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## Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832

Email & Skype: info@chipsmall.com Web: www.chipsmall.com

Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China



# UM10966

## NTAG I<sup>2</sup>C *plus* Explorer Kit - Android Demo

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### Document information

Info	Content
<b>Keywords</b>	NTAG I <sup>2</sup> C <i>plus</i> , Explorer Kit, Android, NFC tag
<b>Abstract</b>	This User Manual describes the functionalities and how to use the Android and PC application of the NTAG I <sup>2</sup> C <i>plus</i> Explorer kit. Both applications provide the same functionality and have the same look and feel so this User Manual is valid for both.



**Revision history**

Rev	Date	Description
2.1	20170309	Update - Bluetooth Pairing added
2.0	20170201	Updates
1.0	20160216	Initial Version

**Contact information**

For more information, please visit: <http://www.nxp.com>

## 1. Object

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NTAG I<sup>2</sup>C *plus* Explorer kit is an all-in-one demonstration and development resource to demonstrate the unique properties of the NTAG I<sup>2</sup>C *plus* connected tag. By including a full complement of hardware and software tools, users can investigate the capabilities of the chip through the various demonstrations, develop and test their own applications (with additional LPC-Link2 debug probe<sup>1</sup>).

This User Manual explains how to use the NTAG I<sup>2</sup>C *plus* demo application for Android. The Windows app is not detailed in this User Manual since it provides identical functionalities as the Android app, therefore the same User Manual is valid.

Technical aspects related to the IC features are beyond the scope of this document. To get further technical details please consult the dedicated Datasheet “NTAG I<sup>2</sup>C *plus*, NFC Forum Type 2 Tag compliant IC with I<sup>2</sup>C interface” (refer to [[NTAGI2Cplus](#)]).

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<sup>1</sup> [www.nxp.com/LPC-LINK2](http://www.nxp.com/LPC-LINK2)

## 2. NTAG I<sup>2</sup>C plus introduction

The NTAG I<sup>2</sup>C plus part of NXP's NTAG family offering both contactless and contact interfaces. In addition to the passive NFC Forum compliant RF interface, the NTAG I<sup>2</sup>C plus provides an I<sup>2</sup>C interface that allows the IC to communicate with the microcontroller when the chip is powered by an external device, i.e. a NFC mobile phone.

The NTAG I<sup>2</sup>C plus operating in energy harvesting mode provides the possibility to supply external low power devices (e.g. microcontrollers) with the energy generated from the RF field of the external NFC device.

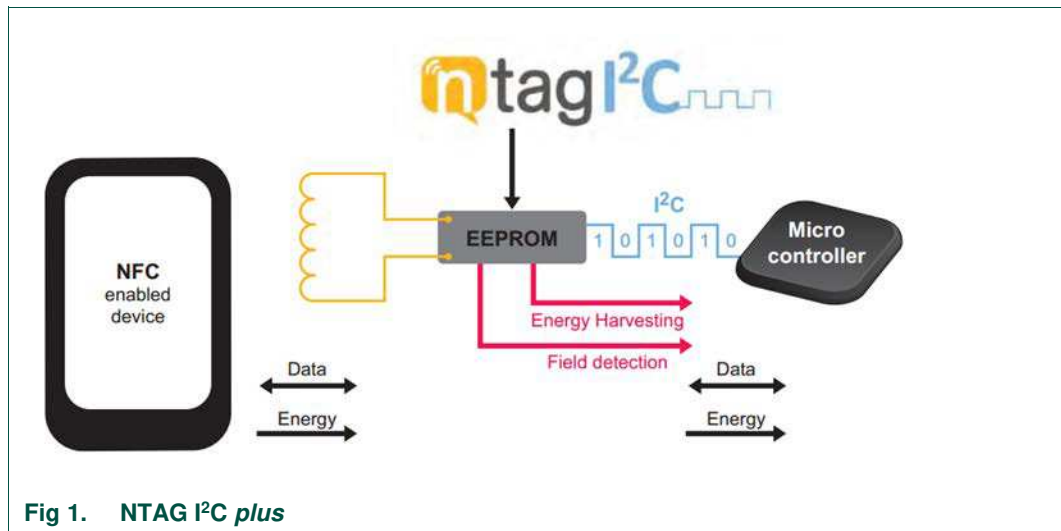


Fig 1. NTAG I<sup>2</sup>C plus

The NTAG I<sup>2</sup>C plus product has two types of memories:

1. EEPROM memory compliant with the NFC Forum Type 2 Tag implementation.
2. 64-byte SRAM memory, which is mapped to the EEPROM memory and it is externally powered.

The NTAG I<sup>2</sup>C plus features a pass-through mode that allows fast download and upload of data from the RF interface to the I<sup>2</sup>C interface and vice versa. This functionality makes use of the SRAM memory that allows fast data transfer between interfaces without the EEPROM performance limitations.

In addition to the I<sup>2</sup>C interface functionality, the NTAG I<sup>2</sup>C plus product features an Event Detection pin for waking up the connected host devices or synchronizing the data transfer between the two interfaces.

The NTAG I<sup>2</sup>C plus offers the possibility to protect the memory access. This protection is done by authenticating the tag with a password. When the tag is protected, authentication is needed to access the memory. The NTAG I<sup>2</sup>C plus also improves the speed when writing into the SRAM memory.



### 3. NTAG I<sup>2</sup>C *plus* Explorer kit contents

The NTAG I<sup>2</sup>C *plus* Explorer kit (NEK) consists of hardware and software tools that developers can use to understand the NXP NTAG I<sup>2</sup>C *plus* functionalities and create first prototypes to demonstrate its potential for other application. The kit includes:

#### 3.1 Hardware components

##### 3.1.1 NTAG I<sup>2</sup>C *plus* Explorer Board

A hardware board based on the NXP LPC 11U24 microcontroller (refer to [LPC11U24](#)), with on-board LCD display, NXP LM75B temperature sensor (refer to [LM75B](#)), voltage monitors, I<sup>2</sup>C serial bus connector, JTAG/SWD debug connector, RGB LED micro USB connector and five push buttons.

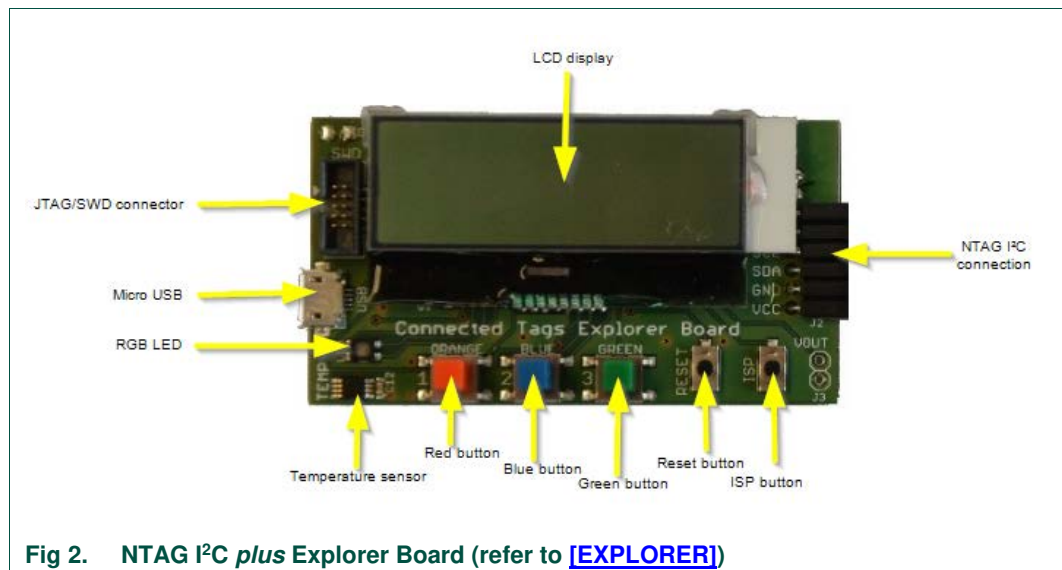


Fig 2. NTAG I<sup>2</sup>C *plus* Explorer Board (refer to [EXPLORER](#))

### 3.1.2 Antenna board

The antenna board carries the NTAG I<sup>2</sup>C *plus* 2k version itself and provides two interfaces:

- The RF interface to an NFC device.
- The I<sup>2</sup>C interface to the host, e.g. the NTAG I<sup>2</sup>C *plus* Explorer board.

The design files for both the PCB and Flex antenna can be found on the web page (refer to [\[PCB Antenna\]](#) and [\[Flex Antenna\]](#))

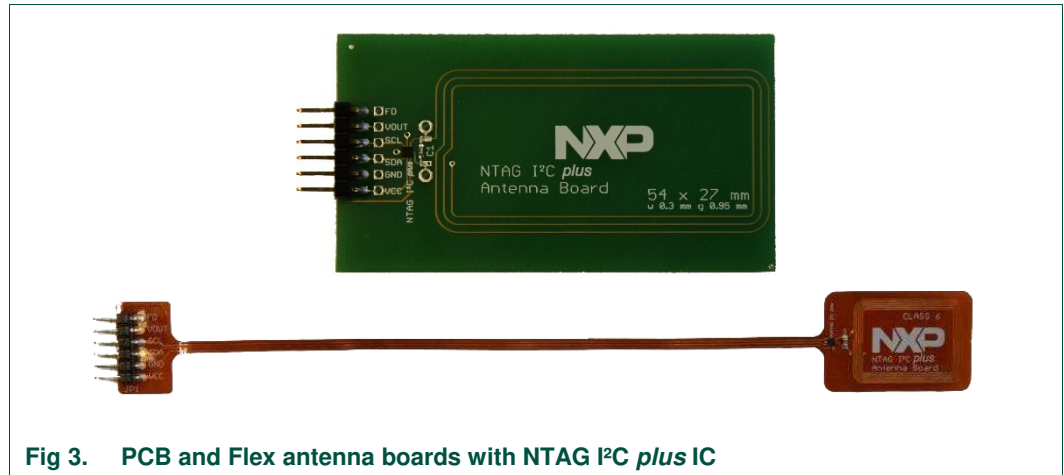


Fig 3. PCB and Flex antenna boards with NTAG I<sup>2</sup>C *plus* IC

### 3.1.3 Field detector board

The position of the antenna of NFC devices vary from device to device. To use the Explorer Kit with an NFC Device, NFC radio needs to be enabled. To find the position of the antenna, it is convenient to use the included field detector board. The LED helps to find the antenna position.

Design files may be downloaded from the demo board homepage (refer to [\[Field Detector\]](#))

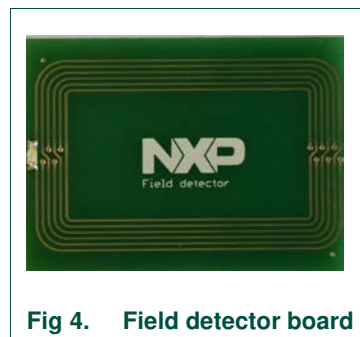


Fig 4. Field detector board

### 3.1.4 USB reader

Instead of a NFC device, the USB (PCSC) reader (Identiv uTrust CLOUD 3700F) may be used in combination with the Windows app to develop applications.



Fig 5. Identiv uTrust CLOUD 3700F reader

To install the reader, download latest driver from the web page (refer to [\[Identiv\]](#)), extract “Identiv uTrust Installer.zip” and install it with no reader connected.

In Windows 7 operative systems, when a smartcard is placed over the reader there is frequently an issue regarding the smartcard mini-drivers. Although a solution to this problem is given in this section, more information can be found on the Windows Support Webpage<sup>2</sup>. To solve this issue the Smart Card Plug has to be disabled and Play in local Group Policy has to be changed to primary group policy settings for smart cards. The procedure is as follows:

1. Click **Start**, type *gpedit.msc* in the **Search programs and files** box, and then press ENTER.
2. In the console tree under **Computer Configuration**, click **Administrative Templates**.
3. In the details pane, double-click **Windows Components**, and then double-click **Smart Card**.
4. Right-click **Turn on Smart Card Plug and Play service**, and then click **Edit**.
5. Click **Disabled**, and then click **OK**.
6. Click **Start**, type *regedit.exe* in the **Search programs and files** box, and then press ENTER.
7. Go through the tree key, on the left, up to the key
  - **HKEY\_LOCAL\_MACHINE \ Software \ Microsoft \ Cryptography \ Calais** for 32-bit system or
  - **HKEY\_LOCAL\_MACHINE \ SOFTWARE \ Wow6432Node \ Microsoft \ Cryptography \ Calais** for 64-bit system
8. Add a new DWORD value named **CardDisconnectPowerDownDelay** and set its value to 0.
9. Click **Start**, type *services.msc* in the **Search programs and files** box, and then press ENTER.
10. Find the smart card service in the list, right-click and click **Restart**.
11. Now you may plug the reader

<sup>2</sup> <https://support.microsoft.com/en-us/kb/976832>.



### 3.1.4.1 USB Reader firmware update

In some cases, reader is not functioning properly with Windows “NTAG I<sup>2</sup>C plus Demo” application. This is due to newer Reader’s firmware. In this case, it needs to be updated, using patch tool<sup>3</sup>.

## 3.2 Software components

### 3.2.1 NTAG I<sup>2</sup>C *plus* Explorer board firmware

The firmware runs on the NTAG I<sup>2</sup>C *plus* Explorer board and is flashed during production at the MCU which supports the demonstration functionality of the hardware. The delivered NTAG I<sup>2</sup>C *plus* Explorer board firmware consists of three applications:

- **NTAG\_I<sup>2</sup>C\_Explorer\_Bootloader:** This project implements the secondary bootloader application. It is flashed at on-chip memory address starting at 0x0000 0000 and it is the first application to be executed after the MCU boots. This application has three functions:
  - Jump to the start memory of the user application.
  - Enter into flashing mode functionality.
  - Enter into USB mode (Peek and Poke).
- **NTAG\_I<sup>2</sup>C\_Explorer\_Demo:** This project implements the logic supporting the Android / Windows demonstration applications. It is flashed at on-chip flash memory starting at 0x0000 4000 address and it is executed after the bootloader jumps to the application start address.
- **NTAG\_I<sup>2</sup>C\_Explorer\_Blink:** This is a sample project that sets into blinking mode the NTAG\_I<sup>2</sup>C Explorer board as soon as the RF field is detected. This application is provided to illustrate the NFC flashing functionality and its binary image is provided embedded by default into the Android app (see Section 4.5).

### 3.2.2 Android app

The demo application on an Android NFC phone (“NFC mobile”) showcasing the various features of the NTAG I<sup>2</sup>C *plus*. The NTAG I<sup>2</sup>C Demo application is available for download from the public NXP website as well as at Google Play.

<sup>3</sup> <http://www.nxp.com/demoboard/OM5569-NT322ER/documents/software/SW4044.zip>

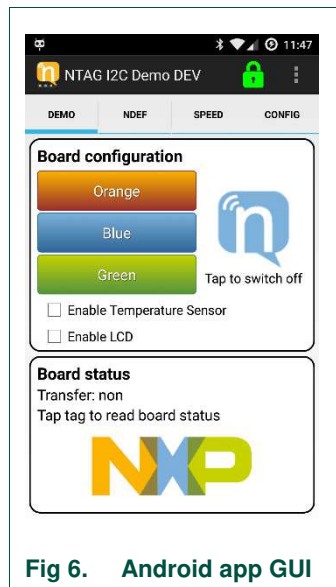


Fig 6. Android app GUI

**Note:** The UM10989 (refer to [UM10989](#)) describes in detail how to get started with the development of Android Applications.

### 3.2.3 Windows app

Together with the USB reader, the Windows app can be utilized to substitute a missing NFC mobile phone. The Windows app has similar functionalities as the Android app. This software component is available as a download from the public NXP website. The software will include a setup file which will install the Windows App in the folder 'Program files/NXP Semiconductors', this installation process will create a shortcut to the Windows App on your desktop. No further procedure is required to run this application.

1. Download the NTAG I<sup>2</sup>C Demo App (refer to [PC App](#))
2. If not done, install the Identiv uTrust driver as described above and the NTAG I<sup>2</sup>C Demo App
3. Launch the NTAG I<sup>2</sup>C Demo App

There are some points to consider when using the Windows App, since it is connected to an external reader via USB. There are sometimes issues with the connection between the reader and the tag. On these cases, it is recommended to restart the app and re-plug the reader.

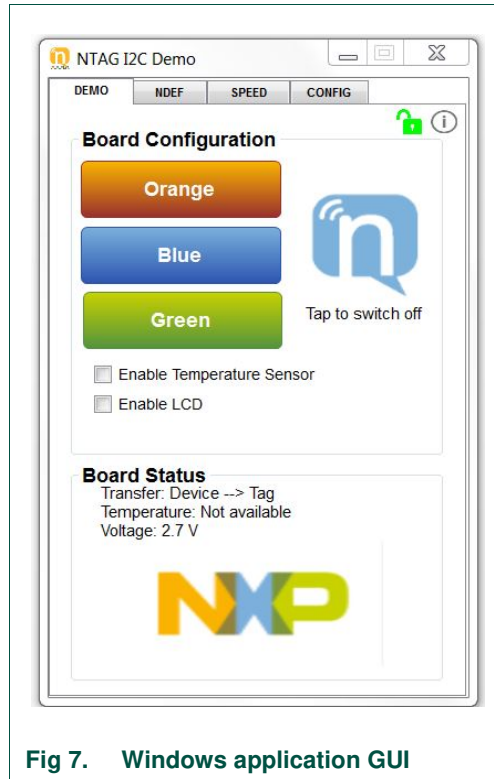


Fig 7. Windows application GUI

**Note:** The Windows application functionalities, GUI and look and feel are intentionally made the same as the Android application. The Windows application is intended to run in a Windows environment together with the Identiv uTrust CLOUD 3700F reader as a substitute in case an NFC phone is not available. Therefore, this User Manual is valid for both the Android app and Windows application. However, only Android app screenshots are shown in this document.

### 3.2.4 Peek and Poke GUI

The Peek and Poke GUI is a Windows app that can be used to examine the detailed memory contents of the NTAG I<sup>2</sup>C *plus* EEPROM via I<sup>2</sup>C interface. From hardware point of view only a USB cable connection from the board to the PC is needed (no need of the USB NFC reader). This software component is available as a download from the public NXP website (refer to [\[Peek&Poke\]](#)).

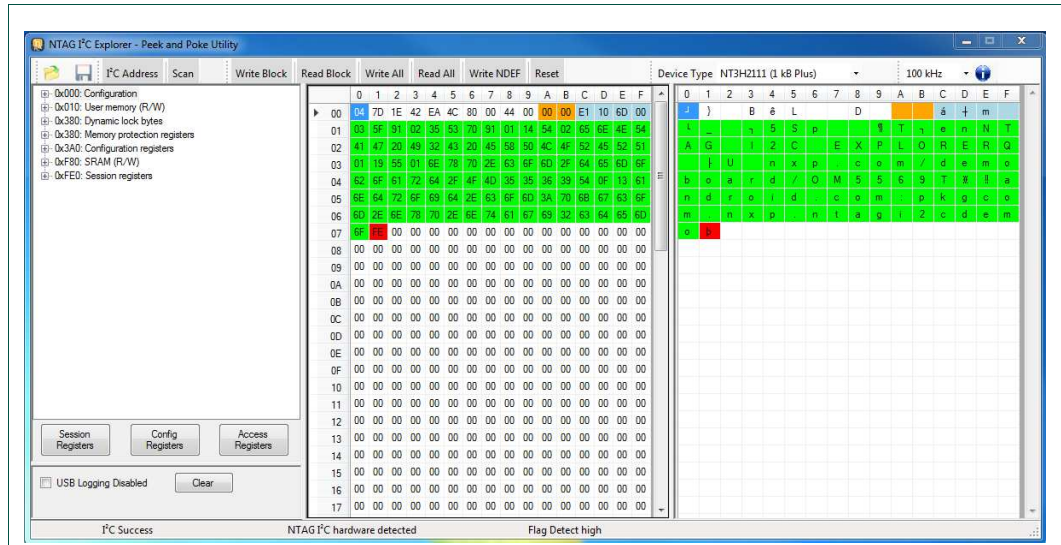


Fig 8. Peek and Poke GUI

**Note:** The UM10967 (refer to [\[UM10967\]](#)) describes in detail how to get started with the Peek and Poke tool and the different functionalities it offers.

## 4. NTAG I<sup>2</sup>C plus Explorer Demo app

The Android application is intended to operate on devices running Android version 4.0 and above. The application has been optimized for a correct visioning of the graphical elements in smartphones featuring different resolutions.

As seen in Fig 9, the Android application consists of two demos that can be launched from the main activity of the application and four configuration functionalities that are accessed from the configuration selection view in the main activity.

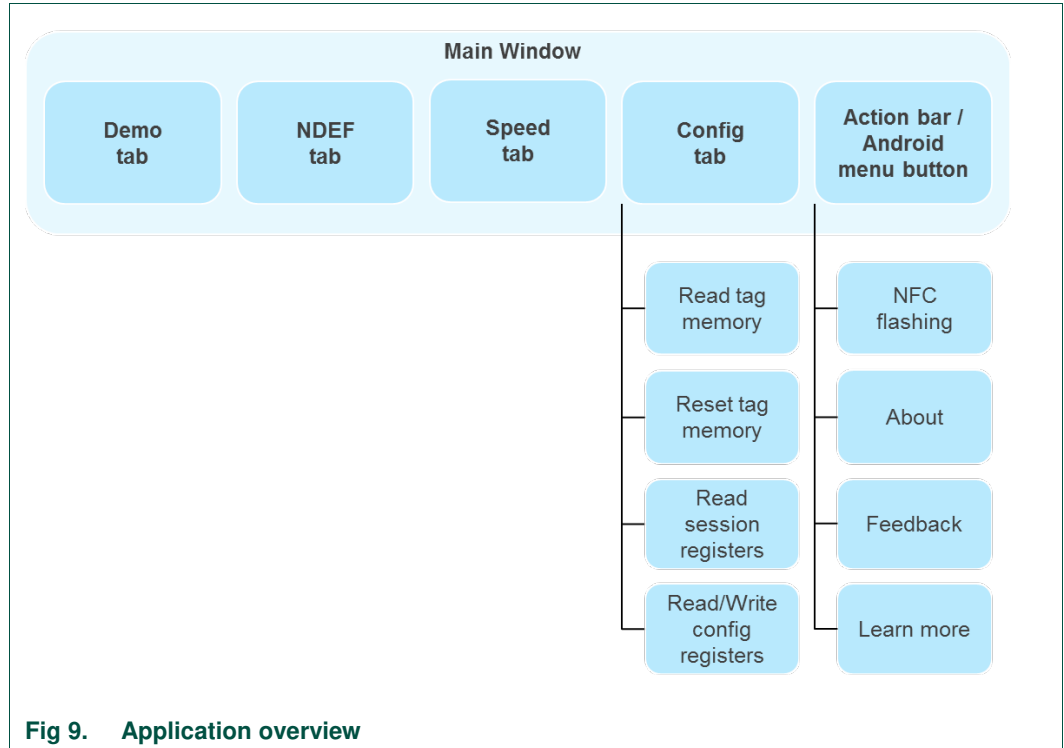


Fig 9. Application overview

### 4.1 Demo tab

After the Splash window closes, the Demo tab will appear. This screen allows the user to launch the Demo tab itself, the NDEF demo tab, the Speed demo tab and access the Configuration tab, with all configuration functionalities supported by the application.

Regarding the Demo tab, it allows demonstrating:

- The **Energy harvesting** functionality of the NTAG I<sup>2</sup>C plus that enables the powering up of the complete demo kit board with the energy harvested from the RF interface without any battery.
- The **RF to I<sup>2</sup>C** communication enabling us to modify the LED color by pressing the related color button on the NFC device screen.
- The **I<sup>2</sup>C to RF** communication as the set of push buttons pressed by the user on the demo kit board reflected on the NFC device screen.
- The dynamic **bidirectional communication** between the two interfaces as the temperature value as well as the voltage on the energy-harvesting pin get dynamically updated on both the low power screen and the NFC device screen.



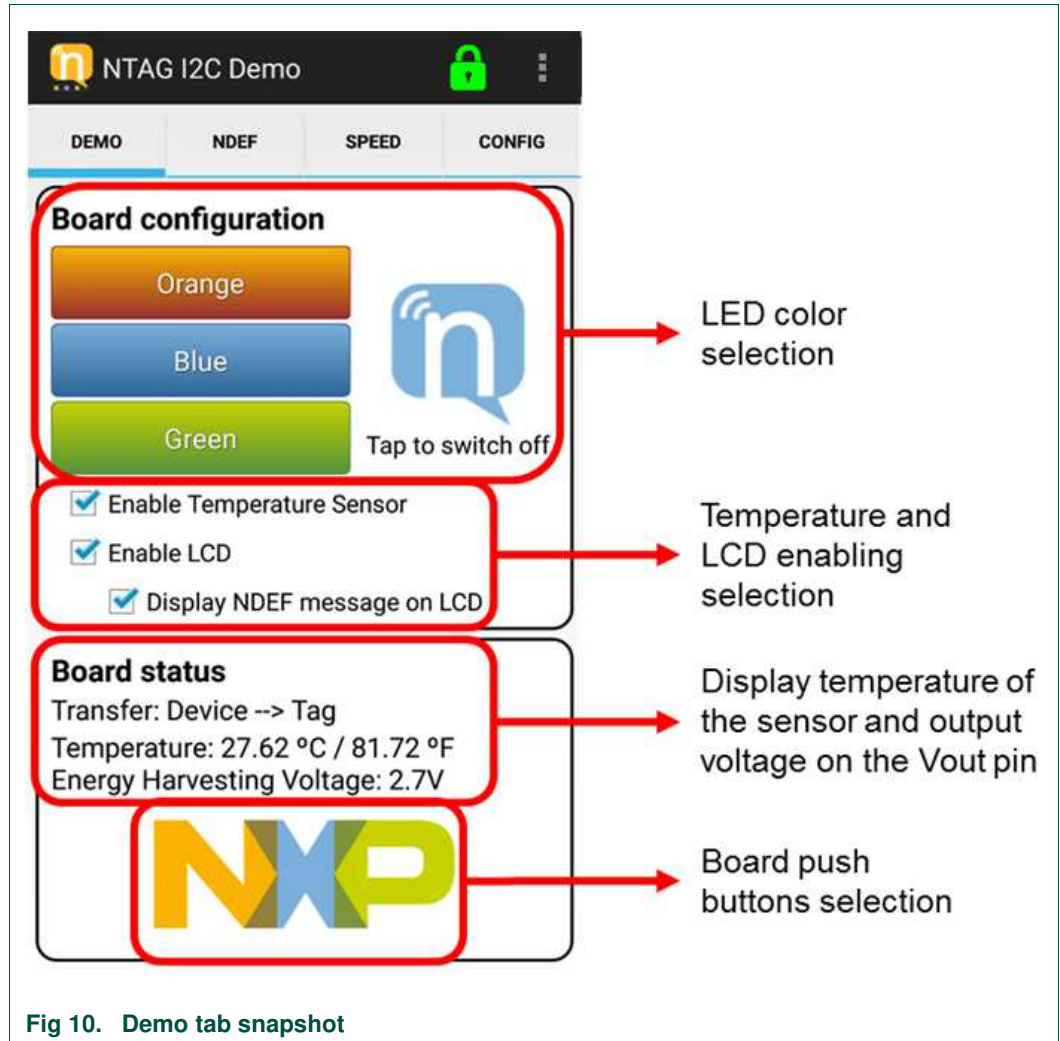


Fig 10. Demo tab snapshot

#### 4.1.1 Configuring NEK board to demonstrate RF to I<sup>2</sup>C communication

The board configuration part of the demonstration shows how the NTAG I<sup>2</sup>C *plus* passes a command from the RF input through the SRAM and I<sup>2</sup>C serial interface output to the microprocessor, which acts upon the command and lights the appropriate LED.

1. Touch one of the colored board configuration buttons on your mobile device. The NTAG icon then changes color, indicating the color selection.
2. Tap your mobile device on the antenna. When properly placed, the LED will illuminate in the chosen color. Optionally, the LCD display will display the harvested voltage, the temperature sensed by the board, the default text or the stored NDEF message if the corresponding options are enabled in the board configuration menu.



Fig 11. Green LED board configuration selection

4.1.2 Reading board input to demonstrate I<sup>2</sup>C to RF communication

The three colored buttons on the NEK board demonstrate information from the board being transferred from the microprocessor through the I<sup>2</sup>C serial bus to the NTAG I<sup>2</sup>C *plus*, which then sends it via the RF field to the mobile device for display. When pressed, each colored button on the NEK board will cause a corresponding shade off on the board input NXP logo.

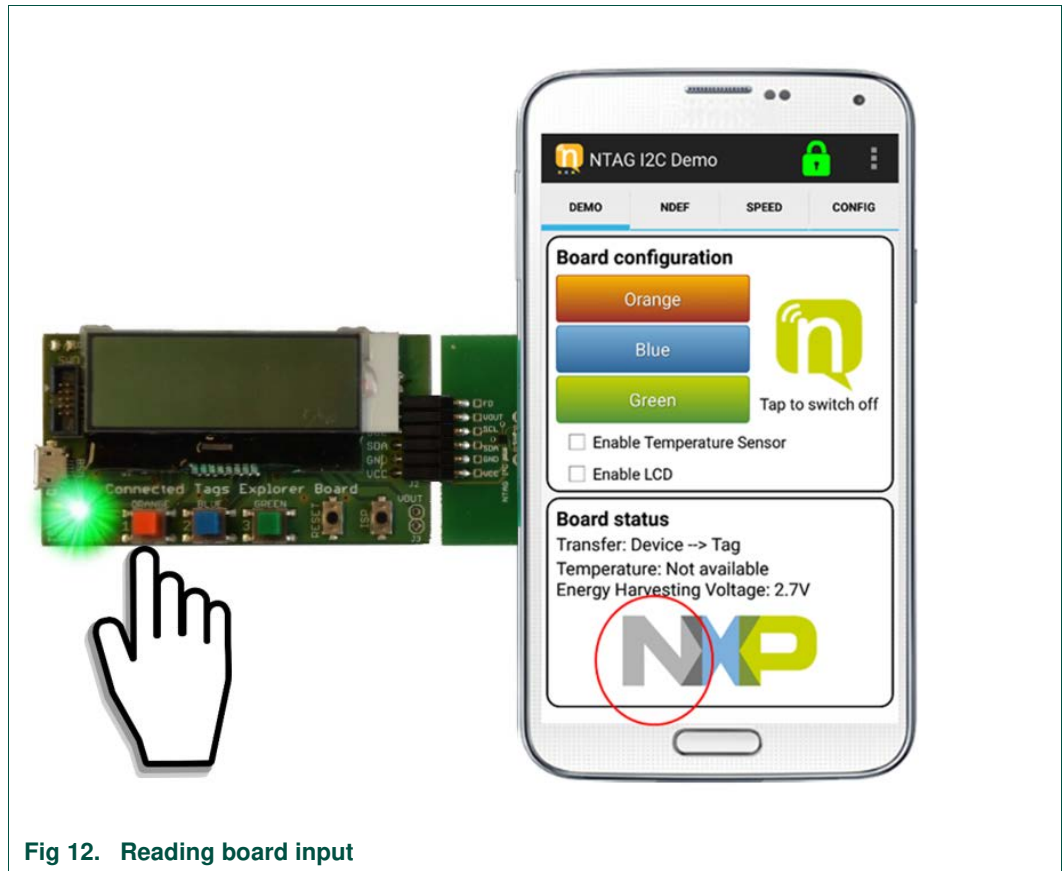


Fig 12. Reading board input

### 4.1.3 Temperature sensor

The NEK board incorporates a temperature sensor for measuring the ambient temperature. This information can be shown in the Demo tab of the Android/PC application. Additionally it can be shown in the LCD display if the option is checked in the menu.

This operation demonstrates the NTAG I<sup>2</sup>C *plus* operating in pass-through mode, in which data passes through its SRAM. It is also another demonstration of passing data from the microprocessor through the I<sup>2</sup>C serial bus to the NTAG I<sup>2</sup>C *plus*, which can be read through the RF interface for display on the mobile device.

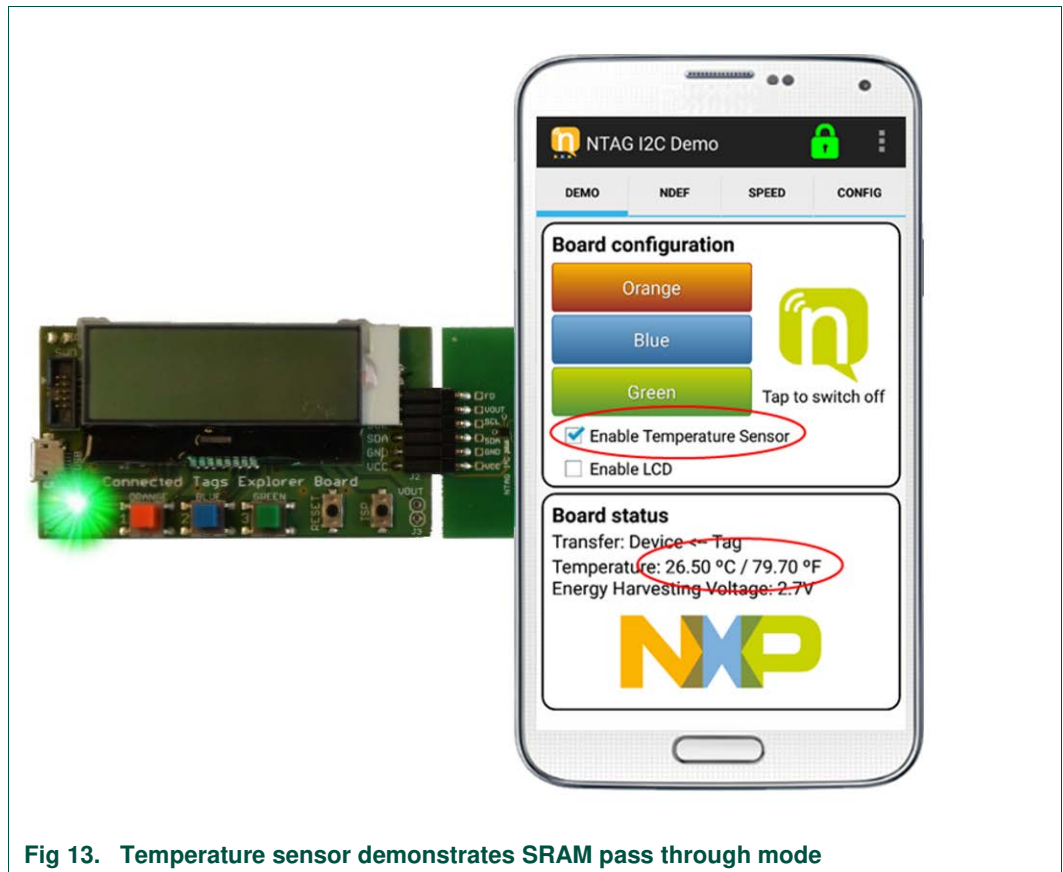


Fig 13. Temperature sensor demonstrates SRAM pass through mode

#### 4.1.4 Enabling LCD display

You can enable the NEK board LCD by touching the *Enable LCD* selection box. When doing so, the LCD will show the predefined *NTAG I<sup>2</sup>C plus Explorer* text message, the energy harvested and, if enabled, the temperature sensed by the board in Celsius and Fahrenheit degrees.

Once again, this operation demonstrates the NTAG I<sup>2</sup>C plus chip operating in pass-through mode sends a command from the RF input through the I<sup>2</sup>C serial interface output to the microprocessor, which in turn acts upon the command and turns on the LCD display.



Fig 14. Enabling NEK board LCD



#### 4.1.5 Displaying NDEF text message on the NEK board LCD

You can display the NDEF text message on the NEK board LCD by touching the *Display NDEF message on LCD* selection box.

Again, this operation demonstrates the NTAG I<sup>2</sup>C *plus* operating in pass-through mode. First, the NDEF message is read from the NTAG I<sup>2</sup>C *plus* EEPROM memory and is transferred to the MCU using the SRAM memory, which displays it in the display.



Fig 15. Displaying NDEF text message on NEK board LCD

## 4.2 NDEF tab

The NDEF tab allows the user to read or write an NDEF message to the NTAG I<sup>2</sup>C *plus* EEPROM. Actually, it could be used to read or write an NDEF message to any NFC Forum Type 2 Tag, such as a MIFARE Ultralight, NTAG21x, ...

On the **Read NDEF** mode, the application reads the NDEF message TLV from the NTAG I<sup>2</sup>C *plus* and returns its content and the type of NDEF message.

On the **Write NDEF** mode, the application allows the user to write a Text type, URI type, Bluetooth pairing type or Smart Poster NDEF message.

- *Text record* type is used to store plain text data.
- *URI record* type allows NFC tags to trigger actions on the NFC device (usually the smartphone), such as opening a webpage or sending an SMS message.
- *Bluetooth pairing* NDEF messages contain information about a Bluetooth device that allows the smartphone to pair with that Bluetooth device by just tapping the tag. In the case of writing a Bluetooth pairing type message, it is important to remember that the MAC address shall be 6 bytes, in hexadecimal (therefore, 12 characters from 0 to F).
- *Smart Poster* record type defines a structure including a URI record type and a Text record type as building blocks.

The NDEF tab also contains a **Write default NDEF message** button. When this button is pressed, the application automatically writes a NDEF Smart Poster message with the 2 records (optionally 3):

- Text record "NTAG I2C plus EXPLORER"
- URI content: [www.nxp.com/demoboard/OM5569](http://www.nxp.com/demoboard/OM5569).
- Optionally: AAR (Android Application Record)

More on **Write default NDEF message** is described below in [section 4.2.2](#).

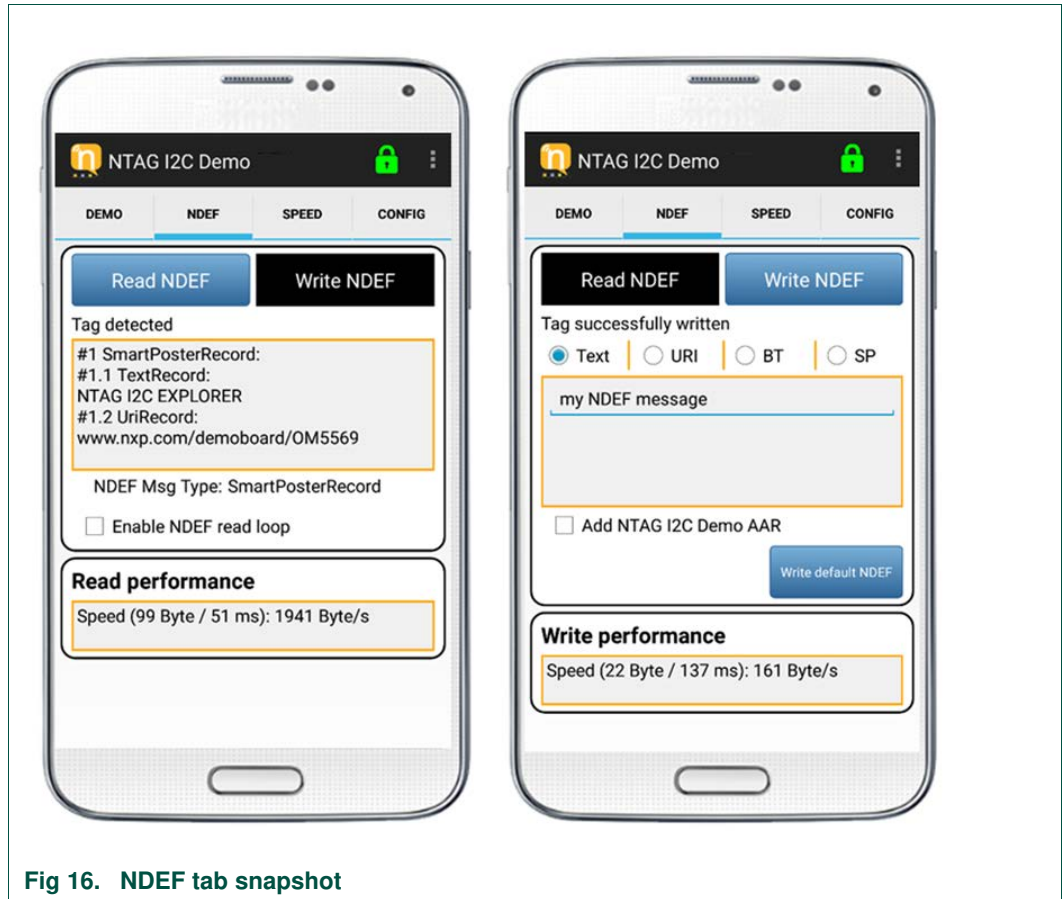


Fig 16. NDEF tab snapshot

When the NDEF message has been successfully written the “write tag successfully done” popup appears temporarily in the application informing the user that the message has been correctly written. There is no need to tap the tag again if you want to write multiple NDEF messages and read them in between.

In order to learn more about the different types of NDEF messages and what structure they have, please refer to the following NFC Forum specifications:

- “NFC Data Exchange Format (NDEF) Technical Specifications”
- “NFC Record Type Definition (RTD) Technical Specification”
- “NFC Text RTD Technical Specification”
- “NFC URI RTD Technical Specification”
- “NFC Forum Connection Handover Technical Specification”
- “NFC Smart Poster RTD Technical Specification”
- “Bluetooth Secure Simple Pairing Using NFC”

4.2.1 Reading NDEF data

To read a NDEF message out of NTAG I<sup>2</sup>C plus:

1. Select *Read NDEF* from the tab on the right of the mobile device screen.
2. Tap the mobile device onto the antenna.
3. A proper read will result in a message on the mobile device indicating *Read tag successfully done*. If no NDEF message is found or NTAG I<sup>2</sup>C plus is not formatted as defined in NFC Forum Type 2 Tag spec, it will result in a message *NTAG I2C plus product is not NDEF formatted*. Additionally, the *Enable NDEF read loop* selection box can be used to set the application to permanently read the EEPROM memory, so any change will automatically appear in the window.

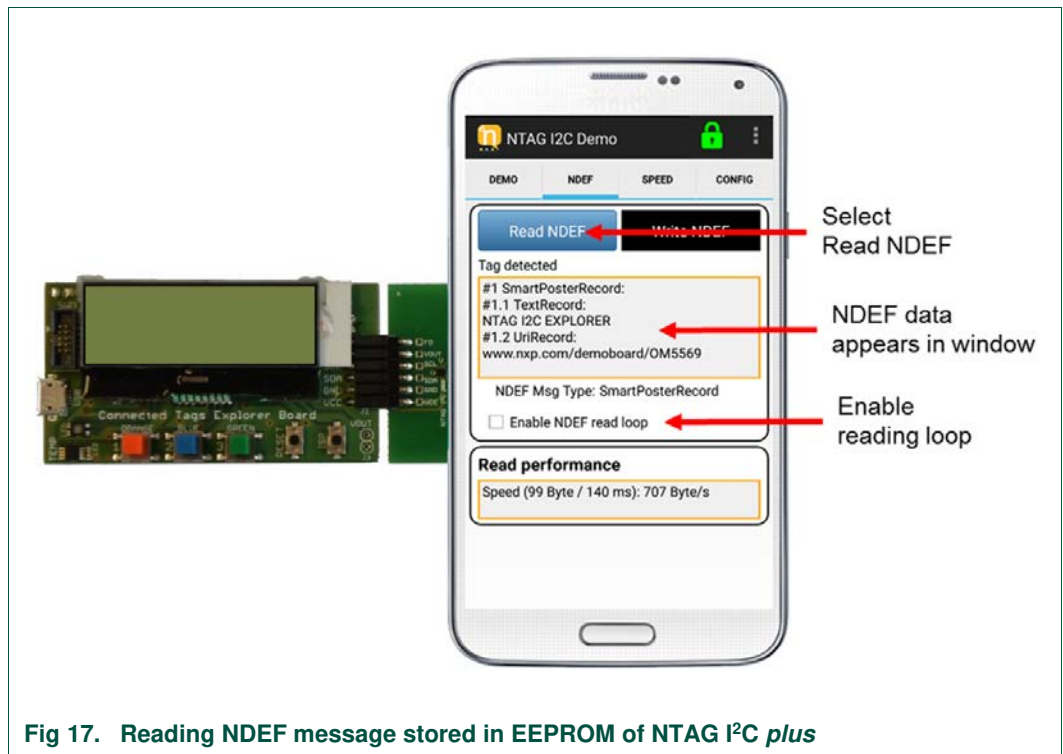


Fig 17. Reading NDEF message stored in EEPROM of NTAG I<sup>2</sup>C plus

4.2.2 Writing NDEF data

To write an NDEF message into the NTAG I<sup>2</sup>C plus:

1. Select *Write NDEF* from the tab on the right of the mobile device screen.
2. Type a message into the NDEF message area. Or alternatively, press *Write Default NDEF message* on your screen, which writes a NDEF Smart Poster message with the text content: “NTAG I<sup>2</sup>C plus EXPLORER” and the URI content: [www.nxp.com/demoboard/OM5569](http://www.nxp.com/demoboard/OM5569). Additionally, you can add to your NDEF message an Android Application Record (AAR), which adds the package name of the NTAG I<sup>2</sup>C plus Demo application embedded inside the NDEF record. You can add an AAR to any NDEF record of your NDEF message because Android searches the entire NDEF message for AARs. If it finds an AAR, it starts the application based on the package name inside the AAR. If the application is not present on the device, Google Play is launched to download the application.
3. Tap the mobile device onto the antenna.
4. A proper write will result in a message on the mobile device indicating *write tag successfully done*.

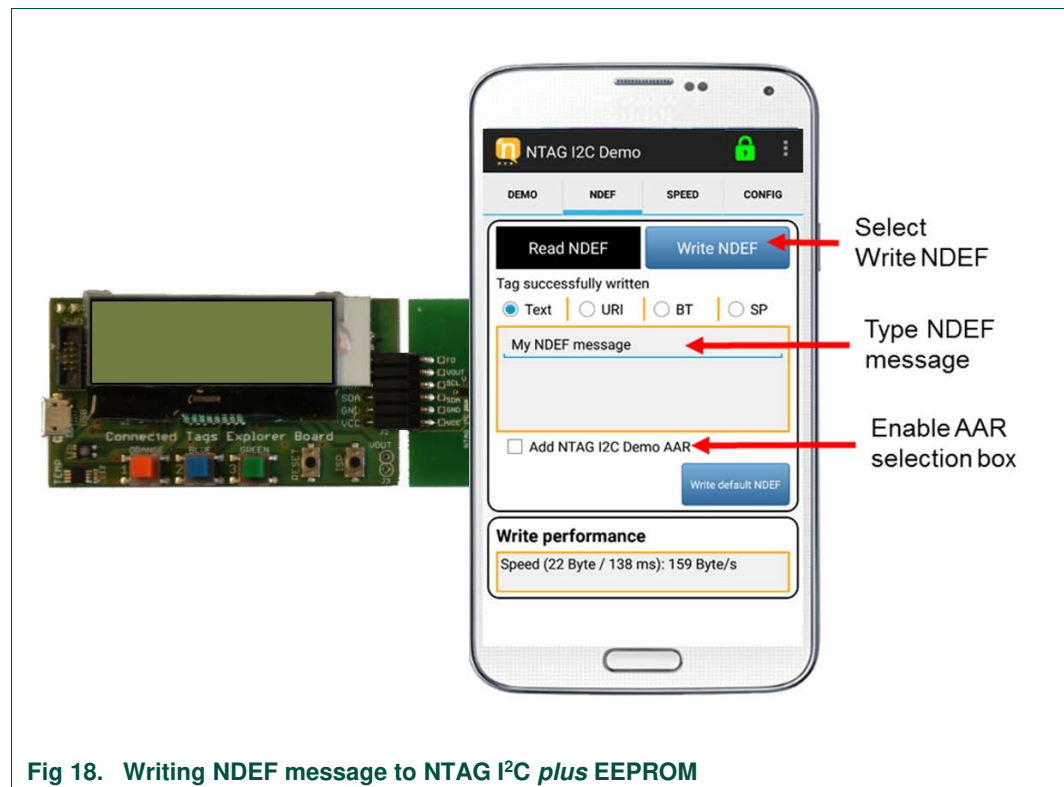


Fig 18. Writing NDEF message to NTAG I<sup>2</sup>C plus EEPROM

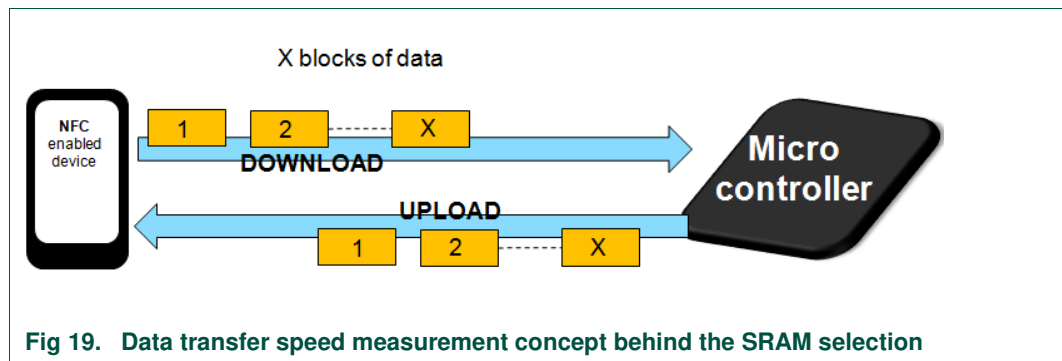


**4.3 Speed tab**

The speed Test Demo measures the transfer bit rate when communicating with the NTAG I<sup>2</sup>C *plus* Explorer board according to different configurations.

**4.3.1 SRAM speed test**

The SRAM speed Test measures the speed at which the data is transferred from the application to the microcontroller through the SRAM (with the NTAG I<sup>2</sup>C *plus* in pass-through mode), and vice versa. First, the application writes data to the SRAM several times, and the microcontroller reads from it. This way, the throughput of the communication in pass-through mode from the application to the microcontroller can be obtained. Once this first test has finished, the microcontroller starts writing to the SRAM memory, while the application reads from it. This way, the throughput from the microcontroller to the application can be measured.



**Fig 19. Data transfer speed measurement concept behind the SRAM selection**

Since the size of the SRAM memory is 64 bytes, the data to be transmitted and received has to be a multiple of 64. Actually, what is transmitted is the number of 64-byte blocks defined by the user in the Block multiplier field (10 by default).

The integrity of the data transferred in both directions is checked by appending a CRC32 value in the last block. The CRC32 is calculated for the whole message that has been transferred (for all the blocks). If the CRC32 from the message received by the application is right, it will show an “Integrity of the data: OK” message. On the other hand, if the CRC32 from the message received by the board is right, it will turn on the green LED at the end of the Speed Test.

Once the test has been finished, both the application and the microcontroller indicate whether the integrity check was successful (through a green LED at the microcontroller), and the application shows the time, mean speed and data transferred for both directions.

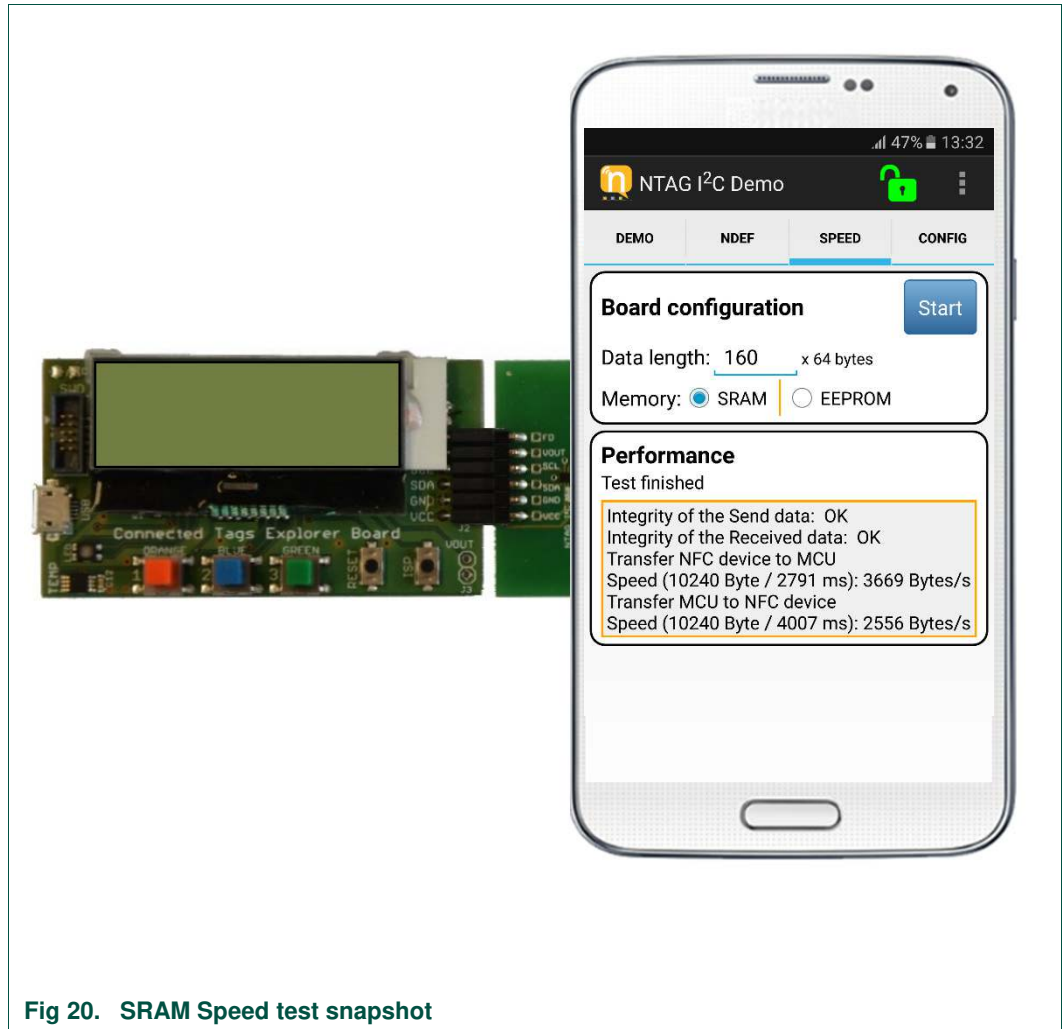


Fig 20. SRAM Speed test snapshot

### 4.3.2 EEPROM speed test

The EEPROM Speed Test measures the speed at which the application is able to write and read the EEPROM memory of the NTAG I<sup>2</sup>C *plus*. In order to do this, an NDEF message is written to the EEPROM, and then, the same NDEF message is read. The written NDEF message is a text type message that contains the data in the textbox of the application repeated as many times as indicated in the Block multiplier field.

First, the application creates the NDEF message to be written by creating a string that contains the content from the textbox as many times as indicated, and adding the appropriate header. Then, it writes it to the EEPROM memory by sending as many NFC Forum Type 2 Tag Write commands as necessary, and measuring the time it takes to do so. Once it has finished writing, it reads the NDEF message from the NTAG I<sup>2</sup>C *plus* EEPROM memory.

Once the test is finished, the application shows the number of bytes, mean speed and time for both the reading and writing process. The user can also check the content of the memory to ensure that the NDEF message has been written appropriately.

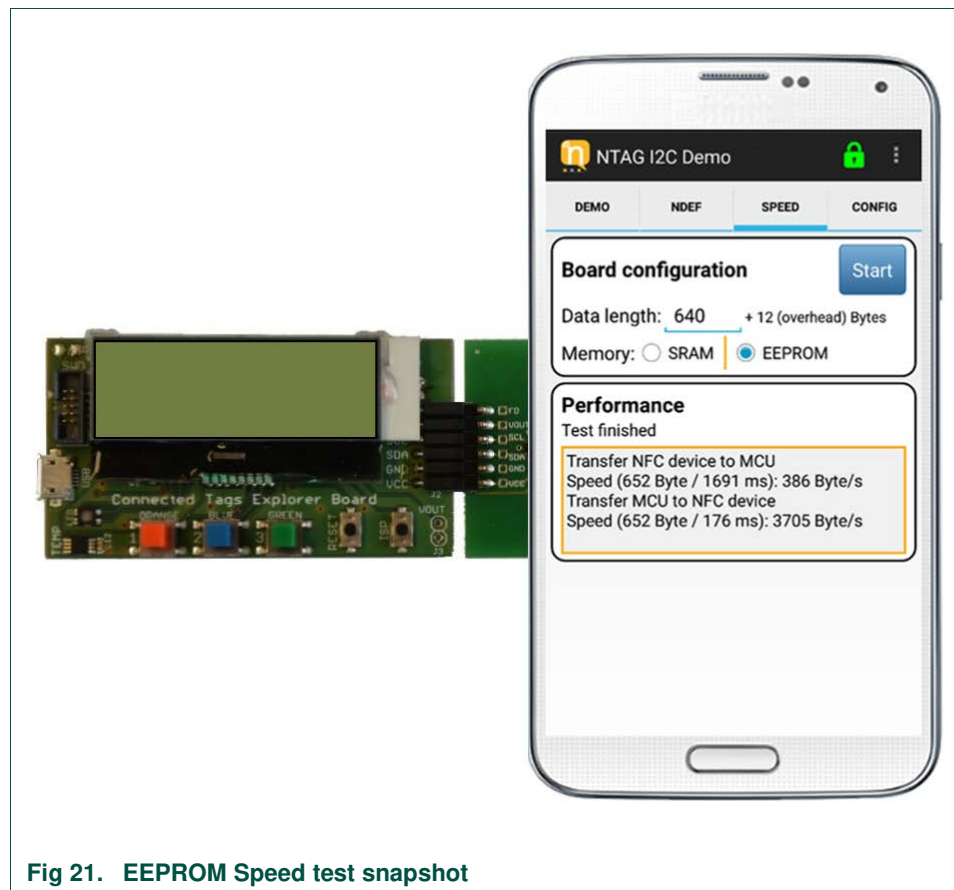


Fig 21. EEPROM Speed test snapshot

Comparison between EEPROM read/write Fig 21 and SRAM read/write Fig 20 is represented. Performing operations on SRAM memory with FAST\_READ and FAST\_WRITE commands, highly improve overall communication speed.