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HOST system ↔ INTERFACE MCU NFC

NFC NUTSHELL KIT

MCU Modules

USER MANUAL

REVISION 1.3

Document information

Info	Content
Keywords	User Manual GMMC
Abstract	This document describes how to use MCU Modules of the GMMC´s NFC Nutshell KIT and its related tools

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1. NFC Nutshell MCU Modules

1.1 General Topology

The Kit consists of different types of modules, which can be connected application specific. Each module type has a different color.

- Interface
- MCU
- NFC
- Antenna
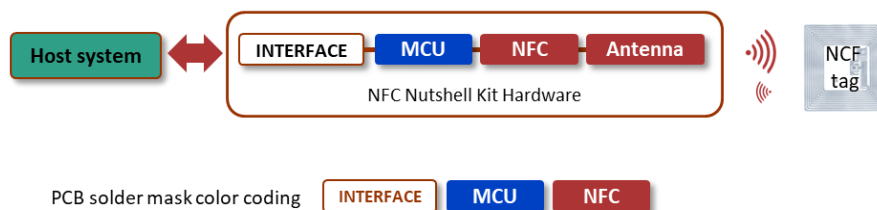
Fig 1. Kit modules and PCB solder mask color coding

1.2 Module interconnection concept

The Nutshell Kit can be operated in different configurations. The connection between the different modules is done via FFC cables and zero force sockets.
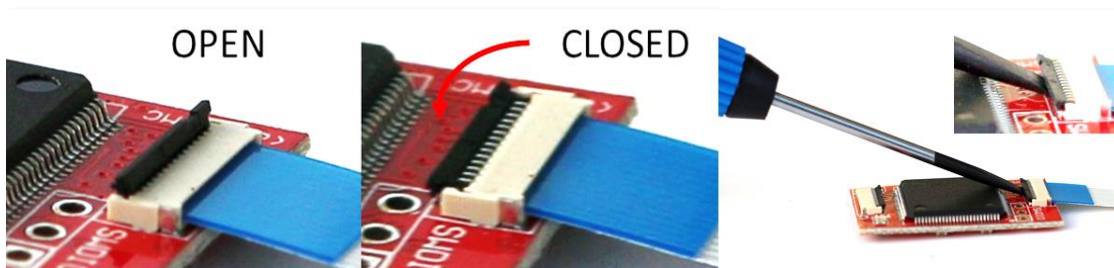
Fig 2 Kit modules interconnection via FFC cables

For ensuring a proper connection the cable must be inserted straight at any time

Fig 3 correct insertion of the FFC cable

The Kit modules can be connected to a host via different interface modules. See details in the NFC Nutshell Kit INTERFACE Module user manual.

Important Notes:

- *Open and close the connector **carefully***
- *Always **insert straight** – do not apply force*
- *Avoid cable/connector misalignment – potential short cut and damage*
- *If you observe communication issues over time, exchange the FFC cable with a spare one*
- *DO NOT disconnect, bend or move the Kit while modules are powered to avoid short circuits*

1.2.1 Module Connector Signal pin-out

The following figure describes the signal which can be analyzed using the Extender module.

Detailed information can be found in the user manual of the INTERFACE modules.

| GND |
| +5V |
| USB D- |
| USB D+ |
| xCS |
| SCLK |
| MOSI |
| MISO |
| SDA |
| SDL |
| RxD |
| TxD |
| AUX1 |
| AUX2 |
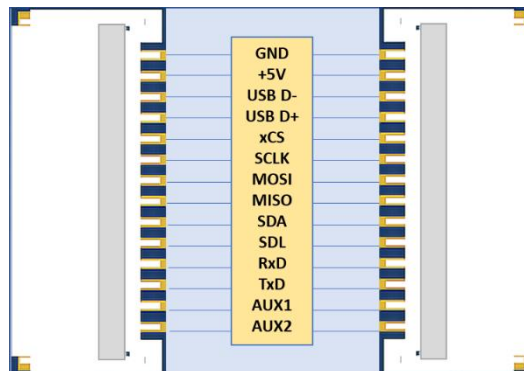
Fig 4 Module Zero Force FFC Connector Signal Pinout

1.3 Module power concept

The Kit requires a power supply of +5V DC. This can be applied using one of the following options:

- Using one of the interface modules
  - USB supply voltage (4.75V to 5.25 V) is available on all connected modules.
- Using an external power supply and the Signal extender module
  - +5V is required

If other voltages than 5V are needed by the module, this is generated onboard with an LDO.

Important Note:

If an external power supply is used, ensure the correct Voltage and connection polarity before powering up of the Kit.

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2. MCU Modules

Fig 5 MCU Module

Currently the NFC Nutshell KIT features the following MCUs:

- **LPC11U68**
- **LPC1769**

2.1 LPC11U68 short facts

This 32-Bit MCU is based on a Cortex M0+ core. It features on-board USB and several Peripherals like UART, SPI and I2C. Some features are:

- Cortex M0+
- 256kB Flash Memory
- 4kB EEPROM
- 36kB SRAM
- Running up to 50MHz
- USB Mass Storage device bootloader

It is ideal for mid-range solution which requires an USB interface. More details about this MCU can be found in the user manual.

2.2 LPC1769 short facts

This high performance MCU is based on a 32-Bit Cortex M3 core. It also features USB 2.0 OTG, Ethernet and most common interfaces like CAN, UART, SPI and I2C. Some important parameters are:

- Cortex M3
- 512kB Flash Memory
- 64kB SRAM
- Running up to 120MHz
- USB 2.0 OTG
- Ethernet

It is also compatible with most NXP NFC demo boards like the Blueboards. This enhances the portability of existing software.

This MCU module can be used to run the NFC Cockpit and PEGODA example.

2.3 Hardware setup with MCU

The following figure shows the hardware setup of Interface , MCU and NFC Modules of the NFC Nutshell Kit.

Fig 6. Hardware setup with MCU

Depending on the use case, the appropriate interface module and set up has to be selected. Please find further details in the interface user manual.

3. MCU hardware configurations options

The following figure shows the available options for the Interface. These have to be selected application specific.
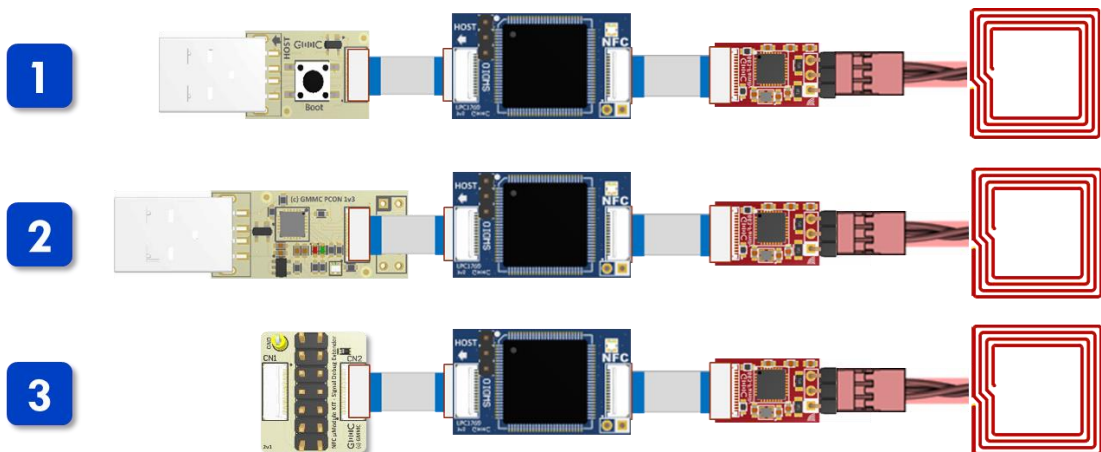
Fig 7 MCU module connection options. (MCU and NFC module images are examples)

Note:
Ad 2: The PROTOCOL Converter interface module might be set for a wrong host interface. Therefore check the color of the RGB LED, which indicates the current mode of the Protocol Converter module.

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4. MCU - LPC1769 Module

This module features the LPC1769 USB enabled MCU from NXP. It is based on an ARM Cortex M3 CPU with a system frequency of up to 120MHz. Please see the related product data sheet for details on the MCU features and resources.
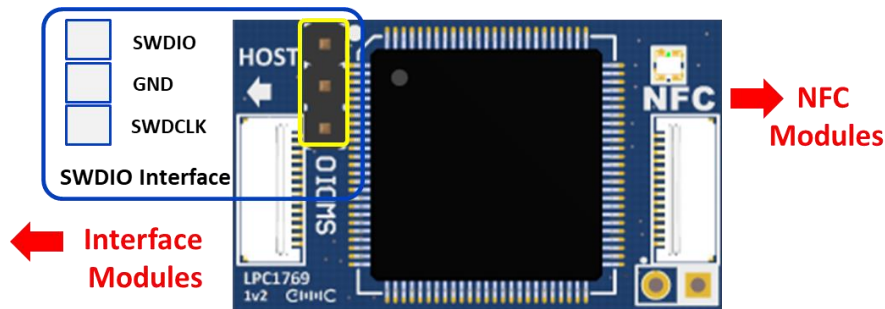
Fig 8 Image LPC1769 MCU and SWDIO interface pin-out

The module features a RGB LED, SWDIO debug interface and EEPROM. A special adapter is available which allows the use of the LPC-LINK debug probe with the NFC Nutshell Kit.

Note: please observe connection direction
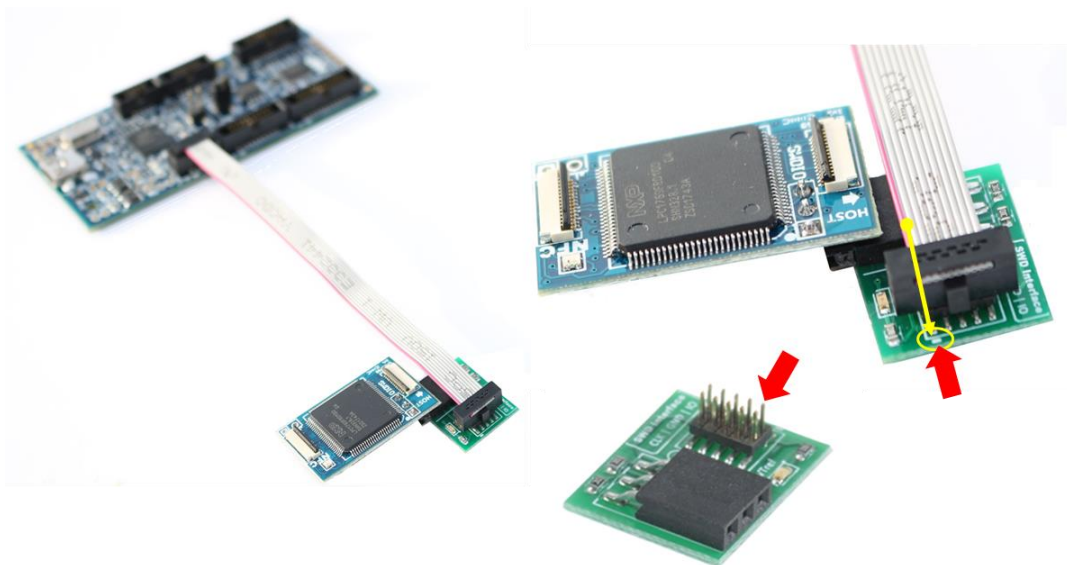
Fig 9 Image LPC1769 MCU LPC Link2 connection

Important Note:
Always observe the red wire and pin 1 location as shown above for correct setup and operation. Depending on the cable insertion on the LPC Link2 board the cable might show in the opposite direction as shown above! Always make sure that the red wire is aligned with the PIN 1 position – marked with a small white dot on the PCB and as indicated by the red arrows in above image.

4.1 LPC1769 Module Features

- USB Mass Storage Bootloader[1]
- USB interface [2]
- I2C, SPI and UART host interface[3]
- RGB status LED
- SPI communication to RF Frontend
- RFID Discover with PEGODA firmware
- NFC Cockpit firmware support using CLRC663 and its derivates
- SWDIO debug interface

Notes:

[1] USB Mass storage Bootloader firmware needs to be uploaded first, USB plug module with boot button needs to be used.

[2] USB plug module with boot button needs to be used.

[3] GMMC´s Protocol converter module required.

The communication to the RF frontend is fixed to the SPI interface. This allows to communicate with the RF frontend at the maximum speed and hence provides highest performance.

5. Firmware download procedure and options

Depending on the MCU, different firmware download options are available.

5.1 UART Bootloader

Fig 10 LPC1769 hardware configuration and standard UART bootloader

The Protocol Converter Module supports the LPC1769 MCU Module and its built in UART bootloader.

Required:

- Flash Magic Tool
- Protocol Converter module, configured in UART Flash mode
- USB Protocol Converter Configuration tool
  - Instructions for configuring the protocol converter module can be found in the NFC Nutshell Kit Interface User Manual.
- SWD Interface via LPC LINK2 and adapter

5.2 Mass Storage Device Bootloader

This MCU doesn't support this option out of the box. Therefore a bootloader is required, which can be found on the homepage of the MCU.

Fig 11 LPC1769 hardware configuration with flashed USB Mass Storage boot loader

As the LPC1769 doesn't feature an USB mass storage bootloader out of the box, the bootloader must be loaded using the Protocol Converter module in UART flash mode.
Once the bootloader is programmed, the mass storage boot loader is available on the device.

Note:
All user applications must start above address 0x2000, in order to not overwrite the mass storage bootloader.

5.3 Firmware download using the LPC Link2 and Flash Magic Tool

With the help of the Flash Magic Tool and the LPC Link2 it is also possible to flash firmware onto supported MCUs. Set the ISP settings as per below image, connect the LPC Link2 board with the LPC Link2 adapter and flash the desired firmware into the MCU. Under the ISP menu you will find different options such as blank checking, verification or device signature read out.

If your MCU firmware features a USB host communication, simply use the USB plug interface and update your firmware via LPC Link2 and adapter.

You do not need is no need to use the Protocol Converter Module for firmware download and to change the interface adapter to the USB plug afterwards.

5.3.1 Flash Magic Tool setting

The following picture shows the usage of Flash magic and the LPC-Link2 debug probe.
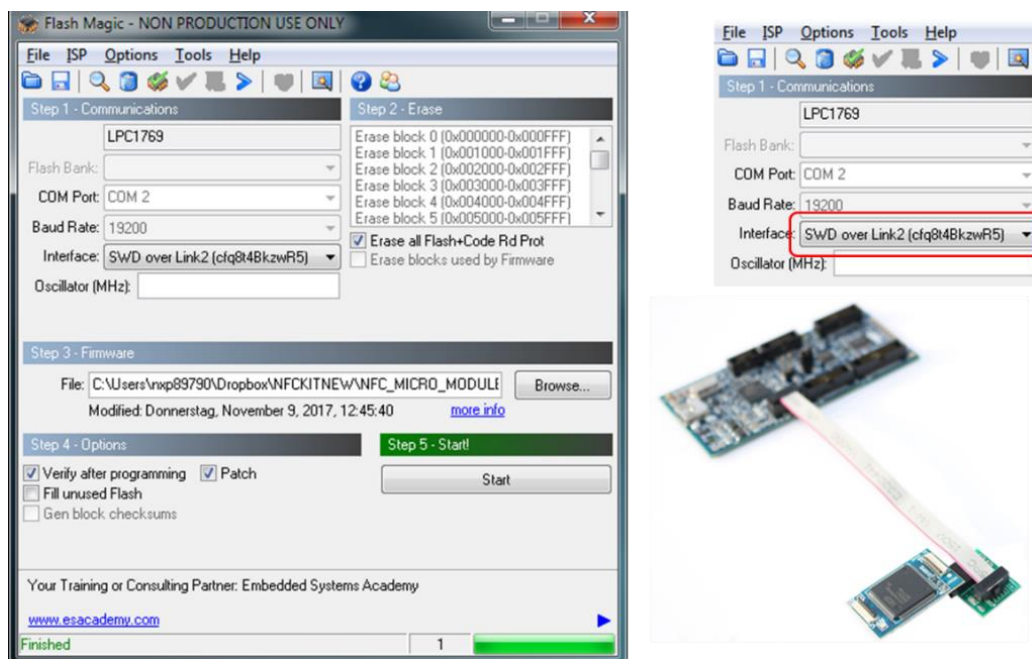
Fig 12 Flash Magic Tool configuration for LPC Link2

Note:
*The NFC Nutshell Kit **is not powered** by the debug probe. Therefore it is important to supply sufficient power using one of the interface module.*

5.3.2 Hardware setup using the LPC1769 in USB host communication mode

The following picture shows the detailed description how the debug adapter has to be connected.

Fig 13 Hardware setup Firmware Update via Flash Magic Tool and LPC Link2

Note:

The cable direction in above picture depends on cable insertion on LPC Link board. Make sure the red cable is always aligned with PIN1 position which is marked with a white dot on Adapter PCB.

6. Software Examples

6.1 Precompiled Examples

The NFC Nutshell Kit provides some precompiled firmware examples that run out of the box on this MCU LPC1769 module. The NFC Nutshell Kit has to be connected properly for correct functionality.
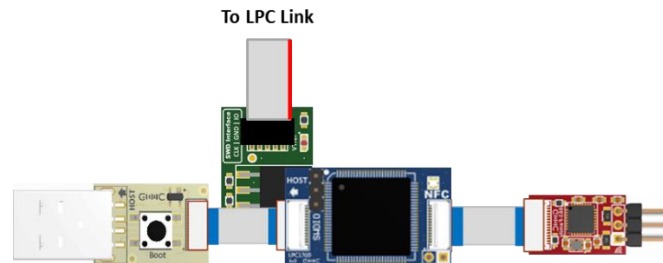
Note:
*.hex *files must be programmed using the UART ISP Bootloader mode and the Protocol Converter module needs to be set to UART Flash Mode.*
*.bin *files must be flashed using the USB Mass Storage Bootloader (MSD needs to be present already).*

6.2 MCUXpresso Examples

The NXP reader library is also available for this microcontroller. It allows the use of different front NFC front ends. To run an example, you have to do perform the following steps:

Required

- MCUXpresso needs to be installed and working.
- Select Import Project and select the desired *.zip file.
  This imports all the selected example of the NXP reader library using the LPC1769 MCU Module.
- After compiling the source example code it can be downloaded via the UART flash bootloader and the Protocol Converter Module in flash mode. Or if you change the **linker script** it can also be programmed using the mass storage device bootloader.

6.3 PEGODA Firmware and RFID Discover

The LPC1769 MCU Module can also run a modified PEGODA firmware. A special version of the PEGODA firmware is available which is restricted to USB CCID interface and does not provide SAM support.

For downloading the ***.hex file must be programmed using the Protocol Converter Interface Module configured in Flash boot mode as per below:

Fig 14 LPC1769 hardware configuration for PEGODA firmware download

After the firmware is uploaded successfully, the topology of the NFC Nutshell Kit must be changed, which can be seen in the following figure.

Fig 15 LPC1769 hardware configuration for PEGODA / RFIDDiscover operation

Note:
To execute and operate the MCU1769 with the PEGODA firmware you need to reconfigure the kit as per below image. (Exchange the Protocol converter interface Module with the USB plug module attached for USB communication.

6.4 PEGODA - RFIDDiscover step by step

1. USB Converter attached to LPC1769 MCU module hardware configuration (Figure 9).
2. Protocol converter mode: Select Flash Magic mode
3. Download firmware using Flash Magic Tool and PEGODA_663 .hex-file
4. After successful down unplug / un-power kit
5. Change USB Converter module to USB plug module
6. Plug in / re-power kit
7. CCID-reader should be available
8. If not: Download and install the PEGODA driver from here
9. Remove any contactless card from the antenna before starting RFIDDiscover.
10. Start RFIDDiscover and select PEGODA (CCID-Reader)

Note:
DON'T put any contactless card/tag on the antenna during start-up of RFIDDiscover.

6.4.1 RFIDDiscover: PEGODA reader selection and usage example

For more information on the RFIDDiscover tool please visit www.nxp.com.

As a first step the Pegoda reader must be selected in the Contactless Reader Selection menu. This is shown next.
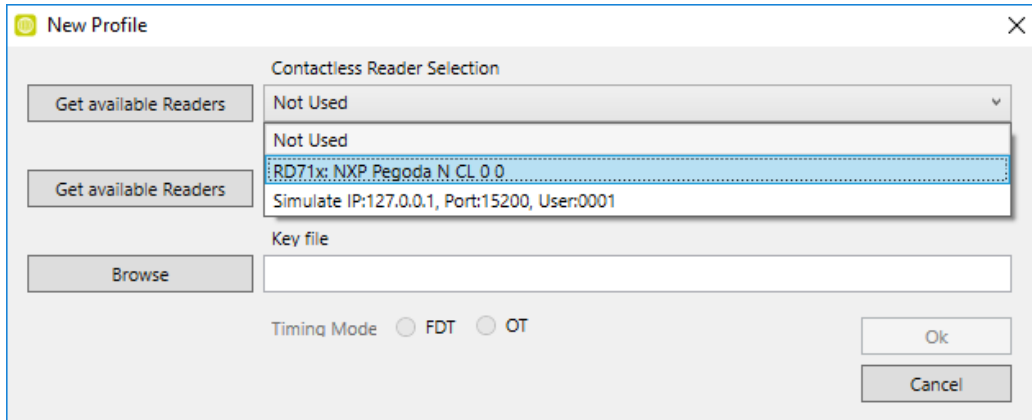

Fig 16 Select PEGODA within RFIDDiscover

After this is done, the software opens the device and connects to it. This can be seen on the bottom left of the window.

As a next step the show cards command can be used to show available Tags (don't forget to put a Tag on the reader)
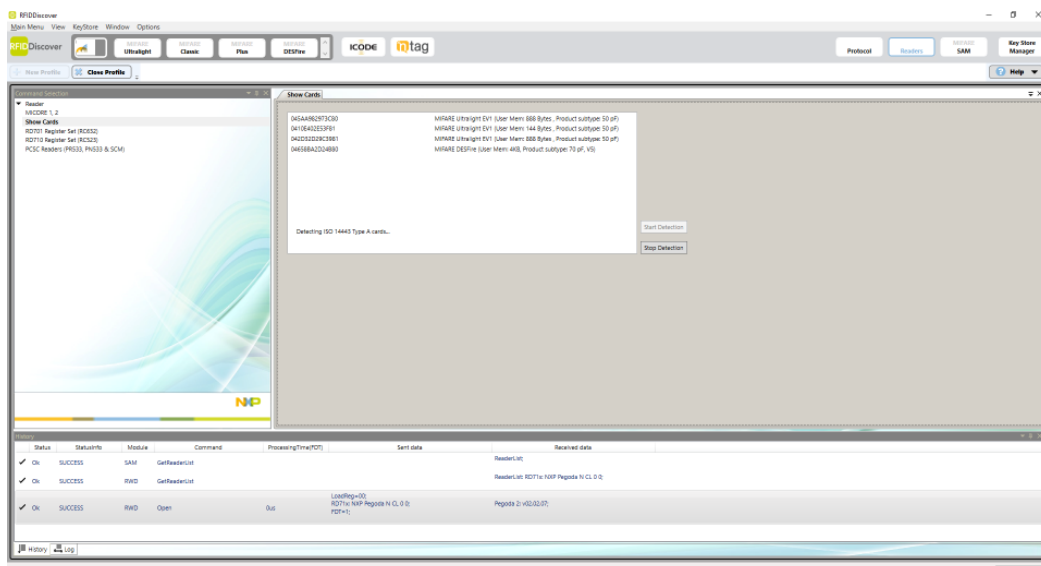

Fig 17 Example RFIDDiscover show cards command

6.5 NFC Cockpit firmware and application

The NFC Nutshell Kit LPC1769 MCU module can also be flashed with the NXP NFC Cockpit firmware, which allows to run the kit and NFC frontends with the NFC Cockpit PC application. NFC Cockpit tool allows to configure different settings of the NFC ICs and communication with different NFC and RFID chip families and protocols.

6.5.1 NFC Cockpit firmware download on MCU LPC1769 module

For using the NFC Nutshell Kit as RFIDDiscover reader, the NFC Cockpit firmware has to be programmed via the Protocol Converter module in UART Flash Magic Tool mode. See mode Converter module configuration in the Interface Module user manual.
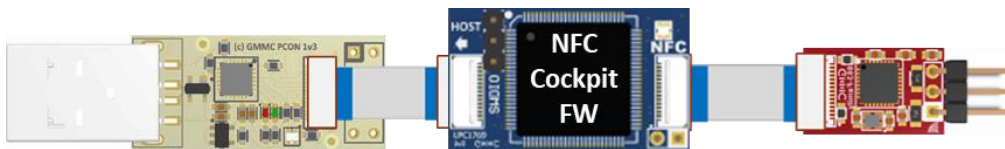

Fig 18 LPC1769 hardware configuration for NFC cockpit **firmware download**

Note:
After the firmware is downloaded successfully, the Kit has to be configured as follows:

Fig 19 LPC1769 hardware configuration for NFC cockpit **execution**

6.5.2 NFC Cockpit GUI

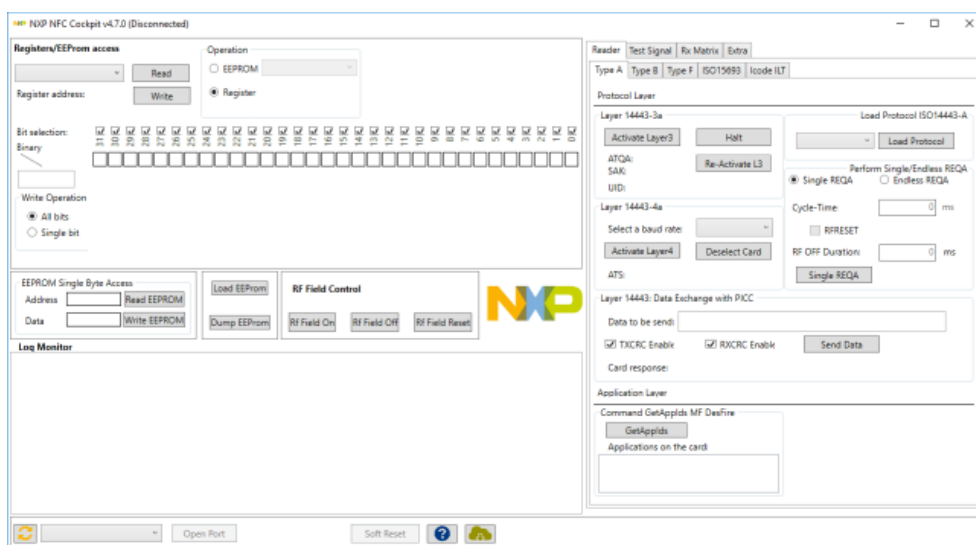For more information on the NFC Cockpit tool please visit www.nxp.com.

Fig 20 NFC cockpit start up screen

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7. MCU - LPC11U68 Module

This module features the LPC11U68 USB enabled microcontroller. It is based on an ARM Cortex M0+ CPU. Please see the [data sheet](#) for details on the MCU features and resources.
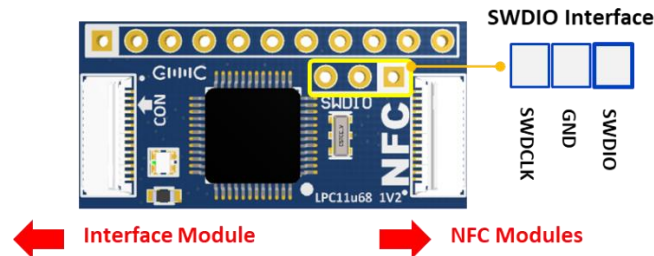

Fig 21 Image LPC1769 MCU and SWDIO pin out

This MCU module features a header for additional function as well as a SWDIO debug interface. This can be used together with the debug interface extender to work with LPC-Link2

Note:
Please observe connectison direction – host and NFC

7.1 LPC11U68 Module Features

- USB Mass Storage Bootloader
- USB interface
- I2C, SPI and UART host interface
- RGB status LED
- SPI communication to NFC Frontend
- RFID Discover with PEGODA firmware
- NFC Cockpit firmware support using CLRC663 and its derivates
- Expansion connector for peripheral hardware
- SWDIO debug interface

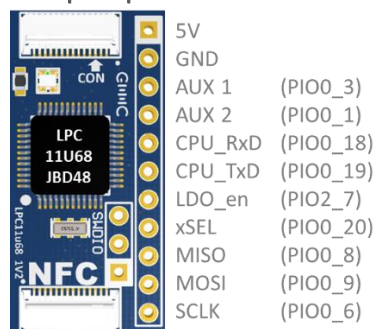## 7.2 Signal expansion connector for peripheral hardware

Fig 22 Signal pin out on LPC11U68 MCU Module

The expansion connector on the LPC11U68 MCU Module allows to connect peripheral hardware which can be controlled by the customer´s MCU firmware.

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A UART and SPI interface, chip select, enable and to AUX signals are available on this module, allowing to connect e.g. WIFI, BLE or other connectivity modules.

7.3 Hardware setup options depending on firmware defined host communication interface

Depending on the use case, one of the following host interfaces can be used. The appropriate interface has to be implemented in the mcu module.

7.3.1 I2C or UART or SPI firmware host communication interface setup

For I2C, SPI or UART interface the interface module can be used. Ensure that the interface module is configured correct for the target application. Tis can be done using the color of the RGB LED.
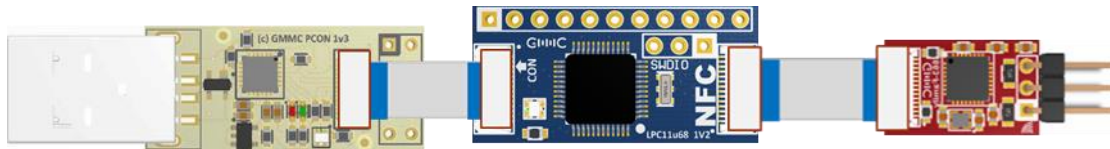

Fig 23 LPC11U68 MCU Module with Protocol converter interface (UART, I2C, SPI)

7.3.2 USB firmware host communication interface setup

For using the internal USB interface the USB module can be used. It connects the DP and DM lines of the controller with the usb plug. Beside data, also power is applied by the module.
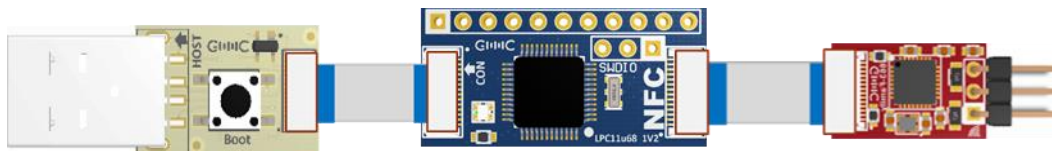

Fig 24 LPC11U68 MCU Module with USB plug interface (USB communication FW)

Depening on the Code Read Protection (CRP) of the mcu, the button on the USB plug module can be used to enter the mass storage device bootloader for firmware download. Additional details about CRP and the bootloader can be found in the user manual of the mcu.

Note:
If you experience host communication issues after FW download via the Flash Magic Tool, make sure you have the correct interface module corresponding to your firmware host interface communication attached.

Revision history

Rev	Date	Description
1.0	2018 Feb. 6th	Initial version MGa
1.1	2018 March 1th	Update MGa
1.2	2018 March 10th	Update MGa
1.3	2018 March 18th	Update TPI