EMB-GW1301-O
QUICK START GUIDE

Rev 1.0

Embit s.r.l.
### Versions & Revisions

<table>
<thead>
<tr>
<th>Revision</th>
<th>Date</th>
<th>Author</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1</td>
<td>2019-02-07</td>
<td>Embit-AM</td>
<td>Initial release</td>
</tr>
<tr>
<td>0.5</td>
<td>2019-02-12</td>
<td>Embit-MDD</td>
<td>Version Edited</td>
</tr>
<tr>
<td>0.6</td>
<td>2019-02-14</td>
<td>Embit-AM</td>
<td>TTN example added</td>
</tr>
<tr>
<td>1.0</td>
<td>2019-02-15</td>
<td>Embit</td>
<td>Revision 1.0</td>
</tr>
</tbody>
</table>
## Index

1 Introduction .......................................................................................................................... 4  
2 Hardware Specification ........................................................................................................ 5  
3 Main Features ....................................................................................................................... 5  
4 Power Supply ....................................................................................................................... 6  
5 Antenna Configuration .......................................................................................................... 7  
6 Quick Start ............................................................................................................................ 8  
7 LoRaWAN™ Gateway Configuration Web Interface ......................................................... 8  
8 Network Configuration Web Interface .................................................................................. 12  
9 Example: A2A Smart City LoRaWAN™ Network Server ................................................. 13  
10 Example: The Things Network LoRaWAN™ Network Server .......................................... 21  
11 Annex: EMB-LR1301mPCIe Datasheet .............................................................................. 29  
   11.1 Introduction .................................................................................................................. 29  
   11.2 Description ................................................................................................................... 31  
   11.3 Connections ................................................................................................................ 33  
   11.4 Electrical Characteristics ............................................................................................ 35  
   11.5 References .................................................................................................................... 36  
12 Disclaimer of liability ............................................................................................................ 37  
   12.1 Disclaimer of liability ..................................................................................................... 37  
   12.2 Handling Precautions ................................................................................................... 37  
   12.3 Limitations ................................................................................................................... 37  
   12.4 Trademarks ................................................................................................................ 37
# 1 Introduction

This guide explains how to start using the EMB-GW1301-O. The EMB-GW1301-O gateway is a multi service up-gradable platform, designed to meet IoT (Internet Of Things) and M2M (Machine-2-Machine) scenario. It enables LoRaWAN™ connectivity, having the role of fully compliant LoRaWAN™ Gateway. It provides the LoRaWAN™ packet forwarder functionality: the SX1301 radio will start to operate as a LoRaWAN™ base station, receiving radio packets and forwarding them to a LoRaWAN™ network server. It can be connected to the network through a PoE connection and / or via a SIM card. In the latter case, high latency could lead to the LoRaWAN™ network performance decrease. Using the **Embit Gateway Configuration web interface** it is possible to set up and launch several LoRaWAN™ packet forwarders with custom parameter. It will be described in the following paragraphs with details.

EMB-GW1301-O manages **8 LoRa channels** in order to handle **thousand of end-devices**.

Thanks to the **Semtech SX1301** performances and the efficient **Embit RF design**, the possible radio ranges are up to 15 km in the country side and up to 3 km in urban areas.

The gateway must be powered with a **PoE IEEE 802.3at**, and it has a power consumption less than 20 Watt. Whith a different power supplier, its functionalities may stop irretrievably.

--

*Figure 1: LoRaWAN Network Scenario*
2 Hardware Specification

- Processor: Quad-Core ARM Cortex – A7 (1.2 GHz)
- RAM Memory: 1 GB, DDR3
- Flash Memory: 4 GB, EMMC
- LAN Connection: Ethernet RJ45 10/100/1000 Base-T
- LoRaWAN™ Connectivity: Semtech SX1301 +20/+27 dBm @ 868 MHz
- Connectivity: GPS
- Cellular Connectivity: 4G LTE
- Optional Connectivity: 802.15.4 / ZigBee / Wireless M-Bus
- Power Source: PoE IEEE 802.3at
- Ports: Ethernet 10/100/1000 RJ 45 / N-Type Antenna Connector
- Power Consumption: 20 W
- Operating System: Embedded Linux
- Dimensions: L: 276 mm W: 272 mm H: 96 mm
- Weight: 1.9 kg
- Certifications: CE according to RED

3 Main Features

- Full Compliance with LoRaWAN™ network protocol;
- Rapid deployment with existing LoRaWAN™ compliant Network Server or your own LoRaWAN™ Network Server;
- Powerful Semtech SX 1301 8 channels handles thousands of end-devices;
- Supports LoRaWAN™ version 1.0.1 and proprietary LoRa;
- Optional wireless interfaces compliant to IEEE 802.1504, ZigBee, Wireless M-BUS, WiFi IEEE 802.11 b/g/n or proprietary products;
- Easy, proactive monitoring of processes.
4 Power Supply

The power supply is provided by the **PoE connection**. PoE cable must be connected to the Ethernet port is present on the side of the gateway as indicated in the figures below. The PoE injector has to provide at least 20 W.

*Figure 2: PoE Connection*
5 Antenna Configuration

In the same side of the Ethernet connector, SMA connectors are placed (see Figure 4). There should be several connectors in the same side, according to the Gateway model you ordered. On top of each SMA, a label shows what kind of antenna has to be connected.
Antenna has to be screwed on the connector. The result is showed in the figure below.

![Antenna View](image)

**Figure 5: Antenna View**

### 6 Quick Start

Since you have connected the power supplier, the Gateway starts working and providing LoRaWAN™ connectivity as well as Internet connectivity, so it can be reached from any kind of web browser. Using the provided web UI, it is possible to set different networks and LoRaWAN™ parameters from the browser.

### 7 LoRaWAN™ Gateway Configuration Web Interface

**Emb-1301GW-O** provides a web interface, which allows to select and configure the desired LoRaWAN™ packet forwarder.

It is reachable at `https://[gateway_IP_address]:10000`. The default data access are:

- **username**: embit
- **password**: password
"Embit Gateway Configuration" is located in the left menu, in the category Networking (Figure 7).

Figure 6: Embit Web Interface - Log In Page
In the "Packet Forwarder" tab, the system state information are reported (Figure 8). In this page is possible to select the LoRaWAN™ packet forwarder among the installed ones, from the drop-down menu. Once selected, the chosen LoRaWAN™ packet forwarder starts running.
Quick Start Guide

In the configuration tab, it is possible to customize the network parameter of the LoRaWAN™ packet forwarders (Figure 9).

**Figure 8: Embit Gateway Configuration - Packet Forwarder Tab**

**Figure 9: Embit Gateway Configuration - Configuration Tab**
The following parameters can be changed in the The Things Network packet forwarder (Figure 10).

![The Things Network Configuration](image)

*Figure 10: Embit Gateway Configuration - The Things Network Configuration Page*

The changes are applied through the “Apply” button in the main tab (Figure 8).

8 Network Configuration Web Interface

In the provided Web Interface, **EMB-GW1301-O** network configuration can be managed.

"Network Configuration“ is located in the left menu, in the category “Networking“ (Figure 11).

![Network Configuration](image)

*Figure 11: Embit Web Interface - Webmin*
Selecting "Network Interfaces", all the network interface are reported. They are grouped in two tabs (Figure 12):

- Active Now
- Active at Boot

“Active now” tab enables to de-activate the selected network interfaces among the available one.

![Figure 12: Embit Web Interface - Network Interfaces](image)

To apply the selected preferences, press "Apply Configuration" button in the main "Network Interfaces" page (Figure 12).

**9 Example: A2A Smart City LoRaWAN™ Network Server**

In this section, it is explained how to register a gateway in a LoRaWAN™ Network Server. The LoRaWAN™ Network Server taken into account for this example is **A2A Smart City Network Server**.

It is important to know that the **EMB-GW1301-O** can support different packet forwarders.

**Step 1: Take your Unique Gateway ID**

The **Unique Gateway ID** is a number which allows the Network Server to identify your gateway. This parameter is written in the label of the **EMB-GW1301-O** Gateway. It can be changed, according to your preferences, through **Embit Gateway Configuration Web Interface**, under the “Configuration Tab”. Once pressed the button related to the Network Server you would like to use, the field "Select the Gateway ID" can be filled with a 8-bytes (hex) value (Figure 13). Be
sure your EMB-GW1301-O is running **A2A Smart City** packet forwarder, checking on Embit Gateway Configuration Web Interface. In case it is not running the wanted packet forwarder, select it from the drop-down menu and press “Apply”.

![Figure 13: A2A Gateway Configuration Web Interface](image)

**Step 2: Sign Up with your A2A Smart City Account**

![Figure 14: A2A Smart City Log In Web Page](image)
Step 3: Create a Gateway

In “Gateway” Tab, press “+ INSERT” to add your gateway to the Gateway List (Figure 15).

![Gateway List Web Page](image)

Figure 15: Gateway List Web Page

Step 4: Register your Gateway Data

Add your Gateway Unique ID to the Address field and select the Profile among the available ones.

Note: if there are no profiles available, you can create your own profile, under “Profiles” tab, pressing “+ INSERT”. At the end of each registration, pay attention to press “SAVE” (Figure 16).

![Gateway List - Parameters](image)

Figure 16: Gateway List - Parameters
Step 5: Look at the Data

At this point, your gateway is on the Gateway List page. Pressing on "Info", and then on "EVENTS" tab it is possible to look at the data which your gateway is transmitting and receiving (Figure 18). The payload is encrypted, to guarantee privacy and security.
Step 6: Create your own Application

To connect your devices to your gateway, you need to create your application in "Devices" tab (Figure 19). In the Application List, press "+ INSERT" and a configuration pop up will appear (Figure 20). In the ID and Label fields you can put values and text human readable. Join EUI field represents the App EUI, and it has to be set with a 8-bytes (hex) value.
Step 7: Register your Device

Selecting your new Application, "Applications Devices" menu appears (Figure 21), just below the Application List. Press "+ INSERT" and register your Device. In case of choosing OTAA activation, the Device EUI field has to be filled with a 8-bytes (hex) value and the App Key field with a 16-bytes (hex) value.

If ABP activation is chosen, DevEUI, DevAddr, Network Session Key and Application Session Key has to be set with 8-bytes (hex) value, 8-bytes (hex) value, 16-bytes (hex) value and 16-bytes (hex) value respectively.

Figure 20: Device Configuration

Figure 21: Application Device Web Page
Step 8: Let’s Network Start

If OTAA activation mode is selected, your end-device has to be set with *Device EUI*, *App EUI* and *App Key*. These parameters **must be the same** configured in the *Network Server Application*. Then, the end-device has to send a *Join Request*. When a *Join Accept* message is received by the end-device, the network is started. The packets are visible under the **Gateway Info Page**, as described in Step 5, or pressing on the “*Info*” icon related to your *Dev Eui* in the *Application Devices List*.

![Application Devices](image)

**Figure 22: Device Web page**

In the “*Console*” tab of your device, it is possible to look at the data transmitted and to set downlink message which are to be sent by the Gateway to your device during the Rx windows.

In “*Logs*” table data are showed without encryption, because only the account and application owner can access to this page (Figure 23).
If ABP activation mode is chosen, your end-device needs to be set with DevEUI, DevAddr, Network Session Key and Application Session Key. These parameters must be the same configured previously in the Network Server. In this case, the network starts when a packet with all these valid fields is received.

Figure 23: Device Data Web Page
In this section, it is explained how to register a gateway in an open LoRaWAN™ Network Server. The LoRaWAN™ Network Server taken into account is The Things Network.

**Step 1: Take your Unique Gateway ID**

The **Unique Gateway ID** is a number which allows the Network Server to identify your gateway. This parameter is written in the label of the EMB-GW1301-O Gateway. It can be changed, according to your preferences, through *Embit Gateway Configuration Web Interface*, under the “Configuration Tab”. Once pressed the button related to the Network Server you would like to use, the field “Select the Gateway ID” can be filled with a-8 bytes (hex) value (Figure 24). Be sure your EMB-GW1301-O is running The Things Network packet forwarder, checking on Embit Gateway Configuration Web Interface. In case it is not running the wanted packet forwarder, select it from the drop-down menu and press “Apply”.

![Figure 24: The Things Network Gateway Configuration Web Interface](image)
Step 2: Sign Up with your The Things Network Account

![The Thing Network Log In Page](image)

**Figure 25: The Thing Network Log In Page**

Supporting 61623 developers in building industrial grade LoRaWAN solutions

Step 3: Go to Gateway page

From your account, open “Console“ section and then press on “Gateways“ button. (Figure 26)

![The Things Network Console](image)

**Figure 26: The Things Network Console**
Step 4: Register your Gateway

Press “Register Gateway” button and a configuration page will open (Figure 27). Pay attention to the flag “I’m using the legacy packet forwarder”. Fill Gateway EUI field with a 8-bytes (hex) value. Select “Frequency Plan” and “Router” according to your region. Then press “Register Gateway”.

![Figure 27: Register Gateway Page](image)

Step 5: Check Gateway Connection

Go to your Gateway page, select the one you have just created and “General Information” will appear.

When your Gateway is connected, a green dot is showed near the “Status” string (Figure 28).
Step 6: Traffic Monitoring

Pressing “Traffic” tab, up to the right corner in Gateway Overview page, the user can look at the transmitted and received data by the Gateway (Figure 29). In this case, data are encrypted due to safety reason.

Figure 28: Gateway Overview Page

Figure 29: Gateway Traffic Monitoring Page
**Step 7: Go to Application**
From your account, open “Console” section and then press “Applications” button.

![The Things Network Console](image1)

*Figure 30: The Things Network Console*

**Step 8: Register your Application**
Press “Add Application” and a configuration page will open. Application ID and Description are human-readable string, Application EUI is automatically assigned by The Things Network Server and select “Handler Registration” according to your region (Figure 31).

![Add Application Page](image2)

*Figure 31: Add Application Page*
**Step 9: Register your Device**

Go to the “Application Overview” page and press “Register Device” (Figure 32).

"Registration Device” page will open (Figure 33). *Device ID* field can be filled with a human-readable string, *Dev EUI* must be filled with a 8-bytes (hex) value, *AppKey* is automatically generated by The Things Network Server, and *App EUI* is related to your *Application*. Pressing “Register” button, the device is registered.
Step 10: Let’s Network Start

If OTAA activation mode is selected, your device has to send Device EUI, App EUI and App Key to the Gateway. These values must be the same configured in the Network Server Application. Then, the device has to send a Join Request. When a Join Accept message is received, the network is started. The packets are visible in the “Gateway Overview” page, as in Step 6, or in “Application Overview” page in “Data” tab (Figure 34).
If ABP activation mode is chosen, you have to change the Device Settings. In the “Devices Overview” page, in the “Setting” tab, you must select ABP as activation method. All the keys are automatically generated (Figure 35).

Your Device needs to be set with DevEUI, DevAddr, Network Session Key and Application Session Key. These parameters must be the same configured previously in the Network Server. In this case, the network starts when a packet with all these valid fields is received.
11 Annex: EMB-LR1301mPCIe Datasheet

11.1 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 the possibility 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.

### 11.1.1 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
Quick Start Guide

- 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)
11.2 Description

11.2.1 Block Diagram

The EMB-LR1301-mPCIE block diagram:

The EMB-LR1301-mPCIE block diagram:

Figure 37: EMB-LR1301-mPCIE block diagram.

11.2.2 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/Loranet/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.

### 11.2.3 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.

### 11.2.4 SX1272 Module and FPGA

The **SX1272** [3] transceivers feature the LoRaTM 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).

### 11.2.5 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.

### 11.2.6 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.
The table below gives the description of the pin out of the mPCIe interface.

<table>
<thead>
<tr>
<th>Number</th>
<th>Pin Name</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SCK_FPGA_HOST</td>
<td>Input</td>
<td>FPGA SPI Clock</td>
</tr>
<tr>
<td>2</td>
<td>VBIAS3</td>
<td>Power</td>
<td>+5V</td>
</tr>
<tr>
<td>3</td>
<td>CSN_FPGA_HOST</td>
<td>Input</td>
<td>FPGA SPI Chip Select</td>
</tr>
<tr>
<td>4</td>
<td>GND9</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>5</td>
<td>MOSI_FPGA_HOST</td>
<td>Input</td>
<td>FPGA SPI MOSI</td>
</tr>
<tr>
<td>6</td>
<td>V1-1V5</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>7</td>
<td>MISO_FPGA_HOST</td>
<td>Output</td>
<td>FPGA SPI MISO</td>
</tr>
<tr>
<td>8</td>
<td>SPI-MOSI</td>
<td>Input</td>
<td>SX1301 SPI MOSI</td>
</tr>
<tr>
<td>9</td>
<td>GND1</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>10</td>
<td>SPI-MISO</td>
<td>Output</td>
<td>SX1301 SPI MISO</td>
</tr>
<tr>
<td>11</td>
<td>PPS_IN</td>
<td>Input</td>
<td>GPS PPS Input</td>
</tr>
<tr>
<td>12</td>
<td>SPI-SCLK</td>
<td>Input</td>
<td>SX1301 SPI Clock</td>
</tr>
<tr>
<td>13</td>
<td>RES5-REFCLK+</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>14</td>
<td>SPI-CS</td>
<td>Input</td>
<td>SX1301 SPI Chip Select</td>
</tr>
<tr>
<td>15</td>
<td>GND10</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>16</td>
<td>RES3</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>17</td>
<td>CRESET_N</td>
<td>Input</td>
<td>FPGA Configuration Reset, active low</td>
</tr>
<tr>
<td>18</td>
<td>GND10</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>19</td>
<td>C_DONE</td>
<td>Output</td>
<td>FPGA Configuration Done</td>
</tr>
<tr>
<td>20</td>
<td>RES14**W_DISABL_E#</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>21</td>
<td>GND3</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>22</td>
<td>PERST#</td>
<td>Input</td>
<td>SX1301 Reset Pin, active low</td>
</tr>
<tr>
<td>23</td>
<td>RES6-PERN0</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>24</td>
<td>VBIAS4</td>
<td>Power</td>
<td>+5V</td>
</tr>
<tr>
<td>25</td>
<td>RES7-PERP0</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>26</td>
<td>GND11</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>27</td>
<td>GND4</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>28</td>
<td>V2-1V5</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>29</td>
<td>GND5</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>30</td>
<td>I2C_SCL</td>
<td>Input</td>
<td>Crypto Serial Clock</td>
</tr>
<tr>
<td>31</td>
<td>RES8-PETN0</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td></td>
<td>I2C_SDA</td>
<td>Input/Output</td>
<td>Crypto Serial data</td>
</tr>
<tr>
<td>---</td>
<td>---------------</td>
<td>--------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>32</td>
<td>RES9-PETP0</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>33</td>
<td>GND12</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>34</td>
<td>GND6</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>35</td>
<td>USB_D-</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>36</td>
<td>GND7</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>37</td>
<td>USB_D+</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>38</td>
<td>VBIAS1</td>
<td>Power</td>
<td>+5V</td>
</tr>
<tr>
<td>39</td>
<td>GND13</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>40</td>
<td>VBIAS2</td>
<td>Power</td>
<td>+5V</td>
</tr>
<tr>
<td>41</td>
<td>RES</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>42</td>
<td>GND8</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>43</td>
<td>RES1</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>44</td>
<td>RES10*</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>45</td>
<td>RES2</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>46</td>
<td>GPS_RESET_N</td>
<td>Input</td>
<td>GPS Reset Pin, active low</td>
</tr>
<tr>
<td>47</td>
<td>V3-1V5</td>
<td>NC</td>
<td>Not Connected</td>
</tr>
<tr>
<td>48</td>
<td>GPS_UART_RXD</td>
<td>Input</td>
<td>Serial Interface (RX)</td>
</tr>
<tr>
<td>49</td>
<td>GND14</td>
<td>Power (GND)</td>
<td>Ground</td>
</tr>
<tr>
<td>50</td>
<td>GPS_UART_TXD</td>
<td>Output</td>
<td>Serial Interface (TX)</td>
</tr>
<tr>
<td>51</td>
<td>VBIAS5</td>
<td>Power</td>
<td>+5V</td>
</tr>
</tbody>
</table>

*Table 1: mPCIe Interface Pin Out.*
11.4 Electrical Characteristics

11.4.1 Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage</td>
<td>+5.5</td>
<td>Vdc</td>
</tr>
<tr>
<td>Storage Temp. Range</td>
<td>-50 to +150</td>
<td>°C</td>
</tr>
</tbody>
</table>

*Table 2: Absolute maximum ratings.*

11.4.2 Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Voltage (Vcc)</td>
<td>+5</td>
<td>+5.5</td>
<td>V</td>
</tr>
<tr>
<td>Operating Temperature range</td>
<td>-40</td>
<td>+85</td>
<td>°C</td>
</tr>
<tr>
<td>Logic Low Input threshold</td>
<td>Vss</td>
<td>Vss+0.4</td>
<td>V</td>
</tr>
<tr>
<td>Logic High Input threshold</td>
<td>Vcc-0.4</td>
<td>Vcc</td>
<td>V</td>
</tr>
<tr>
<td>Logic Low Output Level</td>
<td>Vss</td>
<td>Vss+0.4</td>
<td>V</td>
</tr>
<tr>
<td>Logic High Output Level</td>
<td>Vcc-0.4</td>
<td>Vcc</td>
<td>V</td>
</tr>
</tbody>
</table>

*Table 3: Operating Conditions.*

11.4.3 Power Consumption

<table>
<thead>
<tr>
<th>Mode</th>
<th>Typ. value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmission @ +27dBm</td>
<td>815</td>
<td>mA</td>
</tr>
<tr>
<td>Transmission @ +20dBm</td>
<td>525</td>
<td>mA</td>
</tr>
<tr>
<td>Transmission @ +14dBm</td>
<td>415</td>
<td>mA</td>
</tr>
<tr>
<td>Reception</td>
<td>600</td>
<td>mA</td>
</tr>
</tbody>
</table>

*Table 4: Power Consumption.*

11.4.4 RF Characteristic
### Condition

<table>
<thead>
<tr>
<th>Condition</th>
<th>Min</th>
<th>Typ.</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Power</td>
<td></td>
<td></td>
<td>+27</td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver sensitivity SF12; BW=125KHz</td>
<td>-135</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver sensitivity SF11; BW=125KHz</td>
<td>-133</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver sensitivity SF11; BW=125KHz</td>
<td>-131</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver sensitivity SF11; BW=125KHz</td>
<td>-128</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver sensitivity SF11; BW=125KHz</td>
<td>-125</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver sensitivity SF11; BW=125KHz</td>
<td>-122</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver sensitivity SF12; BW=250KHz</td>
<td>-132</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
<tr>
<td>Receiver sensitivity SF7; BW=250KHz</td>
<td>-119</td>
<td></td>
<td></td>
<td>dBm</td>
</tr>
</tbody>
</table>

*Table 5: RF Characteristic.*

### 11.5 References

[1] Semtech, SX1301 Datasheet from [www.semtech.com](http://www.semtech.com)


12 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.

12.1 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.).

12.2 Handling Precautions

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

12.3 Limitations

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

12.4 Trademarks

Embit is a registered trademark owned by Embit s.r.l.

All other trademarks, registered trademarks and product names are the sole proprietary of their respective owners.