Smart Remote 3 for nRF52
User Guide v1.0
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# Revision history

<table>
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<tr>
<th>Date</th>
<th>Version</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>September 2016</td>
<td>1.0</td>
<td>First release.</td>
</tr>
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</table>
Chapter 1
Introduction

The nRFready Smart Remote 3 for nRF52 reference design (nRF6939) is a high-performance development platform providing a quick and easy starting point for TV remote control used with Internet-enabled TVs, set-top boxes, and media players. Providing a single chip solution that is easily implemented, this kit comes complete with source code and documentation for Bluetooth® low energy applications.

This reference design contains two remote controls, one for development and another for demo purposes.

Smart Remote 3 DK add-on

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

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

Features:
- 2 digital PDM (nRF52) and 1 analog microphone input (nRF51)
- Wake-up accelerometer
- 6-axis gyroscope
- Touchpad
- Standard remote control keypad
- Infrared LED output
- Arduino standard interface for connection to nRF5x Development Kit

Smart Remote 3 nRF52 product example

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:
- 2 digital PDM microphones
- Low-power accelerometer for wake-up generation, allowing advanced power management
- 6-axis gyroscope for motion tracking, allowing air mouse functionality
- Standard remote control keyboard
- Infrared LED output/input
- NFC tag
- Buzzer for findme profile implementation

---

1 Input is not supported in Rev1.0 of the reference firmware.
2 Not supported in Rev1.0 of the reference firmware.
Chapter 2

Key features

Key features for the two Smart Remote 3 devices.

Smart Remote 3 DK add-on

- Normal remote control keypad
- Multi-touch trackpad (supports up to five points of contact)
- Motion tracking device
- Wake-up accelerometer
- Voice input
- Infrared LED for legacy support
- DC/DC boost regulator for the trackpad
- Powered by two AA batteries or through the USB connection on the nRF5x DK

Smart Remote 3 nRF52 product example

- nRF52832 SoC solution
- Bluetooth® low energy compatible
- Voice input
- SWD interface connector for programming and debugging
- Normal remote control keypad
- Motion tracking device
- WakeUp accelerometer
- Infrared LED for legacy support
- Buzzer
- NFC tag
- Preprogrammed, can be used out of the box
- Powered by two AA batteries

---

3 Input is not supported in Rev1.0 of the reference firmware.
4 Not supported in Rev1.0 of the reference firmware.
Chapter 3

Hardware requirements

Additional hardware needed to use the Smart Remote 3 DK add-on.

- nRF52 Development Kit (sold separately)
Chapter 4

Computer support requirements

The following is needed to set up a computer as the Bluetooth® Smart Ready host.

• To use HID over GATT:
  • Windows 8 or Windows 10
  • Linux with Bluetooth® 4.0 support (for example BlueZ 5.0 or later)
• To use HID over GATT with audio:
  • Ubuntu 16.04 LTS with Nordic Voice System (NVS) package installed\(^5\)

---

\(^5\) 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.
Chapter 5
Kit content

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

5.1 Hardware content
nRFready Smart Remote 3 nRF52 reference design hardware.

Figure 1: nRFready Smart Remote 3 for nRF52 Series hardware content
5.2 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.

5.2 Firmware package

- Application firmware for nRFready Smart Remote 3 for nRF52
  - Precompiled HEX files
  - Source code
- nRF5x SDK v11.0.0-SR3
- S132 SoftDevice
- Nordic Voice System (NVS) package version 5.1 (requires Ubuntu 16.04 LTS)
- Firmware Documentation (will be available in a folder on your computer after you have run the installer file)

  **Important:** Refer to firmware documentation for details regarding SDK, Softdevice and compiler options.

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

The ZIP file and its subdirectories contain 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

5.2 Other relevant nRF52832 documentation

- nRF52832 Product Specification
- S132 SoftDevice Specification
- nRF52832 Errata
- nRF5 SDK
Chapter 6
Quick start

This section shows you how to set up the nRFready Smart Remote 3 for nRF52 reference design and provides example applications to help you start programming your device.

The Product example comes with pre-installed firmware. For a quick start with this device, just put batteries in, and continue reading in Turn on and pair with Windows on page 13 or Turn on and pair with Ubuntu on page 16.

6.1 Assemble the 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.

6.2 Power up

The DK add-on can be powered either from the USB or from the batteries.

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.

3. The Smart Remote 3 for nRF52 product example will be on as soon as the batteries are inserted.

6.3 Program your DK with the 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 the Smart Remote 3 on page 57 for details on firmware update.

6.4 Turn on and pair 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 Ch+ and Vol Up buttons.
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.

6.5 Ubuntu setup

The software package comes with a Ubuntu LiveCD integrating the NVS package. You can run or install this LiveCD directly.

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

1. Download the NVS package `nvs-5.1.tgz` from the Smart Remote 3 for nRF52 start page.
2. Open a terminal (CTRL + ALT + T).
3. Navigate to the folder where nvs-5.1.tgz is located.
4. Unpack the nvs-5.1.tgz file by typing `tar -xf nvs-5.1.tgz`.
5. Open the file `nvs-5.1/binaries/HOWTO-install.txt` and follow the steps there to complete the installation.

6.6 Turn on and pair with Ubuntu

The following steps are an example of the pairing process using Ubuntu.

Make sure that you have set up Ubuntu as described in Ubuntu setup on page 15 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 wasn’t 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 Ch+ and Vol Up buttons.

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 in the connected Devices list.
6.7 Configure Audio input

The Bluetooth® audio input needs to be selected before the voice recognition will work.

Make sure that you have set up Ubuntu as described in Ubuntu setup on page 15 before you start.

1. Under All Settings, select Sound and then select the Input tab.
2. Select the NVS device from the list of input sources.
3. The Input level should now indicate that it is receiving input.
4. To stop streaming, select another audio source.

6.7.1 Test 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. If you are redirected to a local Google version, click Google.com in the lower-right corner of the webpage.

   **Important:** 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.

3. Click the microphone icon. Start to talk to test voice input. Chrome will stop recording automatically when you stop talking. If you do not see the microphone symbol, the GVoice application might not have been installed. Go to the Google Chrome Web Store to download and install GVoice.
6.7.2 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.
Chapter 7
System overview

This chapter describes the functionality of the remote controls including how they can be used for development purposes.

There are two main hardware components in the reference design:

- nRFready Smart Remote 3 DK add-on (nRF6932)
- nRFready Smart Remote 3 nRF52 product example (nRF6937)

See Assemble the Smart Remote 3 hardware on page 12 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.

**Important:** The term host refers to a Bluetooth® Smart Ready compliant device which supports the HID over GATT profile. Windows 10, for instance, natively supports the HID over GATT profile provided there is Bluetooth® Smart Ready hardware 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.

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

7.1 Remote control

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.

**Important:** Gyroscope calibration is performed automatically the first time the firmware is run on the hardware.

7.1.1 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.

7.1.2 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.

7.1.2 Basic use

To use the trackpad, place one of your fingers on the surface of the pad as shown in Figure 2: One-finger movement on page 22. 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](Image)

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.

7.1.2 Common gestures

Figure 3: Two-finger horizontal scroll on page 23 and Figure 4: Two-finger vertical scroll on page 23 depict trackpad gestures that can be performed.
7.1.3 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 3-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 26).

Use of this module is optional. See the firmware documentation for details.

### 7.1.4 Free-space navigation

The remote control includes a 3-axis gyro and 3-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.

**Important:** The in-air pointing functionality is only provided as precompiled HEX files. To use the Smart-Motion library in your design, please contact InvenSense® or visit the InvenSense® Developers Corner (sign up required).

### 7.1.4 Basic use

To enable the free-space navigation feature, press the orange button between the Ch+ and Volume Up buttons (see Figure 5: Enable the free-space navigation feature on page 24). The remote control will then switch from trackpad to free-space navigation mode. 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 trackpad mode, press the orange button again. The free-space navigation mode will also be deactivated if the remote control has not moved in 7 seconds.

![Figure 5: Enable the free-space navigation feature](image)

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 will lead to vertical mouse...
cursor movement, and rotation around the Z axis (side to side movements) will lead to horizontal mouse cursor movement. See Figure 6: Coordinate system for free-space movement on page 25 as reference.

![Coordinate system for free-space movement](image)

**Figure 6: Coordinate system for free-space movement**

### 7.1.4 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 Figure 7: Trackpad functionality in free-space mode on page 26.

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

Smart Remote 3 firmware performs initial calibration on 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.

7.1.5 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.

7.1.6 Keypad

The remote control includes a common remote control keypad that is used in TVs and set-top boxes.
7.1.7 Infrared LED and infrared learning feature

To support control of legacy electronic devices that are only fitted with infrared (IR) remote control receivers, the SR3 DK add-on and the SR 3 product example is fitted with an IR LED.

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

**Important:** Only IR LED functionality example is implemented in Rev. 1.0 of the firmware.
7.1.8 NFC
The SR 3 product example has an NFC antenna mounted inside, ready to be used.

**Important:** NFC functionality is not present in Rev. 1.0 of the firmware.

7.2 Supported operating systems
Supported operating system will depend on which features are used.

**Basic use**
The nRFready Smart Remote 3 complies with the HID over GATT profile and is compatible with all host systems incorporating this profile.

**Use with audio**
Ubuntu 16.04 LTS with NVS package.
Chapter 8
Hardware description Smart Remote 3 DK add-on

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

**Important:** 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
### 8.1 Hardware figures Smart Remote 3 DK add-on

![Diagram of DK add-on board (PCA63519), front side]

Figure 13: DK add-on board (PCA63519), front side
Figure 14: DK add-on board (PCA63519), back side

8.2 Block diagram
8.3 Design description

This section contains more detailed descriptions about the hardware blocks on the Smart Remote 3 DK add-on.

8.3.1 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 Table 1: Trackpad pin description on page 32 for the pin description.

Table 1: Trackpad pin description

<table>
<thead>
<tr>
<th>Pin</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NC</td>
<td>Not connected</td>
</tr>
<tr>
<td>2</td>
<td>WU_IRQ_TP</td>
<td>Interrupt from trackpad</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>4</td>
<td>I2C_CLK_TP</td>
<td>Two-wire serial clock</td>
</tr>
</tbody>
</table>
**Table:**

<table>
<thead>
<tr>
<th>Pin</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>I2C_DATA_TP</td>
<td>Two-wire serial data</td>
</tr>
<tr>
<td>6</td>
<td>3V3</td>
<td>Power supply for trackpad</td>
</tr>
</tbody>
</table>

The trackpad requires a stable 3.3 V supply (see Figure 24: Voltage regulator for the trackpad on page 38 for details). Because of this the signals going from the nRF device to the trackpad needs to be level shifted. See Figure 17: Level translation circuit for the trackpad on page 33.

---

**8.3.2 Keypad matrix**

The keypad on the PCA63519 board has 39 buttons.

The matrix has 6 rows and 8 columns that gives room for 48 buttons in firmware, 39 are used by the keypad, and one row is used for two push buttons that function as left and right mouse buttons. A total of 41 of 48 locations are in use. See Figure 18: Keypad matrix on page 34.
**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 35.

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 - where no Arduino interface is used - the I/O expander circuit is not needed.
8.3.3 Low power accelerometer circuit

To obtain low power consumption and long battery lifetime, a low power 3-axis accelerometer (U3) has been added to the remote control.

See Figure 20: Accelerometer circuit on page 36 for the schematic. See also Intelligent power saving on page 26.
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.

8.3.4 Motion tracking device

For advanced features, the remote control has a 3-axis gyro integrated with a 3-axis accelerometer (U2).

The circuit is connected to the MCU by the first I2C, if you want to use the second I2C there are 4 solder bridges that you need to change. SB22 and SB23 have to be soldered and SB20 and SB21 have to be cut. This circuit is a ±250°/sec/±500°/sec/±1000°/sec/±2000°/sec selectable 3-axis gyro and a ±2 g/±4 g/±8 g/±16 g selectable 3-axis accelerometer.
8.3.5 Power supply
The Smart Remote 3 DK add-on get its power from two AA batteries or from the nRF52 DK.

The batteries can be alkaline (2 x 1.5 V) or rechargeable NiMH (2 x 1.2 V) batteries. The battery circuit has a protection diode to avoid reverse current if the USB is connected to the nRF52 DK while batteries are inserted.

![Battery schematic](image)

**Figure 22: Battery schematic**

On the Smart Remote 3 there is a switch to turn 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 nRF52 DK. See **Figure 23: Power on/off switch schematic** on page 37. The low-power accelerometer is always powered.

![Power on/off switch schematic](image)

**Figure 23: Power on/off switch schematic**

The voltage from the batteries or nRF52 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 38.
3V3
VCC
SHDN
6
GND
1
VOUT
3
C
-5
C
+
4
VIN
2
U9
LTC3240EDC-3.3
C53
1.0µF
C49
1.0µF
C54
4.7µF
Q1
FDV303N
R2
220R
DISCHARGE
TP SHD
R25
1M0
R23
2R2
IR_LED
SB28
R1
1M0
VIO
LD1
IR333C/H2
C37
100µF
Q3
FDV303N
Figure 24: Voltage regulator for the trackpad

**Important:** The input voltage for this regulator is 1.8 V to 5.5 V.

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

The IR 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.

### 8.3.7 Codec
A CODEC is used to get the analog signal from the microphone to digital signals.

For codec\(^6\), the ES8218 from Everest Semiconductor is chosen. ES8218 is set up with the use of two-wire interface. The microphone signal is transferred to the nRF51 DK via I2S interface.

---

\(^6\) Codec is to be used in conjunction with nRF51 DK. See the Smart Remote 3 for nRF51 documentation for details.
8.3.8 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 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 bridge SB34, SB35, and SB27 must be shorted, see Figure 27: Digital microphones schematic on page 39.

8.3.9 nRF51 DK interface

Connector 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 40 for pin information.
### Table 2: nRF51 DK interface connections

<table>
<thead>
<tr>
<th>Pin</th>
<th>Label</th>
<th>Description</th>
<th>Short</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1_1</td>
<td>VIO</td>
<td>Voltage domain VIO</td>
<td></td>
</tr>
<tr>
<td>P1_2</td>
<td>VIO</td>
<td>Voltage domain VIO</td>
<td></td>
</tr>
<tr>
<td>P1_3</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P1_4</td>
<td>VIO</td>
<td>Voltage domain VIO</td>
<td></td>
</tr>
<tr>
<td>P1_5</td>
<td>V5V</td>
<td>Voltage domain V5V</td>
<td></td>
</tr>
<tr>
<td>P1_6</td>
<td>GND</td>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>P1_7</td>
<td>GND</td>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>P1_8</td>
<td>VIN</td>
<td>Voltage domain VIN</td>
<td></td>
</tr>
<tr>
<td>P3_1</td>
<td>TP SHDN</td>
<td>TP voltage regulator on/off</td>
<td></td>
</tr>
<tr>
<td>P3_2</td>
<td>A1</td>
<td>LD3 control</td>
<td>SB1</td>
</tr>
<tr>
<td>P3_3</td>
<td>I2S LRCK</td>
<td>ADC audio data left and right</td>
<td></td>
</tr>
<tr>
<td>P3_4</td>
<td>I2S MCLK</td>
<td>Master clock</td>
<td></td>
</tr>
<tr>
<td>P3_5</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P3_6</td>
<td>I2S DOUT</td>
<td>ADC audio data</td>
<td></td>
</tr>
<tr>
<td>P4_1</td>
<td>I2S SCLK</td>
<td>Audio data bit clock</td>
<td>SB33</td>
</tr>
<tr>
<td>P4_2</td>
<td>I2S SCLK</td>
<td>Audio data bit clock</td>
<td>SB3</td>
</tr>
<tr>
<td>P4_3</td>
<td>D2</td>
<td>Connected to D3</td>
<td></td>
</tr>
<tr>
<td>P4_4</td>
<td>D3</td>
<td>Connected to D2</td>
<td></td>
</tr>
<tr>
<td>P4_5</td>
<td>POWER ON/OFF</td>
<td>Control signal power switch</td>
<td></td>
</tr>
<tr>
<td>P4_6</td>
<td>D5</td>
<td>LD4 control</td>
<td>SB4</td>
</tr>
<tr>
<td>P4_7</td>
<td>I2S CLK2</td>
<td>I2C 2 clock</td>
<td>SB5</td>
</tr>
<tr>
<td>P4_8</td>
<td>ICM-20608 INT</td>
<td>Motion tracking device interrupt</td>
<td>SB6</td>
</tr>
<tr>
<td>P6_1</td>
<td>DISCHARGE</td>
<td>Discharges the TP voltage regulator</td>
<td>SB10</td>
</tr>
<tr>
<td>P6_2</td>
<td>NC</td>
<td>Not connected</td>
<td>SB9</td>
</tr>
<tr>
<td>P6_3</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P6_4</td>
<td>IR LED</td>
<td>Infrared LED control signal input</td>
<td></td>
</tr>
<tr>
<td>P6_5</td>
<td>WU IRQ</td>
<td>TP interrupt or IO expander interrupt</td>
<td>SB11</td>
</tr>
<tr>
<td>P6_6</td>
<td>LIS3DH INT1</td>
<td>Low power accelerometer interrupt 1</td>
<td></td>
</tr>
<tr>
<td>P6_7</td>
<td>GND</td>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>P6_8</td>
<td>I2C_DATA2</td>
<td>I2C 2 data</td>
<td>SB12</td>
</tr>
<tr>
<td>P6_9</td>
<td>I2C_DATA</td>
<td>I2C 1 data</td>
<td></td>
</tr>
<tr>
<td>P6_10</td>
<td>I2C_CLK</td>
<td>I2C 1 clock</td>
<td></td>
</tr>
</tbody>
</table>
8.3.10 nRF52 DK interface
Connector 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 41 for pin information.

Table 3: nRF52 DK interface connections

<table>
<thead>
<tr>
<th>Pin</th>
<th>Label</th>
<th>Description</th>
<th>Short</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1_1</td>
<td>VIO</td>
<td>Voltage domain VIO</td>
<td></td>
</tr>
<tr>
<td>P1_2</td>
<td>VIO</td>
<td>Voltage domain VIO</td>
<td></td>
</tr>
<tr>
<td>P1_3</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P1_4</td>
<td>VIO</td>
<td>Voltage domain VIO</td>
<td></td>
</tr>
<tr>
<td>P1_5</td>
<td>V5V</td>
<td>Voltage domain V5V</td>
<td></td>
</tr>
<tr>
<td>P1_6</td>
<td>GND</td>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>P1_7</td>
<td>GND</td>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>P1_8</td>
<td>VIN</td>
<td>Voltage domain VIN</td>
<td></td>
</tr>
<tr>
<td>P3_1</td>
<td>TP SHDN</td>
<td>TP voltage regulator on/off</td>
<td></td>
</tr>
<tr>
<td>P3_2</td>
<td>A1</td>
<td>LD3 control</td>
<td>SB1</td>
</tr>
<tr>
<td>P3_3</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P3_4</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P3_5</td>
<td>I2C CLK</td>
<td>I2C clock</td>
<td>SB2</td>
</tr>
<tr>
<td>Pin</td>
<td>Label</td>
<td>Description</td>
<td>Short</td>
</tr>
<tr>
<td>-------</td>
<td>-----------</td>
<td>-------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>P3_6</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P4_1</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P4_2</td>
<td>I2C CLK2</td>
<td>I2C 2 clock</td>
<td>SB3</td>
</tr>
<tr>
<td>P4_3</td>
<td>MIC CLK</td>
<td>Digital microphone clock</td>
<td></td>
</tr>
<tr>
<td>P4_4</td>
<td>MIC DOUT</td>
<td>Digital microphone data output</td>
<td></td>
</tr>
<tr>
<td>P4_5</td>
<td>POWER ON/OFF</td>
<td>Control signal power switch</td>
<td></td>
</tr>
<tr>
<td>P4_6</td>
<td>D5</td>
<td>LD4 control</td>
<td>SB4</td>
</tr>
<tr>
<td>P4_7</td>
<td>NC</td>
<td>Not connected</td>
<td>SB5</td>
</tr>
<tr>
<td>P4_8</td>
<td>NC</td>
<td>Not connected</td>
<td>SB6</td>
</tr>
<tr>
<td>P6_1</td>
<td>DISCHARGE</td>
<td>Discharges the TP voltage regulator</td>
<td>SB10</td>
</tr>
<tr>
<td>P6_2</td>
<td>ICM-20608 INT</td>
<td>Motion tracking device interrupt</td>
<td>SB9</td>
</tr>
<tr>
<td>P6_3</td>
<td>NC</td>
<td>Connected to test point 2</td>
<td></td>
</tr>
<tr>
<td>P6_4</td>
<td>IR LED</td>
<td>Infrared LED control signal input</td>
<td></td>
</tr>
<tr>
<td>P6_5</td>
<td>WU IRQ</td>
<td>TP interrupt or IO expander interrupt</td>
<td>SB11</td>
</tr>
<tr>
<td>P6_6</td>
<td>LIS3DH INT1</td>
<td>Low power accelerometer interrupt 1</td>
<td></td>
</tr>
<tr>
<td>P6_7</td>
<td>GND</td>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>P6_8</td>
<td>I2C_DATA2</td>
<td>I2C 2 data</td>
<td>SB12</td>
</tr>
<tr>
<td>P6_9</td>
<td>I2C_DATA</td>
<td>I2C 1 data</td>
<td></td>
</tr>
<tr>
<td>P6_10</td>
<td>I2C_CLK</td>
<td>I2C 1 clock</td>
<td></td>
</tr>
<tr>
<td>P7_1</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P7_2</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P7_3</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P7_4</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P7_5</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P7_6</td>
<td>GND</td>
<td>Ground</td>
<td></td>
</tr>
<tr>
<td>P8_1</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P8_2</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P8_3</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P8_4</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P8_5</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P8_6</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P8_7</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
<tr>
<td>P8_8</td>
<td>NC</td>
<td>Not connected</td>
<td></td>
</tr>
</tbody>
</table>
8.3.11 Current measurement
On the Smart Remote 3 DK add-on there are two pin headers available for current measurement. With these we can 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. If 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.

8.3.12 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.
Table 4: I2C bus connector pin configuration

<table>
<thead>
<tr>
<th>Pin</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P5_1</td>
<td>VCC</td>
<td>Power supply</td>
</tr>
<tr>
<td>P5_2</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>P5_3</td>
<td>I2C_CLK</td>
<td>I2C 1 clock</td>
</tr>
<tr>
<td>P5_4</td>
<td>I2C_DATA</td>
<td>I2C 1 data</td>
</tr>
</tbody>
</table>

8.3.13 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 Bill of Materials, schematics and pcb layout files in pdf format, Altium Designer files, and production files (assembly drawings, gerber files, drill files, pick & place files).
Chapter 9

Hardware description Smart Remote 3 nRF52 product example

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

Figure 30: Smart Remote 3 nRF52 product example
9.1 Hardware figures SR 3 product example

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

Figure 32: SR 3 product example board (PCA20023), back side
9.2 Block diagram

![Block diagram of Smart Remote 3 nRF52 product example]

Figure 33: Block diagram

9.3 Design description

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

9.3.1 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.

Table 5: I/O usage

<table>
<thead>
<tr>
<th>I/O</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0.00</td>
<td>XL1</td>
<td>32.768 kHz crystal</td>
</tr>
<tr>
<td>P0.01</td>
<td>XL2</td>
<td>32.768 kHz crystal</td>
</tr>
<tr>
<td>P0.02</td>
<td>DEBUG_LED</td>
<td>Output for debug LED</td>
</tr>
<tr>
<td>P0.03</td>
<td>KEYOUT_4</td>
<td>Output to keypad column 4</td>
</tr>
<tr>
<td>P0.04</td>
<td>Buzzer</td>
<td>Output to buzzer</td>
</tr>
<tr>
<td>P0.05</td>
<td>MIC_DOUT</td>
<td>Input from digital microphone</td>
</tr>
<tr>
<td>P0.06</td>
<td>MIC_CLK</td>
<td>Clock signal for digital microphone</td>
</tr>
<tr>
<td>P0.07</td>
<td>VIO_GYRO_SW</td>
<td>On/off switch for accelerometer and gyro</td>
</tr>
<tr>
<td>P0.08</td>
<td>KEYOUT_2</td>
<td>Output to keypad column 2</td>
</tr>
<tr>
<td>P0.09</td>
<td>NFC1</td>
<td>NFC antenna</td>
</tr>
<tr>
<td>P0.10</td>
<td>NFC2</td>
<td>NFC antenna</td>
</tr>
<tr>
<td>P0.11</td>
<td>KEYOUT_3</td>
<td>Output to keypad column 3</td>
</tr>
<tr>
<td>I/O</td>
<td>Label</td>
<td>Description</td>
</tr>
<tr>
<td>-------</td>
<td>--------------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>P0.12</td>
<td>KEYOUT_0</td>
<td>Output to keypad column 0</td>
</tr>
<tr>
<td>P0.13</td>
<td>I2C_DATA_2</td>
<td>Two-wire 2 master data</td>
</tr>
<tr>
<td>P0.14</td>
<td>I2C_CLK_2</td>
<td>Two-wire 2 master clock</td>
</tr>
<tr>
<td>P0.15</td>
<td>I2C_CLK</td>
<td>Two-wire 1 master clock</td>
</tr>
<tr>
<td>P0.16</td>
<td>KEYIN_0</td>
<td>Input from keypad row 0</td>
</tr>
<tr>
<td>P0.17</td>
<td>KEYIN_1</td>
<td>Input from keypad row 1</td>
</tr>
<tr>
<td>P0.18</td>
<td>KEYIN_2</td>
<td>Input from keypad row 2</td>
</tr>
<tr>
<td>P0.19</td>
<td>KEYIN_4</td>
<td>Input from keypad row 4</td>
</tr>
<tr>
<td>P0.20</td>
<td>KEYOUT_6</td>
<td>Output to keypad column 6</td>
</tr>
<tr>
<td>P0.21</td>
<td>IR_SIGNAL</td>
<td>Input IR signal</td>
</tr>
<tr>
<td>P0.22</td>
<td>ICM-20608_INT</td>
<td>Motion tracking device interrupt</td>
</tr>
<tr>
<td>P0.23</td>
<td>IR_REC</td>
<td></td>
</tr>
<tr>
<td>P0.24</td>
<td>IR_LED</td>
<td>Output for IR LED</td>
</tr>
<tr>
<td>P0.25</td>
<td>KEYOUT_7</td>
<td>Output to keypad column 7</td>
</tr>
<tr>
<td>P0.26</td>
<td>VIO_PDM_SW</td>
<td>On/off switch on power supply for digital microphones</td>
</tr>
<tr>
<td>P0.27</td>
<td>KEYOUT_5</td>
<td>Output to keypad column 5</td>
</tr>
<tr>
<td>P0.28</td>
<td>KEYOUT_1</td>
<td>Output to keypad column 1</td>
</tr>
<tr>
<td>P0.29</td>
<td>KEYIN_3</td>
<td>Input from keypad row 3</td>
</tr>
<tr>
<td>P0.30</td>
<td>LIS3DH_INT1</td>
<td>Low power accelerometer interrupt 1</td>
</tr>
<tr>
<td>P0.31</td>
<td>I2C_DATA</td>
<td>Two-wire 1 master data</td>
</tr>
</tbody>
</table>

### 9.3.2 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. 39 are used by the keypad with one unused. The matrix is connected directly to the nRF52 SoC on the board. See Figure 34: Keypad matrix on page 49.
9.3.3 Low power accelerometer circuit

To obtain low power consumption and long battery lifetime, a low-power 3-axis accelerometer (U7) has been added to the remote control.

See Figure 35: Accelerometer circuit on page 50 for the schematic. See also Intelligent power saving on page 26.
**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.

**9.3.4 Motion tracking device**

For advanced features, the remote control has a 3-axis gyro integrated with a 3-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 4 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 ±250°/sec/±500°/sec/±1000°/sec/±2000°/sec selectable 3-axis gyro and a ±2 g/±4 g/±8 g/±16 g selectable 3-axis accelerometer.

9.3.5 Power supply

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

The batteries can be alkaline (2 x 1.5 V) or rechargeable NiMH (2 x 1.2 V) batteries. 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. See Figure 37: Battery schematic on page 52.
Figure 37: Battery schematic

There is a power switch on the Smart Remote 3 that is connected to most of the circuits. The nRF chip controls the two transistors, which will turn on or off power to the microphones and to the motion tracking device. See Figure 38: Power on/off switch schematic on page 52. The low power accelerometer is always powered.

Figure 38: Power on/off switch schematic

9.3.6 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, see Figure 39: Location of SWD interface connector P1 on page 53.
Firmware update of the Smart Remote 3 on page 57 describes how to connect and perform firmware upgrades and debugging of the product example.

**Important:** Make sure that pin 1 on the P1 connector on the PCA20023 board is connected to pin 1 of the connector on the programmer unit.

### Table 6: SWD interface connector pin configuration

<table>
<thead>
<tr>
<th>Pin</th>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1_1</td>
<td>VDD</td>
<td>Reference voltage for programmer</td>
</tr>
<tr>
<td>P1_2</td>
<td>SWDIO</td>
<td>Serial wire debug data</td>
</tr>
<tr>
<td>P1_3</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>P1_4</td>
<td>SWDCLK</td>
<td>Serial wire debug clock</td>
</tr>
<tr>
<td>P1_5</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>P1_6</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>P1_7</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>P1_8</td>
<td>NC</td>
<td>No connection</td>
</tr>
<tr>
<td>P1_9</td>
<td>GND</td>
<td>Ground</td>
</tr>
<tr>
<td>P1_10</td>
<td>NC</td>
<td>No connection</td>
</tr>
</tbody>
</table>

### 9.3.7 Digital microphones

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

The microphones are configured so 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 bridge SB9, SB10, and SB11 must be shorted, see Figure 40: Digital microphones schematic on page 54.
9.3.8 Matching network
The matching network is made up of discrete components and the impedance is tuned to 50 Ω.

9.3.9 Antenna
The antenna is of meander type, and 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 re-tuned. The antenna can be re-tuned 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

9.3.10 NFC
NFC connector circuitry.
The NFC antenna must be connected to P4, to enable the NFC feature of the smart remote.

![Figure 42: NFC connector schematic](image)

**9.3.11 Infrared emitter/receiver**

Infrared emitter and receiver circuitry.

The IR emitter are turned on and off by applying PWM pulses to the IR LED pin (P0.24). The IR receiver are turned on by pulling the IR_REC pin (P0.23) high. The IR signal from the IR receiver are sent to the nRF52 SoC through the node IR SIGNAL pin (P0.21).

![Figure 43: Infrared emitter/receiver schematic](image)

**9.3.12 Buzzer**

Buzzer circuitry.

The buzzer is activated by pulling the buzzer pin (P0.04) high.
Figure 44: Buzzer schematic

9.3.13 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:

\nRFready 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, Altium Designer files, and production files (assembly drawings, gerber files, drill files, pick & place files).
Chapter 10
Firmware update of the Smart Remote 3

A step-by-step guide for connecting your remote control to a debugger for firmware upgrades on the nRF52832 SoC is included in this section.

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.

10.1 Connect the product example to the nRF52 DK

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

To be able to program and debug, the product example needs to be connected to a SEGGER J-Link device. In this user guide we will use the nRF52 DK as reference, but the nRF51 DK can also be used. 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 45: Pin 1 position on page 57 shows the position of pin 1 on the Debug out connector.

Figure 45: 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 there will be a 1-1 mapping of the pins. Figure 46: nRF52 DK connected to the product example on page 57 shows what the connection should look like.

Figure 46: nRF52 DK connected to the product example
10.2 Flash programming

The Smart Remote 3 flash memory can be programmed through the SWD interface.

The application can be used either as a stand-alone application or on top of the S132 SoftDevice (protocol stack). Note that the S132 SoftDevice is not a part of your application, but a completely separate binary that ensures total independence for both HEX files. For more information, see the S132 SoftDevice Specification. This chapter describes how to program and erase the S132 SoftDevice or another application HEX file on the nRF52832 SoC. If you want to start developing on the nRF52832 SoC without using the S132 SoftDevice, see section Programming an application on page 60.

10.3 Programming and erasing flash using nRFgo Studio

Use nRFgo Studio to erase memory content or program SoftDevice and application HEX file onto the nRF52832 chip.

**Important**: For details on memory organization and protection, see the nRF52832 Product Specification.

![nRFgo Studio dashboard](image)

Figure 47: nRFgo Studio dashboard
10.4 Selecting a board to program

This shows the steps you need to do to select the board to program.

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.

10.5 Identifying the nRF52 chip and chip content

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

The following chip and memory information is displayed:

- **nRF52 chip identification** - Identifies the chip by name and code variant (for example, nRF52832 QFAAAA0). If the debugger is not connected to the chip, or the debugger has a problem communicating with the chip, it will show 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."

- **Code memory** - Shows how the code memory is organized in one or two regions (Region 0 and 1) and the size of each region. For devices containing a SoftDevice, the code memory is divided in 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.

- **Memory readback protection** - Shows how the readback protection is set. The two possible options are readback protection on 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.

- **SoftDevice identification** - 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) for the unrecognized firmware it displays the FWID number.

10.6 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 59. Then click Erase all.

10.7 Programming a SoftDevice

This function lets you program the SoftDevice onto the chip.
1. Follow the steps in Selecting a board to program on page 59 and then select the Program SoftDevice tab.
2. Click Browse and select the HEX file to program.
3. Select whether to enable or disable readback protection of Region 0.
4. Set the SoftDevice size. This sets the size of the code memory region 0 and will not be available if the size is defined by the HEX file.
5. Click Program.
   
   Important: The S132 SoftDevice is included in the installer file of the Smart Remote 3 for nRF52.

10.8 Programming an application

This function lets you program an application onto the chip.

Before nRFgo Studio starts programming it verifies that the HEX file matches the actual memory configuration. If it matches, nRFgo Studio continues with the programming, if not, it stops the programming and returns an error message. For example, if an application requires the SoftDevice on the chip, it will check the memory configuration for the SoftDevice before programming the chip.
**Important:** This programming will not set up any memory Regions.

![Programming an application with nRFgo Studio](image)

1. Follow the steps in Selecting a board to program on page 59 and then select the Program Application tab.
2. Click Browse and select the HEX file to program.
3. Select whether to enable or disable readback protection of the entire chip. If you enable readback protection, you will have to do an Erase All to reprogram the chip again.
4. Click Program.

A chip that is programmed with Lock entire chip from readback enabled will not work with a development toolchain. To make it work you must perform Erase all.

Lock entire chip from readback can be used to prevent an accidental overwrite of the chip content.
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