

nRF52840 DK

User Guide

v1.4.1



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Revision history

| Date | Version | Description |
|----------------|---------|---|
| April 2020 | 1.4.1 | Editorial changes |
| December 2019 | 1.4 | Fixed broken links |
| February 2019 | 1.3 | Updated Introduction on page 5: nRF52811 support |
| September 2018 | 1.2 | Updated: <ul style="list-style-type: none">• Nordic tools and downloads on page 10• Start developing on page 13• Preparing the development kit on page 38 |
| June 2018 | 1.1 | Updated Getting started on page 9 |
| April 2018 | 1.0 | First release |

Previous versions

PDF files for relevant previous versions are available here:

- [nRF52840 PDK User Guide v1.2](#)
- [nRF52840 PDK User Guide v1.0](#)

1 Introduction

The nRF52840 DK is a *Development Kit (DK)* that includes hardware, firmware source code, documentation, hardware schematics, and layout files.

This kit can be used for developing for either the nRF52840 or nRF52811 *System on Chip (SoC)s*.

The key features of the *DK* are:

- nRF52840 flash-based ANT™/ANT+™, Bluetooth® Low Energy SoC solution
- Supporting development for the nRF52840 and nRF52811 SoCs
- 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
- UART interface through virtual COM port
- USB
- Flash memory
- Drag-and-drop *Mass Storage Device (MSD)* programming
- Supporting *NFC-A Listen Mode*

For access to firmware source code, hardware schematics, and layout files, see www.nordicsemi.com.



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.

2 Minimum requirements

Before you start, check that you have the required hardware and software.

Hardware requirements

- Personal computer (PC) or Mac
- Micro-USB 2.0 cable

Software requirements

- Operating system: Windows 7, Windows 8, Windows 10, MacOS, or Linux
- SEGGER J-Link Software

3 Kit content

The nRF52840 DK consists of hardware, access to software components, reference design files, and documentation.

3.1 Hardware content

The nRF52840 DK (PCA10056) comes with a *Near Field Communication (NFC)* antenna.

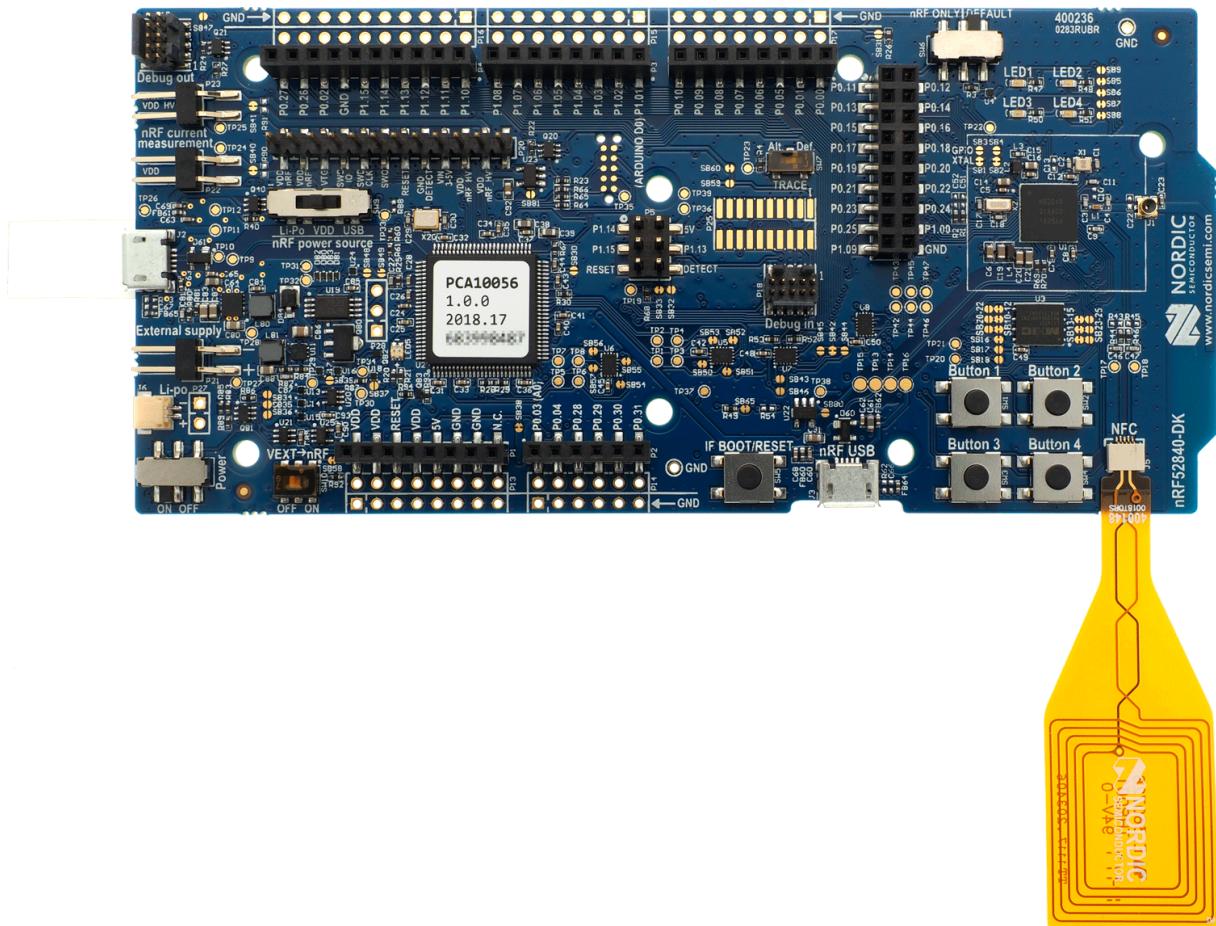


Figure 1: nRF52840 DK and NFC antenna

3.2 Downloadable content

The nRF52840 DK downloadable content includes the hardware files.

- In the [nRF5 SDK](#), you can find precompiled application firmware examples.

Hardware files

Schematics, layout, bill of materials, and Gerber files for the nRF52840 DK are included in a zip file.

- [nRF52840 DK hardware files](#)

3.3 Related documentation

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

Nordic documentation

- [nRF52840 Product Specification](#)
- [nRF52840 Compatibility Matrix](#)
- [nRF5 SDK v16.0.0](#)
- [nRF52840 Errata](#)

4 Getting started

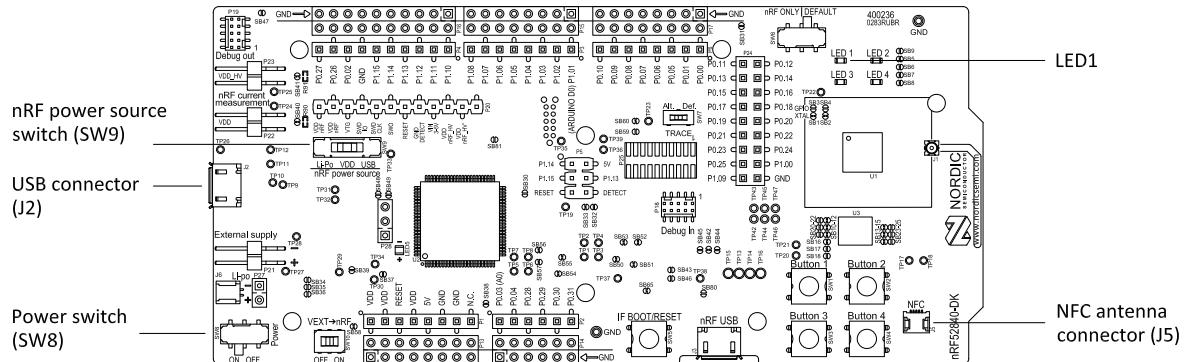
Before you start developing, complete a few steps to set up the hardware and download the required software.

Before you start:

- Unpack the **DK**.
- Check [Minimum requirements](#) on page 6.

Follow the steps below to set up your kit:

1. Connect the *NFC* antenna to the connector marked **NFC**.



2. To power up the *DK*:

- Connect a micro-USB 2.0 cable to the USB connector **J2** on the nRF52840 DK and the other end to one of your PC's USB host port.

In addition to providing power to the *DK*, the USB connection supports target programming.

- Slide the nRF power source switch **SW9** to VDD.
- Slide the power switch **SW8** to the ON position.

A pop-up may appear. You can ignore it.

Check that **LED1** has started pulsating. For more information, see [Buttons and LEDs](#) on page 29.

Open Windows Explorer to check that the nRF52840 DK has appeared as a removable drive named "JLINK".

This allows you to program the chip on the *DK*.

3. Set up the software following the instructions in [Nordic tools and downloads](#) on page 10. The actual software required depends on your operating system and, if using Linux, the bitness of the operating system.

4. To set up a connection between your smart phone and the *DK*, enable *NFC* on your smart phone and bring your phone close to the *DK*.

Your phone will prompt you to open [Getting started with the nRF52840 DK](#). This page contains a link that makes it easy to install the nRF Toolbox mobile app.

5 Nordic tools and downloads

Once you have your kit set up you can start developing. Our software tools help you develop and test your device through all the steps in the software development cycle.

Development IDE

Pick one of the IDEs with a compiler supported by Nordic:

| IDE | Windows | Linux | OSX |
|------------------------------|---------|-------|-----|
| SEGGER Embedded Studio (SES) | Yes | Yes | Yes |
| MDK-ARM Keil µVision | Yes | No | No |
| GNU/GCC | Yes | Yes | Yes |
| IAR | Yes | No | No |

SES is the recommended platform. It is free for use with nRF devices.

Essential tools

You need to download these Nordic tools to develop with our devices.

| Tool | Description | Download | Documentation | Protocol |
|--------------------------------|---|------------------------|---|--|
| SDK (Software Development Kit) | Application examples, source files, SoftDevices | Windows/Linux | nRF5 SDK v16.0.0 nRF5 SDK for Mesh v4.1.0 nRF5 SDK for Thread and Zigbee v4.0.0 | BLE/ANT Bluetooth Mesh Thread and Zigbee |
| nRF Command Line Tools | Collection of command line tools, like nrfjprog, mergehex | nRF Command Line Tools | nRF Command Line Tools | BLE/ANT |

Optional tools

These tools are not essential, but we recommend that you use them.

| Tool | Description | Download | Documentation | Protocol |
|-----------------------------|---|---|--|----------|
| SoftDevice | Wireless protocol stack | Compatible downloads for nRF52840 Compatible downloads for nRF52833 Compatible downloads for nRF52832 Compatible downloads for nRF52811 Compatible downloads for nRF52810 Compatible downloads for nRF51822 Compatible downloads for nRF51422 | nRF51 SoftDevice Specifications nRF52 SoftDevice Specifications | BLE/ANT |
| nRF Connect for Desktop | Expandable desktop tool with several apps, including: <ul style="list-style-type: none"> • Peer device emulator • Power Profiler • Programmer • Cloud Gateway | nRF Connect for Desktop | nRF Connect Bluetooth Low Energy | BLE |
| nRF Connect for Mobile | Peer device emulator app for smartphones | Android v4.3 or later IOS v8 or later | | BLE |
| Nordic nRF Toolbox app | App that contains all the Nordic apps | Android v4.3 or later IOS v8 or later Windows Phone v8.1 or later | | BLE |
| nRF pynrfjprog | Simple Python interface for the nrfjprog DLL | nRF pynrfjprog | nRF5x pynrfjprog | BLE/ANT |
| ANTware II | Peer device emulator for the ANT protocol running on computers | ANTware II | | ANT |
| nRF Sniffer | App for monitoring on-air traffic | nRF Sniffer download | nRF Sniffer for Bluetooth LE | BLE |
| nRF Thread Topology Monitor | Tool for visualizing Thread mesh network topology in real time | nRF Thread Topology Monitor | nRF Thread Topology Monitor | Thread |
| Thread Border Router | Gateway for connecting Thread | Thread Border Router | Thread Border Router | Thread |

| Tool | Description | Download | Documentation | Protocol |
|------|-------------------------|----------|---------------|----------|
| | network to the Internet | | | |

See also [Nordic mobile apps](#) for a list of available Bluetooth Low Energy and Mesh mobile apps for iOS, Android, and Windows Phones.

6 Start developing

After you have set up the *DK* and installed the toolchain, it is time to start developing.

There are several ways to continue from here, depending on which networking protocol you want to use.

- For nRF5 SDK for Bluetooth Low Energy, ANT, or proprietary 2.4Ghz, see [nRF5 SDK Getting Started](#).
- For nRF5 SDK for Mesh, see [Getting Started with Mesh](#).
- For nRF5 SDK for Thread and Zigbee, see [Getting Started with Thread and Zigbee](#).

See also [Software development Getting Started Guides](#) for guidance for the main *Integrated Development Environment (IDE)s*.

7

Interface MCU

The interface MCU on the nRF52840 DK runs SEGGER J-Link OB interface firmware and is used to program and debug the firmware of the nRF52840 SoC.

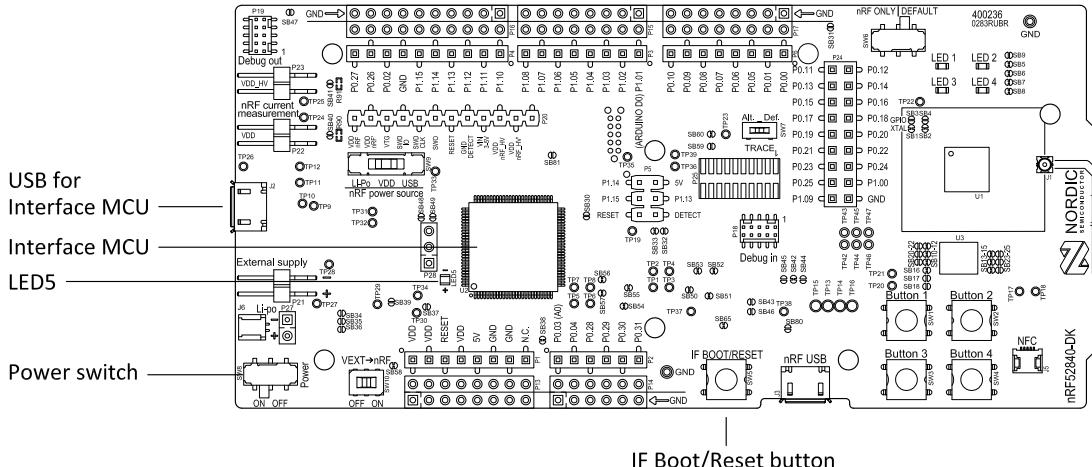


Figure 2: Interface MCU

7.1 IF Boot/Reset button

The nRF52840 DK is equipped with an IF Boot/Reset button (**SW5**).

This button is connected to the interface MCU on the *DK* and has two functions:

- Resetting the nRF52840 SoC.
- Entering bootloader mode of the interface MCU.

During normal operation the button will function as a reset button for the nRF52840 SoC. For this to work, pin reset on **P0.18** needs to be enabled in the SoC.

The button is also used to enter the bootloader mode of the interface MCU. To enter the bootloader mode, keep the reset button pressed while powering up the *DK* until **LED5** starts to blink. You can power up the *DK* either by disconnecting and reconnecting the USB cable or by toggling the power switch (**SW8**).

Note: Pin reset can be enabled by adding the `CONFIG_GPIO_AS_PINRESET` variable to the compiler preprocessor macros. The way of doing this depends on the IDE/toolchain in use:

- When using SEGGER Embedded Studio, go to **Project > Edit Options > Code > Preprocessor > Preprocessor Definitions** and add the `CONFIG_GPIO_AS_PINRESET` variable.
- When using Keil, go to **Project > Options for Target > C/C++ > Preprocessor Symbols > Define** and add the `CONFIG_GPIO_AS_PINRESET` variable.

If your program does not enable pin reset, this functionality can also be enabled on an already programmed device by calling `nrfjprog.exe` with argument `--pinresetenable`. To disable pinreset again, reprogram with `--chiperase`.

7.2 Virtual COM port

The onboard interface MCU features a UART interface through a virtual COM port.

The virtual COM port has the following features:

- Flexible baud rate setting up to 1 Mbps.¹
- Dynamic *Hardware Flow Control (HWFC)* handling.
- Tri-stated UART lines when no terminal is connected.

The table below shows an overview of the UART connections on nRF52840 and the interface MCU.

| GPIO nRF52840 | nRF52840 UART |
|---------------|---------------|
| P0.05 | RTS |
| P0.06 | TXD |
| P0.07 | CTS |
| P0.08 | RXD |

Table 1: Relationship of UART connections on nRF52840 and interface MCU

The UART signals are routed directly to the interface MCU. The UART pins connected to the interface MCU are tri-stated when no terminal is connected to the virtual COM port on the computer.

Note: The terminal software used must send a *Data Terminal Ready (DTR)* signal to configure the UART interface MCU pins.

The **P0.05 (Request to Send (RTS))** and **P0.07 (Clear to Send (CTS))** can be used freely when *HWFC* is disabled on the *SoC*.

7.2.1 Dynamic HWFC handling

When the interface MCU receives a *DTR* signal from a terminal, it performs automatic *HWFC* detection.

Automatic *HWFC* detection is done by driving **P0.07 (CTS)** from the interface MCU and evaluating the state of **P0.05 (RTS)** when the first data is sent or received. If the state of **P0.05 (RTS)** is high, *HWFC* is assumed not to be used. If *HWFC* is not detected, both CTS and RTS can be used freely by the nRF application.

After a power-on reset of the interface MCU, all UART lines are tri-stated when no terminal is connected to the virtual COM port. Due to the dynamic *HWFC* handling, if *HWFC* has been used and detected, **P0.07 (CTS)** will be driven by the interface MCU until a power-on reset has been performed or until a new *DTR* signal is received and the detection is redone.

To ensure that the UART lines are not affected by the interface MCU, the solder bridges for these signals can be cut and later resoldered if needed. This might be necessary if UART without *HWFC* is needed while **P0.05 (RTS)** and **P0.07 (CTS)** are used for other purposes.

7.3 MSD

The interface MCU features an *MSD*. This makes the *DK* appear as an external drive on your computer.

This drive can be used for drag-and-drop programming. However, files cannot be stored on this drive. By copying a HEX file to the drive, the interface MCU will program the file to the device.

¹ Baud rate 921 600 is not supported through the virtual COM port.

Note:

- Windows might try to defragment the *MSD* part of the interface MCU. If this happens, the interface MCU will disconnect and be unresponsive. To return to normal operation, the *DK* must be power cycled.
- Your antivirus software might try to scan the *MSD* part of the interface MCU. Some antivirus programs trigger a false positive alert in one of the files and quarantine the unit. If this happens, the interface MCU will become unresponsive.
- If the computer is set up to boot from USB, it can try to boot from the *DK* if the *DK* is connected during boot. This can be avoided by unplugging the *DK* before a computer restart, or changing the boot sequence of the computer.

You can also disable the *MSD* of the kit by using the **msddisable** command in J-Link Commander. To enable, use the **msdenable** command. These commands take effect after a power cycle of the *DK* and stay this way until changed again.

8 Hardware description

The nRF52840 DK (PCA10056) can be used as a development platform for the nRF52840 SoC. It features an onboard programming and debugging solution.

In addition to radio communication, the nRF52840 SoC can communicate with a computer through USB and a virtual COM port provided by the interface MCU.

8.1 Hardware drawings

nRF52840 DK hardware drawings show both sides of the PCA10056.

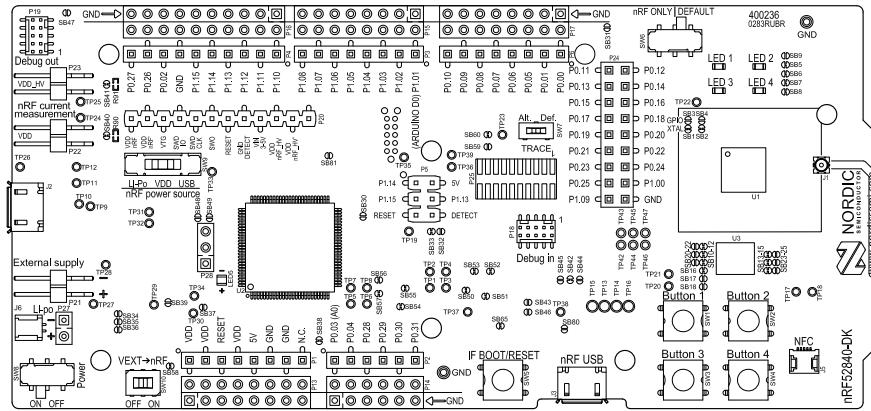


Figure 3: nRF52840 DK (PCA10056) front view

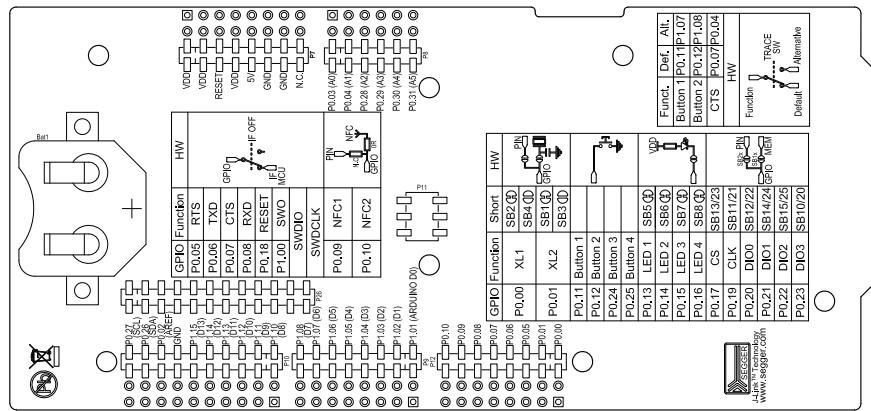


Figure 4: nRF52840 DK (PCA10056) back view

8.2 Block diagram

The nRF52840 DK block diagram shows the connections between the different blocks.

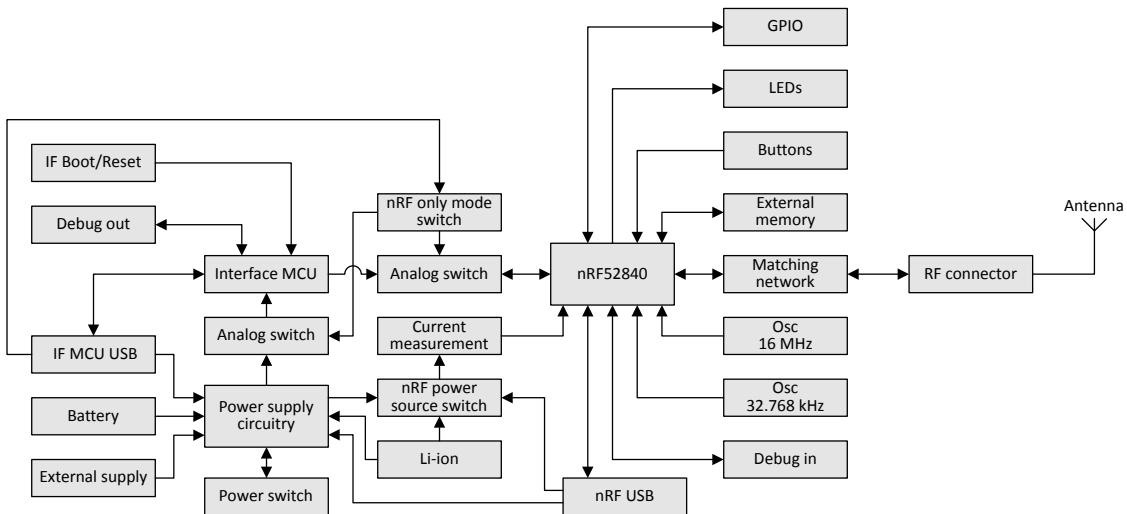


Figure 5: Block diagram

8.3 Power supply

The nRF52840 DK has multiple power options.

The power options are:

- USB connector **J2** for the interface MCU (5 V)
- USB connector **J3** for the nRF52840 (5 V)
- Lithium polymer (Li-Po) battery connectors **J6** or **P27** (2.5–5.0 V)
- VIN 3–5 pin on **P20** (3.0–5.0 V)
- External supply on **P21** (1.7–3.6 V)
- Coin cell battery

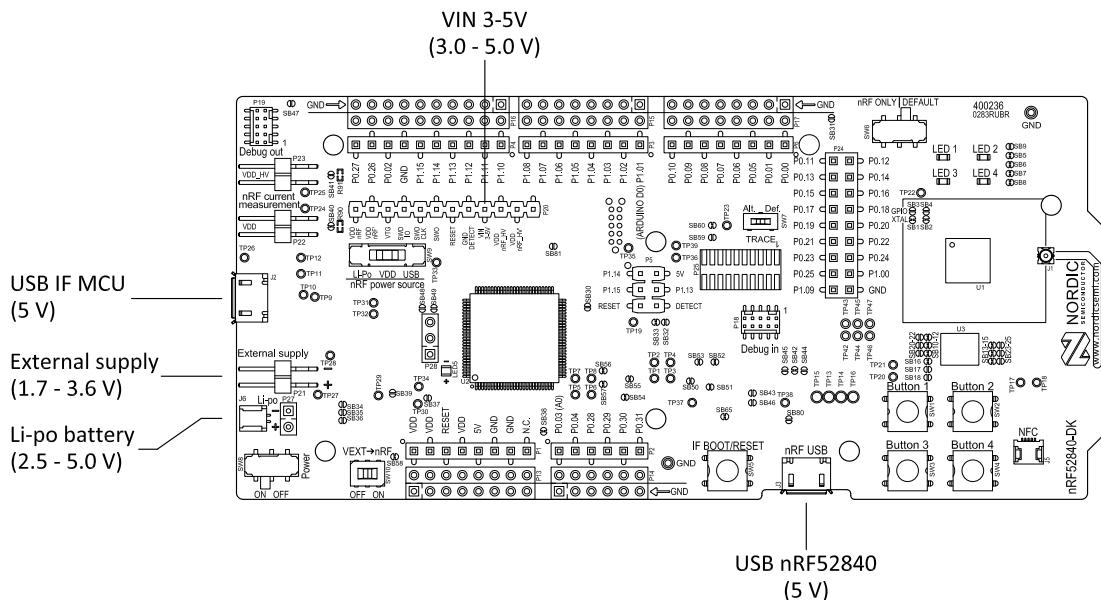


Figure 6: Power supply options (front)

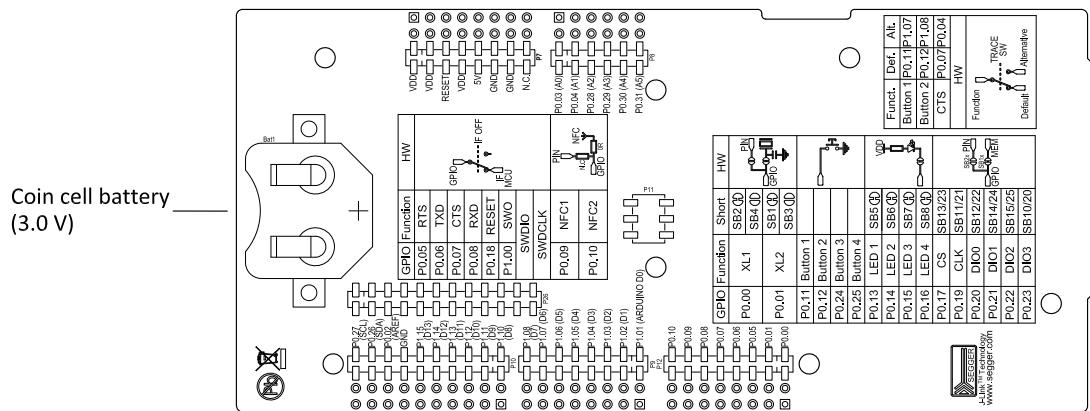


Figure 7: Power supply options (back)

8.3.1 5 V power sources

The nRF52840 DK has a 5 V boost regulator.

It gives a stable 5 V output from four possible sources:

- USB connector **J2** for the interface MCU
 - USB connector **J3** for the nRF52840
 - Li-Po polymer battery connectors (**J6** or **P27**)
 - VIN 3–5 V pin on **P20**

Each of these sources has a reverse protection diode to prevent current flowing in the wrong direction if multiple sources are connected at the same time.

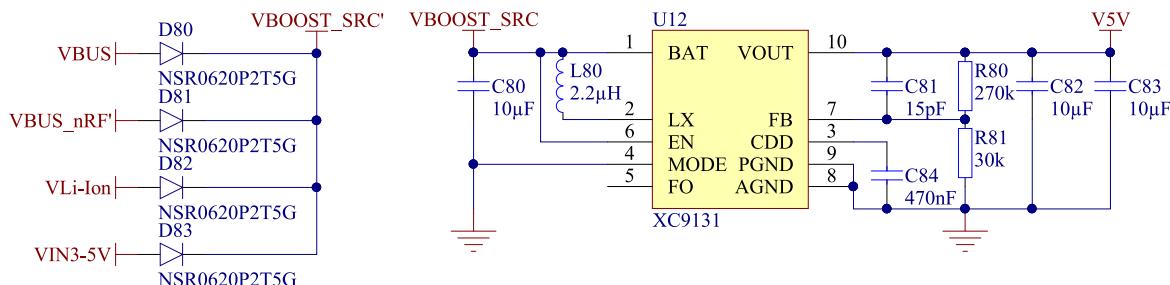


Figure 8: 5V regulator and protecting diodes

8.3.2 VDD power sources

The main supply (VDD) can be sourced from the 5 V domain, external power supply, and coin cell battery.

For the 5 V domain, there are two regulators, one fixed 3 V buck regulator and one voltage follower regulator that follows the VDD_nRF voltage. The coin cell battery and external power supply are not regulated.

- 5 V domain:
 - Fixed 3 V buck regulator
 - VDD_nRF voltage follower
 - External power supply
 - Coin cell battery

For more information about power sources, see section [nRF52840 power source](#) on page 22.

The power sources are routed through a set of load switches, which is controlled by logic to give the correct priority of the power sources.

If the high voltage regulator of the nRF52840 is used, the *DK* will be supplied from the *VDD_nRF* voltage follower regardless of the state of the other power sources.

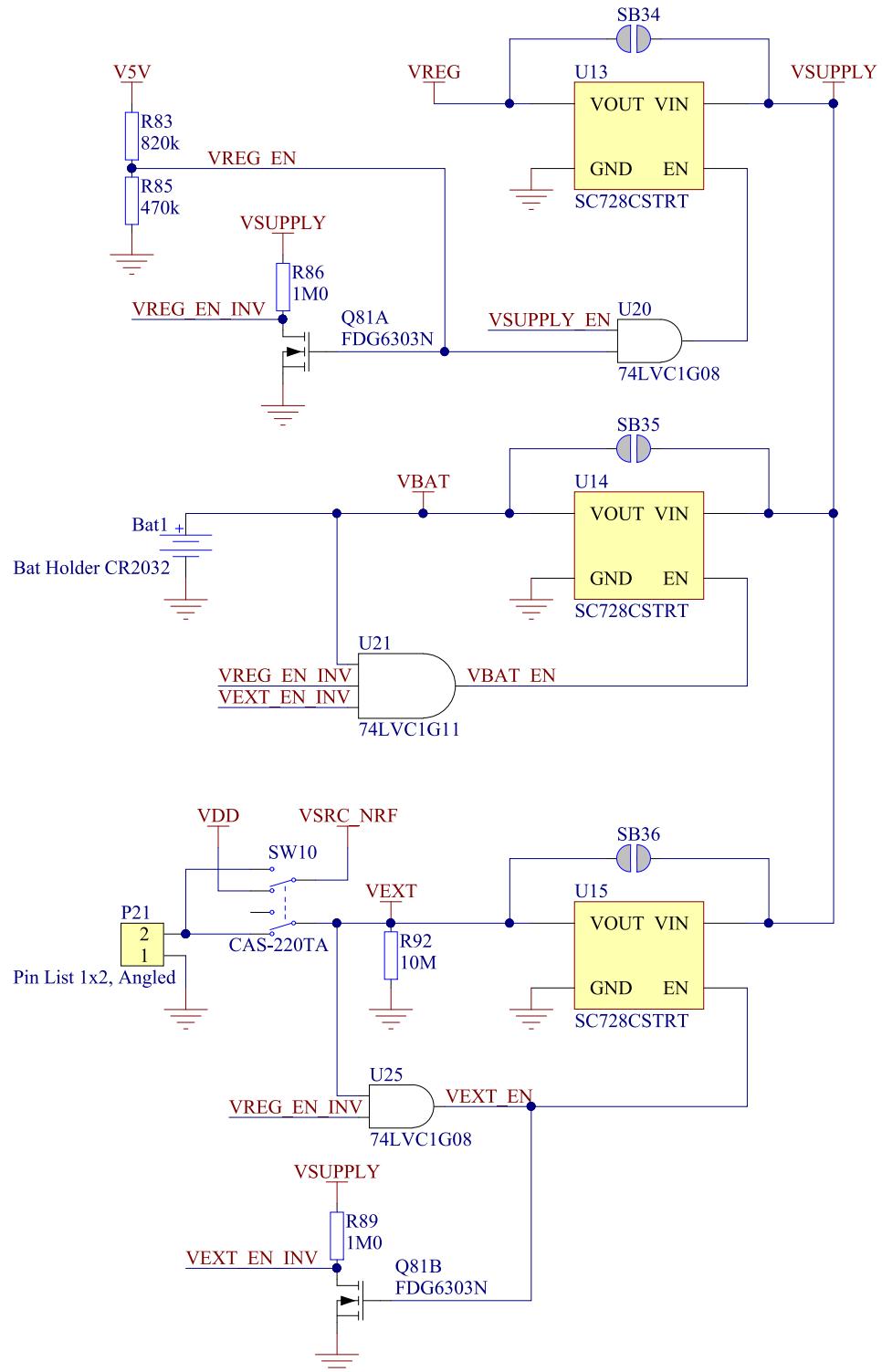


Figure 9: Power supply circuitry

The power switches work in the way that the body diode of the internal transistor powers the *VSUPPLY* net, which supplies the gates controlling the enable signal of the switches. If 5 V is present, the switches for external supply and battery are disabled. If external supply is present, the switch for the battery is disabled.

The power switches can be bypassed by shorting one or more solder bridges.

| Power source | Power switch bypass | Voltage level |
|-------------------|---------------------|---------------|
| Regulator | SB34 | 3.0 V |
| Coin cell battery | SB35 | Battery |
| External supply | SB36 | 1.7 V–3.6 V |

Table 2: Power switch bypass solder bridges

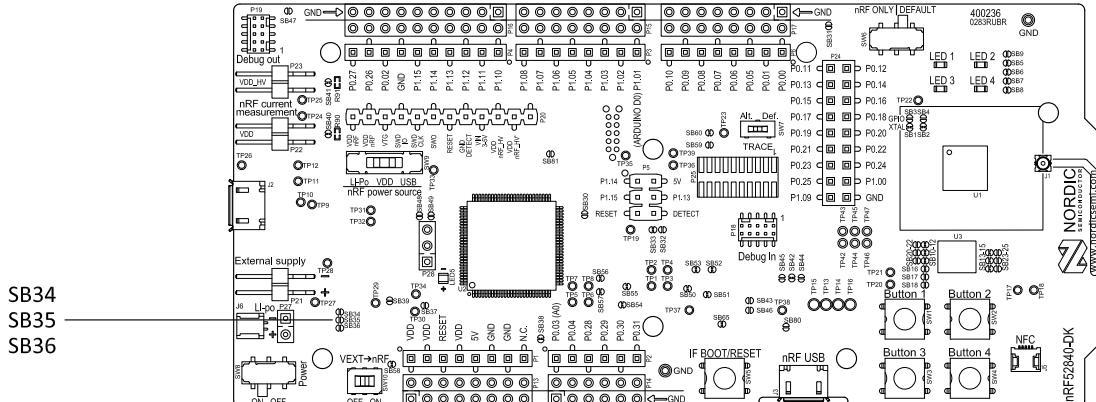


Figure 10: Power switch bypass solder bridges

Note: Connect only one power source at a time. Shorting the solder bridges removes the reverse voltage protection.

8.3.3 Interface MCU power

The power for the interface MCU is routed through two load switches, one for the VDD supply and one for the USB supply. This makes it possible to disconnect the interface MCU from the power domain when not in use.

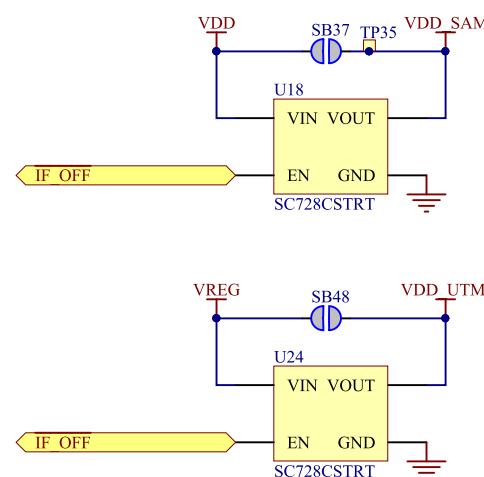


Figure 11: Interface MCU power switch

These switches are controlled by the presence of a USB connected to the interface MCU USB connector (**J2**), and the state of the nRF only switch (**SW6**). See section [Operating modes](#) on page 23 for more information.

8.3.4 nRF52840 power source

The nRF52840 DK has a power source switch (**SW9**) for selecting between three power sources for the nRF52840 SoC.

The three positions of the switch are:

- VDD (default)
 - Li-Po
 - USB

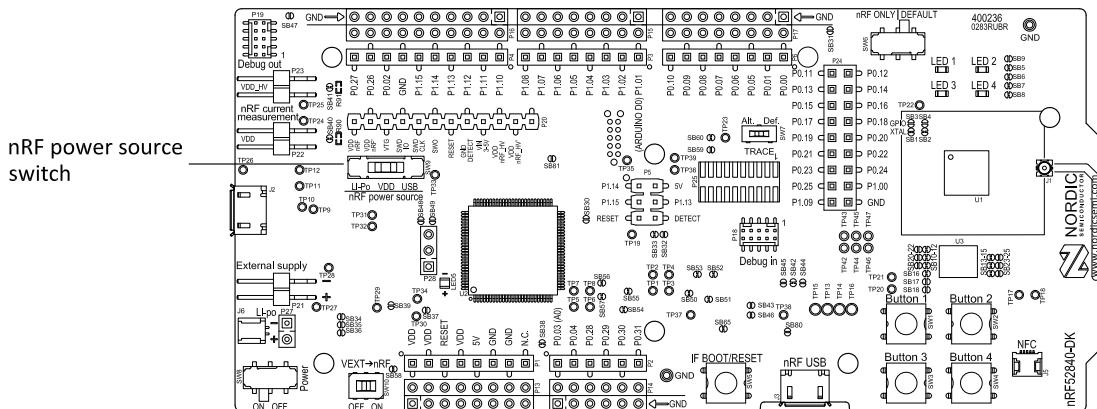


Figure 12: nRF52840 power source switch

The nRF52840 SoC has a high voltage buck regulator that can support up to 5 V input. In the VDD position, the SoC is powered either from the onboard buck regulator, coin cell battery, or external supply (**P21**). In the Li-Po position, the high voltage regulator of the SoC is supplied directly from the Li-Po battery connectors (**J6** or **P27**). In the USB position, the USB high voltage regulator gets power from the nRF52840 USB connector (**J3**).

When the high voltage regulator is used, the VDD_nRF voltage can be set by the firmware of the SoC. To make sure the rest of the *DK* has the same voltage level, the VDD of the *DK* is sourced by a regulator following the VDD_nRF voltage when the high voltage regulator is used.

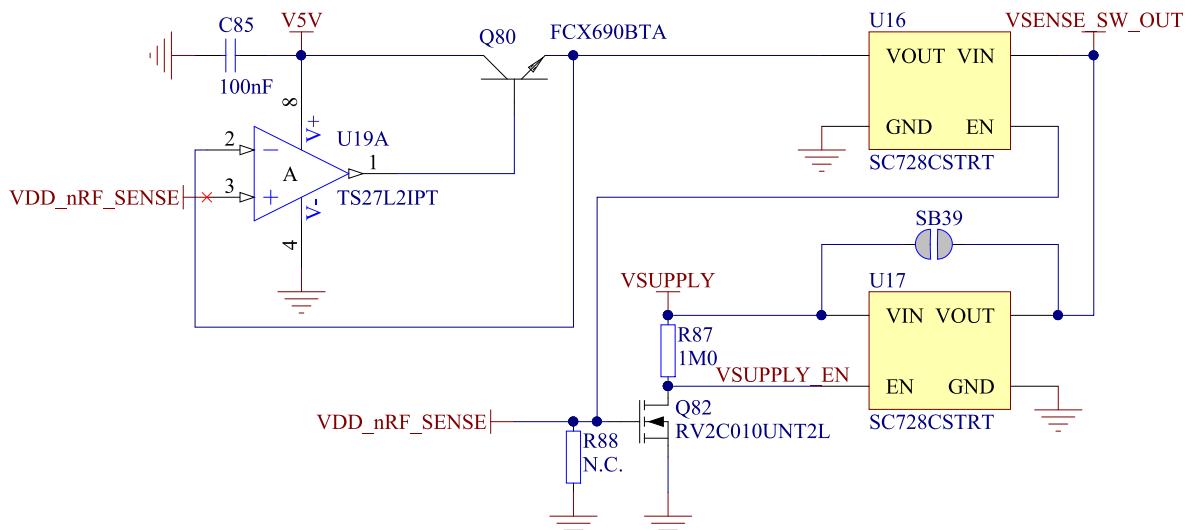


Figure 13: VDD nRF voltage follower and switch

To make sure that the nRF52840 is not powered when the nRF power switch (**SW8**) is OFF, two load switches are used, one for the high voltage regulator (**U23**) and one for the USB supply (**U22**). These switches are controlled by VDD.

8.3.5 nRF52840 direct supply

It is possible to power the *SoC* directly from a source without powering the rest of the *DK* from the same source.

The external source can be connected to the external supply connector (**P21**) and the VEXT->nRF switch (**SW10**) put in the ON position. The nRF power source switch (**SW9**) must be in the VDD position, and the allowed voltage range is 1.7–3.6 V.

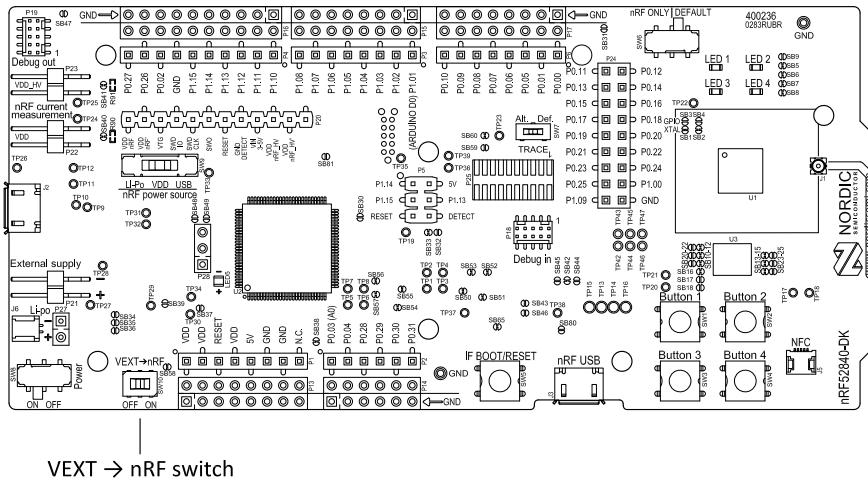


Figure 14: VEXT->nRF switch (SW10)

Since it is only the nRF52840 *SoC* that is supplied from this source, it is recommended to supply the VDD domain from a different source to prevent the pins of the *SoC* to be connected to unpowered devices.

To avoid voltage differences on the *DK*, the External supply is also connected to the input of the voltage follower when **SW10** is in the ON position. The voltage follower circuit requires 5 V to be present on the *DK*, see section [5 V power sources](#) on page 19.

The voltage follower can be disconnected from the External supply by cutting **SB58**. To prevent leakage due to voltage differences, the *DK* should be set in the nRF only mode, see section [Operating modes](#) on page 23.

Note: To reduce trace length and parasitic components, the external memory is connected to the *SoC* directly instead of using analog switches. It is recommended to cut solder bridges to avoid leakage, see section [External memory](#) on page 26.

8.4 Operating modes

The nRF52840 *DK* has various modes of operation.

8.4.1 USB detect

To detect when USB for the interface MCU is connected, there is a circuit sensing the VBUS of USB connector **J2**.

When the USB cable is connected, the VDD is propagated to the **USB_DETECT** signal.

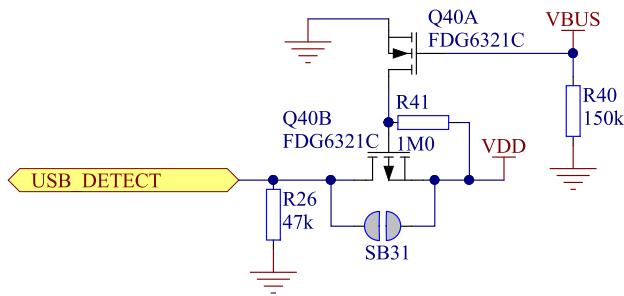


Figure 15: USB detect

8.4.2 nRF only mode

The nRF only mode disconnects the power supply of the interface MCU, the external memory, and the LEDs as well as disconnects the signal lines between the nRF52840 SoC and the interface MCU using analog switches.

This is done to isolate the chip on the *DK* as much as possible, and can be of use when measuring currents on low-power applications.

The power supply of the external memory can be changed to maintain operation in the nRF only mode. See section [External memory](#) on page 26.

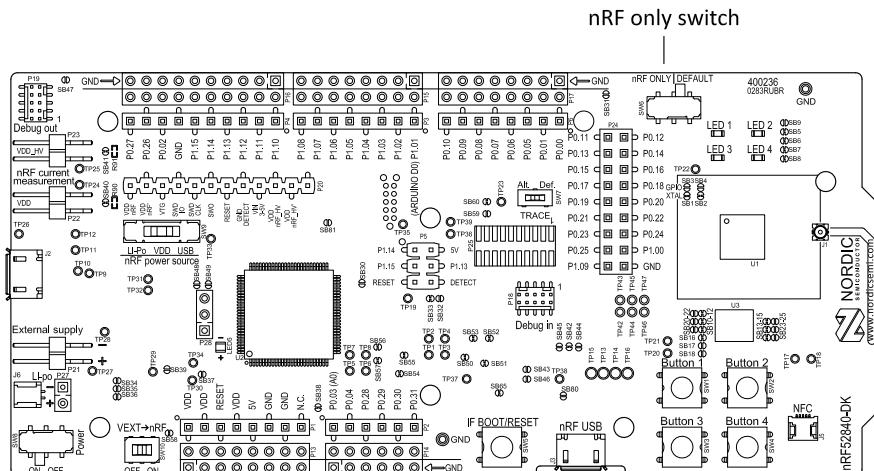


Figure 16: nRF only switch (SW6)

8.4.3 Signal switches

On the nRF52840 DK, there are multiple analog switches that are used to connect and disconnect signals based on different scenarios.

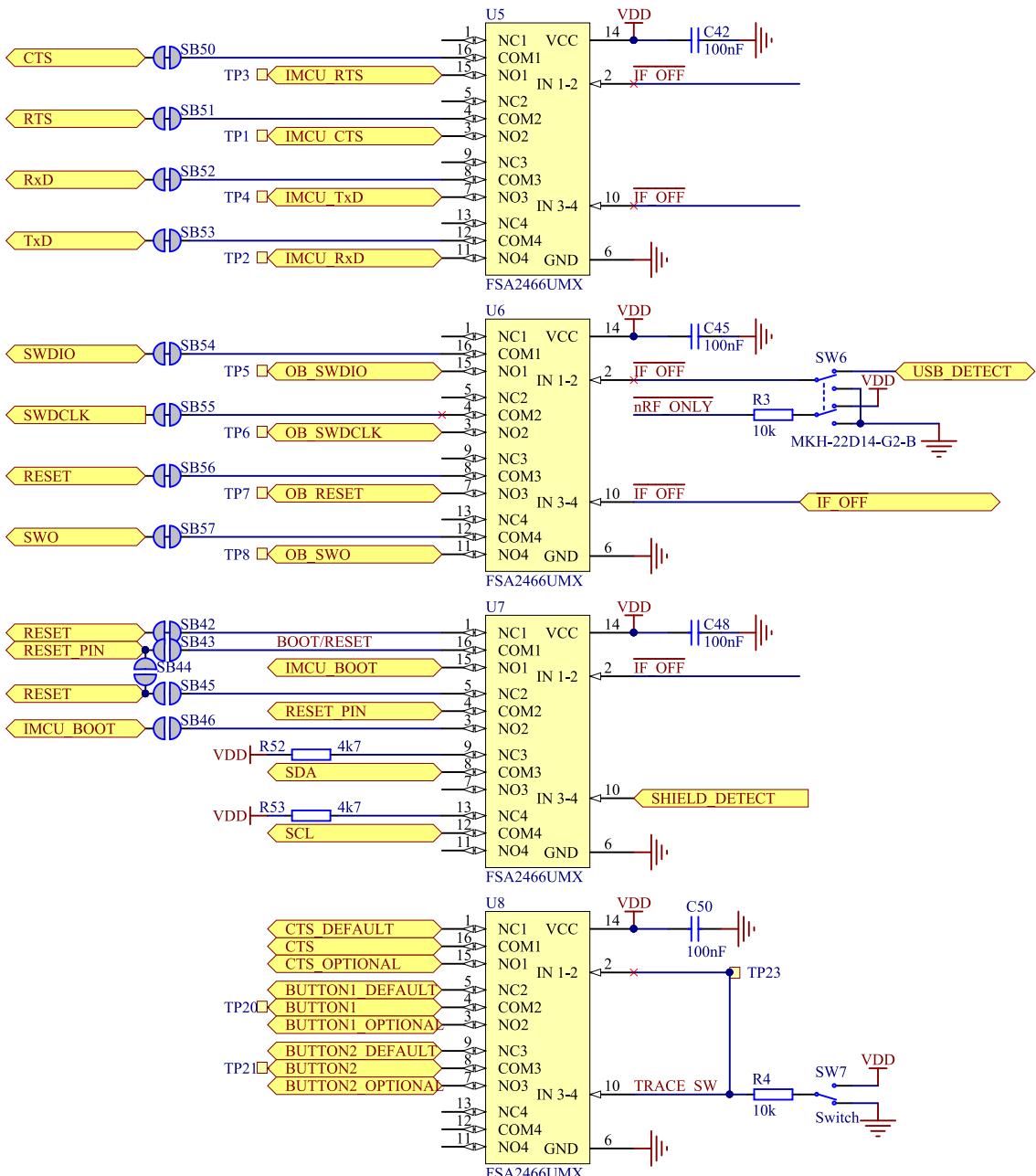


Figure 17: Signal switches

The USB and **SW6** control the signal switches by using **USB_DETECT** as an input to **SW6**. Therefore, the interface MCU can be disconnected either by unplugging the USB cable in **J2** or by toggling **SW6**.

The signal controls a set of switches (**U5**, **U6**, **U7**) that break the connection between the nRF52840 and the interface MCU, and control the power for the interface MCU. For more information, see section [Interface MCU power](#) on page 21.

Switches **U5** and **U6** break the connection of the UART lines and SWD/RESET lines. In addition, the signal controls the routing of the RESET signal depending on user preference when the interface MCU is connected/disconnected.

- When the interface MCU is disconnected, cutting **SB42** will disconnect the IF Boot/Reset button from the reset pin (**P0.18**) of nRF52840.
- When the interface MCU is disconnected, shorting **SB45** will connect the RESET pin in the Arduino interface to the reset pin (**P0.18**) of nRF52840.

- When the interface MCU is connected, shorting **SB46** will connect the RESET pin in the Arduino interface to the BOOT input of the interface MCU.
- Shorting **SB43** will connect the RESET pin in the Arduino interface to the IF Boot/Reset button.
- Shorting **SB44** will connect the RESET pin in the Arduino interface to the reset pin (**P0.18**) of nRF52840.

When a shield is connected, there are two analog switches connecting the pull-up resistors to the I2C bus lines (SDA and SCL). This function is using one ground pin on the Arduino shield to control the switch. This feature can be disabled by cutting **SB33**. To permanently enable pull-up resistors, short **SB32**.

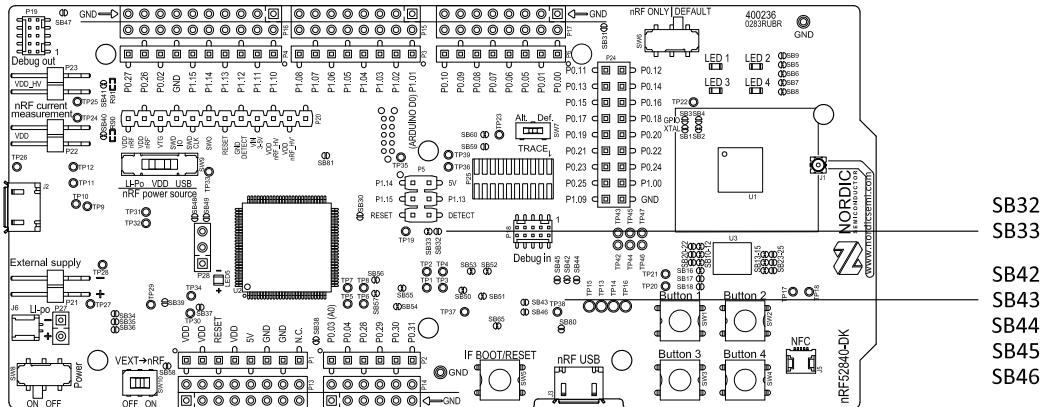


Figure 18: Solder bridges: Shield detect and reset behavior

The last switch (**U8**) controls which GPIOs certain signals are routed to. This is due to some features using the same GPIOs as the Trace output by default. These analog switches are controlled by **SW7**. See section [Debug input and trace](#) on page 31 for more information.

8.5 External memory

The nRF52840 DK has a 64 Mb external flash memory. The memory is a multi-I/O memory supporting both regular SPI and Quad SPI.

The memory is connected to the chip using the following GPIOs:

| GPIO | Flash memory pin | Solder bridge for memory use (default: shorted) | Solder bridge for GPIO use (default: open) |
|-------|------------------|---|--|
| P0.17 | CS | SB13 | SB23 |
| P0.19 | SCLK | SB11 | SB21 |
| P0.20 | SIO_0/SI | SB12 | SB22 |
| P0.21 | SIO_1/SO | SB14 | SB24 |
| P0.22 | SIO_2/WP | SB15 | SB25 |
| P0.23 | SIO_3/HOLD | SB10 | SB20 |

Table 3: Flash memory GPIO usage and connecting solder bridges

To use the GPIOs for a purpose other than the onboard external memory and have them available on the **P24** connector, six solder bridges (**SB10–SB15**) must be cut and six solder bridges (**SB20–SB25**) must be shorted. See the following figure for details.

Note: If debugging the QSPI communication is needed, the **SB20–SB25** can be shorted without cutting **SB10–SB15**, but the pins should not be driven externally.

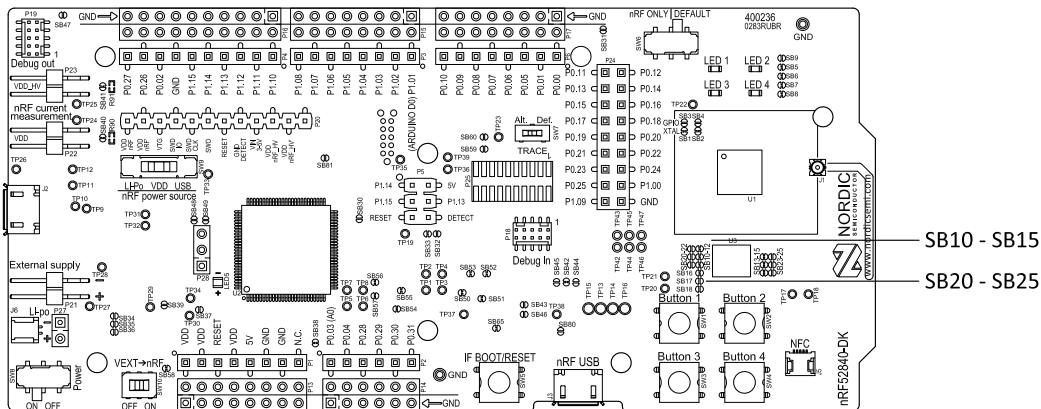


Figure 19: Configuring GPIOs for external memory

By default, the power supply of the external memory is coming from the VDD domain and it is controlled by the nRF only switch (**SW6**). In the nRF only mode, there are two optional power sources for keeping the external memory powered, VDD and VDD_nRF. If VDD_nRF is selected, the power consumption of the external memory will be added to the nRF52840 current measured on **P22** or **P23**. See the following table for configuration:

| Power source | Solder bridge | Default state |
|--------------|---------------|---------------|
| VDD_PER | SB16 | Shorted |
| VDD | SB17 | Open |
| VDD_nRF | SB18 | Open |

Table 4: Flash memory power source configuration

8.6 Connector interface

Access to the nRF52840 GPIOs is available from connectors **P2**, **P3**, **P4**, **P5**, **P6**, and **P24**.

The **P1** connector provides access to ground and power on the nRF52840 DK.

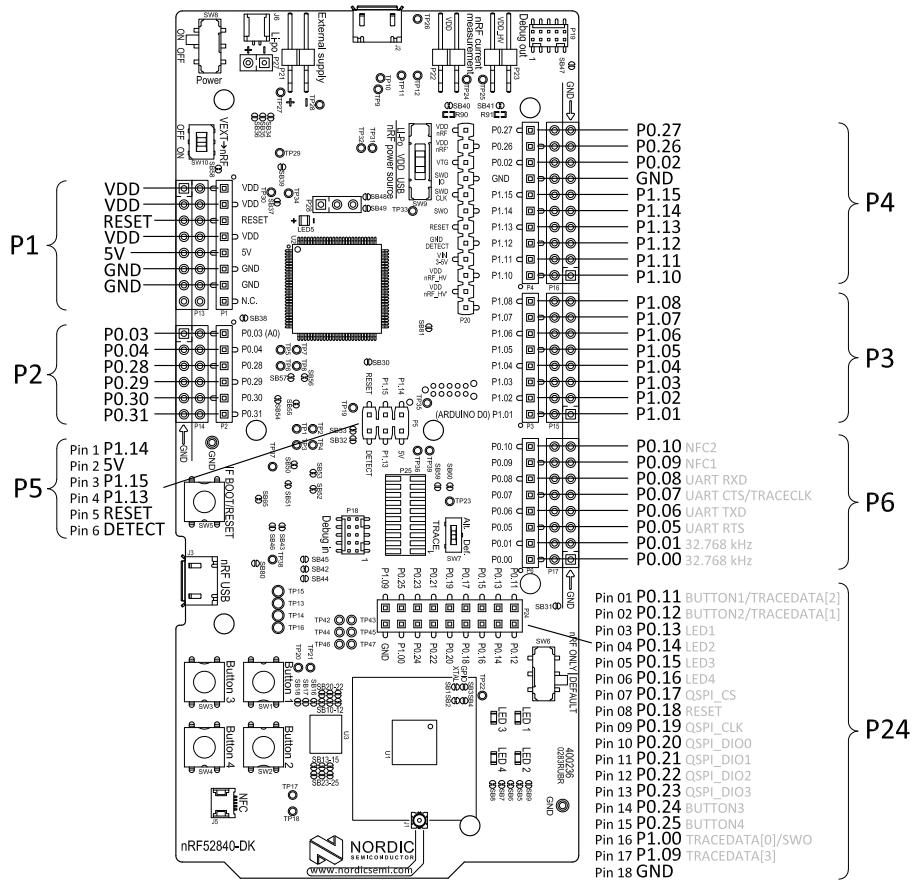


Figure 20: nRF52840 DK connectors

Some of the signals are also available on connectors **P7**, **P8**, **P9**, **P10**, **P11**, and **P12**, which are on the bottom side of the *DK*. By mounting pin lists on the connector footprints, the nRF52840 DK can be used as a shield for Arduino motherboards² or other boards that follow the Arduino standard.

For easy access to GPIO, power, and ground, the signals can also be found on the through-hole connectors **P13–P17**.

Note:

Some pins have default settings:

- **P0.00** and **P0.01** are used for the 32.768 kHz crystal and are not available on the connectors. For more information, see section [32.768 kHz crystal](#) on page 31.
- **P0.05**, **P0.06**, **P0.07**, and **P0.08** are used by the UART connected to the interface MCU. For more information, see section [Virtual COM port](#) on page 14.
- **P0.09** and **P0.10** are by default used by NFC1 and NFC2. For more information, see section [NFC antenna interface](#) on page 33.
- **P0.11–P0.16** and **P0.24–P0.25** are by default connected to the buttons and LEDs. For more information, see section [Buttons and LEDs](#) on page 29.
- **P0.17** and **P0.19–P0.23** are by default connected to the external memory. For more information, see section [External memory](#) on page 26.

When the nRF52840 DK is used as a shield together with an Arduino standard motherboard, the Arduino signals are routed as shown in the figure below.

² Only 3.3 V Arduino boards.

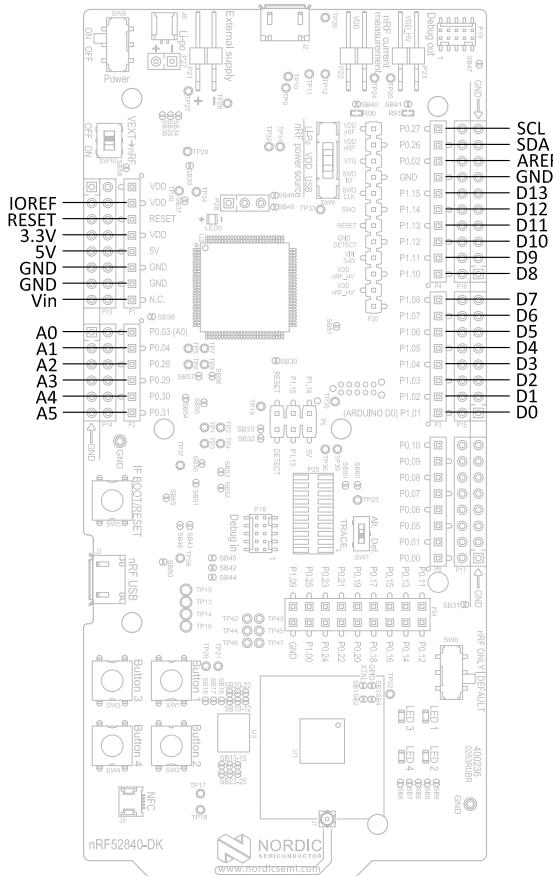


Figure 21: Arduino signals routing on the nRF52840 DK

8.6.1 Mapping of analog pins

The table shows the mapping between GPIO pins, analog inputs, and the corresponding Arduino analog input naming.

| GPIO | Analog input | Arduino naming |
|-------|--------------|----------------|
| P0.03 | AIN1 | A0 |
| P0.04 | AIN2 | A1 |
| P0.28 | AIN4 | A2 |
| P0.29 | AIN5 | A3 |
| P0.30 | AIN6 | A4 |
| P0.31 | AIN7 | A5 |

Table 5: Mapping of analog pins

8.7 Buttons and LEDs

The four buttons and four LEDs on the nRF52840 DK are connected to dedicated GPIOs on the nRF52840 chip.

| Part | GPIO | GPIO alternative | Solder bridge |
|----------|-------|------------------|---------------|
| Button 1 | P0.11 | P1.07 | - |
| Button 2 | P0.12 | P1.08 | - |
| Button 3 | P0.24 | | - |
| Button 4 | P0.25 | | - |
| LED 1 | P0.13 | | SB5 |
| LED 2 | P0.14 | | SB6 |
| LED 3 | P0.15 | | SB7 |
| LED 4 | P0.16 | | SB8 |

Table 6: Button and LED connection

If **P0.13–P0.16** are needed elsewhere, the LEDs can be disconnected by cutting the short on **SB5–SB8**, see figure [Figure 22: Disconnecting the LEDs](#) on page 30. Since **P0.11** and **P0.12** are used as a part of the Trace functionality, Button 1 and Button 2 can be moved to alternative GPIOs, see chapter [Debug input and trace](#) on page 31 for more information.

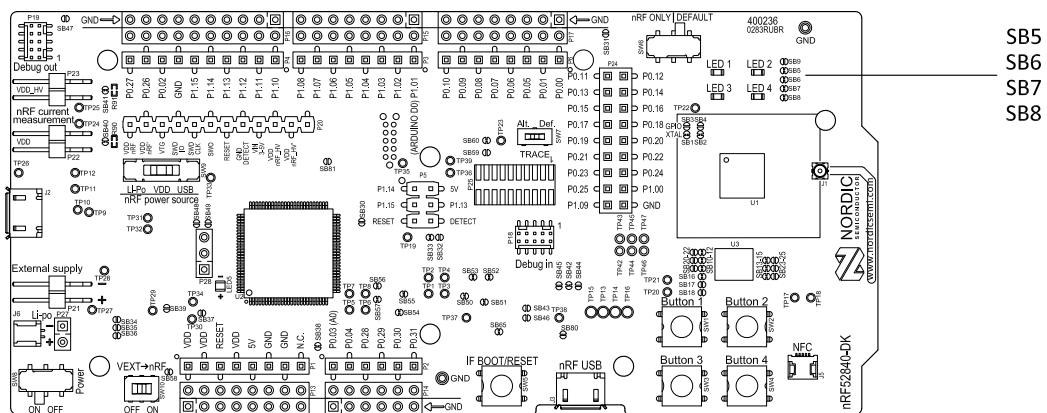


Figure 22: Disconnecting the LEDs

The buttons are active low, meaning that the input will be connected to ground when the button is activated. The buttons have no external pull-up resistor, and therefore, to use the buttons, the **P0.11**, **P0.12**, **P0.24**, **P0.25** pins must be configured as an input with an internal pull-up resistor.

The LEDs are active low, meaning that writing a logical zero ('0') to the output pin will illuminate the LED.

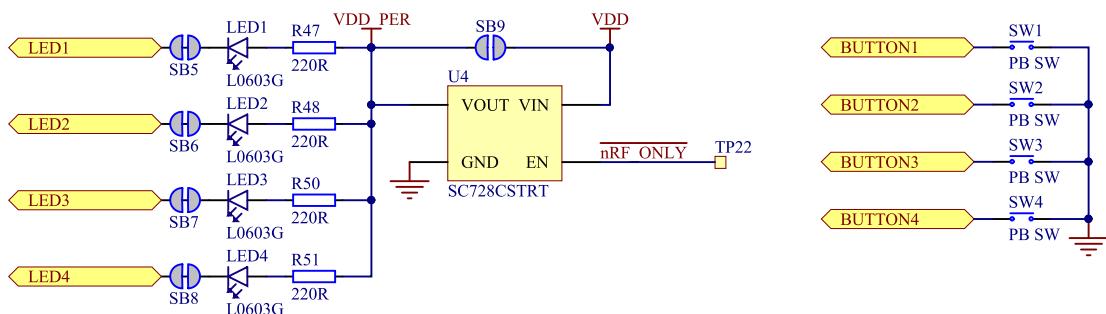


Figure 23: Button and LED configuration

8.8 32.768 kHz crystal

The nRF52840 SoC can use an optional 32.768 kHz crystal (**X2**) for higher accuracy and lower average power consumption.

On the nRF52840 DK, **P0.00** and **P0.01** are used for the 32.768 kHz crystal by default and are not available as GPIO on the connectors.

Note: When using ANT/ANT+, the 32.768 kHz crystal (**X2**) is required for correct operation.

If **P0.00** and **P0.01** are needed as normal I/Os, the 32.768 kHz crystal can be disconnected and the GPIO routed to the connectors. Cut the shorting track on **SB1** and **SB2**, and solder **SB3** and **SB4**. See the following figure for reference.

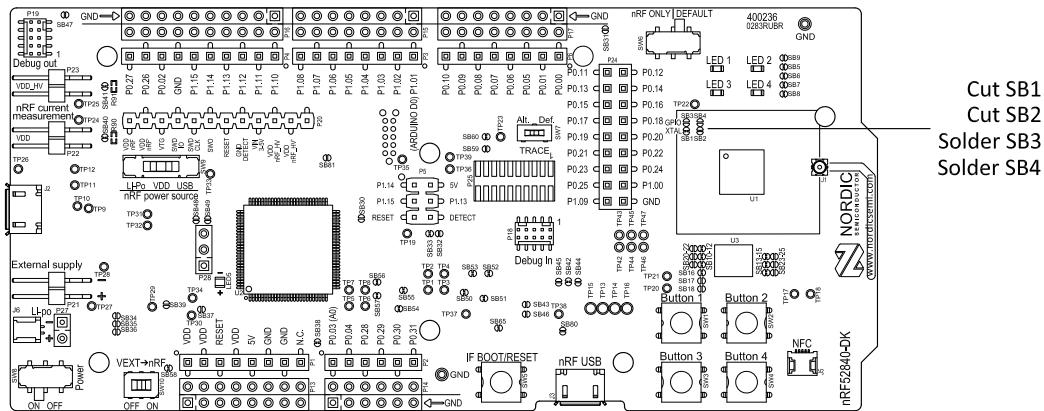


Figure 24: Configuring **P0.00** and **P0.01**

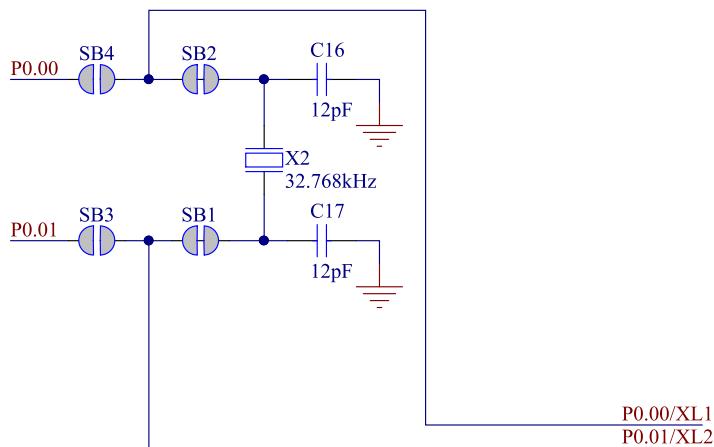


Figure 25: 32.768 kHz crystal and **SB1–SB4**

8.9 Debug input and trace

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

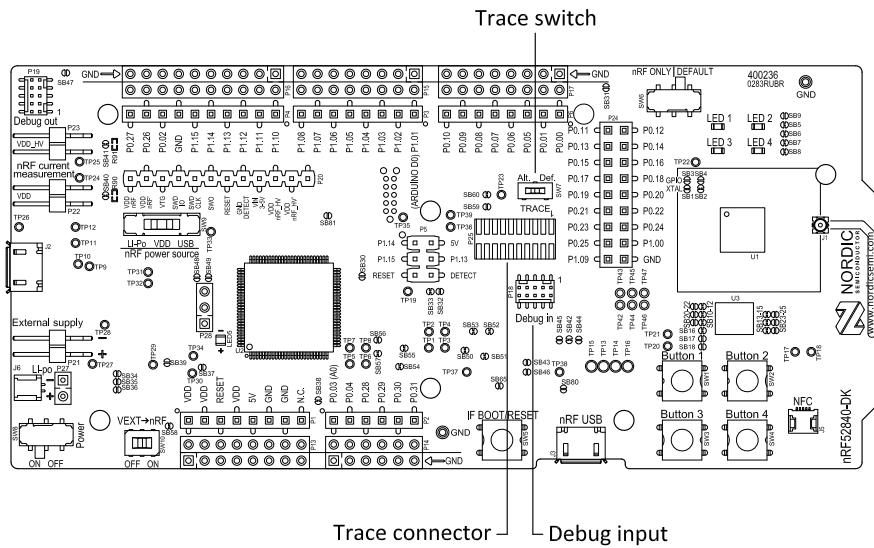


Figure 26: Debug input and trace connectors

For trace, a footprint for a 20-pin connector is available (**P25**). If trace functionality is required, it is possible to mount a 2×10 pin 1.27 mm pitch surface mount pin header.

Some of the trace pins are by default used for other functionality on the *DK*. By sliding the TRACE switch (**SW7**) from Def. to Alt., the functionality is moved to other GPIOs. See the following table:

| GPIO | Trace | Default use | Optional GPIO |
|-------|--------------|-------------|---------------|
| P0.07 | TRACECLK | UART CTS | P0.04 |
| P1.00 | TRACEDATA[0] | | |
| P0.11 | TRACEDATA[1] | Button 1 | P1.07 |
| P0.12 | TRACEDATA[2] | Button 2 | P1.08 |
| P1.09 | TRACEDATA[3] | | |

Table 7: Default and Trace GPIOs

The reference voltage for the debug input and trace is by default connected to VDD_nRF'. This can be connected to the VDD by cutting **SB60** and soldering **SB59**.

8.10 Debug output

The nRF52840 DK supports programming and debugging external boards with nRF51 or nRF52 SoCs. To debug an external board with SEGGER J-Link OB IF, connect to the Debug out connector (**P19**) with a 10-pin cable.

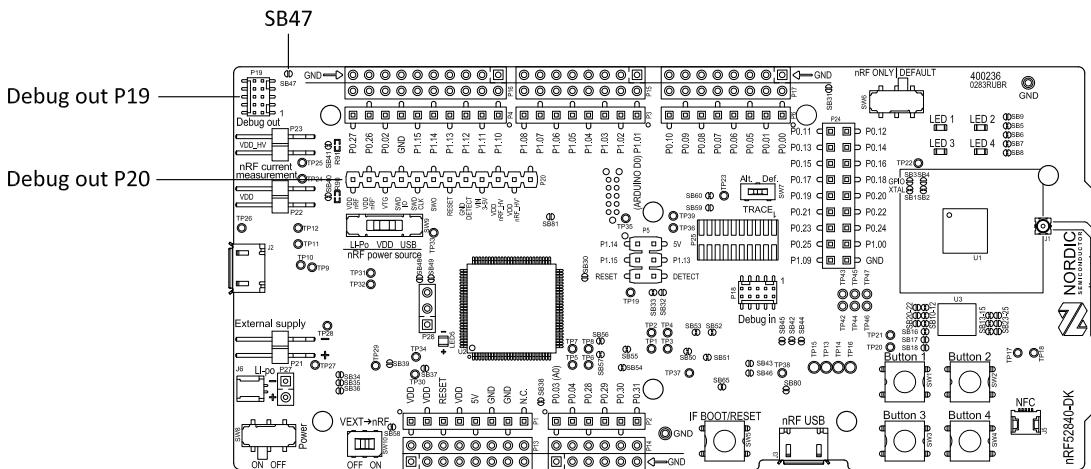


Figure 27: Debug output connector

When the external board is powered, the interface MCU will detect the supply voltage of the board and program/debug the target chip on the external board instead of the onboard nRF52840 SoC.

Note: The voltage supported by external debugging/programming is VDD voltage. Normally, this is 3 V when running from USB, but if the onboard nRF52840 SoC is supplied from either USB or Li-Ion, the nRF power source switch (**SW9**) is in either Li-Po or USB position, and VDD can be set by the nRF52840 firmware. Make sure the voltage level of the external board matches the VDD of the nRF52840 DK.

You can also use **P20** as a debug out connection to program shield-mounted targets. For both **P19** and **P20**, the interface MCU will detect the supply voltage on the mounted shield and program/debug the target connected to **P19**.

If the interface MCU detects target power on both **P19** and **P20**, it will by default program/debug the target connected to **P19**.

If it is inconvenient to have a separate power supply on the external board, the nRF52840 DK can supply power through the Debug out connector (**P19**). To enable this, short solder bridge **SB47**. Note that as long as **SB47** is shorted, it is not possible to program the onboard nRF52840 SoC even if the external board is unplugged.

8.11 NFC antenna interface

The nRF52840 DK supports an *NFC* tag.

NFC-A listen mode operation is supported on the nRF52840 SoC. The *NFC* antenna input is available on connector **J5** on the nRF52840 DK.

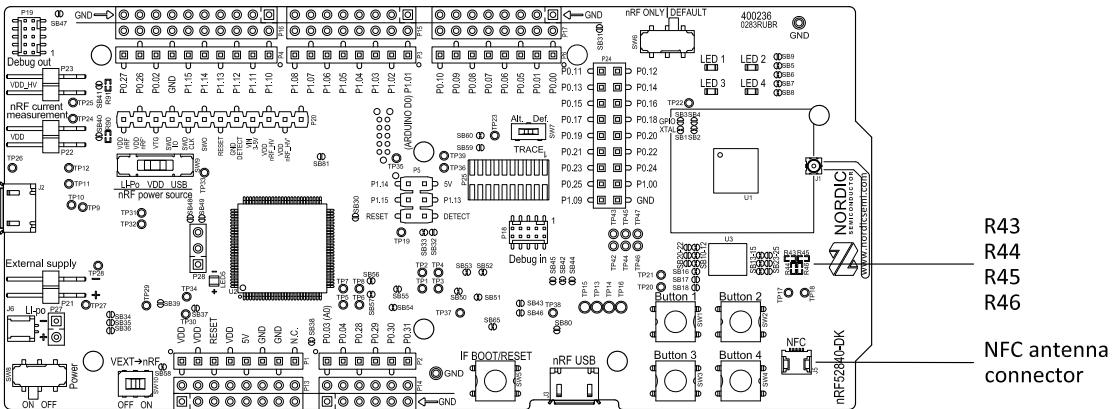


Figure 28: NFC antenna connector

NFC uses two pins, **L24** (NFC1) and **J24** (NFC2), to connect the antenna. These pins are shared with GPIOs (**P0.09** and **P0.10**) and the PROTECT field in the NFCPINS register in UICR defines the usage of these pins and their protection level against abnormal voltages. The content of the NFCPINS register is reloaded at every reset.

Note: The NFC pins are enabled by default.

NFC can be disabled and GPIOs enabled by defining the CONFIG_NFCT_PINS_AS_GPIOS variable in the project settings. The way of doing this depends on the IDE/toolchain in use:

- When using SEGGER Embedded Studio, go to **Project > Edit Options > Code > Preprocessor > Preprocessor Definitions** and add the CONFIG_NFCT_PINS_AS_GPIOS variable.
- When using Keil, go to **Project > Options for Target > C/C++ > Preprocessor Symbols > Define** and add the CONFIG_NFCT_PINS_AS_GPIOS variable.

Pins **L24** and **J24** are by default configured to use the *NFC* antenna, but if they are needed as normal GPIOs, **R44** and **R46** must be NC and **R43** and **R45** must be shorted by **OR**.

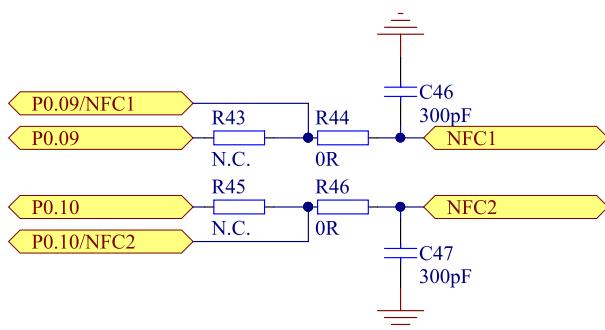


Figure 29: NFC input

8.12 Extra op-amp

The voltage follower for the power supply uses a dual package op-amp.

The extra op-amp has been routed out to a connector (**P28**, not mounted) so that it is accessible for the user.

For more information on the power supply, see section [Power supply](#) on page 18.

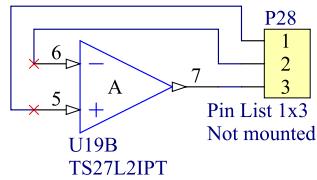


Figure 30: Extra op-amp

8.13 Solder bridge configuration

This complete overview of solder bridges on the nRF52840 DK helps to change the default state.

| Solderbridge | Default | Function |
|--------------|---------|---|
| SB1 | Closed | Cut to disconnect the 32.768 kHz on P0.01 |
| SB2 | Closed | Cut to disconnect the 32.768 kHz on P0.00 |
| SB3 | Open | Short to enable P0.01 as normal GPIO |
| SB4 | Open | Short to enable P0.00 as normal GPIO |
| SB5 | Closed | Cut to disconnect LED1 |
| SB6 | Closed | Cut to disconnect LED2 |
| SB7 | Closed | Cut to disconnect LED3 |
| SB8 | Closed | Cut to disconnect LED4 |
| SB9 | Open | Short to bypass peripheral power switch |
| SB10 | Closed | Cut to disconnect the QSPI memory from P0.23 |
| SB11 | Closed | Cut to disconnect the QSPI memory from P0.19 |
| SB12 | Closed | Cut to disconnect the QSPI memory from P0.20 |
| SB13 | Closed | Cut to disconnect the QSPI memory from P0.17 |
| SB14 | Closed | Cut to disconnect the QSPI memory from P0.21 |
| SB15 | Closed | Cut to disconnect the QSPI memory from P0.22 |
| SB16 | Closed | Cut to disconnect QSPI memory power supply from VDD_PER |
| SB17 | Open | Short to connect QSPI memory power supply to VDD |
| SB18 | Open | Short to connect QSPI memory power supply to VDD_nRF |
| SB20 | Open | Short to enable P0.23 as a normal GPIO |
| SB21 | Open | Short to enable P0.19 as a normal GPIO |
| SB22 | Open | Short to enable P0.20 as a normal GPIO |
| SB23 | Open | Short to enable P0.17 as a normal GPIO |
| SB24 | Open | Short to enable P0.21 as a normal GPIO |
| SB25 | Open | Short to enable P0.22 as a normal GPIO |
| SB20 | Open | Short to reset the interface MCU |

| Solderbridge | Default | Function |
|--------------|---------|--|
| SB31 | Open | Short to bypass the USB detect switch |
| SB32 | Open | Short to permanently enable the I ² C pull-up resistors |
| SB33 | Closed | Cut to permanently disable the I ² C pull-up resistors |
| SB34 | Open | Short to bypass the power switch on the USB power |
| SB35 | Open | Short to bypass the power switch on the coin cell battery power |
| SB36 | Open | Short to bypass the power switch on the external supply power |
| SB37 | Open | Short to bypass the interface MCU power switch |
| SB38 | Closed | Cut to disable VDD power to the Arduino interface |
| SB39 | Open | Short to bypass the power switch for regulator, coin cell, or external supply |
| SB40 | Closed | Cut for current measurements of the VDD_nRF |
| SB41 | Closed | Cut for current measurements of the VDD_nRF_HV |
| SB42 | Closed | Cut to disconnect IF Boot/Reset button from nRF52840 reset pin when the interface MCU is disconnected |
| SB43 | Open | Short to connect IF Boot/Reset button to RESET pin on the Arduino interface |
| SB44 | Open | Short to connect the RESET pin on the Arduino interface to the nRF52840 reset pin |
| SB45 | Open | Short to connect the RESET pin on the Arduino interface to the interface nRF52840 reset pin when the interface MCU is disconnected |
| SB46 | Open | Short to connect the RESET pin on the Arduino interface to the interface MCU Boot when the interface MCU is disconnected |
| SB47 | Open | Short to enable power supply of the external device when using the debug out connector |
| SB48 | Open | Short to bypass the interface MCU USB power switch |
| SB49 | Open | Short to connect VDD_UTMI to VDD_SAM |
| SB50 | Closed | Cut to disconnect the nRF52840 CTS line from the signal switch and interface MCU |
| SB51 | Closed | Cut to disconnect the nRF52840 RTS line from the signal switch and interface MCU |
| SB52 | Closed | Cut to disconnect the nRF52840 RxD line from the signal switch and the interface MCU |
| SB53 | Closed | Cut to disconnect the nRF52840 TxD line from the signal switch and interface MCU |
| SB54 | Closed | Cut to disconnect the nRF52840 SWDIO line from the signal switch and interface MCU |
| SB55 | Closed | Cut to disconnect the nRF52840 SWDCLK line from the signal switch and interface MCU |

| Solderbridge | Default | Function |
|--------------|---------|--|
| SB56 | Closed | Cut to disconnect the nRF52840 RESET line from the signal switch and interface MCU |
| SB57 | Closed | Cut to disconnect the nRF52840 SWO line from the signal switch and the interface MCU |
| SB58 | Closed | Cut to disconnect voltage follower from external supply when SW10 is in ON position |
| SB59 | Open | Solder to connect debug in and trace reference voltage to VDD |
| SB60 | Closed | Cut to disconnect debug in and trace reference voltage from VDD_nRF' |
| SB65 | Closed | Cut to disable the pull-up resistor of the IMCU_BOOT line |
| SB80 | Open | Short to bypass the power switch for the VBUS of nRF52840 |
| SB81 | Open | Short to bypass the power switch for VDD_HV of nRF52840 |

Table 8: Solder bridge configuration

9 Measuring current

The current drawn by the nRF52840 *SoC* can be monitored on the nRF52840 DK.

Current can be measured using various test instruments. Examples of test equipment are the following:

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

Power analyzer and Power Profiler Kit measurements will not be described in the present document. For more information on Power Profiler Kit, see [Power Profiler Kit User Guide](#).

For instructions for measuring, see sections [Using an oscilloscope for current profile measurement](#) on page 39 and [Using an ampere-meter for current measurement](#) on page 40.

The nRF52840 *SoC* has two possible power supplies, VDD (1.7–3.6 V) and VDDH (2.5–5.5 V). The nRF52840 DK is prepared for measuring current on both domains. Only the VDD domain current measurement is described here, but the approach is the same with the VDDH supply. See the following table for the corresponding components:

| Component | VDD | VDDH |
|-----------------------|------|------|
| Measurement connector | P22 | P23 |
| Solder bridge | SB40 | SB41 |
| Series resistor | R90 | R91 |

Table 9: Components for current measurement on VDD and VDDH

Note: When measuring the current consumption:

- It is not recommended to use a USB connector to power the *DK* during current measurements. However, when measuring current on an application using the USB interface of the nRF52840 *SoC*, the USB must be connected. It is recommended to power the *DK* from a coin cell battery, external power supply on connector **P21** (1.7–3.6 V), or through the Li-Po connector **J6** or **P27** (2.5–5.0 V).
- The current measurements will become unreliable when a serial terminal is connected to the virtual COM port.
- After programming the nRF52840 *SoC*, the USB for the interface MCU must be disconnected.

For more information on current measurement, see the tutorial [Current measurement guide: Introduction](#).

9.1 Preparing the development kit

To measure current, you must first prepare the *DK*.

The suggested configurations actually split the power domains for the nRF52840 *SoC* and the rest of the *DK*.

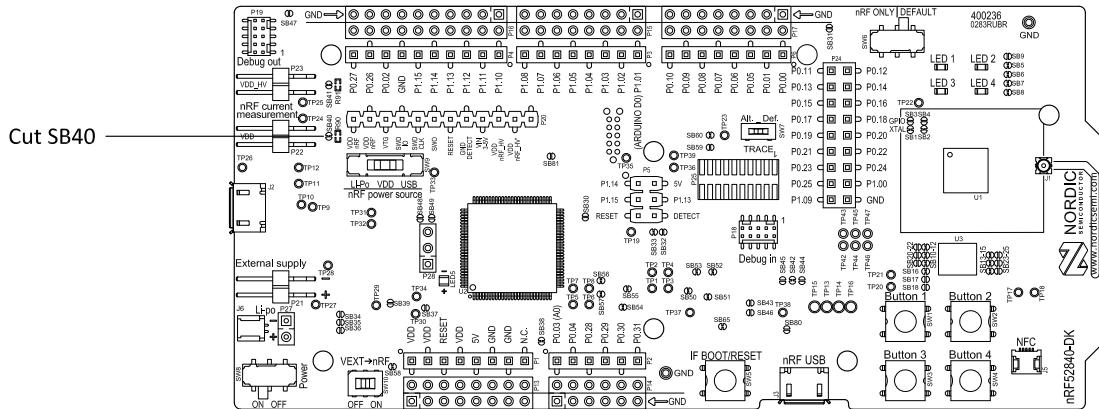


Figure 31: Preparing the DK for current measurements

- To put **P22** in series with the load, cut the PCB track shorting solder bridge **SB40**.
- To restore normal kit function after measurement, solder **SB40** or apply a jumper on **P22**.
- To reprogram the nRF52840 SoC while the DK is prepared for current measurements, remove measurement devices from **P22**, and then connect the USB cable.

9.2 Using an oscilloscope for current profile measurement

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

Make sure you have prepared the DK as described in section [Preparing the development kit](#) on page 38.

1. Mount a $10\ \Omega$ resistor on the footprint for **R90**.
2. Connect an oscilloscope in differential mode or similar with two probes on the pins of the **P22** connector as shown in the figure below.
3. Calculate or plot the instantaneous current from the voltage drop across the $10\ \Omega$ resistor by taking the difference of the voltages measured on the two probes. The voltage drop will be proportional to the current. The $10\ \Omega$ resistor will cause a 10 mV drop for each 1 mA drawn by the circuit being measured.

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.

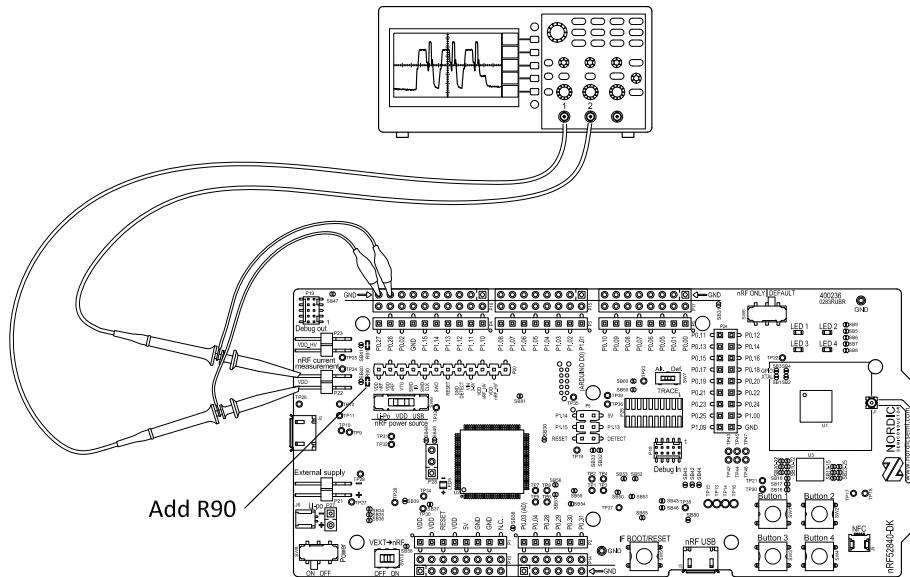


Figure 32: Current measurement with an oscilloscope

Some tips to reduce noise:

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

Use a minimum of 200 kSa/s (one sample every 5 µs) to get the correct average current measurement.

9.3 Using an ampere-meter for current measurement

The average current drawn by the nRF52840 SoC can be measured using an ampere-meter. This method will monitor the current in series with the nRF device.

Make sure you have prepared the DK as described in section [Preparing the development kit](#) on page 38.

Connect an ampere-meter between the pins of connector **P22** as shown in the figure below.

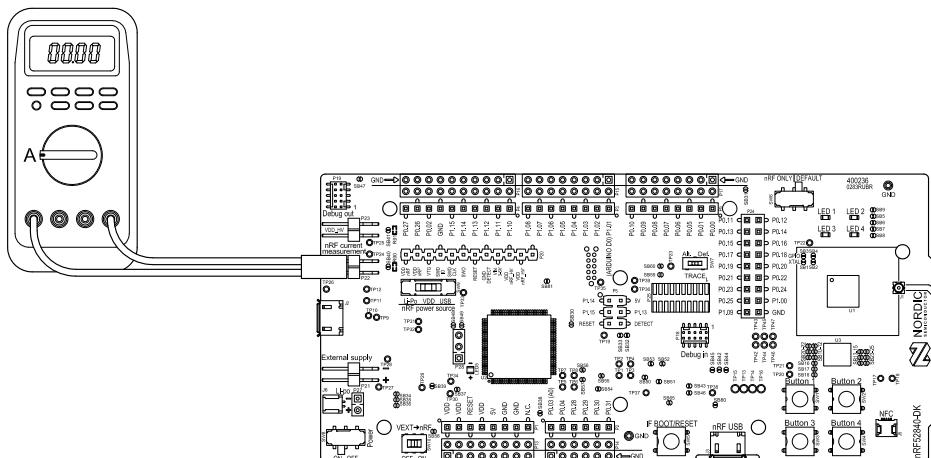


Figure 33: Current measurement with an ampere-meter

Note: An ampere-meter will measure the average current drawn by the nRF52840 SoC if:

- The SoC is in a state where it draws a constant current, or, the activity on the device changing load current, like BLE connection events, is repeated continuously and has a short cycle time (less than 100 ms) so that the ampere-meter will average whole load cycles and not parts of the cycle.
- The dynamic range of the ampere-meter is wide enough to give accurate measurements from 1 μ A to 15 mA.

It is recommended that you use a true RMS ampere-meter.

10 RF measurements

The nRF52840 DK is equipped with a small coaxial connector (**J1**) for conducting measurements of the RF signal using a spectrum analyzer.

The connector is of SWF type (Murata part no. MM8130-2600) with an internal switch. By default, when no cable is attached, the RF signal is routed to the onboard trace antenna.

A test probe is available (Murata part no. MXHS83QE3000) with a standard SMA connection on the other end for connecting instruments (the test probe is not included with the kit). When connecting the test probe, the internal switch in the SWF connector will disconnect the onboard antenna and connect the RF signal from the nRF52840 SoC to the test probe.

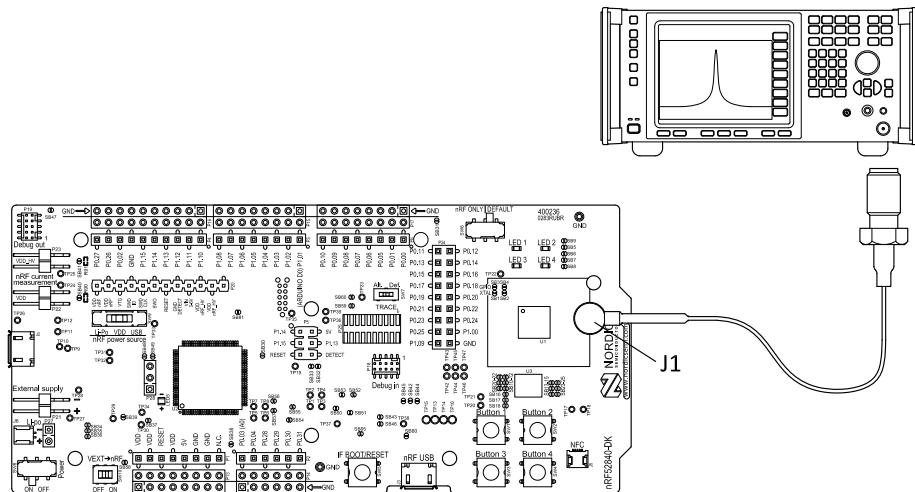


Figure 34: Connecting a spectrum analyzer

The connector and test probe will add loss to the RF signal, which should be taken into account when measuring, see the following table:

| Frequency (MHz) | Loss (dB) |
|-----------------|-----------|
| 2440 | 1.0 |
| 4880 | 1.7 |
| 7320 | 2.6 |

Table 10: Typical loss in connector and test probe

Glossary

Clear to Send (CTS)

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

Data Terminal Ready (DTR)

A control signal in RS-232 serial communications transmitted from data terminal equipment, such as a computer, to data communications equipment.

Development Kit (DK)

A development platform used for application development.

Hardware Flow Control (HWFC)

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

Integrated Development Environment (IDE)

A software application that provides facilities for software development.

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.

Near Field Communication (NFC)

A standards-based short-range wireless connectivity technology that enables two electronic devices to establish communication by bringing them close to each other.

NFC-A Listen Mode

Initial mode of an NFC Forum Device when it does not generate a carrier. The device listens for the remote field of another device. See [Near Field Communication \(NFC\)](#) on page 43.

Operational Amplifier (op-amp)

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

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.

Root Mean Square (RMS)

An RMS meter calculates the equivalent direct current (DC) value of an alternating current (AC) waveform. A true-RMS meter can accurately measure both pure waves and the more complex nonsinusoidal waves.

SubMiniature Version A (SMA) Connector

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

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.

Acronyms and abbreviations

These acronyms and abbreviations are used in this document.

CTS

Clear to Send

DK

Development Kit

DTR

Data Terminal Ready

HWFC

Hardware Flow Control

IDE

Integrated Development Environment

MSD

Mass Storage Device

NFC

Near Field Communication

op-amp

Operational Amplifier

RMS

Root Mean Square

RTS

Request to Send

RXD

Receive Data

SMA

SubMiniature version A

SoC

System on Chip

TXD

Transmit Data

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