TECHNICAL INFORMATION MANUAL

Revision 0.3 – 04 July 2019

Hadron R4320C

High Performance 4-port Embedded RAIN RFID Reader

R4320C - Hadron - 4-port UHF RFID Reader
P.N. WR4320CXAAAA
FCC ID: UVECAENRFID027

CAEN RFID srl
via Vetraia 11
55049 - Viareggio (Italy)

3V + 5V
max. 9W

This device complies with Part 15 of the FCC Rules.
Operation is subject to the following two conditions:
(1) this device may not cause harmful interference, and
(2) this device must accept any interference received,
including interference that may cause undesired operation.

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MADE IN ITALY

PRELIMINARY

easy2read

CAENRFID

Scope of Manual

The goal of this manual is to provide the basic information to work with the Hadron R4320C Reader.

Change Document Record

Date	Revision	Changes	Pages
23 Oct 2018	0	Preliminary Release	-
12 Mar 2019	0.1	Added *Federal Communications Commission (FCC) Notice (Preliminary)*	2
		Added *FCC Compliance* paragraph in the *Regulatory Compliance* chapter	24
01 July 2019	0.2	Updated *FCC Compliance* paragraph in the *Regulatory Compliance* chapter	24
04 July 2019	0.3	Updated *FCC Compliance* paragraph in the *Regulatory Compliance* chapter	24

Reference Document

[RD1]   EPCglobal: EPC Radio-Frequency Identity Protocols Class-1 Generation-2 UHF RFID Protocol for Communications at 860 MHz – 960 MHz, Version 2.0.1 (April, 2015).

Federal Communications Commission (FCC) Notice (Preliminary)

This device was tested and found to comply with the limits set forth in Part 15 of the FCC Rules. Operation is subject to the following conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received including interference that may cause undesired operation. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This device generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instruction manual, the product may cause harmful interference to radio communications. Operation of this product in a residential area is likely to cause harmful interference, in which case, the user is required to correct the interference

at their own expense. The authority to operate this product is conditioned by the requirements that no modifications be made to the equipment unless the changes or modifications are expressly approved by CAEN RFID.
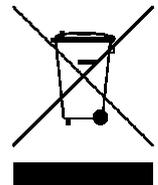
Preliminary Product Information

This document contains information for a new product. CAEN RFID reserves the right to modify this product without notice.

"Preliminary" product information describes products that are ready for production, but for which full characterization data is not yet available. CAEN RFID believes that the information contained in this document is accurate and reliable. However, the information is subject to change without notice and is provided "AS IS" without warranty of any kind (Express or implied). You are advised to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability. No responsibility is assumed by CAEN RFID for the use of this information, including use of this information as the basis for manufacture or sale of any items, or for infringement of patents or other rights of third parties.

Disposal of the product

Do not dispose the product in municipal or household waste. Please check your local regulations for disposal/recycle of electronic products.

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1   INTRODUCTION

Product Description

The Hadron (Model R4320C), embedded module of the easy2read© product line, is a RAIN RFID multiregional compact reader for high performances applications. With programmable output power from 10dBm to 31.5dBm, the reader reaches top reading performances being able to detect RAIN tags from a distance of 9 m (30 feet) depending on the antenna and the tag used.

The radio frequency core of the module allows to achieve fast reading/writing operations and to work in dense reader and dense tag environments for top-class rated performances.

Due to its compact form factor, the module is specifically designed to be easily embedded in battery powered devices such as high performances handhelds and sleds. Thanks to the 4-antenna ports and the high power capability, the Hadron module is the perfect RAIN RFID core component to design full size readers for portals, industrial automation readers or any RFID device requiring long reading distances.

Fig. 1.1: Hadron reader (Model R4320C): top view

Fig. 1.2: Hadron reader (Model R4320C): bottom view

The Mod. R4320CEVB - R4320C Hadron Evaluation Board allows managing the Hadron R4320C reader directly via USB and RS232 interfaces. This board is particularly suited for Hadron R4320C reader evaluation and SW development purpose.

Fig. 1.3: Hadron R4320CEVB Evaluation Board

Development Kit

A development kit with adapter, antennas, cable and demo tags is available:

Fig. 1.4: R4320CXDK: Accessories kit with adapter, antennas, cable and demo tags

The kit includes:

- n. 1 WR4320CXEVBX R4320C - Hadron - Evaluation Board
- n.1 Circular Polarized Quadrifilar Antenna MMCX (ETSI or FCC)
- n. 1 Set of Labels
- n. 1 A927Z Temperature Logger Tag
- n. 1 RT0005 Temperature Logger Tag
- n. 1 WALIM0000002 Power Supply for Hadron R4320C Adapter Board
- n. 1 USB cable

The R4320C Hadron reader and its development kit are a complete set up for a quick implementation of RFID solutions.

Ordering Options

	Code	Description
Reader	WR4320CXAAAA	R4320C - Hadron - High Performance 4-port Embedded UHF RFID Reader
Development kit	WR4320CXDKEU	Hadron - ETSI Dev Kit with antenna, interface, power supply and tags (reader not included)
	WR4320CXDKUS	Hadron - FCC Dev Kit with antenna, interface, power supply and tags (reader not included)
Accessories	WR4320CXEVBX	R4320C - Hadron - Evaluation Board
	WANT020XMMCX	ANT020/MMCX - Quad - Circular polarized quadrifilar antenna (ETSI) - MMCX
	WANT021XMMCX	ANT021/MMCX - Quad - Circular polarized quadrifilar antenna (FCC) - MMCX
	WALIM0000002	Power Supply for Hadron R4320C Adapter Board

2 HADRON R4320C

Technical Specifications Table

Frequency Range	– 865.600÷867.600 MHz (ETSI EN 302 208 v3.1.1) – 902÷928 MHz (FCC part 15.247)
RF Power	Programmable from 10dBm to 31.5dBm (30dBm for FCC)
Output Power Accuracy	+/- 1dB[1]
Antenna VSWR Requirement	< 2:1 for optimum performances
Antenna Connectors	Nr. 4 MMCX jacks
Frequency Tolerance	±10ppm over the entire temperature range
Number of Channels	– 4 channels (compliant to ETSI EN 302 208 v3.1.1) – 50 hopping channels (compliant to FCC part 15.247)
Standard Compliance	EPC C1G2 / ISO18000-63
Digital I/O	4 I/O lines 3.3V out @ 3mA; 5V tolerant
Forward Link Characteristics	PR-ASK 40kBit/s; DSB-ASK 160kBit/s (FCC only)
Return Link Characteristics	– Miller encoding (M=4; LF=250kHz) – Miller encoding (M=4; LF=300kHz) – FM0 400kbit/s (FCC only)
Connectivity	USB interface One USB 2.0 Full Speed (12 Mbit/s) device port UART Serial Port – Baudrate: up to 115200 – Databits: 8 – Stopbits:1 – Parity: none – Flow control: none – 3.3 V I/O voltage level
Dimensions	(L) 60 x (W) 42 x (H) 7,5 mm^3
Power Consumption (max)	8.5W peak (TX/RX mode)
DC Power	3,5 VDC ÷ 5.5 VDC
Operating Temperature	-20°C to +60°C
Weight	35 g

Tab. 2.1: Hadron R4320C Technical Specifications

Y **Warning**: *The RF settings must match the country/region of operating to comply with local laws and regulations.*

The usage of the reader in different countries/regions from the one in which the device has been sold is not allowed.

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[1] For output power less than 14dBm the accuracy may exceed the specification

External Connections

The location of the connectors is shown in Fig. 2.1: Hadron R4320C Technical Drawings page 11. Their part numbers are listed here below:

Antenna Ports: RF Coax Connector Huber+Suhner type 82_MMCX-S50-0-2/111_K (to be used with Huber+Suhner type 11_MMCX-50-1-1/111_O)

MOLEX Connector: PCB Header Molex type 53261-1571
(to be used with Molex Type 51021-1500 + 15pcs crimp terminal type 50058-8100)
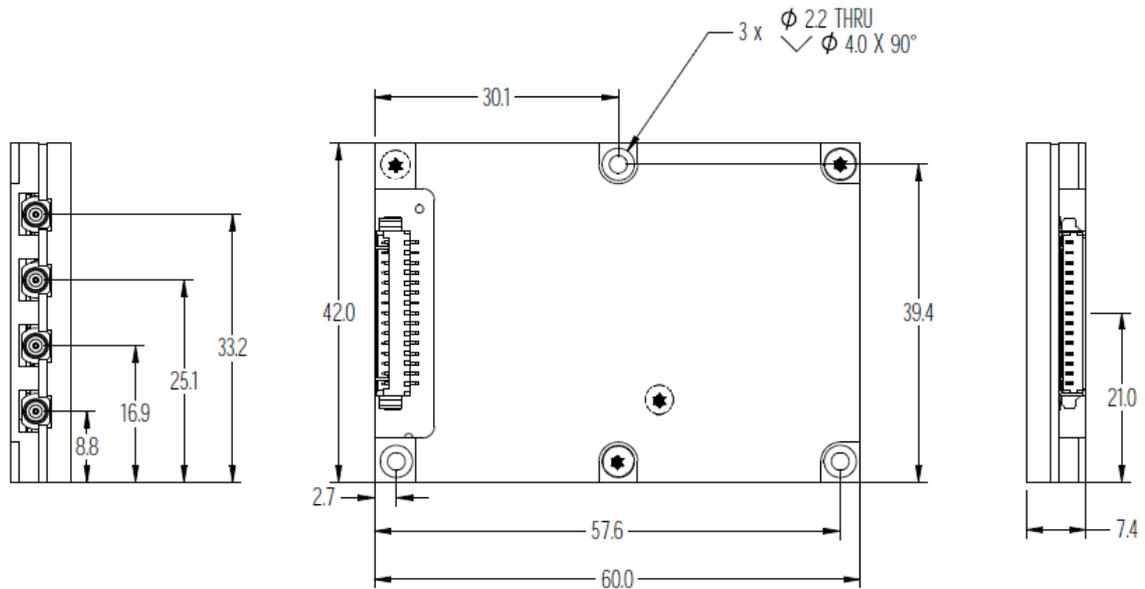
Fig. 2.1: Hadron R4320C Technical Drawings

Connector pinout

In the following table Hadron R4320C power supply and interface connector pinout is reported.

Pin #	Name	Direction	Function
1	GND	-	Ground
2	GND	-	Ground
3	VCC	-	Supply voltage
4	VCC	-	Supply voltage
5	GPIO0	IN/OUT	General purpose I/O #0
6	GPIO1	IN/OUT	General purpose I/O #1
7	GPIO2	IN/OUT	General purpose I/O #2
8	GPIO3	IN/OUT	General purpose I/O #3
9	RXD	IN	UART RX (input to the module)
10	TXD	OUT	UART TX (output from the module)
11	USB DM	IN/OUT	USB DM signal
12	USB DP	IN/OUT	USB DP signal
13	5V USB	IN	USB supply voltage input
14	SHUTDOWN	IN	Shutdown of the module
15	ERASE	IN	FW recovery/upgrade enabling

Tab. 2.2: Hadron R4320C Supply and Interface Connector Pinout

The GPIO0-GPIO3 pins are 4 general purpose bidirectional pins, their default direction is IN.

The RXD/TXD pins are used to communicate with the R4320C board via UART port; to establish a link with the device you must configure your COM port as follows[2]:

Baud rate: 115200

Parity: None

Data bits: 8

Stop bits: 1

Flow Control: none

5V USB signal is used to sense the presence of an USB host device connected to the module and not for supply the device. This pin shall be left unconnected for UART operation.

Powering on the module with ERASE pin tied at high level for more than 220ms enables the internal microcontroller FW recovery/upgrade procedure.

When SHUTDOWN pin is at high level the internal circuitry of the module is powered off and the current consumption is reduced down to less than 1mA.

Power supply and interface connector electrical characteristics[3]

Pin name	Pin No.	Parameter	Min	Typ	Max	Unit
VCC	3,4	Supply DC voltage	3.5	4.25	5.5	V
		Supply DC current	0.25		2.4	A
GPIO[0:3]	5, 6, 7, 8	VOL	0		0.4	V
		VOH	2.0		3.3	V
		Output current			3.0	mA
		VIL	-0.3		0.8	V
		VIH	2.0		5.5	V
		Input current			1	µA
RXD	9	VIL	-0.3		0.8	V
		VIH	2.0		5.5	V
		Input current			1	µA
TXD	10	VOL	0		0.4	V
		VOH	2.4		3.3	V
		Output current			1.5	mA
USB DM	11	VIL			0.8	V
		VIH	2			V
		VOL	0		0.3	V
		VOH	2.8		3.3	V
USB DP	12	VIL			0.8	V
		VIH	2			V
		VOL	0		0.3	V
		VOH	2.8		3.3	V
5V USB	13	VIL	-0.3		0.8	V
		VIH	2		5.5	V
		Input current			1	µA
SHUTDOWN	14	VIL	0		0.8	V
		VIH	2		5.5	V
		Input current			40	µA
ERASE	15	VIL	0		0.8	V
		VIH	2		5.5	V
		Input current			6	mA
GND	1,2					

Tab. 2.3: Hadron R4320C Supply and Interface Connector Electrical Characteristics

[2] Since R4320C RX/TX are TTL level signals, in order to connect it with a PC, a TTL/RS232 translator shall be used.
[3] Exceeding maximum values reported in the table may cause permanent damage to the model.

Power supply connection

In the following schematic suggested R4320C power supply connection is shown.

The use of a resettable fuse (F1) is recommended since R4320C does not provide internal current limitation protection.

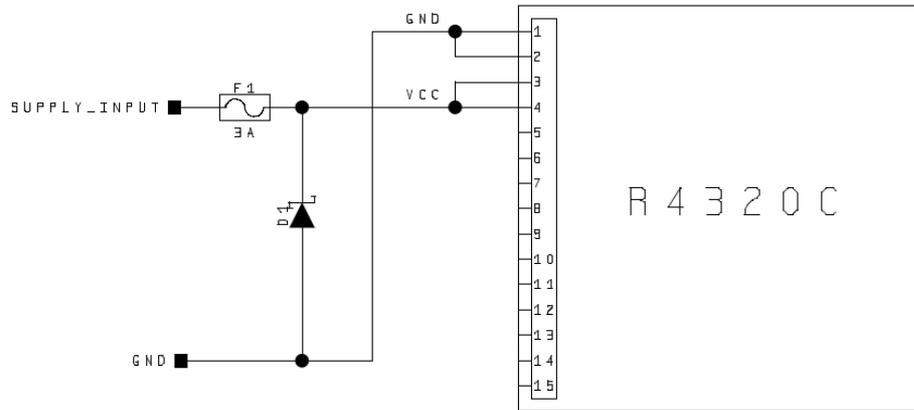Diode D1 avoid damage to the reader in case of reverse polarity connection.

Fig. 2.2: Hadron R4320C Power Supply Connection

General purpose I/O connections

The GPIO0-GPIO3 pins are 4 general-purpose bidirectional pins. Their default direction after a power on reset or a general reset is set to input.

GPIO, when configured as Outputs, can be used to drive indicators as LEDs or buzzers or to send trigger signal to others equipment.

GPIO, when configured as Inputs, can accept control signals from other equipment or trigger signals from sensors (i.e. photocells).

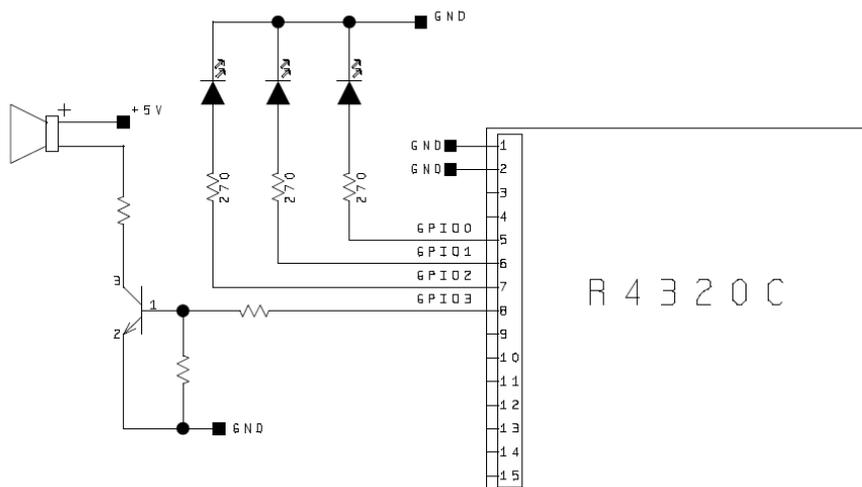In the following schematic an example of application of GPIO is shown.

Fig. 2.3: Hadron R4320C GPIO Connection Example

Shutdown pin

R4320C SHUTDOWN pin allows to set the module in power off mode (current consumption less than 1mA) and can be used also for manual reset operation.

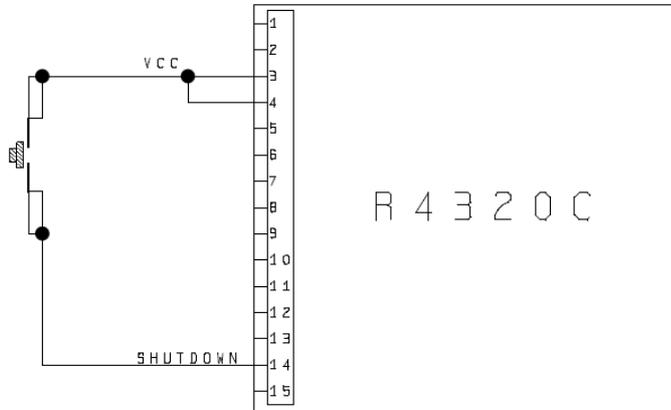SHUTDOWN pin is pulled-down by an internal resistor.

Fig. 2.4: Hadron R4320C SHUTDOWN pin connection

Communication interface selection

The communication with Hadron R4320C module can be performed via UART or USB interface.

If at power up an USB host is already connected to the module the USB interface is selected otherwise if USB pins are not connected the UART interface is selected.

UART connection

The RXD/TXD pins are used to communicate with the R4320C module via UART port. Since R4320C RX/TX are TTL level signals, in order to connect it with a PC, a TTL/RS232 translator shall be used (please refer to the diagram below)[4].

To establish a link with the device host COM port shall be configured as follows:

Baud rate: 115200

Parity: None

Data bits: 8

Stop bits: 1

Flow Control: none

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[4] R4320C service board (R4320CEVB) hosts both RS232 and USB full interfaces.
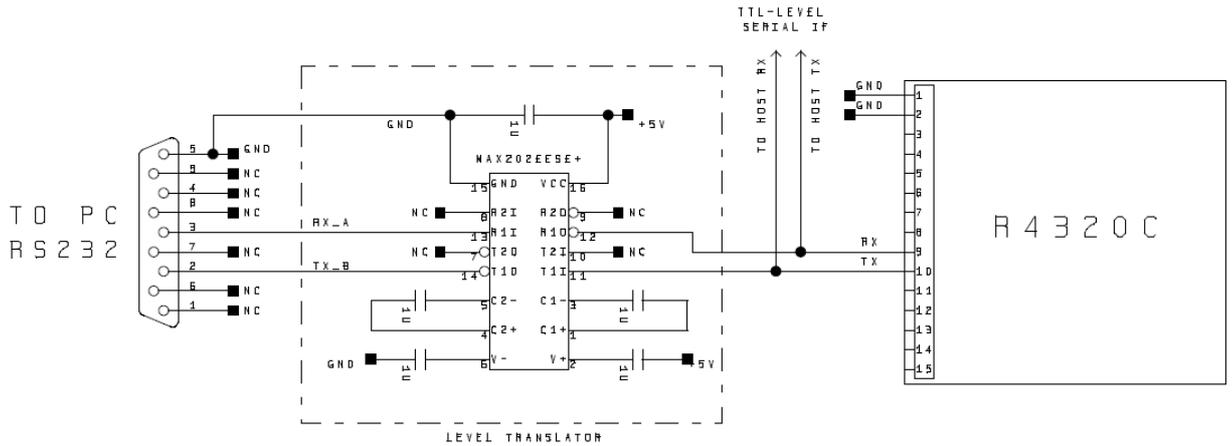
Fig. 2.5: Hadron R4320C RS232 Connection

FW Recovery/Upgrade

ERASE pin is reserved and shall be used only to perform the microcontroller FW recovery/upgrade procedure during which it must be forced at high level (3.3V or 5V).

In the following diagram a manual recovery mechanism is shown: in order to perform the R4320C boot recovery the jumper JP shall be inserted, then R4320C module shall be switched on for 5s at least. After that the reader shall be switched off and the jumper removed: at the next switch on the reader will execute the boot recovery program.

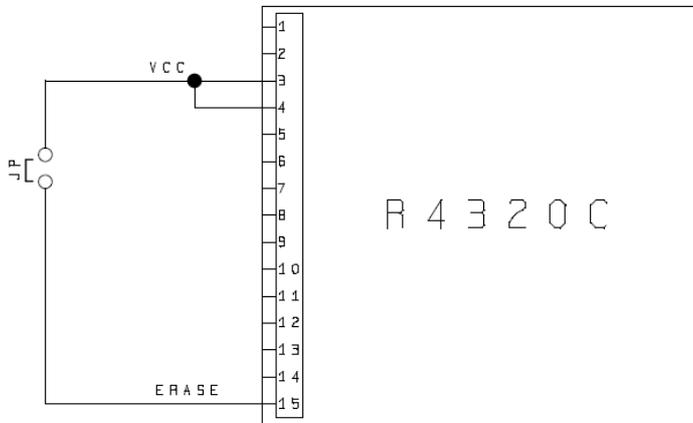For further details please see § *Firmware Upgrade* page 16.

Fig. 2.6: Hadron R4320C ERASE Pin Connection

Antenna port specifications

In the following table the pinout of R4320C antenna ports is shown.

Pin #	Function	Direction	Description
INNER	RF OUT	OUT	RF output
OUTER	GND	-	Ground

Tab. 2.4: RF Port Pinout

Parameter	Min	Typ.	Max	Unit
RF output power (nominal)	10		1400	mW
	10		31.5	dBm
Output power vs. power setting accuracy			± 1	dB[5]
RF port impedance		50		Ω
Recommended antenna VSWR			2:1	-

Tab. 2.5: RF Port Electrical Characteristics

Reader - Tag Link Profiles

R4320C reader supports different modulation and return link profiles according to EPC Class1 Gen2 protocol [RD1].

In the following table are reported all profiles that have been tested for the compliance with ETSI and FCC regulations.

| Link profile #	Regulation	Modulation	Return Link
1	FCC	PR-ASK; f=40kHz	Miller (M=4); f = 250kHz
2	ETSI	PR-ASK; f=40kHz	Miller (M=4); f = 300kHz
3	FCC	DSB-ASK; f=160kHz	FM0; f = 400kHz

Tab. 2.6: Hadron R4320C Reader to Tag Link Profiles

Firmware Upgrade

R4320C reader firmware upgrade can be performed via USB or RS232 interface.

In the following procedure it is assumed to use the R4320CEVB adapter board and a PC as host.

1) With the board powered off insert the jumper J5 in the position shown below.
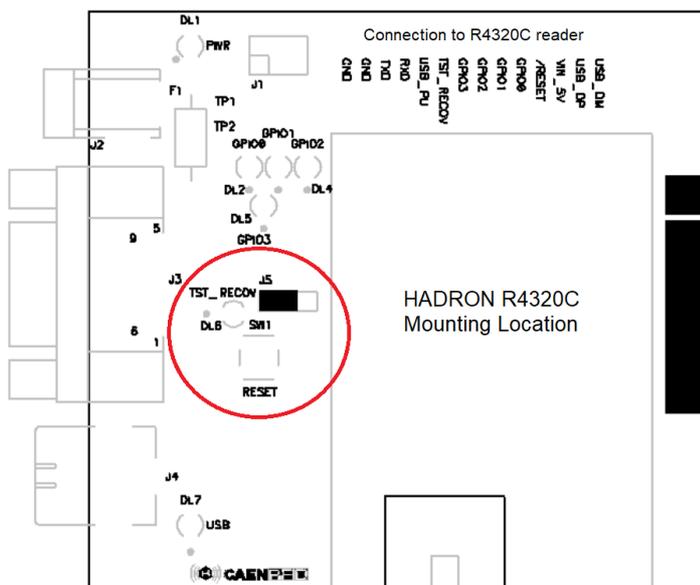
[5] For output power less than 14dBm the accuracy may exceed the specification

2)   Power on the board for at least 5s.

3)   Remove the power supply.

4)   Place the jumper in the original position.

5)   Connect the USB or the RS232 cable to the board.

6)   Power on the board.

7)   Launch the R4320C Upgrade Tool and click on *Next* button.

8)   Select the COM port related to the device (the COM address of RS232 in case of use of the serial interface, the Bossa Program Port assigned by OS in case of use of the USB interface). Note that the driver identification name depends on the OS type version.

9)   Select the R4320C FW image file.

10) Click on *Upgrade Firmware* button.
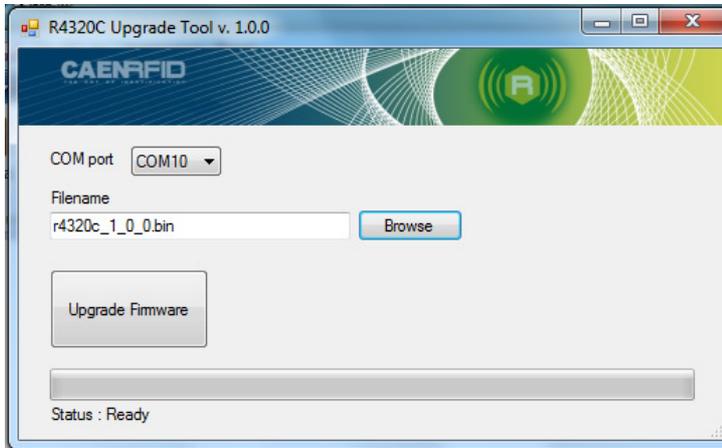
11) Wait for the progress bar to be full.
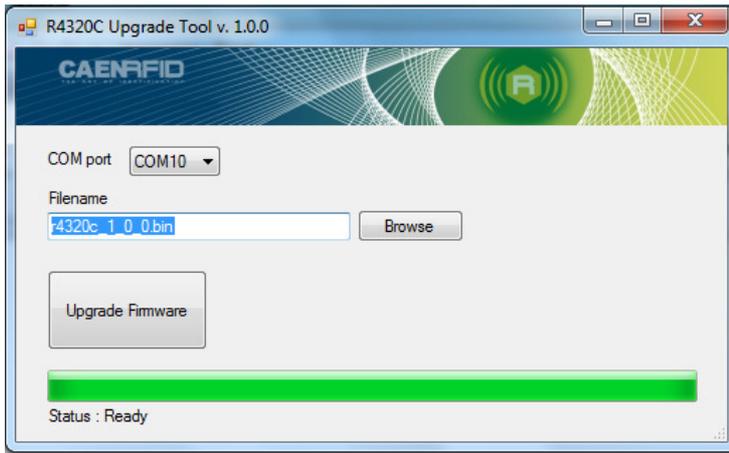
12) Switch off the module; at the next power on the device will be operating with the new FW image.

3   HADRON R4320CEVB

Technical Specifications Table

Digital I/O	Four I/O lines 3.3 V out @ 3mA, 5 V tolerant
USB Port	USB B female connector USB 2.0 device It appears as R4320C Virtual COM Port device; drivers for all Windows OS
RS232 Port	Baudrate: 115200 Databits: 8 Stopbits: 1 Parity: none Flow control: none 9.6÷115 kbit/s data rate (settable)
LED display	RED: Power GREEN: GPIO[0..3], USB connection YELLOW: RECOVERY procedure
Dimensions	(W)81 x (L)76 x (H)28 mm^3 (3.2 x 3.0 x 1.1 inch^3)
Electrical Power	DC Voltage 5V +/-5% Current consumption: 2A max.
Operating Temperature	-20 °C to +60 °C

Tab. 3.1: Hadron R4320CEVB Technical Specifications

Connection Diagram

The following block diagram shows how to connect the Hadron R4320C with the PC host via the Hadron R4320CEVB service board.

The board equipped with R4320C reader shall be powered by an external 5V 2A DC adapter.
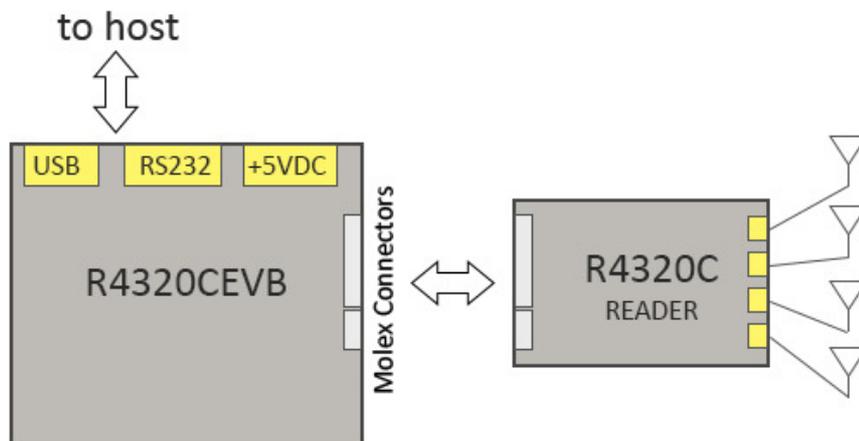

Fig. 3.1: Hadron R4320CEVB Evaluation Board Connection Diagram

Installation Notice

Fix the Hadron R4320C reader to the R4320CEVB board using 3 M2x12 countersunk screws and 3 M2 screws nuts and connect the Molex connectors.

The reader case shall be kept electrically isolated via thermal sildpad from the ground plane.

The correct way to connect the R4320C module to the R4320CEVB evaluation board is shown in the following picture:
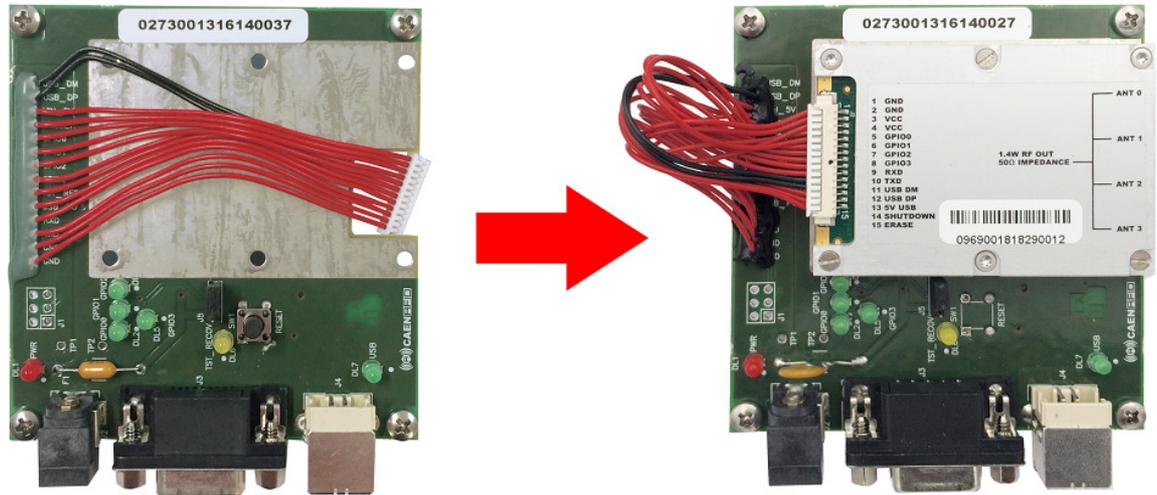

Fig. 3.2: Connection of the R4320C module to the R4320CEVB evaluation board

Technical drawings

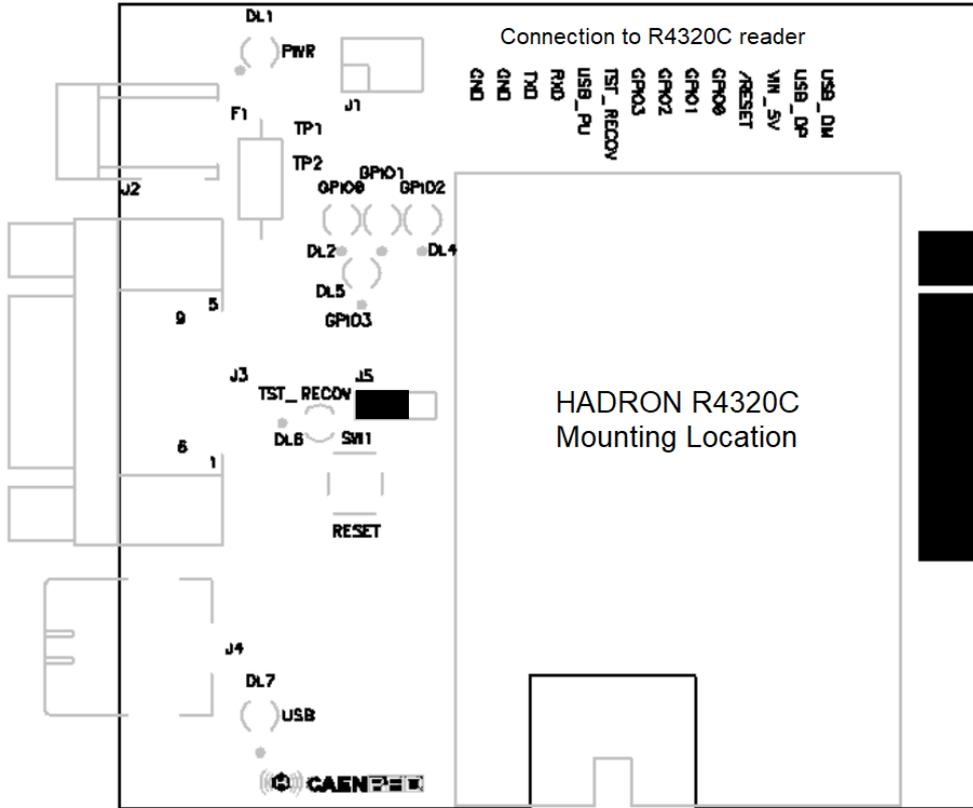The following drawing shows the R4320CEVB components position.

Fig. 3.3: Hadron R4320CEVB Technical Drawing

Electrical schematic

The electrical schematic of the Hadron R4320CEVB is shown in the following figure:

Fig. 3.4: Hadron R4320CEVB Electrical Schematic

External Connections

Please refer to § *Fig. 3.3: Hadron R4320CEVB Technical Drawing* page 21.

J1: free PTH pads for GPIO external connection

- J1-1 = GPIO0 (in/out)

- J1-2 = GPIO3 (in/out)

- J1-3 = GPIO1 (in/out)

- J1-4 = ERASE

- J1-5 = GPIO2 (in/out)

- J1-6 = Not Connected

J2: Power Supply connector: central pin (2.54mm diam.) is the positive terminal.

J3: RS232 DB9 female connector

J4: USB Type B port

J5: Connector for FW Recovery/Upgrade Procedure

LEDs

Please refer to § *Fig. 3.3: Hadron R4320CEVB Technical Drawing* page 21.

DL1 (red) = Power Supply

DL2 (green) = GPIO0

DL3 (green) = GPIO1

DL4 (green) = GPIO2

DL5 (green) = GPIO3

DL6 (yellow) = ERASE

DL7 (green) = USB connection

Firmware Upgrade

Please refer to § *Firmware Upgrade* page 16.

4   REGULATORY COMPLIANCE

FCC Compliance

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

   a. Reorient or relocate the receiving antenna.

   b. Increase the separation between the equipment and receiver.

   c. Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

   d. Consult the dealer or an experienced radio/TV technician for help.

This tansmitter module has been tested and found to comply with Part 15 of the FCC Rules.

NOTE:

   a. Any changes or modifications not approved by CAEN RFID could void the user's authority to operate the equipment.

   b. Hadron R4320C module is approved for operation with the following antennas:

     –   CAEN RFID antenna Mod. WANTENNAX020 Circular polarized antenna FCC with 5.5dBi gain

     –   CAEN RFID antenna Mod. WANT021XMMCX QUAD Circular Polarized Quadrifilar Antenna FCC with 0.7dBi gain

   c. Use of other than the approved antennas with this unit may result in harmful interference with other users and cause the unit to fail to meet regulatory requirements.

   d. The device requires professional installation since one of the approved antennas (CAEN RFID mod. WANTENNAX020) has a standard type N connector.

   e. The device shall be used such that a minimum separation distance of 25cm is maintained between each antenna and user's/nearby people's body.

   f. This transmitter module is authorized to be used in other devices only by OEM integrators under the following conditions:

     1.   The RFID Module antenna shall have a separation distance of at least 25 cm from all persons

     2.   The transmitter module must not be co-located with any other antenna or transmitter

   g. The host integrator installing this module into their product must ensure that the final composite product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules, including the transmitter operation and should refer to guidance in KDB 996369.

   h. The module is authorized for FCC part 15.247 only, the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

   i. The module has been tested and found to comply with the limits for a Class B digital device, however the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

j.   If the FCC ID is not visible when the module is installed inside another device, the OEM integrator shall apply a label in a visible area on his product with the following statement:

Contains Transmitter Module FCC ID: UVECAENRFID027

or

Contains FCC ID: UVECAENRFID027

RoHS EU Directive

The Hadron R4320C RFID reader is compliant with the EU Directive 2011/65/CE on the Restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS2).