Datasheet

Sentrius™ RG1xx-M2 Concentrator Card
Pluggable M2.COM LoRaWAN™ Adapter

Version 2.4
## Revision History

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<th>Date</th>
<th>Notes</th>
<th>Contributors</th>
<th>Approver</th>
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<td>1.0</td>
<td>20 July 2017</td>
<td>Initial Release</td>
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<td>Added JSON files for EU and US in Section 8</td>
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<td>Updated +25°C and +85°C power table values</td>
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<td>2.4</td>
<td>08 Aug 2019</td>
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1 INTRODUCTION

The Sentrius™ RG1xx-M2 LoRaWAN Concentrator Card combines Laird’s long-standing expertise in optimized RF design with the emerging LoRaWAN ecosystem. The Sentrius™ RG1xx-M2 card enables OEMs to integrate a high-performance, certified LoRaWAN gateway interface to any Linux-based platform. Laird’s optimum hardware solution expands upon Sentrius™ drivers and reference design for improved RF performance. Comprehensive integration and design services for a custom gateway are also available via Laird’s dedicated Engineering Services team. Qualified LoRa antenna solutions are available from Laird.

2 OVERVIEW

The module is designed around the Sentrius™ SX1301 digital baseband chip with an integrated LoRa concentrator IP, which is designed to perform high performance gateway function in the ISM band. The RF front-end consists of two of the SX1257, high performance digital I and Q modulator/demodulator transceiver chips. The SX1257 is designed to operate over the frequency band of 862 – 960 MHz to cover the Europe and North American markets. The RF front-end is terminated with standard U.FL connector. The board form factor and connector pinout are designed to conform to M2.COM specifications. The card requires a single 5-volt supply and it generates its power supply requirements on-board. Standard SPI communication, reset, and power supply to the board are provided through a 75-position host interface connector.

2.1 Key Features

- Optimized RF performance – Improved performance over temperature and frequency
- Superior TX performance – Up to +28 dBm
- Standardized interface – M2 connector with compliance to M2.COM standard E-type key.
- Comprehensive certifications – FCC, IC, CE

![RG1xx board](https://connectivity.lairdtech.com/wireless-modules/lorawan-solutions/sentrius-rg1xx-lora-enabled-gateway-wi-fi-bluetooth-ethernet)

**Figure 1: RG1xx board**

Application Areas

- Smart metering
- Security and remote sensing
- Agricultural monitoring
- Internet of things (IoT)
- M2M applications

**Note:** Some of the figures in this document are driven from the Semtech SX1301 and SX1257 datasheets.
### Specification Summary

<table>
<thead>
<tr>
<th>Category</th>
<th>Feature</th>
<th>Specification</th>
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<tr>
<td><strong>General Radio</strong></td>
<td>Semtech Radios</td>
<td>SX1301 and SX1257 (x2)</td>
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<td>Reference Design</td>
<td>Based on Semtech Rev 1.0 - SX1301 AP1</td>
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<tr>
<td><strong>Connectors</strong></td>
<td>Connector Type</td>
<td>M2.COM E Key - <a href="http://www.m2com-standard.org/en-us">http://www.m2com-standard.org/en-us</a></td>
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<td></td>
<td>External Antenna</td>
<td>U.FL connector</td>
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<tr>
<td><strong>Power</strong></td>
<td>Consumption</td>
<td>RX (all channels) – 340 mA</td>
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<tr>
<td></td>
<td></td>
<td>Idle – 40 mA</td>
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<tr>
<td><strong>Voltage Input</strong></td>
<td>Input</td>
<td>5V (+/- 10%)</td>
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<tr>
<td><strong>RF Characteristics</strong></td>
<td>Frequency Range</td>
<td>RG186-M2: 863 to 870 MHz</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RG191-M2: 902 to 928 MHz</td>
</tr>
<tr>
<td></td>
<td>RX Sensitivity</td>
<td>Up to -140 dBm</td>
</tr>
<tr>
<td></td>
<td>Max RF TX Output Power</td>
<td>Up to +28 dBm (RG191-M2) – see Software Support</td>
</tr>
<tr>
<td></td>
<td>(conducted)</td>
<td>Up to +25 dBm (RG186-M2) – see Software Support</td>
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<tr>
<td><strong>Software</strong></td>
<td>Host Interface</td>
<td>SPI</td>
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<td>Driver Support</td>
<td><a href="https://github.com/Lora-net/lora_gateway">https://github.com/Lora-net/lora_gateway</a></td>
</tr>
<tr>
<td></td>
<td>(Laird testing done with Linux)</td>
<td></td>
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<td><strong>Temperature</strong></td>
<td>Operating Range</td>
<td>-40°C to +85°C</td>
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<td><strong>Physical</strong></td>
<td>Dimensions</td>
<td>75 x 53 x 3.8 mm</td>
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<tr>
<td></td>
<td>Weight</td>
<td>&lt;11 g</td>
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<td><strong>Warranty</strong></td>
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4 HARDWARE SPECIFICATIONS

Figure 2: Schematic
# 5 PIN DEFINITIONS

## Table 1: Pin definitions

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<thead>
<tr>
<th>Pin #</th>
<th>Pin Name</th>
<th>Laird RG1xx-M2 Pinout</th>
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<td>1</td>
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<tr>
<td>2</td>
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<td>Population</td>
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<td>Population</td>
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<td>I2S_SCK</td>
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<td>-----------------------</td>
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<td>73</td>
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<td>75</td>
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</tbody>
</table>
6 J5 SIGNALS DESCRIPTION

SPI interface signals including power, ground and RESET are also available on seven plated through-holes (labeled as J5). These make it easier when hand prototyping or when the M2.COM interface is not being used for host communication.

Figure 3: J5 signals description

7 MECHANICAL DETAILS

Figure 4: RG1xx-M2 mechanical drawing
8 SOFTWARE SUPPORT

A driver/HAL to build a gateway using a RG186-M2 or RG191-M2 concentrator board is available from the following GitHub link: https://github.com/Lora-net/lora_gateway

Radio TX power tables optimized for RG191-M2 and RG186-M2 are shown in Table 2 (RG191-M2) and Table 3 (RG186-M2).

**IMPORTANT!**

The RG186-M2 and RG191-M2 are certified with these power table values. Using different radio power table values other than those published may invalidate regulatory certification.

**Table 2: RG191-M2 Radio TX power table**

<table>
<thead>
<tr>
<th>RF Registers</th>
<th>RG191-M2 Conducted TX power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>at -40°C</td>
</tr>
<tr>
<td>dig</td>
<td>mix</td>
</tr>
<tr>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>0</td>
<td>9</td>
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<td>0</td>
<td>10</td>
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<tr>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

**Table 3: RG186-M2 Radio TX power table**

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<tr>
<th>RF Registers</th>
<th>RG186-M2 Conducted TX power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>at -40°C</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>dig</td>
<td>mix</td>
</tr>
<tr>
<td>0</td>
<td>14</td>
</tr>
<tr>
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<td>0</td>
<td>10</td>
</tr>
<tr>
<td>0</td>
<td>9</td>
</tr>
</tbody>
</table>

The following are sample JSON files – one for the US and one for EU.

8.1 Sample JSON File for US

```
{
    "gateway_conf":{
        "gateway_ID":"C0EE400000000000",
        "autoquit_threshold":5,
        "country_code": "US"
    },
    "SX1301_conf":{
        "lorawan_public":true,
        "clksrc":1,
        "antenna_gain":2,
        "lbt_cfg":{
            "enable":false
        },
        "tx_lut_0":{
            "pa_gain":0,
            "mix_gain":8,
            "rf_power":0,
            "dig_gain":0
        },
        "tx_lut_1":{
            "pa_gain":0,
            "mix_gain":10,
            "rf_power":2,
            "dig_gain":0
        },
        "tx_lut_2":{
            "pa_gain":0,
            "mix_gain":13,
        }
    }
}
```
"rf_power":5,
"dig_gain":0
},
"tx_lut_3":{
"pa_gain":1,
"mix_gain":8,
"rf_power":10,
"dig_gain":0
},
"tx_lut_4":{
"pa_gain":1,
"mix_gain":9,
"rf_power":12,
"dig_gain":0
},
"tx_lut_5":{
"pa_gain":1,
"mix_gain":10,
"rf_power":13,
"dig_gain":1
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"mix_gain":8,
"rf_power":26,
"dig_gain":0
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"mix_gain":9,
"rf_power":27,
"dig_gain":0
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"tx_lut_15":{"pa_gain":3,
"mix_gain":10,
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"dig_gain":0
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"radio_0":{
"enable":true,
"type":"SX1257",
"freq":9043000000,
"rssi_offset":-166.0,
"tx_enable":true,
"tx_freq_min":9230000000,
"tx_freq_max":9280000000
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"radio_1":{
  "enable":true,
  "type":"SX1257",
  "freq":9050000000,
  "rssi_offset":-166.0,
  "tx_enable":false
},
"chan_multiSF_0":{
  "enable":true,
  "radio":0,
  "if":-400000
},
"chan_multiSF_1":{
  "enable":true,
  "radio":0,
  "if":-200000
},
"chan_multiSF_2":{
  "enable":true,
  "radio":0,
  "if":0
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"chan_multiSF_3":{
  "enable":true,
  "radio":0,
  "if":200000
},
"chan_multiSF_4":{
  "enable":true,
  "radio":1,
  "if":-300000
},
"chan_multiSF_5":{
8.2 Sample JSON File for EU

```json
{
  "gateway_conf":{
    "gateway_ID":"C0EE400000000000",
    "autoquit_threshold":5,
    "country_code": "EU"
  },
  "SX1301_conf":{
    "lorawan_public":true,
    "clksrc":1,
    "antenna_gain":2,
    "lbt_cfg":{
      "enable":false
    },
    "tx_lut_0":{
      "pa_gain":0,
      "mix_gain":8,
      "rf_power":-3,
      "dig_gain":0
    },
    "tx_lut_1":{
      "pa_gain":0,
      "mix_gain":9,
      "rf_power":0,
      "dig_gain":0
    },
    "tx_lut_2":{
      "pa_gain":0,
      "mix_gain":12,
      "rf_power":3,
      "dig_gain":0
    },
    "tx_lut_3":{
      "pa_gain":0,
      "mix_gain":13,
      "rf_power":4,
      "dig_gain":0
    },
    "tx_lut_4":{
      "pa_gain":1,
      "mix_gain":8
    }
  }
}
```
"rf_power":6,
"dig_gain":0
},
"tx_lut_5":{
"pa_gain":1,
"mix_gain":9,
"rf_power":9,
"dig_gain":0
},
"tx_lut_6":{
"pa_gain":1,
"mix_gain":10,
"rf_power":10,
"dig_gain":0
},
"tx_lut_7":{
"pa_gain":1,
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"tx_lut_8":{
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"rf_power":16,
"dig_gain":0
},
"tx_lut_11":{
"pa_gain":2,
"mix_gain":16,
"rf_power":17,
"dig_gain":0
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"mix_gain":10,
"rf_power":19,
"dig_gain":0
},
"tx_lut_12":{
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"rf_power":21,
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},
"tx_lut_15":{
"pa_gain":2,
"mix_gain":14,
"rf_power":25,
"dig_gain":0
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"radio_0":{
"enable":true,
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"tx_freq_max":870000000
},
"radio_1":{
"enable":true,
"type":"SX1257",
"freq":868500000,
"rssi_offset":-166.0,
"tx_enable":false
},
"chan_multiSF_0":{
"enable":true,
"radio":1,
"if":-400000
},
"chan_multiSF_1":{
"enable":true,
"radio":1,
"if":-200000
},
"chan_multiSF_2":{
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"chan_multiSF_7":{
"enable":true,
"radio":0,
"if":400000
},
"chan_Lora_std":{
  "enable":true,
  "radio":1,
  "if":-200000,
  "bandwidth":250000,
  "spread_factor":7
},
"chan_FSK":{
  "enable":true,
  "radio":1,
  "if":300000,
  "bandwidth":125000,
  "datarate":50000
}
}
9  FCC AND ISED CANADA REGULATORY STATEMENTS

<table>
<thead>
<tr>
<th>Model</th>
<th>US/FCC</th>
<th>CANADA/IC</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG191-M2</td>
<td>SQG-1001</td>
<td>3147A-1001</td>
</tr>
</tbody>
</table>

The OEM must follow the regulatory guidelines and warnings listed below to inherit Laird’s modular approval.

The RG191-M2 holds full modular approvals and is certified for integration to products only by OEM integrators under the following conditions:

1. The antenna(s) must be installed such that a minimum separation distance of 20 cm is always maintained between the radiator (antenna) and all persons.
2. The transmitter module must not be operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.

If the two conditions above are met, further transmitter testing is not required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, RF Exposure/SAR, etc.).

IMPORTANT NOTE: If these conditions cannot be met (for certain configurations or co-location with another transmitter), then the FCC and Industry Canada authorizations are no longer considered valid and the FCC ID and IC Certification Number cannot be used on the final product. In these circumstances, the OEM integrator is responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC and Industry Canada authorization.

LSR 001-0002 center-fed 900 MHz dipole antenna and LSR 080-0001 U.FL to Reverse Polarity SMA connector

Power Exposure Information

Federal Communication Commission (FCC) Radiation Exposure Statement:

To comply with FCC RF exposure limits for general population/uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and operating in conjunction with any other antenna or transmitter.

WARNING: The OEM must ensure that FCC and Industry Canada labelling requirements are met. This includes a clearly visible label on the outside of the OEM enclosure specifying the appropriate Laird FCC and ISED Canada identifier for this product.

Contains FCC ID: SQG-1001
Contains IC: 3147A-1001

The OEM of the RG191-M2 module must only use the approved antenna(s) which have been certified with this module. The OEM integrator must not provide information to the end user regarding how to install or remove this RF module or change RF related parameters in the user manual of the end-product.

The user manual for the end-product must also include the following information in a prominent location:

To comply with FCC and Industry Canada RF exposure limits for general population/uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures. If the size of the end product is larger than 8x10cm, then the following FCC part 15.19 statement has to also be available on visible on outside of device:

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.
CAUTION: The OEM should have their device which incorporates the RG191-M2 tested by a qualified test house to verify compliance with FCC Part 15 Subpart B limits for unintentional radiators.

WARNING: Changes or modifications not expressly approved by Laird could void the user’s authority to operate the equipment.

FCC Interference Statement

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in an installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one or more of the following measures:

- Re-orient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Connect the equipment to an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Warning:

“THIS DEVICE COMPLIES WITH PART 15 OF THE FCC RULES OPERATION IS SUBJECT TO THE FOLLOWING TWO CONDITIONS: (1) THIS DEVICE MAY NOT CAUSE HARMFUL INTERFERENCE, AND (2) THIS DEVICE MUST ACCEPT ANY INTERFERENCE RECEIVED, INCLUDING INTERFERENCE THAT MAY CAUSE UNDESIRED OPERATION.

Industry Canada (IC) Warning:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

French equivalent is:

Le présent appareil est conforme aux CNR d'Industrie Canada applicable aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l’appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.

ISED Radiation Exposure Statement

To comply with ISED Canada RF exposure limits for general population / uncontrolled exposure, the antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be operating in conjunction with any other antenna or transmitter.

REMARQUE IMPORTANTE

Déclaration IC d’exposition aux radiations

Pour se conformer à Industrie Canada RF limites d’exposition pour la population générale / exposition non contrôlée, l’antenne utilisée pour ce transmetteur doit être installée pour fournir une distance d’au moins 20 cm de toutes les personnes et ne doit pas fonctionner en conjonction avec toute autre antenne ou transmetteur.

Modular Approval

OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).
Approbation modulaire
OEM intégrateur est toujours responsable de tester leur produit final pour les exigences de conformité supplémentaires nécessaires à ce module installé (par exemple, les émissions de périphériques numériques, les exigences de périphériques PC, etc.)

IMPORTANT NOTE:
If these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end-product (including the transmitter) and obtaining a separate Canada authorization.

NOTE IMPORTANTE:
Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d’une autorisation distincte au Canada.

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: "RG191-M2 Contient des IC: 3147A-1001";
### 10 CE Regulatory

The RG186-M2 has been tested for compliance with relevant standards for the EU market. The RG186-M2 module has been tested with LSR 001-0028 center-fed 868 MHz dipole antenna and LSR 080-0001 U.FL to Reverse Polarity SMA connector.

The OEM should consult with a qualified test house before entering their device into an EU member country to make sure all regulatory requirements have been met for their complete device.

Reference the Declaration of Conformities listed below for a full list of the standards that the modules were tested to. Test reports are available upon request.

#### 10.1 Antenna Information

The following antennas have been certified with the RG1xx-M2 cards.

- RG186-M2 – LSR 001-0028 center-fed 868 MHz dipole antenna and LSR 080-0001 U.FL to Reverse Polarity SMA connector
- RG191-M2 – LSR 001-0002 center-fed 900 MHz dipole antenna and LSR 080-0001 U.FL to Reverse Polarity SMA connector

#### 10.2 EU Declarations of Conformity

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Laird</th>
</tr>
</thead>
<tbody>
<tr>
<td>Products</td>
<td>RG186-M2</td>
</tr>
<tr>
<td>Product Description</td>
<td>Sentrius™ Concentrator Card – Pluggable M2.COM LoRaWAN™ Adapter</td>
</tr>
</tbody>
</table>

Reference standards used for presumption of conformity:

<table>
<thead>
<tr>
<th>Article Number</th>
<th>Requirement</th>
<th>Reference standard(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1b</td>
<td>Protection requirements – Electromagnetic compatibility</td>
<td>EN 301 489-1 v2.2.0 (2017-03)</td>
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<td></td>
<td></td>
<td>EN 301 489-3 v2.1.1 (2017-03)</td>
</tr>
<tr>
<td>3.2</td>
<td>Means of the efficient use of the radio frequency spectrum (ERM)</td>
<td>EN 300 220-1 v3.1.1 (2017-02)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>EN 300 220-2 v3.1.1 (2017-02)</td>
</tr>
</tbody>
</table>

**Declaration:**

We, Laird, declare under our sole responsibility that the essential radio test suites have been carried out and that the above product to which this declaration relates is in conformity with all the applicable essential requirements of Article 3 of the EU Radio Equipment Directive 2014/53/EU, when used for its intended purpose.

**Place of Issue:**

Laird  
W66N220 Commerce Court, Cedarburg, WI 53012 USA  

**Date of Issue:**  
15 June 2017

**Name of Authorized Person:**  
Thomas T Smith, Director of EMC Compliance

**Signature of Authorized Person:**

[Signature]
11 Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>RG186-M2</td>
<td>LoRaWAN Concentrator Card – M2.COM Interface (Europe)</td>
<td>July 2017</td>
</tr>
<tr>
<td>RG191-M2</td>
<td>LoRaWAN Concentrator Card – M2.COM Interface (N. America)</td>
<td>July 2017</td>
</tr>
</tbody>
</table>

12 Additional Assistance

Please contact your local sales representative or our support team for further assistance:

Email: wireless.support@lairdtech.com
Phone:  
Americas: +1-800-492-2320
Europe: +44-1628-858-940
Hong Kong: +852 2923 0610