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# Introduction

This document contains instructions on how to program Nordic nRF51 SoC based custom boards with the bootloader, BLE soft device and the application firmware. Two approaches are documented here:

1. Exclusively using a PC only. Suitable for factory programming.
2. Using a combination of a PC and a mobile phone.

Exclusively using a PC involves creating a bootloader version hex file, using the *nrfutil* utility program, creating a combined bootloader, soft device, application f/w and bootloader version hex file, using the *mergehex* utility program, and using the *nrfjprog* device programming utility.

Using a combination of a PC and a mobile phone involves using *mergehex* utility program to combine the bootloader and the BLE soft device in a single hex file, using the *nrfjprog* device programming utility to program the custom board with the bootloader and the soft Device, and finally, using the *nRF Connect* mobile app to program the device with the application firmware. The custom board is required to have the nRF51 SoC’s SWD data and clock pins accessible.

# Hardware Setup

The following hardware items are needed:

1. 3V3 power supply.
2. Segger J-Link in-circuit programmer/debugger.
3. iOS or Android device.

The wiring diagram below shows how to connect together a power supply, the nRF51 custom board, and the J-Link in-circuit programmer.

A diagram of a computer

Description automatically generated

# Software Setup

## NRFUTIL Installation

Follow the steps below to install the nrfutil.exe tool on an MS Windows PC:

1. Go to <https://www.nordicsemi.com/Products/Development-tools/nrf-util>
2. Download the nrfutil.exe for Windows (x64).
3. Create the folder NRF51 in your Documents folder and copy the file to the NRF51 folder.

## NRF MERGEHEX & NRFJPROG Installation

Follow the steps below to install the mergehex.exe tool on an MS Windows PC:

1. Go to [*https://www.nordicsemi.com/Products/Development-tools/nrf-command-line-tools/download*](https://www.nordicsemi.com/Products/Development-tools/nrf-command-line-tools/download)
2. Download the latest version of the *nRF-Command-Line-Tools*.
3. and launch it.
4. Select installation of nrfjprog and mergehex from the installation option list.
5. The nrfjprog.exe tool will be installed in the *C:\Program Files\Nordic Semiconductor\nrf-command-line-tools\bin folder* and can only be run from this folder.
6. Copy the mergehex.exe utility to the NRF51 folder in your Documents folder.

## NRF CONNECT Mobile App Installation

Follow the steps here below to install the nRF Connect iOS or Android mobile app:

1. Search for the nRF Connect app in the Apple App Store or the Google Play Store.
2. Install it.

# Script Creation

## Exclusive PC Use Script Creation

Two scripts are required for this use case. The first script will combine the Follow the steps here below for this use case:

1. Open a new file in NotePad++
2. Copy the following 4 lines into NotePad++:

*nrfutil.exe settings generate --family NRF52 --application ble\_app\_buttonless\_dfu\_pca10040\_s132.hex --application-version 23080702 --bootloader-version 1 --bl-settings-version 1 settings.hex*

*C:\Program Files\Nordic Semiconductor"\nrf-command-line-tools\bin\mergehex --merge s132\_nrf52\_6.1.1\_softdevice.hex secure\_bootloader\_ble\_s132\_pca10040.hex ble\_app\_buttonless\_dfu\_pca10040\_s132.hex settings.hex -o all.hex*

*C:\Program Files\Nordic Semiconductor"\nrf-command-line-tools\bin\nrfjprog --family nRF52 --eraseall*

*C:\Program Files\Nordic Semiconductor"\nrf-command-line-tools\bin\nrfjprog --family nrf52 --program all.hex --verify –reset*

1. Save the file as NRF51*/nRF51-programming.bat*.

The first line will create the bootloader version page. The items highlighted in yellow can be chosen somewhat arbitrary. The application version in blue highlight should be set to the same version as recorded in the version.h file in the application f/w source code.

**References:**

1. Creating a bootloader settings file: <https://infocenter.nordicsemi.com/index.jsp?topic=%2Fug_nrfutil%2FUG%2Fnrfutil%2Fnrfutil_settings_generate_display.html>
2. Merging hex files with mergehex: <https://infocenter.nordicsemi.com/index.jsp?topic=%2Fug_nrf_cltools%2FUG%2Fcltools%2Fnrf_command_line_tools_lpage.html>
3. Programming Nordic Semi SoCs with nrfjprog: <https://infocenter.nordicsemi.com/index.jsp?topic=%2Fug_nrf_cltools%2FUG%2Fcltools%2Fnrf_command_line_tools_lpage.html>

## PC and Mobile Device Use Script Creation

### Bootloader & Soft Device Hex File Merge Script

Follow the steps here below:

1. Open a new file in NotePad++
2. Copy the following two lines into NotePad++:

*"C:\Program Files\Nordic Semiconductor"\nrf-command-line-tools\bin\nrfjprog --family nRF52 --eraseall*

*"C:\Program Files\Nordic Semiconductor"\nrf-command-line-tools\bin\nrfjprog --family nrf52 --program blsd.hex --verify --reset*

1. Save the file as NRF51*/nRF51-blsd.bat*.

### OTA Package Generation Script

Follow the steps here below:

1. Open a new file in NotePad++
2. Copy the following line into NotePad++:

*nrfutil pkg generate --application ble\_app\_buttonless\_dfu\_pca10040\_s132.hex --application-version 2 --application-version-string "1.0.1" --hw-version 52 --sd-req 0xB7 --key-file private.key package.zip*

1. Save the file as NRF51*/nrfgenpkg.bat*.

**Notes:**

1. The item in green highlight is optional and only included to illustrate use of a string for the application version instead of a number.
2. The items in yellow highlight are arbitrarily chosen.
3. The items in blue highlight are to be stated as indicated. The *private.key* file can be generated following the instructions at <https://infocenter.nordicsemi.com/index.jsp?topic=%2Fug_nrfutil%2FUG%2Fnrfutil%2Fnrfutil_keys_generate_display.html>.

# Device Programming

## Exclusive PC Use Custom Board Programming

Follow the steps below:

1. Copy the required *ble\_app\_buttonless\_dfu\_pca10040\_s132.hex* application f/w file, the *secure\_bootloader\_ble\_s132\_pca10040.hex* secure bootloader file and the *s132\_nrf52\_6.1.1\_softdevice.hex* soft device file to the NRF51 folder.
2. Open a command line window.
3. Change folder to *Documents/NRF51*.
4. Run *nRF51-programming.bat* from the command line. The following printout should show up in the command line window:

A black background with white text

Description automatically generated

The device is now fully programmed with the bootloader, soft device, and application f/w, and ready to be used with your mobile app.

**References:**

1. The secure bootloader can be found in *\nRF5\_SDK\_15.3.0\_59ac345\examples\dfu\secure\_bootloader\pca10040\_ble\ses\Output\Release\Exe\secure\_bootloader\_ble\_s132\_pca10040.hex*
2. The BLE soft device can be found in *\nRF5\_SDK\_15.3.0\_59ac345\components\softdevice\s132\hex\s132\_nrf52\_6.1.1\_softdevice.hex*

## PC and Mobile Device Combo Custom Board Programming

### The PC Part: Device Bootloader and Soft Device Programming

Follow the steps below:

1. Copy the required blsd.hex file to the NRF51 folder.
2. Open a command line window.
3. Change folder to *Documents/NRF51*.
4. Run *nRF51-blsd.bat* from the command line. The following printout should show up in the command line window:

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### The Mobile Device Part: Device OTA Programming

Follow the steps below to program the device with the application f/w over OTA via BLE

1. Copy the application *package.zip* file to a folder on the mobile device where you can access it via the nRF Connect app. In the case of iOS that would be your iCloud Drive, accessible from your PC as well as your iPhone.
2. Connect the J-LINK in-circuit programmer to a USB port on the PC and to the SWD pins on the board. Make sure the connections between the J-Link programmer and the SWD pins are as indicated here above.
3. Turn on the 3.0V ±0.3V power supply to the device.
4. Launch the nRF Connect app.
5. Search for the name of your custom board in the list of detected BLE devices.
6. Select Connect for your custom board.
7. Choose the file package.zip from the iCloud Drive folder where it was stored and initiate the programming.
8. Once finished, close the nRF Connect app, shut off the power to the PCB and remove the PCB from the programming probe.

--- And That’s All Folks ---