Getting started with the NFC card reader expansion board based on ST25R300 for STM32 and STM8 Nucleos

Introduction

The X-NUCLEO-NFC12A1 NFC card reader expansion board is based on the ST25R300 device.

The expansion board is configured to support all five NFC Forum tag types in reader mode.

The ST25R300 manages frame coding and decoding in reader mode for standard applications. It supports ISO/IEC 14443 type A and B, ISO/IEC 15693 (single subcarrier only) and ISO/IEC 18092 communication protocols as well as the detection, reading and writing of NFC Forum type 1, 2, 3, 4, and 5 tags.

Integrated HF reader/NFC initiator/NFC target IC with an antenna etched on the PCB and the related tuning circuit.

Figure 1. X-NUCLEO-NFC12A1 expansion board

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www.st.com

1 Getting started

1.1 Overview

The X-NUCLEO-NFC12A1 expansion board features:

- On-board NFC card reader and host card emulation IC: ST25R300
- NFC Forum NFC-A, NFC-B, NFC-F, and NFC-V poller
- NFC Forum NFC-A, NFC-F listener
- 13.56 MHz inductive antenna, 47 x 34 mm, four turns, etched on PCB and associated tuning circuit
- Possibility of driving two antennas in a single-ended configuration
- Six general-purpose LEDs
- Equipped with Arduino® UNO R3 connector
- Free comprehensive development firmware library compatible with STM32Cube and samples for ST25R300
- FCC and CE certified
- RoHS and WEEE compliant

1.2 Board connection

Connect the X-NUCLEO-NFC12A1 to an STM32 Nucleo-64 development board via Arduino® UNO R3 connectors.

The PC USB port has to be capable to delivering at least 300 mA at 5 V supply.

A green LED indicates whether the 5 V supply is present, while the six status LEDs are controlled via MCU.

Provision for unpopulated jumpers enables alternative connections of all lines (except the SPI) to the STM32 MCU.

To demonstrate the wake-up feature, two capacitive electrodes are placed on the PCB and the automatic antenna tuning variable capacitors are also implemented.

The board is connected to a power supply. It should be used on a clean and nonflammable surface.

1.3 Hardware requirements

The X-NUCLEO-NFC12A1 expansion board is designed to be used with any STM32 Nucleo board, although complete testing has been performed using the NUCLEO-L476RG hosting the STM32L476RG microcontroller.

The STM32 Nucleo firmware and the related documentation are available at dedicated page.

1.4 System requirements

To use STM32 Nucleo boards with the X-NUCLEO-NFC12A1 expansion board the following software and hardware are required:

- An STM32 Nucleo-64 development board
- A Windows® PC to install the firmware package
- A USB type A to Mini-B USB cable to connect the STM32 Nucleo board to the PC
- The unit must be supplied by a safety extralow voltage with falling characteristics (<5 V, <15 W), according to EN60950-1. This power supply has to be classified as electrical source 1 (ES1), PS1 according to EN62368-1

To install the board firmware package (order code: X-CUBE-NFC12) the PC must have:

- 128 MB of RAM
- 40 MB of free hard disk space

The X-CUBE-NFC12 firmware and the related documentation are available at ST site.

2 Board setup

To set up the board:

Step 1. Connect the X-NUCLEO-NFC12A1 expansion board to the STM32 Nucleo board from the top through the Arduino® UNO R3 connectors

Step 2. Power the STM32 Nucleo board using a Mini-B USB cable

Step 3. Program the firmware on the STM32 Nucleo board using the provided example

Step 4. Reset the MCU using the reset button available on the STM32 Nucleo board.
The evaluation kit is ready to be used.

3 Hardware

The X-NUCLEO-NFC12A1 expansion board allows the user to test the functionality of the ST25R300, which supports the reader/writer and the card emulation modes.

The ST25R300 IC module and the STM32 Nucleo board are connected through CN5, CN6, CN8 and CN9 connectors (see the tables below).

Table 1. Interconnections between the X-NUCLEO-NFC12A1 expansion board and the NUCLEO-L476RG board (left side)

Signal	Connector	Pin number	NUCLEO-L476RG	X-NUCLEO-NFC12A1
NC	CN6 Power	1	(NC)	(NC)
IOREF		2	3V3 (VDD_IO)	(NC)
RESET		3	NRST	(NC)
3V3		4	3V3 (VDD_IO)	3V3 (VDD_IO)
5V		5	5V (VDD)	5V (VDD)
GND		6	GND	GND
GND		7	GND	GND
VIN		8	VIN	NC
A0	CN8 Power	1	PA0	IRQ_MCU
A1		2	PA1	MCU_LED1
A2		3	PA4	MCU_LED2
A3		4	PB0	MCU_LED3
A4		5	PC1	-
A5		6	PC0	-

Table 2. Interconnections between the X-NUCLEO-NFC12A1 expansion board and the NUCLEO-L476RG board (right side)

Signal	Connector	Pin number	NUCLEO-L476RG	X-NUCLEO-NFC12A1
D15	CN5 Digital	10	PB8	SCL_MCU
D14		9	PB9	SDA_MCU
AVDD		8	AVDD	NC
GND		7	GND	GND
D13		6	PA5	SCLK_MCU
D12		5	PA6	MISO_MCU
D11		4	PA7	MOSI_MCU
D10		3	PB6	/SS_MCU
D9		2	PC7	-
D8		1	PA9	RESET
D7	CN9 Digital	8	PA8	MCU_LED4
D6		7	PB10	MCU_LED5
D5		6	PB4	MCU_LED6
D4		5	PB5	-
D3		4	PB3	NC
D2		3	PA10	NC

Signal	Connector	Pin number	NUCLEO-L476RG	X-NUCLEO-NFC12A1
D1	CN9 Digital	2	PA2	NC
D0		1	PA3	NC

3.1 Host interface and GPIO connection

The X-NUCLEO-NFC12A1 expansion board contains the ST25R300-AQET chip and is powered by the STM32 Nucleo board.

The ST25R300 is driven by the microcontroller via an SPI interface.

The six LEDs indicate the detected RFID technology (for example, ISO14443 Type A for LED4).

3.2 X-NUCLEO-NFC12A1 expansion board component placement

Figure 2. X-NUCLEO-NFC12A1 component placement

1. General purpose LEDs
2. ST25R300
3. Matching circuit
4. 47x34 mm four-turn antenna

3.3 ST25R300 device

The ST25R300 is a high-performance NFC universal device supporting NFC initiator, NFC target, NFC reader, and NFC card emulation modes.

The ST25R300 includes an advanced analog front end (AFE) and a highly integrated data framing system for:

- ISO 18092 passive and active initiator, ISO18092 passive and active target
- NFC-A/B (ISO 14443A/B) reader including higher bit rates
- NFC-F (Felica™) reader
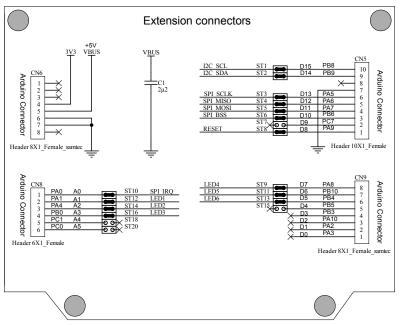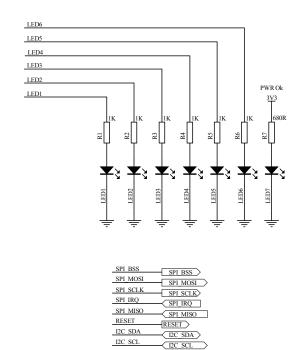- NFC-V (ISO 15693) reader up to 53 kbps
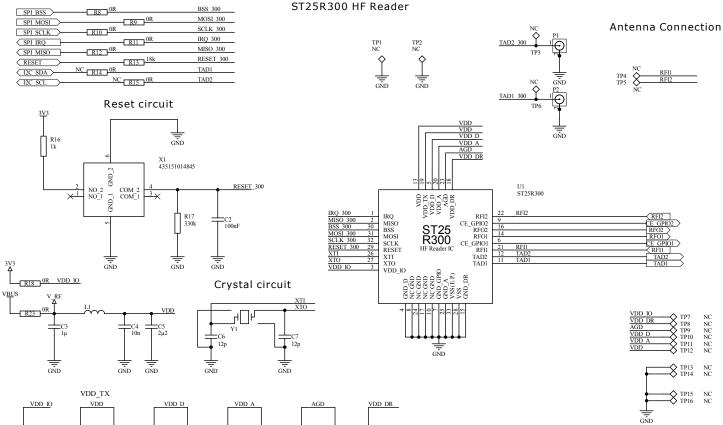
- NFC-A and NFC-F card emulation

Special stream and transparent modes of the AFE and framing system can be used to implement other custom protocols such as MIFARE® classic in reader or card emulation mode.
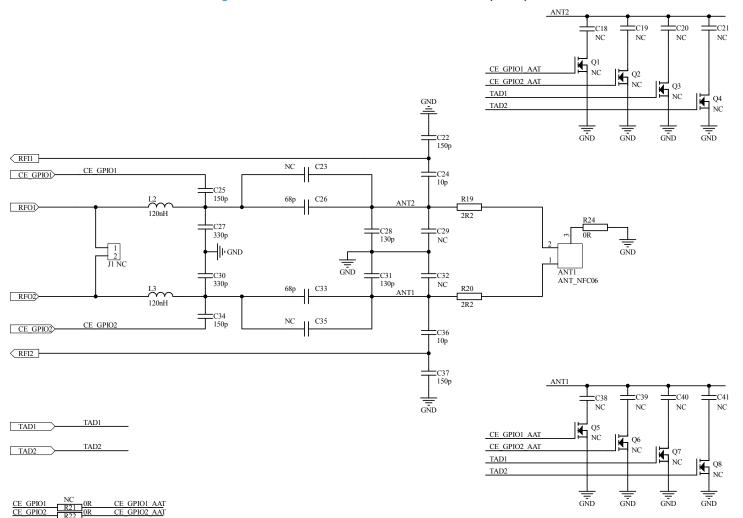
4 Schematic diagrams

Figure 3. X-NUCLEO-NFC12A1 circuit schematic (1 of 3)

Figure 4. X-NUCLEO-NFC12A1 circuit schematic (2 of 3)

ST25R300 HF Reader

Figure 5. X-NUCLEO-NFC12A1 circuit schematic (3 of 3)

5 Bill of materials

Table 3. X-NUCLEO-NFC12A1 bill of materials

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
1	5	C1, C5, C9, C11, C13	2u2	2u2_X5R	Murata	GRM155R60J225ME01D
2	2	C2, C8	100n	100n_X7R	Murata	GCM155R71H104KE02J
3	2	C3, C15	1u	1u_X5R	MURATA	GRM155R61C105KA12D
4	5	C4, C10, C12, C14, C16	10n	10n_x7R	AVX	04023C103KAT2A
5	2	C6, C7	12p	12p_COG	Murata	GCM1555C1H120FA16D
6	1	C17	47n	47n_X7R	Murata	GCM155R71E473KA55D
7	2	C18, C38	6p8	6.8p_COG	Murata	GCM1555C1H6R8BA16D
8	2	C19, C39	12p	12p_COG	Murata	GCM1555C1H120FA16D
9	2	C20, C40	27p	27p_COG	Murata	GCM1555C1H270FA16D
10	2	C21, C41	68p	68p_COG	Murata	GRT1555C1H680FA02J
11	2	C22, C37	150p	150p_COG	Murata	GCM1555C1H151FA16D
12	2	C23, C35	100p	100p_COG	Murata	GCM1885C2A101FA16D
13	2	C24, C36	10p	10p_COG	Murata	GCM1555C1H100FA16D
14	2	C25, C34	150p	150p_COG	KEMET	C0603C151F5GACTU
15	2	C26, C33	68p	68p_COG	KEMET	C0603C680F1GACTU
16	2	C27, C30	330p	330p_COG	YAGEO	CC0603FRNPO9BN331
17	2	C28, C31	130p	130p_COG	KEMET	C0603C131F5GACTU
18	2	C29, C32	6p8	6.8p_COG	KEMET	C0603C689J5GACTU
19	1	CN5		Header, 10-Pin, Single row,female	Samtec	SSQ-110-03-L-S
20	2	CN6, CN9		Header, 8-Pin, Single row,female	Samtec	SSQ-108-03-L-S
21	1	CN8		Header, 6-Pin, Single row,female	Samtec	SSQ-106-03-L-S
22	1	L1			muRata	BLM15EG121SH1D
23	2	L2, L3	LQW18CNR27J0ZD		Murata	LQW18CNR12J0ZD
24	6	LED1, LED2, LED3, LED4, LED5, LED6			Lite-On	LTST-C190TBKT
25	1	LED7			Lite-On	LTST-C190KGKT
26	2	P1, P2		U.FL-R-SMT-1	HIROSE(HRS)	U.FL-R-SMT-1(10)
27	8	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8		nCh MOS Fet	Diodes Incorporated	BSS123WQ-7-F
28	7	R1, R2, R3, R4, R5, R6, R16	1k	1k, 0402	Panasonic	ERJ2GEJ102X
29	1	R7	680R	680R, 0402	Yageo	RC0402JR-07680RL

Item	Q.ty	Ref.	Part/Value	Description	Manufacturer	Order code
30	8	R8, R9, R10, R11, R12, R18, R23, R24	0R	0R, 0402	VISHAY	CRCW04020000ZSTD
31	4	R21, R22, R14, R15	0R	0R, 0402	VISHAY	CRCW04020000ZSTD
32	1	R13	18k	18k, 0402	MULTICOMP	MCWR04X1802FTL
33	1	R17	330k	330k, 0402	VISHAY	CRCW0402330KFKED
34	2	R19, R20	2R2	2R2, 0603	Vishay Dale	CRCW06032R20FKEA
35	18	ST1, ST2, ST3, ST4, ST5, ST6, ST7, ST8, ST9, ST10, ST11, ST12, ST13, ST14, ST15, ST16, ST18, ST20		CONN HE14 2PTS MALE VERTICAL NOT FITTED		
36	1	U1	ST25R300-AQET QFN32	HF Reader IC QFN32	ST	ST25R300-AQET
37	1	X1		Tactile Switches WS-TASV Tact Switch	Wurth Elektronik	435151014845
38	1	Y1		NX2016SA-27.12MHZ-EXS00A-CS01188	NDK	CS01188-27.12M

6 Board versions

Table 4. X-NUCLEO-NFC12A1 versions

PCB version	Schematic diagrams	Bill of materials
XN$NFC12A1A [1]	XN$NFC12A1A schematic diagrams	XN$NFC12A1A bill of materials

1. This code identifies the X-NUCLEO-NFC12A1 expansion board first version. It is printed on the board PCB.

7 Regulatory compliance information

Notice for US Federal Communication Commission (FCC)

Part 15.19

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Part 15.21

Any changes or modifications to this equipment not expressly approved by STMicroelectronics may cause harmful interference and void the user's authority to operate this equipment.

Part 15.105

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.

- Increase the separation between the equipment and receiver.

- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

- Consult the dealer or an experienced radio/TV technician for help.

Notice for Innovation, Science and Economic Development Canada (ISED)

FCC ID: YCPNFC12A1

This device complies with Innovation, Science and Economic Development Canada's license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation. This device contains license-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's license-exempt RSS(s). Operation is subject to the following two conditions:

(1) This device may not cause interference.

(2) This device must accept any interference, including interference that may cause undesired operation of the device.

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

1) L'appareil ne doit pas produire de brouillage;

2) L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Notice for the European Union

The X-NUCLEO-NFC12A1 is in conformity with the essential requirements of the Directive 2014/53/EU (RED) and of the Directive 2015/863/EU (RoHS). Applied harmonized standards are listed in the EU Declaration of Conformity.

Notice for United Kingdom

The X-NUCLEO-NFC12A1 is in compliance with the UK Radio Equipment Regulations 2017 (UK SI 2017 No. 1206 and amendments) and with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 (UK SI 2012 No. 3032 and amendments). Applied standards are listed in the UK Declaration of Conformity.

Revision history

Table 5. Document revision history

Date	Revision	Changes
29-Apr-2025	1	Initial release.

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