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## **SPRINGCARD K663**

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### **Hardware integration guide**

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## 1. INTRODUCTION

### 1.1. ABSTRACT

**SpringCard K663** is an OEM RFID and NFC reader module. The **K663** OEM module is ideal for integration in any industrial or embedded system.

This document provides all necessary information to integrate the **K663** OEM module in your design and take benefit from all its features.

### 1.2. PRODUCT IDENTIFICATION

2 hardware versions of the **K663** OEM module exist:

- **K663S** ' output is balanced (symmetrical) so it could drive a **directly-matched, balanced antenna**. The distance between the module and the antenna shall not exceed 20cm.
- **K663A** features a 50Ω-matched unbalanced (asymmetrical) output, optimized to drive a **50Ω-matched unbalanced antenna**. The connexion between the module and the antenna shall use a **50Ω coaxial cable**, up to 2m. For a distance shorter than 25cm, a twisted pair may be used instead of the coaxial cable.

### 1.3. RELATED DOCUMENTS

Editor	Doc #	Description
SpringCard		<i>To be done</i>

### 1.4. IMPORTANT – READ ME FIRST

#### 1.4.1. Antenna design

The **K663** OEM module needs an external antenna to work as a contactless (RFID / NFC) coupler. The antenna has to be designed carefully for the target module (symmetrical for **K663S**, asymmetrical for **K663A**) and depending on your own specifications (size constraints, expected operating distance), but flexibility is limited to some extent due to the requirements of the ISO standards and the EMC regulations.

**SpringCard** engineers have a strong experience in antenna design. Do not hesitate to consult us any time you need a custom design.

We also offer **ready-to-use couplers**, featuring the **K663** module mounted on an antenna (**K663-TTL, K663-232**).

Please visit [www.springcard.com/products](http://www.springcard.com/products) for an up-to-date list.

## 1.5. AUDIENCE

This manual is designed for use by electronic hardware integrators. It assumes that the reader has expert knowledge of digital electronics.

## 1.6. SUPPORT AND UPDATES

Related documentation (e.g. product datasheets, application notes, sample software, HOWTOs and FAQs...) is available at SpringCard's web site:

[www.springcard.com](http://www.springcard.com)

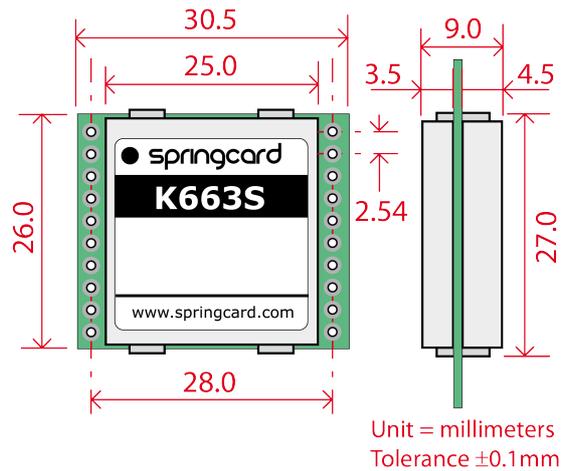
Updated versions of this document and others are posted on this web site as soon as they are available.

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

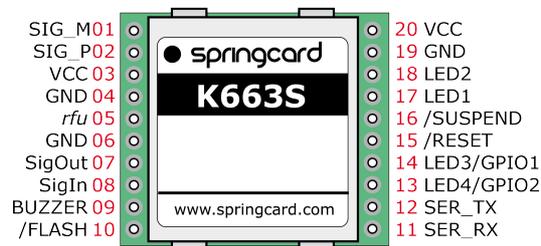
[www.springcard.com/support](http://www.springcard.com/support)

## 2. HARDWARE AND PINOUT – K663S

### 2.1. DIMENSIONS



### 2.2. PINOUT



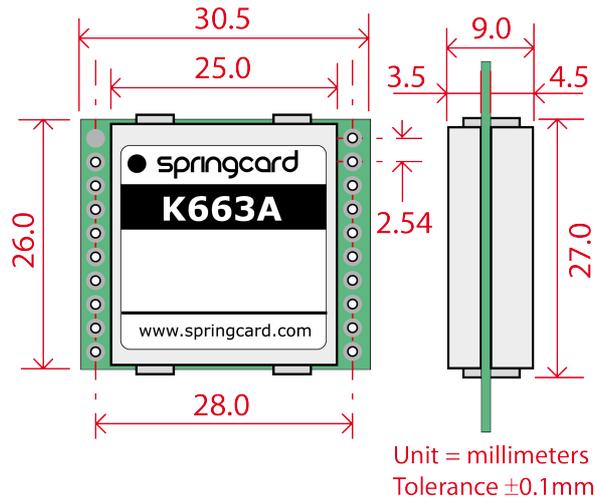
**Table 2: pinout details for K663S**

PIN	NAME	Type	Description	Remark	See §
1	SIG_M	Analog	Symmetric antenna		6.1
2	SIG_P	Analog	Symmetric antenna		6.1
3	VCC	Power	Power supply		5.1.1
4	GND	Ground	Ground		
5	RFU	N/A		Leave unconnected	
6	GND	Ground	Ground		
7	SIG_OUT	OUT	CLRC663's SIG_OUT pin	Leave unconnected	
8	SIG_IN	IN	CLRC663's SIG_IN pin	Leave unconnected	
9	BUZZER	OUT	Buzzer output		
10	/FLASH	IN	Firmware upgrade	Internal pull-up	8
11	SER_RX	IN	Serial port – host to K663	<b>External pull-up required</b>	5.4
12	SER_TX	OUT	Serial port – K663 to host		5.4
13	/LED4	OUT	LED 4	<i>BLUE</i>	5.2
14	/LED3	OUT	LED 3	<i>YELLOW</i>	5.2
15	/RESET	IN	K663 reset	Internal pull-up	5.1.2
16	/SUSPEND	IN	K663 suspend	Internal pull-up	5.1.3
27	/LED1	OUT	LED 1	<i>RED</i>	5.2
28	/LED2	OUT	LED 2	<i>GREEN</i>	5.2
29	GND	Ground	Ground		
30	VCC	Power	Power supply		5.1.1

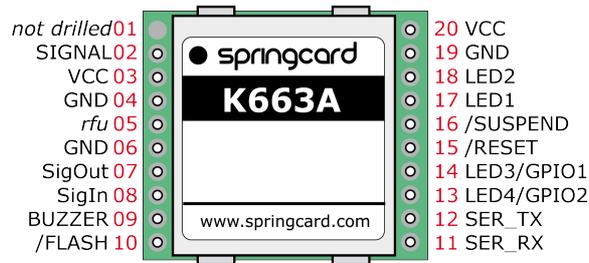
**NB:** for correct operation, all VCC pins shall be connected to power supply, and all GND pins shall be connected to ground.

### 3. HARDWARE AND PINOUT - K663A<sup>1</sup>

#### 3.1. DIMENSIONS



#### 3.2. PINOUT



<sup>1</sup> Note that in a most situations, K663A could be used as drop-in replacement for earlier K531 or K632.

**Table 1: pinout details for K663A**

PIN	NAME	Type	Description	Remark	See §
1				Hole not drilled	
2	SIGNAL	Analog	50Ω unbalanced antenna		7.1
3	VCC	Power	Power supply		5.1.1
4	GND	Ground	Ground		
5	RFU	N/A		Leave unconnected	
6	GND	Ground	Ground		
7	SIG_OUT	OUT	CLRC663's SIG_OUT pin	Leave unconnected	
8	SIG_IN	IN	CLRC663's SIG_IN pin	Leave unconnected	
9	BUZZER	OUT	<i>To be done</i>		
10	/FLASH	IN	Firmware upgrade	Internal pull-up	8
11	SER_RX	IN	Serial port – host to K663	<b>External pull-up required</b>	5.4
12	SER_TX	OUT	Serial port – K663 to host		5.4
13	/LED4	OUT	LED 4	<i>BLUE</i>	5.2
14	/LED3	OUT	LED 3	<i>YELLOW</i>	5.2
15	/RESET	IN	K663 reset	Internal pull-up	5.1.2
16	/SUSPEND	IN	K663 suspend	Internal pull-up	5.1.3
17	/LED1	OUT	LED 1	<i>RED</i>	5.2
18	/LED2	OUT	LED 2	<i>GREEN</i>	5.2
19	GND	Ground	Ground		
20	VCC	Power	Power supply		5.1.1

**NB:** for correct operation, all VCC pins shall be connected to power supply, and all GND pins shall be connected to ground.

## 4. ELECTRICAL CHARACTERISTICS

### 4.1. ABSOLUTE MAXIMUM RATINGS

Stresses beyond those listed under ‘Absolute Maximum Ratings’ may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these conditions is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

SYMBOL	Parameter	Min	Max	Unit
VCC <sub>ABS</sub>	DC supply voltage with respect to ground	-0.3	6.0	V
V <sub>IN,ABS</sub>	Voltage to any pin with respect to ground	-0.3	VCC+0.3	V
I <sub>OUT,ABS</sub>	Total DC output current on all I/O pins		200	mA
I <sub>SIGNAL PEAK</sub>	Peak current delivered by the SIGNAL pin		200	mA
T <sub>STORAGE</sub>	Storage temperature	-20	+70	°C

### 4.2. OPERATING CONDITION RANGE

SYMBOL	Parameter	Condition	Min	Typ	Max	Unit
T <sub>OPERATION</sub>	Operating temperature		-20	+25	+70	°C
VCC	Supply voltage		3.0	5.0	5.5	V
ICC	Power supply current	Soft power down			6	mA
		RF field OFF		30	35	
		RF field ON <sup>2</sup>		150	250	

<sup>2</sup> The antenna has a strong impact on the current consumed by the module. Typical value is observed with SpringCard’s reference antenna (§ 4.6.2) correctly tuned.

### 4.3. INPUT PIN CHARACTERISTICS

Pins RX, /SUSPEND, /RESET, /FLASH, /WAKEUP and /GPIOx (when configured as input) have TTL input characteristics.

SYMBOL	Parameter	Min	Max	Unit
$V_{IL}$	LOW-level going threshold		0.8	V
$V_{IH}$	HIGH-level going threshold	2.0		V
$I_{LEAK}$	Input leakage current		4	$\mu$ A

### 4.4. OUTPUT PIN CHARACTERISTICS

Pins TX, /ANT\_SEL, /LEDx, and /GPIOx (when configured as output) have TTL output characteristics.

SYMBOL	Parameter	Min	Max	Unit
$V_{OL}$	Output LOW-level		0.4	V
$V_{OH}$	Output HIGH-level	2.4		V
$I_O$	Output current source or sink		4	mA

## 5. INTEGRATION GUIDE

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### 5.1. GENERAL

*To be written*

*This schematic depicts a K663A but also applies to K663S in all aspects but the link to the antenna (same pinout but pins 1 & 2).*

100nF decoupling capacitors (C5 and C6 on the above schematic) shall be placed as close as possible to pins #3 and #4, #20 and #19, respectively.

#### 5.1.1. Power supply

Connect both VCC pins (#3 and #20) to the DC power supply (3 to 5V).

#### 5.1.2. Reset

The **K663** has its own reset supervisor. The /RESET pin (#15) shall be used only if a manual reset is needed. Otherwise, cycling the power is enough to ensure a proper reset of the module.

**Tip:** if you don't have to be able to reset the module externally, you may leave the /RESET pin unconnected.

When /RESET is set to LOW, the module's CPU stops. When /RESET is set to HIGH again, firmware execution restarts. Depending on the firmware release and the activated options, the module takes 10 to 50ms to be ready after a reset. The module is ready as soon as it sends its identifier "K663" on the serial line.

*Note that the /RESET pin has no effect on the RF front-end. If the RF field was ON before reset, it remains ON until the firmware instructs it to go OFF, or the module is powered down.*

### 5.1.3. Suspend mode (soft power down)

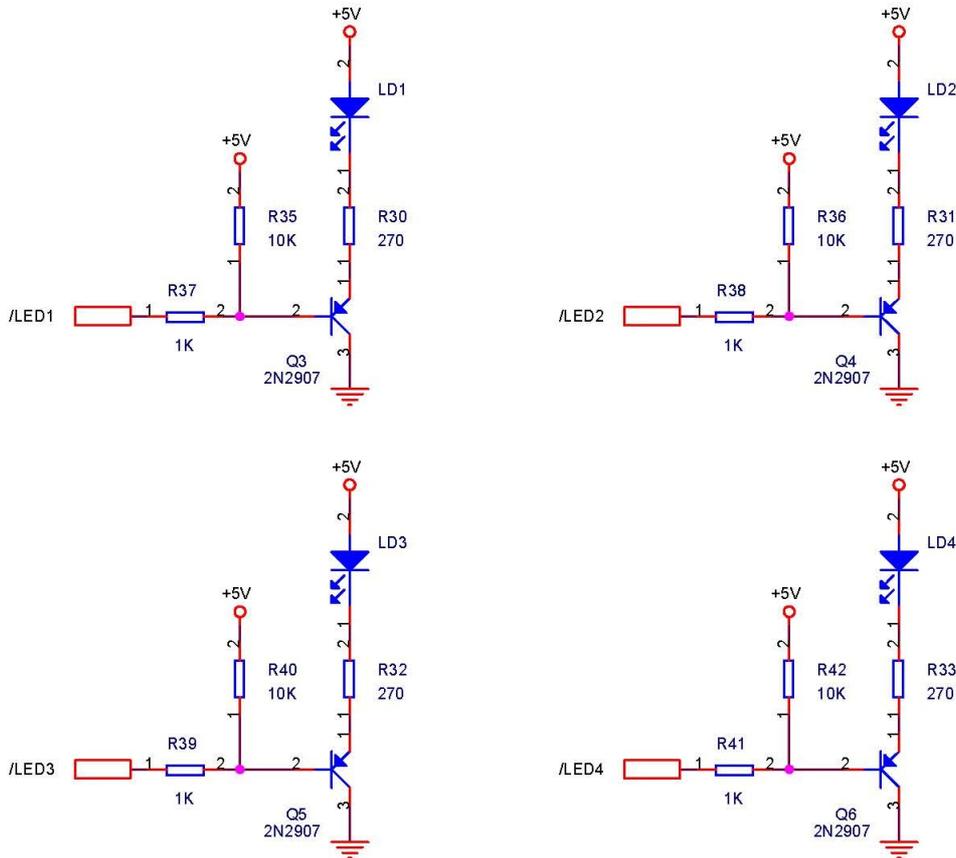
The /SUSPEND pin (#16) is intended to put the module in soft power down mode, to limit power consumption to a minimum.

When /SUSPEND is set to LOW, the RF field is shut down, the RF front-end and the smartcard interfaces are powered down and the internal clock slows down. The module stops listening to the serial interface.

When /SUSPEND state is set to HIGH again, firmware execution resumes after 1 to 10ms.

## 5.2. LED DRIVERS

**K663** LED output lines are active LOW and must be buffered to drive the LEDs. Use bipolar transistors, as follow:



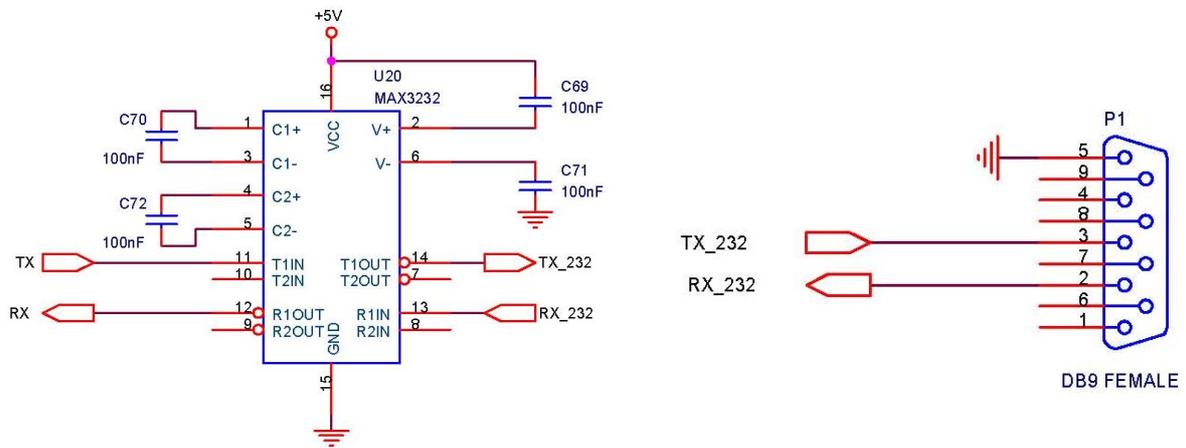
### 5.3. BUZZER

To be written

### 5.4. SERIAL INTERFACE

The K663 features a serial communication interface at TTL-level (CMOS tolerant).

Observe the following schematic to implement this interface according to RS-232 specifications (+12V/-12V, DB9 plug).



## 5.5. RECOMMENDED BOM

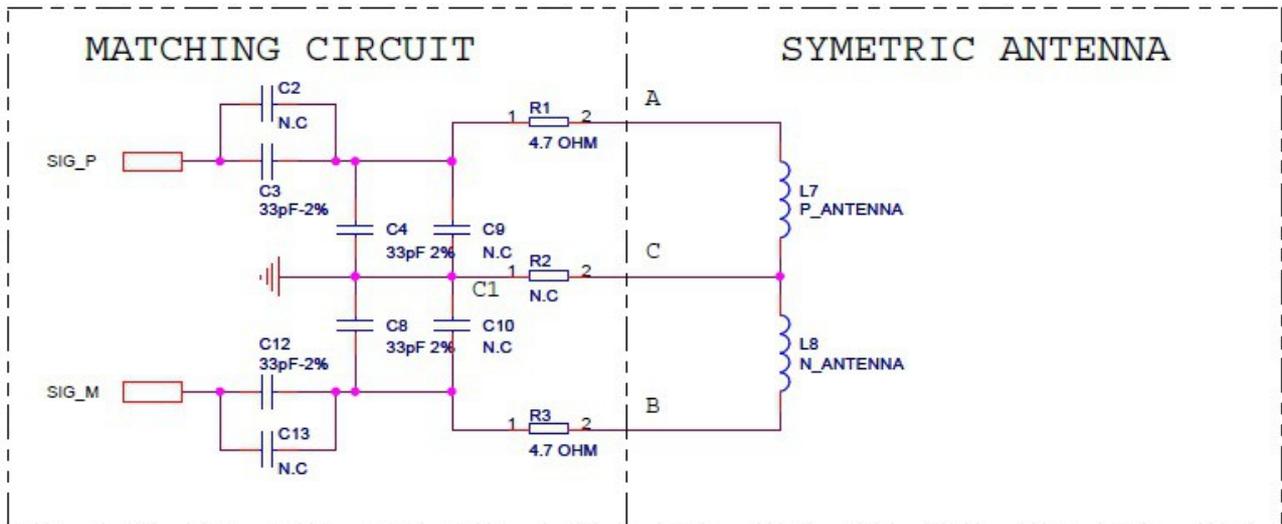
Component	Value	Tolerance	Recommended part #	Manufacturer
C11	10nF/25V	10%	2238-587-15636	PHYCOMP
C5, C6, C14, C69, C70, C71, C72	100nF/25V	10%	0402YD104KAT2A	AVX
C20, C22	15pF/50V	5%	2238-869-15159	PHYCOMP
C137	470pF/50V	10%	2238-587-15518	PHYCOMP
R20, R35, R36, R42	10K	5%	232270570103	PHYCOMP
R37, R38, R39, R41	1K	5%	232270570102	PHYCOMP
R30, R31, R32, R33	270	5%	232270260271	PHYCOMP
Q3, Q4, Q5, Q6			MMBT2907A	FAIRCHILD
L5			BLM41PG600SN1L	MURATA
L6	22nH	5%	NLV32T-022J-PF	TDK
L9			744231091	WURTH
D4			PRLL5817	NXP
F2	750mA		MINISMDC075F-2	TYCO
J2			U.FL-R-SMT-1(10)	HIROSE
J3			675031020	MOLEX
P1			D09P13A4GX00LF	FCI
U20			MAX3232CUE+	MAXIM

## 6. SYMMETRIC (BALANCED) ANTENNA (K663S)

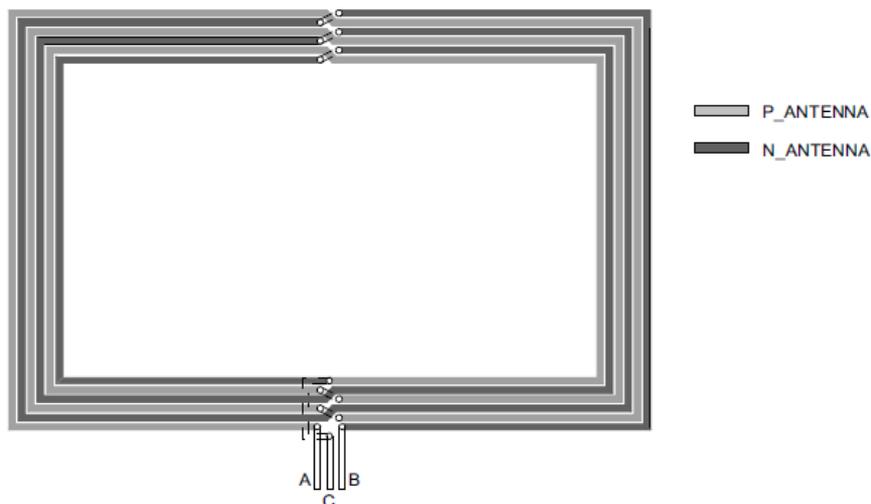
### 6.1. THE SIG\_P AND SIG\_M PINS

K663's SIG\_N pin (#1) and SIG\_P pin (#2) are designed to drive **balanced antenna**.

The antenna shall be connected to the module with 50mm maximum distance.



### 6.2. ANTENNA TOPOLOGY



### 6.2.1. Shielding

This antenna does not need ground plane protecting against H field like Unbalanced Antenna (see 6.2.2).

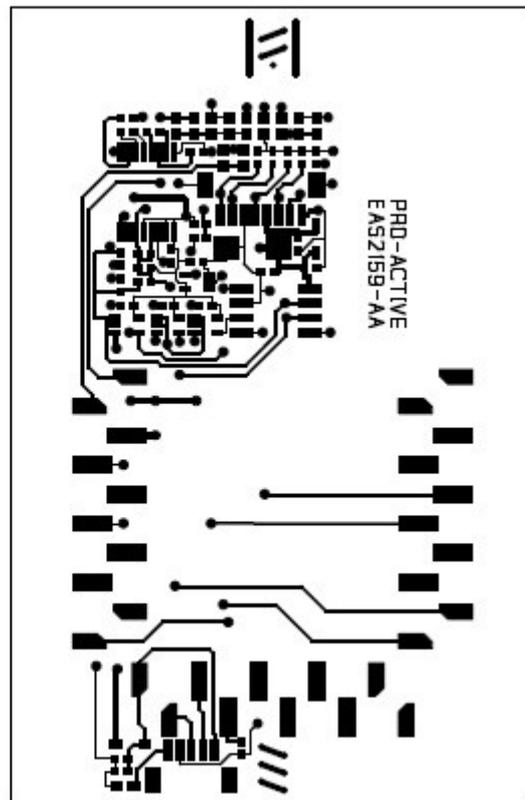
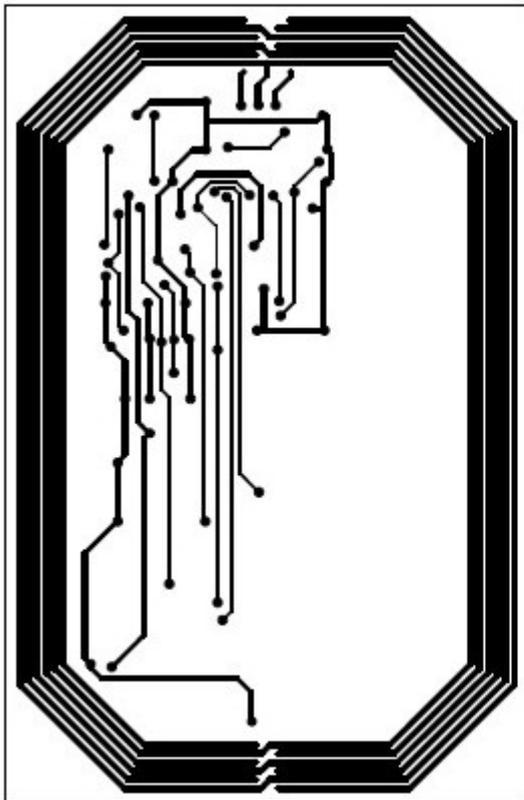
When P\_Antenna has positive H field emission, the N\_Antenna has an opposite H field emission, doing H fields vanish.

### 6.2.2. Matching and tuning circuit

This circuit has two roles:

- **Tune up** P\_antenna and N\_Antenna as a band-pass filter centred on 13.56MHz (C4, C9, C8, C10) with a **quality factor (Q)** of approx. 40 (R1, R3).
- **Match** P\_antenna and N\_Antenna to 100Ω (C2, C3, C12, C13).

### 6.3. ANTENNA REFERENCE



## 6.4. RECOMMENDED BOM

Component	Value	Tolerance	Recommended part #	Manufacturer
C2, C9, C10, C13	Unmounted			
R2	Unmounted			
C3, C12	33pF/100V	2%	06031U270GAT2A	AVX
C4,C8	12pF/100V	2%	06031U150GAT2A	AVX
R94	4,7	5%	232273464708	PHYCOMP

## 6.5. DESIGNING A CUSTOM ANTENNA

Designing an antenna for 13.56MHz RFID or NFC applications requires expertise and can't be improvised. A poorly designed antenna may be the cause of a too-short operating distance, 'holes' in the operating volume, excessive power consumption and overheating, damages in the module's output stage, non-compliance with ISO standards and EMC regulations.

As reference documentations, please refer to NXP (formerly Philips Semiconductors) application notes on the subject:

- **NXP AN 077925 : Directly matched antenna design**  
[http://www.nxp.com/documents/application\\_note/077925.pdf](http://www.nxp.com/documents/application_note/077925.pdf)
- **NXP AN 78010 : 13.56MHz RFID proximity antennas**  
[http://www.nxp.com/documents/application\\_note/78010.pdf](http://www.nxp.com/documents/application_note/78010.pdf)

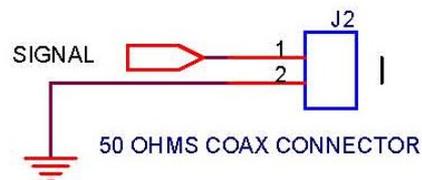
The RF chipset in **K663** is NXP CLRC663. Please take into account RC663's limiting characteristics. **SpringCard** engineers have a strong experience in antenna design. Do not hesitate to consult us any time you need a custom design.

## 7. ASYMMETRIC (BALANCED) ANTENNA (K663A)

### 7.1. THE SIGNAL PIN

K663's SIGNAL pin (#2) is designed to drive directly a **50Ω-matched, unbalanced antenna**. No external component is needed.

The antenna shall be connected to the module through a 50Ω coaxial cable (max recommended distance: 2m). Therefore, the SIGNAL pin shall be linked to a coaxial connector within the minimum distance.



When the distance between the module and the antenna is short enough (< 50mm), an unshielded twisted pair, or copper lines on the PCB could be used instead of the coaxial cable.

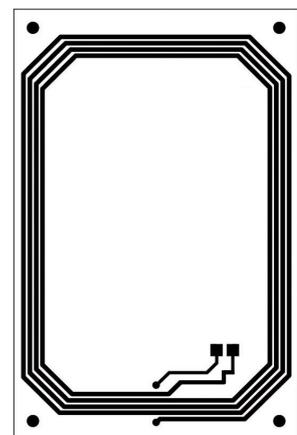
### 7.2. REFERENCE ANTENNA

We provide here as a reference the schematics and layout of **CrazyWriter's** standard antenna.

This antenna fits a 69 x 45 mm PCB, 1.6mm thick, with 2 copper layers: one for the antenna, the other for the EMC shielding.

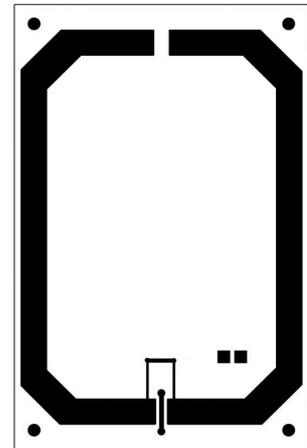
#### 7.2.1. Antenna loop

The antenna shall have an inductance between 300nH and 1.5μH. This gives us 4 turns in the available surface.



### 7.2.2. Shielding

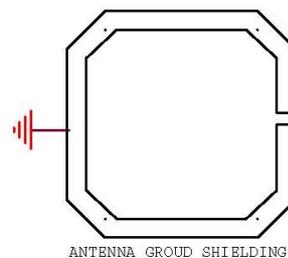
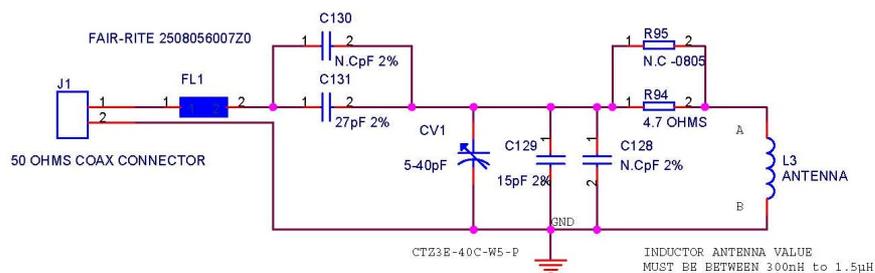
To comply with EMC regulations, the antenna shall be shielded to limit the radiated *E* field (only *H* field is useful in 'near field' communication). The shield is a large open loop, tied to Ground, on the opposite side of the active loop.



### 7.2.3. Matching and tuning circuit

This circuit has two roles:

- **Tune up** the antenna as a band-pass filter centred on 13.56MHz (C129, C128, CV1) with a **quality factor (Q)** of approx. 40 (R94, R95), and
- **Match** the antenna to 50Ω (C129, C130), so it can't be connected to **K663's** SIGNAL pin either directly or through a coaxial cable.



### 7.3. RECOMMENDED BOM

Component	Value	Tolerance	Recommended part #	Manufacturer
J1			U.FL-R-SMT-1(10)	HIROSE
C130, C1280	<i>Unmounted</i>			
R95	<i>Unmounted</i>			
C131	27pF/100V	2%	06031U270GAT2A	AVX
C129	15pF/100V	2%	06031U150GAT2A	AVX
R94	4,7	5%	232273464708	PHYCOMP
CV1	5-30pF		TZC3P300A110R00	MURATA
FL1			2508056007Z0	FAIR-RITE

### 7.4. DESIGNING A CUSTOM ANTENNA

Designing an antenna for 13.56MHz RFID or NFC applications requires expertise and can't be improvised. A poorly designed antenna may be the cause of a too-short operating distance, 'holes' in the operating volume, excessive power consumption and overheating, damages in the module's output stage, non-compliance with ISO standards and EMC regulations.

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- **NXP AN 78010 : 13.56MHz RFID proximity antennas**  
[http://www.nxp.com/documents/application\\_note/78010.pdf](http://www.nxp.com/documents/application_note/78010.pdf)

The RF chipset in **K663** is NXP CLRC663. Please take into account RC663's limiting characteristics. **SpringCard** engineers have a strong experience in antenna design. Do not hesitate to consult us any time you need a custom design.

## 8. FIRMWARE UPGRADE

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The /FLASH pin (#10) is intended to put the module in firmware upgrade mode. Set /FLASH to LOW and reset the module (or cycle power) to enter this mode.

*To be written*



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