

Smart Remote 3 for nRF52

User Guide

v2.0

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Revision history

Date	Version	Description
February 2018	2.0	Added nRF52810 product example
July 2017	1.1	<ul style="list-style-type: none">• Updated schematics in Current measurement on page 40• Added Power consumption performance on page 52• Updated Firmware update of Smart Remote 3 on page 63
September 2016	1.0	First release

1 Introduction

The nRFready Smart Remote 3 for nRF52 is a set of hardware and software reference designs providing a quick and easy starting point for a TV remote control used with Internet-enabled TVs, set-top boxes, and media players. The reference design consists of a development platform and two product examples. Providing a single chip solution that is easily implemented, this kit comes complete with source code and documentation for *Bluetooth*[®] Low Energy applications.

The development platform contains three remote controls, one for development and two for demo purposes.

To obtain The Smart Remote 3 nRF52810 product example (nRF6942), please contact Nordic sales.



Environmental Protection

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

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

1.1 Smart Remote 3 DK add-on

The Smart Remote 3 DK add-on (nRF6932) is a board that allows you to connect to the nRF52 Development Kit (nRF52 DK, not included in this kit). Plugging the DK add-on onto the nRF52 DK gives you access to the radio components for developing your remote control design.

Based on the nRF52832 multiprotocol System on Chip (SoC), it is optimized for low-power high performance applications and leverages both *Bluetooth* Low Energy and 2.4 GHz proprietary protocols.

Note: The Smart Remote 3 DK add-on rev. 1.2 and later is compatible with both nRF51 and nRF52 development kits.

Features:

- Standard remote control keypad
- Motion wakeup detection using low-power accelerometer
- 3D motion tracking using gyroscope and InvenSense[®] motion library
- Multi-touch trackpad (supports up to five points of contact)
- Voice input using an analog electrostatic microphone (only nRF51)
- Voice input using two digital PDM microphones (only nRF52)
- Infrared LED for legacy support (only nRF52)
- Arduino standard interface for connection to the nRF5x Development Kit
- Optimized power management for low power consumption

1.2 Smart Remote 3 product example for nRF52832

The Smart Remote 3 nRF52 product example (nRF6937) is a fully-designed remote control with audio input, air mouse functionality, infrared LED, NFC tag, and buzzer. It features a subset of the functionality

of the Smart Remote 3 DK add-on, allowing the board to nicely fit into an almost finished remote control plastic housing.

Features:

- Standard remote control form factor
- Standard remote control keypad
- nRF52832 QFAA SoC from Nordic
- Voice input using up to two digital PDM microphones, which enable the use of (optional) active noise reduction algorithms
- 3D motion tracking using gyroscope and InvenSense® motion library
- Motion wakeup detection using low-power accelerometer
- Infrared LED ¹
- NFC tag for tap to pair²
- Buzzer for the Find Me service
- Device firmware update (DFU)
- Preprogrammed, can be used out of the box
- Powered by two AA batteries
- SWD interface connector for programming and debugging
- Optimized power management for low power consumption

1.3 Smart Remote 3 product example for nRF52810

The Smart Remote 3 nRF52810 product example (nRF6942) is a cost-optimized remote control with audio input, air mouse functionality, and infrared LED. It features a subset of the functionality of the Smart Remote 3 DK add-on, allowing the board to nicely fit into an almost finished remote control plastic housing.

nRF52810 support starts from firmware rev. 1.2.

Features:

- Standard remote control form factor
- Standard remote control keypad
- nRF52810-QFAA SoC from Nordic
- Voice input using one digital PDM microphone
- 3D motion tracking using gyroscope and InvenSense motion library
- Motion wakeup detection using low-power accelerometer
- Infrared LED
- Device firmware update (DFU)
- Preprogrammed, can be used out of the box
- Powered by two AA batteries
- SWD interface connector for programming and debugging
- Optimized power management for low power consumption

Because of modular firmware, the feature set can be configured. It is possible to add some features present in the nRF52832 version of the firmware while removing others from the nRF52810 version to make sure there is enough memory. For more information, see firmware documentation available in a folder on your computer after you have run the installer file.

To obtain The Smart Remote 3 nRF52810 product example (nRF6942), please contact Nordic sales.

¹ Support starts from reference firmware rev. 1.1.

² Support starts from reference firmware rev. 1.1.

2 Minimum requirements

Before you start setting up the nRFready Smart Remote 3 for nRF52 reference design, check that you have the required hardware and software.

Hardware requirements

The following additional hardware is needed to use the Smart Remote 3 DK add-on:

- [nRF52 Development Kit](#) (sold separately)³

Operating system requirements

The nRFready Smart Remote 3 complies with the HID-over-GATT profile. The following is needed to set up a computer as the *Bluetooth* Low Energy host.

- Basic use:
 - Windows 8 or Windows 10 for HID-over-GATT standard functions, or
 - Linux with *Bluetooth* 4.0 support (for example BlueZ 5.0 or later)
- Use with audio:
 - Ubuntu 16.04 LTS with Nordic Voice System (NVS) package. See [Setting up Ubuntu](#) on page 13.⁴

³ The Smart Remote 3 DK add-on rev. 1.2 and later is compatible with both nRF51 and nRF52 development kits.

⁴ NVS for Linux is part of the software package for Smart Remote 3 for nRF52. It comes as Linux .DEB install files, as well as a Linux LiveCD image for test with or without install.

3 Kit content

The nRFready Smart Remote 3 reference design consists of hardware and access to software components, reference design files, and documentation.

3.1 Hardware content

nRFready Smart Remote 3 reference design hardware consists of the DK add-on, product example, batteries and a *Bluetooth* dongle.



Figure 1: nRFready Smart Remote 3 for nRF52 Series hardware content

nRF52810 product example is not included in the kit. It is available on request.

3.2 Downloadable content

The nRFready Smart Remote 3 for nRF52 Series reference design includes firmware source code, documentation, hardware schematics, and layout files.

To access these files, go to the [Smart Remote 3 for nRF52](#) web page and follow the instructions.

Firmware package

- Application firmware for nRFready Smart Remote 3 for nRF52
 - Precompiled HEX files
 - Precompiled DFU packages
 - Source code
- nRF5x SDK v14.2.0-SR3
- S132 and S112 SoftDevices
- Nordic Voice System (NVS) package version 5.4 (requires Ubuntu 16.04 LTS)
- Firmware documentation (will be available in a folder on your computer after you have run the installer file)

Note: Refer to firmware documentation for details regarding SDK, SoftDevice and compiler options.

Schematics, Bill of Materials, PCB layout files, and production files

The zip file contains the hardware design files for the nRFready Smart Remote 3 for nRF52 Series reference design.

- Altium Designer files
- Schematics
- PCB layout files
- Production files
 - Drill files
 - Assembly drawings
 - Gerber files
 - Pick-and-place files
 - Bill of materials

Other relevant documentation

- [nRF52832 Product Specification](#)
- [nRF52810 Product Specification](#)
- [S132 SoftDevice Specification](#)
- [S112 SoftDevice Specification](#)
- [nRF52 Development Kit](#)
- [nRF52832 Errata](#)
- [nRF52810 Errata](#)
- [nRF5 SDK](#)

4 Quick start

Setting up the nRFready Smart Remote 3 for nRF52 reference design requires only a few steps. Example applications help you start programming your device.

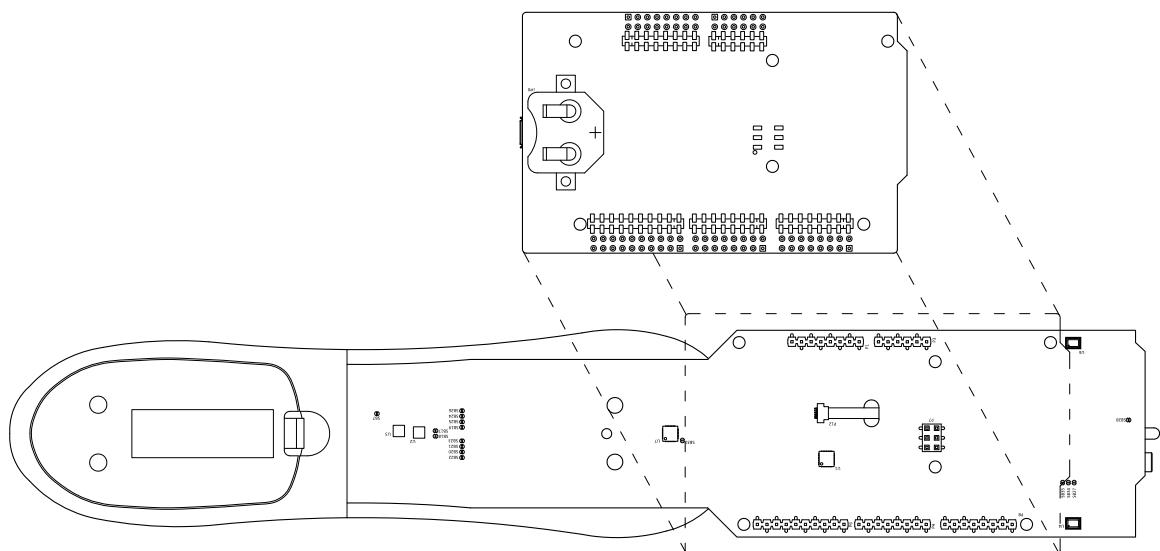
The Product example comes with pre-installed firmware. For a quick start with this device, just insert batteries, and continue reading in [Pairing with Windows](#) on page 11 (basic use) or [Pairing with Ubuntu](#) on page 13 (use with audio).

Before you start, check [Minimum requirements](#) on page 7.

4.1 Assembling Smart Remote 3 hardware

Unpack the kit and connect the DK add-on to the nRF52 DK.

1. Unpack your nRFready Smart Remote 3 for nRF52 reference design.
2. Plug the nRF52 DK (sold separately) carefully on the backside of the Smart Remote 3 DK add-on as shown in the figure.

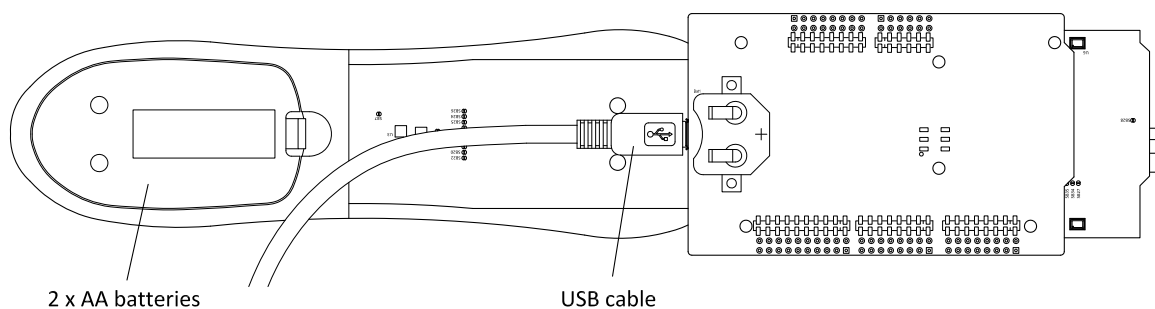


4.2 Powering up

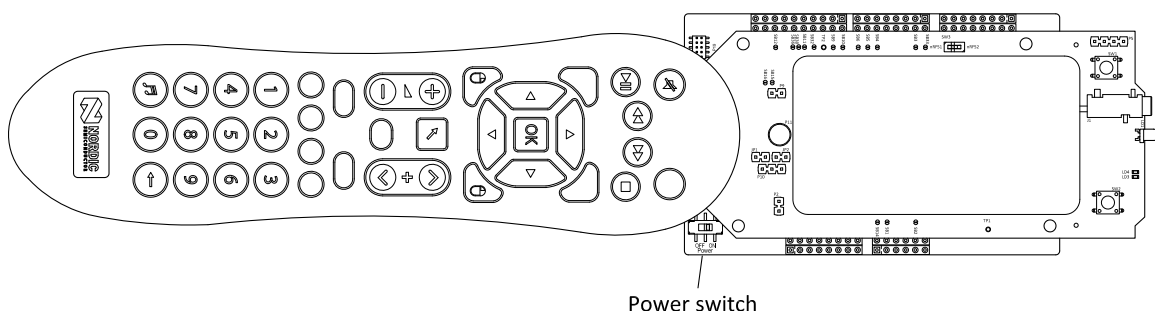
The Smart Remote 3 for nRF52 product example will be on as soon as the batteries are inserted. The DK add-on can be powered either from the USB or from the batteries.

Follow the steps below to power up the DK add-on:

1. Plug in the USB cable or insert batteries into the battery compartment.



2. If powered from the USB, turn on the power with the power switch. If powered from the batteries, it will be on as soon as the batteries are inserted.



4.3 Programming DK with Smart Remote 3 for nRF52 firmware

To use the DK add-on, the nRF52 DK must first be programmed with the firmware. The product example is preprogrammed and does not need any programming to get started.

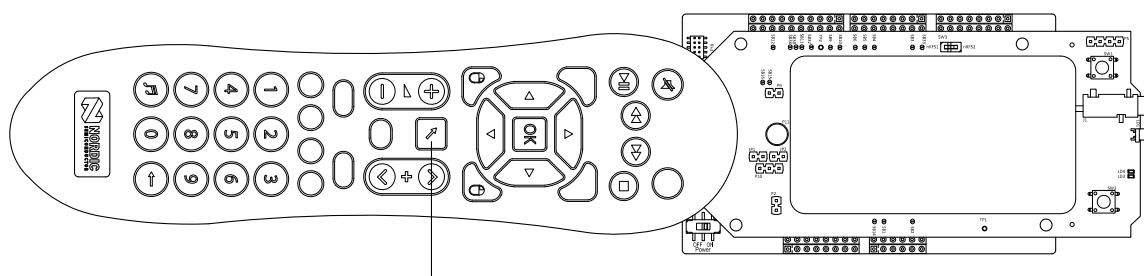
1. Connect the nRF52 DK with DK add-on attached to a computer with a USB cable.
2. See [Firmware update of Smart Remote 3](#) on page 63 for details on firmware update.

4.4 Pairing with Windows

The Smart Remote 3 for nRF52 can be connected to a host system with *Bluetooth* Low Energy.

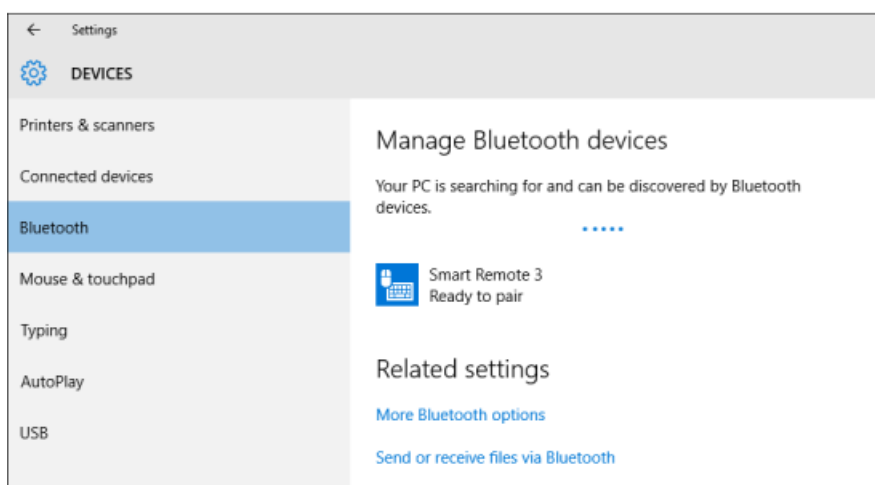
nRFready Smart Remote will only pair and work with *Bluetooth* 4.0 and HID-over-GATT compliant host systems. The nRFready Smart Remote 3 functionality will vary depending on the supported features in these platforms.

1. If your computer is not *Bluetooth* 4.0 hardware enabled, insert the *Bluetooth* dongle (supplied) into your computer and wait until the dongle is recognized and the drivers installed properly.
2. Power up the board either by inserting batteries into the battery compartment or by sliding the **Power** switch on the DK to **ON** position (DK add-on only).
3. Pairing mode is automatically selected if the Smart Remote 3 wasn't bound to a previous host. To delete existing bonds and enter into pairing mode, power up the Smart Remote 3 while pressing the orange button between **Channel+** and **Volume+** buttons.

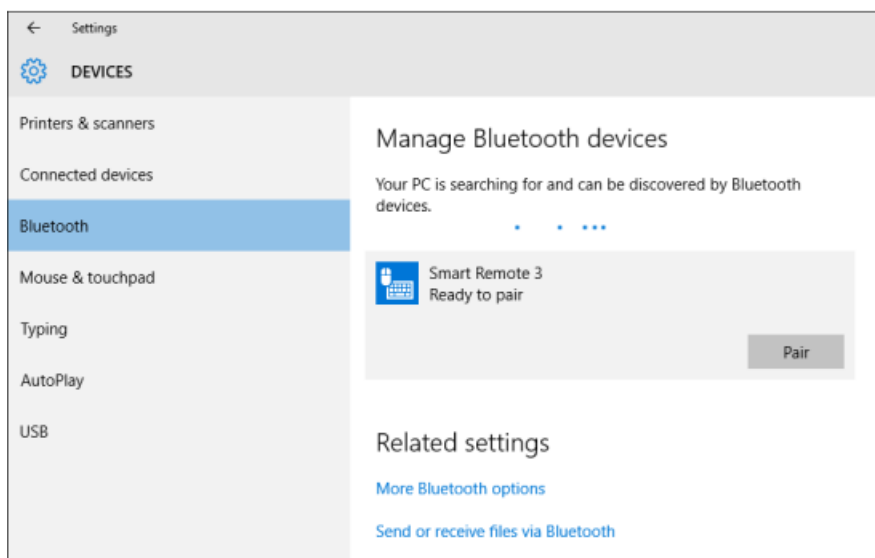


To delete existing bonds and enter pairing mode, hold button while powering up

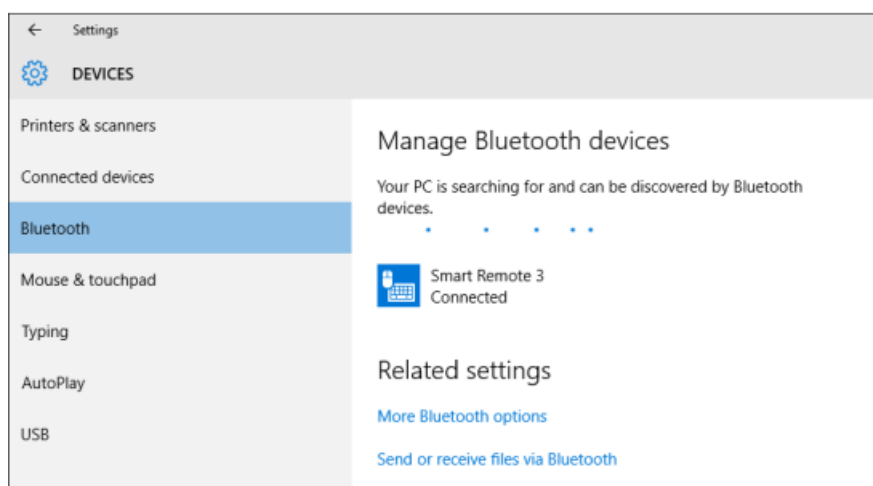
4. On your computer, navigate to the **Bluetooth** menu (press **Windows** key or open the **Start** menu and type Bluetooth).



5. When discovered, you will see Smart Remote 3 in the list over *Bluetooth* devices. Select it and click **Pair** to begin pairing.



6. After successfully pairing, the device will show up as connected in the list of *Bluetooth* devices.



4.5 Setting up Ubuntu

Set up Ubuntu to use the voice recognition feature.

The Smart Remote 3 software package comes with a Ubuntu LiveCD containing the Nordic Voice System (NVS) package. You can run or install this LiveCD directly. Download the LiveCD from **Downloads > nRFready Smart Remote 3 for nRF52 Series Linux Host LiveCD** at [Smart Remote 3 for nRF52](#).

If you have a computer already operating with Ubuntu 16.04 LTS, you will need to install just the NVS package.

To install the NVS package, complete the following steps:

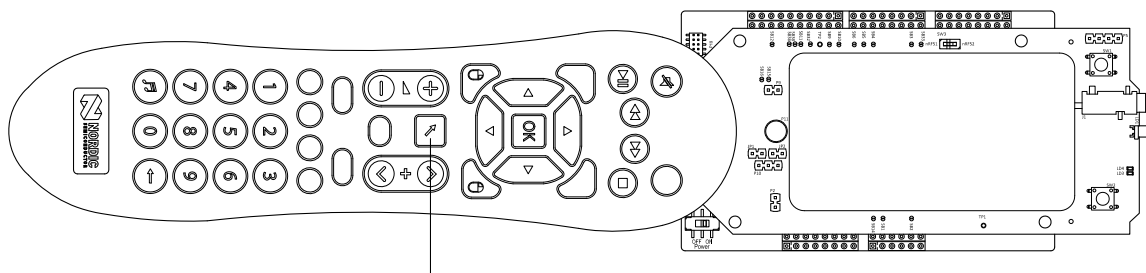
1. Download the NVS package `nvs-5.4.tgz` from **Downloads > nRFready Smart Remote 3 for nRF52 Series Linux Host Software install Files** at [Smart Remote 3 for nRF52](#).
2. Open a terminal (**CTRL + ALT + T**).
3. Navigate to the folder where `nvs-5.4.tgz` is located.
4. Unpack the `nvs-5.4.tgz` file by typing `tar -xf nvs-5.4.tgz`.
5. Open the file `nvs-5.4/binaries/HOWTO-install.txt` and follow the steps there to complete the installation.

4.6 Pairing with Ubuntu

The Smart Remote 3 for nRF52 can be connected with *Bluetooth* to a host system using Ubuntu.

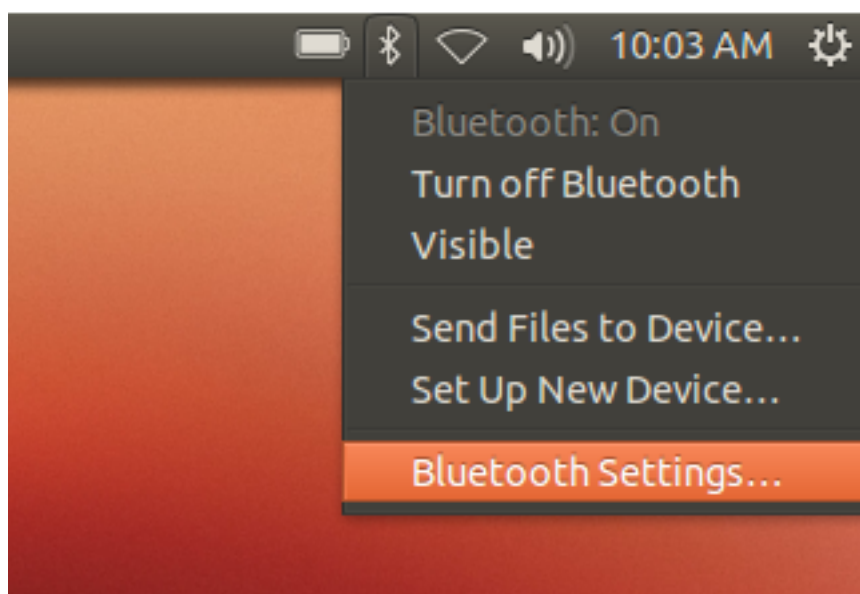
Make sure that you have set up Ubuntu as described in [Setting up Ubuntu](#) on page 13 before you start.

1. If your computer is not *Bluetooth 4.0* enabled, insert the *Bluetooth* dongle (supplied) into your computer and wait until the dongle is recognized and the drivers installed properly.
2. Power up the board, either by inserting batteries into the battery compartment, or by sliding the **Power** switch on the DK to ON position (DK add-on only).
3. Pairing mode is automatically selected if the Smart Remote 3 was not bound to a previous host. To delete existing bonds and enter pairing mode, power up the Smart Remote 3 while pressing the orange button between between the **Channel +** and **Volume +** buttons.

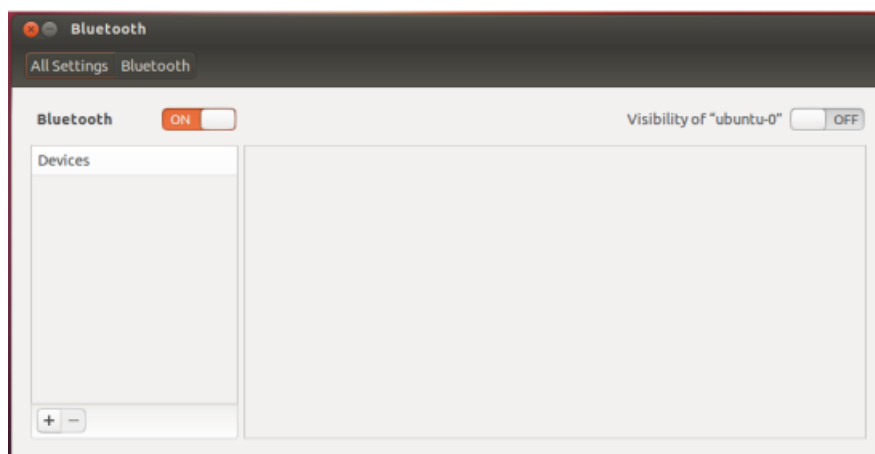


To delete existing bonds and enter pairing mode, hold button while powering up

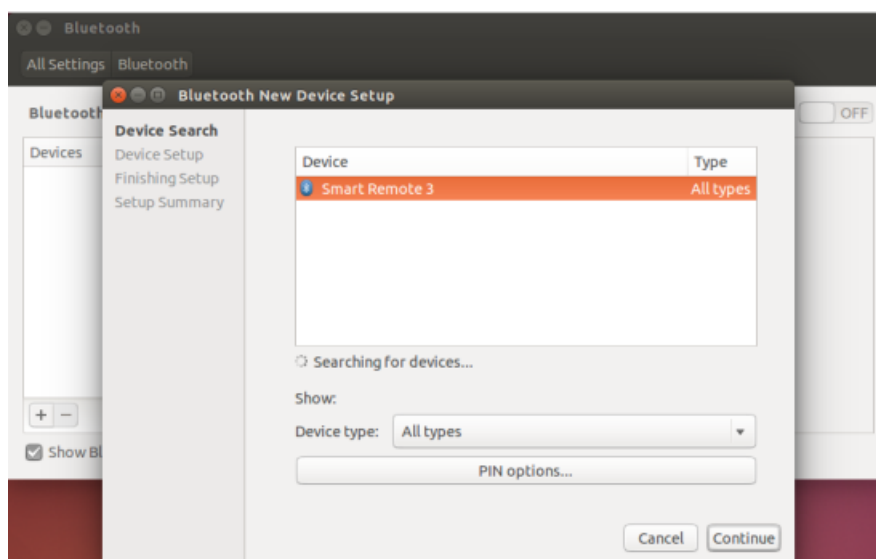
4. On your computer, navigate to the **Bluetooth** icon and select **Bluetooth Settings**.



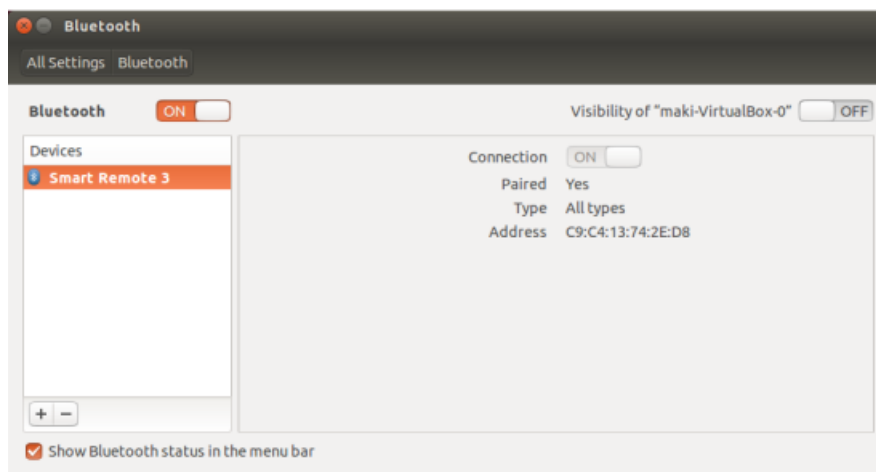
5. To search for a new device, click the + button in the **Bluetooth** window.



6. When discovered, you will see Smart Remote 3 in the **Device** list. Select it and click **Continue** to begin pairing.



7. After successfully pairing, the device will show up connected in the **Devices** list.

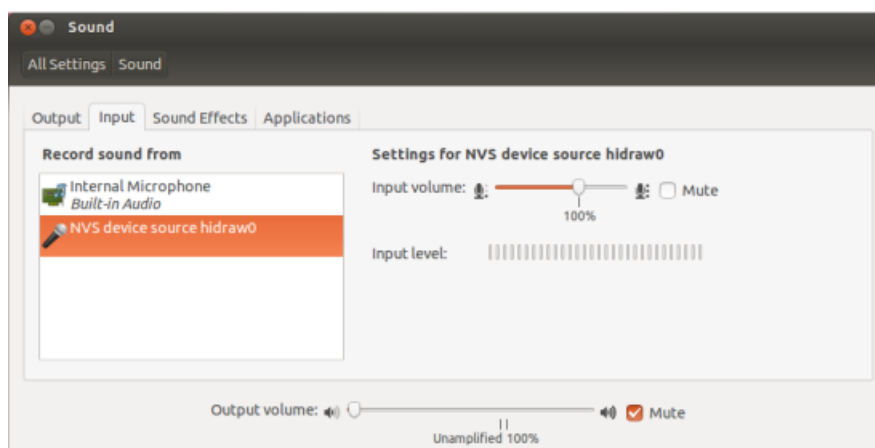


4.7 Configuring audio input

The Ubuntu audio settings need to be configured before voice recognition will work.

Before you start, make sure that you have set up Ubuntu as described in [Setting up Ubuntu](#) on page 13.

1. Under **All Settings**, select **Sound** and then select the **Input** tab.
2. Select the **NVS device** from the list of input sources.
Input level should now indicate that it is receiving input.

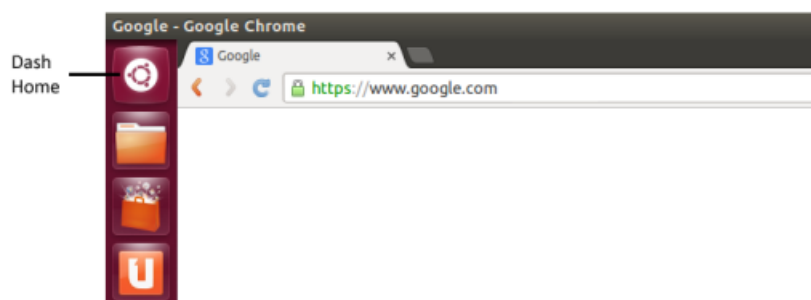


3. To stop streaming, select **All Settings** or close the window.

4.7.1 Testing voice recognition

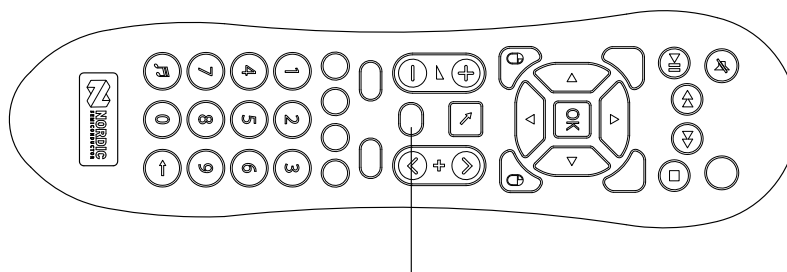
To test the voice recognition feature, you can download and install Google Chrome.

1. Open up Chrome. Select **Dash Home** and type Google Chrome. Click the **Google Chrome** icon that is displayed.



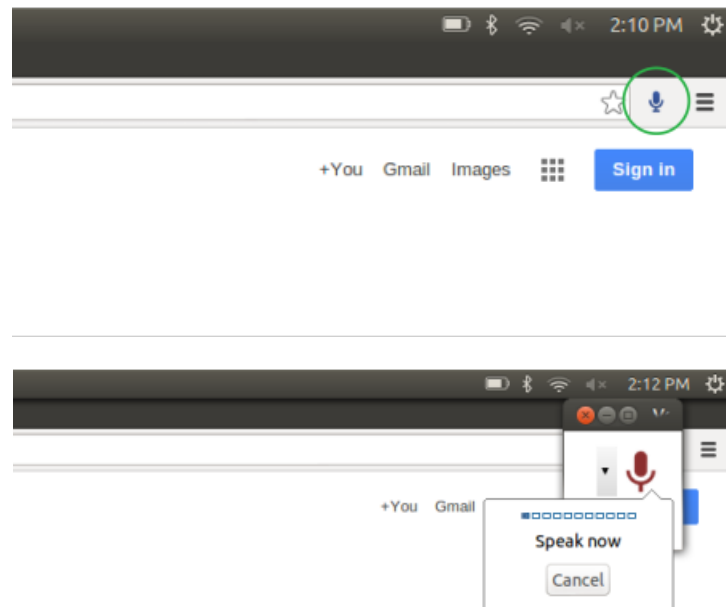
2. Go to [google.com](https://www.google.com). If you are redirected to a local Google version, click **Google.com** in the lower-right corner of the webpage.

Note: On the SmartRemote 3 for nRF52 product example, press the button marked in the figure below to automatically invoke Chrome audio input. The Smart Remote 3 for nRF52 sends the Google Voice Search shortcut (Ctrl+Shift+.). If the Google Chrome is in focus and voice input is possible on the given page, voice input will be activated without clicking the microphone icon.



Activate Google Voice Search

3. Click the **microphone** icon. Chrome will stop recording automatically when you stop talking. If you do not see the microphone icon, the GVoice application might not be installed. Go to the Google Chrome Web Store to download and install GVoice.



4.7.2 Listening to audio quality

Audio quality can be verified by looping the sound directly from the Ubuntu input source (Voice Input Module) to the output (speakers).

1. To enable loopback, open a terminal (**CTRL + ALT + T**).
2. In the terminal window, type the following command:

```
pactl load-module module-loopback latency_msec=20
```

(The command `latency_msec=20` is optional. It helps to minimize the acoustic feedback. Some machines do not accept the command and may return error codes. In that case, just invoke `module-loopback` without specifying latency.)

3. If successful, this command returns a handle number. Invoking this command multiple times generates multiple loopback instances with independent handles.
4. To disable the loopback, type the following command in the terminal window:

```
pactl unload-module x
```

Where `x` is the handle module number returned when enabling the loopback. If the Smart Remote 3 is not connected and selected as the audio input source, sound will be streamed from the computer microphone to the computer speakers causing acoustic feedback.

5 System overview

This system overview provides a description of the main hardware components and functionalities of the nRFready Smart Remote 3 for nRF52 remote control reference design.

The main hardware components in the reference design are the following:

- nRFready Smart Remote 3 DK add-on (nRF6932)
- nRFready Smart Remote 3 product example:
 - nRF6937 for nRF52832
 - nRF6942 for nRF52810

See [Assembling Smart Remote 3 hardware](#) on page 10 for assembly instructions for the Smart Remote 3 DK add-on.

Communication in the system is digital and packet-based, which means that data between the remote control and the host is exchanged as discrete packets of information. The nRF device checks the status of the trackpad and the keypad matrix before sending this information to the host. The driver on the computer decodes the packages allowing you to use the remote control as both a pointing device and keypad.

Note: The term *host* refers to a *Bluetooth* Smart Ready compliant device that supports the HID-over-GATT profile. Windows 10, for instance, natively supports the HID-over-GATT profile if *Bluetooth* Smart Ready hardware is connected to the system. A computer with Ubuntu 16.04 LTS, NVS package and *Bluetooth* 4.0 dual-mode (Smart Ready) hardware can also be a host.

The flexibility of the remote control allows you to experiment with your own firmware and functionality. After pairing, the trackpad, accelerometer, and free-space navigation can be enabled and calibrated.

For further details on the software and firmware included, consult the firmware documentation, code API, or the code itself.

5.1 Pairing

When the remote control is turned on, it will attempt to connect to a bonded *Bluetooth* Smart Ready compatible master if bonds are available. Otherwise it will be in pairing mode and will wait for connection from host.

The Smart Remote 3 features the HID-over-GATT profile and can connect to any *Bluetooth* Smart Ready host system supporting this profile. The HID-over-GATT profile is a direct mapping from the USB HID standard. In addition to controlling how the HID data is transferred through the wireless link, the profile requires the use of *Bluetooth* device security. Security and data encryption are handled by the *Bluetooth* Security Manager, which is a *Bluetooth* Protocol Layer handled by nRF52832. On the master side of the *Bluetooth* link, the Security Manager is handled in the *Bluetooth* driver stack.

If no bonds are stored in flash, the remote control will start to advertise to Smart Ready devices for pairing when it is turned on. When Smart Remote 3 is in this advertising state, the *Bluetooth* Host platform should be instructed to start scanning for and then to connect to it. During this initial connection an encrypted link is configured by nRF52832 and the host transmits HID commands to the Smart Remote 3 according to the HID-over-GATT profile.

The remote control will stay in bond mode for 180 seconds waiting for a *Bluetooth* connection. If no connection is established, the remote control will enter deep sleep. Bonding mode will be resumed upon user activity.

Although the specifics of the pairing process may differ between platforms, the main steps remain the same.

1. Scan for the Smart Remote 3.
2. Connect to the Smart Remote 3.
3. Bond/pair with the Smart Remote 3.

Read more about *Bluetooth* Low Energy and HID over GATT at developer.bluetooth.org.

5.2 Trackpad

The trackpad has five-point multi-touch functionality and advanced gesture recognition, making it a versatile interface device for the remote control.

The trackpad is a **Synaptics®** ClickPad and is identified as a standard mouse by your computer. It does not require any special software application to work.

5.2.1 Basic use

To use the trackpad, place one of your fingers on the surface of the pad.

As you move your finger along the trackpad surface, you should see the mouse cursor on your computer screen moving according to the movement of your finger.

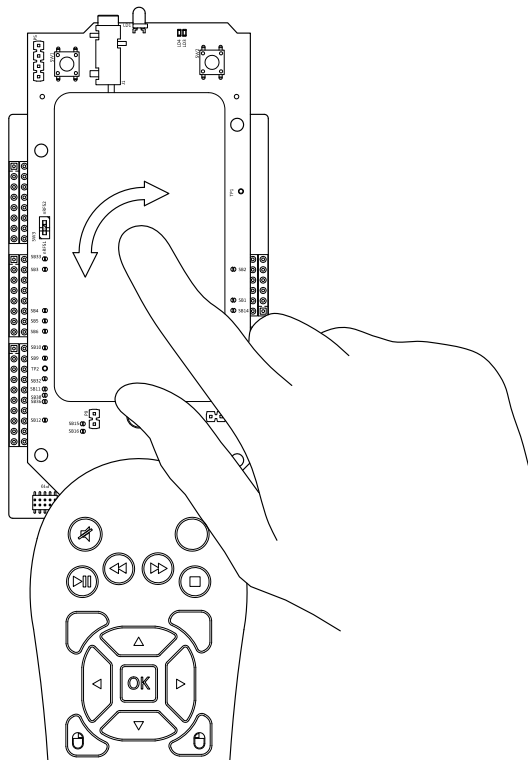


Figure 2: One-finger movement

To perform the equivalent to a left-click on your mouse, you can either press down the left side of the trackpad until you feel a button-like click, or tap the surface of the trackpad anywhere with your finger.

5.2.2 Common gestures

Two-finger horizontal and vertical scroll are the gestures that can be used on the trackpad.

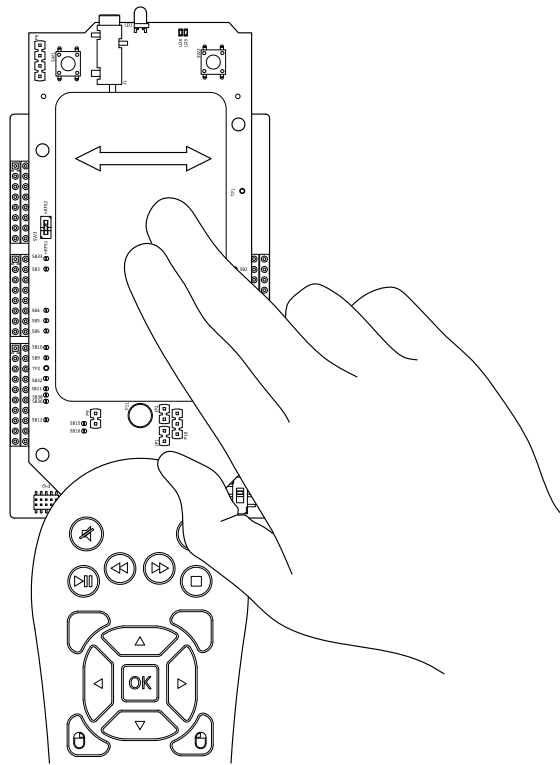


Figure 3: Two-finger horizontal scroll

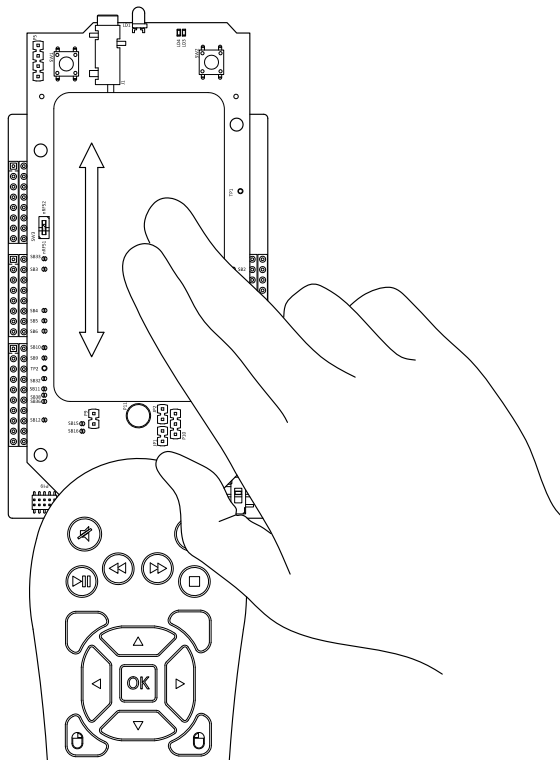


Figure 4: Two-finger vertical scroll

5.3 Accelerometer

When the remote control is in low-power sleep mode, any user interaction will be detected by the accelerometer and then wake up the remote control.

The LIS3DH three-axis ultra-low power accelerometer from [ST Microelectronics](#) is used to detect user interaction and wake up the MCU, which in turn wakes up the rest of the system. This provides intelligent power-saving (see [Intelligent power saving](#) on page 23).

Using this module is optional. See the firmware documentation for details.

5.4 Free-space navigation

The remote control includes a three-axis gyro and three-axis accelerometer combo circuit that can be used as a free-space navigation sensor, enabling the user to move a mouse cursor through gesturing with the remote control.

The gyro and accelerometer combo circuit is the ICM-20608 from InvenSense. The gyro and accelerometer circuit is used as an input device for a SmartMotion[®] firmware library from InvenSense that is integrated into the Smart Remote 3 firmware. Output data from the InvenSense library is fitted into a HID mouse report and sent to the host.

Note: The in-air pointing functionality is only provided as precompiled HEX files. To use the SmartMotion library in your design, please contact InvenSense or visit the [InvenSense[®] Developers Corner](#) (sign-up required).

5.4.1 Basic use

The remote control switches from trackpad to free-space navigation mode when you press the orange button between the **Channel +** and **Volume +** buttons.

In this mode, acceleration and rotational data from the gyro is processed by the SmartMotion firmware library.

When operating in the free-space navigation mode, the button just above the volume control is the **Left** mouse button and the button just above the program selector is the **Right** mouse button enabling point-and-click functionality. To deactivate free-space mode and go back to the trackpad mode, press the orange button again. The free-space navigation mode will also be deactivated if the remote control has not moved in seven seconds.

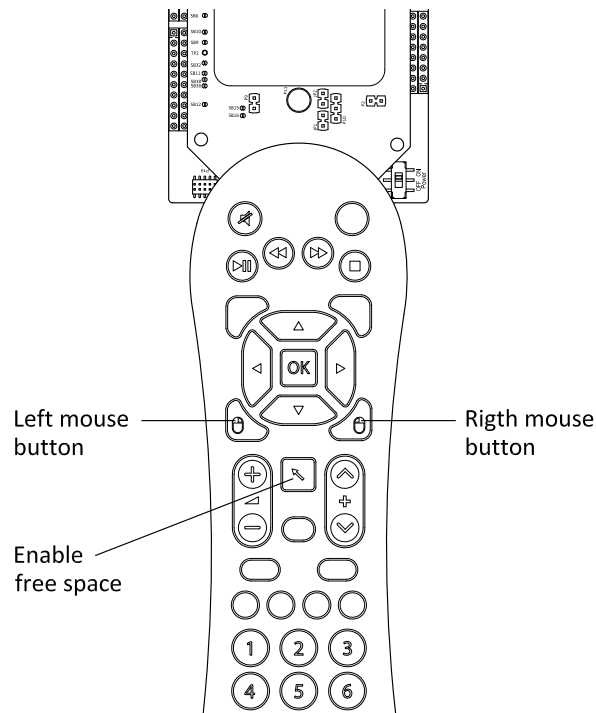


Figure 5: Enable the free-space navigation feature

Movement of the remote control is translated into two-dimensional mouse cursor movement. Rotation around the x-axis (upward and downward movements) of the remote control leads to vertical mouse cursor movement and rotation around the z-axis (side to side movements) leads to horizontal mouse cursor movement. See the following figure:

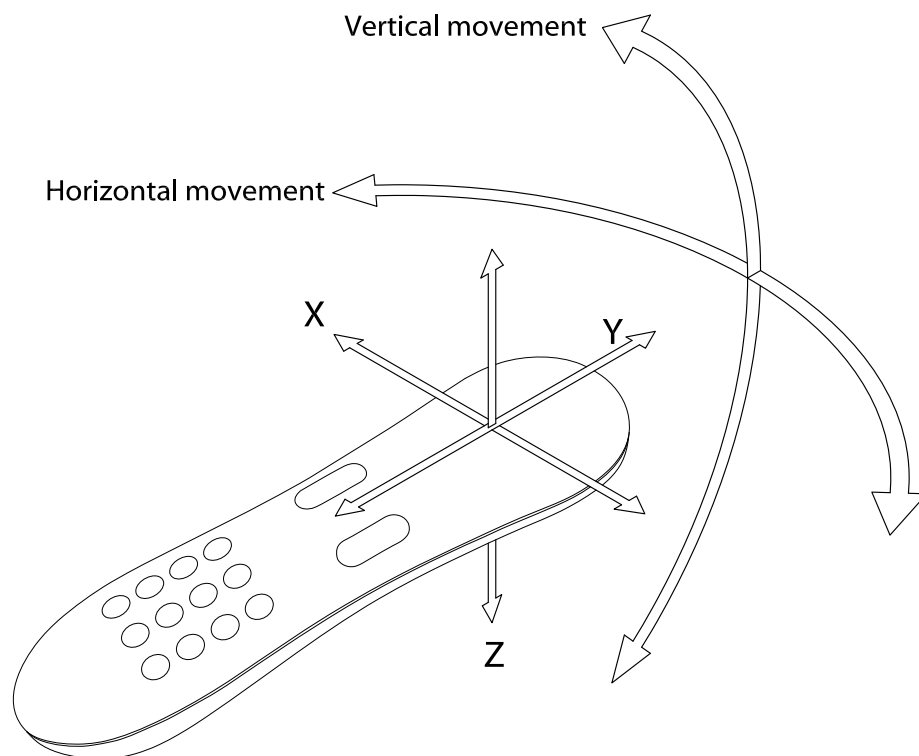


Figure 6: Coordinate system for free-space movement

5.4.2 Trackpad functionality in free-space mode

Once free-space navigation mode is enabled, the trackpad functionality changes.

Moving a finger on the trackpad does not cause the cursor to move, but results in a “scroll” motion (similarly to the scroll wheel on a mouse). Vertical movement on the trackpad causes vertical scroll, while horizontal movement results in horizontal scroll motion. This is illustrated in the following figure.

Tapping or clicking the trackpad results in left-click gestures, which is not any different from the regular trackpad use.

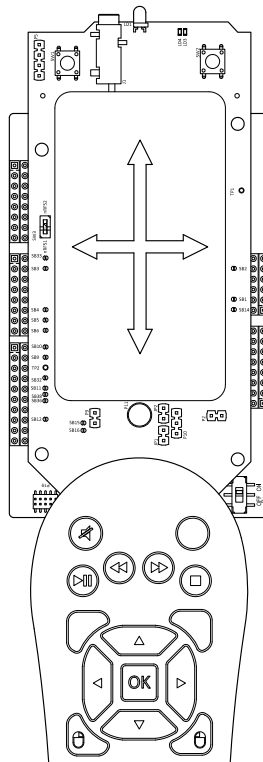


Figure 7: Trackpad functionality in free-space mode

5.4.3 Gyro calibration

Gyroscope calibration is performed automatically the first time the firmware is run on the hardware. For nRF6937 product example and nRF6932 add-on, it is also possible to trigger gyroscope calibration by holding the orange button between **Channel +** and **Volume +** buttons for three seconds.

Smart Remote 3 firmware performs initial calibration on the first firmware run, but if you experience that the cursor is moving involuntarily when you start using the free-space navigation, this is due to gyro wandering. The SmartMotion firmware library will automatically compensate for this movement. Simply leave the Smart Remote on a flat surface with free-space navigation enabled. After a few seconds the cursor will stop moving and you can pick up the Smart Remote and start using the free-space navigation feature.

5.5 Intelligent power saving

When the remote control has not been used for a few seconds, most of its functions are powered down to conserve energy, including the trackpad, which means it will not react to user input.

In this powered down state the remote control relies on the low power accelerometer for notification of user activity. When the remote control is picked up or nudged lightly, it will resume normal operation.

5.6 Keypad

The remote control includes a common remote control keypad that is used in TVs and set-top boxes.

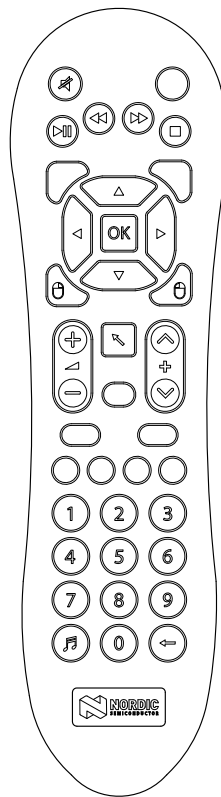


Figure 8: Remote control keypad

5.7 Infrared LED and infrared learning feature

To support the control of legacy electronic devices that are only fitted with infrared (IR) remote control receivers, the Smart Remote 3 DK add-on and the Smart Remote 3 product example is fitted with an IR LED.

The IR LED and IR protocols are handled by the MCU. The Smart Remote 3 product example also contains a chip for use in code learning applications.

Note: LED output is implemented in firmware rev. 1.1 and later. IR receiving function is not implemented in the firmware.

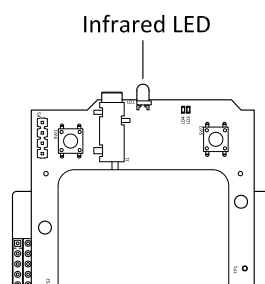


Figure 9: Location of the infrared LED on Smart Remote 3 add-on

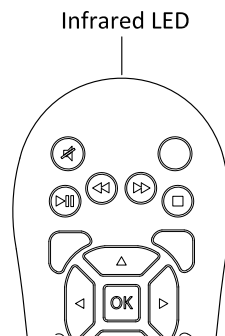


Figure 10: Location of the infrared LED on Smart Remote 3 product example

5.8 NFC

The Smart Remote 3 nRF52832 product example has an NFC antenna mounted inside, ready to be used.

Note: NFC functionality is not present in rev. 1.0 of the firmware.

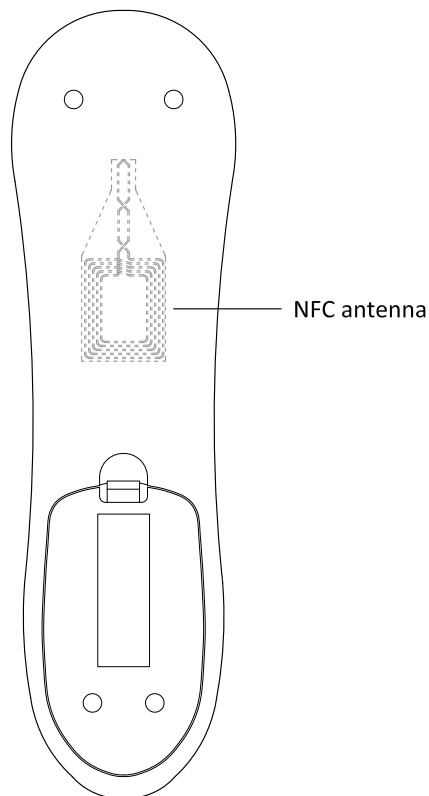


Figure 11: Location of the NFC antenna

6 Hardware description: Smart Remote 3 DK add-on

The DK add-on contains all the hardware necessary for user interaction, including batteries.

Note: The Smart Remote 3 DK add-on rev 1.2 and beyond is compatible with both nRF51 and nRF52 DKs. For using this add-on with nRF51 DK, switch **SW3** must be set in the position **nRF51**.

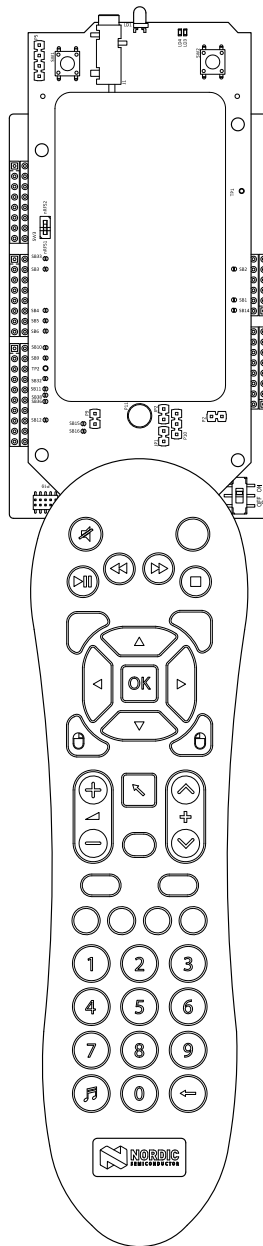


Figure 12: Smart Remote 3 DK add-on

6.1 Hardware figures: Smart Remote 3 DK add-on

The hardware drawings show both sides of the DK add-on board (PCA63519).

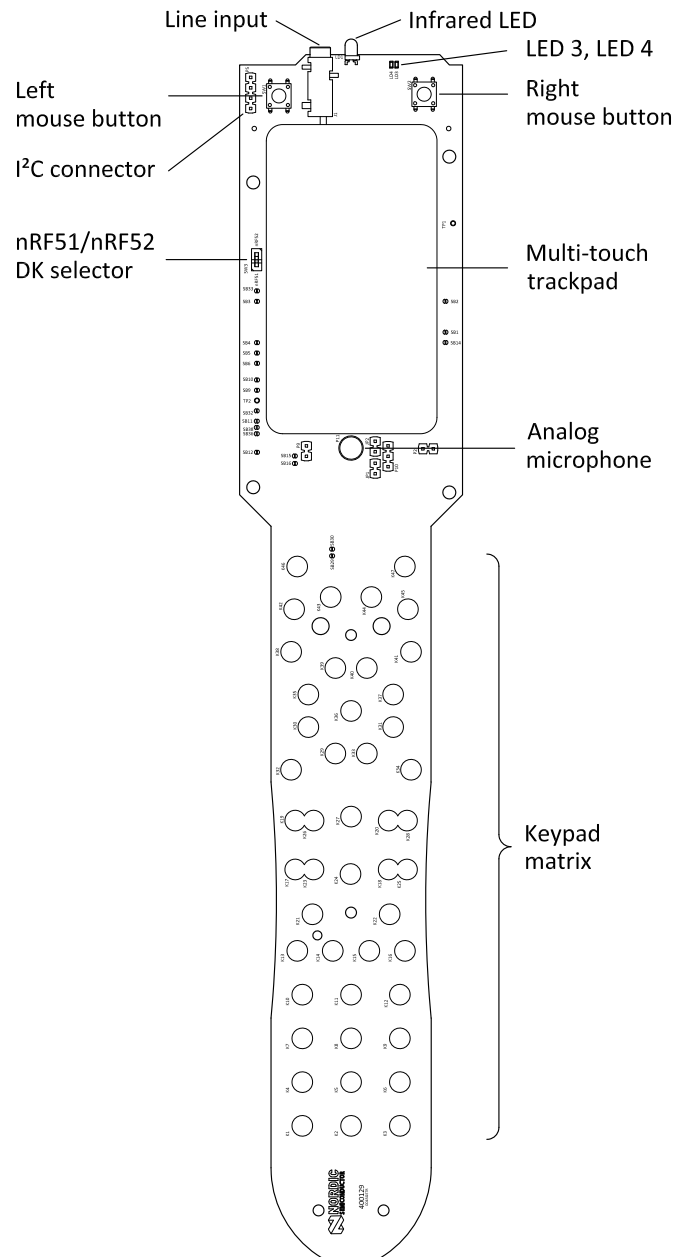


Figure 13: DK add-on board (PCA63519), front side

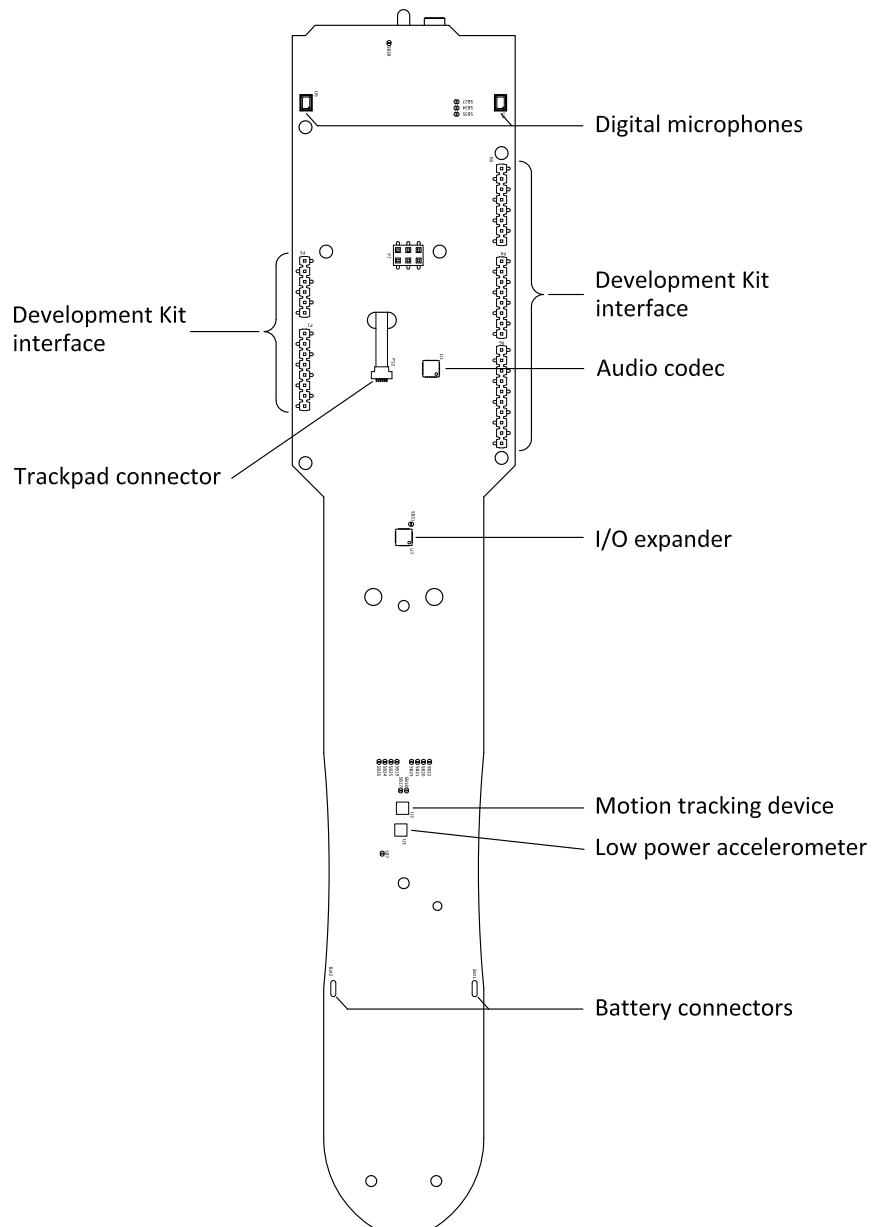


Figure 14: DK add-on board (PCA63519), back side

6.2 Block diagram

The block diagram illustrates Smart Remote 3 DK add-on functional architecture.

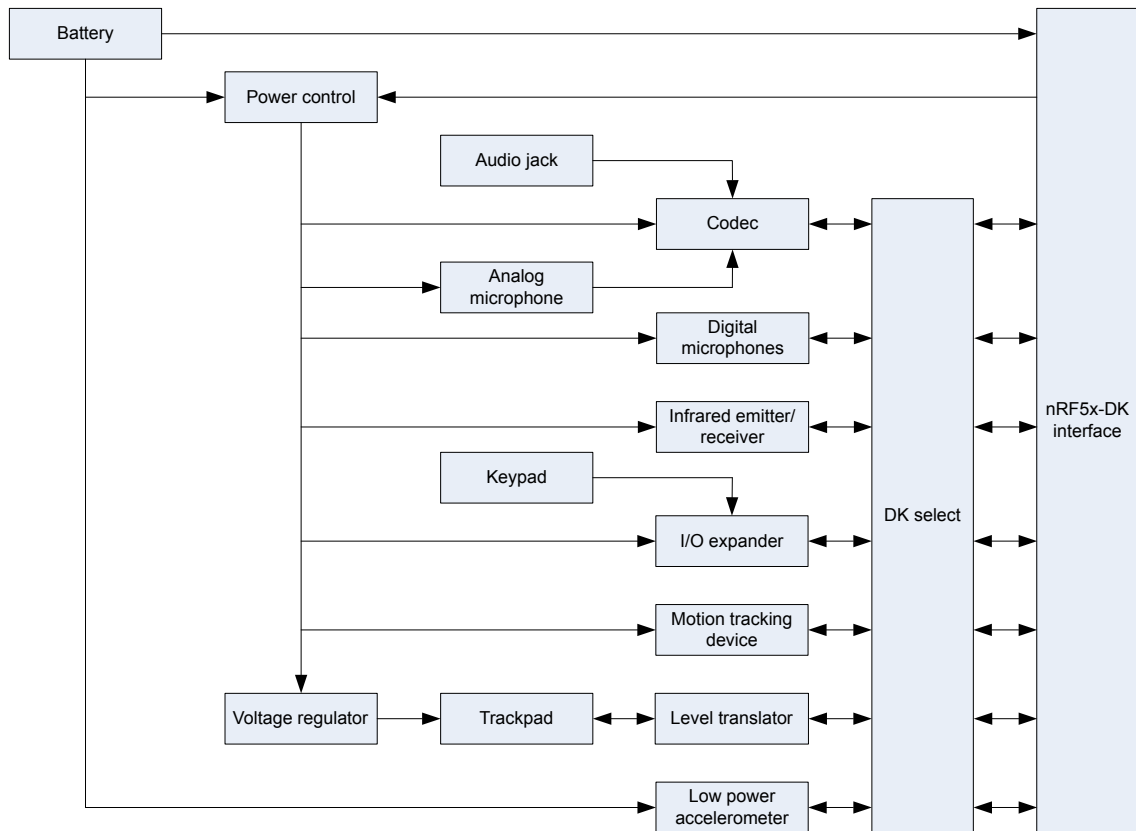


Figure 15: Block diagram

6.3 Design description

The design description provides detailed descriptions of Smart Remote 3 DK add-on hardware blocks.

6.3.1 Trackpad

The trackpad is mounted onto the PCA63519 board and connected to the **P12** connector.

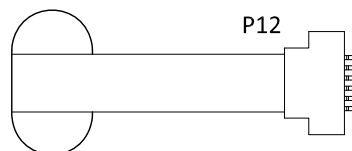


Figure 16: Trackpad interface connector

The trackpad is interfaced through the two-wire bus interface. See the table below for the trackpad pin description:

Pin	Label	Description
1	NC	Not connected
2	WU_IRQ_TP	Interrupt from trackpad
3	GND	Ground
4	I2C_CLK_TP	Two-wire serial clock
5	I2C_DATA_TP	Two-wire serial data
6	3V3	Power supply for trackpad

Table 1: Trackpad pin description

The trackpad requires a stable 3.3 V supply (see [Figure 24: Voltage regulator for the trackpad](#) on page 35 for details). Because of this the signals going from the nRF device to the trackpad need to be level-shifted.

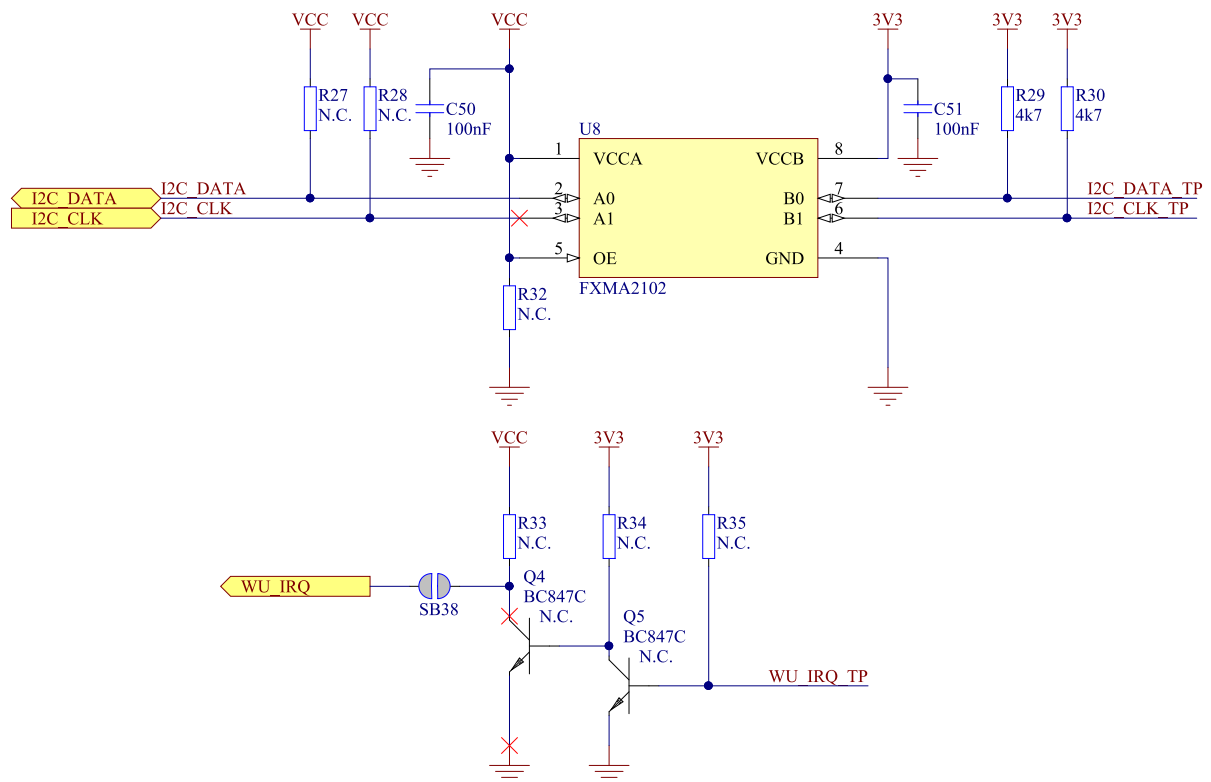


Figure 17: Level translation circuit for the trackpad

6.3.2 Keypad matrix

The keypad on the Smart Remote 3 DK add-on board (PCA63519) board has 39 buttons.

The matrix has six rows and eight columns that gives room for 48 buttons in firmware, of which 39 are used by the keypad, and one row is used for two push buttons that function as the left and right mouse buttons. A total of 41 of 48 locations are in use.

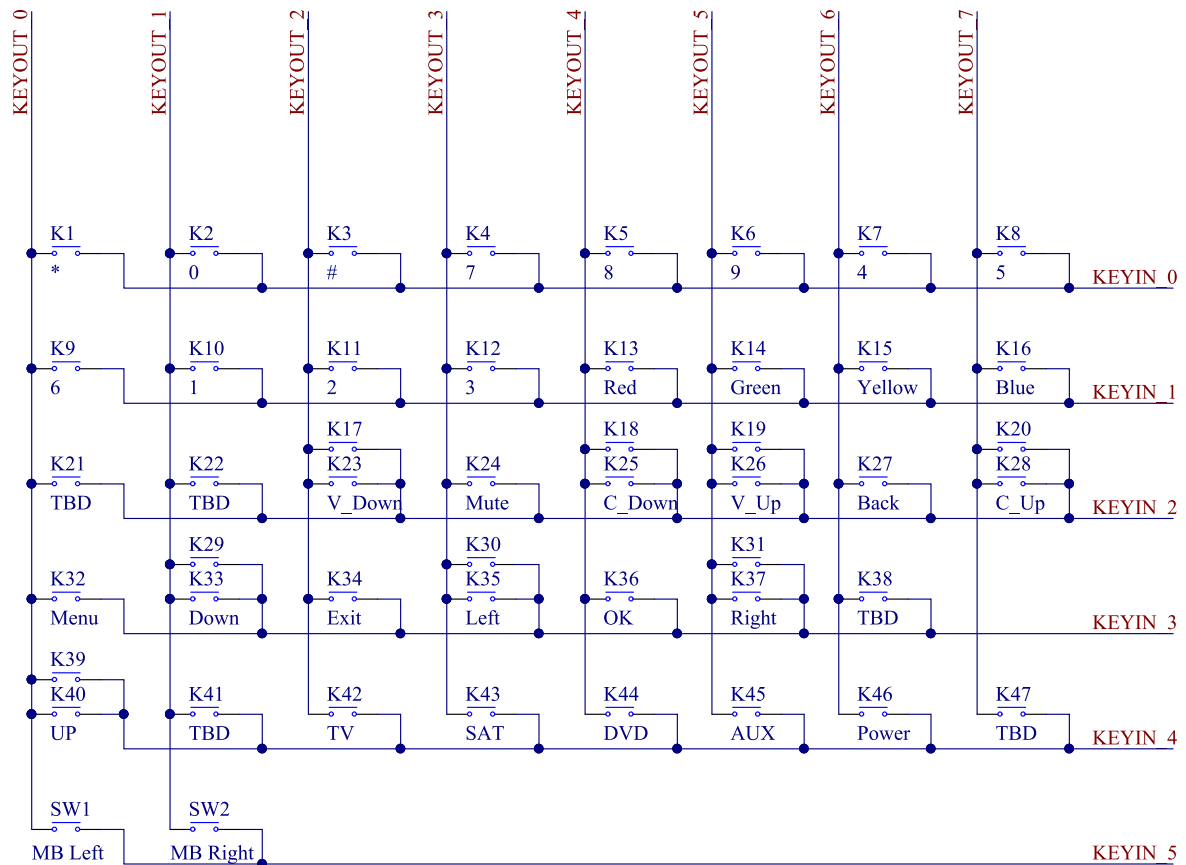


Figure 18: Keypad matrix

The matrix is connected to an I/O expander that is controlled by the nRF device using I²C. See [Figure 19: Keypad matrix I/O expander](#) on page 32.

The I/O expander circuit is added on the DK add-on so that it strictly uses the I/O set available in the Arduino interface system. On the product example, which does not have an Arduino interface, the I/O expander circuit is not needed.

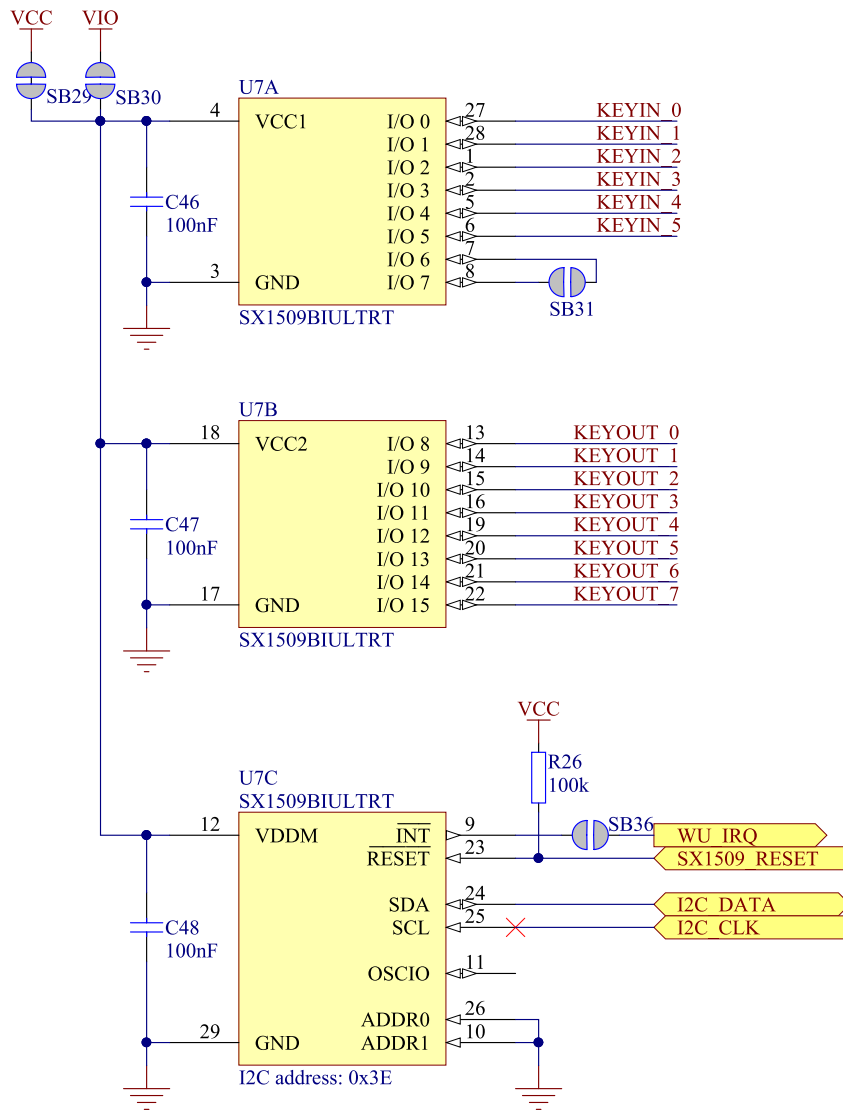


Figure 19: Keypad matrix I/O expander

6.3.3 Low-power accelerometer circuit

To obtain low power consumption and long battery lifetime, a low-power three-axis accelerometer (**U3**) has been added to the remote control.

See below for the schematic. See also [Intelligent power saving](#) on page 23.

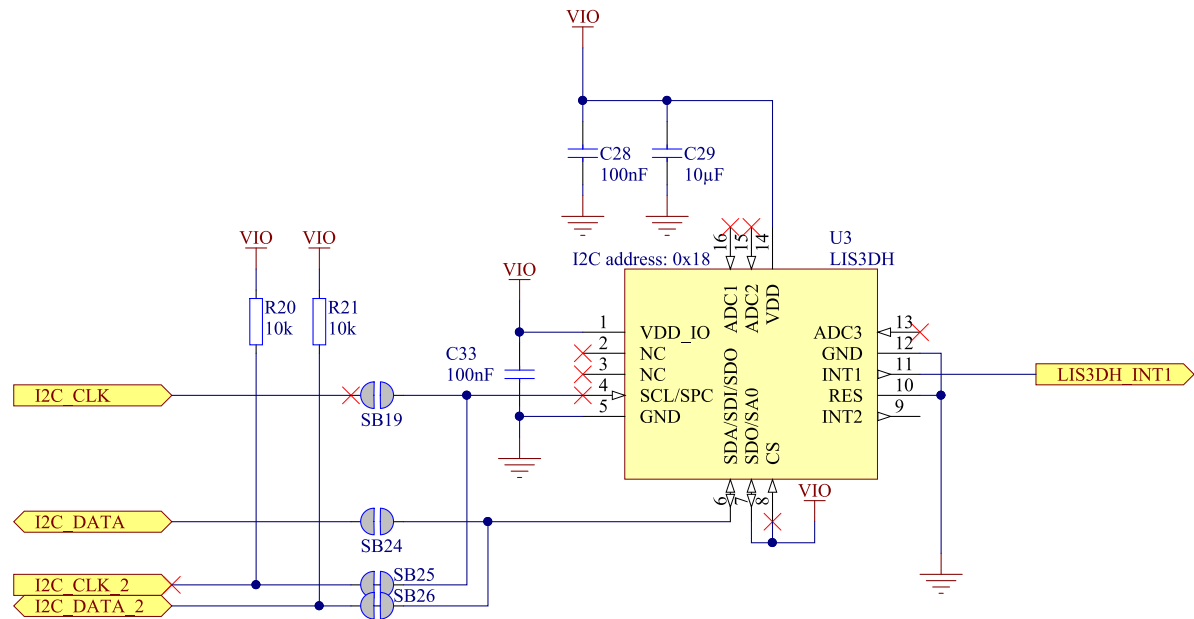


Figure 20: Accelerometer circuit

The accelerometer has I²C outputs and can detect motion on three axes. The sensitivity is configurable to ± 2 g/ ± 4 g/ ± 8 g/ ± 16 g.

6.3.4 Motion tracking device

For advanced features, the remote control has a three-axis gyro integrated with a three-axis accelerometer (U2).

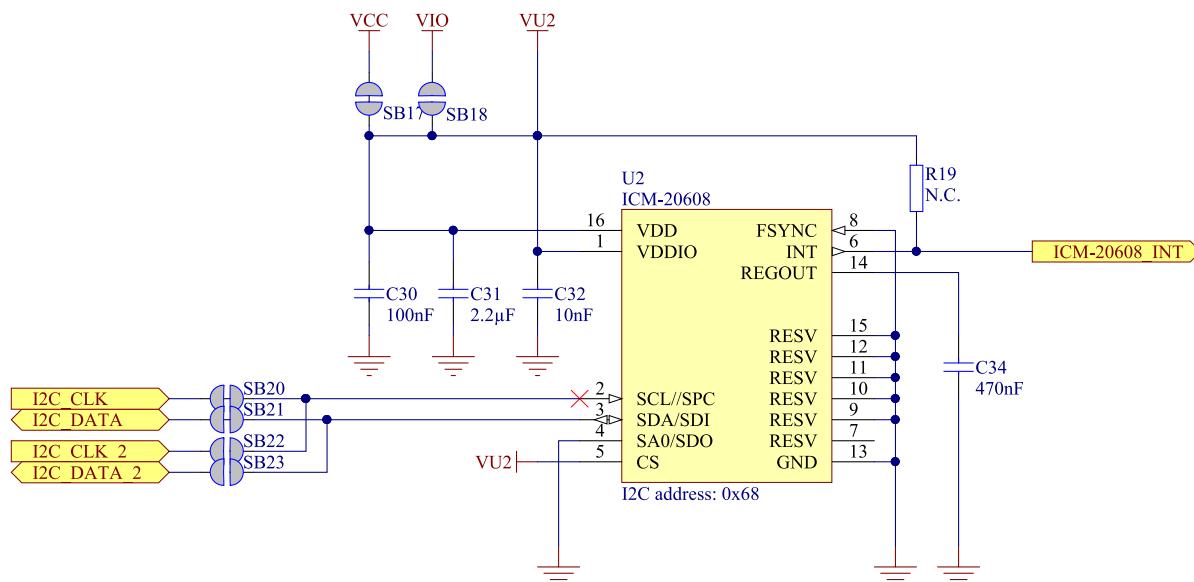


Figure 21: Gyro/accelerometer circuit

The circuit is connected to the MCU by the first I²C. If you want to use the second I²C there are four solder bridges that you need to change:

- Solder **SB22** and **SB23**
- Cut **SB20** and **SB21**

This circuit is a $\pm 250^\circ$ per sec/ $\pm 500^\circ$ per sec/ $\pm 1000^\circ$ per sec/ $\pm 2000^\circ$ per sec selectable three-axis gyro and a ± 2 g/ ± 4 g/ ± 8 g/ ± 16 g selectable three-axis accelerometer.

6.3.5 Power supply

The Smart Remote 3 DK add-on gets its power from two AA batteries or from the nRF5x Development Kit (DK).

Either alkaline (2×1.5 V) or rechargeable NiMH (2×1.2 V) batteries can be used. The battery circuit has a protection diode to avoid reverse current if the USB is connected to the nRF5x DK while batteries are inserted.

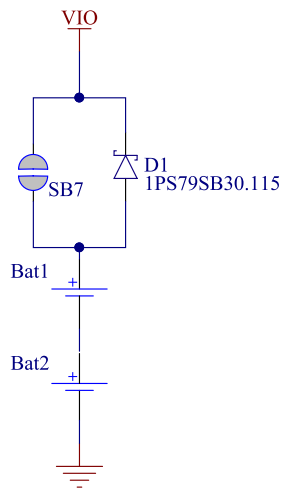


Figure 22: Battery schematic

Smart Remote 3 has a switch for turning the power on or off for most of the circuits. One transistor is used for this, which is controlled by the nRF chip on the nRF5x DK. See [Figure 23: Power on/off switch](#) on page 34. The low-power accelerometer is always powered.



Figure 23: Power on/off switch

The voltage from the batteries or nRF5x DK is used unregulated for most part of the design. However, the trackpad requires a stable voltage of 3.3 V. To achieve this, the trackpad gets the power from a fixed step-up/step-down charge pump generator that outputs 3.3 V. See [Figure 24: Voltage regulator for the trackpad](#) on page 35.

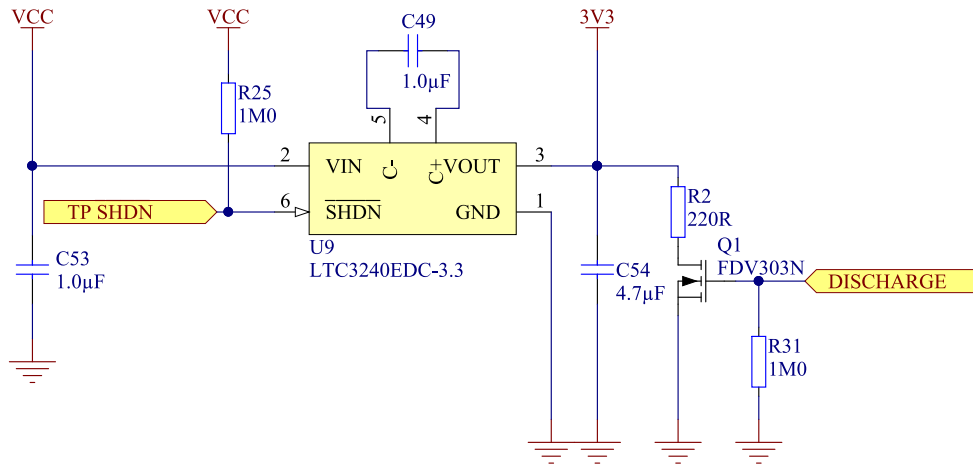


Figure 24: Voltage regulator for the trackpad

Note: The input voltage for this regulator is 1.8 V–5.5 V.

6.3.6 Infrared LED and driver

To support legacy products, the remote control has an infrared LED with a driver circuit.

The infrared LED is driven by a transistor (**Q3**) to offer higher current than the MCU I/O can offer.

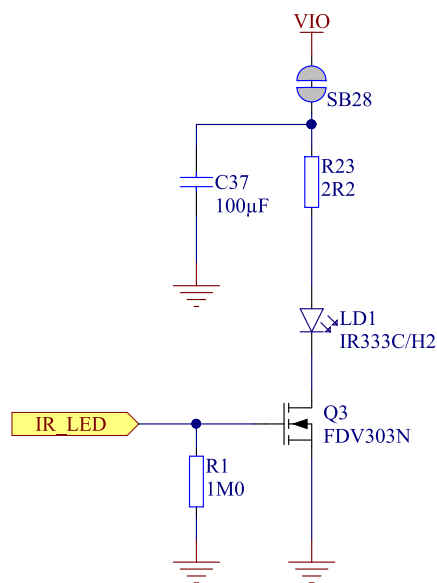


Figure 25: Infrared LED and driver circuit

The control signal is active high meaning that when the IR_LED signal has logic high level, the LED emits infrared light.

6.3.7 Codec

A codec is used in conjunction with the nRF51 DK to get the analog signal from the microphone to digital signals.

The codec used is the ES8218 analog-to-digital converter (ADC) from Everest Semiconductor. ES8218 is set up with the use of a two-wire interface. The microphone signal is transferred to the nRF5x DK via I²S interface.

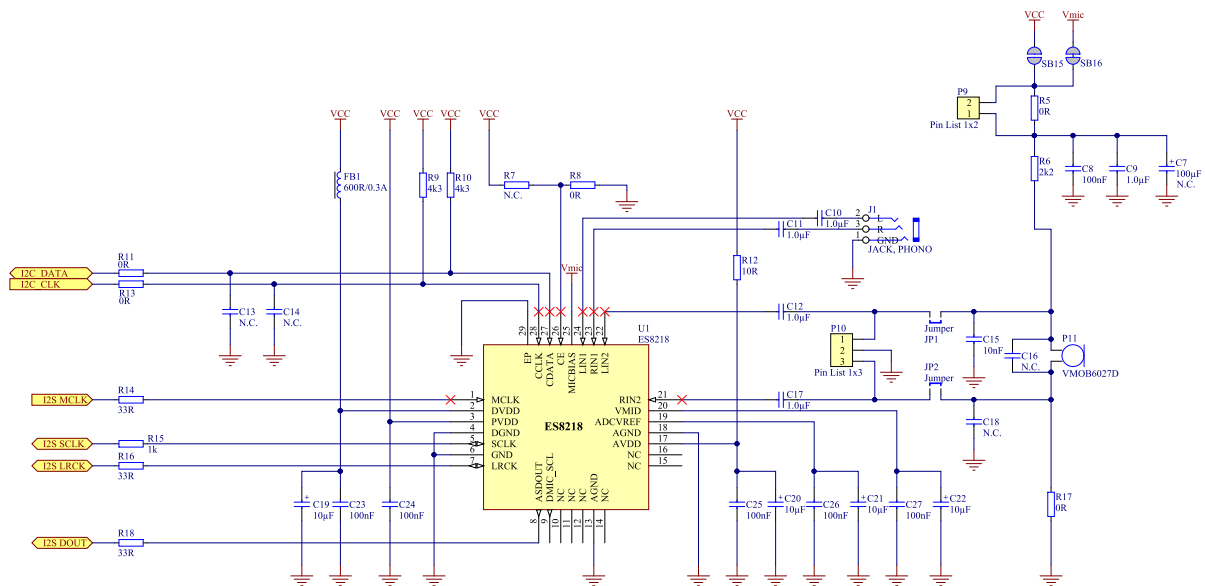


Figure 26: Codec and appurtenant components

6.3.8 Digital microphones (only for use with nRF52 DK)

The Smart Remote 3 DK add-on is equipped with two digital output PDM microphones.

The microphones are configured so that they can be used to sample stereo audio, but are by default set to mono audio. The microphones are by default disconnected from the power supply and the interface connectors. To connect to the development kit and enable power, solder bridges **SB34**, **SB35**, and **SB27** must be shorted. See the following schematic:

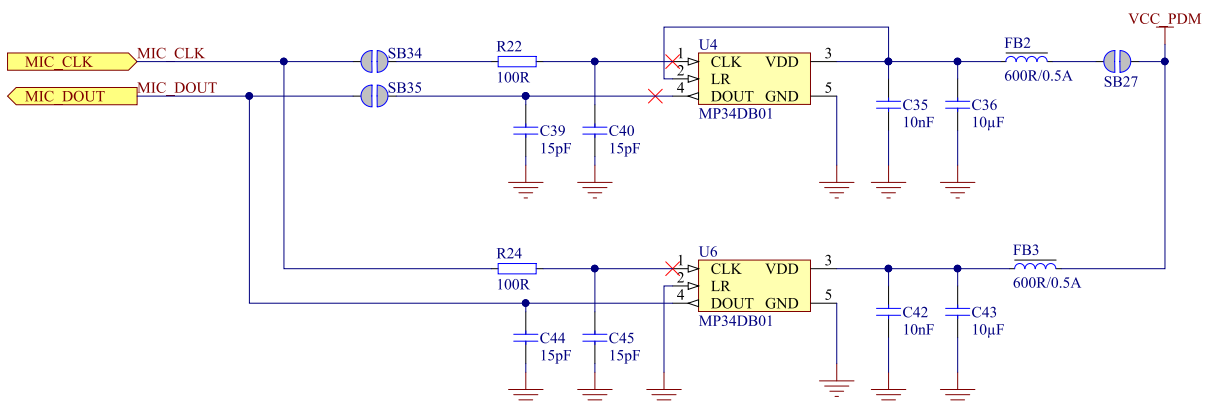


Figure 27: Digital microphones

6.3.9 nRF51 DK interface

Connectors **P1**, **P3**, **P4**, **P6**, **P7**, and **P8** are used to connect the DK add-on to the nRF51 DK.

Through these connectors, all the functionality of the DK add-on can be accessed by the nRF51 DK. See [Table 2: nRF51 DK interface connections](#) on page 36 for pin information.

Pin	Label	Description	Short
P1_1	VIO	Voltage domain VIO	
P1_2	VIO	Voltage domain VIO	

Pin	Label	Description	Short
P1_3	NC	Not connected	
P1_4	VIO	Voltage domain VIO	
P1_5	V5V	Voltage domain V5V	
P1_6	GND	Ground	
P1_7	GND	Ground	
P1_8	VIN	Voltage domain VIN	
P3_1	TP SHDN	TP voltage regulator on/off	
P3_2	A1	LD3 control	SB1
P3_3	I2S LRCK	ADC audio data left and right	
P3_4	I2S MCLK	Master clock	
P3_5	NC	Not connected	
P3_6	I2S DOUT	ADC audio data	
P4_1	I2S SCLK	Audio data bit clock	SB33
P4_2	I2S SCLK	Audio data bit clock	SB3
P4_3	D2	Connected to D3	
P4_4	D3	Connected to D2	
P4_5	POWER ON/OFF	Control signal power switch	
P4_6	D5	LD4 control	SB4
P4_7	I2S CLK2	I ² C 2 clock	SB5
P4_8	ICM-20608 INT	Motion tracking device interrupt	SB6
P6_1	DISCHARGE	Discharges the TP voltage regulator	SB10
P6_2	NC	Not connected	SB9
P6_3	NC	Not connected	
P6_4	IR LED	Infrared LED control signal input	
P6_5	WU IRQ	TP interrupt or I/O expander interrupt	SB11
P6_6	LIS3DH INT1	Low-power accelerometer interrupt 1	
P6_7	GND	Ground	
P6_8	I2C_DATA2	I ² C 2 data	SB12
P6_9	I2C_DATA	I ² C 1 data	
P6_10	I2C_CLK	I ² C 1 clock	
P7_1	NC	Not connected	
P7_2	NC	Not connected	
P7_3	NC	Not connected	

Pin	Label	Description	Short
P7_4	NC	Not connected	
P7_5	NC	Not connected	
P7_6	GND	Ground	
P8_1	NC	Not connected	
P8_2	NC	Not connected	
P8_3	NC	Not connected	
P8_4	NC	Not connected	
P8_5	NC	Not connected	
P8_6	NC	Not connected	
P8_7	NC	Not connected	
P8_8	NC	Not connected	

Table 2: nRF51 DK interface connections

6.3.10 nRF52 DK interface

Connectors **P1**, **P3**, **P4**, **P6**, **P7**, and **P8** are used to connect the DK add-on to the nRF52 DK.

Through these connectors, all the functionality of the DK add-on can be accessed by the nRF52 DK. See [Table 3: nRF52 DK interface connections](#) on page 38 for pin information.

Pin	Label	Description	Short
P1_1	VIO	Voltage domain VIO	
P1_2	VIO	Voltage domain VIO	
P1_3	NC	Not connected	
P1_4	VIO	Voltage domain VIO	
P1_5	V5V	Voltage domain V5V	
P1_6	GND	Ground	
P1_7	GND	Ground	
P1_8	VIN	Voltage domain VIN	
P3_1	TP SHDN	TP voltage regulator on/off	
P3_2	A1	LD3 control	SB1
P3_3	NC	Not connected	
P3_4	NC	Not connected	
P3_5	I2C CLK	I ² C clock	SB2
P3_6	NC	Not connected	
P4_1	NC	Not connected	SB33

Pin	Label	Description	Short
P4_2	I2C CLK2	I ² C 2 clock	SB3
P4_3	MIC CLK	Digital microphone clock	
P4_4	MIC DOUT	Digital microphone data output	
P4_5	POWER ON/OFF	Control signal power switch	
P4_6	D5	LD4 control	SB4
P4_7	NC	Not connected	SB5
P4_8	NC	Not connected	SB6
P6_1	DISCHARGE	Discharges the TP voltage regulator	SB10
P6_2	ICM-20608 INT	Motion tracking device interrupt	SB9
P6_3	NC	Connected to test point 2	
P6_4	IR LED	Infrared LED control signal input	
P6_5	WU IRQ	TP interrupt or I/O expander interrupt	SB11
P6_6	LIS3DH INT1	Low-power accelerometer interrupt 1	
P6_7	GND	Ground	
P6_8	I2C_DATA2	I ² C 2 data	SB12
P6_9	I2C_DATA	I ² C 1 data	
P6_10	I2C_CLK	I ² C 1 clock	
P7_1	NC	Not connected	
P7_2	NC	Not connected	
P7_3	NC	Not connected	
P7_4	NC	Not connected	
P7_5	NC	Not connected	
P7_6	GND	Ground	
P8_1	NC	Not connected	
P8_2	NC	Not connected	
P8_3	NC	Not connected	
P8_4	NC	Not connected	
P8_5	NC	Not connected	
P8_6	NC	Not connected	
P8_7	NC	Not connected	
P8_8	NC	Not connected	

Table 3: nRF52 DK interface connections

6.3.11 Current measurement

The Smart Remote 3 DK add-on has two pin headers available for current measurement. These pin headers make it possible to measure current for the DK add-on and for the microphone.

By default, a 10 Ω resistor (**R3**) is parallel to **P2** and a 0 Ω resistor (**R5**) is parallel to **P9**. When performing current measurement, the resistor has to be removed.

There are two ways of measuring the current consumption: using an ampere-meter or an oscilloscope.

With ampere-meter:

- Remove **R3** and/or **R5**
- Connect an ampere-meter between the pins of connector **P2** and/or **P9**. This will monitor the current directly.

With oscilloscope:

- On **R3**, use the default mounted 10 Ω resistor. On **R5**, replace the 0 Ω resistor with a resistor not larger than 10 Ω .
- Connect an oscilloscope in differential mode or similar with two probes on the pins of the **P2** and/or **P9** connectors.
- Measure the voltage drop. The voltage drop will be proportional to the current consumption. For example, if a 10 Ω resistor is chosen, 10 mV equals 1 mA.

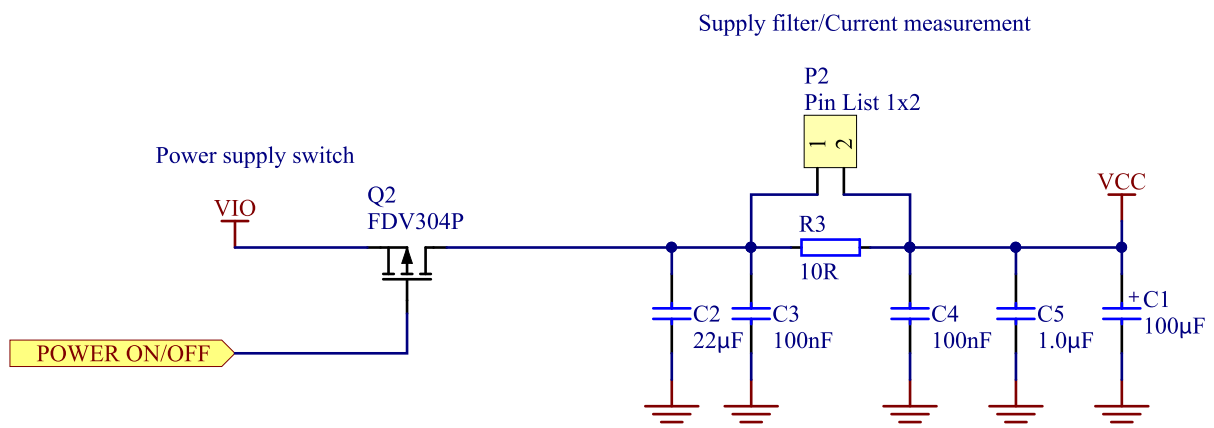


Figure 28: DK add-on current measurement

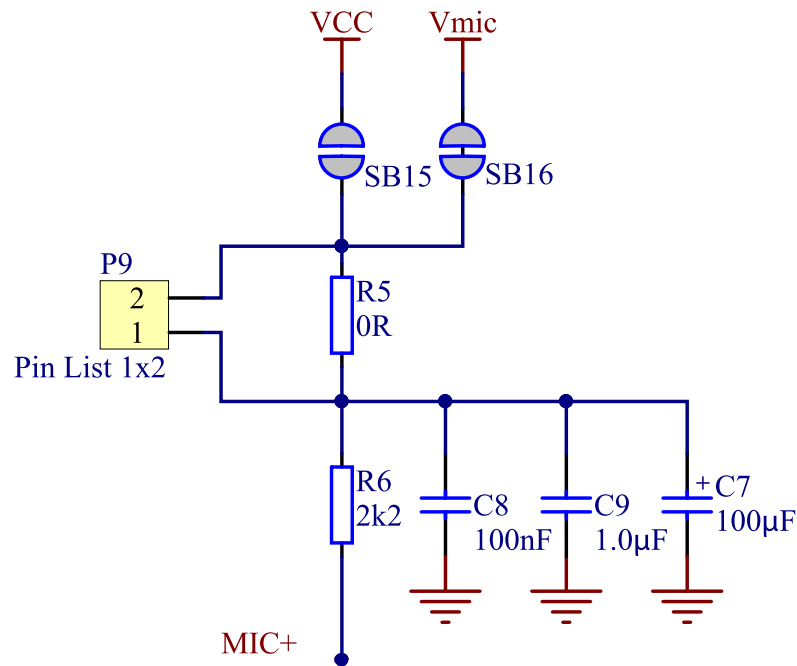


Figure 29: Microphone current measurement

In the figure above, MIC+ refers to the positive side of the microphone.

6.3.12 I²C bus connector

A connector for the I²C bus is available on the **P5** header. This can be used for debugging or connecting to external sensors.

Pin	Label	Description
P5_1	VCC	Power supply
P5_2	GND	Ground
P5_3	I2C_CLK	I ² C 1 clock
P5_4	I2C_DATA	I ² C 1 data

Table 4: I²C bus connector pin configuration

6.3.13 Schematics, bill of materials, PCB layout files, production files

All hardware files for the Smart Remote 3 DK add-on are available in a zip package.

The hardware files for the Smart Remote 3 DK add-on are located in the following folder in the hardware files zip package:

```
\nRFready Smart Remote 3 for nRF52 series x_x_x\nRF6932 - DK Add-on
x_x_x
```

In this folder you can find the bill of materials, schematics, and PCB layout files in PDF format, Altium Designer files, and production files (assembly drawings, gerber files, drill files, and pick-and-place files).

7 Hardware description: Smart Remote 3 for nRF52832 product example

The product example contains all the hardware necessary for user interaction, including batteries.

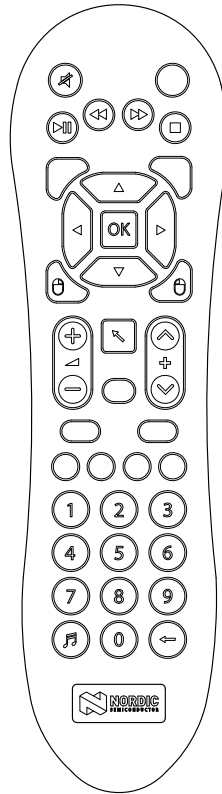


Figure 30: Smart Remote 3 nRF52 product example

7.1 Hardware figures: Smart Remote 3 for nRF52832 product example

The hardware drawings show both sides of the Smart Remote 3 product example board (PCA20023).

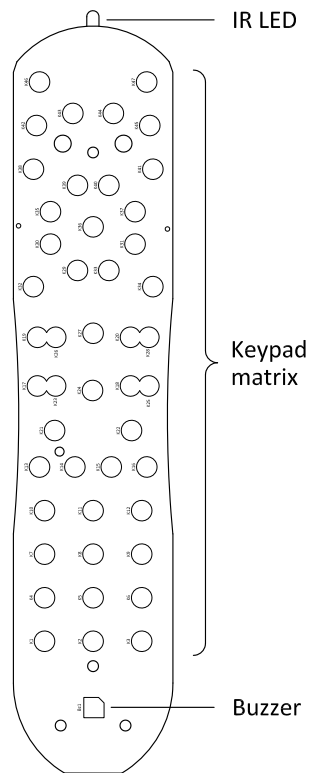


Figure 31: Smart Remote 3 product example board (PCA20023), front side

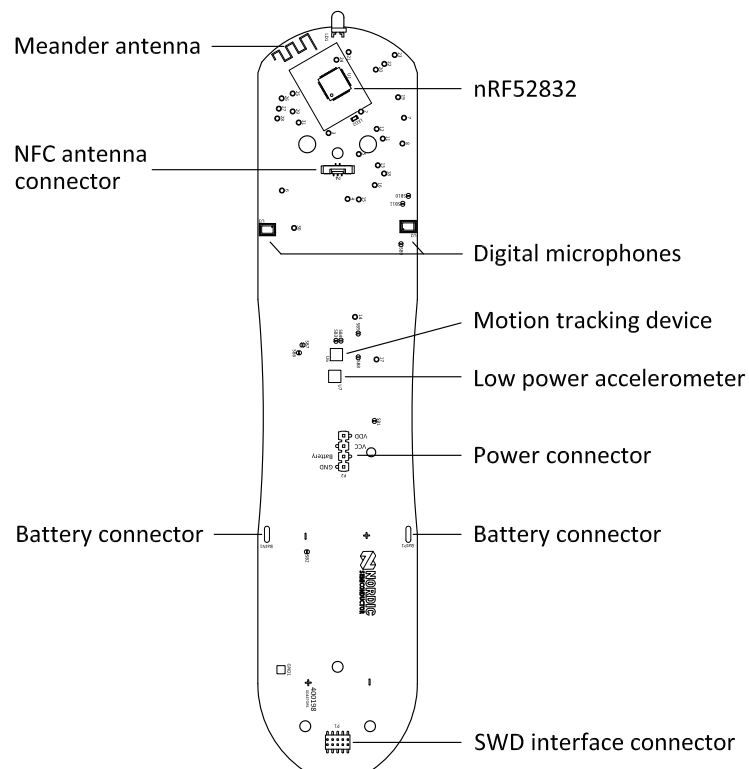


Figure 32: Smart Remote 3 product example board (PCA20023), back side

7.2 Block diagram

The block diagram illustrates Smart Remote 3 DK product example functional architecture.

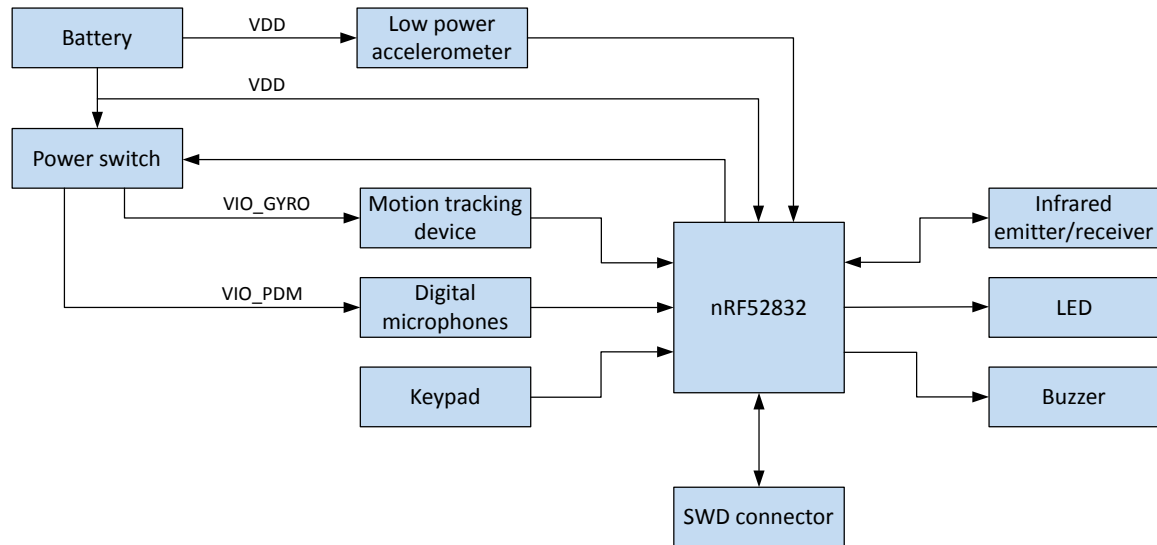


Figure 33: Block diagram

7.3 Design description

This chapter contains details about the hardware blocks on the Smart Remote 3 for nRF52 product example.

7.3.1 I/O usage

The nRF52832-QFAA has 32 generic I/Os available. All I/Os are used in this design and are organized as shown in table below.

I/O	Label	Description
P0.00	XL1	32.768 kHz crystal ⁵
P0.01	XL2	32.768 kHz crystal ⁵
P0.02	DEBUG_LED	Output for debug LED
P0.03	KEYOUT_4	Output to keypad column 4
P0.04	Buzzer	Output to buzzer
P0.05	MIC_DOUT	Input from digital microphone
P0.06	MIC_CLK	Clock signal for digital microphone
P0.07	VIO_GYRO_SW	On/off switch for accelerometer and gyro
P0.08	KEYOUT_2	Output to keypad column 2
P0.09	NFC1	NFC antenna
P0.10	NFC2	NFC antenna

⁵ Optional

I/O	Label	Description
P0.11	KEYOUT_3	Output to keypad column 3
P0.12	KEYOUT_0	Output to keypad column 0
P0.13	I2C_DATA_2	Two-wire 2 master data
P0.14	I2C_CLK_2	Two-wire 2 master clock
P0.15	I2C_CLK	Two-wire 1 master clock
P0.16	KEYIN_0	Input from keypad row 0
P0.17	KEYIN_1	Input from keypad row 1
P0.18	KEYIN_2	Input from keypad row 2
P0.19	KEYIN_4	Input from keypad row 4
P0.20	KEYOUT_6	Output to keypad column 6
P0.21	IR_SIGNAL	Input IR signal
P0.22	ICM-20608_INT	Motion tracking device interrupt
P0.23	IR_REC	
P0.24	IR_LED	Output for IR LED
P0.25	KEYOUT_7	Output to keypad column 7
P0.26	VIO_PDM_SW	On/off switch on power supply for digital microphones
P0.27	KEYOUT_5	Output to keypad column 5
P0.28	KEYOUT_1	Output to keypad column 1
P0.29	KEYIN_3	Input from keypad row 3
P0.30	LIS3DH_INT1	Low power accelerometer interrupt 1
P0.31	I2C_DATA	Two-wire 1 master data

Table 5: I/O usage

7.3.2 Keypad matrix

The keypad on the PCA20023 board has 39 buttons.

The keyboard matrix is five rows by eight columns, providing 40 available buttons for firmware. Thirty-nine are used by the keypad with one unused. The matrix is connected directly to the nRF52 SoC on the board.

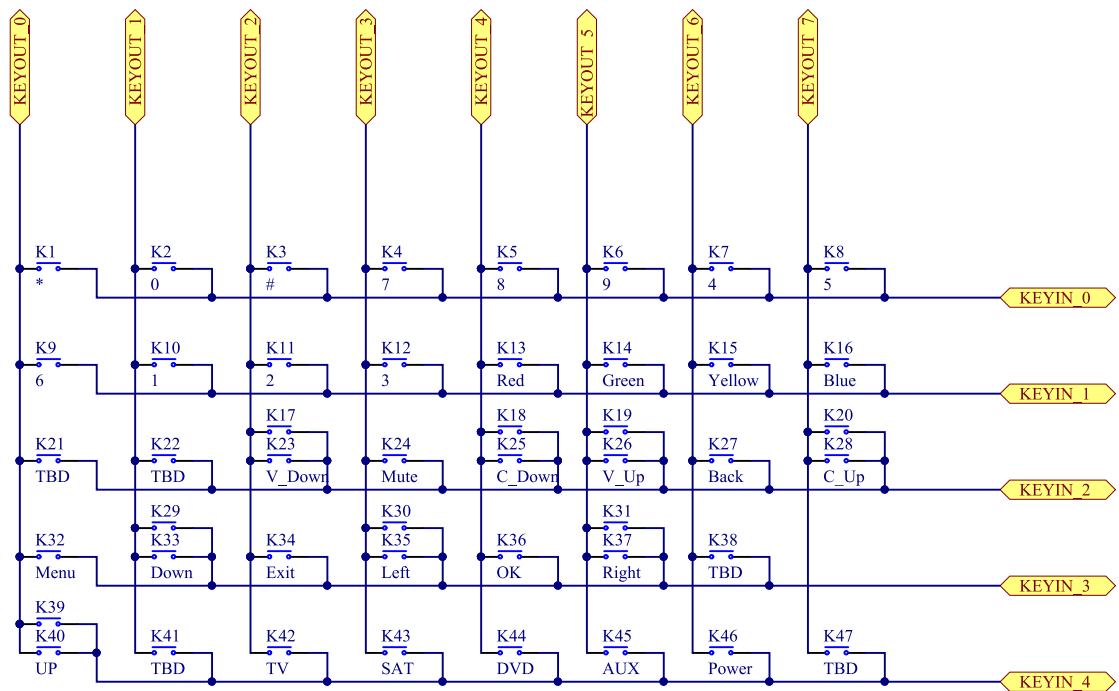


Figure 34: Keypad matrix

7.3.3 Low-power accelerometer circuit

To obtain low power consumption and long battery lifetime, a low-power three-axis accelerometer (**U7**) has been added to the remote control.

See [Figure 35: Accelerometer circuit](#) on page 46 for the schematic. See also [Intelligent power saving](#) on page 23.

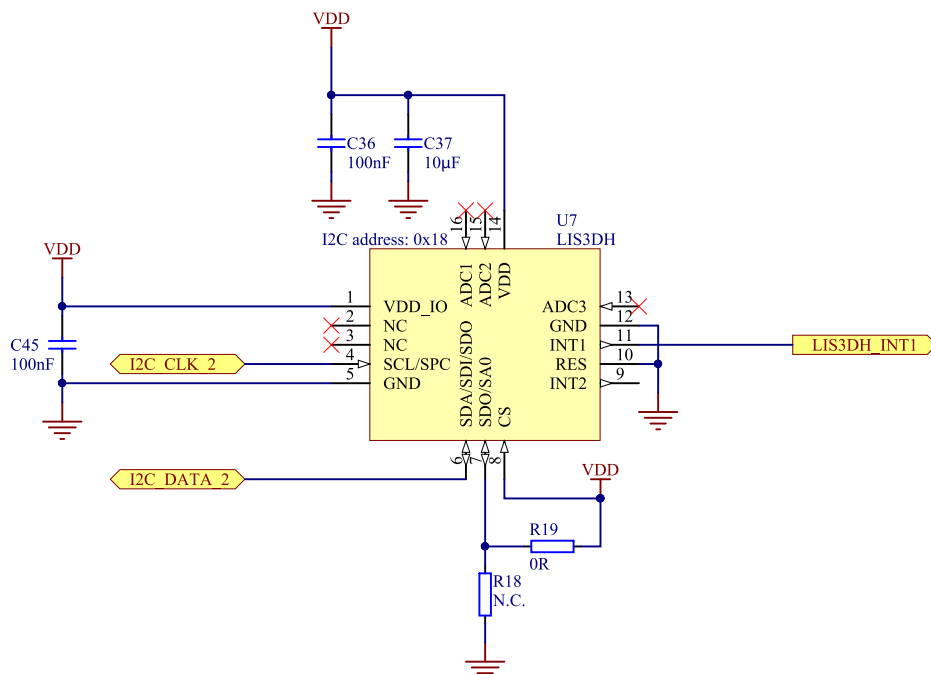


Figure 35: Accelerometer circuit

The accelerometer has I²C outputs and can detect motion on 3 axes. The sensitivity is configurable to ± 2 g/ ± 4 g/ ± 8 g/ ± 16 g.

7.3.4 Motion tracking device

For advanced features, the remote control has a three-axis gyro integrated with a three-axis accelerometer (U6).

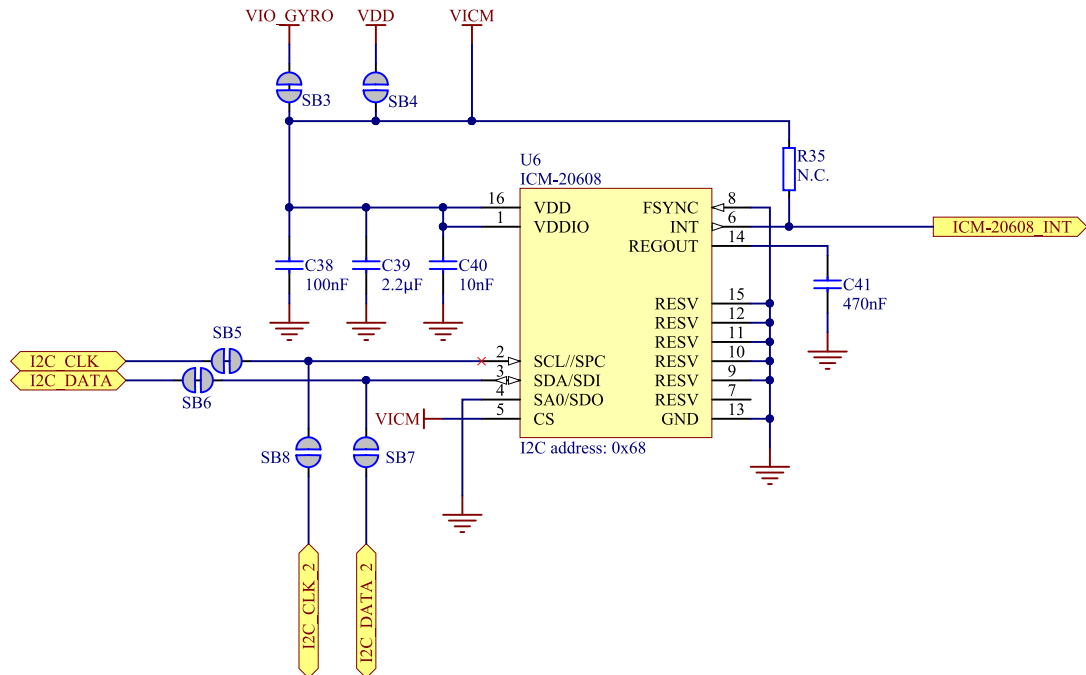


Figure 36: Motion tracking device

The circuit is connected to the MCU by the first I²C. If you want to use the second I²C, there are four solder bridges that you need to change. **SB7** and **SB8** have to be soldered and **SB5** and **SB6** have to be cut. This circuit is a $\pm 250^\circ$ per sec/ $\pm 500^\circ$ per sec/ $\pm 1000^\circ$ per sec/ $\pm 2000^\circ$ per sec selectable 3-axis gyro and a ± 2 g/ ± 4 g/ ± 8 g/ ± 16 g selectable three-axis accelerometer.

7.3.5 Power supply

The Smart Remote 3 product example is powered from two AA batteries.

Either alkaline (2×1.5 V) or rechargeable NiMH (2×1.2 V) batteries can be used. The battery circuit has a protection diode to avoid reverse current if the board is powered elsewhere. In parallel with the battery there is a connector (**P3**) that can be used for supply during development.

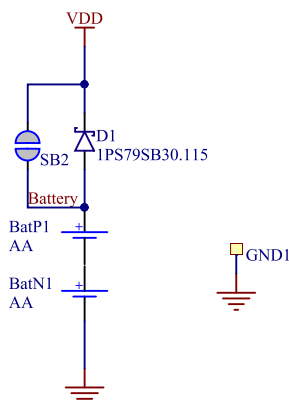


Figure 37: Battery schematic

Smart Remote 3 has a power switch that is connected to most of the circuits. The nRF chip controls the two transistors, which turn the power to the microphone and to the motion tracking device on or off. See the following figure. The low power accelerometer is always powered.

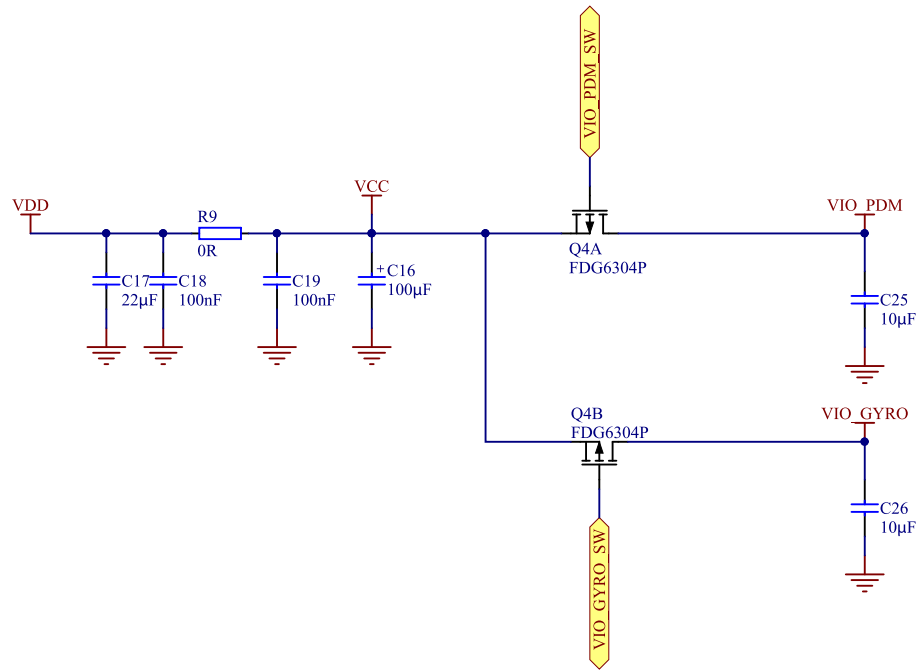


Figure 38: Power on/off switch schematic

7.3.6 Programming interface

A connector for the ARM SWD interface is included on the product example for easy firmware upgrade purposes.

When this interface is connected to a compatible programmer, firmware upgrades can be made directly on the board. The interface is found on the 10 pin connector **P1**.

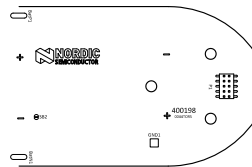


Figure 39: Location of SWD interface connector P1

[Firmware update of Smart Remote 3](#) on page 63 describes how to connect and upgrade firmware, and debug the product example.

Note: Make sure that pin 1 on the **P1** connector on the PCA200xx board is connected to pin 1 of the connector on the programmer unit.

Pin	Label	Description
P1_1	VDD	Reference voltage for programmer
P1_2	SWDIO	Serial wire debug data
P1_3	GND	Ground
P1_4	SWDCLK	Serial wire debug clock
P1_5	GND	Ground
P1_6	NC	No connection
P1_7	NC	No connection
P1_8	NC	No connection
P1_9	GND	Ground
P1_10	NC	No connection

Table 6: SWD interface connector pin configuration

7.3.7 Digital microphones

The Smart Remote 3 product example is equipped with two digital output PDM microphones.

The microphones are configured so that they can be used to sample stereo audio, but are by default set to mono audio. The microphones are by default disconnected from the power supply and the interface connectors. To connect to the development kit and enable power, solder bridges **SB9**, **SB10**, and **SB11** must be shorted, see [Figure 40: Digital microphones schematic](#) on page 49.

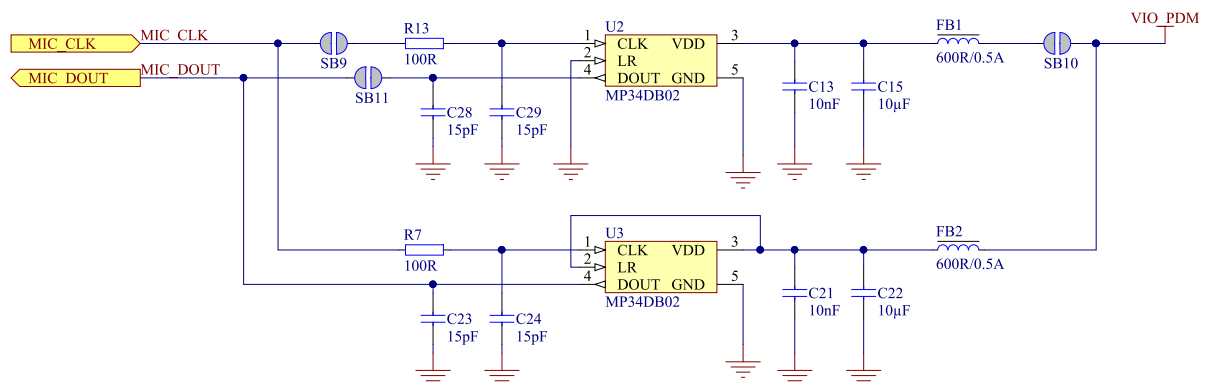


Figure 40: Digital microphones schematic

7.3.8 Matching network

The matching network is made up of discrete components and the impedance is tuned to 50 Ω .

7.3.9 Antenna

The antenna is of meander type and it is integrated in the PCB layout.

The antenna is tuned to be resonant at 2.44 GHz, and the impedance is matching the 50 Ω output from the matching network. The antenna in this design is tuned for this layout only and with the same plastic casing. If the layout and/or the casing is changed, it is likely the antenna must be retuned. The antenna can be retuned by adjusting the values of **C14**, **R17**, and **L4**. The exact values of the components must be determined by measurements with a vector network analyzer.

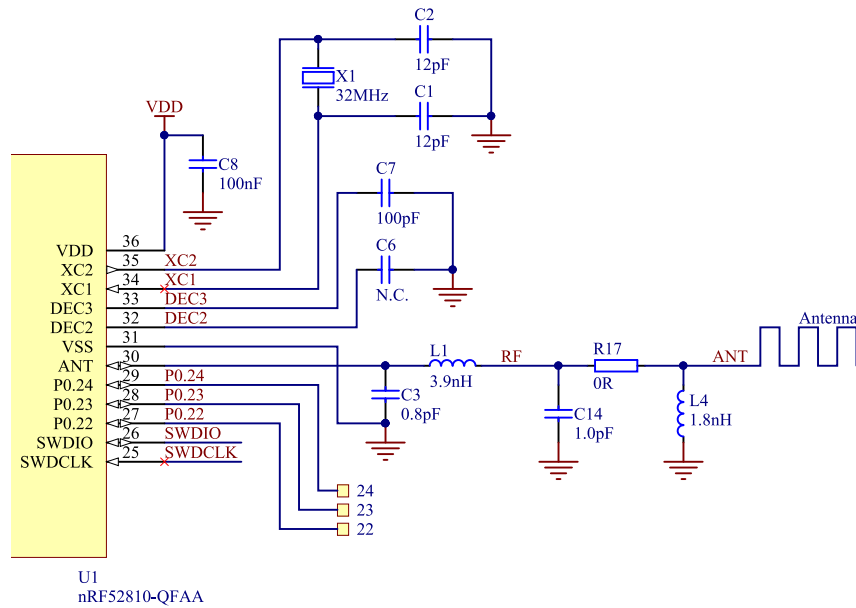


Figure 41: Matching network and antenna circuit

7.3.10 NFC

To enable the NFC feature of the smart remote, the NFC antenna must be connected to **P4**.

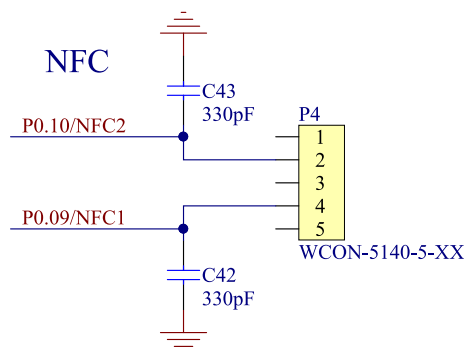


Figure 42: NFC connector

7.3.11 Infrared emitter/receiver

The infrared (IR) emitter is turned on and off by applying PWM pulses to the IR LED pin (**P0.24**).

The IR receiver is turned on by pulling the IR_REC pin (**P0.23**) high. The IR signal from the IR receiver is sent to the nRF52 SoC through the node IR SIGNAL pin (**P0.21**).

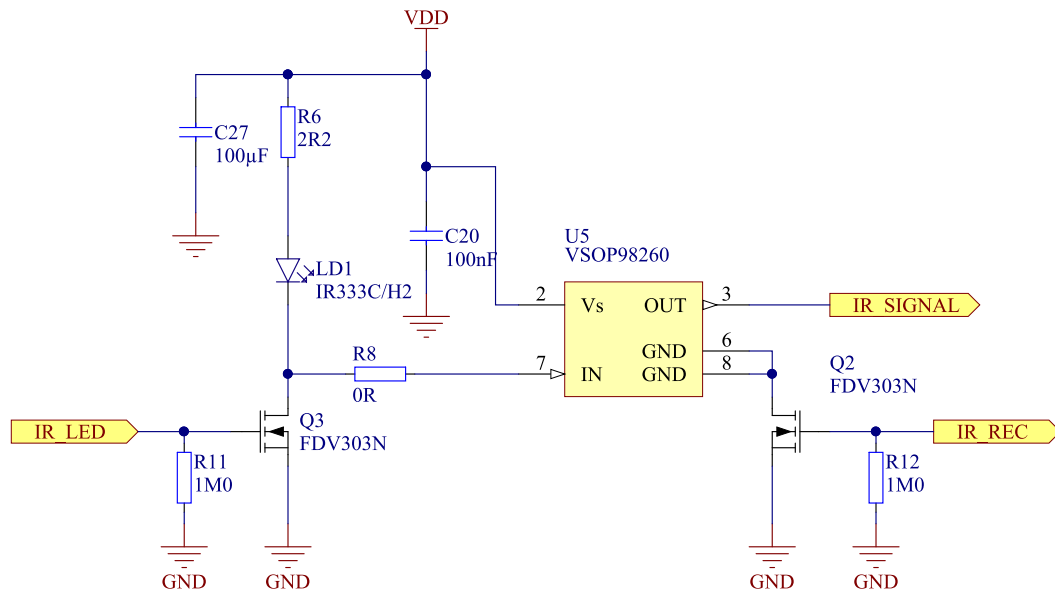


Figure 43: Infrared emitter/receiver schematic

7.3.12 Buzzer

The buzzer is activated by pulling the buzzer pin (**P0.04**) high.

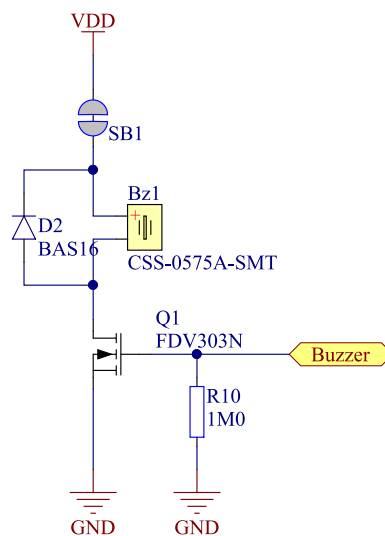


Figure 44: Buzzer schematic

7.3.13 Schematics, bill of materials, PCB layout files, production files

Hardware files for the Smart Remote 3 nRF52 product example are available in a zip package.

The hardware files for the Smart Remote 3 nRF52 product example are located in the following folder in the hardware files zip package:

```
\nRFree Smart Remote 3 for nRF52 series x_x_x\nRF6937 - nRF52 Product Example x_x_x
```

In this folder you can find bill of materials, schematics, and PCB layout files in PDF format, as well as Altium Designer files and production files (assembly drawings, gerber files, drill files, and pick-and-place files).

7.3.14 Power consumption performance

These Smart Remote 3 performance indications for the product example are reached by specific hardware and firmware revisions.

Hardware and firmware revisions:

- Hardware: PCA20023 rev. 1.1.0
- Firmware: SR3-nRF52 v1.2, using the default settings
- SoC nRF52832-QFAA

Firmware settings can be modified to obtain a different set of performances.

Measurement conditions:

- Average current, measured at battery connectors
- DC/DC enabled, if not mentioned otherwise
- The current measurements have been obtained with a 3.3 V power supply.

Electrical specifications	PCA20023 rev. 1.1.0/Typical value	Comments/conditions
Connected idle ⁶	19 μ A	Typical wakeup latency (from idle to data ready to be sent) 20 ms
Idle—Disconnected (motion wakeup using LP accelerometer)	12 μ A	Typical wakeup latency (from idle to data ready to be sent) Influenced by host and matching of the crystal oscillators.

Table 7: Performances, no activity

Electrical specifications	PCA20023 rev. 1.1.0/Typical value	Comments/conditions
Gyro air mouse in action	3.7 mA	Device moved in circles, no pause
Keyboard typing (1 key/s)	70 μ A	
Keyboard typing (3 keys/s)	114 μ A	
Voice input ^{7, 8}	8 mA	LDO power supply (DC/DC disabled)
	5 mA	DC/DC-enabled power supply
Power supply voltage	Min: 2 V Typ: – Max: 3.6 V	The product example accommodates two AA batteries connected in series

Table 8: Performances, activity

⁶ Connection interval 7.5 ms. Slave latency: 100, supervision time-out 60 s

⁷ Codec Opus-CELT-VBR

⁸ These are typical values. The actual value may vary depending on your audio configuration settings.

8

Hardware description: Smart Remote 3 for nRF52810 product example

The product example contains all the hardware necessary for user interaction, including batteries.

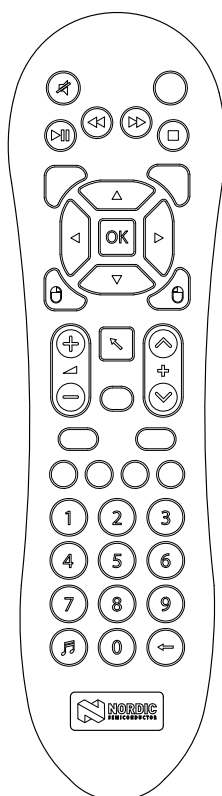


Figure 45: Smart Remote 3 nRF52810 product example

8.1 Hardware figures: Smart Remote 3 for nRF52810 product example

The hardware drawings show both sides of the Smart Remote 3 product example board (PCA20031).

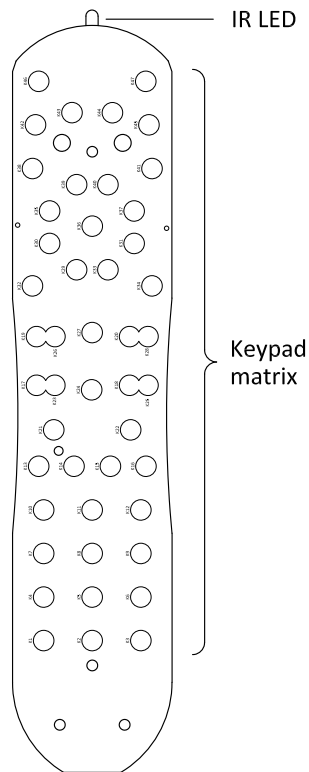


Figure 46: Smart Remote 3 product example board (PCA20031), front

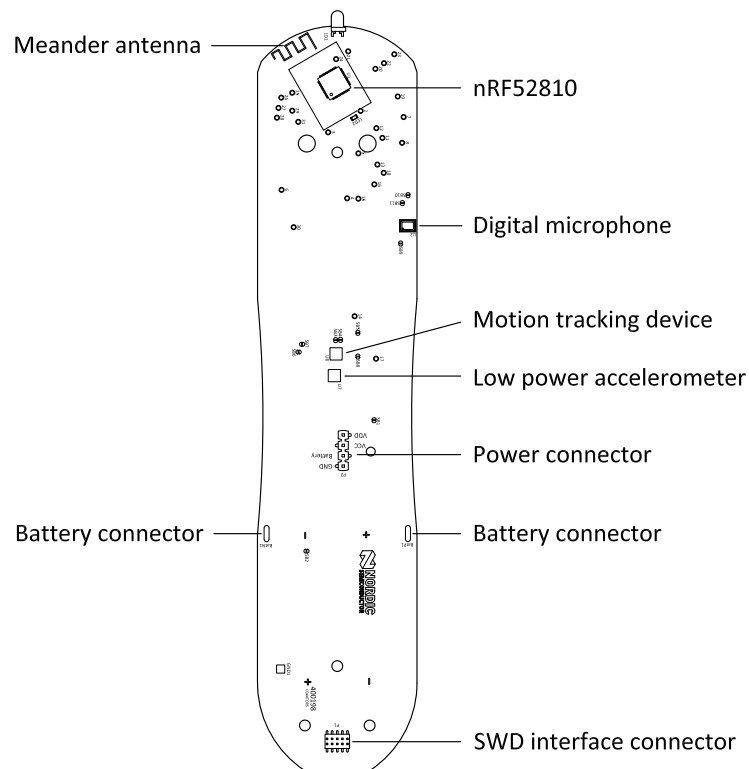


Figure 47: Smart Remote 3 product example board (PCA20031), back

8.2 Block diagram

The block diagram illustrates the functional architecture of Smart Remote 3 product example for nRF52810.

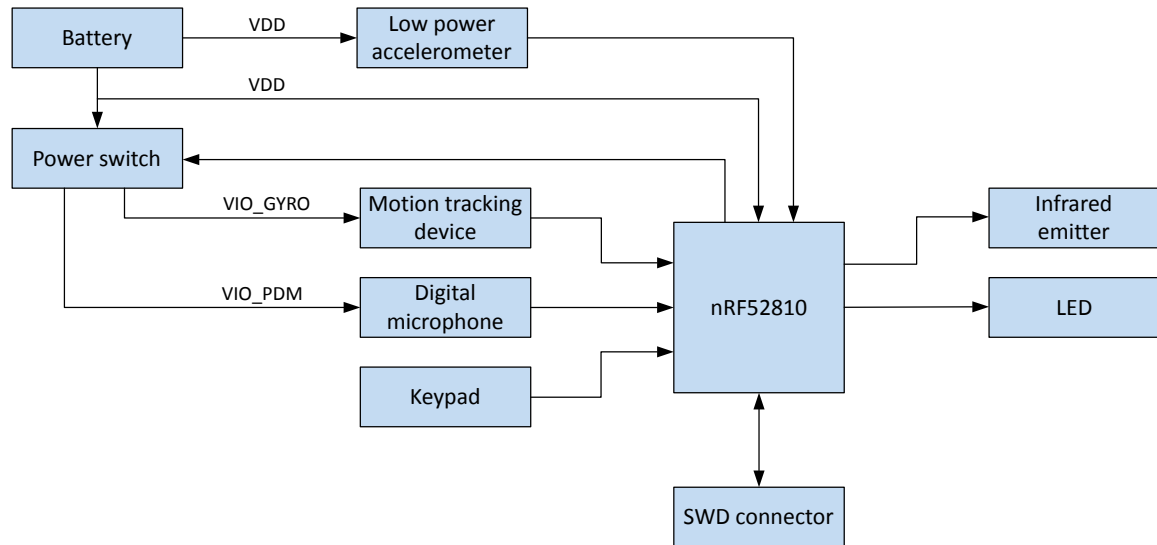


Figure 48: Block diagram

8.3 Design description

The design description contains details about the hardware blocks on the Smart Remote 3 for nRF52810 product example.

8.3.1 I/O usage

The nRF52810-QFAA has 32 generic I/Os available. All I/Os are used in this design and are organized as shown in table below.

I/O	Label	Description
P0.00	XL1	32.768 kHz crystal ⁹
P0.01	XL2	32.768 kHz crystal ⁹
P0.02	DEBUG_LED	Output for debug LED
P0.03	KEYOUT_4	Output to keypad column 4
P0.04	Not in use	Test point 4
P0.05	MIC_DOUT	Input from digital microphone
P0.06	MIC_CLK	Clock signal for digital microphone
P0.07	VIO_GYRO_SW	On/off switch for accelerometer and gyro
P0.08	KEYOUT_2	Output to keypad column 2
P0.09	Not in use	Test point 1
P0.10	Not in use	Test point 9

⁹ Optional

I/O	Label	Description
P0.11	KEYOUT_3	Output to keypad column 3
P0.12	KEYOUT_0	Output to keypad column 0
P0.13	I2C_DATA_2	Two-wire 2 master data
P0.14	I2C_CLK_2	Two-wire 2 master clock
P0.15	I2C_CLK	Two-wire 1 master clock
P0.16	KEYIN_0	Input from keypad row 0
P0.17	KEYIN_1	Input from keypad row 1
P0.18	KEYIN_2	Input from keypad row 2
P0.19	KEYIN_4	Input from keypad row 4
P0.20	KEYOUT_6	Output to keypad column 6
P0.21	Not in use	Test point 21
P0.22	ICM-20608_INT	Motion tracking device interrupt
P0.23	Not in use	Test point 23
P0.24	IR_LED	Output for IR LED
P0.25	KEYOUT_7	Output to keypad column 7
P0.26	VIO_PDM_SW	On/off switch on power supply for digital microphones
P0.27	KEYOUT_5	Output to keypad column 5
P0.28	KEYOUT_1	Output to keypad column 1
P0.29	KEYIN_3	Input from keypad row 3
P0.30	LIS3DH_INT1	Low power accelerometer interrupt 1
P0.31	I2C_DATA	Two-wire 1 master data

Table 9: I/O usage

8.3.2 Keypad matrix

The keypad on the PCA20031 board has 39 buttons.

The keyboard matrix is five rows by eight columns, providing 40 available buttons for firmware. Thirty-nine are used by the keypad with one unused. The matrix is connected directly to the nRF52810 SoC on the board.

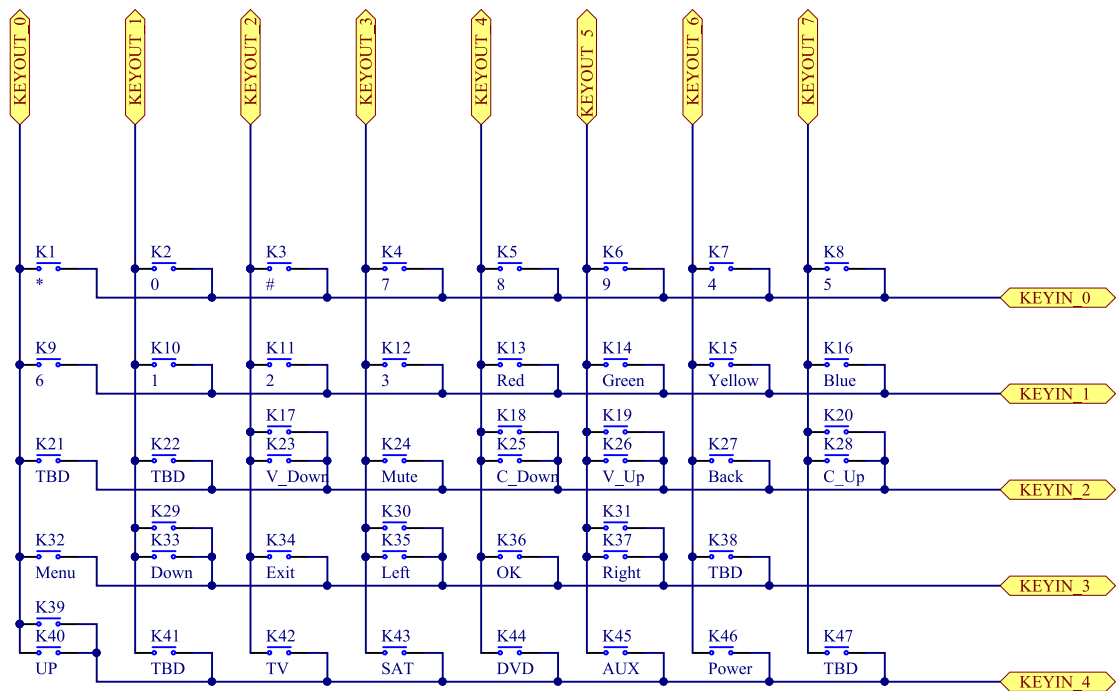


Figure 49: Keyboard matrix

8.3.3 Low-power accelerometer circuit

To obtain low power consumption and long battery lifetime, a low-power three-axis accelerometer (**U7**) has been added to the remote control.

See [Figure 35: Accelerometer circuit](#) on page 46 for the schematic. See also [Intelligent power saving](#) on page 23.

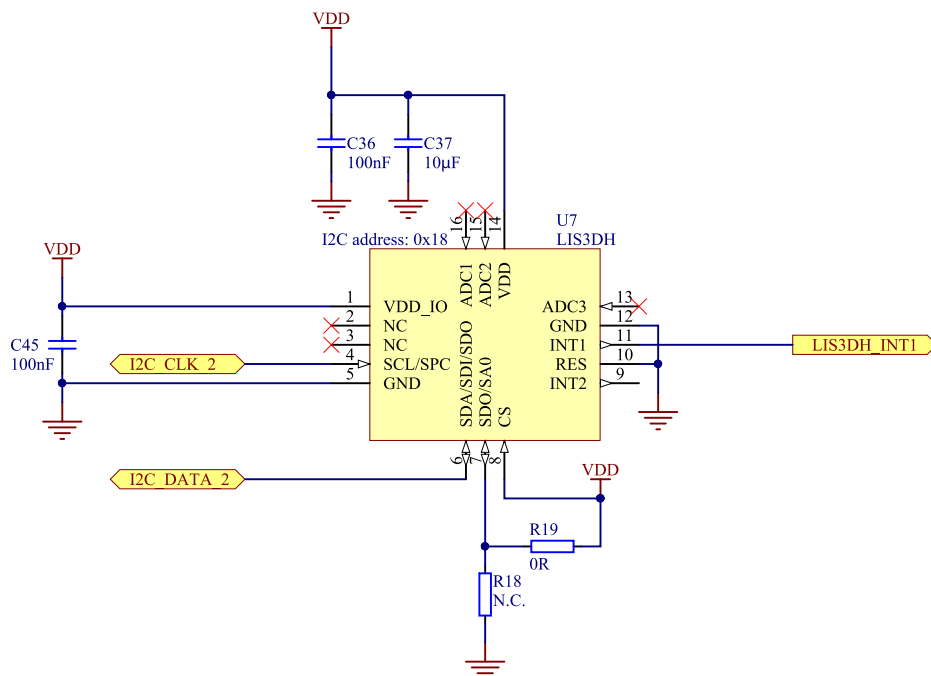


Figure 50: Accelerometer circuit

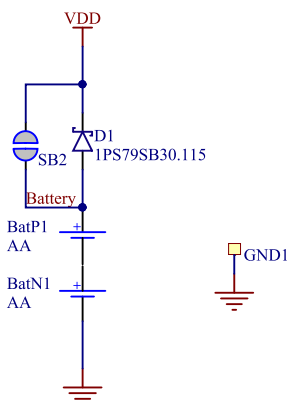
The accelerometer has I²C outputs and can detect motion on 3 axes. The sensitivity is configurable to ± 2 g/ ± 4 g/ ± 8 g/ ± 16 g.

[illegible]

The circuit is connected to the MCU by the first I²C. If you want to use the second I²C, there are four solder bridges that you need to change. **SB7** and **SB8** have to be soldered and **SB5** and **SB6** have to be cut. This circuit is a $\pm 250^\circ$ per sec/ $\pm 500^\circ$ per sec/ $\pm 1000^\circ$ per sec/ $\pm 2000^\circ$ per sec selectable 3-axis gyro and a ± 2 g/ ± 4 g/ ± 8 g/ ± 16 g selectable three-axis accelerometer.

8.3.5 Power supply

Either alkaline (2×1.5 V) or rechargeable NiMH (2×1.2 V) batteries can be used. The battery circuit has a protection diode to avoid reverse current if the board is powered elsewhere. In parallel with the battery there is a connector (**P3**) that can be used for supply during development.



Smart Remote 3 has a power switch that is connected to most of the circuits. The nRF chip controls the two transistors, which turn the power to the microphone and to the motion tracking device on or off. See the following figure. The low power accelerometer is always powered.

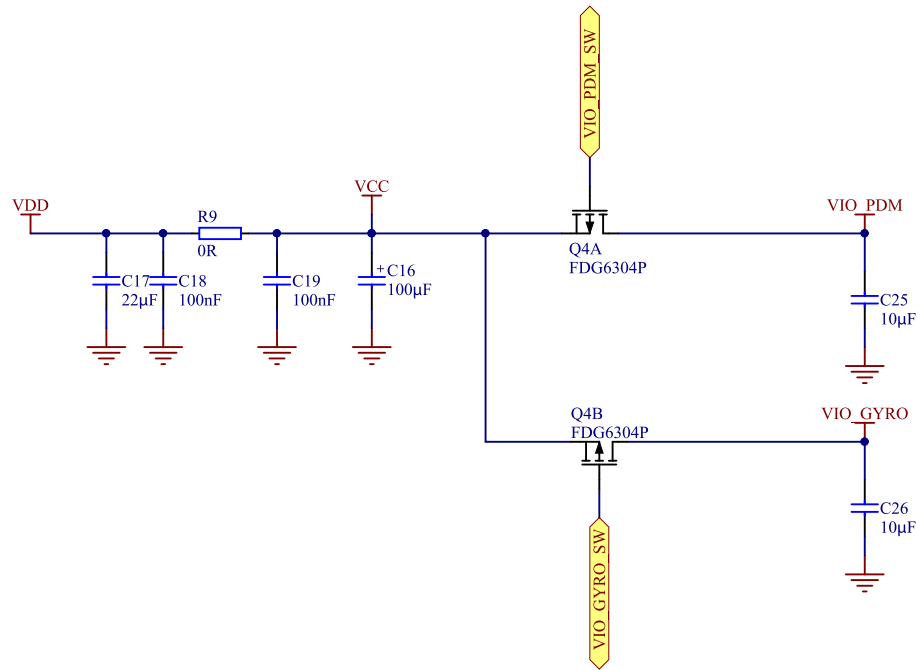


Figure 53: Power on/off switch schematic

8.3.6 Programming interface

A connector for the ARM SWD interface is included on the product example for easy firmware upgrade purposes.

When this interface is connected to a compatible programmer, firmware upgrades can be made directly on the board. The interface is found on the 10 pin connector **P1**.

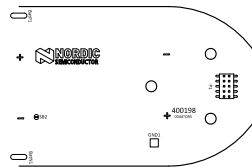


Figure 54: Location of SWD interface connector P1

[Firmware update of Smart Remote 3](#) on page 63 describes how to connect and upgrade firmware, and debug the product example.

Note: Make sure that pin 1 on the **P1** connector on the PCA200xx board is connected to pin 1 of the connector on the programmer unit.

Pin	Label	Description
P1_1	VDD	Reference voltage for programmer
P1_2	SWDIO	Serial wire debug data
P1_3	GND	Ground
P1_4	SWDCLK	Serial wire debug clock
P1_5	GND	Ground
P1_6	NC	No connection
P1_7	NC	No connection
P1_8	NC	No connection
P1_9	GND	Ground
P1_10	NC	No connection

Table 10: SWD interface connector pin configuration

8.3.7 Digital microphone

The Smart Remote 3 product example is equipped with one digital output PDM microphone.

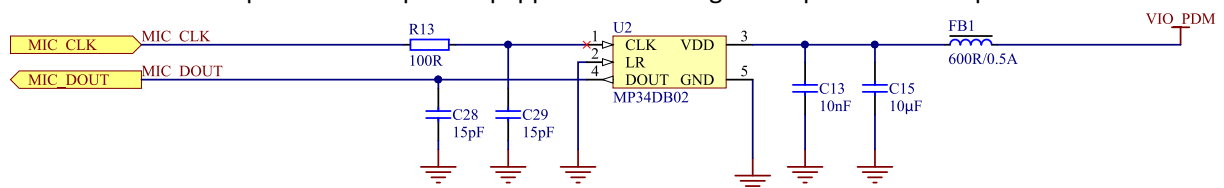


Figure 55: Digital microphone

8.3.8 Matching network

The matching network is made up of discrete components and the impedance is tuned to 50 Ω .

8.3.9 Antenna

The antenna is of meander type and it is integrated in the PCB layout.

The antenna is tuned to be resonant at 2.44 GHz, and the impedance is matching the 50 Ω output from the matching network. The antenna in this design is tuned for this layout only and with the same plastic casing. If the layout and/or the casing is changed, it is likely the antenna must be retuned. The antenna can be retuned by adjusting the values of **C14**, **R17**, and **L4**. The exact values of the components must be determined by measurements with a vector network analyzer.

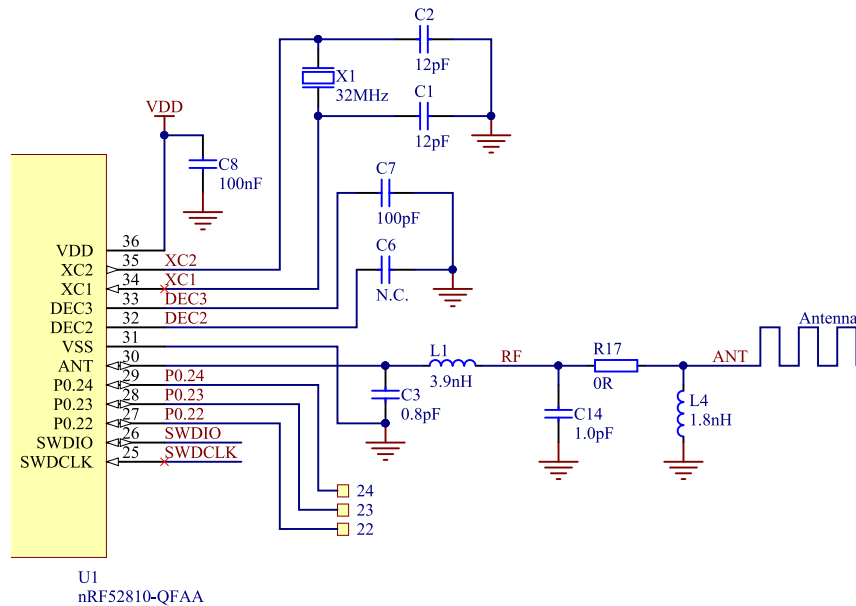


Figure 56: Matching network and antenna circuit

8.3.10 Infrared emitter

The infrared emitter is turned on and off by applying PWM pulses to the IR LED pin (**P0.24**).

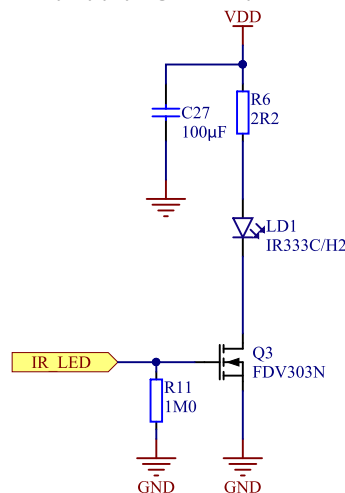


Figure 57: Infrared emitter

8.3.11 Schematics, bill of materials, PCB layout files, production files

Hardware files for the Smart Remote 3 nRF52810 product example are available in a zip package.

The hardware files for the Smart Remote 3 nRF52810 product example are located in the following folder in the hardware files zip package:

```
\nRFready Smart Remote 3 for nRF52 series x_x_x\nRF6942 - nRF52810
Product Example x_x_x
```

In this folder you can find the bill of materials, schematics, and PCB layout files in PDF format, Altium Designer files, and production files (assembly drawings, gerber files, drill files, and pick-and-place files).

8.3.12 Power consumption performance

These Smart Remote 3 performance indications for the product example are reached by specific hardware and firmware revisions.

Hardware and firmware revisions:

- Hardware: PCA20031 rev. 0.1.0
- Firmware: SR3-nRF52 v1.2, using the default settings
- SoC nRF52810-QFAA

Firmware settings can be modified to obtain a different set of performances.

Measurement conditions:

- Average current, measured at battery connectors
- DC/DC enabled, if not mentioned otherwise
- The current measurements have been obtained with a 3.3 V power supply.

Electrical specifications	PCA20031 rev. 0.1.0/ Typical value	Comments/conditions
Connected idle ¹⁰	18 μ A	Typical wakeup latency (from idle to data ready to be sent) 20 ms
Idle–Disconnected (motion wakeup using LP accelerometer)	13 μ A	Typical wakeup latency (from idle to data ready to be sent) Influenced by host and matching of the crystal oscillators.

Table 11: Performances, no activity

Electrical specifications	PCA20031 rev. 0.1.0/ Typical value	Comments/conditions
Gyro air mouse in action	4 mA	Device moved in circles, no pause
Keyboard typing (1 key/s)	46 μ A	
Keyboard typing (3 keys/s)	103 μ A	
Voice input ^{11, 12}	8 mA	LDO power supply (DC/DC disabled)
	5 mA	DC/DC-enabled power supply
Power supply voltage	Min: 2 V Typ: – Max: 3.6 V	The product example accommodates two AA batteries connected in series

Table 12: Performances, activity

¹⁰ Connection interval 7.5 ms. Slave latency: 100, supervision time-out 60 s

¹¹ mSBC codec

¹² These are typical values. The actual value may vary depending on your audio configuration settings.

9 Firmware update of Smart Remote 3

You can update firmware using nRFGo Studio. This guidance covers some basic steps. More details about the firmware update procedure can be found in the firmware documentation.

If you are programming the DK add-on, the nRF52 DK has the SEGGER J-Link built in and can be used through the USB cable. If you are programming the product example, the nRF52 DK can be used as the debugger.

For links to the tools, see [Nordic tools and downloads](#).

9.1 Connect product example to nRF52 DK

The programming and debugging interface of the nRF52832 is accessed through a 10-pin connector (**P1**) on the product example.

In this user guide we will use the nRF52 DK as reference, but the nRF51 DK can also be used.

To be able to program and debug, the product example needs to be connected to a SEGGER J-Link device. Make sure that pin 1 on the **Debug Out** connector on the nRF52 DK is connected to pin 1 on the **P1** connector on the PCA20023 board. [Figure 58: Pin 1 position](#) on page 63 shows the position of pin 1 on the **Debug out** connector.

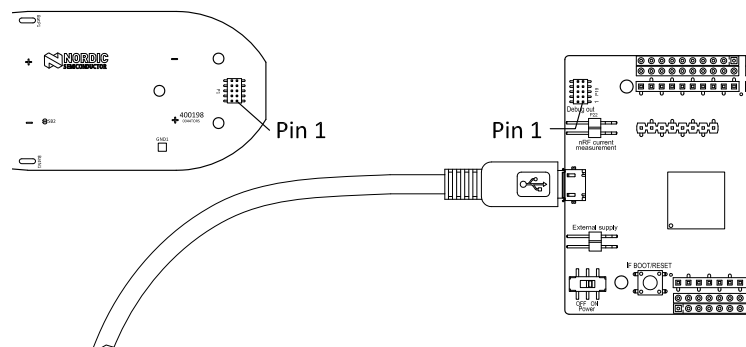


Figure 58: Pin 1 position

To connect the product example to the nRF52 DK, use a 10-pin flat cable. Connect the cable to the product example so that there is a 1–1 mapping of the pins. [Figure 59: nRF52 DK connected to the product example](#) on page 63 shows what the connection should look like.

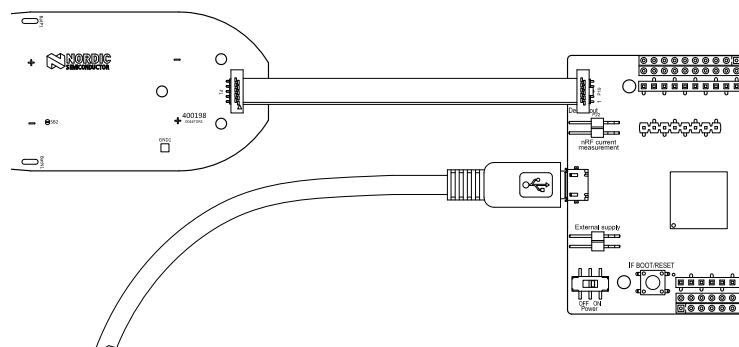


Figure 59: nRF52 DK connected to the product example

9.2 Selecting a board to program

To select a board to program, you need to complete three steps.

1. Open nRFgo Studio.
2. In the Device Manager pane, select nRF52 development boards.
3. Select the Segger ID matching the nRF52 DK connected to the product example.

9.2.1 Chip and memory information

When you select a board, nRFgo Studio identifies the nRF chip and how its memory is organized.

Chip and memory information	Description
nRF chip identification	<p>Identifies the chip by name and code variant (for example, nRF52832 QFAAA0).</p> <p>If the debugger is not connected to the chip, or the debugger has a problem communicating with the chip, it shows the following message “No device detected. Ensure that you have the SEGGER connected correctly to the board and that the board is powered and configured for debugging.”</p>
Code memory	<p>Shows how the code memory is organized in one or two regions (Region 0 and 1) and the size of each region.</p> <p>For devices containing a SoftDevice, the code memory is divided into two regions, with the SoftDevice in Region 0. The tool shows you how much memory is used by the SoftDevice and how much is left for the application.</p>
Memory readback protection	<p>Shows how readback protection is set.</p> <p>The two possible options are readback protection of Region 0 or readback protection of the whole code memory. If there is only one region, the option is readback protection on (All) or off.</p>
SoftDevice identification	<p>nRFgo Studio tries to identify the firmware located in the chip at Region 0. For the firmware that it recognizes it displays the ID (in clear text) and for unrecognized firmware it displays the FWID number.</p>

Table 13: Chip and memory information displayed in nRFgo Studio

9.3 Erase all

The Erase all function will clear everything in the flash memory.

Use Erase all in the following situations:

- You have a chip that is programmed with a SoftDevice but you want to remove it and have a blank chip.
- You have programmed an application on a clean chip using nRFgo Studio with the option **Lock entire chip from readback**.

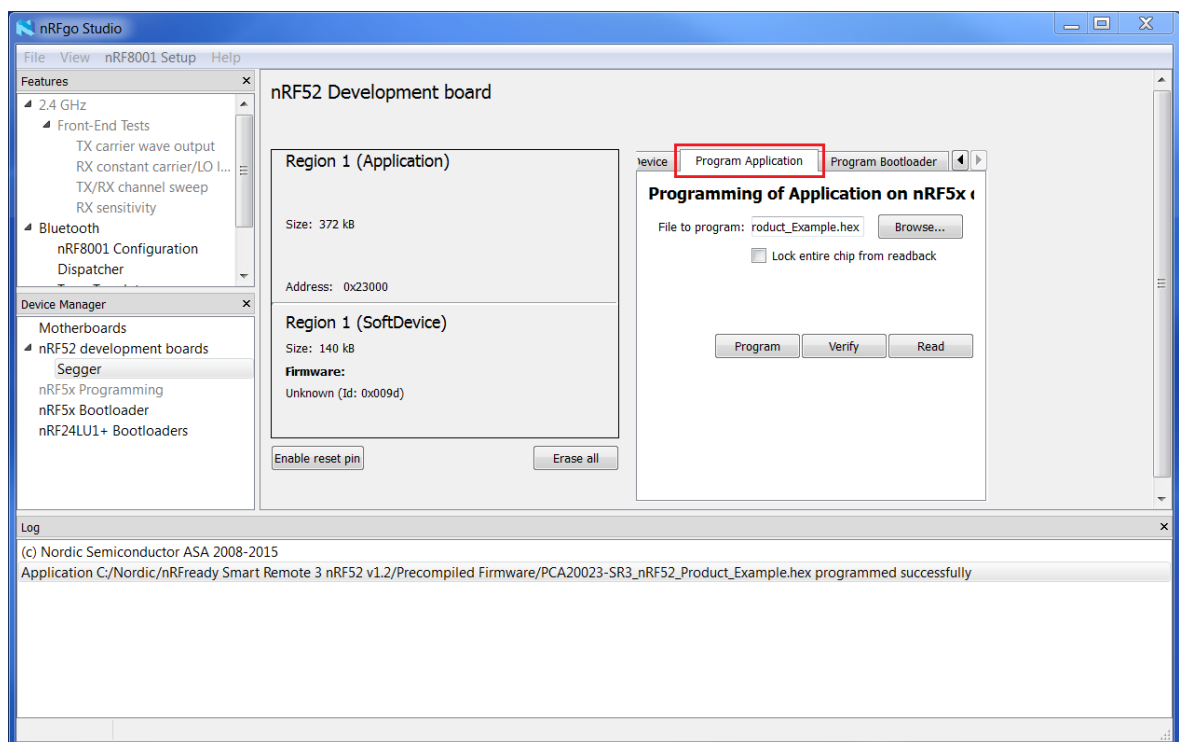
To use the Erase all function, follow the steps in section [Selecting a board to program](#) on page 64. Then click **Erase all**.

9.4 Programming with Nordic firmware

Smart Remote 3 for nRF52 contains precompiled files that integrate the SoftDevice, the application, the bootloader, and the bootloader settings.

If you are using this Nordic firmware mentioned above, follow the steps below to program complete firmware onto the chip. If you are using your own firmware, see the firmware documentation available via the Smart Remote installer, section *OTA-DFU - Generating your own packages*.

1. Start nRFgo Studio.



2. Connect your board to the host as instructed in [Pairing with Windows](#) on page 11 and [Pairing with Ubuntu](#) on page 13.

3. In the **Device Manager** pane, select the board to program.

4. Select the Segger ID matching the nRF52 DK connected to the product example.

5. Select the **Program Application** tab.

6. Click **Browse** to locate the application HEX file that you want to program.

It can be found in: <installation_path>\nRFready Smart Remote 3 nRF52 v1.2\Precompiled Firmware\.

The default installation path is: C:\Nordic Semiconductor\.

7. Click **Program**.

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