Bluetooth® Low Energy expansion board based on the STM32WB05KN for STM32 Nucleo boards

Introduction

The X-NUCLEO-WB05KN1 expansion board provides Bluetooth® Low Energy connectivity for developer applications and can be plugged into an STM32 Nucleo development board (for example NUCLEO-U575ZI-Q) through its ARDUINO® Uno V3 connectors.

The expansion board features Bluetooth® v5.4 compliant and FCC-certified STM32WB05KN. This SoC manages the complete Bluetooth® Low Energy stack and protocols on its Arm® Cortex®-M0+ core and programmable flash memory. STM32WB05KN supports central and peripheral modes and increased transfer rates with data length extension (DLE).

X-NUCLEO-WB05KN1 interfaces with the STM32 Nucleo microcontroller via UART (default) with and without hardware flow control. Full duplex SPI with an interrupt line is also available. The firmware loaded on the module defines the host interface and, to modify it, simply change the firmware without modifying the hardware.

Figure 1. X-NUCLEO-WB05KN1 global view

Picture is not contractual.

1 Typical application

The X-NUCLEO-WB05KN1 expansion board can be used for the evaluation of the STM32WB05KN device in many applications, such as:

- Point-to-point communication
- Sensor application
- Home automation and lighting
- Direct test mode (DTM)

2 Features

- Based on STM32WB05KN with preloaded network coprocessor firmware with UART interface
  - Bluetooth® v5.4 compliant
  - Bluetooth® Low Energy data packet length extension
- Embedded MLPF-NRG-01D3 integrated impedance matching network with harmonics filter
- On-board PCB antenna
- SPI interface optional through dedicated firmware
- Compatible with STM32 Nucleo boards
- Equipped with ARDUINO® Uno V3 expansion connector
- Scalable solution, capable of cascading multiple boards for larger systems
- Free comprehensive development firmware library and examples, compatible with the X-CUBE-WB05N expansion software package for STM32Cube

Note: For information on Bluetooth®, refer to the www.bluetooth.com website

Note: Arm and Cortex are registered trademarks of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

3 Ordering information

To order the X-NUCLEO-WB05KN1 expansion board, 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 references	Target STM32
X-NUCLEO-WB05KN1	• MB2160[1] • MB2032[2]	STM32WB05KNV6

1. *ARDUINO® interface board*
2. *MCU RF board*

3.1 Codification

The meaning of the codification is explained in Table 2.

Table 2. Codification explanation

X-NUCLEO-XXYYZTN	Description	Example: X-NUCLEO-WB05KN1
X-NUCLEO	STM32 Nucleo expansion boards	STM32 Nucleo expansion boards
XX	MCU series in STM32 32-bit Arm Cortex MCUs	STM32WB0 series
YY	MCU product line in the series	STM32WB05 product line
Z	STM32 package pin count: • K for 32 pins	32 pins
T	Target application	Network coprocessor
N	Sequential number	First generation of Bluetooth® Low Energy expansion board based on the STM32WB05KN for STM32 Nucleo boards

4 Development environment

4.1 System requirements

- Multi-OS support: Windows® 10, Linux® 64-bit, or macOS®
- USB Type-A or USB Type-C® to USB Type-C® cable

Note: macOS® is a trademark of Apple Inc., registered in the U.S. and other countries and regions.
Linux® is a registered trademark of Linus Torvalds.
Windows is a trademark of the Microsoft group of companies.

4.2 Development toolchains

- IAR Systems® - IAR Embedded Workbench®(1)
- Keil® - MDK-ARM(1)
- STMicroelectronics - STM32CubeIDE

1. *On Windows® only.*

5 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 fitted between Pin 1 and Pin 2
Solder bridge SBx ON	SBx connections closed by 0 Ω resistor
Solder bridge SBx OFF	SBx connections left open
Resistor Rx ON	Resistor soldered
Resistor Rx OFF	Resistor not soldered
Capacitor Cx ON	Capacitor soldered
Capacitor Cx OFF	Capacitor not soldered

6 Safety recommendations

6.1 Targeted audience

This product targets users with at least basic electronics or embedded software development knowledge like engineers, technicians, or students.

This board is not a toy and is not suited for use by children.

6.2 Handling the board

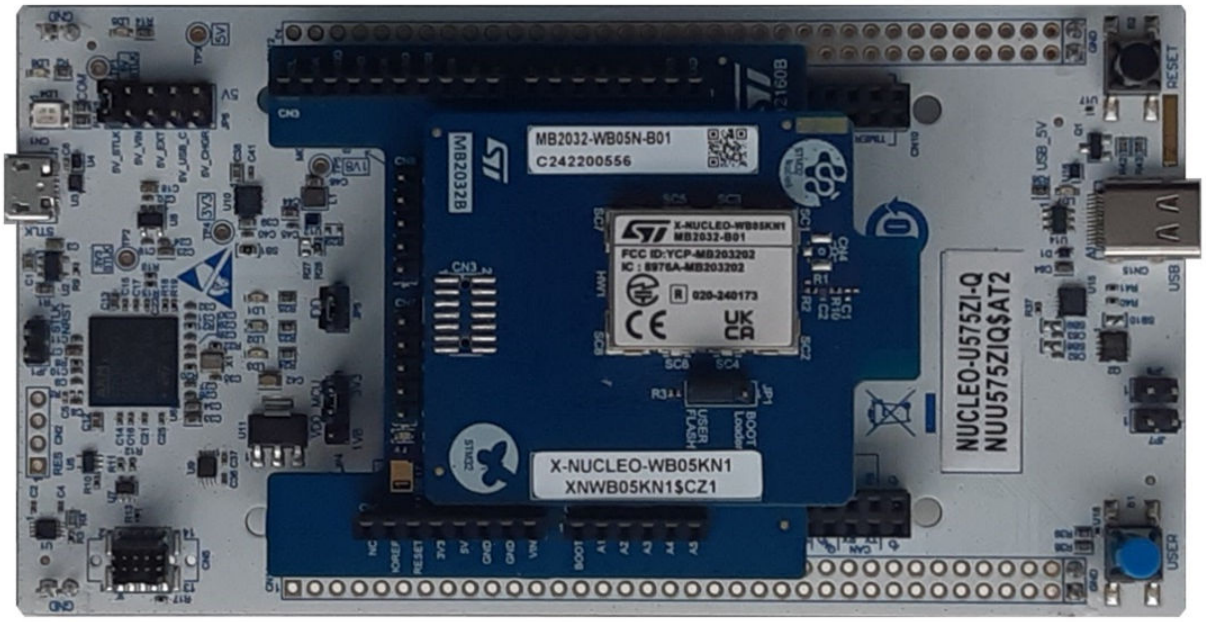
This product contains a bare printed circuit board. Like all products of this type, the user must pay attention to the following points:

- The connection pins on the board might be sharp. Be careful when handling the board to avoid personal damage.
- This board contains static-sensitive devices. To avoid damaging it, handle the board in an ESD-proof environment.
- While powered, do not touch the electric connections on the board with fingers or anything conductive. The board operates at voltage levels that are not dangerous, but components might be damaged when shorted.
- Do not put liquids on the board, and avoid using it near water or in high humidity.
- Do not operate the board if dirty or dusty.

7 Hardware requirements

The X-NUCLEO-WB05KN1 expansion board is designed for use with any STM32 Nucleo development board equipped with an ARDUINO® Uno V3 connector. The expansion board must be plugged into the matching pins of the development board connector.

Figure 2. X-NUCLEO-WB05KN1plugged into NUCLEO-U575ZI-Q



To complete the system setup, the user needs:

- A PC/laptop with Microsoft Windows 7® or above to install the software package (X-CUBE-WB05N)
- DTM project to be flashed in the STM32WB05KN device
- A USB Type-A to USB Mini-B cable to connect the STM32 Nucleo to the PC/laptop
- A 5-pin connector programming wire connected to the SWD connector (CN3) of X-NUCLEO-WB05KN1 to program it using the STM32 Nucleo or an external ST-LINK

8 Board setup

1. Connect X-NUCLEO-WB05KN1 to the STM32 Nucleo board as shown in Figure 2.
2. Connect the STM32 Nucleo to the PC/laptop.
3. Program the STM32 Nucleo with the corresponding firmware to use X-NUCLEO-WB05KN1 as a network coprocessor.

The evaluation kit is ready to use.

9 Hardware description and configuration

9.1 Interconnection details

The X-NUCLEO-WB05KN1 expansion board and the NUCLEO-U575ZI-Q development board connection details are listed in Table 4.

Table 4. **X-NUCLEO-WB05KN1 and NUCLEO-U575ZI-Q connection details**

Left connectors					Right connectors				
X-NUCLEO connector	**Pin number**	**Signal name**	**X-NUCLEO-WB05KN1 signal(1)**	**NUCLEO-U575ZI-Q MCU port(1)**	**X-NUCLEO-WB05KN1 signal(1)**	**NUCLEO-U575ZI-Q MCU port(1)**	**Signal name**	**Pin number**	**X-NUCLEO connector**
					-	PB8	D15	10	CN3 Digital
					-	PB9	D14	9	
					-	-	AVDD	8	
					GND	**GND**	GND	7	
CN5 Power	1	-	-	5V_IN test	**PB3/SPI3_SCK**	**PA5/SPI_SCK**	D13	6	
	2	IOREF	**IOREF**	**IOREF**	**PA8/SPI3_MISO**	**PA6/SPI_MISO**	D12	5	
	3	NRST	RSTN	NRST	**PA11/SPI3_MOSI**	**PA7/SPI_MOSI**	D11	4	
	4	3V3	**3V3**	**3V3**	**PA9/SPI3_NSS**	**PD14/SPI_CS**	D10	3	
	5	5V	-	5V	PB0/UART_RX	PD15	D9	2	
	6	GND	**GND**	**GND**	PA1/UART_TX/ UART_RX	PF12	D8	1	
	7	GND	**GND**	**GND**					
	8	VIN	-	VIN	**RSTN**	**PF13**	D7	8	CN4 Digital
					-	PE9	D6	7	
CN6 Analog	1	A0	**PA10/BOOT/SPI_IRQ**	**PA3**	-	PE11	D5	6	
	2	A1	-	PA2	LED	PE14	D4	5	
	3	A2	-	PC3	-	PE13	D3	4	
	4	A3	-	PB0	PA1/UART_TX	PF15	D2	3	
	5	A4	-	PC1	**PB0/UART_RX**	**PG7/UART_TX**	D1	2	
	6	A5	-	PC0	**PA1/UART_TX**	**PG8/UART_RX**	D0	1	

1. *Default connected signals are in bold.*

9.2 SPI/UART connection options

UART interface options:

X-NUCLEO-WB05KN1 interfaces with the STM32 Nucleo microcontroller via UART (default) with and without hardware flow control.

Several UART connection options between the STM32 Nucleo board and the X-NUCLEO-WB05KN1 expansion board can be used, depending on the STM32 Nucleo used, in case of signal conflict occurs when using other expansion boards, or else. To know which UART signals to connect, first look at the STM32 Nucleo schematics.

SPI interface option

X-NUCLEO-WB05KN1 can also interface with the STM32 Nucleo microcontroller via full duplex SPI with an interrupt line. For SPI connection, refer to Table 4.

9.3 X-NUCLEO-WB05KN1 description

X-NUCLEO-WB05KN1 is designed around STM32WB05KN.

X-NUCLEO-WB05KN1 includes two boards (one ARDUINO® interface board or shield board and one MCU RF board. The ARDUINO® interface board is called MB2160. It includes ARDUINO® Uno V3 expansion connectors, an SWD connector, a UART connector, one user LED, and connects to the MCU RF board via two 50-pin connectors. The MCU RF board is called MB2032 and embeds the STM32WB05KN application processor.

Figure 3 and Figure 4 help users locate the components on X-NUCLEO-WB05KN1.

Figure 3. X-NUCLEO-WB05KN1 PCB top view

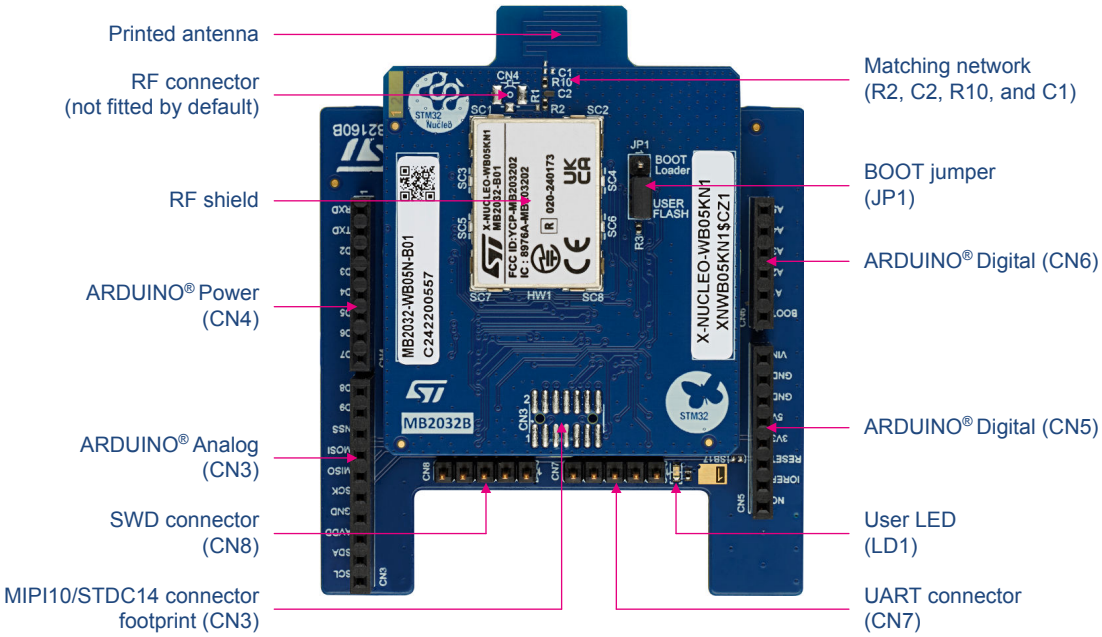
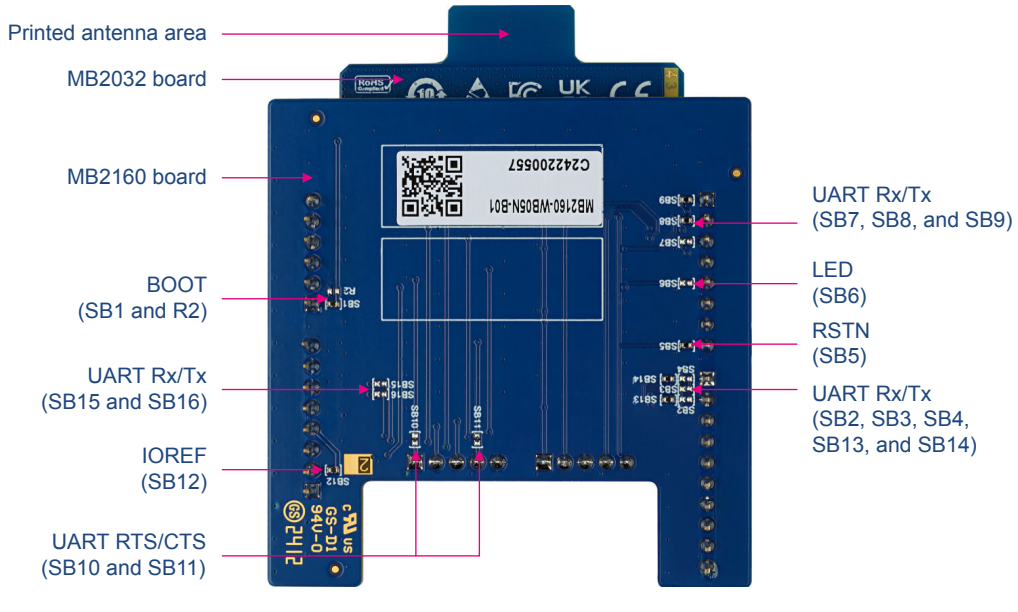


Figure 4. **X-NUCLEO-WB05KN1 PCB bottom view**



9.3.1 Power

X-NUCLEO-WB05KN1 is powered by 3V3 from the STM32 Nucleo board through the ARDUINO® Uno V3 expansion connector.

VDD supplies of the STM32WB05KN are directly connected to 3V3.

9.3.2 SWD connector

X-NUCLEO-WB05KN1 has an SWD connector (CN8) for debugging/programming STM32WB05KN. The table below describes the SWD header and what each pin does.

Table 5. **Debugging/programming connector pinout (CN8)**

Pin	CN8	Designation
1	3V3	VDD from application
2	SWCLK	Target SWD clock
3	GND	Ground
4	SWDIO	Target SWDIO data input/output
5	RSTN	RESET of target

9.3.3 UART connector

It is possible to interface X-NUCLEO-WB05KN1 with the STM32 Nucleo microcontroller via a UART connector (CN7) with hardware flow control.

The table below describes the UART connector pinout.

Table 6. UART connector pinout (CN7)

Pin	CN7	Designation
1	T_UART_CTS	Target UART_CTS (clear to send)
2	T_UART_TX	Target UART_TX
3	T_UART_RX	Target UART_RX
4	T_UART_RTS	Target UART_RTS (request to send)
5	GND	Ground

9.3.4 User LED

One general-purpose blue LED (LD1) is available for user applications. It is connected to pin 5 of CN4 of X-NUCLEO-WB05KN1 and it emits with a high level of the corresponding port of the host MCU connected to pin 5 of CN4.

10 X-NUCLEO-WB05KN1 product information

10.1 Product marking

The stickers located on the top or bottom side of all PCBs provide product information:

- First sticker: product order code and product identification, generally placed on the main board featuring the target device.
  Example:

  Product order code
  Product identification

- Second sticker: board reference with revision and serial number, available on each PCB.
  Example:

  MBxxxx-Variant-yzz
  syywwxxxxx

On the first sticker, the first line provides the product order code, and the second line the product identification.

On the second sticker, the first line has the following format: *"MBxxxx-Variant-yzz"*, where *"MBxxxx"* is the board reference, *"Variant"* (optional) identifies the mounting variant when several exist, *"y"* is the PCB revision, and *"zz"* is the assembly revision, for example B01. The second line shows the board serial number used for traceability.

Parts marked as *"ES"* or *"E"* are not yet qualified and therefore not approved for use in production. ST is not responsible for any consequences resulting from such use. In no event will ST be liable for the customer using any of these engineering samples in production. ST's Quality department must be contacted prior to any decision to use these engineering samples to run a qualification activity.

"ES" or *"E"* marking examples of location:

- On the targeted STM32 that is soldered on the board (for an illustration of STM32 marking, refer to the STM32 datasheet *Package information* paragraph at the *www.st.com* website).
- Next to the evaluation tool ordering part number that is stuck, or silk-screen printed on the board.

Some 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.

To use the same commercial stack in their applications, the developers might need to purchase a part number specific to this stack/library. The price of those part numbers includes the stack/library royalties.

10.2 X-NUCLEO-WB05KN1 product history

Table 7. Product history

Order code	Product identification	Product details	Product change description	Product limitations
X-NUCLEO-WB05KN1	XNWB05KN1$CZ1	MCU: STM32WB05KNV6 silicon revision "9"	Initial revision	No limitation
		MCU errata sheet: *STM32WB05xN device errata* (ES0633)		
		Boards: • MB2160-WB05N-B01 (ARDUINO® interface board) • MB2032-WB05N-B01 (MCU RF board)		

10.3 Board revision history

Table 8. **Board revision history**

Board reference	Board variant and revision	Board change description	Board limitations
MB2160 (ARDUINO® interface board)	WB05N-B01	Initial revision	No limitation
MB2032 (MCU RF board)	WB05N-B01	Initial revision	No limitation

11 Federal Communications Commission (FCC) and ISED Canada Compliance Statements

11.1 FCC Compliance Statement

Identification of products: X-NUCLEO-WB05KN1

FCC ID: YCP-MB203202

Radio Frequency (RF) Exposure Compliance of Radio communication: To satisfy FCC RF Exposure requirements, a separation distance of 20cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operation at a closer distance than this is not recommended. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

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.

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. 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.

Responsible party (in the USA)

Francesco Doddo
STMicroelectronics, Inc.
200 Summit Drive | Suite 405 | Burlington, MA 01803
USA
Telephone: +1 781-472-9634

11.2 ISED Compliance Statement

Identification of products: X-NUCLEO-WB05KN1
IC: 8976A-MB203202

Identification du produit : X-NUCLEO-WB05KN1
Contient sous-ensemble certifié IC : 8976A-MB203202

Compliance Statement

Notice: This device complies with ISED 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.

Déclaration de conformité

Avis: Le présent appareil est conforme aux CNR d'ISDE 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.

RF exposure statement

This device complies with ISED radiation exposure limits set forth for general population. This device must be installed to provide a separation distance of at least 20cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Le présent appareil est conforme aux niveaux limites d’exigences d’exposition RF aux personnes définies par ISDE. L’appareil doit être installé afin d’offrir une distance de séparation d’au moins 20cm avec les personnes et ne doit pas être installé à proximité ou être utilisé en conjonction avec une autre antenne ou un autre émetteur.

12 RED Compliance Statement

Déclaration de conformité CE simplifiée

STMicroelectronics déclare que l'équipement radioélectrique du type "X-NUCLEO-WB05KN1" est conforme à la directive 2014/53/UE.

Bande de fréquence utilisée en transmission et puissance maximale rayonnée dans cette bande :

- Bande de fréquence : 2400-2483.5 MHz (Bluetooth®)
- Puissance maximale : 8 mW p.i.r.e

Simplified EC compliance statement

Hereby, STMicroelectronics declares that the radio equipment type "X-NUCLEO-WB05KN1" is in compliance with Directive 2014/53/EU.

Frequency range used in transmission and maximal radiated power in this range:

- Frequency range: 2400-2483.5 MHz (Bluetooth®)
- Maximal power: 8 mW e.i.r.p

Revision history

Table 9. **Document revision history**

Date	Revision	Changes
03-Jul-2024	1	Initial release.
04-Oct-2024	2	Updated Table 4 with SPI3 signals replacing SPI1 signals and Product history table with corrected MCU silicon version.

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