AN14224

How to use PN7220 in Dual-Host mode

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Document information

Information	Content
Keywords	PN7220, NCI, EMVCo, NFC Forum, Android, NFC
Abstract	This document describes how to use PN722xBP2 with examples for K82 as "secure" MCU.

1 Introduction

This document describes how to use PN7220 in Dual-Host mode. The following sections provide the reader with a basic understanding of the PN7220 Dual-Host architecture, step-by-step instructions for preparing the MCUXpresso environment, and explanations on how to run the examples.

Note: *Before reading this document, it is necessary to consult PN7220 Quick start guide.*

2 Architecture

The complete architecture consists of three parts.

1. Android DH
2. PN7220
3. Secure MCU

Figure 1 shows the basic Dual-Host architecture.

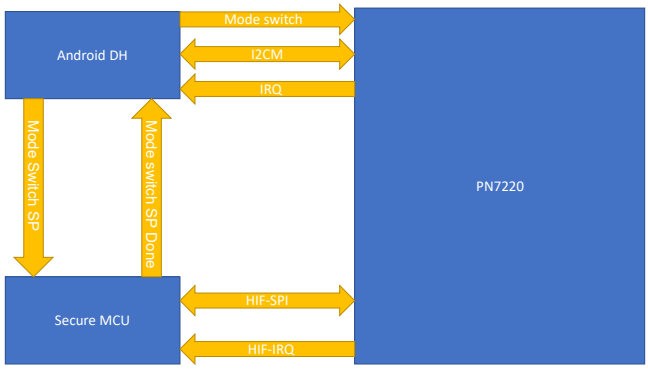

Figure 1. PN7220 Dual-Host architecture

The Android host is the main DH, and it is driving the NFC Forum communication. It uses an I2CM interface to communicate with PN7220. The IRQ line indicates to the Android host that PN7220 has data to be read out. The Mode switch GPIO is connected to the PN7220 and switches between the application processors (Android <–> Secure MCU).

The Secure MCU is driving the EMVCo communication and uses an HIF-SPI interface to communicate with the PN7220. HIF-IRQ has the same task as the IRQ line between the Android host and the PN7220.

But the connections mentioned above are not enough. NXP doesn't provide any "Library or stack" support between Android host and Secure MCU. For showing the use case, NXP provides the handshake mechanism between Android host and Secure MCU. Handshake is done with the help of two GPIOs (see Table 1):

1. Mode Switch SP
2. Mode Switch SP Done

Table 1. Signal overview for handshake in Dual-Host architecture

GPIO	Android host	Secure MCU
Mode Switch SP	output	input
Mode Switch SP Done	input	output

On the Mode switch toggle, the PN7220 switches to another DH, and this action resets the PN7220 with a combination of the following commands:

- CORE_RESET_CMD
- CORE_INIT_CMD

Reset is mandatory to clear all buffers. This prevents any unwanted data transfer between the Secure MCU and Android host.

3 Environment preparation

This chapter describes how to set up the environment for Dual-Host mode and running the examples provided by NXP.

To set up environment, the following resources must be downloaded:

- MCUXpresso [2]
- FRDM-K82 SDK [5]
- NCIRdLib examples [7]

3.1 MCUXpresso installation

To download the necessary files for the installation:

1. Go to [2]
2. Scroll down to the section shown in Figure 2 and click the "DOWNLOAD" button
   Note: *The image is just a sample. The webpage can change over time.*

Figure 2. MCUXpresso download

3. Log in to your NXP account to access the installation files.
4. After successful login, select the desired version of MCUXpresso and download it.
5. Run the installer and follow the instructions in Section 3.2.

Additional information can be found in the following material:

- MCUXpresso IDE – user guide [3]
- MCUXpresso IDE – installation guide [4]

3.2 SDK installation

PNEV722xBP2 board uses FRDM-K82 as "secure" MCU. As all examples are based on K82, the FRDM-K82F SDK is needed to run the examples. The following instructions show how to acquire the SDK resources and install it in the MCUXpresso IDE.

1. Go to MCUXpresso SDK Builder Webpage and select "Select Development Board".

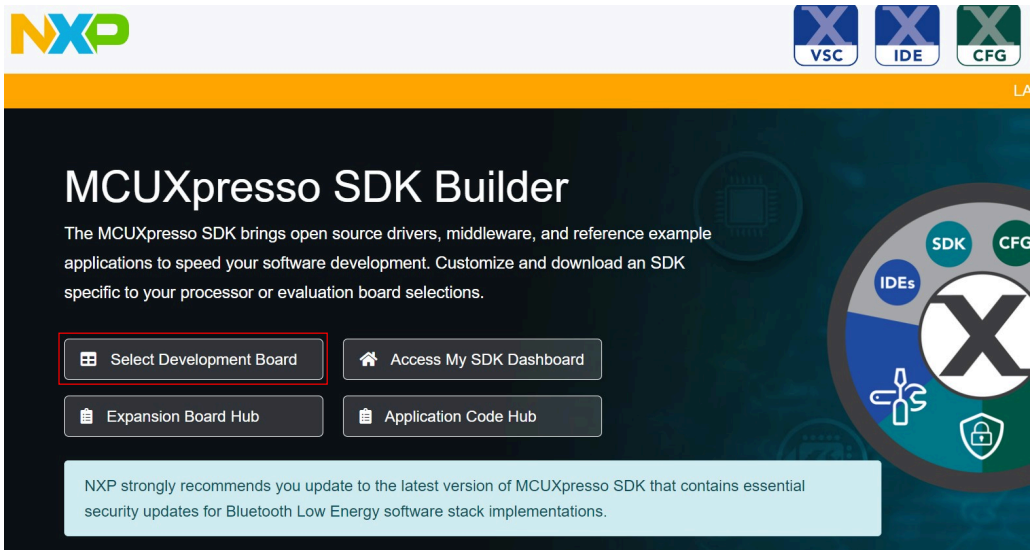

Figure 3. MCUXpresso SDK Builder webpage

2. Search for "FRDM-K82F".

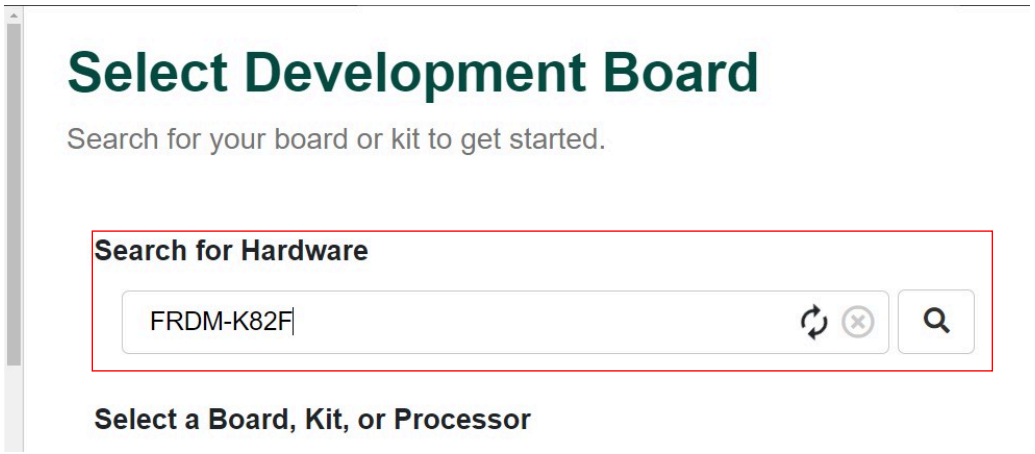

Figure 4. Search for specific HW

3. Select "FRDM-K82F" and click "Build MCUXpresso SDK".

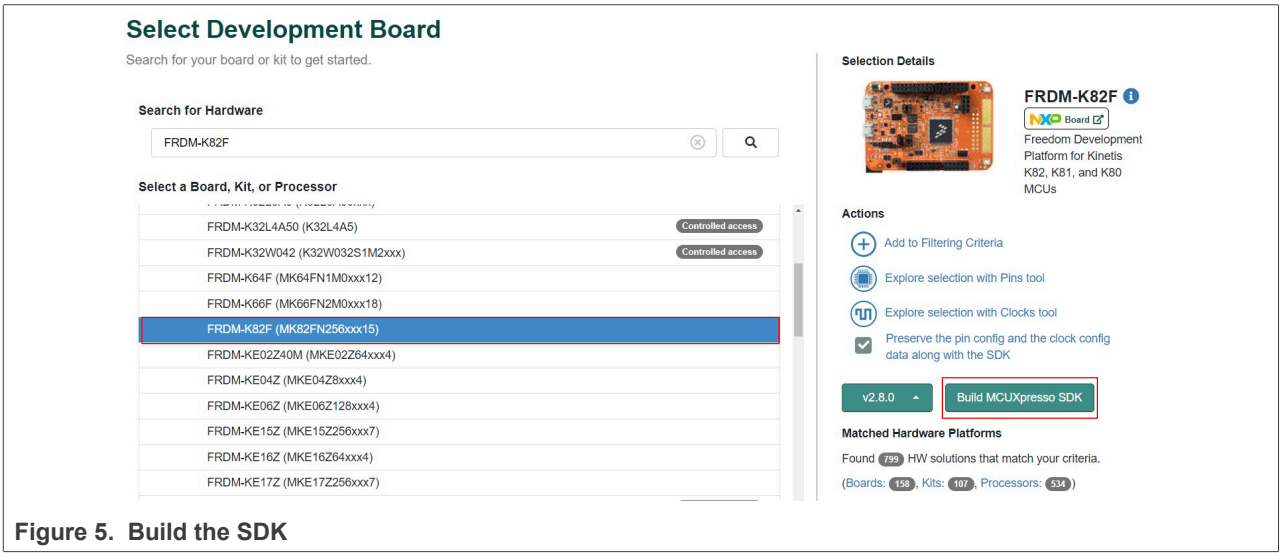

Figure 5. Build the SDK

4. Select the necessary resources for the build.

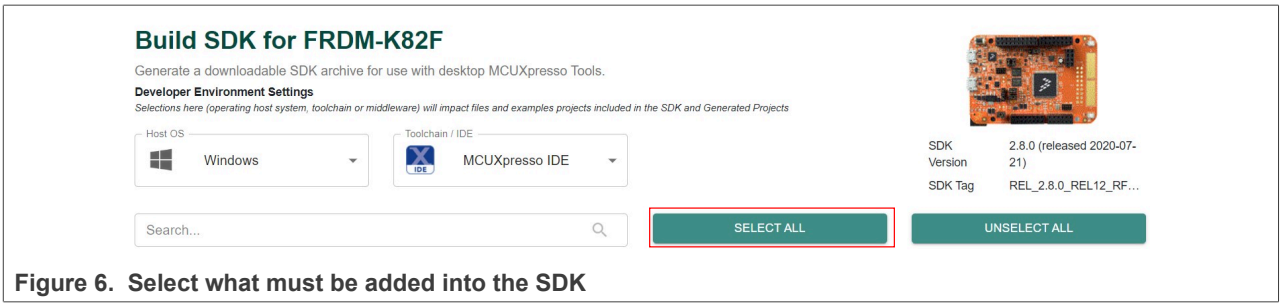

Figure 6. Select what must be added into the SDK

Note: *It is recommended to use the option "SELECT ALL".*

5. Click "DOWNLOAD SDK".

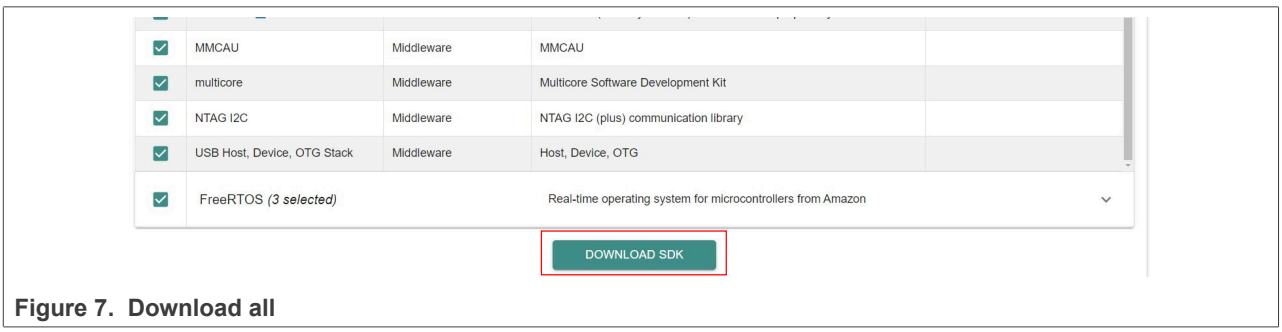

Figure 7. Download all

6. Check the requested SDK build and click "Download SDK".

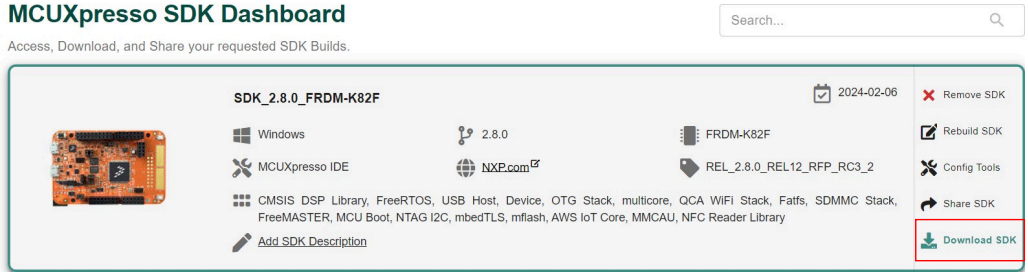

Figure 8. Confirm download

7. A window pops up. Click to "Download SDK Archive".

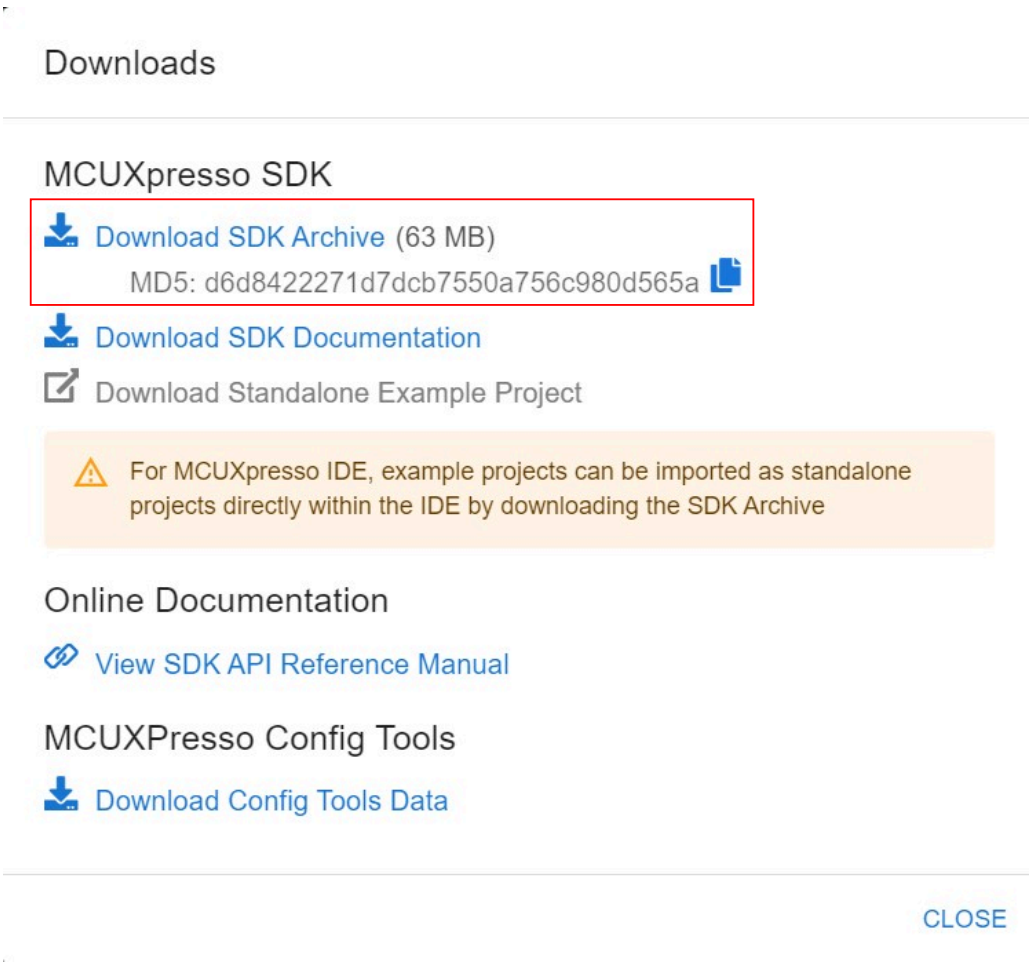

Figure 9. Download SDK Archive

The next step is to import the SDK into the MCUXpresso IDE.

1. Drag the archived file into the MCUXpresso "Installed SDK's" section.

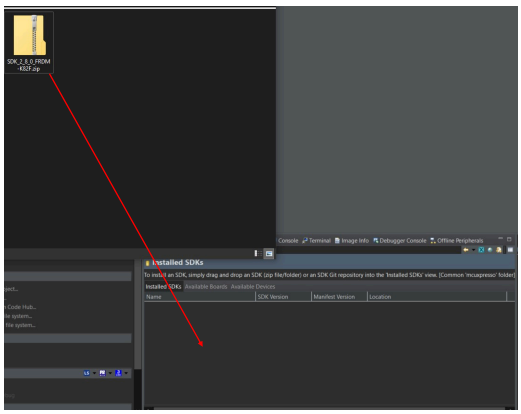

Figure 10. Drag&Drop SDK to MCUXpresso

2. Confirm by clicking the "OK" button.

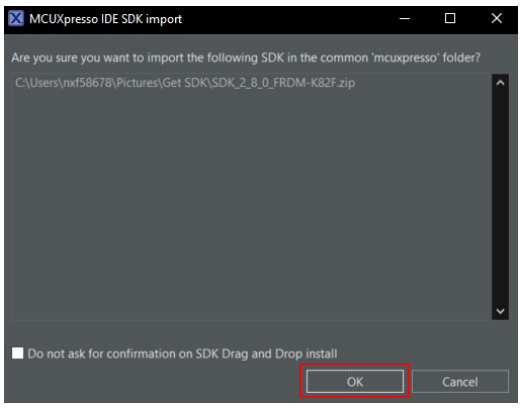

Figure 11. Click the "OK" button

This is one way of installing the SDK. Follow Importing and SDK package into MCUXpresso IDE for other options.

3.3 Examples

Examples provided by NXP can be found under [7]. After downloading, unzip the package.

Follow the steps below to import them into the MCUXpresso IDE:

1. Click "Import project(s) from file system...".

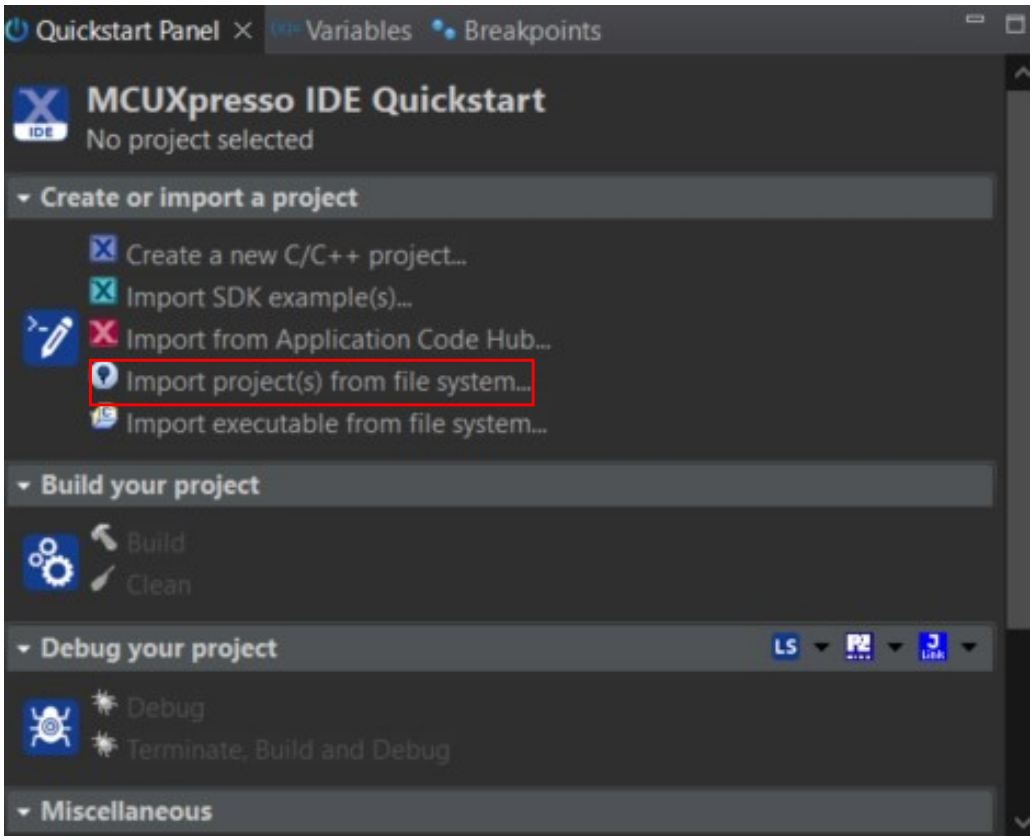

Figure 12. Import project(s) from file system

2. Click "Browse" in "Project directory (unpacked)".

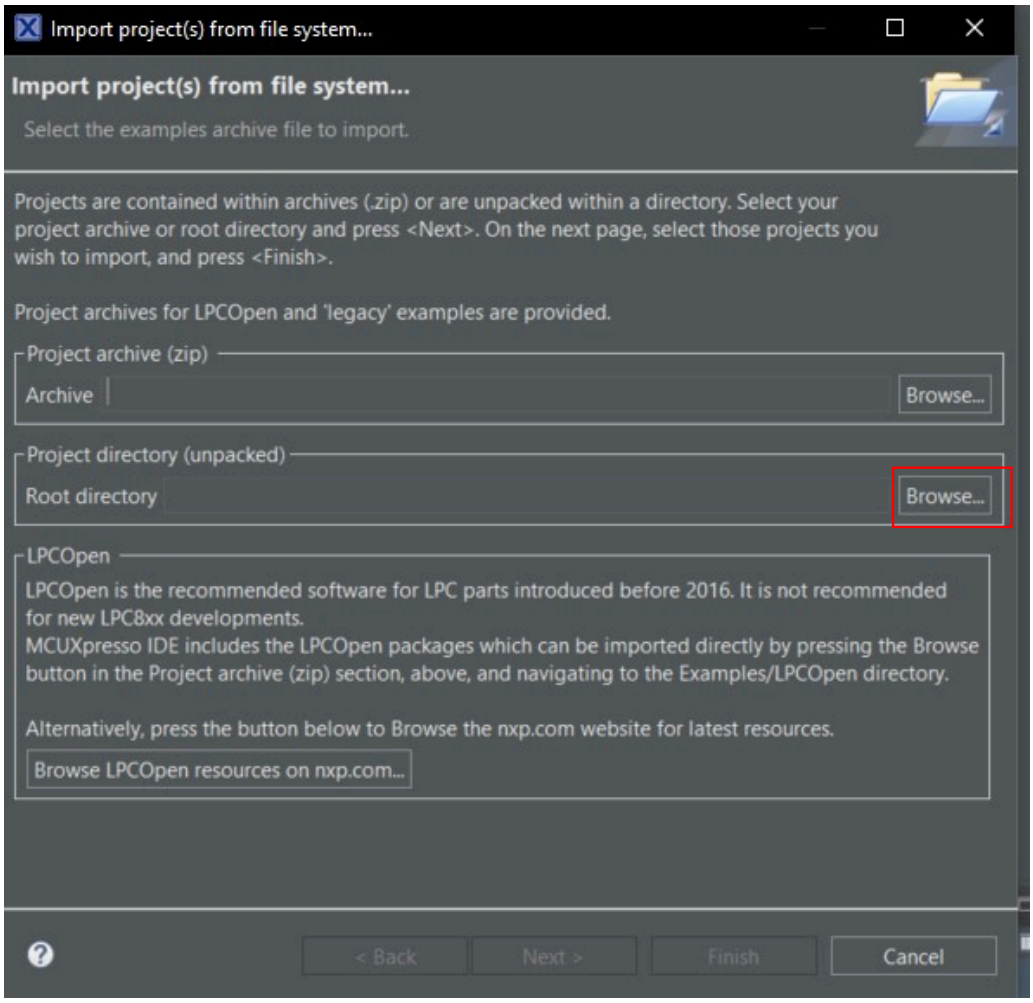

Figure 13. Browse for examples

3. Search for the unzipped directory and select it.

Figure 14. Select an unzipped directory

4. Click "Next >".

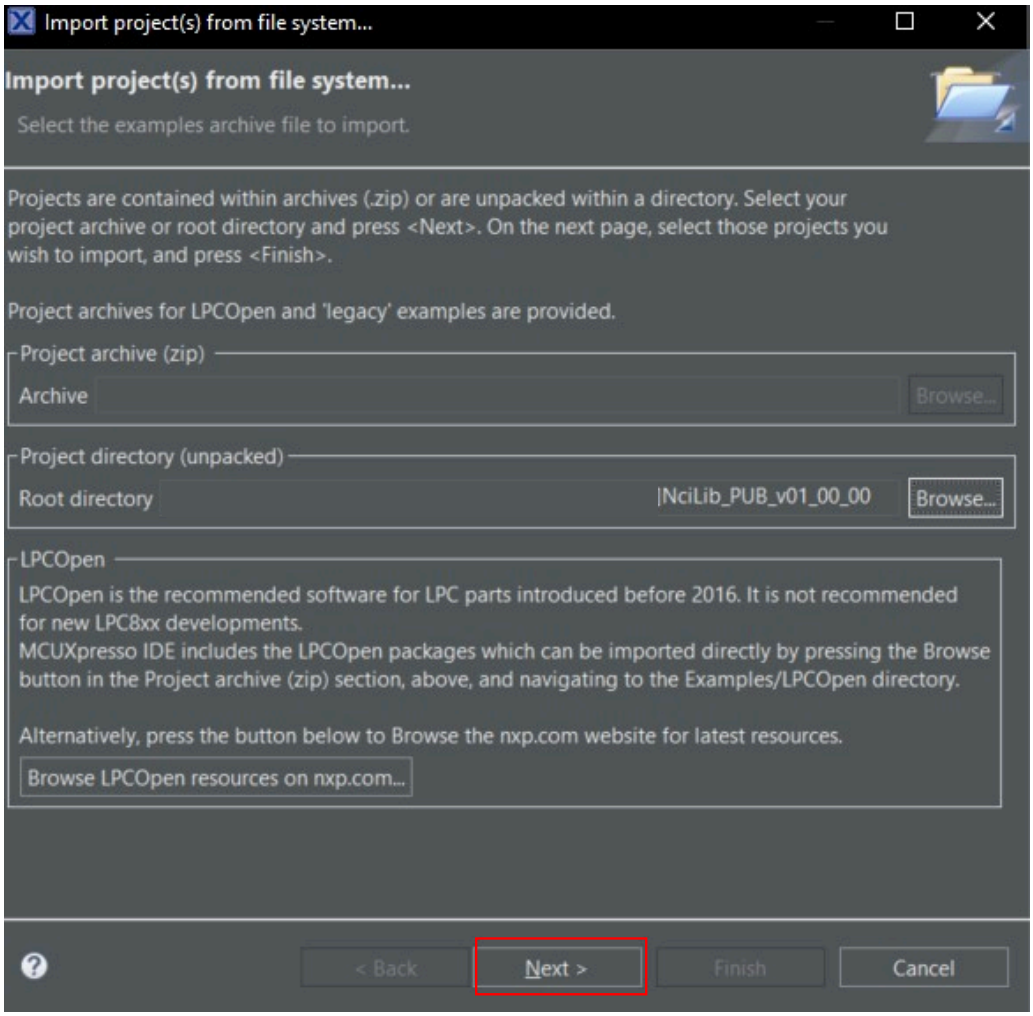

Figure 15. Click "Next >"

5. Deselect "Copy projects into workspace" and click "Finish".

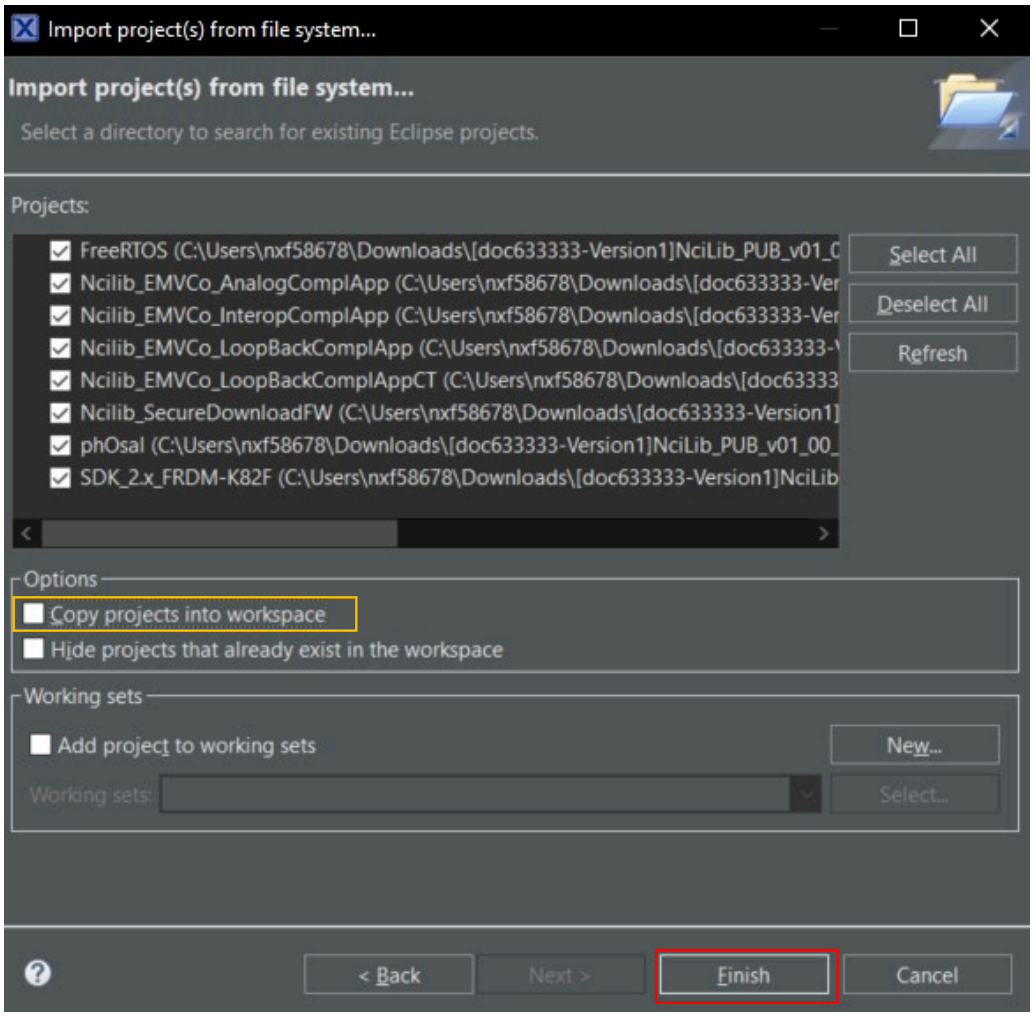

Figure 16. Unclick "Copy project into workspace" and click "Finish"

6. Examples are now imported and ready to use.

Figure 17. Imported examples

4 Hardware

Dual-Host functionality can only be used with PNEV722xBP2. PNEV722xBP2 must be connected to the Android host, K82, which is used as a "secure" MCU is already integrated on the board.

K82 can be flashed with an external debugger like J-Link or any similar tool. The external debugger must be connected to the J35.

For detailed information on connections and where to connect the external debugger, refer to the [1], specifically the section related to PNEV722xBP2 HW.

5 Explanation of applications

- **Secure MCU mode switch application**: How to install it can be found in [1]. This application is responsible for toggle the Mode switch pin. It is an important application, since all examples in NCIRdLib are waiting for the mode switch to toggle.
- **Ncilib_EMVCo_AnalogComplApp**: this application is used to perform EMVCo3.0(L1) Analog compliance validation.
- **Ncilib_EMVCo_InteropComplApp:** This example is an Interoperability Loopback Application, which is used to perform EMVCo IOP(L1) with add-on (TTA Bulletin No.195) compliance validation.
- **Ncilib_EMVCo_LoopBackComplApp:** For the EMVCo profile, this example provides a full EMVCo digital demonstration along with to SELECT PPSE Commands. This application is used to perform EMVCo CLIF compliance validation.
- **Ncilib_EMVCo_LoopBackComplAppCT:** This application is used to perform EMVCo CT compliance validation.
- **Ncilib_SecureDownloadFW:** This application is used to perform secure firmware download.

In Ncilib_SecureDownloadFW, the user must provide the location of FW, this is done in Ncilib_SecureDownloadFW.c. FW can be downloaded from the PN7220 webpage ([8]).

Figure 18. Provide the location of FW

6 Running the examples

This section describes how to run the examples. As mentioned earlier, the main host is the Android device. Therefore, it is necessary to use the "Secure MCU Mode Switch application" (refer to the PN7220 Quick start guide). With this application, the "Mode switch" pin toggles based on the selection setting. This is required to instruct PN7220 that Secure MCU is taking over the communication.

The following sections show how to run an EMVCo loopback example:

1. Flash the K82 with *Ncilib_EMVCo_LoopBackComplApp*

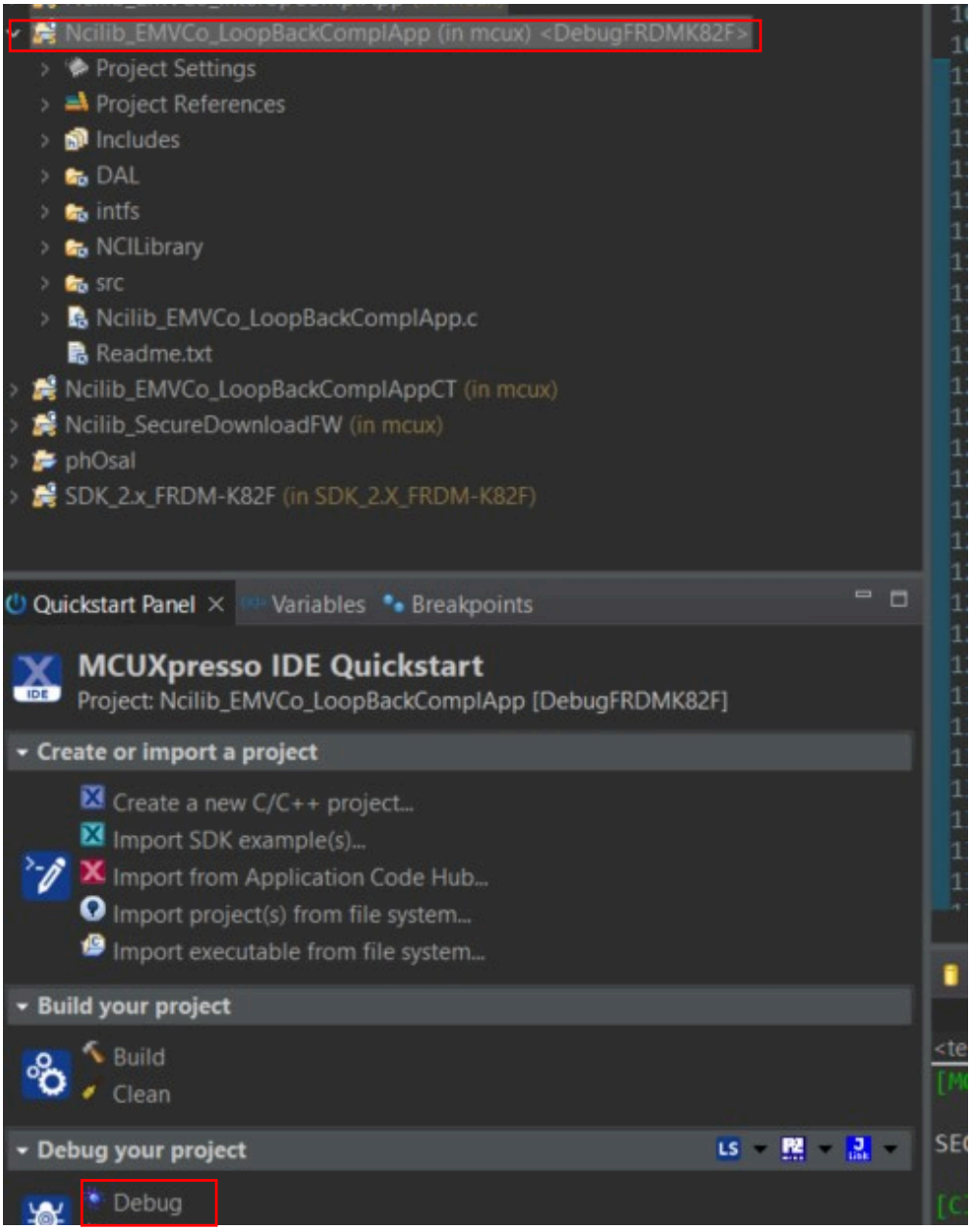

Figure 19. Run the example

2. After running the example, it will wait for the Mode switch to toggle High (the same for all applications)

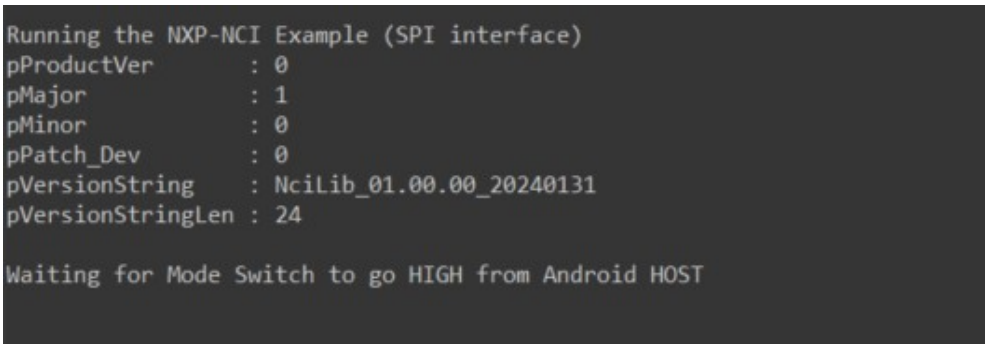

Figure 20. Application wait Mode switch to toggle high

3. Now, run the Secure MCU Mode Switch application

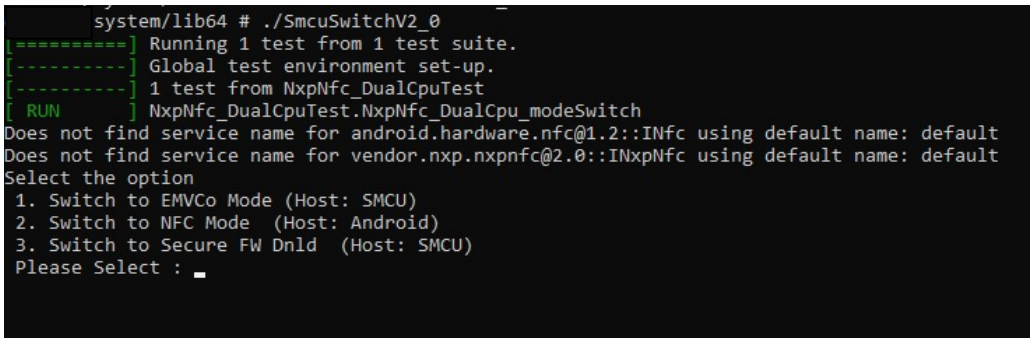

Figure 21. Run Secure MCU Mode Switch application

- If 1 is selected, the Mode Switch pin goes high and Secure MCU runs the EMVCo profile
- If 2 is selected, the Mode Switch pin goes low and the Android host runs the NFC Forum profile
- If 3 is selected, the Mode Switch pin goes high and Secure MCU starts with FW update

4. Select 1 and press enter
   - Initially, all three pins (MODE_SWITCH, MODE_SWITCH_SP and MODE_SWITCH_SP_DONE) are low.

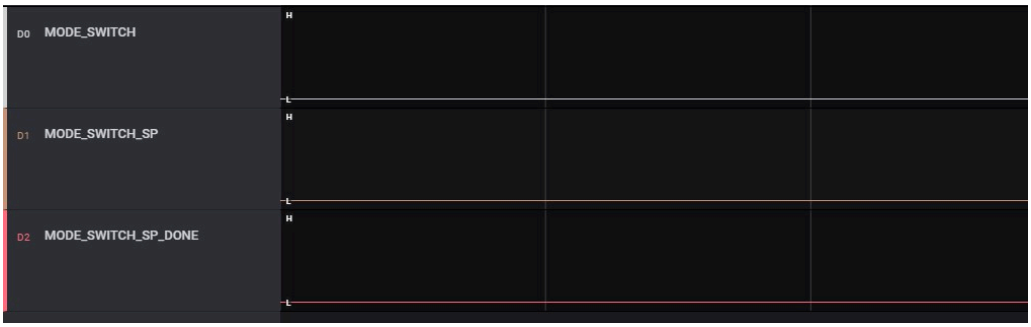

Figure 22. Initial values on pins

   - When 1 is selected, MODE_SWITCH and MODE_SWITCH_SP are toggling high.

Figure 23. Pins change value to high

- Now, Secure MCU has taken over and PN7220 is running in EMVCo mode. PN7220 can now detect the card in EMVCo mode, and communication runs between the PN7220 and the Secure MCU.

```
Running the NXP-NCI Example (SPI interface)
pProductVer       : 0
pMajor            : 1
pMinor            : 0
pPatch_Dev        : 0
pVersionString    : NciLib_01.00.00_20240131
pVersionStringLen : 24

Waiting for Mode Switch to go HIGH from Android HOST

Waiting to Detect Contactless Card Tapping
```

Figure 24. PN7220 can detect card in EMVCo mode

5. • If 2 is selected, the pins toggle to low and Android takes over the execution (NFC Forum)

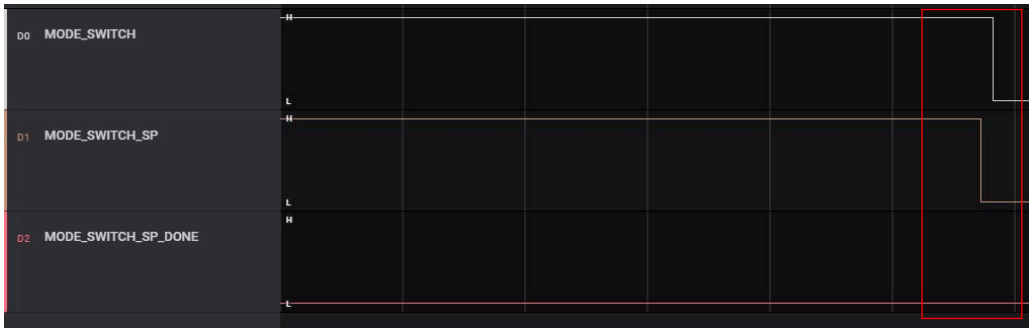

Figure 25. Changing back to Android host (NFC Forum)

Based on choices in the Secure MCU Mode Switch application, the values of three pins change, and the selected host is responsible for communication.

The steps described above are common to all examples, except for the FW update, where a different option is enabled in "Secure MCU Mode Switch" (option 3), however, this does not affect the execution of the examples.

7 Abbreviations and acronyms

Table 2. Abbreviations

Acronym	Description
APDU	application protocol data unit
AOSP	Android open source project
DH	device host
HAL	hardware abstraction layer
FW	firmware
I^2C	Inter-Integrated Circuit
LPCD	lower powered card detection
NCI	NFC controller interface
NFC	near-field communication
MW	middleware
PLL	phase-locked loop
P2P	peer to peer
RF	radio frequency
SDA	serial data
SMCU	secure microcontroller
SW	software

8 References

[1] User guide – UG10068 – PN7220 - Quick start guide (link)
[2] Webpage – MCUXpresso Integrated Development Environment (IDE) (link)
[3] User guide – MCUXpresso IDE (link)
[4] Installation Guide – MCUXpresso IDE (link)
[5] Webpage – MCUXpresso SDK Builder (link)
[6] Webpage – MCU Tech Minutes | Importing an SDK Package into MCUXpresso IDE (link)
[7] Design resource – NciLib_PUB (link)
[8] Webpage – PN7220 – EMV L1 Compliant NFC Controller with NCI Interface Supporting EMV and NFC Forum Applications (link)

9 Note about the source code in the document

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10 Revision history

Table 3. Revision history

Document ID	Release date	Description
AN14224 v.1.0	08 April 2024	• Initial version

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