EMB-LR1302/3-mPCIe
Datasheet

Embit s.r.l.

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Document information

Versions & Revisions

Revision	Date	Author	Comments
Preliminary	2021-02-08	Embit	Preliminary
1.0	2021-07-07	Embit	Initial release
1.1	2022-12-14	Embit	Minor changes
1.2	2023-11-3	Embit	USB version Pin Out fix

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1 Introduction

EMB-LR1303-mPCIe provides long range connectivity using LoRa® modulation characterized by high interference immunity. It introduces a new Fine Timestamp capability that enables Time Difference of Arrival (TDOA) network-based geolocation.

EMB-LR1303-mPCIe is designed around the Semtech SX1303 which is a new baseband processor for LoRa® gateways. The SX1303 is pin to pin compatible with SX1302.

It offers up to 8 LoRa® channels in the 868 MHz (or 915 MHz) frequency allowing it to receive up to 64 LoRa® packets simultaneously. It is able to achieve a sensitivity of *-140dBm* and a RF output power of *+27dBm* making it the ideal device to use in LoRa® gateways applications. It supports two new spreading factors: SF5 and SF6. This enables users to reach higher data rate communication.

Figure 1. EMB-LR1302/3-mPCIe.

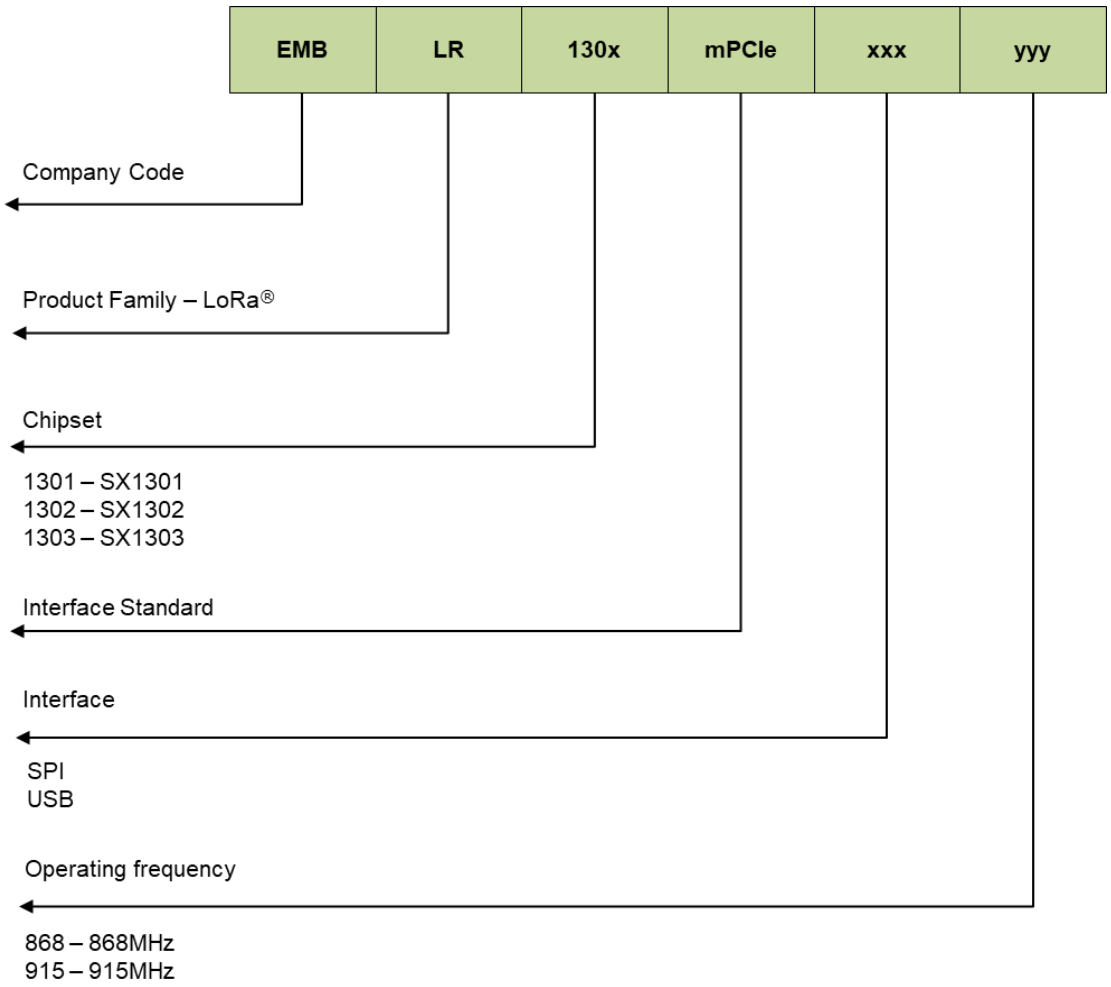
EMB-LR1303-mPCIe supports the Listen Before Talk (LBT) that allows scanning of the channel prior to the transmission.

1.1 Specifications

- Operating Voltage: 3.3V / 5V
- Current Consumption: 421mA (Tx@+27dBm); 39mA (Rx)
- Modulation: LoRa® Spread Spectrum, FSK, GFSK
- Operating Frequency: 868MHz (EU) / 915MHz (US)
- Frequency Range: 860MHz to 1020MHz
- Operating Temperature: -40°C to +85°C
- RF Output Power: Up to +27dBm
- Interfaces: Standard mPCIe or Proprietary mPCIe (SPI / I2C / GPIOs)
- Sensitivity: Up to -140 dBm
- Dimensions: 30.00×50.95×1.00 mm

- Features: On-board uFL antenna connector,
  8 LoRa® Channels

1.2 Ordering Information



1.3 Applications

The device can be used in several applications where LoRa gateway is needed, such as:

- Internet Of Things (IoT)
- Automated Meter Reading
- Smart Cities
- Home and Building Automation
- Wireless Alarm and Security System
- Machine to Machine (M2M)
- Industrial Monitoring and Control
- Long Range Irrigation System.

2 Description

2.1 Block Diagram

The **EMB-LR1303-mPCIe** block diagram:

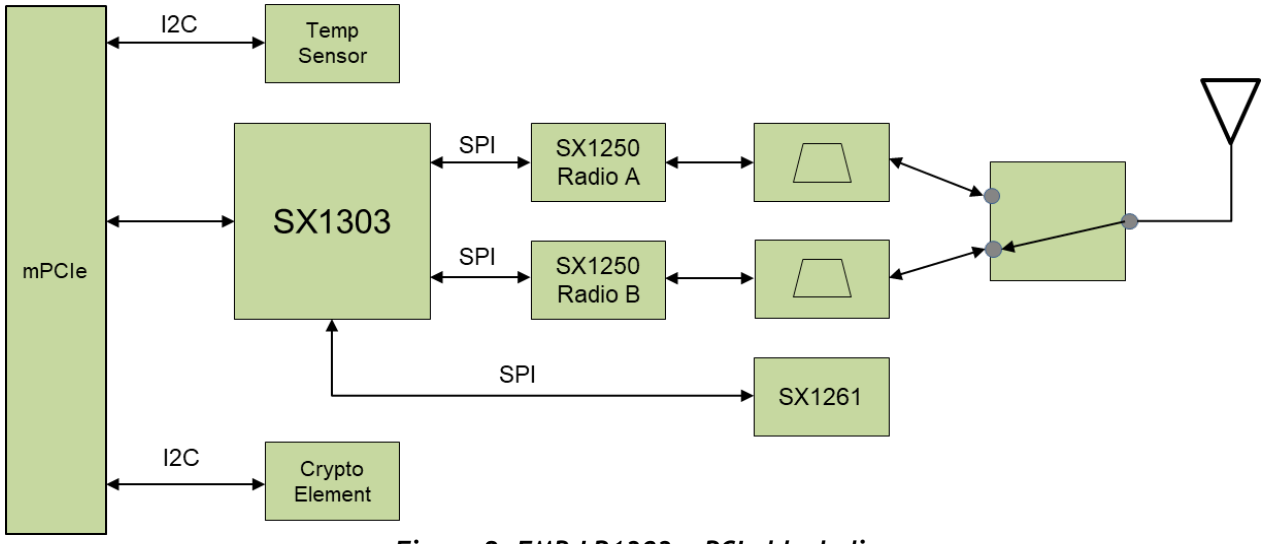


Figure 2: EMB-LR1303-mPCIe block diagram.

2.2 SX1303 Module

The SX1303 is a new generation of baseband LoRa® chip for gateways. It is pin to pin compatible with the SX1302 and it excels in reducing current consumption, simplifies the thermal design of gateways and it is capable of handling a higher amount of traffic than preceding devices.

Main features:

- **SPI / USB** link with the CPU
- **RF standard supported**: LoraWAN®
- **Frequency band**: 868 MHz, 915MHz
- **libloragw** is the driver of the SX1302/3, that provides API for LoRa® packet exchange using the SX1302/3 (developed by Semtech, customized and ported by Embit® to this specific platform)
- **packet_forwarder** is the application that allows the exchange of LoRaWAN® packet with a LoRaWAN® server. It forwards RF packets received by the gateway to a server through an IP/UDP link, and emits RF packets that are sent by the server.
- **Sample Projects**:
  - Semtech source code available SX1302/3-Hal
  - **helper programs**: util_pkt_logger, util_spi_stress, util_tx_test,

util_tx_continuous, spectral_scan.

2.3 SX1250 Module

The two **SX1250** [2] are a half-duplex sub-1 GHz RF to IQ transceiver designed to work along with Semtech's SX1302 baseband engine, to design a high-performing LoRaWAN® gateway.

The SX1250 is capable of low power operation in the 150-960 MHz ISM frequency bands. It has a maximum signal bandwidth of 500 kHz both in transmission and reception.

The SX1250 transceiver is controlled by its companion baseband chip SX1302 through an SPI interface.

2.4 SX1261 Module

The **SX1261** [3] is a LoRa transceiver ideal for long range wireless application.

The SX1261 is capable of low power operation in the 150-960 MHz ISM frequency bands. It offers Listen-Before-Talk (LBT) and the spectral scan capabilities that helps detecting occupied bands and get interferer profile.

2.5 Crypto Element (ATECC608)

The Crypto element is a high-security cryptographic device which combines world-class hardware-based key storage with hardware cryptographic accelerators to implement various authentication and encryption protocols.

The includes an EEPROM array which can be used for storage of up to 16 keys, certificates, miscellaneous read/write, secret data, and security configurations. Access to the various sections of memory can be restricted in a variety of ways and then the configuration can be locked to prevent changes.

It can be used as an Ecosystem control and Anti-Counterfeiting and validates if a system or component is authentic and came from the OEM shown on the name plate.

Access to the device is made through a standard I2C Interface at speeds of up to 1 Mb/s.

2.6 External Antenna Connection

The **EMB-LR1302-mPCIe** has a uFL connector for 868MHz antenna (or 915MHz for US market).

3 Connections

3.1 Pin Out Description (SPI Version)

The table below gives the description of the pin out of the mPCIe interface.

Number	Pin Name	Type	Description
1	SX1261_NSS	Input	SPI Slave Select for SX1261
2	VCC	Power	5V
3	NC	NC	Not Connected
4	GND	Power (GND)	Ground
5	POWER_ENABLE	Input	SX1302/3 Enable Pin
6	GPIO6	I/O	General Purpose IO
7	CLKREQ#	NC	Not Connected
8	SPI-MOSI	Input	SX1302/3 SPI MOSI
9	GND	Power (GND)	Ground
10	SPI-MISO	Output	SX1302/3 SPI MISO
11	PPS	Input	GPS PPS Input
12	SPI-SCLK	Input	SX1302/3 SPI Clock
13	REFCLK+	NC	Not Connected
14	SPI-CSN	Input	SX1302/3 SPI Chip Select
15	GND	Power (GND)	Ground
16	UIM_VPP	NC	Not Connected
17	SX1261_DIO1	NC	SX1261 Radio DIO1 Pin
18	GND	Power (GND)	Ground
19	SX1261_BUSY	Output	SX1261 Busy Pin
20	W_DISABLE#	NC	Not Connected
21	GND	Power (GND)	Ground
22	SX1303_RESET	Input	SX1302/3 Reset Pin (Active High)
23	PERn0	NC	Not Connected
24	VCC	Power	5V
25	PERp0	NC	Not Connected
26	GND	Power (GND)	Ground
27	GND	Power (GND)	Ground
28	1.5V	NC	Not Connected
29	GND	Power (GND)	Ground
30	I2C_SCL	Input	I2C Clock Pin

31	PETn0	NC	Not Connected
32	I2C_SDA	Input/Output	I2C data Pin
33	PETp0	NC	Not Connected
34	GND	Power (GND)	Ground
35	GND	Power (GND)	Ground
36	USB_D-	NC	Not Connected
37	GND	Power (GND)	Ground
38	USB_D+	NC	Not Connected
39	VCC	Power	5V
40	GND	Power (GND)	Ground
41	VCC	Power	5V
42	SX1261_NRESET	Input	SX1261 Reset Pin (Active Low)
43	GND	Power (GND)	Ground
44	LED_WLAN#	NC	Not Connected
45	Reserved	NC	Not Connected
46	LED_WPAN#	NC	Not Connected
47	Reserved	NC	Not Connected
48	1.5V	NC	Not Connected
49	Reserved	NC	Not Connected
50	GND	Power (GND)	Ground
51	Reserved	NC	Not Connected
52	VCC	Power	5V

Table 1: mPCIe Interface Pin Out.

3.2 Pin Out Description (USB Version)

Number	Pin Name	Type	Description
1	SX1261_NSS	NM	Not Mounted
2	VCC	Power	3.3/5 V
3	NOT USED	NC	Not Connected
4	GND	Power (GND)	Ground
5	POWER_ENABLE	NM	Not Mounted
6	GPIO6	NM	Not Mounted
7	NOT USED	NC	Not Connected
8	SPI-MOSI	NM	Not Mounted
9	GND	Power (GND)	Ground
10	SPI-MISO	NM	Not Mounted
11	PPS	Input	GPS PPS Input
12	SPI-SCLK	NM	Not Mounted
13	NOT USED	NC	Not Connected
14	SPI-CSN	NM	Not Mounted
15	GND	Power (GND)	Ground
16	NOT USED	NC	Not Connected
17	SX1261_DIO1	NM	Not Mounted
18	GND	Power (GND)	Ground
19	SX1261_BUSY	NM	Not Mounted
20	NOT USED	NC	Not Connected
21	GND	Power (GND)	Ground
22	SX1303_RESET	NM	Not Mounted
23	NOT USED	NC	Not Connected
24	VCC	Power	3.3/5 V
25	NOT USED	NC	Not Connected
26	GND	Power (GND)	Ground
27	GND	Power (GND)	Ground
28	NOT USED	NC	Not Connected
29	GND	Power (GND)	Ground
30	I2C_SCL	Input	I2C Clock Pin
31	NOT USED	NC	Not Connected
32	I2C_SDA	Input/Output	I2C data Pin
33	NOT USED	NC	Not Connected

34	GND	Power (GND)	Ground
35	GND	Power (GND)	Ground
36	USB_D-	I/O	USB negative
37	GND	Power (GND)	Ground
38	USB_D+	I/O	USB positive
39	VCC	Power	3.3/5 V
40	GND	Power (GND)	Ground
41	VCC	Power	3.3/5 V
42	SX1261_NRESET	NM	Not Mounted
43	GND	Power (GND)	Ground
44	BOOT0	NM	Not Mounted
45	NOT USED	NC	Not Connected
46	MCU NRESET	NM	Not Mounted
47	NOT USED	NC	Not Connected
48	NOT USED	NC	Not Connected
49	NOT USED	NC	Not Connected
50	GND	Power (GND)	Ground
51	NOT USED	NC	Not Connected
52	VCC	Power	3.3/5 V

Table 2: mPCIe Interface Pin Out.

4 Electrical Characteristics

4.1 Absolute Minimum and Maximum Ratings

Parameter	Min	Max	Unit
Power Supply Voltage	-0.5	5.5	Vdc
Storage Temperature	-40	125	°C

Table 3: Absolute minimum and maximum ratings.

4.2 Operating Conditions

Parameter	Min	Typ	Max	Unit
Power Supply Voltage (Vcc) SPI	3.0	5	5.5	V
Power Supply Voltage (Vcc) USB	3.0	3.3	3.6	V
Operating Temperature range	-40	25	+85	°C
Logic Low Input threshold	-0.3		0.3*Vcc	V
Logic High Input threshold	0.7*Vcc		Vcc+0.3	V
Logic Low Output Level	0		0.4	V
Logic High Output Level	Vcc-0.6		Vcc	V

Table 4: Operating Conditions.

4.3 Power Consumption

Mode	Typ. value	Unit
Transmission @ +27dBm	421	mA
Transmission @ +20dBm	262	mA
Transmission @ +14dBm	148	mA
Reception	39	mA

Table 5: Power Consumption.

4.4 RF Characteristics

Condition	Min.	Typ.	Max.	Unit
Output Power			+27	dBm
Receiver sensitivity SF12; BW=125KHz		-140		dBm
Receiver sensitivity SF11; BW=125KHz		-137		dBm
Receiver sensitivity SF10; BW=125KHz		-134,5		dBm
Receiver sensitivity SF9; BW=125KHz		-131,5		dBm
Receiver sensitivity SF8; BW=125KHz		-129		dBm
Receiver sensitivity SF7; BW=125KHz		-125,5		dBm
Receiver sensitivity SF6; BW=125KHz		-124		dBm
Receiver sensitivity SF5; BW=125KHz		-121		dBm
Receiver sensitivity SF9; BW=250KHz		-125,5		dBm

Table 6: Receiver Sensitivity.

5 Mechanical Characteristics

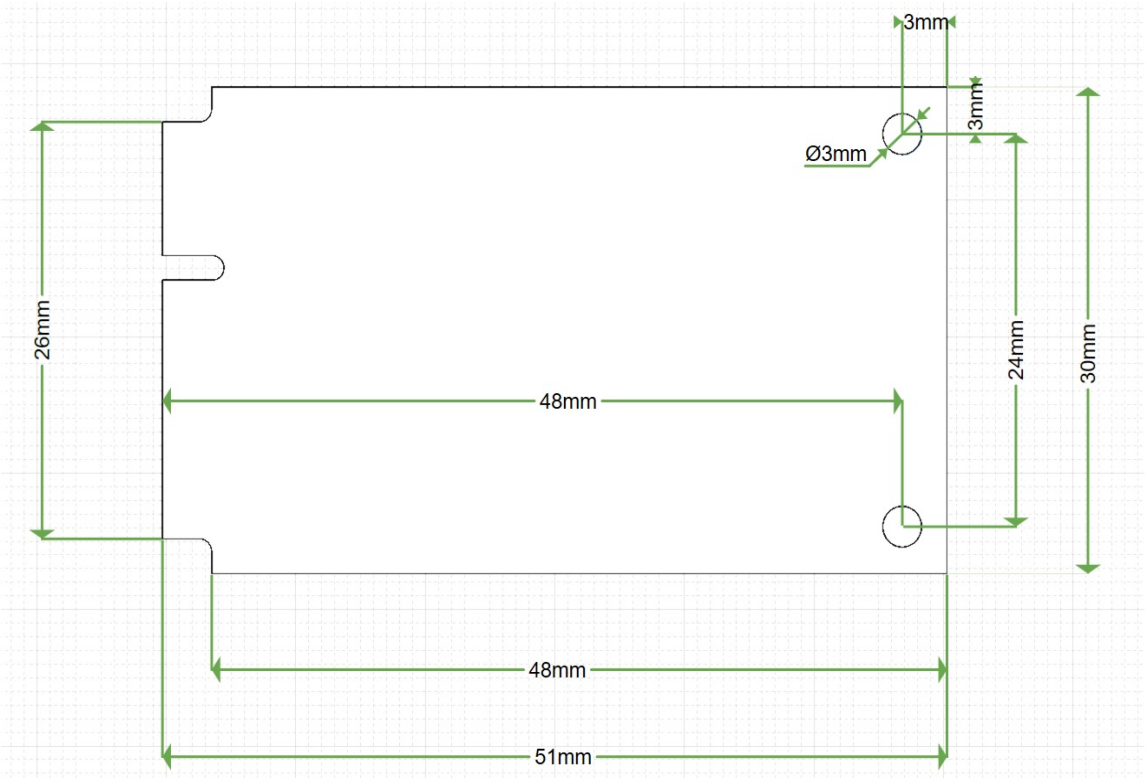


Figure 4: EMB-LR1303-mPCIe mechanical dimensions.

6 Packet Forwarder

The software needed to build a LoRaWAN network using the EMB-LR1302/3-mPCIe is called "packet forwarder" and it is provided by Semtech through their Github pages.

Semtech fully abstracts the complexity of the SX1302/3 and its companions chips by delivering two libraries as open-source code:

• SX1302/3 HAL (Hardware Abstraction layer), incorporating all of the required code to initialize, calibrate, run and

exchange radio packets with the gateway board

• SX1302/3 Packet Forwarder, which is a simple example application of how a gateway can be connected to a host. The host, in a LoRaWAN network, is typically cloud-based, but can also be co-located with the gateway in case of small-scale networks

All of these open-sourced libraries are available from Github on https://github.com/Lora-net/sx1302_hal

7 References is called

[1] Semtech, SX1303 Datasheet from www.semtech.com

[2] Semtech, SX1250 Datasheet from www.semtech.com

[3] Semtech, SX1261 Datasheet from www.semtech.com

8 Disclaimer of liability

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.).

8.1 Handling Precautions

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

8.2 Limitations

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

8.3 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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