Release Note

NxpNfcRdLib

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Document information

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CUSTOMER	NxpNfcRdLib external release
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Contents

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1. Document purpose

This document describes the content of the source code incremental release package of the NXP NFC Reader Library for LPC1769 and LPC11u68 board used along with PNEV512B v1.5 blue board, CLRC663 Blue board v3.0 and Pn5180 V1.0 board.

This document also lists known problems, restrictions and some tips.

2. Hardware Requirements

- NXP LPC1769 board or NXP LPC11u68 board
- CLRC663 blue board v3.0
- PNEV512B v1.5 blue board with CE certification mark
- Pn5180B V1.0 development board
- Sample cards
- USB Cables, etc

3. Features

The NFC Reader Library provides a full featured software stack written in C programming language that is tested for

- NFC Forum CR8 (TCCL 2.11) compliance,
- EMVCo 2.3.1a compliance and
- ISO 10373-6 PCD compliance
- ISO 10373-6 PICC compliance for Type 4A (ISO 14443-4, ISO 14443-4A) PICC.

The NFC Reader Library provides APIs that enable customers to create their own software stack and applications for the NXP contactless reader ICs.

The NFC Reader Library is designed as a versatile and multi-layered architecture. From bottom to top, the NFC Reader Library is composed of the following layers:

- Bus Abstraction Layer (BAL): Implements the communication interface between the host device and the contactless reader IC.

- Hardware Abstraction Layer (HAL): Implements the hardware specific elements of the contactless reader IC and executes native commands of the chip.

- Protocol Abstraction Layer (PAL): Implements the functions for contactless card activation, contactless card protocols and peer mode protocols.

- Application Layer (AL): Implements the commands to work with several contactless smart card technologies.

- NFC Forum Tag Operations (TOP): Implements a set of APIs for developers to perform read and write operations on top of the five Tag Types defined in the NFC Forum specifications.

- NFC Activity: Implements a routine (Discovery loop) for sensing the RF field to detect the presence of contactless smart cards, NFC tags or other NFC-enabled devices in close proximity.

- HCE: Implements the host card emulation of NFC Forum Type 4A technology PICC.

- NFC P2P Package: Implements P2P functionality based on the NFC Forum defined P2P protocol stack allowing two NFC devices to exchange data when they are brought into proximity.
- On top of this, several example applications are provided that demonstrate dedicated functionality as documented in the corresponding ReadMe.txt files within the source folders of these example applications.
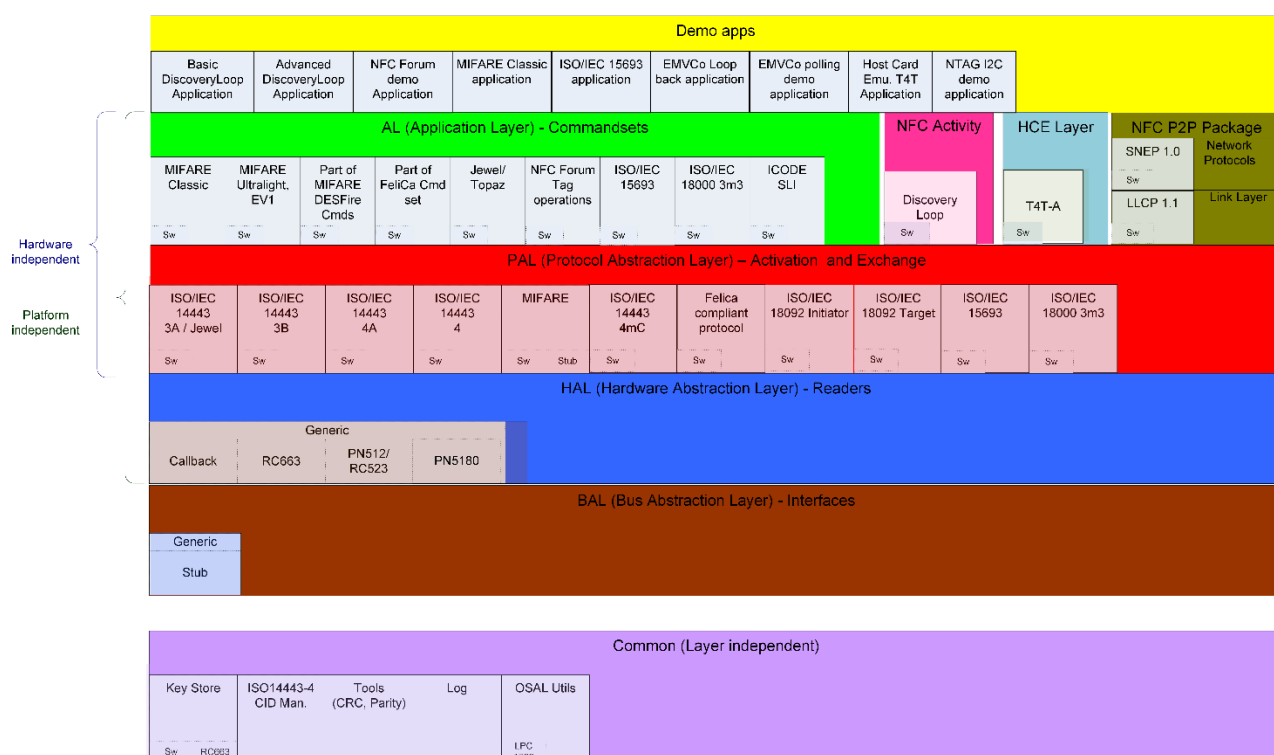

Figure 1 Layer diagram

3.1 Additions / changes in this version of the NXP NFC reader library

3.1.1 Discovery loop

The discovery loop component is developed to comply with NFC Forum activity specification version 1.0 (NFCForum-TS-Activity-1.0 dated 2010-11-18).

The discovery loop supports for Type A, Type B, Type F, Type V (ISO 15693) and ISO 18000p3m3 polling mode and Type A, Type F technologies in listen mode.

In addition, it also has a mode to poll as per EMVCo 2.3.1a specification (See section 9 PCD Processing of EMV Contactless Communication Protocol Specification Version 2.3.1 November 2013).

3.1.2 HAL

The HAL architecture has changed as compared to previous library releases. The change is in the lowest level where in the polling approach (for interrupt status of the NFC contactless IC) has been changed to interrupt based approach. The whole library is now changed to be easily used with an RTOS. FreeRTOS is used in the package for demonstration. The HAL component will enable the required interrupts in the NFC contactless IC and then wait for an OS event, thereby blocking the task for an interrupt while the CPU is freed. The event will be triggered in the ISR when an interrupt occurs and thereby unblocks the waiting task.

HAL of Pn5180 Contactless frontend IC has been added newly in the reader library. This enables usage of this library on Pn5180 as well in addition to Pn512 and CLRC663.

3.1.3 LLCP, SNEP

The logical link control protocol component (LLCP) has been developed freshly as per NFCForum-TS-LLCP_1.1 technical specification dated 2011-06-20. LLCP implementation makes RTOS mandatory.

The simple NDEF exchange protocol component (SNEP) has been developed freshly as per NFCForum-TS-SNEP_1.0 technical specification dated 2011-08-31.

3.1.4 ISO 18092MT

The ISO 18092 target mode component has been refactored to make it easy to use and also to integrate seamlessly with upper layers like LLCP. This component complies with NFCForum-TS-DigitalProtocol-1.0 technical specification dated 2010-11-17. The ISO 18092MT component requires an RTOS in order to realize the full functionality like Response time extensions. The ISO 18092MPI (Initiator mode) component also complies with the same specification.

3.1.5 ISO 18000p3m3

This PAL component has been refactored since previous version of the reader library to handle timing critical operations like sending an *ACK* and *ReqRn* within HAL itself. The operations like *BeginRound*, *ACK* and *ReqRn* are all handled in the HAL while the PAL provides some utility functions to help create the command for *Select* and *BeginRound*. The ISO 18000p3m3 implementation complies with section 6.3 (Mode 3) of Information technology — Radio frequency identification for item management — Part 3: Parameters for air interface communications at 13.56 MHz

3.1.6 Host card emulation (Type 4A tag)

ISO 14443-4mC (Card mode protocol) has been implemented in the reader library. The implementation complies with NFCForum-TS-DigitalProtocol-1.0 technical specification dated 2010-11-17, section 13. The Host card emulation for Type 4A tag (phceT4T) has been implemented in the reader library. This implementation complies with NFCForum-TS-Type-4-Tag_2.0 technical specification version 2011-06-28.

3.1.7 Compliance testing and resulting corrections

As mentioned in section 3 introduction, the entire library has been compliance tested with the relevant tools and standards as mentioned. The short comings or failures detected during compliance testing have been fixed across all relevant components of the reader library.

3.1.8 Example applications

Nine example applications are provided with the library. There perform dedicated functions as documented in ReadMe.txt files within the respective directories.

1. NfcrdlibEx1_BasicDiscoveryLoop
2. NfcrdlibEx2_AdvancedDiscoveryLoop
3. NfcrdlibEx3_NFCForum
4. NfcrdlibEx4_MIFAREClassic
5. NfcrdlibEx5_ISO15693
6. NfcrdlibEx6_EMVCo_Loopback
7. NfcrdlibEx7_EMVCo_Polling
8. NfcrdlibEx8_HCE_T4T
9. NfcrdlibEx9_NTagI2C

3.1.9 API documentation

Detailed API documentation for all the components of the reader library is available at NxpRdLib\docs\14_user_doc\NXP NFC Reader Library.chm. This document also provides some sequence / flow diagrams to help user understand the usage of the APIs.

3.2 Detailed list of Components

10. |NxpNfcRdLib

11. |----BAL

12. |--------Stub

13. |

14. |----HAL

15. |--------Pn512/Rc523

16. |--------Rc663

17. |--------Callback

18. |--------Pn518

19. |

20. |----PAL

21. |--------I14443p3a

22. |-----------Sw

23. |

24. |--------I14443p3b

25. |-----------Sw

26. |

27. |--------I14443p4

28. |-----------Sw

29. |

30. |--------I14443p4a

31. |-----------Sw

32. |

33. |--------I14443p4mC

34. |-----------Sw

35. |

36. |--------Mifare

37. |-----------Sw

38. |-----------Stub

39. |

40. |--------Felica

41. |-----------Sw

42. |

43. |--------I18092mPI (Active and Passive)

44. |-----------Sw

45. |

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46. |--------I18092mT (Active and Passive)

47. |-----------Sw

48. |

49. |--------I15693

50. |-----------Sw

51. |

52. |--------I18000p3m3

53. |-----------Sw

54. |----LN

55. |--------LLCP

56. |-----------Sw

57. |----NP

58. |--------SNEP

59. |-----------Sw

60.

61. |----AC

62. |--------DiscLoop

63. |-----------Sw

64.

65. |----CE

66. |--------phceT4T

67. |-----------Sw

68.

69. |----AL

70. |--------Mfc

71. |-----------Sw

72. |

73. |--------Mful

74. |-----------Sw

75. |

76. |--------Mfdf

77. |-----------Sw

78. |

79. |--------T1T

80. |-----------Sw

81. |

82. |--------TOP

83. |-----------Sw

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```
85.   |--------Felica
86.   |------------Sw
87.   |
88.   |--------ICode SLI
89.   |------------Sw
90.   |
91.   |--------15693
92.   |------------Sw
93.   |
94.   |--------18000p3m3
95.   |------------Sw
96.
97.   |----Common
98.   |--------CidManager
99.   |------------Sw
100. |
101. |--------KeyStore
102. |------------Sw
103. |------------Rc663
104. |
105. |--------Log
106. |--------Tools
107. |
108. |--------OSAL
109. |------------Stub
110. |
111. |----Documents
112. |--------14_user_doc
113. |------------NXP_SLDA.pdf
114. |------------Nxp Nfc Reader Library.chm
115. |
116. |--------22_rel_doc
117. |------------NXP Reader Library Release Note
118. |
119. |LPC1769
120. |----STUB
121. |--------BAL
122. |--------OSAL
123. |LPC11u68
```

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124. |----Includes

125. |----lpc_board_nxp_lpcxpresso_11u68

126. |----lpc_chip_11u6x

127. |----Startup_code

128. |----Stub

129. |--------BAL

130. |--------OSAL

131.

132. |Sample examples

133. --------- **NfcrdlibEx1_BasicDiscoveryLoop**

134. --------- **NfcrdlibEx2_AdvancedDiscoveryLoop**

135. --------- **NfcrdlibEx3_NFCForum**

136. --------- **NfcrdlibEx4_MIFAREClassic**

137. --------- **NfcrdlibEx5_ISO15693**

138. --------- **NfcrdlibEx6_EMVCo_Loopback**

139. --------- **NfcrdlibEx7_EMVCo_Polling**

140. --------- **NfcrdlibEx8_HCE_T4T**

141. --------- **NfcrdlibEx9_NTagI2C**

4.Installation instructions

This release is built for NXP LPC1769 and NXP LPC11u68 MCUs. A project file for LPCXpresso (Version: LPCXpresso v7.7.x and above) has been packaged along with this release.

Detailed list of instructions on how to run the examples are described in the Readme.txt in the sample examples folders. For example, for basic discovery loop application it is available at 02_Libraries\NfcrdlibEx1_BasicDiscoveryLoop\Readme.txt.

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5.Known problems and Restrictions

5.1 Hardware Changes Required (Applicable only when used with CLRC663 and Pn512):

- When using PNEV512 v1.5 board with LPC1769, GPIO 2.13 (Pin #27) of LPC1769 should be connected to IRQ PIN (#26) of PNEV512 Blue board without this **system will not work either in Initiator or Target Mode**.

- On CLRC663, Remove R35 resistor and solder 0 ohm resistor to R34 on Rc663 blueboard V3.0.

    a. NOTE: By default Pin 32 of CLRC663 will be connect to Ground via R35. Remove R35 and connect a 0 Ohm to R34. This will connect CLRC663 IRQ pin connect to LPC 1769 Port 2.12 pin, which is an external interrupt for LPC1769.
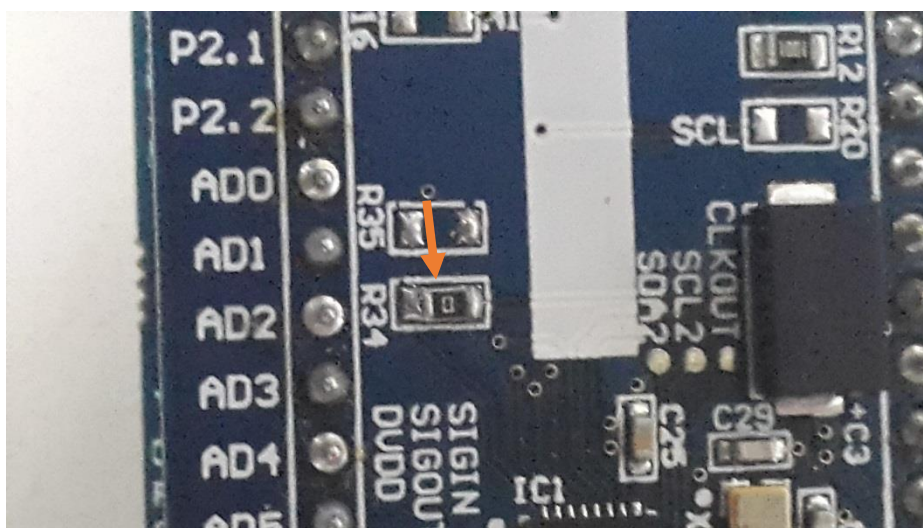

Figure 2 CLRC663 R34 and R35

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5.2 Open Issues, limitations, tips and tricks

5.2.1 EMVCo 2.3.1a compliance

	Item	Explanation	Current status
1	EMVCo 2.3.1a tests	Out of total 607 test cases one test case fails due to conflicting spec (TB107_4) Detailed Report is available at	This is a known issue and the test description is in conflict with TB304_14.

5.2.2 Logical Link Control Protocol (LLCP) Interoperability with smart phones

Extensive interoperability tests have been performed with Samsung Galaxy S3, S4, S5 and S6 phones. The tests have been performed with Reader library + Pn5180 as one system and the counterpart being the phone. The following observations/limitations are seen on the phones.

Observed behavior with Samsung Galaxy S3:

After a first successful SNEP PUT, for the next PUT, Samsung GS3 responds with RTOx packet that is not expected. Every alternate SNEP PUT works. Further investigation reveals that the phone does not handle the LLCP deactivation procedure as specified in the NFC Forum specification. The phone expects that we keep on exchanging SYM PDUs till a timeout occurs by taking the peer off the field.

Conclusion: This is a limitation in the phone. From a user experience point of view the system always recovers and ensures that the next PUT is successful.

Observed behavior with Samsung Galaxy S4:

With Android version 4.2.2 of the phone, during SNEP PUT from Pn518 system to the phone, the phone returns "SNEP Continue" instead of "SNEP Success". This results in the application on Pn518 system flagging this as protocol error.

With Android version 5.0.1 of the phone, after every successful SNEP PUT from Pn518 system to the phone, the phone's NFC feature does not function. It needs NFC option in the settings tab to be turned OFF and turned ON back for the phone to function. This happens in active communication mode.

Conclusion: This is a limitation of the phone.

Behavior seen with Google Nexus 5:

Google Nexus 5 phone is found to send a PSL_REQ by setting non-zero values for bits 8 and 7 of the BRS byte. Please refer to ISO/IEC IS092 Information technology — Telecommunications and information exchange between systems — Near Field Communication — Interface and Protocol (NFCIP-1) document dated 2013-03-15.
As per the above mentioned standard, the bits 8 and 7 of the BRS byte shall be set to zero. This is specified in the section 12.5.3.1.1 – Definition of the PSL_REQ bytes of the standard.

Since the phone is found to send non-compliant values for this byte, this is rejected by the reader library and a PSL_RES is not sent.

If user wishes to bypass this check in the reader library, the code at the following location should be commented out.

File: NxpRdLib\comps\phpalI18092mT\src\Sw\phpalI18092mT_Sw.c

Lines: Code at 287 to 290 within the function `phpalI18092mT_Sw_PslRes` that checks the BRS byte should be commented out.

5.2.3 LLCP SYMM timer configuration

In the LLCP header file under NxpRdLib\intfs\phlnLlcp.h file a configuration parameter is defined to set the SYMM timer value for LLCP. This is defined as a percentage of link time out (LTO) for target and MAC timeout (at ISO 18092 level). The default value is currently set to 10%. This can be varied by the user based on the system design. Please note that changing this value to be high has performance implications.

5.2.4 CLRC663 configuration to use active high interrupt output

In the library examples, CLRC663 is by default configured to output active low interrupt at the IRQ pin. This is done by writing a register as follows.

```
status = phhalHw_Rc663_WriteRegister(&sHal_Nfc_Ic.sHal,
PHHAL_HW_RC663_REG_IRQ0EN, 0x80);
```

Please refer to any of the example applications where this line is present.

If it has to be configured to produce an active high output at the IRQ then the following changes need to be done in the example applications.

Set irq0en (08h) register bit 8(irq_inv) to 0 to configure interrupt as active high. Irq1en register's IrqPushPull and IrqPinEN bits have to be set.

```
status = phhalHw_Rc663_WriteRegister(&sHal_Nfc_Ic.sHal,
PHHAL_HW_RC663_REG_IRQ0EN, 0x00);
    CHECK_STATUS(status);
status = phhalHw_Rc663_WriteRegister(&sHal_Nfc_Ic.sHal,
PHHAL_HW_RC663_REG_IRQ1EN, 0xC0);
    CHECK_STATUS(status);
```

In addition to this, the GPIO configuration of the MCU needs to be modified to use rising edge or falling edge trigger (or level trigger). An example below is show to configure LPC1769 GPIOs for rising edge triggered interrupt. This code is present in NfcrdlibEx1_BasicDiscoveryLoop/src/phHwConfig_Lpc1769.c file.

In function Set_Interrupt

```
/*
   For falling edge trigger use 1 as third argument.
   For rising edge trigger, use 0 as third argument.
*/
```

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```
        GPIO_IntCmd(2, 1<<12, 0);


    In function CLIF_IRQHandler
        /*
           For falling edge trigger use 1 as third argument.
           For rising edge trigger, use 0 as third argument.
         */

        regVal = GPIO_GetIntStatus(2, 12, 0);
```

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6. Document management

6.1 Abbreviations and terminology

Table 1:Abbreviations and terminology

Abbreviation	Description
EMV	Europay Master Visa standard
NFC	Near Field Communication
LLCP	Logic Link Control Protocol
SNEP	Simple NDEF Exchange Protocol
HCE	Host Card Emulation
HAL	Hardware abstraction layer
PAL	Protocol abstraction layer
AL	Application layer
AC	Activity layer
LN	Link abstraction layer
NP	Network protocol layer
BAL	Bus abstraction layer
P2P	Peer to Peer
TOP	Tag Operations

6.2 Reference Documents

[1] **Data Sheet** MF1S503X MIFARE Classic 1K - Mainstream contactless smart card IC for fast and easy solution development, available on http://www.nxp.com/documents/data_sheet/MF1S503x.pdf

[2] **Data Sheet** - MIFARE Ultralight ; MF0ICU1, MIFARE Ultralight contactless single-ticket IC, BU-ID Doc. No. 0286**[1], available on http://www.nxp.com/documents/data_sheet/MF0ICU1.pdf

[3] **Data Sheet** – MIFARE Ultralight EV1- contactless ticket IC, available on http://www.nxp.com/documents/data_sheet/MF0ULX1.pdf

[4] **Data Sheet** – MIFARE MF0ICU2 – MIFARE Ultralight C, available on http://www.nxp.com/documents/short_data_sheet/MF0ICU2_SDS.pdf

[5] **Data Sheet** - MIFARE DESFire; MF3ICDx21_41_81, MIFARE DESFire EV1 contactless multi-application IC, BU-ID Doc. No. 1340**, available on http://www.nxp.com/documents/short_data_sheet/MF3ICDX21_41_81_SDS.pdf

[6] **Data Sheet** - JIS Standard JIS X 6319 Specification of implementation for integrated circuit(s) cards - Part 4: High Speed proximity cards

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[7] **Data Sheet** – Innovision Topaz, http://downloads.acs.com.hk/drivers/en/TDS_TOPAZ.pdf

[8] **Data sheet** - MFRC523; Contactless reader IC, BU-ID Doc. No. 1152**, available on http://www.nxp.com/documents/data_sheet/MFRC523.pdf

[9] **Data sheet** - CLRC663; Contactless reader IC, BU-ID Doc. No. 1711**, available on http://www.nxp.com/documents/data_sheet/CLRC663.pdf

[10] **Data sheet** – PN512; Transmission module, BU-ID Doc. No. 1113**, available on http://www.nxp.com/documents/data_sheet/PN512.pdf

[11] **ISO/IEC Standard** - ISO/IEC 14443 Identification cards - Contactless integrated circuit cards - Proximity cards

[12] **ISO/IEC Standard** - ISO/IEC 18092 Information technology - Telecommunications and information exchange between systems - Near Field Communication- Interface and Protocol (NFCIP-1)

[13] **Technical Specification** Logical Link Control Protocol, NFCForum-TS-LLCP_1.1, available on www.nxp.com/redirect/nfc-forum.org/specs/spec_license

[14] **Technical Specification** – Simple NDEF Exchange Protocol, NFCForum-TS-SNEP_1.0, available on www.nxp.com/redirect/nfc-forum.org/specs/spec_license

[15] **Technical Specification** – Type 1 Tag Operation, NFCForum-TS-Type-1-Tag_1.1, available on www.nxp.com/redirect/nfc-forum.org/specs/spec_license

[16] **Technical Specification** – Type 2 Tag Operation, NFCForum-TS-Type-2-Tag_1.1, available on www.nxp.com/redirect/nfc-forum.org/specs/spec_license

[17] **Technical Specification** – Type 3 Tag Operation, NFCForum-TS-Type-3-Tag_1.1, available on www.nxp.com/redirect/nfc-forum.org/specs/spec_license

[18] **Technical Specification** – Type 4 Tag Operation, NFCForum-TS-Type-4-Tag_2.0, available on www.nxp.com/redirect/nfc-forum.org/specs/spec_license

[19] **Technical Specification** – NFC Data Exchange Format, NFCForum-TS-NDEF_1.0, available on www.nxp.com/redirect/nfc-forum.org/specs/spec_license

[20] **Application note** - AN11211 Quick Start Up Guide RC663 Blueboard, available on http://www.nxp.com/documents/application_note/AN11211.pdf

[22] **Application note** – AN11308 Quick Start Up Guide PNEV512B, available on http://www.nxp.com/documents/application_note/AN11308.pdf

[23] LPCZone, http://www.nxp.com/techzones/microcontrollers-techzone/news.html

[24] NXP DocStore, https://www.docstore.nxp.com/flex/DocStoreApp.html#/l

[25] LPCXPresso IDE, http://www.lpcware.com/lpcxpresso/code-red

[26] LPCXpresso target boards, http://www.nxp.com/techzones/microcontrollers-techzone/tools-ecosystem/lpcxpresso.html

[27] **Application note** - AN11211 CLEV663B Blueboard Quick Start Guide, http://www.nxp.com/documents/application_note/AN11211.pdf

[28] **Application note** - AN11308 PNEV512B Blueboard Quick Start Guide, http://www.nxp.com/documents/application_note/AN11308.pdf

[29] NXP Contactless reader IC Demoboards ordering, http://www.nxp.com/products/identification_and_security/#demoboards

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