EMB-LR1272
EMB-LR1272E

Datasheet

Document information

Versions & Revisions

Revision	Date	Author	Comments
0.6	2014-11-07	Embit	Preliminary version
0.7	2015-02-18	Embit	Preliminary version
0.8	2015-07-01	Embit	Preliminary version
0.9	2015-12-17	Embit	Added EMB-LR1272E
1.0	2016-02-04	Embit	Modified Analog inputs

References

Ref	Version	Date	Author	Title

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1   Description

EMB-LR1272(E) is the first sub-1GHz **Embit**'s wireless module featuring the **Semtech's LoRa™** long range modem providing **ultra-long range** spread spectrum communication and high interference immunity on the 868 MHz SRD radio band. It is also compatible with **Wireless M-Bus   EN 13757-4:2013** mode S/T/R/C specifications.

EMB-LR1272(E) can be configured as an embedded micro system or simple data modem for low power applications in the 868 MHz radio band (EU). It is based on Semtech SX1272 transceiver coupled with Atmel® SAM MCU, equipped with up to 256 KB of FLASH memory and up to 32 KB of SRAM memory.

EMB-LR1272(E) can communicate with other devices through a wide range of serial interfaces: UART, I2C and SPI ports, several digital and analog I/O ports useful for the management of external devices and interfaces. Targets of the module are flexibility and power-awareness: EMB-LR1272(E) can be configured as network coordinator or router, as well as an end-device thanks to the extremely reduced power consumption (less than 3 µA in sleep mode with RTC running / 1 µA using XLP sleep with RTC running).

The **EMB-LR1272E** is the 2nd version of the LoRa™ module and it is pin-to-pin and software compatible with the **EMB-LR1272**; it features a higher power efficiency in transmission at the expense of a reduced maximum output power (+14 dBm in place of +19 dBm). EMB-LR1272E includes an embedded IEEE 64-bit Global Identifier (EUI-64) in compliance to the LoRaWAN specifications.

EMB-LR1272(E) firmware can be easily developed due to the module compatibility with the LoRaWAN™ network protocol stack. Moreover the associated Embit evaluation kit (EMB-LR1272-EVK) contains all the documentation, software and hardware tools to get started with EMB-LR1272.

1.1 Specifications

- MCU: 32-bit ARM Cortex™-M0+ Atmel ATSAMD20G1x series (optional on request ATSAML21G1x series)
- up to 256 KB Flash, up to 32 KB RAM
- Transceiver: Semtech SX1272
- RF output power: up to +14 dBm (optional on request +19 dBm) – EMB-LR1272E
      up to +19 dBm – EMB-LR1272
- RF sensitivity: beyond -137 dBm
- RF modulation: FSK/GFSK/ASK (compatible with Wireless M-Bus EN 13757-4:2013 mode S/T/R/C) or proprietary spread spectrum LoRa™ modulation
- Embedded 64-bit IEEE address EUI-64 (EMB-LR1272E only)
- U.FL connector or PCB pads
- Edge SMD connector

1.2 Applications

- Smart meter
- Smart grid concentrator
- Smart grid router/repeater or translator
- Proprietary solutions
- Industrial monitoring
- Wireless alarms
- Long range agricultural applications
- Smart cities / public light management

1.3 Block diagram

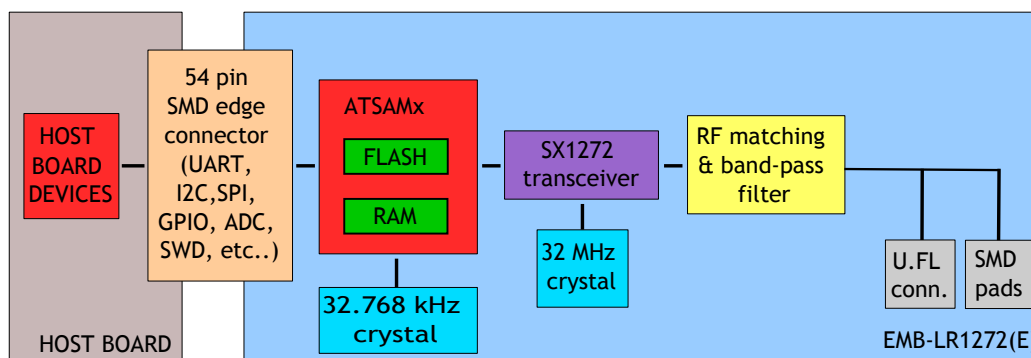The block diagram for the **EMB-LR1272** is shown in Image 1.

Image 1: Block diagram of EMB-LR1272 / EMB-LR1272E

For some notes about the design of the host board referenced in Image 1 (i.e., the board where the EMB-LR1272 is installed) please refer to Section 4.

1.4 Microcontroller

The **EMB-LR1272** employs an Atmel ATSAMD20G (or opt. ATSAML21G) series of MCU.

Such families of microcontrollers is characterized by a low-power, high-performance ARM Cortex™-M0+ architecture, achieving >2.14 Coremark/MHz, and capable of a clock frequency up to 48 MHz @ 3.3V.

The MCU includes several peripherals such as: an advanced programmable interrupt controller, eight flexible 16-bit timer/counters with compare modes and PWMs, six serial communication modules (SERCOM), one 14-channel/12-bit A/D converter, 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 SWD (ARM Serial Wire Debug), that represents a fast 2-pin standard interface.

1.5 Transceiver

The SX1272 transceiver feature the LoRa™ long range modem that provides ultra-long range spread spectrum communication and high interference immunity whilst minimizing current consumption.

Using Semtech's patented LoRa™ modulation technique SX1272 can achieve a sensitivity of over -137 dBm. The high sensitivity combined with the integrated power amplifier yields industry leading link budget, making it optimal for any application requiring long range and link robustness. LoRa™ also provides significant advantages in both blocking and selectivity capabilities over all conventional modulation techniques, improving the traditional design compromises between coverage, interference immunity and energy consumption.

1.6 Antenna

The **EMB-LR1272** offers three antenna options:

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

Note: the antenna choice is done via a 0 Ω resistor on the RF path; please refer to the section "Ordering information".

1.7 Firmware

The **EMB-LR1272** can be operated with the LoRaWAN™ protocol stack, extended with Embit additional features; moreover, a serial bootloader can be provided to upgrade the device without any additional hardware needed.

1.8 Development tools

The **EMB-LR1272** supports the Semtech's LoRaWAN™ wireless protocol stack, plus proprietary customizations form Embit.

To work with the EMB-LR1272 module, the following software tools are suggested:

- Atmel Studio 6.2 SP2 IDE (minimum version)
- Atmel-ICE debugger and programmer (or any other programmer/debugger supporting Atmel SAM D20 microcontrollers) or SEGGER J-LINK

To quickly get started with Embit modules, Embit also provides ready-to-use firmware for the EMB-LR1272 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-LR1272 firmware development and "EBI" usage, please refer to the associated Embit evaluation kit (EMB-LR1272-EVK), which contains all the documentation, software and hardware tools to get started with EMB-LR1272.

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

2 Size and footprint

2.1 Size

The mechanical dimensions of the **EMB-LR1272** are, as every other module from Embit: 29,50 x 22,60 mm. The thickness is under 4 mm.

The **EMB-LR1272** module has three 18 pin "edge" connector with a 1,00 mm pitch, for a total of 54 pins, plus 3 g*round-signal-ground* (GSG) pins for RF signal. Each pin is a metalized half hole 0,50 mm in diameter. The position of the connector is shown in the following image:
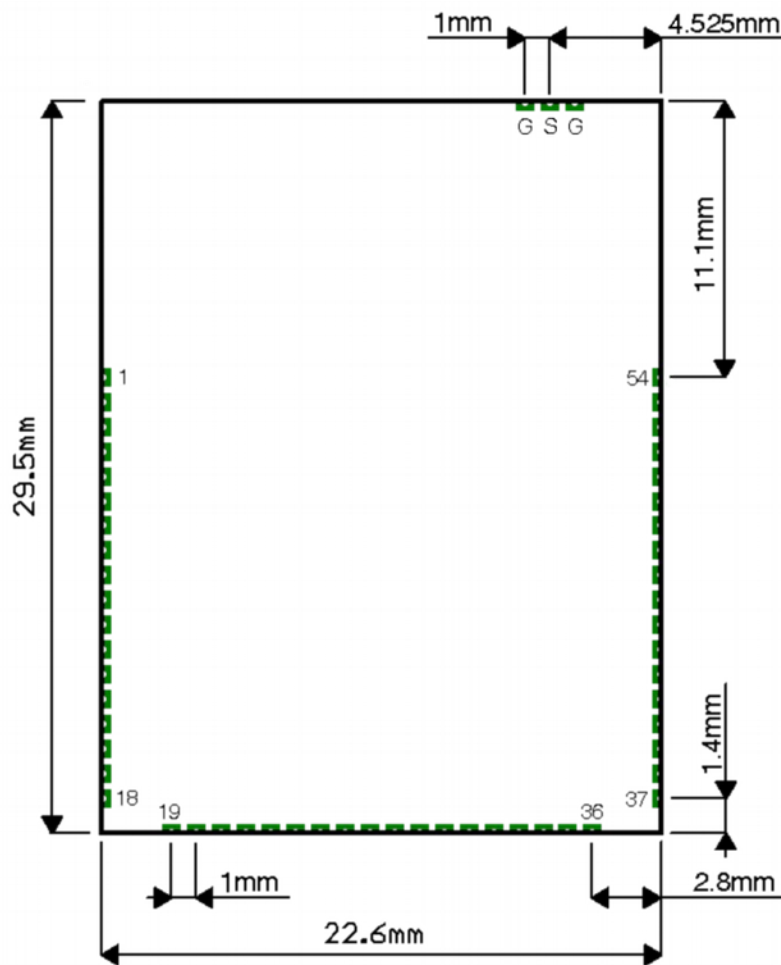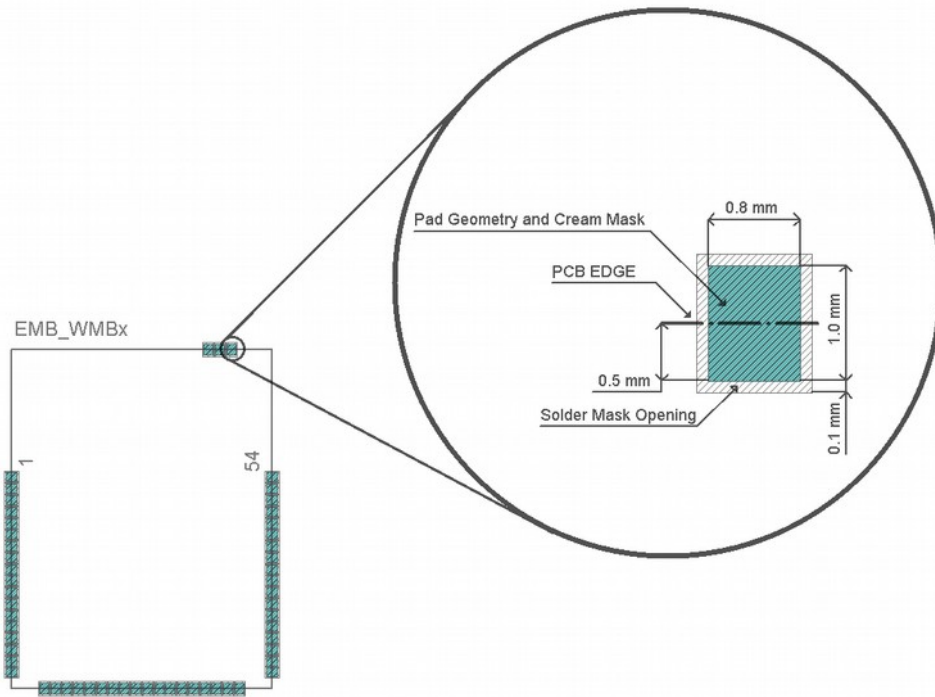

Image 2: Connector positions

2.2 Suggested footprint

The **EMB-LR1272** footprint consists in 57 smd pads 1,00 x 0,80 mm in dimensions positioned as following:

Image 3: Suggested Footprint

2.3 External antenna connection

The antenna output of the module is matched to 50 Ω. By using a 50 Ω antenna, no additional matching is required. Connection with antenna should be as short as possible, and must represent a characteristic impedance of 50 Ω. A grounded coplanar waveguide is suggested to minimize the interaction with the external environment.

2.4 Notes

- The area underneath the module must be kept free of components (both top and bottom layers) and must be covered with solder resist.
- The PCB top layer underneath the module must be free of nets, power planes and vias. The bottom layer shall provide a ground plane.
- The power supply of the module must be as clean as possible; it must be decoupled placing a ceramic capacitor as near as possible at the Vcc pins, additional filtering made by a ferrite bead is recommended.
- Noisy electronic components (such as switching power supply) must be placed as far as possible and adequately decoupled.
- The ground pins of the module shall be connected to a solid ground plane.

Note: Taking no account this recommendations may affect the radio performances.

3   Connections

3.1   Module pinout

Pin #	Pin Name	Type	Description	IC Pin #
1	GND	GND	GND	--
2	N.C.	Not connected	Not connected pin	--
3	PA3_VREFA	Analog Input or Digital I/O	ADC voltage reference / AIN0 / PA3	4
4	N.C.	Not connected	Not connected pin	--
5	N.C.	Not connected	Not connected pin	--
6	PA2_ADC1	Analog Input or Digital I/O	AIN1 / PA2	3
7	N.C.	Not connected	Not connected pin	--
8	N.C.	Not connected	Not connected pin	--
9	N.C.	Not connected	Not connected pin	--
10	N.C.	Not connected	Not connected pin	--
11	N.C.	Not connected	Not connected pin	--
12	N.C.	Not connected	Not connected pin	--
13	N.C.	Not connected	Not connected pin	--
14	N.C.	Not connected	Not connected pin	--
15	SWCLK	JTAG	SWD Debug port clock	45
16	SWDIO	JTAG	SWD Debug port data	46
17	N.C.	Not connected	Not connected pin	--
18	VCC	Power Input	Supply voltage	--
19	N.C.	Not connected	Not connected pin	--
20	N.C.	Not connected	Not connected pin	--
21	N.C.	Not connected	Not connected pin	--
22	PA15_UART1_RTS	Digital I/O	Sercom_4 / UART1 RTS input / PA15	24
23	PA13_UART1_CTS	Digital I/O	Sercom_4 / UART1 CTS output / PA13	22
24	PA14_UART1_RX	Digital I/O	Sercom_4 / UART1 RX input / PA14	23
25	PA12_UART1_TX	Digital I/O	Sercom_4 / UART1 TX output / PA12	21
26	PA8_I2C_SDA	Analog Input or Digital I/O	AIN16 / Sercom_2 / I2C SDA / PA8	13
27	PA9_I2C_SCL	Analog Input or Digital I/O	AIN17 / Sercom_2 / I2C SCL / PA9	14
28	N.C.	Not connected	Not connected pin	--
29	N.C.	Not connected	Not connected pin	--
30	PB11_TMR1	Digital I/O	TMR1 / PB11	20
31	PB10_TMR0	Digital I/O	TMR0 / PB10	19
32	PA5_SPI_SCK	Analog Input or Digital I/O	AIN5 / Sercom 0 / SPI SCK / PA5	10
33	PA4_SPI_MOSI	Analog Input or Digital I/O	AIN4 / Sercom 0 / SPI MOSI / PA4	9

Pin #	Pin Name	Type	Description	IC Pin #
34	PA7_SPI_MISO	Analog Input or Digital I/O	AIN7 / Sercom 0 / SPI MISO / PA7	12
35	PA6_SPI_SS	Analog Input or Digital I/O	AIN6 / Sercom 0 / SPI SS / PA6	11
36	N.C.	Not connected	Not connected pin	--
37	VCC	Power Input	Supply voltage	--
38	N.C.	Not connected	Not connected pin	--
39	N.C.	Not connected	Not connected pin	--
40	N.C.	Not connected	Not connected pin	--
41	N.C.	Not connected	Not connected pin	--
42	N.C.	Not connected	Not connected pin	--
43	PB22_GPIO	Digital I/O	PB22	37
44	PB8_GPIO	Analog Input or Digital I/O	AIN2 / PB8	7
45	N.C.	Not connected	Not connected pin	--
46	N.C.	Not connected	Not connected pin	--
47	PA10_GPIO	Digital I/O	PA10	15
48	PB9_GPIO	Analog Input or Digital I/O	AIN3 / PB9	8
49	N.C.	Not connected	Not connected pin	--
50	N.C.	Not connected	Not connected pin	--
51	RESET#	Reset Input	System reset input (active low)	40
52	N.C.	Not connected	Not connected pin	--
53	N.C.	Not connected	Not connected pin	--
54	GND	GND	GND	--

Note: All GPIO supports the MCU interrupt request, except ("PA15_UART1_RTS" and "PB22_GPIO").

3.2 Typical application circuit

The external supply shall include protection from spikes, short circuits and it requires adequate decoupling.

Note:

- Voltage glitches on VCC supply may cause reset or malfunctioning of the microcontroller.

- Slow voltage ramp on VCC or RESET# may cause malfunctioning of the microcontroller.

- Do not reset or turn off the power of the module while writing to the flash; otherwise memory corruption may occur.

4 Typical application circuitry

A basic application circuit for the **EMB-LR1272** is shown below. The EMB-LR1272 allows for a minimal number of external components (thus decreasing system costs).

A LED indicator (LED1) and a push button (SW1) are used to provide a minimal user interface. The SWD programming/debugging interface, generally speaking, should 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 the image below allows to:

1. program the MCU of the EMB-LR1272 (thanks to the weak pull-up to VCC);

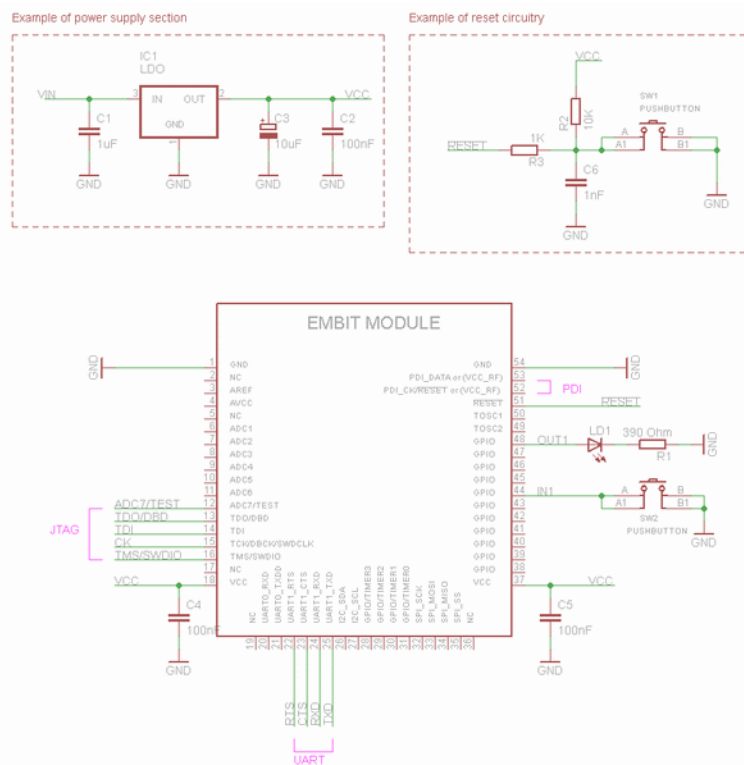2. manually reset the MCU, if needed (thanks to SW_RESET).

Image 4: Typical application circuit for genieric module

Note:

- an EMI filter bead (e.g., Murata BLM18PG300SN1D) is suggested to filter the Vcc power supply

- the EMB-LR1272 includes a 2-wire SWD programming interface, not the complete JTAG in the above image.

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	-40 ~ +125	ºC

5.2 Operating Conditions

Parameter	Min	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. value	Unit
Transmit @ +19dBm 3,3V (EMB-LR1272)	125	mA
Transmit @ +14dBm 3,3V (EMB-LR1272E)	40	mA
Receive	12	mA
Sleep (*)	3	µA
XLP Sleep (**)	1	µA

* with RTC running.

** with RTC running. Requires special hardware configuration (Atmel SAM L21 MCU ; availab. Q1 2016).

5.4 RF Characteristics

EMB-LR1272 RF Characteristics (Vcc=3.3V 25°C):

	Min	Typ.	Max	Unit	Note
RF Frequency range	863.000		870.000	MHz	
Frequency tolerance		15		ppm	
RF Data Rate (G)FSK	0.6		300	kbps	
RF Data Rate LoRa™	0.3		37.5	kbps	
Programmable Output Power Range			+19 +14	dBm dBm	EMB-LR1272 EMB-LR1272E
Rx Bandwidth	8		250	kHz	
Receiver Sensitivity 4.8kbps GFSK FD=5kHz		-119		dBm	GFSK modulation
Receiver Sensitivity RB=300 bps BW=125 kHz		-137		dBm	LoRa™ modulation
Receiver Sensitivity RB=3.1 kbps BW=125 kHz		-126		dBm	LoRa™ modulation
Receiver Sensitivity RB=9 kbps BW=125 kHz		-121		dBm	LoRa™ modulation
Receiver Sensitivity RB=1.2 kbps BW=500 kHz		-129		dBm	LoRa™ modulation
Receiver Sensitivity RB=3.9 kbps BW=500 kHz		-126		dBm	LoRa™ modulation
Receiver Sensitivity RB=37 kbps BW=500 kHz		-111		dBm	LoRa™ modulation
RF Input saturation		+10		dBm	
Blocking ± 2 MHz ± 10 MHz		TBD TBD		dB dB	As specified in EN 300 220

5.5 MCU Characteristics

	Min	Typ.	Max	Unit	Note
MCU core frequency		8	48	MHz	
UART data rate	1.2		115.2	kbps	

6 Soldering

Temperature profile for reflow soldering:

	Nm	Val.
Pre-heating	Ramp-up	3°C/s max
Minimum pre-heating temperature	Tsoak min	150°C
Maximum pre-heating temperature	Tsoak max	200°C
Pre-heating interval	Tsoak	60-120 s
Reflow temperature	Tl	217°C
Reflow interval	Tl	60-150 s
Peak temperature	Tpeak	260°C
Interval to 5°C from tpeak	--	20-30 s
Interval to 25°C from tpeak	--	8 min. max
Cool down	Ramp-down	6°C/s max

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.

- <u>Water cleaning</u>: the cleaning process using water can involve water entering underneath the module between the two PCBs creating short circuits.
- <u>Alcohol cleaning</u>: the cleaning process with alcohol can damage the module.
- <u>Untrasound cleaning</u>: 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.

IMPORTANT: 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 open for more than 168 hours or not stored at <10% RH should be baked before any subsequent reflow.

7 Ordering information

7.1 Types

Module part numbers:

Part No.	Mcu	Description
EMB-LR1272/PC	ATSAMD20G18	**NRND -** EMB-LR1272 without U.FL connector (GSG pads only)
EMB-LR1272/UL	ATSAMD20G18	**NRND -** EMB-LR1272 with U.FL connector
EMB-LR1272/CA	ATSAMD20G18	**NRND -** EMB-LR1272 with ceramic antenna
EMB-LR1272E/PC	ATSAMD20G18	EMB-LR1272E without U.FL connector (GSG pads only)
EMB-LR1272E/UL	ATSAMD20G18	EMB-LR1272E with U.FL connector
Contact us	other	-

Related products:

Part No.	Mcu	Description
EMB-LR1272E-EVK	ATSAMD20G18	EMB-LR1272 Evaluation Kit

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 (e.g., 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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