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SPRINGCARD H512S

Hardware integration guide

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			Tech.	Qual.		
AA	27/08/13	LOC				First release, some schematics still missing

Contents

1. Introduction

1.1. Abstract

SpringCard H512S is an OEM PC/SC RFID and NFC reader module. The **H512S** OEM module is ideal for integration in any industrial or embedded system.

This document provides all necessary information to integrate the **H512S** OEM module in your design and take benefit from all its features.

1.2. Product identification

1.2.1. Hardware

H512S is the OEM module, on top of which the **H512 Series** is based.

1.3. Related documents

Editor	Doc #	Description
SpringCard	PMD2176	H512 Developer's Reference Manual

1.4. Important – read me first

1.4.1. Antenna design

The **H512S** OEM module needs an external antenna to work as a contactless (RFID / NFC) coupler. The symmetrical antenna has to be designed carefully for the target module 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 **H512S** module.
Please visit 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

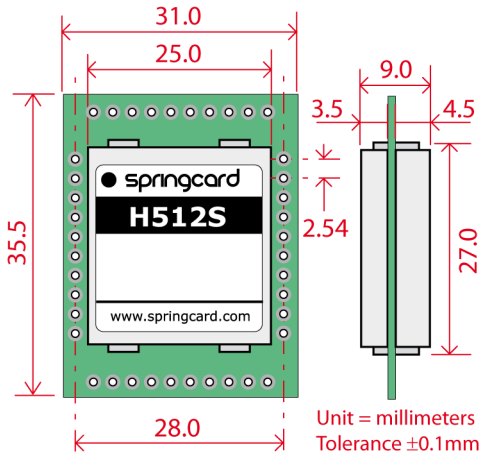
Updated versions of this document and others are posted on this web site as soon as they are available.

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

www.springcard.com/support

2. Hardware and pinout

2.1. Dimensions



2.2. Pinout

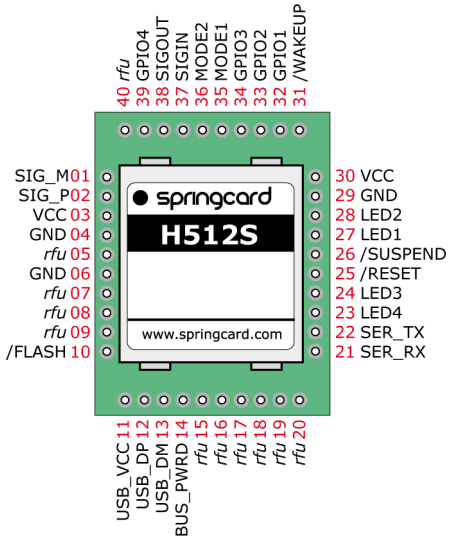


Table 1: pinout details for H512S

PIN	NAME	Type	Description	Remark	See §
1	SIG_M	Analog	Symmetric antenna		5.1
2	SIG_P	Analog	Symmetric antenna		5.1
3	VCC	Power	Power supply		4.1.1
4	GND	Ground	Ground		
5	RFU	N/A		Leave unconnected	
6	GND	Ground	Ground		
7	RFU	N/A		Leave unconnected	
8	RFU	N/A		Leave unconnected	
9	RFU	N/A		Leave unconnected	
10	/FLASH	IN	Firmware upgrade	Internal pull-up	4.1.5
11	USB_VCC	Power	Bus power supply for USB link		4.1.1/4.2
12	USB_DP	IN/OUT	USB D+		4.2
13	USB_DM	IN/OUT	USB D-		4.2
14	/USB_PWRD	IN	H512S is powered by the bus		4.2
15	RFU	N/A		Leave unconnected	
16	RFU	N/A		Leave unconnected	
17	RFU	N/A		Leave unconnected	
18	RFU	N/A		Leave unconnected	
19	RFU	N/A		Leave unconnected	
20	RFU	N/A		Leave unconnected	
21	SER_RX	IN	Serial port – host to H512	**External pull-up required**	4.5
22	SER_TX	OUT	Serial port – H512 to host		4.5
23	/LED4	OUT	LED 4	*BLUE*	4.3
24	/LED3	OUT	LED 3	*YELLOW*	4.3
25	/RESET	IN	H512 reset	Internal pull-up	4.1.2
26	/SUSPEND	IN	H512 suspend	Internal pull-up	4.1.3

Table continuing next page

Table 2 (continuing)

PIN	NAME	Type	Description	Remark	See §
27	/LED1	OUT	LED 1	*RED*	4.3
28	/LED2	OUT	LED 2	*GREEN*	4.3
29	GND	Ground	Ground		
30	VCC	Power	Power supply		4.1.1
31	/WAKEUP	IN	H512 wakeup	Internal pull-up	
32	GPIO1	IN/OUT			4.4
33	GPIO2	IN/OUT			4.4
34	GPIO3	IN/OUT			4.4
35	MODE1	IN	Firmware operating mode	Internal pull-up	4.1.4
36	MODE2	IN	Firmware operating mode	Internal pull-up	4.1.4
37	SIGIN	IN	RC663's SIGIN	Leave unconnected if not used	
38	SIGOUT	OUT	RC663's SIGOUT	Leave unconnected if not used	
39	GPIO4	IN/OUT			4.4
40	ANT_SEL			Leave unconnected	

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

3. Electrical characteristics

3.1. 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
$I_{OUT,ABS}$	Total DC output current on all I/O pins		200	mA
$I_{SIGNAL\ PEAK}$	Peak current delivered by the SIGNAL pin		200	mA
$T_{STORAGE}$	Storage temperature	-20	+70	°C

3.2. Operating condition range

SYMBOL	Parameter	Condition	Min	Typ	Max	Unit
$T_{OPERATION}$	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[1]		150	250	

[1] The antenna has a strong impact on the current consumed by the module. Typical value is observed with SpringCard's reference antenna.

3.3. 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	µA

3.4. 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

4. Integration guide

4.1. General

To be written

100nF decoupling capacitors (C5 and C6 on the above schematics) shall be placed as close as possible to pins #3 and #4, #30 and #29, respectively.

4.1.1. Power supply

a. No USB, or USB plus external power source

- Connect both VCC pins (#3 and #30) to the DC power supply (3 to 5V),
- Leave pin /USB_PWRD (#14) unconnected, or tie it to HIGH level.

b. USB – Bus powered operation

- Connect USB's VBUS line to USB_VCC (#11) and to the VCC pins (#3 and #30),
- Tie pin /USB_PWRD (#14) to LOW level.

See § 4.2 for more details regarding the USB interface.

4.1.2. Reset

The **H512S** has its own reset supervisor. The /RESET pin (#25) 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 "H512S" on the serial line or is reported "hot plugged" on the USB interface.

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.

4.1.3. Suspend mode (soft power down)

The /SUSPEND pin (#26) 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.

IMPORTANT DISCLAIMER:

DO NOT USE THE /SUSPEND PIN FEATURE when the module operates as an USB device. Suspend mode shall be only driven by the host's USB driver in this case. Always leave this pin unconnected when the module is used through USB.

4.1.4. Firmware operating mode

The MODE1 and MODE2 pins (#35 and #36) select the operating mode of the firmware. Every standard firmware behaves as follow:

MODE1	MODE2	Firmware operating mode
H	H	PC/SC mode (CCID profile), USB serial number is different for every module
H	L	PC/SC mode (CCID profile), USB serial number is fixed to "....."
L	H	Test mode 1 (factory only, do not use)
L	L	Test mode 2 (factory only, do not use)

Tip: in a typical setup you may leave both pins unconnected, so they are read as being H,H.

For the other (non-standard) firmwares, please refer to the actual documentation of the firmware or final product to know the role of the MODE1 and MODE2 pins.

4.1.5. Firmware upgrade

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.

The firmware upgrade is made through the USB interface. The **H512S** uses the standard USB DFU profile (USB Device Firmware Upgrade). Please refer to the page "H512/H663 family firmware upgrade procedure" hosted on **SpringCard's developer blog** for details.

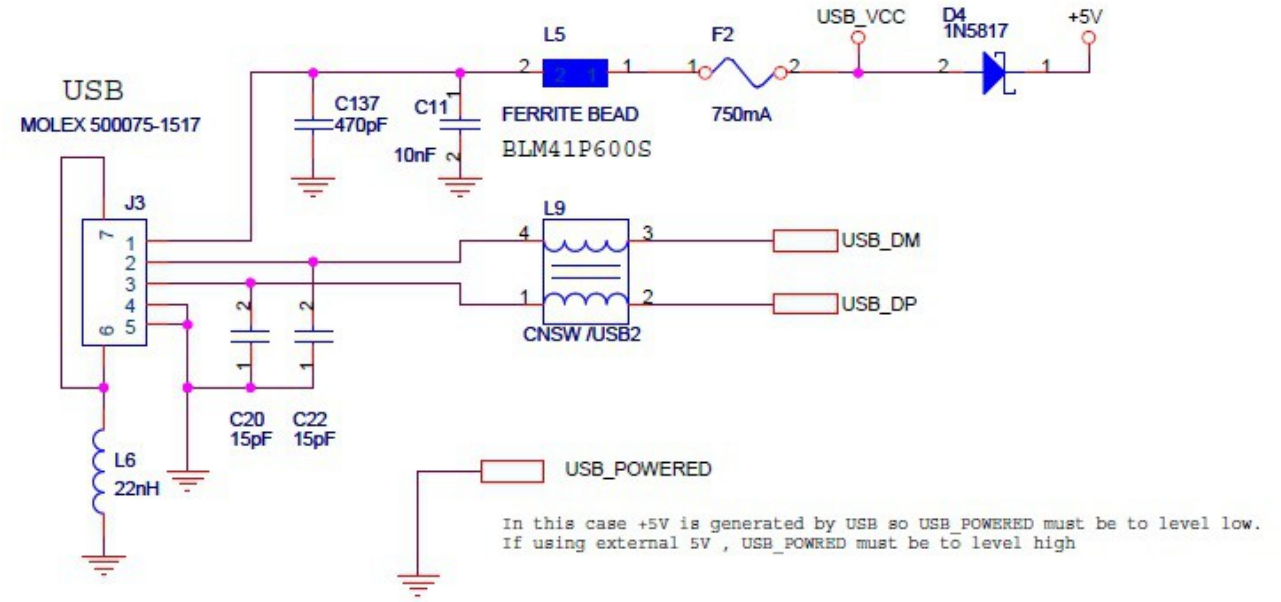
IMPORTANT DISCLAIMER:

DO NOT TRY TO UPGRADE THE FIRMWARE while the RF field is switched ON and/or the smartcard interface is running. To enter firmware upgrade mode safely, please either cycle power after setting the /FLASH pin to low, or switch RF field to OFF and disable the smartcard interface by sending appropriate software commands before any action on the /RESET pin.

4.2. USB Interface

4.2.1. Schematics

The **H512S** features a USB 2.0 device interface. Observe the following schematic to implement this interface according to USB hardware specifications.



Note: MOLEX 500075-1571 is a mini type B USB connector.

4.2.2. Powered by the bus, or external power

The /USB_PWRD pin (#14) tells the firmware whether the module has an external power supply or is powered by the bus.

/USB_PWRD	Impact on firmware
L	USB descriptor announces “bus powered, 250mA”
H	USB descriptor announces “bus powered + external power, 50mA”

IMPORTANT DISCLAIMER:

Setting /USB_PWRD to the correct value for your hardware is important. If the H512S claims it has an external power supply, yet tries to drain more than 50mA from the bus due to a missing external power source, the USB host is likely to drop the link and signal a fatal error.

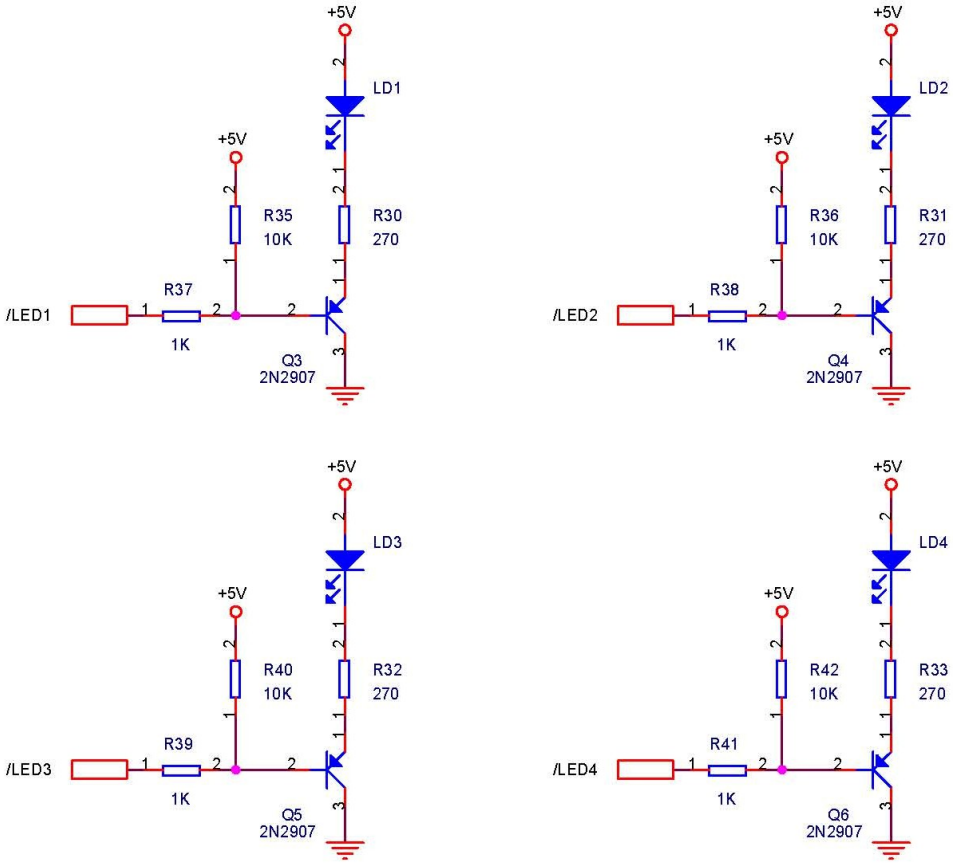
4.2.3. USB cable

Due to the chosen values for C20, C22 and L9, the length of the USB cable shall not exceed 1.8m.

Please contact us in case you need to connect the **H512S** through a longer cable.

4.3. LED DRIVERS

H512S' LED output lines are active LOW and must be buffered to drive the LEDs. Use bipolar transistors, as follow:



4.4. GPIOs

The GPIOs pins are configured as input upon start-up.

- Any call to a “GPIO write” instruction will configure the related GPIO pin as output.
- Any call to a “GPIO read” instruction will reconfigure the related GPIO pin as input.

Please refer to document **PMD2176 : H512S Developer's Reference Manual** for details regarding both instructions.

4.4.1. Using a GPIO as output

The GPIO pins shall not drive more than 4mA (see § 3.4). Use the same schematics (i.e. use a transistor) as for the LED output lines (see § 4.3).

4.4.2. Using a GPIO as input

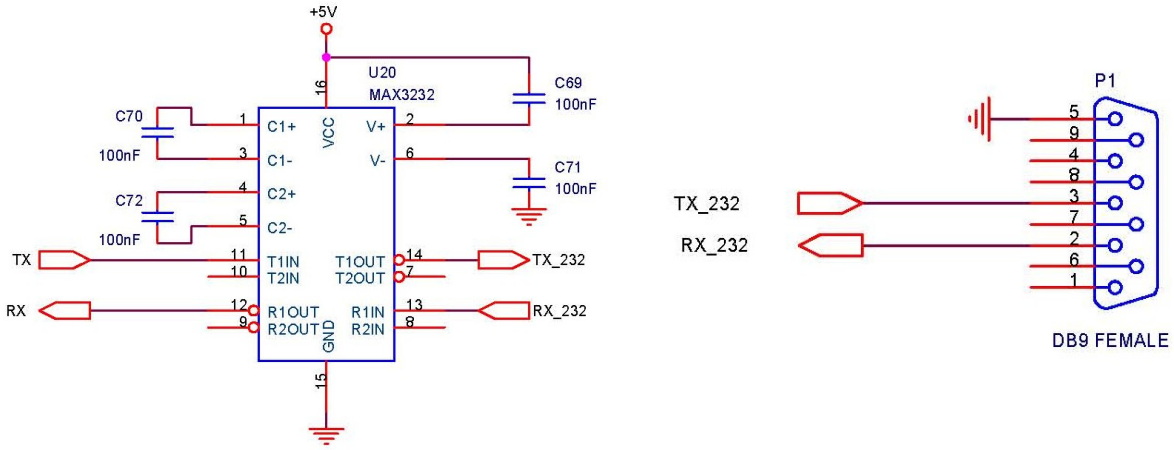
It is recommended to insert a 100Ω resistor in the signal path between your system's output and the **H512S**' GPIO used as input.

Doing so, the chips will not be damaged in case the **H512S'** GPIO is erroneously configured as output.

4.5. Serial interface

The **H512S** features a serial communication interface at TTL-level (CMOS tolerant) for debugging and in case a custom firmware is running.

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



4.6. Recommended BOM

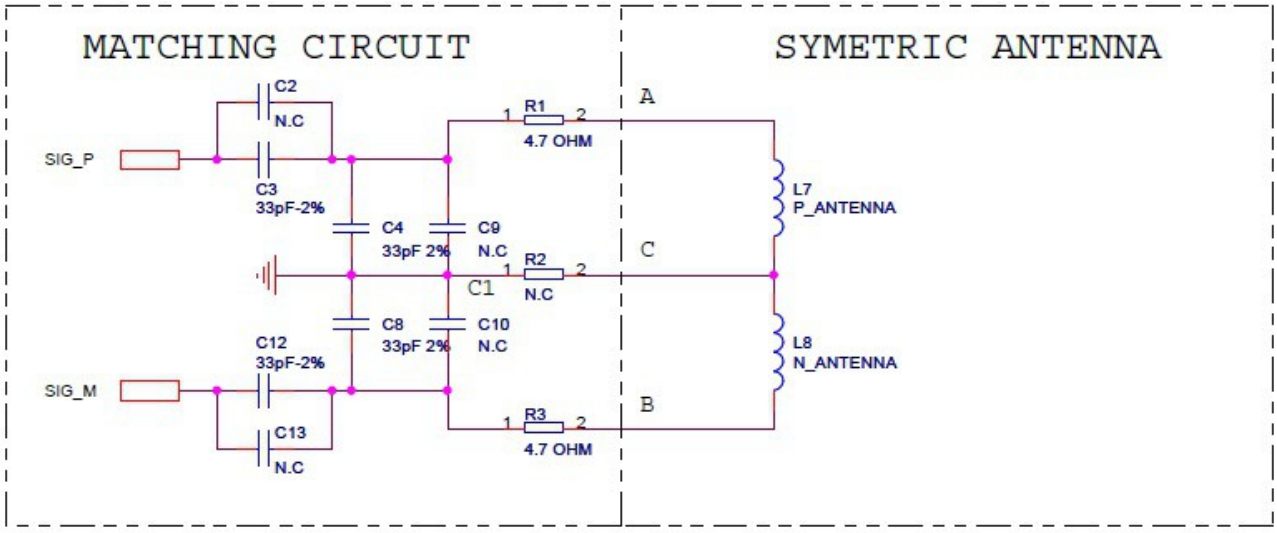
Component	Value	Tolerance	Recommended part #	Manufacturer
C11	10nF/25V	10%	2238-587-15636	PHYCOMP
C5, C6, C14, C69, C70, C71, C72	100nF/25V	10%	0402YD104KAT2A	AVX
C20, C22	15pF/50V	5%	2238-869-15159	PHYCOMP
C137	470pF/50V	10%	2238-587-15518	PHYCOMP
R20, R35, R36, R42	10K	5%	232270570103	PHYCOMP
R37, 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

5. Symmetric (balanced) antenna

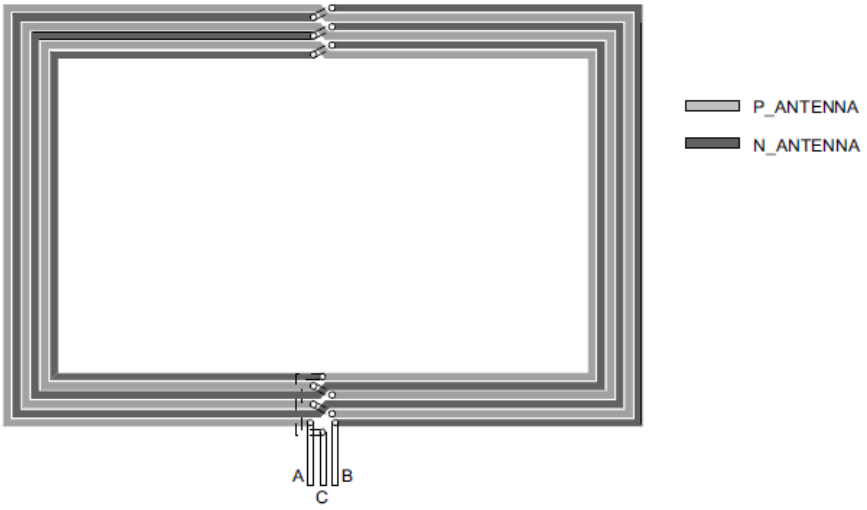
5.1. The SIG_P and SIG_M pins

H512S' SIG_N pin (#1) and SIG_P pin (#2) are designed to drive a **balanced antenna.**

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



5.2. Antenna topology



5.2.1. Shielding

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

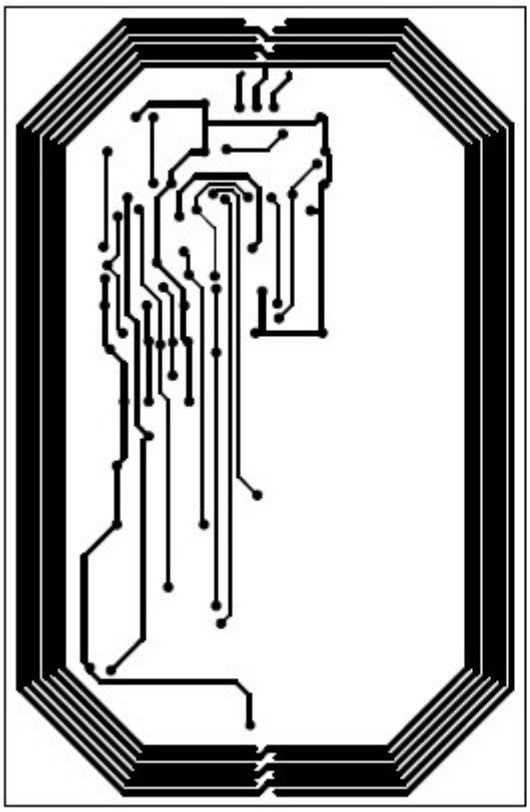
When P_Antenna has positive H field emission, the N_Antenna has an opposite H field emission, doing H fields vanish.

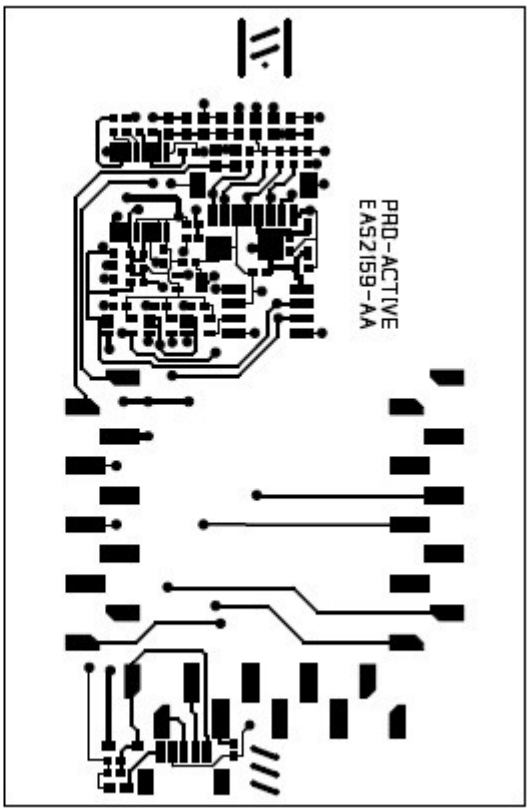
5.2.2. Matching and tuning circuit

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).

5.3. Antenna reference





5.4. 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

5.5. 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
- **NXP AN 78010 : 13.56MHz RFID proximity antennas**
  http://www.nxp.com/documents/application_note/78010.pdf

The RF chipset in H512S 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.

(C1 pin off SAM1 can be connected to 3V3OUT for 3,3V application)

6. USB IMPLEMENTATION

6.1. STANDARD AND PROFILE

The **H512** 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).

6.2. PRODUCT IDENTIFICATION IN THE USB DESCRIPTOR

6.2.1. Vendor ID and Product ID

Vendor ID	Product ID		
	PC/SC mode (standard)	CDC mode (RFU)	HID mode (RFU)
$_H$1C34	$_H$A1A1	$_H$7041	

6.2.2. Vendor name

Vendor Name
SpringCard

6.2.3. Product name

Product ref.	Product Name
H512S	H512

6.3. Drivers and software support

Please refer to document **PMD2176 : H512S Developer's Reference Manual** .

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