

The logo for embit, featuring the word "embit" in a lowercase, sans-serif font. To the right of the text is a stylized graphic consisting of several curved, overlapping lines that suggest a circular or orbital path.

# EMB-LR1301-mPCIe Datasheet

embit s.r.l.

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## Document information

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### Versions & Revisions

Revision	Date	Author	Comments
0.1	2018-03-28	Embit	Initial release
0.5	2018-05-15	Embit	Preliminary version
1.0	2018-10-04	Embit	Revision 1.0

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# 1 Introduction

**EMB-LR1301-mPCIe** provides long range connectivity using ultra-long range spread spectrum communication and high interference immunity on the 868/915 MHz radio bands. It increases operational capacity keeping the gateway cost low.

**EMB-LR1301-mPCIe** offers up to 8 LoRa Channels in the 868MHz (or 915MHz) frequency allowing it to receive up to 8 LoRa packets simultaneously and it is able to achieve a sensitivity of **-137dBm** and a RF output power of **+27dBm** making it the ideal device to use in LoRaWAN gateways applications.

It is designed around the Semtech SX1301 [1] digital baseband chip with the RF front-end that consists of two of SX1257, high performance digital I and Q modulator/demodulator transceiver chip, terminated with a standard U.FL connector.

It has also the **Listen Before Talk (LBT)** capability giving to the user to share the same channel. When enabled, the device monitors channels continuously and transmits only if the channel is free. It includes as well a GPS module.



*Figure 1. EMB-LR1301-mPCIe.*

## 1.1 Specifications

- Operating Voltage: +5V
- Current Consumption: 815mA (Tx@+27dBm); 600mA (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: mPCIe (SPI / I2C / UART / GPIOs)
- Sensitivity: Up to -137dBm
- Dimensions: 71 x 40 x 1 mm
- Weight:

- Features: Listen Before Talk (LBT) Capability, GPS (optional), On-board uFL antenna connector, 8 LoRa Channels, FPGA supports LoRa Spectral Scan
- Part Numbers: EMB-LR1301-mPCIe-G (GPS included)  
EMB-LR1301-mPCIe (without GPS)

## 1.2 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-LR1301-mPCIe** block diagram:

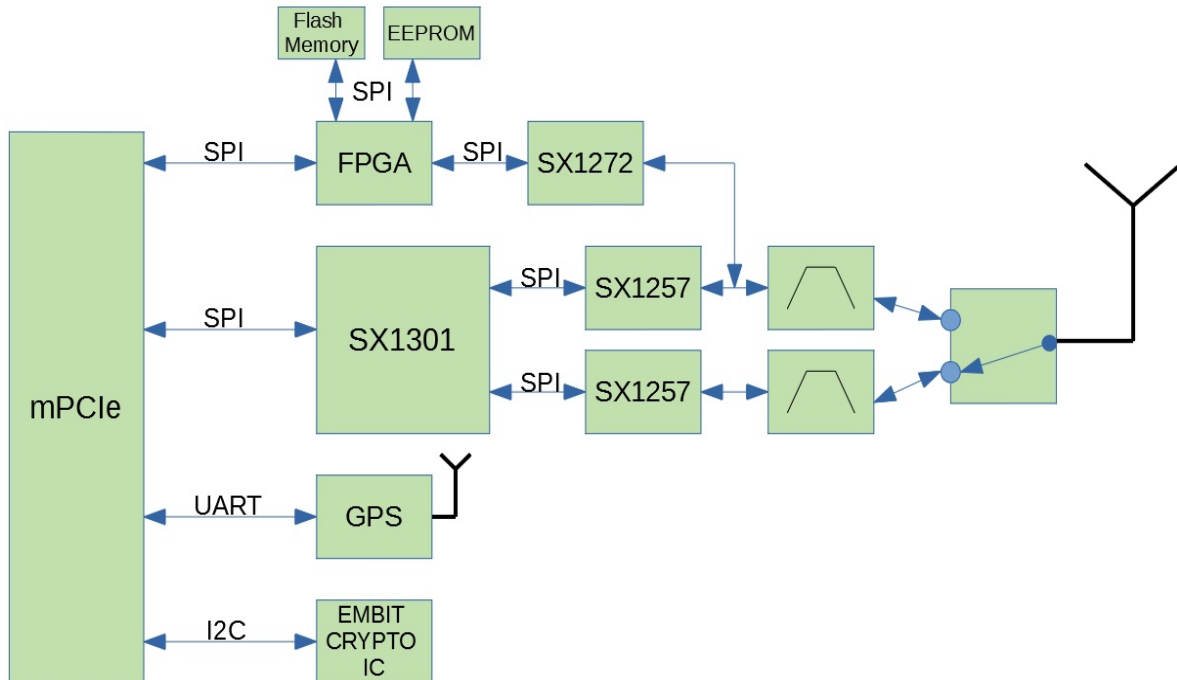


Figure 2: EMB-LR1301-mPCIe block diagram.

### 2.2 SX1301 Module

The **SX1301** digital baseband chip is a massive digital signal processing engine specifically designed to offer breakthrough gateway capabilities in the ISM bands worldwide. It integrates the LORA concentrator IP. The SPI interface gives access to the configuration register via a synchronous full-duplex protocol. Only the slave side is implemented.

Main features:

- **SPI** link with the CPU
- **RF standard supported:** LoraWAN™
- **Frequency band:** 868 / 915 MHz
- **libloragw** is the driver of the SX1301, that provides API for LoRa packet exchange using the SX1301 (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
- **Sample Projects:**
  - Semtech source code available <https://github.com/Lora->

- net/lora\_gateway
- **libloragw core library**
- **helper programs:** util\_pkt\_logger, util\_spi\_stress, util\_tx\_test, util\_tx\_continuous
- **packet\_forwarder:** the basic packet forwarder is a program running on the host of a Lora Gateway that forwards RF packets received by the concentrator to a server through a IP/UDP link, and emits RF packets that are sent by the server.

## 2.3 SX1257 Module

The two **SX1257** [2] are a highly integrated RF front-end to digital I and Q modulator and demodulator Multi-PHY mode transceiver capable of supporting multiple constant and non-constant envelope modulation schemes.

The SX1257 has a maximum signal bandwidth of 500 kHz in both transmission and reception and is intended as a high performance, low-cost RF-to-digital converter and provides a generic RF front-end that allows several constant and non-constant envelope modulation schemes to be handled.

The two transceiver are used instead of one to be able to simultaneously receive 8 LoRa 200 kHz channels.

## 2.4 SX1272 Module and FPGA

The **SX1272** [3] transceivers feature the LoRa™ long range modem that provides ultra-long range spread spectrum communication and high interference immunity whilst minimising current consumption.

It is driven by an **FPGA** providing to the EMB-LR1301-mPCIe the Listen-Before-Talk (LBT) and the spectral scan capabilities. Moreover, the FPGA acts also as 200Khz Notch filter for TX (not programmable).

## 2.5 GPS (ZOE-M8Q)

The **ZOE-M8Q** [4] is a highly integrated GNSS SiPs (System in Package) based on the high performing u-blox M8 concurrent positioning engine. It includes a SAW filter, LNA and TCXO.

UART interface is used for communication to a host and supports configurable baud rates.

## 2.6 External Antenna Connection

The **EMB-LR1301-mPCIe** has two uFL connectors, one for 868MHz antenna (or 915MHz for US market) and one for GPS antenna.

## 3 Connections

### 3.1 Pin Out Description

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

Number	Pin Name	Type	Description
1	SCK_FPGA_HOST	Input	FPGA SPI Clock
2	VBIAS3	Power	+5V
3	CSN_FPGA_HOST	Input	FPGA SPI Chip Select
4	GND9	Power (GND)	Ground
5	MOSI_FPGA_HOST	Input	FPGA SPI MOSI
6	V1-1V5	NC	Not Connected
7	MISO_FPGA_HOST	Output	FPGA SPI MISO
8	SPI-MOSI	Input	SX1301 SPI MOSI
9	GND1	Power (GND)	Ground
10	SPI-MISO	Output	SX1301 SPI MISO
11	PPS_IN	Input	GPS PPS Input
12	SPI-SCLK	Input	SX1301 SPI Clock
13	RES5-REFCLK+	NC	Not Connected
14	SPI-CS	Input	SX1301 SPI Chip Select
15	GND2	Power (GND)	Ground
16	RES3	NC	Not Connected
17	$\overline{\text{CRESET\_N}}$	Input	FPGA Configuration Reset, active low
18	GND10	Power (GND)	Ground
19	C_DONE	Output	FPGA Configuration Done
20	RES14**W_DISABLE#	NC	Not Connected
21	GND3	Power (GND)	Ground
22	PERST#	Input	SX1301 Reset Pin, active low
23	RES6-PERN0	NC	Not Connected
24	VBIAS4	Power	+5V
25	RES7-PERP0	NC	Not Connected
26	GND11	Power (GND)	Ground
27	GND4	Power (GND)	Ground
28	V2-1V5	NC	Not Connected
29	GND5	Power (GND)	Ground
30	I2C_SCL	Input	Crypto Serial Clock
31	RES8-PETN0	NC	Not Connected



## Connections

32	I2C_SDA	Input/Output	Crypto Serial data
33	RES9-PETP0	NC	Not Connected
34	GND12	Power (GND)	Ground
35	GND6	Power (GND)	Ground
36	USB_D-	NC	Not Connected
37	GND7	Power (GND)	Ground
38	USB_D+	NC	Not Connected
39	VBIAS1	Power	+5V
40	GND13	Power (GND)	Ground
41	VBIAS2	Power	+5V
42	RES	NC	Not Connected
43	GND8	Power (GND)	Ground
44	RES1	NC	Not Connected
45	RES10*	NC	Not Connected
46	RES2	NC	Not Connected
47	GPS_RESET_N	Input	GPS Reset Pin, active low
48	V3-1V5	NC	Not Connected
49	GPS_UART_RXD	Input	Serial Interface (RX)
50	GND14	Power (GND)	Ground
51	GPS_UART_TXD	Output	Serial Interface (TX)
52	VBIAS5	Power	+5V

**Table 1: mPCIe Interface Pin Out.**

## 4 Electrical Characteristics

### 4.1 Absolute Maximum Ratings

Parameter	Value	Unit
Power Supply Voltage	+5.5	Vdc
Storage Temp. Range	-50 to +150	°C

Table 2: Absolute maximum ratings.

### 4.2 Operating Conditions

Parameter	Min	Max	Unit
Power Supply Voltage (Vcc)	+5	+5.5	V
Operating Temperature range	-40	+85	°C
Logic Low Input threshold	Vss	Vss+0.4	V
Logic High Input threshold	Vcc-0.4	Vcc	V
Logic Low Output Level	Vss	Vss+0.4	V
Logic High Output Level	Vcc-0.4	Vcc	V

Table 3: Operating Conditions.

### 4.3 Power Consumption

Mode	Typ. value	Unit
Transmission @ +27dBm	815	mA
Transmission @ +20dBm	525	mA
Transmission @ +14dBm	415	mA
Reception	600	mA

Table 4: Power Consumption.

## 4.4 RF Characteristic

Condition	Min.	Typ.	Max.	Unit
Output Power			+27	dBm
Receiver sensitivity SF12; BW=125KHz		-135		dBm
Receiver sensitivity SF11; BW=125KHz		-133		dBm
Receiver sensitivity SF11; BW=125KHz		-131		dBm
Receiver sensitivity SF11; BW=125KHz		-128		dBm
Receiver sensitivity SF11; BW=125KHz		-125		dBm
Receiver sensitivity SF11; BW=125KHz		-122		dBm
Receiver sensitivity SF12; BW=250KHz		-132		dBm
Receiver sensitivity SF7; BW=250KHz		-119		dBm

Table 5: RF Characteristic.

## 5 References

- [1] Semtech, SX1301 Datasheet from [www.semtech.com](http://www.semtech.com)
- [2] Semtech, SX1257 Datasheet from [www.semtech.com](http://www.semtech.com)
- [3] Semtech, SX1272 Datasheet from [www.semtech.com](http://www.semtech.com)
- [4] U-blox, ZOE-M8Q Datasheet from [www.u-blox.com](http://www.u-blox.com)

## 6 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.).

### 6.1 Handling Precautions



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

### 6.2 Limitations

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

### 6.3 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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