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## AN056: Global Support for RIIM

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## Background

The number of SRDs (Short Range Devices) has been rising non-stop over the last decades. However, with the rise of IoT and LPWANs (Low Power Wide Area Networks), SRDs are projected to be even more abundant.

The main advantage of SRD-enabled LPWANs and what makes them very widely used, is their use of unlicensed spectrum. This means that an operator using an LPWAN does not, usually, have to apply for a special license, nor pay fees to use the frequency spectrum for his application. Countries usually impose restrictions on the use of their frequency spectrum, for both security and fair-usage policies. Most of a country's frequency band is usually reserved for military, cellular, and tv and radio broadcast applications. However, small fragments of the radio band are allowed to be used by radio developers without the need for license fees. This helps make smart and IoT applications feasible for their developers.

However, to avoid the situation where one radio user is occupying the radio spectrum all for himself, unlicensed radio bands are often highly regulated. Such regulations impose certain channels to be used, at certain duty cycles and by using controlled output power. From a regulator's point of view, regulating the use of unlicensed frequency bands is essential to allow for a fair distribution of radio frequency use. On the other hand, this puts extra restriction on radio users as they are only allowed to use radio channels under certain conditions.

In Europe for example, under the European Telecommunications Standards Institute (ETSI) regulations, a radio's maximum duty cycle is often 1% (could be 0.1% or 10% in some conditions), which means, the radio is allowed to transmit only in 1% of the time. For instance, over the course of one hour, a radio is allowed transmission only for 36 seconds. This clearly reduces the amount of time the radio can stay on air, which by turn reduces the total radio throughput. This can be problem at times when there is a need for passing on much data through the network.

This document describes some of the radio regulations in various parts of the world. In addition, this document shows how RIIM™ fits the aforementioned regulations. Lastly, the document also presents the correct ICI setting to be used with each set of regulations.

## Europe

The European directive for frequency allocation dictates a number of different channels, in the Sub 1-GHz band for SDR (Short Range Devices) operation. These channels can be used for applications involving short range radios in civil use cases.

The RIIM™ module designed for operation in Europe is the RC1882CEF-IPM for low power and RC1882HPCF-IPM for high power. This module operates in the frequency range between 863 MHz – 870 MHz. In this frequency band, RIIM supports 32 channels, and the duty cycle ranges from 0.1% to 1% as shown in Table 1 for low power. For frequency hopping, RIIM™ hops on 16 channels, they are highlighted in grey in table 1.

Channel	Center frequency [MHz]
0	863.125
1	863.325
2	863.525
3	863.725
4	863.925
5	864.125
6	864.325
7	864.525
8	864.725
9	864.925
10	865.125
11	865.325
12	865.525
13	865.725
14	865.925
15	866.125
16	866.325
17	866.525
18	866.725
19	866.925
20	867.125
21	867.325
22	867.525
23	867.725
24	867.925
25	868.125
26	868.325
27	868.525
28	868.725
29	868.925
30	869.125
31	869.325
32	869.525
33	869.725

Table 1. Frequency Channels used by RIIM in the 868 MHz range for low power.

Source: [https://radiocrafts.com/uploads/RC1882-IPM\\_Datasheet.pdf](https://radiocrafts.com/uploads/RC1882-IPM_Datasheet.pdf)

However, for high power operation, regulations differ. Under ETSI regulations, radios transmitting with output power of around 500 mW (which translates to the 27 dBm RIIM™ HP uses) are only allowed transmission in the frequency channel between 869.400 MHz to 869.650 MHz. In this band, the high-power radio can utilize a duty cycle of up to 10%. You can learn more about ETSI regulations by checking the tables starting from page 20 here: [https://www.etsi.org/deliver/etsi\\_en/300200\\_300299/30022002/03.01.01\\_30/en\\_30022002v030101v.pdf](https://www.etsi.org/deliver/etsi_en/300200_300299/30022002/03.01.01_30/en_30022002v030101v.pdf)

According to ETSI regulations, RIIM™ can transmit with duty cycles of 0.1% or 1% for low-power transmissions, or it can be up to 10% duty cycle for high-power. However, ETSI dictates that under the condition that Polite Spectrum Access techniques are used (such as LBT-Listen Before Talk and AFA- Adaptive Frequency Agility), duty cycle can be increased till up to around 40%. For more information about this and how to enable Polite Spectrum Access techniques for higher duty cycle usage with RIIM™, please refer to our application note 51: [https://radiocrafts.com/uploads/AN051\\_High\\_Throughput\\_Networking\\_With\\_Polite\\_Spectrum\\_Access\\_in\\_RIIM.pdf](https://radiocrafts.com/uploads/AN051_High_Throughput_Networking_With_Polite_Spectrum_Access_in_RIIM.pdf)

To choose the Europe-compliant frequency band, please use:

**`Network.setFreqBand(RF_BAND_868);`**

### USA/Canada

In the USA and Canada, and a few other countries, the regulation body responsible for regulating frequency usage is the FCC (Federal Communications Commission). In low-power operation, the RC1882CEF-IPM can still be used to support FCC frequencies. To operate under FCC regulations, the RC1882CEF-IPM module can be set to operate in the 902 MHz – 928 MHz frequency band. For single channel usage, this spans over 129 channels.

For high-power operation, the RC1892HPCF-IPM module has to be used. For frequency hopping, FCC dictates that a radio such as RIIM™ has to use at least 50 channels on its hopping list, which RIIM supports.

To use the frequency band compliant with the FCC requirements, please use:

**`Network.setFreqBand(RF_BAND_915);`**

### Mexico/South America

The USA and Canada are not the only countries which follow FCC regulations. In addition to the USA and Canada, the following South American countries also operate under FCC regulations and in the band 902 MHz to 928 MHz:

Source: [https://www.gs1.org/docs/epc/uhf\\_regulations.pdf](https://www.gs1.org/docs/epc/uhf_regulations.pdf)

These band allows the whole 902-928 MHz band

- Argentina
- Guatemala
- Honduras
- Puerto Rico
- Trinidad & Tobago

Chile, Peru, Colombia and Uruguay allow 915 – 928 MHz, which is the same band as Australia. El Salvador allow 912 – 928 MHz, which include the band in Australia. Local rules on radiated spurious and hopping channel must be instigated country by country.

French Guinea might be an exception as it follows ETSI standards.

### Brazil

The regulations in Brazil are made by the government organization Anatel. The latest regulation for SRD band sub 1 GHz is given in Resolution 680 from 2017, with the technical requirement in ACT 14448/2017. The allowed band is 902-907.5 MHz and 915-928 MHz. The band 907.5-915 MHz is dedicated to cellular radio.

There is also a requirement for minimum 35 hopping channels and the allowed output power is 1 watt. The support for this is not implemented in RIIM SDK 3.0.0, but are in the backlog for future releases.

### Australia/New Zealand

Operation is in the 915-928 MHz. They use 20 channels for channel hopping. The main difference between their regulations and the FCC is that the band 902 MHz – 915 MHz is used for cellular communications in Australia. Therefore, the band RIIM™ offers for the AU/NZ regulations does not go below 915 MHz. It can be set by: **`Network.setFreqBand(RF_BAND_920_AUS);`**

### Vietnam

In Vietnam, the frequency band used is 918.8-921.8 MHz. For channel hopping, RIIM™ can use 14 channels out of the 16 available. To set the frequency band suitable for Vietnam, please use:

**`Network.setFreqBand(RF_BAND_920_VNM);`**

### India

In India, the whole allowed band is 865-867 MHz, however, the band where RIIM™ operates is 865.125-866.725 MHz. For channel hopping, RIIM™ uses 9 channels. Maximum output power is high enough so the RC1882HPCF-IPM can also be used. To choose the frequency band compliant with the Indian regulations, please use:

**`Network.setFreqBand(RF_BAND_866_IND);`**

### North Africa/Middle East

Most North African and middle east countries acknowledge ETSI regulations. However, this cannot be guaranteed. Therefore, the best way to be certain is by contacting the respective authorities.

**Summary**

Country/Area	Regulatory Body followed	Frequency range, Low Power [MHz]	Frequency range, High Power [MHz]	Suitable RIIM™ module part number	Frequency Hopping channels	Band to be chosen in ICI	Notes
<b>Europe</b>	ETSI	863 - 870	869.400-869.650	RC1882CEF-IPM/ RC1882HPCF-IPM	16 Only 14 can be used simultaneously	RF_BAND_868	Only 1 ch. for HP 869.525
<b>UK Saudi Arabia UAE South Africa Turkey Russia</b>		863 - 870 / 433	HP varies by country		Might vary by country		
<b>USA/ Canada</b>	FCC**	902 - 928		RC1882CEF-IPM / RC1892HPCF-IPM	50	RF_BAND_915	Same 50 ch. for HP
<b>Most South America, except Brazil</b>		915 - 928			35	TDB	French Guinea might be exception
<b>Brazil</b>	Anatel						
<b>Australia/ New Zealand</b>	AU/GURL				20	RF_BAND_920_AUS	
<b>India</b>	WPC	865.128 - 866.725		RC1882CEF-IPM/ RC1882HPCF-IPM	9 Only 7 can be used simultaneously	RF_BAND_866_IND	
<b>Vietnam</b>		918.8-921.8	No spec for HP	RC1882CEF-IPM	16 Only 14 can be used simultaneously	RF_BAND_920_VNM	
<b>Hong Kong</b>		923 - 925	No spec for HP	RC1882CEF-IPM		RF_BAND_915	
<b>Japan</b>	ARIB	920 - 923	No spec for HP	RC1882CEF-IPM			

Table 2. Brief idea of frequency allocation for commonly-asked-about countries

\*Please note that this table is prepared to the best of our knowledge and that it does not fully encompass nor replace the actual regulations of each country or area. The radio user is required to self-verify the allowed frequencies and other spectrum usage restrictions before deploying any radio network.

\*\*FCC §15.247 is used as standard, but the available channels differ from country to country in South America.

## Document Revision History

Document Revision	Changes
1.0	First release

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