

LoRa Concentrator Spectrum - EU868 Settings Guide

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1. Overview

This is the LoRa RF Radio unit. It integrated two Semtech SX1257 front-end modules with the most popular LoRaWAN Baseband chip, the SX1301. Because of the design of the concentrator module, there are two separate RX chains, which need to have the proper number of channels assigned in order for the module to function optimally. The chains are refer to as Radio 0 and Radio 1 in the Web UI.

Radio 0 can work in both TX and RX mode. It can have up to 5 channels assigned

Radio 1 works solely in RX mode. It can also have up to 5 channels assigned.

The concentrator module supports up to 8 Multi-Spreading Factor Channels (MultiSF), 1 Lora Standard Channel and 1 FSK channels, that can be spread over the 2 Radios as long as the 5 channel per radio rule is obeyed.

2. Spectrum Settings

Let us take as an example the EU863-870 band. In fact, there is a template for it that you can import directly, no need to set every channel manually. However, the way it has been pre-configured is in accordance with principles that apply for any band.

Step 1: Setting the Center Frequencies:

The user should start by setting the center frequencies for the two Radios:

Radio 0 Freq and Radio 1 Freq. These are for the Rx channels.

Next, set the minimum and maximum of the frequency range of Radio:

Radio 0 Tx Freq Min and Radio 1 Tx Freq Max. These are for the Tx only.

Figure 1 shows what the values for the EU863-870 band should be.

Radio 0 Freq.	<input type="text" value="867500000"/>
Radio 0 Tx Freq Min	<input type="text" value="863000000"/>
Radio 0 Tx Freq Max	<input type="text" value="870000000"/>
Radio 1 Freq.	<input type="text" value="868500000"/>

Figure 1

Step 2: Selecting the Radios/Channels

Let us have a summary of the parameters that can be seen Figure 2, which is below the Radio 0 and Radio 1 frequency fields we talked about in Step 1.

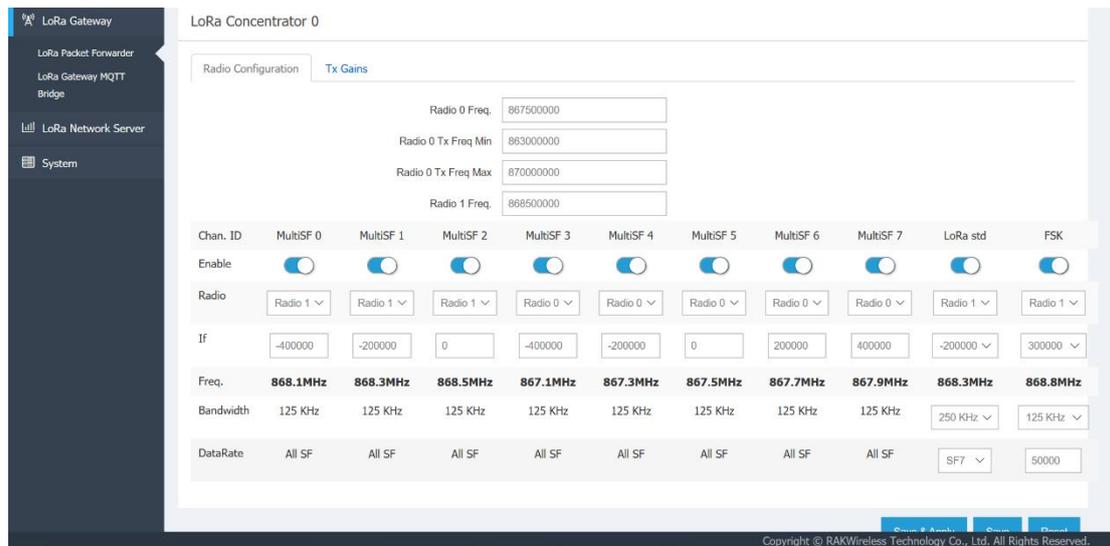


Figure 2

Chain. ID:

Unique identifier of the channel (8 Multi-SF Channels, 1 LoRa Standard, 1 FSK).

Enable:

Slider for turning a channel on/off.

Radio:

The Radio the channel will be assigned to (max 5 per Radio).

If [Hz]:

The frequency offset from the center frequency for the given channel.

Freq [MHz]:

The resulting frequency for the channel after summing the center frequency with the *If* field value

Bandwidth [KHz]:

This is only selectable for the LoRa Standard and FSK channels. The MultiSF are static.

Datarate:

Essentially this is the Spreading Factor (SF) as it is directly related to the bitwise data rate. The MultiSF channels can dynamically use any of the available SFs (SF7 – SF12). The Standard LoRa channel has to have a single value assigned (SF7 - SF12). The FSK channel has a field with a numeric value to be entered in *bps*.

In order to have each channel at the desired frequency the user needs to set the appropriate offset from the central frequency. This way you can end up with a number of channels spread above and below the center frequency.

Step 3: Setting the frequency offset

The TTN plan for the EU863-868 region is as follows:

Uplink:

1. **868.1** - SF7BW125 to SF12BW125
2. **868.3** - SF7BW125 to SF12BW125 and SF7BW250
3. **868.5** - SF7BW125 to SF12BW125
4. **867.1** - SF7BW125 to SF12BW125
5. **867.3** - SF7BW125 to SF12BW125
6. **867.5** - SF7BW125 to SF12BW125
7. **867.7** - SF7BW125 to SF12BW125
8. **867.9** - SF7BW125 to SF12BW125
9. **868.8** - FSK

Downlink:

- Uplink channels 1-9 (RX1)
- **869.525** - SF9BW125 (RX2 downlink only)

Now it is easy to see why we have chosen the values in Figure 1. We want to keep two things in mind. We need to cover the whole spectrum for the Uplink, from the lowest to the highest frequency. Additionally we need to have the 5 channels per radio be as close as possible to each other, so we need to group the Radios by frequency, not by number of channels. For the aforementioned reason TTN channels 1,2,3,9 should be assigned to the first radio (additionally there is one more channel, number 2, but with SF7 and 250KHz bandwidth). The second Radio can get the other five channels 4,5,6,7,8.

Now in order to keep the bandwidth tight, we pick a channel in each of the two Radio ranges as close as possible to the middle. Ideally, as we have five channels, this would be the 3rd one. The center channels are than TTN channels 3 and 6. This leads us to the center frequencies that are in Figure 1. As for the Uplink, we simply need to cover the whole band, in this case 863MHz to 870MHz.

Now we can start calculating the frequency offset we need to have from the center frequency for each channel. We use the following formula:

$$I_f = \text{MultiSF} - \text{Radio Freq}$$

So to calculate the I_f frequency offset we need to subtract the Radio Freq (center frequency) from the MultiSF (desired channel frequency)

We have:

Radio 1:

$$\text{MultiSF 0} = \text{TTN 1} = 868100000\text{Hz}$$

$$I_f 0 = \text{MultiSF 0} - \text{Radio 1 Freq} = 868100000 - 868500000 = -400000\text{Hz}$$

$$\text{MultiSF 1} = \text{TTN 2} = 868300000\text{Hz}$$

$$I_f 1 = \text{MultiSF 1} - \text{Radio 1 Freq} = 868300000 - 868500000 = -200000\text{Hz}$$

$$\text{MultiSF 2} = \text{TTN 3} = 868500000\text{Hz}$$

$$I_f 2 = \text{MultiSF 2} - \text{Radio 1 Freq} = 868500000 - 868500000 = 0\text{Hz}$$

Those are the first 3 TTN channels. The next channel however is at a lower frequency than all the previous ones. Thus, it will be assigned to Radio 0

We have:

Radio 0:

$$\text{MultiSF 3} = \text{TTN 4} = 867100000\text{Hz}$$

$$I_f 3 = \text{MultiSF 3} - \text{Radio 0 Freq} = 867100000 - 867500000 = -400000\text{Hz}$$

$$\text{MultiSF 4} = \text{TTN 5} = 867300000\text{Hz}$$

$$I_f 4 = \text{MultiSF 4} - \text{Radio 0 Freq} = 867300000 - 867500000 = -200000\text{Hz}$$

$$\text{MultiSF 5} = \text{TTN 6} = 867500000\text{Hz}$$

$$I_f 5 = \text{MultiSF 5} - \text{Radio 0 Freq} = 867500000 - 867500000 = 0\text{Hz}$$

$$\text{MultiSF 6} = \text{TTN 7} = 867700000\text{Hz}$$

If 6 = MultiSF 6 - Radio 0 Freq = 867700000 – 867500000 = 200000Hz

MultiSF 7 = TTN 8 = 867900000Hz

If 7 = MultiSF 7 - Radio 0 Freq = 867900000 – 867500000 = 400000Hz

The LoRa Standard Channel is the same as the Channel 2, but with 250KHz bandwidth. Thus, it belongs to Radio 1 and is calculated as:

LoRa std = TTN 2 = 868300000Hz

If 7 = MultiSF 7 - Radio 1 Freq = 868300000 – 868500000 = -200000Hz

Finally the FSK channel:

LoRa std = TTN 2 = 868800000Hz

If 7 = MultiSF 7 - Radio 1 Freq = 868800000 – 868500000 = 300000Hz

Finally we have all the *f* frequency values and we only need plug them in the fields to get the TTN EU863-868 frequency plan.

Do not forget to manually set the Bandwidth and DataRate of the LoRa std at 250KHz (SF7) and FSK at 125KHz (50000bps).

This concludes setting up the two Radios with the appropriated frequencies, bandwidths and data rates.

3. Revision History

Revision	Description	Date
1.0	Initial version	2019-06-20
1.1	Modify the layout	2019-06-21

4. Document Summary

Prepared by	Checked by	Approved by
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About RAKwireless:

RAKwireless is the pioneer in providing innovative and diverse cellular and LoRa connectivity solutions for IoT edge devices. It's easy and modular design can be used in different IoT applications and accelerate time-to-market.

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