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SpringCard CrazyWriter HSP

Hardware integration guide

www.springcard.com

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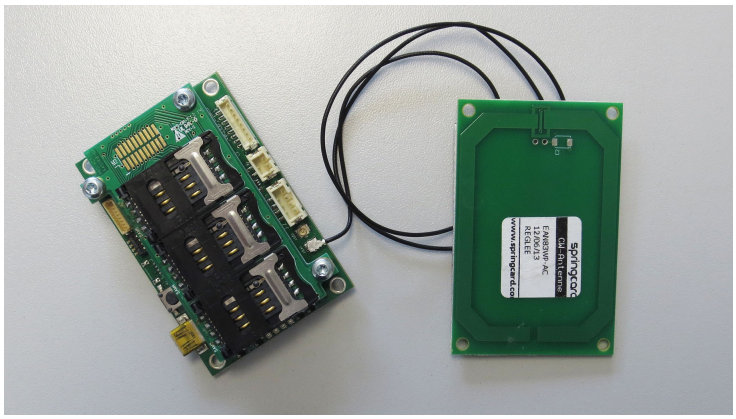

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1. Introduction

1.1. Abstract

SpringCard CrazyWriter HSP is a OEM PC/SC contactless and contact coupler. It is both a versatile RFID and NFC coupler, with 1 or 2 remote antennas, as well as a multi-slot smartcard reader, providing 1 or 4 SIM/SAM slots. The **CrazyWriter HSP** is ideal for integration in card printers, vending machines, kiosks...

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

1.2. Product identification

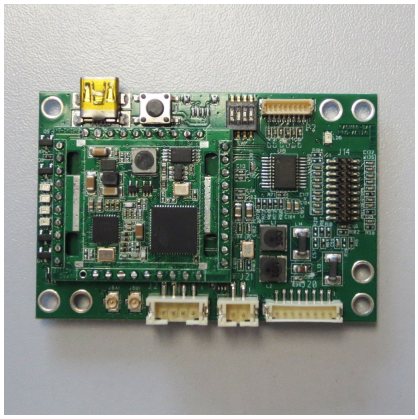
1.2.1. Main board

The **CrazyWriter HSP**'s main board is the product's core.

It is based the **SpringCard H663** PC/SC module, and holds 1 SAM slot.

There are two versions of the main board:

- The “standard” version has provision to accept a single antenna through a micro-coax connector.
- The Dual version has two micro-coax and is able to work with two antennas.



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1.2.2. Antenna and micro-coax cable

The **CrazyWriter HSP** comes with a remote antenna (two antennas for “Dual” version).

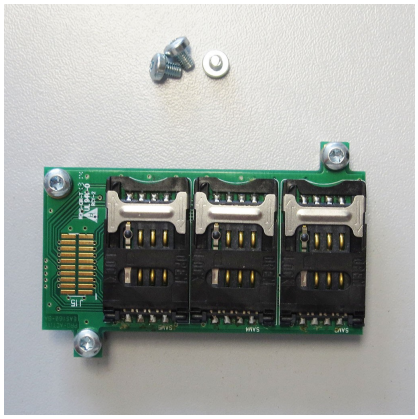
The antenna connects to the main board using a 50Ω -matched micro-coax cable. A 50cm cable is supplied with the standard antenna.

SpringCard *also offers custom antennas of various shapes or different sizes, as well as shorter or longer micro-coax cable. Don't hesitate to contact us should you need a specific hardware.*

1.2.3. 3 SAM slot expansion board

The **CrazyWriter HSP** 3 SAM expansion board is a daughter board to be mounted on top of the main board.

It brings the product to a total of 4 SIM/SAM slots.



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1.3. Product list

Product name	Order code	Description
CrazyWriter HSP	SC0168	Contact & contactless PC/SC OEM coupler with 1 x SAM + 1 x remote antenna (50Ω) with cable (50cm)
CrazyWriter HSP Dual	SC14148	Contact & contactless PC/SC OEM coupler with 1 x SAM + 2 x remote antennas (50Ω) with cables (2 x 50cm)
	SC0168	3 SAM expansion board for CrazyWriter HSP

1.4. Related documents

Editor	Doc #	Description
SpringCard	PMU14092	CrazyWriter HSP QuickStart Guide
SpringCard	PMD2271	H663 Group – Developer's reference manual

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1.5. Important – read me first

1.6. Audience

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

1.7. 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

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

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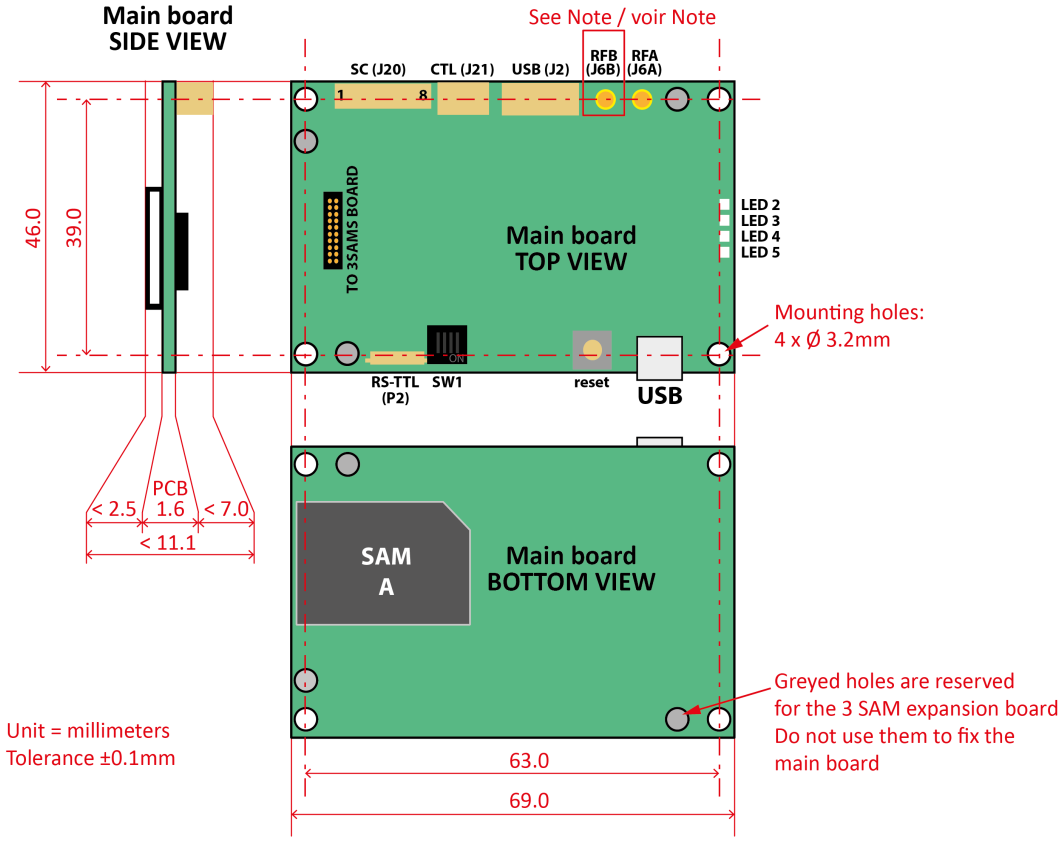
2. Main board

2.1. Reference drawings



Note: RFB (J6B) micro-coax connector is present only on **CrazyWriter HSP <u>Dual</u>**.

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2.2. Connectors and pinout

2.2.1. USB mini B (J3)

Use this connector to connect the **CrazyWriter HSP** to a computer's USB port, using a standard USB mini B cable.

Note: USB may also be connected using the J2 connector (§ 2.2.5).

DO NOT connect both USB connectors (J3 and J2) at the same time.

2.2.2. RS-TTL (P2)

This connector is used only in factory and for custom products. Leave unconnected.

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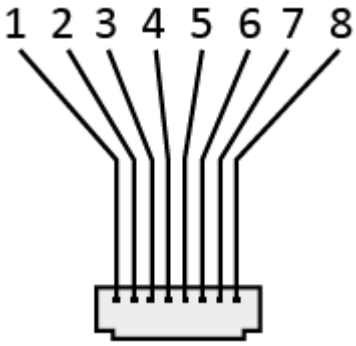
2.2.3. SC (J20)

The SC connector is to connect a smartcard claw, to interface the **CrazyWriter HSP** with ISO 7816, ID-1 contact cards.



Reference

JST ZHR-8

Pinout details

PIN	NAME	Type	Description	Remark
1	SC_VCC	Power	Smart card VCC	
2	SC_RST	OUT	Smart card RESET	
3	SC_CLK	OUT	Smart card CLOCK	
4	SC_C4		Smart card C4 pad	Not used – may be left unconnected
5	SC_C8		Smart card C8 pad	Not used – may be left unconnected
6	SC_IO	IN/OUT	Smart card I/O	
7	SC_GND	Ground	Smart card GROUND	
8	SC_C6		Smart card C6 pad	Not used – may be left unconnected

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2.2.4. CTL (J21)

When a smartcard claw is linked to the SC (J20) connector, the CTL (J21) connector shall be linked to the “card presence” switch.

Reference

JST PHR-2

Pinout details

PIN	NAME	Type	Description
1	/SC_PRESENT	IN/OUT	Leave /SC_PRESENT floating (high Z) when the card is absent. Tie /SC_PRESENT to Ground when the card is present. (note that the logic could be inverted in the coupler's configuration)
2	GND	Ground	

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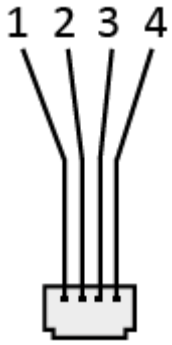
2.2.5. USB (J2)

Use this connector to connect the **CrazyWriter HSP** to a computer's USB port, using a custom cable terminated by a 4-point connector.

Note: USB may also be connected using the J3 connector (§ 2.2.1).

DO NOT connect both USB connectors (J3 and J2) at the same time.



Reference

JST PHR-4

Pinout details

PIN	NAME	Type	Description
1	VBUS	Power	USB power supply (5V)
2	DM	IN/OUT	USB D-
3	DP	IN/OUT	USB D+
4	GND	Ground	Both ground wire and cord's shielding

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2.2.6. RF antenna (J6A & J6B)

J6A is a micro-coax connector. Use a 50Ω-matched coaxial cable to connect the coupler's antenna to the main board.

On the **CrazyWriter HSP** version, J6B is not mounted.

On the **CrazyWriter HSP <u>Dual</u>** version, J6B is a micro-coax connector. Use a 50Ω-matched coaxial cable to connect a second antenna to the main board. The coupler will alternate its RF field between the two antennas.

> ***SpringCard*** *provides a 50cm cable with every antenna. Other lengths could be bought at SpringCard's or sourced from alternate providers. For correct operation, the length of the cable shall not exceed 200cm.*

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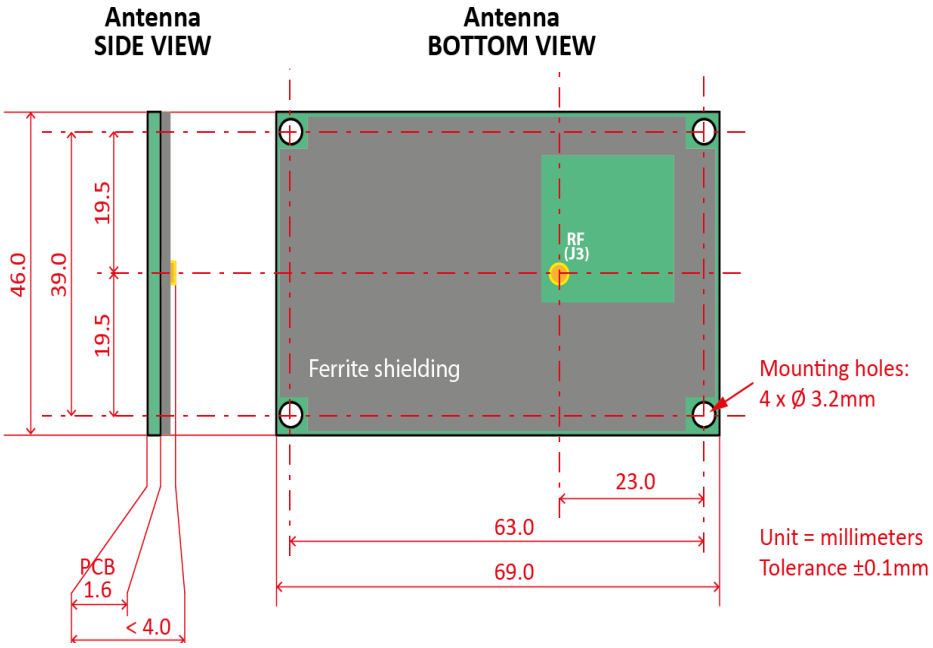
3. Antenna

3.1. Reference drawings



The BOTTOM of the antenna is the face holding the ferrite shield and the micro-coax connector. The TOP is the opposite face. The contactless card shall be presented over the TOP face.

3.2. Pinout

J3 is a micro-coax connector. Use a 50Ω-matched coaxial cable to connect the antenna to the coupler's main board (J6A or J6B).

***SpringCard** provides a 50cm cable with every antenna. Other lengths could be bought at SpringCard's or sourced from alternate providers. For correct operation, the length of the cable shall not exceed 200cm.*

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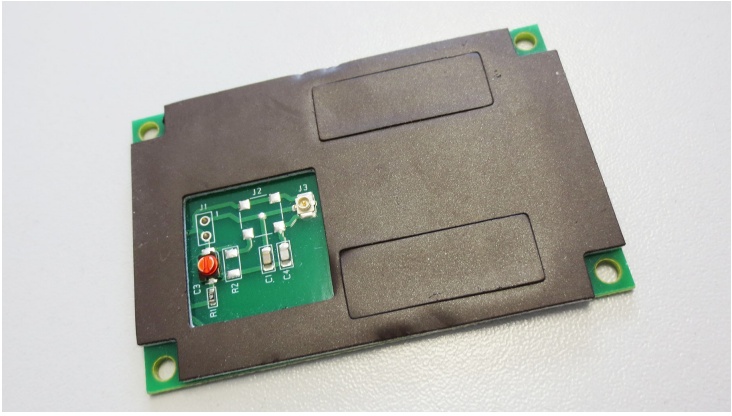
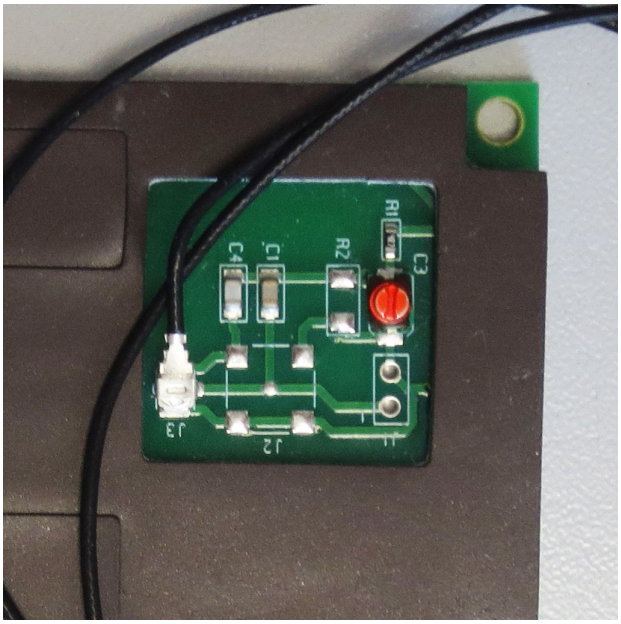
3.3. Ferrite shield

A ferrite sheet is glued to the BOTTOM face of the antenna and helps “pushing” the RF field toward the TOP face. Do not remove the ferrite sheet.



3.4. Trimming capacitor

The antenna holds an adjustable capacitor that is trimmed in factory for correct performance. Once trimmed, the capacitor is locked into position using a drop of glue (red). Do not change the trimming.



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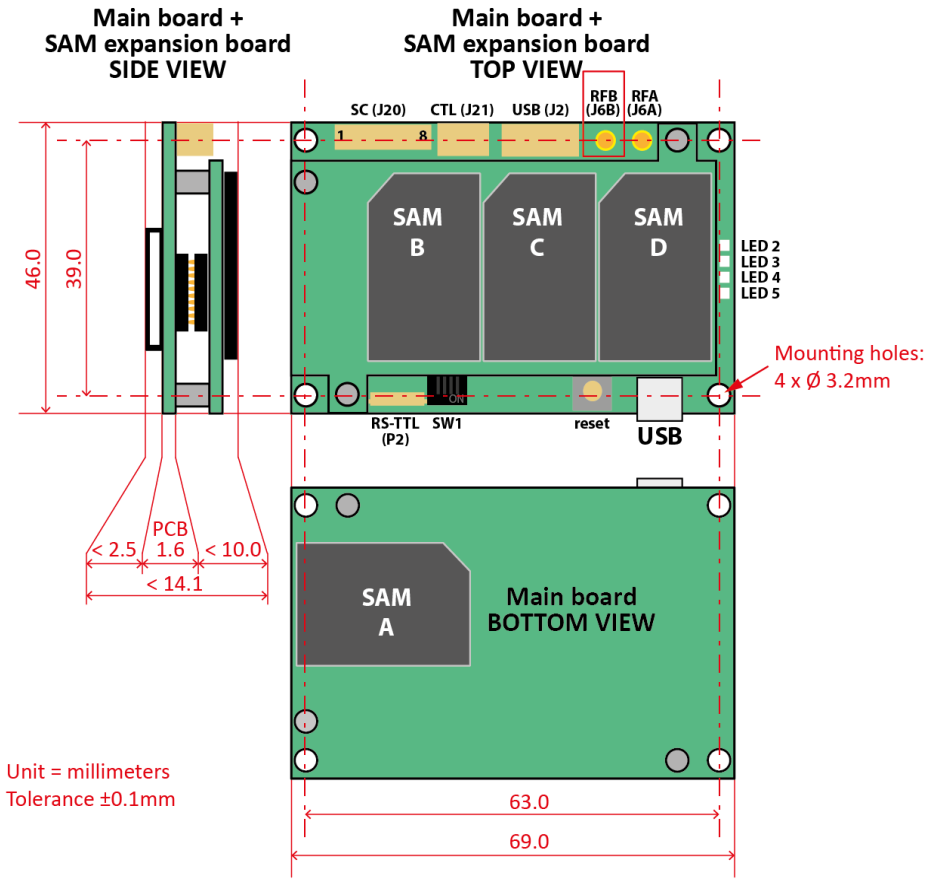
4. 3 SAM expansion board

The 3 SAM expansion board is mounted on top of the main board using 3 screws and mounting braces (supplied).

4.1. Reference drawings



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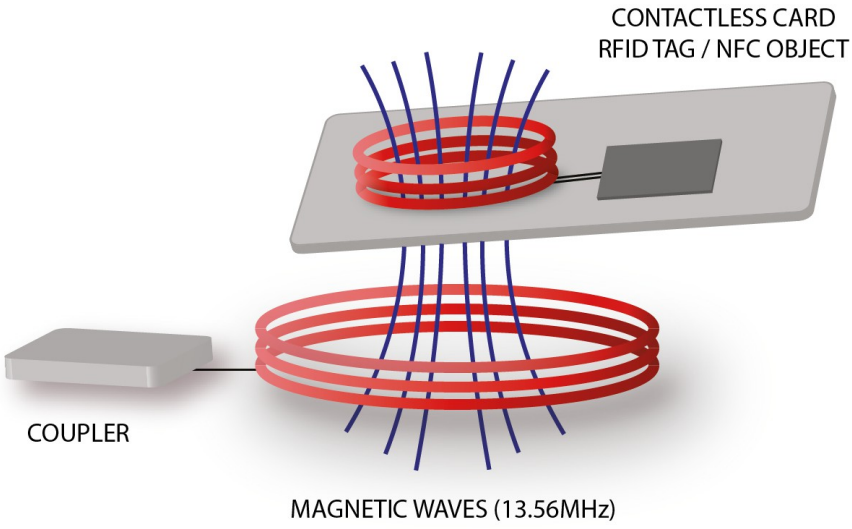
5. Placing the CrazyWriter HSP in your equipment

5.1. Placing the antenna

5.1.1. Foreword

The **CrazyWriter HSP** communicates with contactless cards using magnetic waves in the RFID HF band (carrier frequency: 13.56MHz).

Such a RFID HD could be seen as a transformer, the primary circuit being the coupler, and the secondary circuit the card. The reliability of the communication is directly tied to the coupling factor between the two circuits of the transformer, i.e. tied to the relative position of the antenna and the card and to the electro-magnetic characteristics of the environment.



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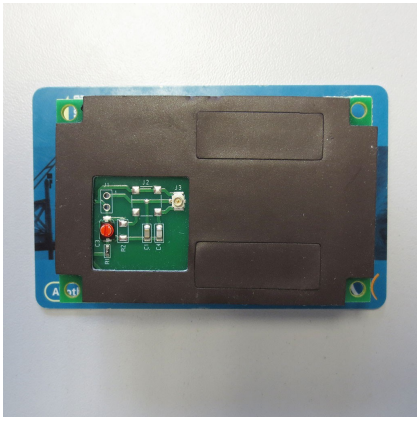
Observe the following advices to reach the **a reliable communication channel** between the antenna and the contactless card, RFID tag or NFC object.

Situations pictured as “wrong” below doesn't mean that the coupler and the card will not communicate. In most cases, the communication will even takes place as if everything was fine. But choosing the “good” picture is the only way to make sure that the **CrazyWriter HSP** will operate at the **fastest** possible transaction speed with virtually **any kind** of contactless card.

> *When the card is presented by a user, it is impossible to specify the exact location of the card, so these advices are “informative only”. But the user is likely to wave the card until the transaction is performed as expected.*
> *When it comes to card printers or machines where the card is conveyed on a path, there's nobody to wave the card, so it is important to design the whole system with the advices in mind.*

5.1.2. Direction

The card shall be place in front of the **top face** of the antenna. The top face is the one opposite to the connector and ferrite shielding.



GOOD
The card faces the antenna's top

WRONG
The card faces the antenna's bottom

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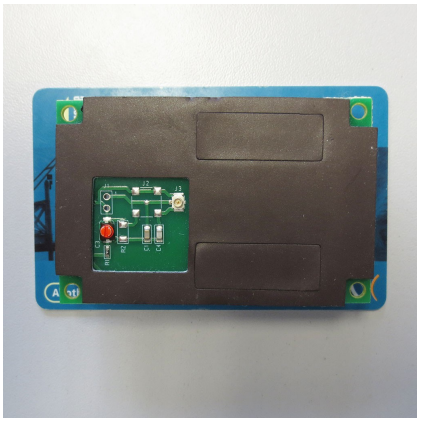
5.1.3. Orientation

The antenna and the card shall be parallel and in the same direction.



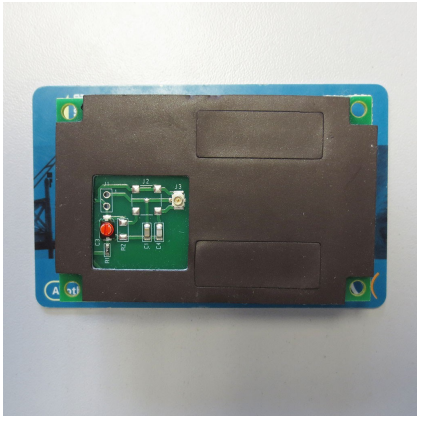
GOOD
The card and the antenna are parallel and in the same direction

WRONG
The card and the antenna are parallel, but not in the same direction

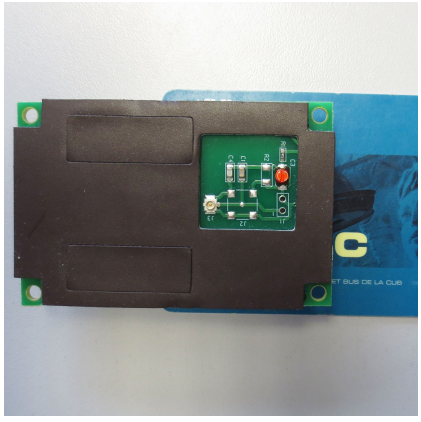
WRONG
The card is not parallel to the antenna

5.1.4. Alignment

The antenna and the card shall be aligned.



GOOD
The card and the antenna are aligned



WRONG
The card and the antenna are not aligned

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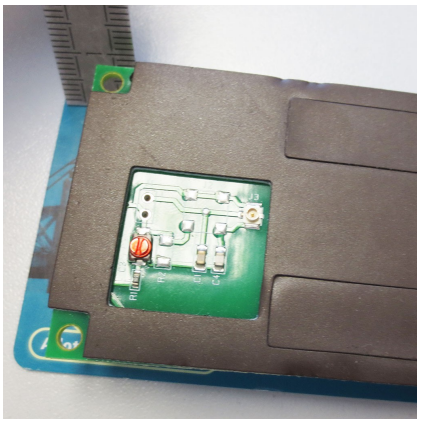
5.1.5. Distance

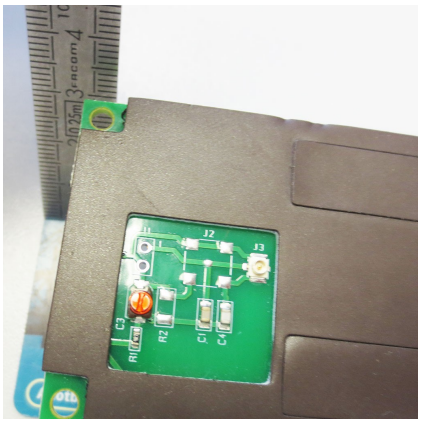
The typical operating range is 5 to 50mm with most contactless cards. With “good” cards it could reach 70mm, but with smaller cards, or with cards that need more power or have a weaker modulation level, it could be difficult to go further than 30mm.

As a consequence, the recommended distance between the card and the antenna that will work in virtually any situation is **10mm**.



GOOD
≈ 1cm between the antenna and the card

WRONG
The card is too close



WRONG
The card is too far

5.1.6. Environment

The coupler's antenna communicate with the card using **inductive coupling** (near field radio, i.e. magnetic waves).

- Magnetic waves are not able to cross any conductive surface (metal, metal-loaded plastics or paintings, PCD ground layers). For this reason, there shall be **no conductive surface between the antenna and the card**.
- Magnetic waves induce eddy current (Foucault currents) in any conductive surface. The eddy current reduces dramatically the practical distance where contactless cards could be “seen”, for a large part of the RF field is transformed into heat. That's why there shall be **no conductive surface in the nearby**.
- The propagation of the magnetic waves is tied to the magnetic permeability of the medium (μ). Most plastic materials, as well as dry air, have more or less the same permeability as the vacuum (μ_0) and allow the RF field to propagate well. On the other hand, **glass**, **wet organic materials** or any particular materials which magnetic permeability is too **far from the magnetic permeability of the vacuum** ($\mu_R \neq 1$) **shall be avoided**.

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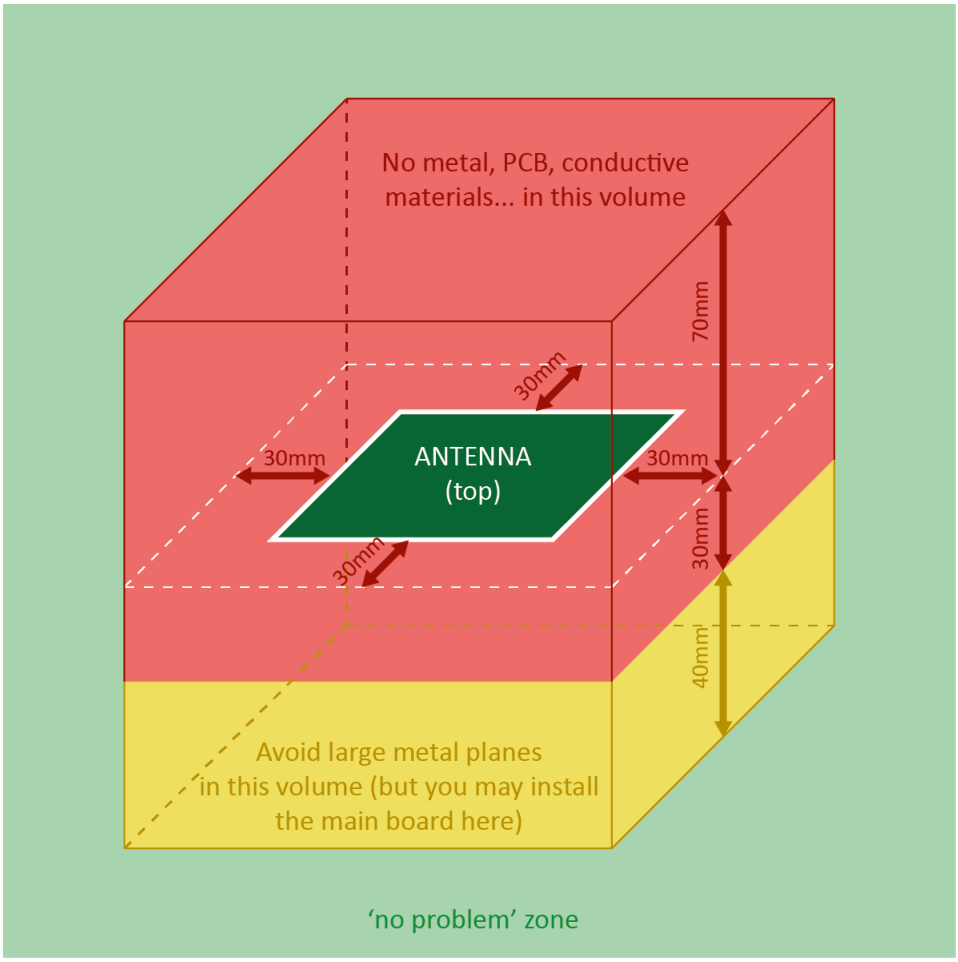
The drawing below summarizes **SpringCard** recommendations in the matter.

This must be seen as a first approach rule-of-thumb, and it is often possible to observe correct communication in the “don't” zones, but no assumption could be made on the reliability of the system in this case.



5.1.7. Proximity of other communication devices operating in the 13.56MHz range

For correct operation, **do not place any other communication device** working in the same band (13.56MHz, HF) **at a distance less than 20cm** of the **CrazyWriter HSP**'s antenna, in all directions.

Pay attention that a few electronic equipments (some LCD displays for instance) use 27.12MHz as their main clock. Such devices are likely to radiate a 13.56MHz sub-harmonic, that will prevent the **CrazyWriter HSP** to work as expected.

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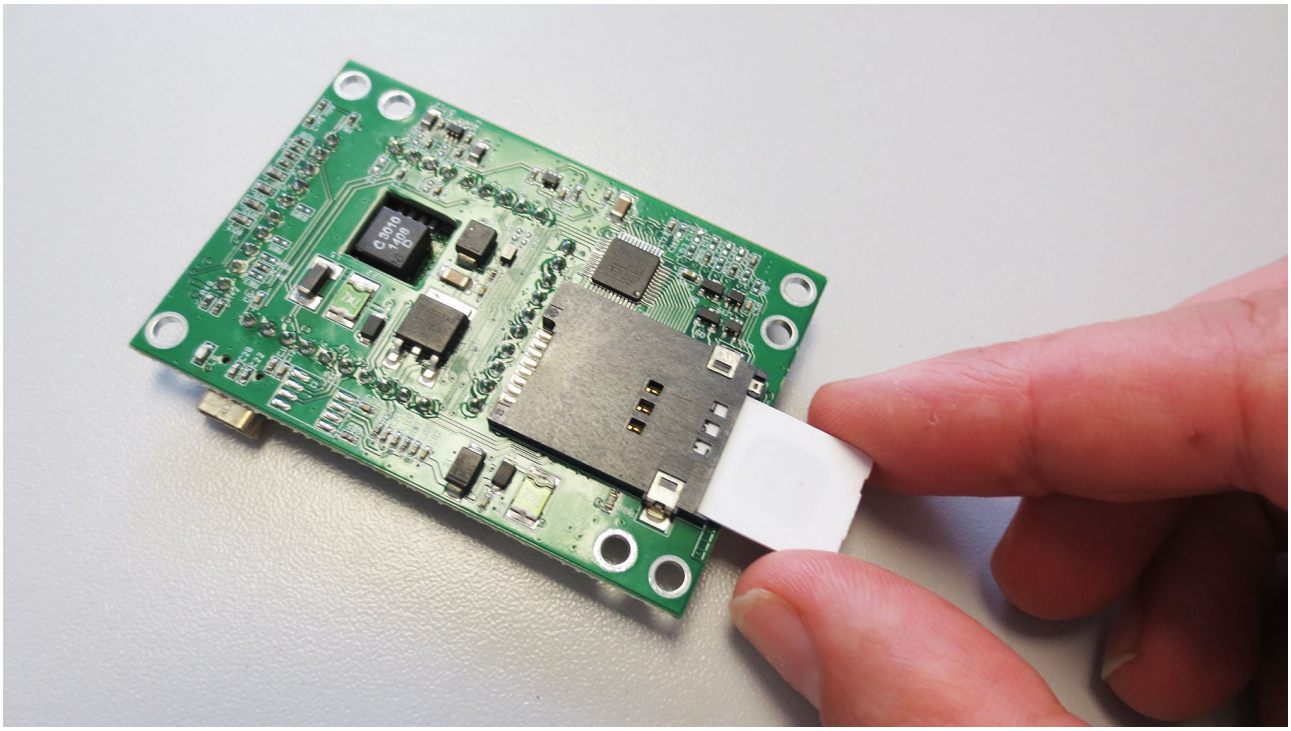
5.2. Main board

Install the main board in a place where it could be easily accessed for maintenance (firmware upgrade for instance) or to insert / remove a SAM in the *SAM A* slot.

Pay attention that you must preserve enough room around the product to access the SAM comfortably.



Consider the distance between the main board and the antenna (or the 2 antennas for **CrazyWriter HSP Dual**). Standard antenna comes with a 50cm micro-coax cable.

The micro-coax cable shall not be twisted, bended or pinched. Make sure that the cable will not be harmed when your device's shell is mounted or dismounted, opened or closed. If your device is exposed to vibrations, use Rilsan collars at both sides to keep the cable(s) firmly mounted on its micro-coax connectors.

> *Note that the main board could be placed in the yellow area in the picture in § 5.1.6*

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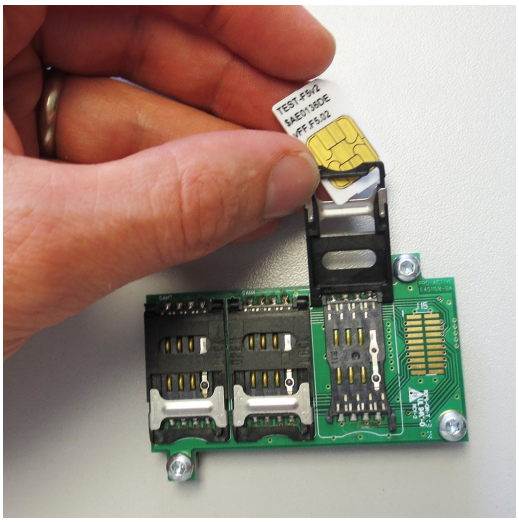
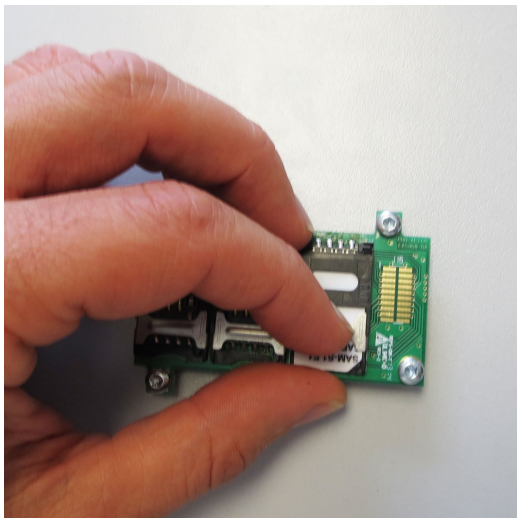
5.3. Main board with 3 SAM expansion board

The 3 SAM expansion board is mounted on top of the main board using 3 screws and mounting braces (supplied).

The SAM are installed in *SAM B*, *SAM C* and *SAM D* slots as pictured below.

Pay attention that you must preserve enough room around the product to access the SAM comfortably.





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6. Electrical characteristics

6.1. 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_{ABS}	DC supply voltage with respect to ground	-0.3	6.0	V
$V_{IN,ABS}$	Voltage to any pin with respect to ground	-0.3	VCC+0.3	V
$T_{STORAGE}$	Storage temperature	-40	+80	°C

6.2. Operating condition range

SYMBOL	Parameter	Condition	Min	Typ	Max	Unit
$T_{OPERATION}$	Operating temperature		-20	+25	+70	°C
VCC	Supply voltage (VBUS on USB)		4.5	5.0	5.5	V
ICC	Power supply current	Before USB enum.		40	50	mA
		After USB enum.		250	500	mA

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7. USB IMPLEMENTATION

7.1. STANDARD AND PROFILE

The **CrazyWriter HSP** complies with

- USB, revision 2.0 (April 27rd, 2000),
- USB Device Class : Specification for Integrated Circuit(s) Cards Interface Devices (CCID), revision 1.1 (April 22rd, 2005),
- PC/SC part. 2, revision 2.01.01 (September 2005),
- PC/SC part. 3, revision 2.01.09 (June 2007),
- PC/SC part. 3 supplemental document, revision 2.01.08 (June 2011).

7.2. PRODUCT IDENTIFICATION IN THE USB DESCRIPTOR

7.2.1. Vendor ID and Product ID

Vendor ID	Product ID
	PC/SC mode (standard)
$_H$1C34	$_H$91B1

7.2.2. Vendor name

Vendor Name
SpringCard

7.2.3. Product name

Vendor Name	Product Name
CrazyWriter HSP	CrazyWriter
CrazyWriter HSP Dual	CrazyWriter

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7.3. Drivers and software support

Please refer to document **PMD2271 : H663 Developer's reference manual** .

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8. Annex I: Smartcard interface guide lines

To be written.

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9. Annex II: Designing a custom antenna for CrazyWriter HSP

In some situations, it may be required to design a custom antenna instead of using an antenna provided by **SpringCard**.

The **CrazyWriter HSP**'s RF (J6A) connector (and J6B for CrazyWriter HSP Dual) accepts a **50Ω-matched, unbalanced antenna** through a 50Ω coaxial cable (max recommended distance: 2m).

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

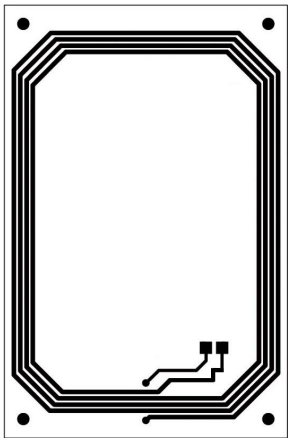
9.1. Reference antenna

We provide here as a reference the schematics and layout of the **CrazyWriter HSP**'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.

9.1.1. Antenna loop

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



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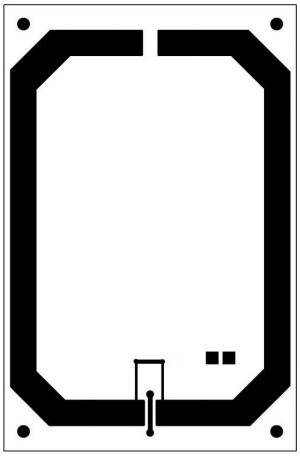
9.1.2. Shielding

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).

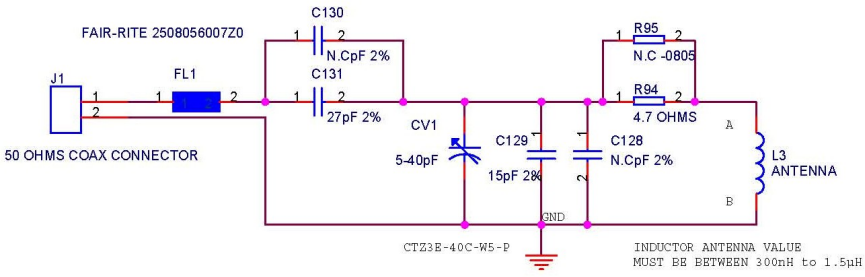
The shield is a large open loop, tied to Ground, on the opposite side of the active loop.

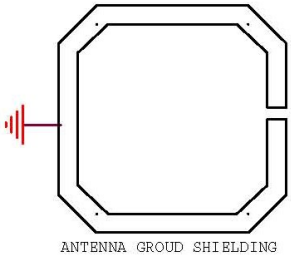


9.1.3. Matching and tuning circuit

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 through a coaxial cable.





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9.2. Recommended BOM

Component	Value	Tolerance	Recommended part #	Manufacturer
J1			U.FL-R-SMT-1(10)	HIROSE
C130, C1280	*Unmounted*			
R95	*Unmounted*			
C131	27pF/100V	2%	06031U270GAT2A	AVX
C129	15pF/100V	2%	06031U150GAT2A	AVX
R94	4,7	5%	232273464708	PHYCOMP
CV1	5-30pF		TZC3P300A110R00	MURATA
FL1			250805600720	FAIR-RITE

9.3. 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
- **NXP AN 78010 : 13.56MHz RFID proximity antennas**
  http://www.nxp.com/documents/application_note/78010.pdf

The RF chipset in H663 is NXP CLRC663. Please take into account RC663's limiting characteristic, as documented by NXP.

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Editor's information

PRO ACTIVE SAS company with a capital of 227 000 €

RCS EVRY B 429 665 482

Parc Gutenberg, 2 voie La Cardon

91120 Palaiseau – FRANCE

Contact information

For more information and to locate our sales office or distributor in your country or area, please visit

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