# Getting started with the X-NUCLEO-GNSS2A1 expansion board based on the Teseo-VIC3DA dead-reckoning GNSS module for STM32 Nucleo

## Introduction

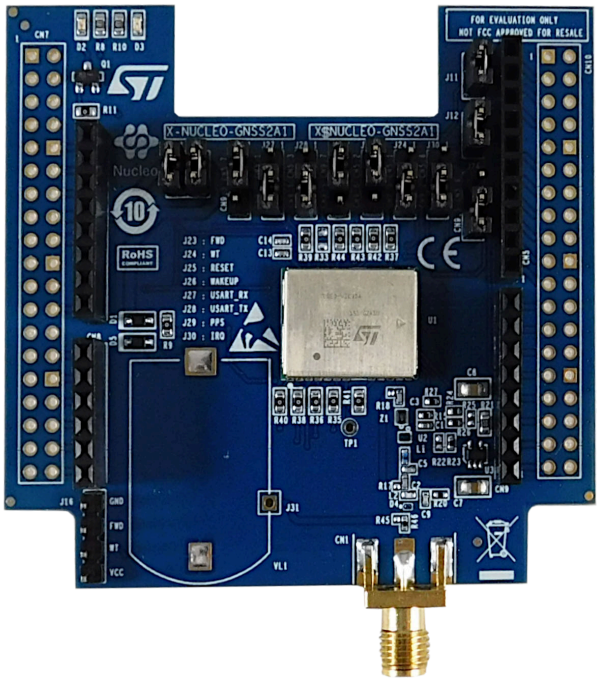
The X-NUCLEO-GNSS2A1 expansion board is based on the Teseo-VIC3DA tiny GNSS module. It represents an affordable, easy-to-use, global navigation satellite system (GNSS) module, which embeds a TeseoIII single die standalone positioning receiver IC, usable in different configurations in your STM32 Nucleo project.

The Teseo-VIC3DA is a compact (16.0 x 12.2 mm) module that provides superior accuracy thanks to the on-board temperature compensated crystal oscillator (TCXO) and a reduced time-to-first fix (TTFF) with its dedicated real-time clock (RTC) oscillator.

The Teseo-VIC3DA module runs the GNSS firmware (X-CUBE-GNSS1) to perform all the GNSS operations including acquisition, tracking, navigation, and data output without any external memory support.

The X-NUCLEO-GNSS2A1 expansion board is compatible with the Arduino UNO R3 connector and the ST morpho connector. It can be plugged to an STM32 Nucleo development board and stacked with additional STM32 Nucleo expansion boards.

**Figure 1. X-NUCLEO-GNSS2A1 expansion board**



# 1 Getting started

## 1.1 Board overview

The X-NUCLEO-GNSS2A1 expansion board for STM32 Nucleo is a GNSS multiconstellation receiver with dead-reckoning that covers a wide range of applications where geo-location is required.

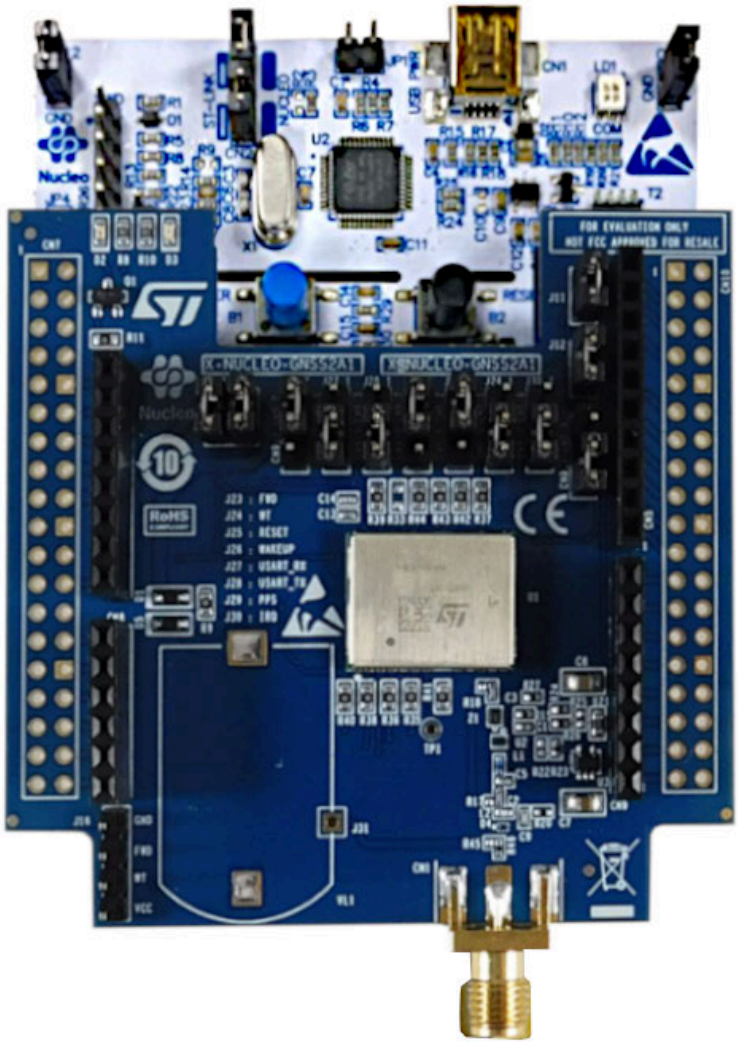
The key features are:

- Operating supply voltage: 3.3 V
- Ambient temperature: -40/+85°C
- Sensitivity: -163 dBm (tracking mode)
- Interfaces:
  - a UART port
  - an I²C port
  - configurable digital I/O time pulse
  - EXTINT input for wake-up
- NMEA protocol
- Assisted GNSS:
  - autonomous AGNSS
  - real-time, server-based
- Simultaneous multiconstellation:
  - GPS
  - Galileo
  - Glonass
  - BeiDou
  - QZSS
- Compatible with STM32 Nucleo development boards
- Compatible with the Arduino UNO R3 connector
- Teseo-VIC3DA dead-reckoning automotive firmware
- Provision of FWD and WHEELTICK signals
- Automotive GNSS and 6-axis inertial sensor
- LNA and SAW filters on the RF path
- SMA female antenna connector
- RoHS and WEEE compliant

## 1.2 Hardware and software requirements

The X-NUCLEO-GNSS2A1 must be plugged onto an STM32 Nucleo development board through the Arduino UNO R3 connectors, as shown in the figure below.

**Figure 2. X-NUCLEO-GNSS2A1 expansion board connected to an STM32 Nucleo development board**



The X-NUCLEO-GNSS2A1 can be connected to any STM32 Nucleo development board, even though complete testing has been performed on the NUCLEO-F401RE board.

To use the STM32 Nucleo development boards with the X-NUCLEO-GNSS2A1 expansion board, the following software and hardware specifications are required:

- a PC with Microsoft Windows® 10 to install the software package (X-CUBE-GNSS1);
- an STM32 Nucleo development board (NUCLEO-L053R8 or NUCLEO-F401RE);
- a type A to mini-B USB cable to connect the STM32 Nucleo to the PC;
- the X-CUBE-GNSS1 software package;
- TESEO-SUITE.

The installation of the X-CUBE-GNSS1 and the TESEO-SUITE graphical user interface utility on the user PC requires:

- 128 MB of RAM;
- 40 MB of hard disk space.

## 1.3 Board setup

To set up the X-NUCLEO-GNSS2A1 expansion board, follow the procedure below.

**Step 1.** Check the jumper position shown below:

**Table 1. X-NUCLEO-GNSS2A1 expansion board - jumper 1 default settings**

| Signal | Jumper | Configuration |
|---|---|---|
| I²C-SCL | J11 | Closed |
| I²C-SDA | J12 | Closed |
| VCC-VCC_IO | J14 | Closed |
| V14Bat | J15 | Closed |
| SYS_FWD | J23 | 1-2 |
| SYS_WHEELTICK | J24 | 2-3 |
| SYS_RESETn | J25 | 1-2 |
| SYS_WAKEUP | J26 | 2-3 |
| UART-RX | J27 | 2-3 |
| UART-TX | J28 | 2-3 |
| SYS_PPS | J29 | 1-2 |
| SYS_IRQ | J30 | 2-3 |

**Step 2.** Connect the X-NUCLEO-GNSS2A1 to the STM32 Nucleo development board.

**Step 3.** Power the STM32 Nucleo development board using the type A mini-B USB cable.

**Step 4.** Program the STM32 Nucleo development board using the firmware example provided.

**Step 5.** Reset the MCU via the STM32 Nucleo development board [**reset**] button.
The evaluation kit is ready-to-use.

# 2 Hardware description

## 2.1 X-NUCLEO-GNSS2A1 expansion board for STM32 Nucleo

The X-NUCLEO-GNSS2A1 allows testing the Teseo-VIC3DA GNSS module functionality via the firmware package contained in the X-CUBE-GNSS1 software.

*Important: Program the microcontroller on the STM32 Nucleo development board.*

The Teseo-VIC3DA module and the STM32 Nucleo development board communicate through the expansion board connectors (CN5, CN6, CN8, and CN9) as listed in the tables below.

**Table 2. Interconnection between STM32 Nucleo development board and X-NUCLEO-GNSS2A1 expansion board (left-side connectors)**

| STM32 Nucleo pins | X-NUCLEO-GNSS2A1 | | |
|---|---|---|---|
| | CN6 (power) | | CN8 (analog) |
| | Pin | Signal | |
| NC | X | | |
| IOREF | 2 | 3V3 | |
| RESET | 3 | | |
| 3V3 | 4 | 3V3 | |
| 5V | 5 | | |
| GND | 6 | GND | |
| GND | 7 | GND | |
| VIN | 8 | | |
| A0 | | | 1 |
| A1 | | | 2 |
| A2 | | | 3 |
| A3 | | | 4 |
| A4 | | | 5 |
| A5 | | | 6 |

**Table 3. Interconnection between STM32 Nucleo development board and X-NUCLEO-GNSS2A1 expansion board (right-side connectors)**

| STM32 Nucleo pins | X-NUCLEO-GNSS2A1 | | | |
|---|---|---|---|---|
| | CN5 (digital) | | CN9 (digital) | |
| | Pin | Signal | Pin | Signal |
| D15 | 10 | SCL2 | | |
| D14 | 9 | SDA2 | | |
| AREF | 8 | | | |
| GND | 7 | GND | | |
| D13 | 6 | WAKE_UP | | |
| D12 | 5 | | | |
| D11 | 4 | | | |
| D10 | 3 | | | |

| STM32 Nucleo pins | X-NUCLEO-GNSS2A1 | | | |
|---|---|---|---|---|
| | CN5 (digital) | | CN9 (digital) | |
| | Pin | Signal | Pin | Signal |
| D9 | 2 | RESET | | |
| D8 | 1 | RX0 | | |
| D7 | | | 8 | RESET |
| D6 | | | 7 | PPS |
| D5 | | | 6 | |
| D4 | | | 5 | WAKE_UP |
| D3 | | | 4 | |
| D2 | | | 3 | TX0/PPS |
| D1 | | | 2 | RX |
| D0 | | | 1 | TX |

## 2.2 Teseo-VIC3DA module

The X-NUCLEO-GNSS2A1 expansion board embeds the Teseo-VIC3DA automotive GNSS dead-reckoning module with 6-axis IMU.

The Teseo-VIC3DA is an easy-to-use global navigation satellite system (GNSS) standalone module. It embeds the TeseoIII single-die standalone positioning receiver IC, which works simultaneously on multiple constellations (GPS/Galileo/Glonass/BeiDou/QZSS).

**Table 4. Teseo-VIC3DA details**

| Feature | Description |
|---|---|
| Sales type | Teseo-VIC3DA |
| Package | LLC 24 pins (16.0 mm x 12.2 mm) |
| Operating voltage | 3.3 V |

## 2.3 GNSS antenna

The GNSS antenna (manufacturer INPAQ, part number B3G02G-S3-XX-A) is attached to the board through a SMA connector (with its trademark and model).

*Important: The antenna provided by the manufacturer can be replaced only with an identical one.*

## 2.4 UART, I²C, and GPIO connection options

The Teseo-VIC3DA module embedded in the X-NUCLEO-GNSS2A1 expansion board can be used to work with the board in different configurations when different expansion boards are used and a conflict of signals occurs.

Table 5. **X-NUCLEO-GNSS2A1 expansion board: Teseo-VIC3DA interface with the STM32 Nucleo development board**

| Signal | Pins | STM32 Nucleo (optional connections) |
|---|---|---|
| I²C-SCL | d15 | - |
| I²C-SDA | d14 | - |
| Wakeup | d13 | d4 |
| Reset | d7 | d9 |
| PPS | d6 | d2 |
| UART-RX | d8 | d1 |
| UART-TX | d2 | d0 |

For the optional connections, modify the firmware according to the STM32 resources to be used.

## 2.5 Current measurement

To monitor the Teseo-VIC3DA module power consumption, insert an ammeter probe between J14 pin (VCC) and J15 pin (VBAT).

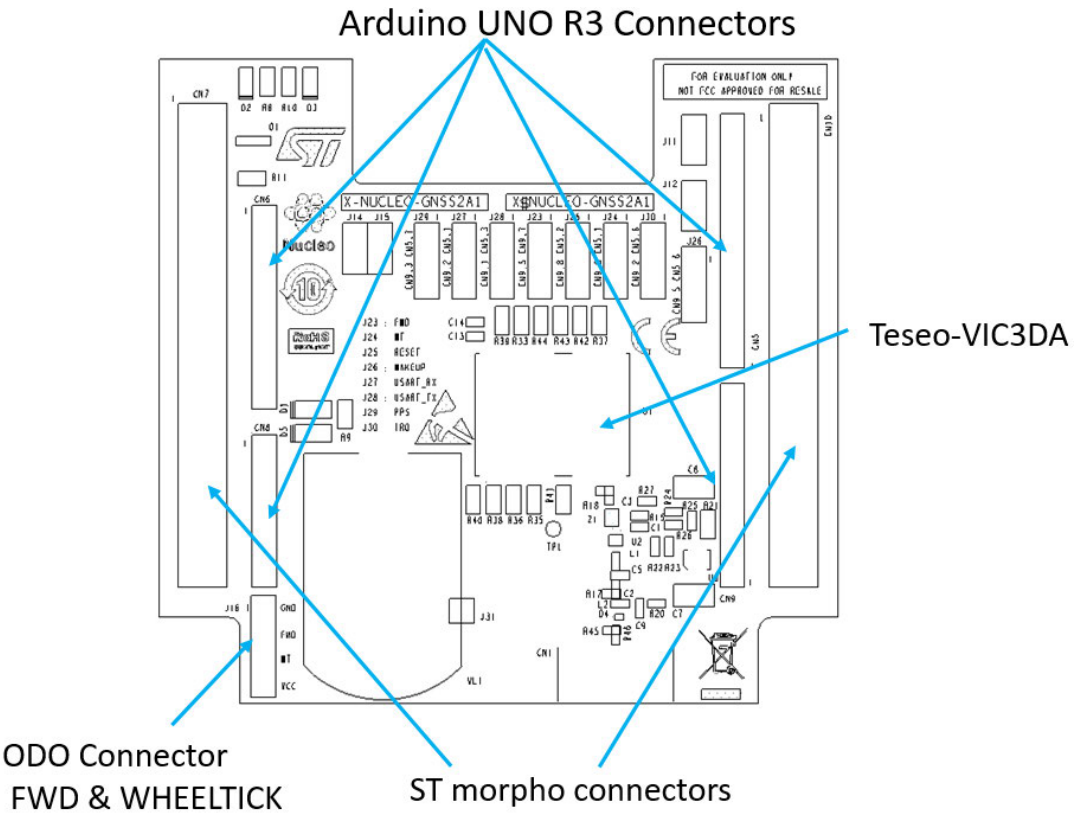
As the Teseo-VIC3DA power consumption is very low during most of its operating time, an accurate instrument in the range of few µA is required.

## 2.6 ODO connector

The ODO connector on the X-NUCLEO-GNSS2A1 exposes two input signals for the Teseo-VIC3DA, which embeds the TESEO dead reckoning. These two signals are specific to dead-reckoning applications and provide the odometer information using the pins FWD (pin2) and WHEELTICK (pin3).

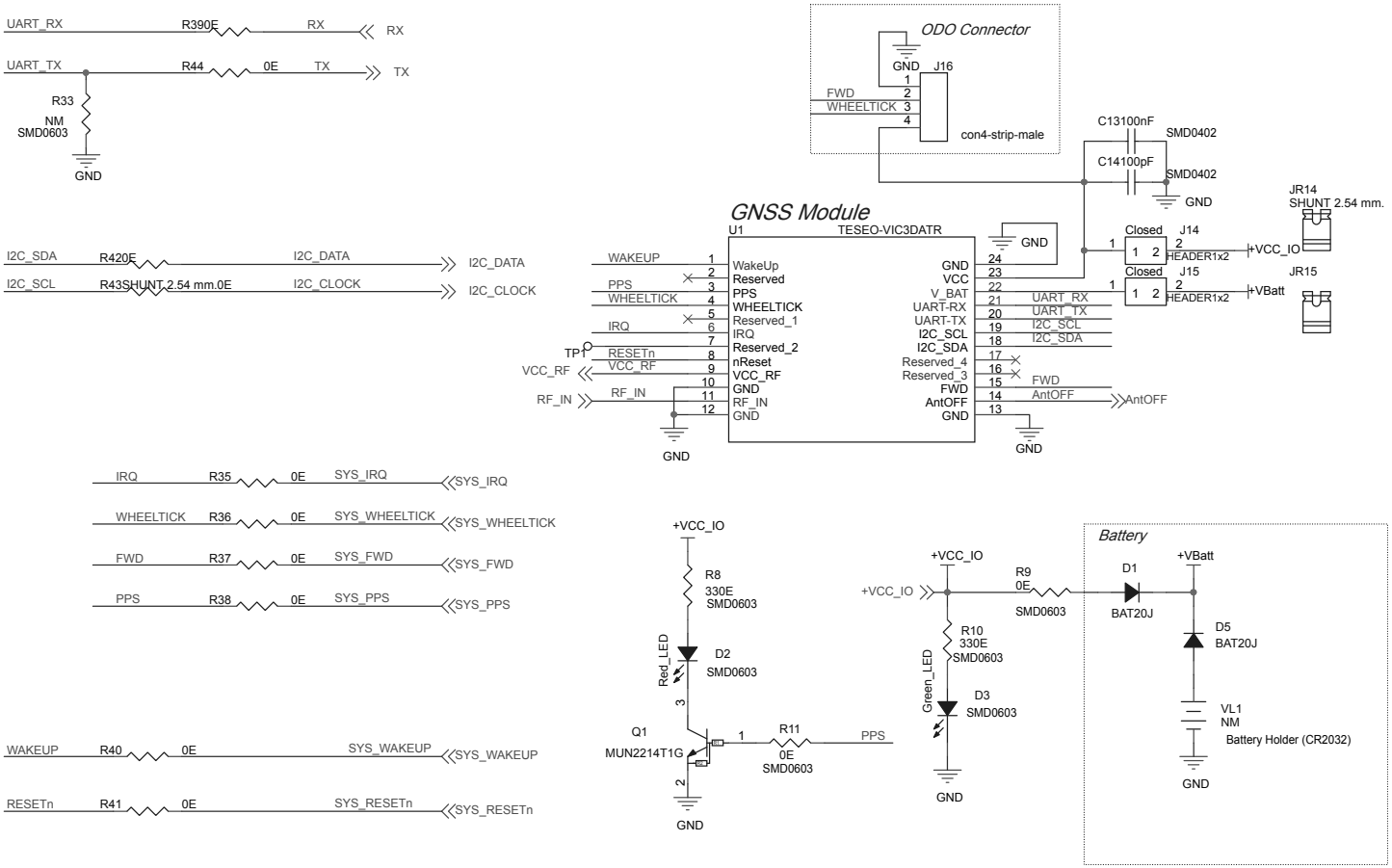
## 2.7 X-NUCLEO-GNSS2A1 expansion board component placement

Figure 3. **X-NUCLEO-GNSS2A1 expansion board component placement details**



# 3 Schematic diagrams

**Figure 4. X-NUCLEO-GNSS2A1 circuit schematic (1 of 3)**



## Figure 5. X-NUCLEO-GNSS2A1 circuit schematic (2 of 3)

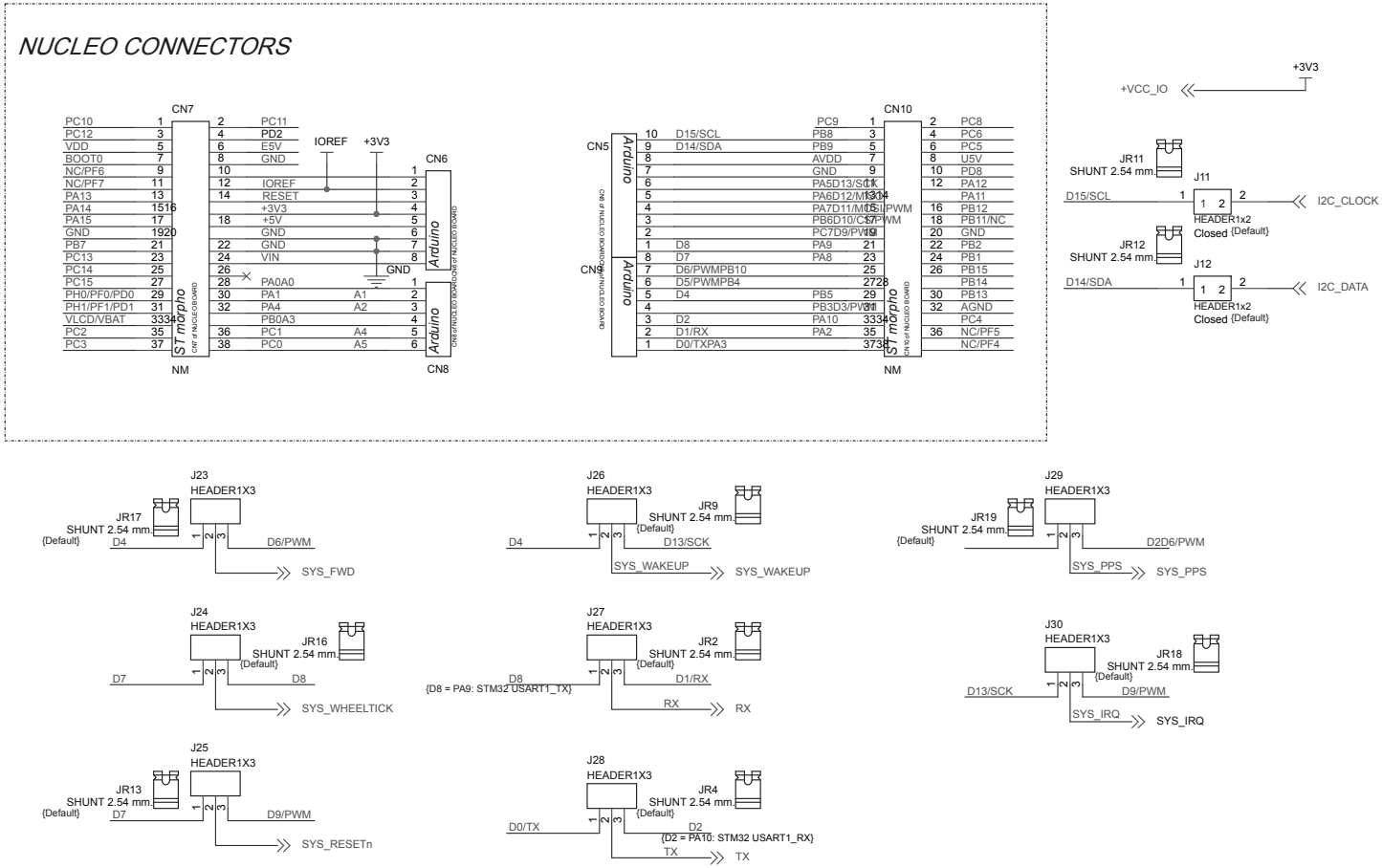
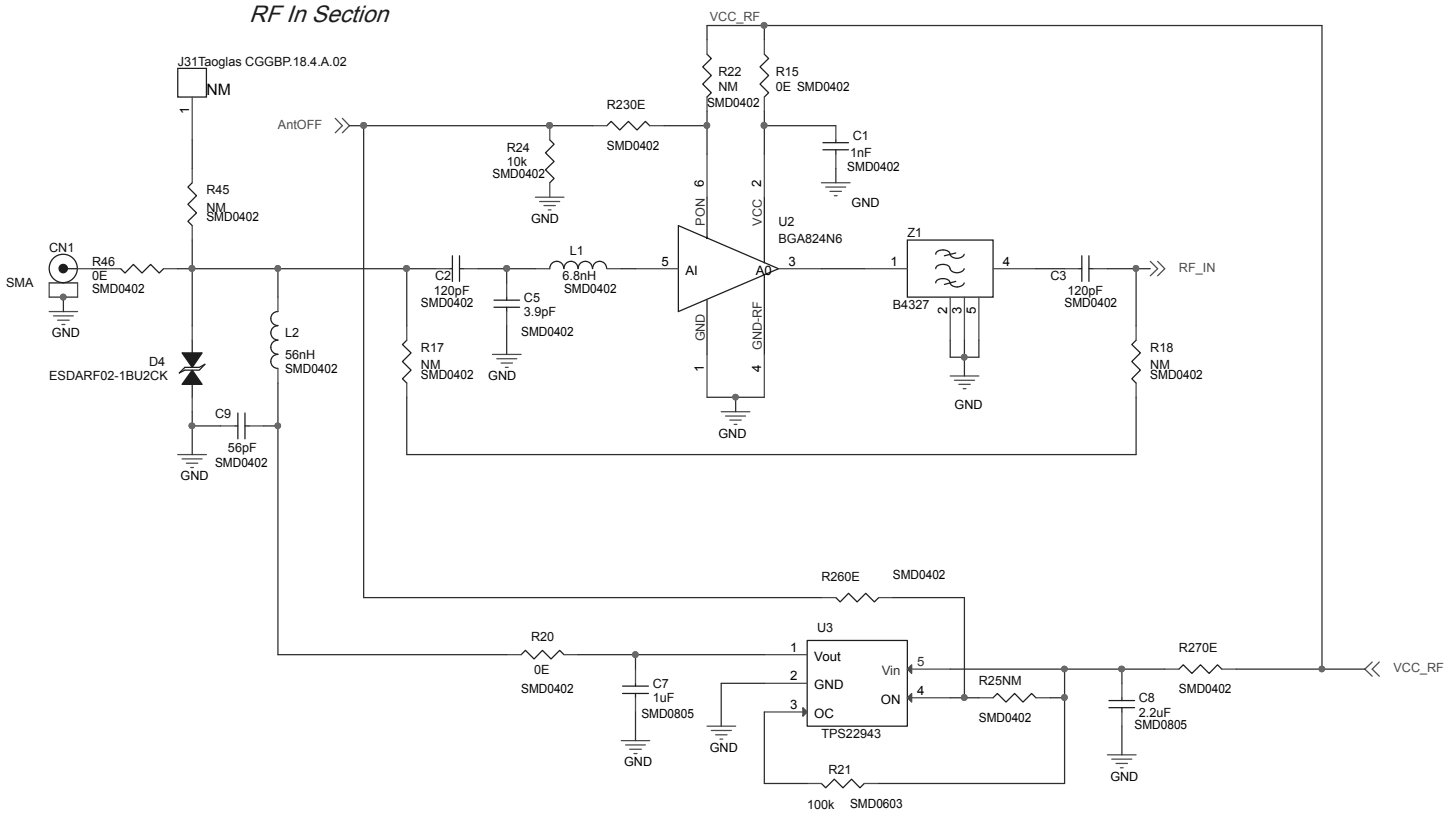


**Figure 6. X-NUCLEO-GNSS2A1 circuit schematic (3 of 3)**



# 4 Bill of materials

Table 6. **X-NUCLEO-GNSS2A1 bill of materials**

| Item | Q.ty | Ref. | Value | Description | Manufacturer | Order code |
|---|---|---|---|---|---|---|
| 1 | 1 | CN1 | SMA, COAX_SMA_EDGE | SMA jack | Molex | 73251-1150 |
| 2 | 1 | CN5 | ARDUINO_10x1, TH | Elevated socket | 4UCONN | 15286 |
| 3 | 2 | CN6, CN9 | ARDUINO_8x1, TH | Elevated sockets | 4UCONN | 15284 |
| 4 | 0 | CN7,CN10 | ST_MORPHO_19x2, TH | Elevated sockets (not mounted) | 4UCONN | 8413 |
| 5 | 1 | CN8 | ARDUINO_6x1, TH | Elevated socket | 4UCONN | 15282 |
| 6 | 1 | C1 | 1 nF, SMD 0402, 16 V, X7R | Chip capacitor | Murata | GRM155R71H102KA01D |
| 7 | 2 | C2,C3 | 120 pF, SMD 0402, 16 V, NP0 | Chip capacitors | Murata | GRM1555C1H121JA01D |
| 8 | 1 | C5 | 3.9 pF, SMD 0402, 16 V, NP0 | Chip capacitor | Murata | GRM1555C1H3R9WA01D |
| 9 | 1 | C7 | 1 µF, SMD 0805, 16 V, X7R | Chip capacitor | Taiyo Yuden | EMK212B7105KGHT |
| 10 | 1 | C8 | 2.2 µF, SMD0805, 16 V, X7R | Chip capacitor | Taiyo Yuden | EMK212B7225KGHT |
| 11 | 1 | C9 | 56 pF, SMD 0402, 16 V, X7R | Chip capacitor | Murata | GRM1555C1H560JA01D |
| 12 | 1 | C13 | 100 nF, SMD 0402, 16 V, X7R | Chip capacitor | Murata | GRM155R71C104KA88D |
| 13 | 1 | C14 | 100 pF, SMD 0402, 16 V, COG | Chip capacitor | Murata | GRM1555C1H101JA01D |
| 14 | 2 | D1, D5 | BAT20JFILM, SOD323 | 23 V, 1 A general purpose signal Schottky diodes | ST | BAT20JFILM |
| 15 | 1 | D2 | Red_LED, SMD 0603 | Diode LED | Lite-On | LTST-C193KRKT-5A |
| 16 | 1 | D3 | Green_LED, SMD 0603 | Diode LED | Lite-On | LTST-C191KGKT |
| 17 | 1 | D4 | ESDARF02-1BU2CK, ST0201 | Single line bidirectional ESD protection for high-speed interfaces | ST | ESDARF02-1BU2CK |
| 18 | 12 | JR2, JR4, JR9, JR11, JR12, JR13, JR14, JR15, JR16, JR17, JR18, JR19 | 2.54 mm, TH, 3 A max. | Jumpers | TE Connectivity/AMP | 1-382811-6 |

| Item | Q.ty | Ref. | Value | Description | Manufacturer | Order code |
|---|---|---|---|---|---|---|
| 19 | 4 | J11, J12, J14, J15 | HEADER1x2, TH, 2.54 mm, 2-pin, single row | Headers | Wurth Elektronik | 61300211121 |
| 20 | 1 | J16 | HEADER1x4, TH, 2.54 mm, 4-pin, single row | Header | Wurth Elektronik | 61300411121 |
| 21 | 8 | J23, J24, J25, J26, J27, J28, J29, J30 | HEADER1x3, TH, 2.54 mm, 3-pin, single row | Headers | Wurth Elektronik | 61300311121 |
| 22 | 1 | J31 | Taoglas CGGBP.18.4.A.02 , 18 mm x 18 mm x 4 mm (pin mount) | RF antenna (not mounted) | Taoglas | CGGBP.18.4.A.02 |
| 23 | 1 | L1 | 6.8 nH, SMD 0402, 0.7 A, ±0.02 % | SMD inductor | Murata | LQW15AN6N8G00D |
| 24 | 1 | L2 | 5 6nH, SMD 0402, 0.2 A, ±0.05 % | SMD inductor | Wurth Elektronik | 744784156A |
| 25 | 1 | Q1 | MUN2214T1G, SC-59 | NPN digital transistor | ON Semiconductor | MUN2214T1G |
| 26 | 2 | R8, R10 | 330E, SMD 0603, ±0.01 % | Chip resistors | Stackpole Electronics Inc | RMCF0603FT330RTR-ND |
| 27 | 12 | R9, R11, R35, R36, R37, R38, R39, R40, R41, R42, R43, R44 | 0E, SMD 0603, ±0.01 % | Chip resistors | Stackpole Electronics Inc | RMCF0603ZT0R00 |
| 28 | 6 | R15, R20, R23, R26, R27, R46 | 0E, SMD 0402, ±0.01 % | Chip resistors | Stackpole Electronics Inc | RMCF0402ZT0R00 |
| 29 | 1 | R21 | 100 k, SMD 0603, ±0.01 % | Chip resistor | Yageo | AF0603FR-07100KL |
| 30 | 1 | R24 | 10 k, SMD0402, ±0.01 % | Chip resistor | Yageo | RE0402FRE0710KL |
| 31 | 0 | R17, R18, R22, R25, R45 | 0E, SMD0402, 0.01 %, | Chip resistors (not mounted) | Stackpole Electronics Inc | RMCF0402ZT0R00 |
| 32 | 0 | R33 | 0E, SMD 0603, ±0.01 % | Chip resistor (not mounted) | Stackpole Electronics Inc | RMCF0603ZT0R00 |
| 33 | 1 | TP1 | TP, tp_60f | Test point | Keystone Electronics | 5117 (or 5000 or 5001) |
| 34 | 1 | U1 | TESEO-VIC3DATR, LCC 24-pin package | Automotive GNSS dead-reckoning module with 6-axis IMU | ST | TESEO-VIC3DATR |
| 35 | 1 | U2 | BGA824N6, TSNP-6-2 | Low noise amplifier for GNSS | Infineon | BGA824N6E6327XTSA1 |
| 36 | 1 | U3 | TPS22943, SC70 | IC load switch | Texas Instruments | TPS22943DCKR |
| 37 | 0 | VL1 | CR2032, HOLDER_CR2032_S8421-45R | Coin battery holder (not mounted) | Harwin Inc. | S8421-45R |

| Item | Q.ty | Ref. | Value | Description | Manufacturer | Order code |
|---|---|---|---|---|---|---|
| 38 | 1 | Z1 | B4327, QCS5P | Saw RF filter | TDK | B39162B4327P810 |
| 39 | 1 | - | B3G02G-S3-XX-A | GPS/GLONASS/ Beidou antenna | INPAQ | B3G02G-S3-XX-A |

# 5 Board versions

Table 7. **X-NUCLEO-GNSS2A1 versions**

| PCB version | Schematic diagrams | Bill of materials |
|---|---|---|
| X$NUCLEO-GNSS2A1 (1) | X$NUCLEO-GNSS2A1 schematic diagrams | X$NUCLEO-GNSS2A1 bill of materials |

1. *This code identifies the X-NUCLEO-GNSS2A1 expansion board first version. It is printed on the board PCB.*

# 6 Regulatory compliance information

### Formal Notice Required by the U.S. Federal Communications Commission

**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 Innovation, Science and Economic Development

**Canada compliance**:

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).

### Formal product notice required by EU

The X-NUCLEO-GNSS2A1 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.

# Revision history

Table 8. **Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 25-Jul-2022 | 1 | Initial release. |

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