NFC Tandem User Manual

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User manual
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Document information

Information	Content
Keywords	NFC, PN7150, NTAG-I2C plus
Abstract	This user manual describes the design, the use and the software aspects of the NFC Tandem board.

Revision history

Rev	Date	Description
0.2	20180817	Fix broken links
0.1	20171017	Initial version

1 Introduction

The present document describes the NFC Tandem concept based on PN7150 NFC Controller (see [1]) and NTAG I^{2}C *plus* NFC connected tag (see [2]) sharing one unique antenna.

The NFC Tandem concept offers combination of "no power" NFC functionality of NTAG I^{2}C *plus* and full NFC functionality of PN7150 when powered on. NTAG I^{2}C *plus* being visible over NFC interface until the PN7150 gets enabled, basically when device is being powered-on. NTAG I^{2}C *plus* remaining accessible from the host through the I^{2}C interface.

This document first gives an overview of the use cases offered by NFC Tandem.

Then it presents the NFC Tandem reference design, providing matching guidelines and pointing to the related software ressources.

Finally it describes NFC Tandem demonstration setup.

2 Use Cases

Combining PN7150 Full NFC controller solution and NTAG I^{2}C *plus* zero-power operation, NFC Tandem concept enables innovative use cases.

The following examples relates to Gateways and Set Top Boxes applications but are of course not exhaustive and could also be applicable to some other applications.

Those use cases are shown using NFC Tandem demonstration setup (see Section 4).

2.1 Service configuration

As first step, NTAG I^{2}C *plus* memory could be initiliazed with a link to the Operator related phone application. This way, before powering-on the device (can even be done prior to unboxing), tapping his NFC phone user will be guided to download the application from the store. If already installed, the application will automatically be launched. The application can instruct the user how to connect and install the device.

Then the phone application can allow activating Gateway or Set Top Box device by transferring credentials to NTAG I^{2}C *plus* memory via NFC. This could eventually been done by in the shop by the merchant (device inbox). When powered-on, the host reading those credentials from the NTAG I^{2}C *plus* memory through I^{2}C can perform device activation over the network.

2.2 WiFi and IoT node pairing

When powered-on, the device can share WiFi credential of the network over NFC (thanks to PN7150). When tapped, NFC phones retrieving this information will automatically connect to the WiFi network without no other user action than simple confirmation. WiFi credential can also be transfered in the same way to another device e.g. a WiFi repeater.

PN7150 is also capable of retrieving NFC information offering simplified pairing of IoT nodes supporting NFC Smart commissioning: just tapping the node to the device allows getting it added to the network in a simple and secured way. For more details about Smart NFC commissioning refer to [4].

2.3 Error diagnostic and assistance

NTAG I^{2}C *plus* memory can be used to store useful information during runtime for later error diagnostic and assistance. These information being accessible from NFC interface when device is powered off (or in case of network issue), it can be interpreted by phone application to troubleshoot. Alternatively, it can be a source of analysis by manufacturer in case of customer return.

3 NFC Tandem reference design

3.1 Schematics

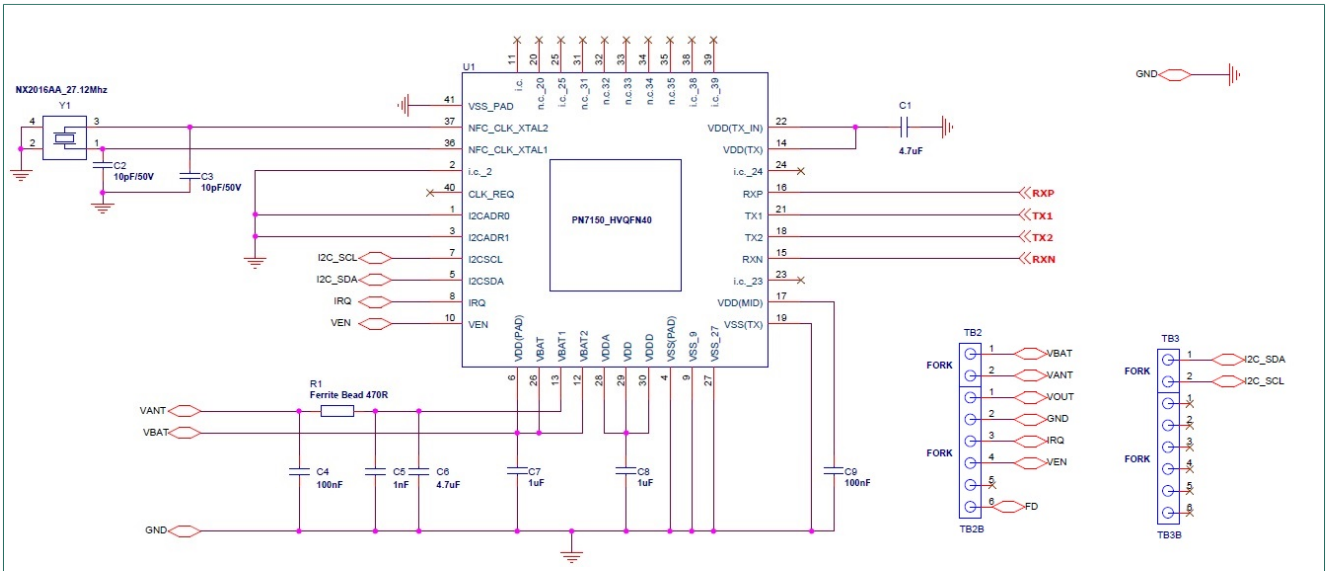

Figure 1. NFC Tandem reference design schematics - PN7150 and connectors

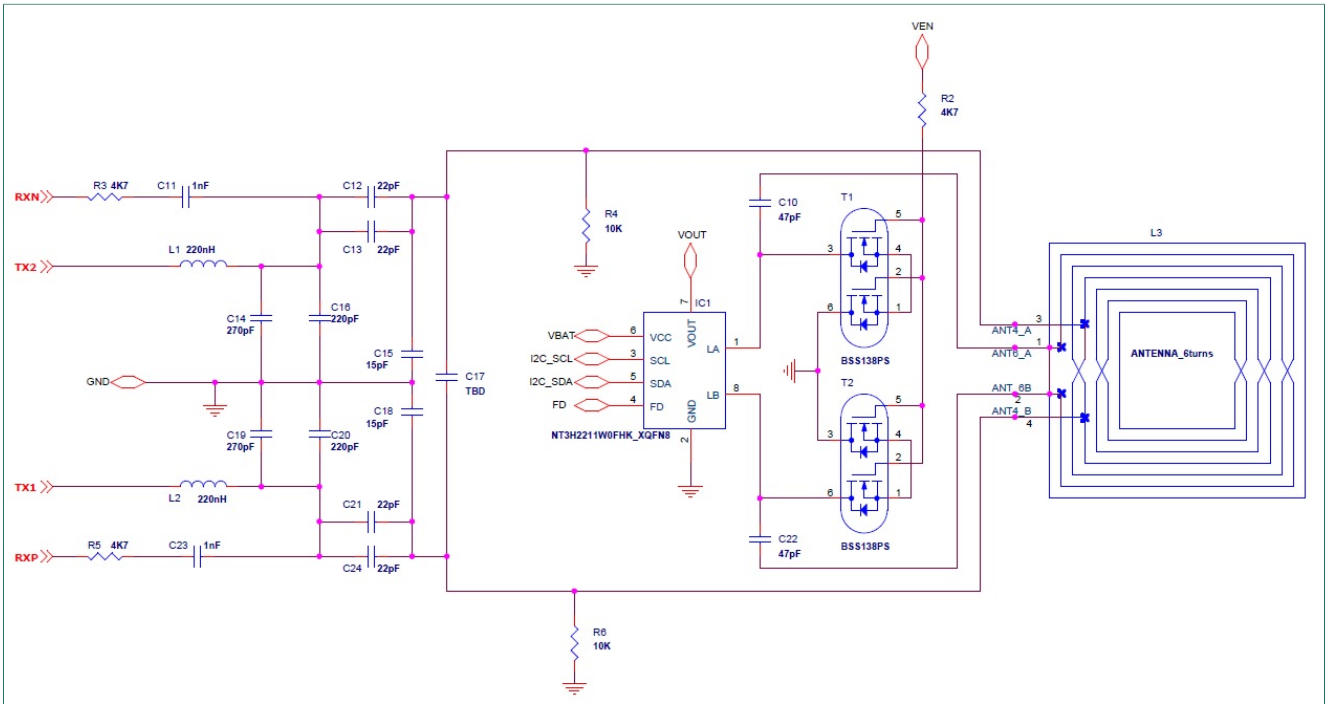

Figure 2. NFC Tandem reference design schematics - NtagI2C and antenna

3.2 Matching guide

The NFC Tandem reference design comprised of 2 matching/tuning areas, respectively for PN7150/NTAG I^{2}C *plus*, influencing each other.

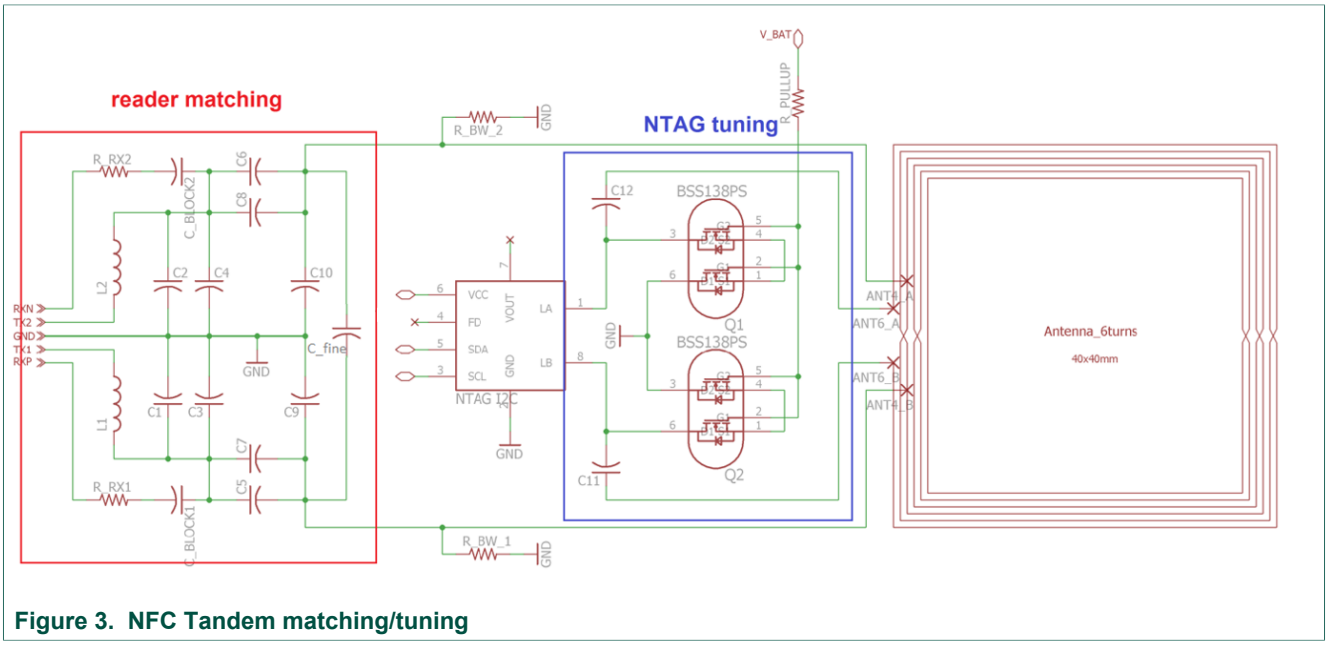

Figure 3. NFC Tandem matching/tuning

3.2.1 Step 1 - Reader matching

- Plug TX1 and TX2 to an NWA/NVA and enable the switching transistors (VBAT = High/3V3/5V)
- Just match like a "normal" reader matching using NWA / VNA
- Define matching impedance to e.g. 30Ohms
- Bandwitdh resistors serial or paralell (shown) possible
  - Parallel e.g. 10kOhms
  - Serial e.g. 1,8 Ohms

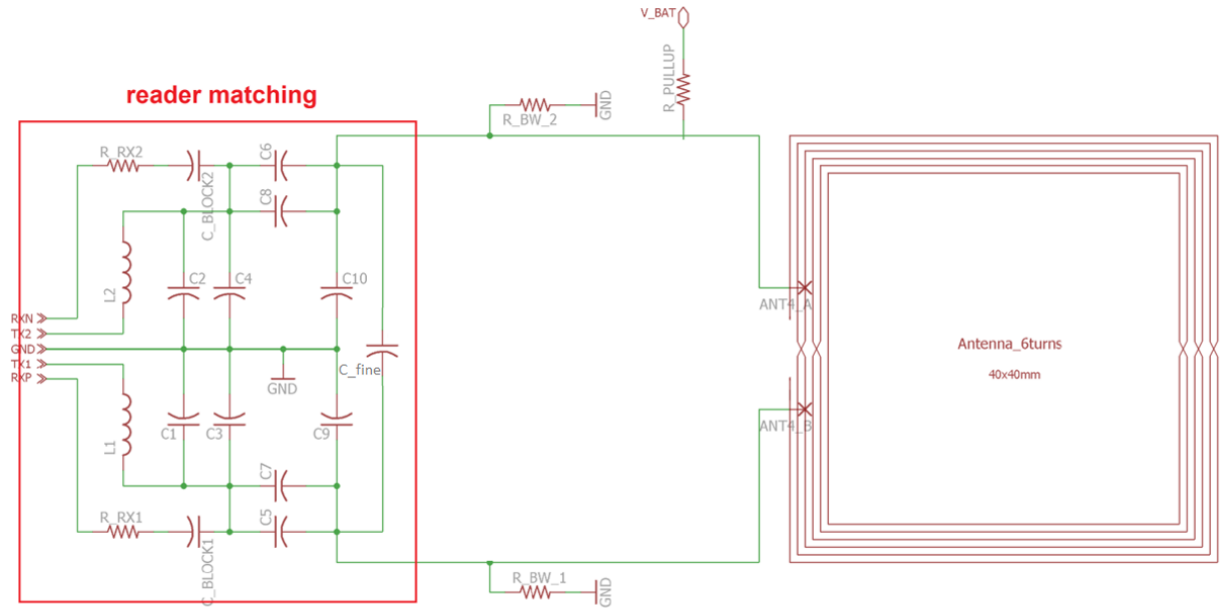

Figure 4. NFC Tandem reader matching

3.2.2 Step 2 - Ntag tuning

- Disable switching transistors (V_BAT = low/GND)
- Place 33pF for C11 & C12
  - Outcome will be that resonance frequency will be lower than 13,56MHz
  - Will be re-adjusted in the next step

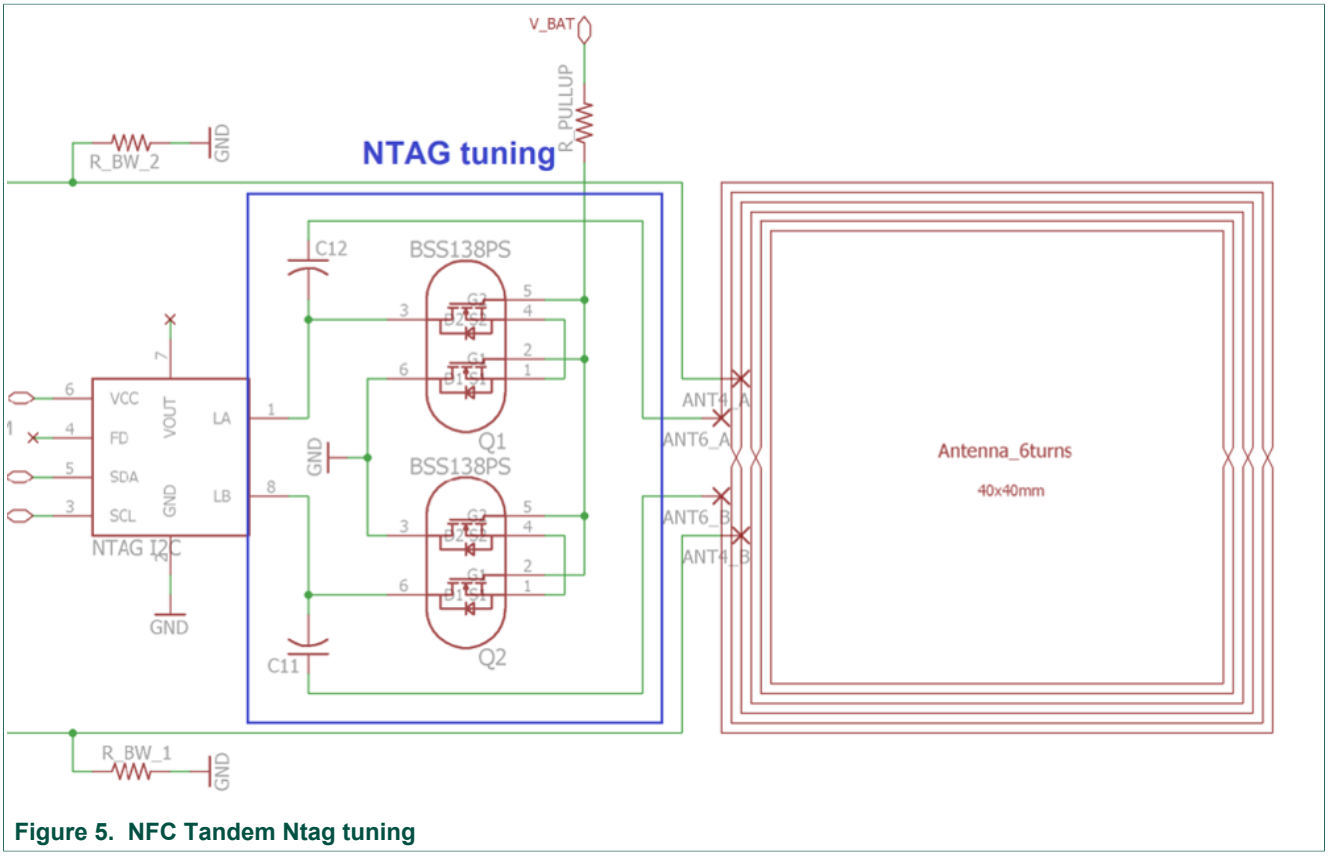

Figure 5. NFC Tandem Ntag tuning

3.2.3 Step 3 - Re-adjust reader matching

- Now the C9 & C10 values defined in Step 1 need to be re-adjusted
  - Therefore enable reader mode / disable NTAG
- Reduce C9 & C10 by 2 x C11(=C12)
  - e.g. C9 & C10 were 100pF à C11 = 33pF
  - New C9 & C10 = 100pF - 2x33pF = 34pF
- C_fine can now be used to fine tune the reader matching to 13,56MHz

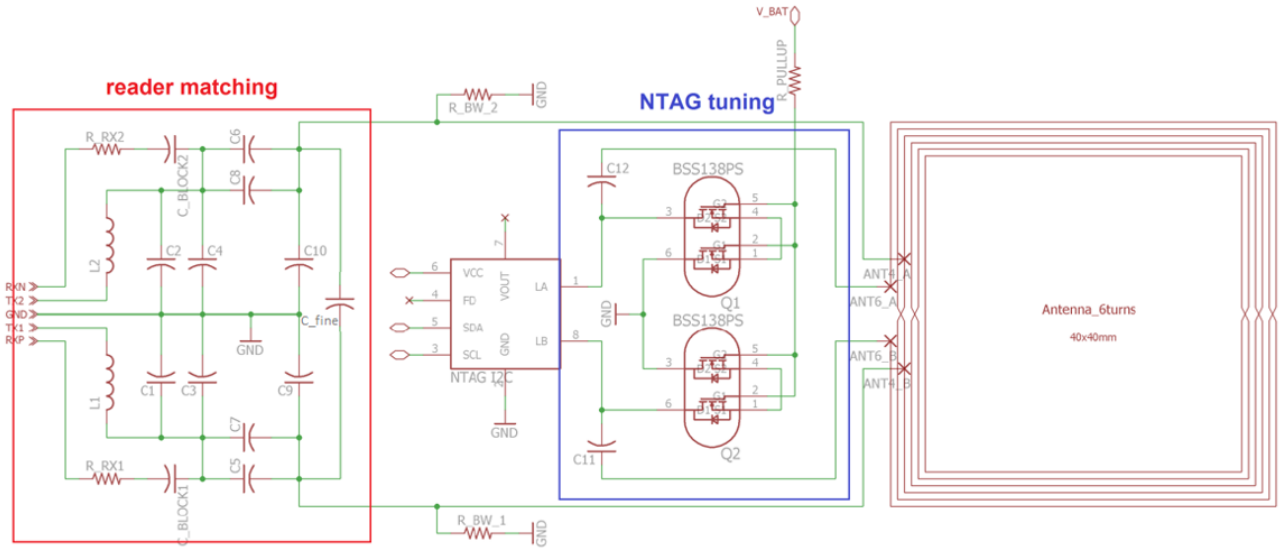

Figure 6. NFC Tandem reader matching re-adjusting

3.2.4 Step 4 - Check Ntag tuning

- Enable NTAG mode (see Step 1)
- Check resonance frequency
  - Use contactless method to check reflection on the antenna
  - Should be around 14.0 – 14.5 MHz

3.3 Software

Even if sharing the same I^2C bus, PN7150 and NTAG I^2C *plus* are independent from software perspective.

Refer to the respective software support for more information:

For PN7150 refer to [1], and for NTAG I^2C *plus* see [2].

4 NFC Tandem demonstration

NFC Tandem functionalities can be demonstrated using NFC Tandem reference design board together with OM29110/RPI or OM29110/ARD Interface boards (see [3]) respectively allowing connection to Raspberry Pi board (see [5]) or Arduino compatible boards (e.g. UDOO Neo see [6]).

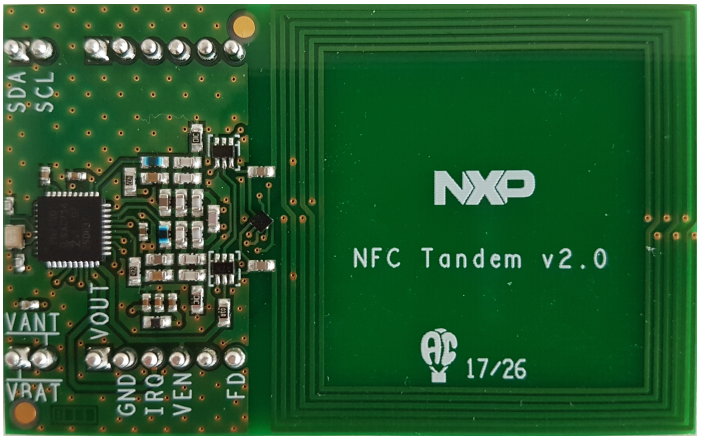

Figure 7. NFC Tandem board

4.1 Hardware setup

In order to run NFC Tandem demonstration, the following hardware pieces are required:

¤ a microSD card of at least 4Gb (2Gb sufficient for Raspberry Pi setup)

¤ and a computer board, either:

- Raspberry Pi, any B model (see [5])
  + WLan USB Module (except for Raspberry Pi 3 version where WiFi module is integrated): e.g. WiPi (see [14])

Figure 8. Raspberry Pi board and WiPi module

- or UDOO Neo Extended or Full version, since including WiFi module (see [6])

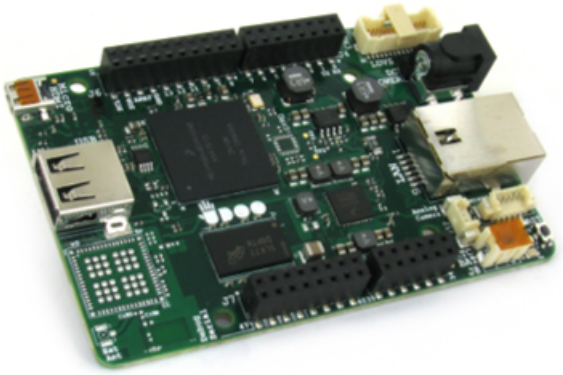

Figure 9. UDOO Neo board

4.2 Smartphone counterpart device

Additionally, an NFC Android phone with Lollipop (5.0) or later Android version is required.

The following 2 applications must be installed:

- NXP TagWriter (see [7])
- NTAG I2C Demoboard (see [8])

4.3 Initial setup

Follow the following steps during initial setup of the NFC Tandem demo (only first time using NFC Tandem board):

1. Download NFC Tandem demo image, either Raspberry Pi (see [9]) or UDOO Neo (see [10]) related one
2. Write the image to µSD card following instructions for Raspberry Pi (see [11]) or UDOO Neo (see [12])
3. Assemble the NFC Tandem board on the Raspberry Pi or UDOO Neo and insert the µSD card
4. Format* the NTAG I^2C *plus* embedded in the Tandem board using 'NTAG I2C Demo' application, « CONFIG » -> « Reset Tag » function

Figure 10. NTAG I2C Demo application "CONFIG" page

** The NTAGI2C+ is not NDEF formatted during production and NXP TagWriter Android application doesn't suceed to format it*

4.4 Demonstration

At this step NTAG I^{2}C *plus* is accessible over NFC interface while the Raspberry Pi or UDOO Neo is not powered ON. Using NXP TagWriter Android application, it is possible to read and write NDEF information from/to NTAG I^{2}C *plus* memory.

Then, when powering ON the Raspberry Pi or UDOO Neo, the demo image is reading the NTAG I^{2}C *plus* memory via I^{2}C interface, and if NDEF WiFi Connection Handover information is found it will use the credential to broadcast related WiFi network. Now the NTAG I^{2}C *plus* memory is not anymore visible over NFC interface, instead the PN7150 is sharing alternatively:

- NDEF WiFi Connection Handover information of the broadcasted WiFi network offering smart connection of an NFC phone when tapped
- NDEF URL information allowing opening NFC Tandem demo page (shared from the Raspberry Pi or UDOO Neo over the WiFi network) on NFC phone when tapped

PN7150 is also capable to read NFC Forum tags and display related information to the NFC Tandem demo page (previously opened from the NFC phone following previous step).

In the NFC Tandem demo page, a button allows to write NDEF information (NDEF Text message simulating an error log) to the NTAG I^{2}C *plus* memory via the I^{2}C

interface when pressed. This way, after unpowering the Raspberry Pi or UDOO Neo, this information can be retrieved over the NFC interface by tapping the NFC phone.

You can refer to the NFC Tandem video (see [13]) of the demonstration for more illustrated details.

4.4.1 Demo #1 Service Configuration

Pre-requisite: Access the NTAG I^{2}C *plus* via NFC (board unpowered), within 'NXP TagWriter' application, create a new dataset of type "Launch Application" for "com.nxp.nfc.tagwriter" as package name, and write it to the NTAG I^{2}C *plus* memory.

1. Before powering the board, just tap the NFC phone to the antenna. This trigger automatic launch of the 'NXP TagWriter' application.
2. Within 'NXP TagWriter' application, create a new dataset of type "wifi" defining SSID name and password (8 characters minimum) as you wish (**use WPA2 for authentication and AES for encryption**), and write it to the NTAG I^{2}C *plus* memory.
3. Power on the board, WiFi network becomes visible (can be observed from the phone WiFi settings).

4.4.2 Demo #2 WiFi connection and IoT nodes pairing

Pre-requisite: continue right after demo #1.

1. Tap the phone to the NFC Tandem (board still powered on), PN7150 will "push" Wifi credentials to the phone which then gets connected to the WiFi network.
2. Tap again the phone, it opens a webpage on the phone where NFC functionality of the NFC Tandem board is displayed. Tapping any NFC device on the NFC Tandem antenna then triggers related details into this webpage.

4.4.3 Demo #3 Error diagnostic and assistance

Pre-requisite: continue right after demo #2.

1. On the phone, click on the "Error log" button (inside the NFC Tandem demo page opened during demo #2). It triggers writing a fake error message inside the NTAG I^{2}C *plus* memory.
2. Power down the board, then Tap the phone. The error logs will be displayed on the phone.

5 References

[1] PN7150B0HN: High performance NFC controller, supporting all NFC Forum modes, with integrated firmware and NCI interface

https://www.nxp.com/products/identification-and-security/nfc/nfc-reader-ics/nfc-controller-solutions/high-performance-nfc-controller-supporting-all-nfc-forum-modes-with-integrated-firmware-and-nci-interface:PN7150B0HN?&tab=Documentation_Tab

[2] NTAG I^2C *plus*, NFC Forum Type 2 Tag with I^2C interface

https://www.nxp.com/products/identification-and-security/nfc/nfc-tags-for-electronics/ntag-ic-iplus-i-nfc-forum-type-2-tag-with-ic-interface:NT3H2111_2211

[3] OM29110 NFC's SBC Interface Boards User Manual

https://www.nxp.com/docs/en/user-guide/UM10956.pdf

[4] Simplifying IoT: Connecting, Commissioning, and Controlling with Near Field Communication (NFC) White Paper

https://nfc-forum.org/iot-stakeholders/

[5] The Raspberry Pi is a low cost, credit-card sized computer that plugs into a computer monitor or TV, and uses a standard keyboard and mouse. It is a capable little device that enables people of all ages to explore computing, and to learn how to program in languages like Scratch and Python. It's capable of doing everything you'd expect a desktop computer to do, from browsing the internet and playing high-definition video, to making spreadsheets, word-processing, and playing games.

For more information about it please visit http://www.raspberrypi.org/

[6] UDOO NEO is an all-in-one open hardware low-cost computer equipped with NXP's i.MX 6SoloX applications processor for Android and Linux.

For more information about it please visit http://www.udoo.org/udoo-neo/

[7] NXP TagWriter https://play.google.com/store/apps/details?id=com.nxp.nfc.tagwriter

[8] NTAG I2C Demoboard https://play.google.com/store/apps/details?id=com.nxp.ntagi2cdemo

[9] NFC Tandem demo image for Raspberry Pi

https://community.nxp.com/external-link.jspa?url=https%3A%2F%2Fwww.nxp.com%2Fdoc%2FTANDEM-RPI-LINUX

[10] NFC Tandem demo image for UDOO Neo

https://community.nxp.com/external-link.jspa?url=https%3A%2F%2Fwww.nxp.com%2Fdoc%2FTANDEM-UDOO-LINUX

[11] Raspberry Pi instructions for flashing image to SD card

https://www.raspberrypi.org/documentation/installation/installing-images/

[12] UDOO Neo instructions for flashing image to SD card

https://www.udoo.org/docs-neo/Getting_Started/Create_a_bootable_MicroSD_card_for_UDOO_Neo.html

[13] Video of the NFC Tandem demonstration

https://community.nxp.com/docs/DOC-340244

[14] WiPi - WLAN USB Module, 802.11n

http://www.newark.com/element14/wipi/module-wifi-usb-for-raspberry-pi/dp/07W8938

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Figures

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