

# nRF24LU1 Development Kit

## User Guide v1.0

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## Revision History

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## 1 Introduction

The Development Kit for the nRF24LU1 Single Chip 2.4 GHz RF Transceiver has been developed to enable customers to get hands-on experience with the functionality of the device in their applications.

The nRF24LU1 Development Kit is convenient for use in the prototyping phase when developing, testing and debugging PC software, microcontroller code and/or electronic circuitry for interfacing towards nRF24LU1 and a wireless communication link.

The nRF24LU1 Development Kit contains two nRF24LU1 Radio Modules with a PCB antenna and one nRF24LU1 Radio Module with an SMA connector. Also included is a reference design USB Dongle with the nRF24LU1. The nRF24LU1 USB Dongle reference design is described in the nRF24LU1 USB Dongle reference design User Guide document. This design is USB certified.

Details regarding digital input/output voltage levels, configuration and timing requirements for control of the nRF24LU1 device can be found in the nRF24LU1 datasheet. The nRF24LU1 datasheet can be downloaded from the Nordic Semiconductor web pages: <http://www.nordicsemi.no>.

This document describes radio links with the nRF24LU1 in both ends. In many applications, the nRF24LU1 will normally be used in one end and a nRF24L01 plus a MCU in the other end.

Key features of the nRF24LU1 Development Kit:

- Complete evaluation and development platform for nRF24LU1
- Enables development of full-custom applications with the nRF24LU1
- Supports In circuit software debugging with System Navigator from First Silicon Solutions
- Flexible Basic Feature Board
- nRF24LU1 radio module with PCB antenna and JTAG connector
- nRF24LU1 radio module with SMA connector for RF testing
- 5 samples of the nRF24LU1 chip
- Adaptors for programming the embedded flash on the nRF24LU1
- Evaluation and Configuration application suite
- Easy access to all radio configuration settings in the nRF24LU1
- Export configuration to ANSI-C
- Easy to set up transceiver in constant transmit mode
- Easy Enhanced ShockBurst™ link evaluation for RF protocol Development
- Selectable file for data transfer
- Configurable packet rate
- Comprehensive link report including total transmission time, average data rate, packet error rate and number of retransmissions.
- FCC/ETSI compliant
- Full-speed USB 2.0 compliant
- Complete set of design files for the radio modules
- Comprehensive set of documentation including Getting Started Guide and User Guide
- Seamless integration with the nRF24LU1 Software Development Kit for firmware development



## 2 Content of the development kit

The nRF24LU1 development kit contains hardware modules, software, design files for the radio modules, documentation and compliance reports. Documents, design files and software is available on the attached CD.

### 2.1 Hardware

- 2 of Basic Feature Board
- 2 of nRF24LU1 Radio Module PCB, board version 1.0
- 1 of ISP dongle version 1.0.
- 1 of nRF24LU1 Radio Module SMA, board version 1.0
- 1 of nRF24LU1 USB Dongle, board version 1.0
- 1 of nRF24LU1 USB Dongle Programming Adapter, board version 1.0
- 1 of PS/2 Adapter, board version 1.0
- 1 of nRF24LU1 USB Dongle Programming adapter cable

The revision numbers of the hardware refers to the information given in this document. This is the Bill of Material and the PCB version number.

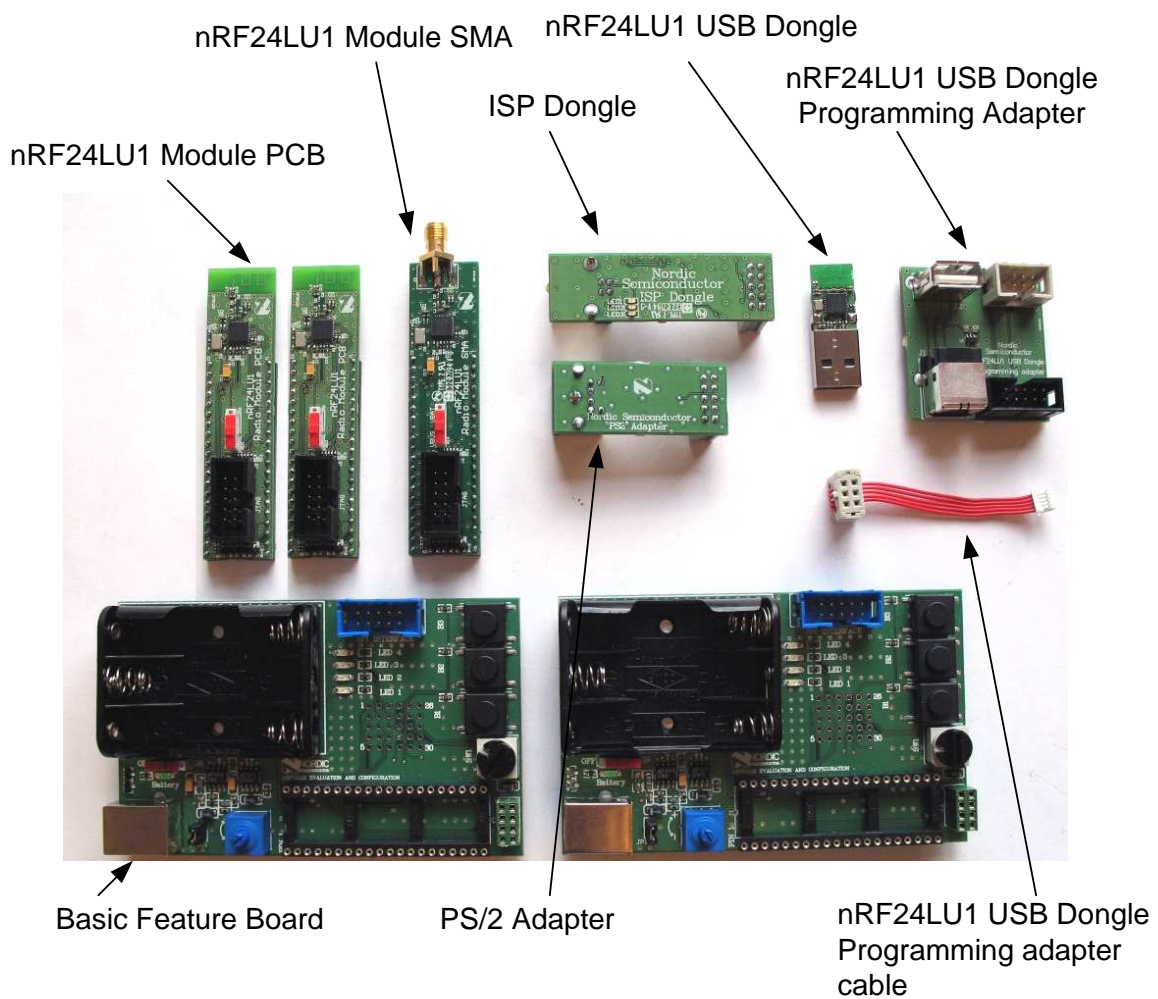


Figure 1: Hardware content of the nRF24LU1 Development kit

## 2.2 Software

The software available with the kit:

- nRF24LU1 Configuration and Evaluation Suite (CES), v1.0, build 1926. Installed by running "nRF24LU1\_DK\_v1.0\_setup.exe." The program file is named "LU1Config.exe."
- nRF24LU1 Flash Programmer application, v1.2, build 1891. Installed by running "nRF24LU1\_SDK\_v1.2\_setup.exe." The program file is named "LU1Prog.exe."
- nRF24LU1 Software Development Kit, v1.2. Installed by running "nRF24LU1\_SDK\_v1.2\_setup.exe."
- nRF2601 Wireless Desktop Protocol, v.1.1. Installed by running "WDP\_v1.1\_setup.exe."
- Evaluation version of Keil c51 compiler and µvision IDE

All nRF24LU1 are pre-programmed with the Configuration and Evaluation Suite Firmware v1.0.

The software can only be used with Microsoft Windows XP operating system.

## 2.3 Design files

The following design files are available for the radio modules:

- Altium Designer 6 files with libraries.
- Gerber files.

## 2.4 Documentation

The following documentation are available in the document folder on the CD:

- nRF24LU1 Development Kit User Guide
- nRF24LU1 USB Dongle Reference Design User Guide
- nRF24LU1 Development Kit Getting Started
- nRF24LU1 USB Dongle Reference Design Getting Started
- nRF24LU1 RF qualification reports for FCC and ETSI.
- nRF24LU1 USB compliance test report

The following documentation is available as part of the software installation packets above:

- Software Developer Guide
- FS2 Installation
- Keil License

## 2.5 Accessories

The following accessories are available:

- 2 USB (A-B) cables
- 1 CD containing Documentation, Software and PCB layout files

### 3 What can you do with the development kit

With the nRF24LU1 Development Kit, you can do the following:

- Program the flash memory in the nRF24LU1
- Develop your application
  - All GPIO pins on the nRF24LU1 is available and can be connected to external circuitry
  - Tools for uploading and debugging firmware
- In circuit software debugging
- Evaluate the nRF24LU1 with measurements
  - Output power measurement
  - Range evaluation
- Wireless Mouse demo
  - The nRF24LU1 Development Kit can loaded with the wireless desktop protocol and connected to a PS/2 mouse to emulate a wireless mouse.

### 4 How to use the development kit

This chapter describes how to use the nRF24LU1 development kit.

#### 4.1 Setup

To start using the development kit, follow these steps first:

1. Run the “nRF24LU1\_DK\_v1.0\_setup.exe” installer file from the CD.
2. Make sure the potentiometer on the Basic Feature Board is set all the way to the ‘+’ side.
3. Make sure the switch S1 on the radio module is set to VBUS

The radio modules and the USB dongle in the development kit comes already programmed with the Configuration and Evaluation Suite (CES) firmware. The CES contains a firmware part, running on the nRF24LU1, and a PC-application running on Windows XP.

The CES is used to evaluate the nRF24LU1. It can be used on any nRF24LU1 design that follows the recommendations in the nRF24LU1 product specification.

The CES can be used in two ways:

1. **Basic:** With only the CES firmware. The CES firmware makes the nRF24LU1 enumerate as a keyboard on the PC it connects to. It enables the nRF24LU1 to write its status to the PC. The user will then be able to read the status if Notepad is opened. Toggling of the different test modes is done by pressing “Num Lock” on the PC.
2. **Advanced:** Using both the CES PC-application and the CES firmware. The CES PC-application gives the user a command window where different parameters and modes in the nRF24LU1 can be set.



### 4.1.1 Basic setup

The Basic setup is used to run the nRF24LU1 through a set of predefined modes, ideal to use when preparing for EMC testing.

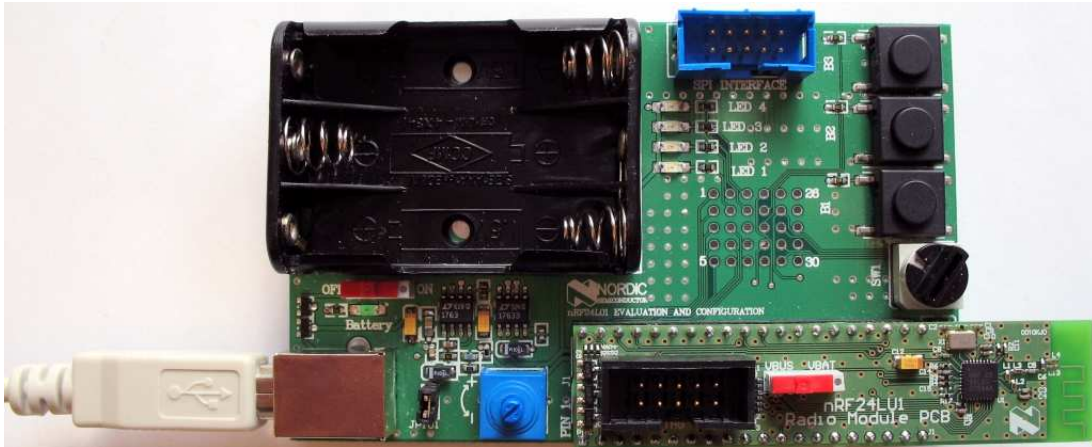


Figure 2: Basic Feature Board with nRF24LU1 Radio Module connected to USB cable

To use the CES firmware in stand alone mode, follow these steps:

1. Connect the Basic Feature Board with the nRF24LU1 Radio Module in place, as configured earlier, to a USB connector on the PC.
2. Start Notepad on the PC. Make sure that the Notepad Window is the active Window as long as you run the test.
3. Press "Num Lock"

The following screen will appear:

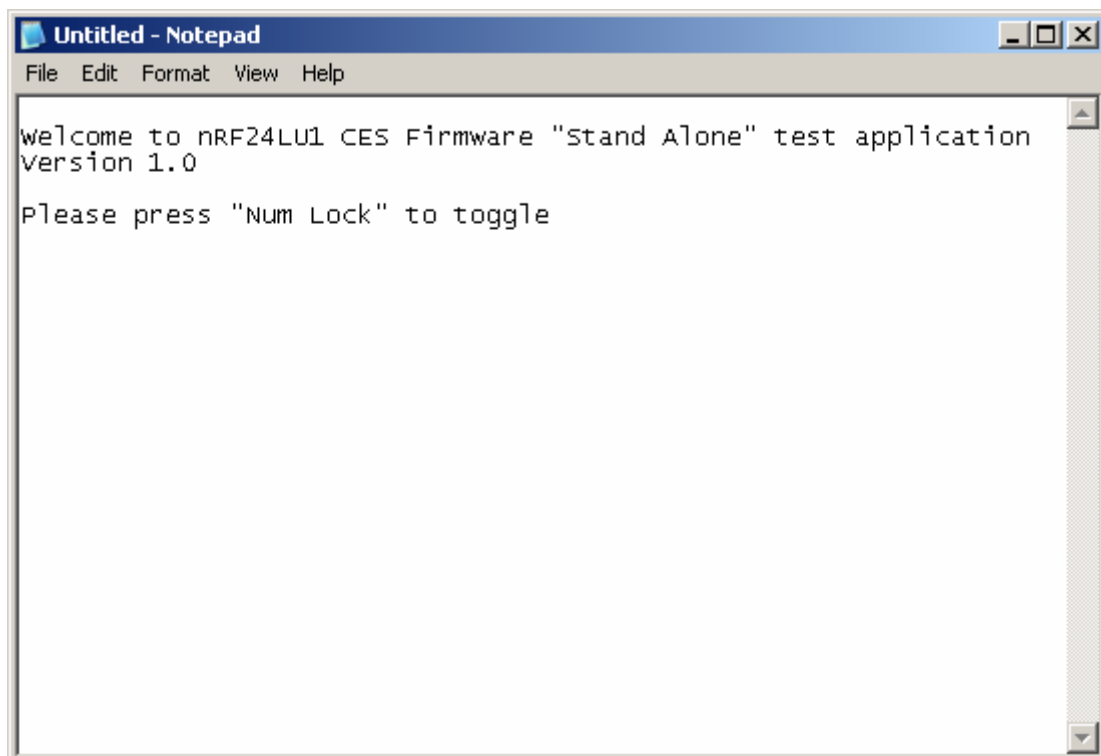
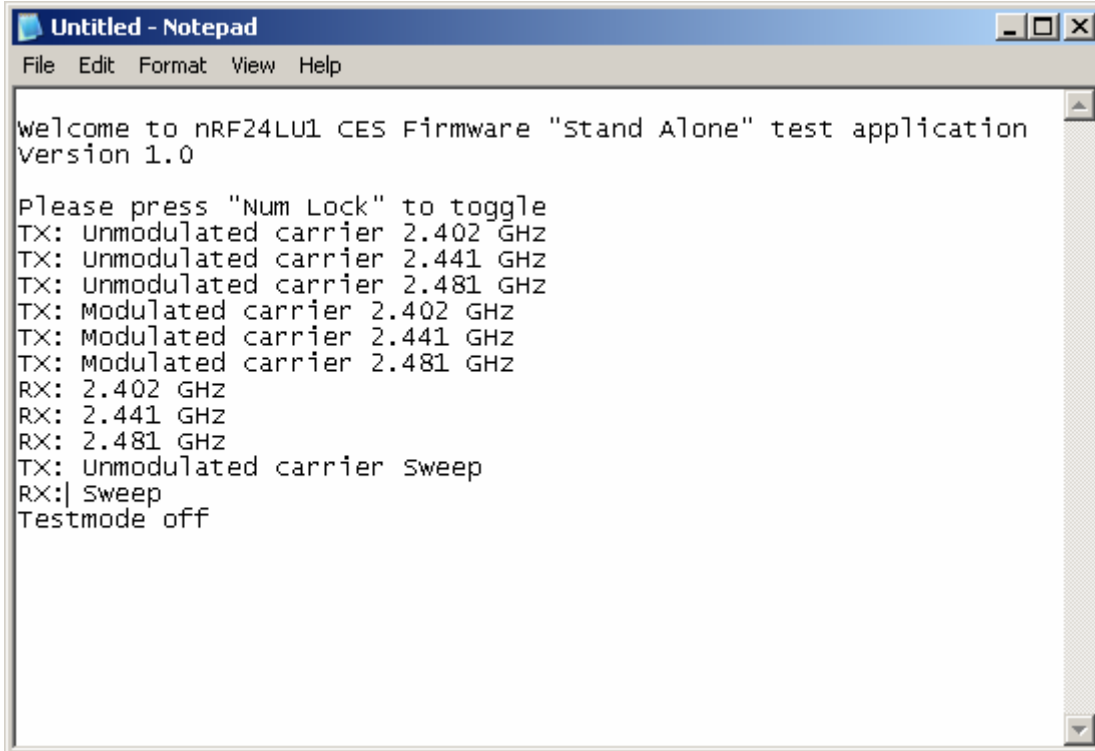


Figure 3 – CES Stand Alone startup screen



4. Pressing “Num Lock” several times will step through available modes in the basic setup:



```
Untitled - Notepad
File Edit Format View Help

welcome to nRF24LU1 CES Firmware "Stand Alone" test application
Version 1.0

Please press "Num Lock" to toggle
TX: Unmodulated carrier 2.402 GHz
TX: Unmodulated carrier 2.441 GHz
TX: Unmodulated carrier 2.481 GHz
TX: Modulated carrier 2.402 GHz
TX: Modulated carrier 2.441 GHz
TX: Modulated carrier 2.481 GHz
RX: 2.402 GHz
RX: 2.441 GHz
RX: 2.481 GHz
TX: Unmodulated carrier Sweep
RX:| Sweep
Testmode off
```

Figure 4 – CES Stand Alone test modes

The modes will start at the beginning after “Test mode off”

**Note:** Make sure the keyboard layout on the PC is set to “English”. Else, parts of the text might be unreadable.

The different modes:

TX Un-modulated carrier:	Measure output power and harmonics
TX Modulated carrier:	Modulated with a PN9 sequence, to do bandwidth measurements.
RX:	To measure LO leakage in RX mode.
TX Un-modulated sweep:	Sweeps the carrier from ch 02 to ch 81. Max hold on spectrum analyzer to measure the whole band.
RX sweep:	Sweeps the receiver from ch 02 to ch 81

All TX modes are with 0dBm output power.

Note: The un-modulated carrier is slightly modulated by the preamble, so the carrier does not look completely clean. This mode is intended for output power measurements only.

The exact same setup can be used with the nRF24LU1 USB Dongle.

## 4.1.2 Advanced setup

Advanced setup gives access to all the different registers in the nRF24LU1 through the CES PC-application. This setup is used during range test and other tests that require access to all parameters in the nRF24LU1.

Advanced setup requires Microsoft .NET framework v2.0 runtime installed on the PC. It can be downloaded from Microsoft's web pages.

To use the CES PC application, follow these steps:

1. Install the nRF24LU1 CES software on the PC.
2. Connect the Basic Feature Board with the nRF24LU1 Radio Module in place, as configured earlier, to a USB connector on the PC.
3. Start the nRF24LU1 CES application from the "Nordic Semiconductor" folder on the Start menu.

The following screen will appear:

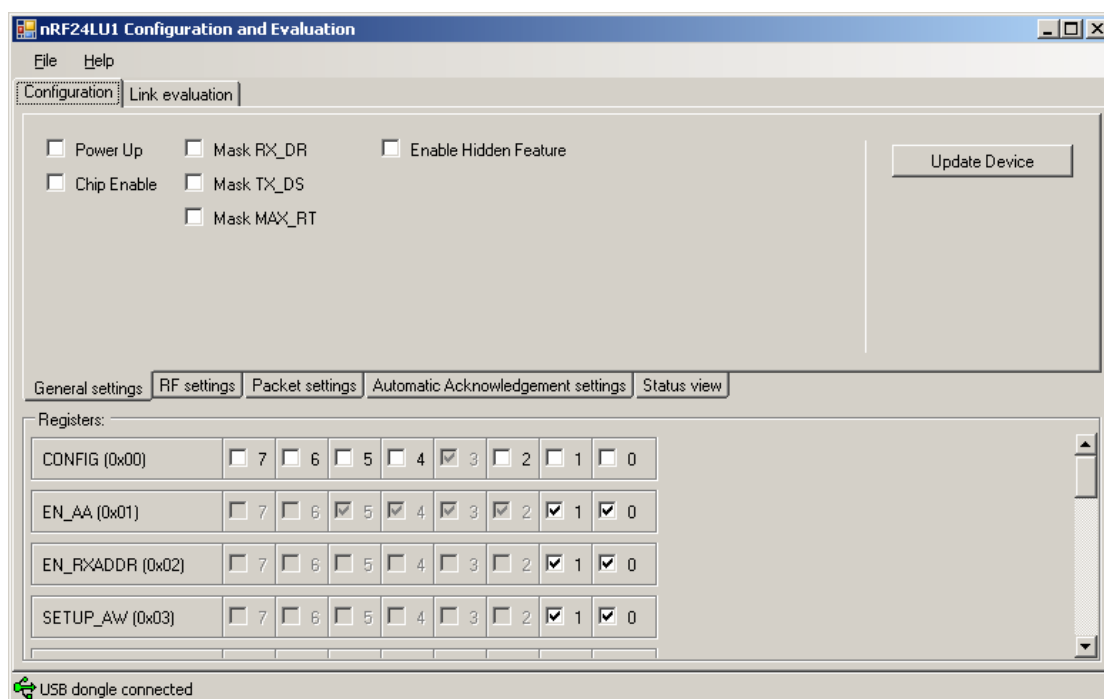


Figure 5 – CES General Settings

The register settings in the bottom part of the screen reflect the settings done in the different tabs in the upper part. All parameters can be set using either the bottom register part, or by ticking the boxes in the upper part of the window. Please refer to the nRF24LU1 Product Specification for details.

On the upper part of the window, two tabs can be selected, Configuration and Link Evaluation

Configuration tab

The "Update Device" button will transfer the settings to the nRF24LU1.

The tab "general settings" has the following parameters, see *Figure 5*.

Power up – sets the radio in standby mode

Chip enable – sets Chip Enable high. This must be ticked to enable the radio in RX mode, and to set a carrier in TX mode. Clicking the “Update Device” button is not needed for altering the Chip Enable line.

Mask RX\_DR, TX\_DS and MAX\_RT – Mask interrupts

Enable hidden feature – To enable the extra enhanced ShockBurst features; dynamic payload, acknowledge on demand and payload sent with the acknowledge packet.

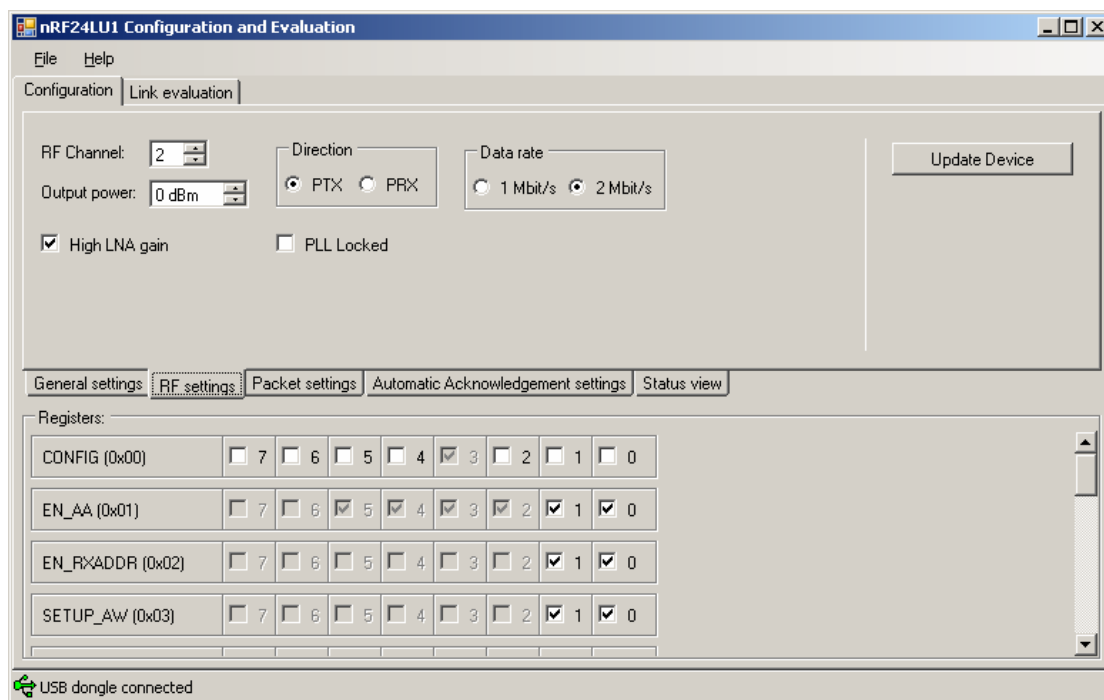


Figure 6 – CES RF Settings

The tab “RF Settings” has the following parameters, see *Figure 6*:

RF channel – Sets the TX or RX frequency, where the frequency is 2400MHz+RF channel

Output Power – Sets the TX output power

Direction – Sets the radio to either PTX or PRX

Data rate – Sets data rate to 1Mb/s or 2Mb/s

High LNA gain – Sets the LNA gain in RX mode. By un-ticking this box, the receiver sensitivity is reduced, but also the current consumption in RX mode is reduced.

PLL locked – Locks the PLL. Modulation is not possible when this box is ticked, but a constant carrier can be output for power measurements.

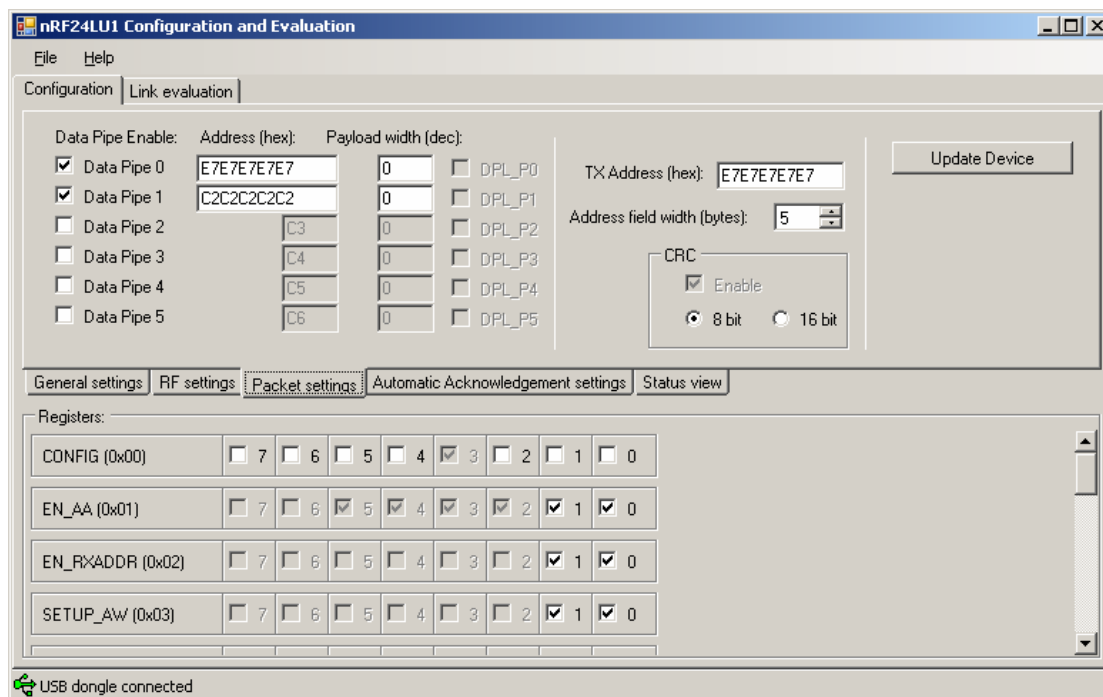


Figure 7 – CES Packet settings

The tab “Packet settings” has the following parameters, see *Figure 7*

Data Pipe Enable – enable the data pipes by ticking the box.

Address - sets the RX address of the different pipes.

Payload width – sets the number of bytes in the payload from 0 to 32 bytes.

TX address – sets the TX address. This must correspond with the RX address for the chosen pipe in the PRX device. To use the Auto Acknowledge function, the Data Pipe 0 and the TX address must be the same.

CRC – can be set to 8 or 16 bits.

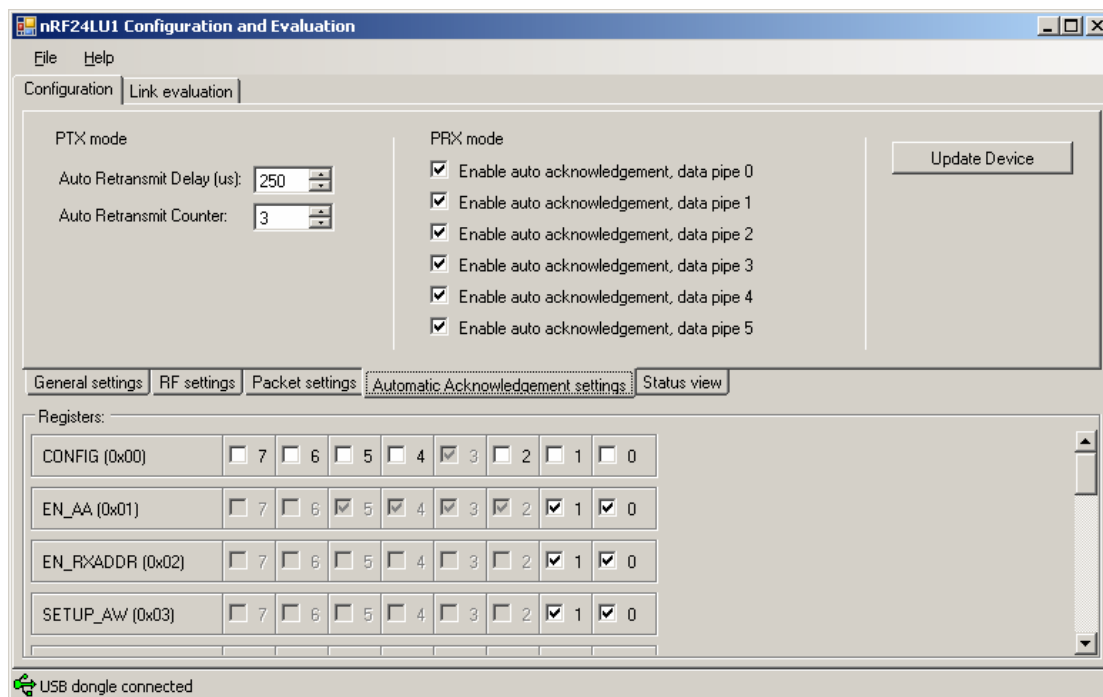


Figure 8 – Auto acknowledge settings

The tab “Automatic Acknowledge settings” has the following parameters, see *Figure 8*:

Auto Retransmit Delay – sets the delay to re-send the packet when the packet or the ack is lost. This value can be set in 250us increments up to 4ms.

Auto Retransmit Counter – Sets the number of times the packet can be retransmitted before the MAX\_RT flag is set.

Enable auto acknowledge, data pipe x – tick the box to enable auto ack on the different pipes.

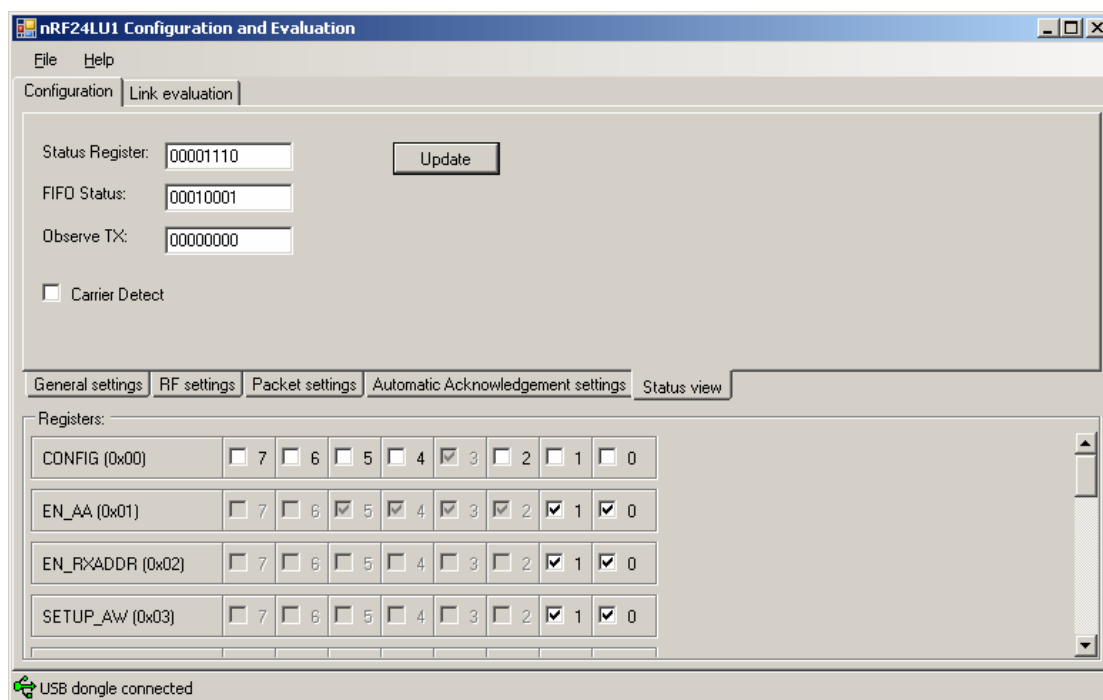


Figure 9 – Status view

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The “Status View” tab, se *Figure 9*, is used to read the Status register and the FIFO Status from the radio. The Observe TX field reads the packet loss and the resent packet counters.

To save or restore the settings, use the “load configuration” and “save configuration” under the “file” menu. The “save configuration” will save a TXT file with the configurations settings in C-code format. This can be used directly in the source code.

## 5 Output power measurements

To measure the RF parameters, like output power and harmonics, you need a spectrum analyzer.

Perform these steps to measure the output power of the carrier:

1. Connect a Basic Feature Board with a nRF24LU1 Radio Module SMA to a USB connector on the PC.
2. Connect a SMA coaxial cable from the SMA connector on the radio module to the spectrum analyzer.
3. Set the centre frequency to the nRF24LU1 operating frequency, span to 10MHz and level to +5dBm on the spectrum analyzer.

Use the CES in stand alone mode to enter the TX modes shown in *Figure 4*.

Note: The carrier will be slightly modulated by the preamble so the carrier will not be a single tone.

With a TX un-modulated carrier test running, the carrier should be visible on the spectrum analyzer.



## 6 Range evaluation

This test requires advanced setup.

The range of a radio link is defined as the distance between a transmitter and a receiver, where the signal from the transmitter is at the sensitivity limit of the receiver at the receiver end of the link. The sensitivity limit is defined as the signal level where the received signal has a Bit Error Rate (BER) of 1/1000. With the nRF24LU1 it is not possible to measure the BER directly, but the nRF24LU1 Development Kit makes it possible to measure the Packet Error Rate (PER.) The relation between the PER and BER is as follows:

For a given BER, the likelihood of get one bit corrupt is BER. The likelihood of getting a bit correct is (1-BER.) If a packet contains n bits (including address, control field, payload and crc,) the likelihood of getting all bits in one packet correct is  $(1-BER)^n$ . From this we get the likelihood of getting the packet wrong:  $PER = 1-(1-BER)^n$ .

By measuring the PER for a given packet length and range, one can use this formula to determine if the sensitivity limit has been reached.

The Link evaluation tab in the CES PC-application, *Figure 10*, enables the user to test the ShockBurst link between two boards. In order to run this test, two PCs are needed. Each PC is running the CES PC application and each has one basic feature board with a radio module with PCB antenna connected.

Use this setup:

1. Under the “General settings” tab: Power up must be ticked for both sides.
2. Under the “RF settings” tab: One side set to PRX and one set to PTX.
3. Under the “Packet settings” tab: Data Pipe 0 address and TX address must be equal for both PTX and PRX side, all 4 fields.
4. Under the “Packet settings”: At the PRX side, payload width for Data Pipe 0 must be set to 1 ore more and it must be equal on the PTX and PRX side.
5. All other settings must be equal on both PTX and PRX side.
6. Under the “Link evaluation tab” press “Select File” to choose a text file on both sides. This must be equal on both sides.
7. Place the two basic feature boards so the distance between them is the same as the range you want to evaluate.
8. Press “Run Tests” on the PRX Side.
9. Press “Run Tests” on the PTX Side.

The PTX will show a report after all packets has been transmitted. Press “Stop Tests” on the PRX to show the report of all received packets.

The report on the PRX side tells how many packets that got lost during the transfer. This is used to calculate the packet error rate (PER) for the link. The PER can be reduced by increasing output power on both PTX and PRX side or increase Auto Retransmit Counter (ARC) on the PTX side. Use this test to find the suitable configuration for your application.

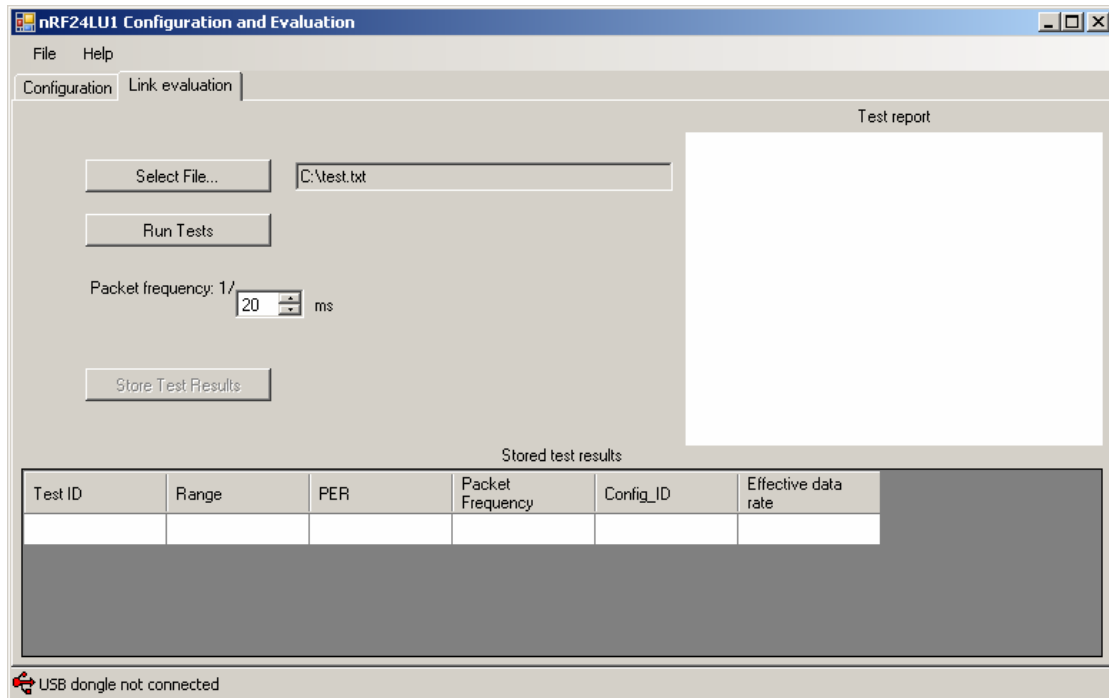


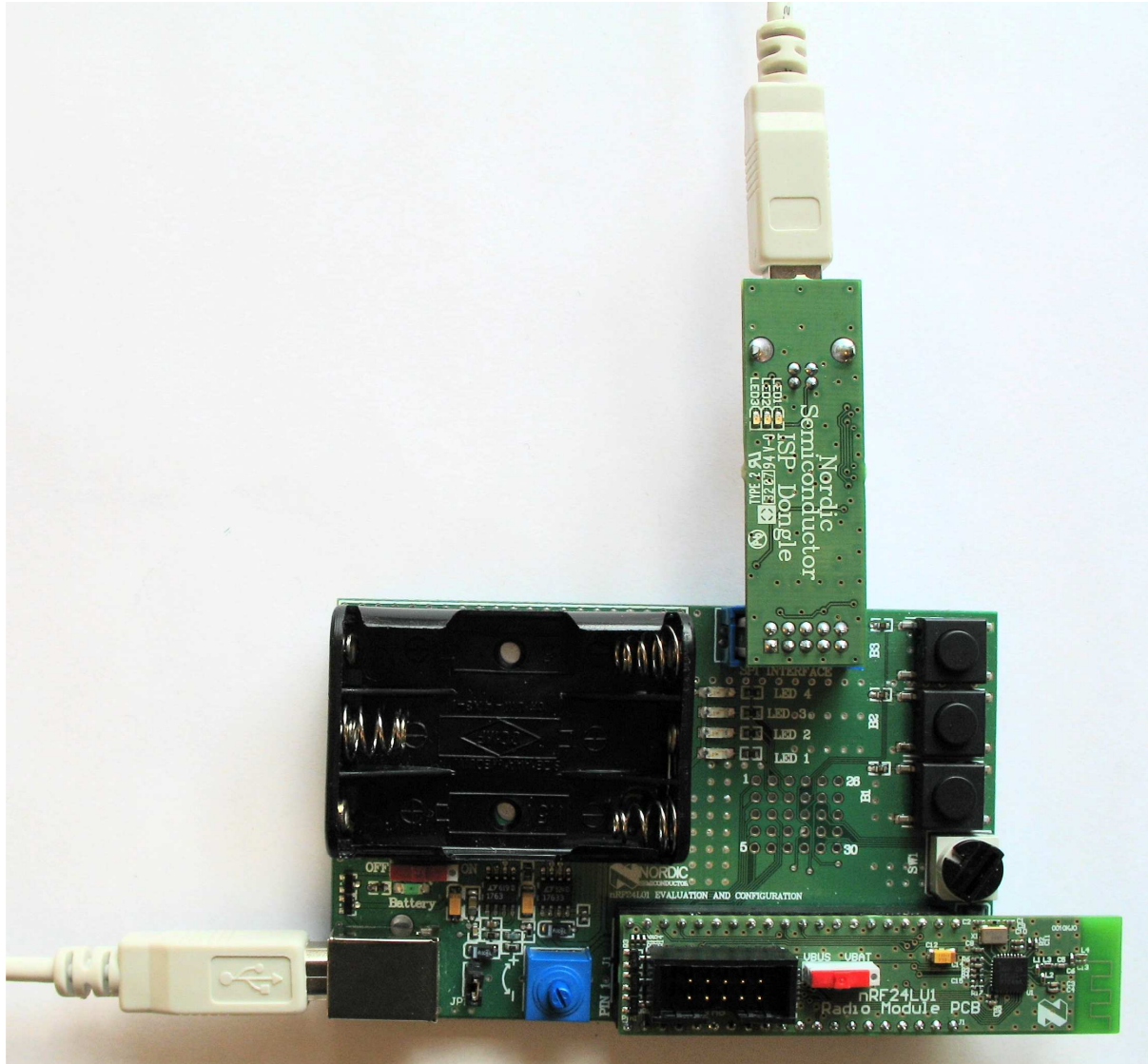
Figure 10 - Link evaluation tab

Note: The test will only test the Enhanced ShockBurst link. For a real application, there will be a protocol layer on top that can handle lost packets on a more secure way. The Wireless Desktop Protocol (nRF2601) is an example of such a upper protocol layer.

## 7 Flash programming

The firmware is programmed into the nRF24LU1 flash memory with the ISP Dongle.

For the nRF24LU1 Radio Modules, the dongle is connected to the “ISP Interface” connector on the Basic Feature Board. See *Figure 11*.



*Figure 11 – ISP dongle connection*

Both the Basic Feature Board and the ISP Dongle must have a separate USB connection to the PC. Make sure the switch on the nRF24LU1 Radio Module is set to “VBUS”. The blue potentiometer must be set all the way to the ‘+’ side.

The nRF24LU1 Flash Programmer application must then be installed on the PC. When the program is started, the following screen will appear:

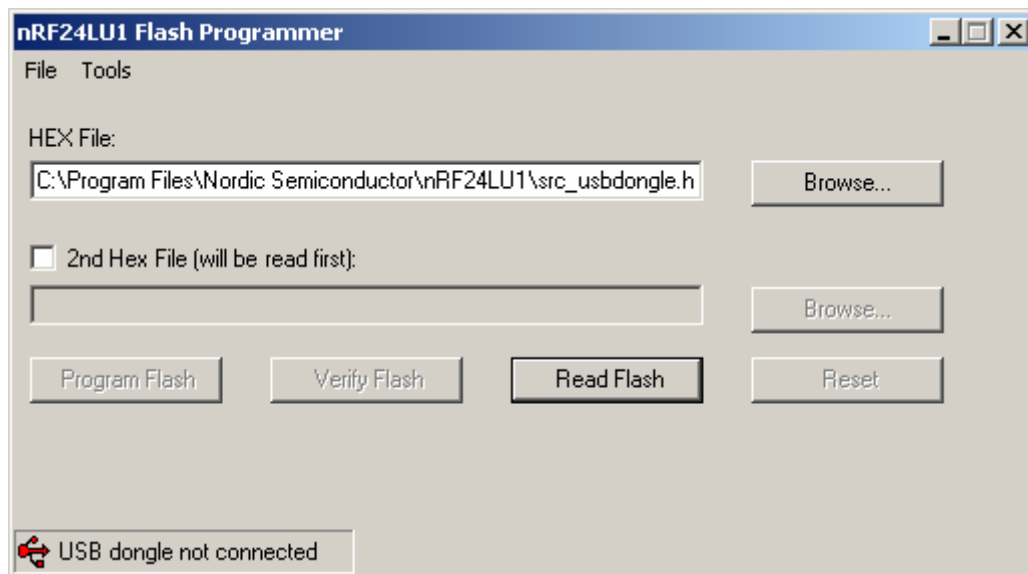


Figure 12 - nRF24LU1 Flash Programmer

When the ISP Dongle is connected to the USB port, the text “USB Dongle not connected” will change to “USB Dongle connected” and the USB symbol will turn green.

Choose the .HEX file with the “Browse” button and press “Program Flash”. A blue progress bar will appear. The FLASH is first programmed and then verified. A box will appear if the verify failed.

## 8 Wireless mouse demo

This demo shows how the nRF24LU1 performs in a wireless mouse application. The demo is turning a wired PS/2 mouse into a wireless mouse running the wireless desktop protocol (nRF2601.) In this demo the nRF24LU1 is used in both ends of the link, while in a real wireless mouse application, the nRF24L01 would have been used in the mouse end.

The following equipment is needed to run the test:

- 2 Basic feature boards with Radio Module with PCB antenna connected
- 1 PS/2 adapter
- 1 PS/2 mouse (not included in the Development kit.)
- 1 PC running Windows XP (not included in the Development kit.)
- 1 USB cable

Before the demo, the radio modules must be programmed with the right firmware. To access the needed files, please make sure the nRF24LU1 SDK is installed.

The files can then be found at:

**C:\Program Files\Nordic Semiconductor\nRF24LU1\Source Code\Builds**

After programming, all devices are unpaired and thus need to be paired. First time programming and pairing are committed using the following procedure:

Follow these steps to setup the development kit:

1. Select one of the Basic Feature Board with an nRF24LU1 Radio Module PCB to be used as the "Host side dongle" This will be connected to the PC via the USB cable during the demo.
2. Program the "Host side dongle" with the file **usb\_dongle.hex**. Follow the instructions in the **Flash programming** chapter above
3. Unplug the "Host side dongle" from the PC.
4. Assemble an Basic Feature Board with a nRF24LU1 Radio Module PCB and one PS2 Adapter to work as the mouse module. The PS/2 adapter must be plugged into the "ISP Interface" connector after the flash is programmed.
5. Program the mouse module with the file **mouse\_keyboard.hex**
6. Power down the mouse module and connect a PS2 mouse to the PS2 adapter. Plug the adapter into the "ISP Interface" connector on the Basic Feature Board.
7. Insert 3xAAA batteries into the battery holder on the Basic Feature Board.
8. Set the switch S1 on the radio module to VBAT.
9. Set the power switch on the Basic Feature Board to ON.
10. Connect the "Host side dongle" to the PC.
11. Start using the mouse within 5 seconds after insertion of the USB dongle.
12. The mouse module is now paired and ready for use.

Regarding the requirement of using the mouse within 5 seconds after insertion of the USB dongle, this is only required the very first time a mouse is to be paired. Once a pairing is successfully committed, all necessary pairing information is stored in Flash, thus pairing is not required on next power up. However, a previously paired mouse can easily be re-paired to another USB dongle by repeating procedure from 9 to 12. In this case, pairing to any previous dongle will be terminated.



Figure 13: Basic Feature Board with PS/2 Adapter and nRF24LU1 Radio Module connected to a PS/2 Mouse

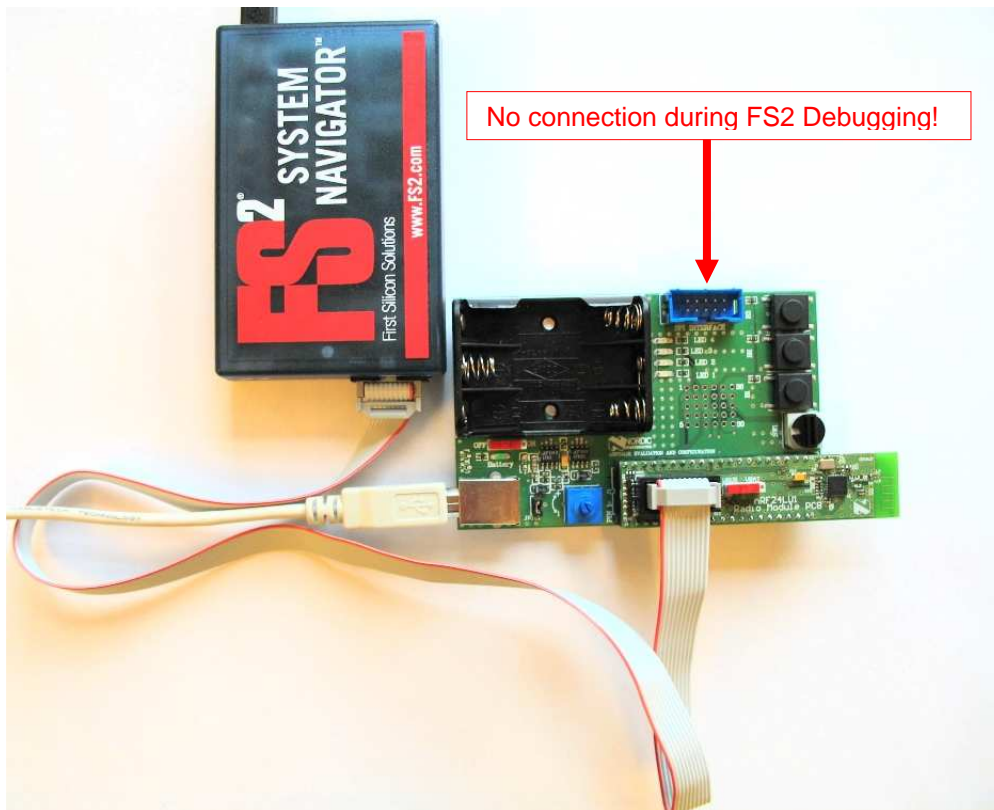
Instead of using a basic feature board with a Radio Module with PCB antenna as the “Host side dongle” one can use the nRF24LU1 USB dongle reference design. Please refer to the nRF24LU1 USB dongle User Guide for details on how to program it with the `usb_dongle.hex` file.



## 9 In circuit software debugging

It is possible to connect a FS2 System Navigator to the nRF24LU1 Radio Module to enable In circuit software debugging.

The FS2 system navigator must be connected to the JTAG connector on the radio module. See *Figure 14*.



*Figure 14: FS2 System Navigator connected to nRF24LU1 Radio Module*

Refer to the document **FS2 Installation.pfd** under **C:\Program Files\Nordic Semiconductor\nRF24LU1\Doc** for instructions how to use and setup the FS2 system navigator. The FS2 system navigator is not included in the development kit and must be purchased separately from First Silicon Solutions. The FS2 System Navigator to be used with nRF24LU1 is the [SNAV-CAST51](#).

**Note:** The FS2 System Navigator and the ISP Dongle must never be connected to the system at the same time. Make sure that the FS2 Navigator is disconnected before the ISP Dongle is connected and vice versa.



## 10 Using the Development Kit for prototyping

The nRF24LU1 is designed to be used on the host side of the wireless link, connected to a host USB port. On the other end of the link, the nRF24L01 together with a MCU will be typical for most applications. However, using nRF24LU1 in both ends will give same link performance as if a nRF24LU1 was communicating with a nRF24L01.

The nRF24LU1 Software Development Kit, SDK, is a good starting point to develop your own firmware. This comes with ready made libraries and example application, making it faster to get the application up and running. Please refer to the SDK documentation for details about the code and the use of this.

The LEDs and buttons on the board can be used for debugging or in a real application if this is needed.

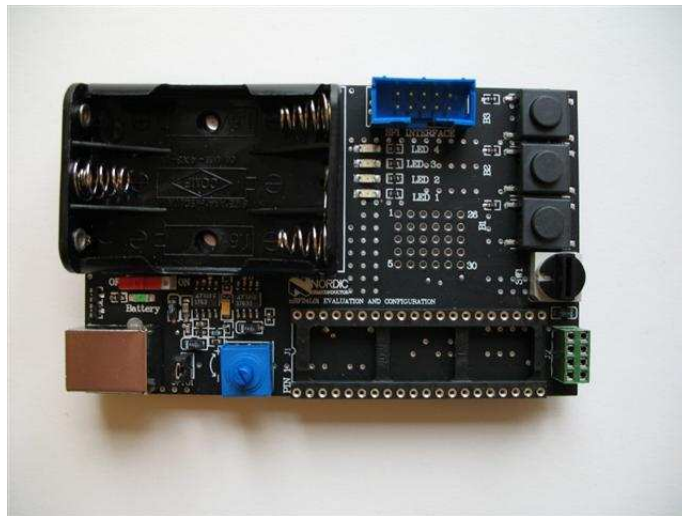
The nRF24LU1 USB dongle is developed as a ready USB dongle. It has limited space for I/O connectors so it will be more convenient to use the Development Kit for prototyping and firmware development. The FS2 hardware debugger can only be connected to the Development Kit. Please refer to the nRF24LU1 USB dongle User Guide for details on how to use this in your development.

## 11 Hardware description

This chapter describes the hardware of the nRF24LU1 Development Kit.

### 11.1 Basic feature board

The BFB contains power supply, connectors, battery holder, LEDs and buttons in order to supply the Development Kit with commonly used features. The Radio Module is inserted in the 40 pin dual in line socket on the BFB as shown in *Figure 16*. The nRF24LU1 radio module contains the nRF24LU1 and the necessary circuitry.



*Figure 15 - Basic Feature Board*

The nRF24LU1 Development Kit can be connected to a PC running the nRF24LU1 Configuration and Evaluation software to perform tests on the radio. A description of test setups with the nRF24LU1 Development Kit is described in the “nRF24LU1 Test Setup” document. Custom made firmware may also be run on the Development Kit.

The schematic of the BFB is shown in *Figure 17*.

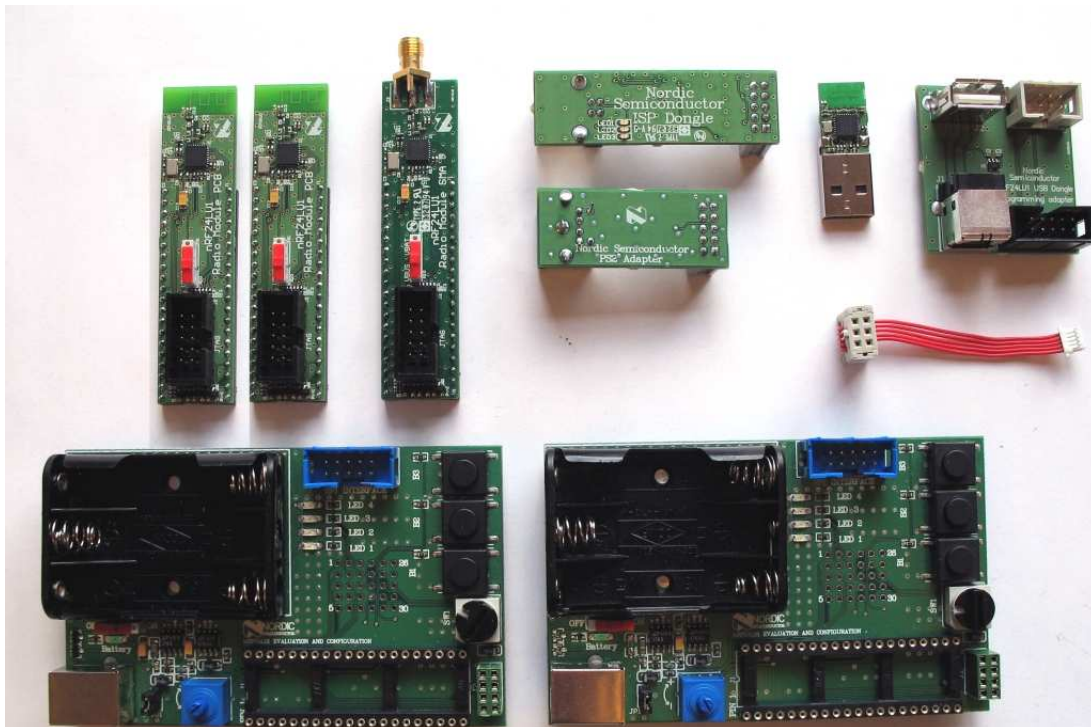


Figure 16 - nRF24LU1 Development kit

## 11.2 Features of the BFB

### 11.2.1 Power supply

The nRF24LU1 Development Kit BFB has two power supply options:

1. Through the USB cable
2. From the 3x AAA battery pack.

The switch close to the battery pack must be set to “ON” to enable supply from the battery. If the USB cable is connected, the power will be sourced from the USB even if the battery switch is set to “ON”.

The nRF24LU1 Development Kit BFB has two power supply regulators; none of the regulators are used to supply the nRF24LU1 Radio Module. This is done by the internal regulator of the nRF24LU1. The nRF24LU1 radio module can be supplied with either USB power or from the battery pack by setting a switch on the Radio Module.

The “ISP Interface” connector that is used for flash programming uses the adjustable regulator as a reference. For proper logic levels, the blue potentiometer must be set to max.

### 11.2.2 LED

There are four yellow LEDs on the nRF24LU1 Development Kit BFB. Three of the LEDs are connected to the nRF24LU1 and can be used to indicate status, depending on the firmware that runs on the nRF24LU1. The green LED on the nRF24LU1 Development Kit BFB indicates the state of the battery switch. If it is lit, the battery switch is on and the batteries are ok.

### 11.2.3 Buttons

There are three buttons on the nRF24LU1 Development Kit BFB that are connected to the nRF24LU1. These are used to give input to the MCU during tests. The function of these buttons depends on the firmware on the nRF24LU1

### 11.2.4 Rotary Switch

The rotary switch is not used when the BFB is used with the nRF24LU1 Radio Module.

### 11.2.5 SPI Interface

This connector is used to program the FLASH on the nRF24LU1. The ISP dongle is then connected here. The pin out of this connector is shown in *Table 1*.

Pin Number	Signal name	Description
1	RF_VDD	Supply voltage
2		Not used
3	RESET	Reset signal to nRF24LU1
4	CSN	SPI CSN
5	MISO	SPI MISO
6	PROG	PROG signal from nRF24LU1
7	MOSI	SPI MOSI
8	SCK	SPI SCK
9		Not used
10	GND	Common ground

*Table 1 - Pinout of the SPI Interface connector*

### 11.2.6 Module connector

A 40 pin dual in line socket, J1, is used to connect the nRF24LU1 Radio Module to the BFB. The pin out for this connector is given in *Table 2*.

Pin Number	Signal name	Description	Connected to
1	GND	Common ground	
2	LED1	Led driver on Radio Module, P0.0	LED 1
3	LED2	Led driver on Radio Module, P0.1	LED 2
4	LED3	Led driver on Radio Module, P0.2	LED 3
5		Not used	LED 4
6		Not used	
7		Not used	
8		Not used	
9		Not used	
10	GND	Common ground	
11		Not used	
12	P0.5	GPIO P0.5	Button B1
13	P0.4	GPIO P0.4	Button B2
14	P0.3/CSN	GPIO P0.3 or SPI CSN	Button B3
15		Not used	
16		Not used	
17		Not used	

Pin Number	Signal name	Description	Connected to
18		Not used	
19	GND	Common ground	
20		Not used	
21		Not used	
22		Not used	
23		Not used	
24		Not used	
25		Not used	
26	GND	Common ground	
27	VBUS	USB supply voltage input	USB Connector
28	VDD	Regulated voltage input	Output of fixed reg.
29	GND	Common ground	
30	D-	USB D- signal	USB Connector
31	D+	USB D+ signal	USB Connector
32	GND	Common ground	
33	P0.0/SCK	GPIO P0.0 or SPI SCK	SPI INTERFACE
34	P0.2/MISO	GPIO P0.2 or SPI MISO	SPI INTERFACE
35	P0.1/MOSI	GPIO P0.1 or SPI MOSI	SPI INTERFACE
36	P0.3/CSN	SPI CSN	SPI INTERFACE
37	RESET	nRF24LU1 Reset	SPI INTERFACE
38	PROG	nRF24LU1 Prog	SPI INTERFACE
39		Not used	
40	VBAT	Battery Voltage	Battery pack

Table 2 - Module connector J1 pin out

### 11.2.7 Signal grid

The signal grid is a grid of 5 x 6 trough-hole pads. All signals that is present on the BFB are routed through this grid. The pin out is shown in Table 3.

Pin Number	Signal name	Description	Connected to
1	VBAT		Battery Switch
2	VDD_REG_RF		Output of variable reg.
3	PROG	nRF24LU1 Prog	
4	RESET	nRF24LU1 Reset	
5	CSN	SPI CSN	
6	P0.1	GPIO	LED 2
7	P0.0	GPIO	LED 1
8	SCK	SPI SCK	
9	MISO	SPI MISO	
10	MOSI	SPI MOSI	
11	P0.2	GPIO	LED 3
12	Led 4	Not connected to the nRF24LU1	LED 4
13	J1 pin 8	Not used	
14	J1 pin 7	Not used	
15	J1 pin 6	Not used	
16	P0.5	GPIO	Button B3
17	P0.4	GPIO	Button B2
18	P0.3	GPIO	Button B1
19	J1 pin 11	Not used	
20	J1 pin 9	Not used	
21	SPARE 6	Not used	
22	J1 pin 18	Not used	Rotary switch
23	J1 pin 17	Not used	Rotary switch

Pin Number	Signal name	Description	Connected to
24	J1 pin 16	Not used	Rotary switch
25	J1 pin 15	Not used	Rotary switch
26	SPARE 5	Not used	
27	SPARE 4	Not used	
28	SPARE 3	Not used	
29	SPARE 2	Not used	
30	SPARE 1	Not used	

Table 3 - Pin out of the signal grid

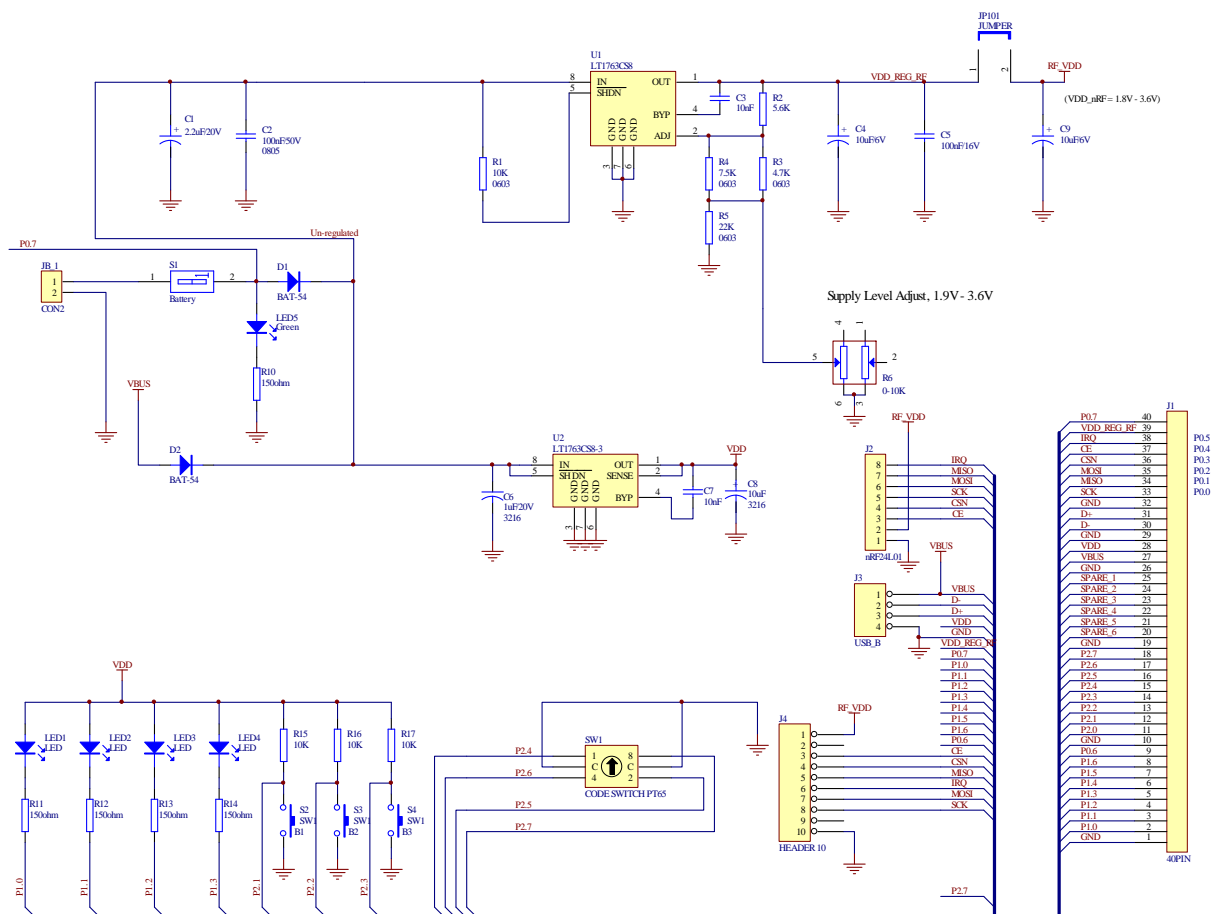


Figure 17 - Schematic of the nRF24LU1 Development Kit Basic Feature Board

### 11.3 PS/2 Adapter

The nRF24LU1 Development kit contains one PS/2 Adapter. These are simple level shifters and a DC-DC converter that enables a PS/2 Mouse or Keyboard to be connected to the nRF24LU1. The PS/2 Adapter connects to the “ISP Interface” connector on the BFB. This setup is intended to emulate a wireless mouse or keyboard using existing devices. The schematic and layout for the PS/2 Adapter is shown in *Figure 18* and *Figure 19*. The BOM is in *Table 5*.

The PS/2 is a bi-directional synchronous link, with one data line and one clock line. The power supply and the logic levels are 5v TTL. To interface this to the nRF24LU1, the PS/2 adapter is used.

The DC-DC converter is a MAX619 3v to 5v IC.

The level shifter is made by resistors and a transistor. Since it is difficult to use a level shifter in a bi-directional data line, the signal is split on the MCU side, so that the input and output are on two different IO's. *Table 4* shows the connection to the nRF24LU1.

PS/2 Signal name	nRF24LU1 Connection
Data in	P0.0
Data out	P0.1
Clock in	P0.3
Clock out	P0.2

*Table 4 - PS/2 connection*



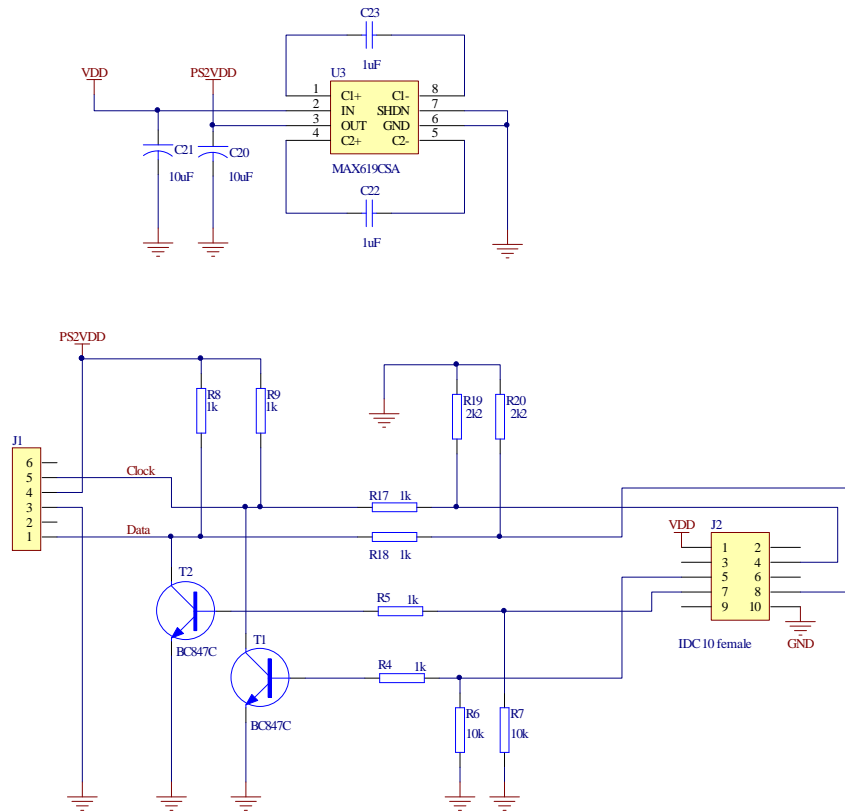
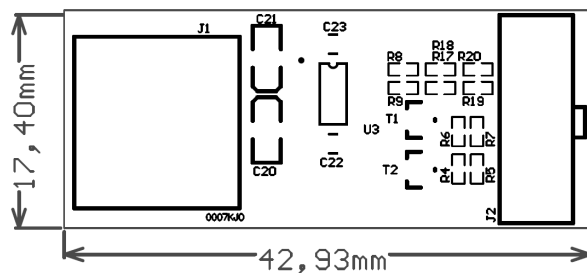


Figure 18 - Schematics of the PS/2 Adapter

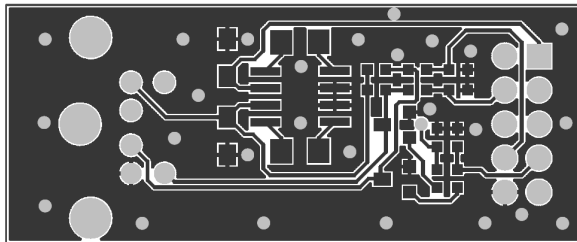
Designator	Value	Footprint	Comment
C20, C21	10uF	3216	10uF Tantal 10V
C22, C23	1uF	3216[1206]	1uF X5R, +/-10% 6.3V
J1	MiniDIN 6-pin	MiniDIN	
J2	IDC 10 female	HDR2x5	
R4, R5, R8, R9, R17, R18	1k	0603s	5%
R6, R7	10k	0603s	5%
R19, R20	2k2	0603s	5%
T1, T2	BC847C	SOT-23	BC847C
U3	MAX619CSA	SO8	MAX619
PCB	0007KJO		

Table 5 - PS/2 Adapter BOM

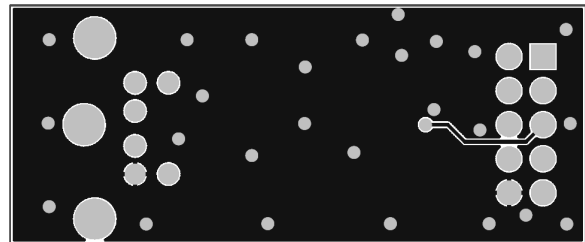


Top silkscreen

No components in bottom layer



Top signal layer



Bottom signal layer

Figure 19 - PS/2 Adapter layout

## 11.4 nRF24LU1 Radio Modules

This chapter describes the nRF24LU1 Radio Modules with the Nordic Semiconductor nRF24LU1 Embedded 2.4GHz Transceiver with USB.



Figure 20 - The nRF24LU1 Radio Module with PCB antenna



Figure 21 -The nRF24LU1 Radio Module with SMA connector

The Radio Modules for the nRF24LU1 Embedded 2.4GHz Transceiver with USB has been developed to enable customers to test functionality, run communication and verify the performance parameters of the device. The nRF24LU1 Radio Modules comes with the nRF24LU1 DEVKIT .The modules come in two versions; one with a SMA connector and one with a quarter wave PCB antenna. The module with SMA connector is developed to make it easy to do conducted measurements to test the performance of the radio. Except for the antenna, the modules have the same layout and same Bill of Material.

The nRF24LU1 Radio Modules are intended for evaluation and development purposes only.

## 11.5 nRF24LU1 Radio Module hardware description

Figure 22 to Figure 25 shows the nRF24LU1 Radio Modules circuit diagrams and PCB layouts. The BOM is given in Table 8.

The module has the nRF24LU1 and all necessary circuit to start using the nRF24LU1. It plugs into the 40 pin DIL connector of the Basic Feature Board (BFB). All I/Os are then available on the Basic Feature Board.

### 11.5.1 Debugger interface

To use the built in debugger of the nRF24LU1, a JTAG/FS2 interface, J2, is available on the module.

J2 pin	JTAG/FS4 name
1	TCK
2	GND
3	TDO
4	VDD
5	TMS
6	VDD
7	Trig out / P0.4
8	RESET
9	TDI
10	Not used

Table 6 - FS2 Debug Interface

### 11.5.2 Led drivers

LED 1-3 on the BFB is driven with LED drivers on the Radio Module

### 11.5.3 Power Supply Switch

The switch S1 can be used to switch the power supply between the battery pack on the BFB for stand alone use, or to VBUS from the USB connector.

### 11.5.4 Flash programming

The FLASH in the nRF24LU1 can be programmed from the "ISP Interface" connector on the BFB by using the ISP Dongle

Note: The JTAG connector on the Radio Modules is not pin compatible with the ISP Dongle from Nordic Semiconductor and can not be used to program the flash.

### 11.5.5 Antenna

For connection of a single ended antenna or to any 50Ω test equipment, the nRF24LU1 Radio Module with the SMA connector can be used.

The nRF24LU1 Radio Module PCB has an integrated PCB antenna for general testing.

Except from the PCB antenna and the SMA connector, the modules are identical. C14 on the nRF24LU1 Radio Module PCB is to match the antenna to the 50 ohm antenna interface and is not present on the SMA version of the module.

### 11.5.6 40 pin DIL connector

Pin number	Description
1	GND
2	LED1
3	LED2
4	LED3
5	LED4 – Not used
6	Not used
7	Not used
8	Not used
9	Not used
10	GND
11	Not used
12	P0.5
13	P0.4
14	P0.3
15	Not used
16	Not used
17	Not used
18	Not used
19	GND
20	Not used
21	Not used
22	Not used
23	Not used
24	Not used
25	Not used
26	GND
27	VBUS
28	VDD – Not used
29	GND
30	D+
31	D-
32	GND
33	P0.0 / SCK
34	P0.2 / MISO
35	P0.1 / MOSI
36	P0.3 / CSN
37	RESET
38	PROG
39	VDD Adjustable – Not used
40	VBAT

Table 7 - Pin out of the module connector

The nRF24LU1 Radio Module is manufactured on a 1.6mm thick, 2 layer FR4 substrate.

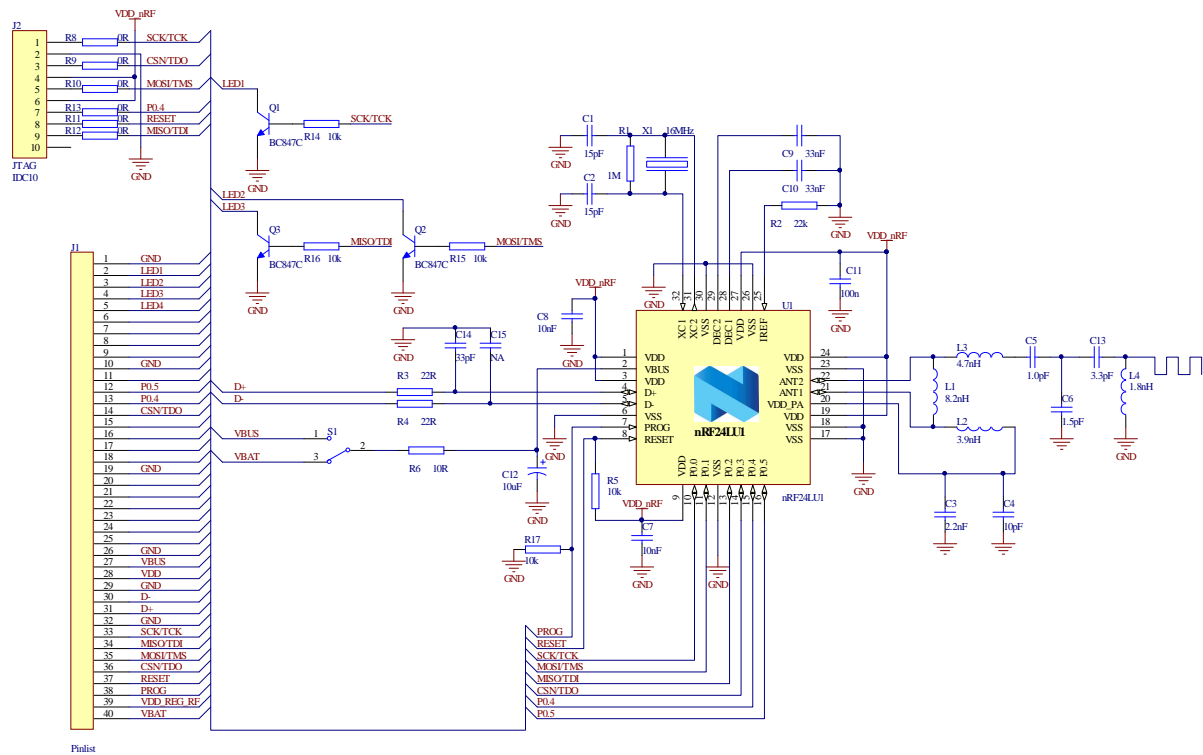
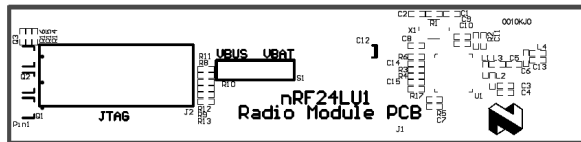
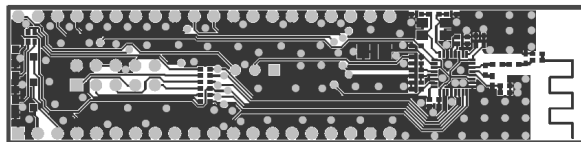


Figure 22 - Schematics of the nRF24LU1 Radio Module PCB

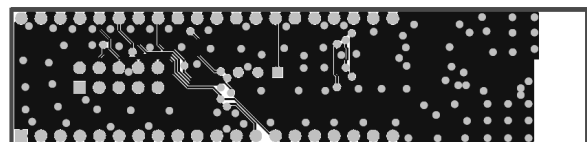


Top silkscreen

No components in bottom layer



Top signal layer



Bottom signal layer

Figure 23 - nRF24LU1 Radio Module PCB antenna PCB layout

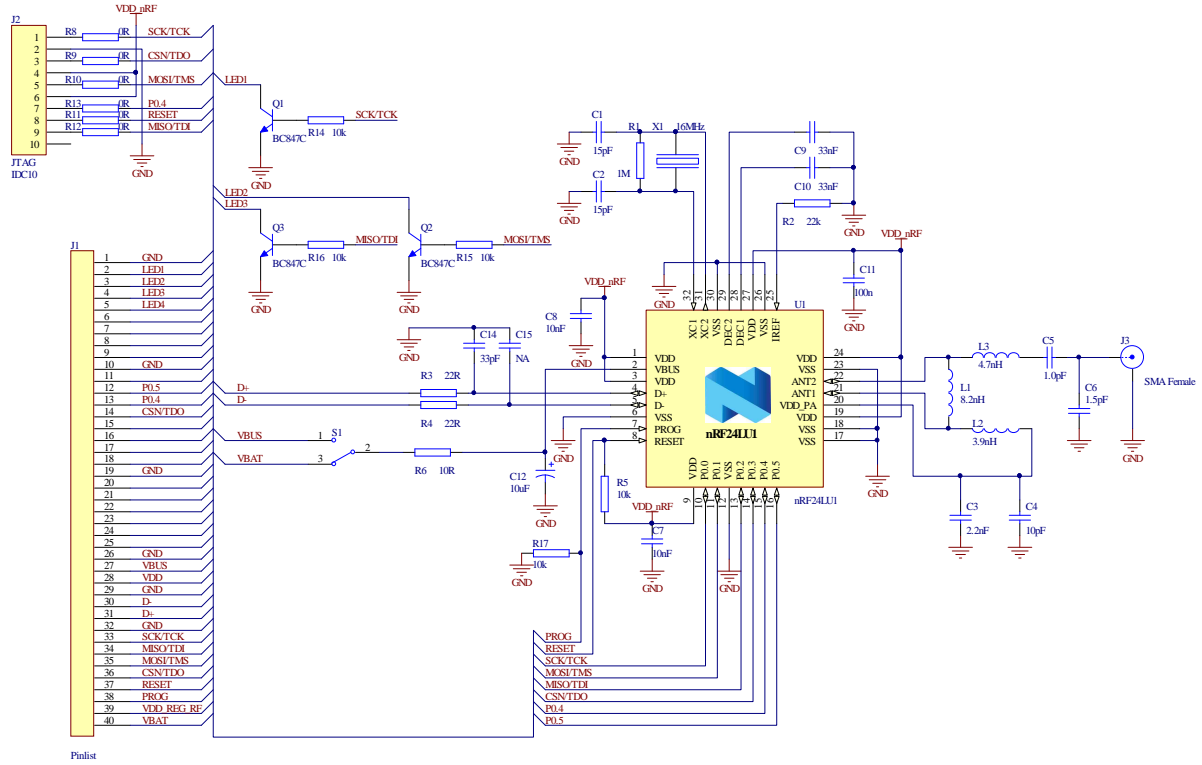
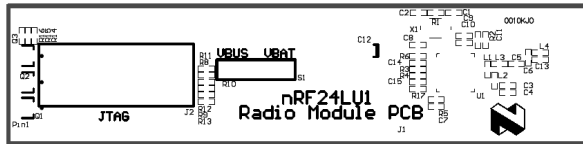
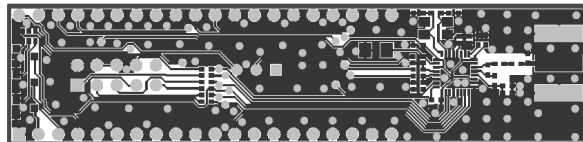


Figure 24 - Schematics of the nRF24LU1 Radio Module SMA

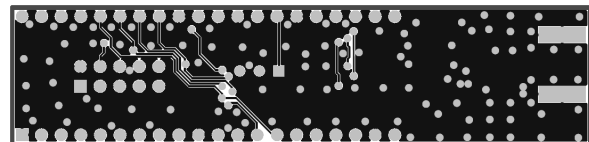


Top silkscreen

No components in bottom layer



Top signal layer



Bottom signal layer

Figure 25 - nRF24LU1 Radio Module SMA layout

Designator	Value	Comment
C1, C2	15pF	NPO, +/-2% 50V
C3	2.2nF	X7R, +/-10% 50V
C4, C13	4.7pF	NPO +/-0.25pF, 50V
C5	1.5pF	NPO +/-0.1pF, 50V
C6	1.0pF	NPO +/-0.1pF, 50V
C7, C8	10nF	X7R, +/-10% 50V
C9, C10	33nF	X7R, +/-10% 50V
C11	100n	X7R, +/-10% 50V
C12	10uF	Tantal 10V
C13	4.7pF	NPO +/-0.25pF, 50V. Only on PCB antenna version
C14	33pF	NPO, +/-2% 50V
C15	NA	
J1	Pinlist	
J2	IDC10	Header 2x5 pin
J3	SMA Female	Only on SMA version
L1	8.2nH	Chip inductor +/-5%. Murata LQP15-series
L2	2.7nH	Chip Inductor +/-5%. Murata LQP15-series
L3	3.9nH	Chip inductor +/-5%. Murata LQP15-series
Q1, Q2, Q3	BC847C	BC847C
R1	1M	5%
R2	22k	1%
R3, R4	22R	5%
R5, R14, R15, R16, R17	10k	5%
R6	10R	5%
R8, R9, R10, R11, R12, R13	0R	
S1	Switch	
U1	nRF24LU1	nRF24LU1
X1	16MHz	TSX-4025, CL=9pF, +/-10%. Se product specification for details.
PCB	0008KJO	nRF24LU1 Radio Module SMA
PCB	0009KJO	nRF24LU1 Radio Module PCB

Table 8 - nRF24LU1 Radio Module Bill of material, common to both versions, except where noted