

The logo for 'embit' is positioned on a green horizontal bar. It features the word 'embit' in a lowercase, sans-serif font. To the right of the text is a graphic element consisting of several concentric, curved lines that resemble a stylized signal or a partial circle.

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

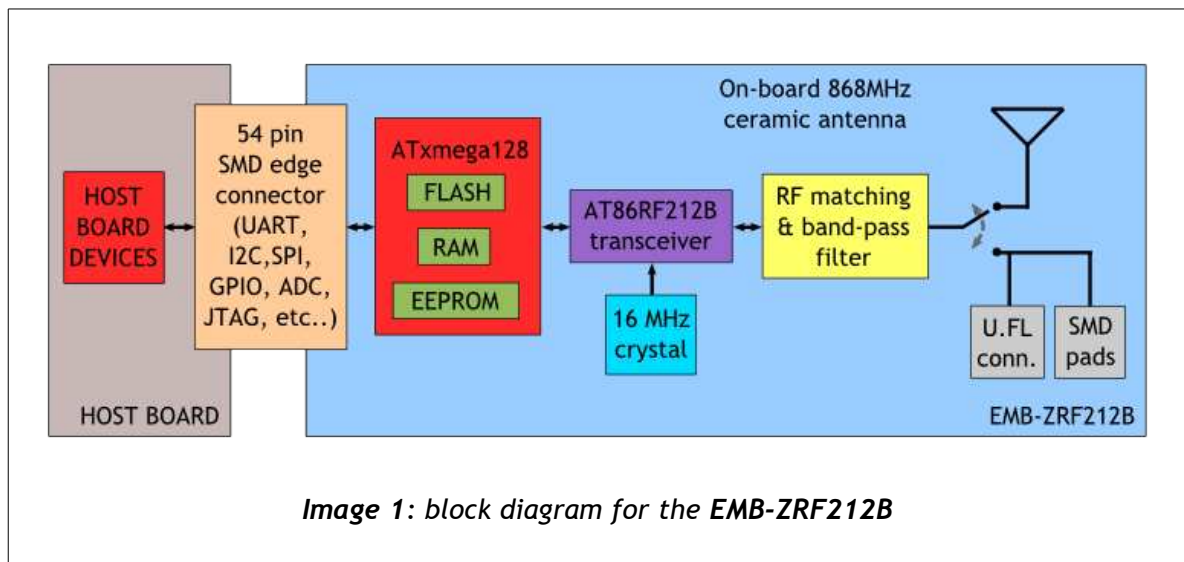
- 8-bit ATxmega128A3U MCU (opt: ATxmega256A3U)
- 128 KB Flash, 8 KB RAM, 2 KB EEPROM
- Output power: up to +10 dBm (10 mW)
- Sensitivity: up to -110 dBm
- Ceramic antenna or U.FL connector
- Coverage: up to 1000 meters LoS
- Edge SMD connector

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.



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

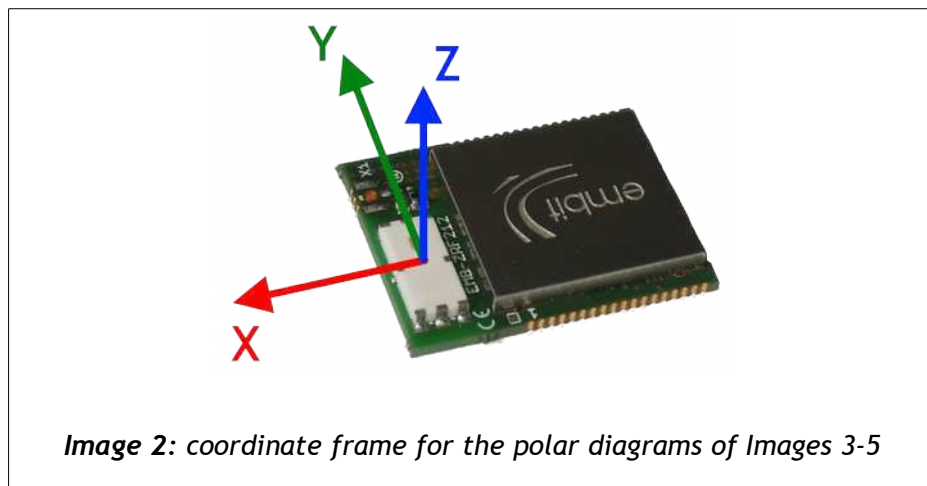
The EMB-ZRF212B offers three options for the antenna:

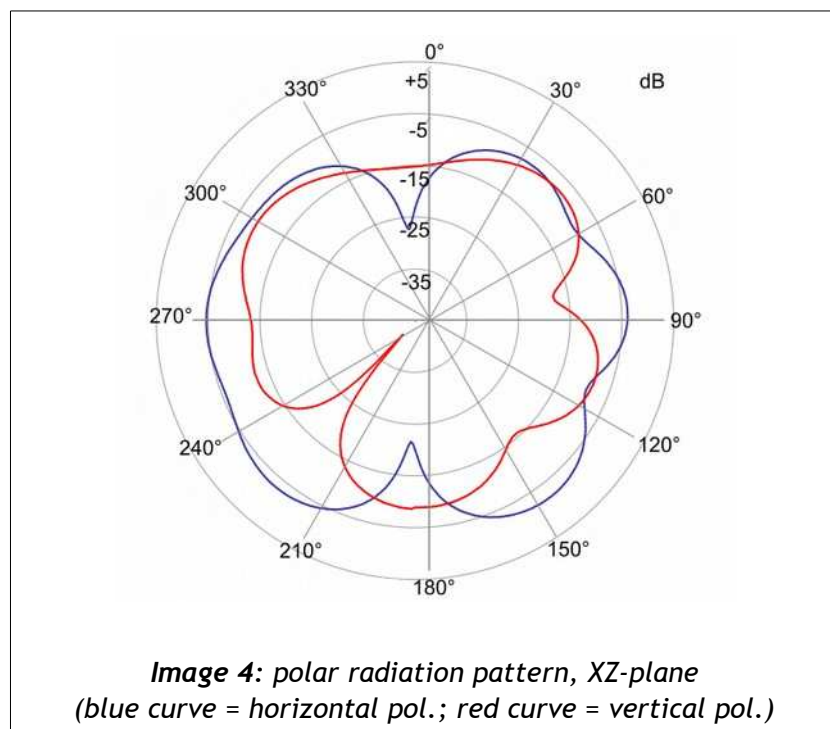
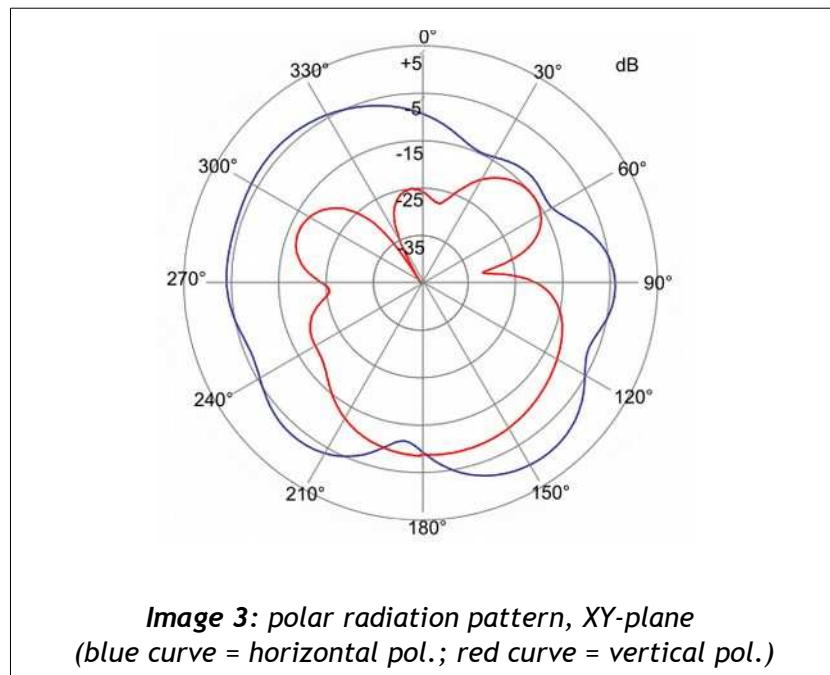
- **Ceramic antenna (optional):** multiband 868/915 MHz antenna
- **External antenna connector (optional):** 50 Ohm single-ended U.FL connector
- **Ground-Signal-Ground (GSG) SMD pads:** for connection to antennas mounted on the host board

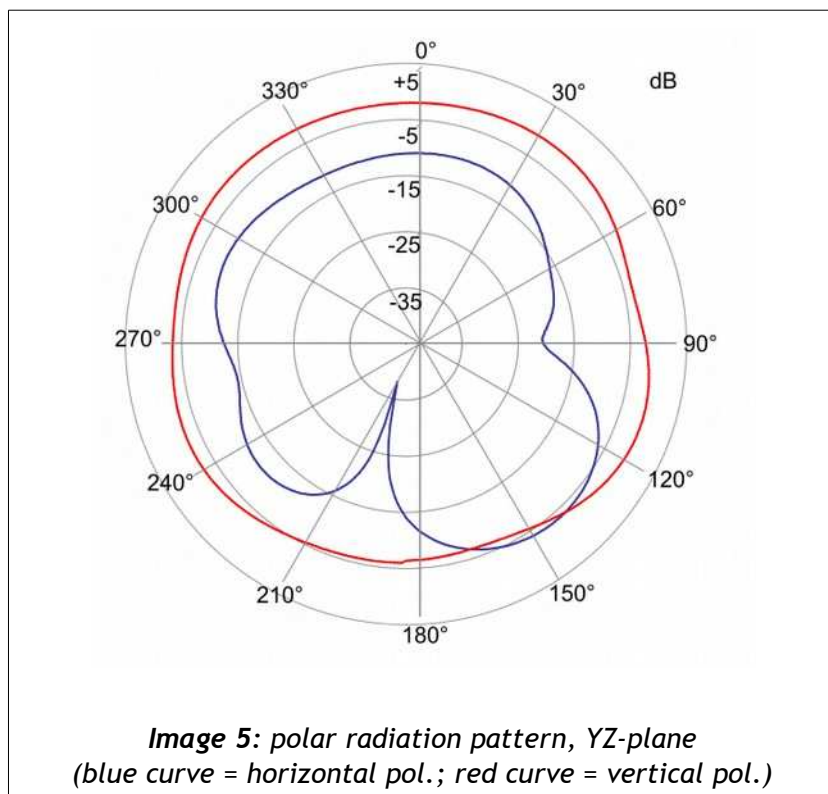
1.5.1 Ceramic antenna radiation diagram

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:

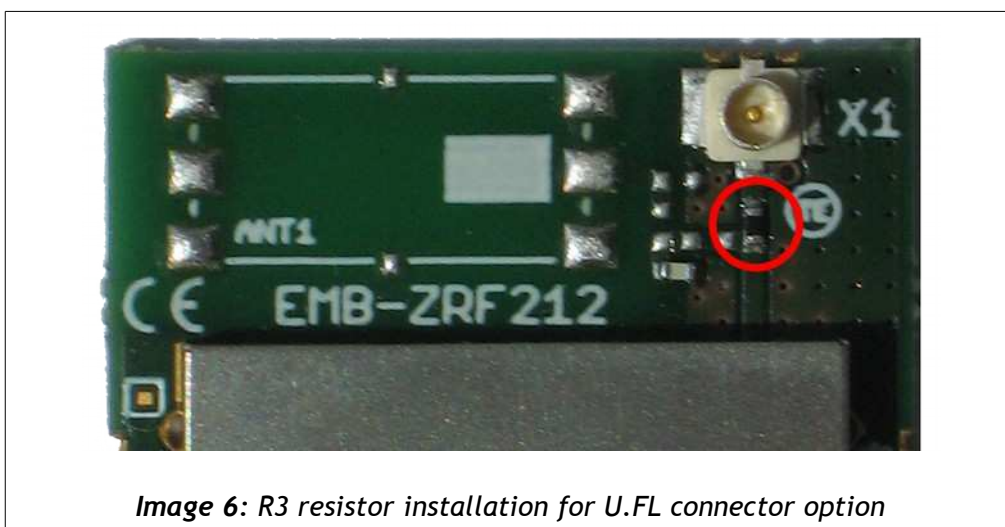






1.5.2 Antenna selection (ceramic/external)

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:



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

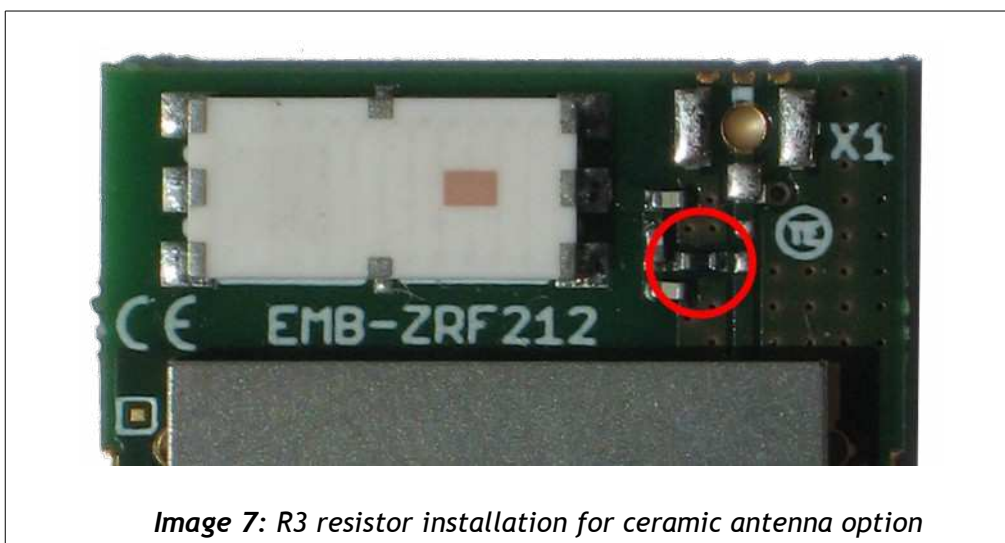


Image 7: R3 resistor installation for ceramic antenna option

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.

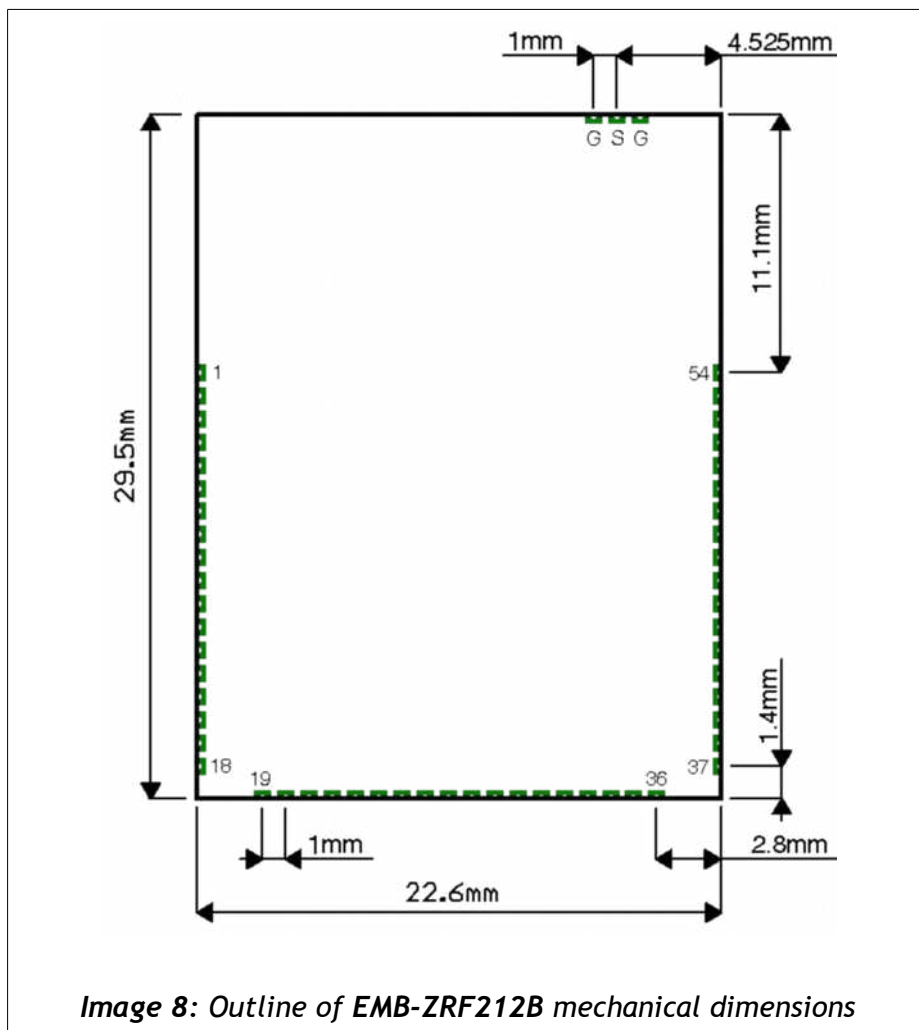
More information are also available on Embit website (www.embit.eu).

2 Size and footprint

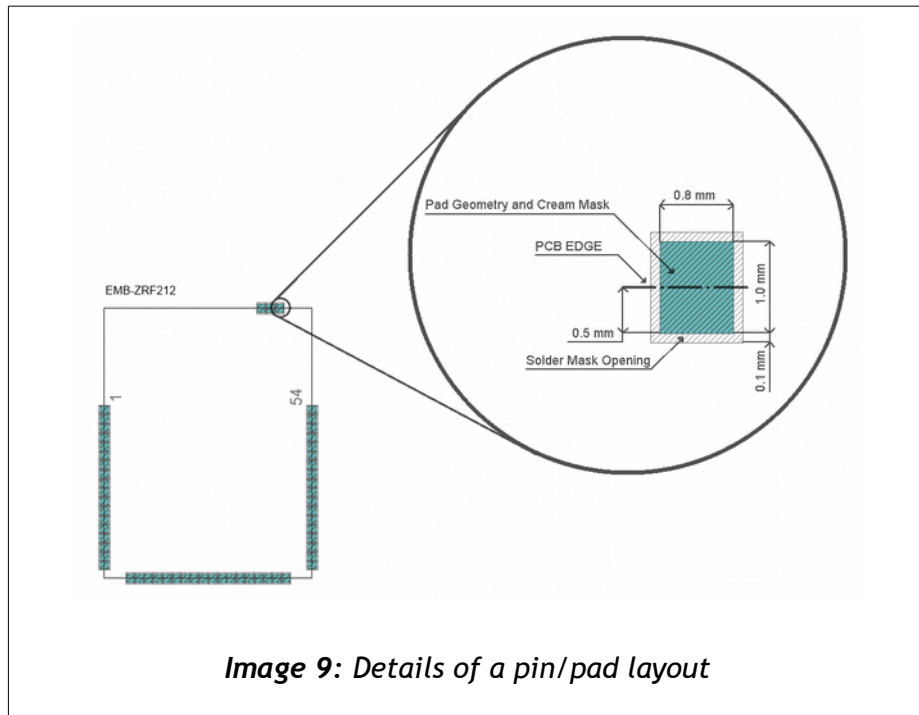
2.1 Size

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 *ground-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:

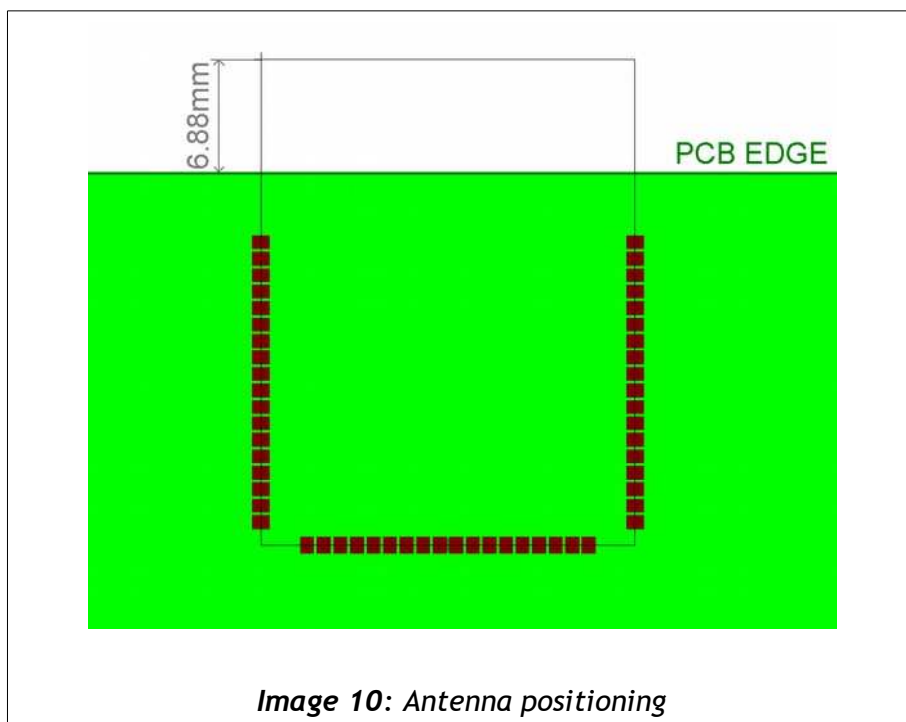


The suggested layout for the pin/pads of the EMB-ZRF212B is shown in the following image:



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:



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 |

Connections

| 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).

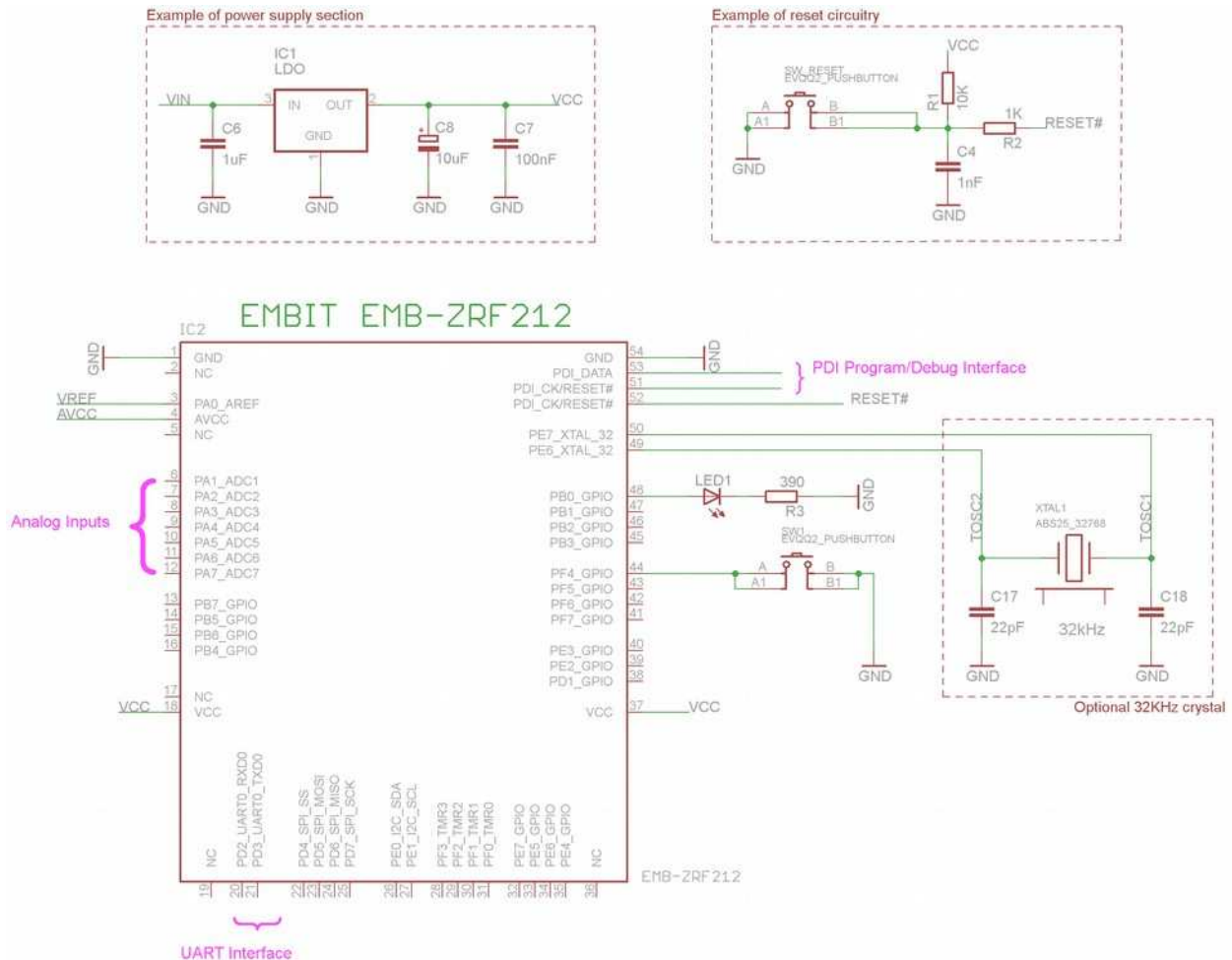


Image 11: Typical application circuit for the EMB-ZRF212B

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 (P _{MAX}) | 10 | dBm |
| Storage Temp. Range | -45 ~ +125 | °C |

5.2 Operating Conditions

| Parameter | Min | Typ | Max | Unit |
|-----------------------------|----------|-----|----------|------|
| Power Supply Voltage (Vcc) | 1.8 | | 3.6 | Vdc |
| Operating Temperature Range | -40 | | 85 | °C |
| 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 °C, 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)”.

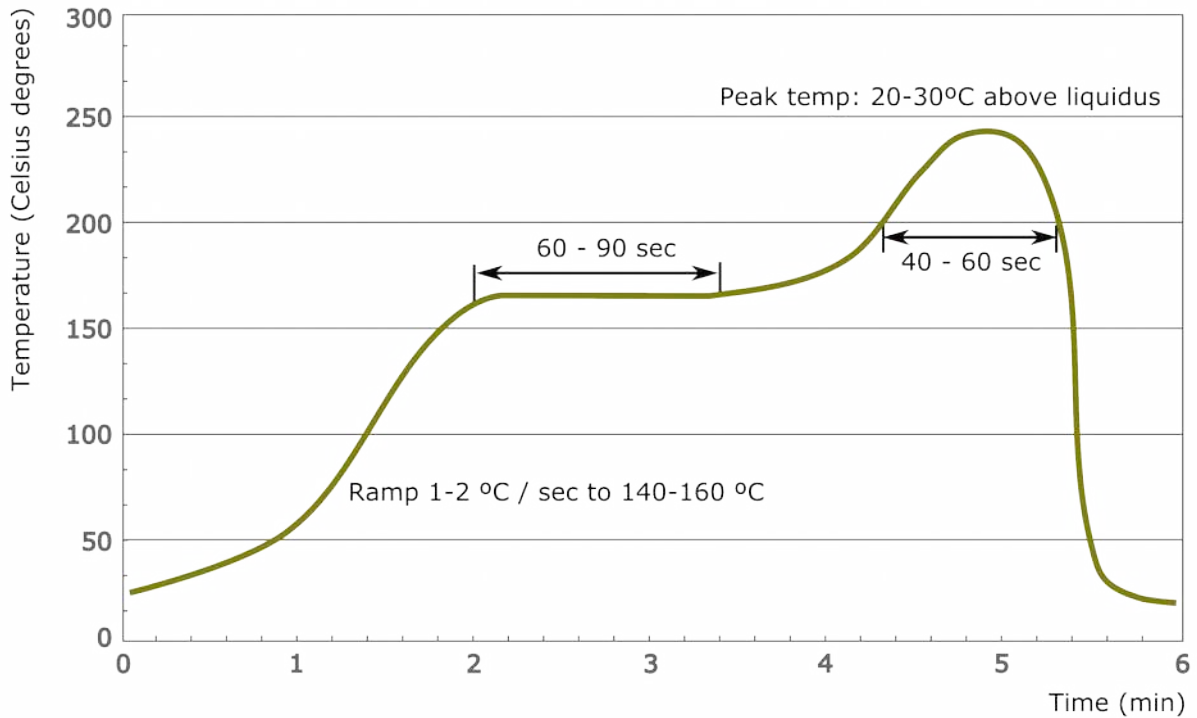
** see Atmel® AT86RF212B datasheet for more information.

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 use 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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