ST25R3911B-15
NFC Reader product presentation

www.st.com/st25r

November 2018
The ST25R family is an integrated reader IC for contactless applications with several benefits:

- **Outstanding analog performance**
  - No external amplifier required to achieve high field strength
  - Automatic antenna tuning
  - Low power wakeup
  - Excellent P2P interoperability

- **Fast time to market**
  - EMVCo, NFC Forum, ISO, and MISRA-C:2012 compliant SW library
  - Single SW library for all products
  - Full integration into STM8 and STM32 eco system

- **Proven solution**
  - Market proven solution in the consumer and automotive space
  - Ensures best customer experience
Main Markets

Payment
- Faster EMVCo certification
- Reduced BOM

Access
- Low power wake-up
- Works in metal housing

Automotive
- Works in metal environment
- Allows small antenna design

Gaming
- Power for special features
- Drives multiple antennas

Transport
- High phone compatibility
- Fast, reliable reads

eGovernment
- Fast transaction time with big data
- Drives multiple antennas
Key Use Cases
NFC for payment

Payments & Home Banking

Today’s Mobile POS versions (mPOS) let small businesses and individuals support cashless transactions with minimal investment.

Enhanced user experience

NFC lets you do more than just process payments, it allows to collect data from the customer’s smartcard or smartphone.
NFC for Access control

Smart locks
NFC-enabled smartphone/device can be used to configure the lock, to grant temporary access to friends, visitors, maintenance or cleaning.

Hotel access
Hotel guests can gain quicker access to their rooms from by just tapping their card or NFC phone/device to the lock.
NFC for Metering

**Payment**

Easy upload and readout of credits

Touch to pay, no manual entry of coupons needed

**Setup and Settings**

Configuration and setup of meter units

Contactless transfer of data, e.g. for calibration

**Diagnostics**

No physical connections anymore

Safe diagnostic readout with any mobile device
NFC for connected homes

Pay per view

Easy payment of streaming services

Tap your NFC smartphone for configuring, while authentication feature let you safely access your online accounts, gaming, or social media.

Second screen & remote UI

NFC: quick and secure pairing to any connected device
With just a tap to a router the secure key is exchanged. Tapping a TV will turn your Phone into a second screen.

life.augmented
NFC for Entertainment

Gaming

Figurines come to life and connect to your games, powered by NFC
Add new powers or weapons, and store experience in the figurine.
Battery less figurines can interact with the player as the entire power is provided by the NFC field
NFC for Automotive

Car access
Convenient access to the car and online distribution of keys to NFC enabled phones

Personal Settings
Just sit in, and the entire cockpit will fit your wishes. Your NFC phone will securely pair with your car!

Diagnostics
No physical connection required anymore for car diagnostics,
ST25R Product ID cards
## ST25R3911B NFC / RFID Reader

### High-Performance NFC Forum Reader

#### Use cases
- Ideal for the traditional POS **Payment** applications
- Gaming, eGovernment passport

#### Key Features
- NFC Forum compliant Reader device with P2P
- 1.4W output power at 5V
- **EMVCo** & **PBOC** certification without external power amplifier
- Automatic Antenna Tuning
- **VHBR** support up to 6.8Mb/s
- **-40°C** to **125°C** temperature range

#### Key Benefits
- Low power operation & Standby mode (capacitive wake-up)
- Works in challenging environment
- Enhanced fast transfer rate for Passport application

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<table>
<thead>
<tr>
<th>ST25R3911B</th>
<th>ISO14443</th>
<th>RAM BUFFER</th>
<th>SPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reader Writer</td>
<td>ISO15693</td>
<td>2.4/5.5V</td>
<td>6Mb/s</td>
</tr>
<tr>
<td>AP2P PP2P*</td>
<td>FeliCa</td>
<td>96-Byte</td>
<td></td>
</tr>
<tr>
<td>1.4W</td>
<td>6.8Mb/s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Initiator only

- **VHBR:** Very High Baud Rate
- **DPO:** Dynamic Power Output
- **AAT:** Automatic Antenna Tuning
- **CIWU:** Capacitive & Inductive Wake Up

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**QFN32**

**Wafer**
## ST25R3912/13 NFC / RFID Reader

### Mid-Range NFC Forum Reader

### Use cases
- Ideal for **Payment** applications such as *small handheld mPOS*
- Access Control, Gaming, Qi charge protection & authentication

### Key Features
- NFC Forum compliant Reader device with active P2P
- **1W** output power at 5V
- *EMVCo & PBOC* certification without external power amplifier
- Automatic Antenna Tuning (3913 only)
- Small 3x2.8mm **WLCSP** package (3912 only)
- -40°C to **125°C** temperature range

### Key Benefits
- Small Footprint on PCB
- Low power operation & Standby mode
- Support market Standard Crypto

### ST25R3912/13

<table>
<thead>
<tr>
<th>Reader Writer</th>
<th>ISO14443</th>
<th>RAM BUFFER</th>
<th>SPI</th>
</tr>
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<tbody>
<tr>
<td><strong>AP2P</strong></td>
<td>ISO15693</td>
<td>96-Byte</td>
<td>2.4/5.5V</td>
</tr>
<tr>
<td><strong>PP2P</strong></td>
<td>FeliCa</td>
<td></td>
<td>6Mb/s</td>
</tr>
<tr>
<td><strong>1W</strong></td>
<td>848kb/s</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*AP2P* and *PP2P* are *initiator only*.

- **QFN32**
- **WLCSP**

*DPO: Dynamic Power Output*

*AAT: Automatic Antenna Tuning (3913)*

*IWU: Inductive Wake Up*
ST25R3914/15 NFC / RFID Reader
Automotive Grade NFC Forum Reader

Use cases
- Ideal for **Automotive** applications
  - Digital Key for entry, start and driver authentication
  - Pairing, data transfer, in car payment
  - NFC enhanced protection for Qi wireless charging

Key Features
- **Automotive AEC-Q100 grade 1** certified
- **1W** output power at 5V
- Automatic Antenna Tuning (3914 only)
- **-40°C to 125°C** temperature range

Key Benefits
- Low power operation & Standby mode (capacitive wake-up)
- Reliable performance even in metallic environment
- MISRA-C:2012 compliant SW library

<table>
<thead>
<tr>
<th>ST25R3914/15</th>
<th>Reader Writer</th>
<th>AP2P PP2P*</th>
<th>ISO14443 ISO15693 FeliCa</th>
<th>RAM BUFFER</th>
<th>SPI</th>
</tr>
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<tr>
<td><strong>1W</strong></td>
<td><strong>96-Byte</strong></td>
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<td><strong>848kb/s</strong></td>
<td><strong>6Mb/s</strong></td>
<td></td>
</tr>
</tbody>
</table>

AECQ: AEC-Q100 Grade 1 qualification
DPO: Dynamic Power Output
AAT: Automatic Antenna Tuning (3914)
CIWU: Capacitive & Inductive Wake Up

*Initiator only

QFN32
QFN32 Wetable flank

848kb/s
2.4/5.5V
6Mb/s

848kb/s
2.4/5.5V
6Mb/s

QFN32 QFN32 Wetable flank
# ST25R HF Readers

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>High-Perf Reader &amp; NFC initiator for Payment / Passport applications</strong></td>
<td>ISO14443A/B</td>
<td>ISO14443A/B</td>
<td>ISO14443A/B</td>
<td>ISO14443A/B</td>
<td>ISO14443A/B</td>
</tr>
<tr>
<td><strong>Reader/Writer mode</strong></td>
<td>ISO15693</td>
<td>ISO15693</td>
<td>ISO15693</td>
<td>ISO15693</td>
<td>ISO15693</td>
</tr>
<tr>
<td><strong>Card emulation mode</strong></td>
<td>FeliCa</td>
<td>FeliCa</td>
<td>FeliCa</td>
<td>FeliCa</td>
<td>FeliCa</td>
</tr>
<tr>
<td><strong>P2P mode</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>RF speed</strong></td>
<td>6.8Mbps (VHBR)</td>
<td>848kbps</td>
<td>848kbps</td>
<td>848kbps</td>
<td>848kbps</td>
</tr>
<tr>
<td><strong>Market certification</strong></td>
<td>Payment (EMVco, PBOC, mini-pay)</td>
<td>Payment (EMVco, PBOC, mini-pay)</td>
<td>Payment (EMVco, PBOC, mini-pay)</td>
<td>Automotive</td>
<td>Automotive</td>
</tr>
<tr>
<td><strong>Advanced features</strong></td>
<td>AAT, DPO, Cap &amp; Ind wake-up</td>
<td>DPO, Ind wake-up</td>
<td>AAT, DPO, Ind wake-up</td>
<td>AAT, DPO, Cap &amp; Ind wake-up</td>
<td>DPO, Cap &amp; Ind wake-up</td>
</tr>
<tr>
<td><strong>Interface</strong></td>
<td>SPI 6Mbps</td>
<td>SPI 6Mbps</td>
<td>SPI 6Mbps</td>
<td>SPI 6Mbps</td>
<td>SPI 6Mbps</td>
</tr>
<tr>
<td><strong>Power supply</strong></td>
<td>2.4V – 5.5V</td>
<td>2.4V – 5.5V</td>
<td>2.4V – 5.5V</td>
<td>2.4V – 5.5V</td>
<td>2.4V – 5.5V</td>
</tr>
<tr>
<td><strong>Output power</strong></td>
<td>1.4W</td>
<td>1.0W</td>
<td>1.0W</td>
<td>1.0W</td>
<td>1.0W</td>
</tr>
<tr>
<td><strong>Temperature range</strong></td>
<td>-40°C to +125°C</td>
<td>-40°C to +125°C</td>
<td>-40°C to +125°C</td>
<td>-40°C to +125°C</td>
<td>-40°C to +125°C</td>
</tr>
<tr>
<td><strong>Package</strong></td>
<td>32-pin QFN (5x5mm) / Wafer</td>
<td>32-pin QFN / WF 32-pin QFN (5x5mm) / WLCSP</td>
<td>32-pin QFN / WF 32-pin QFN (5x5mm)</td>
<td>32-pin QFN / WF 32-pin QFN (5x5mm)</td>
<td>32-pin QFN / WF 32-pin QFN (5x5mm)</td>
</tr>
</tbody>
</table>

**Notes:**
- VHBR: Very High Baud Rate
- P2P: Peer to Peer mode
- AAT: Automatic Antenna Tuning
- DPO: Dynamic Power Output
- Cap & Ind wake-up: Capacitive & Inductive wake-up
- Cap & Ind wake-up: Capacitive & Inductive wake-up
ST25R features
AAT: Automatic Antenna Tuning

- AAT increases Range & Field strength
  - AAT increases the range of an HF reader in bad environmental conditions and sustains maximum output power to the field with best efficiency

- AAT compensates for environment
  - Automatic antenna tuning analyses the phase shift of the antenna and retunes automatically

- AAT reduces production cost
  - The antenna can be tuned with an automatic procedure during production to fine adjust the design to different housings.

- Multiple Tag placement
  - Multiple tags in the field can be compensated to transfer a maximum of power for each.
AAT: How to implement

There are two possibilities to implement AAT on ST25R3911B

• HW based with the chip internal algorithm
• SW based, optimized for maximum amplitude

While the HW based algorithm is fixed the SW based algorithm can be altered to certain needs if required.

In general tuning the Antenna is done in the following steps:

• Measure the antenna
  • D3 Measure Amplitude
• Adjust the antenna
  • Antenna Calibration register 21h-23h
  • This registers will dis/connect the capacitors connected to the TRIMx_x pins and therefore change the impedance of the antenna.
AAT: When to implement

AAT can be used at any given timeframe by using the calibrate antenna D8 command. In terms of usability there are certain aspects where AAT has the highest benefits: Tuning of the

- module after production
- system during startup/shutdown
- antenna in continuous mode

At what times can AAT be used looking at the standard:

- As part of the polling loop
- Before communication/transaction
AAT: During polling loop

AAT after a H-field switch on as part of the polling loop:

- Listen before talk
- Switch on unmodulated alternating H-field until settled
- Execute AAT
- Emit unmodulated H-field
- Poll for cards in the operating volume, e.g. REQA,…

It is allowed to do AAT after the alternating H-field is switched on and settled. There are no further restrictions.
DPO: Dynamic Power, Gain & Squelch

- Achieve min/max power limits easier
  - The ST25R series allows to adjust the output power dynamically via Dynamic Power Output

- Optimal performance from weak to strong card response
  - ST25R series allows to adopt to different power level of card responses via Active Gain Control

- Improved noise immunity
  - Squelch feature allows to scale the signal level to have improved immunity against noise
Automatic modulation depth adjustment

• for ISO14443B and ISO15693
  • ISO14443B: ASK 10% modulation index
  • ISO15693: 10-30%, 100% modulation index

• Automatic modulation depth adjustment keeps the modulation index within standard limits even under varying load conditions

• Cheaper components with higher tolerances can be used
Highest Output Power & Efficiency

• No external Booster required for POS
  • The ST25R391x includes low impedance drivers capable of generating >1.4W of output power
  • EMVCo certification easily possible without external boosters

• Maximum transferred Power
  • “Slave” devices like interface tags are able to harvest far more energy for battery less devices
  • Ideal for sophisticated NextGen Gaming platforms

• Ideal for Challenging Environment
  • The ST25R series is able to operate in metal encapsulations like doorlocks
Low Power Wakeup

- Internal wakeup circuitry
  - The ST25R series includes a fully programmable wakeup scheme. All relevant parameters like cycle time & sensitivity can be programmed.
  - No MCU required to run the wakeup; Capacitive & Inductive wakeup can be serially combined for sophisticated wakeup scripts

- Capacitive wakeup
  - ST25R series with this feature can detect capacitive changes. E.g. the approach of a hand.

- Inductive wakeup
  - The inductive wakeup detects changes in the antenna system caused e.g. by an approaching card
General wakeup functions

• **Timer period**
  - Time in which the IC stays in Sleep mode before checking if a card is present.
  - Can be set from 10 to 800ms in 16 steps

• **Delta (window size)**
  - Allows to set the sensitivity of the wakeup
  - Can be set from 1 to 15 steps of a difference considering the 256 steps of the 8bit ADC

• **Auto averaging**
  - Allows to make the wakeup system more noise immune or to compensate for slow environmental changes.
  - Can be set to average over the last 4/8/16/32 values

• **Automatic reference measurement**
  - Allows to measure the actual environmental influence to the capacitive sensor or the antenna
  - This value is used to calibrate the wakeup system at system start or at any required time
Inductive Wakeup

- **Sleep/Wake up-Mode (10-800ms)**
  - IC will remain in low power wakeup mode before checking for a card ~3.6mAh

- **XTAL startup (1ms)**
  - Time for starting the external oscillator. ~5.4mAh

- **Actual measurement (20μs)**
  - The inductive wakeup is dedicated to detect approaching cards only ~8.7mAh + ITX
Capacitive Wakeup

• Sleep/Wakeup-Mode (10-800ms)
  • IC will remain in low power wakeup mode before checking for a capacitive change. ~3.6µA

• Actual measurement (200µs)
  • The capacitive wakeup will be triggered by any capacitive change, e.g. the approach of a hand. 1.1mA
Very High Baud Rate (VHBR) technology allows the exchange of large amounts of data between a contactless smart card and a reader. Faster data rates create potential for new applications of NFC.

ST25R3911B supports VHBR communication without additional external components.

- **Ideal for eGovernment & Passport**
  - The ST25R3911B increases the maximum bitrate from 848kBit to 6.8Mbit
  - **8x less** transfer time reduces waiting time at boarder control and allows to increase data on eGovernment/Healthcare cards (e.g. high-res images)
The ST25R series allows to drive two single ended antennas or one differential antenna. Address 00h is used for configuration.

For single ended antennas bit 7 must be 1. Bit 6 then allows to switch between the antenna ports.

- Driving two independent antennas
- Less field strength than a differential antenna

On fully differential antennas bit 7 must be 0. bit 6 is a “don’t care”.

- Achieve the maximum field strength possible
- Less sensitive to noise, e.g. GND bounce.
The ST25R family is an integrated reader IC for contactless applications with several benefits:

- **Outstanding analog performance**
  - No external amplifier to achieve high field strength required
  - Automatic antenna tuning
  - Lowest power wakeup
  - Excellent P2P compatibility

- **Fastest time to market**
  - Reduced time to market at our customers significantly

- **Proven solution**
  - The ST25R family is a market proven solution used in the consumer and automotive space.
  - Ensures best customer experience

- **Full integration into the STM32 library**
ST25R Series Benefits

• Outstanding analog performance
  • No external amplifier to achieve high field strength required
  • Automatic antenna tuning
  • Lowest power wakeup
  • Excellent P2P compatibility

• Fastest time to market
  • reduced time to market at our customers significantly

• Proven solution
  • The ST25R family is a market proven solution used in the consumer and automotive space.
  • Ensures best customer experience

• Full integration into the STM32 library
ST25R - Blocks
Functional Overview

Transmitter

• The transmitter incorporates drivers that drive external antenna through pins RFO1 and RFO2. Single sided and differential driving is possible. The transmitter block additionally contains a sub-block that modulates transmitted signal (OOK or configurable AM modulation).

• The ST25R3911B transmitter is intended to directly drive antennas (without 50Ω cable, usually antenna is on the same PCB). Operation with 50Ω cable is also possible, but in that case some of the advanced features are not available.

Receiver

• The receiver detects transponder modulation superimposed on the 13.56 MHz carrier signal. The receiver contains two receive chains (one for AM and another for PM demodulation) composed of a peak detector followed by two gain and filtering stages and a final digitizer stage.

• The filter characteristics are adjusted to optimize performance for each mode and bit rate (with sub-carrier frequencies up to 6.8 MHz).

• The receiver chain inputs are the RFI1 and RFI2 pins. The receiver chain incorporates several features that enable reliable operation in challenging phase and noise conditions.
Phase and amplitude detector

The phase detector is observing the phase difference between the transmitter output signals (RFO1 and RFO2) and the receiver input signals (RFI1 and RFI2). The amplitude detector is observing the amplitude of the receiver input signals (RFI1 and RFI2) via self-mixing. The amplitude of the receiver input signals (RFI1 and RFI2) is directly proportional to the amplitude of the antenna LC tank signal.

The phase detector and the amplitude detector can be used for the following purposes:

- **Doing PM demodulation** by observing RFI1 and RFI2 phase variation
- **Checking average phase** difference between RFOx pins and RFIx pins and optimize antenna tuning
- **Measure amplitude of signal** present on RFI1 and RFI2 pins is used to check and optimize antenna tuning.
A/D converter

- The ST25R3911B contains a built-in Analog to Digital (A/D) converter. Its input can be multiplexed from different sources and is used in several applications (measurement of RF amplitude and phase, calibration of modulation depth...). The result of the A/D conversion is stored in the A/D Converter Output Register and can be read via SPI.

Capacitive Sensor

- The capacitive sensor is used to implement low power detection of transponder presence, it measures the capacitance between two copper patches connected to the CSI and CSO pins. The capacitance changes with the presence of an object (card, hand). During calibration the reference capacitance (representing parasitic capacitance of the environment) is stored. In normal operation the capacitance is periodically measured and compared to the stored reference value, if the measured capacitance differs from the stored reference value by more than a register defined threshold, then an interrupt is sent to the external controller.
External field detector

- The External field detector is a low power block used in NFC mode to detect the presence of an external RF field. It supports two different detection thresholds, Peer Detection Threshold and Collision Avoidance Threshold. The Peer Detection Threshold is used in the NFCIP-1 target mode to detect the presence of an initiator field, and is also used in active communication initiator mode to detect the activation of the target field. The Collision Avoidance Threshold is used to detect the presence of an RF field during the NFCIP-1 RF Collision Avoidance procedure.

Quartz crystal oscillator

- The quartz crystal oscillator can operate with 13.56 MHz and 27.12 MHz crystals. At start-up the trans conductance of the oscillator is increased to achieve a fast start-up. The start-up time varies with crystal type, temperature and other parameters, hence the oscillator amplitude is observed and an interrupt is sent when stable oscillator operation is reached.
- The use of a 27.12 MHz crystal is mandatory for VHBR operation.
The ST25R3911B is a slave device and the external microcontroller initiates all communication. Communication is performed by a 4-wire Serial Peripheral Interface (SPI).

- The ST25R3911B sends an interrupt request (pin IRQ) to the microcontroller, which can use clock signal available on pin MCU_CLK when the oscillator is running.

### SPI general timing

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Parameter</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
<th>Comments</th>
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<tr>
<td>T_{SOH}</td>
<td>SCLK period</td>
<td>167</td>
<td>-</td>
<td>-</td>
<td>ns</td>
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<tr>
<td>T_{SCLL}</td>
<td>SCLK low</td>
<td>70</td>
<td>-</td>
<td>1</td>
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<td></td>
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<tr>
<td>T_{SCLH}</td>
<td>SCLK high</td>
<td>70</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
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<tr>
<td>T_{SSRH}</td>
<td>SPI reset (SS high)</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>ns</td>
<td>Use of shorter SCLK period may lead to incorrect FIFO operation.</td>
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<tr>
<td>T_{SSGL}</td>
<td>/SS falling to SCLK rising</td>
<td>25</td>
<td>-</td>
<td>-</td>
<td>ns</td>
<td>First SCLK pulse</td>
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<td>T_{SSFL}</td>
<td>SCLK falling to /SS rising</td>
<td>300</td>
<td>-</td>
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<td>ns</td>
<td>Last SCLK pulse</td>
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<td>T_{DS}</td>
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<tr>
<td>T_{DH}</td>
<td>Data in hold time</td>
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<td>-</td>
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<td>T_{OD}</td>
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<td>-</td>
<td>ns</td>
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<tr>
<td>T_{ODHZ}</td>
<td>Data out to high impedance delay</td>
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<td>20</td>
<td>-</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>
Communication with external MCU

**Writing data** to addressable registers (Write mode)

- After the SPI operation mode bits, the address of register to be written is provided.
- Then one or more data bytes are transferred from the SPI, always from the MSB to the LSB. The data byte is written in register on falling edge of its last clock.

**Reading data** from addressable registers (Read mode)

- After the SPI operation mode bits the address of register to be read has to be provided from the MSB to the LSB.
- Then one or more data bytes are transferred to MISO output, always from the MSB to the LSB. As in case of the write mode also the read mode supports auto-incrementing address.
- MOSI is sampled at the falling edge of SCLK (like shown in the following diagrams), data to be read from the ST25R3911B internal register is driven to MISO pin on rising edge of SCLK and is sampled by the master at the falling edge of SCLK.
ST25R – Support material
ST25R support eco-system

Documentation

Antenna Design & Application Notes

Eval Board

Schematic, BOM, Gerber

e2e community

PC SW tools

MCU drivers (FW)
ST25R3911B-DISCO

The ST25R3911B-DISCO consists of the ST25R3911B high performance reader frontend controlled by an STM32L476 ultra-low-power ARM Cortex-M4 MCU with 512Kbytes flash. It connects via USB to a Windows PC and can be controlled via the ST25R3911B GUI.

Features:

• Onboard 105 mm x 52 mm, two turn antenna
• Connection point for external antennas
• Reader/Writer modes supported
• RF communication
  • ISO14443 A/B including VHBR
  • ISO15693
  • ISO18092 (P2P, NFCIP-1)
  • FeliCa
• Free comprehensive development library
• Free Schematics, Layout, and Gerber files available
• FCC/CE certified
X-NUCLEO-NFC05A1

The X-NUCLEO-NFC05A1 is a Nucleo shield based on the ST25R3911B high performance reader frontend. With its Arduino U3 connector it fits to the STM32 Nucleo, Raspberry Pi and other platforms.

Features:

- Onboard 47mm x 34mm, four turns antenna
- Connection point for external antennas
- Reader/Writer modes supported
- RF communication
  - ISO14443 A/B including VHBR
  - ISO15693
  - ISO18092 (P2P, NFCIP-1)
  - FeliCa
- Free comprehensive development library
- Free Raspberry Pi Linux driver
- Free Schematics, Layout, and Gerber files available
- FCC/CE certified
Solutions for NFC / RFID Tags and Readers

ST25
Simply
More Connected