Getting started with the STEVAL-STWINBX1 SensorTile wireless industrial node development kit

Introduction

The STWIN.box (STEVAL-STWINBX1) is a development kit and reference design that simplifies prototyping and testing of advanced industrial sensing applications in IoT contexts such as condition monitoring and predictive maintenance.

It is an evolution of the original STWIN kit (STEVAL-STWINKT1B) and features a higher mechanical accuracy in the measurement of vibrations, an improved robustness, an updated BoM to reflect the latest and best-in-class MCU and industrial sensors, and an easy-to-use interface for external add-ons.

The STWIN.box kit consists of an STWIN.box core system, a 480mAh LiPo battery, an adapter for the ST-LINK debugger, a plastic case, an adapter board for DIL 24 sensors and a flexible cable.

The many on-board industrial-grade sensors and the ultra-low power MCU enable applications that feature: ultra-low power, 9 DoF motion sensing, wide-bandwidth vibration analysis, audio and ultrasound acoustic inspection, very precise local temperature, and environmental monitoring.

A rich set of software packages is available in source code. Optimized firmware libraries and a complete companion cloud application help to speed up the design cycle to develop end-to-end solutions.

The kit supports a broad range of connectivity options, including the built-in RS485 transceiver, BLE, Wi-Fi, and NFC.

The STWIN.box also includes a 34-pin expansion connector for small form factor daughter boards associated with the STM32 family, such as the STEVAL-C34KAT1, STEVAL-C34KAT2 and STEVAL-PDETECT1 expansion boards.

The STWIN.box is suitable for field trials, demonstrations, and PoC for industrial IoT applications that use ST software and third-party software.

Figure 1. STWIN.box mounted with the plastic case

1 Getting started

1.1 Precautions for use

Warning: *Charge your device with a DC 5 V–500 mA USB charger at a temperature from 10°C to 35°C.*

The kit must be used within the working temperature range. It must never be exposed to excessive heat such as direct sunlight, fire, or heating equipment.

Danger: *Use only USB chargers equipped with short-circuit protections to prevent fire hazard.*

Danger: *Use only the LiPo battery provided with the kit (HiMax 752535). A replacement of the battery with an incorrect type can defeat a safeguard.*

LiPo batteries can be damaged and even explode if they are short-circuited or overcharge or with an improper usage, such as mechanical crushes, hot oven, or battery cutting.

1.2 Features

- Multisensing wireless platform for vibration monitoring and ultrasound detection
- Built around STWIN.box core system board with processing, sensing, connectivity, and expansion capabilities
- Ultra-low power Arm® Cortex®-M33 with FPU and TrustZone at 160 MHz, 2048 kBytes Flash memory (STM32U585AI)
- MicroSD card slot for standalone data logging applications
- On-board Bluetooth® low energy v5.0 wireless technology (BlueNRG-M2), Wi-Fi (EMW3080) and NFC (ST25DV64K)
- Option to implement authentication and brand protection secure solution with STSAFE-A110
- Wide range of industrial IoT sensors:
  - Ultra-wide bandwidth (up to 6 kHz), low-noise, 3-axis digital vibration sensor (IIS3DWB)
  - 3D accelerometer + 3D gyro iNEMO inertial measurement unit (ISM330DHCX) with Machine Learning Core
  - High-performance ultra-low-power 3-axis accelerometer for industrial applications (IIS2DLPC)
  - Ultra-low power 3-axis magnetometer (IIS2MDC)
  - High-accuracy, high-resolution, low-power, 2-axis digital inclinometer with Embedded Machine Learning Core (IIS2ICLX)
  - Dual full-scale, 1.26 bar and 4 bar, absolute digital output barometer in full-mold package (ILPS22QS)
  - Low-voltage, ultra low-power, 0.5°C accuracy I²C/SMBus 3.0 temperature sensor (STTS22H)
  - Industrial grade digital MEMS microphone (IMP34DT05)
  - Analog MEMS microphone with frequency response up to 80 kHz (IMP23ABSU)
- Expandable via a 34-pin FPC connector

1.3 Kit components

The STEVAL-STWINBX1 development kit includes:

- the STWIN core system (main board);
- a plastic case with M3 bolts;
- a 480 mAh 3.7 V LiPo battery;
- STEVAL-MKIGIBV4 ST-LINK adapter with programming cable;
- an adapter board for DIL24 sensors with a flexible cable.

Figure 2. STEVAL-STWINBX1 components

1.4 Layout of the core system board (STEVAL-STWINBX1) components

Figure 3. Layout of the core system board top components

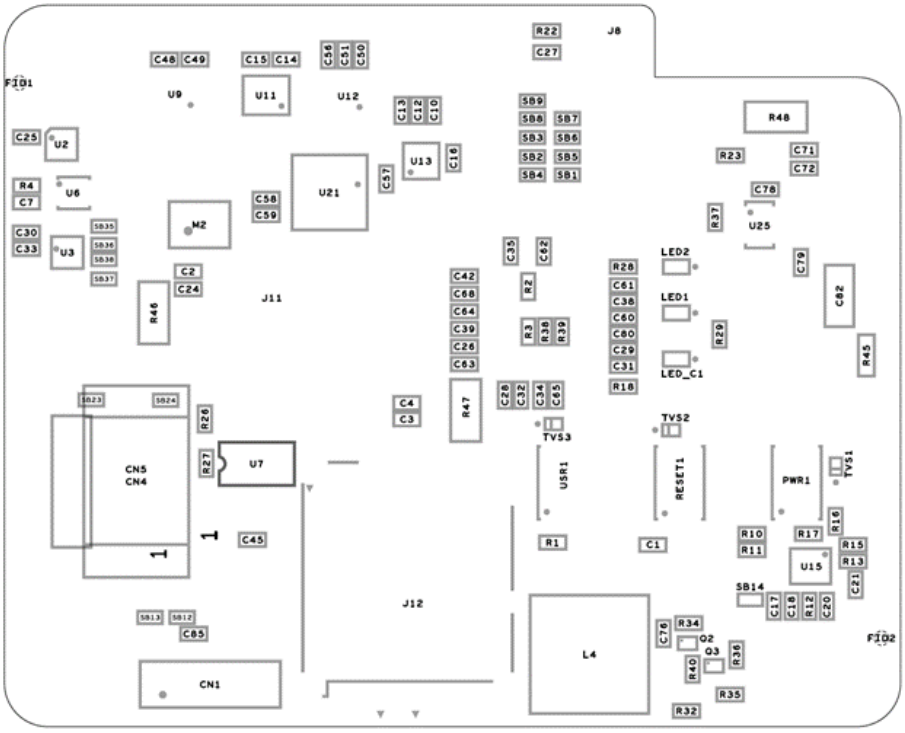
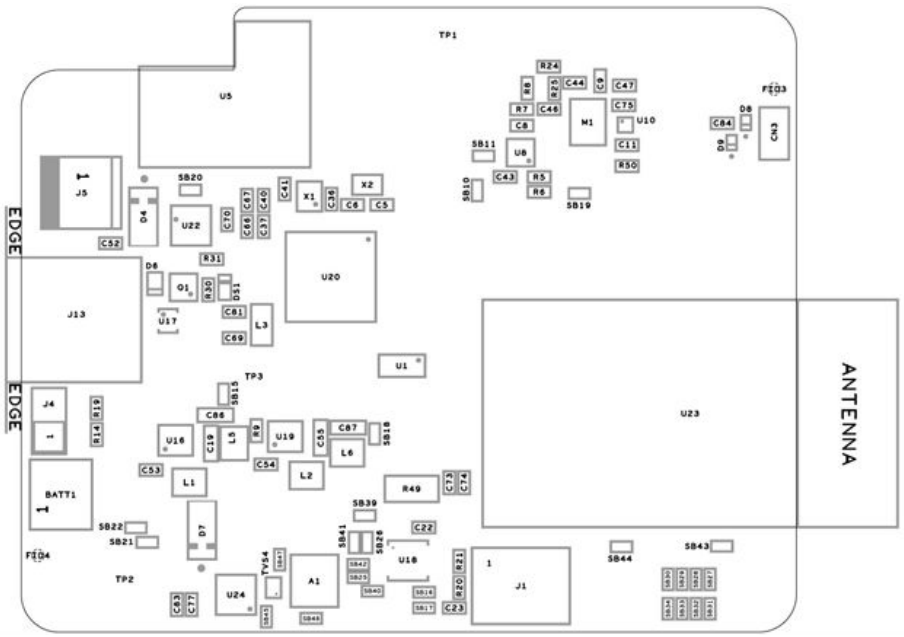


Figure 4. Layout of the core system board bottom components



1.5 Core system board

Figure 5. **STEVAL-STWINBX1 block diagram**

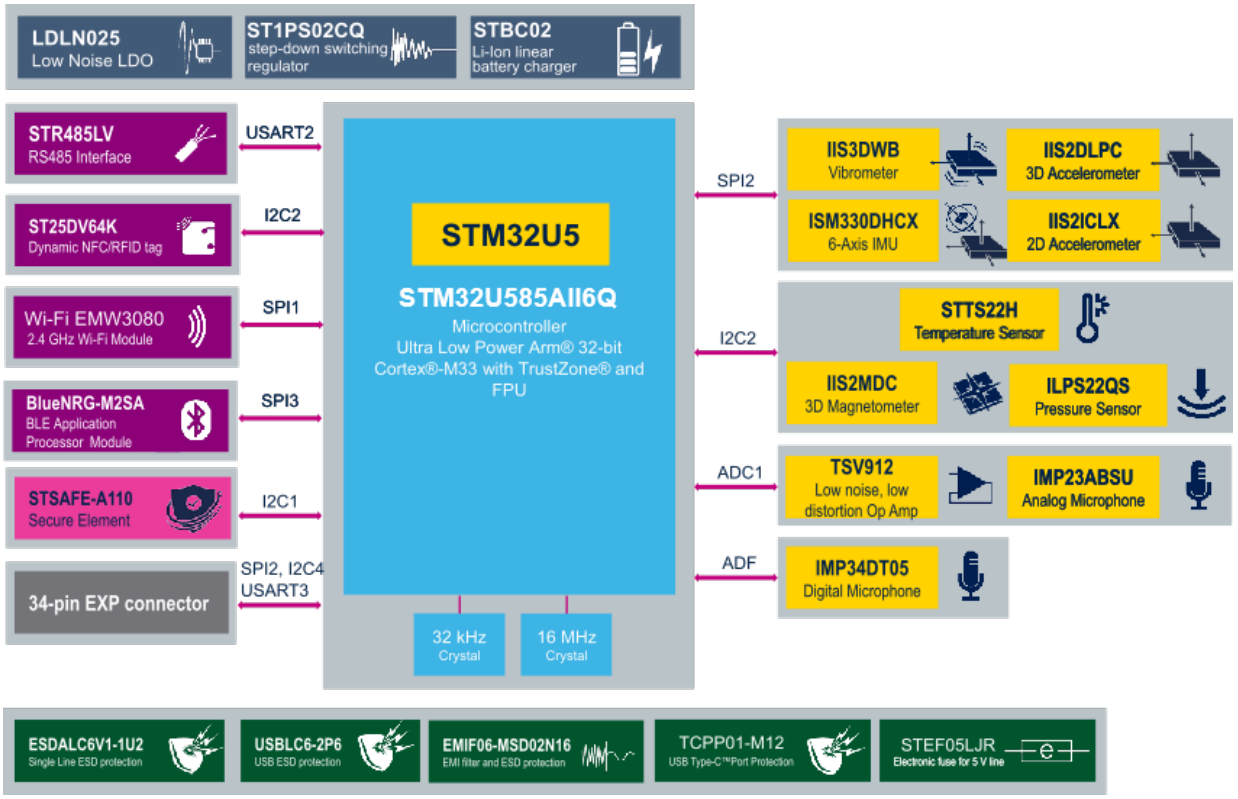


Figure 6. **STEVAL-STWINBX1 evaluation kit (top view)**

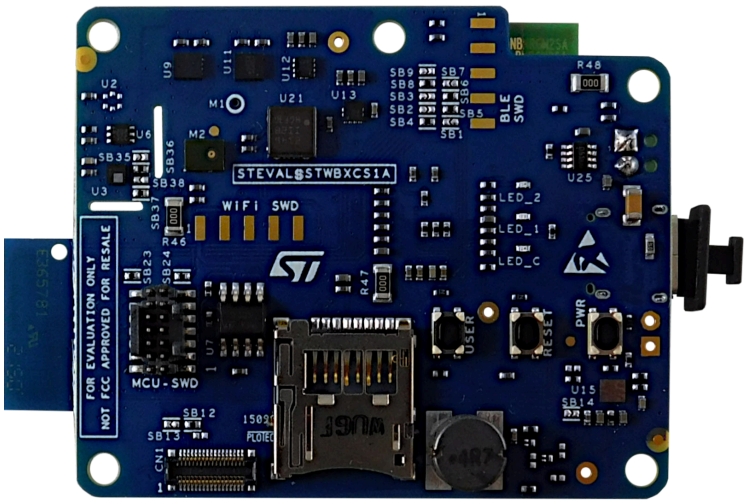
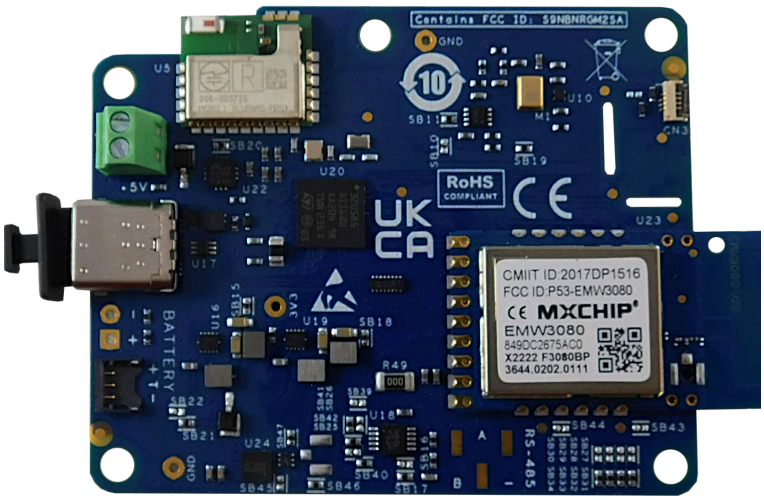


Figure 7. **STEVAL-STWINBX1 evaluation kit (bottom view)**

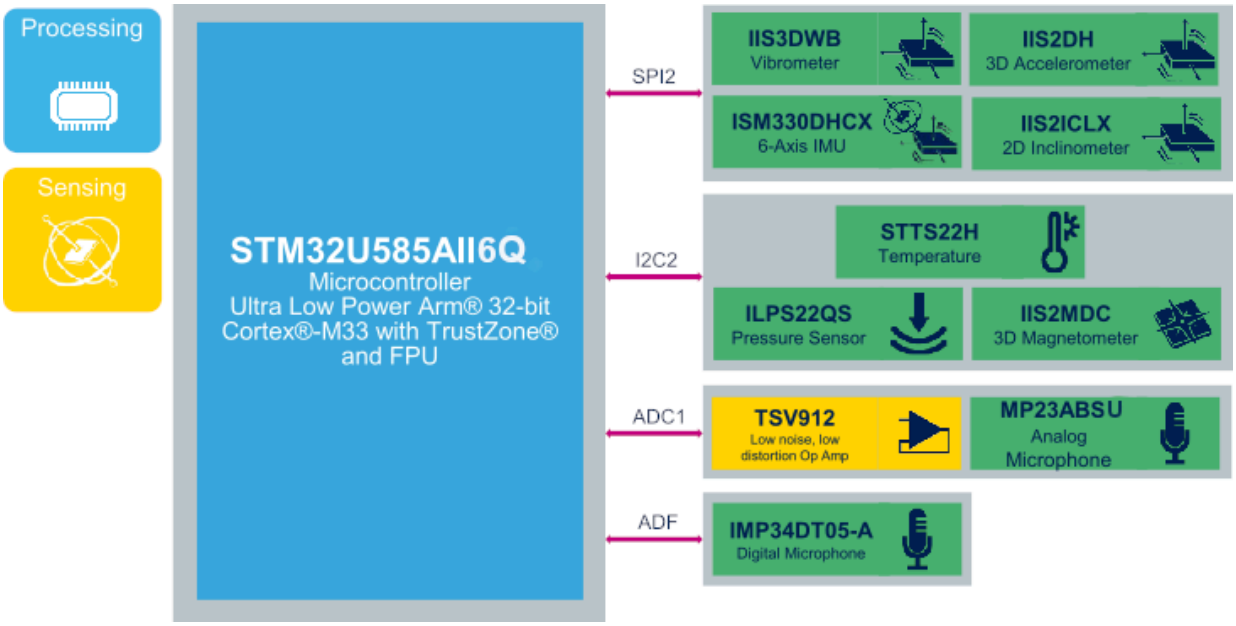


1.6 Functional blocks

1.6.1 Sensing

The core system board offers a comprehensive range of sensors specifically designed to support industrial applications and satisfy the demanding requirements of the Industry 4.0.

Figure 8. **STEVAL-STWINBX1 - overview of the sensing components**



The motion sensors communicate with the STM32U585AI microcontroller via SPI in order to accommodate the high data rates, whereas the magnetometer and environmental sensors communicate via I²C. The suitably filtered signal from the IMP23ABSU analog microphone is amplified by a TSV912 op-amp and then sampled by the internal 12-bit ADC of the MCU. The signal from the digital microphone is directly managed by the audio digital filter (ADF) interface of the MCU.

Figure 9. **STEVAL-STWINBX1 - sensors on the top side**

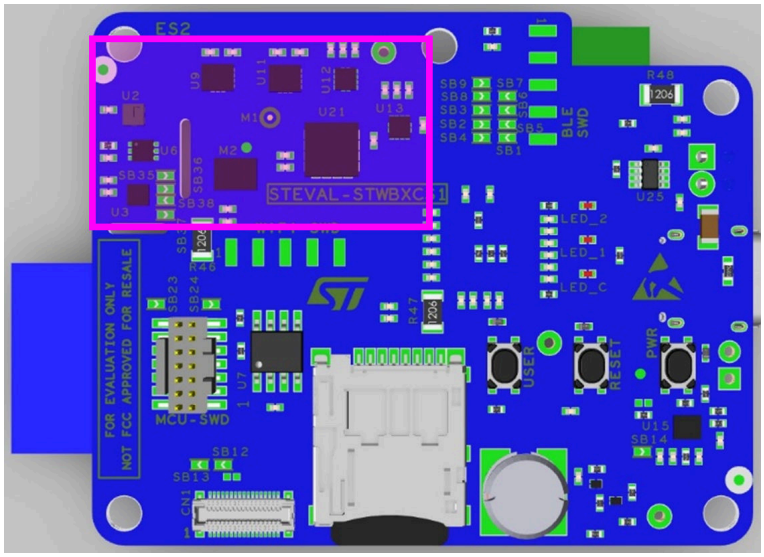
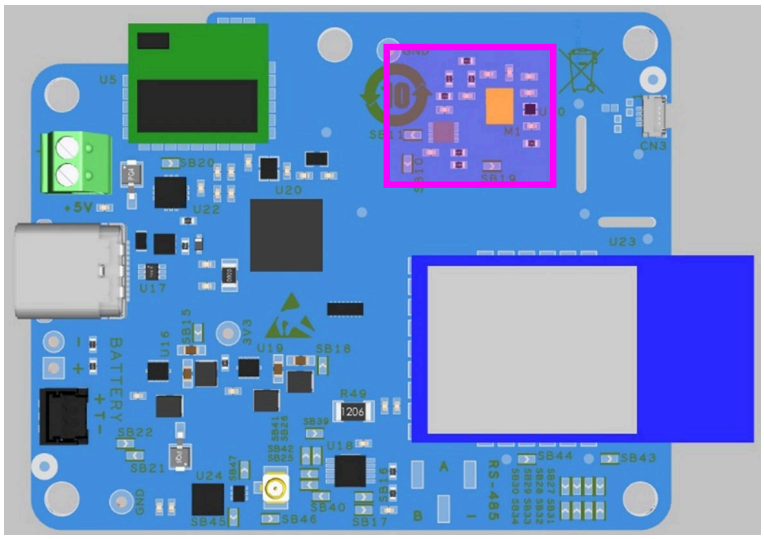


Figure 10. **STEVAL-STWINBX1 - sensors on the bottom side**



- U3: ILPS22QS MEMS pressure sensor
- U6: STTS22H digital temperature sensor
- U8: TSV912 wide-bandwidth (8 MHz) rail-to-rail I/O op-amp
- U9: ISM330DHCX iNEMO IMU, 3D accelerometer and 3D gyroscope with Machine Learning Core and Finite State Machine
- U11: IIS3DWB wide bandwidth accelerometer
- U12: IIS2DLPC high-performance ultra-low-power 3-axis accelerometer for industrial applications
- U13: IIS2MDC 3-axis magnetometer
- U21: IIS2ICLX high-accuracy, high-resolution, low-power, 2-axis digital inclinometer with Machine Learning Core
- M1: IMP23ABSU analog MEMS microphone
- M2: IMP34DT05 digital MEMS microphone

1.6.1.1 *ILPS22QS*

The ILPS22QS is an ultra-compact piezoresistive absolute pressure sensor, which functions as a digital output barometer. It supports dual full-scale up to 4 bar, selectable by the user.

The ILPS22QS embeds a sensing element and an IC interface that communicates over I²C, MIPI I3C^{SM} or SPI interfaces from the sensing element to the application. It also supports a 1.2 V digital interface.

The ILPS22QS features an analog hub-sensing functionality, which is able to connect an analog input and convert it to a digital signal for embedded processing.

The ILPS22QS is available in a full-mold, holed LGA package. It is guaranteed to operate over a temperature range extending from -40°C to +105°C. The package is holed to allow the external pressure to reach the sensing element.

Table 1. ILPS22QS I/O configuration

I/O	Configuration
PH4	I2C2_SCL
PF0	I2C2_SDA

1.6.1.2 *STTS22H*

The STTS22H is an ultra-low-power, high-accuracy, digital temperature sensor. It offers a high performance over the entire operating temperature range.

The STTS22H is coupled with an ASIC featuring A/D converter, signal processing logic, and an I²C/SMBus 3.0 interface.

The sensor is housed in a small 2 x 2 x 0.50 mm 6-lead UDFN package with the exposed pad down for a better temperature match with the surrounding environment.

The STTS22H is factory-calibrated and requires no additional calibration.

The STTS22H units are 100% tested on a production setup that is NIST traceable and verified with equipment calibrated in accordance with the IATF 16949:2016 standard.

Table 2. STTS22H I/O configuration

I/O	Configuration
PH4	I2C2_SCL
PF0	I2C2_SDA
PF5	INT

1.6.1.3 *TVS912*

The TSV91x and TSV91xA operational amplifiers offer low voltage operation and rail-to-rail input and output. They also offer an excellent speed/power consumption ratio, providing an 8 MHz gain-bandwidth product while consuming only 1.1 mA maximum at 5 V.

The op amps are unity-gain stable and feature an ultra-low input bias current. The devices are ideal for sensor interfaces, battery-supplied, and portable applications, as well as active filtering.

1.6.1.4 *ISM330DHCX*

The ISM330DHCX is a system-in-package that features a high-performance 3D digital accelerometer and a 3D digital gyroscope tailored for Industry 4.0 applications.

The various sensing elements are manufactured using specialized micromachining processes, while the IC interfaces are developed using CMOS technology that allows the design of a dedicated circuit, which is trimmed to match the characteristics of the sensing element.

In the ISM330DHCX the sensing elements of the accelerometer and of the gyroscope are implemented on the same silicon die, guaranteeing superior stability and robustness.

The ISM330DHCX has a full-scale acceleration range of ±2/±4/±8/±16 g and a wide angular rate range of ±125/±250/±500/±1000/±2000/±4000 dps that enables its usage in a broad range of applications.

All the design aspects and the calibration of the ISM330DHCX have been optimized to reach superior accuracy, stability, extremely low noise, and full data synchronization. The embedded features (Machine Learning Core, programmable FSM, FIFO, sensor hub, event decoding, and interrupts) enable smart and complex sensor nodes, which deliver high performance at very low power.

The ISM330DHCX is available in a 14-lead plastic land grid array (LGA) package.

Table 3. ISM330DHCX I/O configuration

I/O	Configuration
PI1	SPI2_CLK
PI3	SPI2_MOSI
PD3	SPI2_MISO
PH15	SPI_CS
PB8	INT1
PF4	INT2

1.6.1.5 *IIS3DWB*

The IIS3DWB is a system-in package that features a 3-axis digital vibration sensor with low noise over an ultra-wide and flat frequency range.

The wide bandwidth, low noise, very stable, repeatable sensitivity, and the capability of operating over an extended temperature range (up to +105°C) make the device particularly suitable for vibration monitoring in industrial applications.

The high performance delivered at low power consumption, the digital output, and the embedded digital features, such as FIFO and the interrupts, enable features for battery-operated industrial wireless sensor nodes.

The IIS3DWB has a selectable full-scale acceleration range of ±2/±4/±8/±16 g and is capable of measuring accelerations with a bandwidth up to 6 kHz with an output data rate of 26.7 kHz.

The device integrates a 3 kB first-in, first-out (FIFO) buffer to avoid any data loss and to limit intervention of the host processor.

The ST MEMS sensor module family leverages the robust and mature manufacturing processes already used for the production of micromachined accelerometers and gyroscopes to serve automotive, industrial, and consumer markets. The sensing elements are manufactured using the ST proprietary micromachining process, whereas the embedded IC interfaces are developed using CMOS technology.

The IIS3DWB has a self-test capability, which allows checking whether the sensor is correctly working in the final application.

The IIS3DWB is available in a 14-lead plastic land grid array (LGA) package and is guaranteed to operate over an extended temperature range from -40°C to +105°C.

Table 4. IIS3DWB I/O configuration

I/O	Configuration
PI1	SPI2_CLK
PI3	SPI2_MOSI
PD3	SPI2_MISO
PF12	SPI_CS
PF15	INT1
-	INT2

1.6.1.6 *IIS2DLPC*

The IIS2DLPC is a three-axis linear accelerometer with digital I²C/SPI output interface.

It has full scales of ±2g/±4g/±8g/±16g selectable by the user and can measure accelerations with output data rates from 1.6 Hz to 1600 Hz.

The IIS2DLPC has a high-performance mode and four low-power modes, which can be changed on-the-fly, providing outstanding versatility and adaptability to the requirements of the application.

The accelerometer has an integrated 32-level first-in, first-out (FIFO) buffer that allows the user to store data in order to limit intervention by the host processor. The embedded self-test capability allows checking whether the sensor is correctly working in the final application.

The IIS2DLPC has a dedicated internal engine to process motion and acceleration detection, including free-fall, wake-up, highly configurable single/double-tap recognition, activity/inactivity, stationary/motion detection, portrait/landscape detection, and 6D/4D orientation.

The IIS2DLPC is available in a small thin plastic land grid array package (LGA) and it is guaranteed to operate over an extended temperature range from -40°C to +85°C.

Table 5. IIS2DLPC I/O configuration

I/O	Configuration
PI1	SPI2_CLK
PI3	SPI2_MOSI
PD3	SPI2_MISO
PH6	SPI_CS
PF1	INT1
PF2	INT2

1.6.1.7 *IIS2ICLX*

The IIS2ICLX is a high-accuracy (ultra-low noise, high stability, and repeatability) and low-power two-axis linear accelerometer with digital output.

The IIS2ICLX has a selectable full scale of ±0.5/±1/±2/±3 g. It can provide the measured accelerations to the application over an I²C or SPI digital interface. Its high accuracy, stability over temperature, and repeatability make IIS2ICLX particularly suitable for inclination measurement applications (inclinometers).

The sensing element is manufactured using a dedicated micromachining process developed by STMicroelectronics to produce inertial sensors and actuators on silicon wafers.

The IC interface is manufactured using a CMOS process that allows a high level of integration to design a dedicated circuit, which is trimmed to match the characteristics of the sensing element.

The IIS2ICLX has an unmatched set of embedded features (programmable FSM, machine learning core, sensor hub, FIFO, event decoding, and interrupts). These features are enablers for implementing smart and complex sensor nodes, which deliver high accuracy and performance at very low power.

The IIS2ICLX is available in a high-performance (low-stress) ceramic cavity land grid array (CCLGA) package. It can operate within a temperature range of -40°C to +105°C.

Table 6. IIS2ICLX I/O configuration

I/O	Configuration
PI1	SPI2_CLK
PI3	SPI2_MOSI
PD3	SPI2_MISO
PI7	SPI_CS
PF3	INT1
PF11	INT2

1.6.1.8 *IIS2MDC*

The IIS2MDC is a high-accuracy, ultra-low-power, 3-axis digital magnetic sensor. It features a magnetic field dynamic range up to ±50 gausses.

The IIS2MDC includes an I²C serial bus interface, which supports standard, fast mode, fast mode plus, and high-speed (100 kHz, 400 kHz, 1 MHz, and 3.4 MHz), and an SPI serial standard interface.

You can configure the device to generate an interrupt signal for magnetic field detection.

The IIS2MDC is available in a plastic land grid array package (LGA) and is guaranteed to operate over an extended temperature range from -40°C to +85°C.

Table 7. IIS2MDC I/O configuration

I/O	Configuration
PH4	I2C2_SCL
PF0	I2C2_SDA
PF9	INT

1.6.1.9 *IMP23ABSU*

The IMP23ABSU is a compact, low-power microphone with a capacitive sensing element and an IC interface.

The sensing element, capable of detecting acoustic waves, is manufactured using a specialized silicon-micromachining process to produce audio sensors.

The IMP23ABSU has an acoustic overload point of 130 dBSPL with a typical 64 dB signal-to-noise ratio.

The microphone sensitivity is -38 dBV ±1 dB at 94 dBSPL, 1 kHz.

The IMP23ABSU is available in a package compliant with reflow soldering and is guaranteed to operate over an extended temperature range from -40°C to +85°C.

Table 8. IMP23ABSU I/O configuration

I/O	Configuration
PC1	ADC1_IN2
PC0	ADC1_IN1 (REF)

1.6.1.10 *IMP34DT05*

The IMP34DT05 is an ultra-compact, low-power, omnidirectional, digital MEMS microphone with a capacitive sensing element and an IC interface.

The sensing element, capable of detecting acoustic waves, is manufactured using a specialized silicon-micromachining process dedicated to producing audio sensors.

The IC interface is manufactured using a CMOS process that allows designing a dedicated circuit able to provide a digital signal in PDM format.

The IMP34DT05 features low distortion with a 64 dB signal-to-noise ratio and -26 dBFS ±3 dB sensitivity.

The IMP34DT05 is available in a top-port, SMD-compliant, EMI-shielded package and is guaranteed to operate over an extended temperature range from -40°C to +85°C.

Table 9. IMP34DT05I/O configuration

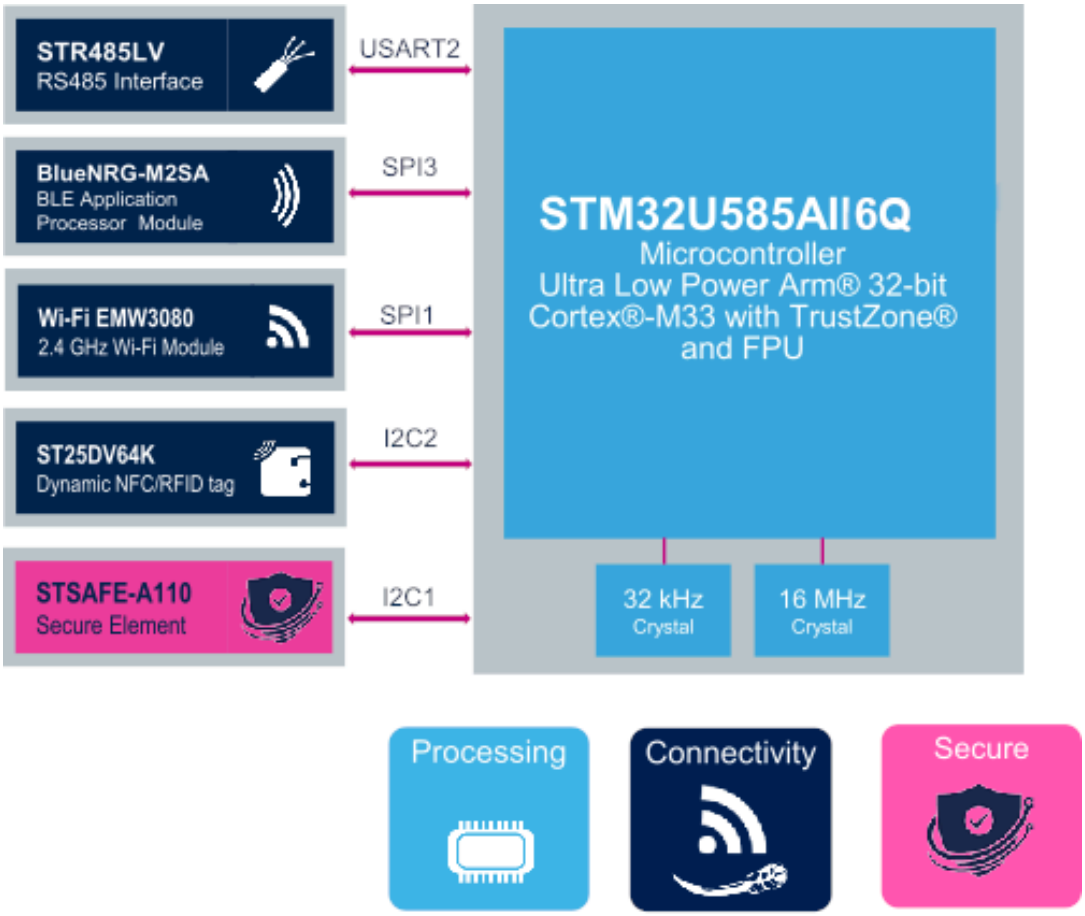
I/O	Configuration
PE10	ADF1_SDIO
PE9	ADF1_CCK0

1.6.2 Processing and connectivity

The STWIN.box core system board features several wired and wireless connectivity options and the STM32U585AI ultra-low-power microcontroller.

The microcontroller belongs to the STM32U5 series of ultra-low-power MCUs based on the high-performance Arm® Cortex®-M33 with TrustZone, which operates at up to 160 MHz and embeds 786 kbytes of SRAM and 2 MB of dual bank Flash memory.

Figure 11. Main connectivity components and the STM32U585AI processing unit



Each connectivity component is connected to an independent bus on the STM32U585AI MCU, so all of them can be individually configured.

Figure 12. MCU and connectivity components (top view)

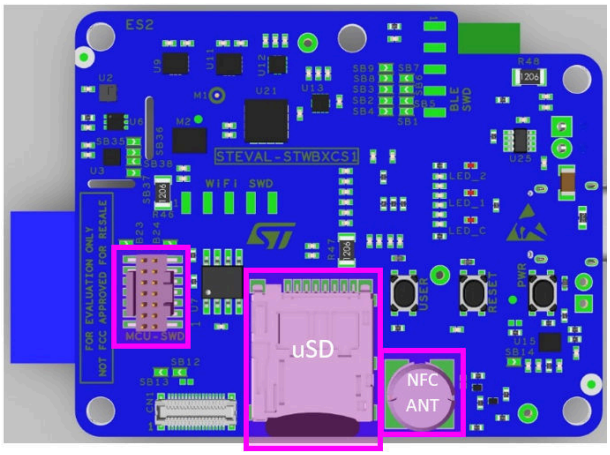
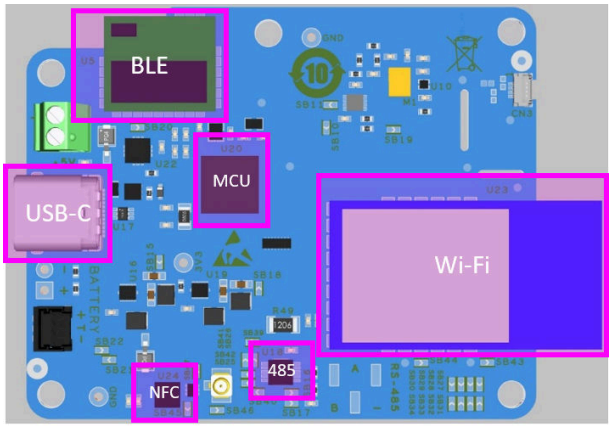


Figure 13. **MCU and connectivity components (bottom view)**



- U20: STM32U585AI ultra-low-power Arm® Cortex®-M33 with FPU and TrustZone at 160 MHz;
- U5: BlueNRG-M2SA Bluetooth® low energy v5.2 wireless technology module;
- U7: STSAFE-A110 authentication and brand protection secure solution;
- U18: STR485 3.3 V RS485 up to 20 mbps;
- U23: MXCHIP EMW3080 (802.11 b/g/n compliant Wi-Fi module);
- U24: ST25DV64K dynamic NFC/RFID tag IC with 64-Kbit EEPROM;
- USB: USB Type-C™ connector (power supply and data);
- CN4: STDC14 programming connector for STLINK-V3MINI;
- SDCard: microSD card socket.

1.6.2.1 *STM32U585AI*

The STM32U585xx device belongs to an ultra-low-power microcontrollers family (STM32U5 series) based on the high-performance Arm® Cortex®-M33 32-bit RISC core. They operate at a frequency of up to 160 MHz.

The Arm® Cortex®-M33 core features a single-precision FPU (floating-point unit), which supports all the Arm® single-precision data-processing instructions and all the data types. It also implements a full set of digital signal processing (DSP) instructions and a memory protection unit (MPU) that enhances the application security.

The device embeds high-speed memories (2 mbytes of Flash memory and 786 kbytes of SRAM), a flexible external memory controller (FSMC) for static memories (for devices with packages of 90 pins and more), two octo-SPI Flash memory interfaces (at least one quad-SPI available on all packages), an extensive range of enhanced I/Os and peripherals connected to three APB buses, three AHB buses, and a 32-bit multi-AHB bus matrix.

The device offers security foundation compliant with the trusted-based security architecture (TBSA) requirements from Arm®. It embeds the necessary features to implement a secure boot, secure data storage, and secure firmware update.

The device also incorporates a secure firmware installation feature that allows the customer to secure the provisioning of the code during its production.

A flexible lifecycle is managed thanks to multiple levels of readout protection and debug unlock with password. Firmware hardware isolation is supported thanks to securable peripherals, memories and I/Os, and privilege configuration of peripherals and memories.

The device features several protection mechanisms for embedded Flash memory and SRAM: readout protection, write protection, secure, and hide protection areas. They also embed several peripherals reinforcing security: a fast AES coprocessor, a secure AES coprocessor with DPA resistance, and a hardware unique key that can be shared by hardware with fast AES, a public key accelerator (PKA) with DPA resistance, an on-the-fly decryption engine for octo-SPI external memories, a HASH hardware accelerator, and a true random number generator.

The device also features active tamper detection and protection against transient and environmental perturbation attacks, thanks to several internal monitoring generating secret data erase in case of attack. This helps to fit the PCI requirements for point of sales applications.

The device offers one fast 14-bit ADC (2.5 Msps), one 12-bit ADC (2.5 Msps), two comparators, two operational amplifiers, two DAC channels, an internal voltage reference buffer, a low-power RTC, four 32-bit general-purpose timers, two 16-bit PWM timers dedicated to motor control, three 16-bit general-purpose timers, two 16-bit basic timers, and four 16-bit low-power timers. The device supports a multifunction digital filter (MDF) with six filters dedicated to the connection of external sigma-delta modulators. Another low-power digital filter dedicated to audio signals is embedded (ADF), with one filter supporting sound-activity detection.

The device embeds a Chrom-ART accelerator dedicated to graphic applications, and mathematical accelerators (a trigonometric functions accelerator plus a filter mathematical accelerator). In addition, up to 24 capacitive sensing channels are available.

The device also features standard and advanced communication interfaces such as: four I^2Cs, three SPIs, three USARTs, two UARTs, one low-power UART, two SAIs, one digital camera interface (DCMI), two SDMMCs, one FDCAN, one USB OTG full-speed, one USB Type-C /USB Power Delivery controller, and one generic synchronous 8-/16-bit PSSI (parallel data input/output slave interface). The device operates in the -40 to +85°C (+105°C junction) and -40 to +125°C (+130°C junction) temperature ranges from a 1.71 to 3.6 V power supply.

A comprehensive set of power-saving modes allows the design of low-power applications. Many peripherals (including communication, analog, timers, and audio peripherals) can be functional and autonomous down to stop mode with direct memory access, thanks to low-power background autonomous mode (LPBAM).

Some independent power supplies are supported like an analog independent supply input for ADC, DACs, OPAMPs and comparators, a 3.3 V dedicated supply input for USB and up to 14 I/Os, that can be supplied independently down to 1.08 V. A VBAT input is available for connecting a backup battery in order to preserve the RTC functionality and to back up 3232-bit registers and 2-Kbyte SRAM. The devices offer eight packages from 48 to 169 pins.

1.6.2.2 *BlueNRG-M2*

The BlueNRG-M2 is a Bluetooth® Low Energy system-on-chip application processor certified module, compliant with BT specifications v5.2 and BQE qualified.

The module supports multiple roles simultaneously and can act at the same time as a Bluetooth® Low Energy master and a slave device.

It is based on the BlueNRG-2 system-on-chip and embeds the entire Bluetooth® Low Energy stack and protocols.

The BlueNRG-2 module provides a complete RF platform in a tiny form factor. The integrated radio, the embedded antenna, and the high frequency oscillators offer a certified solution to optimize the time-to-market of the final applications.

- Operating band: 2402 MHz to 2480 MHz
- Channel spacing: 2 MHz
- RF power: +5 dBm

Table 10. BlueNRG2-M2 I/O configuration

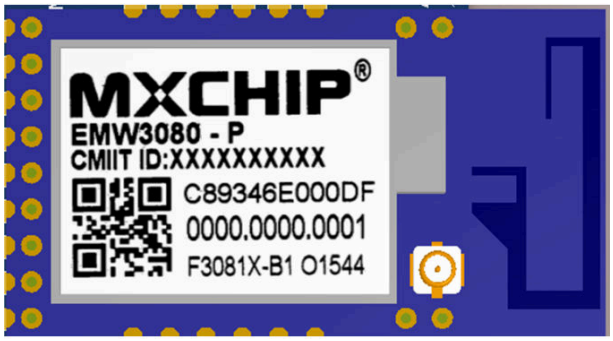
I/O	Configuration
PG9	SPI3_CLK
PB5	SPI3_MOSI
PB4	SPI3_MISO
PE1	SPI_CS
PF14	INT
PD13	RESET

1.6.2.3 *MXCHIP EMW3080*

The MXCHIP EMW3080 module is an embedded device for Internet wireless connectivity. The module uses the SPI2 interface of the STM32U585AI to communicate with the MCU.

This Wi-Fi module requires no operating system and has a completely integrated TCP/IP stack that requires only AT commands to establish the connection.

Figure 14. **MXCHIP EMW3080**



The main features of the MXCHIP EMW3080 module are:

- IEEE 802.11n D7.0, OFDM-72.2 Mbps, single-stream width of 20 MHz, and short GI;
- IEEE 802.11g, OFDM 54 Mbps;
- IEEE 802.11b, DSSS 11 Mbps;
- IEEE 802.11i, security–Wi-Fi protected access (WPA)–PSK/TKIP–Wi-Fi protected access 2 (WPA2)–AES/CCMP/802.1x authentication;
- GPIO, five ADCs (the SPI interface uses the ADC pins);
- Operating band: 2400 MHz ~ 2483.5 MHz (2.4 GHz ISM band)
- RF power: 16 dBm
- Power-saving mode allows the design of low-power applications;
- Lead-free design compliant with RoHS requirements;
- EMI/EMC metal shield to achieve the best RF performance in noisy environments and to accommodate for lower RF emissions/signature for easier FCC compliance;
- FCC/CE compliance certification.

Table 11. **MXCHIP EMW3080 I/O configuration**

I/O	Configuration
PG2	SPI1_CLK
PG4	SPI1_MOSI
PG3	SPI1_MISO
PH7	SPI_CS
PG15	INT (Flow)
PE7	INT (Notify)
PE12	Chip_En

1.6.2.4 *ST25DV64K*

The ST25DV04K, ST25DV16K and ST25DV64K devices are NFC RFID tags offering respectively 4 Kbit, 16 Kbit, and 64 Kbit of electrically erasable programmable memory (EEPROM).

ST25DV04K, ST25DV16K and ST25DV64K offer two interfaces. The first one is an I2C serial link and can be operated from a DC power supply. The second one is a RF link activated when ST25DV04K, ST25DV16K or ST25DV64K act as a contactless memory powered by the received carrier electromagnetic wave. In I2C mode, the ST25DV04K, ST25DV16K and ST25DV64K user memory contains up to 512 bytes, 2048 bytes and 8192 bytes, which could be split in 4 flexible and protectable areas. In RF mode, following ISO/IEC 15693 or NFC forum type 5 recommendations, ST25DV04K, ST25DV16K and ST25DV64K user memory contains respectively up to 128 blocks, 512 blocks and 2048 blocks of 4 bytes which could be split in 4 flexible and protectable areas.

ST25DV04K, ST25DV16K and ST25DV64K offer a fast transfer mode between the RF and contact worlds, thanks to a 256 bytes volatile buffer (also called Mailbox). In addition, the GPO pin of the ST25DV04K, ST25DV16K and ST25DV64K provide data informing the contact world about incoming events, like RF field detection, RF activity in progress or mailbox message availability.

An energy harvesting feature is also proposed when external conditions make it possible. Herein after all concerned devices (ST25DV04K, ST25DV16K and ST25DV64K) are mentioned as ST25DVxxx.

1.6.2.4.1 RF mode

Contactless exchanges are performed in RF mode as specified by ISO/IEC 15693 or NFC Forum Type 5.

The ST25DVxxx communicates via the 13.56 MHz carrier electromagnetic wave on which incoming data are demodulated from the received signal amplitude modulation (ASK:amplitude shift keying).

The received ASK wave is 10% or 100% modulated with a data rate of 1.6 Kbit/s using the 1/256 pulse coding mode or a data rate of 26 Kbit/s using the 1/4 pulse coding mode.

Outgoing data are generated by the ST25DVxxx load variation using Manchester coding with one or two subcarrier frequencies at 423 kHz and 484 kHz. Data are transferred from the ST25DVxxx at 6.6 Kbit/s in low data rate mode and 26 Kbit/s in high data rate mode. The ST25DVxxx supports the 53 Kbit/s in high data rate mode in one subcarrier frequency at 423 kHz.

The ST25DVxxx follows ISO/IEC 15693 or NFC Forum Type 5 recommendation for radio-frequency power and signal interface and for anticollision and transmission protocol.

1.6.2.5 *STR485*

The STR485 is a low-power differential line transceiver for data transmission standard RS485 applications in half-duplex mode.

Data and enable signals are compatible with 1.8 V or 3.3 V supplies.

Two speeds are selectable through the SLR pin: fast data rate up to 20 Mbps or slow data rate for extended cable running to 250 kbps.

The thermal shutdown circuit prevents excessive power dissipation due to bus contention or faults. This circuit forces the driver outputs into a high impedance state.

The receiver has a fail-safe feature, which guarantees a high output state when the inputs are left open, shorted, or idle.

Table 12. STR485LV I/O configuration

I/O	Configuration
PA7	USART3_TX
PA5	USART3_RX
PD12	USART3_RTS

1.6.2.6 *USB connector*

The on-board USB Type-C connector can be used for both power supply and data transfer (USB device only).

You can find several examples of USB class implementation in the STM32 software packages.

Table 13. USB connector I/O configuration

I/O	Configuration
PA12	USB_OTG_DP
PA11	USB_OTG_DM

1.6.2.7 *STSAFE-A110*

The STSAFE-A110 is a highly secure element that provides authentication and secure data management services to a local or remote host. It consists of a full turnkey solution with a secure operating system, which runs on the latest generation of secure microcontrollers.

The STSAFE-A110 can be integrated in IoT devices, smart-home, smart-city, industrial applications, consumer electronics devices, consumables, and accessories.

Table 14. **STSAFE-A110 I/O configuration**

I/O	Configuration
PB6	I2C1_SCL
PB9	I2C1_SDA
PH9	RESET

1.6.2.8 *MicroSD card socket*

On the bottom side of the STWIN.box core system board is a microSD card socket that is accessible even when the board is mounted in the plastic case.

A four-bit wide SDIO port allows accessing the card for the maximum performance.

Table 15. **Micro-SD card socket I/O configuration**

I/O	Configuration
PC8	SDMMC_D0
PC9	SDMMC_D1
PC10	SDMMC_D2
PC11	SDMMC_D3
PC12	SDMMC_CK
PD2	SDMMC_CMD
PG1	SD_Detect

1.6.2.9 *Clock sources*

There are two external clock sources on the STWIN.box core system board:

- X1, which is a 16 MHz high speed external (HSE) oscillator for the MCU;
- X2, which is a 32.768 kHz low speed external (LSE) oscillator for the RTC embedded in the MCU.

1.6.3 Power management

The STWIN.box core system board includes a wide range of power management features that enable very low power consumption in final applications.

The main supply is a lithium ion polymer battery (3.7 V, 480 mAh) and the integrated battery charger (STBC02) with V_{IN} from 4.8 to 5.5 V.

Figure 15. **Power management of the STWIN.box core system board**

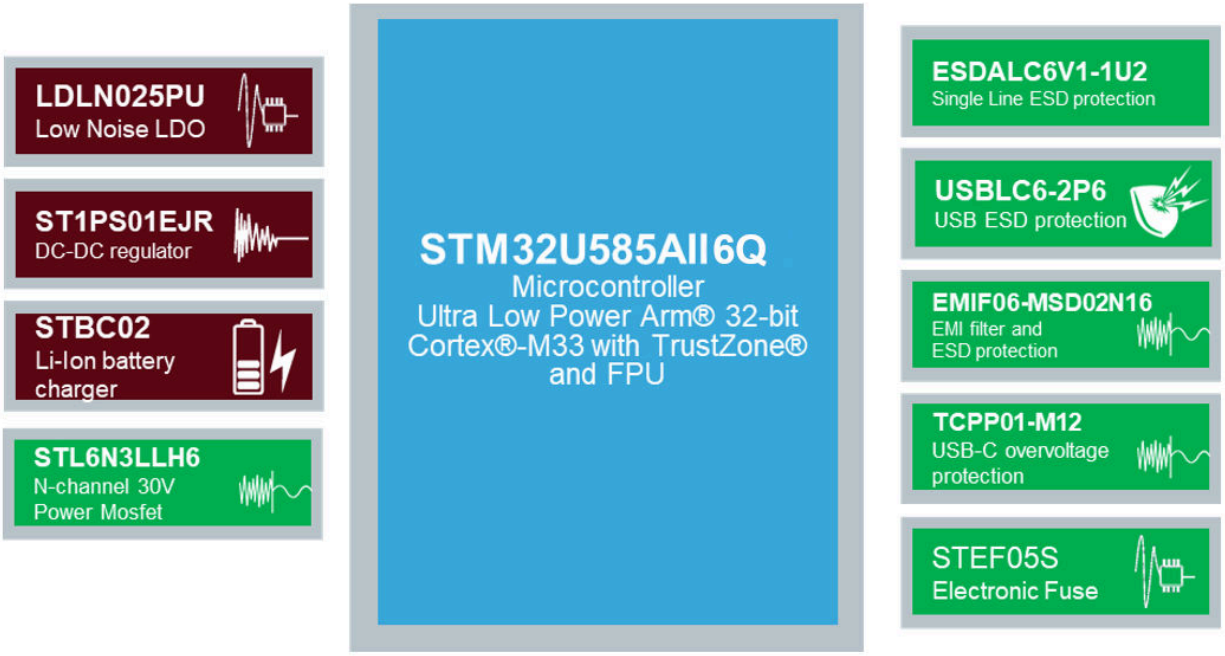
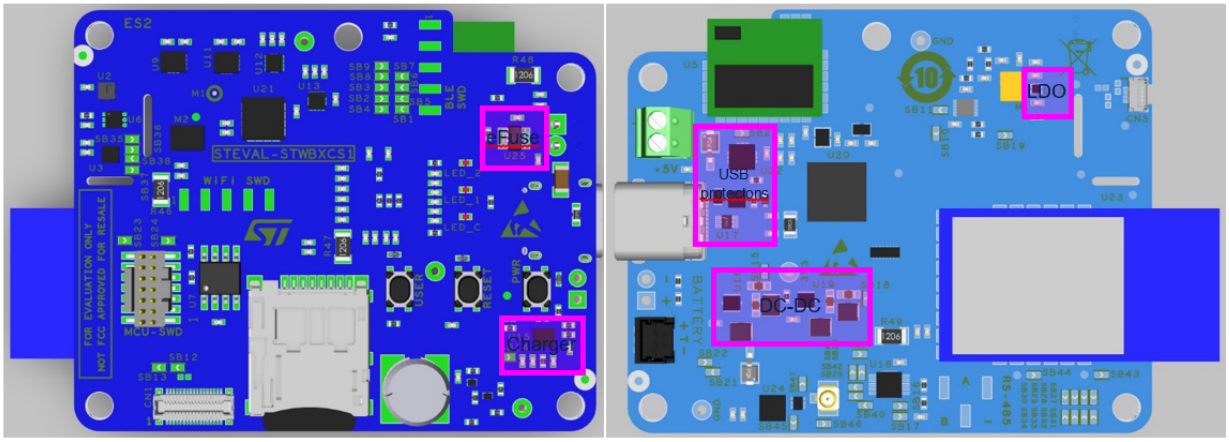


Figure 16. **Power and protections**



Power management IC

- U1: EMIF06-MSD02N16 six-line IPAD, EMI filter and ESD protection
- U10: LDLN025PU275R, 250 mA ultra low noise LDO
- U16, U19: ST1PS02CQ, 400 mA synchronous step-down converter
- U15: STBC02AJR Li-Ion linear battery charger
- U22: TCPP01-M12, USB Type-C™ port protection for Sink applications
- U25: STEF05SGR, electronic fuse for 5 V line
- Q1: STL6N3LLH6, N-channel 30 V, 6 A power MOSFET

Protections and connectors

- U17: USBLC6-2P6, low capacitance ESD protection for USB
- D4: STPS120M, 20 V, 1 A STmite power Schottky rectifier
- D6: ESDA25P35-1U1M, high-power transient voltage suppressor (TVS)
- TVS1, TVS2, TVS3: ESDALC6V1-1M2, single line low capacitance Transil
- TVS4: USBULC6-2M6, ultra large bandwidth ESD protection

- BATT, J4: battery connector
- J5: 5 V external power supply connector
- PWR: power button

1.6.3.1 *TCPP01-M12*

The TCPP01-M12 USB Type-C™ port protection is a single chip that facilitates the migration from USB legacy connectors Type-A or Type-B to USB Type-C™ connectors.

The TCPP01-M12 features a 22 V tolerant ESD protection as per IEC61000-4-2 level 4 on the USB Type-C™ connector configuration channel (CC) pins.

For a safe and reliable USB Type-C™ implementation, the TCPP01-M12 provides overvoltage protection on CC1 and CC2 pins when these pins are subjected to short-circuit with the VBUS pin. This might happen when removing the USB Type-C™ cable from its receptacle.

For sink applications, the TCPP01-M12 triggers an external N-MOSFET on the VBUS line when a defective power source applies a voltage higher than the selected OVP threshold. Moreover, the TCPP01-M12 integrates a dead-battery management logic that is compliant with the latest USB power delivery specification.

The TCPP01-M12 power supply for sink applications operated with a battery can be provided by an MCU 3.3 V GPIO to drop the power consumption in the "cable not attached" condition down to 0 nA. This low-power mode extends the battery operating life when no source equipment is attached.

The TCPP01-M12 can also be used to protect source (provider) applications. It can support the programmable power supply feature from the USB Type-C™ power delivery specification.

1.6.3.2 *STEF05S*

The STEF05S is an integrated electronic fuse optimized to monitor the 5 V DC power lines. When connected in series to the main power rail, it is able to detect precisely and react to overcurrent and overvoltage conditions.

When an overload condition occurs, the device limits the output current to a user-defined safe value. If the overload condition persists, the device enters an open state by disconnecting the load from the power supply.

In the case of an input overvoltage, the device regulates the output to a preset safe value.

The undervoltage lockout prevents the load from malfunctioning, switching the device off if the rail voltage is too low.

The STEF05S features the adjustable turn-on slew rate, which is useful to keep the inrush current under control during startup and hot-swap operations.

1.6.3.3 *EMIF06-MSD02N16*

The EMIF06-MSD02N16 is a six-line, highly integrated device designed to suppress EMI/RFI noise in all systems exposed to electromagnetic interference. This filter includes an ESD protection circuitry, which prevents damage to the application when subjected to ESD surges.

1.6.3.4 *LDLN025*

The LDLN025 is a 250 mA low-dropout voltage regulator, which works with an input voltage range from 1.5 to 5.5 V.

The typical dropout voltage at 250 mA load is 120 mV. The very low quiescent current, which is just 12 µA at no-load, extends the battery life of applications that require a very long standby time.

Thanks to its ultra-low noise value and high PSRR, the LDLN025 provides a very clean output, suitable for ultra-sensitive loads. It is stable with ceramic capacitors.

The enable logic control function makes the device enter shutdown mode, with a total current consumption lower than 1 µA.

The device also includes short-circuit and thermal protections.

Typical applications are noise-sensitive loads such as ADC, VCO in mobile phones and tablets, and wireless LAN devices.

The LDLN025 is designed to keep the quiescent current under control, at a low value also during the dropout operation.

1.6.3.5 *ST1PS02*

The ST1PS02 is a nano-quiescent miniaturized synchronous step-down converter, which is able to provide up to 400 mA output current with an input voltage ranging from 1.8 to 5.5 V.

This converter is designed for applications where the key factors are high efficiency, PCB size, and thickness.

The output voltage can be set using three digital control inputs. A V_{OUT} from 1.0 to 3.3 V can be dynamically selected.

Thanks to the enhanced peak current control (PCC), the ST1PS02 reaches a very high efficiency conversion using just a 2.2 µH inductor and two small capacitors.

The device embeds a controlled load switch to supply a subsystem with the same voltage rail. The advanced design circuitry is implemented to minimize the quiescent current. The device is available in a thin plastic package.

1.6.3.6 *STBC02*

The STBC02 is a highly integrated power management device. It embeds a linear battery charger, a 150 mA LDO, two SPDT load switches, a smart reset/watchdog block, and a protection circuit module (PCM) to prevent battery damage under fault conditions.

The STBC02 uses a CC/CV algorithm to charge the battery. You can program the fast charge and the precharge current independently by using dedicated resistors.

The termination current is set by default, being 5% of the programmed fast charge current, but you can also fix it at different values. Likewise, you can program the battery-floating voltage value and set it to a value up to 4.45 V.

The STBC02 also features a charger enable input to stop the charging process anytime.

The STBC02 is automatically powered off from the connected battery when the IN pin is not connected to a valid power source (battery mode). An external circuitry (NTC thermistor) can detect any battery under/overtemperature condition.

The STBC02 draws less than 10 nA from the connected battery in shipping mode conditions in order to maximize the battery life. The device is available in a flip-chip package.

1.6.3.7 *USBLC6-2*

The USBLC6-2SC6 is a device specific for monolithic applications dedicated to ESD protection of high-speed interfaces, such as USB 2.0, Ethernet links, and video lines.

The very low line capacitance secures a high level of signal integrity without compromising sensitive chip protection against the most stringently characterized ESD strikes.

1.6.3.8 *Battery connectors*

Connect the 480 mA LiPo battery included in the STWIN.box kit to the dedicated battery connector (BATT1) in order to provide the battery supply voltage (VBAT).

Figure 17. BATT1 connector

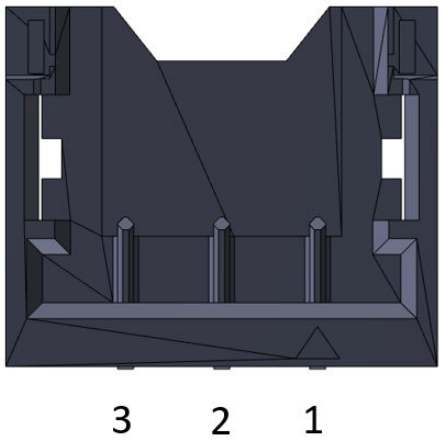


Table 16. BATT1 connector pins and signals

Signal	BATT1 connector
GND	Pin 1

Signal	BATT1 connector
BAT_NC	Pin 2
VBAT	Pin 3

1.6.3.9 *Power supply*

Different sources can supply the STWIN.box core system board:

- V_USB: through USB-Type C connector (sink only, 5 V).
- V_{IN}: through J5 connector (4.8-5.5 V).

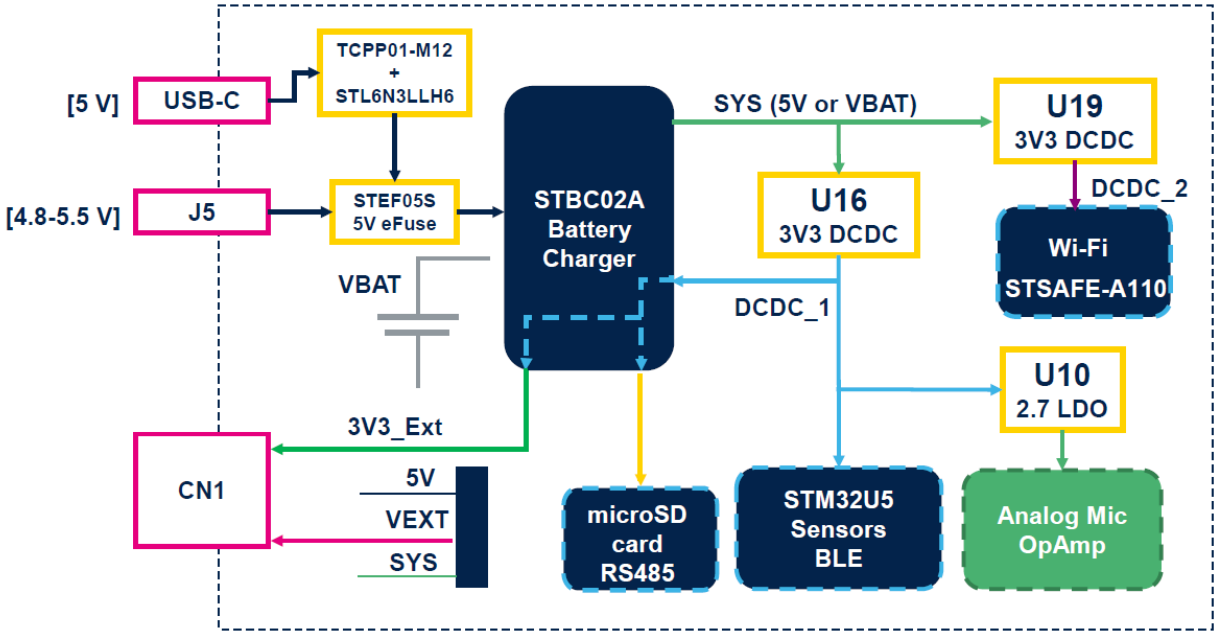
Note: Limit the current on this port to 2 A.

- VBAT: lithium ion polymer battery (3.7 V, 480 mAh) and the STBC02 battery charger integrated in the board.

The battery is optional. The STBC02 battery charger automatically checks the available power inputs and selects one of them to power the system. When the battery or another source is connected, the STBC02 automatically charges the battery.

When battery-powered, the equipment is intended to work properly with an operating temperature of 35°C. Without the battery, the equipment is intended to work properly with an operating temperature of 45°C.

Figure 18. STWIN.box core system board - power supply block diagram



1.6.3.10 *Power on or off procedure*

If the STWIN.box core system board is not powered via a battery, the board turns on or off when you connect or disconnect an external supply, respectively.

Follow the steps below to power the board on and off when it is powered by a LiPo battery.

Step 1. Push the power (PWR) button for about a second to power the board on.

The wake-up hardware feature of the STBC02 battery charger manages the power on.

Step 2. Push the power button again to turn the board off.

The STM32 manages the power off feature via software. Thus, the application code running on the STM32 needs to detect the push action in order to send the shutdown command to the battery charger to switch the power supply off.

1.6.3.11 *Power consumption evaluation*

The STWIN.box features several test points and jumpers to monitor the electrical performance of the running applications. In particular, four resistors monitor the current consumption in each of the four main power supply domains of the board.

To evaluate the general power consumption, remove both the battery and the USB cable, and directly provide 5 V to the J5 connector.

Remove (unsolder) the below mentioned resistors to connect an ammeter. The resistor pads are conveniently designed at a distance of 2.54 mm to facilitate soldering a standard header connector:

- R46 (3V3_SENSORS): all sensors except the analog microphone;
- R47 (VDD_UC): STM32 VDD (except VDDA);
- R48 (VDD_BLE): BlueNRG-M2 module;
- R49 (VDD_WIFI): Wi-Fi module.

There are also two solder bridges in series to the output of the two DC-DC regulators:

- SB15: DCDC_1
- SB18 (BlueNRG-M2): DCDC_2

Figure 19. STWIN.box core system resistors and solder bridges (top view)

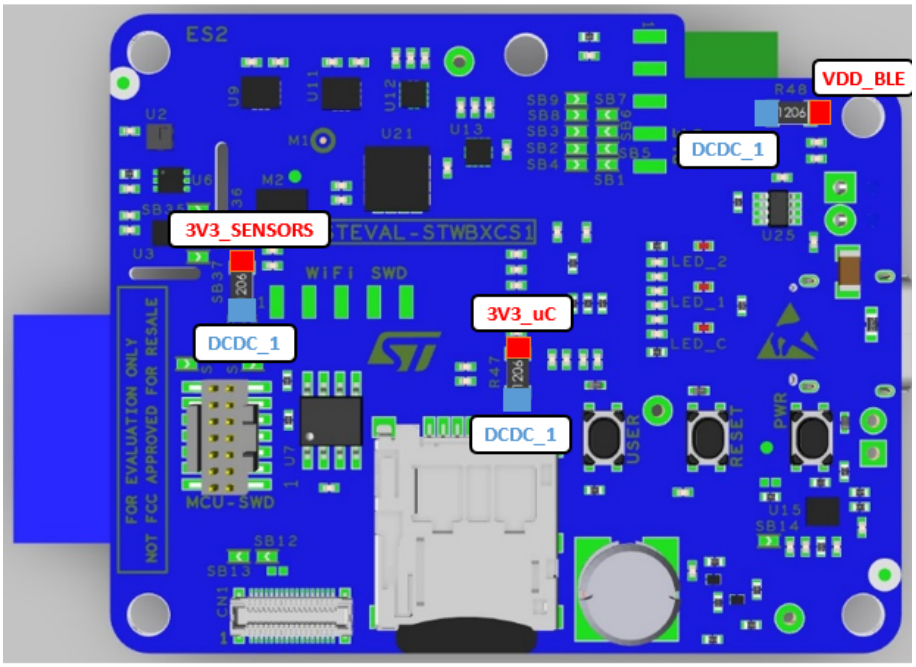
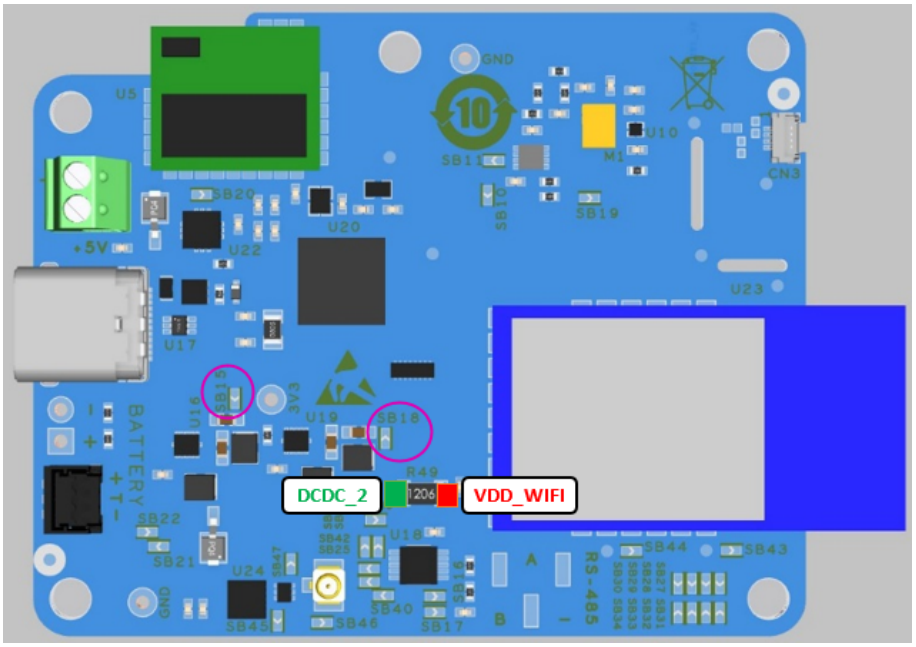


Figure 20. **STWIN.box core system resistors and solder bridges (bottom view)**



1.6.3.12 *Buttons and LEDs*

The STWIN.box core system board includes buttons and LEDs for user interaction:

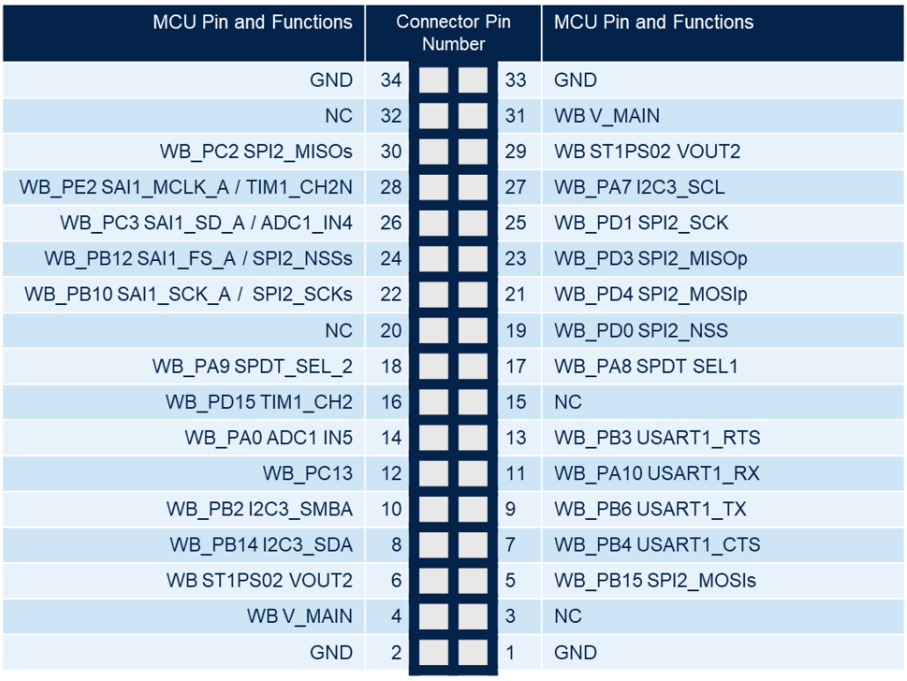
- buttons:
  - USR: generic user button;
  - PWR: connected to the STBC02 for integrated wake-up function and to the STM32 as a generic user button;
  - RESET: connected to the STM32 reset pin (black);
- LEDs:
  - LED_C: red LED connected to the STBC02 for battery status feedback;
  - LED1: green LED connected to the STM32;
  - LED2: orange LED connected to the STM32.

1.6.3.13 *34-pin expansion connector*

The STWIN.box board also features a high current board-to-FPC/board-to-board (0.4 mm pitch) 34-pin connector.

This connector is shared among few other evaluation kits such as STEVAL-PROTEUS1 and STEVAL-ASTRA1B and allows expanding the platform functionality.

Figure 21. Mapping of the 34-pin connector resources



MCU Pin and Functions	Connector Pin Number		MCU Pin and Functions
GND	34	33	GND
NC	32	31	WB V_MAIN
WB_PC2 SPI2_MISOs	30	29	WB ST1PS02 VOUT2
WB_PE2 SAI1_MCLK_A / TIM1_CH2N	28	27	WB_PA7 I2C3_SCL
WB_PC3 SAI1_SD_A / ADC1_IN4	26	25	WB_PD1 SPI2_SCK
WB_PB12 SAI1_FS_A / SPI2_NSSs	24	23	WB_PD3 SPI2_MISOp
WB_PB10 SAI1_SCK_A / SPI2_SCKs	22	21	WB_PD4 SPI2_MOSIp
NC	20	19	WB_PD0 SPI2_NSS
WB_PA9 SPDT_SEL_2	18	17	WB_PA8 SPDT SEL1
WB_PD15 TIM1_CH2	16	15	NC
WB_PA0 ADC1 IN5	14	13	WB_PB3 USART1_RTS
WB_PC13	12	11	WB_PA10 USART1_RX
WB_PB2 I2C3_SMBA	10	9	WB_PB6 USART1_TX
WB_PB14 I2C3_SDA	8	7	WB_PB4 USART1_CTS
WB ST1PS02 VOUT2	6	5	WB_PB15 SPI2_MOSIs
WB V_MAIN	4	3	NC
GND	2	1	GND

Table 17. Flexible expansion connector pins

Pin no.	Description	STM32 pin	Signal
1	GND	-	-
2	GND	-	-
3	Not used	-	-
4	VCONN	-	5V/SYS
5	SPIx_MOSIs	PB15	SPI2_MOSI_p2
6	V REG1	-	3V3_Ext
7	USART_CTS	PD11	USART3_CTS
8	I2Cz_SDA	PG8	I2C3_SDA
9	USART_TX	PA7	USART3_TX
10	INT/I2Cz_SMB	PG5/PG6/PD15	INT_EX
11	USART_RX	PA5	USART3_RX
12	RESET	PB1	GPIO1_EX
13	USART_RTS	PD13	USART3_RTS
14	ADC	PC3	ADC_EX
15	Not used	-	
16	PWM	PC6	TIM3_PWM
17	GPIO3_EX	PF10	GPIO3_EX
18	GPIO2_EX	PF8	GPIO2_EX
19	SPIx_NSS	PI0/PA15	SPI2_NSS/SPI3_NSS
20	Not used	-	
21	SPIx_MOSIp	PI3/PB5	SPI2_MOSI/SPI3_MOSI
22	GPIO1/SAI1_SCK	PE5	SAI1_SCK_A

Pin no.	Description	STM32 pin	Signal
23	SPIx_MISOp	PD3/PB4	SPI2_ MISO/SPI3_MISO
24	GPIO2/SAI1_FS	PE4	SAI1_FS_A
25	SPIx_SCK	PI1/PG9	SPI2_ SCK/SPI3_SCK
26	GPIO3/SAI1_SD	PE3/PE6	SAI1_SD_A/SAI1_SD_B
27	I2Cz_SCL	PG7	I2C3_SCL
28	GPIO4/SAI1_MCLK	PE2	SAI1_MCLK_A
29	V REG2	-	3V3_Ext
30	SPIx_MISOs	PI2	SPI2_MISO_P2
31	VCONN		5V/SYS
32	Not used	-	-
33	GND	-	-
34	GND	-	-

2 How to assemble the STWIN.box

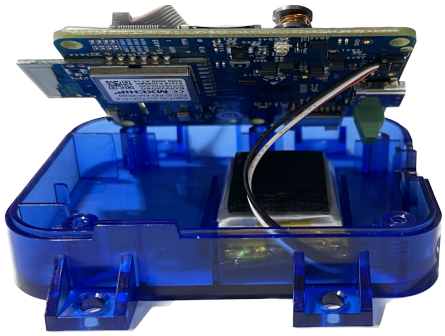
The plastic case is designed to hold the STWIN.box core system board with the battery. The case consists of two parts, the bottom case and the cover. Through the cover you can access the three buttons: USR, RESET, and BOOT.

Step 1. Prepare the required material:

- STWIN.box core system board (STEVAL-STWBXCS1);
- five screws;
- the plastic case (cover and bottom);
- the battery.

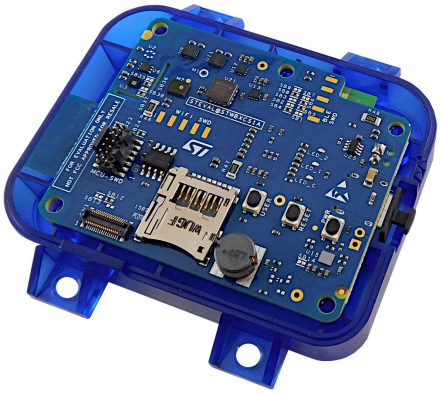
Step 2. Place the battery in the dedicated slot inside the bottom of the plastic case and connect the battery to the core system board through the BATT connector.

Figure 22. Connecting the core system board to the battery



Step 3. Place the core system board inside the bottom case.

Figure 23. STWIN.box core system board placed in the bottom case



DIL24 adapter

The included DIL24 adapter (STEVAL-C34DIL24) allows to expand the capabilities of the STWIN.box by giving the possibility to connect an additional sensor. The DIL24 form factor is compatible with several STEVAL boards, like STEVAL-MKI207V1 or STEVAL-MKI233KA.
The two boards can be connected through the provided flex cable, plugged into CN1 connectors, as shown in the below picture.

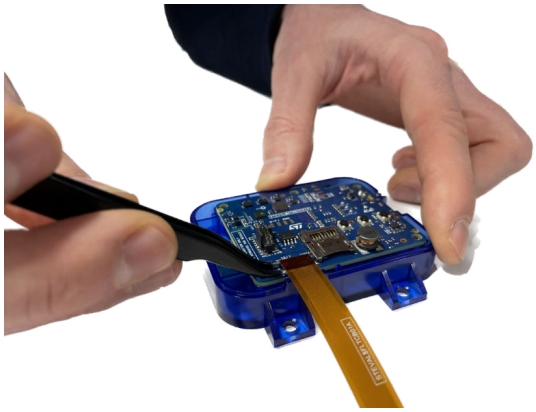
Figure 24. Case+DIL small (open)

The plastic case design allows to mount the cover even if the flex cable is in place.

Figure 25. Case+DIL small (closed)

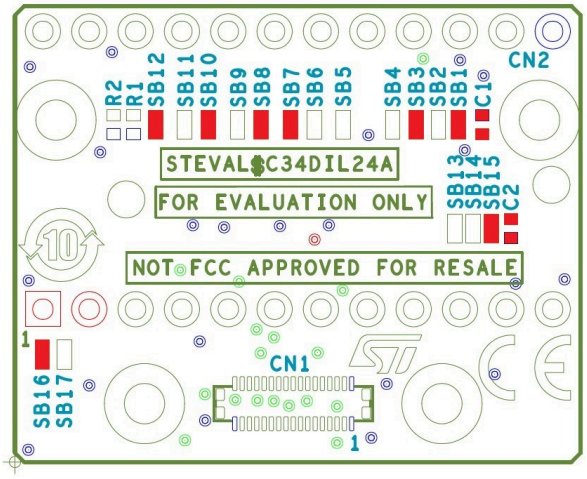
Warning: *Please be careful when you remove the Flex cable as you may damage it. The safest way to remove it is by pulling it next to the connectors using tweezers.*

Figure 26. **C34**



By default the DIL24 adapter is configured in SPI mode with the following solder bridges configuration:

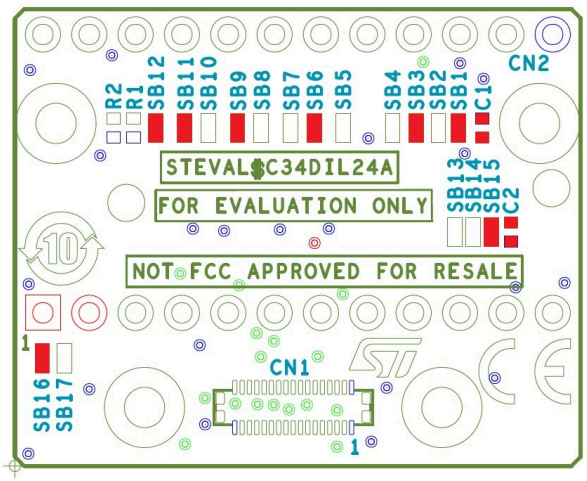
Figure 27. **DIL24 SPI mode**



If you need to use an I2C sensor, you need to modify the solder bridges as following:

– Remove SB7, SB8, SB10
– Solder SB6, SB9, SB11

Figure 28. **DIL24 I2C mode**



Acoustic vents for microphones

The microphones are highly vulnerable to damage or acoustic degradation from environmental contaminants such as water, dust, dirt or the extremely small particles that can be suspended in smoke or smog.
For this reason, in the kit there are some protective membranes that can be applied to the microphone acoustic holes on the plastic case cover.

Figure 29. Acoustic vents

– Features:
  - p/n: GORE AVP2342.04.0
  - No impact up on captured sound to 10 kHz
  - Very low impact (less than 4 dB) up to 60 kHz
  - Ensures pressure equalization while allowing sound transmission

The vents can be applied on the plastic case either on the inside or the outside (inside is preferred for acoustic performance).

Figure 30. Installation of the acoustic vent

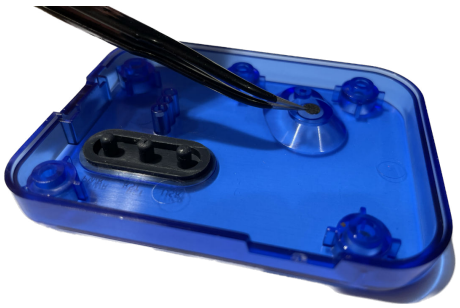


Figure 31. Vents installed on acoustic holes (inside view)

Figure 32. **Vents installed on acoustic holes (outside view)**

Step 4. Close the plastic case with the cover and the five screws.

Figure 33. **STWIN.box assembly**

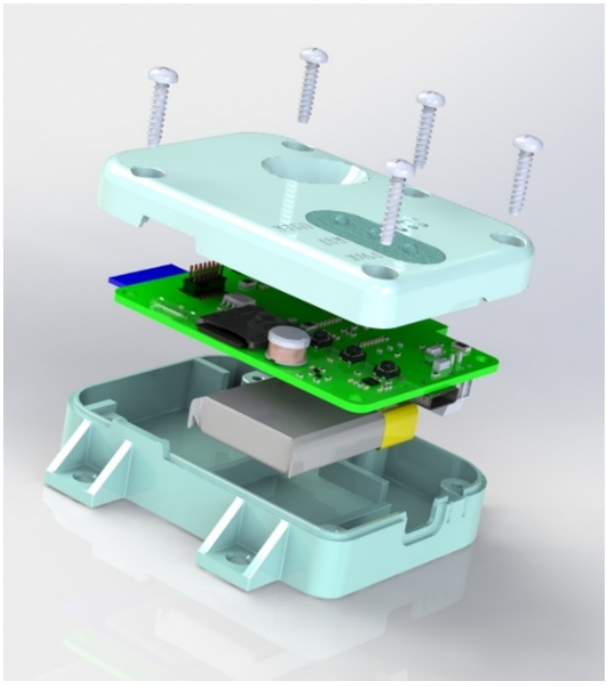
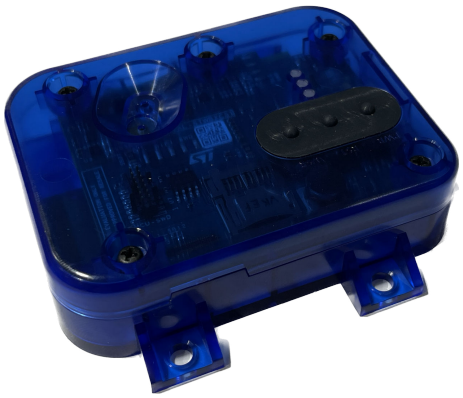


Figure 34. **STWIN.box mounted with the plastic case**



3 How to program the board

3.1 How to program the STWIN.box in “USB mode”

This is the easiest mode if you just want to download a binary into the board via USB, without the need of any debugging capabilities.

The advantage is that no additional debugger is needed, just a USB Type C™ cable and STM32CubeProgrammer installed on your PC.

To enter the "Firmware upgrade" mode, follow the procedure below.

Step 1. Plug the board.

Step 2. Press the RESET button and, while keeping the button pressed, press the USER button.

Step 3. Release the RESET button and then release the USER button.

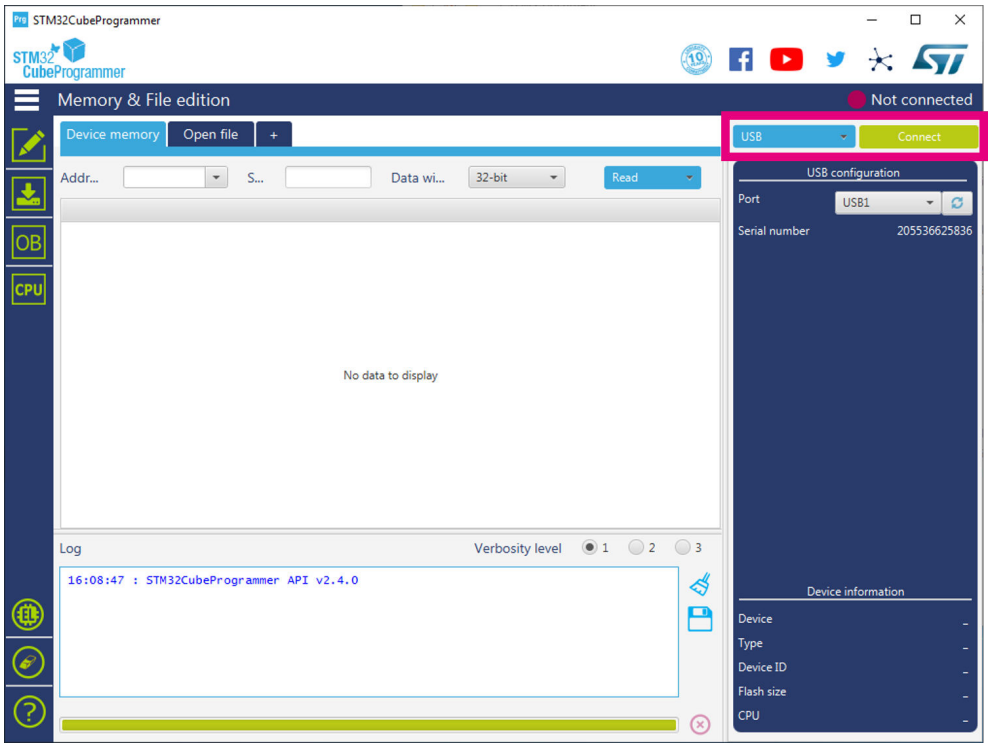
The board starts in the DFU mode and should be automatically recognized by the PC.

Step 4. You can upgrade the firmware by following the steps below:

Step 4a. Open STM32CubeProgrammer.

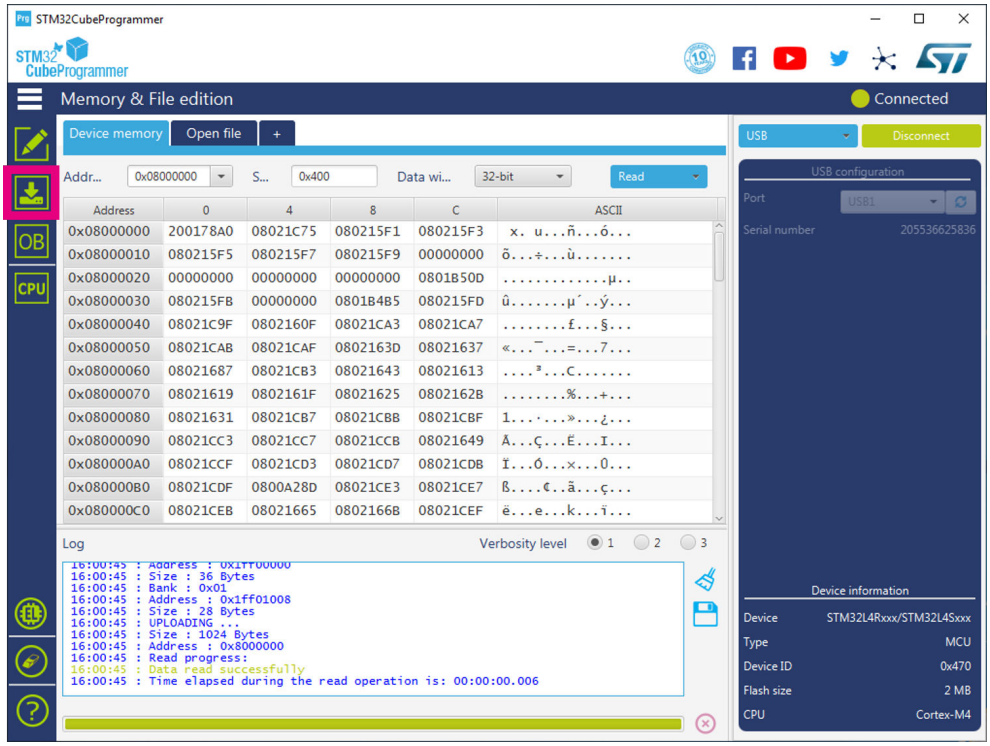
Step 4b. Select [**USB**] on the top-right corner.

Figure 35. STM32CubeProgrammer - USB mode selection



Step 4c. Click on [**Connect**].

Figure 36. STM32CubeProgrammer - connection

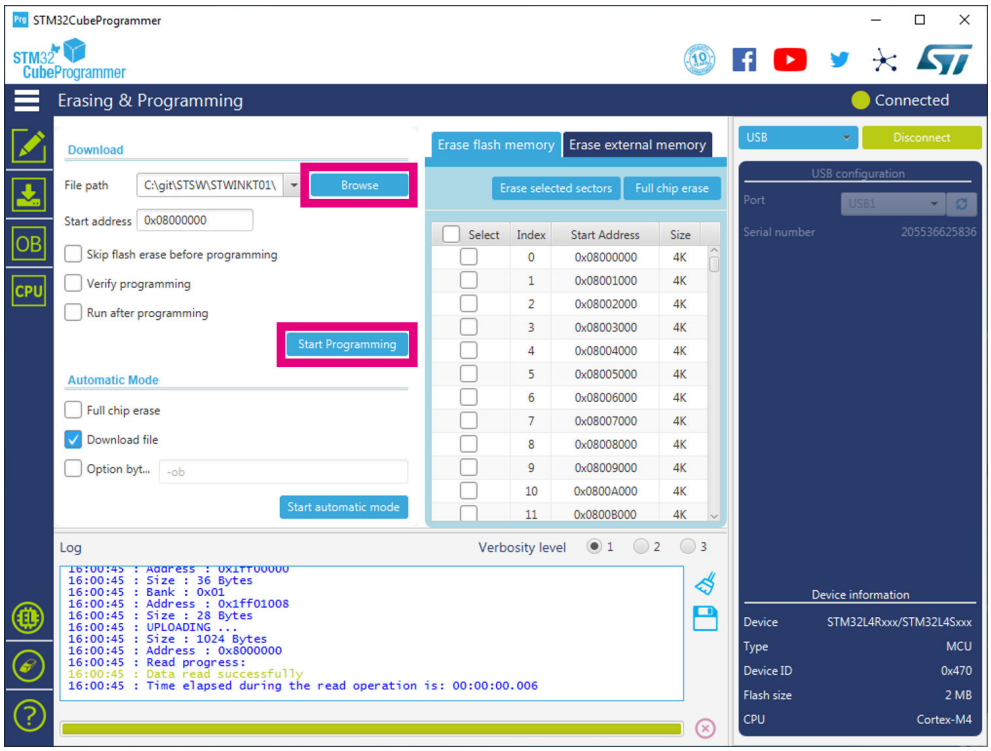


Step 4d. Go to the [**Erasing & Programming**] tab.

Step 4e. Search for the new .bin or .hex binary file to be flashed into the board.

Step 4f. Click on [**Start Programming**].

Figure 37. STM32CubeProgrammer - programming

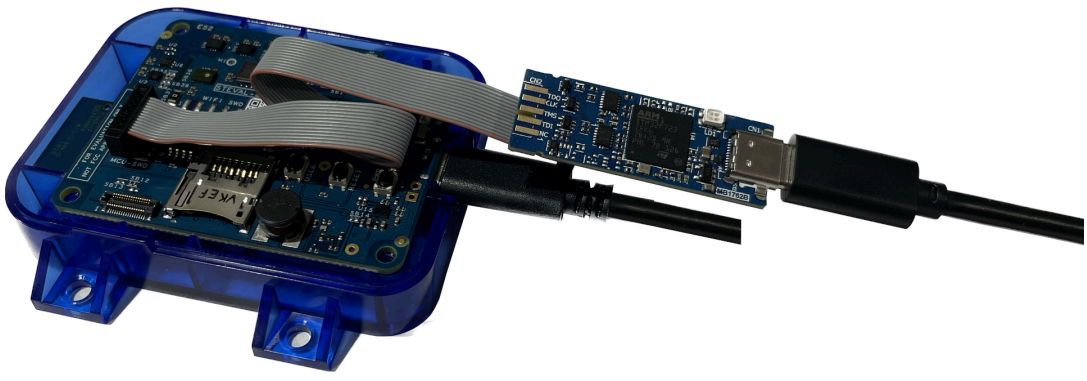


3.2 How to program the STWIN.box with an external debugger

The STWIN.box programming connector is natively compatible with the STLINK-V3 debugger family (STLINK-V3SET or STLINK-V3MINIE).

Note: STLINK-V3 programmers are not included in the kit.

Figure 38. STWIN.box and STLINK-V3MINIE programmer



Alternatively, to offer more alternatives, an adapter to ST-LINK V2-1 (STM32 Nucleo development board) or standard JTAG connector is included in the kit.

When using an STM32 Nucleo development board as an external debugger, you need to disconnect the on-board STM32 by removing the two jumpers on CN2 (see the picture below).

Figure 39. **STWIN.box, adapter, and STM32 Nucleo development board**

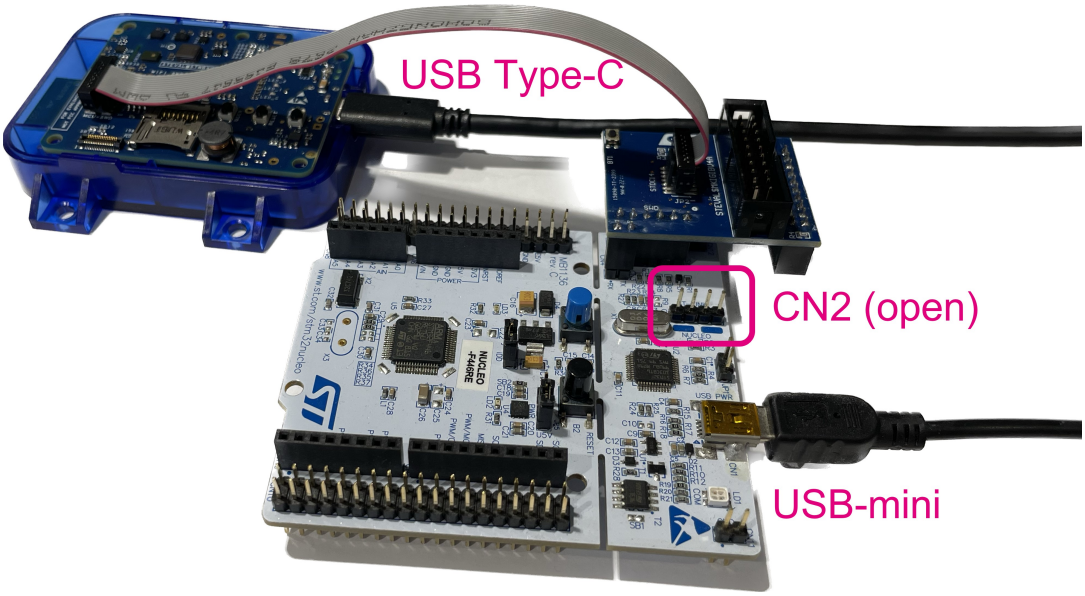
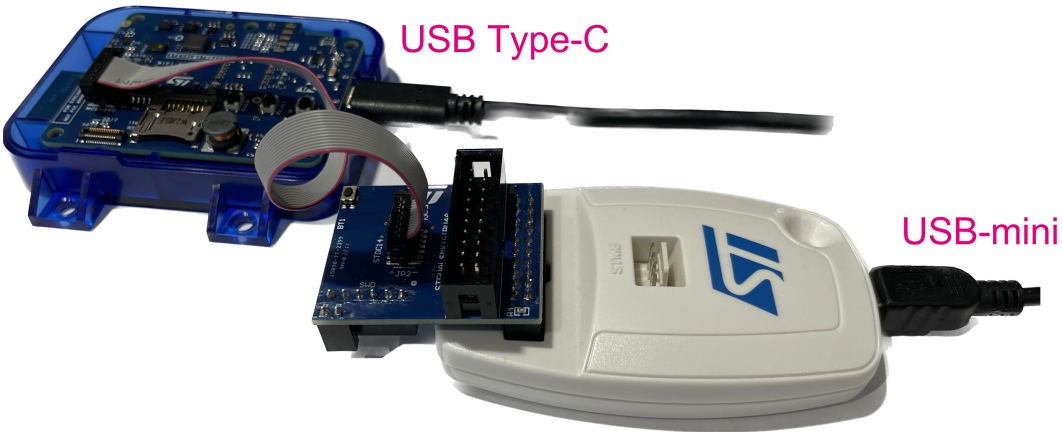


Figure 40. **STWIN.box and ST-LINK/V2 debugger (JTAG 20-pin 2.54 mm pitch connector)**



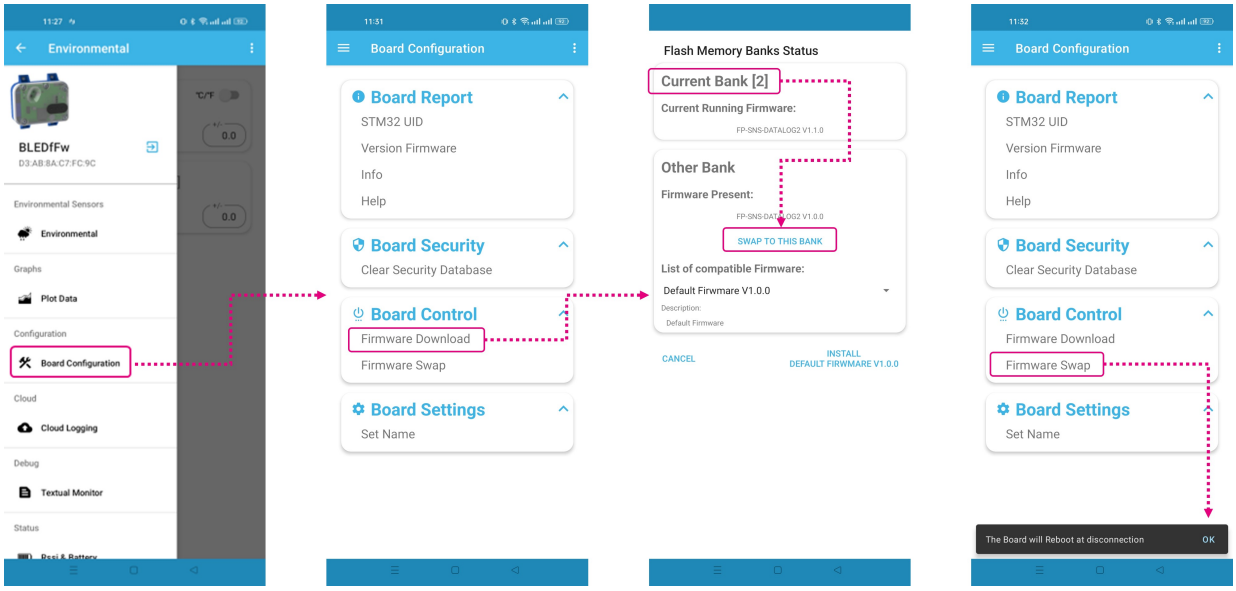
Once the hardware connections are in place, you can either:

- download one of the sample application binaries provided using STM32CubeProgrammer
- recompile and flash memory one of the provided projects with your preferred IDE (STM32CubeIDE, EWARM, or, Keil®)

Note: To debug the code using one of the compatible IDE and debuggers, you need to make sure that the active flash bank is the first one. You can do this using the Mobile App (if the current FW supports the BLE) or using the STM32CubeProgrammer.

- *STBLESensor app*
  - *Check the active bank as shown in the picture below and swap it if necessary.*

Figure 41. Swap flash bank with mobile app



- *STM32CubeProgrammer*
  - *Check the option byte configuration and make sure that the SWAP_BANK field is unchecked.*

Figure 42. Swap flash bank with STM32CubeProgrammer 1/3

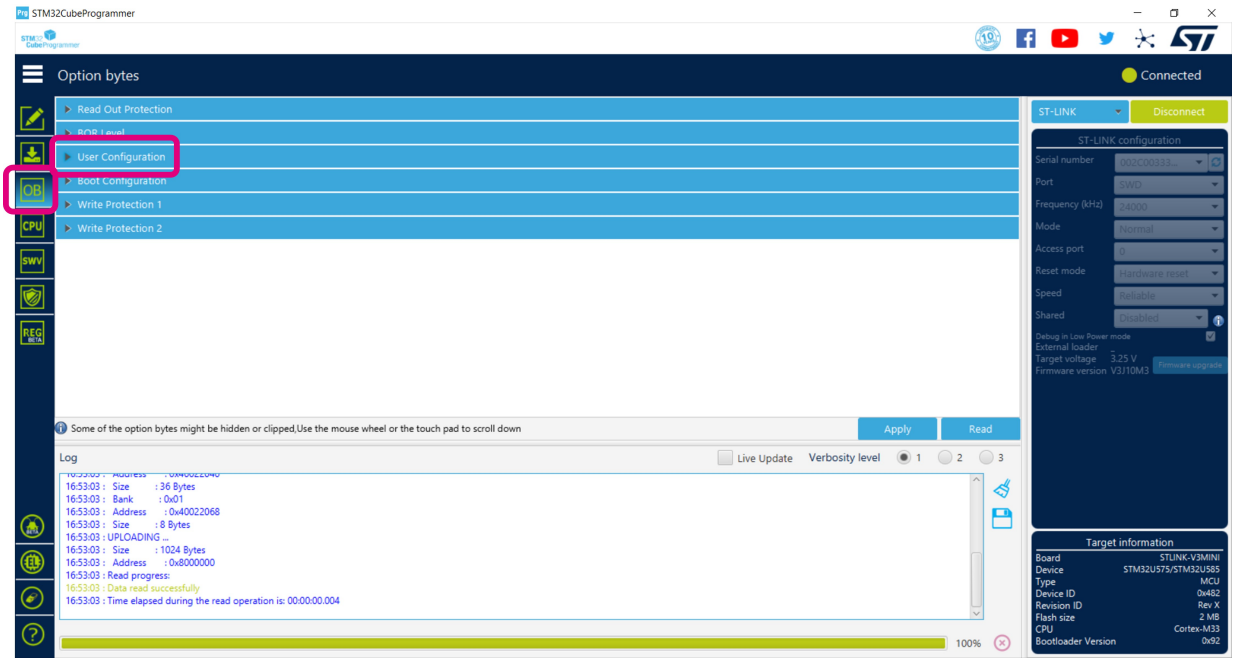


Figure 43. ***Swap flash bank with STM32CubeProgrammer 2/3***

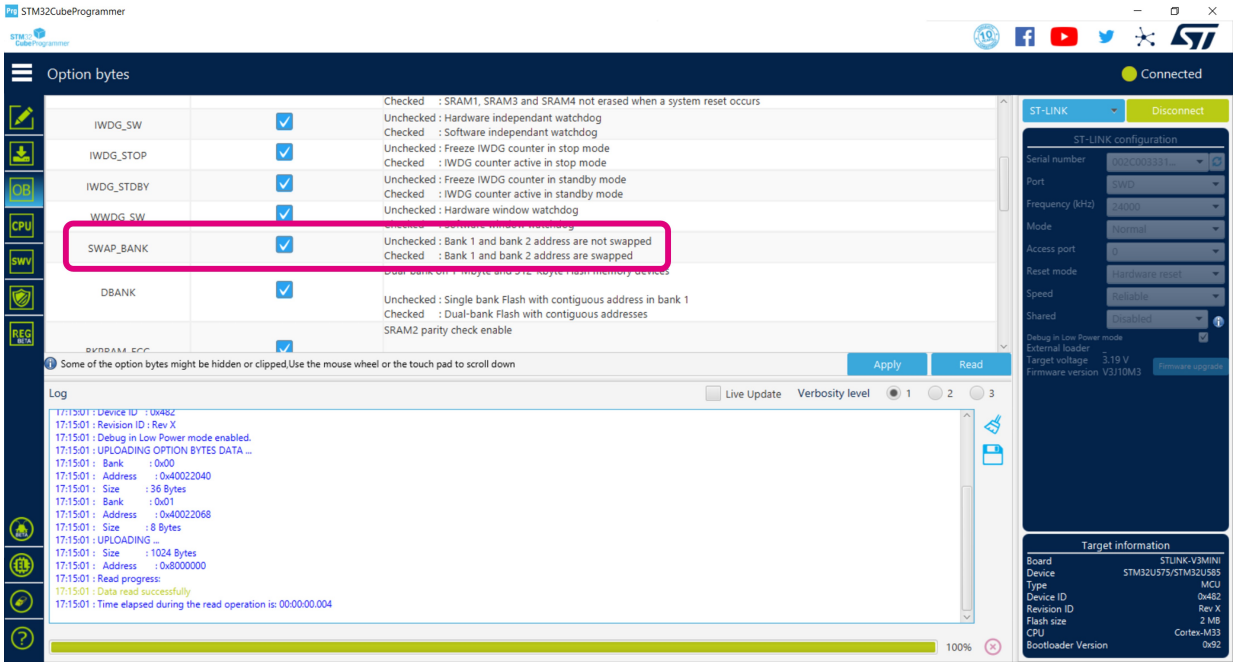
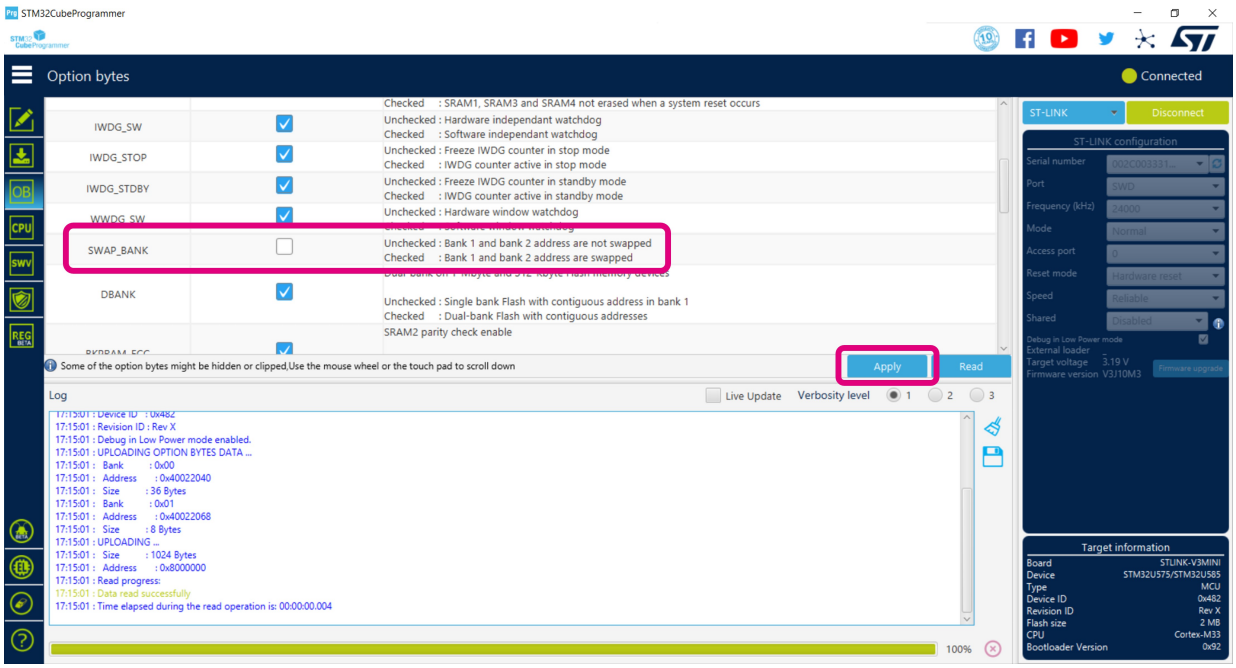


Figure 44. ***Swap flash bank with STM32CubeProgrammer 3/3***

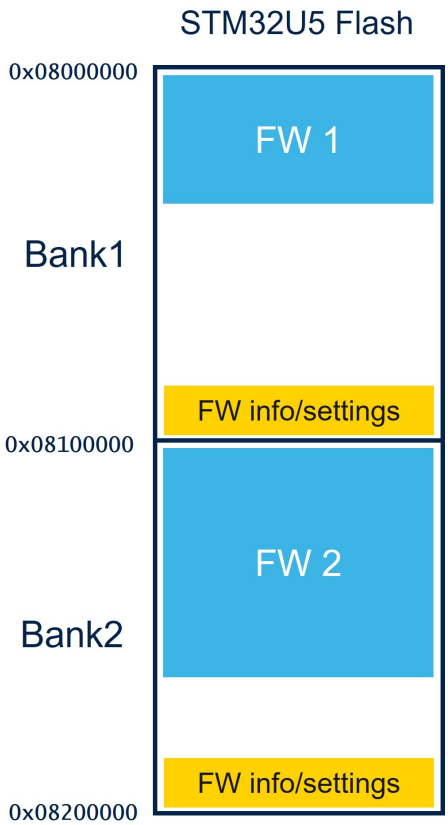


4 Default application

The STEVAL-STWINBX1 is released with a default firmware that enables the Bluetooth pairing via NFC and Fast Firmware On-The-Air upgrade through the STBLESensor app.

STM32U5 microcontroller family supports a double-bank flash memory.

Figure 45. Double-bank flash memory



This feature enables Fast FOTA procedure without the need of designing custom bootloader firmware.

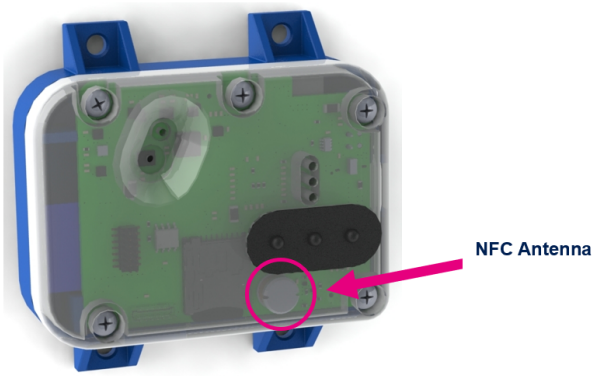
Moreover, two different types of firmware can be downloaded separately (one for each bank) and the boot bank is controlled through STM32 options bytes.

To exploit the default firmware, follow the following steps:

- Install the STBLESensor app on your smartphone from Google Play or App Store.
- Turn on the Bluetooth® Low Energy and NFC on your smartphone.

- Place your smartphone on top of the NFC antenna of the STWIN.box, shown below.

Figure 46. STWIN.box antenna



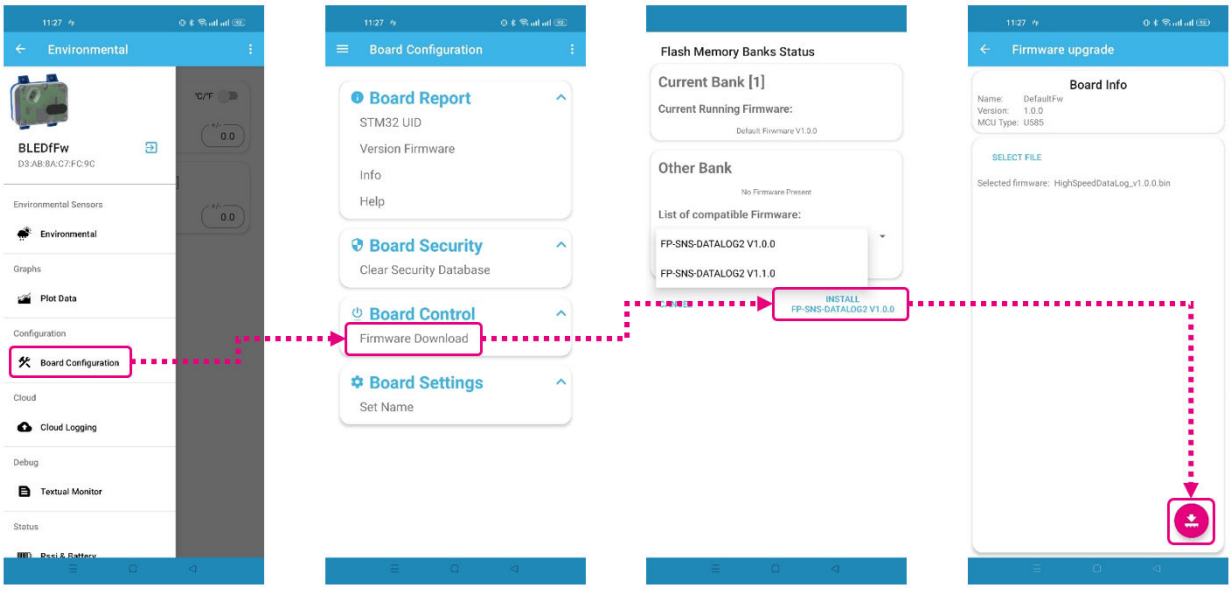
  - The smarphone reads the Bluetooth® Low Energy pairing information and automatically loads the STBLESensor app
  - Ignore any pin request (it disappears automatically in a few seconds)

- In alternative, the STWIN.box can be connected to the STBLESensor app by just open manually the application
- The application shows the environmental data coming from the board (temperature and pressure)

At this point you can choose to upgrade the firmware on the board directly by using the mobile app, by selecting one of the available firmware.

Upgrade the firmware by following the steps shown in the following figure.

Figure 47. Firmware upgrade procedure



5 Schematic diagrams

Figure 48. Core system board circuit schematic (1 of 8)

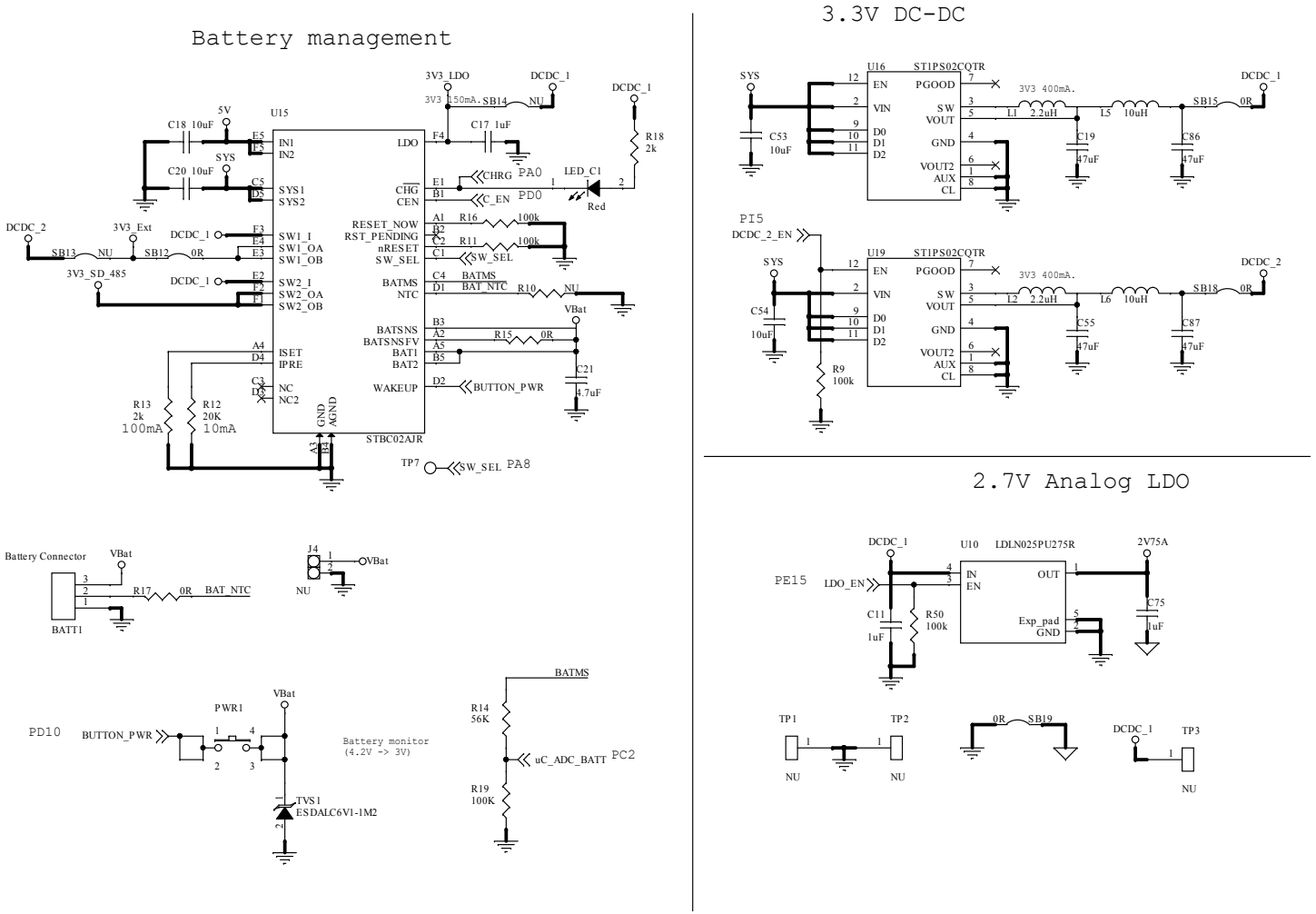


Figure 49. Core system board circuit schematic (2 of 8)

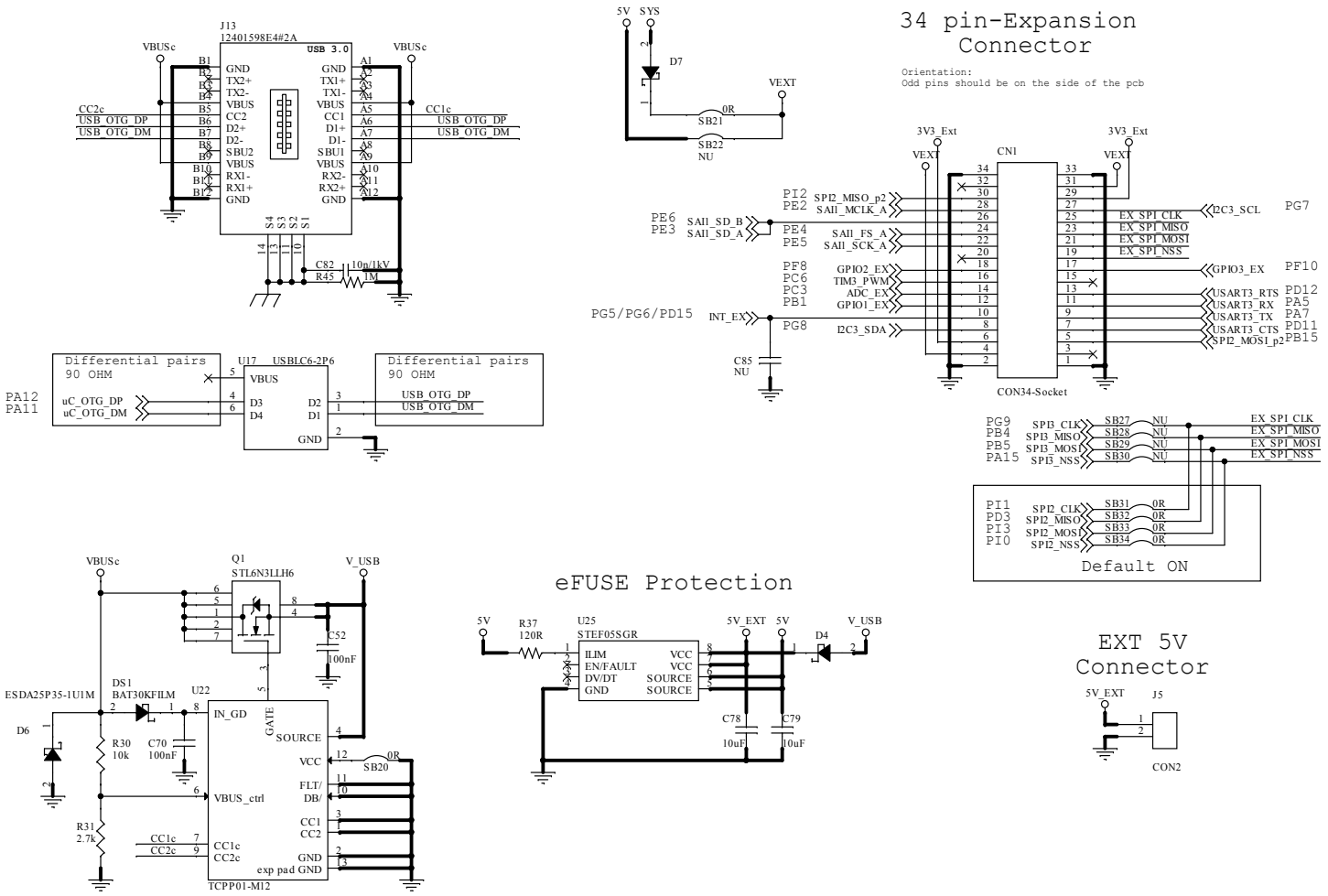


Figure 50. Core system board circuit schematic (3 of 8)

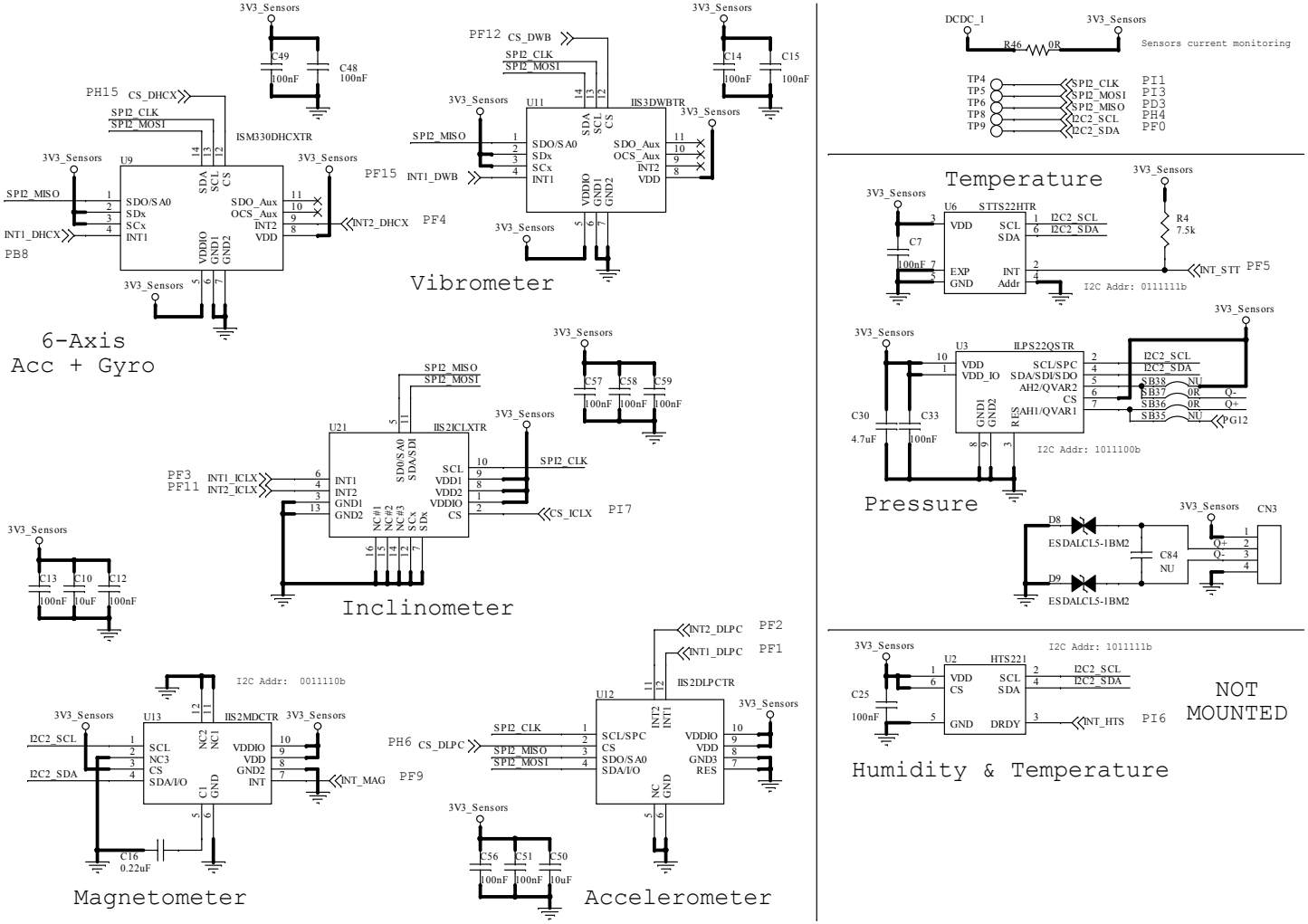
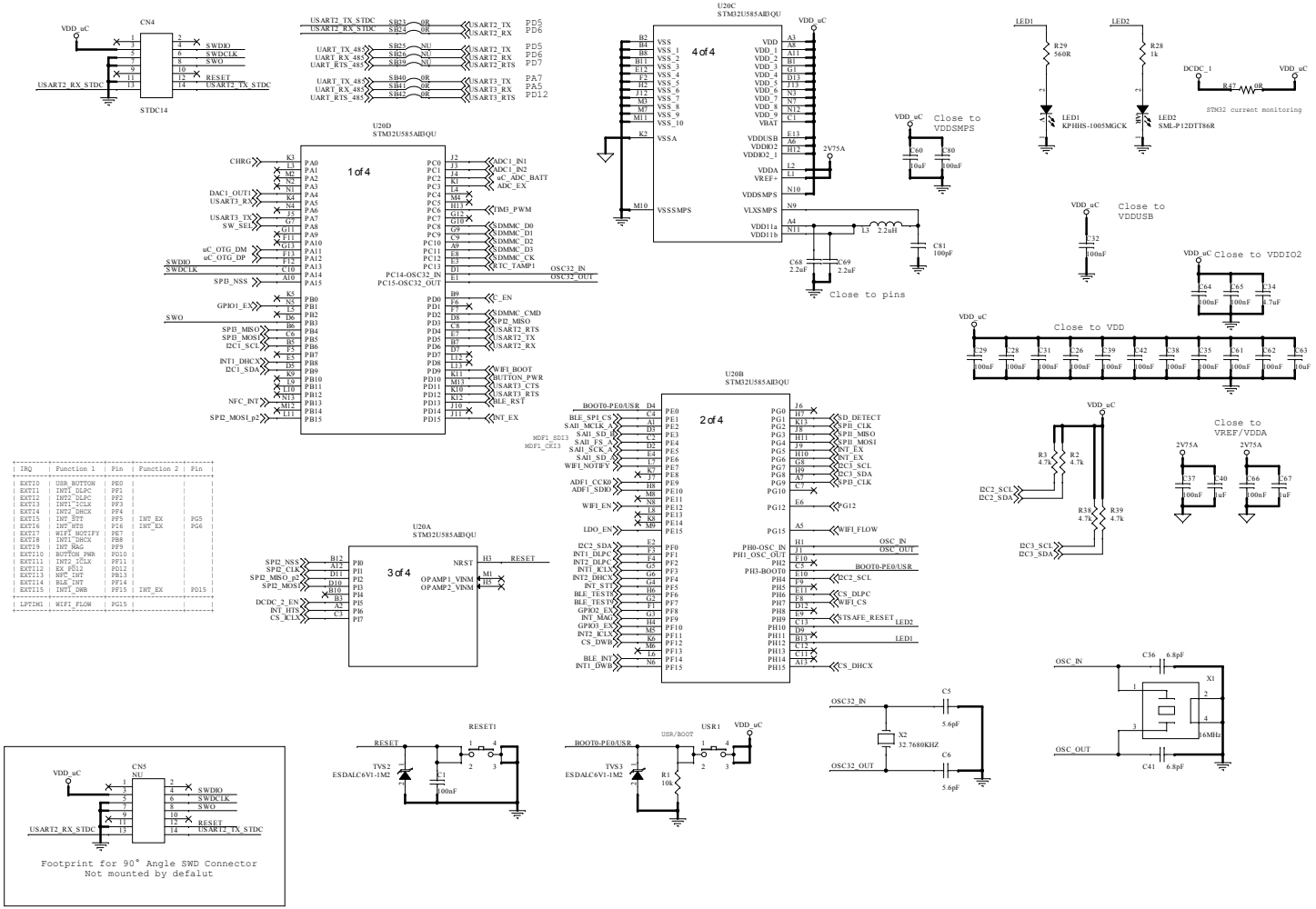


Figure 51. Core system board circuit schematic (4 of 8)



IRQ	Function 1	Pin	Function 2	Pin
EXTI0	USR_BUTTON	PE0		
EXTI1	INT1_DLPC	PF1		
EXTI2	INT2_DLPC	PF2		
EXTI3	INT1_ICLK	PF3		
EXTI4	INT2_DHCX	PF4		
EXTI5	INT_STT	PF5	INT_EX	PG5
EXTI6	INT_BTS	PI6	INT_EX	PG6
EXTI7	WIFI_NOTIFY	PE7		
EXTI8	INT1_DHCX	PB8		
EXTI9	INT_MAG	PF9		
EXTI10	BUTTON_PWR	PD10		
EXTI11	INT2_ICLK	PF11		
EXTI12	EX_POL2	PD12		
EXTI13	NFC_INT	PB13		
EXTI14	BLE_INT	PF14		
EXTI15	INT1_DWB	PF15	INT_EX	PD15
LPTIM1	WIFI_FLOW	PG15		

Figure 52. Core system board circuit schematic (5 of 8)

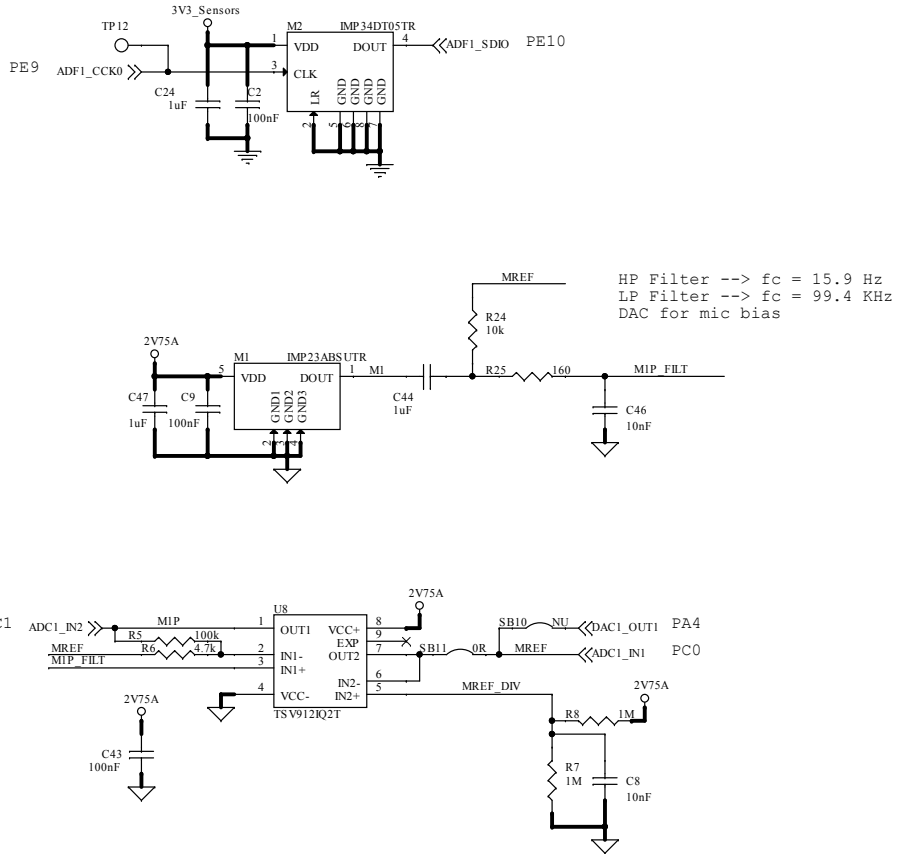


Figure 53. Core system board circuit schematic (6 of 8)

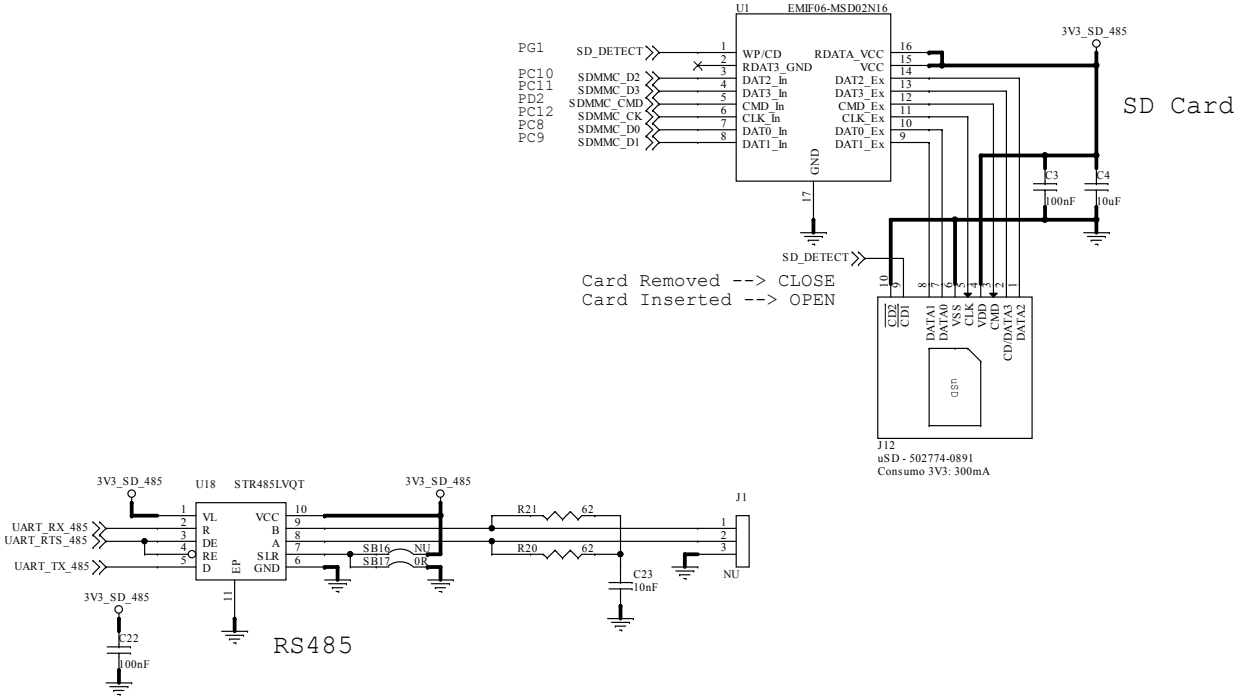


Figure 54. Core system board circuit schematic (7 of 8)

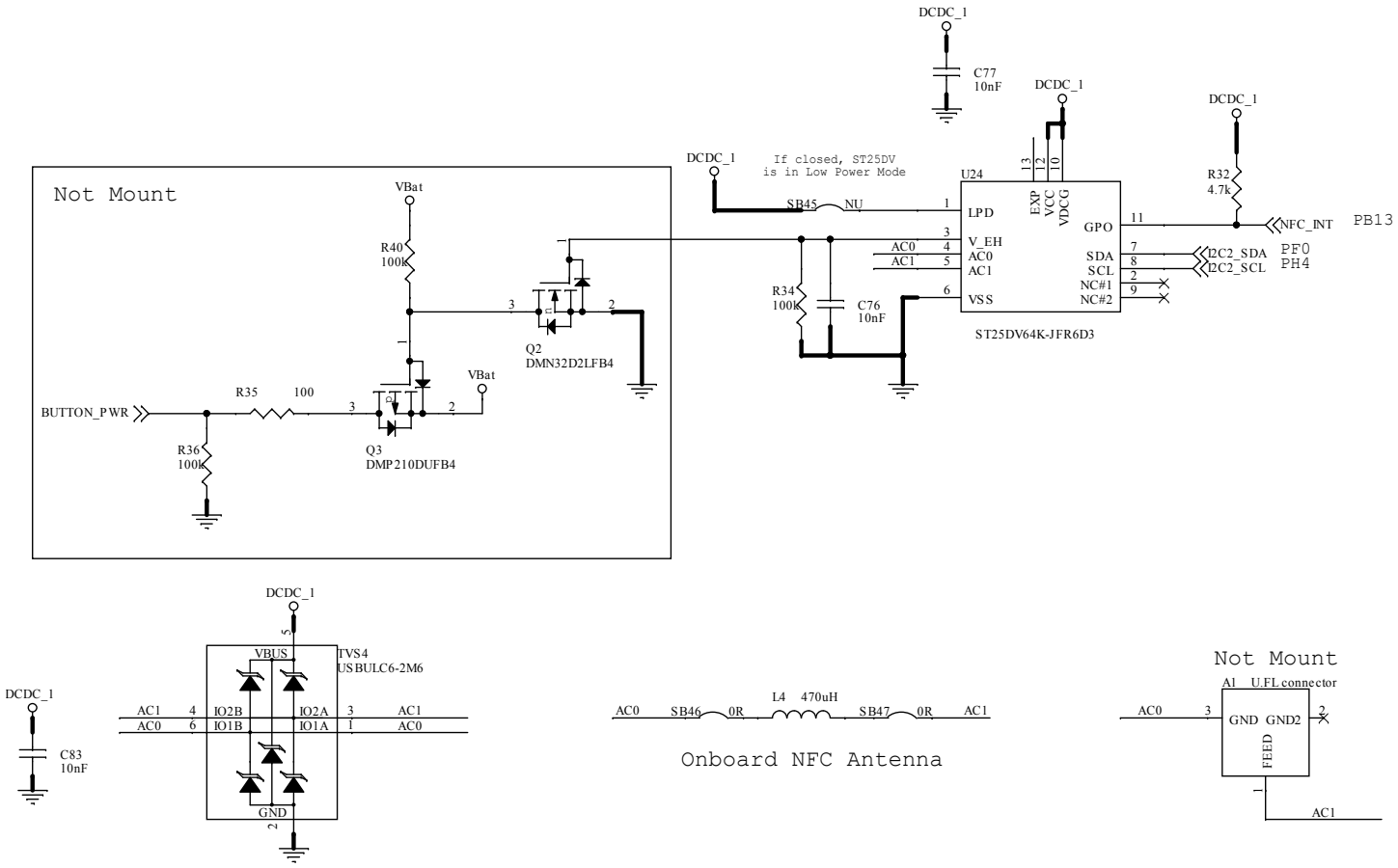


Figure 55. Core system board circuit schematic (8 of 8)

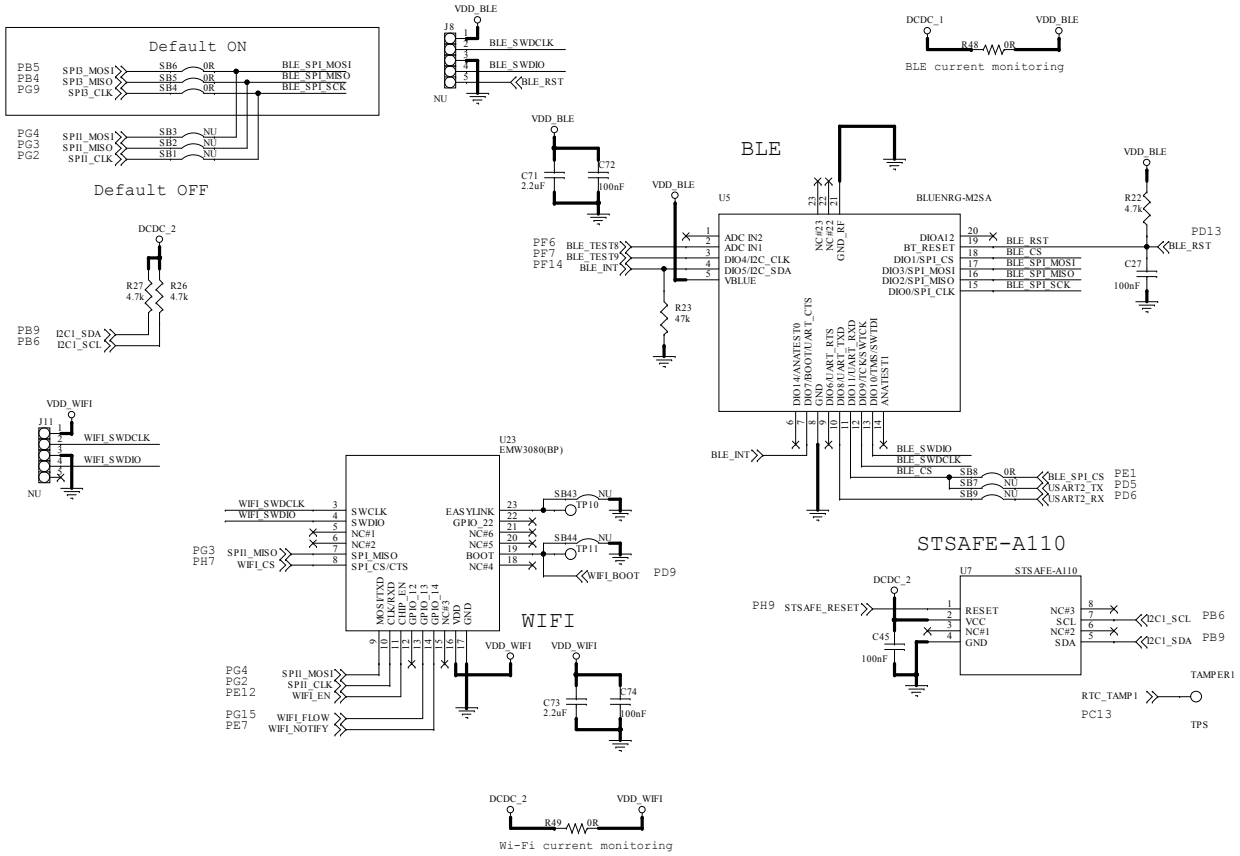
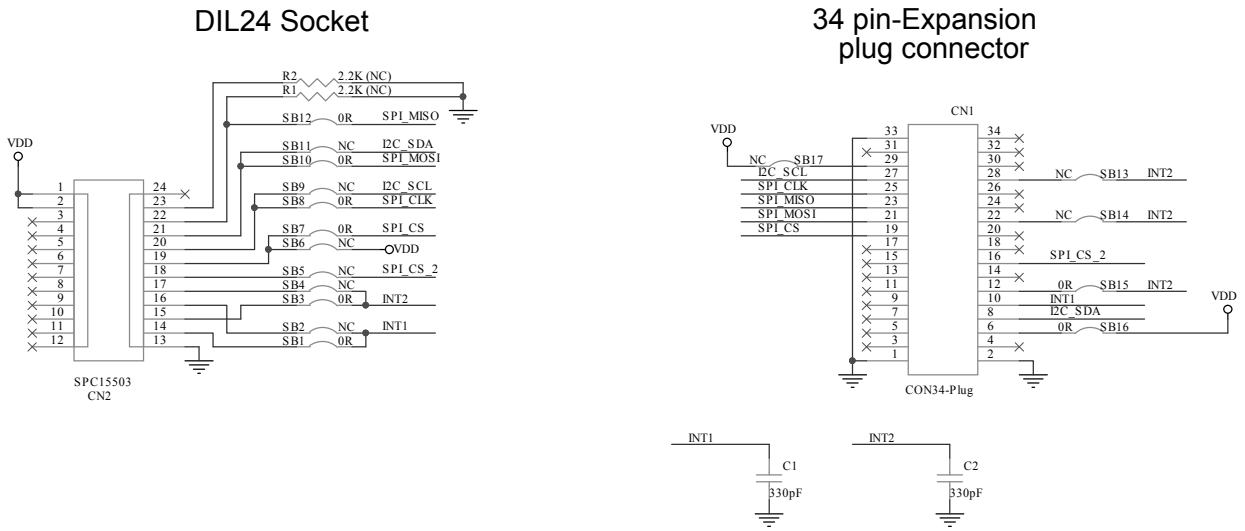


Figure 56. Adapter board circuit schematic



6 Bill of materials

Table 18. STEVAL-STWINBX1 bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	Table 19. STEVAL-STWBXCS1	-	Core system board	ST	Not available for separate sale
2	1	Table 20. STEVAL-C34DIL24	-	Adapter board	ST	Not available for separate sale
3	1	-	-	Plastic case	-	-
4	4	-	-	Screws	-	-
5	1	-	-	Programming cable	-	-

Table 19. Core system board bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	A1	U.FL connector	Coaxial U.FL (not mounted)	-	-
2	1	BATT1	Battery connector	Battery connector	Molex	78171-0003
3	1	CN1	CON34 SMD gold	Connector socket	Panasonic Electric Works	AXF5G3412A
4	1	CN3	CON4, 0.50 mm pitch	4-pin FFC/FPC connector	Hirose	FH33J-4S-0.5SH(10)
5	1	CN4	STDC14	STDC14-ARM MIPI10 compatible	Samtec	FTSH-107-01-L-DV-K-P
6	1	CN5	NU	STDC14- RM MIPI10 compatible (not mounted)	Samtec	FTSH-107-01-L-DV-K-P
7	1	CS1	CS V3 4L 35um	C.S. (not mounted)	-	-
8	42	C1, C2, C3, C7, C9, C12, C13, C14, C15, C22, C25, C26, C27, C28, C29, C31, C32, C33, C35, C37, C38, C39, C42, C43, C45, C48, C49, C51, C52, C56, C57, C58, C59, C61, C62, C64, C65, C66, C70, C72, C74, C80	100 nF, 0402 (1005 metric), 0.1 µF, ±10%, X7R	Ceramic capacitors	Murata Electronics North America	GRM155R71C104KA88J
9	11	C4, C10, C18, C20, C50, C53, C54, C60, C63, C78, C79	10µF, 10 V, 0402 (1005 metric), ±20%, X5R	Ceramic capacitors	Samsung Electro-Mechanics America, Inc.	CL05A106MP8NUB8
11	6	C8, C23, C46, C76, C77, C83	10 nF, 25 V, 0402 (1005 metric), ±10%,X7R	Ceramic capacitors	AVX Corporation	04023C103KAT2A
12	8	C11, C17, C24, C40, C44, C47, C67, C75	1 µF, 10 V, 0402 (1005 metric), ±10%, X5R	Ceramic capacitors	Taiyo Yuden	JMK105BJ105KV-F

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
13	1	C16	0.22 µF, 16 V, 0402 (1005 metric), ±10%, X7R	Ceramic capacitor	Murata Electronics North America	GRM155R71C224KA12D
14	4	C19, C55, C86, C87	47 µF, 10 V, 0603 (1608 metric), ±20%, X5R	Ceramic capacitors	Murata Electronics North America	ZRB18AR60J476ME01L
15	3	C21, C30, C34	4.7 µF, 10 V, 0402 (1005 metric), ±20%, X5R	Ceramic capacitors	Murata Electronics North America	GRM155R61A475MEAAD
16	2	C36, C41	6.8 pF, 10 V, 0402 (1005 metric), ±5%, C0G/NP0	Ceramic capacitors	Murata Electronics North America	GRM0225C1E6R8CA03L
17	4	C68, C69, C71, C73	2.2 µF, 10 V, 1210 (3225 metric), ±20%, X5R	Ceramic capacitors	Wurth Electronics Inc.	Wurth-885012105013
18	1	C81	100 pF, 10 V, 0402 (1005 metric), ±5%, C0G/NP0	Ceramic capacitor	Wurth Electronics Inc.	'885012005013
19	1	C82	10 n/1 kV, 1206, ±10%, X7R	Ceramic capacitor	AVX	1206AC103KAT1A
20	1	C84	10000 PF, NU, 0402 (1005 metric), ±10%, X7R	Ceramic capacitor (not mounted)	-	-
21	1	C85	330 pF, NU, 0402 (1005 metric), ±10%,	Ceramic capacitor (not mounted)	-	-
22	1	DS1	BAT30KFILM, SOD-523	30 V, 300 mA SMD general-purpose signal Schottky diode	ST	BAT30KFILM
23	2	D4, D7	DIODE SCHOTTKY, STmite	20 V, 1 A STmite power Schottky rectifier	ST	STPS120M
24	1	D6	ESDA7P60-1U1M, QFN-2L	High-power transient voltage suppressor	ST	ESDA7P60-1U1M
25	2	D8, D9	NU, VFQFPN 2 0.6x1	Single-line low capacitance and low leakage current ESD protection (not mounted)	ST	ESDALCL5-1BM2
26	4	FID1, FID2, FID3, FID4	TPS	Fiducial (not mounted)	-	-
27	1	J1	NU	Stripline for RS485 (not mounted)	-	-
28	3	J4, J8, J11	NU	Jumpers (not mounted)	-	-

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
29	1	J5	CON2, 2.54 mm pitch	PCB terminal block	Phoenix Contact	1725656
30	1	J12	MicroSD - 502774-0891, 8p, SMT	MicroSD	Molex	502774-0891
31	1	J13	12401598E4#2A	USB 3.0	Amphenol ICC	12401598E4#2A
32	1	LED_C1	Red, 0402 (1005 metric)	Red LED	Vishay Semiconductor Opto Division	VLMS1500-GS08
33	1	LED1	KPHHS-1005MGCK, 0402 (1005 metric)	Green LED	Kingbright	KPHHS-1005MGCK
34	1	LED2	SML-P12DTT86R, 0402 (1005 metric)	Orange LED	Rohm Semiconductor	SML-P12DTT86R
35	2	L1, L2	2.2 µH, 2520, 20%,	2.2 µH, 20%, 1.3A	Wurth	Wurth-74438323022
36	1	L3	2.2µH, 2520, ±20%, 2.1 A	Inductor	Murata	DFE201210S-2R2M=P2
37	1	L4	470 µH, 7.8x7.8x5.3 mm, 3.7 A, ±20%	Inductor	Bourns	SDR0805-4R7ML
38	2	L5, L6	10 µH, 2520, 850 mA, ±20%	Inductors	Wurth	74438323022
39	1	M1	IMP23ABSUTR, RHLGA 2.65X3.5X1.08(MAX)MM 4L	Analog bottom port microphone with frequency response up to 80 kHz for ultrasound analysis and predictive maintenance applications	ST	IMP23ABSUTR
40	1	M2	IMP34DT05TR, HCLGA 4MM X 3 MM X 1.00 MM MICRO	MEMS audio sensor omnidirectional digital microphone for industrial applications	ST	IMP34DT05TR
41	3	USR1, RESET1, PWR1	SW PUSHBUTTON-SPST-2, 4.2x3.2x2.5 mm	Push button	ALPS	SKRPADE010
42	1	Q1	STL6N3LLH6, PowerFLAT 2x2	N-channel 30 V, 0.021 ohm typ., 6 A STripFET H6 power MOSFET	ST	STL6N3LLH6
43	1	Q2	DMN32D2LFB4, 1.05x0.65 mm	Transistor MOSFET	Diodes Incorporated	DMN32D2LFB4

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
44	1	Q3	DMP210DµFB4, 1.05x0.65 mm	TRANSISTOR MOSFET P DMP210DµFB4 µFDFN3 DIODES INC SMT	Diodes Incorporated	DMP210DµFB4
45	3	R1, R24, R30	10 kohm, 0402 (1005 metric), ±1%, SMD	Resistors	Yageo	RC0402FR-0710KL
46	9	R2, R3, R6, R22, R26, R27, R32, R38, R39	4.7 kohm, 0402 (1005 metric), 1/16 W±1%, SMD	Resistors	TE Connectivity Passive Product	CRG0402F4K7
47	1	R4	7.5 kohm, 0402 (1005 metric), 1/16 W±5%, SMD	Resistor	Yageo	RC0402JR-077K5L
48	9	R5, R9, R11, R16, R19, R34, R36, R40, R50	100 kohm, 0402 (1005 metric), 1/16 W±1%, SMD	Resistors	TE Connectivity Passive Product	CRG0402F100K
49	2	R7, R8	1 M, 0402 (1005 metric), ±1%, SMD	Resistors	TE Connectivity	CRG0402F1M0
50	1	R10	10 kohm, NU, 0402 (1005 metric), ±1%, SMD	Resistor (not mounted)	TE Connectivity	CRG0402F10K
51	1	R12	20 K, 0402 (1005 metric), 1/16 W±1%, SMD	Resistor	Yageo	RC0402FR-0720KL
52	2	R13, R18	2 k, 0402 (1005 metric), ±1%, SMD	Resistors	Yageo	RT0402FRE072KL
53	1	R14	56 K, 0402 (1005 metric), ±1%, SMD	Resistor	Yageo	RC0402FR-0756KL
54	27	SB4, SB5, SB6, SB8, SB11, SB12, SB15, R15, SB17, R17, SB18, SB19, SB20, SB21, SB23, SB24, SB31, SB32, SB33, SB34, SB35, SB38, SB40, SB41, SB42, SB46, SB47	0 R, 0402 (1005 metric), SMD	Resistors	Vishay Dale	CRCW04020000Z0ED
55	2	R20, R21	62, 0402 (1005 metric), 1/16 W±1%, SMD	Resistors	Yageo	RC0402FR-0762RL
56	1	R23	47k, 0402 (1005 metric), 1/16 W±1%, SMD	Resistor	Samsung Electro-Mechanics America, Inc.	RC1005F473CS

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
57	1	R25	160, 0402 (1005 metric), 1/16 W±1%, SMD	Resistor	TE Connectivity Passive Product	CRG0402F160R
58	1	R28	1k, 0402 (1005 metric), 1%, SMD	Resistor	Yageo	RC0402FR-071KL
59	1	R29	560R, 0402 (1005 metric), 1/16 W±1%, SMD	Resistor	Yageo	RC0402FR-07560RL
60	1	R31	2.7k, 0402 (1005 metric), 1/16 W±1%, SMD	Resistor		
61	1	R35	100, 0402 (1005 metric), 1/16 W±1%, SMD	Resistor	TE Connectivity Passive Product	CRG0402F100R
62	1	R37	120R, 0402 (1005 metric), 1/16 W±1%	Resistor	TE Connectivity Passive Product	CRGCQ0603F120R
63	1	R45	1M, 0603 (1608 metric), 1/16 W±1%	Resistor	TE Connectivity Passive Product	CRGCQ0603J1M0
64	4	R46, R47, R48, R49	0R, 1206, 1/4W ±5%	Resistors	Yageo	AF1206JR-070RL
65	20	SB1, SB2, SB3, SB7, SB9, SB10, SB13, SB14, SB16, SB22, SB25, SB26, SB27, SB28, SB29, SB30, SB39, SB43, SB44, SB45	0 ohm, NU, 0402 (1005 metric), SMD	Resistors (not mounted)	Vishay Dale	CRCW04020000Z0ED
66	2	SB36, SB37	0 ohm, NU, 0402 (1005 metric), SMD	Resistors	Vishay Dale	CRCW04020000Z0ED
67	10	TAMPER1, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12	TPS	Test points (not mounted)	-	-
68	3	TP1, TP2, TP3	NU	Test points (not mounted)	Keystone Electronics	5001
69	3	TVS1, TVS2, TVS3	ESDALC6V1-1M2, VFQFPN 2 0.6x1	Single-line low capacitance Transil, transient surge voltage suppressor (TVS) for ESD protection	ST	ESDALC6V1-1M2
70	1	TVS4	USBULC6-2M6, QFN-6L	Ultra large bandwidth ESD protection	ST	USBULC6-2M6

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
71	1	U1	EMIF06-MSD02N16	6-line EMI filter and ESD protection for T-Flash and micro-SD card interfaces	ST	EMIF06-MSD02N16
72	1	U3	ILPS22QSTR, HLGA 2X2X.8 10L EXP. SILIC .91SQ	Dual full-scale, 1.26 bar and 4 bar, absolute digital output barometer in full-mold package	ST	ILPS22QSTR
73	1	U5	BLUENRG-M2SA,BLUENRG-2 MODULE QFN, CHIP ANT	Very low power application processor module for Bluetooth® low energy v5.2	ST	BLUENRG-M2SA
74	1	U6	STTS22HTR, UDFN 2X2X.55 6L PITCH0.65	Low-voltage, ultra-low-power, 0.5°C accuracy I2C/SMBus 3.0 temperature sensor	ST	STTS22HTR
75	1	U7	STSAFA110S8 SPL02, SO-8	Secure element	ST	STSAFA110S8SPL02
76	1	U8	TSV912IQ2T, QFN-8L P 0.5 mm	Wide-bandwidth (8 MHz) rail-to-rail input/output 5V CMOS op-amps, dual	ST	TSV912IQ2T
77	1	U9	ISM330DHCXTR, VFLGA2.5X3X.86 14L P.5 L.475X.25	iNEMO inertial module with Machine Learning Core, Finite State Machine with digital output for industrial applications	ST	ISM330DHCXTR
78	1	U10	LDLN025PU275R, DFN4 1x1	250 mA ultra-low noise LDO	ST	LDLN025PU275R
79	1	U11	IIS3DWBTR, VFLGA2.5X3X.86 14L P.5 L.475X.25	Ultra-wide bandwidth, low-noise, 3-axis digital vibration sensor	ST	IIS3DWBTR
80	1	U12	IIS2DLPCTR, LGA2X2X0.7 12 leads	MEMS digital output motion sensor: high-performance ultra-low-power 3-axis accelerometer for industrial applications	ST	IIS2DLPCTR

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
81	1	U13	IIS2MDCTR, LGA2X2X0.7 12 leads	High accuracy, ultra-low-power, 3-axis digital output magnetometer	ST	IIS2MDCTR
82	1	U15	STBC02AJR, chip scale package 0.4 mm pitch	Li-ion linear battery charger with LDO, load switches, and reset generator	ST	STBC02AJR
83	2	U16, U19	ST1PS02CQTR , MLPQ/QFN 1.7x2.0x0.55 12L P0.4	400 mA nano-quiescent synchronous step-down converter with digital voltage selection, Power Good, and AUX switch	ST	ST1PS02CQTR
84	1	U17	USBLC6-2P6, SOT666	ESD protection for USB 2.0	ST	USBLC6-2P6
85	1	U18	STR485LVQT, VDFPN 10 3x3x1.0	3.3 V RS485 compatible with 1.8 V I/Os and selectable speed 20 Mbps or 250 kbps	ST	STR485LVQT
86	1	U20	STM32U585AII 6Q	Ultra-low-power with FPU ARM™ Cortex-M33 with TrustZone, MCU 160 MHz with 2 mbytes of Flash memory	ST	STM32U585AII6Q
87	1	U21	IIS2ICLXTR, LGA 5X5X1.7 16LD ceramic cavity	High-accuracy, high-resolution, low-power, 2-axis digital inclinometer with embedded Machine Learning Core	ST	IIS2ICLXTR
88	1	U22	TCPP01-M12,QFN-12L	Overvoltage protection for USB Type-C™ or Power Delivery	ST	TCPP01-M12
89	1	U23	EMW3080(BP), SoM,	EMW3080 Wi-Fi Module 802.11 bgn	Mxchip	EMW3080(BP)
90	1	U24	ST25DV64K-JFR6D3, UFDFPN 12L 3X3X0.55 pitch 0.50	Dynamic NFC/ RFID tag IC	ST	ST25DV64K-JFR6D3
91	1	U25	STEF05SGR, TSOT 8L	Electronic fuse for 5 V line	ST	STEF05SGR
92	1	X1	16 MHz	Crystal	NDK	NX2016SA 16 MHz EXS00A-CS07826

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
93	1	X2	32.7680 KHz,	Crystal	NDK	NX2012SA 32.768KHz EXS00A-MU00527

Table 20. Adapter board bill of materials

Item	Q.ty	Ref.	Part/value	Description	Manufacturer	Order code
1	1	CN1	CON34-Plug, SMD, gold	Connector socket	Panasonic Electric Works	AXF6G3412A
2	1	CN2	SPC15503	DIL24 socket	E-TEC	BL1-036-G-700-01
3	2	C1, C2	330 pF, 0402 (1005 Metric), ±10 %,	Ceramic capacitors	Murata Electronics North America	GRM1555C1H331GA01D
4	2	R1, R2	2.2 K (NC), 0402 (1005 Metric), 100ppm/C V, 1/16 W ±1%,SMD	Resistors (not mounted)	Vishay Dale	CRCW04022K20FKEDC
5	8	SB1,SB3,SB7,SB8,SB10,SB12, SB15,SB16	0 R, 0402 (1005 Metric), SMD	Resistors	Vishay Dale	CRCW04020000Z0ED
6	9	SB2,SB4,SB5,SB6,SB9,SB11,SB13,SB14,SB17	NC, 0402 (1005 Metric), SMD	Resistors (not mounted)	Vishay Dale	CRCW04020000Z0ED

7 Kit versions

Table 21. **STEVAL-STWINBX1 versions**

PCB version	Schematic diagrams	Bill of materials
STEVAL$STWINBX1A (1)	STEVAL$STWINBX1A schematic diagrams	STEVAL$ISTWINBX1A bill of materials

1. *This code identifies the STEVAL-STWINBX1 evaluation kit first version. The STEVAL-STWINBX1 kit contains the STEVAL$STWBXCS1A main board, the STEVAL$C34DIL24A expansion board, the STEVAL$FLTCB01A flexible cable, and the STEVAL$MKIGIBV4A adapter.*

8 Regulatory compliance information

Formal Product Notice Required by FCC:

For evaluation only; not FCC approved for resale.

FCC NOTICE - This kit is designed to allow:

(1) Product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and

(2) Software developers to write software applications for use with the end product.

This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter 3.1.2.

Formal Product Notice Required by Industry Canada

For evaluation purposes only. This kit generates, uses, and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to Industry Canada (IC) rules.

À des fins d'évaluation uniquement. Ce kit génère, utilise et peut émettre de l'énergie radiofréquence et n'a pas été testé pour sa conformité aux limites des appareils informatiques conformément aux règles d'Industrie Canada (IC).

Notice for the European Union

The kit STEVAL-STWINBX1 is in conformity with the essential requirements of the Directive 2014/53/EU (RED) and of the Directive 2015/863/EU (RoHS). Harmonized standards applied are listed in the EU Declaration of Conformity.

Notice for Great Britain

The kit STEVAL-STWINBX1 is in compliance with the UK Radio Equipment Regulations 2017. The full text of the UK declaration of conformity is available at the following internet address: www.st.com/en/evaluation-tools/steval-stwinbx1.html

Revision history

Table 22. **Document revision history**

Date	Revision	Changes
14-Dec-2022	1	Initial release.
09-Jan-2023	2	Updated *Section 1.6.2 Processing* and *connectivity and Section 2 How to assemble the STWIN.box* Added *Section 1.6.2.4 ST25DV64K* and *Section 1.6.2.4.1 RF mode.*
24-Jan-2023	3	Updated *Section 2 How to assemble the STWIN.box, Section 3.2 How to program the STWIN.box with an external debugger* and *Section 6 Bill of materials*.
01-Mar-2023	4	Updated *Figure 5. STEVAL-STWINBX1 block diagram, Figure 8. STEVAL-STWINBX1 - overview of the sensing components, Figure 11. Main connectivity components and the STM32U585AI processing unit* and *Figure 15. Power management of the STWIN.box core system board.*
20-Mar-2023	5	Updated *Section 1.6.3 Power management* and *Section 4 Default application*
02-Aug-2023	6	Updated *Section 3.1 How to program the STWIN.box in "USB mode".* Updated *Section 1.2 Features:* removed ST25DV04K, added ST25DV64K.
25-Oct-2024	7	Updated Section 5: Schematic diagrams.

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