UM11406

NTAG 5 I²C Cockpit application

Rev. 1.1 — 13 August 2020 User manual

597411 COMPANY PUBLIC

Document information

Information	Content
Keywords	NTAG 5 link, NTAG 5 boost, I2C, reference application
Abstract	Description of NTAG 5 I2C Cockpit application allowing to configure NTAG 5 through I2C interface

Revision history

Rev	Date	Description
v.1.1	20200813	Update of the application
v.1.0	20200511	First version

1 Abbreviations

Table 1. Abbreviations

Acronym	Description
ALM	Active Load Modulation
EH	Energy Harvesting
ED	Event Detection
GUI	Graphical User Interface
I²C	Inter-Integrated Circuit
LED	Light Emitting Diode
NFC	Near Field Communication
RGB	Red Green Blue
SLDA	Software License and Distribution Agreement
USB	Universal Serial Bus
VCOM	Virtual COMmunication
µC	micro-Controller

2 Introduction

This document describes NTAG 5 I²C Cockpit application allowing to configure NTAG 5 through [I²C interface].

The NTAG 5 I²C Cockpit application is a GUI application running on Windows platform, connected to NTAG 5 I²C interface via a "USB-I2C bridge".

The reference "USB-I2C bridge" implementation further presented in chapter USB-I2C bridge is based on LPC11U37H NXP's MCU and [NTAG 5 demoboard], but can also be ported to another environment using instructions provided in chapter Porting to other hardware.

Detailed description of the NTAG 5 Cockpit application can be found in chapter NTAG 5 I²C Cockpit GUI.

In case of issue running the application, one can find debugging information in related troubleshooting chapter Troubleshooting.

3 Setup

3.1 Hardware setup

The hardware used to build the reference setup is the assembly of [LPC11U37H LPCXpresso board] acting as USB-I2C bridge, and [NTAG 5 development kit].

3.1.1 USB-I²C bridge

[OM13074 LPCXpresso board] featuring NXP LPC11U37H MCU is used as reference hardware to provide USB-I²C bridge. It allows offering an easy way to connect NTAG 5 to a computer and exchange over I²C interface.

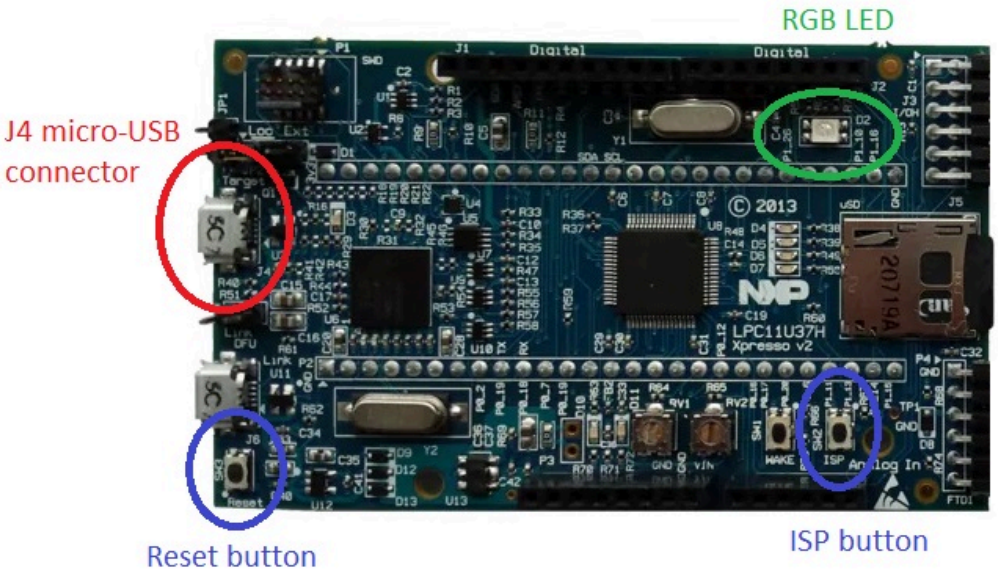

Figure 1. OM13074 LPCXpresso board for LPC11U37H

Dedicated firmware built for this specific function is provided as part of the NTAG 5 I²C Cockpit release.

Flashing the OM13074 board is then simply done following below sequence:

- Connect computer's USB port to J4 OM13074 Micro-USB connector using USB cable (USB male Type A to micro-USB)
- Put the board in flash mode by keeping ISP button pulled while resetting the board (pressing Reset button)
- The board should be mounted as "mass-storage" device on the computer and seen under name "CRP DISABLD" in Windows Explorer:

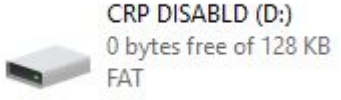

Figure 2. OM13074 LPCXpresso board in flashing mode

- Browse to the related device folder ("*D:*" in the above example), only one single file named "*firmware.bin*" should be present
- Delete the "*firmware.bin*" file
- Copy "*USB-I2C_bridge_LPC11u37h.bin*" file from NTAG 5 I²C Cockpit installation folder to the device folder ("*D:*" in the above example)
- Reset the OM13074 board, pressing Reset Button or unplugging/plugging the USB cable
- The RGB LED should go RED then GREEN and the board should appear as Virtual COM port under Windows Device Manager:

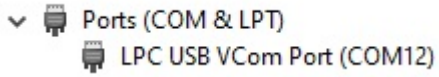

Figure 3. USB-I2C bridge board for LPC11U37H in Device Manager

In case of issue observed during this procedure, please refer to the related troubleshooting chapter Troubleshooting.

3.1.2 NTAG 5 board

Either on of the two versions of [NTAG 5 development kit] ("OM2NTP5332 NTAG 5 link/switch development kit" and "OM2NTA5332 NTAG 5 boost development kit") can be used as reference setup.

Figure 4. OM2NTP5332: NTAG 5 link/switch development kit

Figure 5. OM2NTA5332: NTAG 5 boost development kit

Make sure NTAG 5 is properly set in "I²C use case mode" (which is release default state of the OM2NTx5332 boards) to enable NTAG 5 I²C interface. For further information refer to the troubleshooting chapter Troubleshooting.

Simply assemble OM2NTx5332 board to the Arduino header of OM13074 board. Then plug OM13074 board to computer's USB port (as described in chapter Section 3.1.1), OM2NTx5332 board's LED referenced as "*D1*" should light on. If not, please refer to the troubleshooting chapter Troubleshooting

3.2 Software setup

Installation of the tool is done running NTAG 5 Cockpit installer which can be downloaded from NTAG 5 development kit webpage (OM2NTx5332). NTAG 5 Cockpit installer includes both NTAG 5 I²C Cockpit application and NTAG 5 NFC Cockpit application (see UM11207 for more details).

The installer creates an NTAG5_Cockpit folder (by default under "*C:\nxp*" directory) containing:

- NTAG 5 I²C Cockpit application executable
- USB-I2C_bridge firmware binary for NXP LPC11U37H MCU
- a link to the present document on NXP website
- NXP Infrastructure SLDA licensing terms
- related Software Content Register detailing components license details
- NTAG 5 NFC Cockpit application executable
- an executable allowing to uninstall the current package

The installer also allows creating related folder containing shortcuts in Windows Start Menu, as well as NTAG 5 Cockpit application shortcuts on Windows Desktop.

Running the NTAG 5 I²C Cockpit application executable, considering reference setup depicted in chapter Hardware setup is connected to the computer, shall trigger the following window to open:

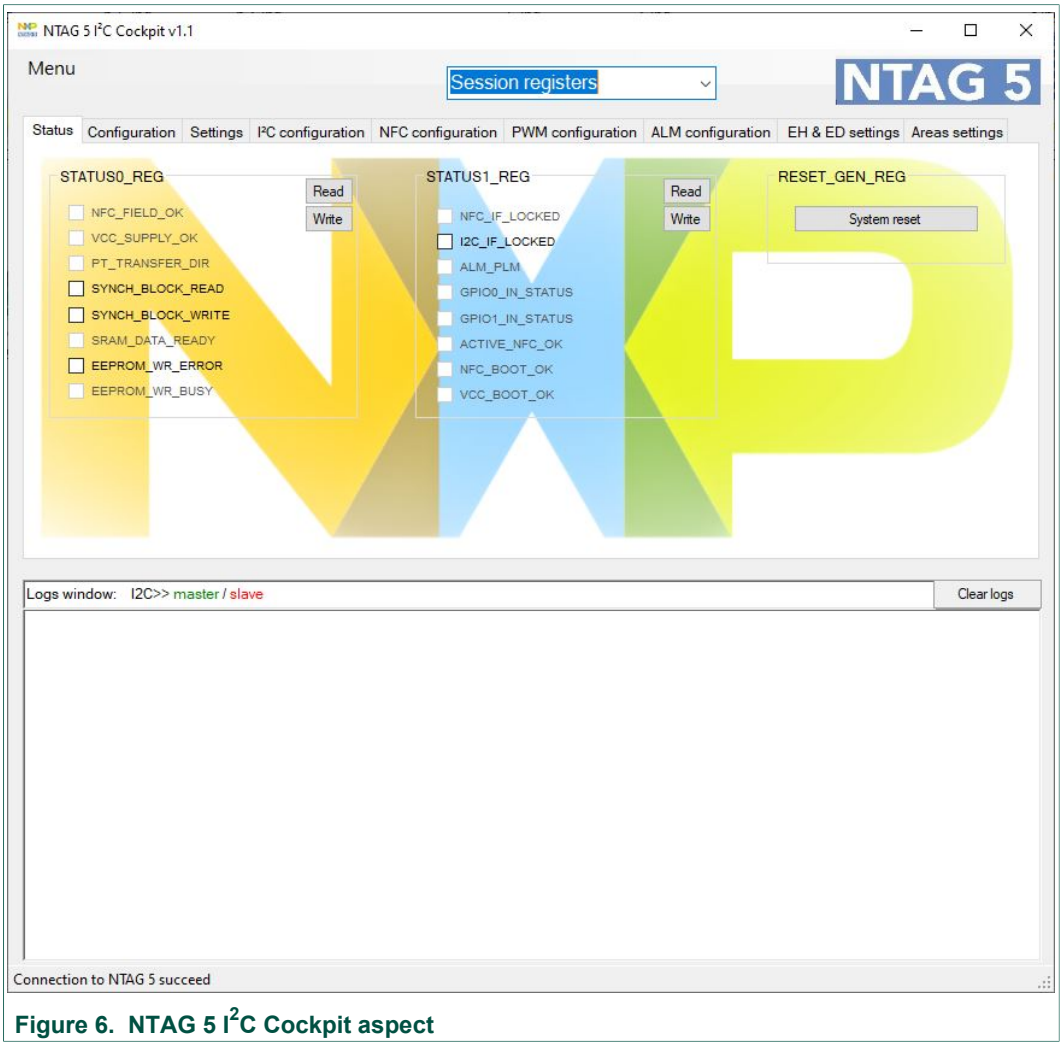

Figure 6. NTAG 5 I²C Cockpit aspect

If not, please refer to the troubleshooting chapter Troubleshooting.

4 NTAG 5 I²C Cockpit GUI

The purpose of the current chapter is to describe the NTAG 5 I²C Cockpit tool in details.

4.1 Register selection

The "Register selection" item allows defining which register bank applies to the "Tabs" items.

Indeed NTAG 5 registers are split between "Configuration registers" (from 1000h to 109Fh in Configuration memory) and "Session registers" (from 10A0h to 10AFh in Configuration memory).

Pay attention that "Session registers" settings apply to the current session (apply as soon as set) while "Configuration registers" settings only apply to the next session (apply after Power On Reset).

Figure 7. Register selection

4.2 Tabs

"Tabs" items exposes NTAG 5 registers definition allowing to set and get NTAG 5 IC configuration. Detailed registers definition is given in NTAG 5 data sheet for reference.

4.2.1 Status

"Status" tab is only valid for "Session registers" since the related registers are only defined for this memory area.

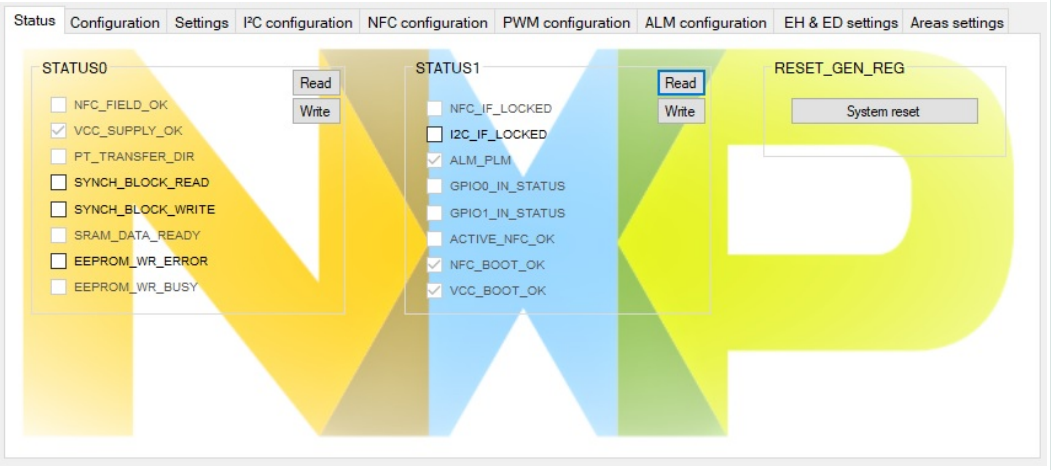

Figure 8. "Status" tab

STATUS0 and STATUS1 registers writeable bits (not grayed ones) can only be written to 0, clearing the related information.

"System reset" button performs software reset of the NTAG 5 IC, thus allowing current configuration settings being loaded to a new session.

4.2.2 Configuration

"Configuration" tab has different looks according to the register selection.

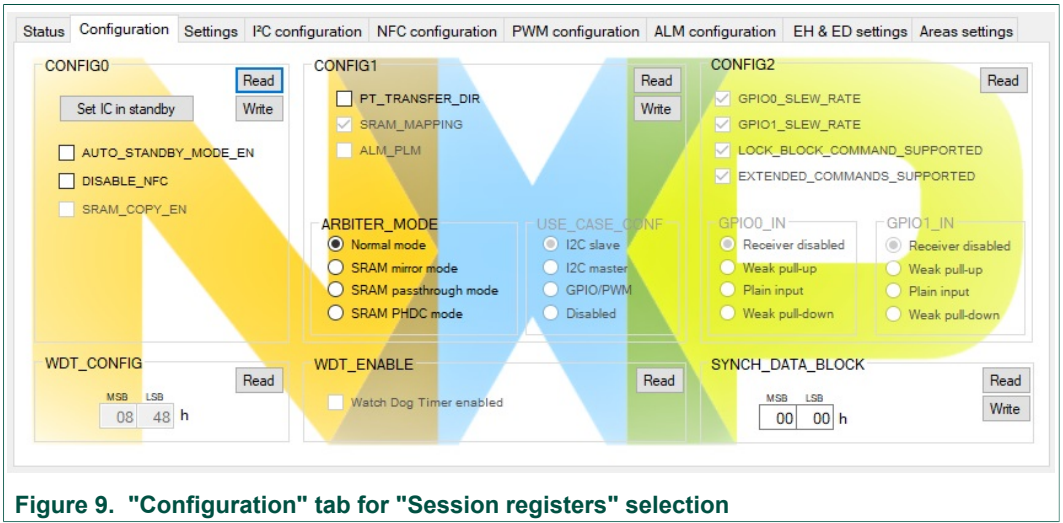

Figure 9. "Configuration" tab for "Session registers" selection

"Set IC in standby" button triggers NTAG 5 IC entering in standby mode. Pay attention that next I²C request will woken-up the NTAG 5 IC thus this first request will fail because not acknowledged by NTAG 5 IC.

"ARBITER_MODE" setting from "CONFIG1 register" can only be set if "SRAM_MAPPING" is enabled. Enabling "SRAM_MAPPING is done setting "SRAM_ENABLE" bit is set in "CONFIG1" register within "Configuration register" area.

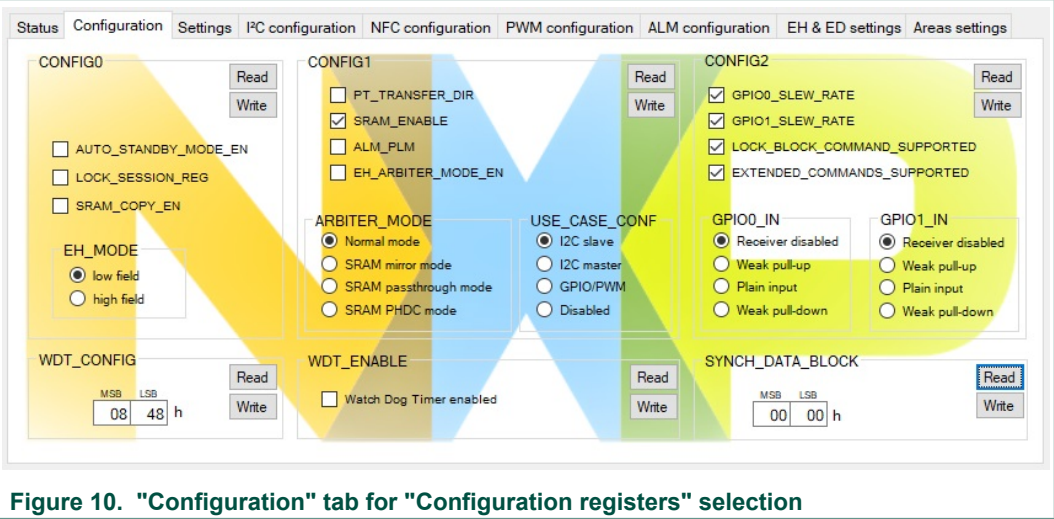

Figure 10. "Configuration" tab for "Configuration registers" selection

Pay attention that changing "USE_CASE_CONFIG" setting from "CONFIG1" register will impact NTAG 5 I²C settings and may prevent (is set to other than "I2C slave") to drive

it from NTAG 5 I²C Cockpit anymore until this setting is reset back to "I2C slave" (only possibility is then via NFC interface).

4.2.3 Settings

"Settings" tab is only valid for "Configuration registers" since the related registers are only defined for this memory area.

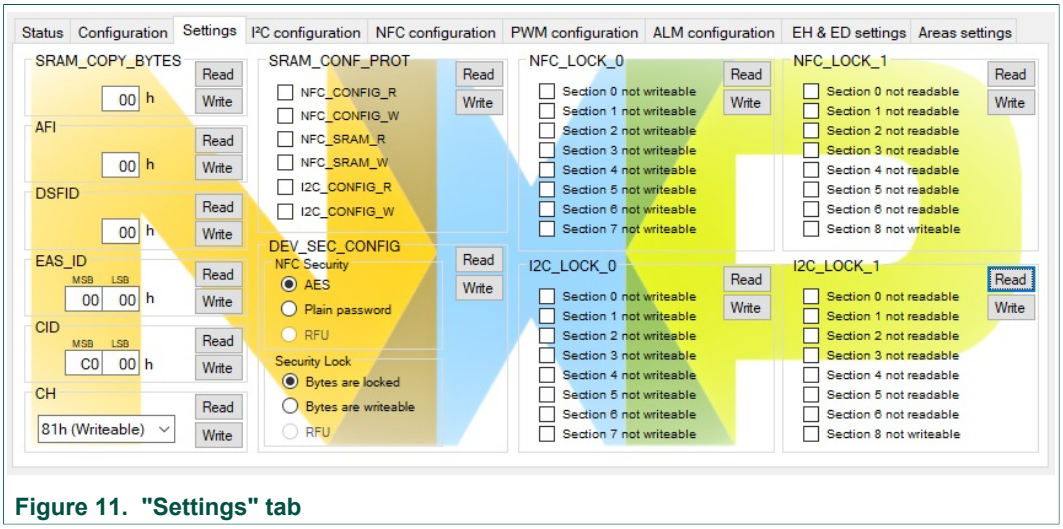

Figure 11. "Settings" tab

4.2.4 I²C configuration

"I²C configuration" tab has different looks according to the register selection.

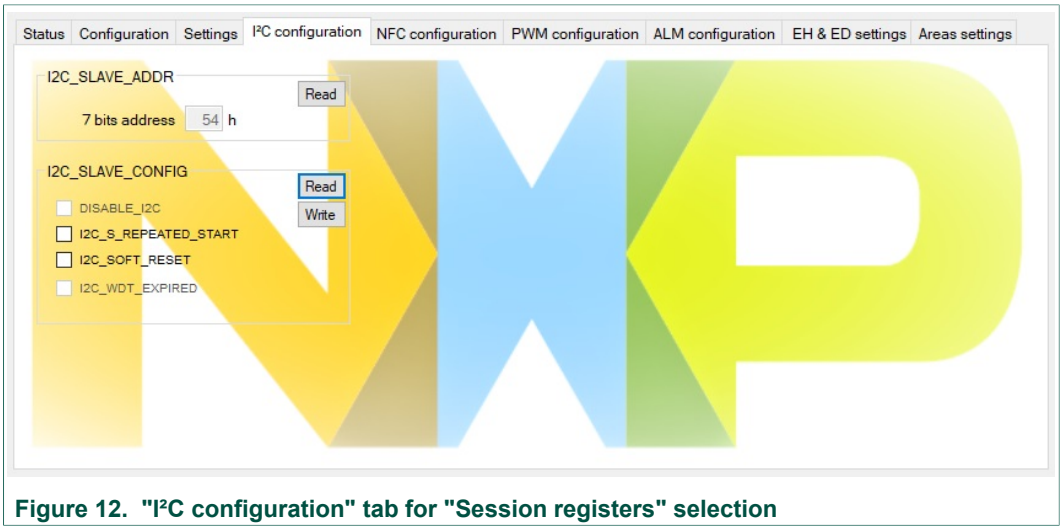

Figure 12. "I²C configuration" tab for "Session registers" selection

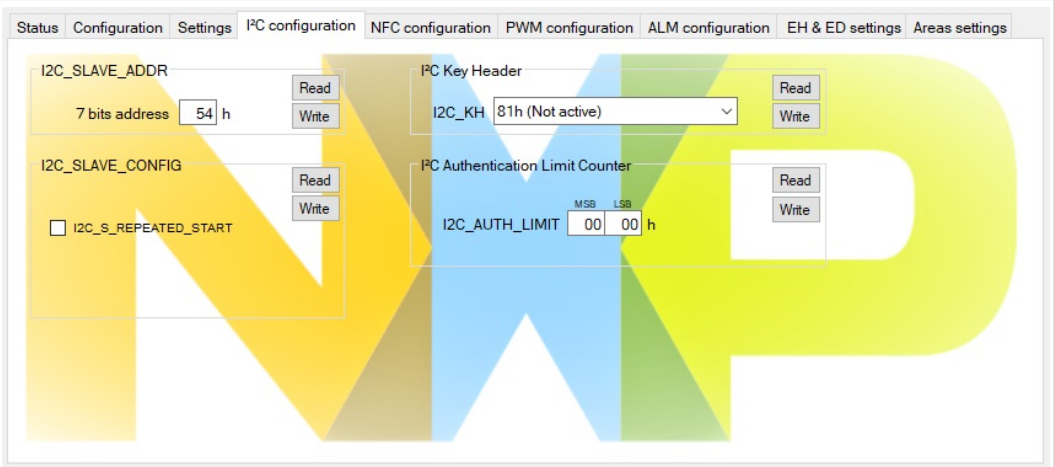

Figure 13. "I²C configuration" tab for "Configuration registers" selection

4.2.5 NFC configuration

"NFC configuration" tab is only valid for "Configuration registers" since the related registers are only defined for this memory area.

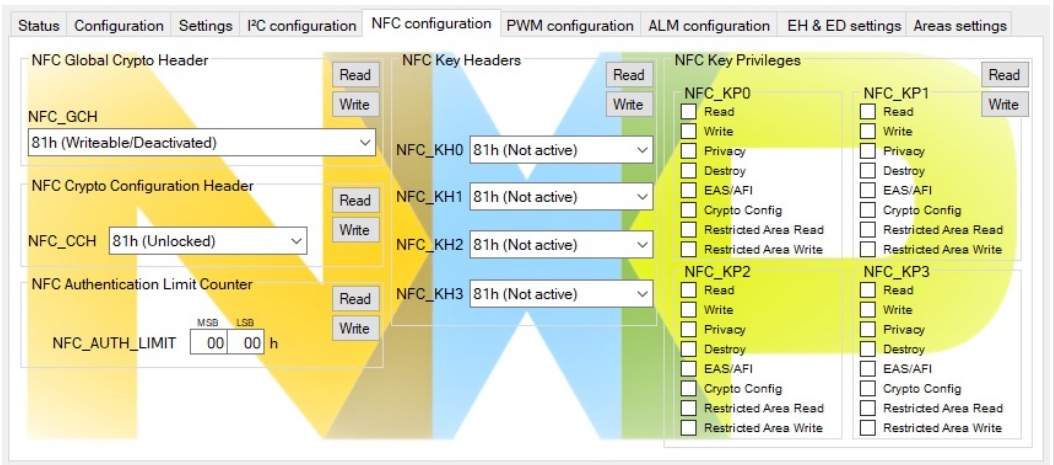

Figure 14. "NFC configuration" tab

"NFC Key Headers" and "NFC Key Privileges" settings can only set if NFC Security is enabled. "NFC Security" setting is set through "DEV_SEC_CONFIG" register (see "Settings" tab).

4.2.6 PWM configuration

"PWM configuration" tab has different looks according to the register selection.

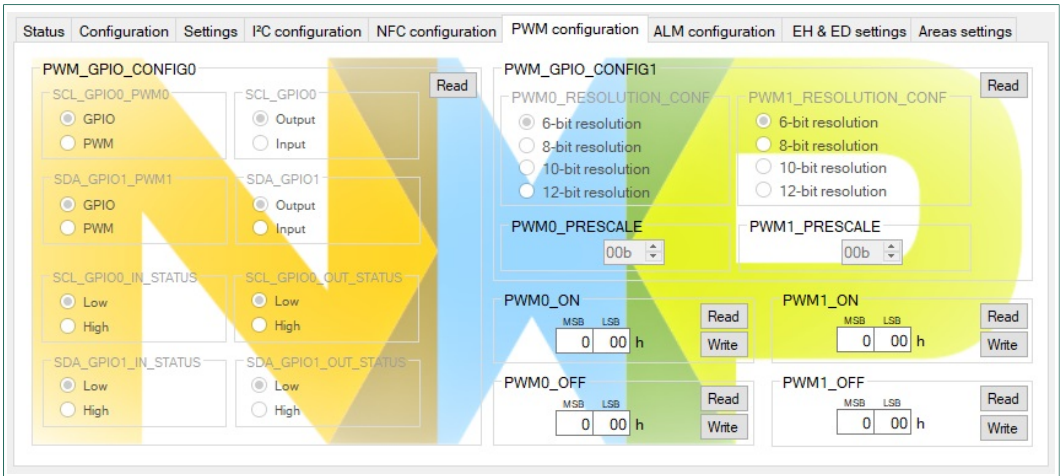

Figure 15. "PWM configuration" tab for "Session registers" selection

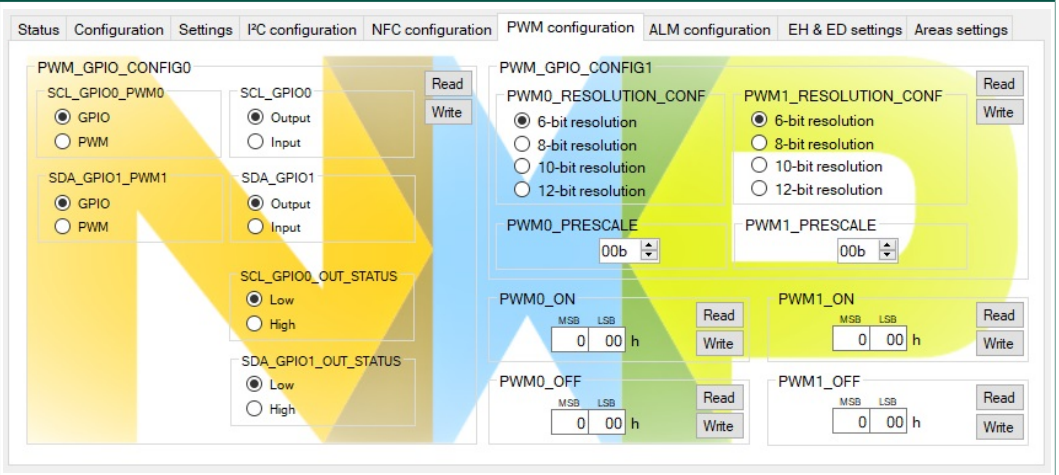

Figure 16. "PWM configuration" tab for "Configuration registers" selection

4.2.7 ALM configuration

"ALM configuration" tab has different looks according to the register selection.

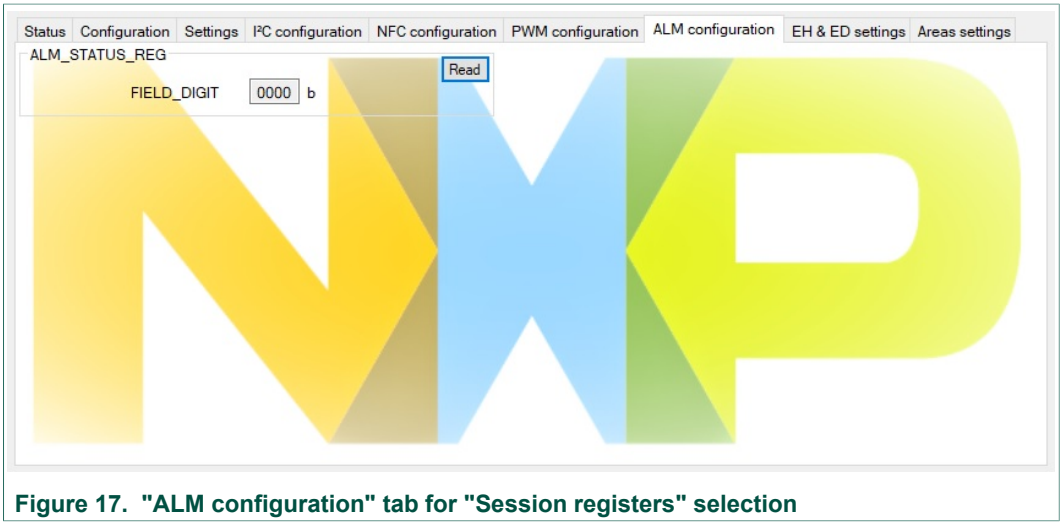

Figure 17. "ALM configuration" tab for "Session registers" selection

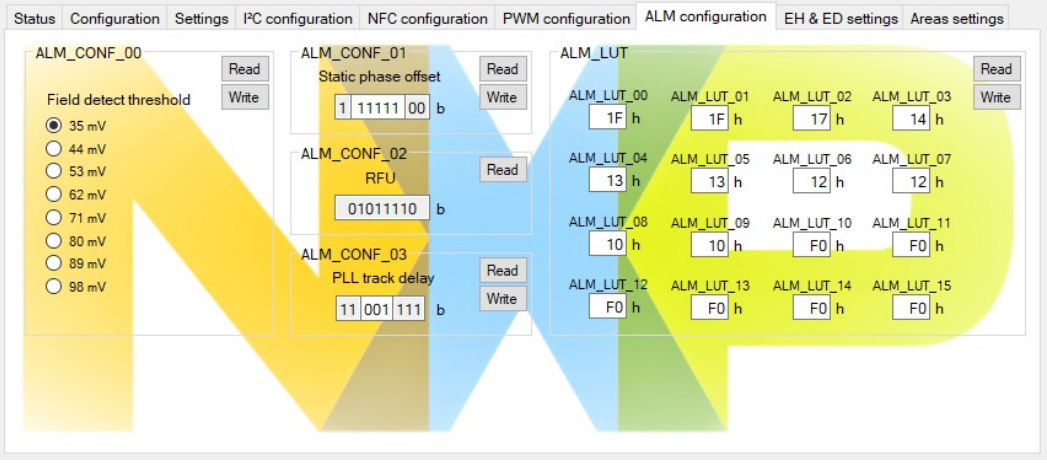

Figure 18. "ALM configuration" tab for "Configuration registers" selection

4.2.8 EH & ED settings

"EH & ED settings" tab has different looks according to the register selection.

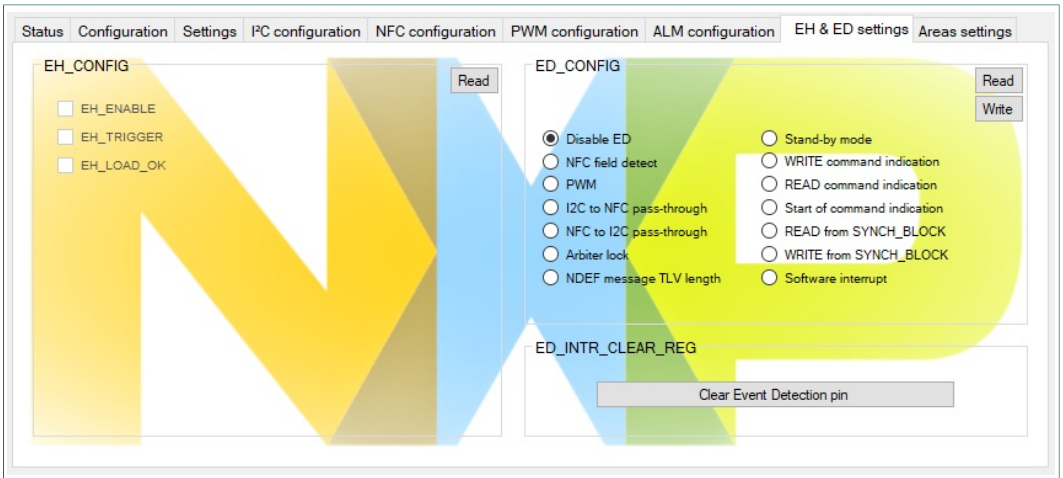

Figure 19. "EH & ED settings" tab for "Session registers" selection

"Clear Event Detection pin" button trigger clearing the detection pin.

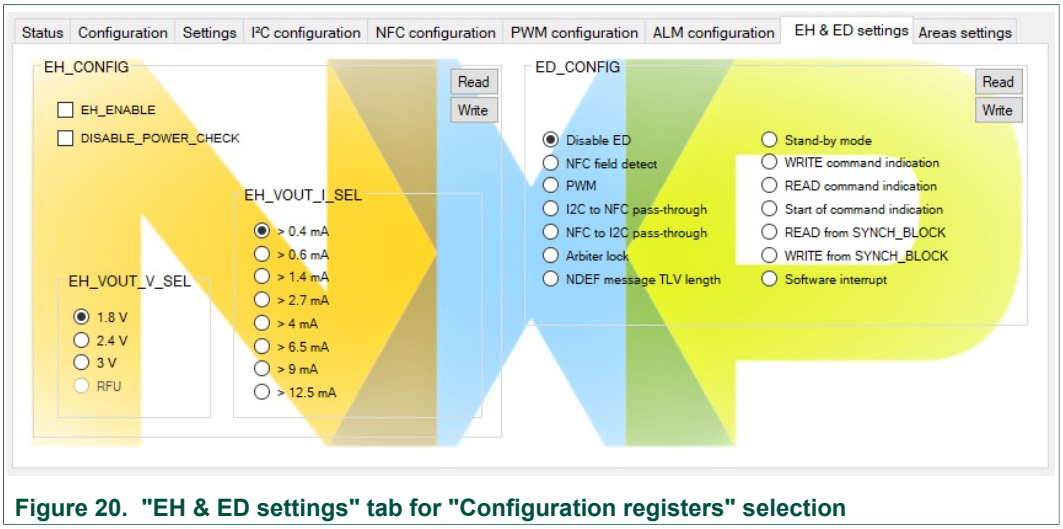

Figure 20. "EH & ED settings" tab for "Configuration registers" selection

4.2.9 Area settings

"Area settings" tab is only valid for "Configuration registers" since the related registers are only defined for this memory area.

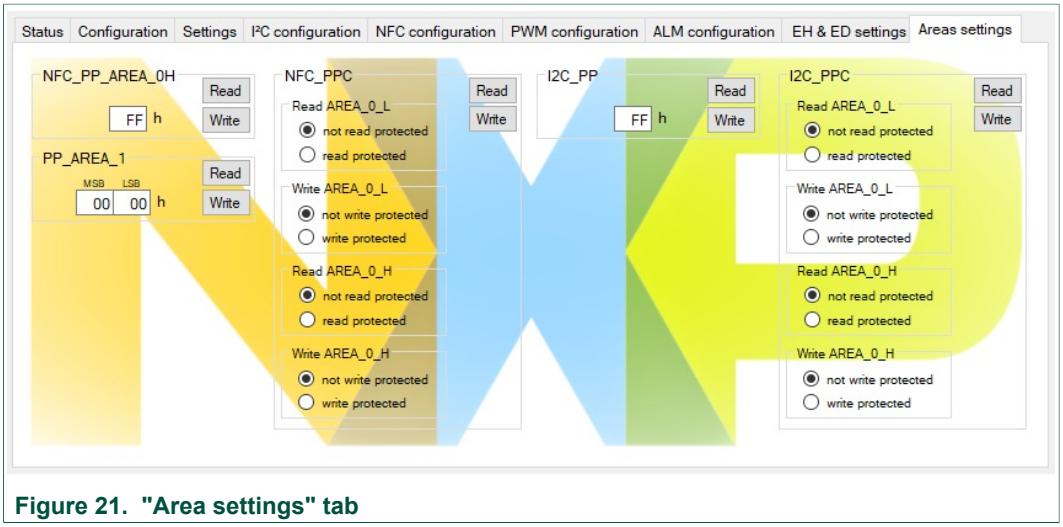

Figure 21. "Area settings" tab

4.3 Logs window

Bottom area of the NTAG 5 I²C Cockpit tool displays logs:

- In blue: operation details
- In Black: status
- In Green: I²C master data (to NTAG 5), 'S' indicating start condition while 'P' indicates stop condition
- In Red: I²C slave data (from NTAG 5), 'S' indicating start condition while 'P' indicates stop condition

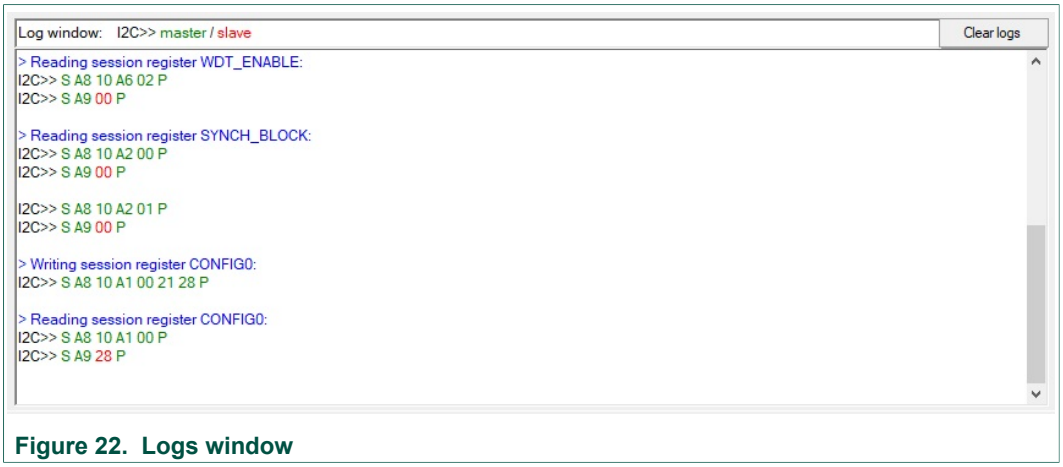

Figure 22. Logs window

More detailed information about I²C interface is given in NTAG 5 data sheet.

4.4 Menu

Additional functionalities are accessible through "Menu" item.

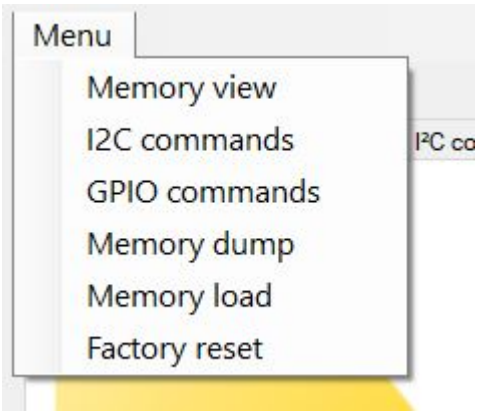

Figure 23. Menu

4.4.1 Memory view

"Memory view" allows displaying and updating NTAG 5 memory. Values are refreshed while scrolling.

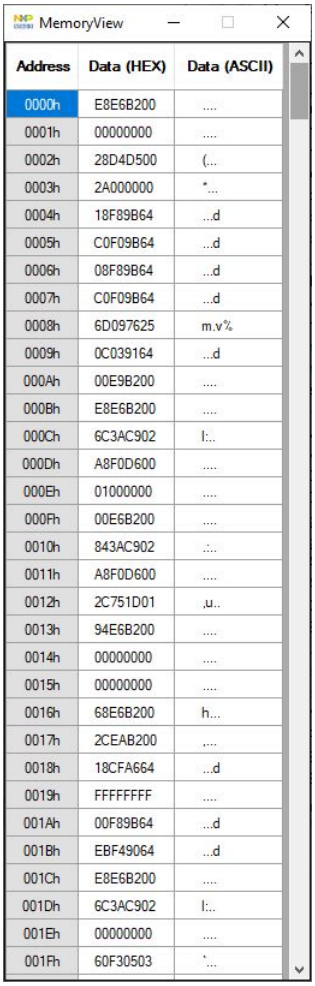

Figure 24. Memory view

4.4.2 I²C commands

"I²C commands" offers possibility to perform read or write memory operations as well as read or write register.

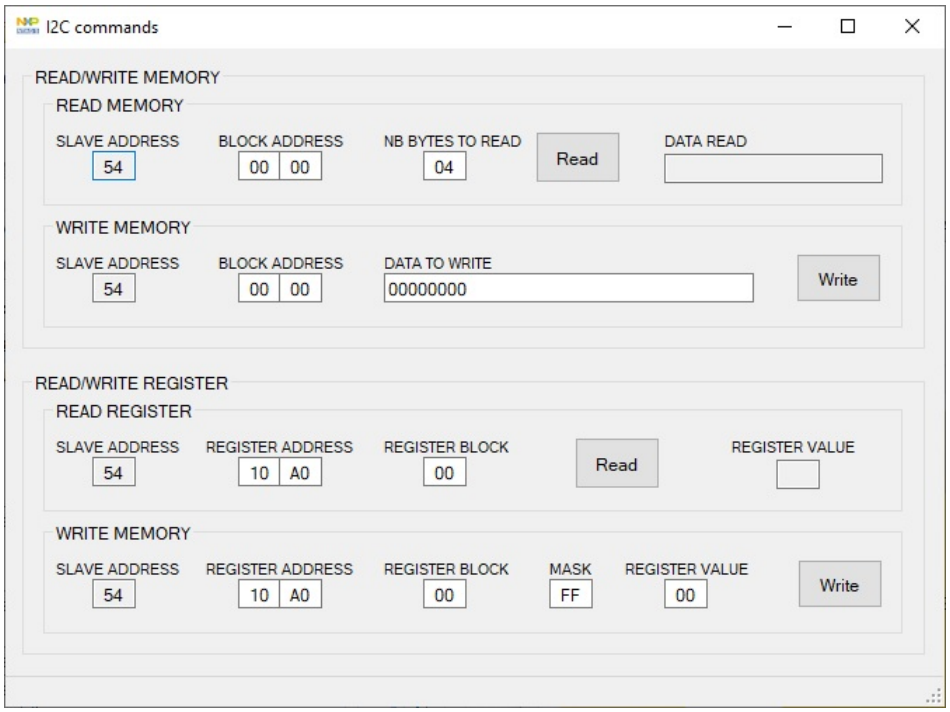

Figure 25. I²C commands

"READ/WRITE REGISTER" operations are reserved to "Session registers" (from 10A0h to 10AFh in Configuration memory). Reading or writing "Configuration registers" (from 1000h to 109Fh in Configuration memory) must be done via "READ/WRITE MEMORY" operations.

4.4.3 Memory dump

"Memory dump" offers possibility to read out NTAG 5 memory and store it to a file.

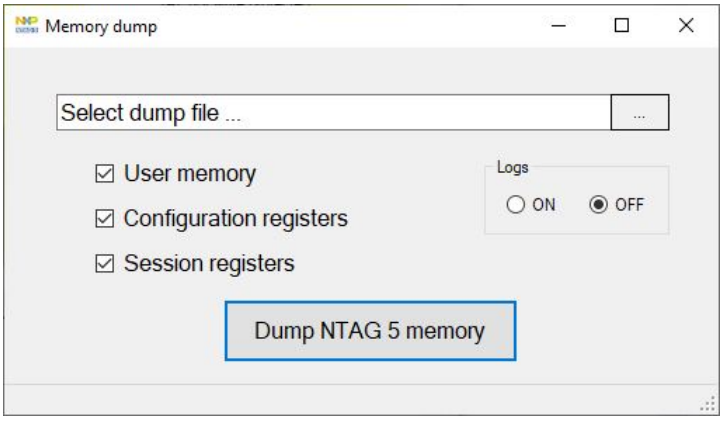

Figure 26. Memory dump

Output file content looks like this:

```
Ntag5 memory dump from 2020-04-28-12:12

User memory:
0000h : FF FF FF FF
0001h : FF FF FF FF
0002h : FF FF FF FF
0003h : FF FF FF FF
0004h : FF FF FF FF
...
01FEh : FF FF FF FF

Configuration registers:
1000h : 00 00 00 00
1001h : 00 00 00 00
1002h : 00 00 00 00
1003h : 00 00 00 00
1004h : 00 00 00 00
...
1099h : 00 00 00 00

Session registers:
10A0h : 02 C4 00 00
10A1h : 08 02 0F 00
10A2h : 00 00 00 00
10A3h : 00 00 00 00
10A4h : 00 00 00 00
10A5h : 00 00 00 00
10A6h : 48 08 00 00
10A7h : 00 00 00 00
10A8h : 00 00 00 00
10A9h : 54 00 00 00
10AAh : 00 00 00 00
10ABh : 00 00 00 00
10ACh : 00 00 04 00
10ADh : 00 00 00 00
```

Figure 27. Memory dump output file content

4.4.4 Memory load

"Memory load" offers possibility to load NTAG 5 memory from data contained in a file.

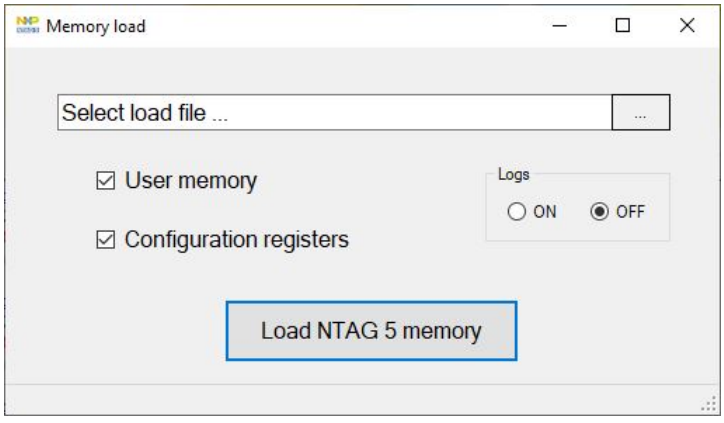

Figure 28. Memory load

The input file must be formatted following below definition for each line (one memory block of 4 bytes per line):

`VVVVh : WW XX YY ZZ` where VVVVh is the memory block base address (in hexadecimal) and WW XX YY ZZ respective values (in hexadecimal) of the memory block.

For example: `1041h : 1F 1F 17 14` triggers writing values 0x1F1F1714 at memory address 1041h (settings ALM_LUT_00, ALM_LUT_01, ALM_LUT_02 and ALM_LUT_03).

File obtained from "Memory dump" operation (see "Memory dump") can be used as input to "Memory load" operation.

It is not possible to load content to "Session registers" area (from 10A0h to 10AFh in Configuration memory) via "Memory Load" operation.

4.4.5 Factory reset

"Factory reset" allows applying default configuration to NTAG 5.

The default configuration is only applied after confirmation from user.

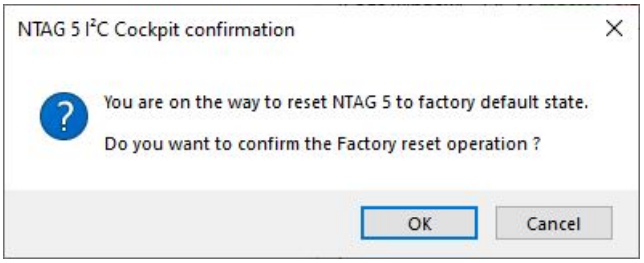

Figure 29. Factory reset

Pay attention that this is done considering the limitation of register access rights (according to the current configuration some registers may not be writeable).

5 Porting to other hardware

5.1 Other USB-I2C bridge

NTAG 5 I²C Cockpit tool can be used with another setup than the one described in chapter Hardware setup. It requires porting USB-I2C bridge implementation to this different environment.

The NTAG 5 I²C Cockpit tool interfaces to USB-I2C bridge via VCOM port. The related USB Device instance path shall contain "USB\VID_1FC9&PID_0083" string.

Frame interface definition is then defined as described in below table:

Table 2. NTAG 5 I²C Cockpit to USB-I2C bridge frame definition

Frame size	I²C address (7 bits)	Nb bytes to write (N)	Bytes to write	Nb bytes to read (M)
1 byte	1 byte	1 byte	N bytes	1 byte

Table 3. USB-I2C bridge to NTAG 5 I²C Cockpit frame definition

Frame size	Status	Bytes read
1 byte	1 byte	M bytes

Table 4. USB-I2C bridge to NTAG 5 I²C Cockpit frame status definition

Status value	Status information
0x00	Success
0x01	USB communication error
0x02	I²C address error
0x03	I²C communication error

The USB-I2C bridge interface also offers possibility to drive MCU GPIO, purpose is providing access to ED and HPD pin functionality.

Frame interface definition is similar to I²C communication, except that 2nd byte (7 bits I²C address byte) must be set to FFh:

Table 5. NTAG 5 I²C Cockpit to USB-I2C bridge frame definition for GPIO access

Frame size	0xFF	Port Nb	Pin Nb	Direction (0 = input, 1 = output)	Pin state (only if output)
1 byte	1 byte	1 byte	1 byte	1 byte	1 byte (if Direction is output, else empty)

Table 6. USB-I2C bridge to NTAG 5 I²C Cockpit frame definition for GPIO access

Frame size	Status	Pin state (only if input)
1 byte	1 byte	1 byte (if Direction is input, else empty)

Table 7. USB-I2C bridge to NTAG 5 I²C Cockpit frame status definition for GPIO access

Status value	Status information
0x00	Success
0x01	USB communication error

The reference implementation of this USB-I2C bridge on NXP's MCU LPC11U37H is provided as part of [SW6090] delivery available from [NTAG 5 development kit] webpage.

5.2 Other NTAG 5 board

It is possible to reuse USB-I2C bridge detailed in chapter Section 3.1.1 to drive NTAG 5 IC from another board than NTAG 5 demo kit depicted in chapter Section 3.1.2.

To do this, following connections between [OM13074 LPCXpresso board] and NTAG 5 IC must be insured:

Table 8. NTAG 5 connections to USB-I2C bridge

Signal	OM13074 LPCXpresso board	NTAG 5 IC pins
I2C_SCL	Arduino connector J1 pin #1	SCL pin #7
I2C_SDA	Arduino connector J1 pin #2	SDA pin #6
Power supply	Arduino connector J7 pin #4 (+3.3 V) or Arduino connector J7 pin #5 (+5 V)	VCC pin #9
Event detection	Arduino connector J2 pin #5	ED pin #8
Hard Power Down	Arduino connector J2 pin #6	HPD pin #10
Ground	Arduino connector J7 pin #6 or #7 or Arduino connector J1 pin #4	GND pin #1

6 Troubleshooting

6.1 Not able to flash OM13074 LPCXpresso board

In case of issue during flashing of USB-I2C bridge firmware to OM13074 LPCXpresso board, refer to the support information in [OM13074 LPCXpresso board].

6.2 USB-I2C bridge not found

While starting NTAG 5 I²C Cockpit tool, in case following issue appears:

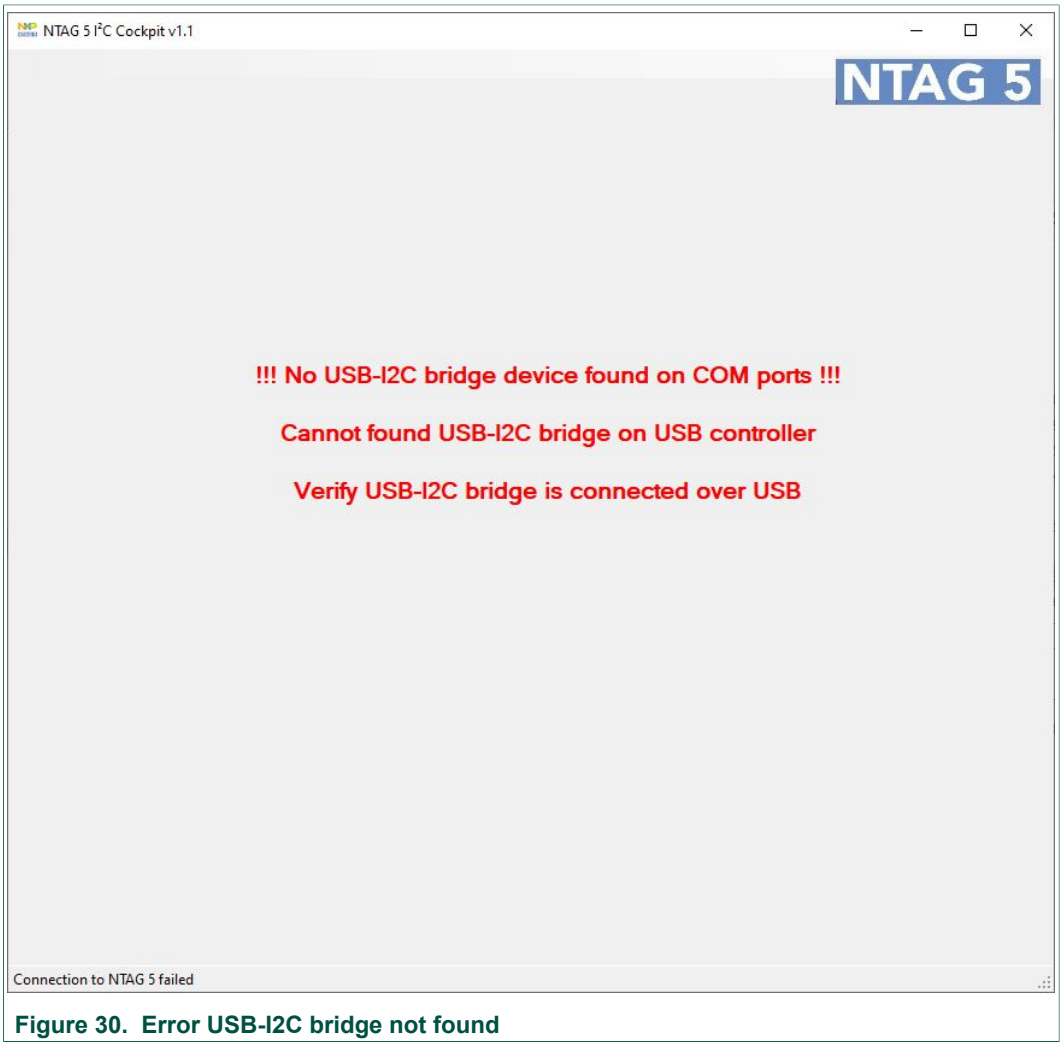

Figure 30. Error USB-I2C bridge not found

If [OM13074 LPCXpresso board] RGB LED is not lighted GREEN, it indicates USB-I2C bridge is not properly detected by the USB controller device:

- Make sure SW6 switch on [OM2NTx5332 board] is set to either "1.8_3.3V" or "5V" selection (by default boards are delivered with SW6 switch kept in the "middle" selection)
- In case of OM2NTA5332 board, make sure SW7 switch is set to "Arduino supply" selection (position "1-3")

- refer to chapter USB-I2C bridge to reflash the [OM13074 LPCXpresso board]

6.3 Virtual COM port already open

While starting NTAG 5 I²C Cockpit tool, in case following issue appears:

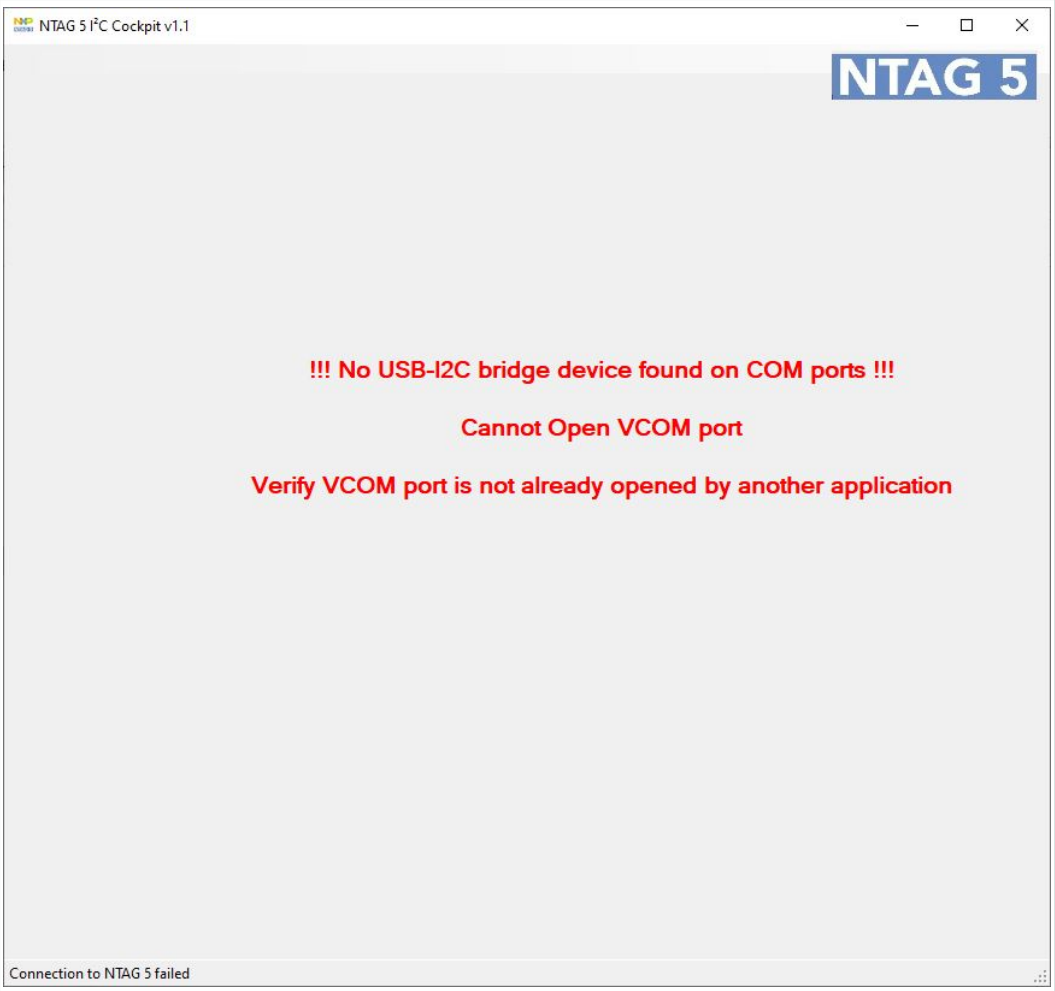

Figure 31. Error COM port already open

It indicates that USB-I2C bridge board has been detected on USB but related Virtual COM port is already open:

- Verify that no other instance of NTAG 5 I²C Cockpit is running
- Check that no other application has an open channel to the USB-I2C bridge-related COM port.

6.4 NTAG 5 not found

While starting NTAG 5 I²C Cockpit tool, in case following issue appears:

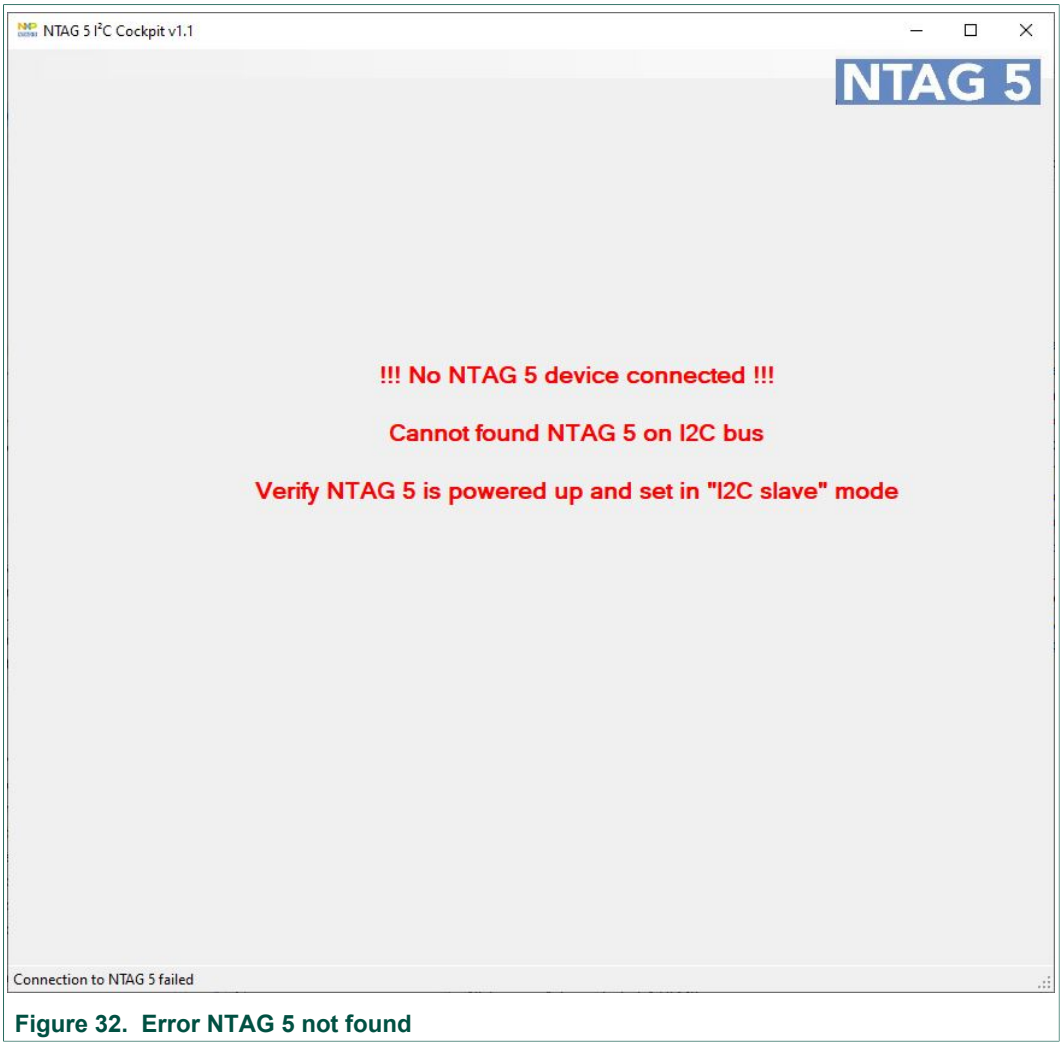

Figure 32. Error NTAG 5 not found

It indicates NTAG 5 is not properly answering on I^2C interface, whatever the I^2C slave address (NTAG 5 I^2C Cockpit tool scans all possible address from 0h to 7Fh):

- Verify that NTAG 5 IC is properly configured in I^2C slave mode (refer to "USE_CASE_CONF" field of "CONFIG_1" NTAG 5 configuration byte)
- Check that NTAG 5 is properly supplied (verify [OM2NTx5332 board] switches setting)

6.5 Any other issue

For any other issue, refer to [NFC support].

7 References

[1] UM10204 - I2C-bus specification and user manual
https://www.nxp.com/docs/en/user-guide/UM10204.pdf

[2] OM13074: LPCXpresso board for LPC11U37H
https://www.nxp.com/products/security-and-authentication/authentication/lpcxpresso-board-for-lpc11u37h:OM13074

[3] OM2NTx5332: NTAG® 5 development kits
https://www.nxp.com/products/rfid-nfc/nfc-hf/ntag/nfc-tags-for-electronics/om2ntx5332-ntag-5-development-kits:OM2NTX5332

[4] SW6090: NTAG 5 Development kit source code and library for LPC microcontrollers
https://www.nxp.com/doc/SW6090

[5] NFC support in NXP community forum
https://community.nxp.com/community/identification-security/nfc?tid=community

[6] UM11207 - NTAG 5 NFC Cockpit application
https://www.nxp.com/docs/en/user-guide/UM11207.pdf

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