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SPRINGCARD RFID+NFC SCANNERS - K663/RDR

Configuration and Software Guide

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Contents

1. Introduction

1.1. Abstract

SpringCard K663/RDR is a OEM RFID and NFC reader. It reads a serial number or virtually any data coming from standards ISO/IEC 14443 proximity cards, ISO/IEC 15693 vicinity labels or tags.

It is also able to fetch NDEF data from RFID chips formatted according to one the NFC Forum Tag specifications, and to receive NDEF data from a NFC Forum “peer-to-peer” (SNEP server on top of LLCP).

This document provides all necessary information to configure the **K663/RDR** and to develop a software that will receive the data coming from the reader.

1.2. Supported products

The **K663/RDR** is the core of **SpringCard RFID+NFC Scanner** family. All products in this family are configured and used the say way as **K663/RDR** itself, and therefore are covered by this document.

At the time of writing, this document refers the products listed below:

- **K663S/RDR**: OEM reader module without antenna designed for balanced (symmetrical) antenna,
- **K663A/RDR**: OEM reader module without antenna designed for unbalanced (asymmetrical) antenna,
- **K663-TTL/RDR:** OEM reader with antenna, featuring a serial interface at TTL/CMOS level,
- **K663-232/RDR**: OEM reader with antenna, featuring a RS-232 serial interface,
- **K663-485/RDR**: OEM reader with antenna, featuring a RS-485 serial interface,
- **Prox'N'Drive/RDR**: reader for in-vehicle applications (automotive, trains, trucks).

1.3. Audience

This manual is designed for use by application developers and system integrators. It assumes that the reader has a good knowledge of computer development and a good knowledge of the RFID/NFC technologies.

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1.4. Support and updates

Useful related materials (product datasheets, application notes, sample software, HOWTOs and FAQs…) are available at SpringCard's web site:

www.springcard.com

Updated versions of this document and others are posted on this web site as soon as they are available.

For technical support enquiries, please refer to SpringCard support page, on the web at

www.springcard.com/support

2. Serial communication – Getting started

The Reader's serial port is able to operate into 3 modes:

- The MK1 serial protocol,
- The MK2 serial protocol,
- The Console mode.

Choosing between MK1 and MK2 protocols is decided by a Configuration Register (and therefore can't be changed until the Reader is reset).

The Console mode is entered at any time by sending

```
[ESC][ESC]shell[CR][LF]
```

as depicted later on.

2.1. Physical layer

2.1.1. Electrical levels

The hardware layer depends on the underlying hardware:

- **TTL/CMOS** level for **K663S/RDR**, **K663A/RDR** and **K663-TTL/RDR**,
- **RS-232** level for **K663-232/RDR** and **Prox'N'Drive/RDR**,
- **RS-485** level for **K663-485/RDR**.

2.1.2. Communication parameters

The default communication parameters are:

- Baudrate = 38400bps,
- 8 data bits,
- 1 stop bit,
- no parity,
- no flow control.

The baudrate could be changed by changing the Configuration Register SER ($_h$67, see § 7.4.1). The other parameters are fixed.

2.2. Validating your hardware integration

The easiest way to test your installation is to use a **terminal emulation software** running on a desktop or laptop computer. Popular terminal emulation software are **HyperTerminal** on Microsoft Windows, and **minicom** on Linux.

> *Only the K663-232/RDR version could be connected directly to a computer's RS-232 port. For RS-TTL and RS-485 versions, you will need a hardware interface between the computer's port and the Reader.*

Open your terminal emulation software, set the communication parameter as specified above, and reset the Reader.

You must see the Reader's startup string (§ Erreur : source de la référence non trouvée).

Enter the string “info” (without the quotes), and hit the ENTER key. The Reader sends its information data in response.

If one of those two tests fails, please double-check your hardware (wiring, power supply...) and the port number you've selected on the computer.

2.3. Used ASCII characters

The constants used in the following paragraphs are specified in the ASCII standard:

ASCII constant	Hex value	Description
[STX]	$_h$01	Start of header
[STX]	$_h$02	Start of text
[ETX]	$_h$03	End of text
[ACK]	$_h$06	Positive acknowledge
[BEL]	$_h$07	Bell or ring
[TAB]	$_h$09	Horizontal tabulation
[LF]	$_h$0A	Line feed
[CR]	$_h$0D	Carriage return
[NAK]	$_h$15	Negative acknowledge
[ESC]	$_h$1B	Escape

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2.4. MK1 or MK2 protocol?

2.4.1. Which protocol shall you use?

The MK1 serial protocol is very simple and “human-readable”. This protocol is made for 1-to-1, peer-to-peer communication. It doesn't provide any kind of collision avoidance or collision detection feature, and therefore its reliability on a RS485 link is poor.

On the over hand, the MK2 protocol is a Master / Slave protocol designed for reliability and performance (collision avoidance, error detection and recovery, strict timings). This makes it the only choice every time more than one Reader must be connected to one Host.

2.4.2. Enabling MK1 protocol

To enable the MK1 protocol, assign the value $_h$0D to Configuration Register OPT ($_h$60) and h00 to Configuration Register SHD ($_h$68).

Using the Console (see below), this is done by sending

```
        [ESC][ESC]cfg60=0D[CR][LF]
```

and

```
        [ESC][ESC]cfg68=00[CR][LF]
```

2.4.3. Enabling MK2 protocol

To enable the MK2 protocol, assign the value $_h$0C to Configuration Register OPT ($_h$60).

Using the Console (see below), this is done by sending

```
        [ESC][ESC]cfg60=0C[CR][LF]
```

The MK2 protocol needs an address for the Reader. This address must be written into Configuration Register SHD ($_h$68).

For instance, if the Address is $_h$17, using the Console (see below), this is done by sending

```
        [ESC][ESC]cfg68=17[CR][LF]
```

Don't forget to assign a different address to every reader connected on the same RS-485 bus.
All the Readers come out of factory with the address $_h$00. It is a good practice to assign only non-zero addresses, so the Host may accept a new Reader at any time and send a configuration command to the address $_h$00 assign a new address to this very Reader.

2.5. READER'S CONSOLE

The Reader features a “human” command processor (shell or console). This feature is primarily made for testing and demonstration purpose. Only the few commands depicted in this chapter could safely be used for configuration and diagnostic.

2.5.1. Sending a Console command to the Reader

> *The Reader must be configured for the MK1 serial protocol in order to accept a Console command.*

Enter “info” to verify that the Reader is actually configured for MK1 protocol and that your communications parameters are correct. If not, go back to § 2.2.

If the Reader answers, you're now ready to communicate with it using the commands listed below.

> *Note that the Reader does not echo the entered characters; you should activate the local echo in your terminal-emulation software to see what you are typing.*
> *The Reader accepts any end-of-line marker: [CR] alone, [LF] alone as well as [CR][LF] are valid.*

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2.5.2. List of Console commands

Command	Meaning
`version`	Show the firmware version
`info`	Show the firmware information data
`show`	Show the current configuration
`cfg`	Dump all Configuration Registers written into persistent memory
`cfgXX=YY...YY`	Write value ${}_{h}$YY...YY to Configuration Register ${}_{h}$XX
`cfgXX=!!`	Erase Configuration Register ${}_{h}$XX
`cfgXX`	Read Configuration Register ${}_{h}$XX
`shell`	Enable the Console (suppress the need to send ESCAPE twice before the commands). This is permanent until next reset, or until the **exit** command is invoked.
`exit`	Leave the Console (send ESCAPE twice to before next Console commands)
`echo on`	Turn echo ON
`echo off`	Turn echo OFF

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3. MK1 serial protocol

3.1. Abstract

The MK1 serial protocol is very simple and "human-readable": the Reader sends a frame every-time it "sees" a card, and the Host sends short commands whenever it wants to drive the Reader's LED or buzzer.

This protocol is made for 1-to-1, peer-to-peer communication. It doesn't provide any kind of collision avoidance or collision detection feature, and therefore its reliability on a RS485 link is poor. Prefer the MK2 serial protocol whenever it is possible to implement it in the host.

3.2. Physical layer

Please refer to § 2.1.

3.3. Reader → Host notifications

3.3.1. Startup string

When configured to use the MK1 serial protocol, upon startup, the reader sends its name and version, for instance

```
SpringCard K663/RDR 1.63
```

If addressing is enabled in SHD register (§ 7.4.2), the startup string also tells the reader's address, for instance,

```
SpringCard K663/RDR 1.63 ADR=9
```

The startup string is always terminated by `[CR][LF]` (carriage-return, line-feed).

The host application may ignore the content of the startup string, but shall wait for the [CR] [LF] sequence that terminates it before sending any command to the reader. Any character coming over the serial line before the end of the startup string will be discarded.

3.3.2. Notification when a card is read

When a card is discovered, the Template System (see chapter 8) is invoked and returns a small piece of data, which is the actual Card Identifier seen by the Reader (it could be either a serial number or some data coming from the card's internal memory – this depends on the Template involved). Normally (when the Template is well-configured for the given card), the Card Identifier is a sequence of numbers or letters according to the ASCII charset.

The Card Identifier is transmitted by the reader over the serial link as follow:

```
<BEGIN SEQUENCE><PREFIX><CARD IDENTIFIER><SUFFIX><END SEQUENCE>
```

Where

- PREFIX and the SUFFIX fields are defined in the Template (and may used to know whether the card obeys to one template or to another)
- BEGIN SEQUENCE and END SEQUENCE fields are configured by bits 7-5 of Register SER (§ 7.4.1). If addressing is enabled in Configuration Register SHD ($_h$69, see § 7.4.2) then the BEGIN SEQUENCE also includes the Reader's address.

a. Frame format without address

If Configuration Register SHD ($_h$69) is equal to $_h$00, addressing is disabled, and the BEGIN/END SEQUENCE fields are configured as follow:

Bits 7-6-5 in SER	BEGIN SEQUENCE	END SEQUENCE	Example with tag's data string = “ABC1234”
000	*(empty)*	*(empty)*	ABC1234
001	*(empty)*	[CR][LF]	ABC1234[CR][LF]
010	[BEL]	[CR][LF]	[BEL]ABC1234[CR][LF]
011	[TAB]	[CR][LF]	[TAB]ABC1234[CR][LF]
100	[STX]	[ETX]	[STX]ABC1234[ETX]
101	[STX]	[ETX][CR][LF]	[STX]ABC1234[ETX][CR][LF]
110	[BEL][STX]	[ETX][CR][LF]	[BEL][STX]ABC1234[ETX][CR][LF]
111	[TAB][STX]	[ETX][CR][LF]	[TAB][STX]ABC1234[ETX][CR][LF]

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b. Frame format without address

If Configuration Register SHD ($_h$69) is different from $_h$00, addressing is enabled, and the BEGIN/END SEQUENCE fields are configured as follow:

Bits 7-6-5 in SER	BEGIN SEQUENCE	END SEQUENCE	Example with tag's data string = “ABC1234” and address = 9
000	*Address* '>'	*(empty)*	9>ABC1234
001	*Address* '>'	[CR][LF]	9>ABC1234[CR][LF]
010	[BEL] *Add.* '>'	[CR][LF]	[BEL]9>ABC1234[CR][LF]
011	[TAB] *Add.* '>'	[CR][LF]	[TAB]9>ABC1234[CR][LF]
100	[SOH] *Add.* [STX]	[ETX]	[SOH]9[STX]ABC1234[ETX]
101	[SOH] *Add.* [STX]	[ETX][CR][LF]	[SOH]9[STX]ABC1234[ETX][CR][LF]
110	[BEL][SOH] *Add.* [STX]	[ETX][CR][LF]	[BEL][SOH]9[STX]ABC1234[ETX][CR][LF]
111	[TAB][SOH] *Add.* [STX]	[ETX][CR][LF]	[TAB][SOH]9[STX]ABC1234[ETX][CR][LF]

> *Note: Address is a value between $_h$0 and $_h$F, i.e. it appears as an ASCII character between '0' and '9' or 'A' and 'F'.*

c. Default configuration

The default configuration is

- BEGIN SEQUENCE = [BEL][STX]
- END SEQUENCE = [ETX][CR][LF]

Alter Configuration Register SER ($_h$67) to change the configuration (see § 7.4.1)

3.3.3. Host's ACK

It is recommended that the Host sends the ASCII “Acknowledge” character ($_h$06) after receiving a valid Card Identifier.

[ACK]

3.4. Host → Reader commands (and Reader's ACK)

3.4.1. Command/response sequences

The Host may send any of the commands listed in § 3.4.3. The command frame has no prefix, and is terminated by `[CR][LF]`:

```
<COMMAND>[CR][LF]
```

3.4.2. Reader's ACK

When a valid command is received from the Host, the Reader sends the ASCII “Acknowledge” character ($_h$06) within 50ms.

```
[ACK]
```

When an invalid command is received or a communication error occurs, the Reader sends the ASCII “Not Acknowledge” character ($_h$15) within 100ms after having detected the error.

```
[NAK]
```

3.4.3. List of commands

Command	Meaning
A0	Stop Reader (RF field OFF, no activity on the RF interface)
A1	Start Reader
R0	Red LED is switched OFF
R1	Red LED is switched ON
R2	Red LED blinks slowly
R3	Red LED blinks quickly
G0	Green LED is switched OFF
G1	Green LED is switched ON
G2	Green LED blinks slowly
G3	Green LED blinks quickly
Z0	Buzzer stops
Z1	Buzzer starts
Z2	Short buzzer sound
Z3	Long buzzer sound
C	Clear LED / buzzer (same as sending R0, G0, Z0)

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4. MK2 serial protocol – Low layers

To be written.

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5. MK2 serial protocol – Application layer

To be written.

6. Editing Reader's configuration

The Reader's configuration is stored in a set of non-volatile Configuration Registers. There are two groups of Registers:

- The Registers that control the behaviour of the Reader are fully documented in chapter 7. Some of them are common to various SpringCard Readers, but some of them are very specific to the **SpringCard K663/RDR**.
- The Registers that control the Template System are shared among all SpringCard Readers. Chapter 8 is therefore a place-holder that redirects to the document describing this Template System precisely.

But this subtle distinction between these two groups is only there to keep the documents short, and to ease switching from one Reader to the other. Technically speaking, all Registers are defined (and accessed) the same way.

There are two ways to edit the Reader's Configuration Registers:

1. Through the serial link, using the Console,
2. Using a Master Card.

6.1. Through the serial link

Enter the Console by sending `[ESC][ESC]shell[CR][LF]` as instructed in § 2.5.

6.1.1. Reading Configuration Registers

Enter "`cfg`" to list all Configuration registers currently defined (registers that are not explicitely defined keep their default value).

Enter "`cfg`XX" to read the value of the Configuration register $_h$XX, from $_h$01 to $_h$FE.

Note that Configuration registers that hold sensitive data (the keys used by Master Cards and the Reader's pin-code for instance) are masked by 'X' characters when read-back.

6.1.2. Writing Configuration Registers

Enter “cfgXX=YYYY” to update Configuration Register $_h$XX with value $_h$YYYY. YYYY can have any length between 1 and 32 bytes.

Enter “cfgXX=!!” to erase Configuration Register $_h$XX.

6.2. Using a Master Card

The Master Cards are NXP Desfire cards formatted and programmed by **SpringCard Configuration Tool (ScMultiConf.exe, ref # SN14007)** for Windows.

Please refer to this software's documentation for details.

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7. Global configuration of the Reader

7.1. General options

Name	Tag	Description	Size
OPT	$_h$60	General option, see table below	1

General options bits

Bits	Value	Meaning
7	0	Normal mode
	1	Power saving mode[1]
6	0	Shutdown RF field when idle
	1	Shutdown RF field only when no card detected[2]
		Anti-collision model :
5-4	00	Process every card one after the other
	01	*RFU*
	10	When 2 cards are in the field, process the 1st and ignore the 2nd
	11	When 2 cards are in the field, ignore both
		Master Card :
3-2	00	Master Cards are disabled[3]
	01	Master Cards are enabled at power up
	10	*RFU*
	11	Master Cards are enabled all the time
		Output interface[4] :
1 - 0	00	serial duplex (RS-TTL, RS-232, USB …) reader
	01	serial half-duplex (RS-485) reader
	10	*RFU*
	11	*RFU*

Default value: $_b$00001101

(Master Cards are enabled all the time, RS-485)

[1] When this value is selected, the card detection loop runs only every 250ms. In the meantime, RC chipset is OFF to reduce average power consumption. Do not choose this mode if you need fast operation at the gates, since it will increase transaction time at least by 250ms.

[2] This is required if strict anti-collision (bits 5-4 = $_b$10 or $_b$11) is needed.

[3] Configuration settings can only be altered through serial link.

[4] Actual RS-232, RS-422, RS-TTL or USB compliance depends on external/optional hardware.

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7.2. Delays and repeat

Name	Tag	Description	Min	Max
ODL	$_h$61	Min. delay between 2 consecutive outputs (0.1s)	0	100
RDL	$_h$62	Min. delay between 2 consecutive identical outputs (0.1s) A value of 255 means that the card must be removed from the field –and re-inserted into– before being read again	0	100

Default value: ODL = 5 (1ms) RDL = 20 (2s)

7.3. LEDs and Buzzer (if provided by the hardware)

Name	Tag	Description	Size
CLD	$_h$63	LEDs control, see table below	1

LEDs control bits

Bits	Value	Meaning
7	0	Short LED sequences (3 seconds)
	1	Long LED sequences (10 seconds)
6	0	*RFU (set to 0)*
5	0	When idle, red LED blinks slowly (“heart beat” sequence)
	1	When idle, red LED is off
4	0	Green LED stays OFF
	1	Green LED blinks when a valid card has been processed
3	0	Red LED stays OFF
	1	Red LED blinks when an unsupported card has been processed
2	0	Green LED stays OFF
	1	Green LED blinks as soon as a card is seen in the field
1 - 0	11	*RFU (set to 11)*

Default value: $_b$00001111

7.4. Serial communication

7.4.1. Baudrate and frame format

Name	Tag	Description	Size
SER	$_h$67	Serial configuration bits. See table a below	1

Serial configuration bits

Bits	Value	Meaning
7	0	No STX / ETX frame markers
	1	Use STX and ETX as frame markers
6 - 5	00	No BEL / TAB / CR/LF frame markers
	01	Use CR/LF only
	10	Use BEL and CR/LF as frame markers
	11	Use TAB and CR/LF as frame markers
		Serial Repeat
4 - 3	00	No repeat
	01	Repeat 4 times with timeout of 100ms (Host must send an ACK to cancel)
	10	Repeat 4 times with timeout of 250ms (Host must send an ACK to cancel)
	11	Repeat 9 times with timeout of 250ms (Host must send an ACK to cancel)
		Baudrate
2 - 0	000	1200bps
	001	2400bps
	010	4800bps
	011	9600bps
	100	19200bps
	101	38400bps
	110	RFU
	111	115200bps

Default value: $_b$11000101

> *NB: bits 7-3 are ignored when the MK2 protocol is selected, but the Baudrate configuration is shared among both protocols (and among the Console too).*

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7.4.2. Addressing

Name	Tag	Description	Size
SHD	$_h$68	Reader address	1

RS-485 configuration bits

Bits	Value	Meaning
7 - 4		*RFU*
3 - 0	0000	Addressing disabled (single device on bus)
	0001 to 1110	Address = $_h$01 ($_d$1) to address = $_h$0E ($_d$14)
	1111	*RFU*

Default value: $_b$00000000

8. The Template System

SpringCard K663/RDR provides 4 “Card Processing Templates” that defines how the Reader which fetch data from various cards/tags, and how the Card Identifier will be constructed from these data before being sent to the Host.

The template system is fully described in document # **PMA13205 “Readers / RFID Scanners Template System**”.

Please use this document as reference to configure the “Reader part” of your **SpringCard K663/RDR.**

9. 3rd-party licenses

SpringCard K663/RDR has been developed using open-source software components.

9.1. FreeRTOS

FreeRTOS is a market leading real time operating system (or RTOS) from Real Time Engineers Ltd. **SpringCard K663/RDR** runs on FreeRTOS v7.5.2.

FreeRTOS is distributed under a modified GNU General Public License (GPL) that allows to use it in commercial, closed-source products.

For more information, or to download the source code of FreeRTOS, please visit

www.freertos.org

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