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NFC-Bluetooth Low Energy Quickstart Guide Rev. 1.1 — 12 December 2018

User manual COMPANY PUBLIC

Document information

Information	Content	
Keywords	NFC, Bluetooth Low Energy, QN9020, CLRC663	
Abstract	This document describes QN9020 Mini Development board in combination with the NFC CLRC663 plus Add-on board. Bluetooth Low Energy solution.	



NFC-Bluetooth Low Energy Quickstart Guide

Revision history

Rev	Date	Description
1.1	20181212	Section "Smartphone Applications" updated Editorial updates
1.0	20180410	Initial version

NFC-Bluetooth Low Energy Quickstart Guide

1 Introduction

The purpose of this document is to describe how to use NFC-Bluetooth® Low Energy development kit. It provides an easy way to evaluate NFC features in the combination with Bluetooth Low Energy.

The NFC-Bluetooth Low Energy package consists of two HW Boards boards, QN9020 Mini Development board and NFC RC663 Plus Add-on board. Both boards and software applications, used for demonstration, are described in next chapters.

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2 Hardware Description

2.1 Introduction

This chapter describes hardware parts of the NFC-Bluetooth Low Energy development kit.

2.1.1 Kit Contents

The NFC-Bluetooth Low Energy development kit includes the following:

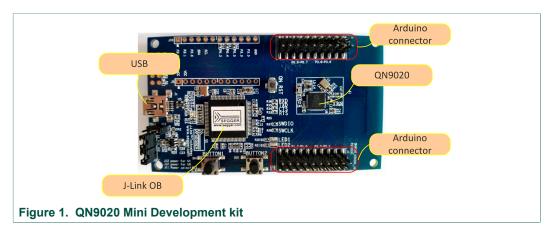
- QN9020 Mini Development kit
- CLRC663 plus Add-on board

2.2 QN9020 Mini Development kit

The QN9020DK board is designed to make it as easy as possible to get started with your project based on NXP® QN9020 Bluetooth Low Energy SOC.

The QN9020 Mini development board provides easy access to peripherals such as buttons, piezo buzzer and LED. The board also provides useful interfaces such as a USB port for UART communication and J-Link debug, and a GPIO/optional sensor board connector.

This document describes how to use it in combination with NFC. The figure below shows the board and main components.



2.2.1 Additional Resources

Detailed description of the board can be found on:

- QN9020DK product webpage: https://www.nxp.com/products/:QN9020DK
- UM10895 QN9020 mini DK user guide: https://www.nxp.com/docs/en/user-guide/ UM10895.pdf

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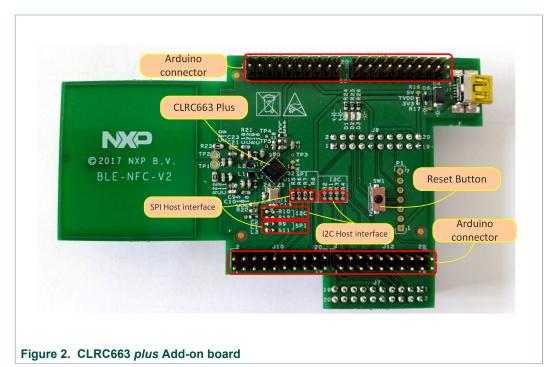
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2.3 CLRC663 plus Add-on board

CLRC663 *plus* Add-on board provides full NFC functionality and it is designed to be used with QN9020 development board.

NFC frontend is represented with the CLRC663 multi-protocol NFC frontend IC.

Figure below shows the board and main components.



Interface selection

2.3.1

RC663 Plus Add-on board provides SPI and I2C host interface connections. The table below shows a right configuration for each interface.

Host Interface Selection

Resistors	SPI	I2C
R1	open	0 Ohm (closed)
R2	open	0 Ohm (closed)
R3	open	0 Ohm (closed)
R4	open	0 Ohm (closed)
R5	0 Ohm (closed)	open
R6	0 Ohm (closed)	open
R7	0 Ohm (closed)	open
R8	0 Ohm (closed)	open
R9	0 Ohm (closed)	open
R10	open	0 Ohm (closed)

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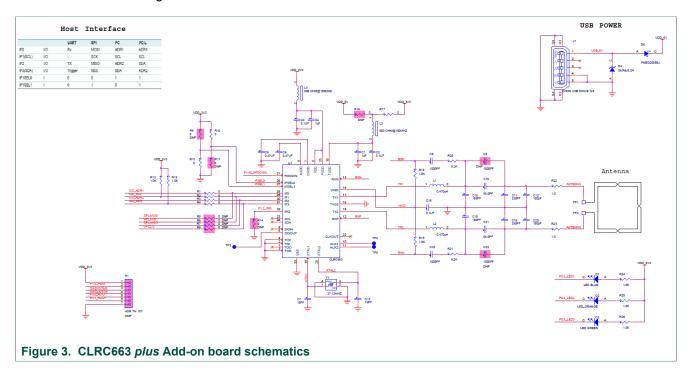
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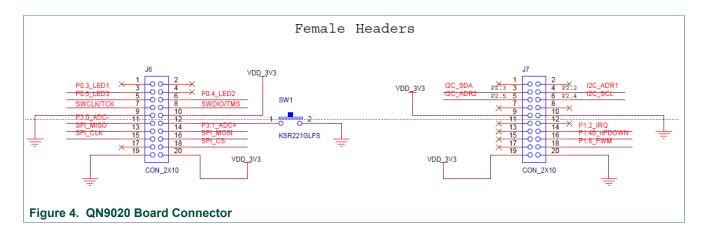
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Resistors	SPI	I2C
R11	0 Ohm (closed)	open
R12	open	0 Ohm (closed)

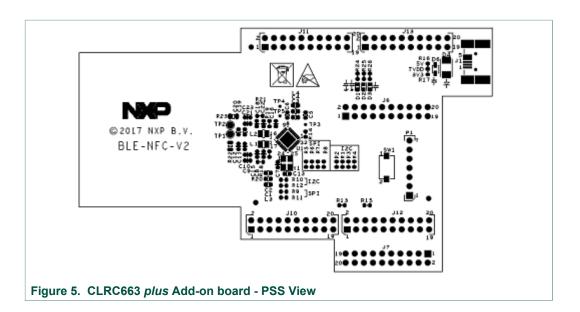
2.3.2 Schematics

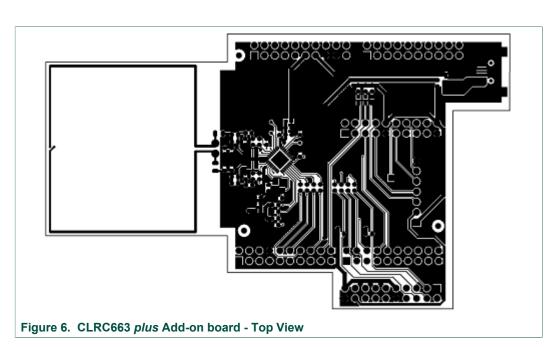
The complete schematics of the CLRC663 *plus* Add-on board are shown in following figures:



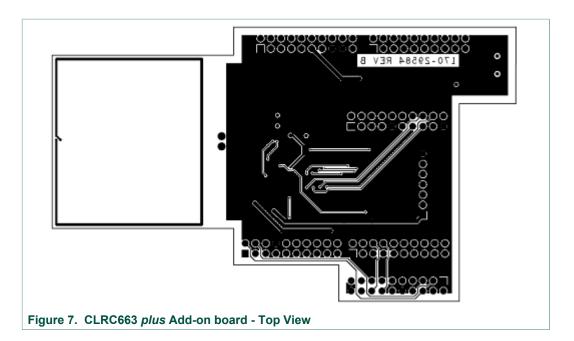


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2.3.3 Additional Resources

Detailed description of the CLRC663 plus can be found on:

• CLRC663 plus product webpage: https://www.nxp.com/products/:CLRC66303HN

2.4 NFC-Bluetooth Low Energy Development kit

NFC-Bluetooth Low Energy Development kit consists of QN9020 Mini development board and CLRC663 *plus* Add-on board.

Figure below shows how to assemble it in right way.

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Figure 8. NFC-Bluetooth Low Energy Development board

Note:

USB mini cable is used to power up the board and to flash new FW.

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3 Software Description

3.1 Introduction

This chapter describes software setup and how to run the NFC-Bluetooth Low Energy demo application.

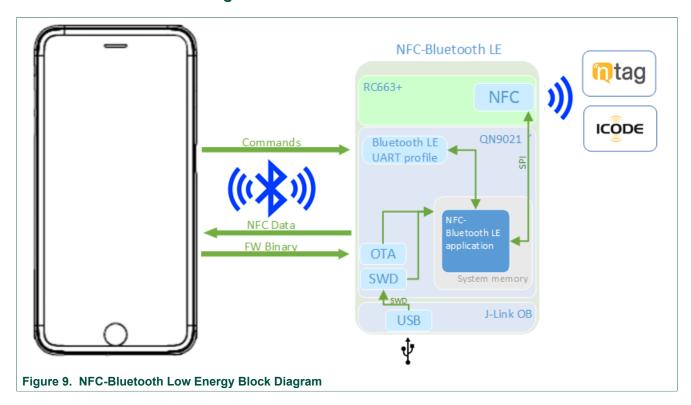
The purpose of the demo application is to manage data on the NFC tag through the application running on a mobile device. The user select read or write command on the device, which is sent to the NFC-Bluetooth Low Energy device via Bluetooth Low Energy. When NFC-Bluetooth Low Energy device receives the command, it executes it and sends the results back to the phone.

The demo also supports Over-The-Air (OTA) programming.

Software stack used in this demo is prepared for the NFC-Bluetooth Low Energy development kit and smartphone. Demo application is split in two, the first application is required for the NFC-Bluetooth Low Energy development kit and the second application for the smartphone. The current version of the demo is supporting only iPhone.

Software stacks are custom developed for this solution to fit special requirements.

3.2 Block Diagram



3.3 QN9020 Software Project

This section describes how to manage software stack on the QN9020 board.

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The application running on the QN9020 is responsible for:

- · managing data through the NFC interface
- advertising and establishing Bluetooth Low Energy connection with the smartphone
- · executing commands received from the smartphone via Bluetooth Low Energy
- · responding results back to the smartphone
- · supporting OTA programming

3.3.1 Flash FW to enable OTA

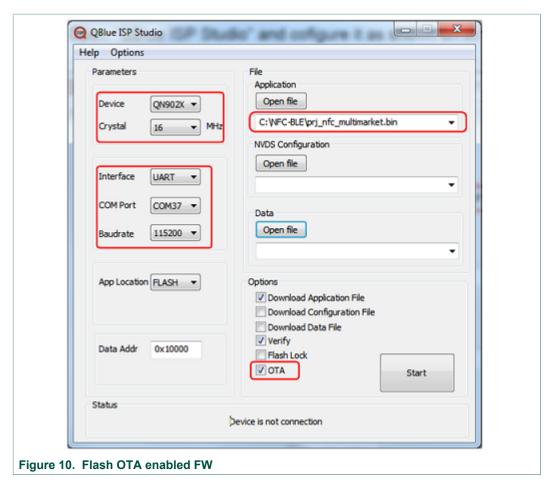
First step to set up the board is to flash FW which enables Over-The-Air programming (OTA). OTA is used to upgrade the firmware of QN9020 over the air. More details about the OTA can be found in the "UM10994 - OTA Programming Guide".

In order to flash OTA supporting program, it is necessary to install QBlue studio first, which supports binary download to QN9020 over the USB. QBlue studio can be downloaded from QN9020 Mini Development Kit (Mini DK)

Follow steps described below to flash FW.

- Open "QBlue ISP Studio"
- Connect QN9020 Mini DK board and PC with USB Mini cable, as shown in Figure
- · Select device and clock
- Select proper interface
- Browse to the "prj_nfc_multimarket.bin" binary
- Check OTA option (important to be selected)
- Click "Start" button to flash FW

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Note:

"prj_nfc_multimarket.bin" binary is provided with the NFC-Bluetooth Low Energy support package.

After that, Bluetooth Low Energy-NFC device is ready to be used. Next step is to open application on the smartphone and flash the appropriate FW using OTA functionality.

Chapters below describes how to flash prepared FW binaries and how to generate FW binaries from the provided source code.

3.3.2 Prepared FW Binaries

NFC-Bluetooth Low Energy development kit is delivered with a prepared SW binary for QN9020. It can be flashed with "QBlue ISP Studio" tool as described in the previous chapter. Binaries are available in "FW_OTA_Bin_20170816.zip" file.

Application descriptions:

- ISO14443/prj nfc multimarket.bin: implements support for nTag cards.
- ISO15693/prj nfc multimarket.bin: implements support for iCode cards.

All prepared binaries support OTA.

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3.3.3 Source Code of the QN9020 project

The source code of the NFC-Bluetooth Low Energy application is provided as a zip file and implements the complete functionality of the NFC-Bluetooth Low Energy application. The application project is prepared for Keil toolchain.

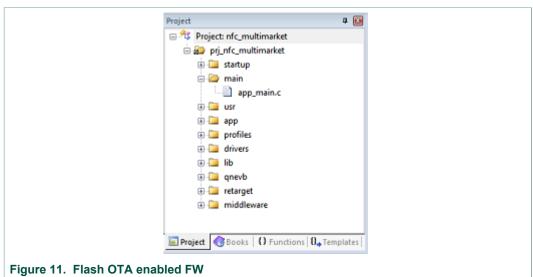
Keil MDK is software development environment for a wide range of Arm Cortex-M-based microcontroller devices. MDK includes the μ Vision IDE, debugger, Arm C/C++ compiler, and essential middleware components. More details about it and license constraints are described on Keil webpage and are not part of this document.

Importing provided SW projects

Application source code is available in "MultiMarket Keil Package 20170912.zip" file.

Follow the sequence described below to import software projects:

- Extract "MultiMarket Keil Package 20170912.zip" file to an empty folder
- Start the Keil µVision IDE
- · Open application project
 - Click on "File/Open" icon
 - Browse to the application project. Path
 "MultiMarket_Keil_Package_20130912\prj_nfc_multimarket\keil\nfc_multimarket.uvproj"
 - Application opens as shown in figure below
- · The software package is ready for use



Build the project

- · Select project in the "Project" window
- Right click on the project and select "Build target" option

Download application

- Select project in the "Project" window
- Click on "Download" icon or click F8 button

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4 Smartphone Applications

4.1 Introduction

This chapter describes the installation process and functionality of the iOS and Android applications running on the smartphone.

The main purpose of the application is to flash the NFC-Bluetooth® Low Energy firmware using OTA and managing data on the NFC tag through the Bluetooth Low Energy connection.

Note:

iOS requirement: iOS 10.0 or later, Bluetooth. Android: Android 6.0+, Bluetooth, Location.

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4.2 iOS Application

4.2.1 Installation

Follow guidelines described below to import software projects:

- · Open iOS Safari application
- Browse to https://fir.im/19mf and install the application from the webpage
- After installation, follow the steps to allow the application to run on the phone

Note:

iOS requirement: iOS 10.0 or later, Bluetooth.

4.2.2 Application Tabs

The application has 3 main tabs: "Reader & Tag", "Detection" and "R/W" (Read/Write).



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4.2.3 Reader and Tag

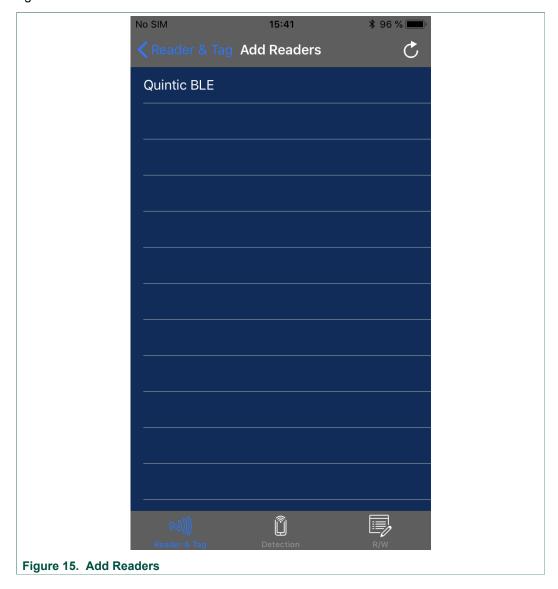
This page displays information about the connected reader. At the top left there is an info button, to navigate to the Info page of the application. At the top right is a refresh button, to recheck the connection status and with the "+" button you get to the "Add Readers". You can change the Firmware of the reader, with the three buttons "NTAG", "ICODE" and "ICODE ILT" (32 MHz).



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4.2.4 Add Readers

This page displays Bluetooth devices that are nearby, select one to connect to it. You get a message and will return to the Reader & Tag tab. Tapping the refresh button in the top right will rescan devices.



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4.2.5 Info Tab

Here you can access:

About

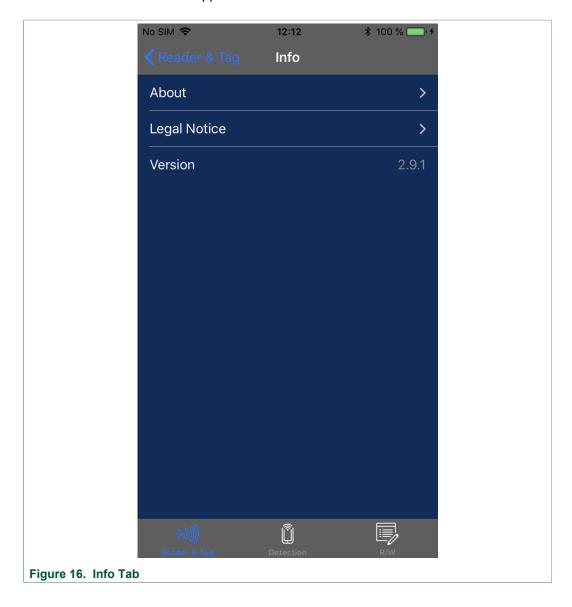
Information about the app.

Legal Notice

License agreement and notices for libraries and other resources used.

Version

The version number of the application.



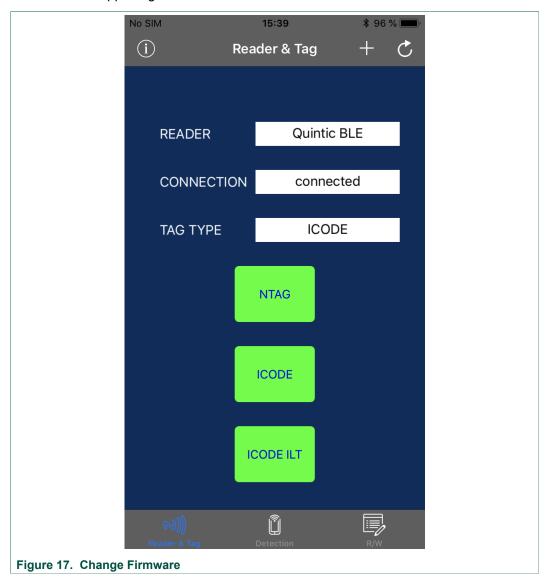
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4.2.6 Change Firmware

NTAG - Supporting 21x product family

ICODE - Supporting ICODE SLIX and SLIX 2 products

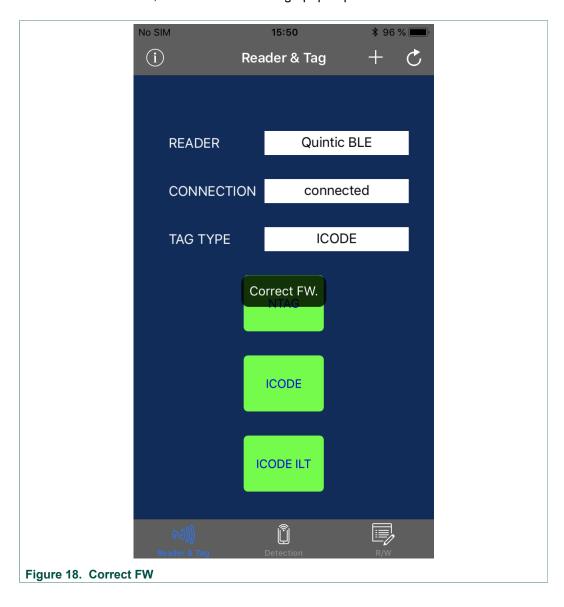
ICODE ILT – Supporting ICODE ILT



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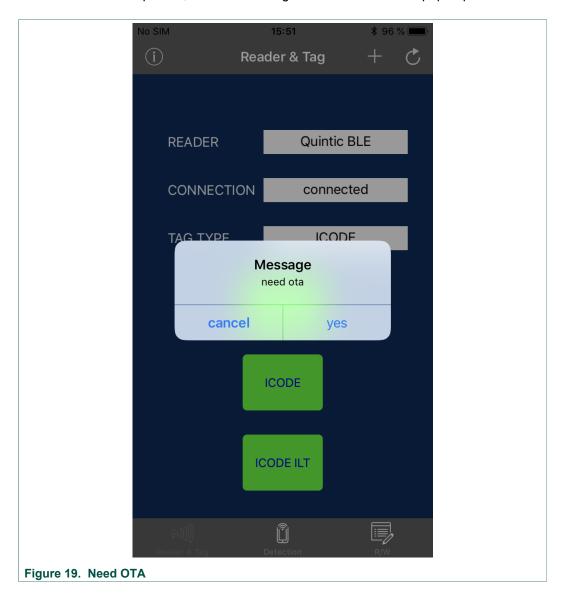
When pressing the NTAG, ICODE or ICODE ILT buttons, the App checks if the correct FW is loaded in the Bluetooth Low Energy IC.

If correct FW is loaded, "Correct FW." message pops-up.



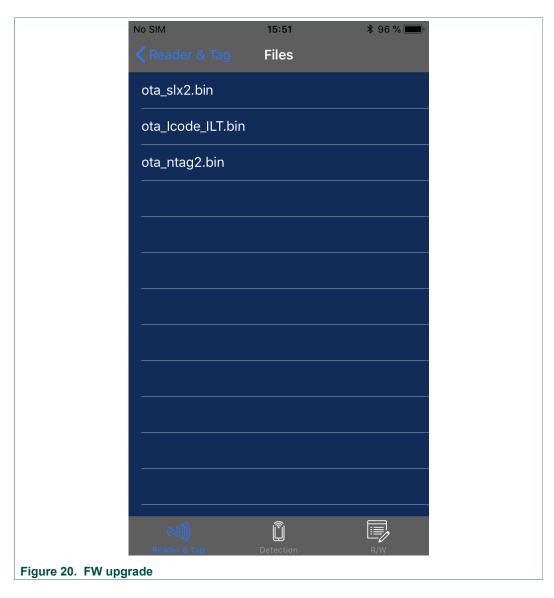
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If the FW needs an updated, then the message "need OTA" window pops-up.



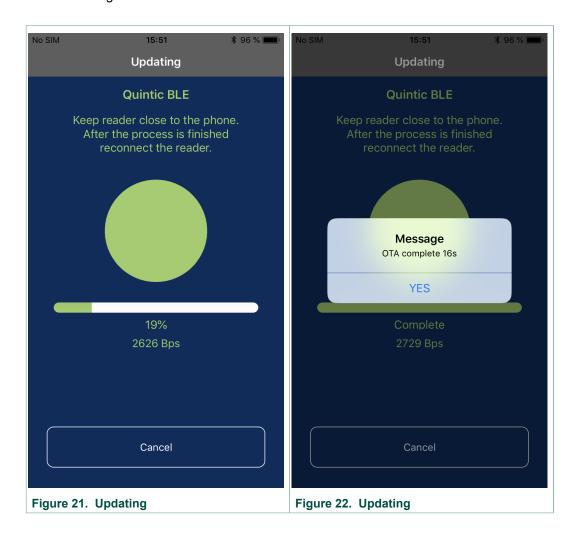
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By pressing YES, you have the option to select the file for the FW upgrade: ota_slx2.bin for ICODE ota_lcode_ILT.bin for ICODE ILT ota_ntag2.bin for NTAG



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FW upgrade starts by selecting the file. When the update is finished a message with the execution time of the update appears. After pressing "yes", you will get back to the "Reader & Tag" tab.

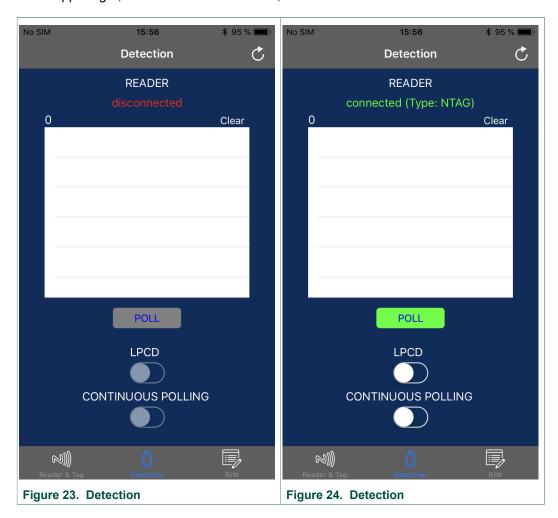


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4.2.7 Detection

After connecting to a reader with correct FW, detection tab can be used.

In the upper right, there is the refresh button, to check the connection to the reader.

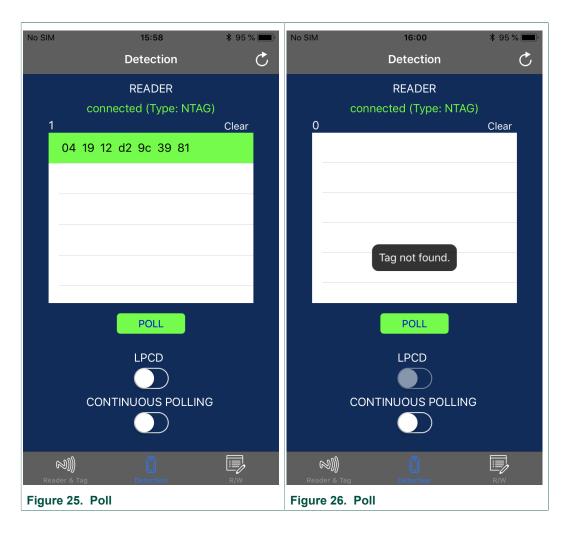


For NTAG and ICODE there are three different detection modes (poll, LPCD and continuous polling) and a different looking tab for ICODE ILT detection.

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4.2.7.1 Poll - NTAG & ICODE

Scans for tags present on the reader at that time. Adds the Tag to the table or displays the message "Tag not found".

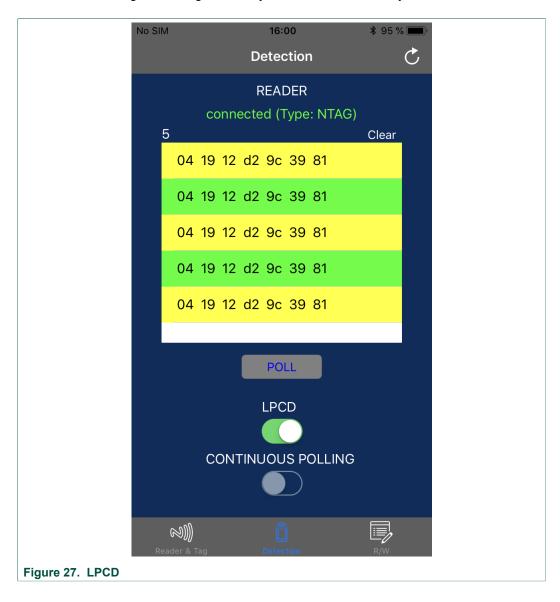


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4.2.7.2 LPCD - NTAG & ICODE

Enables Low-Power Card Detection mode and detects the Tag when it approached the reader antenna. After the tag has been read, it disables and reenables the LPCD mode after a short delay.

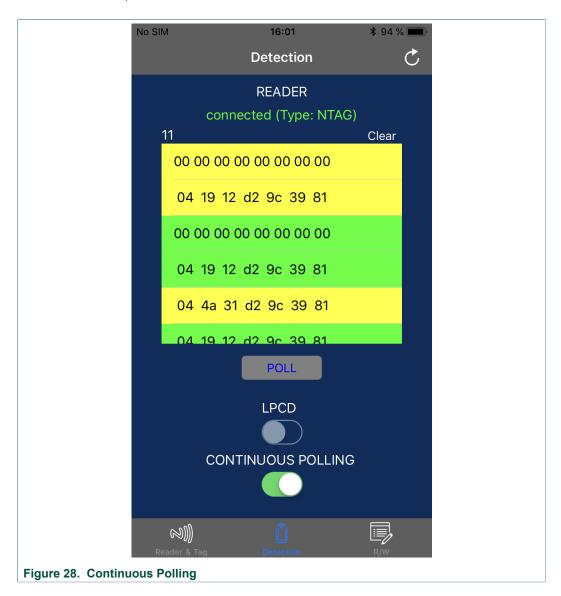
The Color is altering between green and yellow to indicate activity.



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4.2.7.3 Continuous Polling - NTAG & ICODE

Continuously checks for presence of a tag on the reader, if a tag is found the tag is added to the table, else the "00 00 00 00 00 00 00 00" row is added.

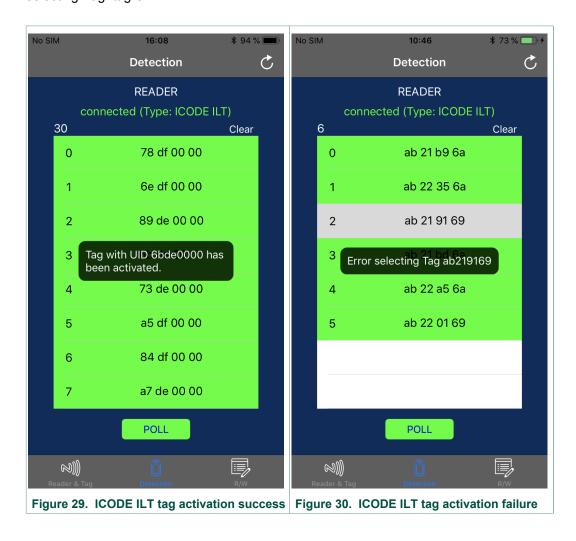


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4.2.7.4 ICODE ILT

The detection tab for ICODE ILT is represented with a bigger table and a poll button. Upon pressing the poll button, all the ICODE ILT tags present on the reader are detected and added to the table.

Upon successful detection, any tag entry in the table can be tapped to be activated for reading/writing. If the activation was successful, the message "Tag with UID /tag UID/ has been activated." Or if the activation failed (e.g. the tag is not present anymore) "Error selecting Tag /tag UID/".



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4.2.8 R/W

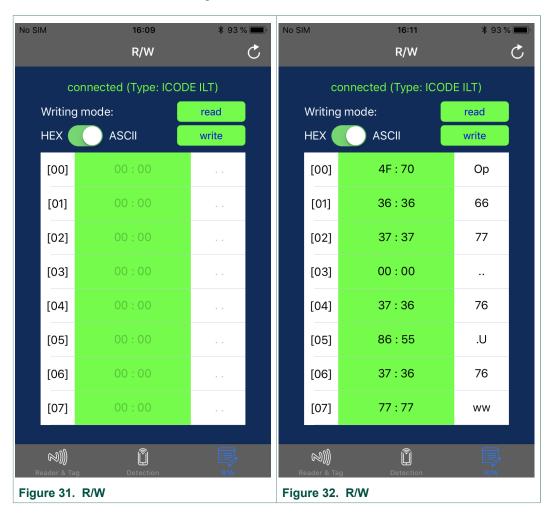
This tab is used to read and write the Tag content. Data is read into the table. First column represents the number of the page, the second the data in HEX format and the third data as ASCII characters. You can edit the data by pressing the cell. You can switch between writing HEX or ASCII input.

READ - It reads the Tag memory (ICODE ILT tags need to be activated first on the detection tab).

WRITE - It writes the content present in the table to the tag memory.

Note: NTAG reads 16 pages - 4 bytes each page and writes 12 (first 4 pages cannot be written to). ICODE reads and writes whole tag - 4 bytes each page. ICODE ILT reads and writes 32 pages - 2 bytes each page.

ASCII/HEX – Switches the writing mode.

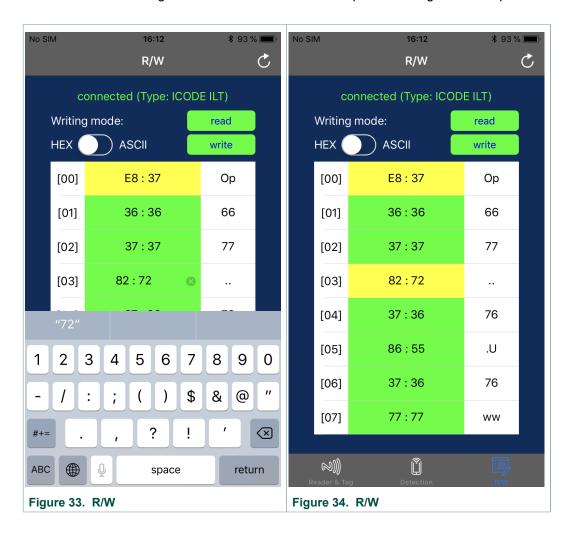


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When finished with the editing of a field you can continue with further editing of another field. Before writing the edited data to the tag **press return on the keyboard to save the edited input**. If the data in a field was changed the color changes to yellow.

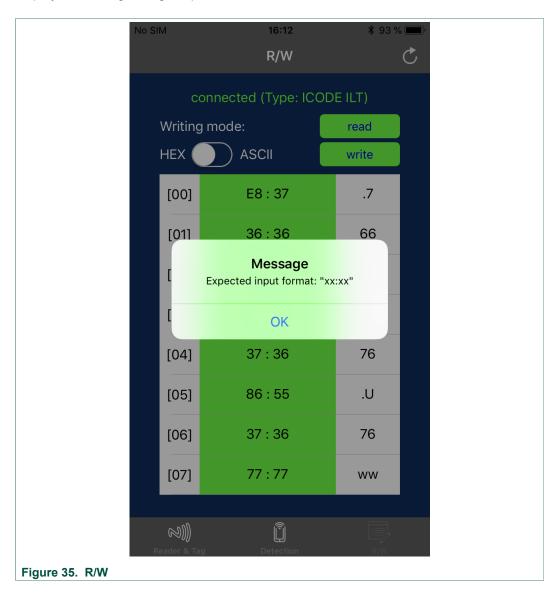
When editing data in HEX mode, you can only input HEX characters, other input is disabled.

The "x" button on the right side of the fields resets the input to the original read input.



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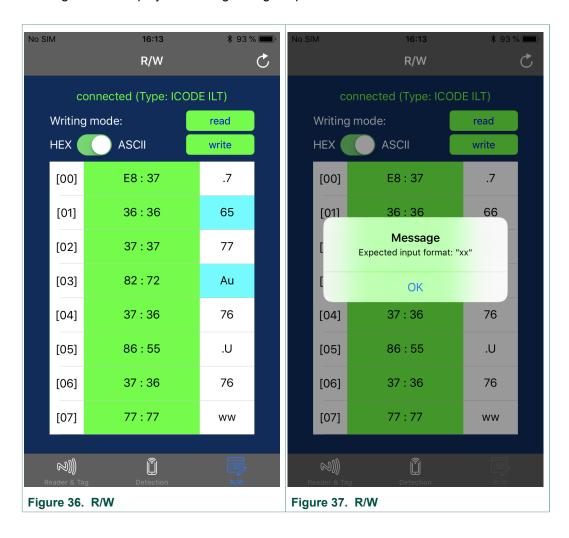
If input is shorter than 4/2 bytes (NTAG & ICODE / ICODE ILT), an error message will be displayed showing the right input format.



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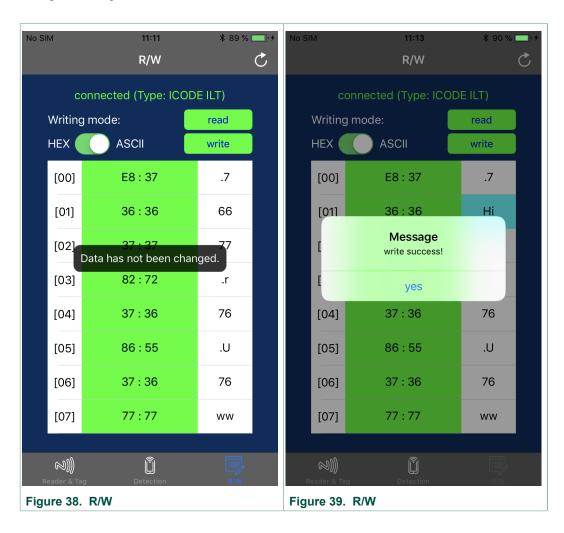
When switching to the ASCII mode, you can edit the 3^{rd} column. If the data was changed the color of the field changes to cyan.

If you enter something else than 4/2 (NTAG & ICODE / ICODE ILT) characters, an error message will be displayed showing the right input format.



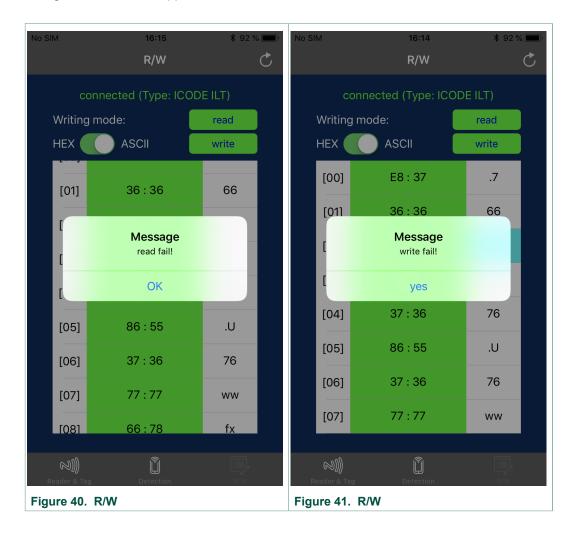
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After pressing write, you will either get an "Data has not been changed" message or a dialog indicating a successful write.



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If the tag was removed, or another unexpected error occurred, while reading/writing the dialog, "read/write fail" appears.



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4.3 Android Application

4.3.1 Installation

Follow the guidelines described below:

- Download the NXP AppCatalog .apk file from the link below http://repo.relution.io/apps/android/latest/Relution-nxp-release.apk
- Install the NXP AppCatalog application and open it.
- Search for the NFC Bluetooth® LE Multicustomer application in the Apps tab and click Install.

Note:

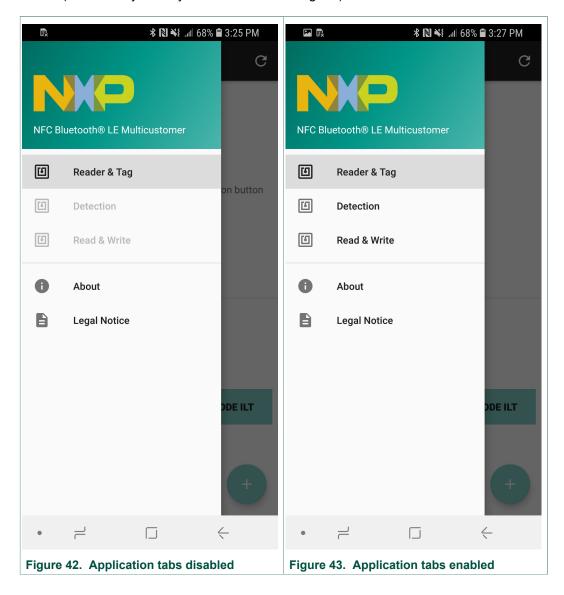
Android: Android 6.0+, Bluetooth, Location.

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4.3.2 Application Tabs

The app has 3 main destinations: Reader & Tag, Detection and Read & Write; and 2 additional destinations: About and Legal Notice.

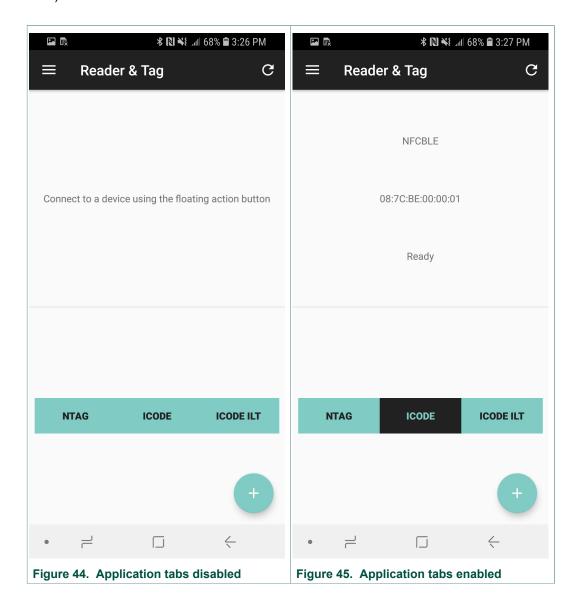
Detection and Read & Write are enabled only if the phone is connected to a suitable reader (indicated by "Ready" on the Reader & Tag tab).



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4.3.3 Reader and Tag

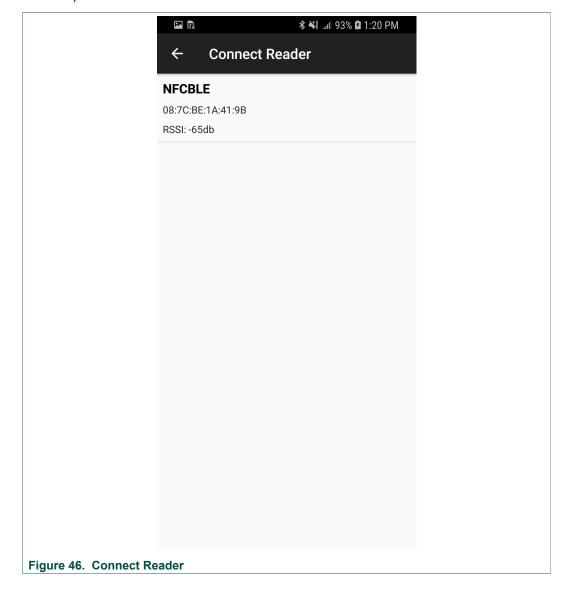
This page displays information about the connected reader. At the top left there is a menu button, to open the navigation drawer of the application. At the top right, there is a refresh button, to recheck the connection status. With the floating action button ("+") in the right bottom corner, you get to the "Connect Reader". You can also change the Firmware of the reader, with the three buttons "NTAG", "ICODE" and "ICODE ILT" (32 MHz).



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4.3.4 Connect Reader

This page displays nearby Bluetooth Low Energy devices with the suiting UUID. To connect to a device, select the device from the list, you will get a message and will return to the Reader & Tag tab. Pulling from the top will rescan devices (Scan active for 10 seconds).



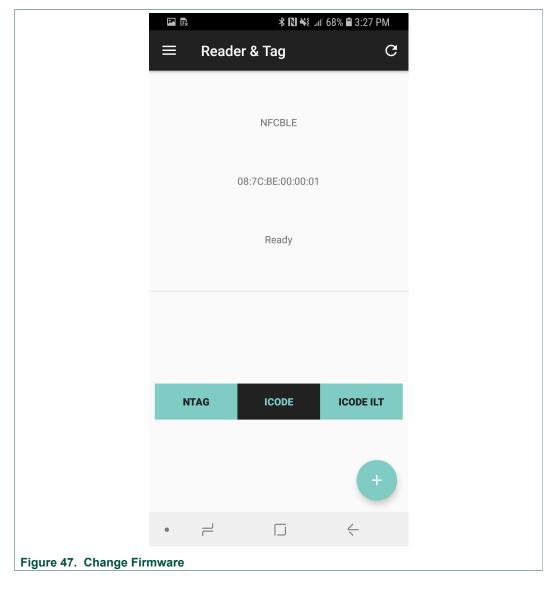
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4.3.5 Change Firmware

NTAG - Supporting 21x product family

ICODE - Supporting ICODE SLIX and SLIX 2 products

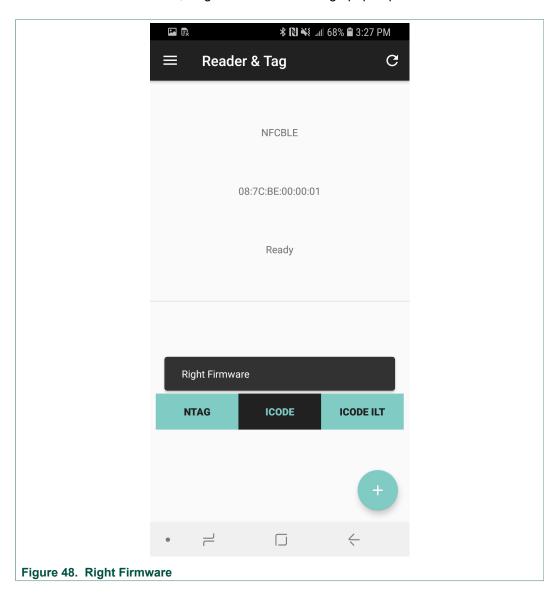
ICODE ILT – Supporting ICODE ILT



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When pressing the NTAG, ICODE or ICODE ILT buttons, the App checks if the correct FW is loaded in the Bluetooth Low Energy IC.

If correct firmware is loaded, "Right Firmware" message pops-up.

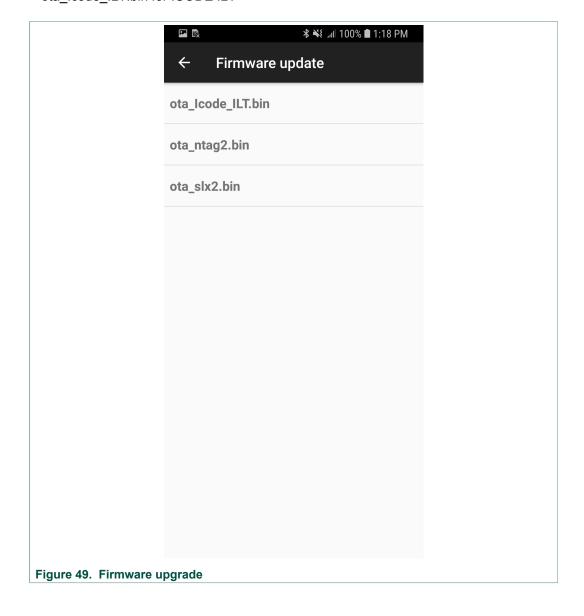


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If a button with a different firmware than the current is clicked, you are navigated to the firmware selection page.

You can select the file for the firmware upgrade from the following list:

- ota slx2.bin for ICODE
- ota_ntag2.bin for NTAG
- ota_lcode_ILT.bin for ICODE ILT

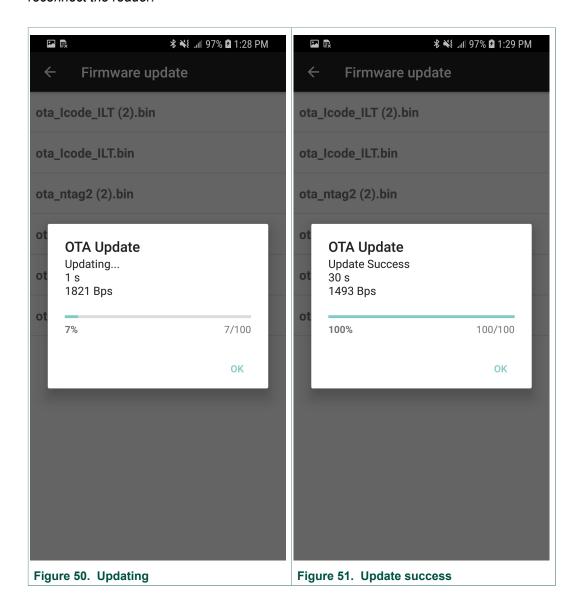


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Firmware upgrade starts by selecting the file, a progress bar is shown. When the update is finished, "Update Success" message appears with the execution time of the update and speed underneath. Press "OK" and you return to the "Reader & Tag" tab. Reconnect the reader after the update.

Note:

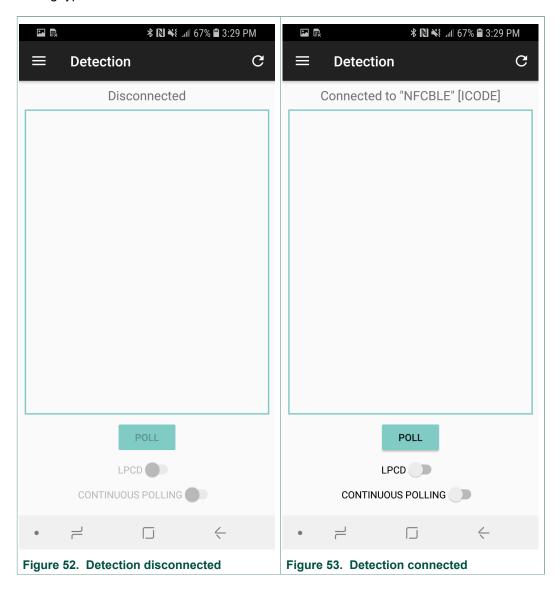
If you press "OK" before the update is finished, and you try to update the firmware again with the same binary file as before it continues. If there comes an error, reset and reconnect the reader.



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4.3.6 Detection

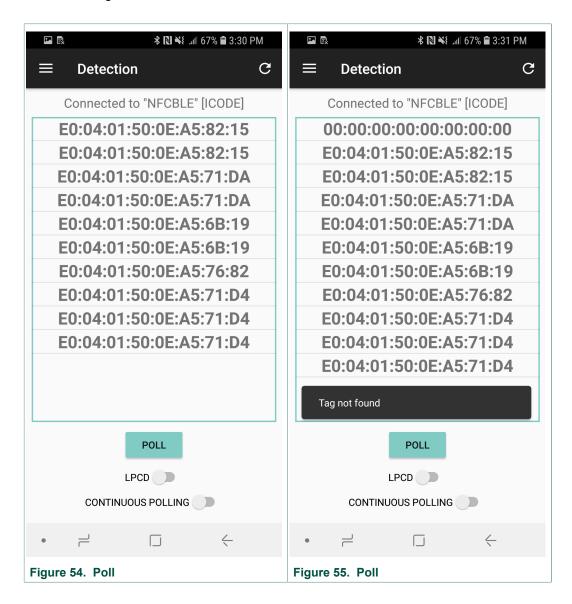
After connecting to a reader with correct firmware, the detection tab can be used. In the upper right, there is the refresh button, to check the connection to the reader and the tag type.



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4.3.6.1 Poll - NTAG & ICODE

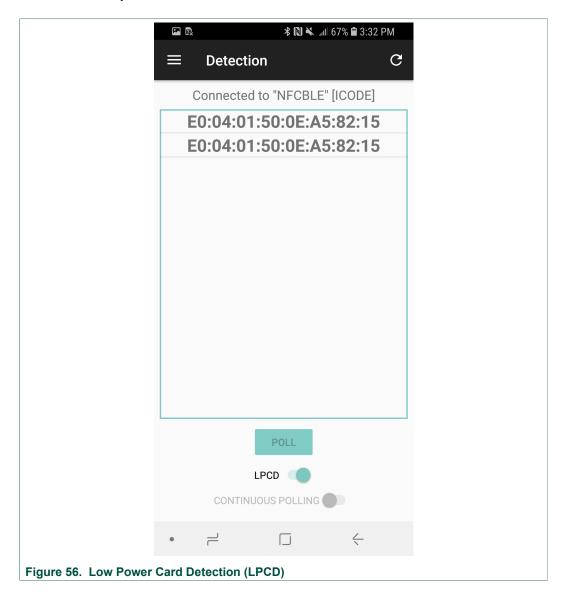
Scans for tags currently present on the reader. Returns the Tag in the table or "Tag not found" message.



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4.3.6.2 LPCD - NTAG & ICODE

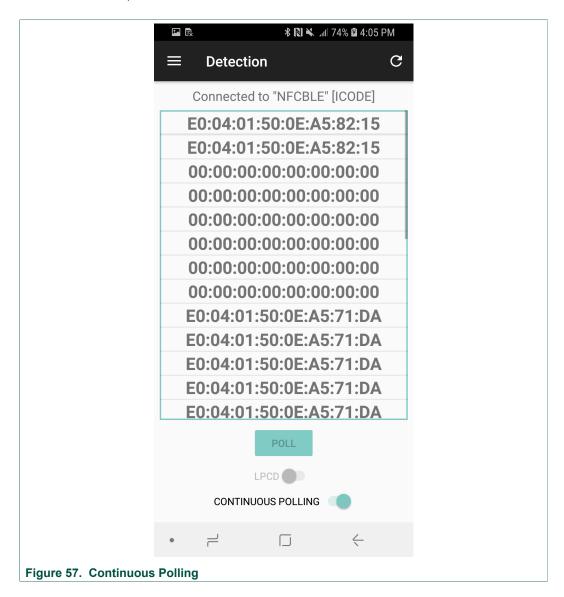
Enables Low-Power Card Detection mode and detects the Tag when it approached the reader antenna. After the tag has been read, it disables and reenables the LPCD mode after a short delay.



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4.3.6.3 Continuous Polling - NTAG & ICODE

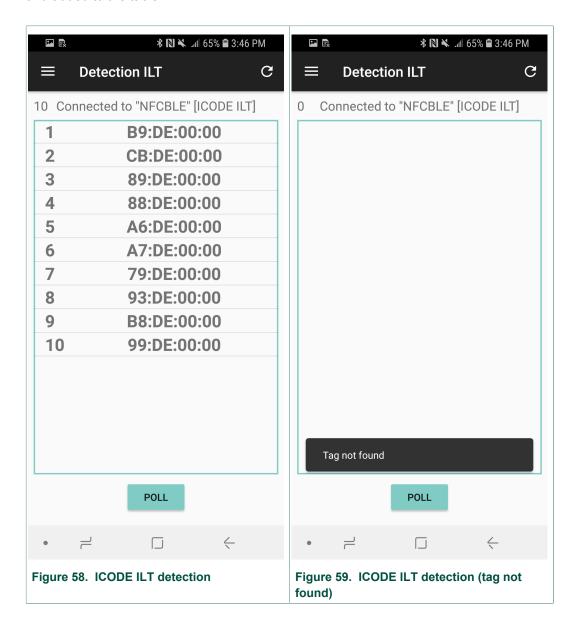
Continuously checks for presence of a tag on the reader. If a tag is found the tag is added to the table, else a row with all zeros is added.



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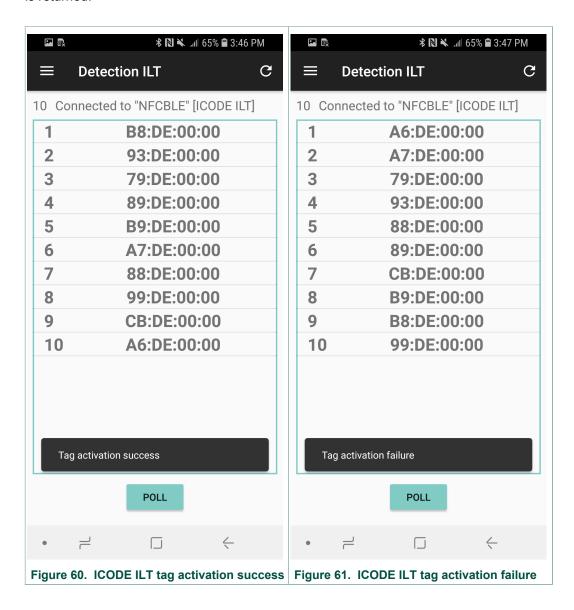
4.3.6.4 ICODE ILT

The detection tab for ICODE ILT is represented with a bigger table and a poll button. Upon pressing the poll button, all the ICODE ILT tags present on the reader are detected and added to the table.



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Upon successful detection, any tag entry in the table can be tapped to be activated for reading/writing. If the activation was successful, the message "Tag activation success" appears and you are automatically navigated to the Read & Write tab where the tag is read. If the activation failed (e.g. the tag is not present anymore), "Tag activation failure" is returned.



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4.3.7 R/W

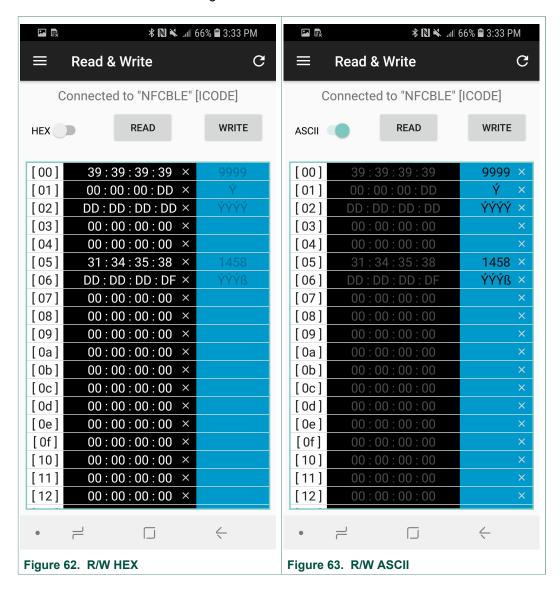
This tab is used to read and write the Tag content. Data is read into the table. First column represents the number of the page, the second the data in HEX format and the third data as ASCII characters. You can edit the data by pressing the cell. You can switch between writing HEX or ASCII input.

READ - It reads the Tag memory (ICODE ILT tags need to be activated first on the detection tab).

WRITE - It writes the content present in the table to the tag memory.

Note: NTAG reads 16 pages - 4 bytes each page and writes 12 (first 4 pages cannot be written to). ICODE reads and writes whole tag - 4 bytes each page. ICODE ILT reads and writes 32 pages - 2 bytes each page.

HEX/ASCII – Switches the writing mode.



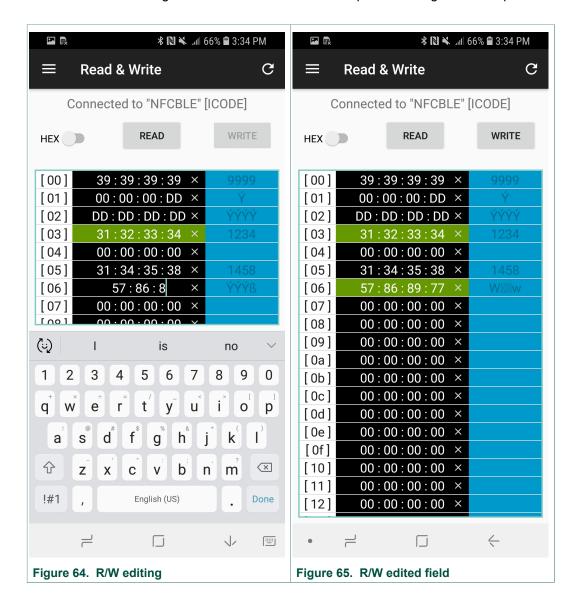
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When finished with the editing of a field you can continue with further editing of another field.

If the data in a field was changed the color changes to green.

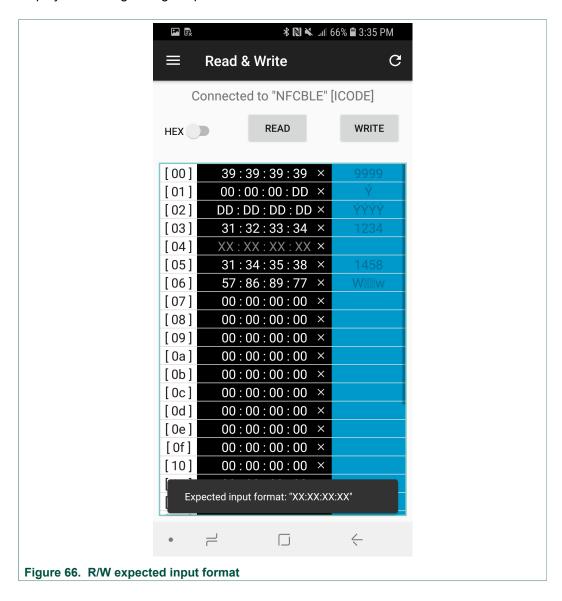
When editing data in HEX mode, you can only input HEX characters other input is disabled.

The "x" button on the right side of the fields resets the input to the original read input.



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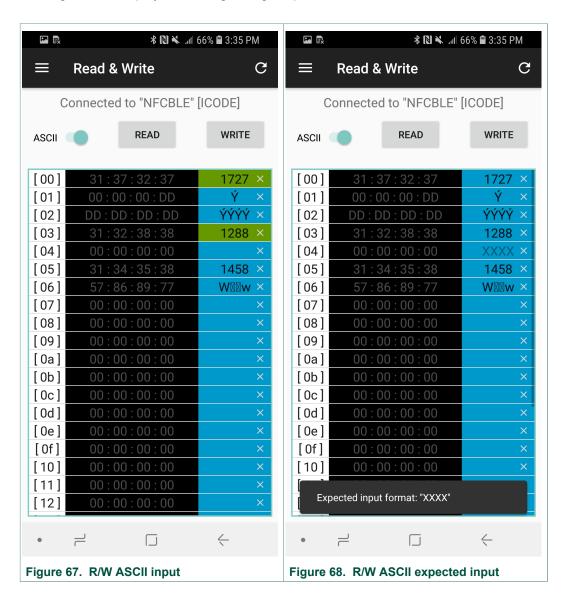
If input is shorter than 4/2 bytes (NTAG & ICODE / ICODE ILT), an error message will be displayed showing the right input format.



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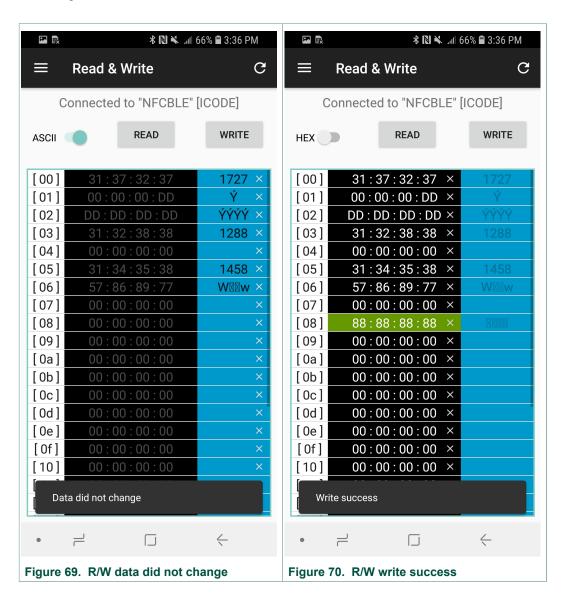
When switching to the ASCII mode, you can edit the 3rd column. If the data was changed the color of the field changes to green.

If you enter something else than 4/2 (NTAG & ICODE / ICODE ILT) characters, an error message will be displayed showing the right input format.



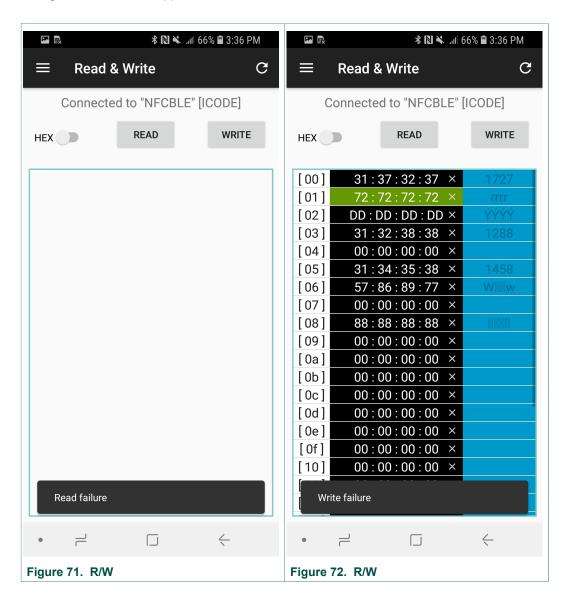
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After pressing write, you will either get an "Data did not change" message or a message indicating a successful write.



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If the tag was removed, or another unexpected error occurred, while reading/writing the dialog, "read/write fail" appears.



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5 Radio Equipment Directive (RED)

The following information is provided per Article 10.8 of the Radio Equipment Directive 2014/53/EU:

- (a) Frequency bands in which the equipment operates.
- (b) The maximum RF power transmitted.

Table 1. Characteristics

PN	RF Technology	(a) Freq Ranges (EU)	(b) Max Transmitted Power
BLE-NFC-V2	ISO14443 & ISO15693 (NFC)	13.56 MHz	240 mW ~23.8 dBm

EUROPEAN DECLARATION OF CONFORMITY (Simplified DoC per Article 10.9 of the Radio Equipment Directive 2014/53/EU). This apparatus, namely FRDM-KW41Z Freedom Development Platform, conforms to the Radio Equipment Directive 2014/53/EU. The full EU Declaration of Conformity for this apparatus can be found at this location: https://ec.europa.eu/growth/sectors/electrical-engineering/red-directive_en

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