

# Nordic Thingy:91 X™ Hardware v1.0.0

User Guide

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# Revision history

Date	Description
December 2024	First release

# Environmental and safety notices

## Power supply

The Nordic Thingy:91 X™ must be powered by a PS1 class (IEC 62368-1) power supply with maximum power less than 15 W.

## Skilled persons

The Nordic Thingy:91 X™ is intended for use only by skilled persons.

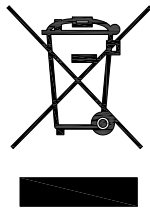
A skilled person is someone with relevant education or experience that enables them to identify potential hazards and takes appropriate action to reduce the risk of injury to themselves and others.



## Electrostatic discharge

The Nordic Thingy:91 X™ is susceptible to *Electrostatic Discharge (ESD)*.

To avoid damage to your device, it should be used in an electrostatic free environment, such as a laboratory.



### Environmental Protection

Waste electrical products should not be disposed of with household waste.

Please recycle where facilities exist. Check with your local authority or retailer for recycling advice.

**Warning:** The battery in this product shall not be replaced by users themselves. Batteries should be removed only by qualified professionals due to the following safety concerns:

- Replacing the battery with an incorrect battery type can cause a fire or explosion.
- Disposing the battery into a fire or hot oven, crushing it mechanically, or cutting it can cause an explosion.
- Leaving the battery in an environment with an extremely high temperature can cause an explosion or the leakage of flammable liquid or gas.
- Subjecting the battery to extremely low air pressure can cause an explosion or the leakage of flammable liquid or gas.

The Nordic Thingy:91 X™ shall not be operated outside the internal battery's discharge temperature range between  $-20^{\circ}\text{C}$  and  $+60^{\circ}\text{C}$  or stored or transported outside the internal battery's storage temperature range between  $-20^{\circ}\text{C}$  and  $+30^{\circ}\text{C}$ .

# 1 Introduction

The Nordic Thingy:91 X™ is a battery-operated prototyping platform for cellular IoT, certified for global operation. It is ideal for rapid development of prototypes for cellular IoT systems and especially suited for asset tracking applications and environmental monitoring.

Nordic Thingy:91 X™ integrates the nRF9151 *System in Package (SiP)* supporting *LTE-M*, *Narrowband Internet of Things (NB-IoT)*, *DECT NR+*, and GNSS, the nRF7002 Wi-Fi® 6 companion *Integrated Circuit (IC)* supporting 2.4 and 5 GHz Wi-Fi operation, and the nRF5340 *System on Chip (SoC)* supporting *Bluetooth®* Low Energy, IEEE 802.15.4 protocols, and USB.

## Key features

- Nordic Thingy:91 X™
  - nRF9151 SiP
  - nRF7002 Wi-Fi 6 companion IC
  - nRF5340 SoC
  - nPM6001 and nPM1300 *Power Management Integrated Circuit (PMIC)s*
  - 600–2200 MHz antenna with active RF front end for *Long-Term Evolution (LTE)* and DECT NR+
  - Dual band 2.4 GHz and 5 GHz antenna for Wi-Fi and Bluetooth Low Energy
  - Linear polarized *Global Navigation Satellite System (GNSS)* antenna for GNSS positioning
  - Insertable current measurement and debug board for easy power profiling and debugging
  - Qwiic and STEMMA QT compatible connector for easy prototyping with breakout boards
  - User-programmable buttons and RGB LEDs
  - Environmental sensor for temperature, humidity, air quality, and air pressure
  - Three-axis low-power accelerometer
  - Six-axis IMU with gyroscope and accelerometer
  - Three-axis magnetometer
  - 256 Mbit external flash memory
  - SIM card socket for nano-SIM (4FF SIM)
  - Rechargeable *Lithium-polymer (Li-Poly)* battery
  - Computer connection and battery charging through USB-C
  - Normal operating temperature range 0–35°C
- nRF9151 SiP
  - Application processor
    - 64 MHz Arm® Cortex®-M33 CPU
    - Arm TrustZone® for trusted execution
    - Arm CryptoCell™ 310 for application layer security
    - 1 MB flash and 256 kB RAM
    - 4 x *Serial Peripheral Interface (SPI)/Universal Asynchronous Receiver/Transmitter (UART)/Two-wire Interface (TWI), Pulse Density Modulation (PDM), Inter-integrated Circuit (I<sup>2</sup>C), Pulse Width Modulation (PWM), ADC*
  - Modem
    - 3GPP LTE release 14 *Cat-M1* compliant
    - 3GPP LTE release 14 *Cat-NB1* and *Cat-NB2* compliant
    - DECT NR+ bands 1, 2, and 9
    - GNSS

- Power saving features: *Extended Discontinuous Reception (eDRX)*, *Power Saving Mode (PSM)*, and *AS-RAI*
- Single pin 50  $\Omega$  antenna interface
- *Universal Integrated Circuit Card (UICC)* interface
- nRF7002 Wi-Fi 6 companion IC
  - Dual-band 2.4 GHz and 5 GHz Wi-Fi 6
  - Compatible with IEEE 802.11ax, also known as Wi-Fi 6, and earlier standards IEEE 802.11a/b/g/n/ac
  - 20 MHz wide channels, 1x1 *Single-Input Single-Output (SISO)* operation, and up to 86 MHz 802.11 PHY rate
  - SPI host interface
  - Three-wire coexistence interface
- nRF5340 SoC
  - Application core
    - 64–128 MHz Arm Cortex-M33 with TrustZone technology
    - 1 MB flash and 512 kB low leakage RAM
    - Arm TrustZone CryptoCell-312 security subsystem
    - Full-speed 12 Mbps USB device
  - Network core
    - 64 MHz Arm Cortex-M33
    - 256 kB flash and 64 kB low leakage RAM
    - Bluetooth 5.2, IEEE 802.15.4-2006, and 2.4 GHz enabled transceiver
- nPM6001 PMIC
  - Four 150–550 mA buck regulators
  - Two 15–30 mA *Low-Dropout Regulator (LDO)s*
  - Three multipurpose GPIOs
  - Controlled through an I<sup>2</sup>C compatible TWI
- nPM1300 PMIC
  - 800 mA battery charger
  - Two 200 mA buck regulators
  - Two 100 mA load switches/50 mA LDOs
  - Fuel gauge
  - System-level watchdog and failed-boot recovery
  - Intelligent power loss warning
  - Five GPIOs
  - Three LED drivers
  - Controlled through an I<sup>2</sup>C compatible TWI
  - USB-C compatible

The firmware source code, hardware schematics, layout files, bill of materials, and Gerber files are available on the [Nordic Thingy:91 X product page](#).

## 2 Kit content

The Nordic Thingy:91 X™ kit consists of hardware and access to software components, hardware design files, applications, and documentation.

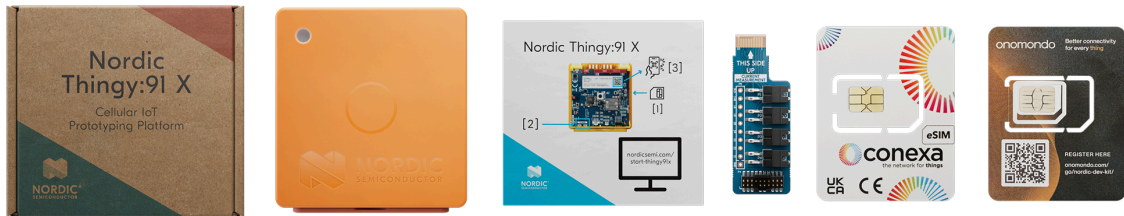


Figure 1: Nordic Thingy:91 X™ hardware content

The Nordic Thingy:91 X™ kit includes the following:

- Nordic Thingy:91 X™ board (PCA20065) with plastic enclosure and battery
- Nordic Thingy:91 X™ current measurement and debug board (PCA64165)
- Two *Embedded SIM (eSIM)*s supported by a nano 4FF SIM card slot
- Information leaflet

**Note:** Power supply adapter is not included in the kit or the safety certification test report. See a separate test report according to IEC 62368. Use a power supply adapter that meets the PS1 requirements.



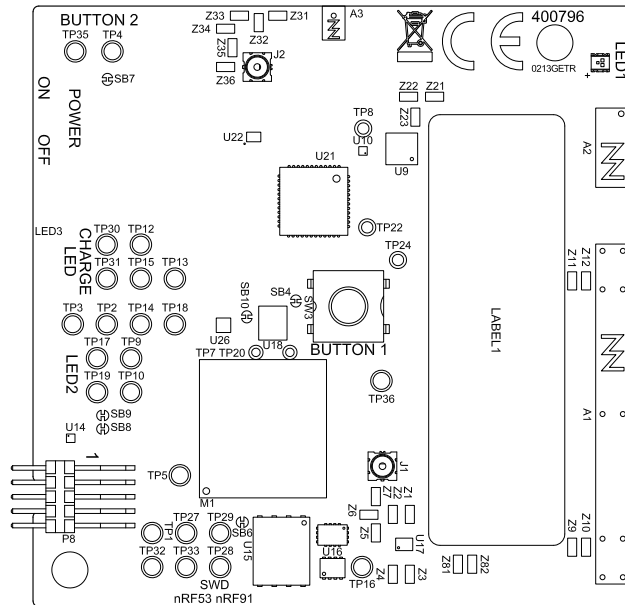


Figure 3: Nordic Thingy:91 X™, front view

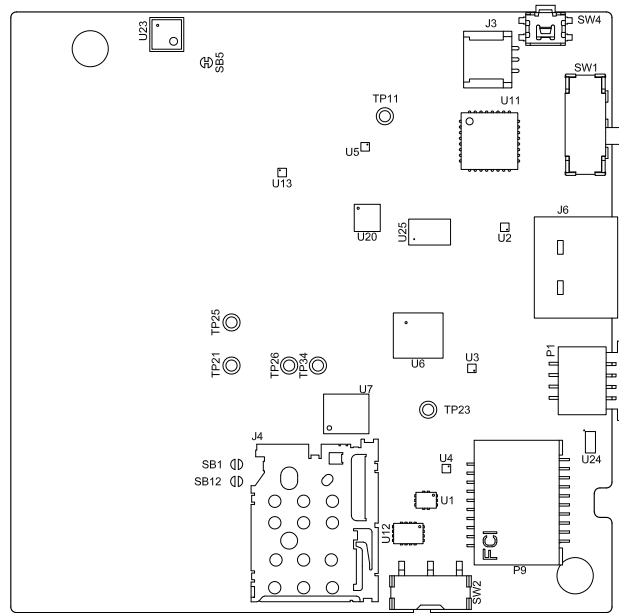


Figure 4: Nordic Thingy:91 X™, back view

The following hardware drawings show both sides of the Nordic Thingy:91 X™ current measurement and debug board.

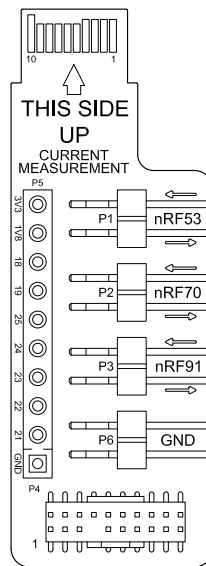


Figure 5: Current measurement and debug board, front view

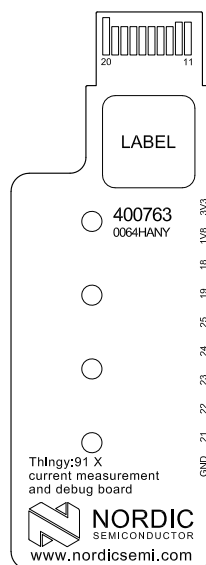


Figure 6: Current measurement and debug board, back view

### 3.3 nRF9151 SiP

The nRF9151 *SiP* is a highly integrated and compact solution specifically designed for cellular IoT and *DECT NR+* applications and certified for global operation. The nRF9151 supports 3GPP release 14 *LTE-M/NB-IoT* Power Class 3 up to 23 dBm output power and Power Class 5 up to 20 dBm output power.

### 3.4 nRF7002 Wi-Fi 6 companion IC

nRF7002 is an ultra-low power dual band wireless companion *IC* for low-power Wi-Fi 6 on the 2.4 GHz and 5 GHz bands.

On the Nordic Thingy:91 X™, the nRF7002 IC provides Wi-Fi connectivity to the nRF9151 *SiP* or the nRF5340 *SoC* through the shared *SPI* bus. On the Nordic Thingy:91 X™, the primary use-case for the nRF7002 IC is to provide support for SSID-based Wi-Fi location tracking on the nRF9151 *SiP*. When the

nRF9151 SiP acts as the host for the nRF7002 IC, only Wi-Fi scanning is supported. The nRF5340 SoC supports coexistence between Bluetooth Low Energy and Wi-Fi and can act as the host for the nRF7002 IC.

## 3.5 nRF5340 SoC

nRF5340 is a multiprotocol SoC with two ArmCortex-M33 processors that support Bluetooth Low Energy, Bluetooth Mesh, LE Audio, and 802.15.4 protocols, such as Thread<sup>®</sup> and Zigbee<sup>®</sup>.

On the Nordic Thingy:91 X<sup>™</sup>, the nRF5340 SoC is primarily used to add USB connectivity to the Nordic Thingy:91 X<sup>™</sup>. The nRF5340 SoC is preprogrammed with the Connectivity bridge application. The nRF5340 SoC acts as a USB composite device exposing two UART interfaces of the nRF9151 SiP to a USB host as two CDC ACM devices used for logging and debugging. The Connectivity bridge application also implements a Bluetooth LE UART service which is disabled by default. The firmware of the nRF5340 SoC can be updated through USB to enable Bluetooth LE or 802.15.4 operation.

For more information, see [Connectivity bridge](#).

## 3.6 RF interfaces

The Nordic Thingy:91 X<sup>™</sup> has RF interfaces for *LTE/DECT NR+*, *GNSS* and *Wi-Fi/Bluetooth Low Energy*.

### 3.6.1 LTE/ DECT NR+ RF interface

The active *LTE/DECT NR+* RF front end ensures the optimal tuning of the *LTE/DECT NR+* antenna (**A1**). The nRF9151 SiP (**M1**) configures the RF switch (**U17**) through its *MIPI RF Front-End Control Interface (RFFE)* interface depending on the frequency of the band.

Conducted measurements can be done through the *Microwave coaxial connector with switch (SWF)* connector (**J1**).

The following figure describes the *LTE/DECT NR+* RF front end.

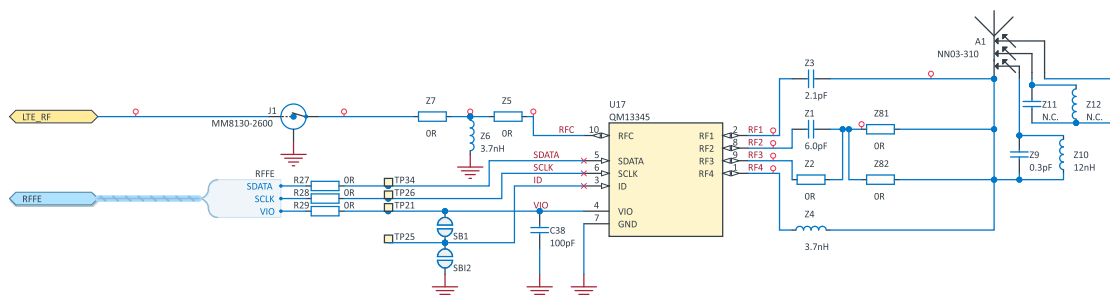


Figure 7: LTE/DECT NR+ Antenna RFFE

The following table describes the RF switch's (**U17**) configurations for the different frequency ranges and whether RF ports 1–4 are in a series configuration with the RF common port (RFC) or connected to ground in a shunt configuration.

Frequency range	Enabled series switches	Enabled shunt switches
600–649 MHz	RF3	RF1
650–699 MHz	RF1 and RF4	-
700–729 MHz	RF4	-
730–790 MHz	RF3	-
790–840 MHz	RF3 and RF4	-
840–890 MHz	RF1, RF2, and RF4	-
890–920 MHz	RF2	RF4
920–970 MHz	RF1	-
970–1010 MHz		RF4
1600–1780 MHz	RF1 and RF3	
1780–2350 MHz	RF2	
2350–2600 MHz	RF1 and RF3	

Table 1: Active LTE/DECT NR+ RFFE antenna tuning

### 3.6.2 GNSS RF interface

The signal from the GNSS antenna (**A2**) is amplified by a *Low-Noise Amplifier (LNA)* (**U9**) before being fed to the GNSS RF port of the nRF9151 SiP (**M1**).

The following figure describes the GNSS RF interface.

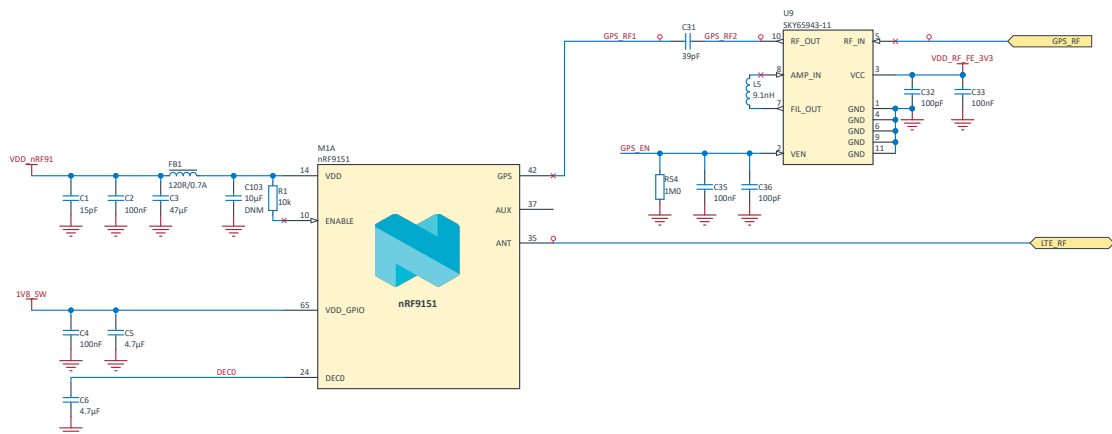


Figure 8: nRF9151 and GNSS RFFE

### 3.6.3 2.4 GHz and 5 GHz RF interface

The dual band 2.4 GHz and 5 GHz antenna (**A3**) is shared between the nRF5340 SoC (**U6**) and the nRF7002 Wi-Fi 6 companion IC (**U21**).

The antenna is connected to a diplexer (**F2**) with the 5 GHz terminal connected directly to the TXRF1 pin of the nRF7002 IC. The 2.4 GHz terminal is connected to an RF switch (**U22**) that connects the 2.4 GHz terminal to the TXRF2 pin of the nRF7002 IC or the ANT pin of the nRF5340 SoC (**U6**). The RF switch (**U22**) is controlled by the 2.4G\_SW\_CTRL signal that is connected to the switch control pin on the nRF5340 SoC (**U6**) and nRF7002 IC (**U21**), enabling coexistence between Bluetooth LE and Wi-Fi.

The following figure describes the 2.4 GHz and 5 GHz RF interface.

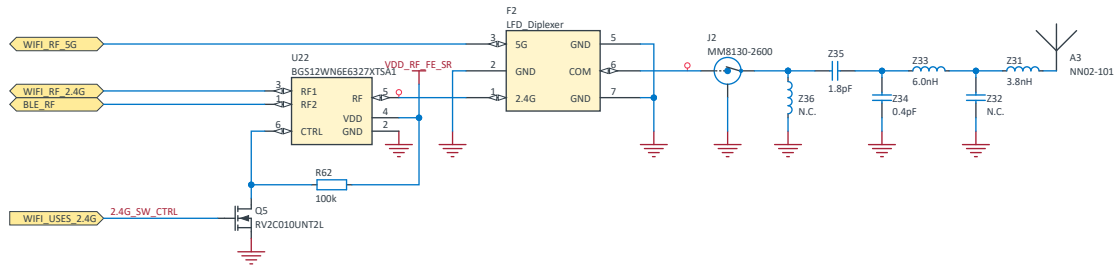


Figure 9: Nordic Thingy:91 X™ 2.4 GHz and 5 GHz RF interface

### 3.7 Power supply

The Nordic Thingy:91 X™ has two PMICs and many other supply domains.

The following figure describes the power supply architecture.

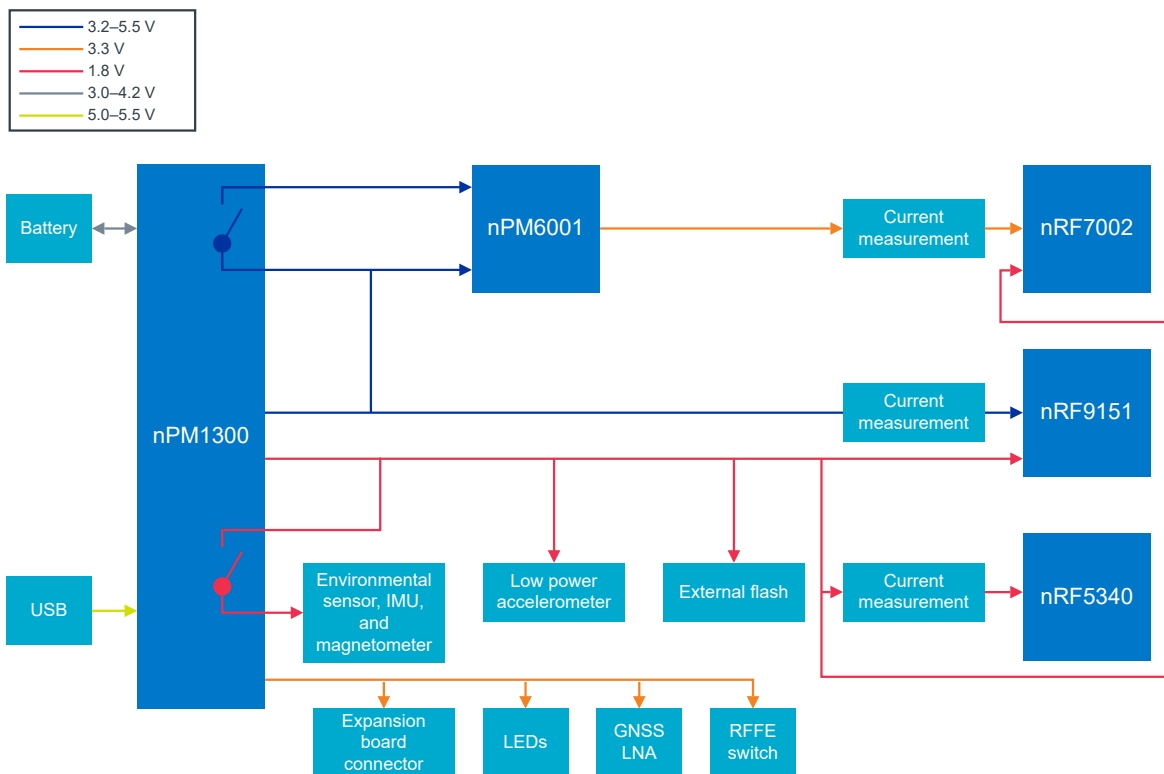


Figure 10: Power supply

#### 3.7.1 nPM1300 PMIC

The nPM1300 PMIC is the main power management IC on the Nordic Thingy:91 X™. It supplies all the main power domains and charges the battery.

The following table describes the supply domains of the nPM1300 PMIC.

nPM1300 PMIC output	Supply domain	Domain voltage
VSYS	<ul style="list-style-type: none"> <li>VDD supply to the nRF9151 SiP</li> <li>VIN input to the nPM6001 PMIC</li> <li>Supply for Charge LED</li> </ul>	3.2–5.0 V
VOUT1	<ul style="list-style-type: none"> <li>VDD and VDDIO supply to on-board sensors</li> <li>External flash VDD</li> <li>Supply to nRF5340 SoC VDD</li> <li>Supply to nRF9151 SiP VDD_GPIO</li> <li>Supply for nRF7002 Wi-Fi 6 companion IC IOVDD</li> </ul>	1.8 V
VOUT2	<ul style="list-style-type: none"> <li>Supply for external circuits connected to the expansion board connector or the current measurement and debug board</li> <li>Supply for LED1 and LED2</li> <li>Supply for GNSS LNA and Wi-Fi/BLE RF front-end switch</li> </ul>	3.3 V
LSOUT1	Load switch 1, enables and disables the nPM6001 PMIC	3.2–5.0 V
LSOUT2	Load switch 2, enables and disables sensor power domain	1.8 V

Table 2: nPM1300 PMIC's supply domains

The following figure describes the circuitry of the nPM1300 PMIC.

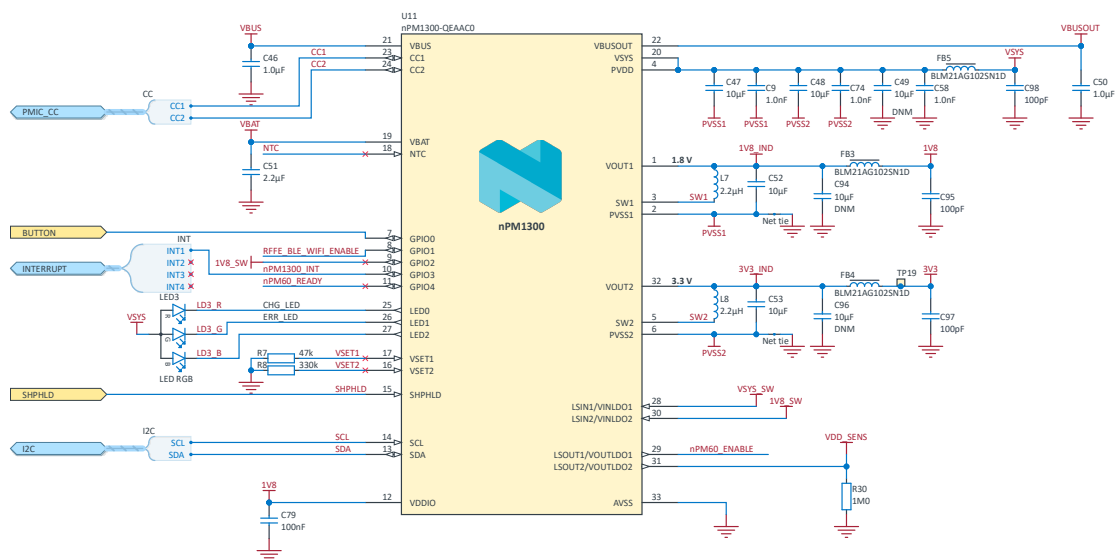


Figure 11: nPM1300 PMIC circuitry

### 3.7.2 nPM6001 PMIC

The nPM6001 PMIC supplies the nRF7002 Wi-Fi 6 companion IC on the Nordic Thingy:91 X™.

The nPM6001 PMIC steps down the unregulated nPM1300 PIMIC VSYS output to 3.6 V. Only BUCK3 is in use. BUCK1 can be disabled in hardware by connecting its output to VIN. BUCK2 can be disabled in hardware by connecting its output to V00. The nPM6001 PMIC LDOs are not in use, and they are disabled by default.

The following figure describes the circuitry of the nPM6001 PMIC.

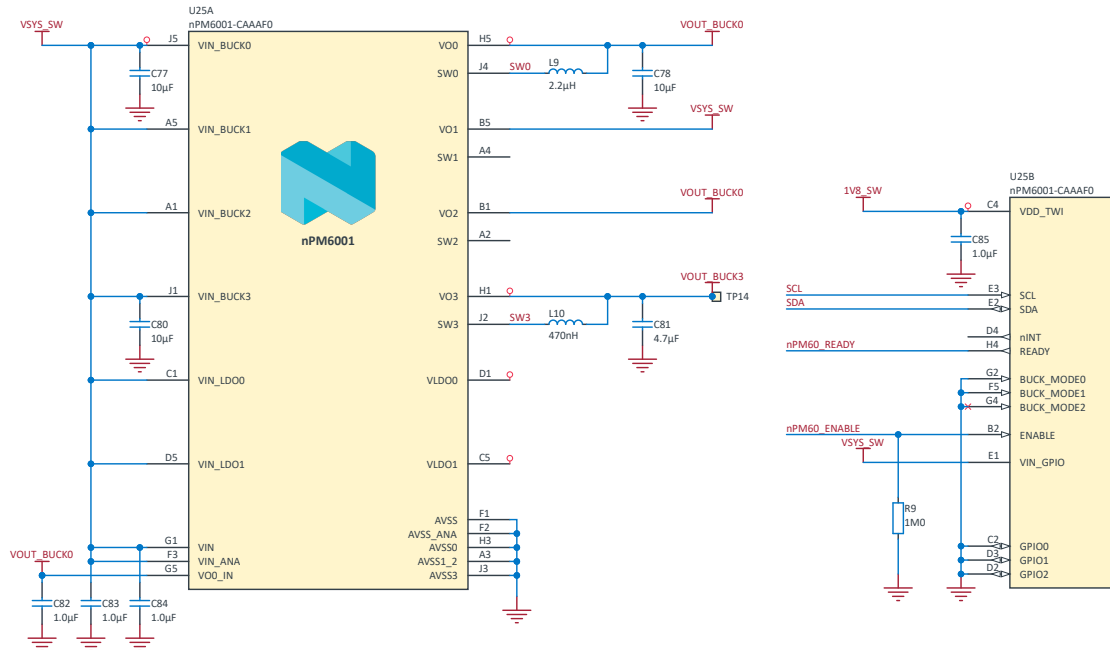


Figure 12: nPM6001 PMIC circuitry

### 3.7.3 Power switch

The power switch (**SW1**) disconnects the VSYS and 1V8 outputs from the nPM1300 PMIC (**U11**).

Disconnecting the 1V8 output also disables the nPM1300 BUCK2 output as the 1V8\_SW net is connected to GPIO2 on the nPM1300 PMIC (**U11**), which on boot is configured to disable BUCK2 when set low. The nPM1300 PMIC (**U11**) is powered from the battery when the power switch (**SW1**) is in the off position and retains its configuration. The battery charges when the power switch (**SW1**) is in the off position.

The following figure describes the power switch.

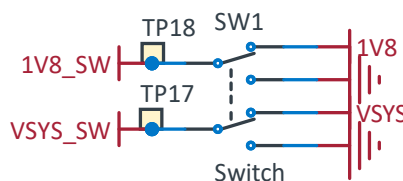


Figure 13: Power switch

### 3.7.4 Load switches

Load switches can be used to turn power on and off to power-optimize the system.

#### 3.7.4.1 Load switches for RF front-end power control

Load switches **U5** and **U13** control power to the RF switches and LNAs in the respective RFFEs.

**U5** controls power to the RF switch (**U22**) in the 2.4 GHz and 5 GHz RF front-end. The control signal VDD\_RF\_FE\_SR\_EN to **U5** is connected to GPIO1 on the nPM1300 *PMIC* and to P0.18 on the nRF5340 SoC.

**U13** controls power to the GNSS LNA (**U9**). **U13** is controlled by the VDD\_RF\_FE\_LR\_EN signal that is connected to the nRF9151 *SiP* COEX2 pin.

The following figure describes the load switches that control power to the RF switches and LNAs.

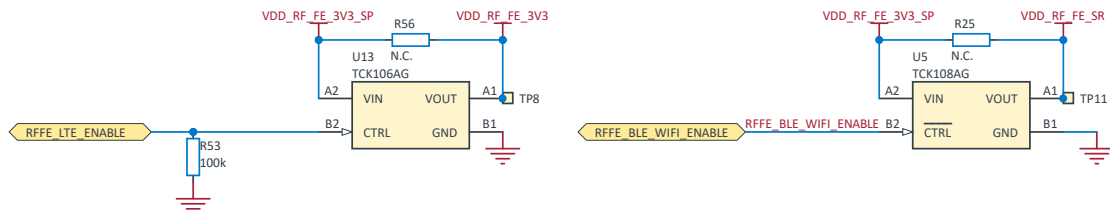


Figure 14: Load switches for RF front-end power control

### 3.7.4.2 Load switches for current measurement board bypass

Load switches **U2**, **U3**, and **U4** route the supply domains for the nRF9151 *SiP*, nRF7002 Wi-Fi 6 companion IC, and the nRF5340 SoC through the Nordic Thingy:91 X™ current measurement and debug board when it is inserted into the **P9** connector.

The following figure describes the load switch circuitry.

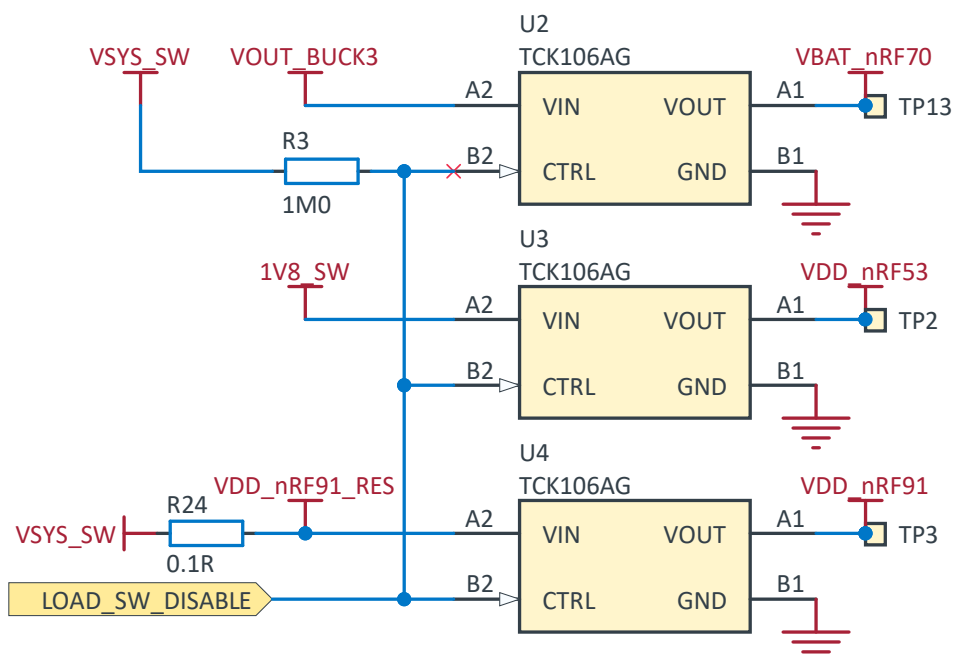


Figure 15: Load switches for current measurement board bypass

### 3.7.4.3 Load switch to power expansion board connector

Load switch **U14** controls the 3V3 power domain to an external circuitry that is connected to the expansion board connector (**P1**). The load switch control signal is connected to P0.03 on the nRF9151 *SiP* (**M1**).

The following figure describes the load switch circuitry.

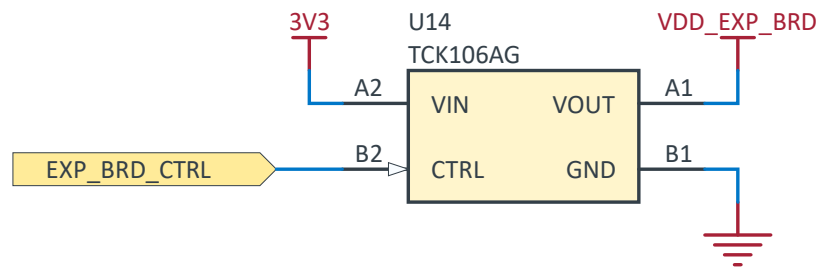


Figure 16: Load switch to power expansion board connector

### 3.8 Motion and orientation sensors

The Nordic Thingy:91 X™ has a low-power three-axis accelerometer (**U20**), a six-axis inertial measurement unit (IMU) (**U18**), and a three-axis magnetometer (**U26**) for sensing motion and orientation.

All motion and orientation sensors are connected to the nRF9151 SiP and the nRF5340 SoC through the shared SPI and I2C buses.

The low-power accelerometer is connected to the I<sup>2</sup>C compatible TWI bus. The low-power accelerometer remains powered even if the nPM1300 PMIC's load switch 2 is disabled as it is supplied directly from the nPM1300 PMIC's VOUT1 output.

It can be used to generate a GPIO interrupt that wakes up the Nordic Thingy:91 X™. The interrupt pin of the low-power accelerometer is connected to P0.11 on the nRF9151 SiP (**M1**) and to P0.28 on the nRF5340 SoC (**U6**).

The following figure describes the low-power accelerometer.

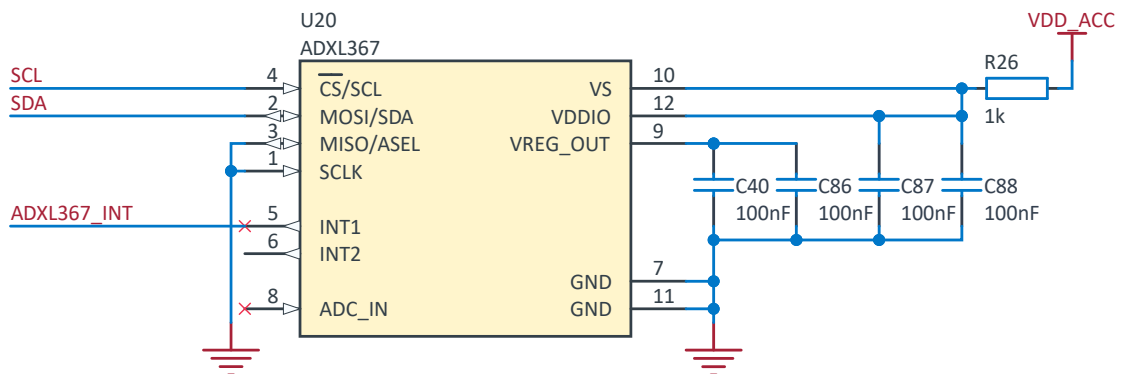


Figure 17: Low-power accelerometer

The six-axis IMU is connected to the SPI bus and can be used for more advanced motion sensing applications. The IMU can generate a GPIO interrupt when sensor data is ready. The interrupt pin of the IMU is connected to P0.06 on the nRF9151 SiP and to P0.17 on the nRF5340 SoC.

The following figure describes the IMU.

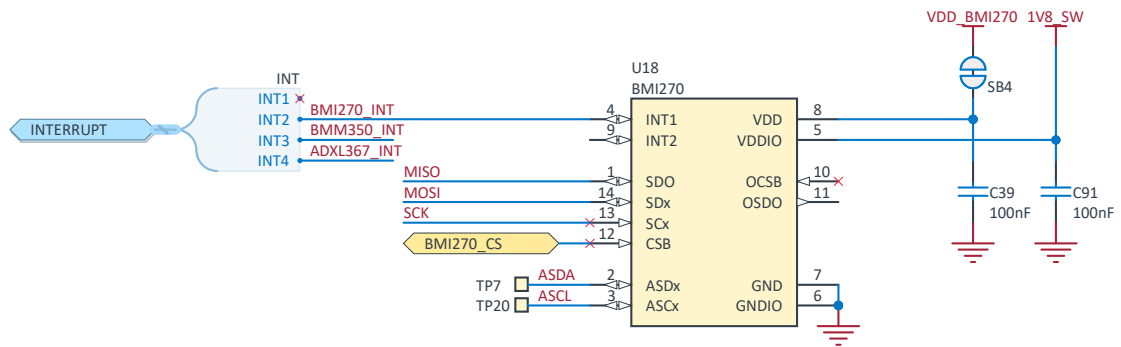


Figure 18: IMU

The magnetometer is connected to the I<sup>2</sup>C compatible TWI bus and can be used to detect magnetic fields around the Nordic Thingy:91 X™. The magnetometer can generate a GPIO interrupt when sensor data is ready. The interrupt pin of the magnetometer is connected to P0.07 on the nRF9151 SiP and P1.13 on the nRF5340 SoC.

The following figure describes the magnetometer.

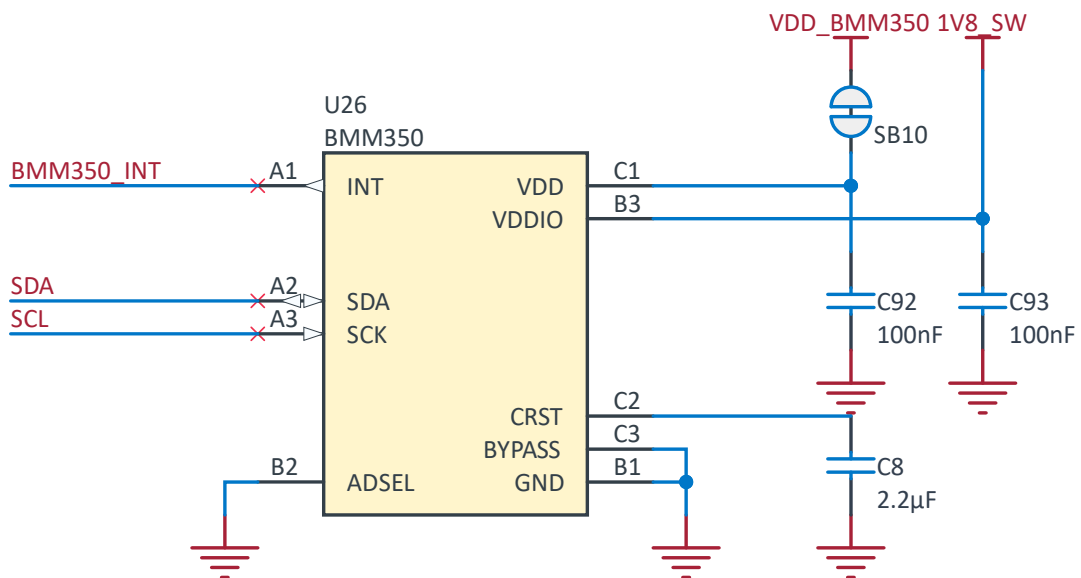


Figure 19: Magnetometer

### 3.9 Environmental sensor

The environmental sensor (**U23**) can measure pressure, humidity, temperature, and gas concentration. It is connected to the nRF9151 SiP (**M1**) and the nRF5340 SoC (**U6**) through an I2C bus.

The following figure describes the environmental sensor.

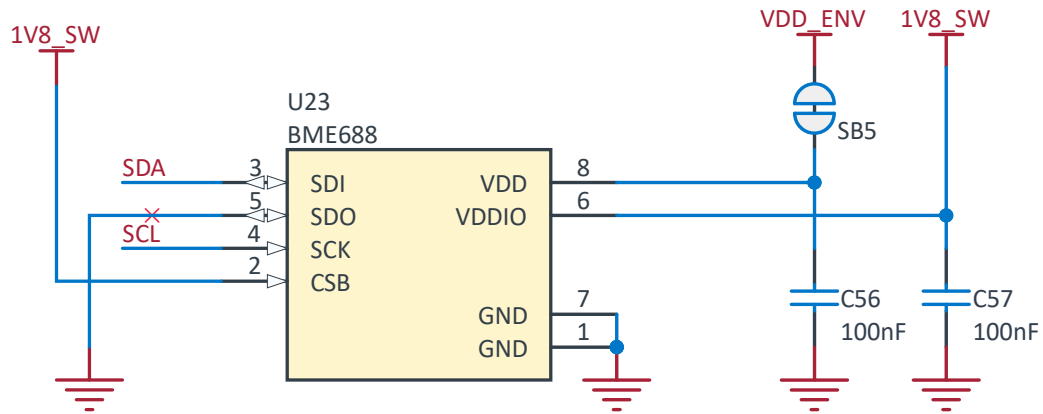


Figure 20: Environmental sensor

### 3.10 External memory

The Nordic Thingy:91 X™ has a 256 Mbit external flash memory (**U7**) that is connected to the nRF9151 SiP (**M1**) and nRF5340 SoC (**U6**) through a shared SPI bus.

The following figure describes the external memory.

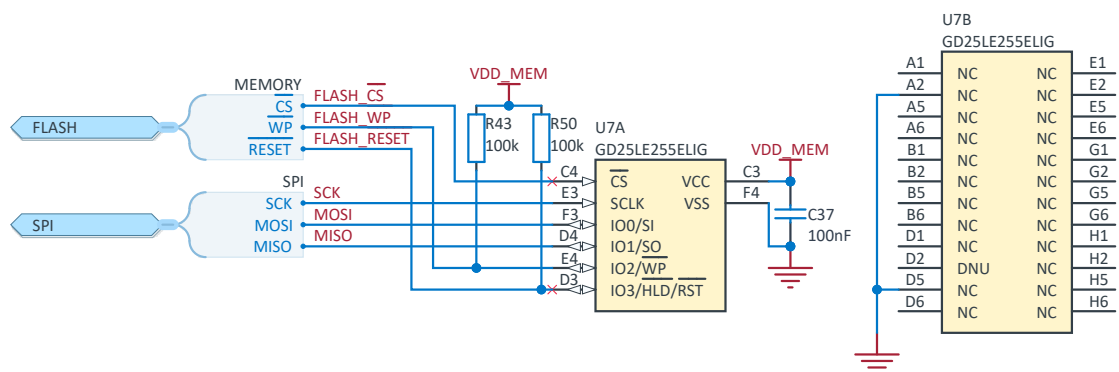


Figure 21: External memory

### 3.11 Buttons

The Nordic Thingy:91 X™ has two buttons for user input.

Button 1 (**SW3**) is connected to P0.26 on the nRF9151 SiP (**M1**). Button 1 is located under the circle on the top part of the casing and can be actuated without removing the casing.

The following figure describes Button 1.

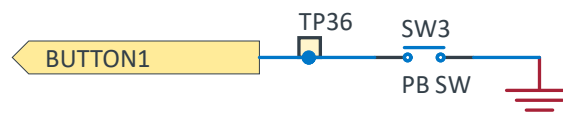


Figure 22: Button 1

Button 2 (**SW4**) is connected to P0.24 on the nRF5340 SoC and acts as a reset button for the nRF9151 SiP when the nRF5340 SoC is programmed with the Connectivity bridge sample. It is connected also to the nPM1300 PMIC SHPHLD pin and can be used to exit shipment mode if the nPM1300 PMIC (**U11**) has been configured to enter this mode. Button 2 is located on the side of the Nordic Thingy:91 X™ PCB. The top casing must be removed to actuate it.

The following figure describes Button 2.

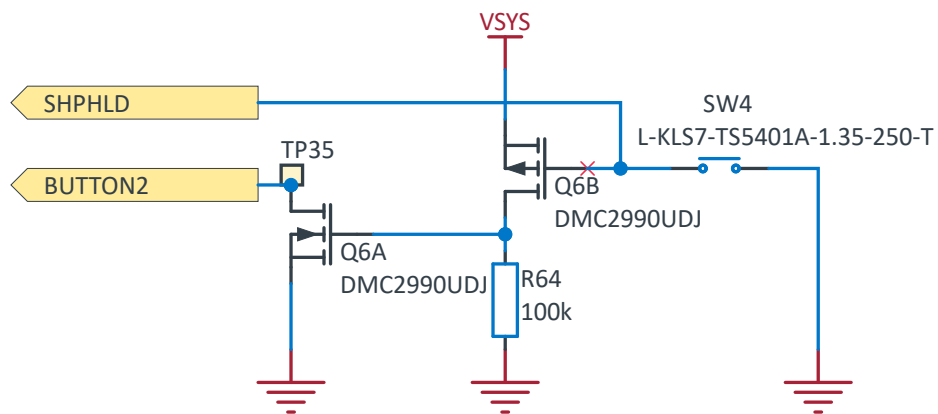


Figure 23: Button 2

The following figure shows the locations of the buttons.

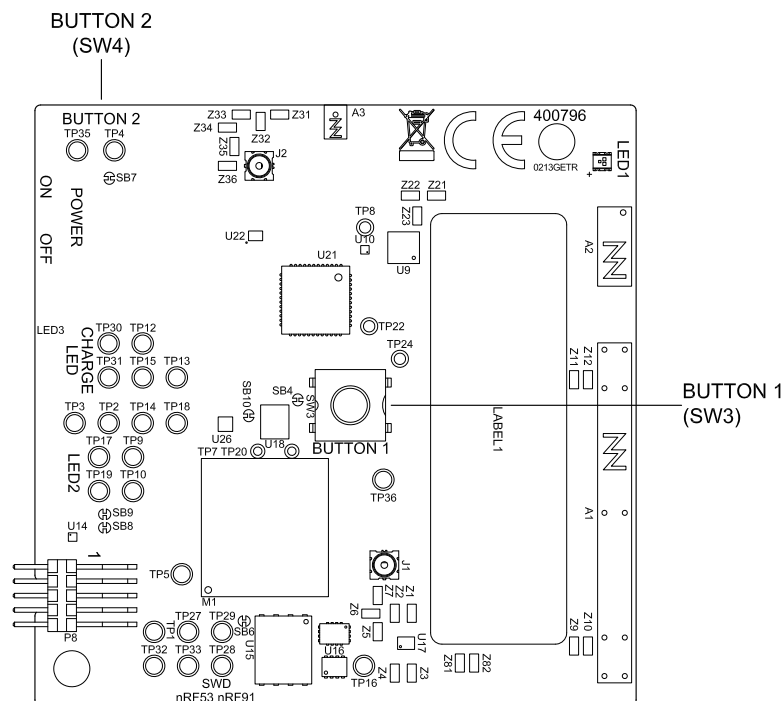


Figure 24: Buttons

### 3.12 LEDs

The Nordic Thingy:91 X™ has three user-programmable RGB LEDs: LED1, LED2, and LED3 (Charge LED).

LED1 is connected to the nRF9151 SiP (M1) and provides visual feedback to the user.

The following figure describes LED1.

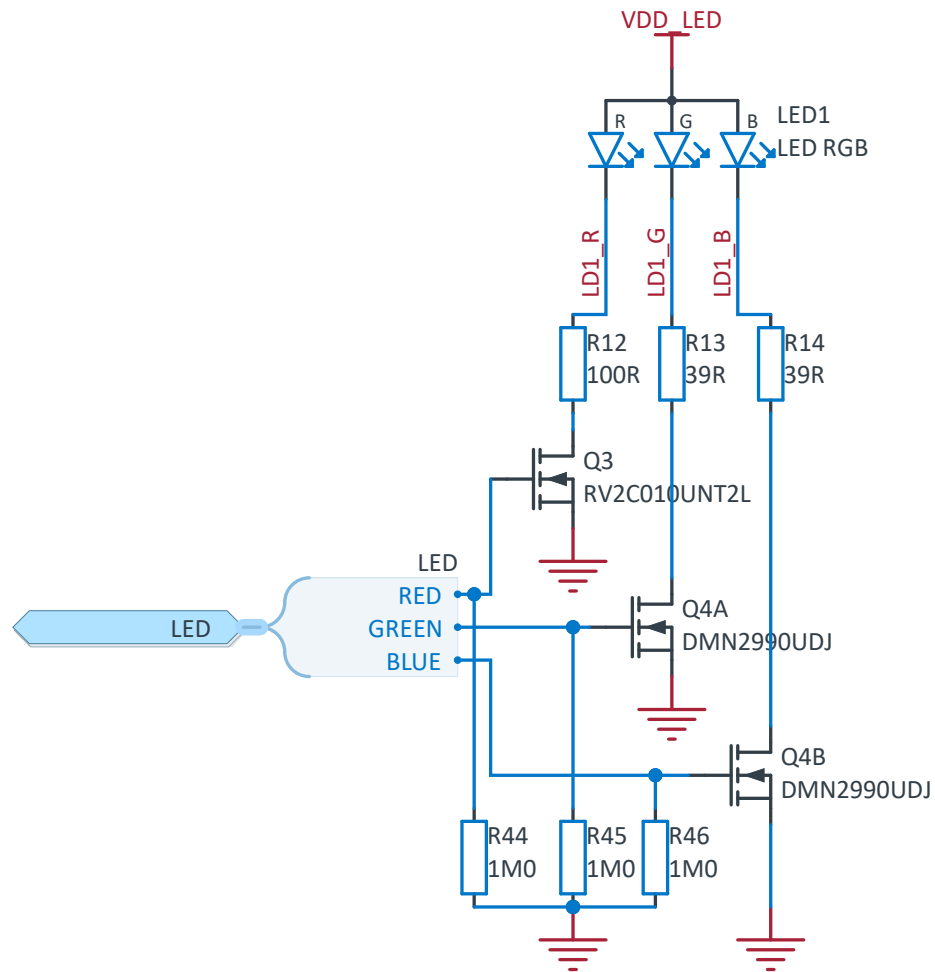


Figure 25: LED1

The following table describes the nRF9151 SiP GPIOs used to control LED1.

nRF9151 SiP GPIO	LED1 color
P0.29	Red
P0.31	Green
P0.30	Blue

Table 3: LED1

LED2 is connected to the nRF5340 SoC (**U6**) and provides visual feedback to the user.

The following figure describes LED2.

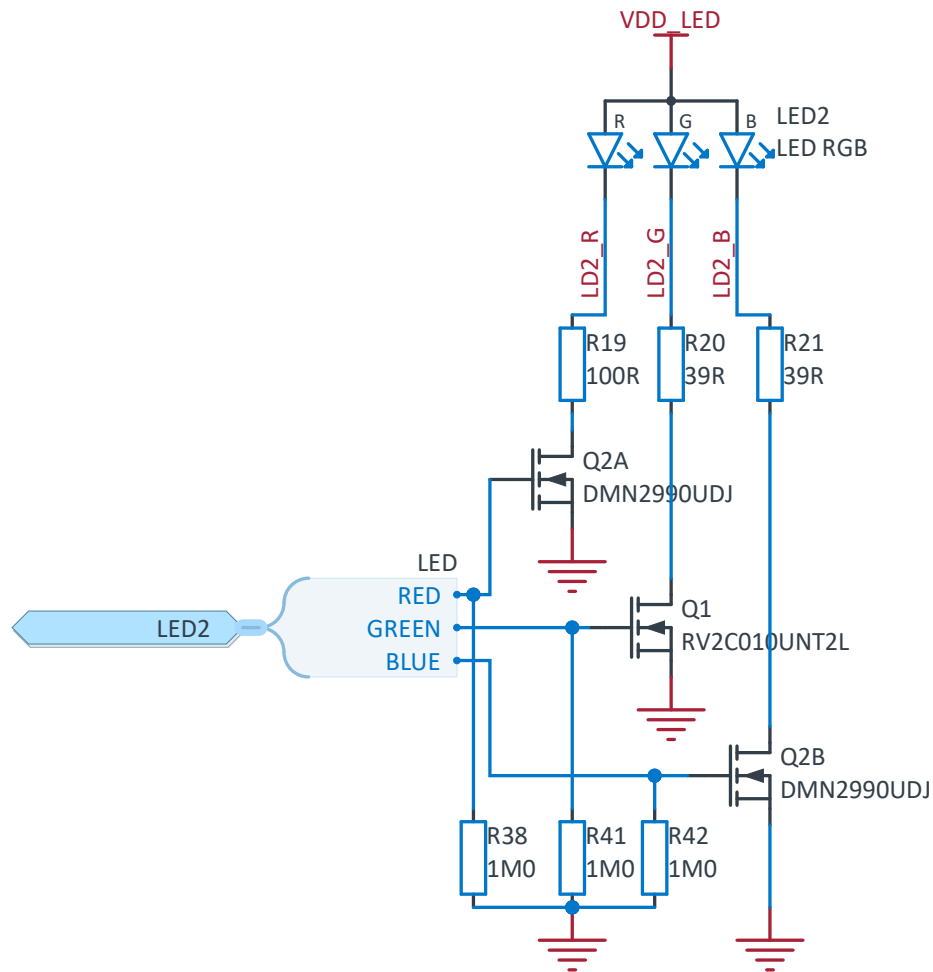


Figure 26: LED2

The following table describes the nRF5340 SoC GPIOs used to control LED2.

nRF5340 SoC GPIO	LED2 color
P0.14	Red
P0.26	Green
P0.15	Blue

Table 4: LED2

LED3 is connected to the nPM1300 PMIC (U11) LED driver pins and indicates charging and charging error.

The following table describes the nPM1300 PMIC GPIOs used to control the LED3 (Charge LED).

nPM1300 PMIC pin	LED3 color
LED0	Red
LED1	Green
LED2	Blue

Table 5: LED3

The following figure shows the locations of the LEDs.

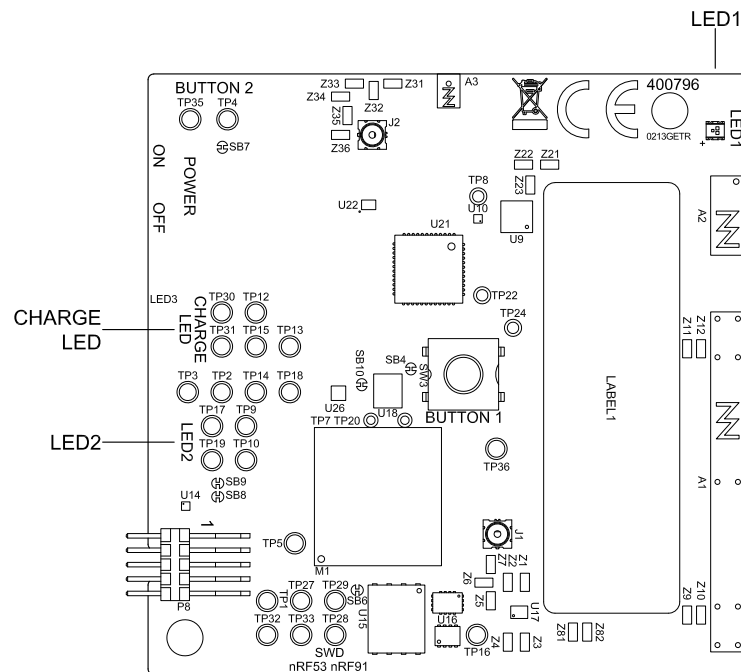


Figure 27: LEDs

## 3.13 Connection interfaces

This section describes the connection interfaces on Nordic Thingy:91 X™.

### 3.13.1 Battery connector

The Nordic Thingy:91 X™ has a three-pin battery connector (**J3**).

The following figure describes the battery connector.

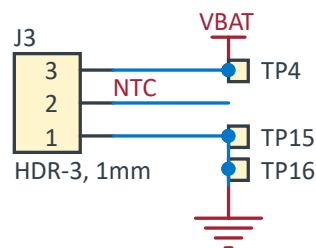


Figure 28: Battery connector

**Warning:** Do not connect batteries without an *Negative Temperature Coefficient (NTC)* wire to the Nordic Thingy:91 X™.

### 3.13.2 USB-C connector

The USB-C connector (**J6**) provides a USB connection to a host for power and serial communication.

The USB data signals D+/- are connected to the nRF5340 SoC (**U6**). The USB connector VBUS and CC signals are connected to the nPM1300 *PMIC* (**U11**) for USB port and power source capability detection.

The following figure describes the USB-C connector.

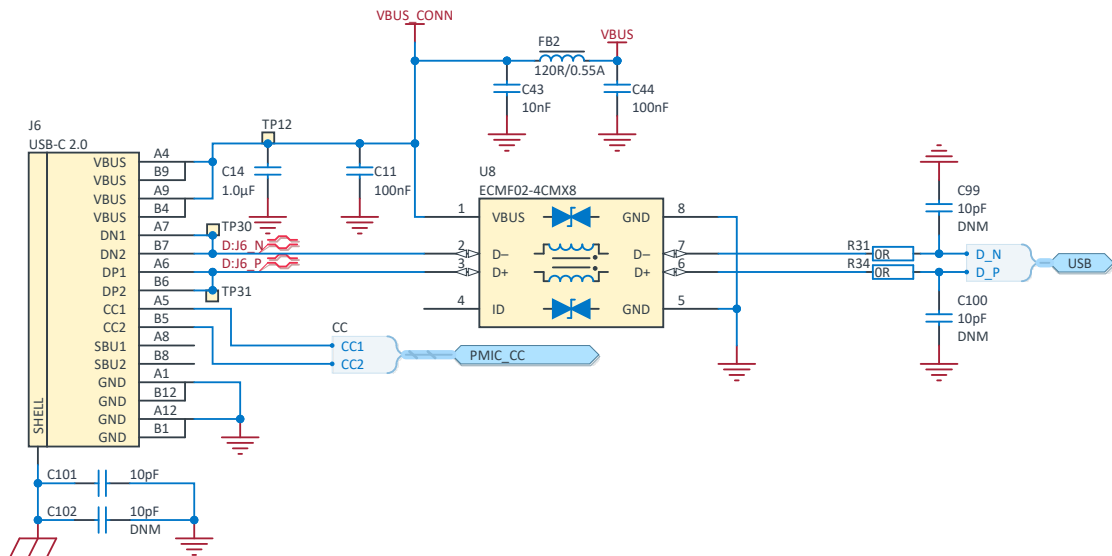


Figure 29: USB-C connector

### 3.13.3 Current measurement and debug board connector

The current measurement and debug board (PCA64165) can be inserted into the current measurement and debug board connector (**P9**) on the Nordic Thingy:91 X™.

The current measurement and debug board simplifies the measuring of current consumption on the power domains supplying the nRF9151 SiP (**M1**), nRF7002 Wi-Fi 6 companion IC (**U21**), and nRF5340 SoC (**U6**) with a power profiling tool, such as the Power Profiler Kit II.

The interface also allows trace debugging and connecting external circuits or boards to the Nordic Thingy:91 X™ by using the nRF9151 SiP's TRACE pins as regular GPIOs. The pins are configured as GPIOs by default.

The following figure describes the current measurement and debug board connector.

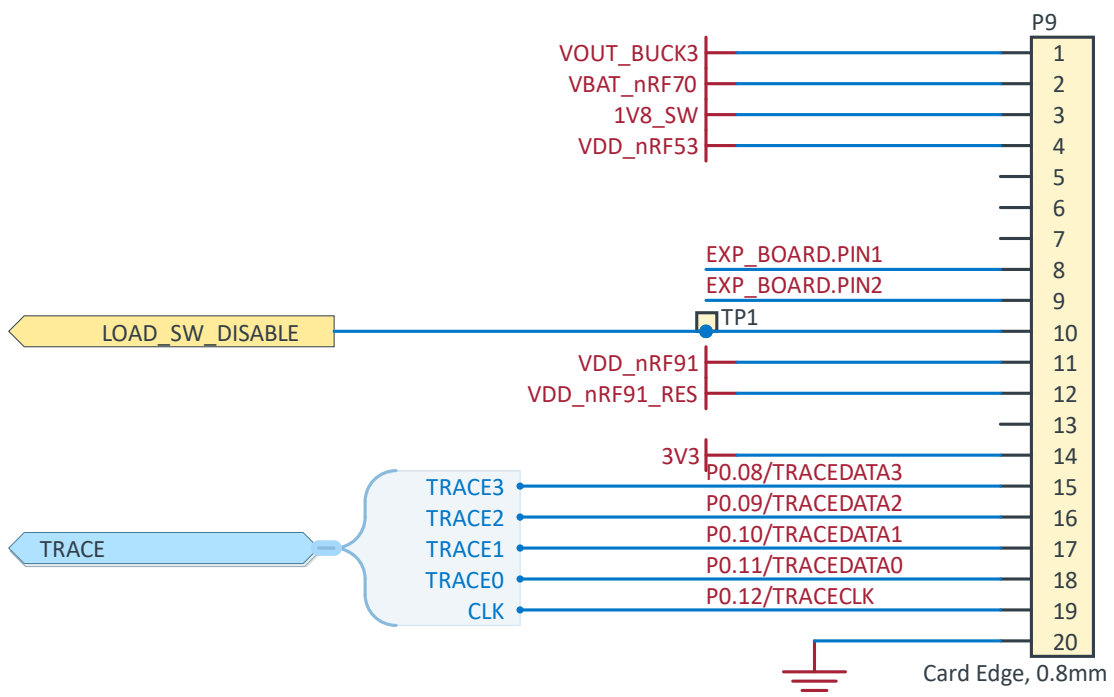


Figure 30: Current measurement and debug board connector

### 3.13.4 Expansion board connector

The expansion board connector (**P1**) is compatible with Qwiic and STEMMA QT and can be used to connect expansion boards.

The expansion board connector is compatible also with the STEMMA, Grove, and DFRobotGravity prototyping systems, but requires a cable to convert from a 1 mm pitch connector to a 2 mm pitch connector. Pins 3 and 4 on the expansion board connector are by default connected to the I2C bus but can be used as regular nRF9151 SiP (**M1**) GPIOs by cutting **SB8** and **SB9**.

Signals from the expansion board connector pass through a level shifter (**U24**) to match the 3.3 V logic level of external circuitry to the 1.8 V domain used by the Nordic Thingy:91 X™.

The following figure describes the expansion board connector.

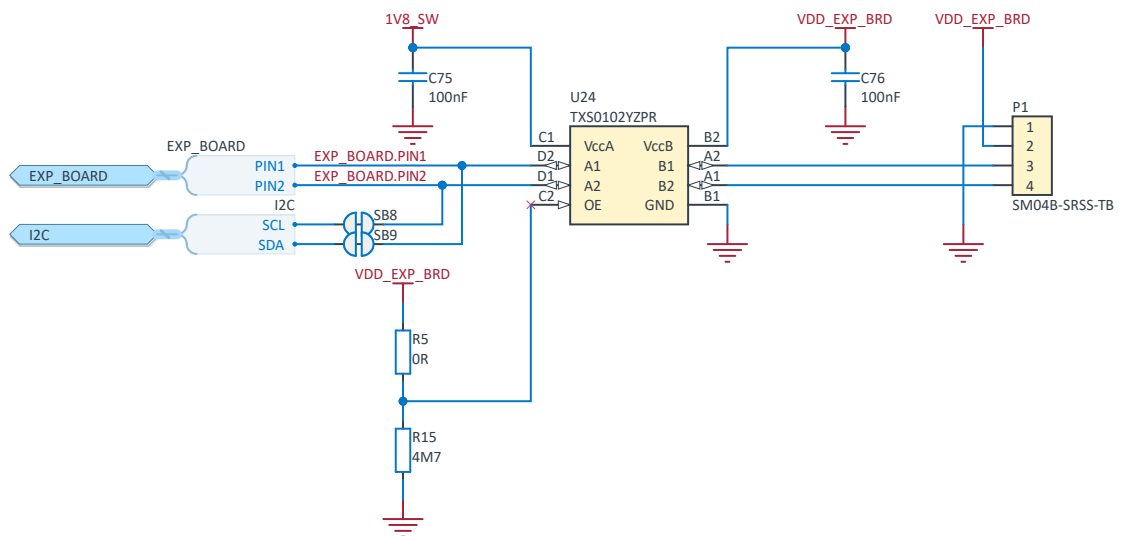


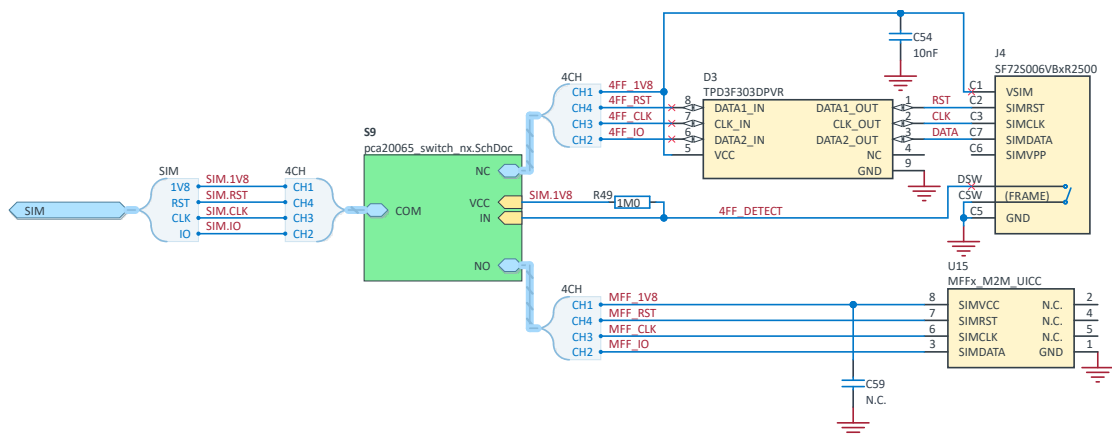
Figure 31: Expansion board connector

### 3.13.5 SIM card interface and connector

The Nordic Thingy:91 X™ supports a SIM card. It has a pluggable SIM card socket (**J4**) that is compatible with a nano-sized SIM (**4FF**). The Nordic Thingy:91 X™ has also an unpopulated eSIM footprint (**U15**) that can be populated with a compatible eSIM IC.

The following figure describes the SIM card interface and connector.

Figure 32: SIM card interface and connector



### 3.13.6 SWD interface connector

The Nordic Thingy:91 X™ has a programming and debugging interface connector (**P8**). The interface is available also on the current measurement and debug interface connector (**P9**).

The SWD select switch (**SW2**) is used to select the nRF9151 SiP (**M1**) or the nRF5340 SoC (**U6**) as the programming target. The SWD lines of the nRF9151 SiP are connected to GPIOs on the nRF5340 SoC even if **SW2** is set to nRF5340. This is to support using the nRF5340 SoC as an on-board debugger IC.

The following figure describes the SWD interface connector.

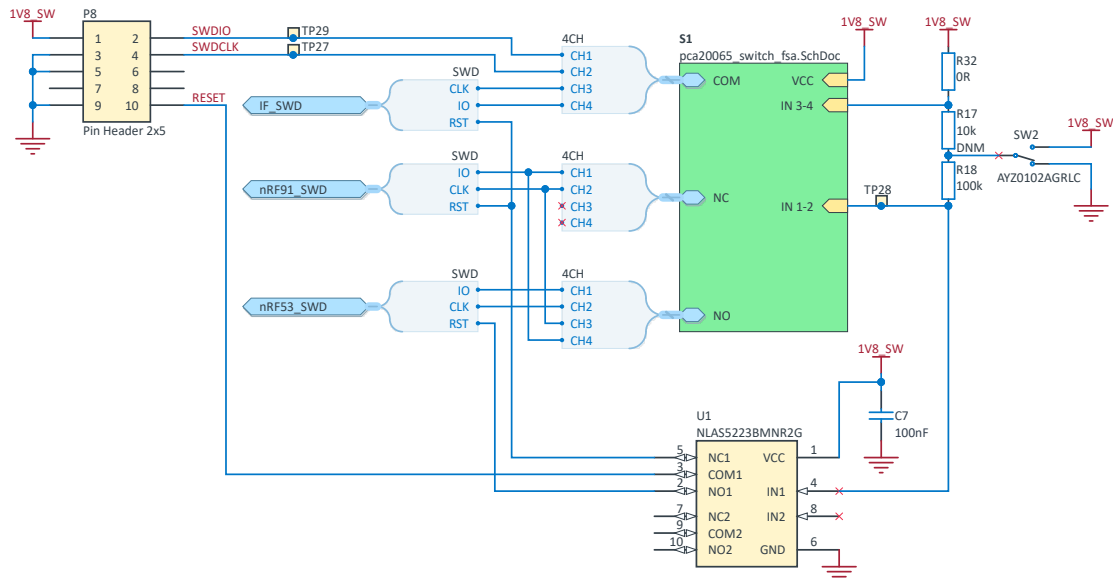


Figure 33: SWD interface connector

### 3.13.7 Solder bridges

Solder bridges can be used to enable and disable functionalities. Changes to the solder bridges are not needed for normal use of the Nordic Thingy:91 X™.

The following table describes the solder bridges and their functions.

Solder bridge	Location	Default	Function
SB1	Bottom	Open	Connect ID pin of RF Switch ( <b>U17</b> ) to VIO
SB2	Bottom	Open	Connect ID pin of RF Switch to Ground
SB4	Top	Closed	Disconnect VDD supply to IMU
SB5	Top	Closed	Disconnect VDD supply to environmental sensor
SB6	Top	Closed	Disconnect SWD reset signal from P0.20 on nRF5340 SoC
SB7	Top	Closed	Disconnect Button 2 from P0.24 on nRF5340 SoC
SB8	Top	Closed	Disconnect SCL from EXP.BOARD Pin 1
SB9	Top	Closed	Disconnect SDA from EXP.BOARD Pin 2
SB10	Top	Closed	Disconnect VDD supply to magnetometer

Table 6: Solder bridges on Nordic Thingy:91 X™

### 3.13.8 Test points

Test points can be used during development and debugging.

The following table describes the test points and their corresponding signals.

Test Point	Location	Signal	Description
TP1	Top	LOAD_SW_DISABLE	Load switch disable signal for the current measurement and debug board
TP2	Top	VDD_nRF5340	Supply to the nRF5340 SoC
TP3	Top	VDD_nRF91	Supply to the nRF9151 SiP
TP4	Top	VBAT	Battery voltage
TP5	Top	nRF5340 SWD reset	SWD reset signal to the nRF5340 SoC
TP7	Top	ASDA	Auxillary SDA for IMU
TP8	Top	VDD_RF_FE_3V3	VDD supply to GNSS LNA
TP9	Top	SCL	I <sup>2</sup> C bus SCL
TP10	Top	SDA	I <sup>2</sup> C bus SDA
TP11	Bottom	VDD_RF_FE_SR	VDD supply to Bluetooth/Wi-Fi RF front end
TP12	Top	VBUS	USB VBUS supply
TP13	Top	VBAT_nRF70	Supply to the nRF7002 Wi-Fi 6 companion IC
TP14	Top	VOUT_BUCK3	nPM6001 PMIC BUCK3 output
TP15	Top	Ground	Ground
TP16	Top	Ground	Ground
TP17	Top	VSYS_SW	nPM1300 PMIC VSYS output after power switch (SW1)
TP18	Top	1V8_SW	nPM1300 PMIC VOUT1 output after power switch (SW1)
TP19	Top	3V3	nPM1300 PMIC VOUT2 output
TP20	Top	ASCL	Auxiliary SCL for IMU
TP21	Bottom	RFFE VIO	VIO for RFFE MIPI interface
TP22	Top	COEX2	nRF9151 SiP COEX2
TP23	Bottom	COEX1	nRF9151 SiP COEX1
TP24	Top	COEX0	nRF9151 SiP COEX0
TP25	Bottom	ID	LTE/DECT NR+ RF switch ID pin
TP26	Bottom	RFFE SCLK	Serial clock for the RFFE MIPI interface
TP27	Top	SWDCLK	SWD clock
TP28	Top	IN 1-2	IN 1-2 input for the S1 switch
TP30	Top	D-	USB D-
TP31	Top	D+	USB D+
TP32	Top	EXP_BOARD_PIN2	Expansion board pin 2
TP33	Top	EXP_BOARD_PIN1	Expansion board pin 1
TP34	Bottom	RFFE SDATA	Serial data for the RFFE MIPI interface
TP35	Top	Button 2	User-controlled button, reset button for the nRF9151 SiP

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Test Point	Location	Signal	Description
TP36	Top	Button 1	User-controlled button

Table 7: Test points on Nordic Thingy:91 X™

# 4 RF measurements

The Nordic Thingy:91 X™ is equipped with two SWF RF connectors with an integrated switch (J1) for easy connection to laboratory equipment.

You can use a Murata adapter cable (part no. MXHS83QE3000) with a standard SMA connection on the other end for connecting instruments. The adapter is not included in the kit. The insertion loss in the adapter cable is approximately 0.5–1 dB.

# 5 Regulatory notices

The following regulatory notices apply to the Nordic Thingy:91 X™.

## 5.1 FCC regulatory notice

The Nordic Thingy:91 X™ contains an FCC certified nRF9151 SiP.

For information on the bands supported by the nRF9151 SiP and for FCC regulatory notices, see Regulatory information in the [nRF9151 Product Specification](#).

The Nordic Thingy:91 X™ is designed to allow the following.

- Product developers to evaluate electronic components, circuitry, or software associated with the Nordic Thingy:91 X™ to determine whether to incorporate such items in a finished product.
- Software developers to write software applications for use with the end product.

The Nordic Thingy:91 X™ is not a finished product and when assembled cannot be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this kit does not cause harmful interference to licensed radio stations and that this kit accept harmful interference. Unless the assembled kit is designed to operate under 47 CFR Part 15, 47 CFR Part 18, and 47 CFR Part 95, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under 47 CFR Part 5.

## 5.2 CE regulatory notice


The Nordic Thingy:91 X™ operates in the 698–960 MHz, 1710–2200 MHz, 2401–2495 MHz, and 5150–5895 MHz bands.

The following table shows the maximum radio frequency power transmitted (*Effective Isotropic Radiated Power (EIRP)*) in the bands.

Band	Frequency	EIRP
Bluetooth Low Energy IEEE 802.15.4 Proprietary 2.4 GHz	2402–2480 MHz	4 dBm
Wi-Fi 6	2401–2495 MHz	19.3 dBm
	5150–5835 MHz	14.5 dBm
LTE B1, B65	1920–2010 MHz	24.1 dBm
LTE B3	1710–1875 MHz	24.1 dBm
LTE B8, B20, B28	703–915 MHz	21.7 dBm
DECT NR+ B1	1880–1900 MHz	21.4 dBm

Table 8: EIRP of bands

The device is restricted to indoor use only when operating in the 5150 MHz to 5350 MHz frequency range. This equipment may be operated in the following countries.

	AT	BE	BG	CH	CZ	DK	EE	FI	FR	DE	HR	IS	IE	IT	EL	ES	CY
	LV	LI	LT	LU	HU	MT	NL	NO	PL	PT	RO	SI	SK	TR	SE	UK(NI)	UA

### 5.3 EN IEC 62311:2020 and IEC 62479:2021

The Nordic Thingy:91 X™ complies with the EN IEC 62311:2020 and IEC 62479:2021 standards when the minimum distance between the antennas and the user is 20 cm or more. Operation in closer proximity to the user, for example, in hand, is allowed as long as the operation is limited to 60 s/6 min period.

### 5.4 REACH SVHC statement

To the present and best of our knowledge, and based upon information available to us from our suppliers, the components used in the Nordic Thingy:91 X™ do not contain substances of very high concern (SVHC), as identified in the ECHA Candidate list, above a limit of 0.1% w/w.

# Glossary

## **Cat-M1**

LTE-M User Equipment (UE) category with a single RX antenna, specified in 3GPP Release 13.

## **Cat-NB1**

NB-IoT User Equipment (UE) category with 200 kHz UE bandwidth and a single RX antenna, specified in 3GPP Release 13.

## **Cat-NB2**

An upgraded version of Cat-NB1, specified in 3GPP Release 14.

## **DECT NR+**

A non-cellular radio standard included as part of the 5G standards by the ITU.

## **Effective Isotropic Radiated Power (EIRP)**

The maximum amount of power that could be radiated from an antenna, given its antenna gain and the transmitter power of the RF system.

## **Electrostatic Discharge (ESD)**

A sudden discharge of electric current between two electrically charged objects.

## **Embedded SIM (eSIM)**

A form of programmable *Subscriber Identity Module (SIM)* that is embedded directly into a device.

## **Extended Discontinuous Reception (eDRX)**

A method to conserve the battery of an IoT (Internet of Things) device by allowing it to remain inactive for extended periods.

## **General-Purpose Input/Output (GPIO)**

A digital signal pin that can be used as input, output, or both. It is uncommitted and can be controlled by the user at runtime.

## **Global Navigation Satellite System (GNSS)**

A satellite navigation system with global coverage. The system provides signals from space transmitting positioning and timing data to GNSS receivers, which use this data to determine location.

## **Integrated Circuit (IC)**

A semiconductor chip consisting of fabricated transistors, resistors, and capacitors.

## **Inter-integrated Circuit (I<sup>2</sup>C)**

A multi-master, multi-slave, packet-switched, single-ended, serial computer bus.

## **Lithium-polymer (Li-Poly)**

A rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid electrolyte.

**Long-Term Evolution (LTE)**

A wireless broadband communication standard for mobile devices and data terminals, based on the GSM/EDGE and UMTS/HSPA technologies.

**Low-Dropout Regulator (LDO)**

A linear voltage regulator that can operate even when the supply voltage is very close to the desired output voltage.

**Low-Noise Amplifier (LNA)**

In a radio receiving system, an electronic amplifier that amplifies a very low-power signal without significantly degrading its signal-to-noise ratio.

**LTE-M**

An open standard that is most suitable for medium throughput applications requiring low power, low latency, and/or mobility, like asset tracking, wearables, medical, POS, and home security applications. Also known as Cat-M1.

**Microwave coaxial connector with switch (SWF)**

A small, RF surface-mount switch connector series for wireless applications.

**MIPI RF Front-End Control Interface (RFFE)**

A dedicated control interface for the RF front-end subsystem. [MIPI Alliance](#)

**Narrowband Internet of Things (NB-IoT)**

A narrowband technology standard with longer range, lower throughput, and better penetration in, for example, cellars and parking garages compared to LTE-M. NB-IoT is most suitable for static, low throughput applications like smart metering, smart agriculture, and smart city applications. Also known as Cat-NB1 or Cat-NB2.

**Negative Temperature Coefficient (NTC)**

A negative temperature coefficient refers to materials where there is a decrease in electrical resistance when their temperature is raised.

**Power Management Integrated Circuit (PMIC)**

A chip used for various functions related to power management.

**Power Saving Mode (PSM)**

A feature introduced in 3GPP Release 12 to improve battery life of IoT (Internet of Things) devices by minimizing energy consumption. The device stays dormant during the PSM window.

**Pulse Density Modulation (PDM)**

A form of modulation used to represent an analog signal with a binary signal where the relative density of the pulses corresponds to the analog signal's amplitude.

**Pulse Width Modulation (PWM)**

A form of modulation used to represent an analog signal with a binary signal where the switching frequency is fixed, and all the pulses corresponding to one sample are contiguous in the digital signal.

**Serial Peripheral Interface (SPI)**

Synchronous serial communication interface specification used for short-distance communication.

**Single-Input Single-Output (SISO)**

The use of only one antenna for transmission and reception.

**Subscriber Identity Module (SIM)**

A card used in User Equipment (UE) containing data for subscriber identification.

**System in Package (SiP)**

Several integrated circuits, often from different technologies, enclosed in a single module that performs as a system or subsystem.

**System on Chip (SoC)**

A microchip that integrates all the necessary electronic circuits and components of a computer or other electronic systems on a single integrated circuit.

**Two-wire Interface (TWI)**

An I<sup>2</sup>C compatible serial communication protocol that enables devices to exchange data by using a two-wire bus system, allowing multiple devices to be connected and controlled by a master device.

**Universal Asynchronous Receiver/Transmitter (UART)**

A hardware device for asynchronous serial communication between devices.

**Universal Integrated Circuit Card (UICC)**

A new generation Subscriber Identity Module (SIM) used in User Equipment (UE) for ensuring the integrity and security of personal data.

**Universal Serial Bus (USB)**

An industry standard that establishes specifications for cables and connectors and protocols for connection, communication, and power supply between computers, peripheral devices, and other computers.

# Recommended reading

In addition to the information in this document, you may need to consult other Nordic documents.

- [nRF9151 product page](#)
- [nRF9151 Product Specification](#)
- [nRF9151 Errata](#)
- [nRF7002 product page](#)
- [nRF7002 Product Specification](#)
- [nRF7002 Errata](#)
- [nRF5340 product page](#)
- [nRF5340 Product Specification](#)
- [nRF5340 Errata](#)
- [nPM1300 product page](#)
- [nPM1300 Product Specification](#)
- [nPM1300 Errata](#)
- [nPM6001 product page](#)
- [nPM6001 Product Specification](#)
- [nRF Connect SDK](#)

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