

nRF9151 SMA DK Hardware

v1.1.0

User Guide

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Revision history

Date	Description
December 2025	First release

Environmental and safety notices

Environmental and safety notices for the DK and power supply requirements.

Note: The nRF9151 SMA DK must be powered by a PS1 class (IEC 62368-1) power supply with maximum power less than 15 W.

Skilled persons

The nRF9151 SMA DK 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 nRF9151 SMA DK 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.

1 Introduction

The nRF9151 SMA DK is a hardware development platform used to design and develop application firmware on the nRF9151 *System in Package (SiP)*. The nRF9151 SiP supports *Long-Term Evolution (LTE)*, *Non-Terrestrial Network (NTN)*, *DECT NR+*, and *Global Navigation Satellite System (GNSS)* depending on the installed network protocol firmware.

The nRF9151 SMA DK is fitted with SMA connectors to facilitate evaluation and performance tests in a laboratory and the use of external antennas. The firmware development and debug and trace features on the nRF9151 SMA DK are identical to the ones on the [nRF9151 DK](#), which also has onboard antennas to facilitate application and firmware focused work.

To get started with the nRF9151 SMA DK, install [nRF Connect for Desktop](#) and from there install the Quick Start app.

Key features

- nRF9151 SiP
 - 3GPP LTE release 14 LTE-M
 - 3GPP LTE release 14 NB-IoT
 - 3GPP NTN release 17 NTN NB
 - DECT NR+ v1.5.1
- SMA connectors for test equipment or external antennas
- Buttons and LEDs for user interaction
- I/O interface for Arduino form factor plug-in modules
- SEGGER J-Link OB Debugger with debug out functionality
- *Universal Asynchronous Receiver/Transmitter (UART)* interfaces through virtual serial ports
- USB connection for debugging and programming and power
- SIM card socket for nano-SIM (4FF SIM)
- Interfaces for nRF9151 current consumption measurements
- External SMA-connected LTE antenna
- External SMA-connected GNSS antenna
- SIM cards

2 Kit content

The nRF9151 SMA DK includes hardware, preprogrammed firmware, an LTE antenna, a GNSS antenna, SIM cards, documentation, hardware schematics, and layout files.

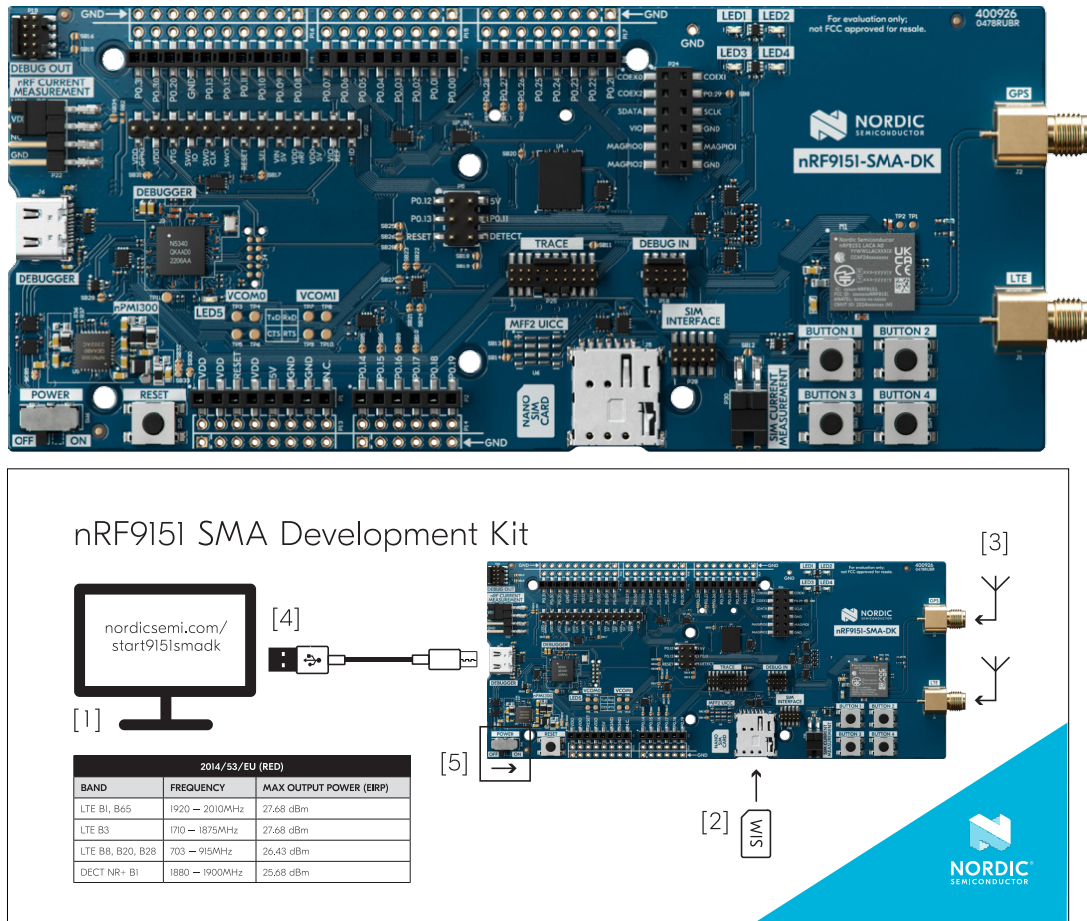


Figure 1: nRF9151 SMA DK kit content

Hardware files

The hardware design files for the nRF9151 SMA DK are available on the [nRF9151 SMA DK](#) product page. They include the following resources:

- Schematics
- PCB layout files
- Bill of materials
- Gerber files

3 Operating modes

The nRF9151 SMA DK can be configured in different ways with nRF Connect for Desktop's Board Configurator application. By default, the nRF9151 SMA DK is configured in firmware development mode. For more information, see [Board Configurator app](#).

3.1 Firmware development mode

The primary interface for programming and debugging the nRF9151 SMA DK is the USB port (J6). The USB port is connected to an interface MCU which embeds a [SEGGER J-Link-OB](#) (Onboard) debug probe.

The following figure shows the USB connector and interface MCU for the debugger/programmer and board controller.

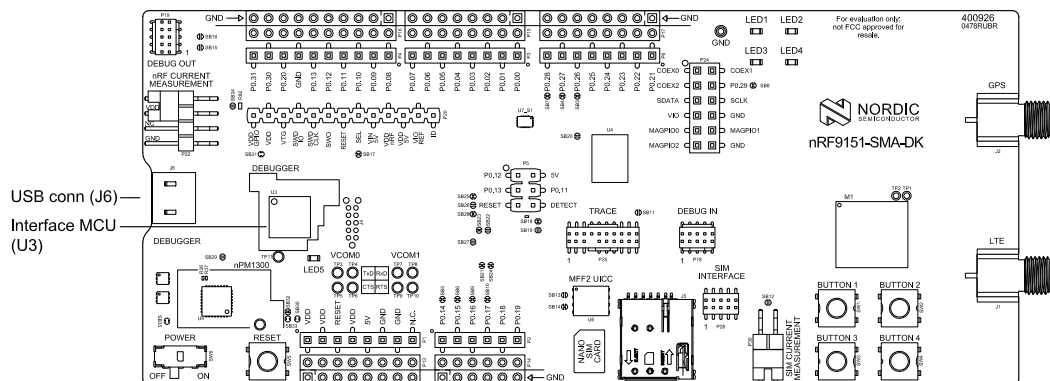


Figure 2: USB connector and interface MCU for the debugger/programmer and board controller

3.1.1 Device programming

The nRF9151 SMA DK supports *Serial Wire Debug (SWD)* programming interfaces for onboard and off-board nRF targets.

The primary target for programming and debugging in the *Development Kit (DK)* is the nRF9151 *SiP*. The interface MCU also supports programming external nRF devices fitted on a shield or through a connector to external boards such as the user's own prototypes.

The interface MCU automatically detects connected external targets.

3.1.2 Virtual serial port

The interface MCU features *UART* interfaces through two virtual serial ports.

The virtual serial ports are the following:

- VCOM0 – Connected to the nRF9151 *SiP* UART1
- VCOM1 – Connected to the nRF9151 *SiP* UART2

The virtual serial ports have the following features:

- Flexible baud rate settings up to 1 Mbps
- *Request to Send (RTS)/Clear to Send (CTS)*-style *Hardware Flow Control (HWFC)*

Note: Baud rate 921600 is not supported through the virtual serial port.

Note: The J-Link OB UART (VCOM) supports only 8 data bits, no parity, and 1 stop bit (8N1). Parity and stop-bit configuration set in the host terminal are not forwarded to the target UART.

3.1.3 Reset

The nRF9151 SMA DK is equipped with a RESET button (**SW5**).

By default, the RESET button is connected to the interface MCU and an analog switch *Integrated Circuit (IC)*. The RESET signal is forwarded from the interface MCU to the nRF9151 SiP or any device connected to the external debugging and programming connectors.

3.2 Performance measurement mode

The nRF9151 SMA DK has flexible configuration options for performance testing and operation analysis.

The interface MCU is enabled as a combined programmer/debugger and board controller. The following features are controlled by the board controller:

- Switches between the interface MCU and the nRF9151 SiP for VCOM0, VCOM0 flow control, VCOM1, VCOM1 flow control, and SWD control
- Switches for selecting whether the nRF9151 SiP GPIOs are connected to the LEDs and buttons or to the Arduino pin headers

The board controller features are controlled with the Board Configurator application.

When the nRF9151 SiP's current consumption is measured on low-power applications, the accuracy of the measurements can be increased by disconnecting the nRF9151 SiP from the interface MCU. This can be done by disabling the following signals with the Board Configurator application:

- VCOM0_CTRL
- VCOM1_CTRL
- VCOM0_HWFC
- VCOM1_HWFC
- SWD_CTRL
- TGT_TWI_CTRL

Normally, the reset button is routed through the interface MCU, but when the SWD_CTRL signal is disabled, the reset button is also routed directly to the nRF9151 SiP.

4 Hardware description

The nRF9151 SMA DK features an onboard programming and debugging solution.

4.1 Hardware drawings

The nRF9151 SMA DK hardware drawings show both sides of the DK.

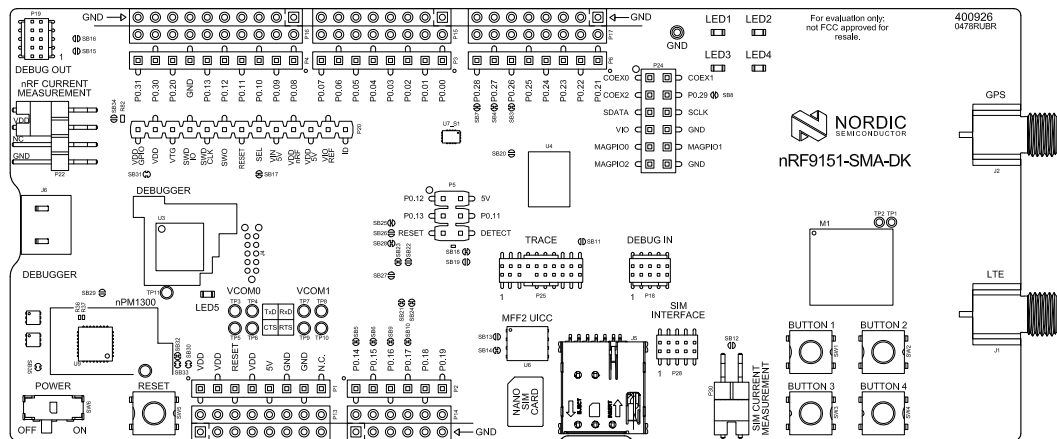


Figure 3: nRF9151 SMA DK, front view

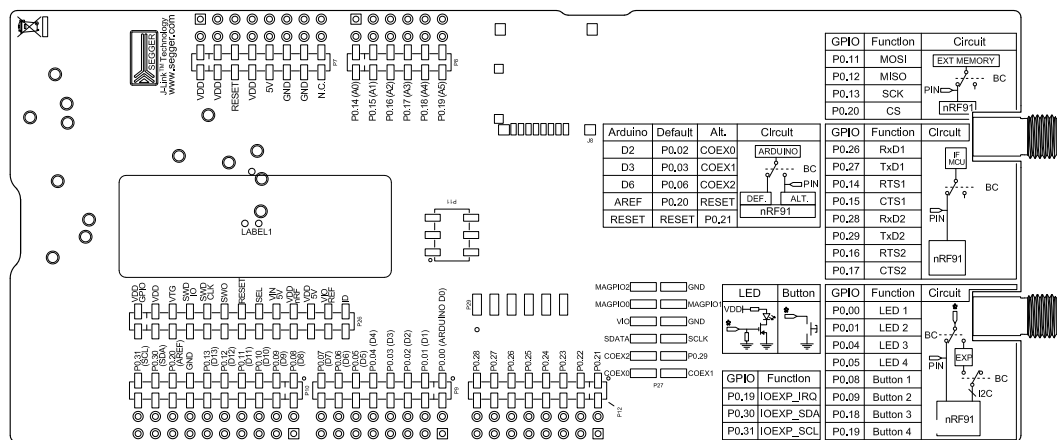


Figure 4: nRF9151 SMA DK, back view

4.2 Block diagram

The block diagram illustrates the functional architecture of the nRF9151 SMA DK.

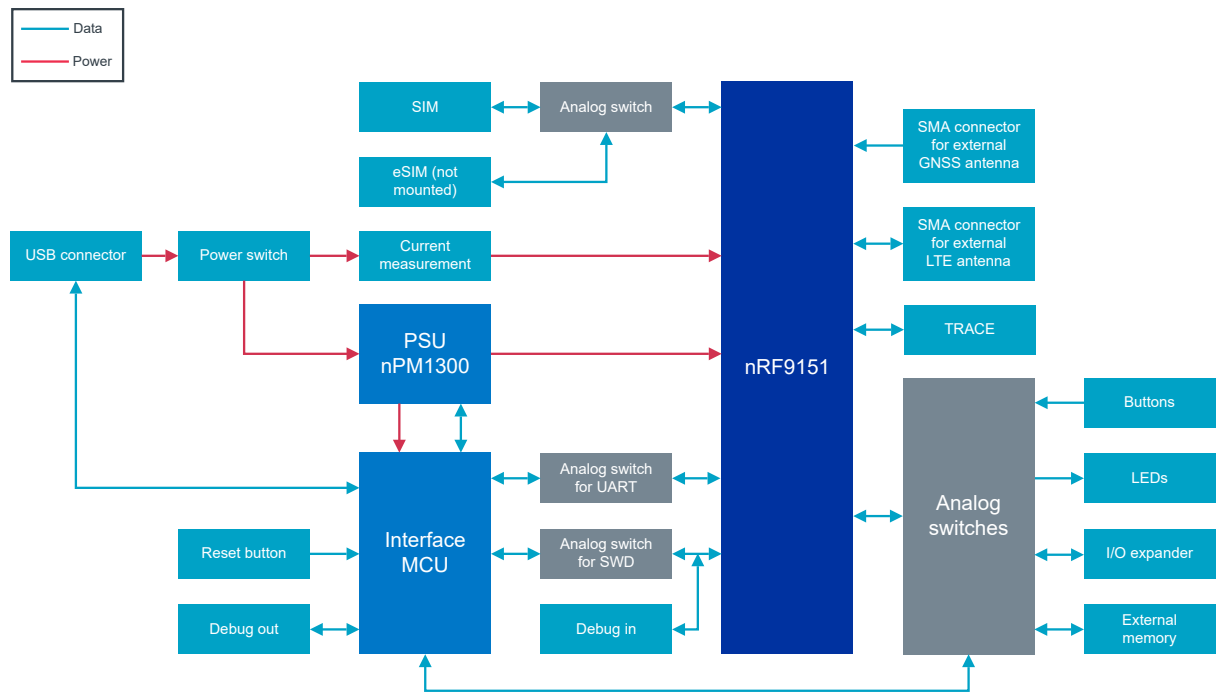


Figure 5: nRF9151 SMA DK block diagram

4.3 Power supply

The DK has a flexible and configurable power supply system to allow software development and testing using different power sources and to facilitate accurate power consumption measurements.

The nRF9151 SMA DK is powered by either of the following sources:

- USB connector **J6** (5 V)
- External supply on pin **VIN 5V** of connector **P20**

The DK is primarily powered by 5 V from the USB connector **J6**. Alternatively, the DK can be powered by the **VIN 5V** pin located on the **P20** header. Both sources support voltages in the range of 4.0 V to 5.5 V with a nominal voltage of 5 V. The DK must be powered by only one source at a time.

Note: By default, a jumper is placed between the **VDD_5V** and **VDD_nRF** pins on connector **P22**. This ensures power supply to the nRF9151 SiP.

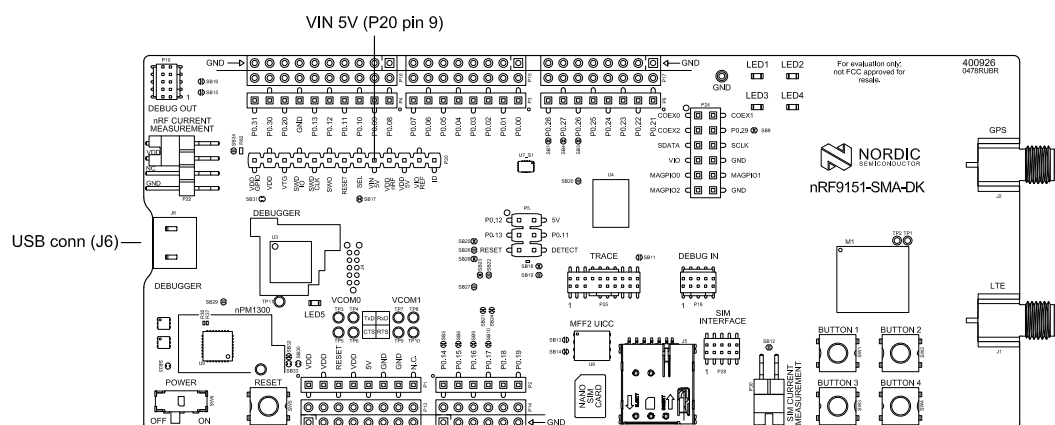


Figure 6: Power supply options

By default, the nRF9151 SiP is supplied from USB through a jumper. To supply other power domains on the board, nPM1300 IC is used. The output voltage of the nPM1300 can be controlled through the board controller. The startup voltage for BUCK1 can be set with resistor R36 and for BUCK 2 with resistor R37.

For more information, see [Board control](#) on page 14 and [Output voltage selection](#) in nPM1300 Product Specification.

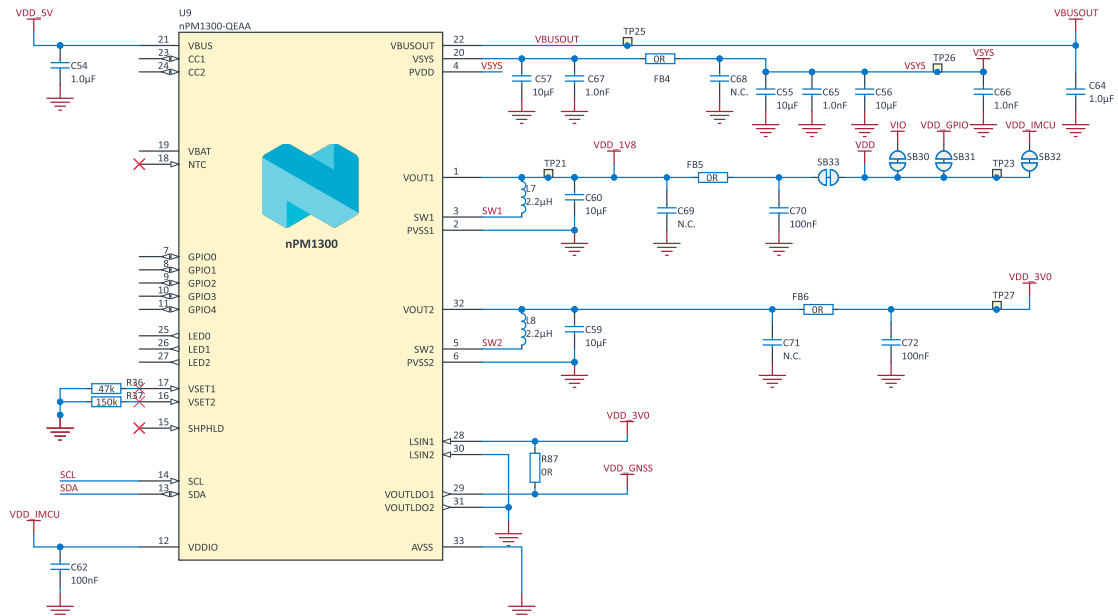


Figure 7: Power management solution

4.3.1 nRF9151 SiP supply rail

The nRF9151 SiP has a supply range of 3.0 V to 5.5 V and is directly powered by the VDD_nRF supply rail.

Powering through VDD_nRF supplies only the nRF9151 SiP.

Feeding VDD_nRF from an external, clean power supply is recommended during RF evaluation, characterization, and production testing as it might improve RF performance. This is because USB power is often affected by noise and transient fluctuations that might degrade RF characteristics, such as phase noise, spurious emissions, and receiver sensitivity. When an external supply is used, ensure that the voltage and current requirements are met within the limits specified for the nRF9151 SiP to avoid potential damage or unstable operation.

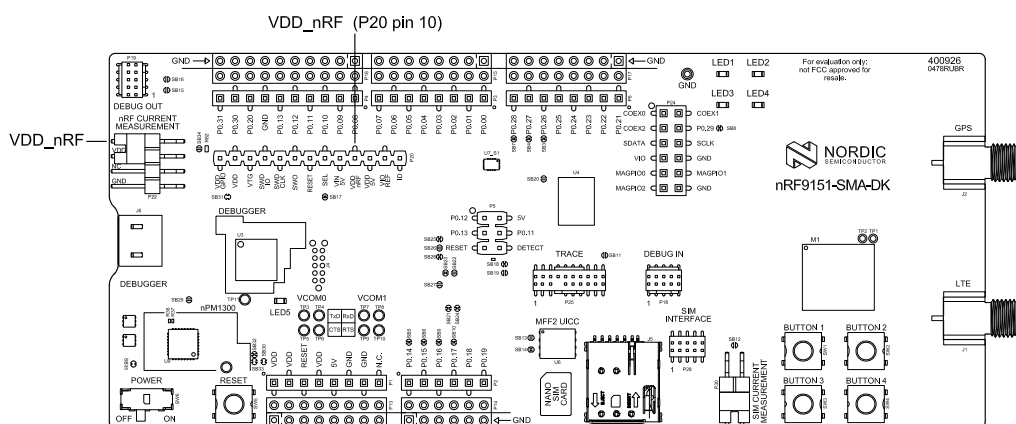


Figure 8: VDD_nRF

For more information, see [Current measurement](#) on page 29.

4.4 Antenna interfaces

The nRF9151 SMA DK has antenna interfaces for connecting external antennas for *LTE* and *GNSS*. *DECT NR+* and *NTN* use the same antenna connector as *LTE*.

The nRF9151 SMA DK has the following antenna interface connectors:

- **J1** – Connector for *LTE*, *DECT NR+*, and *NTN* operation
- **J2** – Connector for an external *GNSS* antenna

External antennas that support the frequency of the desired operating bands must be connected. The nRF9151 SMA DK does not transmit or receive RF signals without external antennas connected.

For more information on the *GNSS* antenna interface, see [GNSS](#) on page 13.

4.5 GNSS

The nRF9151 SMA DK has a dedicated *GNSS* port to support global navigation. *GNSS* functionality requires support in the onboard network protocol firmware.

The external *GNSS* antenna must support the frequencies of the selected *GNSS* navigation system.

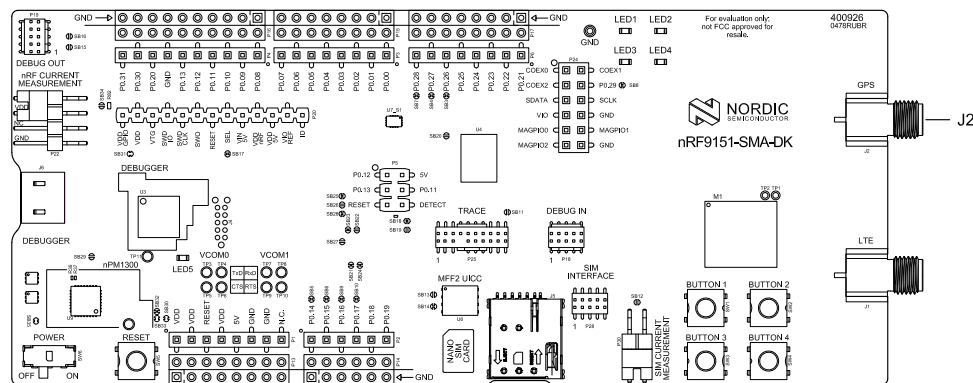


Figure 9: Connector J2

The SMA connector **J2** is by default supplied with 3 V DC for potentially powering an external LNA connected to the SMA connector. The DC voltage can be disconnected by removing the **L3** inductor. The voltage supplied to the SMA connector is supplied from the onboard nPM1300 *Power Management Integrated Circuit (PMIC)*. The voltage level can be changed by reprogramming the nPM1300.

GNSS signals do not usually penetrate ceilings or other structures that well. For best *GNSS* performance, the *GNSS* antenna should be placed in an open space far from sources of interference and other structures that can block the satellite signals.

The following figure shows the nRF9151 SMA DK's *GNSS* circuitry.

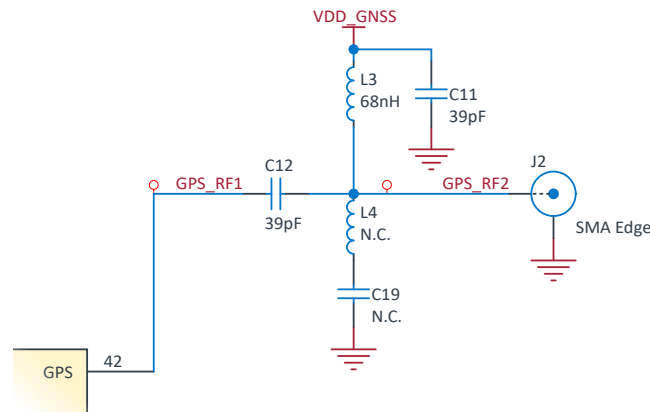


Figure 10: GNSS RF circuitry on the DK

4.6 GPIO interfaces

Access to the nRF9151 *General-Purpose Input/Output (GPIO)*s is available from connectors **P2**, **P3**, **P4**, **P6**, and **P24**. The nRF9151 SMA DK supports the Arduino UNO interface.

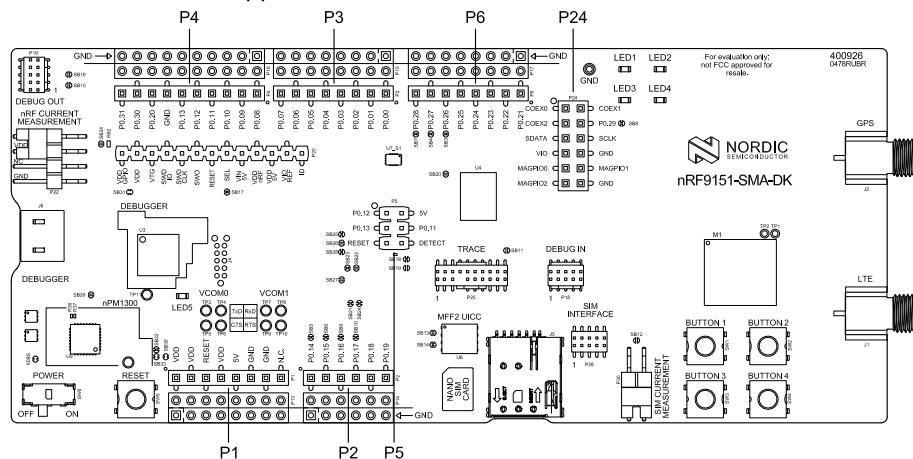


Figure 11: Access to GPIOs

GPIO signals are also available on connectors **P8**, **P9**, **P10**, **P12**, and **P27** which are on the back of the DK. By mounting pin headers on the connector footprints, the nRF9151 SMA DK can be used as a shield for Arduino motherboards.

For easy access to GPIO, power, and ground, the signals can also be found on the through-hole connectors **P14**, **P15**, **P16**, and **P17**.

4.7 Board control

The interface MCU contains a board controller that controls the signals which enable and disable features on the nRF9151 SMA DK.

All features on the nRF9151 SMA DK have a default setting that is applied at the first boot. The configuration of the board controller can be changed through nRF Connect for Desktop's Board Configurator application. For more information, see [Board Configurator app](#).

The configurable features and their default states are shown in the following table.

Feature	Configuration	State	Default state	IMCU pin	Description
VCOM0	True	Disconnected	Connected	P1 . 10	Connect or disconnect the pins for the virtual COM port. When disconnected, the UART0 <i>GPIO</i> pins can be used for other purposes.
	False	Connected			
VCOM0 HWFC	True	Disconnected	Connected	P0 . 20	Connect or disconnect the <i>HWFC</i> pins for the virtual COM port. When disconnected, the HWFC <i>GPIO</i> pins for the target chip can be used for other purposes. When connected, an auto-detect feature is used to determine whether HWFC is enabled on the target chip.
	False	Connected			
VCOM1	True	Disconnected	Connected	P0 . 22	Connect or disconnect the pins for the virtual COM port. When disconnected, the UART1 <i>GPIO</i> pins can be used for other purposes.
	False	Connected			
VCOM1 HWFC	True	Disconnected	Connected	P0 . 23	Connect or disconnect the HWFC pins for the virtual COM port. When disconnected, the HWFC <i>GPIO</i> pins for the target chip can be used for other purposes. When connected, an auto-detect feature is used to determine whether HWFC is enabled on the target chip.
	False	Connected			
SWD control	True	Disabled	Enabled	P0 . 06	Enable or disable the <i>SWD</i> connection between the IMCU and target chip. This allows the use of an external debugger.
	False	Enabled			
Shield reset in	True	Enabled	Disabled	P0 . 07	Enable or disable the reset line coming from a connected DK shield.
	False	Disabled			
Shield reset out	True	Enabled	Disabled	P0 . 08	Enable or disable the reset line going to a connected DK shield.
	False	Disabled			
SIM select	True	SIM card	SIM card	P0 . 14	Select whether SIM card or eSIM is used.
	False	E-sim			
Modem coexistence interface	True	Disabled	Disabled	P0 . 18	Enable or disable the <i>GPIO</i> pin connection to the coexistence interface. This
	False	Enabled			

Feature	Configuration	State	Default state	IMCU pin	Description
					allows the GPIO pins to be used for other use cases.
I/O expander	True	Enabled	Disabled	P1 . 13	Enable or disable the I/O expander module that can control the LEDs and buttons on the DK using an other interface than the GPIOs if the pins are needed for other use cases.
	False	Disabled			
External memory	True	Disabled	Enabled	P1 . 15	Enable or disable the external memory chip.
	False	Enabled			

Table 1: Configurable features on the nRF9151 SMA DK

4.8 Buttons and LEDs

The nRF9151 SMA DK has four LEDs and four buttons for user interaction. By default, they are connected to the nRF9151 *GPIOs* as shown in the following table.

Part	GPIO
LED 1	P0.00
LED 2	P0.01
LED 3	P0.04
LED 4	P0.05
Button 1	P0.08
Button 2	P0.09
Button 3	P0.18/AIN5
Button 4	P0.19/AIN6

Table 2: Button and LED connection

To change default nRF9151 GPIO connections, see [Board control](#) on page 14.

Any LED or button can optionally be routed to an I/O expander. For more information, see [I/O expander](#) on page 17.

The buttons are active low, meaning that the input is connected to ground when the buttons are pushed. They have no external pull-up resistor, and therefore the P0 . 08, P0 . 09, P0 . 18, and P0 . 19 pins must be configured as an input with an internal pull-up resistor.

The LEDs are active high, meaning that writing a logical one (1) to the output pin illuminates the LED. The nRF9151 GPIOs control power transistors, and the LEDs are fed from a separate 3.0 V domain. Therefore, LED current is not drawn from nRF9151 GPIOs or the nRF9151 supply.

The following figure shows the buttons.

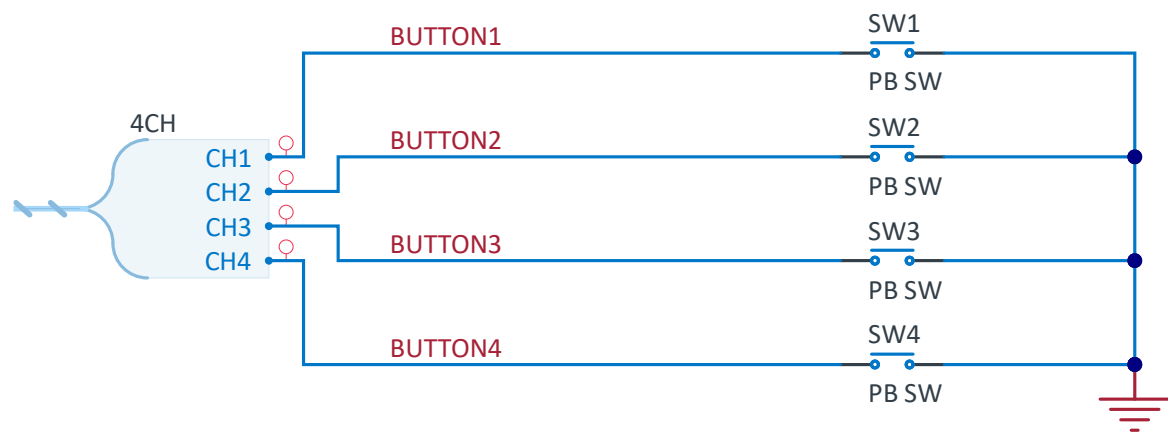


Figure 12: Buttons

The following figure shows the LEDs.

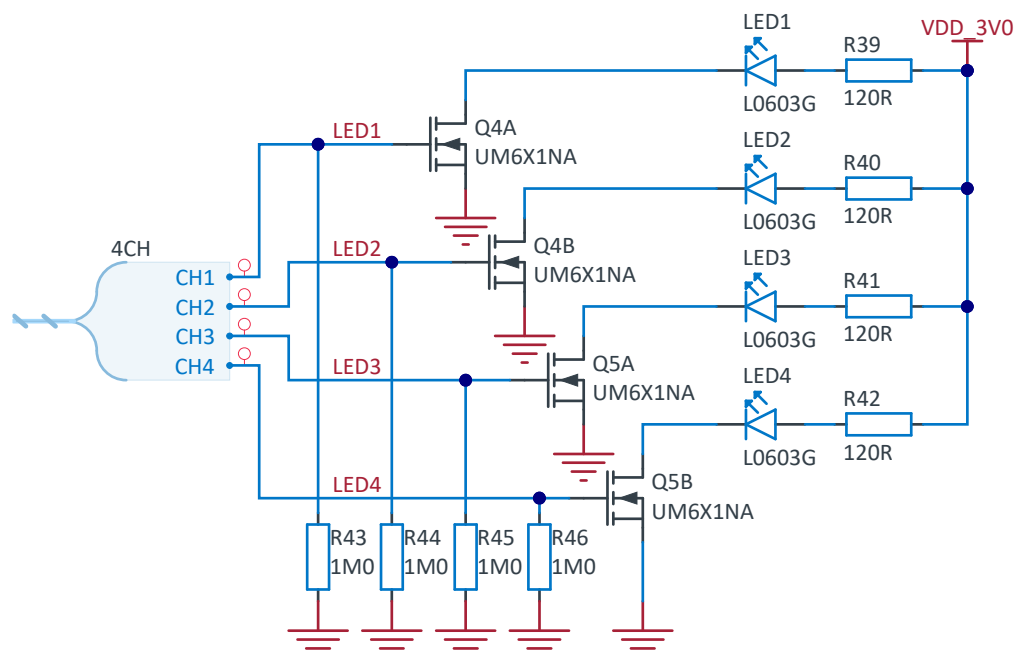


Figure 13: LEDs

4.8.1 I/O expander

The nRF9151 SMA DK has an I/O expander that can optionally be used to interface the LEDs and buttons.

Signal	GPIO	Description
SDA	P0.30	I2C data line
SCL	P0.31	I2C clock line
IOEXP_IRQ	P0.19	Interrupt line from the I/O expander

Table 3: I/O expander interface

The following table shows the I/O expander connections.

Component	I/O expander pin
LED 1	I/O_EXP_IO4
LED 2	I/O_EXP_IO5
LED 3	I/O_EXP_IO6
LED 4	I/O_EXP_IO7
Button 1	I/O_EXP_IO0
Button 2	I/O_EXP_IO1
Button 3	I/O_EXP_IO2
Button 4	I/O_EXP_IO3

Table 4: I/O expander connections

The following figure shows the I/O expander connections.

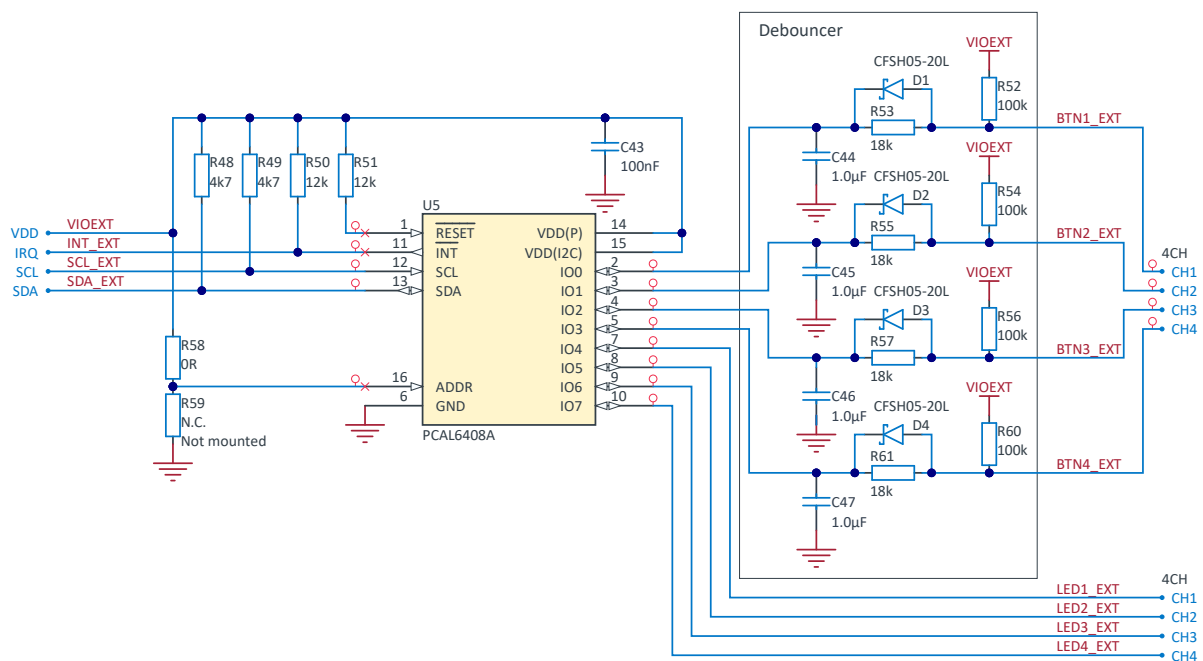


Figure 14: I/O expander

4.9 External memory

The nRF9151 SMA DK has a 256 Mb (32 MB) external flash memory.

The memory is connected to the IC using the following GPIOs.

GPIO	Flash memory pin
P0.20	CS
P0.13	SCLK
P0.11	MOSI
P0.12	MISO

Table 5: Flash memory GPIO usage

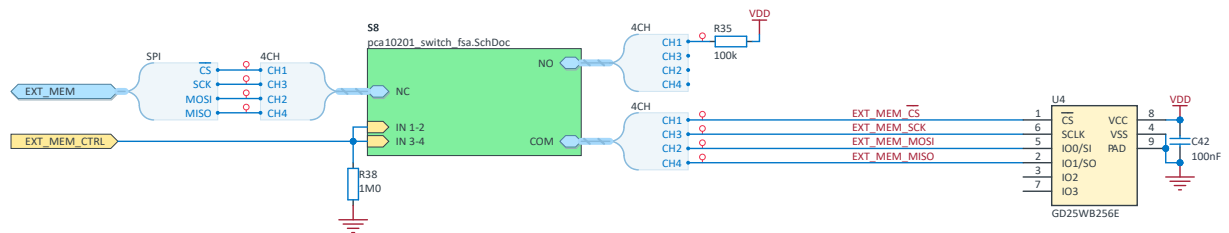


Figure 15: Flash memory

4.10 Debug input and trace options

The primary debug interface on the nRF9151 SMA DK is the Segger OB debugger available through the USB port. If a power supply other than USB is used on the nRF9151 SMA DK, this functionality is disabled.

The Debug in connector **P18** makes it possible to connect external debuggers for debugging when the interface USB cable is not connected or if the DK is in IF MCU DISCONNECT mode.

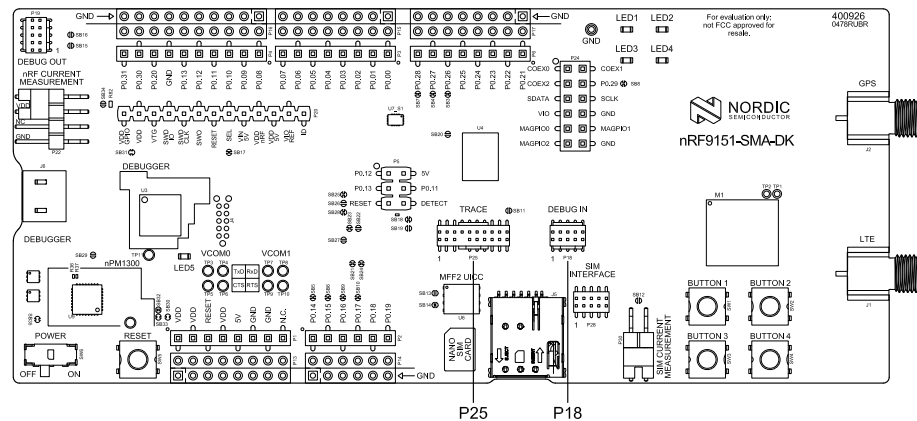


Figure 16: Debug input and trace connectors

To use the software trace feature on nRF9151, a 20-pin connector (**P25**) is available. nRF9151 *GPIOs* used for the trace interface are not available for application firmware use during trace.

GPIO	Trace
P0.21	TRACECLK
P0.22	TRACEDATA[0]
P0.23	TRACEDATA[1]
P0.24	TRACEDATA[2]
P0.25	TRACEDATA[3]

Table 6: Trace interfaces

4.11 Debug out for programming external boards

The nRF9151 SMA DK supports programming and debugging external boards with nRF51 Series, nRF52 Series, nRF53 Series, nRF54 Series, and nRF70 Series *System on Chip (SoC)*s and nRF91 Series *SiPs*.

The interface MCU on the nRF9151 SMA DK runs SEGGER J-Link OB Debugger interface firmware and is used to program and debug the firmware of the nRF9151 *SiP* by default.

To program or debug an external board, connect to the Debug out connector (**P19**) using a 10-pin cable or use **P20** for custom connection.

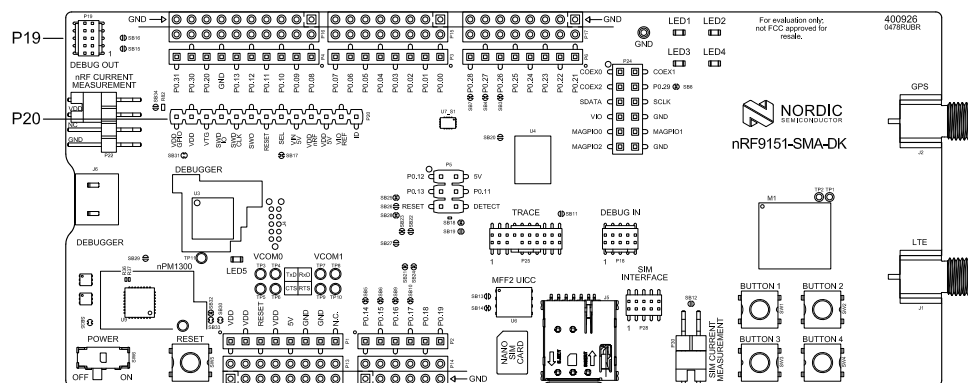


Figure 17: Debug output connectors

4.11.1 Programming an external board

For boards with a standard 10-pin *SWD* connector or a connector that supports a standard 10-pin flat cable, connection to **P19** is recommended.

Connect the boards as shown in the following figure.

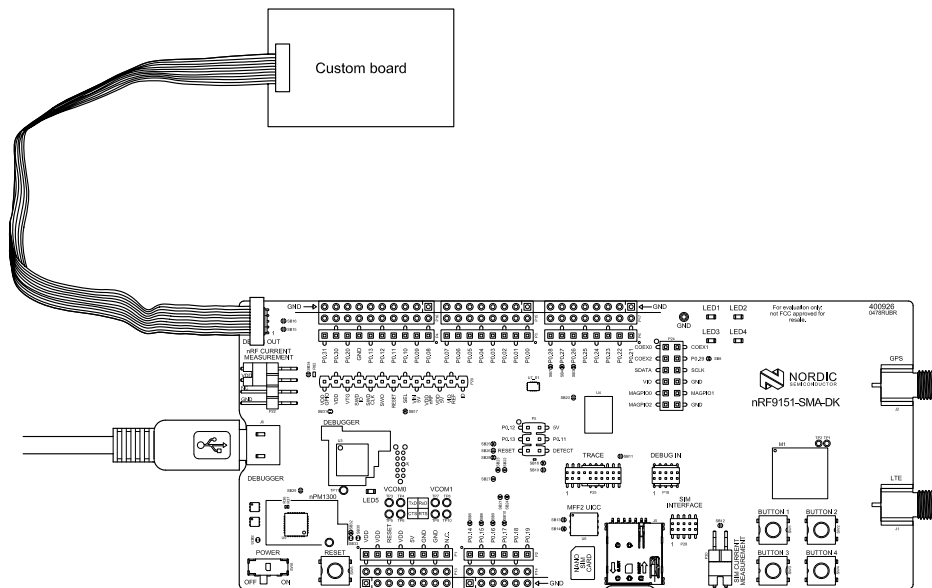


Figure 18: Connecting an external board to P19

It is recommended to power the external board separately from the DK. The voltage of the SWD interface on the external board must match that of the DK. The default voltage is 1.8 V.

When the interface MCU detects GND of the external board on **pin 3 (SELECT)** of **P19**, it programs or debugs the target chip on the external board instead of the onboard nRF9151 SiP.

The following figure shows the **P19** pinout.

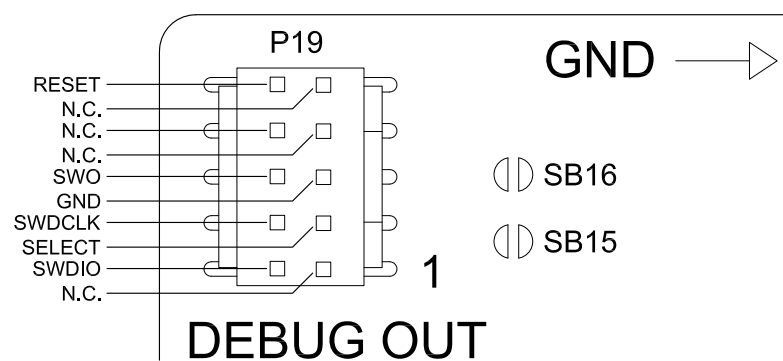


Figure 19: Debug output connector P19

The following table shows the **P19** pinout.

Pin number	Signal	Description
1	EXT_VDD	By default not connected, for configuration see SB15 and SB16 in Solder bridge configuration on page 27
2	SWDIO	SWD data input/output
3	SELECT	Select pin for the interface MCU, should be connected to GND on the external board
4	SWDCLK	Serial wire clock line
5	GND	Ground
6	SWO	<i>Serial Wire Output (SWO)</i> line is not used for programming and debugging over SWD
7	N.C.	Not used
8	N.C.	Not used
9	N.C.	Not used
10	RESET	Reset line

Table 7: Pinout of connector P19 for programming external targets

If you do not have a separate power supply on the external board connected to the Debug out connector **P19**, the external board can be powered from the onboard DK regulator as follows:

1. Short solder bridge **SB16** to enable power output on **P19**.
2. Power the DK through the USB connector.

CAUTION: To avoid damaging your board when **SB16** is shorted, do not connect a separate power supply to the external board.

4.11.2 Programming a board with custom connections

If your external board has custom connections for programming and debugging pins, you can use the debug output on **P20**.

Connect the boards as shown in the following figure.



NORDIC
SEMICONDUCTOR

When the interface MCU detects the voltage of the external board on **pin 3 (VTG)** or ground on **pin 8 (SEL)** of **P20**, it programs or debugs the target chip on the external board instead of the onboard nRF9151 *SiP*.

If there is no separate power supply on the external board, the nRF9151 SMA DK can supply power through pin 2 (**VDD**) of **P20**.

The following figure shows the **P20** connector pinout.

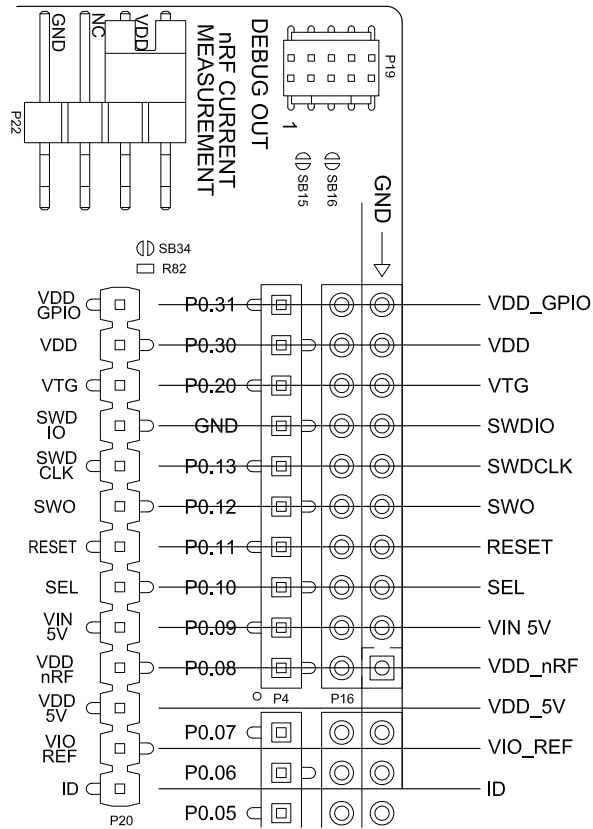


Figure 21: Debug output connector P20

The following table shows the **P20** connector pinout.

Pin number	Signal	Description
1	VDD_GPIO	Supply for the nRF9151 <i>GPIO</i> pins
2	VDD	Main nRF9151 SMA DK <i>GPIO</i> level power domain
3	VTG	Voltage supply from the external target, used as a select pin for the interface MCU to enable this port
4	SWDIO	<i>SWD</i> data line
5	SWDCLK	Serial wire clock line
6	SWO	The <i>SWO</i> line is not used for programming and debugging over <i>SWD</i>
7	RESET	Reset line
8	SEL	Ground detect, used as a select pin for the interface MCU to enable this port
9	VIN 5V	Voltage supply
10	VDD_nRF	nRF9151 SiP power domain
11	VDD_5V	Main nRF9151 SMA DK 5V level power domain
12	VIO_REF	<i>GPIO</i> voltage reference input
13	ID	ID resistor to ground

Table 8: Pinout of connector P20 for programming external targets

4.12 Signal routing switches

Several of the *GPIO* signals of the nRF9151 SMA DK are routed through analog switches for onboard functionality or for having them available on the pin headers for external circuitry or Arduino-type shields.

4.12.1 Switches for UART interface

Two UART interfaces are routed between the interface MCU and the nRF9151 SiP. These can be controlled individually by the board controller.

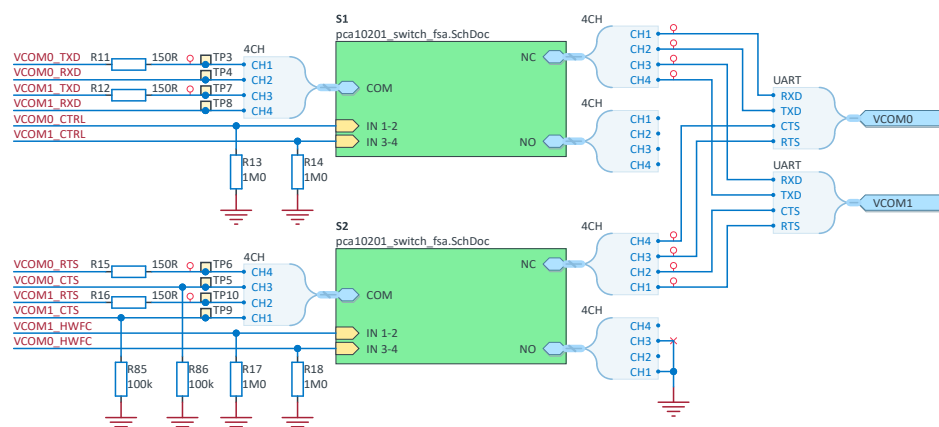


Figure 22: UART interface switches

4.12.2 Switches for buttons and LEDs

On the nRF9151 SMA DK, there are analog switches that are used to connect and disconnect signals to control buttons, switches, and LEDs.

The analog switches control whether the LEDs, buttons, and switches are connected directly to the nRF9151 *GPIO* or to an I/O expander. The switches are controlled by the board controller SoC, which contains Nordic Semiconductor firmware. For more information, see [I/O expander](#) on page 17.

4.12.3 Switches for external memory

An analog switch allows the external memory to be disconnected from the *SIP*.

For more information, see [Figure 15: Flash memory](#) on page 19.

4.13 SIM and eSIM

The nRF9151 SMA DK is designed to support regular SIM and eSIM. For this purpose, it has a pluggable SIM card socket (**J5**) that takes a nano-sized SIM (4FF) and a non-populated footprint for an eSIM (MFF2).

Using the SIM socket is the default. If an eSIM is soldered onto the *DK*, the board controller can be used to select the eSIM. Connector **P28** can be used to connect and monitor the traffic on the SIM interface.

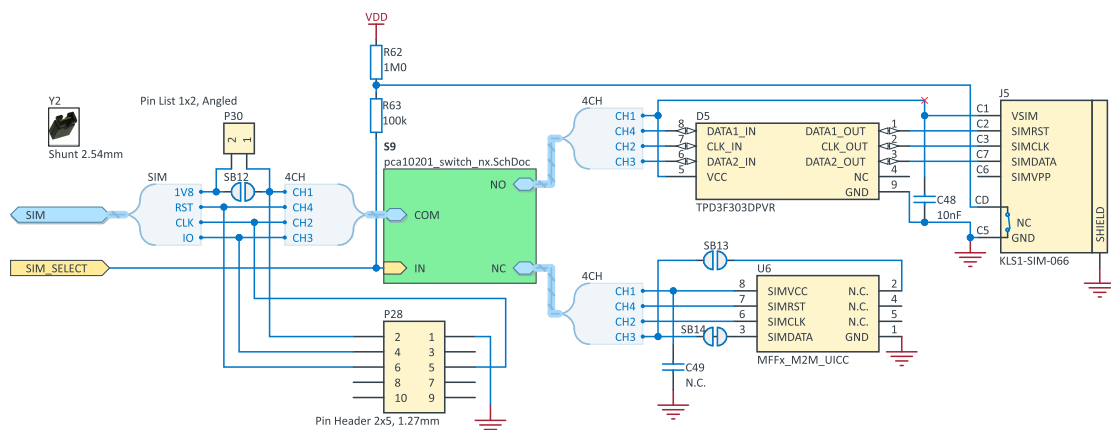


Figure 23: SIM card connector, eSIM, and selection switch

Note: The nano-SIM card is inserted with the electrical interface down in the SIM card holder (**J5**).

4.14 Additional interfaces

The nRF9151 SMA DK supports dedicated interfaces for coexistence management. They are exposed on connector P24.

Three COEX pins enable coexistence handling between multiple wireless devices. The COEX pins are not used on the nRF9151 SMA DK.

The nRF9151 SMA DK has an interface which allows the modem to control external RF applications, such as antenna tuner devices. There are three MIPI RFFE interface pins, namely, VIO, SCLK, SDATA, and three MAGPIO interface pins, namely, MAGPIO0, MAGPIO1, and MAGPIO2.

4.15 SiP enable

4.16 Solder bridge configuration

The following table is a complete overview of the solder bridges on the nRF9151 SMA DK.

Solder bridge	Default	Function
SB3	Closed	Cut to disconnect RXD of UART1 from nRF9151 SiP

Solder bridge	Default	Function
SB4	Closed	Cut to disconnect TXD of UART1 from nRF9151 SiP
SB5	Closed	Cut to disconnect RTS of UART1 from nRF9151 SiP
SB6	Closed	Cut to disconnect CTS of UART1 from nRF9151 SiP
SB7	Closed	Cut to disconnect RXD of UART2 from nRF9151 SiP
SB8	Closed	Cut to disconnect TXD of UART2 from nRF9151 SiP
SB9	Closed	Cut to disconnect RTS of UART2 from nRF9151 SiP
SB10	Closed	Cut to disconnect CTS of UART2 from nRF9151 SiP
SB12	Open	Short to permanently connect SIM VDD, bypass SIM current measurement connector
SB13	Open	Close to reroute SIMDATA to pin 2 of MFF2
SB14	Closed	Cut to disconnect SIMDATA from pin 3 of MFF2
SB15	Open	Short to connect external board power to VIO_REF
SB16	Open	Short to use VDD rail as power source for the external board
SB17	Closed	Cut to disable P20 pin 3 (VTG) as select pin
SB18	Closed	Cut to disconnect P5 pin 6 from shield detect
SB19	Open	Short to connect P5 pin 6 to GND
SB20	Open	Close to connect VDD to the UART1 connector
SB21	Closed	Cut to disconnect RESET from P7
SB22	Open	Short to connect P0 . 21 to RESET on P1
SB23	Closed	Cut to disconnect P0 . 21 from RESET on P7
SB24	Closed	Cut to disconnect RESET from AREF on P4 and P10
SB25	Closed	Cut to disconnect RESET pins of P11 and P7
SB26	Open	Short to connect RESET pins of P11 and P5
SB27	Open	Short to connect RESET pins of P1 and P7
SB28	Closed	Cut to disconnect RESET pins of P1 and P5
SB29	Open	Short to permanently enable USB_DETECT signal
SB30	Closed	Cut to disconnect VIO supply to P1 and P7
SB31	Closed	Cut to enable nRF9151 VDD_GPIO current measurement on P20
SB32	Closed	Cut to disconnect interface MCU power supply
SB33	Closed	Cut to disconnect nPM1300 output from VDD
SB34	Open	Short to permanently connect VDD_nRF and VDD_nRF', bypass current measurement connector
SB35	Closed	Cut to disconnect 5V on P1 and P7 from VDD_5V

Table 10: Solder bridge configuration

5 Current measurement

The current drawn by the nRF9151 SiP can be monitored on the nRF9151 SMA DK.

Current can be measured using any of the following test instruments:

- Power analyzer
- Oscilloscope
- Ampere meter
- Power Profiler Kit II

Power analyzer measurements are not described in this document. For more information on the other instruments, see the following sections and [Power Profiler Kit II](#).

You can use connector **P22** for measuring current consumption or monitoring voltage levels on the nRF9151 SMA DK. For more information, see [Prepare the DK for current measurements](#) on page 29.

The use of a USB connector is not recommended for powering the DK during current measurements due to potential noise from the USB power supply. Instead, the DK should be powered externally through the **VIN 5V** pin on connector **P20**.

For more information on measuring, see [Measure current profile with an oscilloscope](#) on page 30 and [Measure average current with an ampere meter](#) on page 31.

5.1 Prepare the DK for current measurements

To measure the current consumption of the SiP, you must first remove the jumper from **P22**.

Removing the jumper disconnects the nRF9151 SiP from the DK's power supply.

To restore normal kit functionality after measurement, apply the jumper on **P22** or short **SB34**.

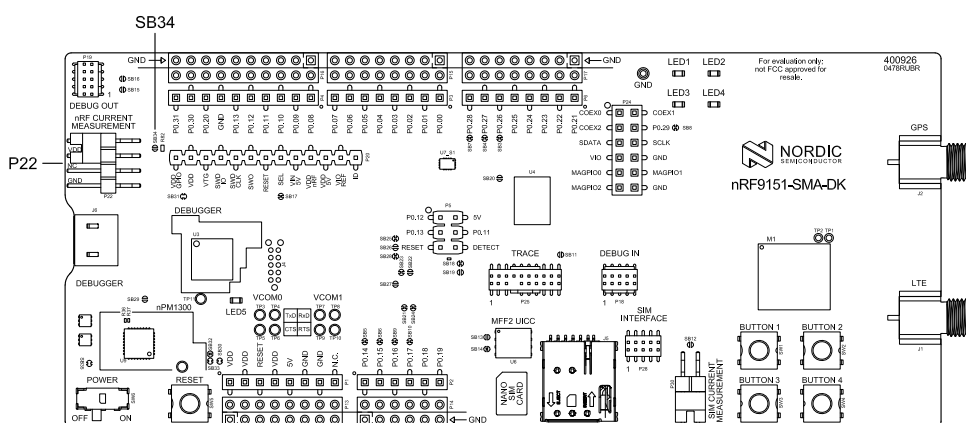


Figure 25: Solder bridge SB34 and P22 on the nRF9151 SMA DK

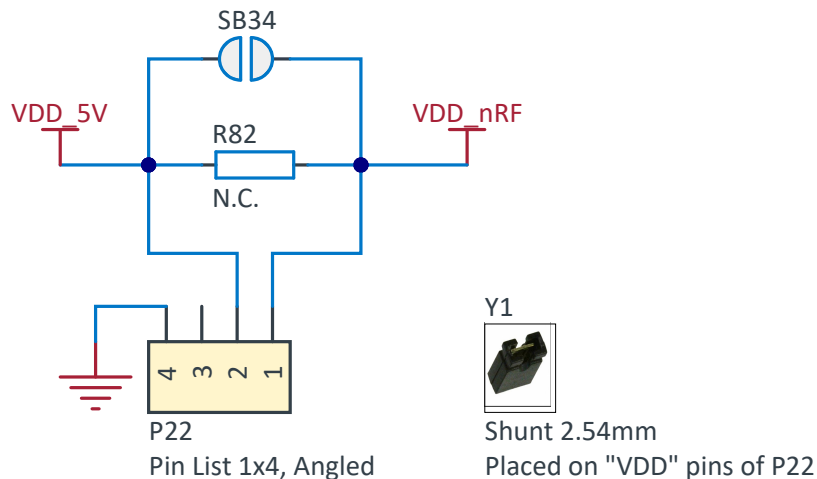


Figure 26: nRF power source select

5.2 Measure current profile with an oscilloscope

An oscilloscope can be used to measure the current over a given or continuous time interval and to capture the current profile.

Before you start, make sure you have prepared the nRF9151 SMA DK as described in [Prepare the DK for current measurements](#) on page 29.

Complete the following steps to measure the current profile of the nRF9151 SMA DK:

1. Solder a 0.5 Ω resistor to **R82**.
2. Set the oscilloscope to differential mode or to a mode that is similar.
3. Connect the oscilloscope using two probes on the pins of the **P22** connector.
4. Calculate or plot the instantaneous current from the voltage drop across the 0.5 Ω resistor by taking the difference of the voltages measured on the two probes.

The voltage drop is proportional to the current.

5. Measure the voltage drop over the 0.5 Ω resistor to get the current power profile.

The plotted voltage drop can be used to calculate the current at a given point in time. The current can then be averaged or integrated to analyze current and energy consumption over a period.

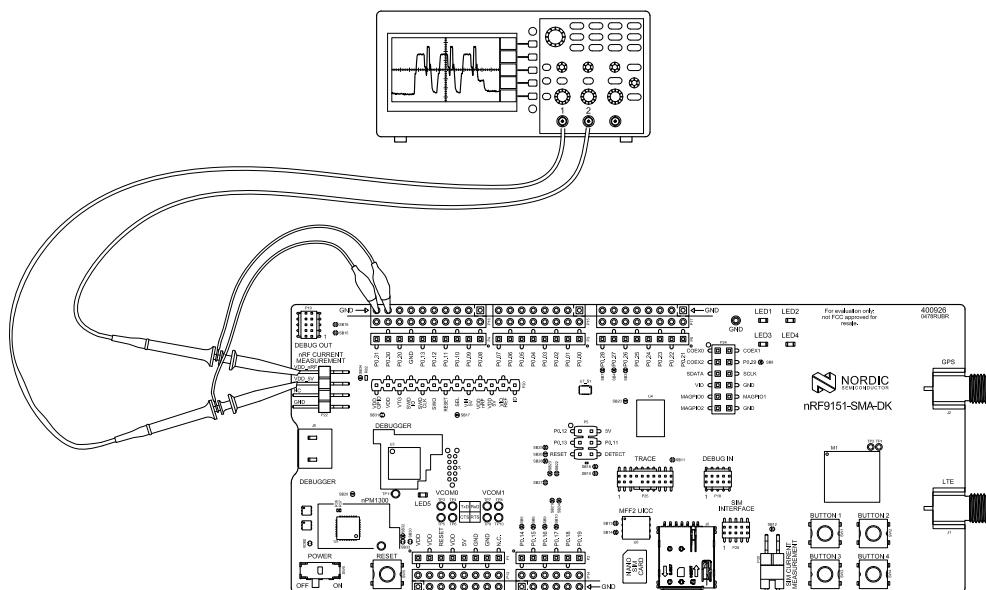


Figure 27: Current measurement with an oscilloscope

To reduce noise, do the following:

- Use probes with 1x attenuation.
- Enable averaging mode to reduce random noise.
- Enable high resolution function if available.

A minimum of one sample every 5 μ s is needed to accurately measure the average current.

5.3 Measure average current with an ampere meter

The current drawn by the nRF9151 SiP can be measured using an ampere meter.

Before you start, make sure you have prepared the nRF9151 SMA DK as described in [Prepare the DK for current measurements](#) on page 29.

Complete the following steps to measure the average current drawn by the nRF9151 SiP:

1. Set the average timing of the ampere meter to a long interval, such as 1 s or longer.
2. Set the dynamic range of the ampere meter between 1 μ A and approximately 500 mA so that it is wide enough to provide accurate measurements.
3. To connect the ampere meter in series with the nRF9151 SiP, connect the ampere meter to the pins on connector **P22**.

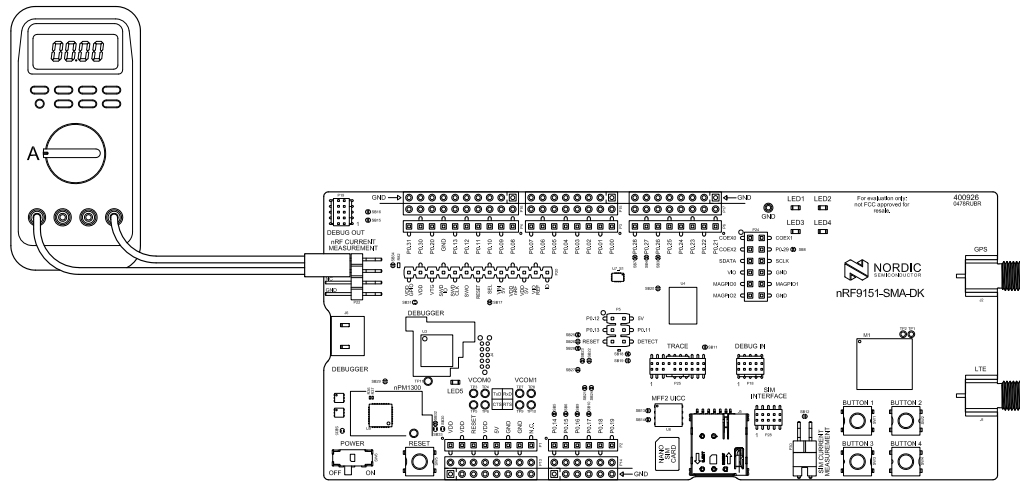


Figure 28: Current measurement with an ampere meter

Note: Use a high-speed, high-dynamic-range ampere meter for the best and most reliable measurements. Switching the current range in the ampere meter can affect the power supply to the nRF9151 SMA DK. High speed and bandwidth are required to detect rapid changes in the current consumption in the nRF9151 SMA DK.

5.4 Measure current with Power Profiler Kit II in Ampere Meter mode

The nRF9151 SMA DK's power consumption can be measured by using the Power Profiler Kit II (PPK2) as an ampere meter.

Before you start, make sure you have prepared the nRF9151 SMA DK as described in [Prepare the DK for current measurements](#) on page 29.

Complete the following steps to connect nRF9151 SMA DK to PPK2 for measuring power consumption in PPK2's Ampere Meter Mode.

1. Connect **P22** connector's pin 1 on nRF9151 SMA DK to **VOUT** on the PPK2.
2. Connect **P22** connector's pin 2 on nRF9151 SMA DK to **VIN** on the PPK2.
3. Connect **P22** connector's pin 4 on nRF9151 SMA DK to **GND** on the PPK2.

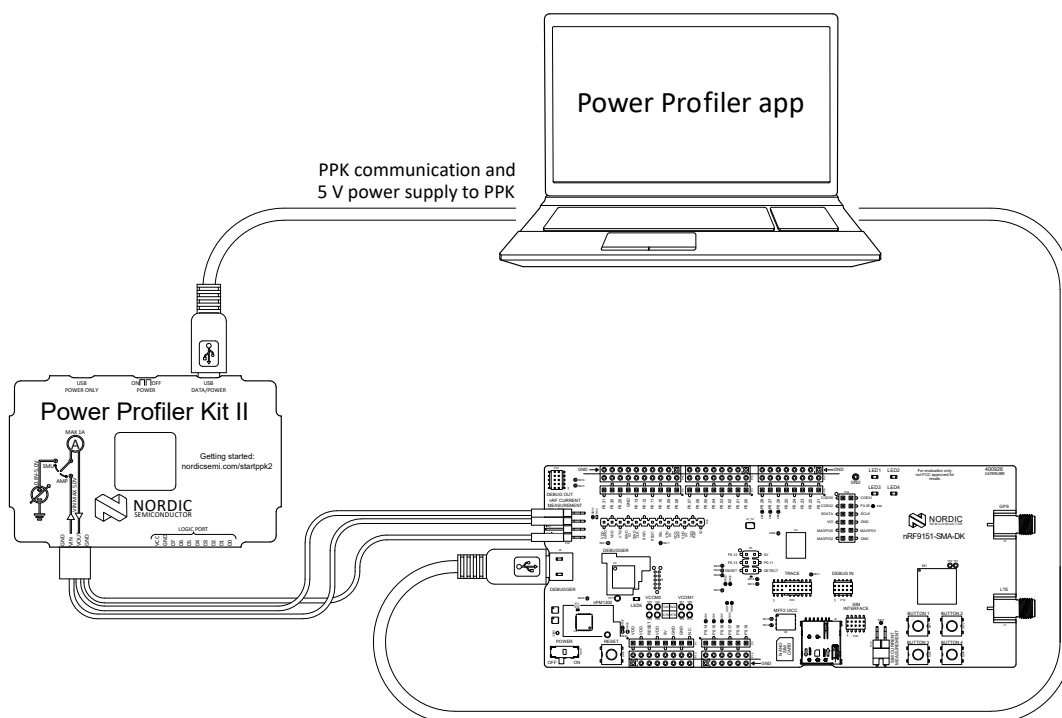


Figure 29: Measuring current in Ampere Meter mode

For more information, see [Power Profiler Kit II](#).

5.5 Measure current with Power Profiler Kit II in Source Meter mode

The nRF9151 SiP's power consumption can be measured with Power Profiler Kit II (PPK2) by providing power to the nRF9151 SMA DK.

Before you start, make sure you have prepared the nRF9151 SMA DK as described in [Prepare the DK for current measurements](#) on page 29.

Complete the following steps to connect nRF9151 SMA DK to PPK2 for measuring power consumption in PPK2's Source Mode.

1. Connect **P22** connector's pin 1 on nRF9151 SMA DK to **VOUT** on the PPK2.
2. Connect **P22** connector's pin 4 on nRF9151 SMA DK to **GND** on the PPK2.

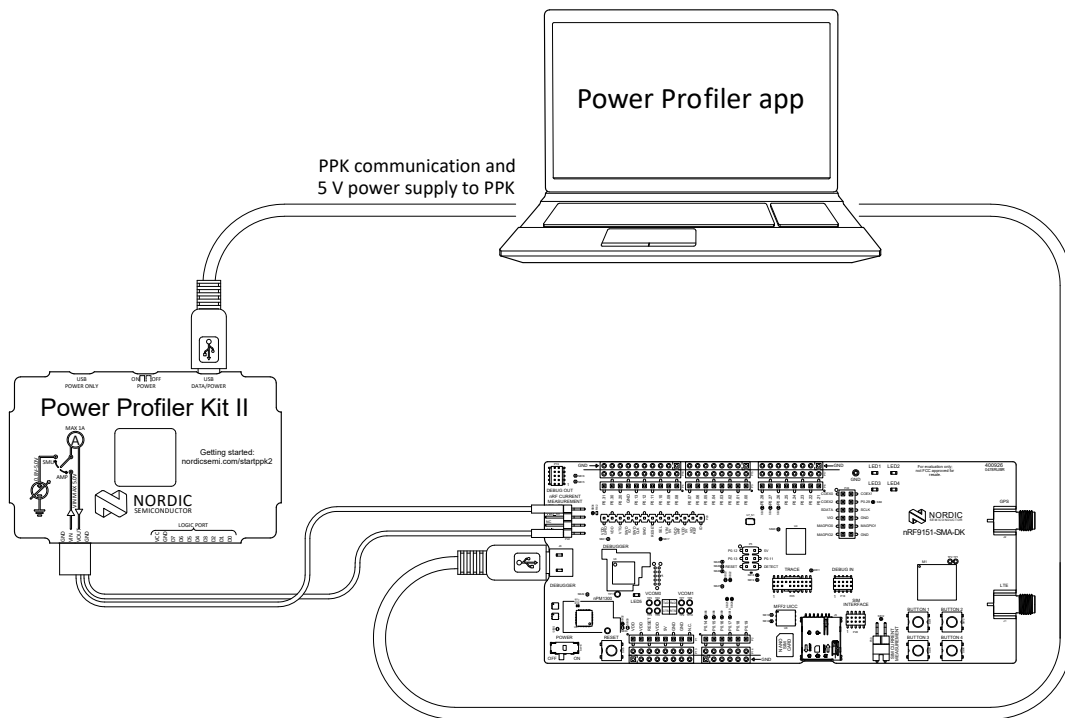


Figure 30: Measuring current in Source Meter mode

For more information, see [Power Profiler Kit II](#).

6 RF measurements

The nRF9151 SMA DK is equipped with SMA connectors for external antennas for radiated or conducted RF measurements for GNSS, LTE, DECT NR+, and NTN.

RF instruments with RF connectors can be connected to the SMA connectors for conducted measurements through adapter cables. The instruments must comply with the impedance, frequency range, and power range of the nRF9151 SIP. The SMA connectors on the nRF9151 SMA DK are impedance matched for 50 Ω .

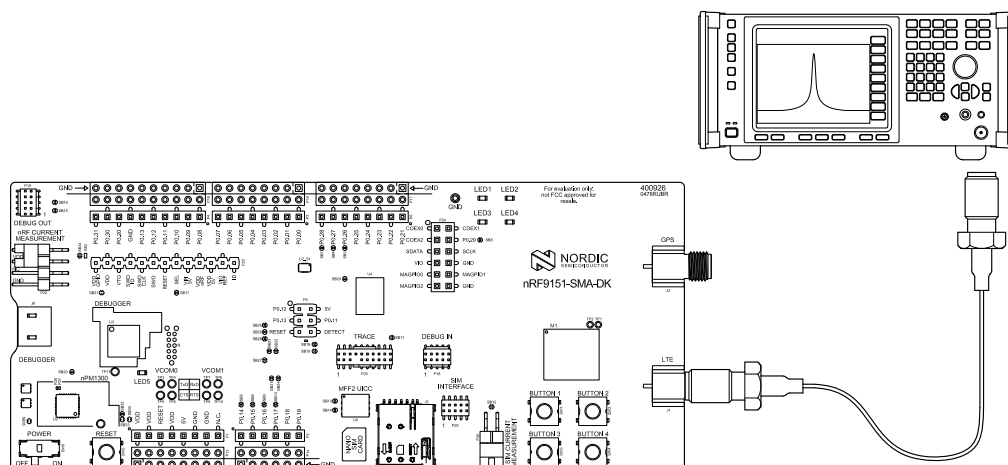


Figure 31: Connecting a spectrum analyzer

Note: To ensure optimal performance in RF measurements, using an external power supply is recommended.

7 Radiated performance

The nRF9151 SMA DK requires external antennas for radiated measurements.

The external antennas are connected to SMA connectors **J1** and **J2**. The external antennas must support the frequency of the selected band of operation. The antennas must be impedance matched for 50 Ω .

Glossary

AT command

A command used to control the modem.

Band-Pass Filter (BPF)

An electronic device or circuit that passes frequencies within a certain range and rejects frequencies outside that range.

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.

Clear to Send (CTS)

In flow control, the receiving end is ready and telling the far end to start sending.

DC

Direct Current

DECT NR+

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

Development Kit (DK)

A hardware development platform used for application development.

Electrostatic Discharge (ESD)

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

Fast Identity Online (FIDO)

A bundle of hardware and software modules serving as a tracing interface between traced device(s) and user application.

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.

Global Positioning System (GPS)

A satellite-based radio navigation system that provides its users with accurate location and time information over the globe.

Hardware Flow Control (HWFC)

A handshaking mechanism used to prevent an overflow of bytes in modems. It uses two dedicated pins on the RS-232 connector, Request to Send and Clear to Send.

Integrated Circuit (IC)

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

Inter-integrated Circuit (I²C)

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

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.

Low-Power Wide Area (LPWA)

A wireless communication technology designed to allow long-range communication at a low bit rate.

Long-Term Evolution (LTE)

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

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 E-UTRAN (WB-S1) and Cat-M1.

Mass Storage Device (MSD)

Any storage device that makes it possible to store and port large amounts of data in a permanent and machine-readable fashion.

Non-Terrestrial Network (NTN)

A 3GPP communication system that delivers wireless connectivity using satellites, drones, or high-altitude platforms instead of ground-based infrastructure.

nRF Cloud

Nordic Semiconductor's platform for connecting IoT devices to the cloud, viewing and analyzing device message data, prototyping ideas that use Nordic Semiconductor chips, and more. It includes a public REST API that can be used for building IoT solutions. See [nRF Cloud portal \(nrfcloud.com\)](https://nrfcloud.com).

Operational Amplifier (op-amp)

A high-gain voltage amplifier that has a differential input and, usually, a single output.

Power Management Integrated Circuit (PMIC)

A chip used for various functions related to power management.

Receive Data (RXD)

A signal line in a serial interface that receives data from another device.

Request to Send (RTS)

In flow control, the transmitting end is ready and requesting the far end for a permission to transfer data.

SAW filter

A high-performing filter using Surface Acoustic Wave (SAW) technology. This technology employs piezoelectric transducers, which, when excited, produce waves that are used to filter out desired frequencies.

Serial Wire Debug (SWD)

A standard two-wire interface for programming and debugging Arm[®] CPUs.

Serial Wire Output (SWO)

A data line for tracing and logging.

SubMiniature Version A (SMA)

A semi-precision coaxial RF connector for coaxial cables with a screw-type coupling mechanism.

Subscriber Identity Module (SIM)

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

Surface Acoustic Wave (SAW)

An acoustic wave traveling along the surface of a material exhibiting elasticity, with an amplitude that typically decays exponentially with depth into the substrate.

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.

Transmit Data (TXD)

A signal line in a serial interface that transmits data to another 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.

User Equipment (UE)

Any device used by an end-user to communicate. The UE consists of the Mobile Equipment (ME) and the Universal Integrated Circuit Card (UICC).

Recommended reading

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

Nordic documentation

- [nRF9151 Product Specification](#)
- [nRF Connect SDK documentation](#)
- [nRF91x1 Cellular AT Commands](#)
- [Programmer app](#)

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