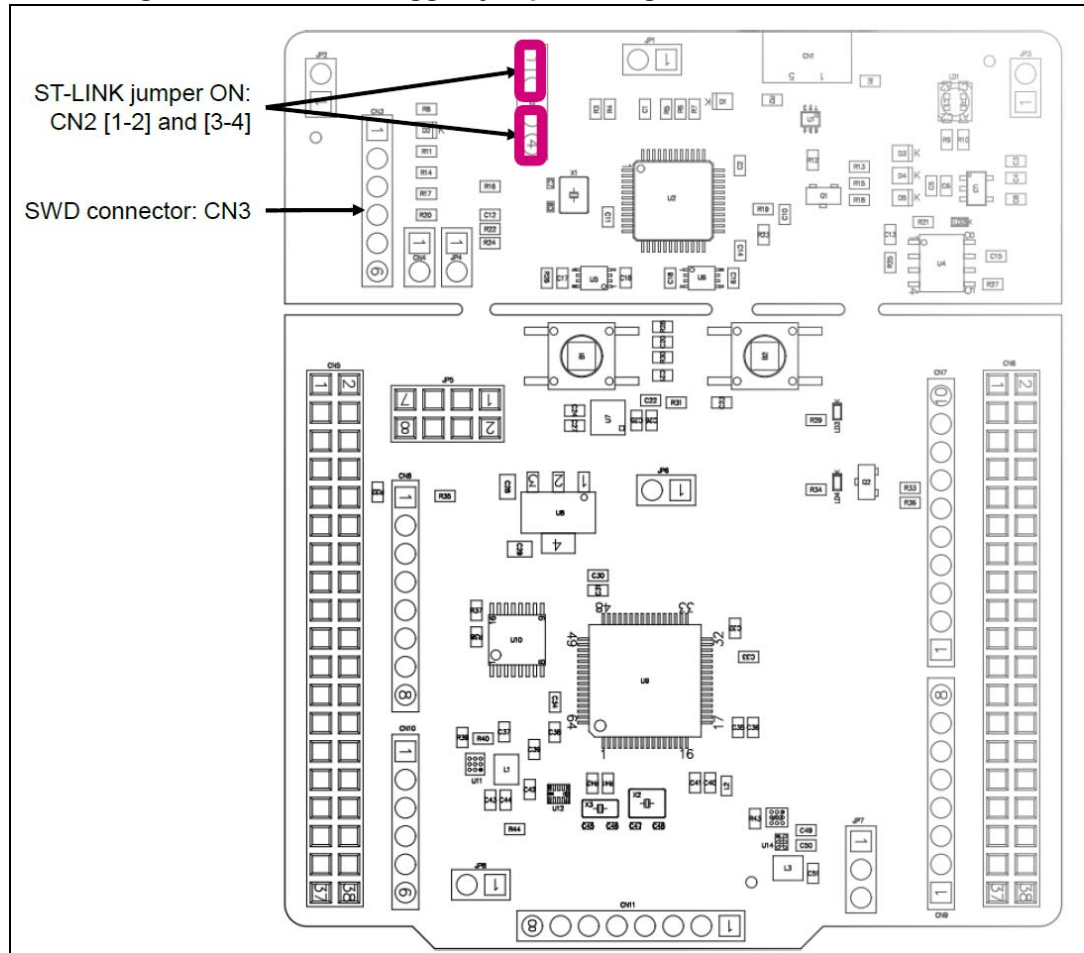
### 6.4.2 ST-LINK/V2-1 firmware upgrade

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 lifetime of the ST-LINK/V2-1 product (for example new functionalities, bug fixes, support for new microcontroller families), it is recommended to keep the ST-LINK/V2-1 firmware up to date before starting to use an STM32 Nucleo-64-P board. The latest version of this firmware is available at the [www.st.com](http://www.st.com) website.

### 6.4.3 Using the ST-LINK/V2-1 to program/debug the STM32

To program the STM32, place the two jumpers marked in red on the connector CN2, as shown in [Figure 8](#). Do not use the SWD connector to not disturb the communication with the STM32 microcontroller of the Nucleo-64-P board.

**Figure 8. ST-LINK debugger: jumper configuration for on-board MCU**



### 6.4.4 Using the ST-LINK/V2-1 to program/debug an external STM32 application.

It is very easy to use the ST-LINK/V2-1 to program the STM32 on an external application.

Simply remove the two jumpers from CN2, as shown in [Figure 9](#), and connect the application to the SWD debug connector according to [Table 6](#).

*Note:* JP4 NRST (target STM32 RESET) must be opened when CN3 pin 5 is used in an external application.

Figure 9. ST-LINK debugger: jumper configuration for external MCU

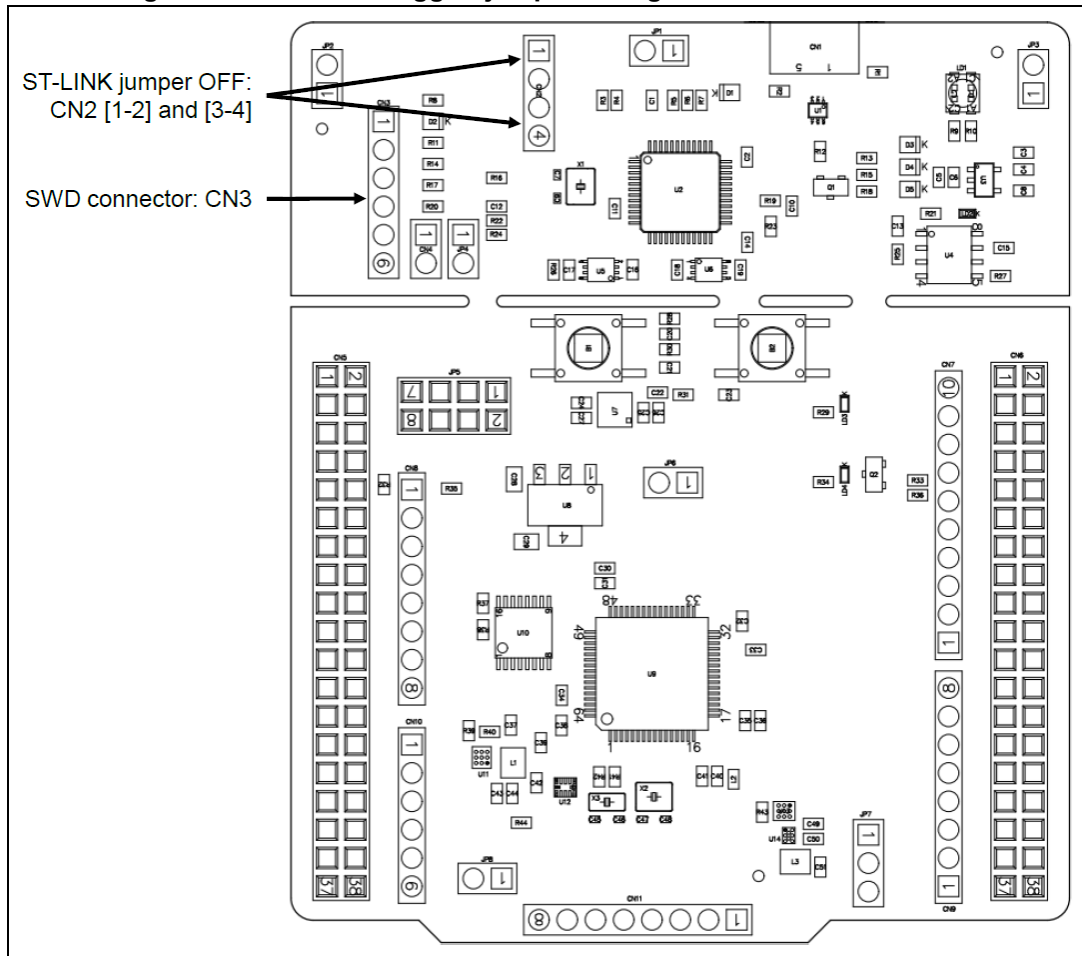


Table 6. Debug connector SWD

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
SWD CN3	1	1	VDD_TARGET: AIN_1	PA0	V <sub>DD</sub> from application
	2	2	T_JTCK	PA5	SWD clock
	3	3	GND	PA12	Ground
	4	4	T_JTMS	PA14	SWD data input/output
	5	5	T_NRST	PB0	RESET of target STM32
	6	6	T_SWO	PA10	SWD out (optional)

## 6.5 Power supply and power selection

### 6.5.1 External Power supply input

The STM32 Nucleo-64-P board is designed to be powered by several DC power supply. It is possible to supply the STM32 Nucleo-64-P board with any of the following sources:

- 5V\_ST\_LINK from ST-LINK USB connector
- $V_{IN}$  (7 V-12 V) from ARDUINO® connector or ST morpho connector
- E5V from ST morpho connector
- 5V\_USB\_CHARGER from ST-LINK USB
- 3.3 V on ARDUINO® connector or ST morpho connector

*Note:* If an external 5V DC power source is used, the Discovery board must be powered by a power supply unit or by an auxiliary equipment complying with the standard EN-60950-1: 2006+A11/2009 and must be Safety Extra Low Voltage (SELV) with limited power capability.

The power supply capabilities are shown in [Table 7](#).

**Table 7. Power supply capabilities**

Input power name	Connector pins	Voltage range	Max current	Limitation
$V_{BUS}$ (5V_STLINK)	CN1 pin 1	4.75 V to 5.25 V	500 mA	Max current depends on the USB enumeration: – 100 mA without enumeration – 500 mA with enumeration OK
$V_{IN}$	CN8 pin 8 CN5 pin 24	7 V to 12 V	800 mA	From 7 V to 12 V only and input current capability is linked to input voltage: – 800 mA input current when $V_{IN}=7$ V – 450 mA input current when $7 V < V_{IN} < 9$ V – 300 mA input current when $10 V > V_{IN} > 9$ V – less than 300 mA input current when $V_{IN} > 10$ V
E5V	CN5 pin 6	4.75 V to 5.25 V	500 mA	
5V_USB_CHG	CN1 pin 1	4.75 V to 5.25 V	500 mA	Max current depends on the USB wall charger used to powered the Nucleo board
3.3V	CN8 pin 4 CN5 pin 16 JP6 pin 2	3 V to 3.6 V	-	Used when ST-LINK part of PCB not used or removed and SB13 OFF

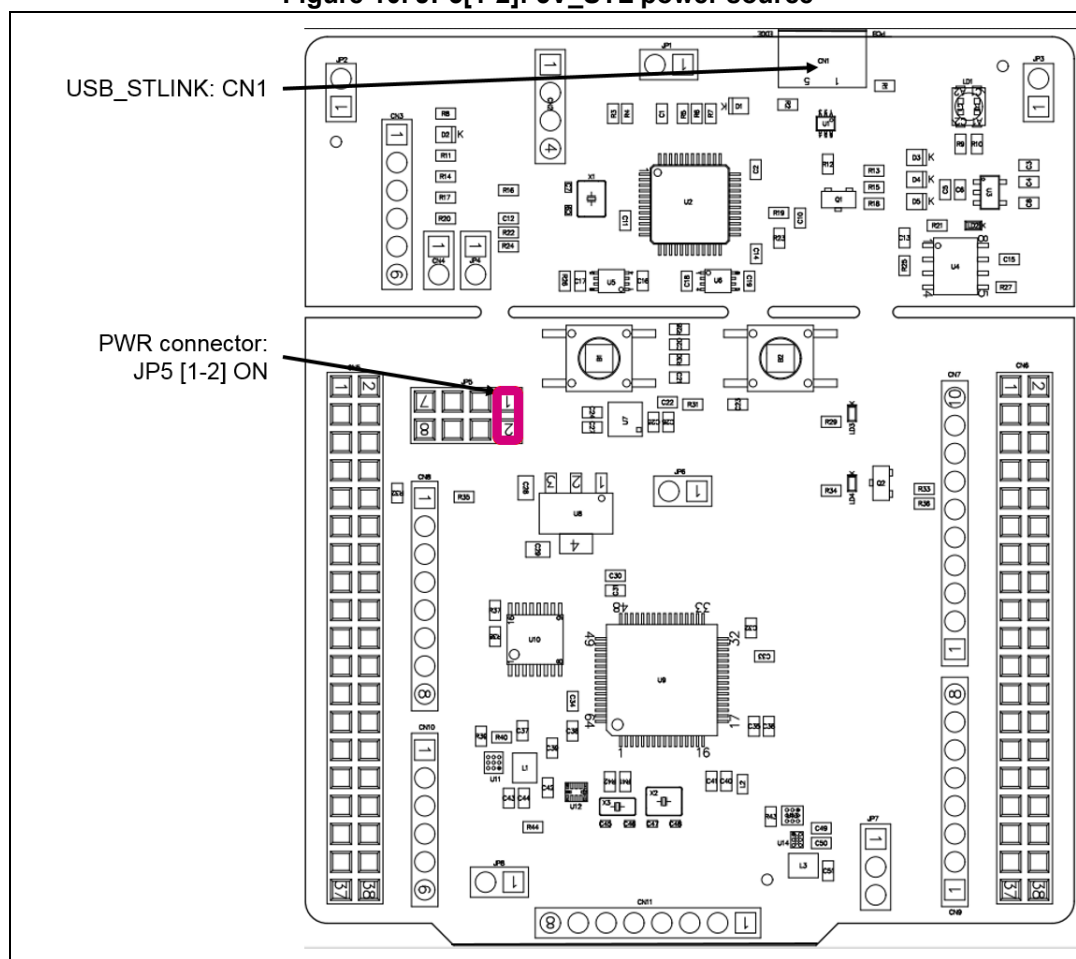
**5V\_ST\_LINK** is a DC power with limitation from ST-LINK USB connector (USB type Micro-B connector of ST-LINK/V2-1). In this case JP5 jumper should be on pins 1 and 2 to select 5V\_STL power source on silkscreen of JP5. This is the default setting. If the USB enumeration succeeds, the 5V\_ST\_LINK power is enabled, by asserting the PWR\_ENn signal (from STM32F103CBT6). This pin is connected to a power switch ST890, which

powers the board. This power switch also features a current limitation to protect the PC in case of a short-circuit on board (more than 750 mA).

The STM32 Nucleo-64-P board and its shield can be powered from the ST-LINK USB connector CN1, but only ST-LINK circuit is powered before USB enumeration, because the host PC only provides 100 mA to the board at that time. During the USB enumeration, STM32 Nucleo-64-P board requires 500 mA of current to the host PC. If the host is able to provide the required power, the enumeration ends by a “SetConfiguration” command and then, the power transistor ST890 is switched ON, the green LED LD3 is turned ON, thus the STM32 Nucleo-64-P board and its shield request no more than 500 mA current. If the host is not able to provide the required current, the enumeration fails. Therefore the power switch ST890 stays OFF and the MCU part including the extension board is not powered. As a consequence the green LED LD3 stays turned OFF. In this case it is mandatory to use an external power supply.

USB power: 5V\_STL configuration: jumper JP5[1-2] should be connected as shown in [Figure 10](#).

**Figure 10. JP5[1-2]: 5V\_STL power source**

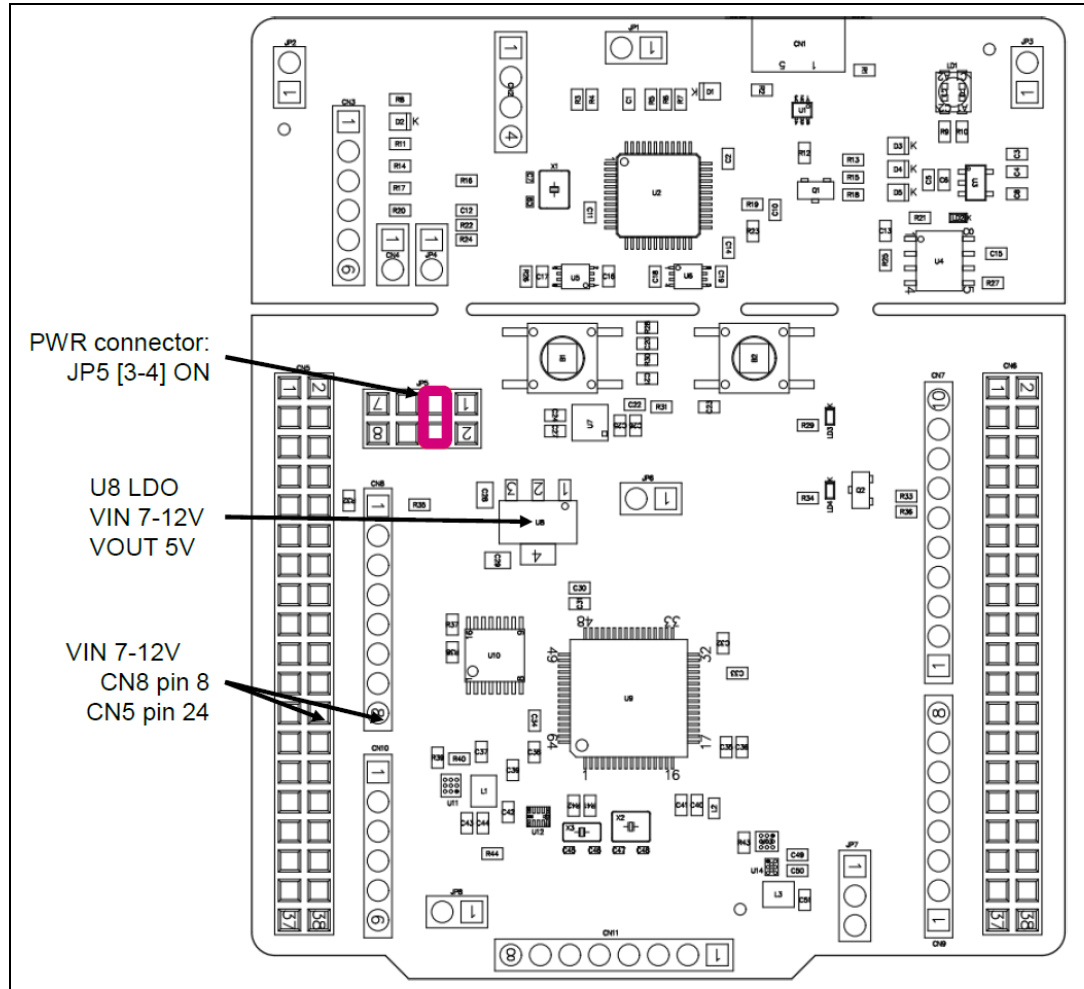


**VIN (5V\_VIN)** is the 7-12 V DC power from ARDUINO® CN8 pin 8 named  $V_{IN}$  on ARDUINO® connector silkscreen or from ST morpho connector CN5 pin 24. In this case JP5 jumper

should be on pins 3 and 4 to select 5V\_VIN power source on silkscreen of JP5. In that case the DC power comes from the power supply through the ARDUINO® Uno V3 battery shield (compatible with Adafruit® PowerBoost 500 shield).

5V\_VIN configuration: jumper JP5[3-4] should be connected as shown in [Figure 11](#).

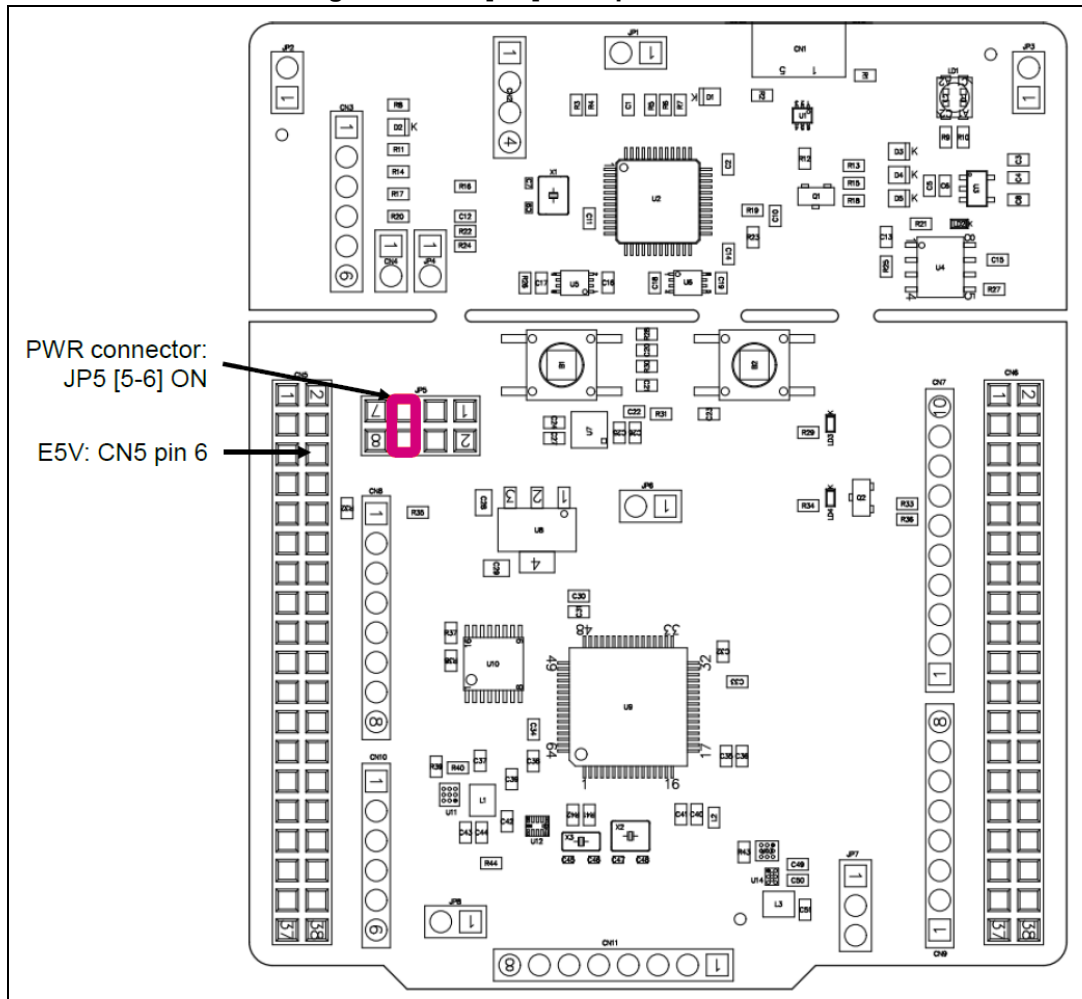
**Figure 11. JP5[3-4]: 5V\_VIN power source**



**E5V** is the DC power coming from external (5V DC power from ST morpho connector CN5 pin 6). In this case JP5 jumper should be on pins 5 and 6 to select E5V power source on silkscreen of JP5.

E5V configuration: Jumper JP5[5-6] should be connected as shown in [Figure 12](#).

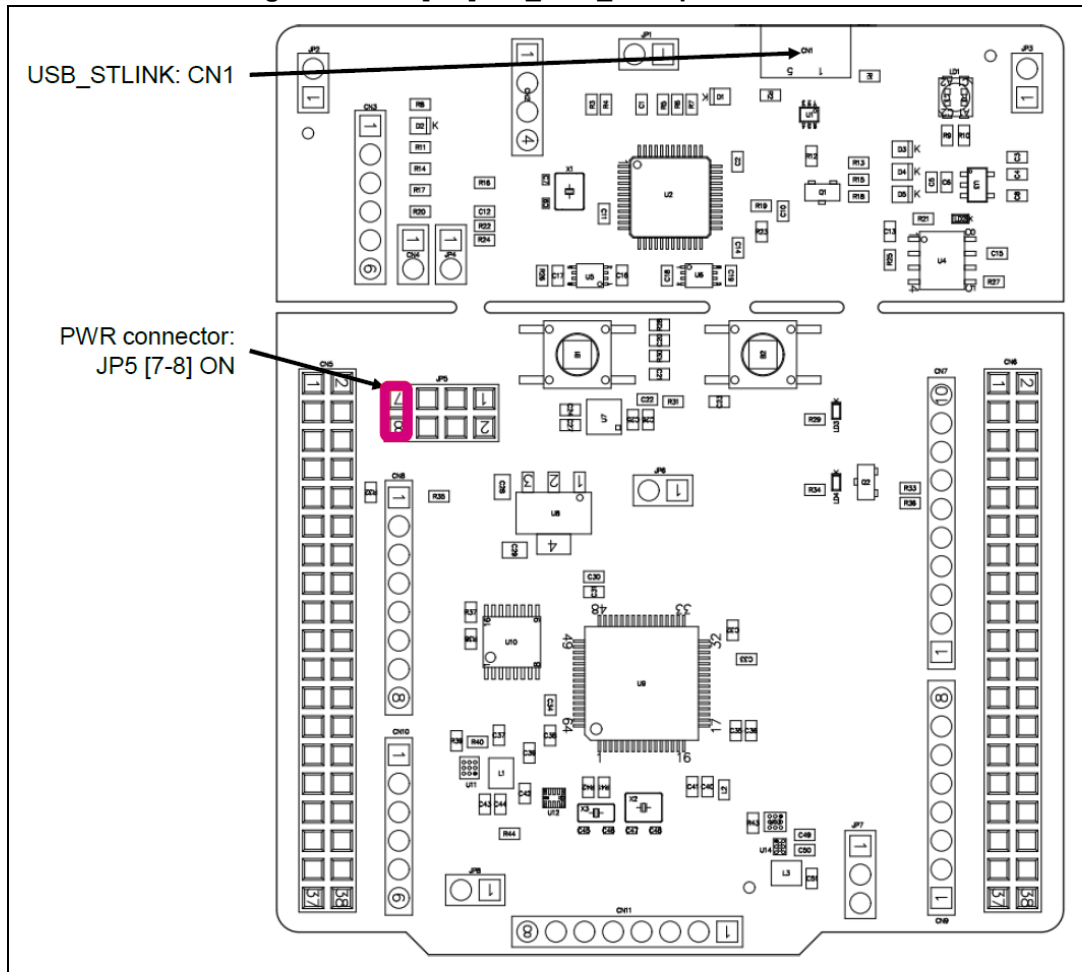
Figure 12. JP5[5-6]: E5V power source



**5V\_USB\_CHARGER** is the DC power charger connected to USB ST-LINK (CN1). To select the 5V\_USB\_CHARGER power source on silkscreen of JP5, the jumper of JP5 should be on pins 7 and 8. In this case, if the STM32 Nucleo-64-P board is powered by an external USB charger the debug is not available. If the PC is connected instead of the charger, the limitation is no more effective, in this case the PC could be damaged.

5V\_USB\_CHG configuration: jumper JP5[7-8] should be connected as shown in [Figure 13](#).

Figure 13. JP6[7-8]: 5V\_USB\_CHG power source



**Caution:** Solder bridge SB9 can be used to bypass the USB power protection ST890. (**This is not an ST recommended setting**). SB9 can be set in case the board is powered by the USB of the PC and maximum current consumption on 5V\_STLINK **does not exceed 100 mA** (including extension board or ARDUINO® shield power consumption). In such condition USB enumeration will always succeed since no more than 100 mA is requested to the PC. Configurations of SB9 are summarized in [Table 8](#).

Table 8. SB9 configurations

Solder bridge	Default position	Power supply	Allowed current
SB9	OFF (not soldered)	USB PWR through CN1	500 mA max limited by ST890
	ON (soldered)		100 mA max
	OFF (not soldered)	VIN or E5V PWR	Whatever current is: no limitation
	ON (soldered)		SB9 must be removed when the board is powered <sup>(1)</sup>

1. SB9 must be removed when the board is powered by E5V (CN5 pin 6) or by V<sub>IN</sub> (CN8 pin 8 or CN5 pin 24).



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**Warning:** In case the maximum current consumption of the STM32 Nucleo-64-P board and its extension boards exceeds 500 mA, it is recommended to power the STM32 Nucleo-64-P board using an external power supply connected to E5V or  $V_{IN}$ .

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## 6.5.2 External power supply output

**5 V:** the 5 V (CN8 pin 5 or CN5 pin 18) can be used as output power supply for an ARDUINO® shield or an extension board, when the STM32 Nucleo-64-P board is powered by USB,  $V_{IN}$  or E5V. In this case the maximum current allowed is shown in [Table 7](#).

**3.3 V:** on CN8 pin 4 or CN5 pin 16 can be also used as power supply output. The current is limited by the maximum current capability of the regulator U7 (LD39050PUR33 from STMicroelectronics). In this condition the maximum consumption of the STM32 Nucleo-64-P board and the connected shield should be less than 500 mA.

## 6.5.3 SMPS power supply

Power figures in Run mode are significantly improved by:

- Generating  $V_{core}$  logic supply from an external SMPS (switched-mode power supply) or from an external connector
- Generating  $V_{DD\_MCU}$  supply from an external SMPS (switched-mode power supply), or from an external connector

The STM32 Nucleo-64-P board is populated with two SMPSs, U11 and U13, with the following functions:

- SMPS U11 allows to supply dynamically the  $V_{DD\_1V2}$  pins in Run mode at 1.1 V with a maximum current of 30 mA.
- SMPS U13 allows to supply the  $V_{DD\_MCU}$  pin at 1.8 V with a maximum current of 50 mA (hysteresis operation mode). The SMPS U13 can deliver higher current (PWM operation mode) but with less efficiency. To set the U13 SMPS in PWM mode remove SB80 and solder SB79. This SMPS is enabled by default.

$V_{DD\_MCU}$  configuration:

- 3.3 V (default): JP7 to pins 1 and 2
- 1.8 V: JP7 to pins 2 and 3 (best ULPBench score)

*Note:* The ST-LINK is still available in this configuration thanks to the level shifters U5 and U6.

For all general information concerning design recommendations for the STM32 with external SMPS, refer to the *Design recommendations for STM32L4xxxx with external SMPS, design guide for ultra-low-power applications with performance* Application note (AN4978) available at the [www.st.com](http://www.st.com) website.

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

$V_{IN}$  or E5V is used as an external power supply in case the current consumption of the STM32 Nucleo-64-P board and its extension boards exceed the allowed current on the USB. In such condition it is still possible to use the USB for communication, programming or debugging only.

In this case it is mandatory to power the board first using  $V_{IN}$  or E5V then to connect the USB cable to the PC. Proceeding this way the enumeration succeeds, thanks to the external power source.

The following power sequence procedure must be respected:

1. Connect jumper JP5 between pins 3 and 4 for  $V_{IN}$  or pins 5 and 6 for E5V
2. Be sure that SB9 is removed
3. Connect the external power source to  $V_{IN}$  or E5V
4. Power ON the external power supply  $7\text{ V} < V_{IN} < 12\text{ V}$  to  $V_{IN}$ , or 5 V for E5V
5. Check that the green LED LD3 is turned ON
6. Connect the PC to the USB connector CN1

If this sequence is not respected, the board may be powered by  $V_{BUS}$  first from the ST-LINK, with the following risks:

- If more than 500 mA current is needed by the board, the PC may be damaged or the current supplied may be limited by the PC. As a consequence the board is not powered correctly.
- 500 mA is requested at the enumeration (since SB9 must be OFF): this request can be rejected and the enumeration does not succeed if the PC cannot provide such current, consequently the board is not power supplied (LED LD3 remains OFF).

## 6.7 OSC clock sources

Three clock sources are listed below:

- LSE which is the 32.768 KHz crystal for the STM32 embedded RTC
- MCO which is the 8 MHz clock from the ST-LINK MCU for the STM32 microcontroller
- HSE which is the 8 MHz oscillator for the STM32 microcontroller. This clock is not implemented on the STM32 Nucleo-64-P board.

### 6.7.1 LSE: OSC 32 KHz clock supply

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

**LSE on-board oscillator X3 crystal (Default configuration).** Refer to *Oscillator design guide for STM8S, STM8A and STM32 microcontrollers* Application note (AN2867) for oscillator design guide for STM32 microcontrollers. It is recommended to use NX3215SA manufactured by NDK (32.768 kHz, 6 pF, 20 ppm).

**Oscillator from external to PC14 input:** from external oscillator through pin 25 of the CN5 connector.

The following configuration is needed:

- SB71 and SB72 ON
- R41 and R42 removed

**LSE not used:** PC14 and PC15 are used as GPIOs instead as low-speed clock.

The following configuration is needed:

- SB71 and SB72 ON
- R41 and R42 removed

### 6.7.2 OSC clock supply

There are four ways to configure the pins corresponding to the external-high-speed clock (HSE):

**MCO from ST-LINK (Default: not connected):** MCO output of ST-LINK MCU is used as an input clock. This frequency cannot be changed, it is fixed at 8 MHz and connected to PH0 OSC\_IN of the STM32 microcontroller.

The following configuration is needed:

- SB67, SB69 and SB70 OFF
- SB64 ON

In this configuration PH1 is used as I/O (SB68 ON)

**HSE: on-board oscillator X2 crystal (Default: not connected):** for typical frequencies and its capacitors and resistors, refer to the STM32 microcontroller datasheet. Refer to the *Oscillator design guide for STM8S, STM8A and STM32 microcontrollers* Application note (AN2867) for oscillator design guide for the STM32 microcontrollers. The X2 crystal has the following characteristics: 8 MHz, 8 pF, 20 ppm. It is recommended to use NX3225GD manufactured by NDK.

The following configuration is needed:

- SB64, SB68, SB70 OFF
- SB67 and SB69 ON
- C47 and C48 soldered with 8.2 pF capacitors

**External oscillator to PH0 input (Default: not connected):** from an external oscillator through pin 29 of the CN5 connector.

The following configuration is needed:

- SB64, SB67 and SB69 OFF
- SB70 ON
- In this configuration PH1 is used as I/O (SB68 ON)

**HSE not used (Default configuration):** PH0 and PH1 are used as GPIO and not as clock.

The following configuration is needed:

- SB58 and SB60 OFF
- SB59 and SB61 ON
- R21 removed

## 6.8 Reset sources

The reset signal of the STM32 Nucleo-64-P board is active low and the reset sources include:

- Reset button B2
- Embedded ST-LINK/V2-1
- ARDUINO® Uno V3 connector from CN8 pin 3
- ST morpho connector CN5 pin 14

## 6.9 Virtual COM port: LPUART1/USART1

The LPUART1 or USART1 interface of the STM32 can be connected to:

- The ST-LINK/V2-1 MCU
- The ARDUINO® Uno V3 connectors: CN9 (pins 1 and 2)
- The ST morpho connector (pins 35 and 37).

The LPUART1 or USART1 interface is selected by setting the related solder bridge (see [Table 9](#) and [Table 10](#)).

**Table 9. LPUART1 connection**

Solder bridge	Feature
SB66 / SB75 ON SB32, SB34, SB60, SB73 OFF	LPUART1 (PA2/PA3) connected to ST-LINK Virtual COM port.
SB60 / SB73 ON SB33, SB35 SB66, SB75 OFF	LPUART1 (PA2/PA3) connected to ARDUINO® and ST morpho connector.

**Table 10. USART1 connection**

Solder bridge	Feature
SB32 / SB34 ON SB33, SB35, SB66, SB75 OFF	USART1 (PA9/PA10) connected to ST-LINK Virtual COM port.
SB33 / SB35 ON SB32, SB34 SB60, SB73 OFF	USART1 (PA9/PA10) connected to ARDUINO® and ST morpho connector.

By default:

- Communication between target STM32 and ST-LINK/V2-1 MCU is enabled on LPUART1 to support the Virtual COM port
- Communication between target STM32 and ARDUINO® and ST morpho connector is enabled on USART1

The Virtual COM port settings are configured as: 115200 b/s, 8 bits data, no parity, 1 stop bit, no flow control.

## 6.10 LEDs

Four LEDs are available on the STM32 Nucleo-64-P board. The four LEDs are located on the top side of the board.

**LD1 COM:** LD1 is a bi-color LED. LD1 default status is red. LD1 turns to green to indicate that communication is in progress between the PC and the ST-LINK/V2-1 as follow:

- Slow blinking red/off: at power-on before USB initialization
- Fast blinking red/off: after the first correct communication between the PC and the ST-LINK/V2-1 (enumeration)
- Red LED on: when initialization between the PC and the ST-LINK/V2-1 is successfully ended
- Green LED on: after successful STM32 communication initialization
- Blinking red/green: during communication with STM32
- Green on: communication well ended
- Orange on: communication ended with failure

**LD2: 5V\_USB:** this red LED switch ON when overcurrent is detected on USB  $V_{BUS}$ . The LED gives the information that more than 500 mA is requested on  $V_{BUS}$ . In this case it is recommended to supply the board by E5V,  $V_{IN}$  or in USB\_CHARGER mode.

**LD3: 5V\_PWR:** this green LED is ON when the STM32 Nucleo-64-P board is powered by a 5 V source.

**LD4 USER:** this green LED is a user LED connected to ARDUINO® signal D13 corresponding to STM32 I/O PB13. To light the LED a high-logic state “1” has to be written in the corresponding GPIO. A transistor is used to drive the LED when the I/O voltage is 1.8 V. LD4 consumption does not impact the  $V_{DD}$  STM32 power measurement, since LD4 is isolated from it.

## 6.11 Push buttons

Two buttons are available on the STM32 Nucleo-64-P board.

- **B1 USER:** the blue button for user and wake-up function is connected to the I/O PC13 (default) or to I/O PA0 (optional) of the STM32. When the button is depressed the logic state is “1”, otherwise the logic state is “0”.
- **B2 RESET:** the black button is connected to NRST and is used to RESET the STM32. When the button is depressed the logic state is “0”, otherwise the logic state is “1”.

The blue and black plastic hats placed on these push-buttons can be removed if necessary when a shield or an application board is plugged on top of the STM32 Nucleo-64-P board. This is to avoid pressure on the buttons and consequently a possible permanent STM32 RESET.

## 6.12 IDD measurement

The jumper JP6, labeled **IDD**, is used to measure the STM32 microcontroller, the level shifter and the SMPS consumptions (depending on solder-bridge configuration), by removing the jumper and by connecting a multimeter:

- Jumper ON: directly powered (default)
- Jumper OFF: a multimeter or an external 3.3 V power source must be connected to measure the consumption

*Note:* The STM32 Nucleo-64-P board LEDs are connected before the jumper. The LED consumptions do not impact the  $V_{DD\_MCU}$  power measurement.

## 6.13 Jumper configuration

The default jumper positions are shown in [Table 4: Default jumper settings](#). [Table 11](#) describes the other available jumper settings.

**Table 11. Jumper settings**

Jumper / CN	Function	State <sup>(1)</sup>	Comment
CN2	T_SWCLK T_SWDIO	<b>ON [1-2] ON [3-4]</b>	<b>ST-LINK/V2-1 enable for on-board MCU debugger</b>
		OFF	ST-LINK/V2-1 functions enabled for external CN2 connector
JP1	STLK_RST	ON [1-2]	Used to reset ST-LINK MCU
		<b>OFF</b>	<b>Normal use</b>
JP2/JP3	GND	OFF	GND probe
JP4	T_NRST	<b>ON</b>	<b>ST-LINK able to reset STM32</b>
		OFF	ST-LINK not able to reset STM32
JP5	5 V Power selection	<b>ON [1-2]</b>	<b>5 V from ST-LINK</b>
		ON [3-4]	5 V from V <sub>IN</sub> 7-12 V
		ON [5-6]	5 V from E5V
		ON [7-8]	5 V from USB_CHG
		OFF	No 5 V power, use 3.3 V
JP6	I <sub>DD</sub> measurement	<b>ON [1-2]</b>	<b>V<sub>DD</sub> = 3.3 V</b>
		OFF	To connect external source (ULPBench probe as an example)
JP7	V <sub>DD_MCU</sub> = 3.3 V	<b>ON [1-2]</b>	<b>V<sub>DD_MCU</sub> voltage selection = 3.3 V</b>
		ON [2-3]	V <sub>DD_MCU</sub> voltage selection = 1.8 V
		OFF	No V <sub>DD_MCU</sub> (forbidden)
JP8	V <sub>DD_IN_SMPS</sub>	<b>ON [1-2]</b>	<b>1.1 V ext SMPS input power supply</b>
		OFF	1.1 V ext SMPS not powered. Legacy configuration

1. Default jumper state is shown in bold.

## 6.14 Configuration of the solder bridges

[Table 12](#) shows the solder bridge configurations and settings.

Table 12. Solder bridge configurations and settings

Definition	Bridge	State <sup>(1)</sup>	Comment
SWD interface (reserved)	SB1/SB3 /SB5/SB7	<b>OFF</b>	Reserved, do not modify.
SWD interface (default)	SB2/SB4 /SB6/SB8	<b>ON</b>	Reserved, do not modify.
USB power by-pass mode	SB9	<b>ON</b>	USB Power switch by-passed (not recommended)
		<b>OFF</b>	USB Power switch protection enabled
SWO level shifter by-pass	SB10	<b>ON</b>	SWO not connected through level shifter
		<b>OFF</b>	SWO connected through level shifter to target MCU for 1.8 V I/O configuration
SWO_MCU	SB11	<b>ON</b>	SWO_MCU connected between ST-LINK and target STM32
		<b>OFF</b>	SWO_MCU not connected between ST-LINK and target STM32
STLK_RX by-pass	SB12	<b>ON</b>	STLK_RX not connected through level shifter
		<b>OFF</b>	STLK_RX connected through level shifter to target STM32 for 1.8 V I/O configuration
3.3 V LDO output	SB13	<b>ON</b>	U7 LDO output provides 3.3 V
		<b>OFF</b>	U7 LDO output does NOT provide 3.3 V, user has to connect an external 3.3 V source.
IOREF selection	SB14	<b>ON</b>	IOREF connected to V <sub>DD_MCU</sub> power supply
		<b>OFF</b>	IOREF NOT connected to V <sub>DD_MCU</sub> power supply
	SB15	<b>ON</b>	IOREF connected to 3.3 V_PER power supply
		<b>OFF</b>	IOREF NOT connected to 3.3 V_PER power supply
	SB21	<b>ON</b>	IOREF connected to 3.3 V power supply
		<b>OFF</b>	IOREF NOT connected to 3.3 V power supply
User LED	SB17	<b>ON</b>	User LED driven by PB13 (ARD_D13)
		<b>OFF</b>	User LED not driven
Peripheral 3.3 V	SB20	<b>ON</b>	Peripheral power supply connected to 3.3 V
		<b>OFF</b>	Peripheral power supply not powered
V <sub>DDUSB</sub> power supply MCU pin48	SB24	<b>ON</b>	V <sub>DDUSB</sub> pin 48 powered by V <sub>DD</sub>
		<b>OFF</b>	V <sub>DDUSB</sub> pin 48 is NOT powered by V <sub>DD</sub>
	SB25	<b>ON</b>	V <sub>DDUSB</sub> pin 48 powered by V <sub>DD_MCU</sub>
		<b>OFF</b>	V <sub>DDUSB</sub> pin 48 is NOT powered by V <sub>DD_MCU</sub>
V <sub>DD_1V2</sub> switch power supply	SB29	<b>ON</b>	U10 V <sub>DD_1V2</sub> power switch powered by V <sub>DD-IN</sub> SMPS 3.3 V
		<b>OFF</b>	U10 V <sub>DD_1V2</sub> power switch NOT powered by V <sub>DD-IN</sub> SMPS 3.3 V
	SB42	<b>ON</b>	U10 V <sub>DD_1V2</sub> power switch powered by 1.8 V
		<b>OFF</b>	U10 V <sub>DD_1V2</sub> power switch NOT powered by 1.8 V

**Table 12. Solder bridge configurations and settings (continued)**

Definition	Bridge	State <sup>(1)</sup>	Comment
U11/U12 SMPS out 1.1 V	SB30 / SB46	ON	V <sub>DD_1V2</sub> powered by U11/U12 through the switch U10
		OFF	V <sub>DD_1V2</sub> powered directly by U11/U12. Switch U10 is not used (not recommended, see AN4978 on the <a href="http://www.st.com">www.st.com</a> website)
	SB43	ON	V <sub>DD_1V2</sub> powered directly by U11/U12. Switch U10 is not used. (not recommended, see AN4978 on the <a href="http://www.st.com">www.st.com</a> website)
		OFF	V <sub>DD_1V2</sub> powered by U11/U12 through the switch U10
VOUTCORE	SB31 / SB46	ON	V <sub>DD_1V2</sub> powered by External V <sub>OUT</sub> V <sub>CORE</sub> from CN10 through the switch U10
		OFF	V <sub>DD_1V2</sub> powered directly by External Voutcore from CN10. Switch U10 is not used (not recommended, see AN4978 on the <a href="http://www.st.com">www.st.com</a> website)
	SB39	ON	V <sub>DD_1V2</sub> powered directly by External Voutcore from CN10. Switch U10 is not used. (not recommended, see AN4978 on the <a href="http://www.st.com">www.st.com</a> website)
		OFF	V <sub>DD_1V2</sub> powered by External Voutcore from CN10 through the switch U10
VOUT2	SB51	ON	MCU V <sub>DD_1V2</sub> connected to U12 V <sub>OUT2</sub>
		OFF	MCU V <sub>DD_1V2</sub> NOT connected to U12 V <sub>OUT2</sub>
PA10 UART1_RX	SB32	ON	STLINK_RX connected to UART1_RX PA10
		OFF	STLINK_RX NOT connected to UART1_RX PA10
	SB33	ON	ARD_D0_RX connected to UART1_RX PA10
		OFF	ARD_D0_RX NOT connected to UART1_RX PA10
PA9 UART1_TX	SB34	ON	STLINK_TX connected to UART1_TX PA9
		OFF	STLINK_TX NOT connected to UART1_TX PA9
	SB35	ON	ARD_D1_TX connected to UART1_TX PA9
		OFF	ARD_D1_TX NOT connected to UART1_TX PA9
PA2 LPUART1_TX	SB60	ON	ARD_D1_TX connected to LPUART1_TX PA2
		OFF	ARD_D1_TX NOT connected to LPUART1_TX PA2
	SB66	ON	STLINK_TX connected to LPUART1_TX PA2
		OFF	STLINK_TX NOT connected to LPUART1_TX PA2
PA3 LPUART1_RX	SB73	ON	ARD_D0_RX connected to LPUART1_RX PA3
		OFF	ARD_D0_RX NOT connected to LP UART1_RX PA3
	SB75	ON	STLINK_RX connected to LPUART1_RX PA3
		OFF	STLINK_RX NOT connected to LPUART1_RX PA3



Table 12. Solder bridge configurations and settings (continued)

Definition	Bridge	State <sup>(1)</sup>	Comment
User button	SB50	ON	User button connected to PC13
		OFF	User button NOT connected to PC13
	SB62	ON	User button connected to PA0
		OFF	User button NOT connected to PA0
AGND	SB56	ON	AGND connected to GND. Reserved, do not modify.
V <sub>BAT</sub> Power Supply MCU pin1	SB61	ON	V <sub>BAT</sub> pin 1 powered by V <sub>DD_MCU</sub>
		OFF	V <sub>BAT</sub> pin 1 NOT powered by V <sub>DD_MCU</sub>
	SB65	ON	V <sub>BAT</sub> pin 1 powered by V <sub>DD</sub>
		OFF	V <sub>BAT</sub> pin 1 NOT powered by V <sub>DD</sub>
HSE CLK selection	SB64	ON	ST-LINK MCO used for HSE CLK
		OFF	ST-LINK MCO NOT used for HSE CLK
	SB67/SB69	ON	HSE provided by External HSE CLK X2
		OFF	HSE NOT provided by External HSE CLK X2
	SB68	ON	PH1 connected to ST morpho connector I/O usage
		OFF	PH1 NOT connected to ST morpho connector
	SB70	ON	PH0 connected to ST morpho connector
		OFF	PH0 NOT connected to ST morpho connector MCO usage
LSE CLK selection	SB71/SB72	ON	PC14&PC15 connected to ST morpho connector, LSE NOT provided by External LSE CLK X3,
		OFF	LSE provided by External HSE CLK X3 (R41/R42) PC13/PC14 not connected to ST morpho connector
SMPS 1.8 V part input	SB76	ON	SMPS 1.8 V U13/U14 powered by V <sub>DD</sub> =3.3 V
		OFF	SMPS 1.8 V U13/U14 NOT powered
AVDD / VREF	SB77	ON	V <sub>DDA</sub> pin 13 powered by V <sub>DD</sub>
		OFF	V <sub>DDA</sub> pin 13 NOT powered by V <sub>DD</sub>
	SB78	ON	V <sub>DDA</sub> pin 13 powered by V <sub>DD_MCU</sub>
		OFF	V <sub>DDA</sub> pin 13 NOT powered by V <sub>DD_MCU</sub>
U13 mode SYN/PWM	SB79	ON	U13 is in PWM mode
	SB80	ON	U13 is in hysteresis mode
ST1PS02 voltage selection	SB81/SB82 SB90/SB91/SB94 SB96/SB97		Refer to ST1PS02 datasheet for voltage range configuration
ADP5301 U9 VID selection	SB83	ON	ADP5301 output voltage factory ADP5301 opt0 = 2.5 V ADP5301 Opt1 = 1.3 V
		OFF	ADP5301 output voltage defined by R39

**Table 12. Solder bridge configurations and settings (continued)**

Definition	Bridge	State <sup>(1)</sup>	Comment
ADP5301 U9 EN selection	SB84 / SB85	<b>SB84 ON</b>	ADP5301 EN pin driven by I/O: SMPS_EN PA4
		SB85 ON	ADP5301 always enabled (level 1)
ADP5301 Mode selection	SB86 / SB95	SB86 ON	ADP5301 set in PWM mode (500 mA out, low efficiency)
		<b>SB95 ON</b>	ADP5301 set in hysteresis mode (50 mA out, best efficiency)
VDD_MCU selection	SB87	<b>ON</b>	V <sub>DD_MCU</sub> connected to CN11 V <sub>OUT</sub> V <sub>DD</sub>
		OFF	V <sub>DD_MCU</sub> not connected to CN11 V <sub>OUT</sub> V <sub>DD</sub>
SMPS_SW enable	SB88	<b>ON</b>	Switch driven by I/O SMPS_SW PA7
		OFF	Switch NOT driven by I/O, Switch driven by U12 pin 1 AUX or CN11 pin 5
ST1PS02 U12 voltage selection	SB89	<b>ON</b>	ST1PS02 U12 output selection by I/O SMPS_V1 PA5
		OFF	ST1PS02 U12 output fixed by solder bridge, or driven by U11 pin 4
SMPS U11/U12 enable	SB92	<b>ON</b>	SMPS U11/ U12 enabled pin driven by the I/O SMPS_EN PA4
		OFF	SMPS U11/ U12 NOT enabled by I/O. Enable pin level fixed by solder bridge or driven by CN11 pin 5
SMPS U11/U12 PWR GOOD	SB93	<b>ON</b>	SMPS U11/ U12 Power Good connected to I/O SMPS_PG PA6
		OFF	<b>SMPS U11/ U12 Power Good NOT to I/O.</b> Can be connected to be driven by CN11 pin 7

1. Default SBx state is shown in bold.

SB16, SB18, SB19, SB22,SB23, SB26, SB27, SB28, SB36, SB37, SB38, SB40, SB41, SB44, SB45, SB47, SB48, SB49, SB52, SB53, SB54, SB55, SB57, SB58, SB59, SB63, **are linked to the STM32 configuration. Do not modify them.**

All STM32 Nucleo-64-P boards are delivered with solder bridges configured according to the target STM32 supported.

## 7 Connectors

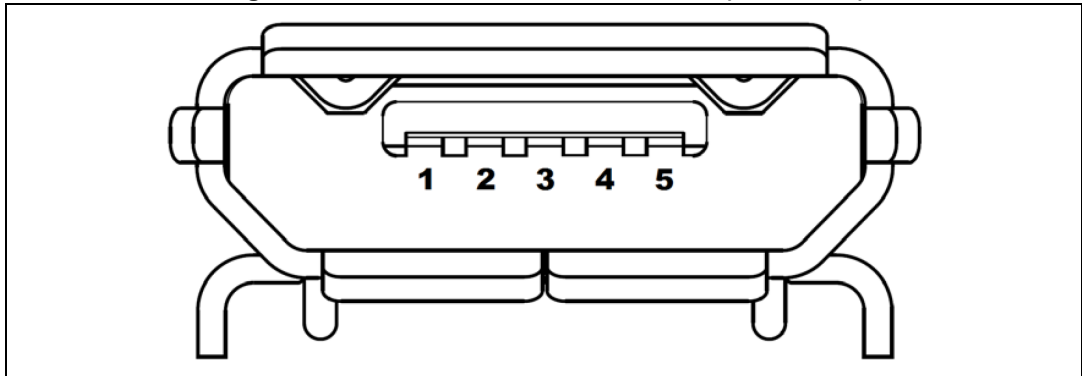
Eight connectors are implemented on the STM32 Nucleo-64-P board:

- CN1: ST-LINK USB connector
- CN7, CN8, CN9 and CN10: ARDUINO® Uno V3 connectors
- CN5 and CN6: ST morpho connectors
- CN11: External SMPS connector

### 7.1 USB Micro-B connector CN1

The USB connector CN1 is used to connect the embedded ST-LINK/V2-1 to the PC for programming and debugging the STM32 Nucleo-64-P board microcontroller.

Figure 14. USB Micro-B connector CN1 (front view)



The related pinout for the USB ST-LINK connector is listed in [Table 13](#).

Table 13. USB Micro-B pinout

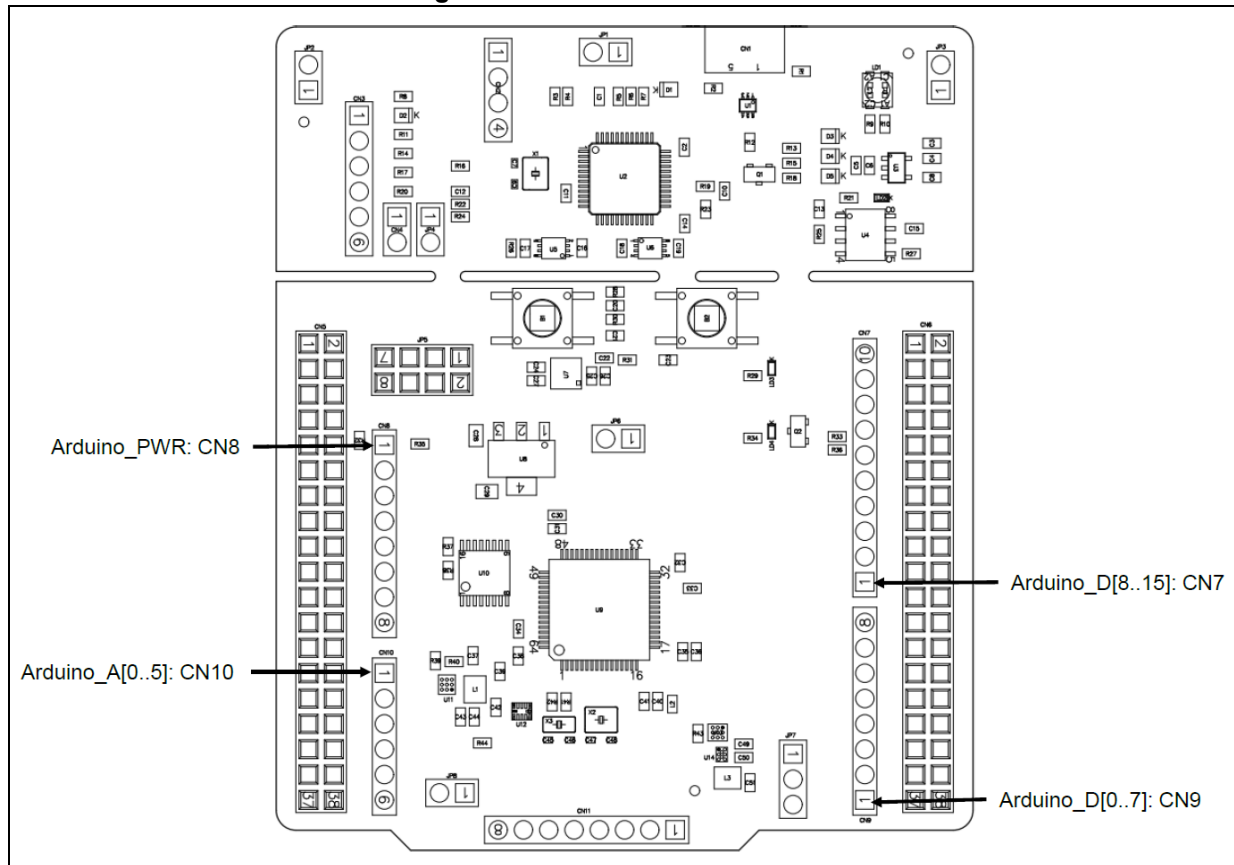
Connector	Pin number	Pin name	Signal name	ST-LINK MCU pin	Function
CN1	1	VBUS	5V_STLINK / 5V_USB_CHG	-	5 V power
	2	DM (D-)	STLINK_USB_D_N	PA11	USB diff pair M
	3	DP (D+)	STLINK_USB_D_P	PA12	USB diff pair P
	4	ID	-	-	-
	5	GND	-	-	GND

## 7.2 ARDUINO<sup>®</sup> Uno V3 connectors

The ARDUINO<sup>®</sup> connectors CN7, CN8, CN9 and CN10 (see [Figure 15](#)) are female connectors compatible with ARDUINO<sup>®</sup> standard. Most shields designed for ARDUINO<sup>®</sup> can fit to the STM32 Nucleo-64-P board.

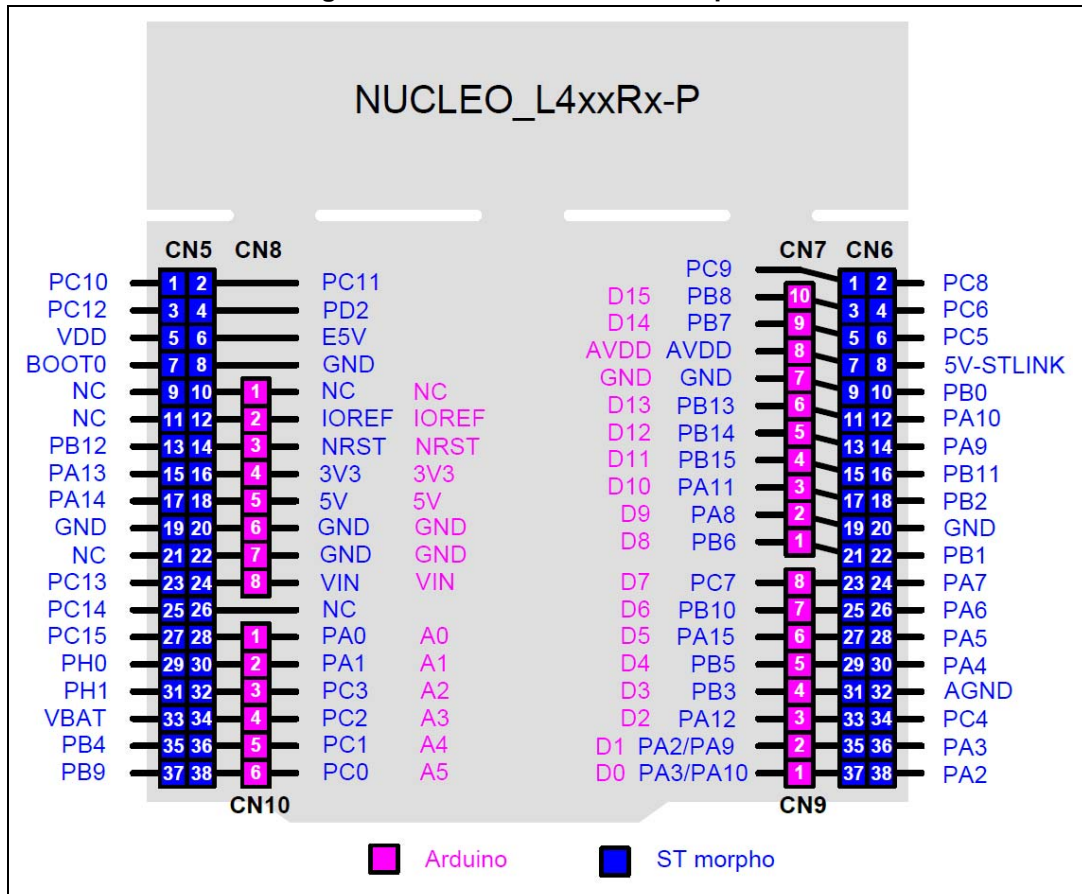
The ARDUINO<sup>®</sup> connectors on STM32 Nucleo-64-P board support the ARDUINO<sup>®</sup> Uno V3.

**Figure 15. ARDUINO<sup>®</sup> connectors**



The related pinout for ARDUINO<sup>®</sup> connector is shown in [Figure 16](#) and listed in [Table 14](#).

Figure 16. ARDUINO® connector pinout



Note: ARDUINO® Uno V3 D0 and D1 signals are connected by default on USART1 (MCU I/O PA9 and PA10). For details about how to modify the UART interface, refer to [Section 6.9: Virtual COM port: LPUART1/USART1](#).

Table 14. ARDUINO® connector pinout

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN8	1	NC	-	-	Reserved for test
	2	IOREF	-	-	I/O reference
	3	NRST	NRST	NRST	RESET
	4	3.3 V	-	-	3.3 V input/output
	5	5V	-	-	5 V output
	6	GND	-	-	GND
	7	GND	-	-	GND
	8	VIN	-	-	7-12 V power input

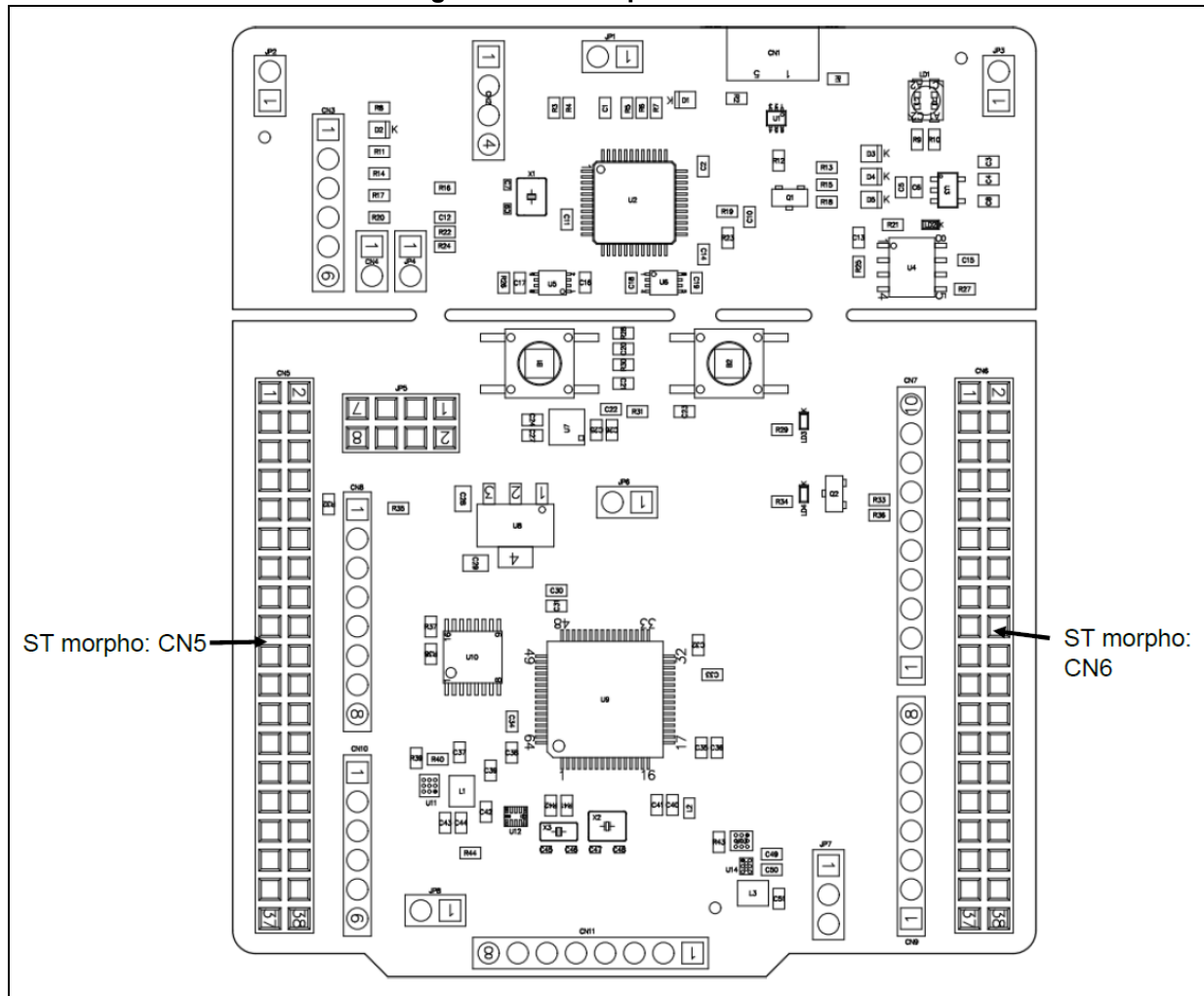
Table 14. ARDUINO® connector pinout (continued)

Connector	Pin number	Pin name	Signal name	STM32 pin	Function
CN10	1	A0	ADC	PA0	ADC1_IN5
	2	A1	ADC	PA1	ADC1_IN6
	3	A2	ADC	PC3	ADC1_IN4
	4	A3	ADC	PC2	ADC1_IN3
	5	A4	ADC	PC1	ADC1_IN2/I2C3_SDA
	6	A5	ADC	PC0	ADC1_IN1/I2C3_SCL
CN7	10	SCL/D15	ARD_D15	PB8	I2C1_SCL
	9	SDA/D14	ARD_D14	PB7	I2C1_SDA
	8	AVDD	VREF	-	VREF
	7	GND	-	-	Ground
	6	SCK/D13	ARD_D13	PB13	SPI2_SCK
	5	MISO/D12	ARD_D12	PB14	SPI2_MISO
	4	PWM/MOSI/D11	ARD_D11	PB15	TIM15_CH2/SPI2_MOSI
	3	PWM/CS/D10	ARD_D10	PA11	TIM1_CH4/SPIx_NSS
	2	PWM/D9	ARD_D9	PA8	TIM1_CH1
	1	D8	ARD_D8	PB6	IO
CN9	8	D7	ARD_D7	PC7	IO
	7	PWM/D6	ARD_D6	PB10	TIM2_CH3
	6	PWM/D5	ARD_D5	PA15	TIM2_CH1
	5	D4	ARD_D4	PB5	EXT_IT_5
	4	PWM/D3	ARD_D3	PB3	TIM2_CH2
	3	D2	ARD_D2	PA12	IO
	2	TX/D1	ARD_D1	PA2 / PA9	LPUSART1_TX / USART1_TX
	1	RX/D0	ARD_D0	PA3 / PA10	LPUSART1_RX / USART1_RX

### 7.3 ST morpho connectors CN5 and CN6

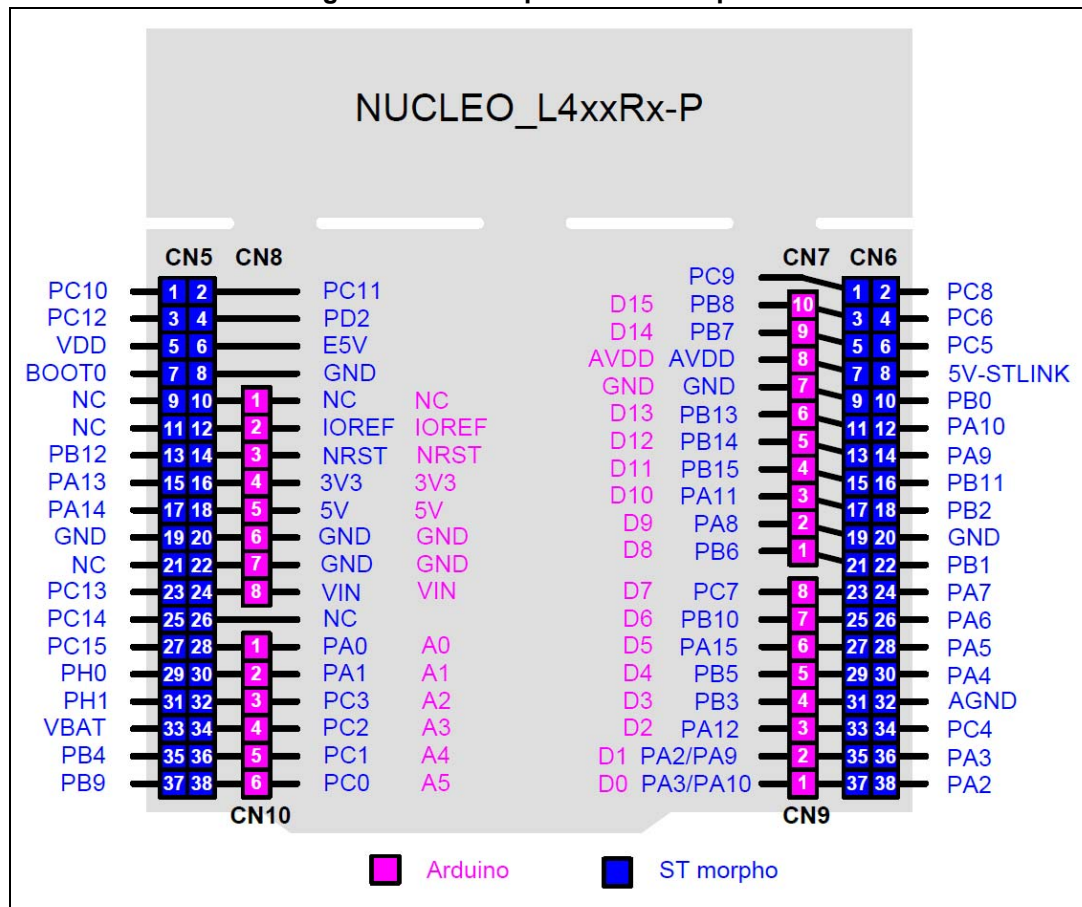
The ST morpho connectors CN5 and CN6 are male pin headers accessible on both sides of the STM32 Nucleo-64-P board (see [Figure 17](#)). All signals and power pins, except  $V_{DD\_CORE}$  1.2 V of the STM32, are available on the ST morpho connectors. These connectors can also be probed by an oscilloscope, logical analyzer or voltmeter.

Figure 17. ST morpho connector



The related pinout and the MCU assignment for the ST morpho connector are listed in [Figure 18](#).

Figure 18. ST morpho connector pinout



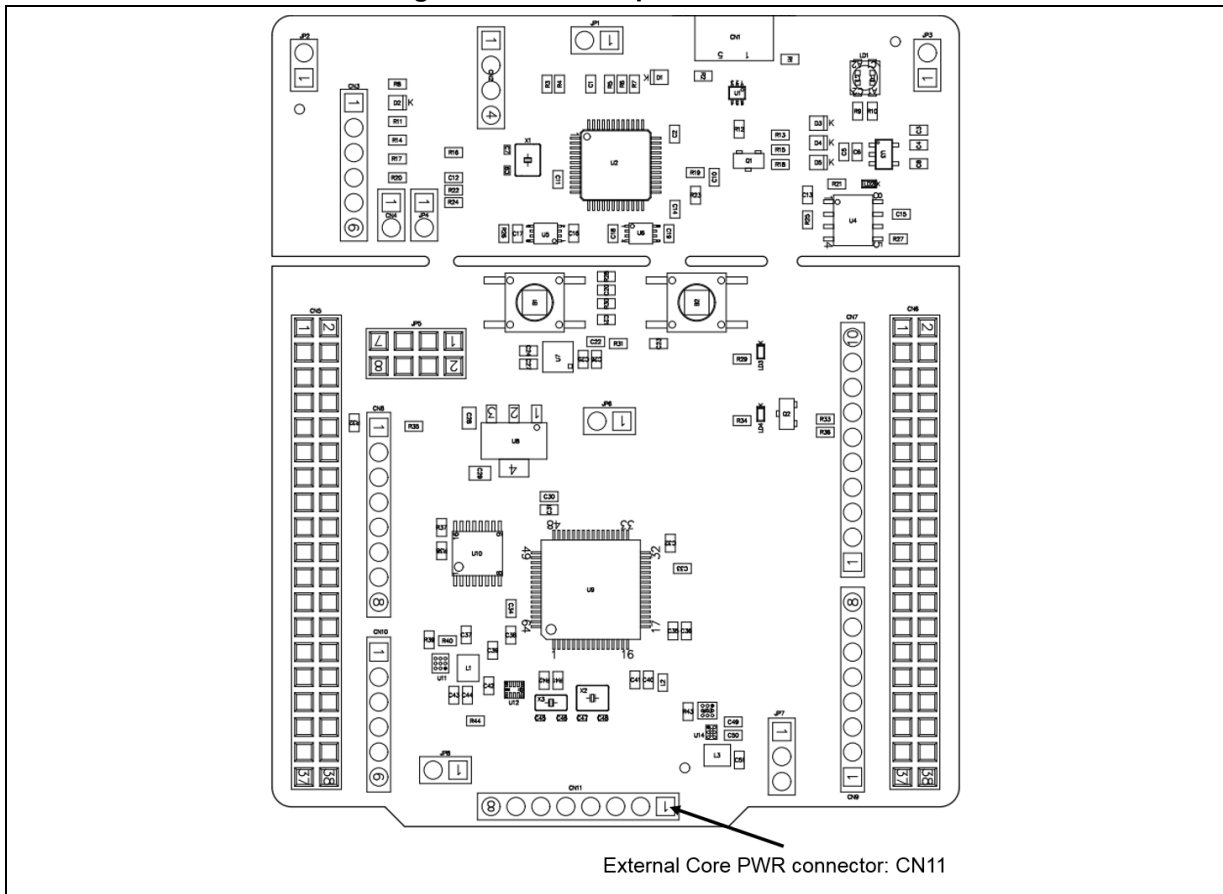
Note: ARDUINO<sup>®</sup> Uno V3 D0 and D1 signals are connected by default on USART1 (MCU I/O PA9 and PA10). Refer to [Section 6.9: Virtual COM port: LPUART1/USART1](#) for details about UART interface modification.

## 7.4 External power connector

The external power connector CN11 is an 8-pin, single-row, 2.54 mm-pitch connector. By default this connector is not soldered. The PCB footprint gives the possibility to easily control the  $V_{core}$  logic and the  $V_{DD\_MCU}$  power supply with an external source. The external power connector is shown in [Figure 19](#).



Figure 19. External power connector



The related pinout for external power connector is listed in [Table 15](#).

Table 15. External power connector pinout

Connector	Pin number	Signal name	STM32 pin	Function
CN11	1	V <sub>DD</sub>	V <sub>DD</sub>	V <sub>DD</sub> @ 3.3 V supply
	2	V <sub>OUTCORE</sub>	V <sub>DD_1V2</sub>	MCU Core PWR 1.2 V/1.1 V
	3	V <sub>OUTVDD</sub>	V <sub>DD_MCU</sub>	V <sub>DD_MCU</sub> : 1.8 V / 3.3 V
	4	SMPS_V1	PA5	I/O for voltage selection
	5	SMPS_EN	PA4	I/O for SMPS enable
	6	SMPS_SW	PA7	I/O for switch control
	7	SMPS_PG	PA6	I/O for Power Good signal
	8	GND	GND	Ground

## Appendix A NUCLEO-L412RB-P, NUCLEO-L433RC-P and NUCLEO-L452RE-P I/O assignment

Table 16. NUCLEO-L412RB-P, NUCLEO-L433RC-P and NUCLEO-L452RE-P I/O assignment

Pin No.	Pin name	Signal or label	Main feature / optional feature (SB)
1	V <sub>BAT</sub>	V <sub>BAT</sub>	PWR V <sub>BAT</sub>
2	PC13	PC13	User Button / I/O
3	PC14-OSC32_IN	OSC32_IN / PC14	LSE CLK / I/O
4	PC15-OSC32_OUT	OSC32_OUT / PC15	LSE CLK / IO
5	PH0-OSC_IN	OSC_IN / PH0	I/O / HSE CLK
6	PH1-OSC_OUT	OSC_OUT / PH1	I/O / HSE CLK
7	NRST	NRST	RESET
8	PC0	PC0	ARD_A5 - ADC1_IN1 / I2C3_SCL / IO
9	PC1	PC1	ARD_A4 - ADC1_IN2 / I2C3_SDA / IO
10	PC2	PC2	ARD_A3 - ADC1_IN3 / IO
11	PC3	PC3	ARD_A2 - ADC1_IN4 / IO
12	VSSA	GND	PWR GND
13	V <sub>DDA</sub> /V <sub>REF+</sub>	AVDD	PWR AVDD
14	PA0	PA0	ARD_A0 - ADC1_IN5 / user button
15	PA1	PA1	ARD_A1 - ADC1_IN6
16	PA2	LPUART1_TX	STLINK_TX / ARD_D1_TX
17	PA3	LPUART1_RX	STLINK_RX / ARD_D0_RX
18	V <sub>SS</sub>	GND	PWR GND
19	V <sub>DD</sub>	VDD_MCU	PWR V <sub>DD_MCU</sub> 1.8 V / 3.3 V
20	PA4	PA4	SMPS_EN / IO
21	PA5	PA5	SMPS_V1 / IO
22	PA6	PA6	SMPS_PG / IO
23	PA7	PA7	SMPS_SW / IO
24	PC4	PC4	I/O
25	PB0	PB0	I/O
26	PB1	PB1	I/O
27	PB2	PB2	PB2
28	PB10	PB10	ARD_D6 / TIM2_CH3
29	PB11	PB11	I/O
30	V <sub>DD1V2</sub>	V <sub>DD12</sub>	PWR ExtSMPS 1V1

**Table 16. NUCLEO-L412RB-P, NUCLEO-L433RC-P and NUCLEO-L452RE-P I/O assignment (continued)**

Pin No.	Pin name	Signal or label	Main feature / optional feature (SB)
31	V <sub>SS</sub>	GND	PWR GND
32	V <sub>DD</sub>	V <sub>DD_MCU</sub>	PWR V <sub>DD_MCU</sub> 1.8 V / 3.3 V
33	PB12	PB12	I/O
34	PB13	PB13	ARD_D13 - SPI2_SCK / LED / IO
35	PB14	PB14	ARD_D12 - SPI2_MISO / IO
36	PB15	PB15	ARD_D11 - SPI2_MOSI - TIM15_CH2 / I/O
37	PC6	PC6	I/O
38	PC7	PC7	ARD_D7 / IO
39	PC8	PC8	I/O
40	PC9	PC9	I/O
41	PA8	PA8	ARD_D9 - TIM1_CH1 / IO
42	PA9	UART1_TX	ARD_D1_TX / STLINK_TX
43	PA10	UART1_RX	ARD_D0_RX / STLINK_RX
44	PA11	PA11	ARD_D10 - TIM1_CH4 - SPIx-CS / IO
45	PA12	PA12	ARD_D2 / IO
46	PA13	PA13	TMS_SWDIO
47	V <sub>SSUSB</sub>	GND	PWR GND
48	V <sub>DDUSB</sub>	V <sub>DD_MCU</sub> / V <sub>DD</sub>	PWR V <sub>DD_MCU</sub> 1.8 V / 3.3 V
49	PA14	PA14	TCK_SWCLK
50	PA15	PA15	ARD_D5 - TIM2_CH1 / IO
51	PC10	PC10	I/O
52	PC11	PC11	I/O
53	PC12	PC12	I/O
54	PB3	PB3	ARD_D3 - TIM2_CH2 / SWO
55	PB4	PB4	I/O
56	PB5	PB5	ARD_D4 / IT5
57	PB6	PB6	ARD_D8 / IO
58	PB7	PB7	ARD_D14 - I2C1_SDA / IO
59	PH3-BOOT0	BOOT0	BOOT0
60	PB8	PB8	ARD_D15 - I2C1_SCL / IO
61	PB9	PB9	I/O
62	V <sub>DD1V2</sub>	V <sub>DD12</sub>	PWR ExtSMPS 1.1 V

Table 16. NUCLEO-L412RB-P, NUCLEO-L433RC-P and NUCLEO-L452RE-P I/O assignment (continued)

Pin No.	Pin name	Signal or label	Main feature / optional feature (SB)
63	$V_{SS}$	GND	PWR GND
64	$V_{DD}$	$V_{DD\_MCU}$	PWR $V_{DD\_MCU}$ 1.8 V / 3.3 V

## Appendix B Federal Communications Commission (FCC) and Industry Canada (IC) Compliance

### B.1 FCC Compliance Statement

#### B.1.1 Part 15.19

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.

#### B.1.2 Part 15.105

This equipment 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 equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment 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 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 circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

#### B.1.3 Part 15.21

Any changes or modifications to this equipment not expressly approved by STMicroelectronics may cause harmful interference and void the user's authority to operate this equipment.

### B.2 IC Compliance Statement

This device complies with FCC and Industry Canada RF radiation exposure limits set forth for general population for mobile application (uncontrolled exposure). This device must not be collocated or operating in conjunction with any other antenna or transmitter.

**B.2.1 Compliance Statement**

Notice: 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.

Industry Canada ICES-003 Compliance Label: CAN ICES-3 (B) / NMB-3 (B)

**B.2.2 Déclaration de conformité**

Avis: Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts 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.

Étiquette de conformité à la NMB-003 d'Industrie Canada: : CAN ICES-3 (B) / NMB-3 (B).

## Appendix C CISPR32

### C.1 Warning

Warning: This device is compliant with Class B of CISPR32. In a residential environment, this equipment may cause radio interference.

Avertissement: Cet équipement est conforme à la Classe B de la CISPR 32. Dans un environnement résidentiel, cet équipement peut créer des interférences radio.

## Revision history

**Table 17. Document revision history**

Date	Revision	Changes
8-Jun-2017	1	Initial release.
6-Sep-2017	2	Updated <i>Section Appendix C: Federal Communications Commission (FCC) and Industry Canada (IC) Compliance</i> and <i>Section Appendix D: CISPR32</i> .
23-Aug-2018	3	Extended document scope to the NUCLEO-L412RB-P board: updated <i>Introduction</i> , <i>Table 1: Ordering information</i> , <i>ST1PS02 voltage selection</i> in <i>Table 12: Solder bridge configurations and settings</i> , and <i>Table 16: NUCLEO-L412RB-P, NUCLEO-L433RC-P and NUCLEO-L452RE-P I/O assignment</i> . Updated <i>Chapter 2: Product marking</i> . Updated schematics from <i>Figure 20</i> to <i>Figure 26</i> for board revision C-01.
3-Apr-2020	4	Updated UART1_TX/SB35 description in <i>Table 12: Solder bridge configurations and settings</i> . Removed <i>Electrical schematics</i> . Reorganized the beginning of the document: <ul style="list-style-type: none"> <li>– Updated document title</li> <li>– Updated <i>Features</i>, <i>Ordering information</i>, and <i>Development toolchains</i></li> <li>– Added <i>Product marking</i> and <i>Codification</i></li> </ul>



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