

### Getting started with the X-NUCLEO-GNSS1A1 expansion board based on Teseo-LIV3F tiny GNSS module for STM32 Nucleo

## Introduction

The X-NUCLEO-GNSS1A1 expansion board is based on the *Teseo-LIV3F* tiny GNSS module.

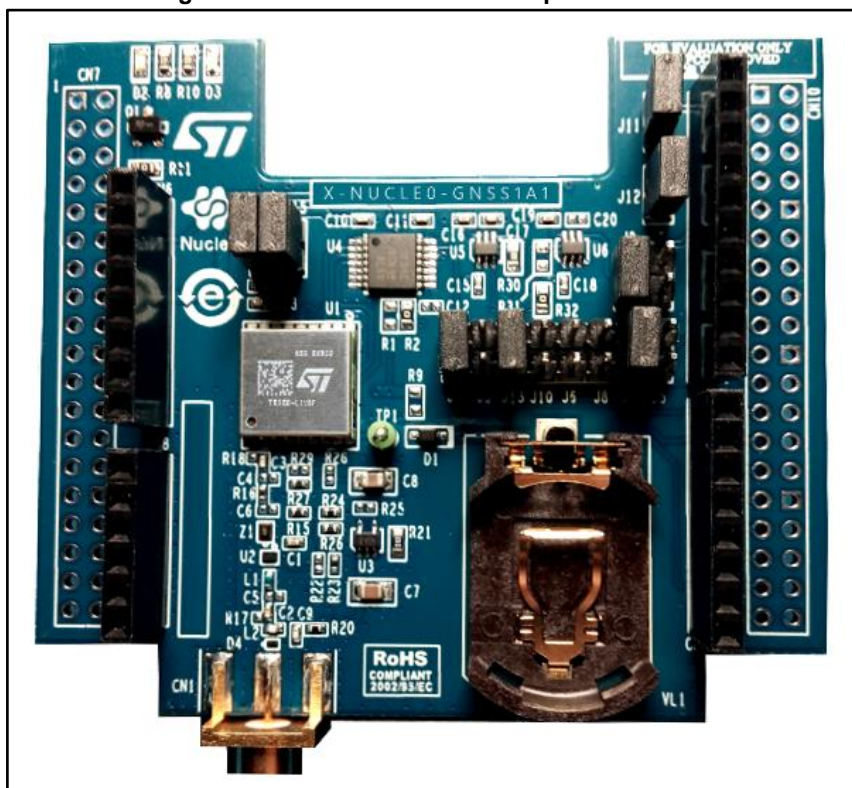
It represents an affordable, easy-to-use, global navigation satellite system (GNSS) module, embedding a TeseoIII single die standalone positioning receiver IC, usable in different configurations in your STM32 Nucleo project.

The Teseo-LIV3F is a compact (9.7x10.1 mm) module that provides superior accuracy thanks to the on-board 26 MHz temperature compensated crystal oscillator (TCXO) and a reduced time-to-first fix (TTFF) with its dedicated 32 KHz real-time clock (RTC) oscillator.

The Teseo-LIV3F module runs complete GNSS firmware (X-CUBE-GNSS1) to perform all GNSS operations including acquisition, tracking, navigation and data output without external memory support.

The X-NUCLEO-GNSS1A1 expansion board is compatible with the Arduino™ UNO R3 connector and the ST morpho connector, so it can be plugged to the STM32 Nucleo development board and stacked with additional STM32 Nucleo expansion boards.

Figure 1: X-NUCLEO-GNSS1A1 expansion board



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# 1 Getting started

## 1.1 Board overview

The X-NUCLEO-GNSS1A1 expansion board for STM32 Nucleo is a GNSS multi-constellation receiver covering a wide range of applications where geo-location is required.

The key features are:

- Operating supply voltage: 3.3 - 5 V
- Ambient temperature: -40/+85 °C
- Sensitivity: -162 dBm indoor (tracking mode)
- Interfaces:
  - a UART port
  - an I<sup>2</sup>C port
  - Configurable digital I/O timepulse
  - EXTINT input for wakeup
- NMEA protocol
- Assisted GNSS:
  - Predictive autonomous
  - Predictive server-based
  - Real-time server-based
- Compatible with STM32 Nucleo boards
- Compatible with the Arduino™ UNO R3 connector
- LNA and SAW filter on the RF path
- SMA female antenna connector
- Battery holder
- RoHS compliant

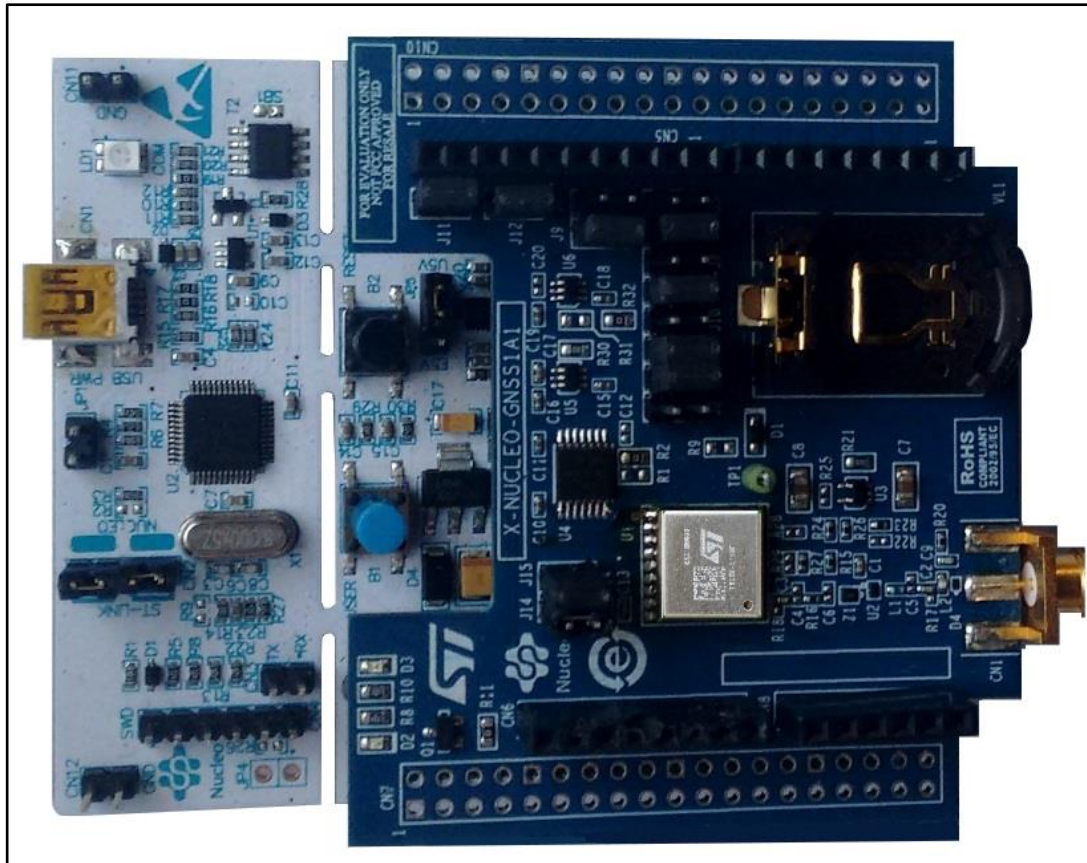
## 1.2 Hardware and software requirements

The X-NUCLEO-GNSS1A1 must be plugged onto an STM32 Nucleo board through the Arduino™ UNO R3 connectors as shown in the figure below<sup>a</sup>.

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<sup>a</sup> Information on STM32 Nucleo is available at <http://www.st.com/stm32nucleo>

Figure 2: X-NUCLEO-GNSS1A1 expansion board connected to an STM32 Nucleo board



The X-NUCLEO-GNSS1A1 can be connected to any STM32 Nucleo board, even though complete testing has been performed on the [NUCLEO-L053R8](#) and [NUCLEO-F401RE](#) boards.

To use the STM32 Nucleo development boards with the X-NUCLEO-GNSS1A1 expansion board, the following software and hardware specifications are required:

- a PC with Microsoft Windows® (7, 8 and above) to install the software package (X-CUBE-GNSS1A1)
- an STM32 Nucleo development board<sup>a</sup>
- a type A to Mini-B USB cable to connect the STM32 Nucleo board to the PC
- the X-CUBE-GNSS1A1 software package (available on [www.st.com](http://www.st.com))
- [TESEO-SUITE](#)

The installation of the X-CUBE-GNSS1A1 and the TESEO-SUITE graphical user interface utility on the user PC requires:

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

<sup>a</sup> NUCLEO-L053R8 or NUCLEO-F401RE.

## 1.3 Board setup

To set up the X-NUCLEO-GNSS1A1 expansion board, follow the procedure below.

- 1 Check the jumper position shown below:

**Table 1: X-NUCLEO-GNSS1A1 expansion board - jumper 1 default settings**

Signal	Jumper	Pins	Configuration
I <sup>2</sup> C-SCL	J11	d15	Open
I <sup>2</sup> C-SDA	J12	d14	Open
Wakeup	J9	d13	Closed
Wakeup	J7	d4	Open
Reset	J10	d9	Open
Reset	J13	d7	Closed
PPS	J6	d6	Closed
PPS	J8	d2	Open
UART-RX	J3	d8	Closed
UART-TX	J4	d2	Closed
UART-RX	J2	d1	Open
UART-TX	J5	d0	Open
VCC-VCC_IO	J14	-	Closed
V14Bat	J15	-	Closed

- 2 Connect the X-NUCLEO-GNSS1A1 to the STM32 Nucleo board
  - 3 Power the STM32 Nucleo board using the type A mini-B USB cable
  - 4 Program the STM32 Nucleo board using the firmware example provided
  - 5 Reset the MCU via the STM32 Nucleo board reset button
- The evaluation kit is ready-to-use.

## 2 Hardware description

### 2.1 X-NUCLEO-GNSS1A1 expansion board for STM32 Nucleo

The X-NUCLEO-GNSS1A1 allows testing the [Teseo-LIV3F](#) GNSS module functionality via the firmware package contained in the X-CUBE-GNSS1A1 software.



Program the microcontroller on the STM32 Nucleo development board.

The Teseo-LIV3F module and the STM32 Nucleo board communicate through the expansion board connectors<sup>a</sup> as listed in the tables below.

**Table 2: Interconnection between STM32 Nucleo board and X-NUCLEO-GNSS1A1 expansion board - left-side connectors**

STM32 Nucleo board pins	X-NUCLEO-GNSS1A1		
	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

<sup>a</sup> CN5, CN6, CN8 and CN9.



**Table 3: Interconnection between STM32 Nucleo board and X-NUCLEO-GNSS1A1 expansion board - right-side connectors**

STM32 Nucleo board pins	X-NUCLEO-GNSS1A1			
	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			
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-LIV3F module

The X-NUCLEO-GNSS1A1 expansion board embeds the [Teseo-LIV3F](#) module, an easy-to-use global navigation satellite system (GNSS) standalone module, embedding TeseoIII single die standalone positioning receiver IC working simultaneously on multiple constellations (GPS/Galileo/Glonass/BeiDou/QZSS).

**Table 4: Teseo-LIV3F details**

Feature	Description
Sales type	Teseo-LIV3F
Package	LLC 18 pins ( 9.7 x10.1 mm)
Operating voltage	3.3 V

## 2.3 UART, I<sup>2</sup>C and GPIO connection options

UART, I<sup>2</sup>C and GPIO connection options between the STM32 Nucleo and TeseoIII<sup>a</sup> 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-GNSS1A1 expansion board: Teseo-LIV3F interface with the STM32 Nucleo board**

Signal	Pins	STM32 Nucleo (optional connections)
I <sup>2</sup> C-SCL	d15	-
I <sup>2</sup> C-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.

## 2.4 Current measurement

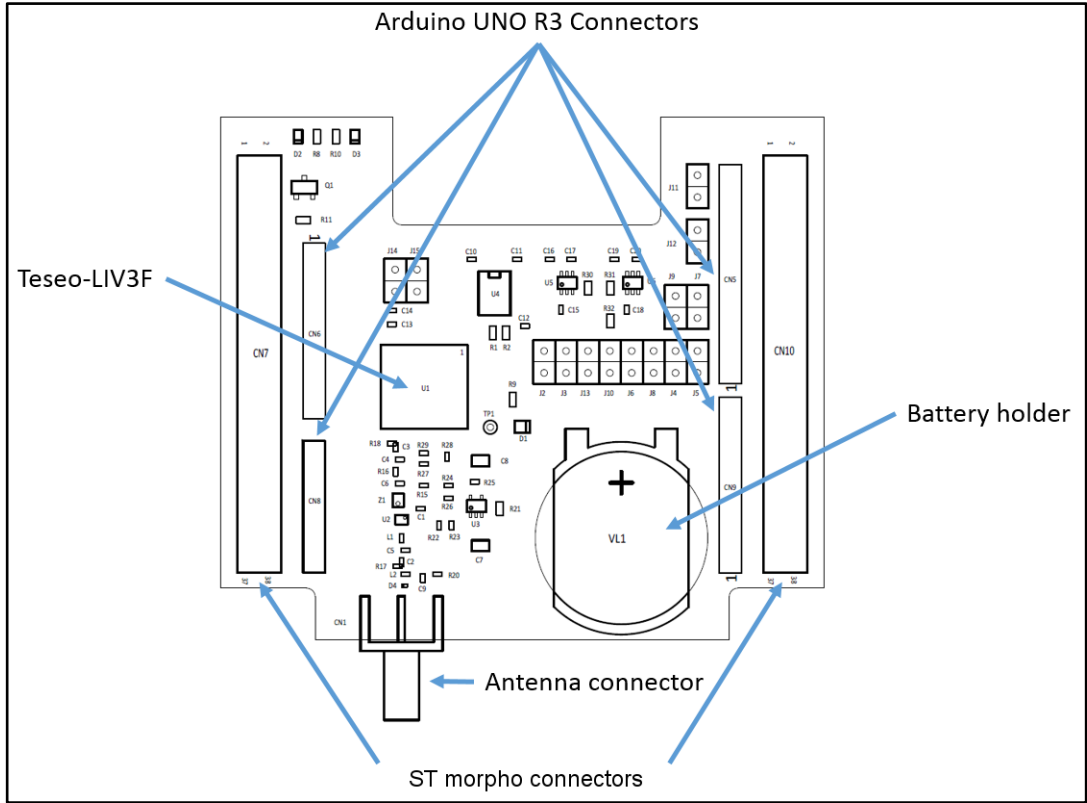
To monitor the *Teseo-LIV3F* module power consumption, insert an ammeter probe between J14 pin (VCC) and J15 pin (VBAT).

As the Teseo-LIV3F power consumption is very low during most of its operating time, an accurate instrument in the range of few  $\mu\text{A}$  is required.

<sup>a</sup> Hosted on the Teseo-LIV3F module embedded in the X-NUCLEO-GNSS1A1 expansion board.

## 2.5 X-NUCLEO-GNSS1A1 expansion board component placement

Figure 3: X-NUCLEO-GNSS1A1 expansion board component placement details



### 3 Schematic diagram

Figure 4: X-NUCLEO-GNSS1A1 circuit schematic (1 of 3)

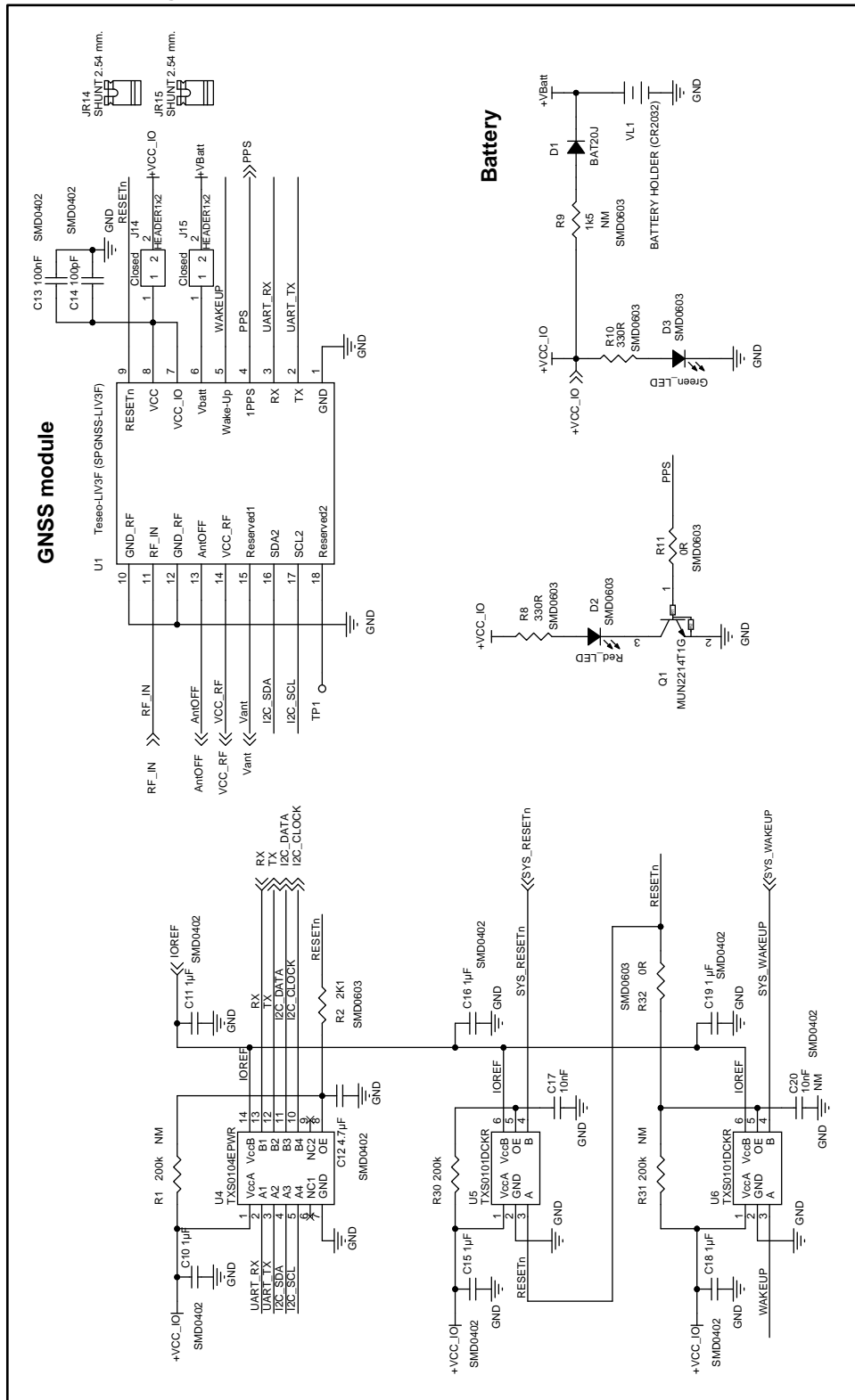


Figure 5: X-NUCLEO-GNSS1A1 circuit schematic (2 of 3)

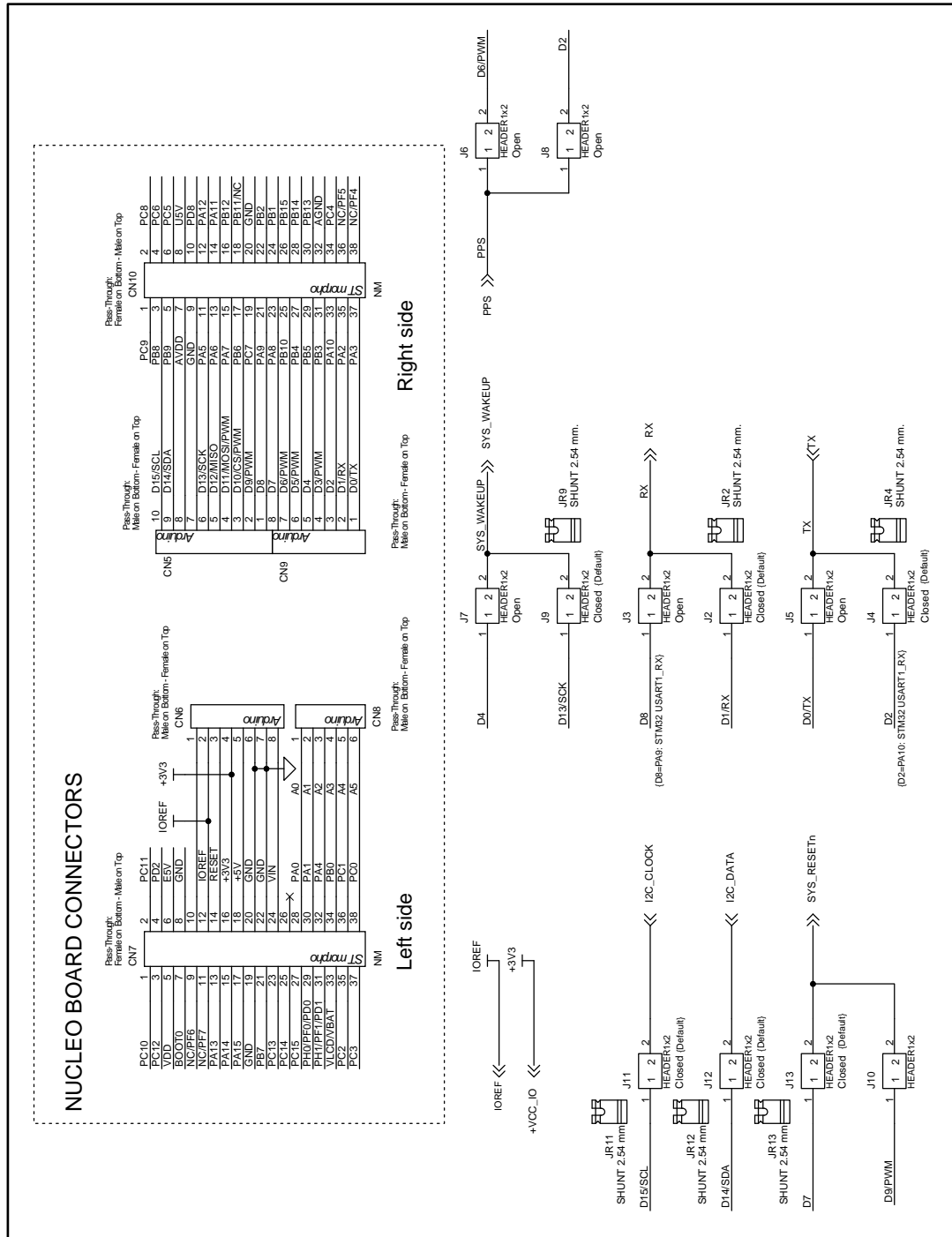
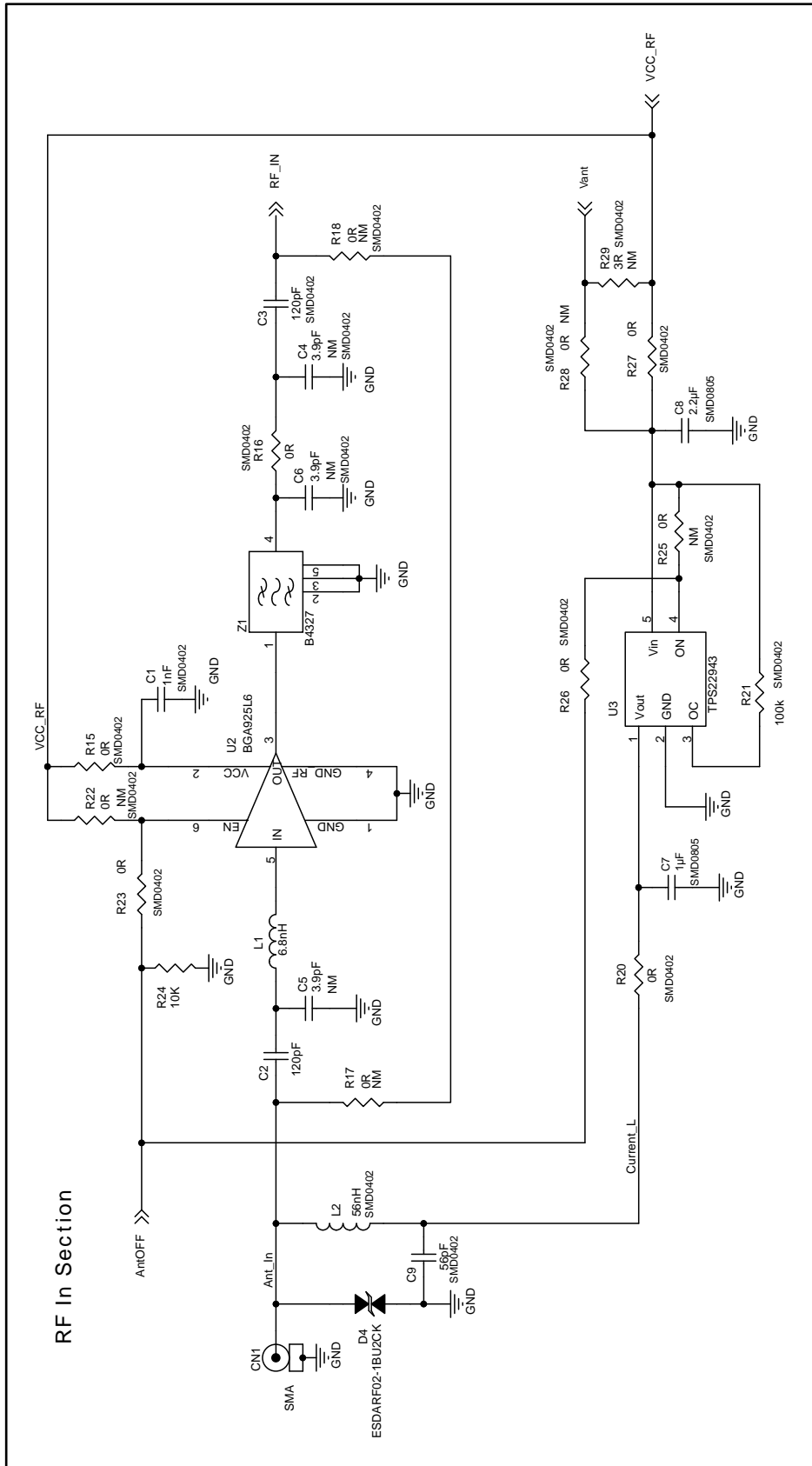


Figure 6: X-NUCLEO-GNSS1A1 circuit schematic (3 of 3)



## 4 Bill of materials

Table 6: X-NUCLEO-GNSS1A1 bill of materials

Item	Q. ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	1	CN1	SMA	Jack	Molex	73251-1150
2	1	CN5	ARDUINO_10x1 TH	Elevated socket	4UConn	15286
					Samtec	ESQ-110-24-T-S
3	2	CN6, CN9	ARDUINO_8x1 TH	Elevated socket	4UConn	15284
					Samtec	ESQ-108-24-T-S
4	2	CN7, CN10	ST_MORPHO_19x2 TH	Elevated socket	4UConn	8413
					Samtec	ESQ-119-24-T-D
5	1	CN8	ARDUINO_6x1 TH	Elevated socket	4UConn	15282
					Samtec	ESQ-106-24-T-S
6	1	C1	1 nF $\pm 10\%$ 50 V SMD 0402 X7R	Capacitor	Murata	GRM155R71H102KA01D
7	2	C2, C3	120 pF $\pm 10\%$ 50 V SMD 0402	Capacitor	Murata	GRM1555C1H121JA01D
8	3	C4, C5, C6	3.9 pF $\pm 10\%$ 50 V SMD 0402	Capacitor - not mounted	Murata	GRM1555C1H3R9WA01D
9	1	C7	1 $\mu$ F $\pm 10\%$ 16 V SMD 0805 X7R	Capacitor	Taiyo Yuden	EMK212B7105KGHT
10	1	C8	2.2 $\mu$ F $\pm 10\%$ 16 V SMD 0805 X7R	Capacitor	Taiyo Yuden	EMK212B7225KGHT
11	1	C9	56 pF $\pm 10\%$ 50 V SMD 0402 X7R	Capacitor	Murata	GRM1555C1H560JA01D
12	6	C10, C11, C15, C16, C18, C19	1 $\mu$ F $\pm 10\%$ 10 V SMD 0402 X5R	Capacitor	Murata	GRM155R61A105KE15D
13	1	C12	4.7 $\mu$ F $\pm 20\%$ 6.3 V SMD 0402 X5R	Capacitor	Murata	GRM155R60J475ME47D

Item	Q. ty	Ref.	Part/Value	Description	Manufacturer	Order code
14	1	C13	100 nF ±10% 16 V SMD 0402 X7R	Capacitor	Murata	GRM155R71C104KA88D
15	1	C14	100 pF ±5% 50 V SMD 0402 COG	Capacitor	Murata	GRM1555C1H101JA01D
16	1	C17	10 nF ±10% 25 V SMD 0402 X7R	Capacitor	Murata	GRM155R71E103KA01D
17	1	C20	10 nF ±10% 25 V SMD 0402 X7R	Capacitor - not mounted	Murata	GRM155R71E103KA01D
18	1	D1	BAT20J SOD323	Schottky diode	ST	<a href="#">BAT20J</a>
19	1	D2	Red_LED SMD 0603	LED diode	Lite-on	LTST-C193KRKT-5A
20	1	D3	Green_LED SMD 0603	LED diode	Lite-On	LTST-C191KGKT
21	1	D4	ESDARF02 -1BU2CK SMD 0201	ESD protection diode	ST	<a href="#">ESDARF02-1BU2CK</a>
22	8	J2, J4, J9, J11, J12, J13, J14, J15	HEADER1x 2 TH	2.54 PIN HEADER SINGLE ROW 2 PIN	Any	
23	6	J3, J5, J6, J7, J8, J10	HEADER1x 2 TH	2.54 PIN HEADER SINGLE ROW 2 PIN	Any	
24	8	JR2, JR4, JR9, JR11 , JR12 , JR13 , JR14 , JR15	SHUNT 2.54 mm. 3 A max. 2.54 mm.	JUMPER	TE Connectivity/ AMP	1-382811-6



Item	Q. ty	Ref.	Part/Value	Description	Manufacturer	Order code
25	1	L1	6.8 nH $\pm$ 2% 0.7 A SMD 0402	SMD Inductor	Murata	LQW15AN6N8G00D
26	1	L2	56 nH $\pm$ 5% 0.2 A SMD 0402	SMD Inductor	Wurth Elektronik	744784156A
27	1	Q1	MUN2214T 1G SC-59	NPN Digital Transistor	ONSemiconductors	MUN2214T1G
28	2	R1,R 31	200 k $\pm$ 1% SMD 0603	Resistor - not mounted	Any	
29	1	R30	200 k $\pm$ 1% SMD 0603	Resistor	Any	
30	1	R2	2K1 $\pm$ 1% SMD 0603	Resistor	Any	
30	2	R11, R32	0 R $\pm$ 1% SMD 0603	Resistor	Any	
31	2	R8,R 10	330 R $\pm$ 1% SMD 0603	Resistor	Any	
32	1	R9	1k5 $\pm$ 1% SMD 0603	Resistor - not mounted	Any	
33	6	R15, R16, R20, R23, R26, R27	0 R $\pm$ 1% SMD 0402	Resistor	Any	
34	5	R17, R18, R22, R25, R28	0 R $\pm$ 1% SMD 0402	Resistor	Any	
35	1	R21	100 k $\pm$ 1% SMD 0603	Resistor	Any	
36	1	R24	10 K $\pm$ 1% SMD 0402	Resistor	Any	
37	1	R29	3 R $\pm$ 1% SMD 0402	Resistor	Any	
38	1	TP1	TESTPOIN T TH	Test point	Keystone Electronics	5117 (or 5000 or 5001)
39	1	U1	Teseo- LIV3F (SPGNSS- LIV3F) SMD	GNSS Module	ST	<a href="#">Teseo-LIV3F</a>
40	1	U2	BGA925L6 TSLP-6-2	Low noise amplifier for GNSS	Infineon	BGA925L6

Item	Q. ty	Ref.	Part/Value	Description	Manufacturer	Order code
41	1	U3	TPS22943 SC70-5	IC load switch	Texas Instruments	TPS22943DCKR
42	1	U4	TXS0104E PWR SC70-6	Voltage level transl. bidirect. 4 channel	Texas Instruments	TXS0104EPWR
43	2	U5, U6	TXS0101D CKR SC70- 6	Voltage level transl. bidirect. 1 channel	Texas Instruments	TXS0101DCKR
44	1	VL1	BATTERY HOLDER (CR2032) SMD	Coin battery holder (CR2032)	Harwin Inc.	S8421-45R
45	1	Z1	B4327 QCS5P	Saw RF filter	TDK	B39162B4327P810

## 5 Revision history

Table 7: Document revision history

Date	Version	Changes
05-Dec-2017	1	Initial release.

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