User's Guide
SLOU386 – May 2014

NFCLink Firmware User's Guide

NFCLink is a complete Near Field Communications (NFC) Firmware and Software solution that Texas Instruments has developed in conjunction with a third party. The hardware used is either a combination of MSP-EXP430F5529 and TRF7970ATB, or a combination of the MSP-EXP430F5529LP and DLP-7970ABP. The total solution is intended to be used for developing applications that require any or all of the possible NFC modes, with a variety of operating systems such as Windows, Android, and Ubuntu.

Integration of NFC into end equipment is growing rapidly (on a worldwide scale) and spanning across consumer, medical, retail, industrial, automotive and smart grid application spaces. This solution is a modular platform (firmware and hardware) designed to not only make it easier for the field to promote the TRF7970A and Texas Instruments microcontrollers in these mentioned areas, but also to serve as a powerful development tool for customers to use immediately for integration into their product. The firmware is provided as a project library with API Stack examples for all three modes of NFC operations.

Topic **Page**

1 Export Control Notice

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2 Description

NFCLink is the market name for a TI based hardware; firmware library and software stack solution for Near Field Communications (NFC). Integration of NFC into end equipment is growing rapidly (on a worldwide scale) and spanning across Consumer, Medical, Retail, Industrial, Automotive and Smart Grid application spaces.

This solution is a modular platform (firmware and hardware) designed to not only make it easier for the field to promote the TRF7970A and TI microcontrollers in these mentioned areas, but also serve as a powerful development tool for customers to use immediately for integration into their product.

The firmware is provided as a project library with API Stack examples for all three modes of NFC operations. The hardware required to demonstrate the capabilities of the solution consists of the following:

- MSP-EXP430F5529 Experimenters board and a TRF7970ATB (plugged onto MSP-EXP430F5529 RF1 & RF2 headers)
- An easy to use GUI running on Windows PC for demonstrating the NFC/RFID reader/writer, peer to peer and card emulation modes.
- The OS stack (NFCStack +Eva, from our partner Stollmann) current offerings are running on Win6.5, WinXP, Win7 and Win8.

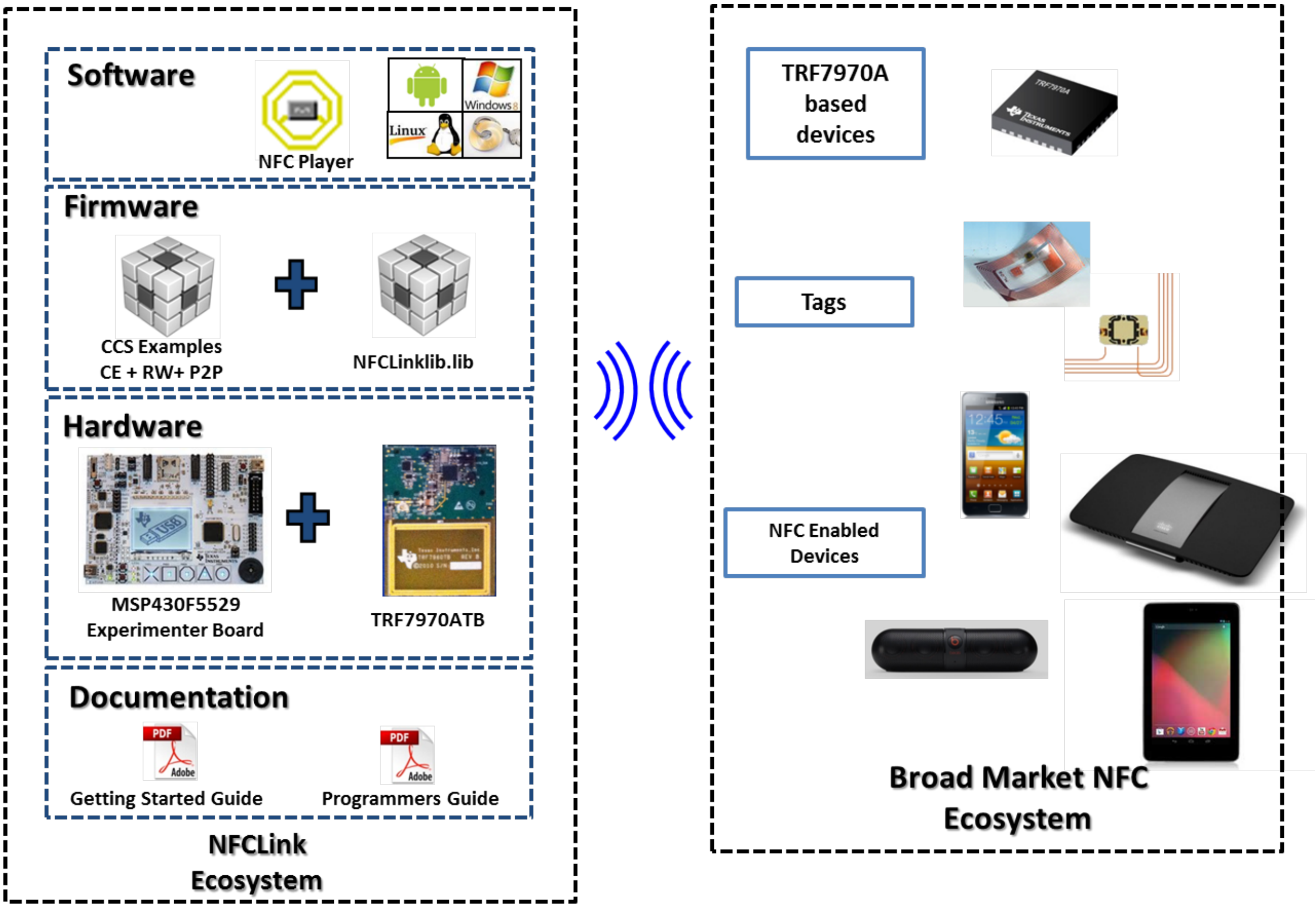


Figure 1. Kit Contents and Target Applications

3 Hardware Requirements

The hardware required to demonstrate the capabilities of the solution consists of the following:

- MSP-EXP430F5529 Experimenters board
- TRF7970ATB (plugged onto MSP-EXP430F5529 RF1 & RF2 headers)
- CCS Project including nfclinklib.lib (for developers)

  Or
- a TI provided binary file (loaded onto the MSP430F5529, for initial demo purposes)
- Instructions for downloading firmware
- link to end section of this document
- USB cable (USB-A to Mini-B)
- NFCLink (downloaded from http://www.ti.com/tool/nfclink)

4 Stack Definition and Function

The Stollmann NFaCe+SPA Evaluation Application demonstrates the functionality of the Stollmann NFC stack (NFaCe+SPA) on an application user interface. It supports Intel, ARM, Cortex and other CPUs. NFCLink uses NFCStack + Eva (Evaluation Application).

The package contains the graphical user interface (GUI) and currently supports the following:

- NFC Modes
  - NFC Read/Write Operations
  - Peer to Peer Operations, including SNEP
  - Host-based Card Emulation
- NFC Tag Platform Types:
  - Type 2 (MIFARE Ultralight, Ultralight C, Infineon my-d™ move, my-d™ move NFC)
  - Type 3 (Sony FeliCa Lite (RC-S965), FeliCa Lite-S (RC-S966))
  - Types 4A & 4B (ISO14443A/B)
  - Type V (ISO15693)
- NFC Controller Interface (NCI), with extensions

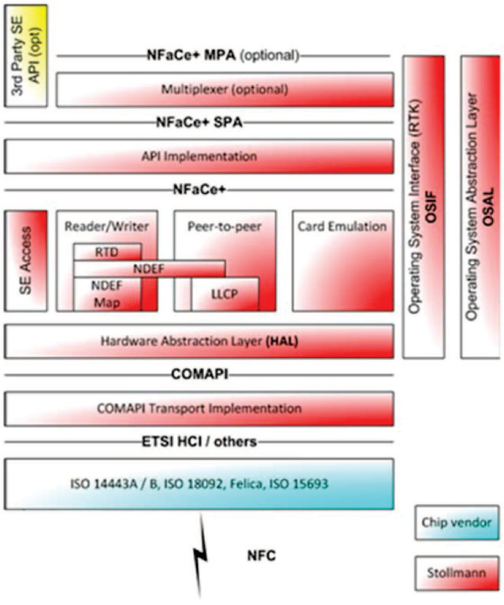


Figure 2. NFCStack + Eva Architecture

5 Integrating the NFCLink Stack

In an actual application, the NFCStack+ would be compiled as:

- a driver component into the OS using applicable compiler and the supplied source code. (host integration / integrated host) NFC module – Run full or parts of the protocol stack on a dedicated CPU w/memory (commonly used for high volume/lower cost, automotive or POS applications)
- OS to NFC Controller (embedded MCU + TRF7970A) – same as first example, but running the stack on the OS.
  - This is basically what the NFCLink solution is currently.

The simplified block diagram of the NFCLink Architecture is shown in Figure 3, where the host could be A8/A9, ARM or other MPU, the embedded MCU could be ARM, MSP430 and the TRF7970A is the NFC transceiver. NFC or RFID devices could be passive tags, other NFC devices (speakers) or NFC enabled handsets/tablets.

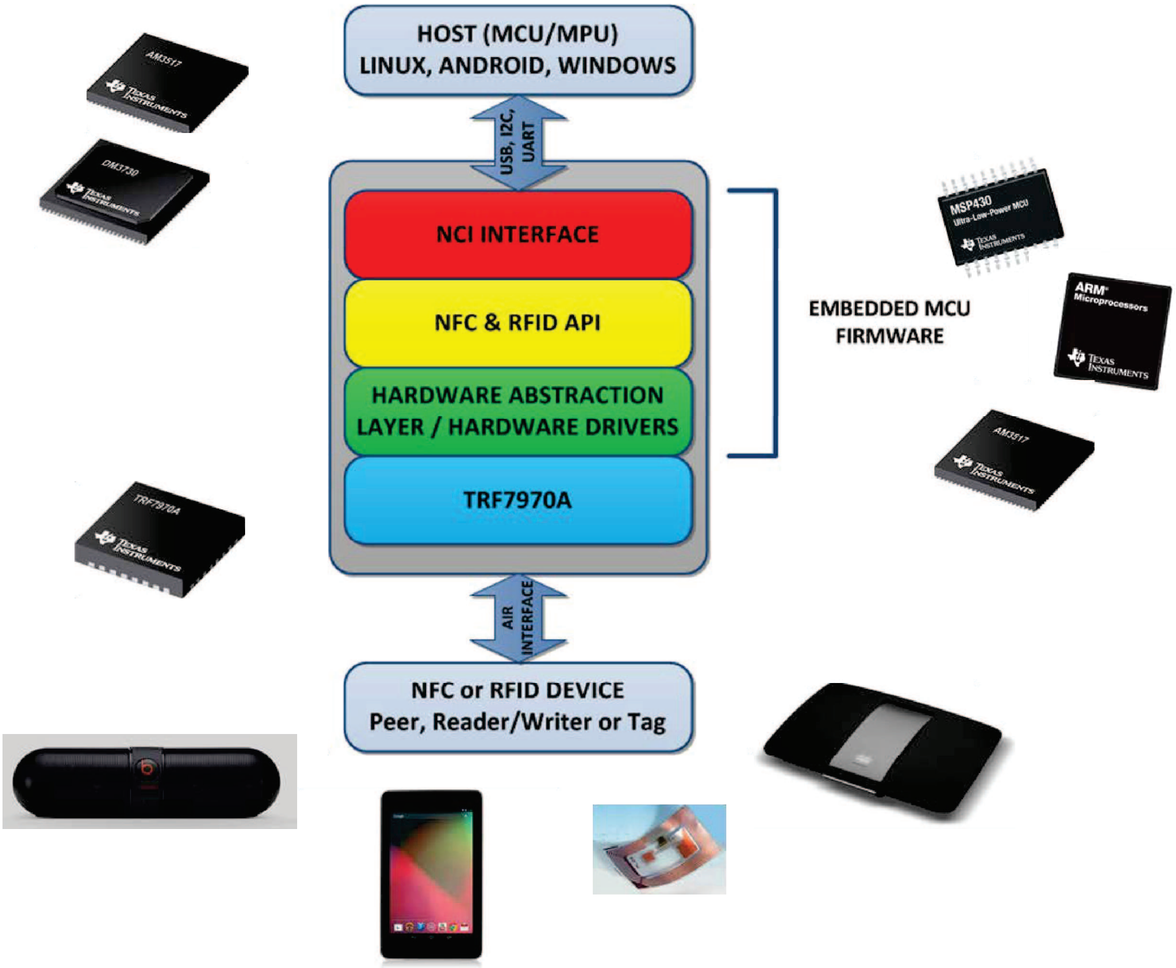


Figure 3. Simplified Block Diagram of NFCLink Architecture

There are MSP430 object code and source code components, with the source code components being the necessary ones needed by the developer to modify for different MSP430 MCUs, while the object code portions are specific to NFC and RFID functions that are completed, thus making it simple for the customer developing a solution just to use it and not have to research and learn all about the low level details of how NFC or RFID works.

Other components of the release are:

- NFCStack+Eva_r6.0.47.5_RC.exe – Windows GUI installer
- NFCLink compiled library (nfclinklib.lib)
- CCS Projects
  - RW_P2P_CE1_Example – for USB CDC applications
  - RW_P2P_CE2_Example – for UART applications

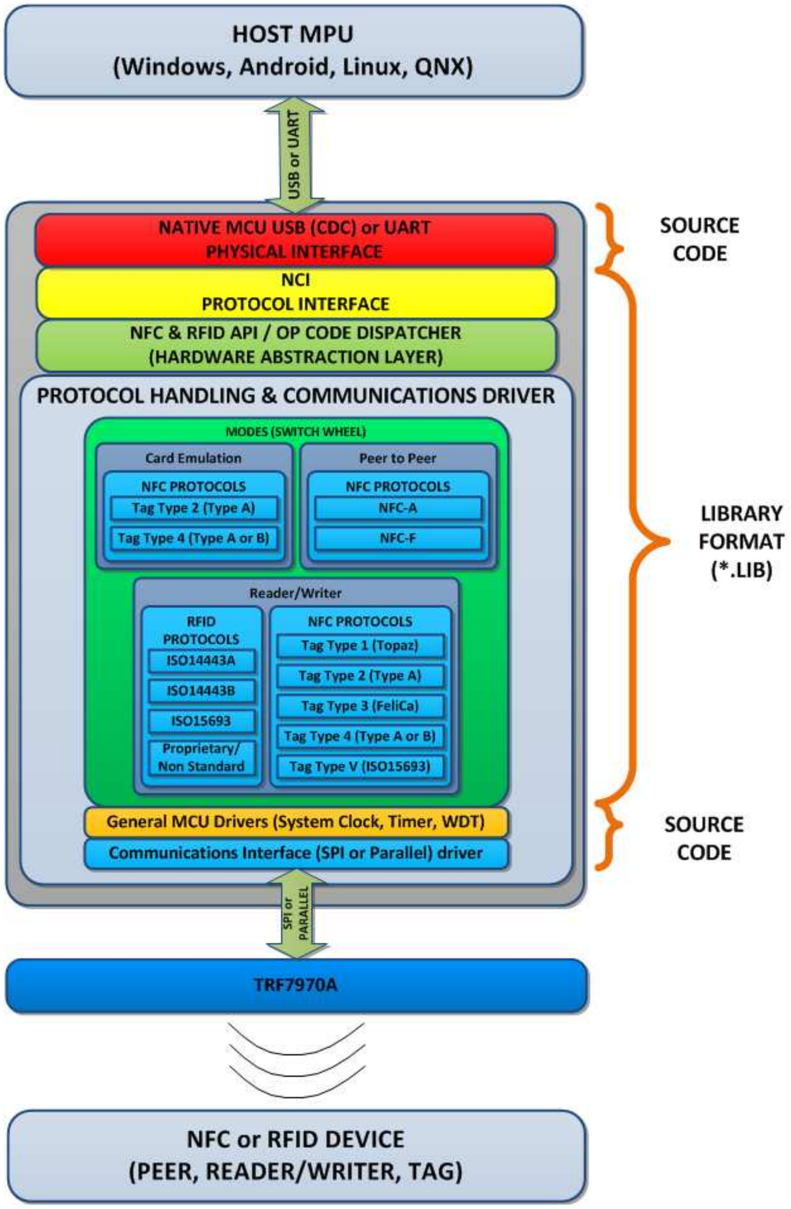


Figure 4. Delivery Format of Available Code

6 Hardware Configuration

Shown in Figure 5 is the NFCLink hardware configuration using the MSP-EXP430F559 and the TRF7970ATB.

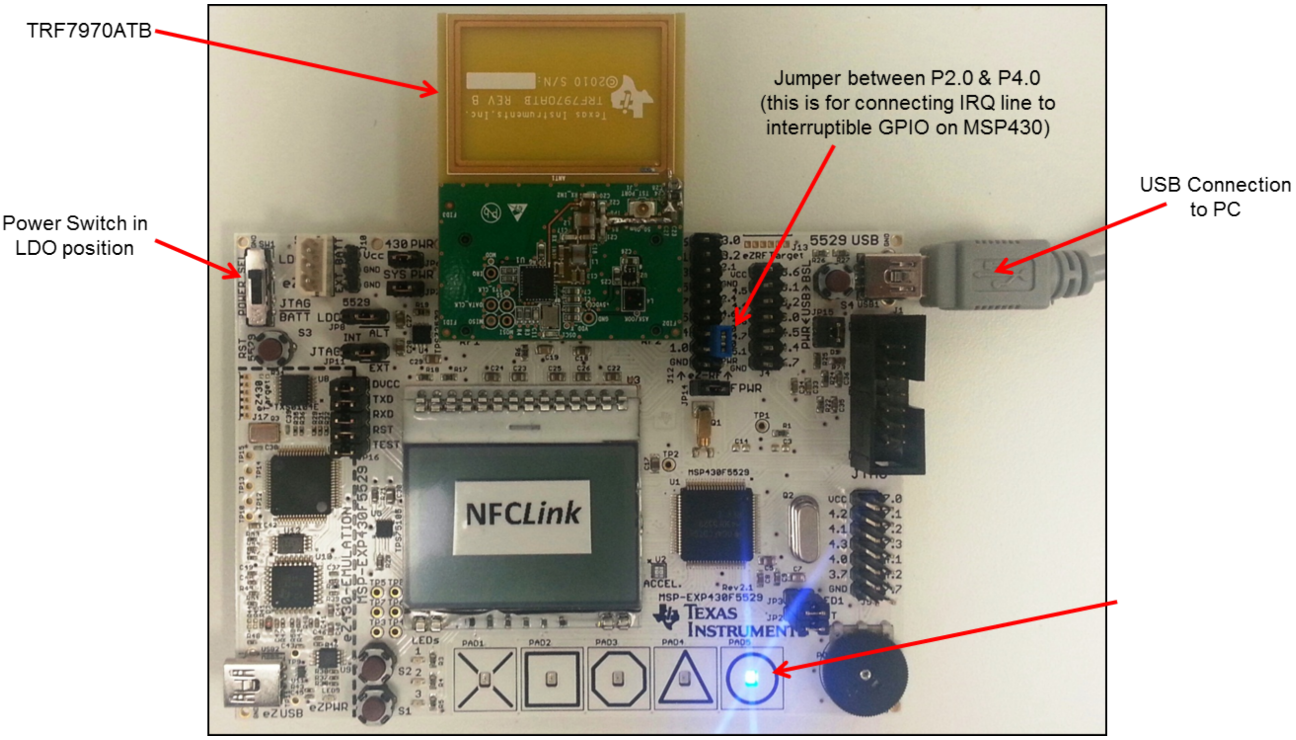

TRF7970ATB
Jumper between P2.0 & P4.0 (this is for connecting IRQ line to interruptible GPIO on MSP430)
USB Connection to PC
Power Switch in LDO position
NFCLink

Figure 5. NFCLink Hardware

7 Loading the Code Project

7.1 Download the Flash Programming Tool

Users can download, unzip and install one of two tools to load the binary file into the hardware.

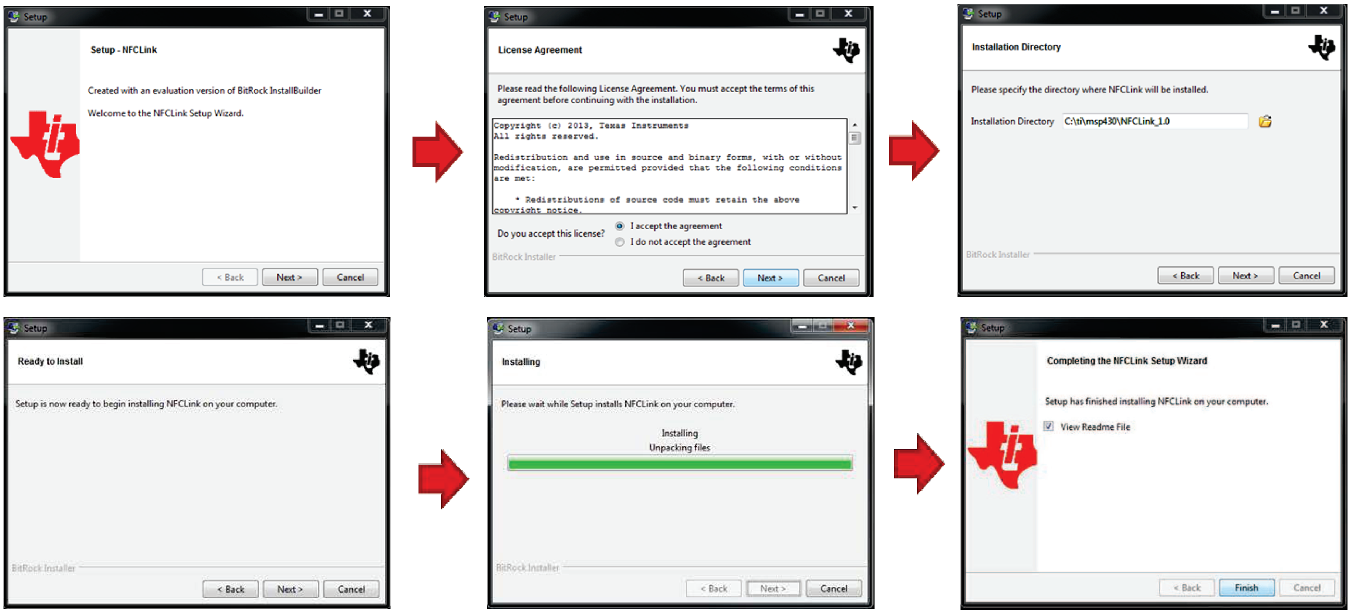
- http://processors.wiki.ti.com/index.php/Category:CCS_UniFlash

  Or

- http://www.elprotronic.com/files/FET-Pro430-Lite-Setup.zip

7.2 Download and Install the NFCLink Package

First, download the NFCLink Installer Package. Then, follow the installer instructions.



Setup - NFCLink

Created with an evaluation version of BitRock InstallBuilder

Welcome to the NFCLink Setup Wizard.

License Agreement

Please read the following License Agreement. You must accept the terms of this agreement before continuing with the installation.

```
Copyright (c) 2013, Texas Instruments
All rights reserved.

Redistribution and use in source and binary forms, with or without
modification, are permitted provided that the following conditions
are met:

   * Redistributions of source code must retain the above
copyright notice,
```

Do you accept this license? ● I accept the agreement ○ I do not accept the agreement

Installation Directory

Please specify the directory where NFCLink will be installed.

Installation Directory C:\ti\msp430\NFCLink_1.0

Ready to Install

Setup is now ready to begin installing NFCLink on your computer.

Installing

Please wait while Setup installs NFCLink on your computer.

Installing
Unpacking files

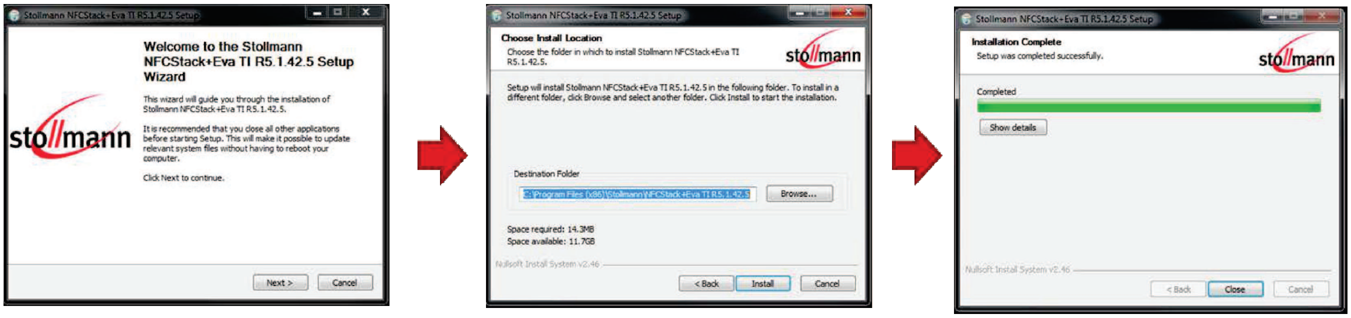
Completing the NFCLink Setup Wizard

Setup has finished installing NFCLink on your computer.

☑ View Readme File

Figure 6. NFCLink Installation Process

After NFCLink package has finished installation, NFCPlayer GUI installation will begin in a new window, as seen in Figure 7.



Welcome to the Stollmann NFCStack+Eva TI R5.1.42.5 Setup Wizard

This wizard will guide you through the installation of Stollmann NFCStack+Eva TI R5.1.42.5.

It is recommended that you close all other applications before starting Setup. This will make it possible to update relevant system files without having to reboot your computer.

Click Next to continue.

Choose Install Location

Choose the folder in which to install Stollmann NFCStack+Eva TI R5.1.42.5.

Setup will install Stollmann NFCStack+Eva TI R5.1.42.5 in the following folder. To install in a different folder, click Browse and select another folder. Click Install to start the installation.

Destination Folder C:\Program Files (x86)\Stollmann\NFCStack+Eva TI R5.1.42.5

Space required: 14.3MB
Space available: 11.7GB

Installation Complete

Setup was completed successfully.

Completed

Stollmann NFCStack+Eva TI R5.1.42.5 Setup
stollmann
Browse...
Show details
Nullsoft Install System v2.46
< Back
Next >
Install
Close
Cancel

Figure 7. NFCPlayer GUI Installation Process

7.3 Download the Code Project onto the MSP-EXP430F5529

After retrieving and installing one of the Flash Programming tools, connect the USB-A end of provided USB cable to PC and mini-USB end of cable to the ezUSB connector on MSP-EXP430F5529 board. (see Figure 8 below).

Switch the POWER SEL switch on MSP-EXP430F559 board to the eZ position (middle position, see Figure 8)

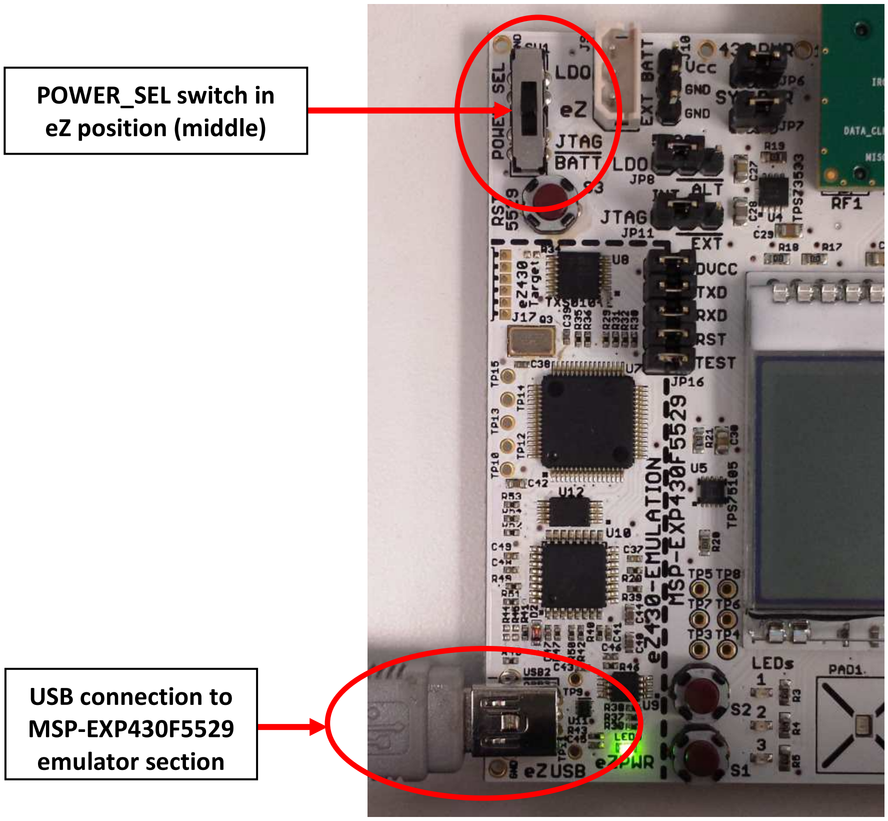

POWER_SEL switch in eZ position (middle)
USB connection to MSP-EXP430F5529 emulator section

Figure 8. Connection and Configuration for Programming MSP430 Flash

Open Flash Programming tool of choice (both tools will be covered here)

7.3.1 Using Uniflash

1. Open Uniflash tool
2. Click File, choose New Target Configuration

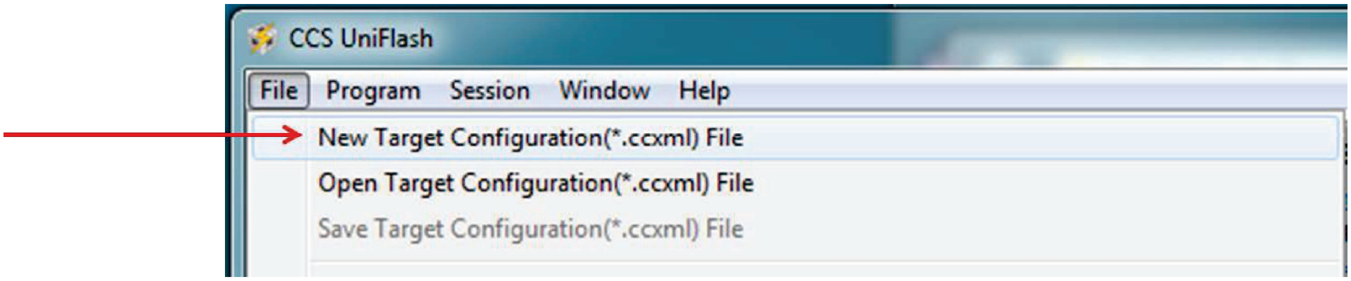
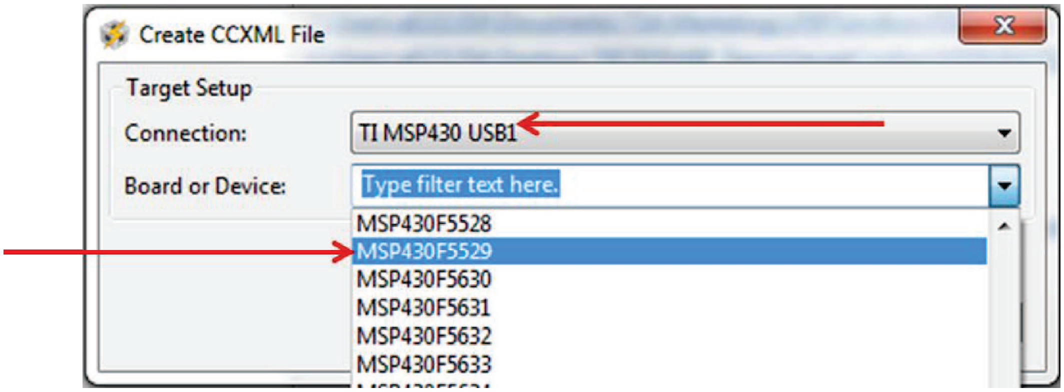

CCS UniFlash
File
Program
Session
Window
Help
New Target Configuration(*.ccxml) File
Open Target Configuration(*.ccxml) File
Save Target Configuration(*.ccxml) File

Figure 9.

3. Select Connection (USB1) and select MSP430F5529 Device



Create CCXML File

Target Setup

Connection: TI MSP430 USB1

Board or Device: Type filter text here.

MSP430F5528
MSP430F5529
MSP430F5630
MSP430F5631
MSP430F5632
MSP430F5633

Figure 10.

4. Load the Target Binary by clicking Program and choosing Load Program

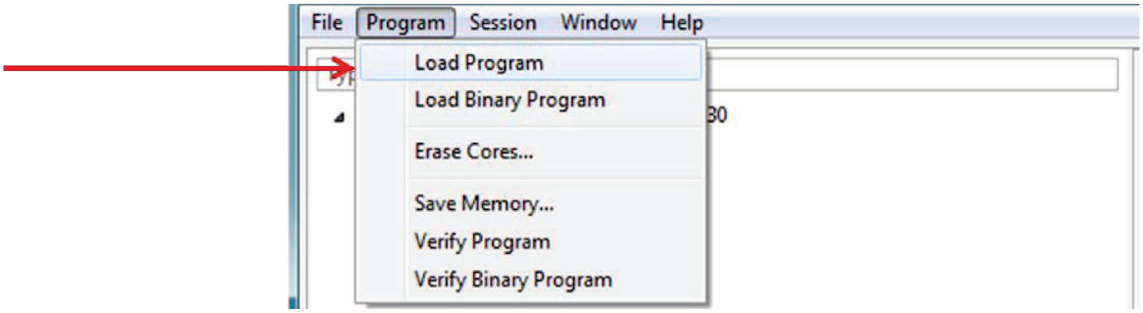
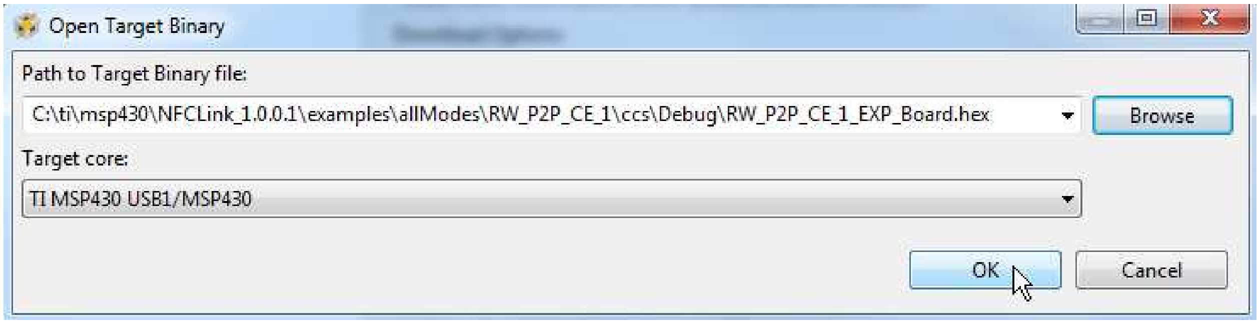


Figure 11.

5. Select path to: `C:\ti\msp430\NFCLink_1.0.0.1\examples\allModes\RW_P2P_CE_1\ccs\Debug\RW_P2P_CE_1.hex`



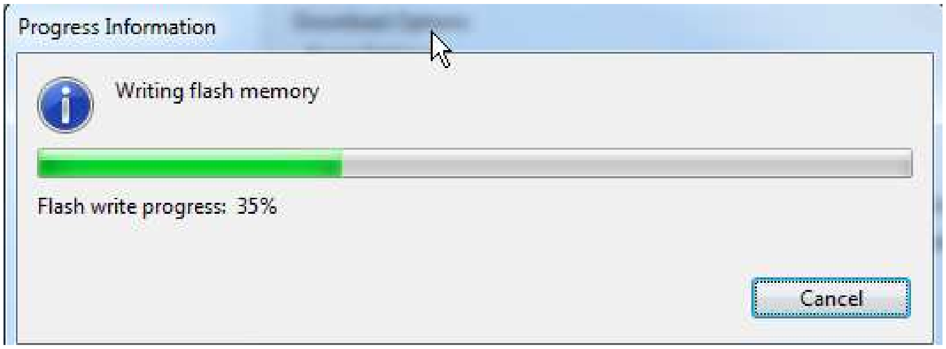
Open Target Binary

Path to Target Binary file: C:\ti\msp430\NFCLink_1.0.0.1\examples\allModes\RW_P2P_CE_1\ccs\Debug\RW_P2P_CE_1_EXP_Board.hex

Target core: TI MSP430 USB1/MSP430

Figure 12.

6. Hit OK and board will program



Writing flash memory

Flash write progress: 35%

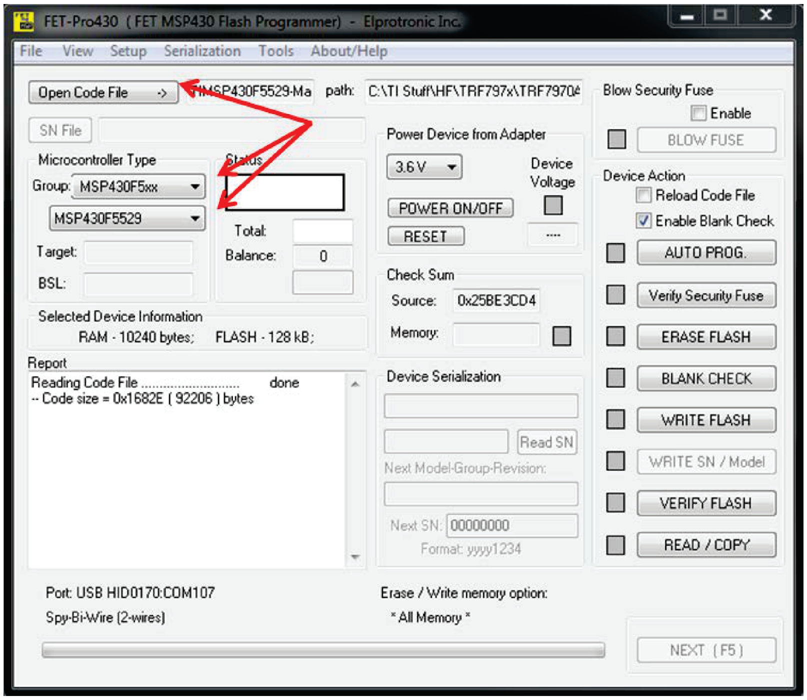
Figure 13.

7.3.2 Using Elprotronic

1. Open Elprotronic tool
2. In upper left corner of the GUI, press Open Code File Button and navigate to where provided FW image is stored on PC and select it.
   - Path is:

   `C:\ti\msp430\NFCLink_1.0.0.1\examples\allModes\RW_P2P_CE_1\ccs\Debug\RW_P2P_CE_1.hex`

3. Choose Microcontroller Type Group: (using dropdown) MSP430F5xx
4. Choose (using dropdown) MSP430F5529



MSP430F5529-Ma path: C:\TI Stuff\HF\TRF797x\TRF7970A

Microcontroller Type
Group: MSP430F5xx
MSP430F5529
Target:
BSL:

Total:
Balance: 0

Device Voltage: 3.6 V

☐ Enable

☐ Reload Code File
☑ Enable Blank Check

Check Sum
Source: 0x25BE3CD4
Memory:

Selected Device Information
RAM - 10240 bytes; FLASH - 128 kB;

Report
Reading Code File .... done
-- Code size = 0x1682E (92206) bytes

Device Serialization
Next Model-Group-Revision:
Next SN: 00000000
Format: yyyy1234

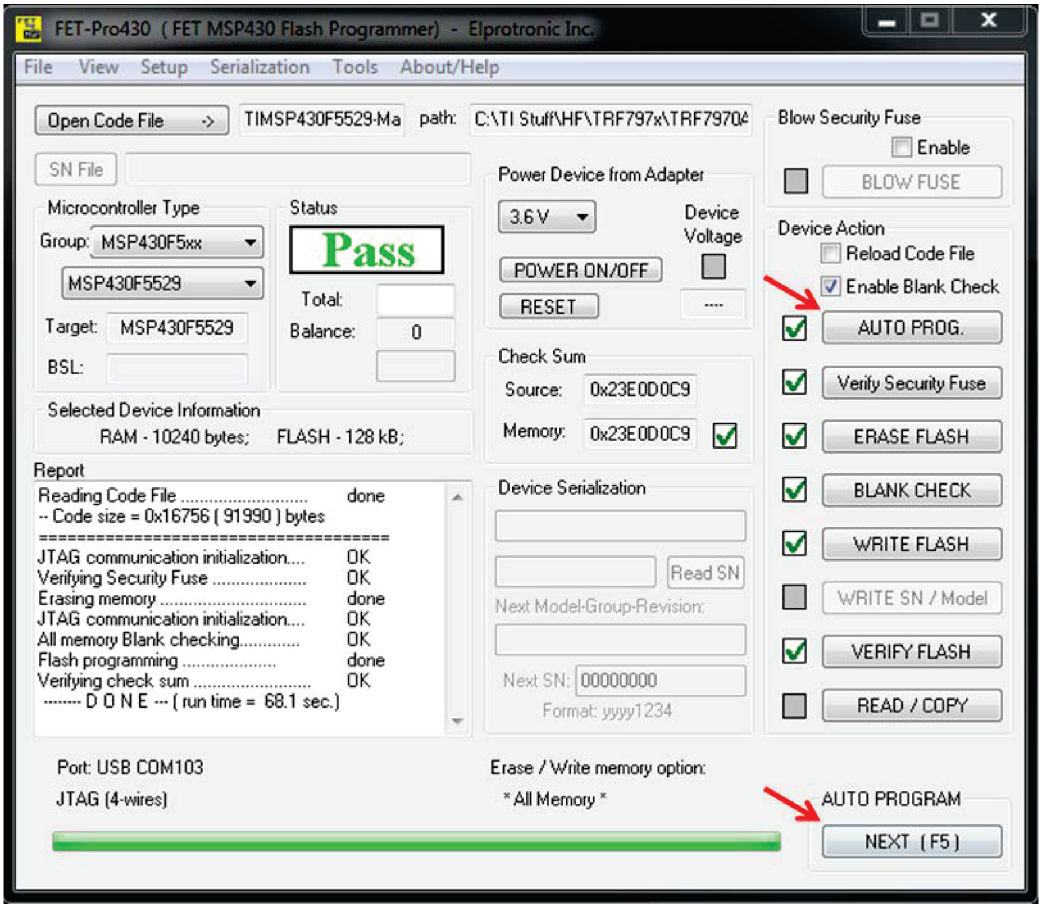
Port: USB HID0170:COM107
Spy-Bi-Wire (2-wires)

Erase / Write memory option:
" All Memory "

Figure 14.

5. Press the AUTO PROG. button in the Elprotronic tool and allow the tool to complete the steps.

NOTE: If more than one board is to be programmed at this time, the NEXT (or F5) button can be used to program additional units instead repeating all the steps.



FET-Pro430 (FET MSP430 Flash Programmer) - Elprotronic Inc.

TIMSP430F5529-Ma path: C:\TI Stuff\HF\TRF797x\TRF7970A

Microcontroller Type
Group: MSP430F5xx
MSP430F5529
Target: MSP430F5529
BSL:

Status: Pass
Total:
Balance: 0

Power Device from Adapter: 3.6 V
Device Voltage: ----

Blow Security Fuse
□ Enable

Device Action
□ Reload Code File
☑ Enable Blank Check
☑ AUTO PROG.
☑ Verify Security Fuse
☑ ERASE FLASH
☑ BLANK CHECK
☑ WRITE FLASH
□ WRITE SN / Model
☑ VERIFY FLASH
□ READ / COPY

Selected Device Information
RAM - 10240 bytes; FLASH - 128 kB;

Check Sum
Source: 0x23E0D0C9
Memory: 0x23E0D0C9 ☑

Device Serialization
Next Model-Group-Revision:
Next SN: 00000000
Format: yyyy1234

Report

```
Reading Code File ..........................      done
-- Code size = 0x16756 ( 91990 ) bytes
======================================
JTAG communication initialization....        OK
Verifying Security Fuse ...................  OK
Erasing memory ..............................done
JTAG communication initialization....        OK
All memory Blank checking............        OK
Flash programming ....................       done
Verifying check sum ........................ OK
 -------- D O N E --- ( run time =  68.1 sec.)
```

Port: USB COM103
JTAG (4-wires)

Erase / Write memory option:
* All Memory *

AUTO PROGRAM

Figure 15.

After flashing the MSP430F5529 (with either tool), disconnect the mini-USB cable connector from the eZ USB board connector, move the POWER SEL switch to the LDO position (topmost), and then connect the mini-USB cable connector to 5529 USB board connector as shown in Figure 16.

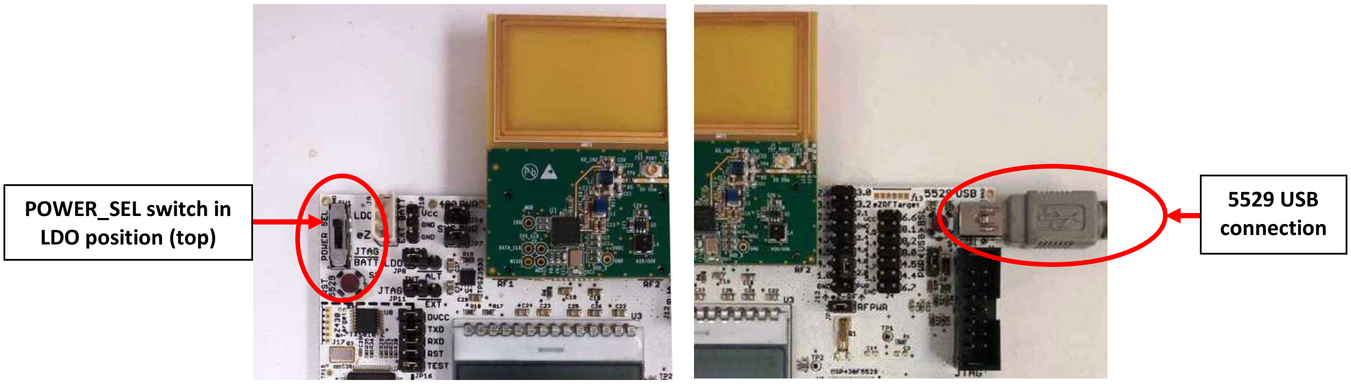


Figure 16. Connecting Mini-USB Cable to 5529 USB Board

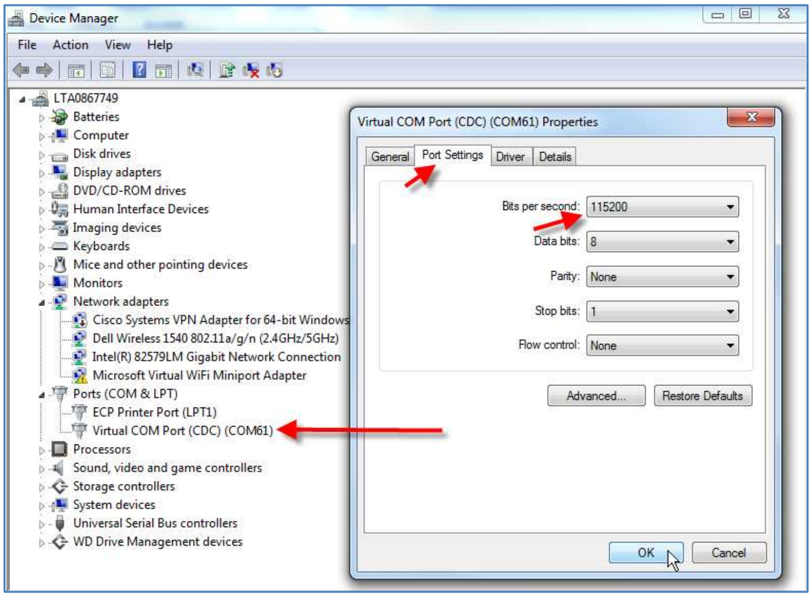
8 Installing USB Driver

If the USB driver is not automatically detected and used when the 5529 USB connection is made, then PC can be pointed to USB driver .inf file (1CDC_descTool.inf) which will be located in this directory (after NFCLink is installed):

```
C:\ti\msp430\NFCLink_1.0.0.1\usblib430\Source\USB_config
```

9 COM Port Settings

1. Proceed to the Device Manager from the PC Control Panel to determine which COM Port the board has enumerated; that port information is needed to configure the COM port correctly. This step will only need to be done the first time the board is enumerated on a given PC system. The board will enumerate as a virtual COM port (USB CDC). in the example shown in Figure 17 the virtual COM port is shown as COM61.


Device Manager
File Action View Help
LTA0867749
Batteries
Computer
Disk drives
Display adapters
DVD/CD-ROM drives
Human Interface Devices
Imaging devices
Keyboards
Mice and other pointing devices
Monitors
Network adapters
Cisco Systems VPN Adapter for 64-bit Windows
Dell Wireless 1540 802.11a/g/n (2.4GHz/5GHz)
Intel(R) 82579LM Gigabit Network Connection
Microsoft Virtual WiFi Miniport Adapter
Ports (COM & LPT)
ECP Printer Port (LPT1)
Virtual COM Port (CDC) (COM61)
Processors
Sound, video and game controllers
Storage controllers
System devices
Universal Serial Bus controllers
WD Drive Management devices
Virtual COM Port (CDC) (COM61) Properties
General
Port Settings
Driver
Details
Advanced...
Restore Defaults
OK
Cancel

Bits per second: 115200

Data bits: 8

Parity: None

Stop bits: 1

Flow control: None

Figure 17.

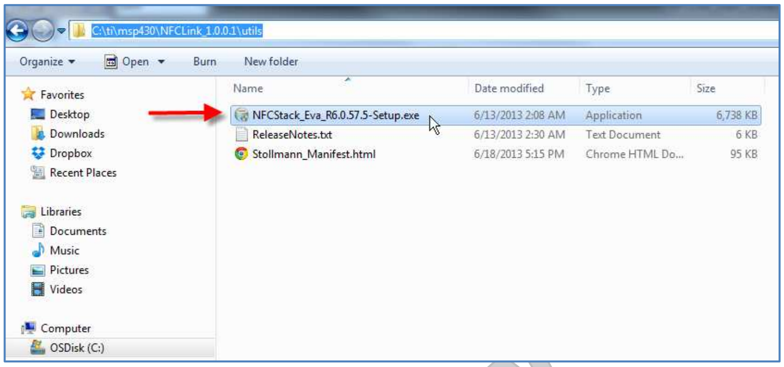
2. Double click on the port in the Device Manager menu window
3. Navigate to Port Settings tab and ensure the baud rate is set for 115200, 8 data bits, no parity and 1 stop bit (8N1)
4. Click OK.

10 PC GUI

10.1 Installation

Installation of the PC GUI should have occurred in Section 7.2 of this document. If for some reason the installation was declined or stopped or cancelled during that step, the following steps should be followed to complete the installation of the GUI.

1. Navigate to NFCLink directory named ‘utils’, double click the executable highlighted in Figure 18.

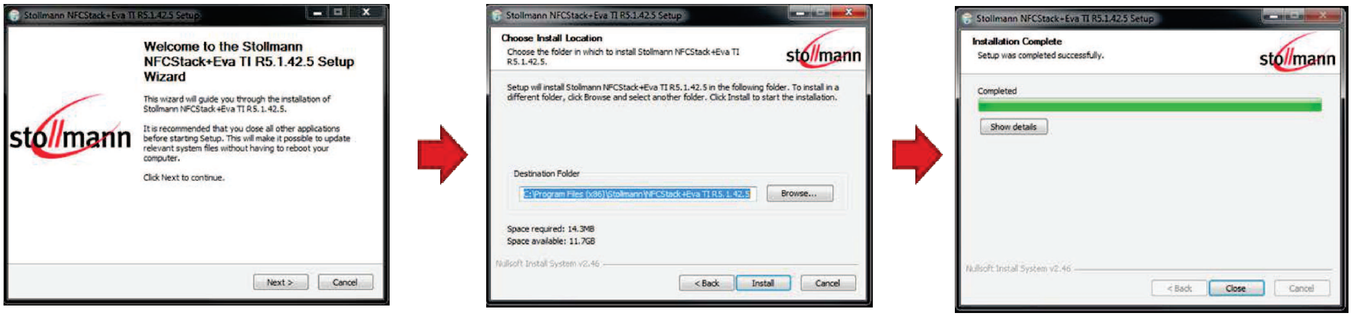


C:\ti\msp430\NFCLink_1.0.0.1\utils

Name	Date modified	Type	Size
NFCStack_Eva_R6.0.57.5-Setup.exe	6/13/2013 2:08 AM	Application	6,738 KB
ReleaseNotes.txt	6/13/2013 2:30 AM	Text Document	6 KB
Stollmann_Manifest.html	6/18/2013 5:15 PM	Chrome HTML Do...	95 KB

Figure 18.

2. Follow the instructions of the installer, as shown in Figure 19.



Stollmann NFCStack+Eva TI R5.1.42.5 Setup

Welcome to the Stollmann NFCStack+Eva TI R5.1.42.5 Setup Wizard

This wizard will guide you through the installation of Stollmann NFCStack+Eva TI R5.1.42.5.

It is recommended that you close all other applications before starting Setup. This will make it possible to update relevant system files without having to reboot your computer.

Click Next to continue.

Stollmann NFCStack+Eva TI R5.1.42.5 Setup

Choose Install Location

Choose the folder in which to install Stollmann NFCStack+Eva TI R5.1.42.5.

Setup will install Stollmann NFCStack+Eva TI R5.1.42.5 in the following folder. To install in a different folder, click Browse and select another folder. Click Install to start the installation.

Destination Folder: C:\Program Files (x86)\Stollmann\NFCStack+Eva TI R5.1.42.5

Space required: 14.3MB
Space available: 11.7GB

Stollmann NFCStack+Eva TI R5.1.42.5 Setup

Installation Complete

Setup was completed successfully.

Completed

Figure 19.

3. Execute the NFCPlayer by navigating to the "Stollmann NFCStack + EVA TI R6.0.57.5" folder (should be in the "Program Files" directory), and double click the NFCPlayer Icon as shown in Figure 20.

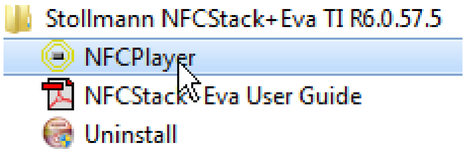
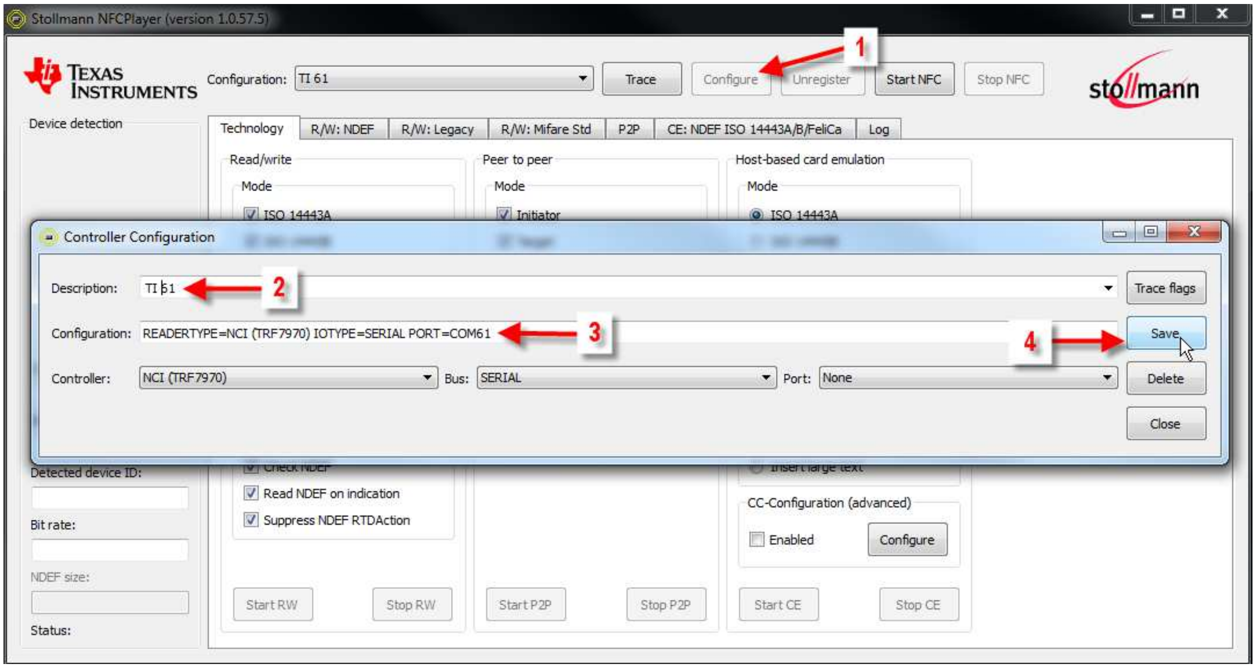


Figure 20.

10.2 GUI Configuration

1. When the GUI opens, navigate to the Configure button.
2. Provide a Description in the Description field
3. Type in the enumerated COM port values.
4. Click save.

NOTE: The configuration steps only need to be done once for a given set of hardware on a PC if step 3 (saving the configuration) is done. Henceforth, if multiple platforms have been set up and saved on the same PC, the description field will be a dropdown menu with all previous selections available to choose from; these steps are illustrated in Figure 21.



Stollmann NFCPlayer (version 1.0.57.5)

Configuration: TI 61

Controller Configuration

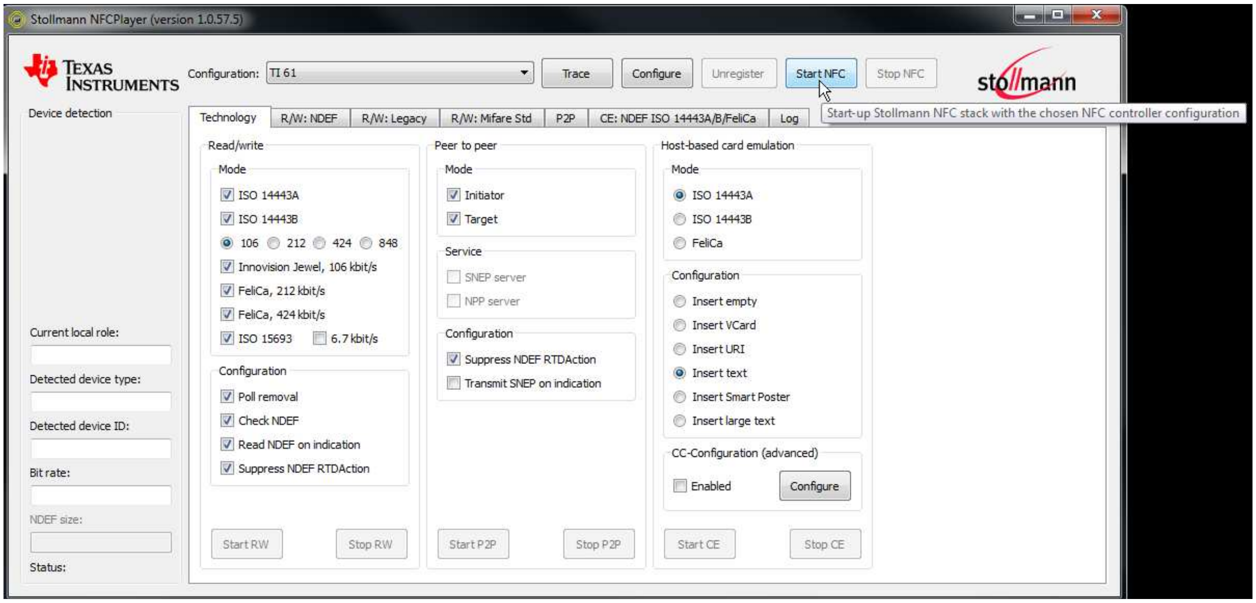
Description: TI 61

Configuration: READERTYPE=NCI (TRF7970) IOTYPE=SERIAL PORT=COM61

Controller: NCI (TRF7970) Bus: SERIAL Port: None

Figure 21. Steps for Configuring the GUI

User will now have the window below presented to them.



Configuration: TI 61

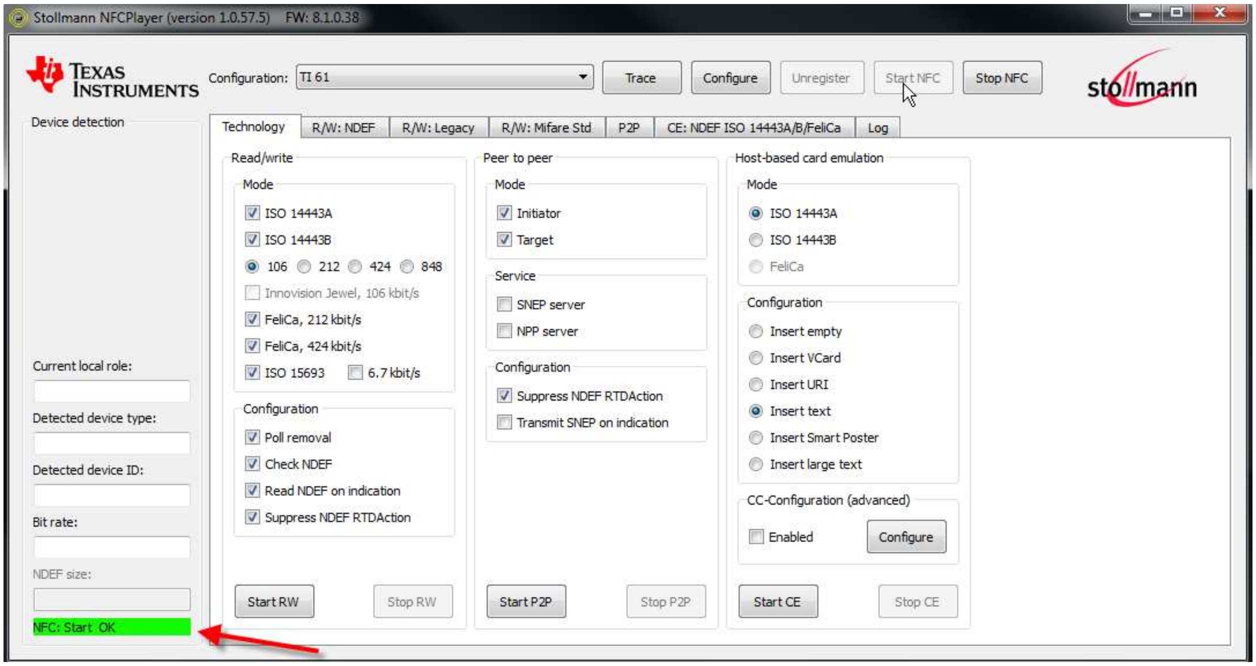
Read/write
Mode
☑ ISO 14443A
☑ ISO 14443B
● 106 ○ 212 ○ 424 ○ 848
☑ Innovision Jewel, 106 kbit/s
☑ FeliCa, 212 kbit/s
☑ FeliCa, 424 kbit/s
☑ ISO 15693 ☐ 6.7 kbit/s
Configuration
☑ Poll removal
☑ Check NDEF
☑ Read NDEF on indication
☑ Suppress NDEF RTDAction

Peer to peer
Mode
☑ Initiator
☑ Target
Service
☐ SNEP server
☐ NPP server
Configuration
☑ Suppress NDEF RTDAction
☐ Transmit SNEP on indication

Host-based card emulation
Mode
● ISO 14443A
○ ISO 14443B
○ FeliCa
Configuration
○ Insert empty
○ Insert VCard
○ Insert URI
● Insert text
○ Insert Smart Poster
○ Insert large text
CC-Configuration (advanced)
☐ Enabled Configure

Figure 22.

When NFCPlayer is started, the status (NFC: Start OK) will be indicated as shown in Figure 23.



Configuration: TI 61

Read/write
Mode
☑ ISO 14443A
☑ ISO 14443B
● 106 ○ 212 ○ 424 ○ 848
☐ Innovision Jewel, 106 kbit/s
☑ FeliCa, 212 kbit/s
☑ FeliCa, 424 kbit/s
☑ ISO 15693 ☐ 6.7 kbit/s
Configuration
☑ Poll removal
☑ Check NDEF
☑ Read NDEF on indication
☑ Suppress NDEF RTDAction

Peer to peer
Mode
☑ Initiator
☑ Target
Service
☐ SNEP server
☐ NPP server
Configuration
☑ Suppress NDEF RTDAction
☐ Transmit SNEP on indication

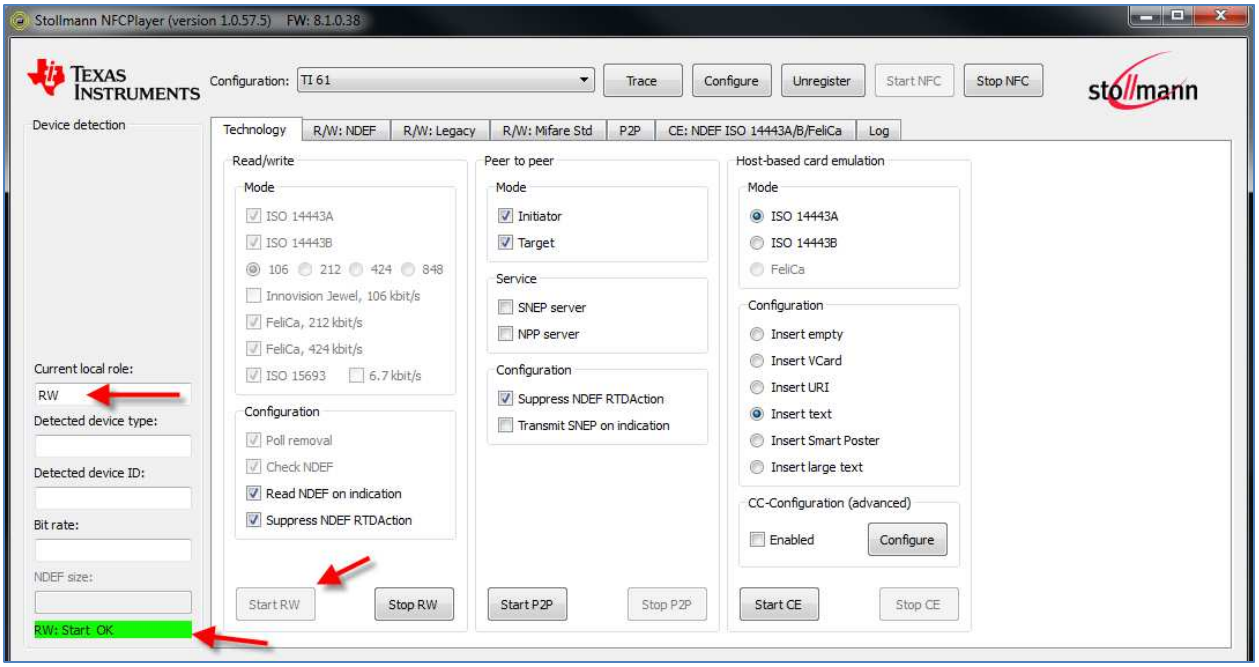
Host-based card emulation
Mode
● ISO 14443A
○ ISO 14443B
○ FeliCa
Configuration
○ Insert empty
○ Insert VCard
○ Insert URI
● Insert text
○ Insert Smart Poster
○ Insert large text
CC-Configuration (advanced)
☐ Enabled Configure

NFC: Start OK

Figure 23.

11 NFC or RFID Reader and Writer Mode Overview

To use the Reader/Writer Mode, press the Start RW button. RW: Start OK will appear in the NFCPlayer status window and the Current local role window will show RW, as shown in Figure 24.



Stollmann NFCPlayer (version 1.0.57.5) FW: 8.1.0.38

Configuration: TI 61

Trace | Configure | Unregister | Start NFC | Stop NFC

Technology | R/W: NDEF | R/W: Legacy | R/W: Mifare Std | P2P | CE: NDEF ISO 14443A/B/FeliCa | Log

Device detection

Current local role: RW

Detected device type:

Detected device ID:

Bit rate:

NDEF size:

RW: Start OK

Read/write

Mode

☑ ISO 14443A

☑ ISO 14443B

● 106 ○ 212 ○ 424 ○ 848

□ Innovision Jewel, 106 kbit/s

☑ FeliCa, 212 kbit/s

☑ FeliCa, 424 kbit/s

☑ ISO 15693 □ 6.7 kbit/s

Configuration

☑ Poll removal

☑ Check NDEF

☑ Read NDEF on indication

☑ Suppress NDEF RTDAction

Start RW | Stop RW

Peer to peer

Mode

☑ Initiator

☑ Target

Service

□ SNEP server

□ NPP server

Configuration

☑ Suppress NDEF RTDAction

□ Transmit SNEP on indication

Start P2P | Stop P2P

Host-based card emulation

Mode

● ISO 14443A

○ ISO 14443B

○ FeliCa

Configuration

○ Insert empty

○ Insert VCard

○ Insert URI

● Insert text

○ Insert Smart Poster

○ Insert large text

CC-Configuration (advanced)

□ Enabled | Configure

Start CE | Stop CE

Figure 24.

When hardware is in reader/writer mode LED1 will be flashing and then go solid, as shown in Figure 25) when an NFC/RFID transponder is presented.

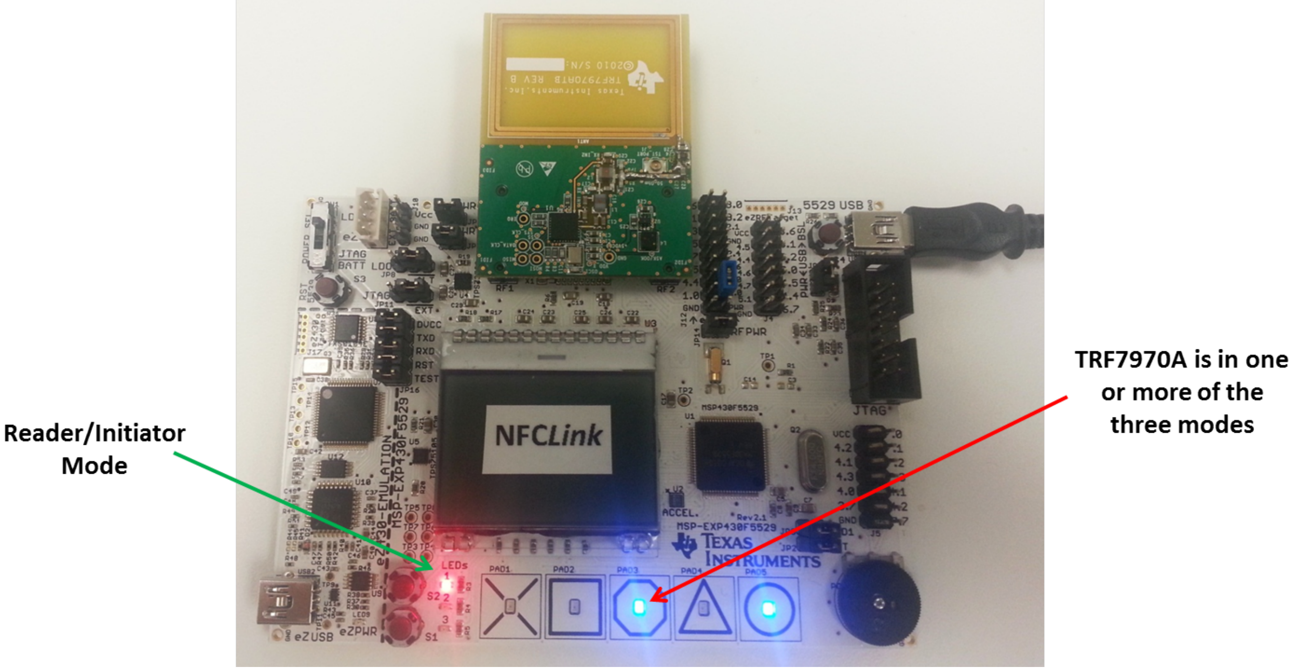
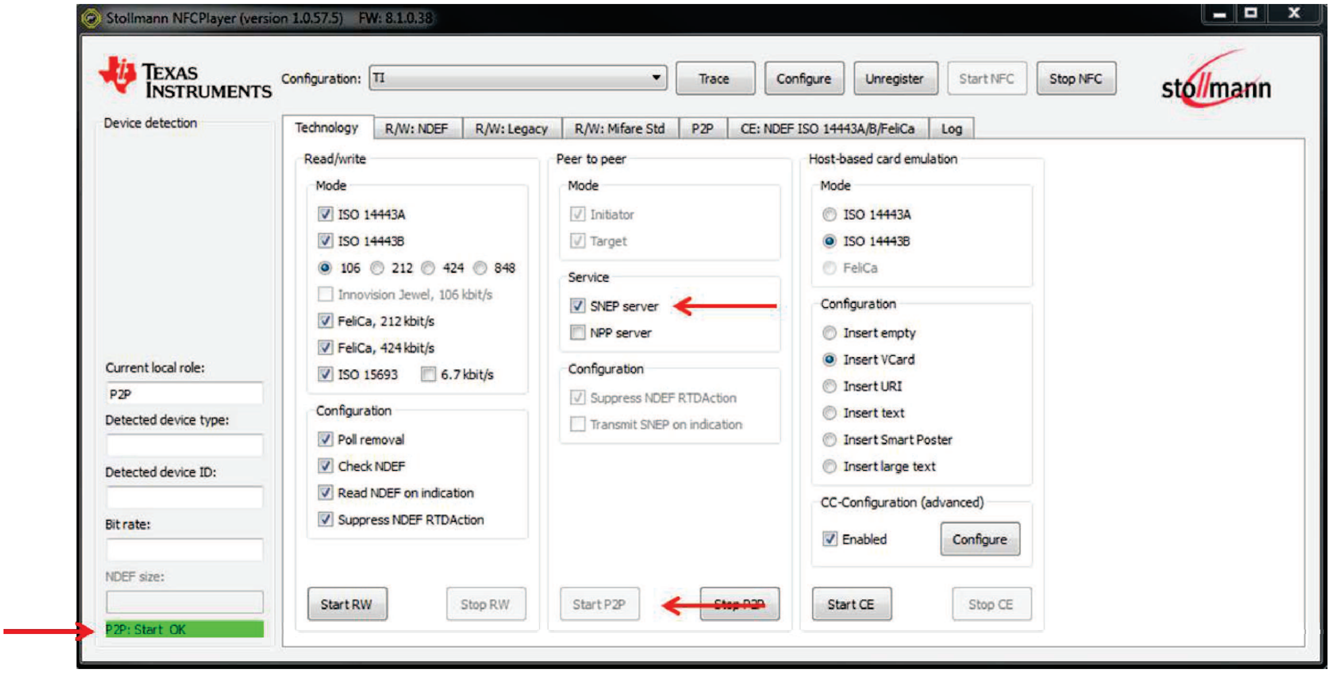


Figure 25.

12 NFC or RFID Peer-to-Peer (P2P) Mode Overview

To use the Peer-to-Peer Mode, press the Start P2P button. P2P: Start OK will appear in the NFCPlayer status window and Current local role window will show P2P, as shown in Figure 26.



Stollmann NFCPlayer (version 1.0.57.5) FW: 8.1.0.38

Configuration: TI

Device detection

Current local role: P2P

Detected device type:

Detected device ID:

Bit rate:

NDEF size:

P2P: Start OK

Read/write

Mode

☑ ISO 14443A
☑ ISO 14443B
● 106 ○ 212 ○ 424 ○ 848
□ Innovision Jewel, 106 kbit/s
☑ FeliCa, 212 kbit/s
☑ FeliCa, 424 kbit/s
☑ ISO 15693 □ 6.7 kbit/s

Configuration

☑ Poll removal
☑ Check NDEF
☑ Read NDEF on indication
☑ Suppress NDEF RTDAction

Peer to peer

Mode

☑ Initiator
☑ Target

Service

☑ SNEP server
□ NPP server

Configuration

☑ Suppress NDEF RTDAction
□ Transmit SNEP on indication

Host-based card emulation

Mode

○ ISO 14443A
● ISO 14443B
○ FeliCa

Configuration

○ Insert empty
● Insert VCard
○ Insert URI
○ Insert text
○ Insert Smart Poster
○ Insert large text

CC-Configuration (advanced)

☑ Enabled

Figure 26.

When the hardware is in P2P Mode, LED1 & LED2 will be alternately flashing. When Peer NFC Device is presented, the mode being used by the hardware (Initiator or Target) will go solid. After transfer of data is complete and the peer is removed, the LEDs will go back to alternately flashing. See Figure 27)

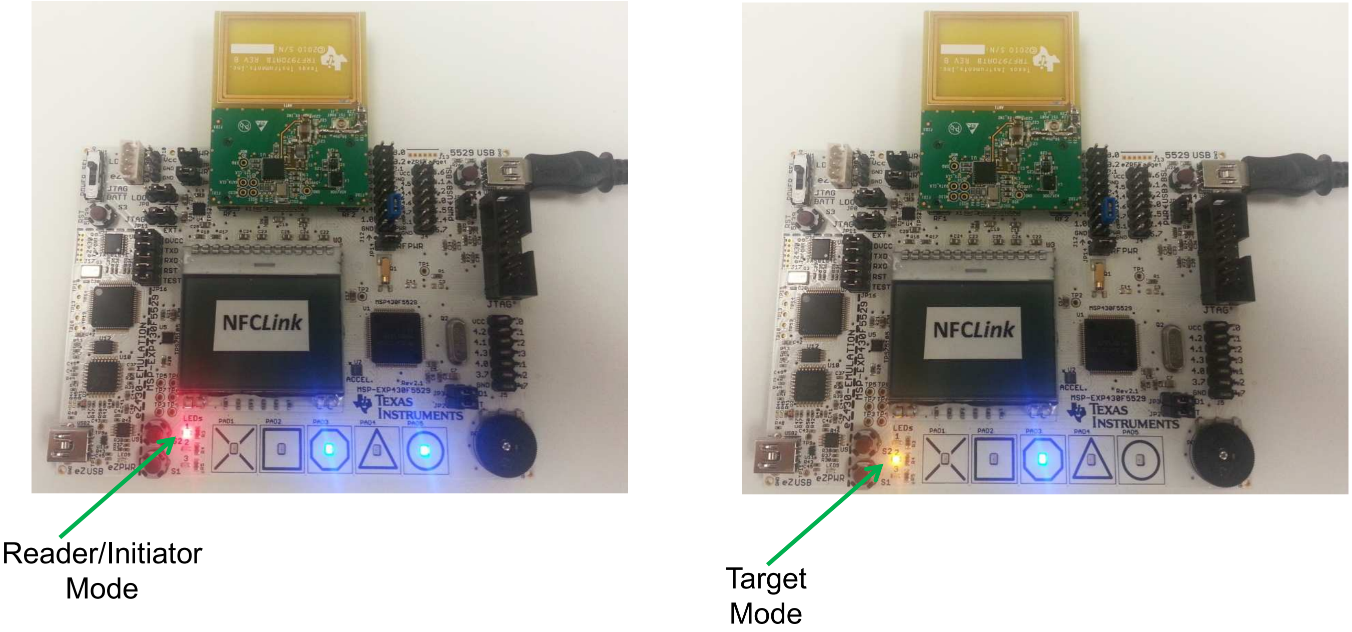
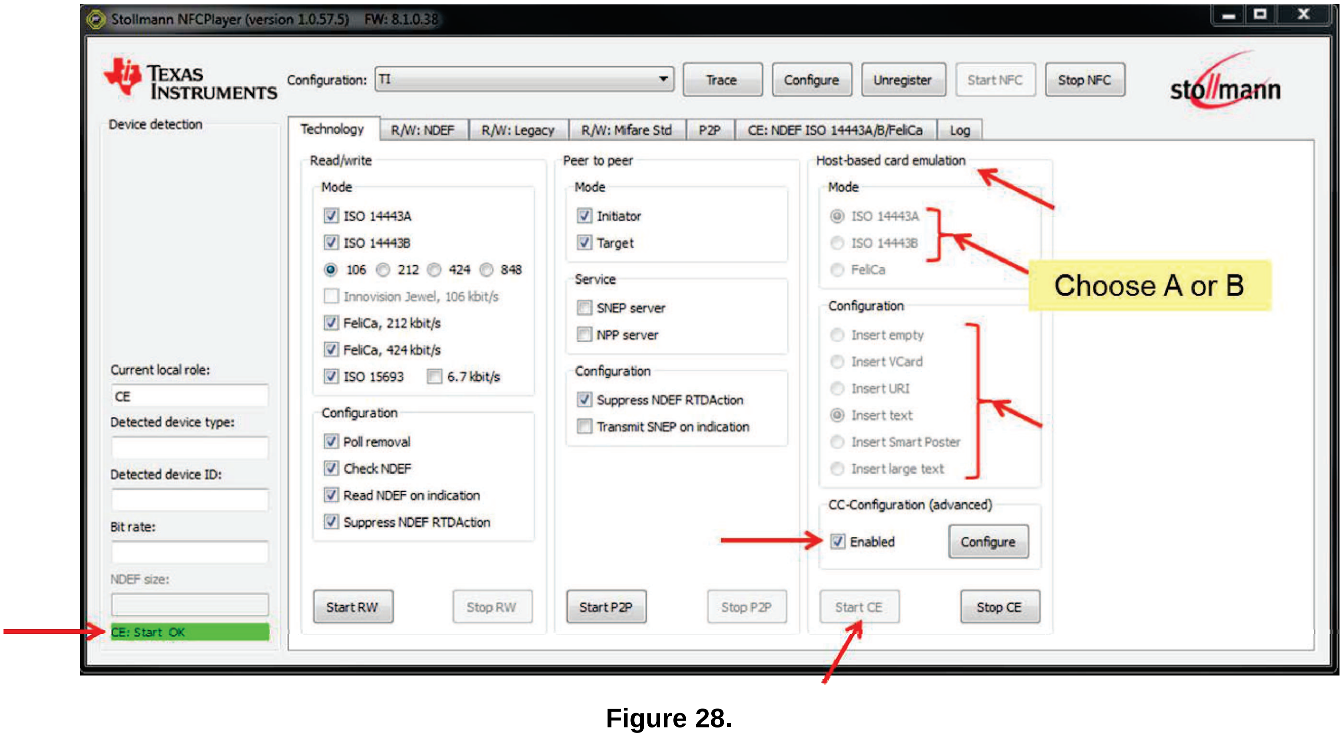


Figure 27.

13 NFC or RFID Card Emulation (CE) Mode Overview

To use the Card Emulation Mode, press the Start CE button. CE: Start OK will appear in the NFCPlayer status window and Current local role window will show CE, as shown in Figure 28.



Stollmann NFCPlayer (version 1.0.57.5) FW: 8.1.0.38

Configuration: TI

Device detection

Current local role: CE

Detected device type:

Detected device ID:

Bit rate:

NDEF size:

CE: Start OK

Technology tab:

Read/write
- Mode
  - ☑ ISO 14443A
  - ☑ ISO 14443B
  - ● 106 ○ 212 ○ 424 ○ 848
  - □ Innovision Jewel, 106 kbit/s
  - ☑ FeliCa, 212 kbit/s
  - ☑ FeliCa, 424 kbit/s
  - ☑ ISO 15693 □ 6.7 kbit/s
- Configuration
  - ☑ Poll removal
  - ☑ Check NDEF
  - ☑ Read NDEF on indication
  - ☑ Suppress NDEF RTDAction

Peer to peer
- Mode
  - ☑ Initiator
  - ☑ Target
- Service
  - □ SNEP server
  - □ NPP server
- Configuration
  - ☑ Suppress NDEF RTDAction
  - □ Transmit SNEP on indication

Host-based card emulation
- Mode
  - ● ISO 14443A
  - ○ ISO 14443B
  - ○ FeliCa
- Configuration
  - ○ Insert empty
  - ○ Insert VCard
  - ○ Insert URI
  - ● Insert text
  - ○ Insert Smart Poster
  - ○ Insert large text
- CC-Configuration (advanced)
  - ☑ Enabled

Choose A or B

Figure 28.

When the hardware is in CE mode, LED3 will be on solid.

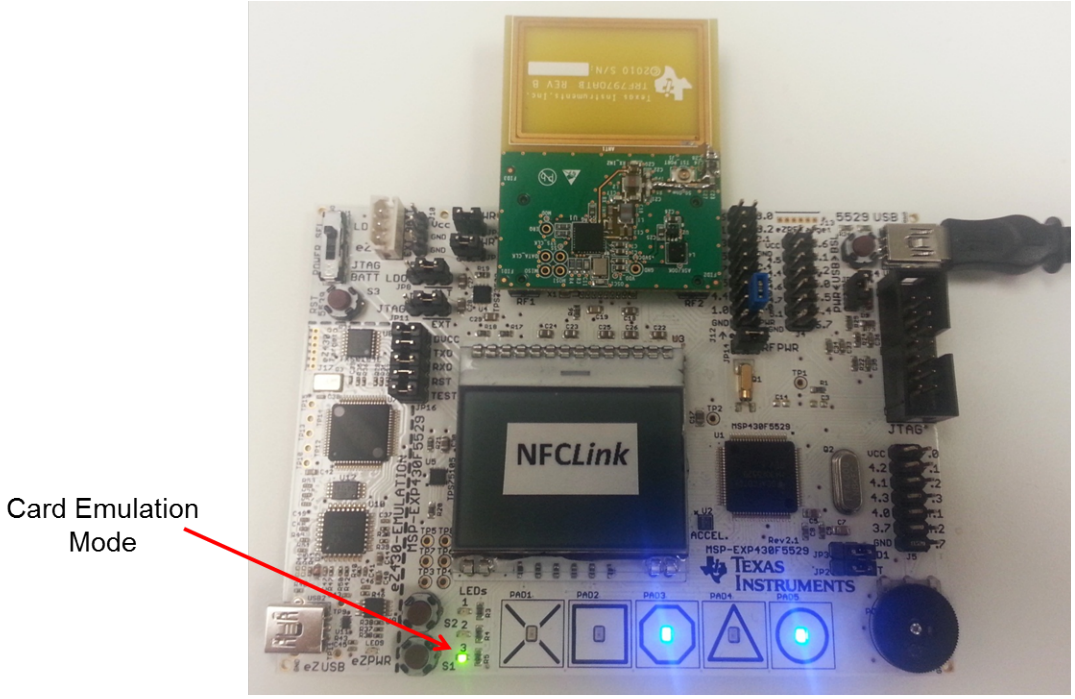


Figure 29.

14 NFC or RFID Reader and Writer (RW) Mode Details

Reader and Writer modes demonstrated and explained by showing the Tag Types and the different types of common data stored.

RTD types:

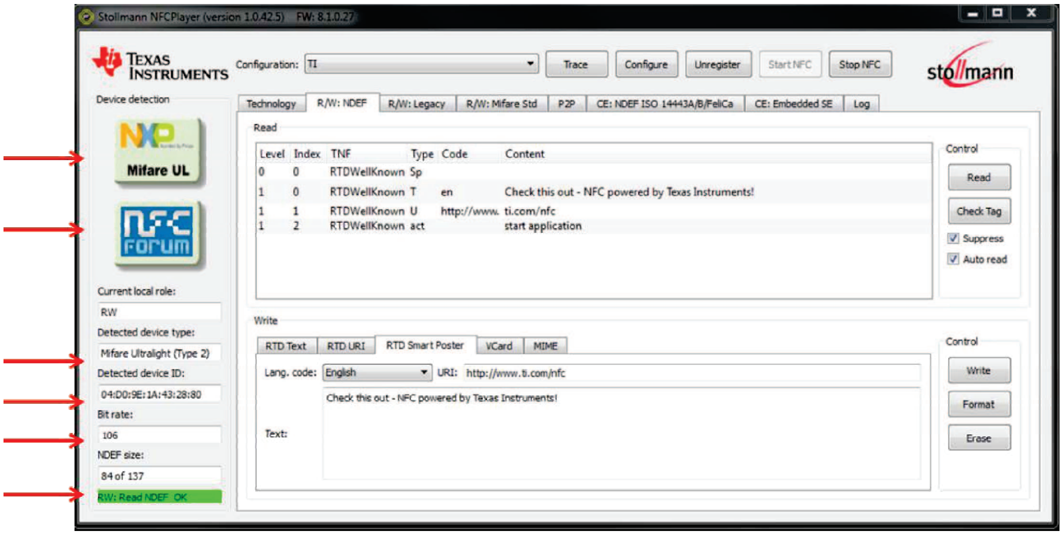
- Text
- URI
- Smart Poster
- Vcard
- MIME

Tag Platforms Types supported are:

- NFC-5 (TI ISO15693)
- NFC-2 (MF UL)
- NFC-3 (Sony FeliCa)
- NFC 4A (DESFire EV1)
- NFC 4B (TI Dynamic Tag, the RF430CL330H)

14.1 NFC Type 2 Tag Platform

Figure 30 shows an NFC Type 2 Tag Platform which has been formatted with the tool and then programmed as RTD Smart Poster. If Suppress NDEF RTD Action (in front panel) box is unchecked, presenting this tag will open browser up and will be routed to http://www.ti.com/tool/nfclink web page.



Stollmann NFCPlayer (version 1.0.42.5) FW: 8.1.0.27

Configuration: TI

Current local role: RW

Detected device type: Mifare Ultralight (Type 2)

Detected device ID: 04:D0:9E:1A:43:28:80

Bit rate: 106

NDEF size: 84 of 137

RW: Read NDEF OK

Read

Level	Index	TNF	Type	Code	Content
0	0	RTDWellKnown	Sp		
1	0	RTDWellKnown	T	en	Check this out - NFC powered by Texas Instruments!
1	1	RTDWellKnown	U	http://www.	ti.com/nfc
1	2	RTDWellKnown	act		start application

☑ Suppress

☑ Auto read

Write

Lang. code: English

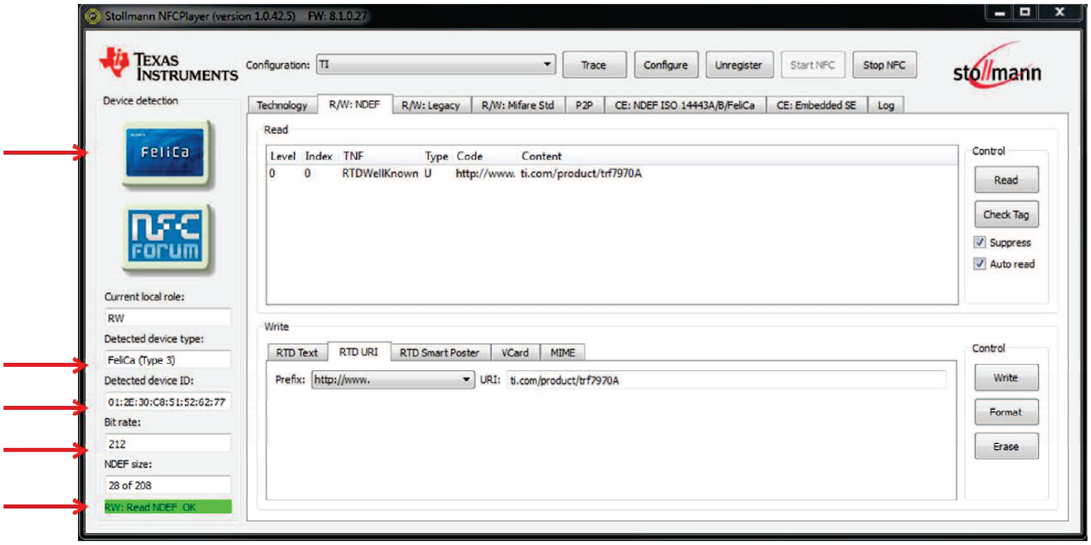
URI: http://www.ti.com/nfc

Text: Check this out - NFC powered by Texas Instruments!

Figure 30.

14.2 NFC Type 3 Tag Platform

Figure 31 shows an NFC Type 3 Tag Platform which has been formatted with the tool and then programmed with an RTD URI.



Configuration: TI

Level	Index	TNF	Type	Code	Content
0	0	RTDWellKnown	U	http://www.	ti.com/product/trf7970A

☑ Suppress
☑ Auto read

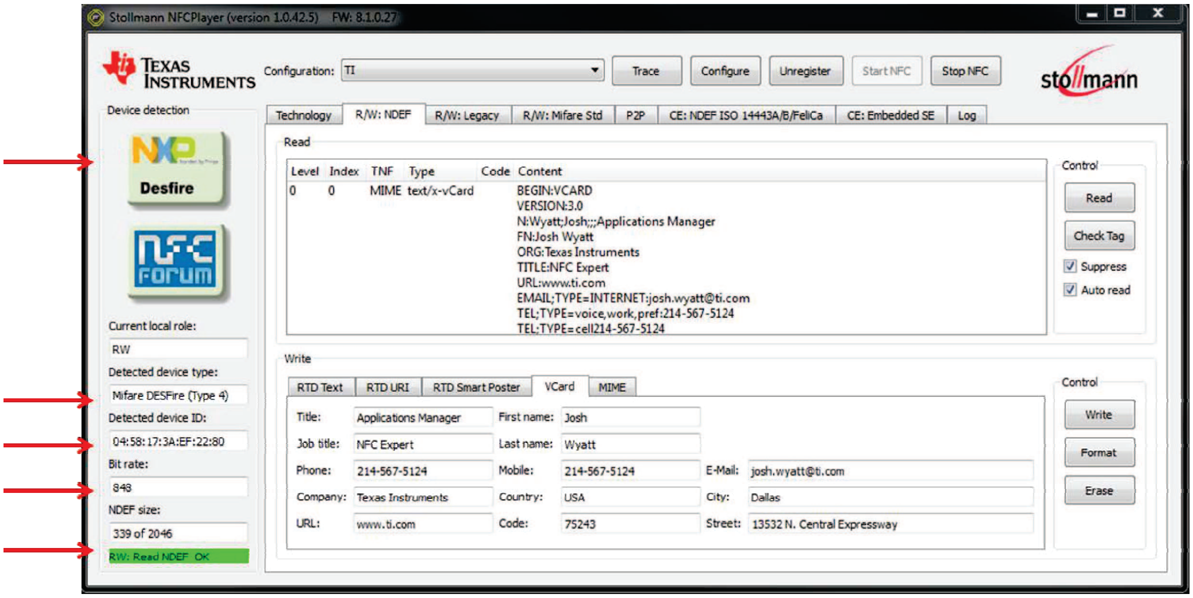
Current local role: RW
Detected device type: FeliCa (Type 3)
Detected device ID: 01:2E:30:C8:51:52:62:77
Bit rate: 212
NDEF size: 28 of 208
RW: Read NDEF OK

Prefix: http://www. URI: ti.com/product/trf7970A

Figure 31.

14.3 NFC Type 4A Tag Platform

Figure 32 shows an NFC Type 4A Tag Platform which has been formatted with the tool and then programmed as a VCard.



Configuration: TI

Level	Index	TNF	Type	Code	Content
0	0	MIME	text/x-vCard		BEGIN:VCARD VERSION:3.0 N:Wyatt;Josh;;;Applications Manager FN:Josh Wyatt ORG:Texas Instruments TITLE:NFC Expert URL:www.ti.com EMAIL;TYPE=INTERNET:josh.wyatt@ti.com TEL;TYPE=voice,work,pref:214-567-5124 TEL;TYPE=cell214-567-5124

☑ Suppress
☑ Auto read

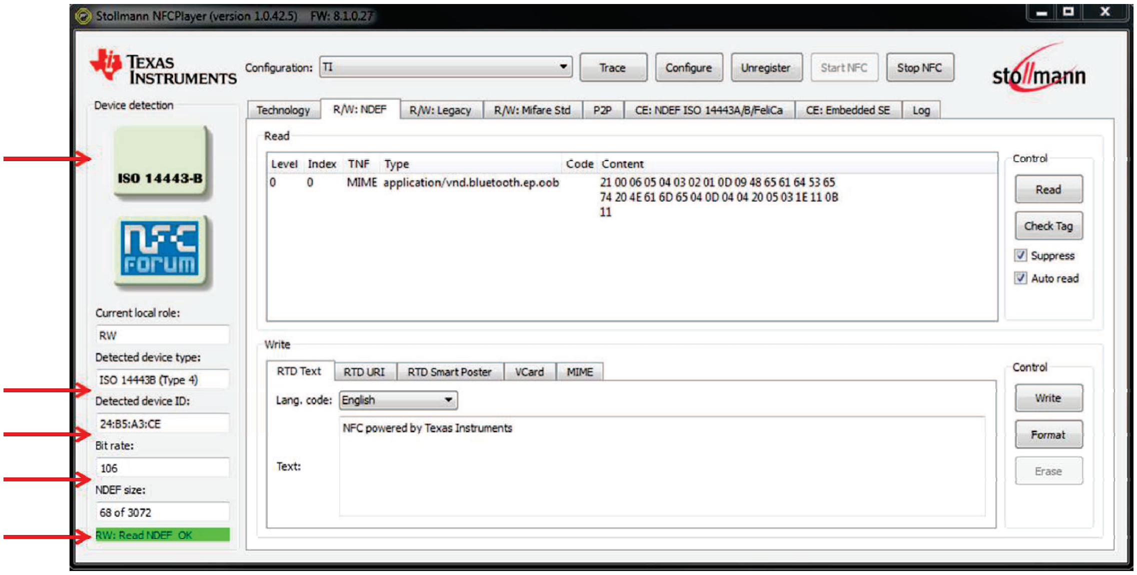
Current local role: RW
Detected device type: Mifare DESFire (Type 4)
Detected device ID: 04:58:17:3A:EF:22:80
Bit rate: 848
NDEF size: 339 of 2046
RW: Read NDEF OK

Title:	Applications Manager	First name:	Josh		
Job title:	NFC Expert	Last name:	Wyatt		
Phone:	214-567-5124	Mobile:	214-567-5124	E-Mail:	josh.wyatt@ti.com
Company:	Texas Instruments	Country:	USA	City:	Dallas
URL:	www.ti.com	Code:	75243	Street:	13532 N. Central Expressway

Figure 32.

14.4 NFC Type 4B Tag Platform

Figure 33 is an NFC Type 4B Tag Platform (RF430CL330H) which has been formatted with the tool and then programmed for NFC Forum Bluetooth Connection Handover.



Stollmann NFCPlayer (version 1.0.42.5) FW: 8.1.0.27

Configuration: TI

Current local role: RW

Detected device type: ISO 14443B (Type 4)

Detected device ID: 24:B5:A3:CE

Bit rate: 106

NDEF size: 68 of 3072

RW: Read NDEF OK

Read

Level	Index	TNF	Type	Code	Content
0	0	MIME	application/vnd.bluetooth.ep.oob		21 00 06 05 04 03 02 01 0D 09 48 65 61 64 53 65 74 20 4E 61 6D 65 04 0D 04 04 20 05 03 1E 11 0B 11

☑ Suppress
☑ Auto read

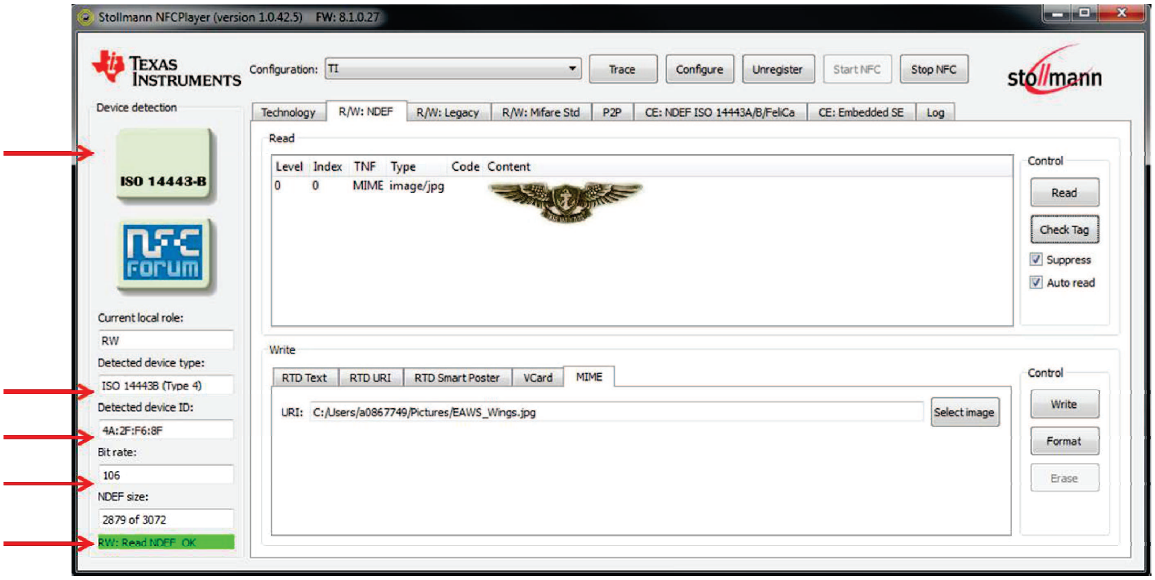
Write (RTD Text)

Lang. code: English

Text: NFC powered by Texas Instruments

Figure 33.

Figure 34 shows the same Tag Type 4B (RF430CL330H) which has been formatted with the tool and then programmed with an image (MIME). This demonstrates a larger file being stored, which could then be extracted out of the tag by another NFC device or via the host over I2C or SPI (wired connection).



Stollmann NFCPlayer (version 1.0.42.5) FW: 8.1.0.27

Configuration: TI

Current local role: RW

Detected device type: ISO 14443B (Type 4)

Detected device ID: 4A:2F:F6:8F

Bit rate: 106

NDEF size: 2879 of 3072

RW: Read NDEF OK

Read

Level	Index	TNF	Type	Code	Content
0	0	MIME	image/jpg		

☑ Suppress
☑ Auto read

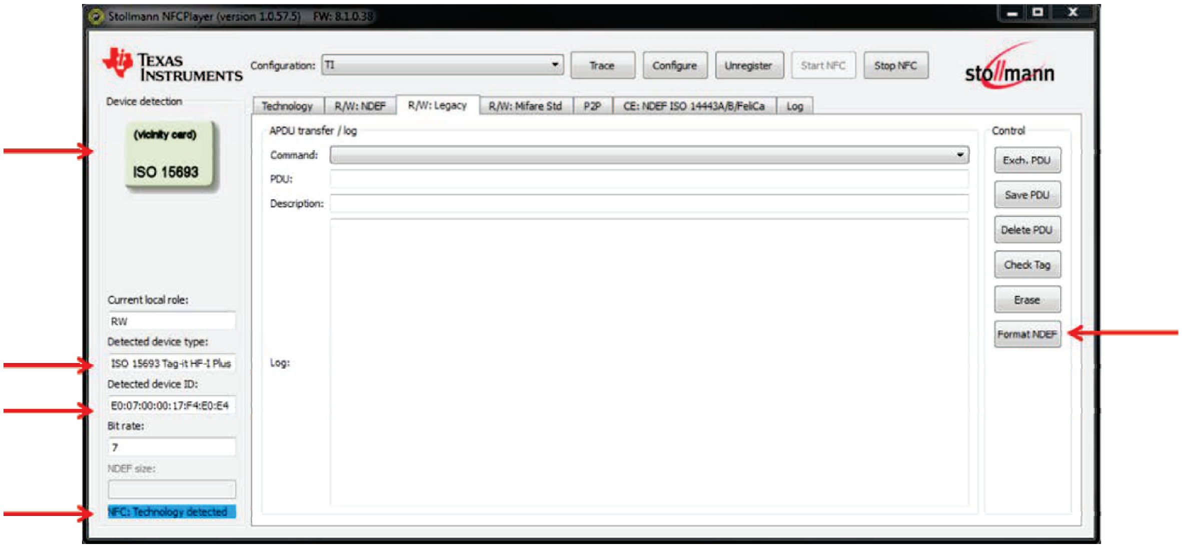
Write (MIME)

URI: C:/Users/a0867749/Pictures/EAWS_Wings.jpg

Figure 34.

14.5 NFC Type 5 Tag Platform

After pressing the R/W button, present a NFC tag (doesn't have to be formatted). in this example we are presenting an unformatted NFC Type 5 (ISO15693, TI HF-I) tag. Note that the tab automatically flips to R/W: Legacy and the type of card is displayed graphically along with the Unique ID (in this case, E007000017F4E0E4). Press the Format NDEF button to make the tag NFC-V type. This puts a Capability Container with empty NDEF in the user memory.


Stollmann NFCPlayer (version 1.0.57.5) FW: 8.1.0.38

Configuration: TI

Current local role: RW

Detected device type: ISO 15693 Tag-it HF-I Plus

Detected device ID: E0:07:00:00:17:F4:E0:E4

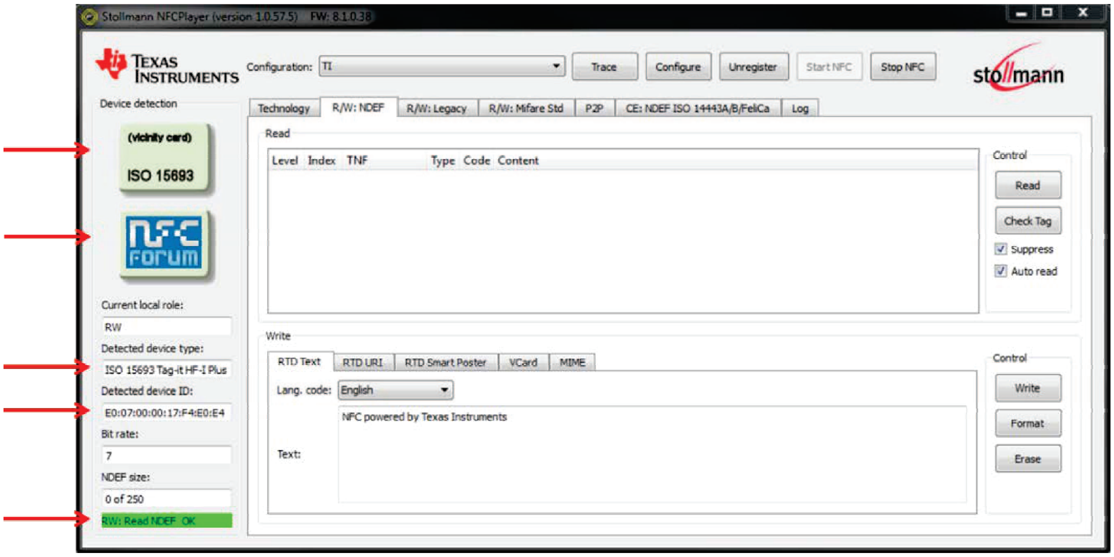
Bit rate: 7

NDEF size:

NFC: Technology detected

Figure 35.

After the tag is formatted, the GUI status window will quickly flip to Format NDEF OK, then present the R/W NDEF with the status changing to RW: Read NDEF OK. Figure 36shows the results (formatted, but with an empty tag)


Stollmann NFCPlayer (version 1.0.57.5) FW: 8.1.0.38

Configuration: TI

Current local role: RW

Detected device type: ISO 15693 Tag-it HF-I Plus

Detected device ID: E0:07:00:00:17:F4:E0:E4

Bit rate: 7

NDEF size: 0 of 250

RW: Read NDEF OK

Level	Index	TNF	Type	Code	Content

☑ Suppress

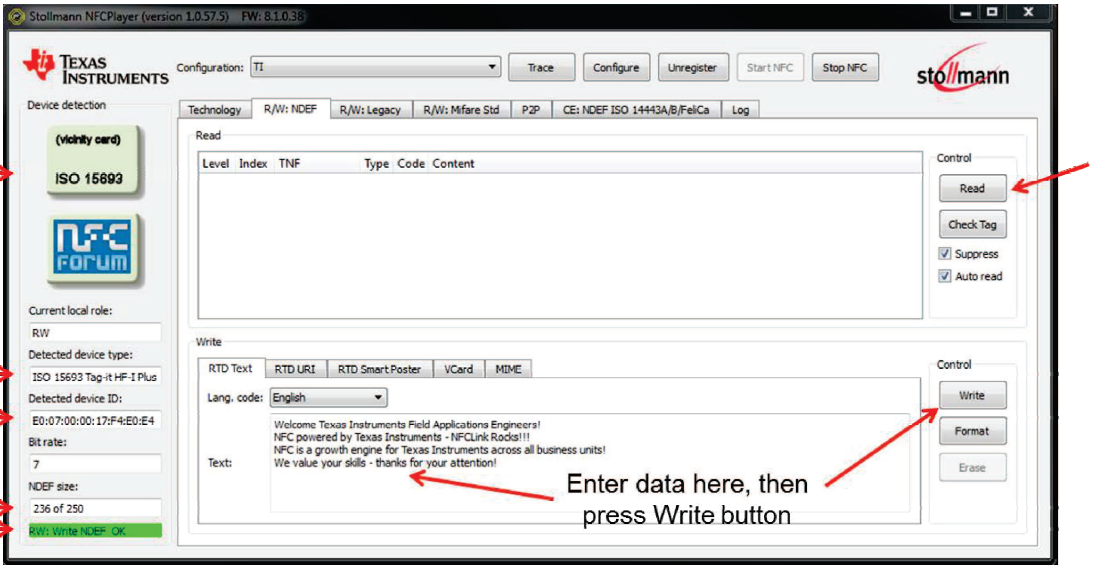
☑ Auto read

Lang. code: English

Text: NFC powered by Texas Instruments

Figure 36.

User can now enter data into the bottom 'Write' window and press the Write button to write a NDEF message into the tag. When this occurs, the screen will quickly flip to Write NDEF. You can then either press the Read button, or remove the tag from the reader/writer antenna and re-present the tag to get the NDEF message read back.



Configuration: TI

Current local role: RW

Detected device type: ISO 15693 Tag-it HF-I Plus

Detected device ID: E0:07:00:00:17:F4:E0:E4

Bit rate: 7

NDEF size: 236 of 250

RW: Write NDEF OK

☑ Suppress

☑ Auto read

Lang. code: English

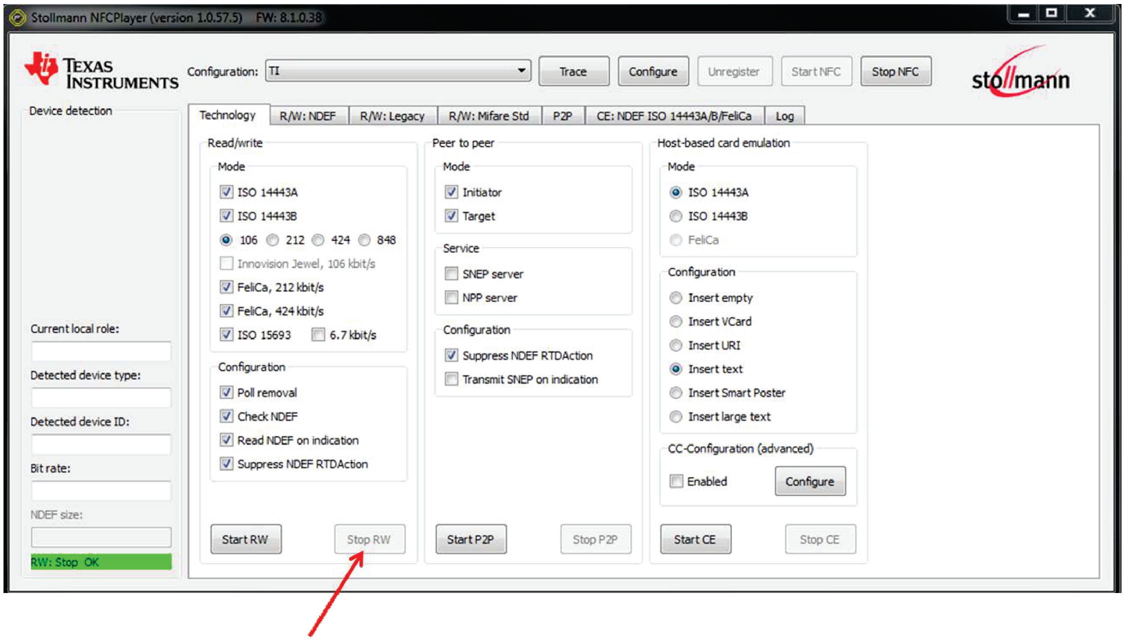
Text:

Welcome Texas Instruments Field Applications Engineers!
NFC powered by Texas Instruments - NFCLink Rocks!!!
NFC is a growth engine for Texas Instruments across all business units!
We value your skills - thanks for your attention!

Enter data here, then press Write button

Figure 37.

To stop the R/W mode, remove the tag from the field and press the Stop RW button.



Configuration: TI

Current local role:

Detected device type:

Detected device ID:

Bit rate:

NDEF size:

RW: Stop OK

Read/write – Mode:

☑ ISO 14443A

☑ ISO 14443B

● 106 ○ 212 ○ 424 ○ 848

□ Innovision Jewel, 106 kbit/s

☑ FeliCa, 212 kbit/s

☑ FeliCa, 424 kbit/s

☑ ISO 15693 □ 6.7 kbit/s

Read/write – Configuration:

☑ Poll removal

☑ Check NDEF

☑ Read NDEF on indication

☑ Suppress NDEF RTDAction

Peer to peer – Mode:

☑ Initiator

☑ Target

Peer to peer – Service:

□ SNEP server

□ NPP server

Peer to peer – Configuration:

☑ Suppress NDEF RTDAction

□ Transmit SNEP on indication

Host-based card emulation – Mode:

● ISO 14443A

○ ISO 14443B

○ FeliCa

Host-based card emulation – Configuration:

○ Insert empty

○ Insert VCard

○ Insert URI

● Insert text

○ Insert Smart Poster

○ Insert large text

CC-Configuration (advanced):

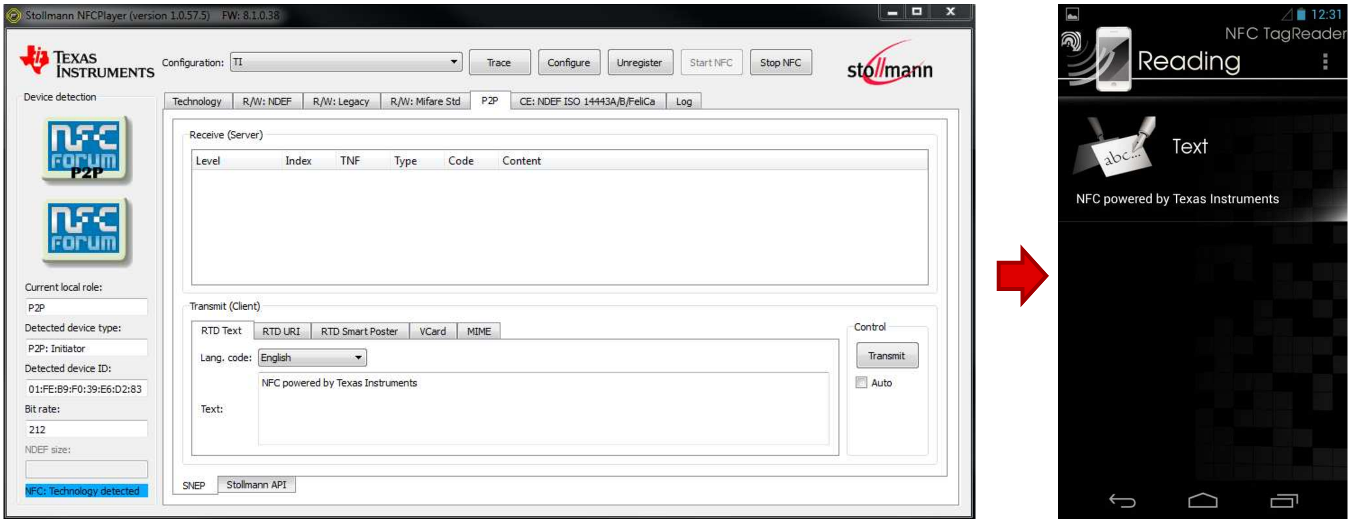
□ Enabled

Figure 38.

15 NFC or RFID Peer-to-Peer (P2P) Mode Details

The TRF7970A is capable of being a Type-A or Type-F peer (target or initiator) @ 106kbps, 212kbps or 424kbps. This section will show how to accomplish this with the use of the host stack and the embedded MCU library. This NFC mode can be used for a variety of applications where a data transport system is needed for data exchange, firmware updates, simplified setup of alternative radios (Bluetooth, Wi-Fi, RF4CE, etc.). This differs from card emulation, because once the connection is established, data can be passed either way. Also, multiple channels can be set up to provide for high-speed full-duplex data transmission schemes over the magnetic link. Early versions of the NFC devices used the NDEF Push Protocol (called NPP), but now the NFC Forum has a newer specification called Simple NDEF (NFC Data Exchange Format) Protocol or “SNEP”. Both are supported with the embedded firmware and the host stack being offered here by Texas Instruments.

When NFC Enabled device is presented (no app open in this case), the GUI screen flips over to P2P mode. Message can now be sent from a GUI to the NFC-enabled device using the Transmit button. This will open either the native app on the phone or a default one (the NFC TagReader from KDDI shown in Figure 39).


Stollmann NFCPlayer (version 1.0.57.5) FW: 8.1.0.38

Configuration: TI

Current local role: P2P

Detected device type: P2P: Initiator

Detected device ID: 01:FE:B9:F0:39:E6:D2:83

Bit rate: 212

NDEF size:

NFC: Technology detected

Lang. code: English

Text: NFC powered by Texas Instruments

NFC TagReader

Reading

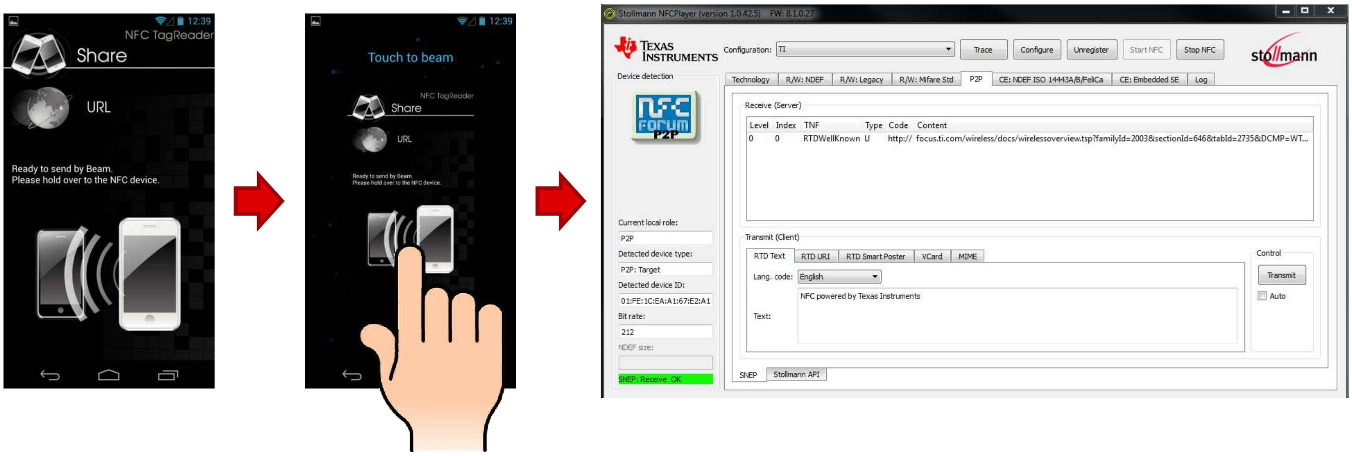
Text

NFC powered by Texas Instruments

Figure 39.

When NFC-enabled device has application open for doing P2P, the GUI screen flips over to P2P mode, as before. Messages can now be sent from the NFC-enabled device to the GUI.

In Figure 40 the device is “Beaming” a URL to a Texas Instruments website. Other message types can be sent as well, such as Alternative Radio Handovers, text content, SmartPoster, Phone Numbers, Applications, Images, etc.



Stollmann NFCPlayer (version 1.0.42.5) FW: 8.1.0.27

Configuration: TI

Trace | Configure | Unregister | Start NFC | Stop NFC

Technology | R/W: NDEF | R/W: Legacy | R/W: Mifare Std | P2P | CE: NDEF ISO 14443A/B/FeliCa | CE: Embedded SE | Log

Device detection

Current local role: P2P

Detected device type: P2P: Target

Detected device ID: 01:FE:1C:EA:A1:67:E2:A1

Bit rate: 212

NDEF size:

SNEP: Receive OK

Receive (Server)

Level	Index	TNF	Type	Code	Content
0	0	RTDWellKnown	U	http://	focus.ti.com/wireless/docs/wirelessoverview.tsp?familyId=2003&sectionId=646&tabId=2735&DCMP=WT...

Transmit (Client)

RTD Text | RTD URI | RTD Smart Poster | VCard | MIME

Lang. code: English

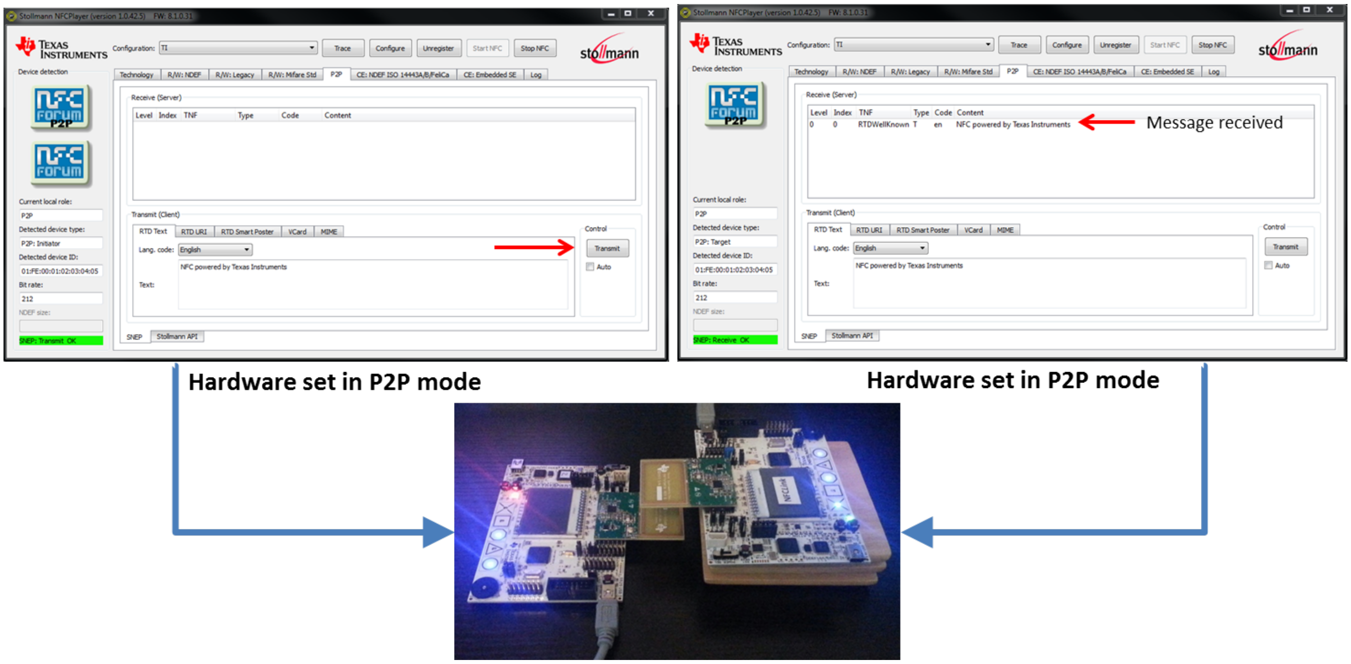
Text: NFC powered by Texas Instruments

Control: Transmit ☐ Auto

SNEP | Stollmann API

Figure 40.

You can also set up two of the hardware sets and run two instances of the GUI on the same PC, then demonstrate the P2P functionality without using a NFC handset. In Figure 41 we have sent an RTD MIME message (in the form of an image) from one hardware set to another using SNEP)



Stollmann NFCPlayer (version 1.0.42.5) FW: 8.1.0.31

Configuration: TI

Trace | Configure | Unregister | Start NFC | Stop NFC

Technology | R/W: NDEF | R/W: Legacy | R/W: Mifare Std | P2P | CE: NDEF ISO 14443A/B/FeliCa | CE: Embedded SE | Log

Current local role: P2P

Detected device type: P2P: Initiator

Detected device ID: 01:FE:00:01:02:03:04:05

Bit rate: 212

NDEF size:

SNEP: Transmit OK

Receive (Server)

Level	Index	TNF	Type	Code	Content

Transmit (Client)

RTD Text | RTD URI | RTD Smart Poster | VCard | MIME

Lang. code: English

Text: NFC powered by Texas Instruments

Control: Transmit ☐ Auto

SNEP | Stollmann API

Stollmann NFCPlayer (version 1.0.42.5) FW: 8.1.0.31

Configuration: TI

Current local role: P2P

Detected device type: P2P: Target

Detected device ID: 01:FE:00:01:02:03:04:05

Bit rate: 212

NDEF size:

SNEP: Receive OK

Receive (Server)

Level	Index	TNF	Type	Code	Content
0	0	RTDWellKnown	T	en	NFC powered by Texas Instruments

Transmit (Client)

RTD Text | RTD URI | RTD Smart Poster | VCard | MIME

Lang. code: English

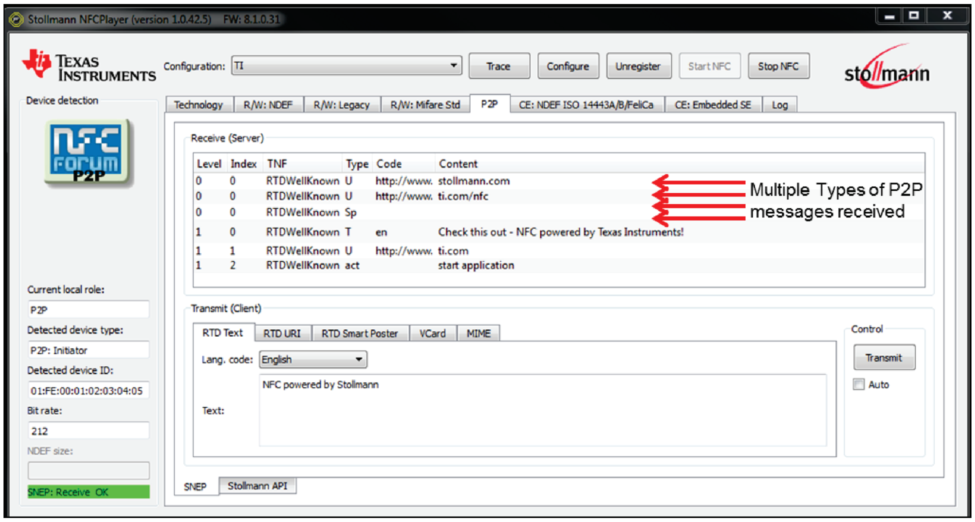
Text: NFC powered by Texas Instruments

Control: Transmit ☐ Auto

SNEP | Stollmann API

Figure 41.

User can also send over and receive all the other types with this hardware setup described. Here we have sent a RTD URI, SmartPoster, VCard from one hardware set to another (also using SNEP). It's important to realize here that once connection and symmetry are established, the device on either side can send a message to the other device, without changing any settings.



Configuration: TI

Receive (Server)

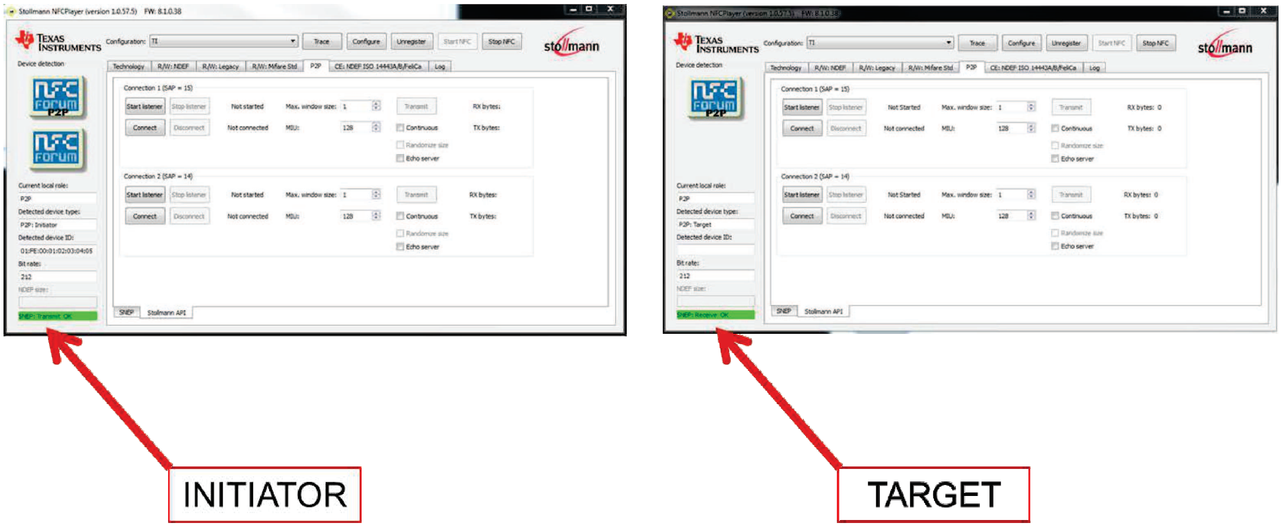
Level	Index	TNF	Type	Code	Content
0	0	RTDWellKnown	U	http://www.	stollmann.com
0	0	RTDWellKnown	U	http://www.	ti.com/nfc
0	0	RTDWellKnown	Sp		
1	0	RTDWellKnown	T	en	Check this out - NFC powered by Texas Instruments!
1	1	RTDWellKnown	U	http://www.	ti.com
1	2	RTDWellKnown	act		start application

Current local role: P2P
Detected device type: P2P: Initiator
Detected device ID: 01:FE:00:01:02:03:04:05
Bit rate: 212
NDEF size:
SNEP: Receive OK

Transmit (Client)
Lang. code: English
Text: NFC powered by Stollmann
□ Auto

Figure 42.

Demonstrating the advanced features that NFC Peer-to-Peer offers, Figure 43 shows that you can see (once P2P connection is established) that a two-channel, bi-directional communication link can be arranged between two kits. This is useful for firmware updates or large data transfers where a user can set the device down for at least a few seconds (NFC Landing Pads…). Figure 43 shows two devices that are set up (one as the target the other as the initiator) and that have communication symmetry.



Configuration: TI

Connection 1 (SAP = 15)
Not started — Max. window size: 1 — RX bytes:
Not connected — MIU: 128 — □ Continuous — TX bytes:
□ Randomize size
□ Echo server

Connection 2 (SAP = 14)
Not started — Max. window size: 1 — RX bytes:
Not connected — MIU: 128 — □ Continuous — TX bytes:
□ Randomize size
□ Echo server

Current local role: P2P
Detected device type: P2P: Initiator
Detected device ID: 01:FE:00:01:02:03:04:05
Bit rate: 212
NDEF size:
SNEP: Transmit OK

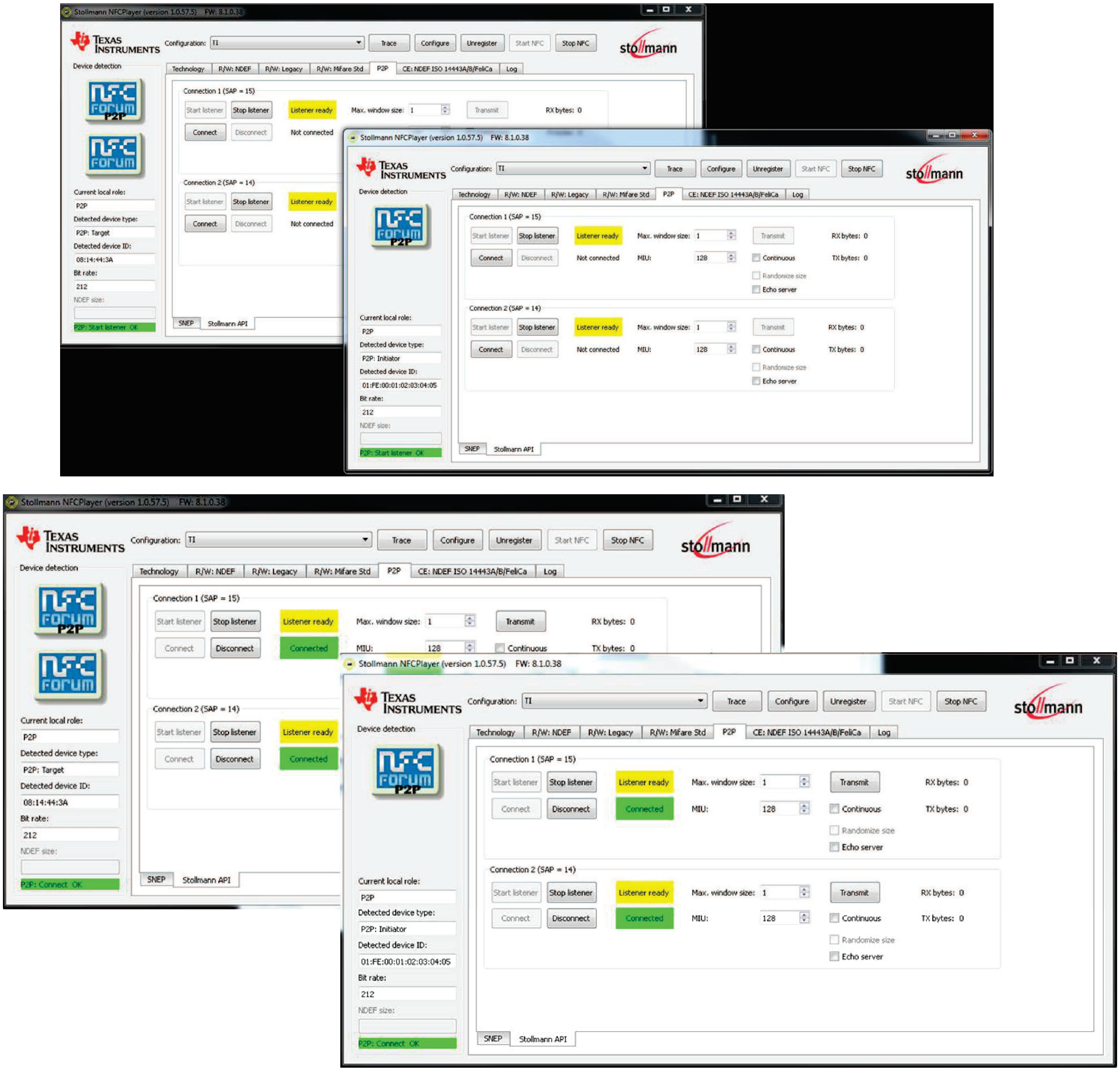
Connection 1 (SAP = 15)
Not Started — Max. window size: 1 — RX bytes: 0
Not connected — MIU: 128 — □ Continuous — TX bytes: 0
□ Randomize size
□ Echo server

Connection 2 (SAP = 14)
Not Started — Max. window size: 1 — RX bytes: 0
Not connected — MIU: 128 — □ Continuous — TX bytes: 0
□ Randomize size
□ Echo server

Current local role: P2P
Detected device type: P2P: Target
Detected device ID:
Bit rate: 212
NDEF size:
SNEP: Receive OK

Figure 43.

We have chosen the Stollman API tab and started the listeners. The next step is to do a connect, on either side. Then, on either side channel – choose continuous under a TRANSMIT button and depress the TRANSMIT button. This will start a continuous stream of data to begin flowing over the NFCLink in two directions, using a NFC magnetic field based on the TRF7970A + MCU device, on either side.



Configuration: TI

Connection 1 (SAP = 15): Listener ready; Not connected; Max. window size: 1; RX bytes: 0

Connection 2 (SAP = 14): Listener ready; Not connected

Current local role: P2P
Detected device type: P2P: Target
Detected device ID: 08:14:44:3A
Bit rate: 212
NDEF size:
P2P: Start listener OK

Connection 1 (SAP = 15): Listener ready; Not connected; Max. window size: 1; MIU: 128; ☐ Continuous; RX bytes: 0; TX bytes: 0

Connection 2 (SAP = 14): Listener ready; Not connected; Max. window size: 1; MIU: 128; ☐ Continuous; RX bytes: 0; TX bytes: 0

Current local role: P2P
Detected device type: P2P: Initiator
Detected device ID: 01:FE:00:01:02:03:04:05
Bit rate: 212
NDEF size:
P2P: Start listener OK

Connection 1 (SAP = 15): Listener ready; Connected; Max. window size: 1; MIU: 128; ☐ Continuous; RX bytes: 0; TX bytes: 0

Connection 2 (SAP = 14): Listener ready; Connected

Current local role: P2P
Detected device type: P2P: Target
Detected device ID: 08:14:44:3A
Bit rate: 212
NDEF size:
P2P: Connect OK

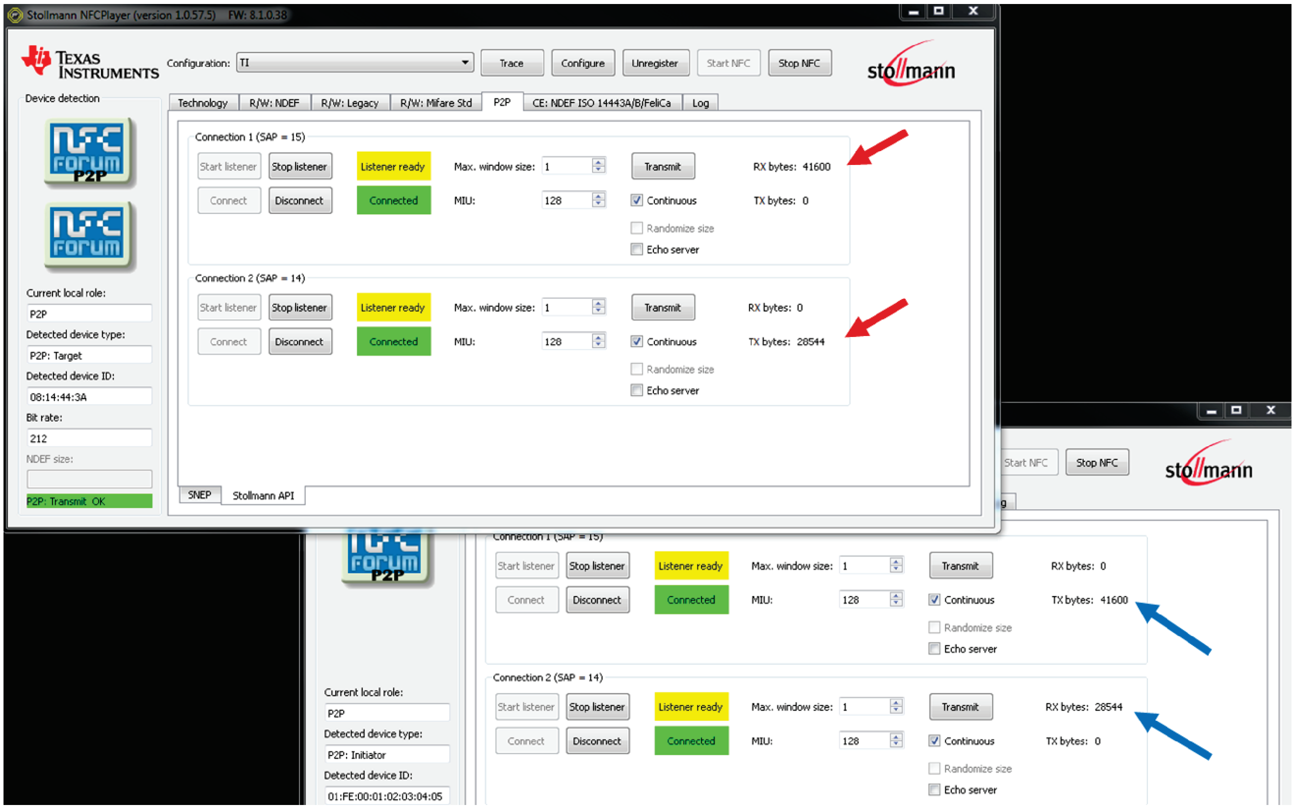
Connection 1 (SAP = 15): Listener ready; Connected; Max. window size: 1; MIU: 128; ☐ Continuous; RX bytes: 0; TX bytes: 0

Connection 2 (SAP = 14): Listener ready; Connected; Max. window size: 1; MIU: 128; ☐ Continuous; RX bytes: 0; TX bytes: 0

Current local role: P2P
Detected device type: P2P: Initiator
Detected device ID: 01:FE:00:01:02:03:04:05
Bit rate: 212
NDEF size:
P2P: Connect OK

Figure 44.

Then the user can see data amounts streaming and in what direction.



Configuration: TI

Connection 1 (SAP = 15)

Max. window size: 1 | MIU: 128 | ☑ Continuous | □ Randomize size | □ Echo server

RX bytes: 41600 | TX bytes: 0

Connection 2 (SAP = 14)

Max. window size: 1 | MIU: 128 | ☑ Continuous | □ Randomize size | □ Echo server

RX bytes: 0 | TX bytes: 28544

Current local role: P2P

Detected device type: P2P: Target

Detected device ID: 08:14:44:3A

Bit rate: 212

NDEF size:

P2P: Transmit OK

Connection 1 (SAP = 15)

Max. window size: 1 | MIU: 128 | ☑ Continuous | □ Randomize size | □ Echo server

RX bytes: 0 | TX bytes: 41600

Connection 2 (SAP = 14)

Max. window size: 1 | MIU: 128 | ☑ Continuous | □ Randomize size | □ Echo server

RX bytes: 28544 | TX bytes: 0

Current local role: P2P

Detected device type: P2P: Initiator

Detected device ID: 01:FE:00:01:02:03:04:05

Figure 45.

16 NFC or RFID Card Emulation (CE) Mode Details

The TRF7970A is capable of emulating (or being) a Type A or Type B card @ 106kbps. This section will show how to accomplish this with the use of the host stack and the embedded MCU library. This NFC mode is being used for a variety of applications where larger tag sizes are needed or more advanced applications need to pass data sizes or methods which exceed the capabilities of passive tags. In a previous section, we showed the RF430CL330H, which is a dynamic tag with 3kB of memory space available, here we are showing something similar, but with 8kB of space. (the size of the emulated card is really limited only by the settings in the system, meaning, the card could be indicated to be much larger)

When hardware is in card emulation mode, and a NFC-enabled device acting as reader or writer is presented, the LED in the center of PAD1 will illuminate. The PAD1 LED will flash as the device approaches, then, when the field strength is sufficient it will stay on solid.

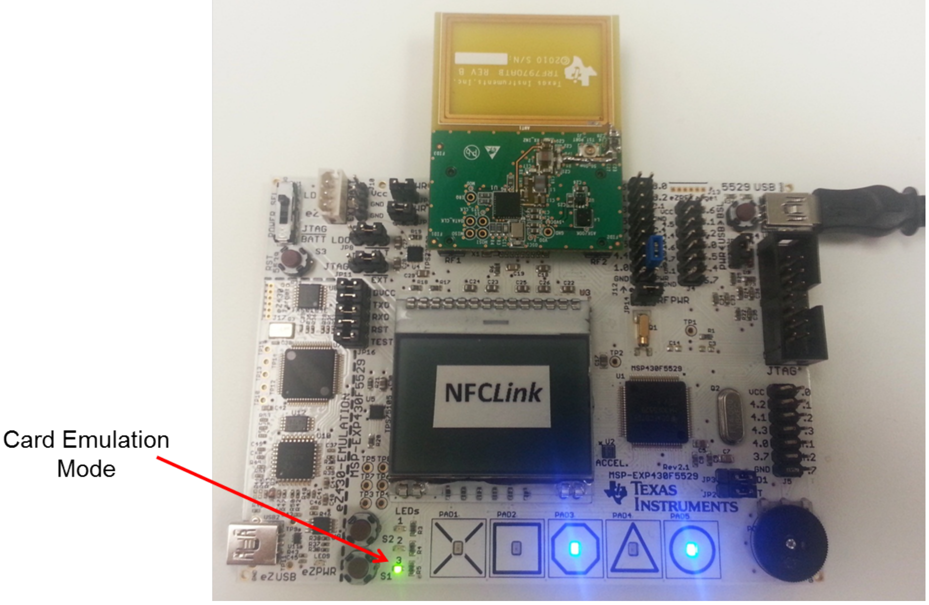
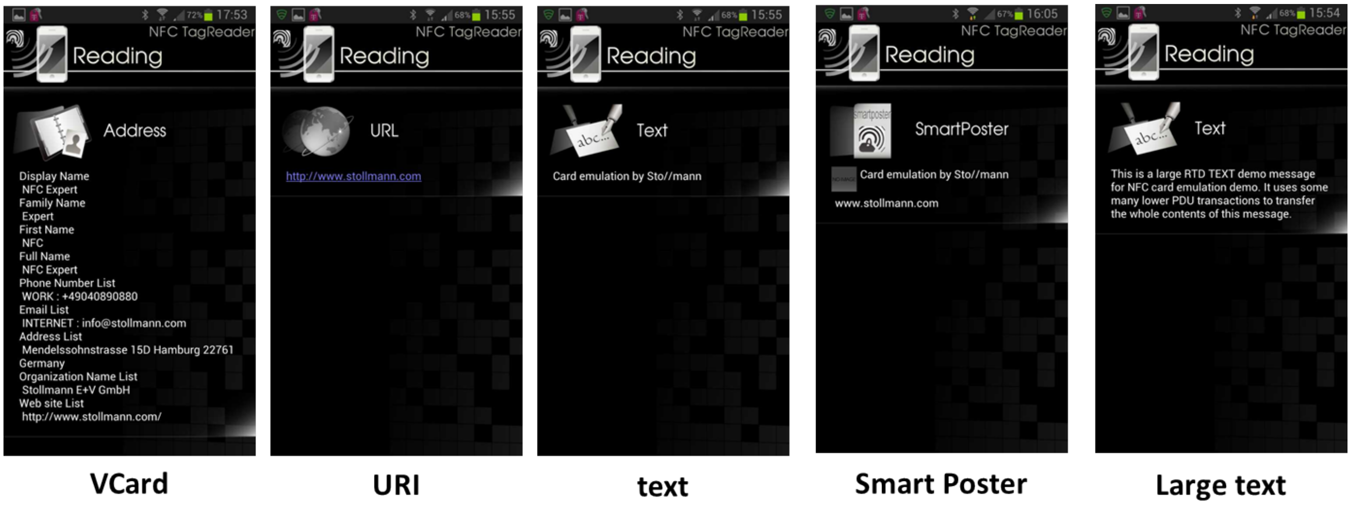


Figure 46.

When an NFC handset (or other NFC enabled reader or writer) is presented, the hardware will be read out just like a passive NFC or RFID tag. Figure 47 shows various screen captures from handset application called NFC TagReader (from KDDI)



Display Name
NFC Expert
Family Name
Expert
First Name
NFC
Full Name
NFC Expert
Phone Number List
WORK : +49040890880
Email List
INTERNET : info@stollmann.com
Address List
Mendelssohnstrasse 15D Hamburg 22761
Germany
Organization Name List
Stollmann E+V GmbH
Web site List
http://www.stollmann.com/

VCard

http://www.stollmann.com

URI

Card emulation by Sto//mann

text

Card emulation by Sto//mann

www.stollmann.com

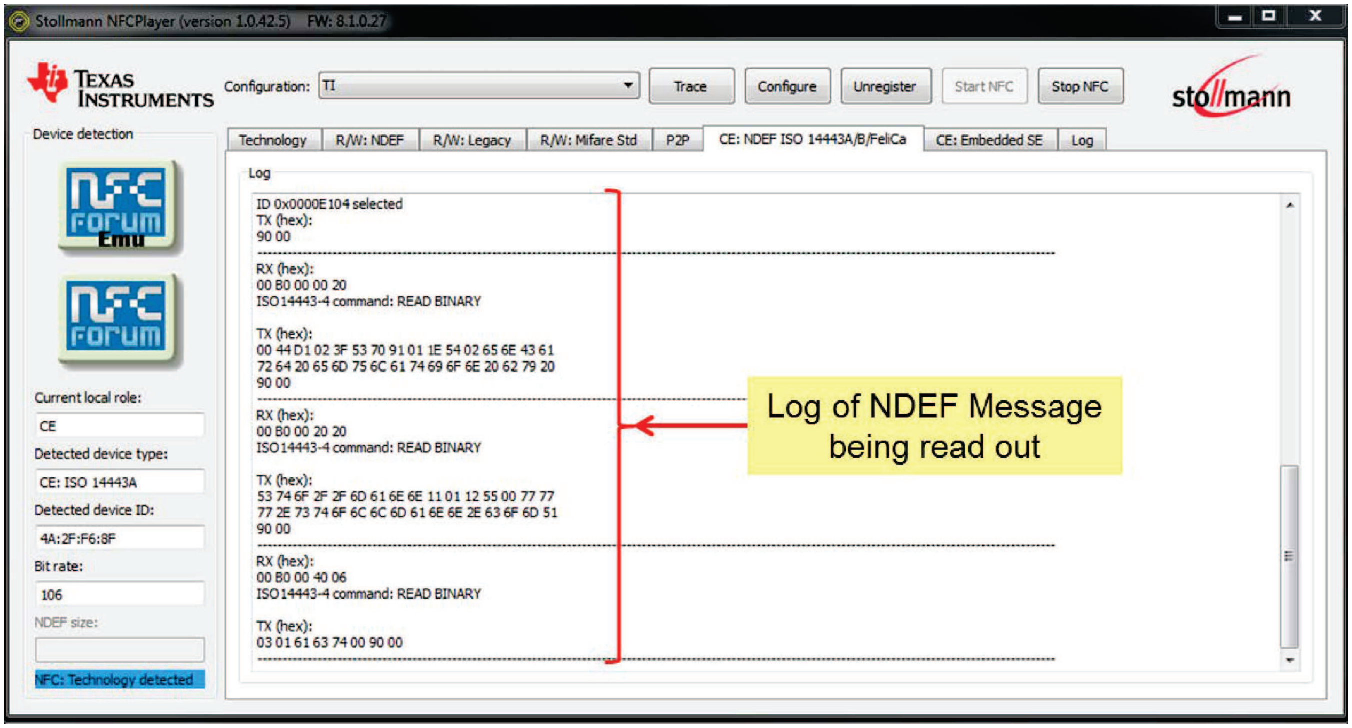
Smart Poster

This is a large RTD TEXT demo message for NFC card emulation demo. It uses some many lower PDU transactions to transfer the whole contents of this message.

Large text

Figure 47.

When an NFC handset (or other NFC-enabled reader or writer) is presented, the hardware will be read out like a passive NFC or RFID tag. Figure 48 shows the GUI screen, as appears when showing the packet activity between the NFC handset (or other reader/writer) and the hardware.



Configuration: TI

Current local role: CE

Detected device type: CE: ISO 14443A

Detected device ID: 4A:2F:F6:8F

Bit rate: 106

NDEF size:

NFC: Technology detected

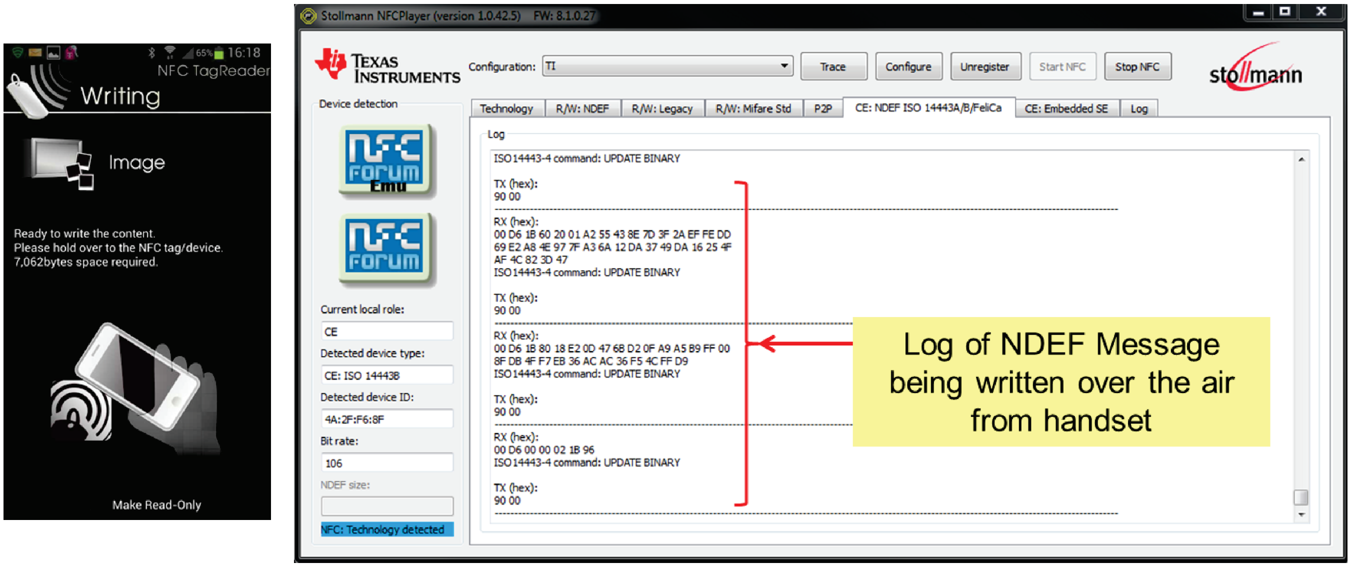
Log

```
ID 0x0000E104 selected
TX (hex):
90 00
--------------------------------------------------------------------------------
RX (hex):
00 B0 00 00 20
ISO14443-4 command: READ BINARY

TX (hex):
00 44 D1 02 3F 53 70 91 01 1E 54 02 65 6E 43 61
72 64 20 65 6D 75 6C 61 74 69 6F 6E 20 62 79 20
90 00
--------------------------------------------------------------------------------
RX (hex):
00 B0 00 20 20
ISO14443-4 command: READ BINARY

TX (hex):
53 74 6F 2F 2F 6D 61 6E 6E 11 01 12 55 00 77 77
77 2E 73 74 6F 6C 6C 6D 61 6E 6E 2E 63 6F 6D 51
90 00
--------------------------------------------------------------------------------
RX (hex):
00 B0 00 40 06
ISO14443-4 command: READ BINARY

TX (hex):
03 01 61 63 74 00 90 00
--------------------------------------------------------------------------------
```

Log of NDEF Message being read out

Figure 48.

You can also use a handset application, like the KDDI application, to write an image (or other message type) to the hardware.



Ready to write the content.
Please hold over to the NFC tag/device.
7,062bytes space required.

Configuration: TI

Current local role: CE

Detected device type: CE: ISO 14443B

Detected device ID: 4A:2F:F6:8F

Bit rate: 106

NDEF size:

NFC: Technology detected

Log

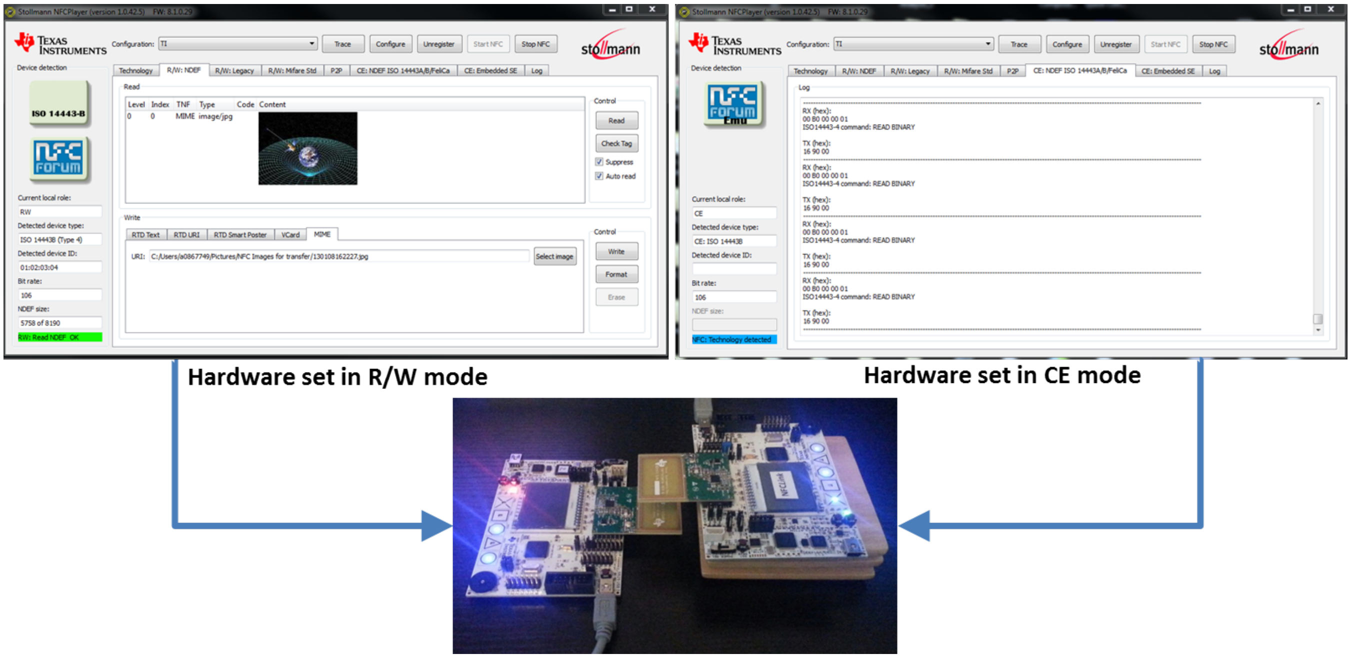
```
ISO14443-4 command: UPDATE BINARY

TX (hex):
90 00
--------------------------------------------------------------------------------
RX (hex):
00 D6 1B 60 20 01 A2 55 43 8E 7D 3F 2A EF FE DD
69 E2 A8 4E 97 7F A3 6A 12 DA 37 49 DA 16 25 4F
AF 4C 82 3D 47
ISO14443-4 command: UPDATE BINARY

TX (hex):
90 00
--------------------------------------------------------------------------------
RX (hex):
00 D6 1B 80 18 E2 0D 47 6B D2 0F A9 A5 B9 FF 00
8F DB 4F F7 EB 36 AC AC 36 F5 4C FF D9
ISO14443-4 command: UPDATE BINARY

TX (hex):
90 00
--------------------------------------------------------------------------------
RX (hex):
00 D6 00 00 02 1B 96
ISO14443-4 command: UPDATE BINARY

TX (hex):
90 00
--------------------------------------------------------------------------------
```

Log of NDEF Message being written over the air from handset

Figure 49.

Then, the application can read back the image (or other data) from the hardware.

You can also set up two of the hardware sets and run two instances of the GUI on the same PC (with one as the reader and writer and the other in card emulation mode) then read and write data without using a NFC handset. (Figure 50 we have written ~5.7kB image and have read it back)



Hardware set in R/W mode:

Configuration: TI

Level	Index	TNF	Type	Code	Content
0	0	MIME	image/jpg		

☑ Suppress
☑ Auto read

URI: C:/Users/a0867749/Pictures/NFC Images for transfer/130108162227.jpg

Current local role: RW
Detected device type: ISO 14443B (Type 4)
Detected device ID: 01:02:03:04
Bit rate: 106
NDEF size: 5758 of 8190
RW: Read NDEF OK

Hardware set in CE mode:

Configuration: TI

Current local role: CE
Detected device type: CE: ISO 14443B
Detected device ID:
Bit rate: 106
NDEF size:
NFC: Technology detected

```
------------------------------------------------------------
RX (hex):
00 B0 00 00 01
ISO14443-4 command: READ BINARY

TX (hex):
16 90 00
------------------------------------------------------------
RX (hex):
00 B0 00 00 01
ISO14443-4 command: READ BINARY

TX (hex):
16 90 00
------------------------------------------------------------
RX (hex):
00 B0 00 00 01
ISO14443-4 command: READ BINARY

TX (hex):
16 90 00
------------------------------------------------------------
RX (hex):
00 B0 00 00 01
ISO14443-4 command: READ BINARY

TX (hex):
16 90 00
------------------------------------------------------------
```

Figure 50.

17 Project File Structure

The NFCLink installation places the following folders at this location:

`C:\ti\msp430\NFCLink_1.0.0.1`

doc —User Guide\Quick Start Presentation. (similar to this document)

examples\allModes —Reader/Writer, Peer to Peer, and Card Emulation projects.

RW_P2P_CE_1: USB (CDC) interface to the host.

RW_P2P_CE_2: UART Module interface to the host.

Libraries — The libraries used by the CCS projects.

driverlib – UART, GPIO and Timer drivers.

nfclinklib – library for NFC operations

usblib430 – USB drivers for the MSP430F5529.

utils — NFC Player installer – Host executable for Windows OS. The program will be installed in C:/Program Files(x86)/Stollmann.

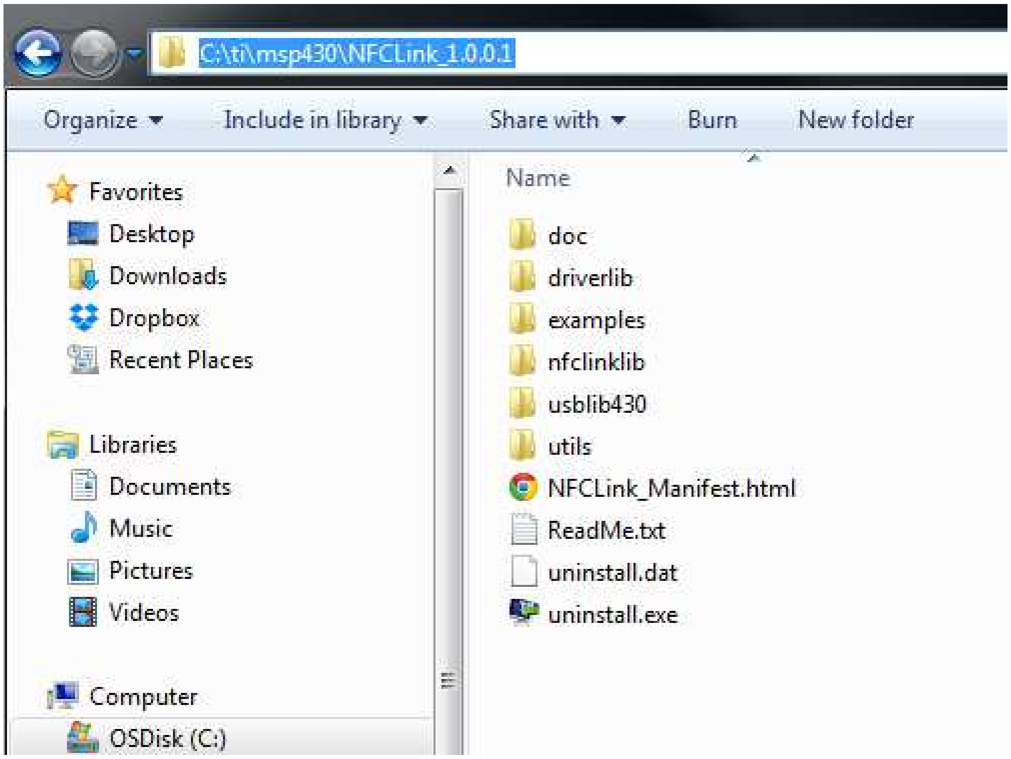


Figure 51.

18 Porting to other MCUs

The following layers will have to be modified when porting to other MSP430s:

1. **Host Interface –** Code examples will include USB / UART. Future releases will include SPI and I2C implementations – i.e. using an Aardvark™ I²C/SPI Host Adapter for testing.
2. **MSP430 Hardware –**Main application, MSP430 MCLK, Watch Dog Timer(WDT), GPIOs (for LEDs and debugging purposes), and one timer.
3. **TRF7970A transceiver Interface –** SPI w/ Slave Select module.

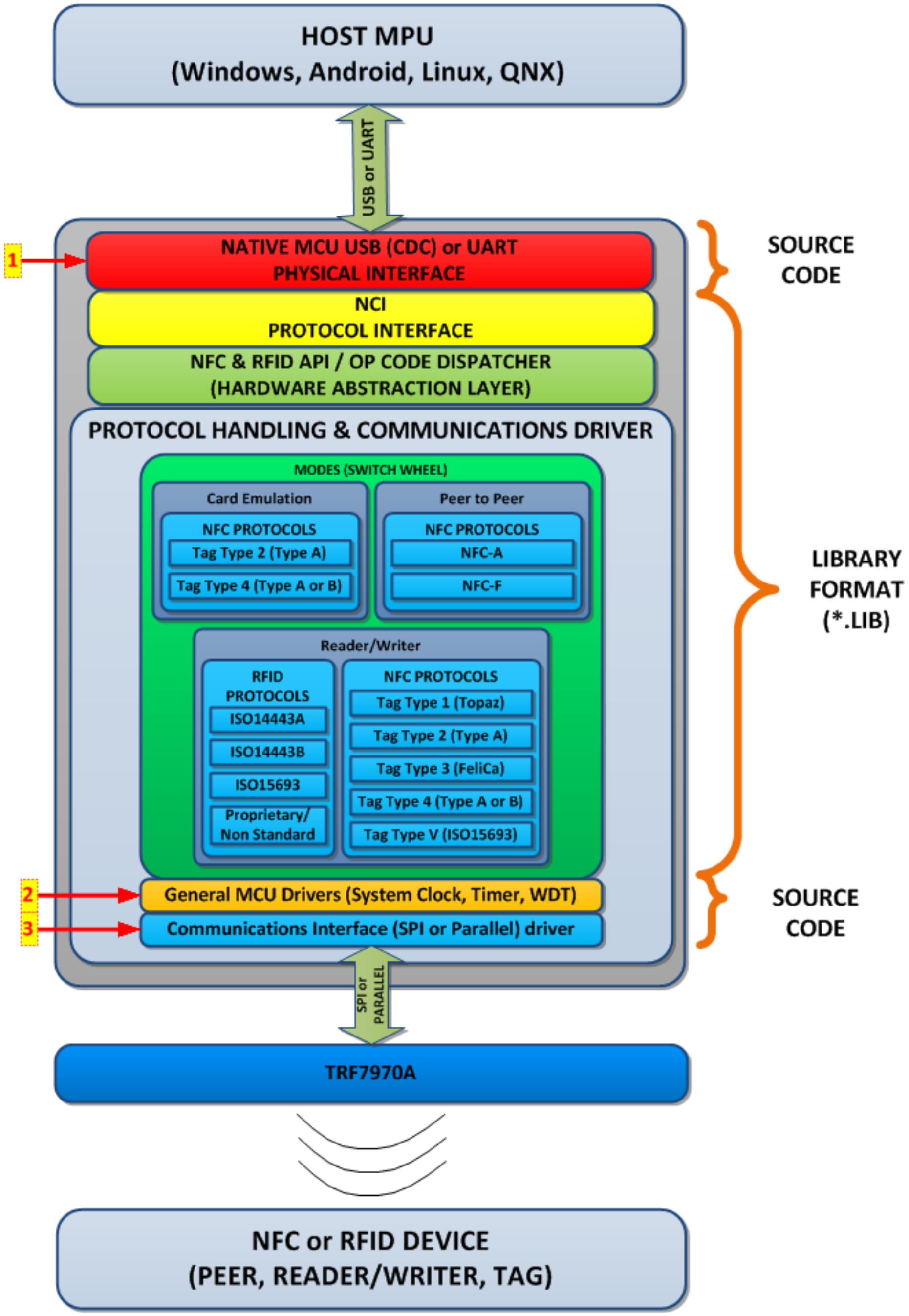


Figure 52.

18.1 Host Interface Modifications

There are three functions that must be modified to interface with the host.

Host_Interface::Init() —Initialization for the module and RX ISR. For RW_P2P_CE1 the function initializes and configures the USB module.

Host_Interface::Write() —Function that transmits to the host. For RW_P2P_CE2 the function writes to the UART_TX buffer with len bytes.

The RX ISR for the host interface—Store incoming bytes into Host_Interface::recbuf.

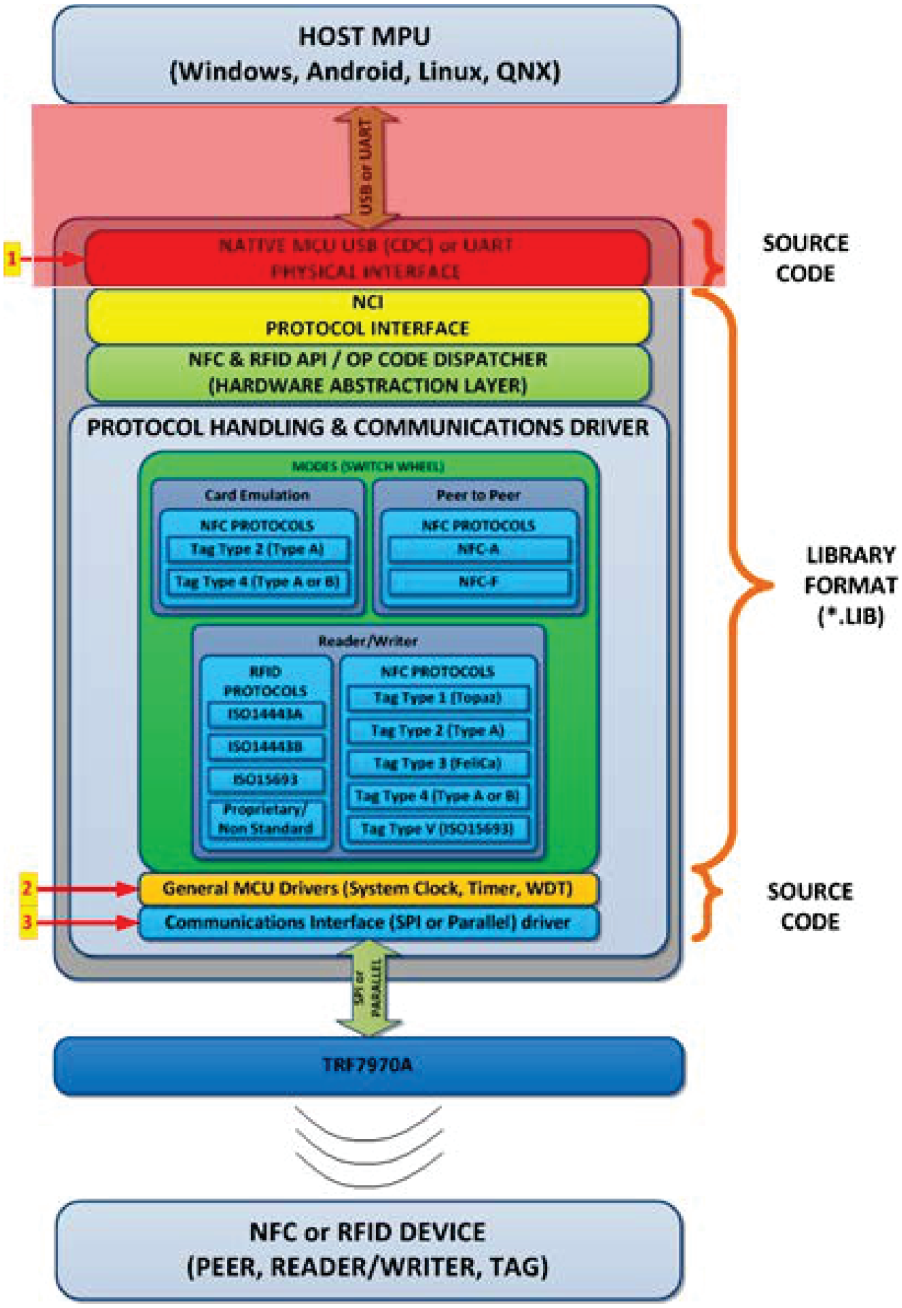


Figure 53.

18.2 General MSP430 Modifications

There are five functions that must be reviewed:

HW_Config::Init() — Disables the WDT. Sets up the Frequency of the MCLK – the current implementation uses the 32.768 kHz crystal (ACLK) , MCLK = DCO = 25MHz.

HW_Config::MCU_Reset() — Reset the MSP430 by setting the BOR flag (this can be modified to a software power on reset depending on the MCU). When a host reset command is received, this function is used to reset the MCU.

HWTimer::Init() — Initialize Timer A using reference of ACLK (32.768kHz) running continuously.

HWTimer::ticks32() — Returns and stores the value of the timer's counter into timervalue.f[0]. Furthermore **TICKS_PER_MSEC** (inside MSP430_hardware.h) needs to be updated based on the CLK being used as reference. (i.e. For a 2MHz Clock -> TICKS_PER_MSEC = Ref. CLK / 1000 = 2 x 10^6 / 1000 = 2000)

GPIO::Init() — Initializes the External Field LED (P1.1), External Field debug pin (P4.1), Any Mode LED (P1.3), RW/Initiator Mode LED (1.0), P2P LED (P8.1), CE (8.2), Serial TX debug pin(4.3) and Serial RX debug pin (4.2). These GPIOs will be helpful to provide feedback to our team.

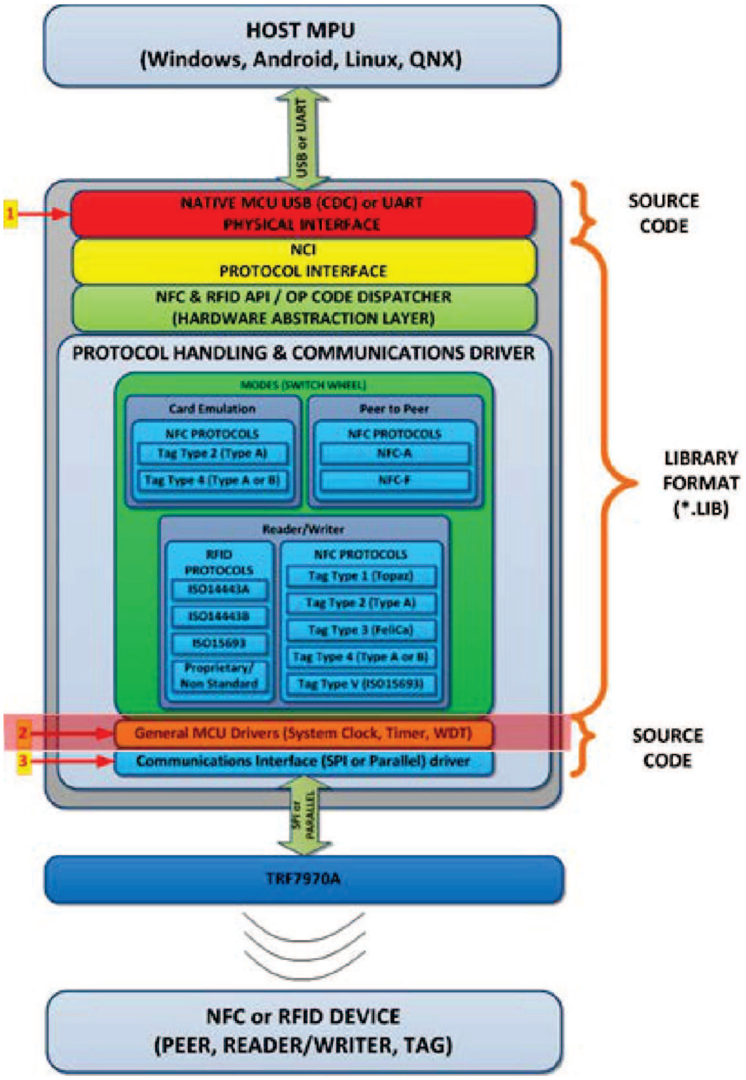


Figure 54.

18.3 TRF7970A SPI Driver Modifications

There are five functions that must be reviewed:

TRF797x_setup() — Initializes the interface to the TRF7970A (SPI / Parallel). Initializes the TRF7970 EN pin, then sets up the IRQ pin with a rising edge interrupt. Afterwards, it writes to the TRF7970 to ensure it has been initialized properly. (RFID.cpp/.h)

Note: At this time, only SPI w/ SS is supported.

RFSPI::init() — Initializes the SPI module as 3 pin SPI, 8 bit Master, MSB, Clock Pol/ Phase = 0, SPI Clock ~ 4MHz using the SMCLK = 25MHz as reference. The Slave Select will be manually set – ensure that SLAVESELECT _OUTPUT is using the correct GPIO (SPI.cpp/.h)

Note: Please see the datasheet to match

TRF797x_IRQ_ISR() — Ensure that the interrupt service routine for the IRQ pin (rising edge interrupt) is setup correctly. (RFID.cpp)

RFSPI::waitBus() — Waits for the SPI module to be idle. (Needs to be modified depending on the USCI) (SPI.cpp)

RFSPI::transfer() — Writes to the SPI TX register, and returns the value of the SPI RX register. (Ensure USPITXBUF and USPIRXBUF are defined appropriately). (SPI.h)

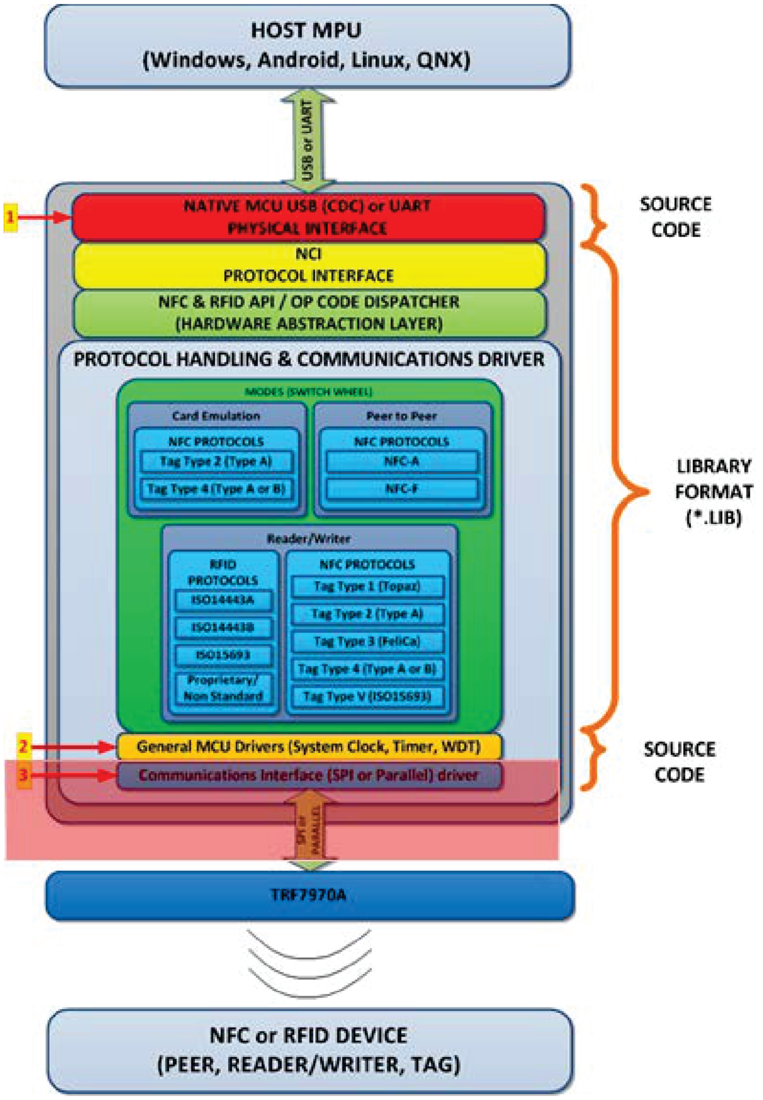


Figure 55.

19 Memory Footprints

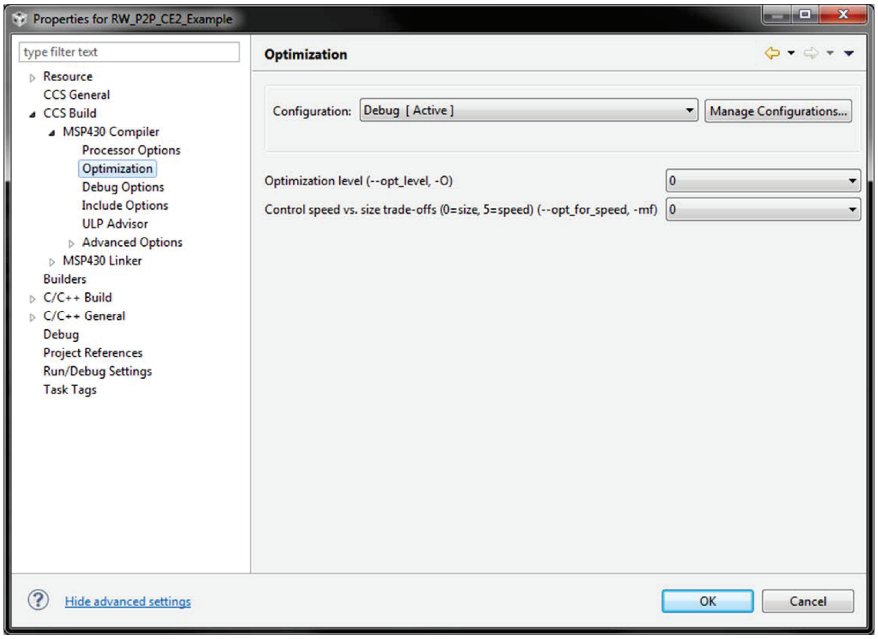
19.1 CCS Optimization Options

There are two knobs available for optimizing the application:

1. Optimization Level (range 0 - 4)
2. Control speed vs. size (range 0 – 5)

Note: For smallest memory footprint the control speed vs. size must be set to 0.

The following section will provide a memory footprint for the examples in the release and the internal development version – by only modifying the optimization level. Since both the library and the CCS project can be optimized independently, the table for the USB will have the best and worst cases scenarios.



Configuration: Debug [Active]

Optimization level (--opt_level, -O) 0

Control speed vs. size trade-offs (0=size, 5=speed) (--opt_for_speed, -mf) 0

Figure 56.

Table 1. CCS Memory Footprint

Mode + USB CDC[1]	Optimization Level (0-4)	Flash (kB)	RAM (kB)
Card Emulation	0	84.3	6.2
	4	62.3	6.2
Peer-to-Peer	0	71.2	6.2
	4	51.3	6.2
Reader/Writer	0	78.4	6.2
	4	57.2	6.2
All Modes	0	91.5	6.2
	4	68.1	6.2

[1] CCS Project stand alone w/e library

Note: The control speed vs. size tradeoffs (0 = size, 5 = speed) for all the memory footprints was set to 0 – optimized for smallest footprint (size).

Table 2. RW_P2P_CE_1 Memory Footprint

RW_P2P_CE1_Ex Optimization Level (0-4)	nfclink.lib Optimization Level (0-4)	Flash (kB)	RAM (kB)
0	0		
[1]1	0		[1]
2	0		[1]
3	0		[1]
4	0		[1]
0	4		
[2]1	4		[2]
2	4		[2]
3	4		[2]
4	4	78	6 kB [2]

[1] Larger Footprint (Development)

[2] Smaller Footprint (Release)

Table 3. RW_P2P_CE Memory Footprint

RW_P2P_CE2_Ex Optimization Level (0-4)	nfclink.lib Optimization Level (0-4)	Flash (kB)	RAM (kB)
0	0		
[1]1	0		[1]
2	0		[1]
3	0		[1]
4	0		[1]
0	4		
[2]1	4		[2]
2	4		[2]
3	4		[2]
4	4	78	6 kB [2]

[1] Larger Footprint (Development)

[2] Smaller Footprint (Release)

20 References

- TRF7970A Data Sheet (literature number: SLOS743)
- MSP-EXP430F5529 Users Guide (literature number: SLAU330)
- ISO14443-3, -3, -4 (link: ISO/IEC 14443-2:2010, ISO/IEC 14443-3:2011, ISO/IEC 14443-4:2008)
- ISO15693-2, -3 (link: ISO/IEC 15693-2:2006, ISO15693-3:2009)
- ISO7816-4 (link: ISO/IEC 7816-4:2013)
- ECMA340 (link: NFCIP-1)
- ISO18092 (link: NFCIP-1)
- ECMA352 (link: NFCIP-2)
- ISO21481 (link: NFCIP-2)
- NFC Forum Specifications (link: NFC Forum Specs)

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Microcontrollers	microcontroller.ti.com	Video and Imaging	www.ti.com/video
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Wireless Connectivity	www.ti.com/wirelessconnectivity		

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