nRFgo Development Kit

nRF2460

User Guide v1.0

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Revision History

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Contents

1 Introduction

The nRF2460 Development Kit is the recommended starting point for developing a new product based on the nRF2460 Wireless Mono Audio Streamer. The nRF2460-DK used in conjunction with the nRFgo Starter Kit (sold separately) is the ideal platform to help you through each stage of the development process. The nRF modules of the nRF2460-DK can run stand-alone with external power supply for simple evaluation, or placed into an nRF module socket on an nRFgo Starter Kit Motherboard to evaluate all the features of the nRF2460. Available headers on the nRF2460-DK make it easy to connect an external audio codec or MCU while developing a product.

1.1 Who should read this user guide?

Anyone developing a product based on the nRF2460 should read this User Guide. It describes all the features of the nRF2460 Development Kit from how to use the pre-compiled firmware in order to evaluate the nRF2460 module, to how to connect external MCU or codec during prototyping of your own hardware.

To fully understand this User Guide a background in software development and/or electronic engineering is required.

1.2 Minimum requirements

Minimum requirements for using the nRF2460 Development Kit are:

- nRFgo Starter Kit
- Computer with 2 USB ports
- Windows XP, Windows 7

1.3 Writing conventions

This user guide follows a set of typographic rules to make the document consistent and easy to read. The following writing conventions are used:

- Commands are written in `Courier New bold.`
- File names and User Interface components are written in regular **bold**.
- Cross references are underlined and highlighted in blue.

2   Development Kit content

The nRF2460 Development Kit is based on the nRFgo development platform, and consists of nRF modules that can be plugged into an nRFgo Starter Kit Motherboard during development and evaluation. You can download all the necessary software and documentation from Nordic Semiconductor's website at www.nordicsemi.com.

The nRFgo compatible nRF2460 Development Kit contains the hardware, software and documentation components outlined in sections 2.2 and 2.3.

Figure 1. Kit content

2.1   Hardware content

The nRF2460 Development Kit consists of one nRF2460 module with a PCB antenna, two nRF2460 modules with an SMA connector, two external 2.4 GHz swivel antennas, and five samples of the nRF2460 IC (integrated circuit).

2.2 Software content

You can download the software package from www.nordicsemi.com. The software package includes:

- nRFgo Studio software
- Pre-compiled firmware for the nRF2460-DK (including source code)

In addition we recommend that you install the Keil^{TM} C51 C compiler (an evaluation version is available) from www.keil.com for writing custom firmware to the nRF module.

2.3 Documentation

The main source of documentation for the nRF2460 module is the product specification for the nRF2460, which contains a complete description of all registers, the application schematic, and a Bill of Materials. In addition the reference layout files for the nRF2460 are available for download from www.nordicsemi.com.

The Development Kit's documentation includes:

- This User Guide
- Getting Started Guide
- Application note "Creating applications with the Keil^{TM} C51 C compiler"

3 Typical usages

The nRF2460 Development Kit is designed to simplify the testing of features and performance in the nRF2460 in different environments and during prototype development.

By default, the nRF modules are pre-programmed from factory to stream audio from the line-in input on the audio source, to the headset output on the audio destination. Setup for demonstration purposes is described in the Getting Started Guide nRFgo Development Kit nRF2460.

Typically, when evaluating a new product, the developer wants to find the typical range of the product and the audio performance in the environments for which the product is planned to operate. Moreover he or she wants to know the power consumption in order to calculate the expected battery lifetime. All this is possible by using pre-compiled firmware.

However during prototype development you will connect the nRF2460 module to your own hardware. If you prefer to use a different MCU or codec instead of those already located on the nRF module, you can make all the digital interfaces for the nRF2460 available on headers on the nRF2460 module.

3.1 Setting up for product evaluation

To evaluate the nRF2460 device with custom configuration, meaning custom latency, hopping table or audio format, the on-board nRF24LE1 must be programmed with new, application firmware from the example projects for the nRF2460 Development Kit.

The nRF module is fitted with an nRF24LE1 to configure and use the nRF2460 through a slave I2C control interface. The nRF24LE1 is a System-on-Chip solution with an embedded Nordic Semiconductor radio and an 8051 MCU. However, for this nRF module only the embedded 8051 MCU is used to set up the nRF2460, and this module will show up as an nRF24LE1 module in the nRFgo Studio **Device Manager** pane.

You must download the nRFgo Studio in order to program the nRF module with any of the pre-compiled firmware files. See chapter and the help file in nRFgo Studio for more information on usage.

Refer to the application note "Creating Applications with the Keil^{TM} C51 C Compiler" if you want to write custom firmware based on the source code for the nRF2460-DK.

3.1.1 How to program the nRF2460 module

This section describes how to program an nRF2460 module from the software application nRFgo Studio to evaluate your nRF2460 device for your end product.

1. Turn the nRFgo Motherboard off by switching the S9 to **OFF**.
2. Plug an nRF2460 module with the PCB antenna (or with the SMA connector and an external antenna) onto the module connector on the nRFgo Starter Kit Motherboard. Position the module so the antenna is leading out from the Motherboard.
3. Connect the nRFgo Motherboard to your computer using a USB cable.
4. Turn the nRFgo Starter Kit Motherboard power on by switching S9 to **ON**.
5. Download the latest version of nRFgo Studio from www.nordicsemi.com onto your computer.
6. Start the nRFgo Studio from the Windows **Start** menu - **Programs** - **Nordic Semiconductor** - **nRFgo Studio**.
7. In nRFgo Studio, select **Motherboards** in the **Device Manager** pane and then select **Module** - <nRF24LE1 32pin 5x5mm - PCB>.
8. Select the precompiled file you want to download to nRF24LE1 for programming.
9. Click the **Program** button.
10. Turn the Motherboard **OFF** and **ON** again for the configuration of nRF2460 to take effect.

Now that you have configured the nRF2460 you can set up application-specific tasks during audio streaming, like a mute, general purpose data transfer and power down from the nRF24LE1 application firmware.

Firmware	Description
nRF2460-DK.hex	Sets up the nRF2460 to stream audio with high latency (default)
nRF2460-Medium.hex	Sets up the nRF2460 to stream audio with medium latency
Test-TX-Sweep.hex	RF test mode that sets up the nRF2460 to TX channel sweep
Test-RX-Sweep.hex	RF test mode that sets up the nRF2460 to RX channel sweep

Table 1. Pre-compiled firmware available for the nRF2460-DK

For your development needs, you can re-configure the nRFmodule in two ways. You can either use the nRFgo Studio software to program pre-compiled firmware, or connect an external MCU or codec directly to the nRF module headers. The nRFgo Studio is typically used for evaluation of the product, while external MCUs or codecs will normally be used during prototype development.

3.2 Setting up for prototype development

When developing a prototype, you need not program the nRF2460 module. However, you will need to set up an external MCU or codec.

3.2.1 Connecting an external MCU

To connect an external MCU, you must first remove the jumpers on header P7. The P7 header gives direct access to slave control I2C or SPI of the nRF2460. Refer to section 4.2.2 on page 11 for full description of pin-out of the headers. For reference when setting up the external MCU for developing your own prototype, the source code for the nRF module and the nRF2460 Product Specification are two good starting points.

3.2.2 Connecting an external codec

To connect an external codec, you must first remove the jumpers on header P10. The P10 header gives direct access to the I2S audio interface. Refer to section 4.2.3 on page 11 for full description of pin-out of the headers. For reference when setting up the external codec for developing your own prototype, the source code for the nRF module and the nRF2460 Product Specification are two good starting points.

3.3 Running stand alone

The nRF module can run stand-alone meaning you have already programmed the nRF module and removed it from the nRFgo Starter Kit Motherboard. In order to run stand alone, connect the external power supply (two AAA batteries) to headers P4 and P8. Refer to section 4.2.4 on page 11 for details on voltage requirements and pin-out.

The nRF modules come in two variants, one with a PCB antenna and one with an SMA connection for external antenna. The radiation pattern of antennas depends heavily on the layout of the antenna, the ground size, casing, and placement. This means that the actual range when running stand-alone depends on how the board is placed and oriented. Typically, when designing a product, you should make the design such that the radiation pattern of the antenna is oriented towards the other nRF module. This is especially important if the module is stationary, since antennas can easily have a difference in gain of 10 to 15dB in different directions.

3.4 Audio performance measurement

The nRF2460 features a digital I2S interface for transparent audio streaming between source and destination, and any loss in audio will be experienced as a soft mute for a minimum of 16 audio samples (500 µs).

Since the interface is digital you are not able to measure any typical analog performance, such as THD or SNR for the audio. However, you are able to use the analog interface (mini-jack connectors) of the nRF module to measure loss in audio across time. This will enable you to evaluate the audio performance for the nRF2460 in different environments and ranges.

A typical way to evaluate the audio performance is to use the analog interface and set up the audio source with a continuous, fixed audio tone, such as 1 kHz, and then record the audio on the destination side. Afterwards, you must filter the recording, using for instance a 1 kHz notch filter, to view the number of times you experience audio loss.

Many websites offer evaluation versions of software for audio filtering. An example of such software is the AVS audio editor. Make sure that the test tone lasts long enough for the entire recording.

3.5 Current consumption measurement

You can measure the current consumption in two ways, depending on whether the nRF module is running stand-alone or not.

If the nRF module is plugged into the nRFgo Starter Kit Motherboard, then you can measure current by connecting a multimeter to the nRF Current Measurement header on the nRFgo Starter Kit Motherboard. If the nRF module is running stand-alone, then you can measure current directly by placing a multimeter in series with the external power supply on header P4.

3.6 Measuring RF parameters

To measure the output power, RX LO leakage and harmonics, the nRF module with an SMA connector must be programmed with RF test firmware. The nRF module should then be connected to a spectrum analyzer for measurement.

Note that the nRF2460 does not support a test mode for measuring the sensitivity limit (BER or PER) directly. A typical way to measure sensitivity is to use two nRF modules with an SMA connector, program them with the default firmware (**nRF2460-DK.hex**) and attach a step attenuator between the modules.

Increase the attenuation until there is audio loss. The sensitivity limit is now the sum of the attenuator setting, cables and connectors.

4 Hardware description

The nRF2460-DK consists of nRFgo radio modules with a common analog input and output (3.5mm mini-jacks), for easy connection to MP3 players and headphones. All digital interfaces, such as the I2S audio, and slave SPI or I2C control interface, are available on headers for easy connection to a third-party MCU or codec during development.

The nRF2460 modules come in two variants, one with a ready-made PCB antenna, and another with an SMA connection. You can set up both variants to work as an audio transmitter (source) or receiver (destination).

4.1 nRF2460 module connectors (bottom side)

The nRF2460 module bottom side connectors (header P5 and P6), have all I/Os required for communicating with the nRFgo Starter Kit Motherboard. By placing the nRF2460 module into the nRFgo Motherboard socket, you can program and develop customized firmware for the on-board nRF24LE1.

The pin out for the module connector is documented in the User Guide for the nRFgo Starter Kit.

4.2 Module I/O port headers (top side)

The top side I/O headers enable you to connect a third-party MCU and codec, or run the nRF module stand-alone by connecting external power supply. The I/O headers are split into four main categories for easy connection during development.

4.2.1 Digital audio interface

All I/Os for the digital I2S audio interface are available directly on the nRF module (Header P10). By removing the jumpers across the pin header, you are able to directly connect a third-party codec, ADC or DAC.

nRF2460 (left side)	Codec (right side)
MCLK	MCLK
DATA	DATA
WS	WS
CLK	CLK

Table 2. Audio header pin (header P10)

4.2.2 Slave control interface

All I/Os for the slave control interface are directly available on the nRF2460 module (header P7). By removing the jumpers across the pin header, you can directly connect a third-party MCU. The slave control interface is enabled by placing a jumper on the slave interface selector (header P1).

nRF2460 (left side)		MCU (right side)
I2C	SPI	
SMOSI	SMOSI	SMOSI
SADR	SCSN	SADR
SSCL	SSCK	SSCL
SSDA	SMISO	SSDA
IRQ	IRQ	IRQ
RESET	RESET	RESET

Table 3. Slave control interface (header P7)

Jumper	Interface enabled
1-2	I2C
2-3	SPI

Table 4. Slave interface selector (SSEL pin, header P1)

4.2.3 Audio operation mode

An nRF2460 module is set up as an audio transmitter (source) or receiver (destination) by placing two jumpers on header P2 and P9. Both P2 and P9 must be set in the same operation mode on the nRF2460 module.

Jumper	Mode
1-2	ATX
2-3	ARX

Table 5. Operation mode (MODE pin, header P2 and P9)

It is important that these jumpers do not change position while the audio is streamed, since this might cause loud noise in the headphone output.

4.2.4 Stand-alone operation

The nRF2460 module can run stand-alone by connecting external power supply to VDD_nRF and VDD_A. An external power supply can only be used while the nRF2460 module is not plugged into the nRFgo Starter Kit Motherboard.

Pin	Header P4	Header P8
1	VDD_nRF (2.2 to 3.3V)	VDD_A (2.4 to 3.3V)
2	GND	GND

Table 6. Stand-alone operation

4.3   Block schematic

The block schematic for the nRF2460 module shows the logical connection between its different active parts.
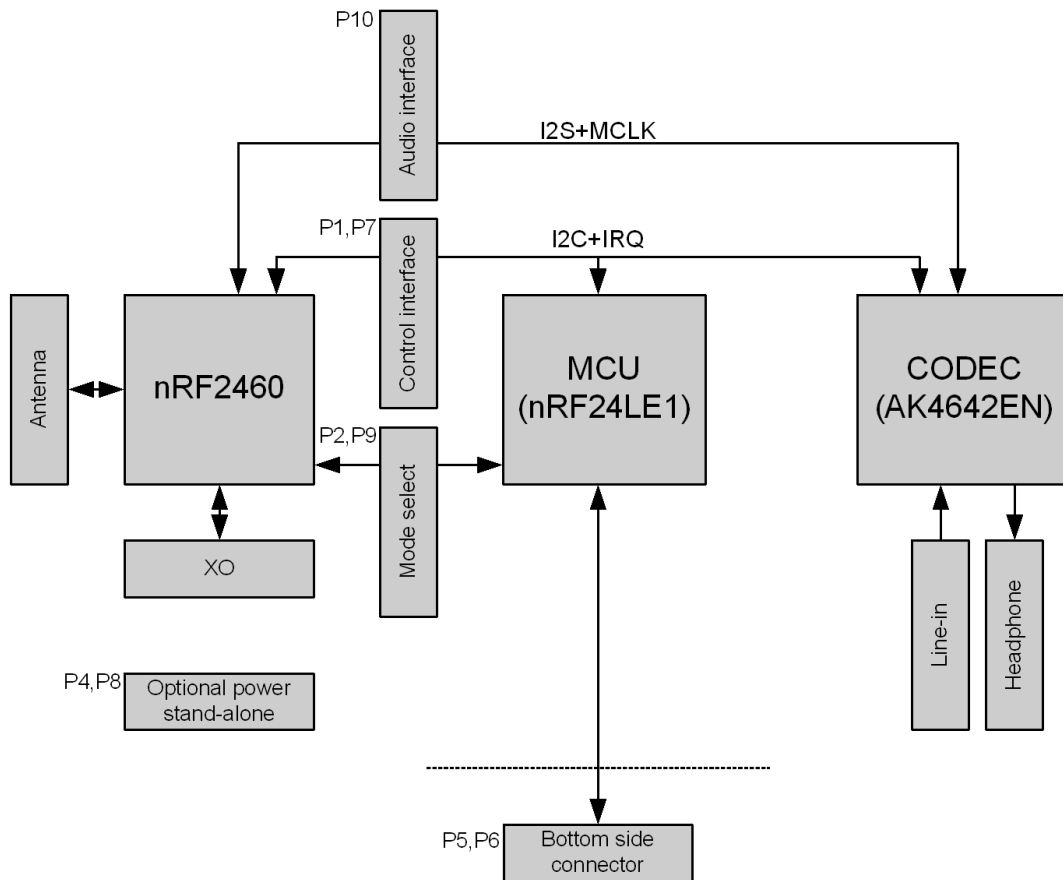

Figure 2. Block schematic for the nRF2460 module

5 Troubleshooting

I have connected the nRFgo Starter Kit Motherboard to the computer with the USB cable, but the LEDs on the Motherboard don't light up.

- Verify that the nRFgo Starter Kit Motherboard is turned **ON** (S9).
- Verify that the power selection button (S8) is set to **VBUS.**
- Remove all third-party hardware connected to the nRFgo Starter Kit Motherboard in order to remove short circuits.
- Change the USB port on the computer.
- Try a different USB cable.

I hear a buzzing sound while listening to the audio.

- Make sure that the power supply is within the range of 2.4 to 3.3V (set by the nRF2460 and codec).
- Try to feed the nRFgo module or the nRFgo Starter Kit Motherboard with a different power supply. For instance use AAA batteries.
- Try to use a different audio source. For instance, use a stand-alone MP3 player.
- Try to reduce the volume of your audio source.

The audio drops out while I am listening to the audio.

- Change the orientation of the nRF module. See section