EMB-ZRF212B

PRELIMINARY

Datasheet

Document information

Versions & Revisions

Version	Date	Author	Comments
1.0	16/05/2013	F. Montorsi	Initial version
1.1	25/07/2013	F. Montorsi	Updated with ATxmega128D3 specs
1.2	29/07/2013	F. Montorsi	Fixed typos
1.3	1/10/2013	F. Montorsi	Removed references to ATxmega256A3
1.4	28/10/2013	F. Montorsi	Updated current measurements
1.5	17/07/2014	C. Biagi	Updated to ATxmega128A3U; fixed frequency range; updated pinout for ATxmega128A3U

References

Ref	Version	Date	Author	Title

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1 Description

EMB-ZRF212B is the first sub-1GHz IEEE® 802.15.4 OEM wireless module for low-cost, high-data rate applications developed by Embit. The module combines high performance to small dimensions and low cost, providing the system integrator a simple and easy way to add IEEE® 802.15.4 / ZigBee / Atmel® LightWeight Mesh wireless connectivity; in particular, mesh networking features provide high flexibility and reliability in over-the-air protocol development.

EMB-ZRF212B is configured as an embedded micro system or simple data modem for low power applications in the 868 MHz band (EU), 915 MHz band (US and Japan) or 780 MHz band (China). It is based on Atmel® AT86RF212B coupled with an AVR® ATxmega128A3U MCU equipped with 128 KBytes of FLASH memory, 8 KBytes of RAM memory and up to 2 KBytes of EEPROM, hardware acceleration for both IEEE 802.15.4 MAC and AES security.

The output power can be increased up to +10 dBm by simple firmware/software configurations, covering distances up to 1 kilometer (LoS); the U.FL receptacle allows the connection of an external antenna.

EMB-ZRF212B can communicate with other devices through a wide range of serial interfaces: UART, I2C and SPI ports, several digital and analog I/O ports (up to 42 digital lines and 8 ADC) useful for the management of external devices and interfaces. Targets of the module are flexibility and power-awareness: **EMB-ZRF212B** can be configured as network coordinator or router, as well as an end-device thanks to the extremely reduced power consumption (less than 1 µA in sleep mode).

EMB-ZRF212B firmware can be easily developed since the module is compatible with Atmel® BitCloud ZigBee stack, with Atmel® Lightweight Mesh stack and with Atmel® 802.15.4 MAC stack. All software and development tools provided by Atmel® can be used with the **EMB-ZRF212B** "as is". Moreover the associated Embit evaluation kit (EMB-ZRF212B-EVK) contains all the documentation, software and hardware tools to get started with **EMB-ZRF212B**.

1.1 Specifications

- 8-bit ATxmega128A3U MCU (opt: ATxmega256A3U)
- 128 KB Flash, 8 KB RAM, 2 KB EEPROM
- Output power: up to +10 dBm (10 mW)
- Sensitivity: up to -110 dBm
- Ceramic antenna or U.FL connector
- Coverage: up to 1000 meters LoS
- Edge SMD connector

1.2 Applications

- **Metering**: thermostat, meters, remote devices, displays, etc...
- **Home/Building Automation**: safety systems and access control, HVAC, door/window control, lightning, etc...
- **Industrial Automation**: process control, wireless sensor networks, identification and asset tracking, etc...
- **Healthcare**: blood pressure monitoring, thermometers, ECG, etc...

1.3 Block diagram

The block diagram for the **EMB-ZRF212B** is shown in Image 1.

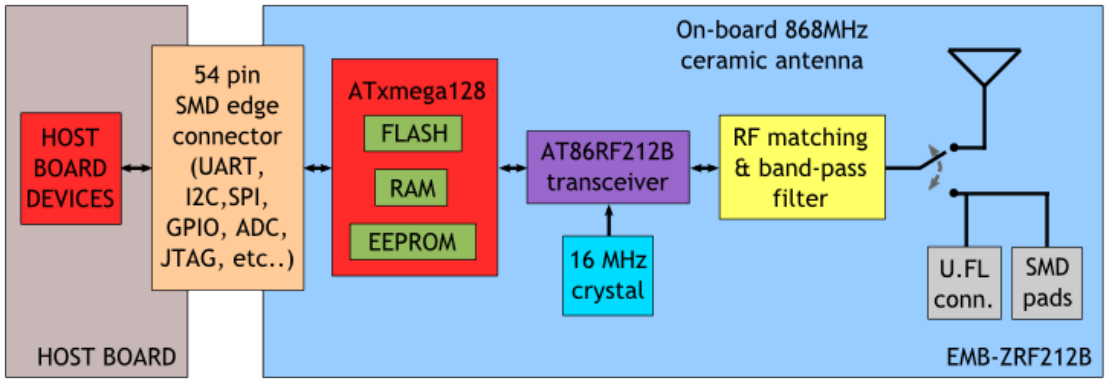


Image 1**: block diagram for the **EMB-ZRF212B

For some notes about the design of the *host board* referenced in Image 1 (i.e., the board where the **EMB-ZRF212B** is installed) please refer to Section 4.

1.4 Microcontroller

The **EMB-ZRF212B** employs an ATxmega128A3U. The ATxmega128A3U is part of Atmel® AVR XMEGA 8/16-bit microcontroller family. Such family of microcontrollers is characterized by a low-power, high-performance AVR-enhanced RISC architecture, achieving >1DMIPS/MHz, and capable of a clock frequency up to 32MHz @ 3.3V.
It features Atmel® PicoPower technology for improved low-power performances and also a good amount of processing power for wireless sensor networks (WSNs) applications.

The MCU includes several peripherals: a programmable multi-level interrupt controller, a 16-bit real time counter, five flexible 16-bit timer/counters with compare modes and PWM, three USARTs, two 2-wire interfaces, two serial peripheral interfaces (one is used

for communications with the RF transceiver), one 16-channel/12-bit A/D converter with optional differential input with programmable gain, two analog comparators with window mode, a programmable watchdog timer with separate internal oscillator, accurate internal oscillators with PLL and prescaler, and a programmable brown-out detection.

The MCU is programmed and debugged via Atmel® Program and Debug Interface (PDI), which is a fast 2-pin interface.

The microcontroller communicates with the RF transceiver through an SPI and some GPIOs.

1.5 Antenna

The **EMB-ZRF212B** offers three options for the antenna:

- **Ceramic antenna (optional):** multiband 868/915 MHz antenna
- **External antenna connector (optional)**: 50 Ohm single-ended U.FL connector
- **Ground-Signal-Ground (GSG) SMD pads**: for connection to antennas mounted on the host board

1.5.1 Ceramic antenna radiation diagram

The ceramic antenna is a simple & easy solution to get started with **EMB-ZRF212B** when operating in the 868MHz (EU) or 915MHz (US and Japan) band. Thanks to its compact size, the ceramic antenna is suitable for all applications involving medium/short-range transmissions. For long-range transmissions, the use of an external 868MHz antenna is recommended.

The following images summarize the RF characteristics of the antenna:

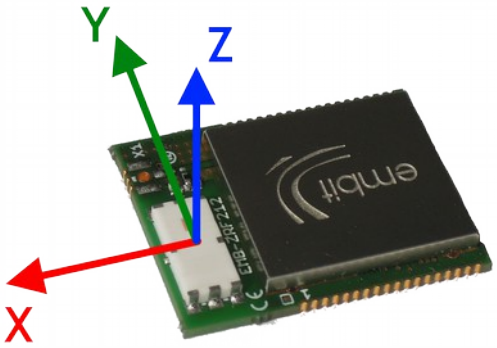


Image 2: *coordinate frame for the polar diagrams of Images 3-5*

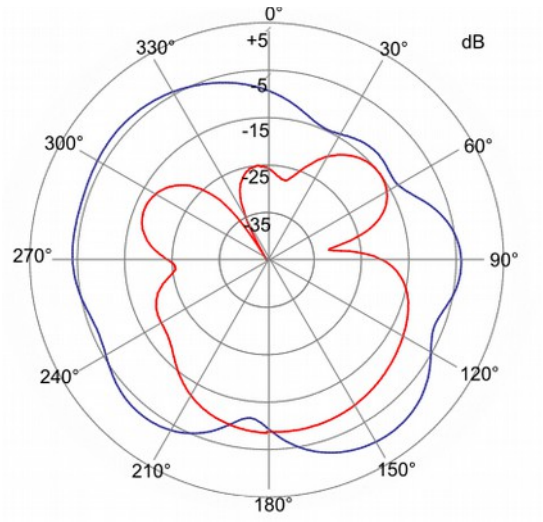


***Image 3**: polar radiation pattern, XY-plane*
(blue curve = horizontal pol.; red curve = vertical pol.)

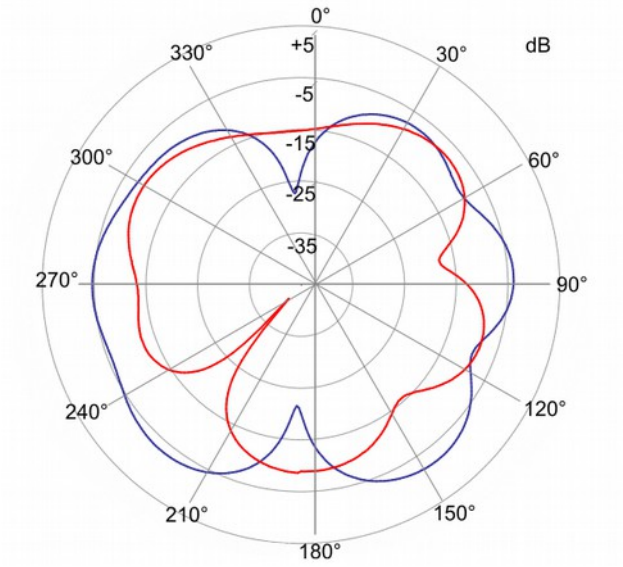


***Image 4**: polar radiation pattern, XZ-plane*
(blue curve = horizontal pol.; red curve = vertical pol.)

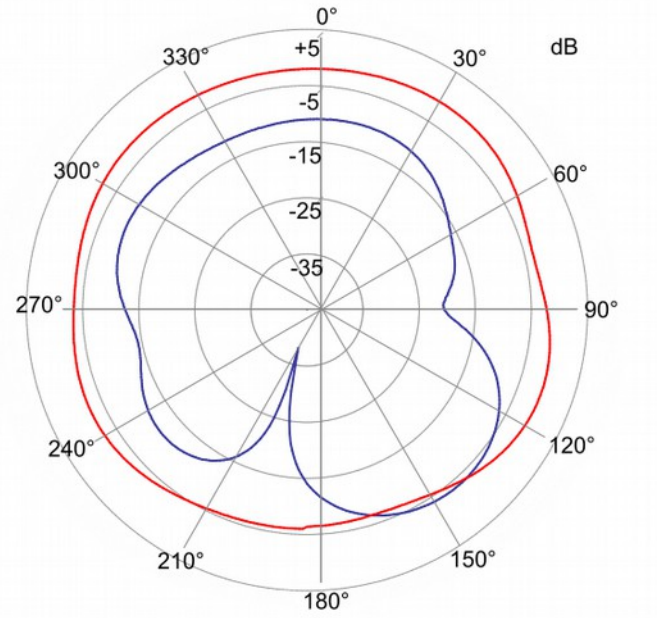


***Image 5**: polar radiation pattern, YZ-plane*
(blue curve = horizontal pol.; red curve = vertical pol.)

1.5.2 Antenna selection (ceramic/external)

If the external antenna is desired, either through U.FL connector or GSG SMD pads, the R3 resistor (0 ohm resistor, case 0402) must be installed in vertical position, as shown in the following picture:

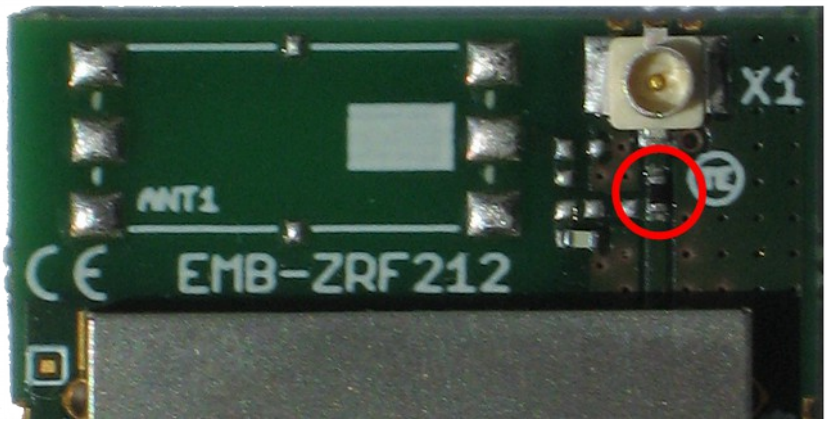


***Image 6**: R3 resistor installation for U.FL connector option*

If the ceramic antenna is to be used the R3 resistor must be installed in horizontal position, as shown in the following picture:

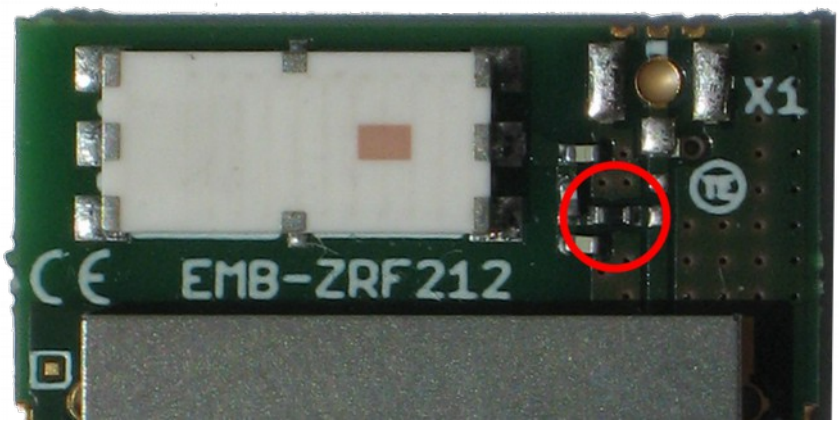


***Image 7**: R3 resistor installation for ceramic antenna option*

1.6 Development tools

The **EMB-ZRF212B** module supports both Atmel® Lightweight Mesh stack, Atmel® BitCloud stack and Atmel® 802.15.4 stack. All ATxmega-compatible Atmel® programmers (e.g., Atmel® AVR Dragon and Atmel® JTAGICE3) can be used to program/debug the module.

To quickly get started with Embit modules, Embit also provides ready-to-use firmware for the EMB-ZRF212B that allow the module to act like a simple modem over UART; through AT-like binary commands it is possible to send/receive data over-the-air and to develop complex applications without the need of writing custom firmware. The protocol and the firmware implementing such features are called “EBI” (Embit Binary Interface).

For more information about EMB-ZRF212B firmware development and “EBI” usage, please refer to the associated Embit evaluation kit (EMB-ZRF212B-EVK), which contains all the documentation, software and hardware tools to get started with EMB-ZRF212B.

More information are also available on Embit website (www.embit.eu).

2 Size and footprint

2.1 Size

The mechanical dimensions of the **EMB-ZRF212B** are identical to the dimensions of all other Embit modules: 29.50 x 22.60 mm. The thickness is 3.6 mm (CAN Shield included).

The **EMB-ZRF212B** module has three 18 pin "edge" connectors with 1.00 mm pitch, for a total of 54 pins, plus 3 g*round-signal-ground* (GSG) pads for the RF signal. Each pin/pad is a metalized half hole 0.50 mm in diameter. The position of the GSG pads is shown in the following image:

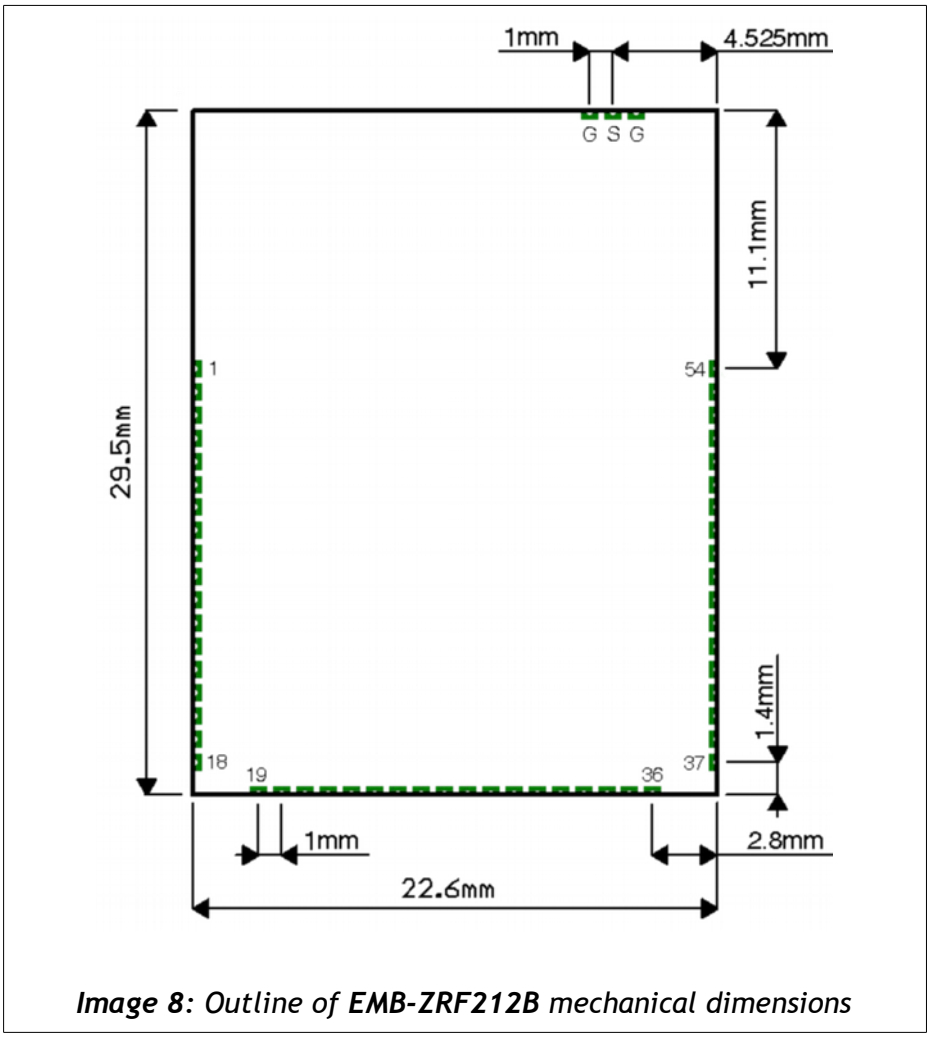


***Image 8**: Outline of **EMB-ZRF212B** mechanical dimensions*

The suggested layout for the pin/pads of the EMB-ZRF212B is shown in the following image:

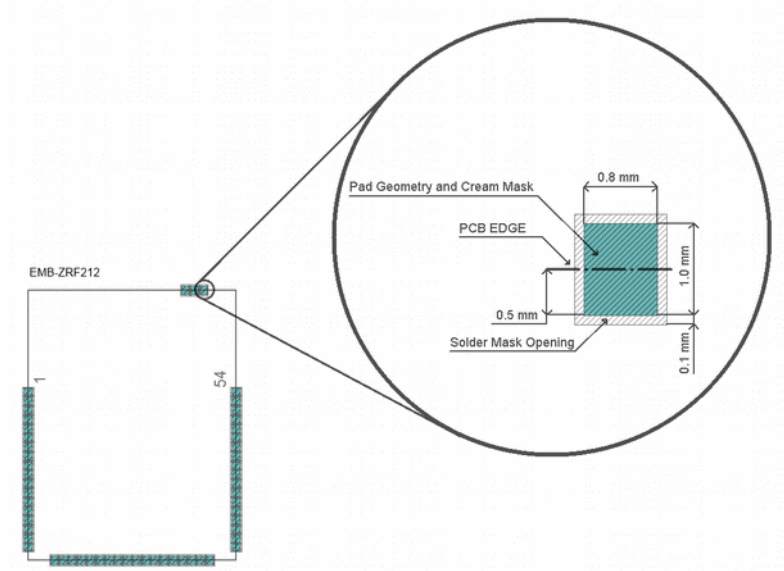


***Image 9**: Details of a pin/pad layout*

2.2 Host board antenna layout

The **EMB-ZRF212B** module must be installed on a PCB in a position such that the area dedicated to the ceramic antenna lies *outside* the host board PCB. In the following image is shown an example of installation on the host board:

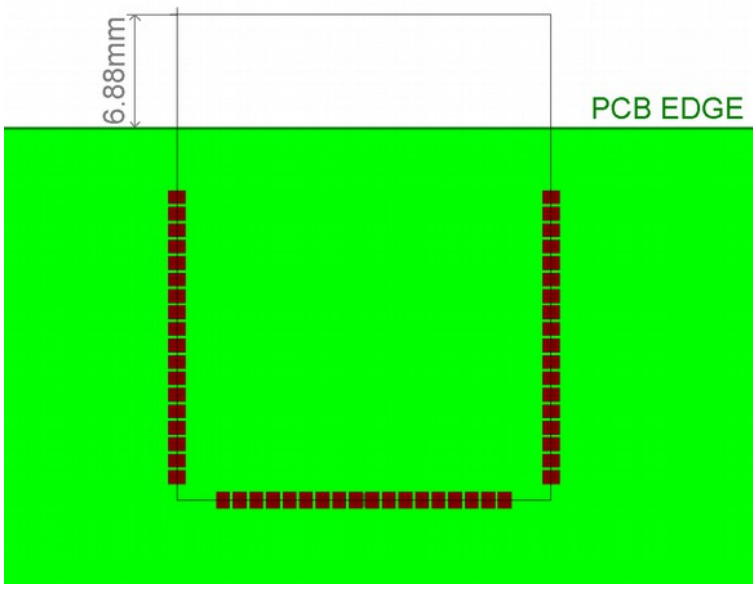


***Image 10**: Antenna positioning*

In Image 10, the 6.88 mm portion of the **EMB-ZRF212B** containing the ceramic antenna lies outside the host board PCB: such installation choice provides optimal RF performances.

2.3 Notes

- The area underneath the module must be free of components (both top and bottom layers).
- The PCB top layer underneath the module must be free of nets, power planes and vias. The bottom layer underneath the module should be a ground plane.
- Keep antenna clear of metal parts of the final product's enclosure.
- When using the integrated ceramic antenna, don't use metal enclosures to avoid RF signal degradation.

3 Connections

The EMB-ZRF212B has the following pin-out (note that the column “MCU Pin #” indicates the ATxmega128A3U pin attached to the Embit module “Pin #”):

Pin #	Pin Name	Type	Description	MCU Pin #
1	GND	GND	GND	--
2	N.C.	Not connected	Not connected pin	--
3	PA0_AREF	Analog input or digital I/O	High reference voltage for ADC/PA0	62
4	AVCC	Analog input	Analog power supply	61
5	N.C.	Not connected	Not connected pin	--
6	PA1_ADC1	Analog input or digital I/O	ADC analog input Channel 1/PA1	63
7	PA2_ADC2	Analog input or digital I/O	ADC analog input Channel 2/PA2	64
8	PA3_ADC3	Analog input or digital I/O	ADC analog input Channel 3/PA3	1
9	PA4_ADC4	Analog input or digital I/O	ADC analog input Channel 4/PA4	2
10	PA5_ADC5	Analog input or digital I/O	ADC analog input Channel 5/PA5	3
11	PA6_ADC6	Analog input or digital I/O	ADC analog input Channel 6/PA6	4
12	PA7_ADC7	Analog input or digital I/O	ADC analog input Channel 7/PA7	5
13	PB7_TDO	Digital I/O	JTAG test data output/PB7	13
14	PB5_TDI	Digital I/O	JTAG test data input/PB5	11
15	PB6_TCK	Digital I/O	JTAG test clock input/PB6	12
16	PB4_TMS	Digital I/O	JTAG test mode select input/PB4	10
17	N.C.	Not connected	Not connected pin	--
18	VCC	Power Input	Supply voltage	--
19	N.C.	Not connected	Not connected pin	--
20	PD2_UART0_RX	Digital I/O	UART0 rx data input/PD2	28
21	PD3_UART0_TX	Digital I/O	UART0 tx data output/PD3	29
22	PD4_UART1_RTS	Digital I/O	UART1 request to send input/PD4	30
23	PD5_UART1_CTS	Digital I/O	UART1 clear to send output/PD5	31
24	PD6_UART1_RX	Digital I/O	UART1 rx data input/PD6	32
25	PD7_UART1_TX	Digital I/O	UART1 tx data output/PD7	33
26	PE0_I2C_SDA	Digital I/O	I2C bus data/PE0	36
27	PE1_I2C_SCL	Digital I/O	I2C bus clock/PE1	37
28	PF3_TMR3	Digital I/O	Timer 3 IO signal/PF3	49
29	PF2_TMR2	Digital I/O	Timer 2 IO signal/PF2	48
30	PF1_TMR1	Digital I/O	Timer 1 IO signal/PF1	47
31	PF0_TMR0	Digital I/O	Timer 0 IO signal/PF0	46
32	PE7_SPI_SCK	Digital I/O	SPI Port Clock/PE7	43
33	PE5_SPI_MOSI	Digital I/O	SPI Port MOSI/PE5	41

Pin #	Pin Name	Type	Description	MCU Pin #
34	PE6_SPI_MISO	Digital I/O	SPI Port MISO/PE6	42
35	PE4_SPI_SS	Digital I/O	SPI Port Slave Select/PE4	40
36	N.C.	Not connected	Not connected pin	--
37	VCC	Power Input	Supply voltage	--
38	PD1_GPIO	Digital I/O	PD1	27
39	PE2_GPIO	Digital I/O	PE2	38
40	PE3_GPIO	Digital I/O	PE3	39
41	PF7_GPIO	Digital I/O	PF7	55
42	PF6_GPIO	Digital I/O	PF6	54
43	PF5_GPIO	Digital I/O	PF5	51
44	PF4_GPIO	Digital I/O	PF4	50
45	PB3_GPIO	Digital I/O	PB3	9
46	PB2_GPIO	Digital I/O	PB2	8
47	PB1_GPIO	Digital I/O	PB1	7
48	PB0_GPIO	Digital I/O	PB0	6
49	PE6_SPI_MISO_XTL	Analog input	SPI port MISO/Optional 32,768KHz crystal oscillator input/PE6	42
50	PE7_SPI_SCK_XTL	Analog output	SPI port SCK/Optional 32,768KHz crystal oscillator output/PE7	43
51	PDI_CLK_RST	Digital Input	System reset input (active low)/PDI clock signal	57
52	PDI_CLK_RST	Digital I/O	PDI clock signal	57
53	PDI_DATA	Digital I/O	PDI data signal	56
54	GND	GND	GND	--

(*) = on all other Embit modules these pins expose different functionalities (e.g., UART, SPI or other interfaces).

4 Typical Application Circuit

A basic application circuit for the **EMB-ZRF212B** is shown in Image 11. The **EMB-ZRF212B** allows for a minimal number of external components (thus decreasing system costs).
In Image 11 a LED indicator (LED1) and a push button (SW1) are used to provide a minimal user interface and a 32kHz crystal is connected to the **EMB-ZRF212**, in case an accurate timer functionality is required (please refer to the ATxmega128A3U datasheet for more information). The PDI programming/debugging interface, generally speaking, will be routed to a connector on the host board for in-circuit programming.

In addition, a simple supply section (based on a 3.3V LDO stabilizing the input voltage VIN) and a simple reset circuitry are shown. In particular, the reset circuitry of Image 11 allows to

1. program the MCU of the **EMB-ZRF212B** (thanks to the weak pull-up to VCC);
2. manually reset the MCU, if needed (thanks to SW_RESET).

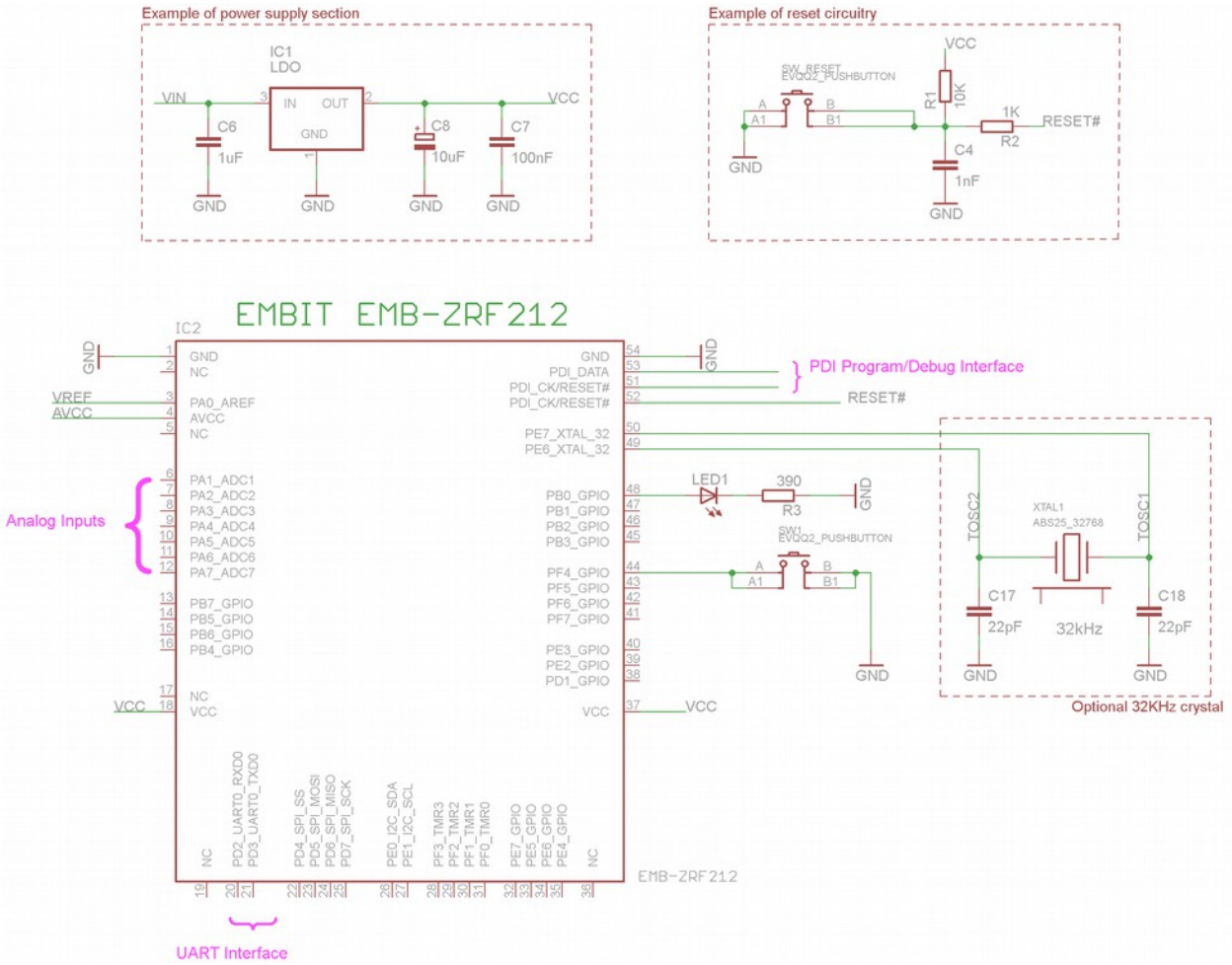


***Image 11**: Typical application circuit for the EMB-ZRF212B*

5 Electrical characteristics

5.1 Absolute Maximum Ratings

	Value	Unit
Power Supply Voltage	+3.6	Vdc
Voltage on any pin	Vcc+0.3 (Max 3.6)	Vdc
RF input power (PMAX)	10	dBm
Storage Temp. Range	-45 ~ +125	ºC

5.2 Operating Conditions

Parameter	Min	Typ	Max	Unit
Power Supply Voltage (Vcc)	1.8		3.6	Vdc
Operating Temperature Range	-40		85	ºC
Logic Input Low Voltage	0		0.2xVcc	Vdc
Logic Input High Voltage	0.8xVcc		Vcc	Vdc
Logic Output Low Voltage	0		0.18xVcc	Vdc
Logic Output High Voltage	0.82xVcc		Vcc	Vdc

5.3 Power Consumption

Mode	Typ	Unit
Transmission @ +10dBm (MCU core running)	36.1	mA
Transmission @ +0dBm (MCU core running)	31	mA
Receive (MCU core running)	14	mA
Idle (MCU core running, radio off)	3.9	mA
Sleep* (MCU core and radio sleeping)	1.3	µA

* with RTC running from low-power 32kHz TOSC.

Test condition: 25 ºC, VDD = 3.3 Vdc, EMB-ZRF212B/UL with EMB-AN868-BB24 external antenna

5.4 RF Characteristic

Parameter	Min	Typ	Max	Unit
RF Frequency Range*	863 902 915		870 928 930	MHz
Over-the-air Data Rate – BPSK modulation**		20	40	kbps
Over-the-air Data Rate – O-QPSK modulation**		100	1000	kbps
RF Output Power			+10	dBm
Receiver Sensitivity (1% PER) – BPSK modulation**		-110		dBm
Receiver Sensitivity (1% PER) – O-QPSK modulation**		-101		dBm
Saturation (IP3) – Maximum Input Level @ 868.3 MHz		-12		dBm
Blocking - BPSK modulation, 10MHz ch. spacing			71	dB

* as specified in “IEEE Standard 802.15.4™-2003: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (WPANs)”.

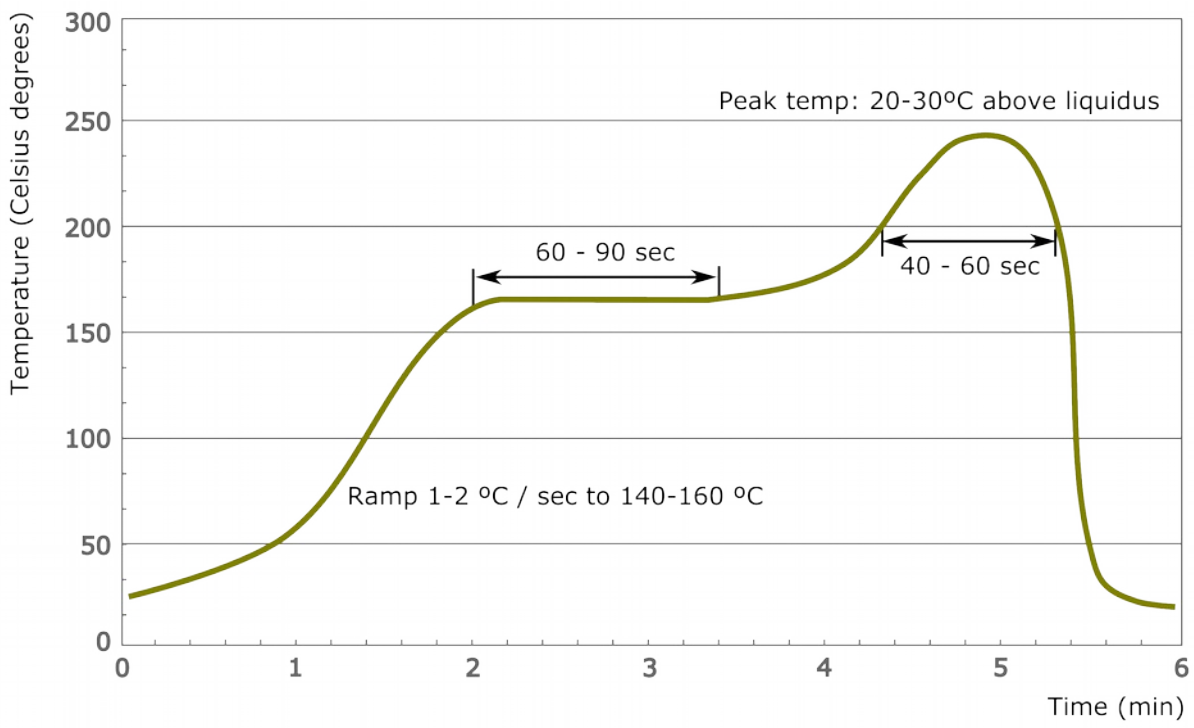
** see Atmel® AT86RF212B datasheet for more information.

5.5 MCU Characteristics

Column	Min	Typ.	Max	Unit	Note
MCU core frequency		8	32	MHz	
UART data rate	1.2		115.2	kbps	

6 Soldering

Temperature profile for reflow soldering:



Pb-Free Soldering Paste: it is suggested to used soldering pastes that don't need later clean for residuals.

Cleaning: it's not suggested to clean the module. Solder paste residuals underneath the module cannot be removed.

- Water cleaning: the cleaning process using water can involve water entering underneath the module between the two pcbs creating short circuits.
- Alcohol cleaning: the cleaning process with alcohol can damage the module.
- Ultrasound cleaning: the cleaning process with ultrasound can damage the module.

It is suggested to use no clean solder paste to avoid any need for cleaning.

Cycles: it is suggested to do only one soldering cycle.

In case of reflow soldering, a drying bake should be done in order to prevent a popcorn effect. Re-baking should be done following IPC standards. Any unused modules that has been exposed to air for more than 168 hours or that has not been stored at <10% RH should be baked before any subsequent reflow.

7 Ordering informations

7.1 Types

Module variations:

Part No.	MCU	Description
EMB-ZRF212B/CA	ATxmega128A3U	EMB-ZRF212B integrated ceramic antenna
EMB-ZRF212B/UL	ATxmega128A3U	EMB-ZRF212B with U.FL connector for external antenna

Related products:

Part No.	Description
EMB-ZRF212B-EVK	EMB-ZRF212B Evaluation Kit for EMB-ZRF212B modules

7.2 Packaging

Embit's modules are delivered in tubes, each tube including 20 items.

The tube dimensions are approximately: 508mm x 33mm x 8mm.

8 Regulatory compliance

The radio module has been designed to comply with the RTTE directive (1999/5/EC) of the European Union. Restrictions in terms of maximum allowed RF power or duty cycle may apply. This radio module has been designed to be embedded into other products (“final products”). According to the RTTE directive, the declaration of compliance and the “CE” labeling is within the responsibility of the manufacturer of the final product.

9 Disclaimer

The user must read carefully all the documentation available before using the product. In particular, care must be taken in order to comply with the regulations (i.e. power limits, duty cycle limits, etc.).

9.1 Handling precautions

This product is an ESD sensitive device. Handling precautions should be carefully observed.

9.2 Limitations

Every operation involving a modification on the internal components of the module will void the warranty.

9.3 Disclaimer of liability

The information provided in this and other documents associated to the product might contain technical inaccuracies as well as typing errors. Regulations might also vary in time. Updates to these documents are performed periodically and the information provided in these manuals might change without notice. The user is required to ensure that the documentation is updated and the information contained is valid. Embit reserves the right to change any of the technical/functional specifications as well as to discontinue manufacture or support of any of its products without any written announcement.

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