nRF52840 DK

v1.0.0

User Guide

NORDIC®
SEMICONDUCTOR

Contents

Revision history

Date	Description
2020-12-03	Editorial changes
April 2020	Editorial changes
December 2019	Fixed broken links
February 2019	Updated Introduction on page 5: nRF52811 support
September 2018	Updated: • Nordic tools and downloads on page 9 • Start developing on page 12 • Preparing the DK on page 37
June 2018	Updated Getting started on page 8
April 2018	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 hardware development platform used to design and develop application firmware on the nRF52840 *System on Chip (SoC)*.

This kit can be used for developing for either the nRF52840 and nRF52811 *SoC*s.

The key features of the *Development Kit (DK)* are:

- nRF52840 flash-based *Bluetooth*® Low Energy, ANT™/ANT+™ *SoC* solution
- Support for nRF52840 and nRF52811 *SoC*s development
- 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
- Support for *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

- One of the following operating systems:
  - Windows 7
  - Windows 8
  - Windows 10
  - macOS
  - Linux
- SEGGER J-Link Software

3 Kit content

The nRF52840 DK includes hardware, preprogrammed firmware, documentation, hardware schematics, and layout files.

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

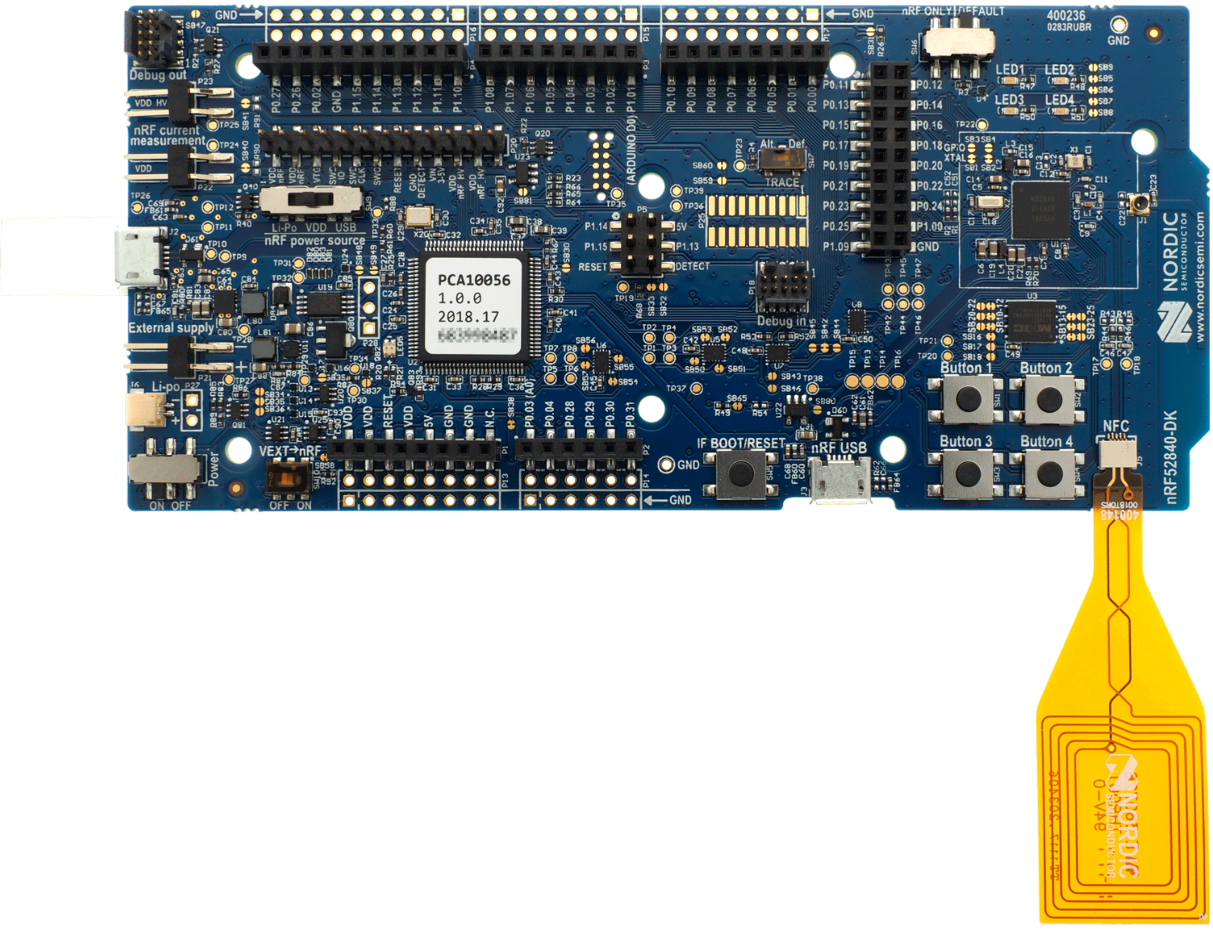


Figure 1: nRF52840 DK (PCA10056) and NFC antenna

Hardware files

The hardware design files including schematics, PCB layout files, bill of materials, and Gerber files for the nRF52840 DK are available on the nRF52840 product page.

4 Getting started

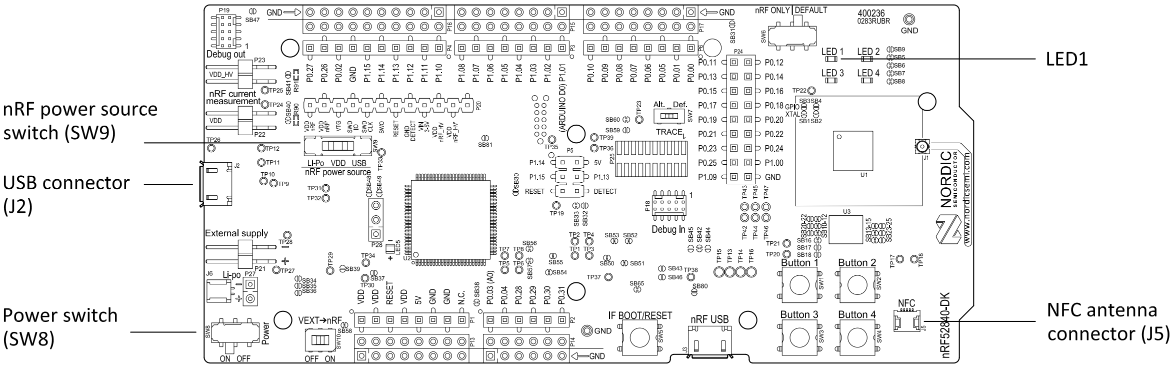
Before you start developing, complete a few steps to set up the hardware and download the required software.

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*:

   a) 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.

   b) Slide the nRF power source switch **SW9** to VDD.

   c) 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 28.

   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 9. 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 v17.0.2 nRF5 SDK for Mesh v5.0.0 nRF5 SDK for Thread and Zigbee v4.1.0	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: • 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	nRF 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 (nRF5 Series devices), see nRF5 SDK Getting Started.
- For nRF5 SDK for Mesh (nRF5 Series devices), 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*.

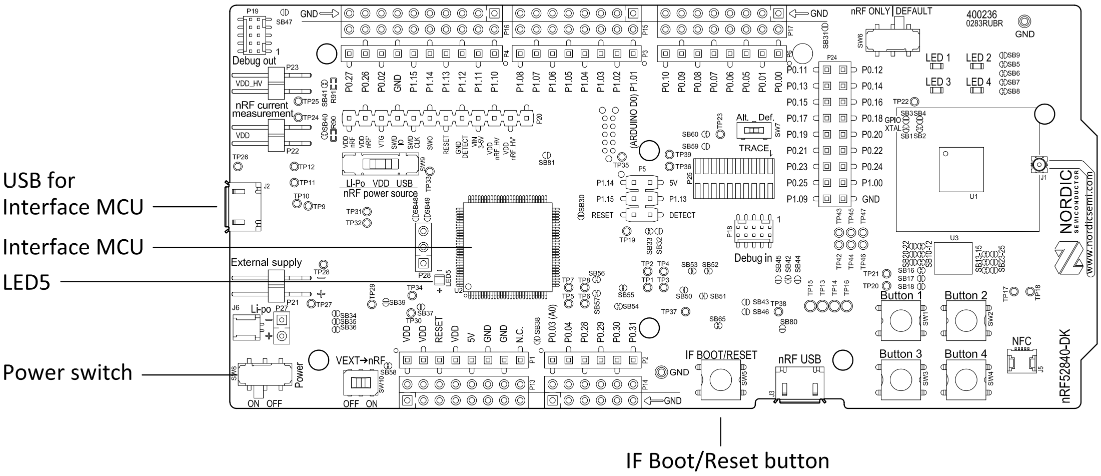


Figure 2: Interface MCU

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 *Universal Asynchronous Receiver/Transmitter (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 following table shows an overview of the *UART* connections on nRF52840 *SoC* 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.

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

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.

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 *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.

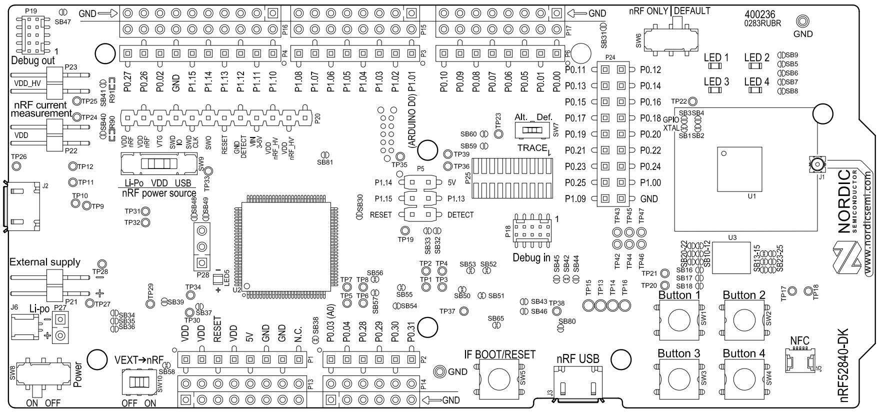
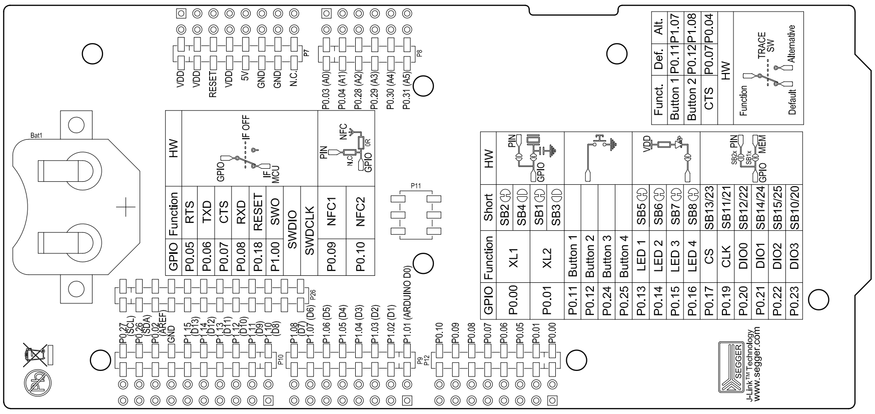


Figure 3: nRF52840 DK (PCA10056) front view



GPIO	Function	HW
P0.05	RTS	
P0.06	TXD	
P0.07	CTS	
P0.08	RXD	
P0.18	RESET	
P1.00	SWO	
SWDIO		
SWDCLK		
P0.09	NFC1	
P0.10	NFC2	

GPIO	Function	Short	HW
P0.00	XL1	SB2	
		SB4	
P0.01	XL2	SB1	
		SB3	
P0.11	Button 1		
P0.12	Button 2		
P0.24	Button 3		
P0.25	Button 4		
P0.13	LED 1	SB5	
P0.14	LED 2	SB6	
P0.15	LED 3	SB7	
P0.16	LED 4	SB8	
P0.17	CS	SB13/23	
P0.19	CLK	SB11/21	
P0.20	DIO0	SB12/22	
P0.21	DIO1	SB14/24	
P0.22	DIO2	SB15/25	
P0.23	DIO3	SB10/20	

Funct.	Def.	Alt.
Button 1	P0.11	P1.07
Button 2	P0.12	P1.08
CTS	P0.07	P0.04
HW		

Figure 4: nRF52840 DK (PCA10056) back view

8.2 Block diagram

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

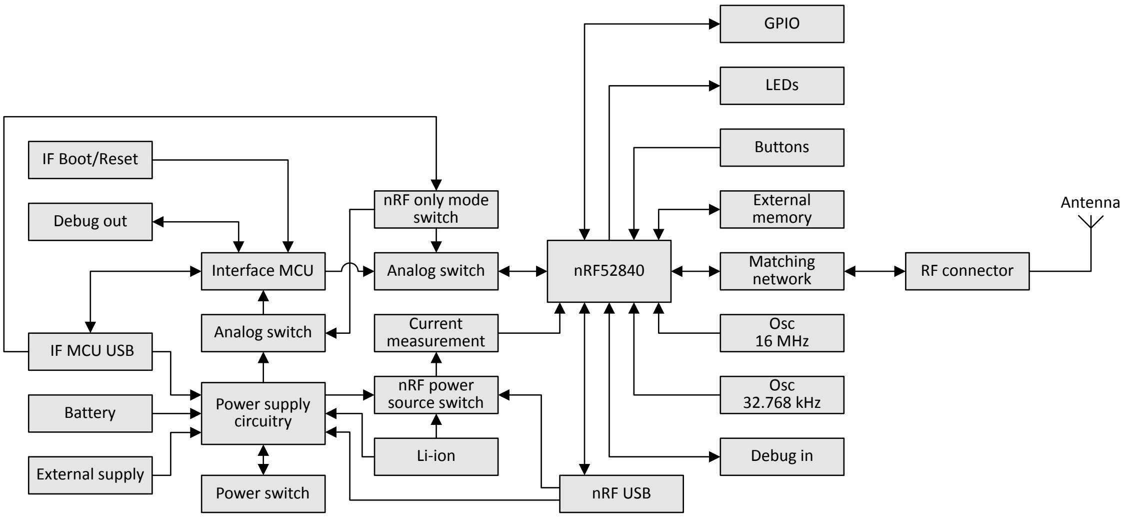


Figure 5: Block diagram

8.3 Power supply

The nRF52840 DK has multiple power options.

The power options are the following:

- USB connector **J2** for the interface MCU (5 V)
- USB connector **J3** for the nRF52840 *SoC* (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

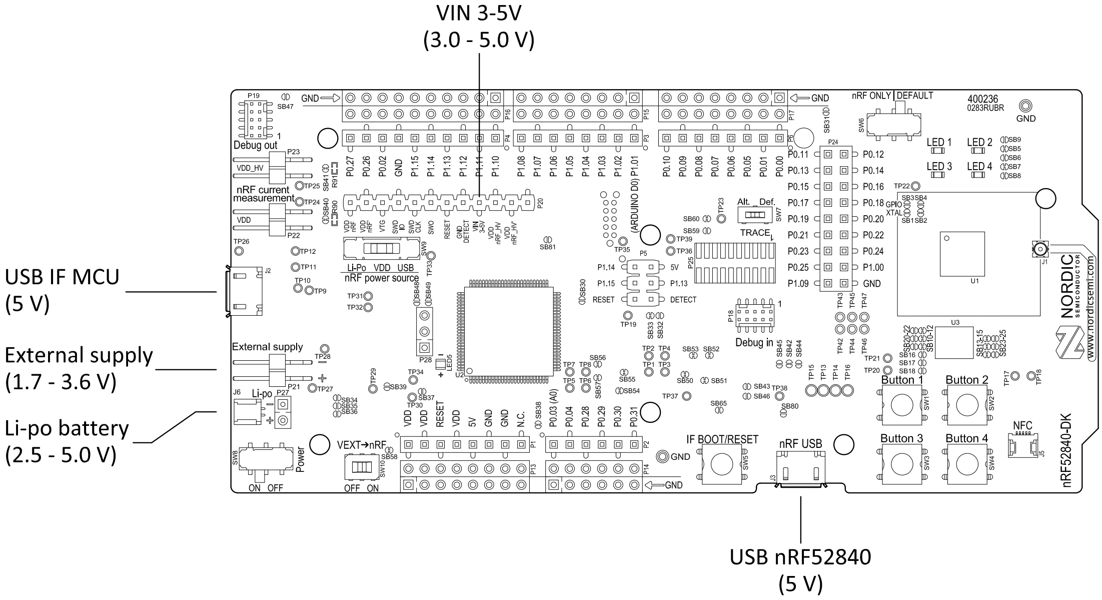


Figure 6: Power supply options (front)

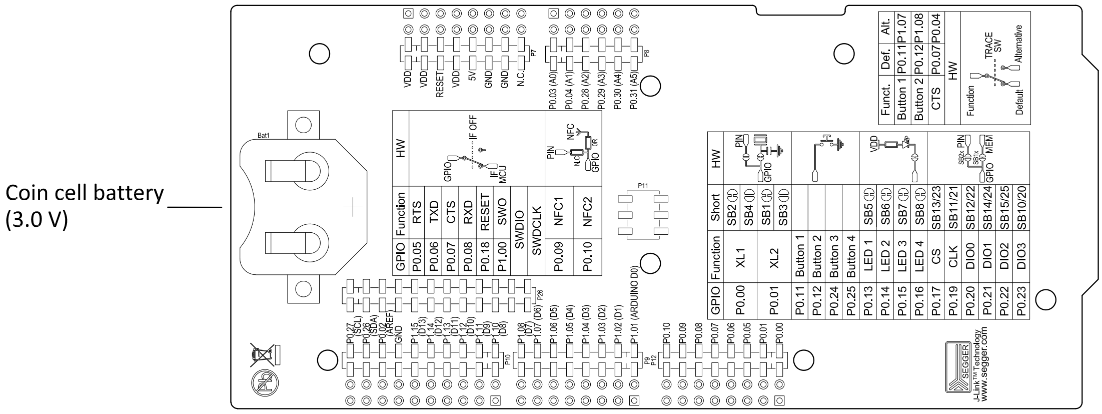


Figure 7: Power supply options (back)

8.3.1 5 V power sources

The nRF52840 DK has a 5 V boost regulator.

It gives a stable 5 V output from the following sources:

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

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

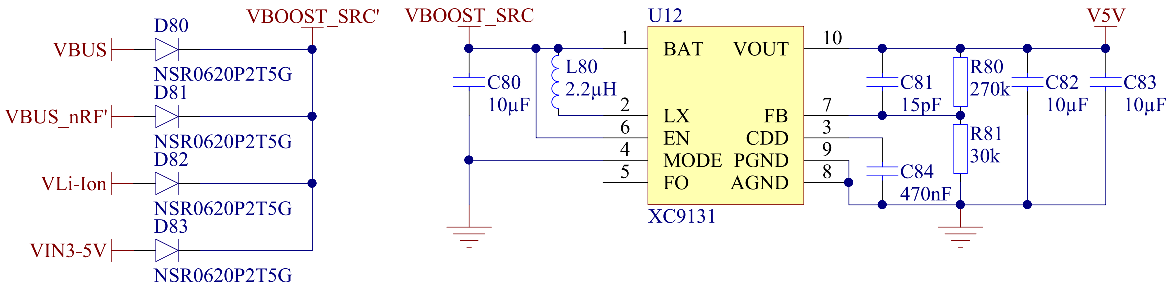


Figure 8: 5 V regulator and protecting diodes

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 nRF52840 power source on page 21.

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

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.

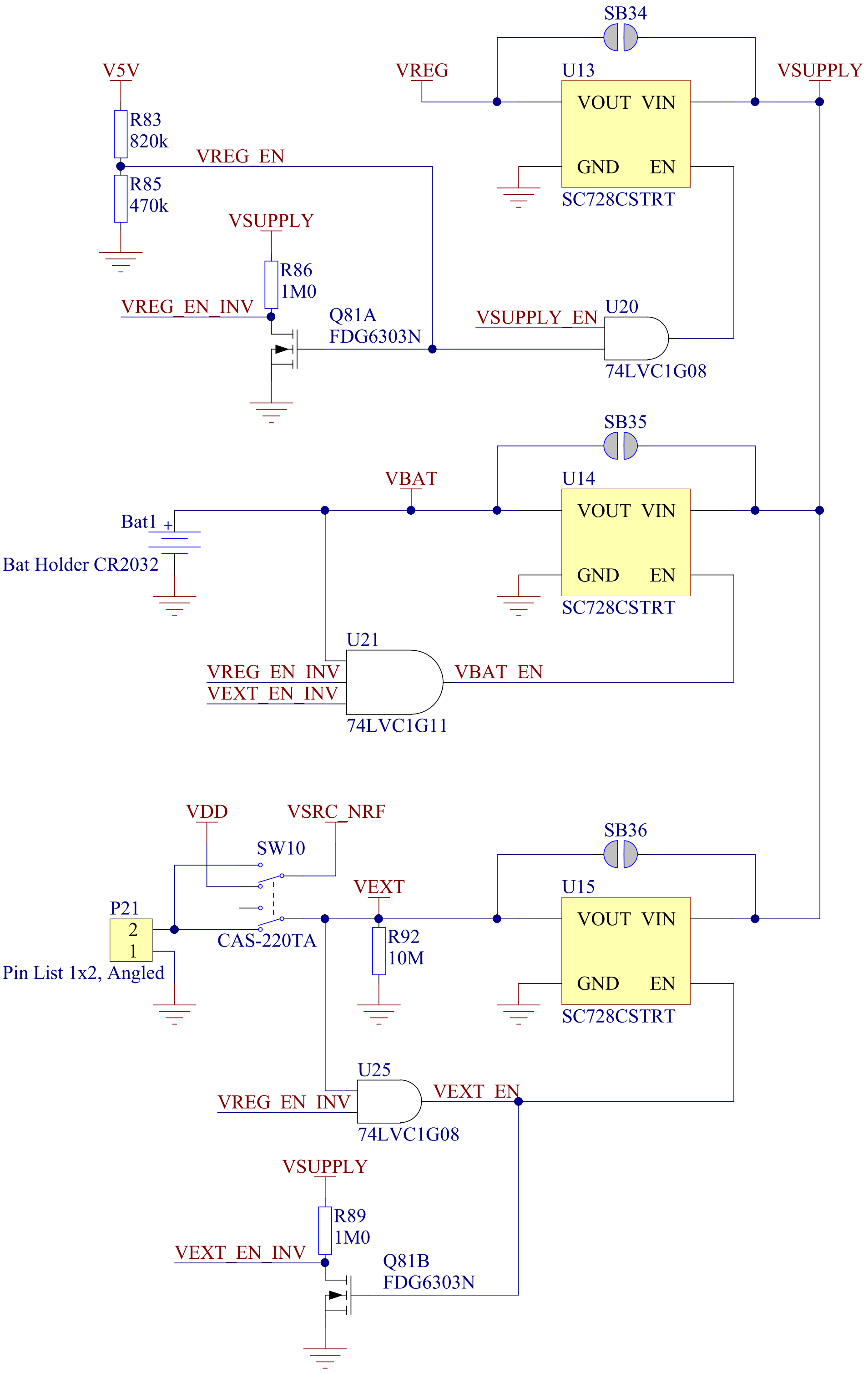


Figure 9: Power supply circuitry

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

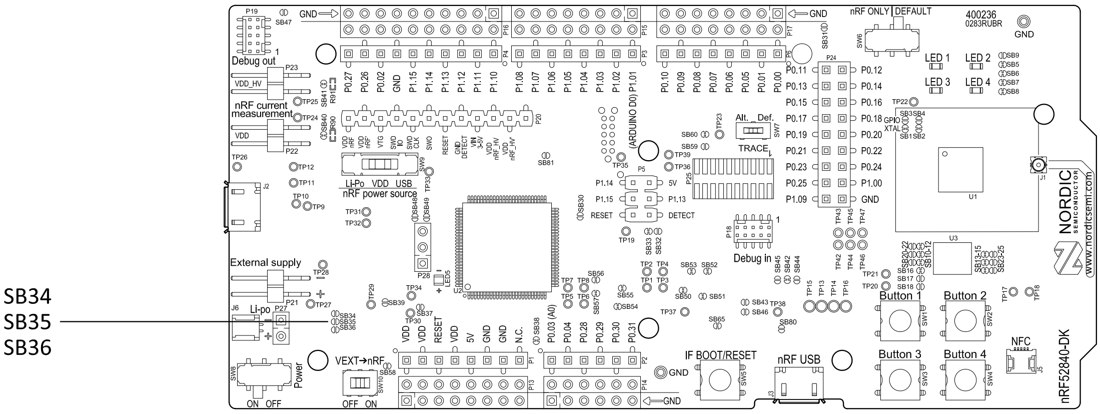


Figure 10: Power switch bypass solder bridges

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.

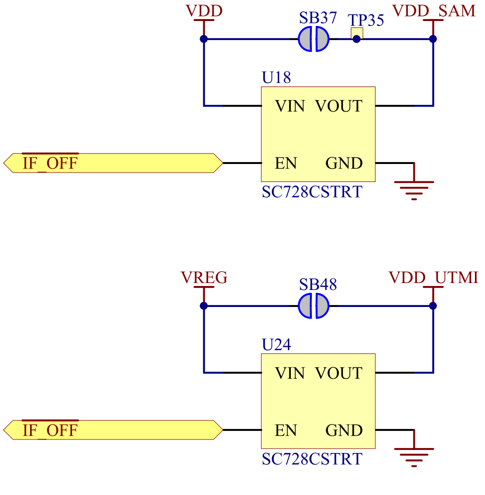


Figure 11: Interface MCU power switch

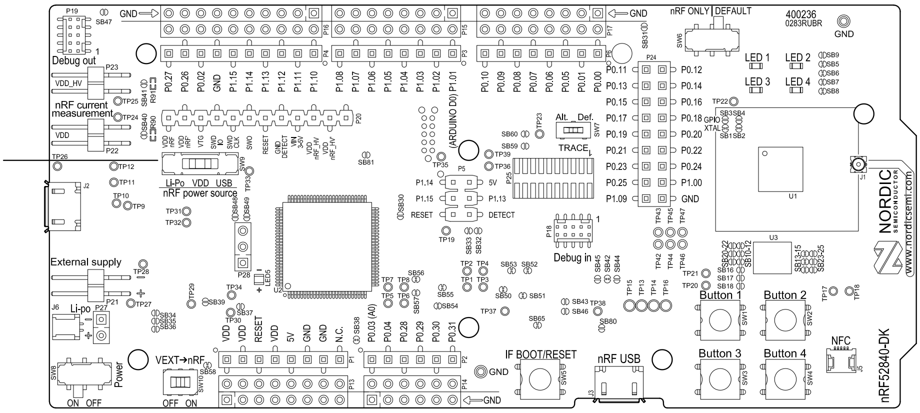
These switches are controlled by the presence of a USB connected to the interface MCU USB connector (**J2**), and the state of the nRF only switch (**SW6**). See Operating modes on page 22 for more information.

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 the following:

- VDD (default)
- Li-Po
- USB



nRF power source switch

Figure 12: nRF52840 DK 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.

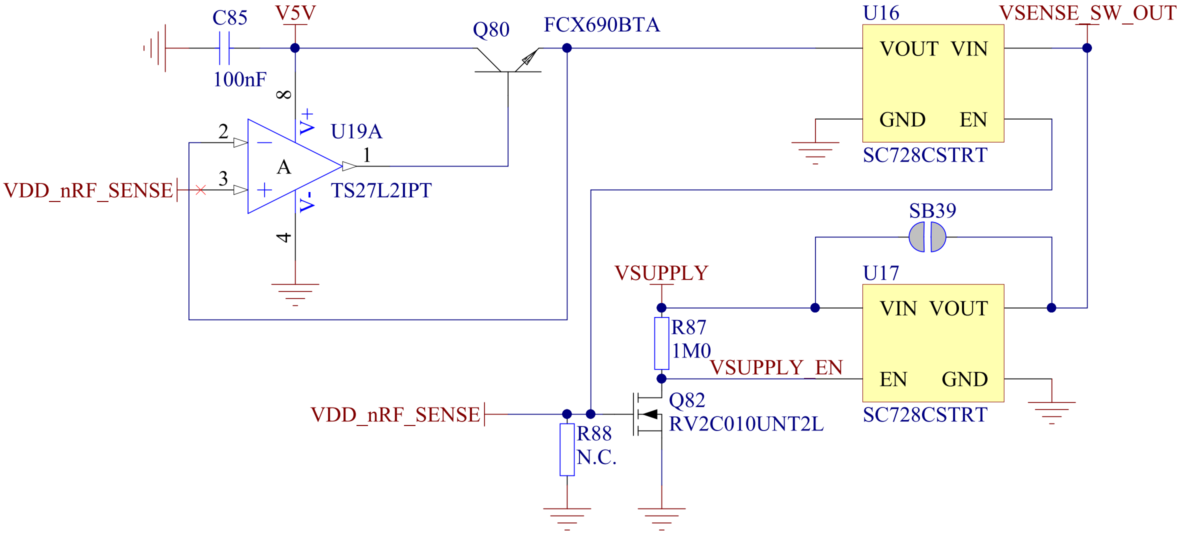


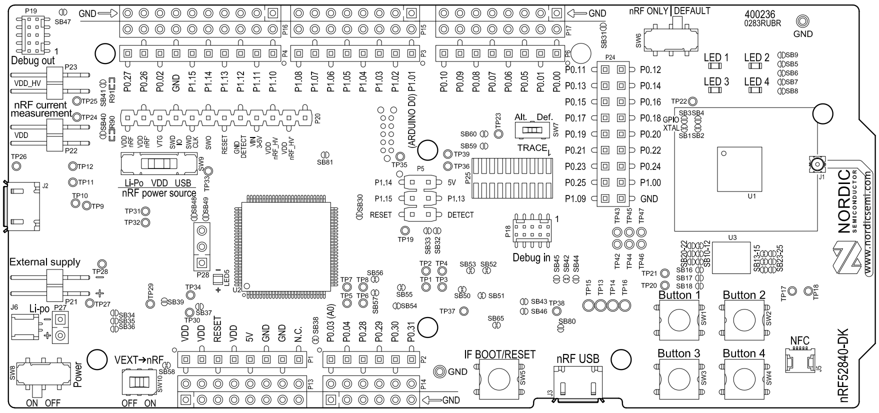
Figure 13: VDD_nRF voltage follower and switch

To make sure that the nRF52840 *SoC* 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 SoC direct supply

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

This is done by connecting the external source to the external supply connector (**P21**) and sliding the **VEXT->nRF** switch (**`SW10`**) to 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.



VEXT → nRF switch

Figure 14: VEXT->nRF switch (SW10)

Since it is only the nRF52840 *SoC* that is supplied from this source, it is recommended that the VDD domain is supplied 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 the **VEXT->nRF** switch (**`SW10`**) is in the ON position. The voltage follower circuit requires 5 V to be present on the *DK*, see 5 V power sources on page 18.

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 nRF only mode 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 External memory on page 25.

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.

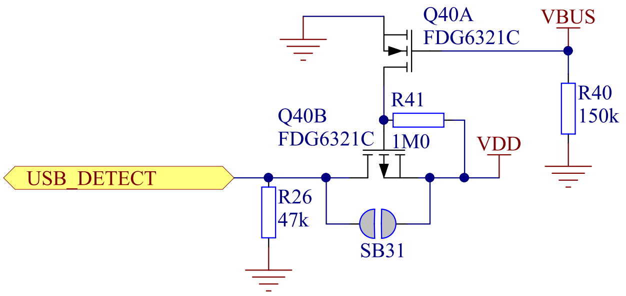


Figure 15: USB detect

8.4.2 nRF only mode

The nRF only mode disconnects the power supply, external memory, and LEDs of the interface MCU. It also 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 External memory on page 25.

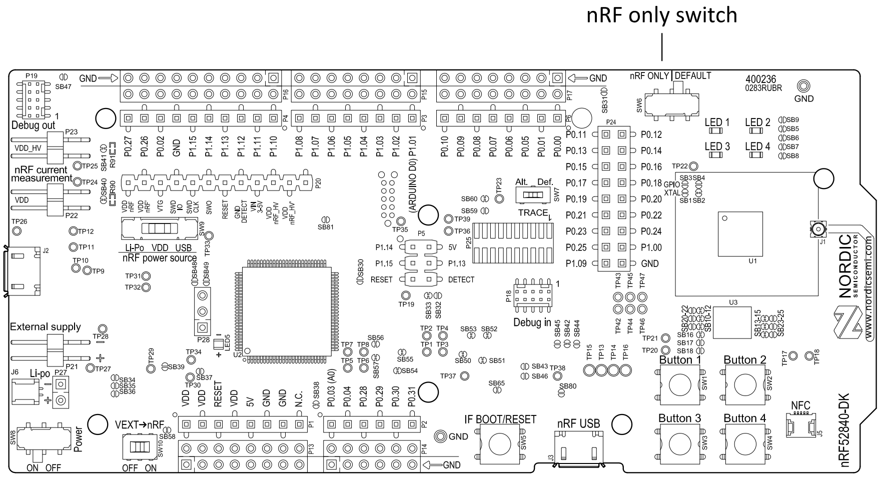


Figure 16: nRF ONLY switch (SW6)

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.

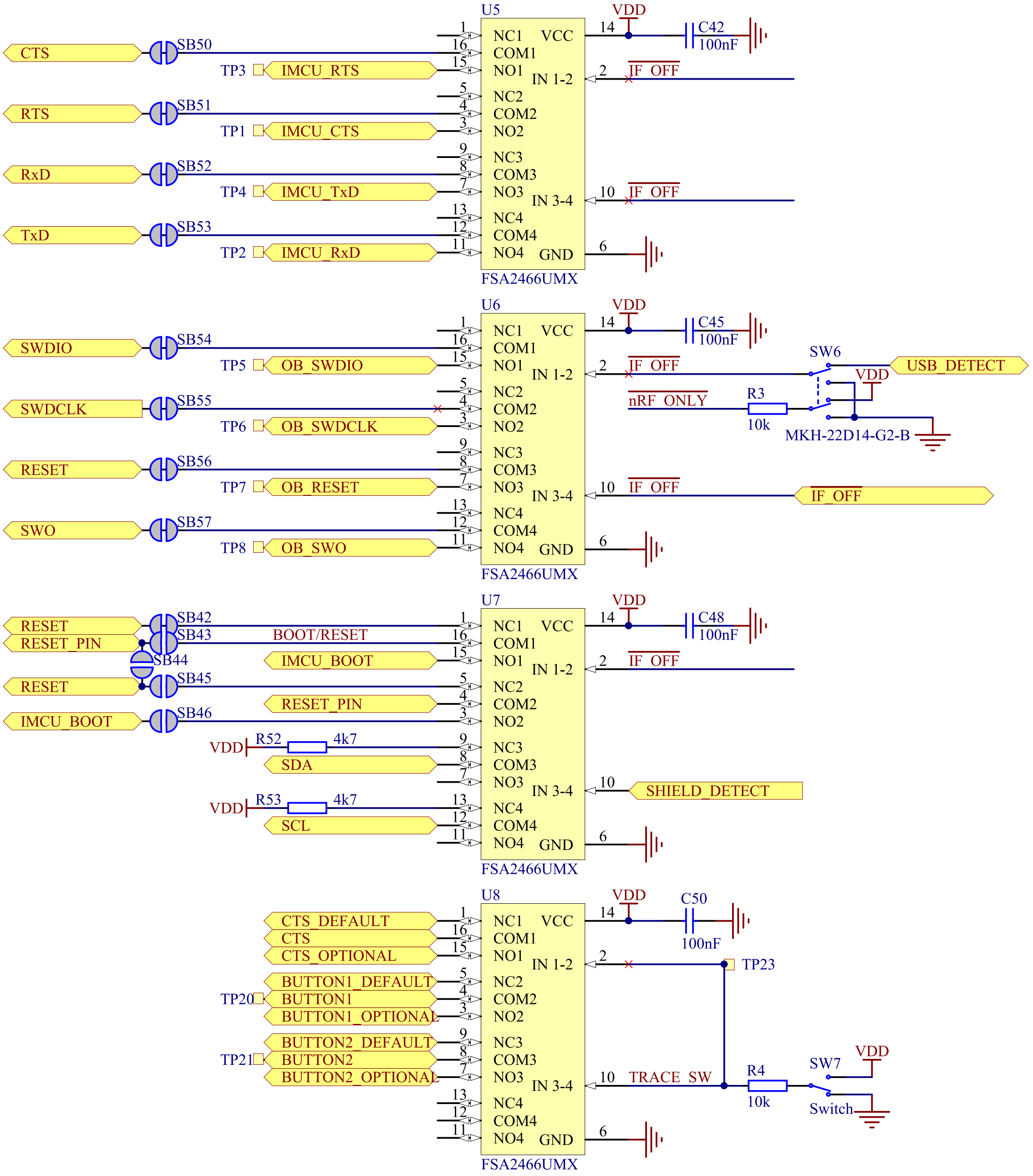


Figure 17: Signal switches

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 from **J2** or by toggling the **nRF ONLY** switch **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 Interface MCU power on page 20.

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 (**SW5**) 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**.

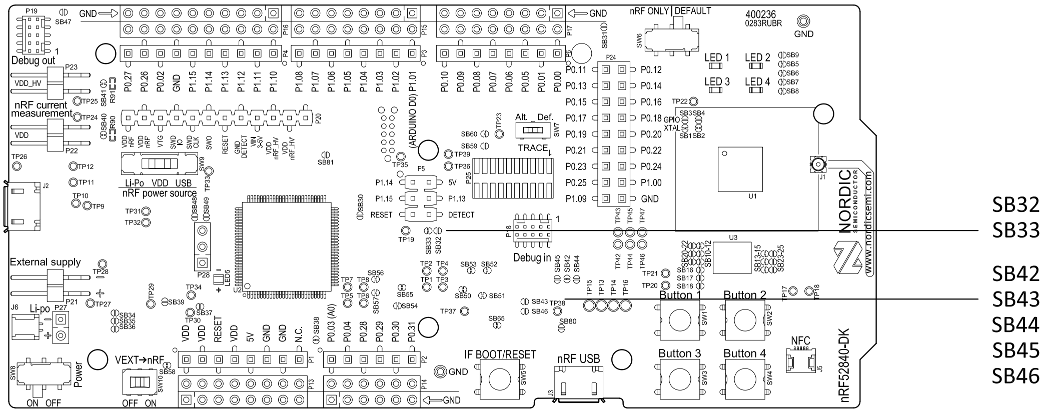


Figure 18: Solder bridges: Shield detect and reset behavior

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 Debug input and trace on page 30 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)
0.17	CS	SB13	SB23
0.19	SCLK	SB11	SB21
0.20	SIO_0/SI	SB12	SB22
0.21	SIO_1/SO	SB14	SB24
0.22	SIO_2/WP	SB15	SB25
0.23	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.

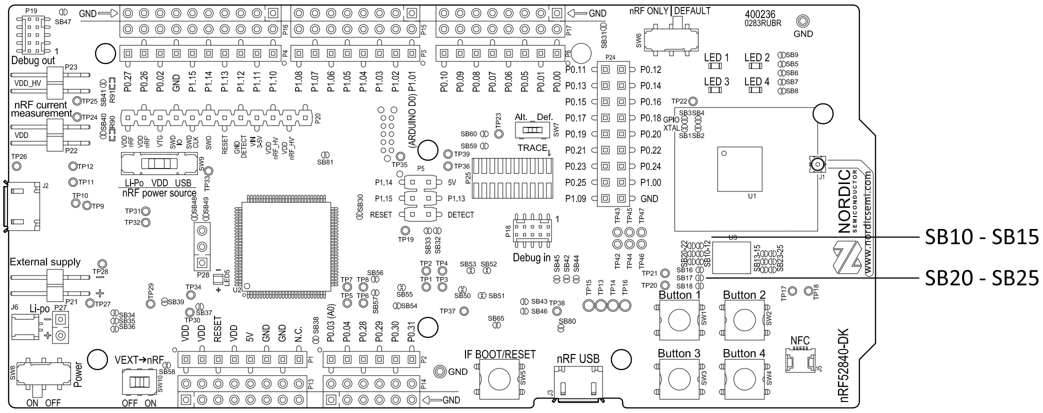


Figure 19: Configuring GPIOs for external memory

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.

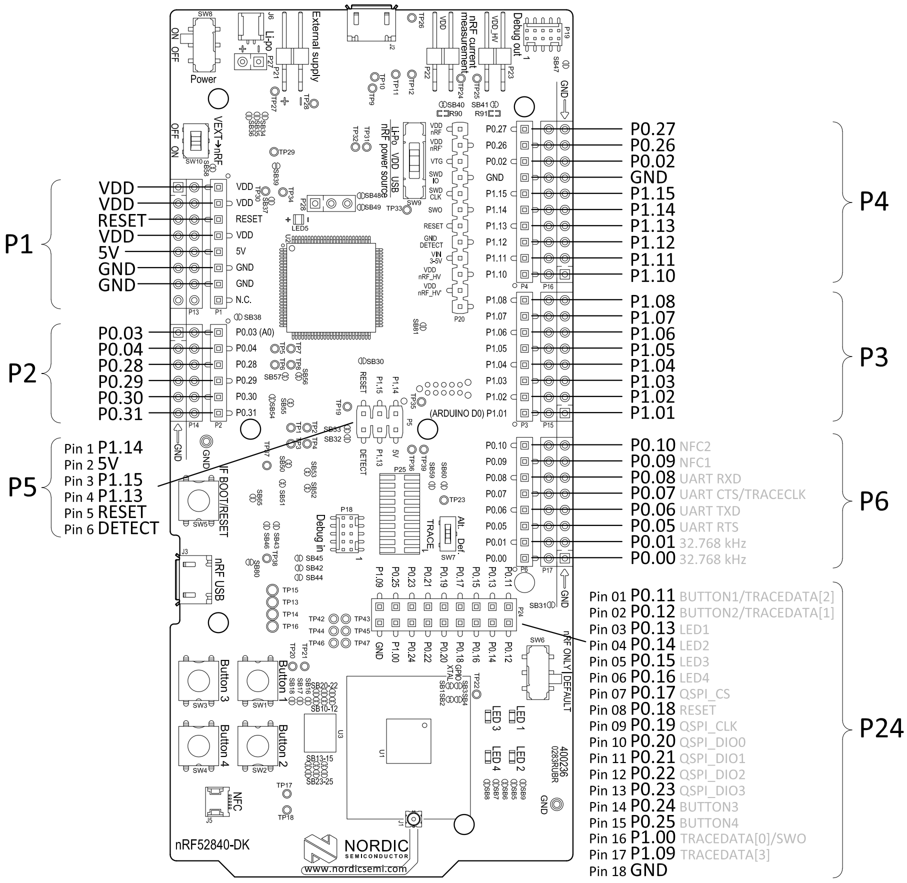


Figure 20: nRF52840 DK connectors

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 motherboards[2] 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 32.768 kHz crystal on page 30.
- **P0.05**, **P0.06**, **P0.07**, and **P0.08** are used by the UART connected to the interface MCU. For more information, see Virtual COM port on page 14.
- **P0.09** and **P0.10** are by default used by NFC1 and NFC2. For more information, see NFC antenna interface on page 32.
- **P0.11**–**P0.16** and **P0.24**–**P0.25** are by default connected to the buttons and LEDs. For more information, see Buttons and LEDs on page 28.
- **0.17** and **0.19**–**0.23** are by default connected to the external memory. For more information, see External memory on page 25.

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

[2] Only 3.3 V Arduino boards.

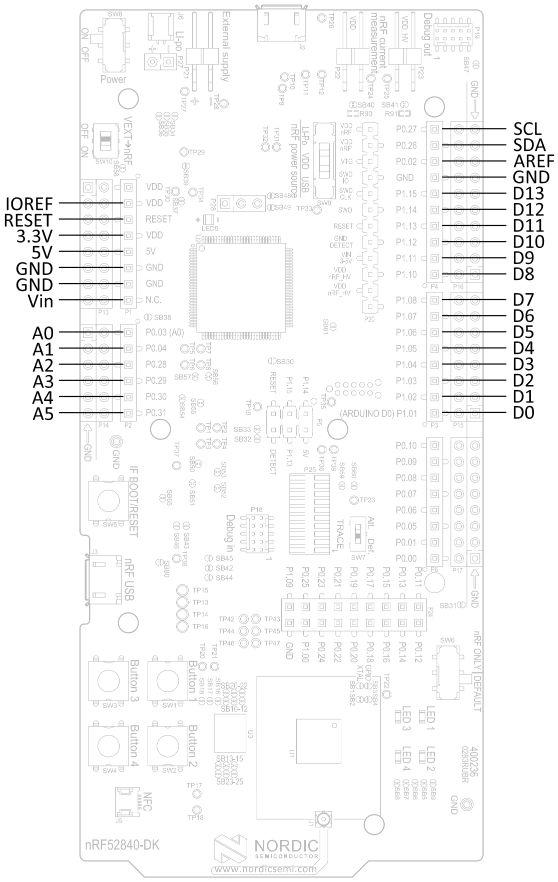


Figure 21: Arduino signals routing on the nRF52840 DK

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 *SoC*.

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 22: Disconnecting the LEDs on page 29 for more information.

Since `P0.11` and `P0.12` are used as part of the Trace functionality, **Button 1** and **Button 2** can be moved to alternative GPIOs. See Debug input and trace on page 30 for more information.

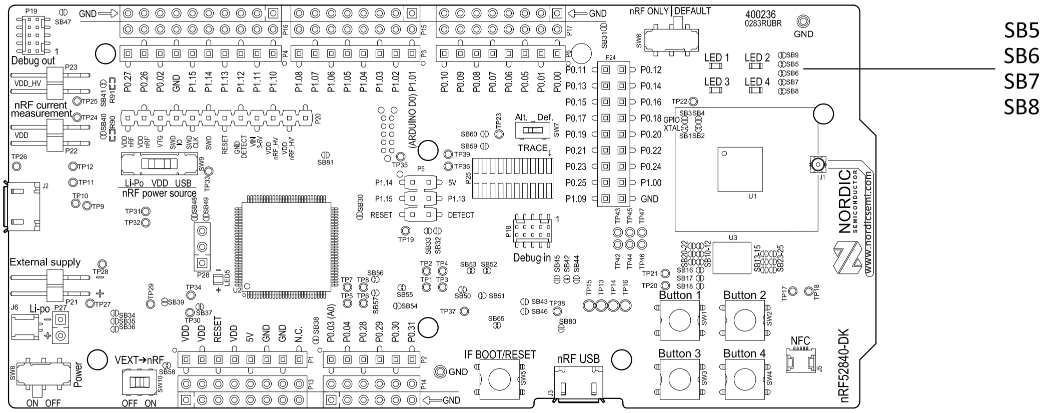


Figure 22: Disconnecting the LEDs

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**, and **P0.25** pins must be configured as 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.

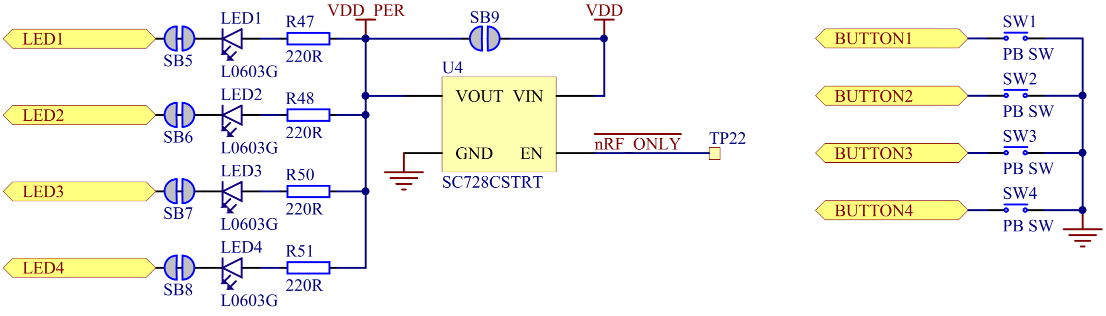


Figure 23: Button and LED configuration

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.

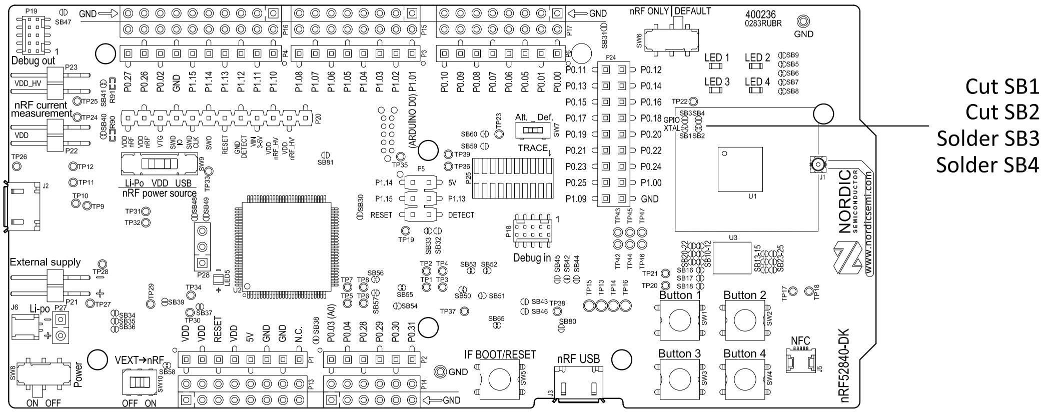


Figure 24: Configuring **P0.00** and **P0.01**

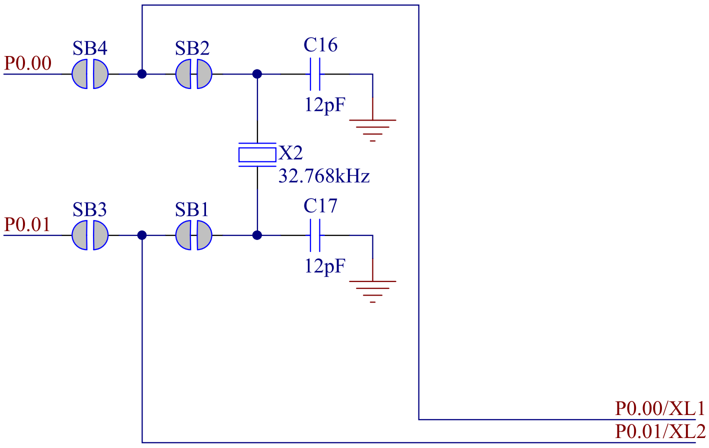


Figure 25: 32.768 kHz crystal and **SB1–SB4**

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.

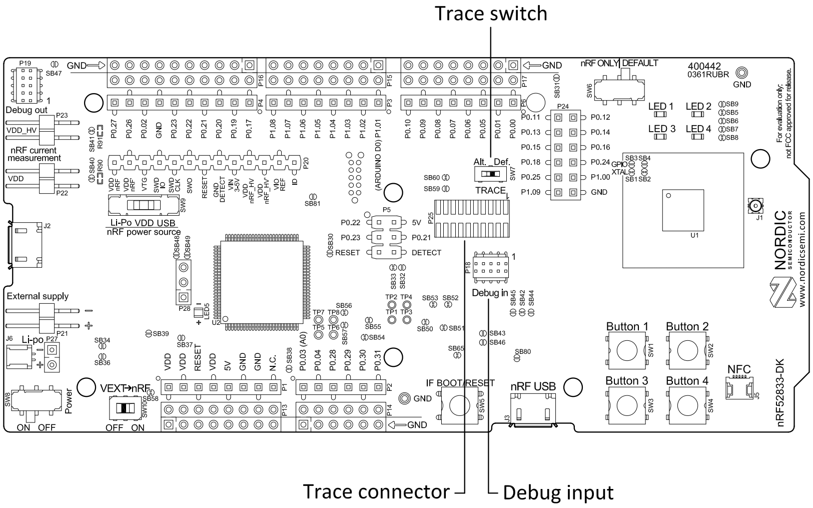


Figure 26: Debug input and trace connectors

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 for more information.

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 Series or nRF52 Series *SoC*s. To debug an external board with SEGGER J-Link OB IF, connect to the Debug out connector (**P19**) with a 10-pin cable.

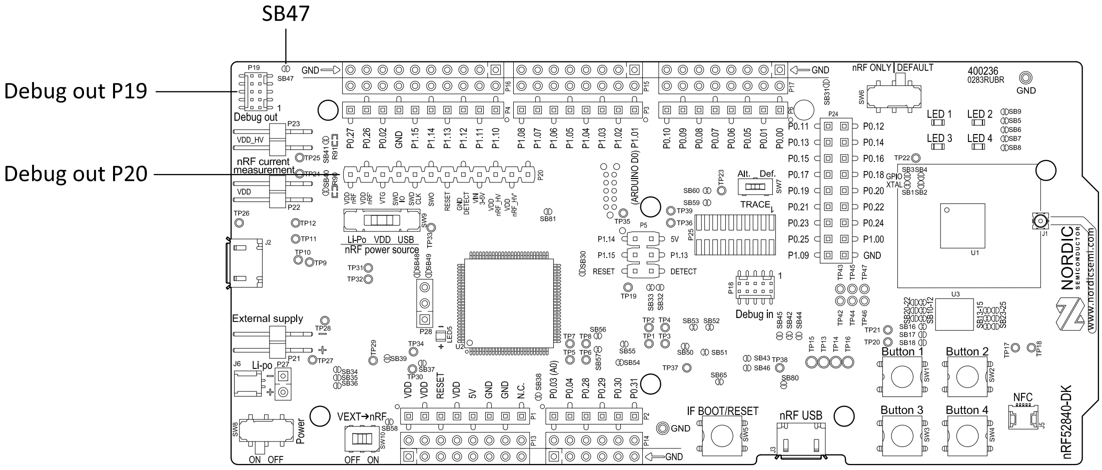


Figure 27: Debug output connector

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.

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**. While **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.

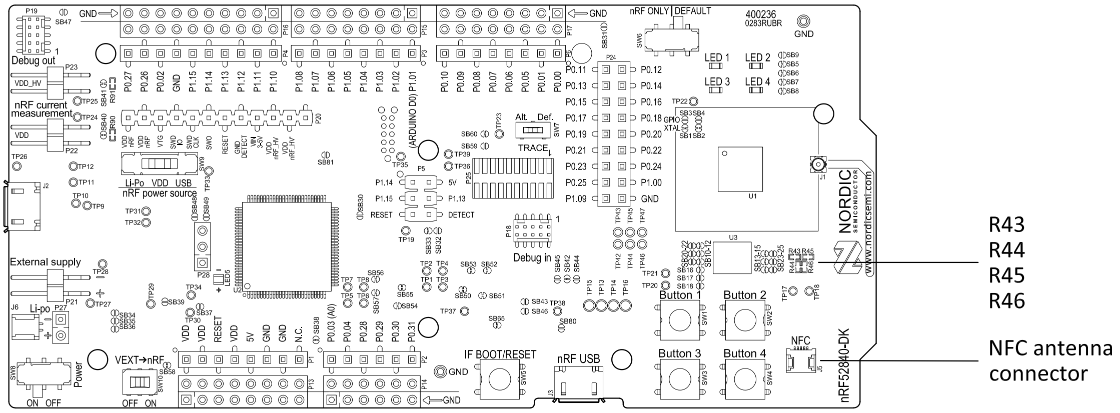


Figure 28: NFC antenna connector

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, select **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 **0R**.

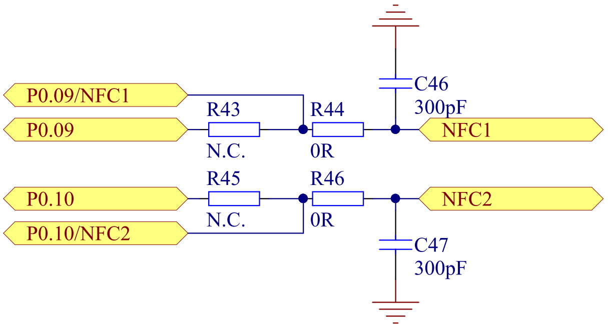


Figure 29: NFC input

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 Power supply on page 17.

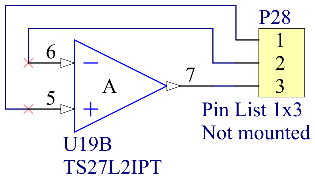


Figure 30: Extra op-amp

8.13 Solder bridge configuration

The nRF52840 DK has a range of solder bridges for enabling or disabling functionality on the *DK*. Changes to these are not needed for normal use of the *DK*.

The following table is a complete overview of the solder bridges on the nRF52840 DK.

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

Solderbridge	Default	Function
SB30	Open	Short to reset the interface MCU
SB31	Open	Short to bypass the USB detect switch
SB32	Open	Short to permanently enable the I^2C pull-up resistors
SB33	Closed	Cut to permanently disable the I^2C 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

Solderbridge	Default	Function
SB55	Closed	Cut to disconnect the nRF52840 SWDCLK line from the signal switch and interface MCU
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 are not described in this document. For more information on Power Profiler Kit, see Power Profiler Kit User Guide.

For measuring instructions, see Using an oscilloscope for current profile measurement on page 38 and Using an ampere meter for current measurement on page 39.

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:

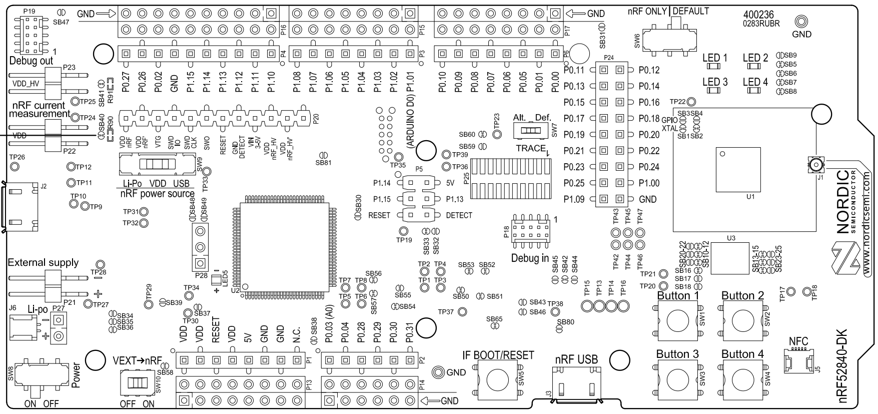
- It is not recommended to use a USB connector to power the *DK* during current measurements due to potential noise from the USB power supply. However, when measuring current on an application using the USB interface of the nRF52840 *SoC*, the USB must be connected. It is recommended to power the *DK* 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 DK

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*.



Cut SB40

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 DK on page 37.

1. Mount a 10 Ω 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 following figure.
3. Calculate or plot the instantaneous current from the voltage drop across the 10 Ω resistor by taking the difference of the voltages measured on the two probes. The voltage drop will be proportional to the current. The 10 Ω 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.

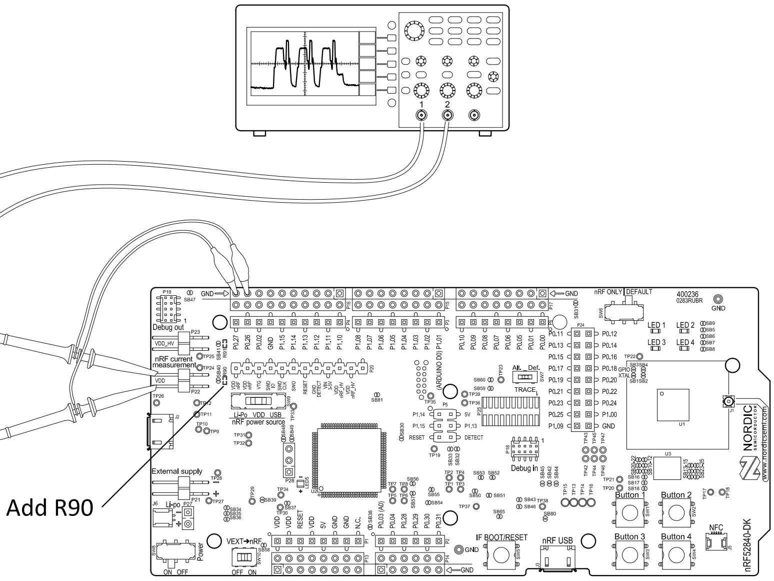


Figure 32: Current measurement with an oscilloscope

Some tips to reduce noise:

- Use probes with 1× 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 monitors the current in series with the nRF device.

Make sure you have prepared the *DK* as described in section Preparing the DK on page 37.

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

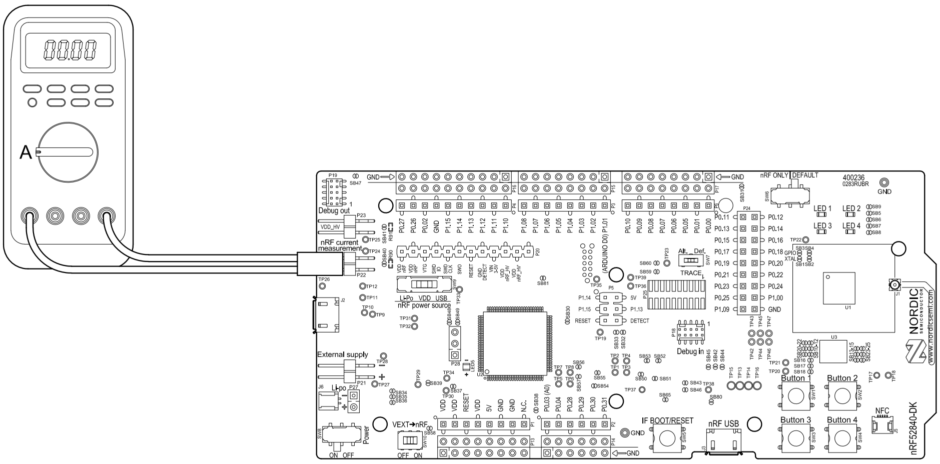


Figure 33: Current measurement with an ampere meter

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 µA to 15 mA.

We recommend 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.

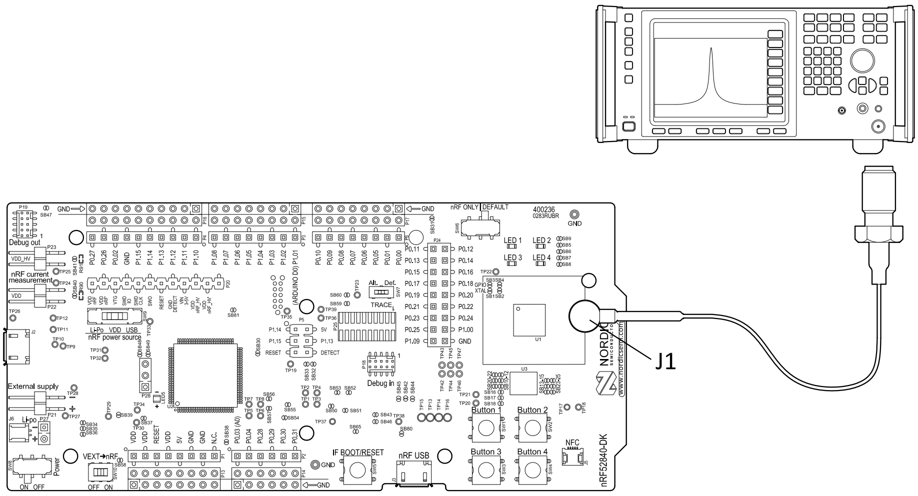


Figure 34: Connecting a spectrum analyzer

The connector and test probe will add loss to the RF signal, which should be taken into account when measuring. See the following table for more information.

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 42.

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.

Universal Asynchronous Receiver/Transmitter (UART)

A hardware device for asynchronous serial communication between devices.

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

UART
Universal Asynchronous Receiver/Transmitter

Recommended reading

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 v17.0.2
- nRF52840 Errata

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