

How to Qualify a LoRaWAN™ Device in Europe

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1. Introduction

The intention of this paper is to propose a path to obtaining CE certification for a LoRaWAN™ device in Europe, on a radio frequency portion. Matters related to electrical safety and electro-magnetic compatibility are out of scope.

1.1 The Past

Until very recently, the R&TTE directive was the reference for the SRD market. On the RF front, the reference standard was the ETSI EN 300 220-1 V2.4.1 (2012-01), providing technical characteristics and test methods, as well as a list of applicable frequency bands, inherited from the CEPT's European Radio Communications Office's recommendation document (ERC/REC 70-03).

But this is the past! The now applicable RED directive references the ETSI EN 300 220 V3.1.1 (2017-02) as harmonized standard. Its "Part 1" portion ("-1" part) [1], still provides "Technical characteristics and methods of measurement", whilst "Part 2" [2] now provides, amongst others, a list of harmonized and non-harmonized frequency bands in correlation with the relevant EC decisions, but we'll get back to this in a moment.

1.2 The Present

A few modifications in the technical characteristic and measurement methods have been ratified and are described in details in a separate paper [3].

When it comes to medium access limitations such as duty cycle restrictions or maximum effective radiated power, [2] provides the relevant information, more specifically its Annex B "EU wide harmonized national radio interfaces from 25 MHz to 1 000 MHz" and Annex C "National Radio Interfaces not EU-wide harmonized".

In particular, it is stated in the introduction of Annex B in [2], that "Table B.1 is in line with the harmonized frequency bands and technical parameters for short-range devices from EC Decision 2013/752/EU [1.3]", referencing the Commission Decision of December 11th 2013, and defining the frequency bands, duty-cycle limitations, and e.r.p. levels accepted for short range devices in the European countries.

An excerpt of Table B.1 is given below. It is a snapshot copy of the EC decision at the time of authoring [2].

Table 1: Channel Characteristics, excerpt of Table B.1

Operational Frequency Band		Maximum effective radiated power, e.r.p.	Channel access and occupation rules (e.g. Duty cycle or LBT + AFA)	Maximum occupied bandwidth	Other usage restrictions	Band number from EC Decision 2013/752/EU [i.3]	Class 1 sub-class number according Commission Decision 2000/299/EU [i.7]
M	868,000 MHz to 868,600 MHz	25 mW	≤ 0,1 % duty cycle or polite spectrum access	The whole band except for audio & video applications limited to 300 kHz		48	28
N	868,700 MHz to 869,200 MHz	25 mW	≤ 0,1 % duty cycle or polite spectrum access	The whole band except for audio & video applications limited to 300 kHz		50	29
O	869,400 MHz to 869,650 MHz	25 mW	≤ 0,1 % duty cycle or polite spectrum access	The whole band		54a	130
P	869,400 MHz to 869,650 MHz	500 mW	≤ 10 % duty cycle or polite spectrum access	The whole band		54b	30
Q	869,700 MHz to 870,000 MHz	5 mW	No requirement	The whole band	Audio and video applications are excluded.	56a	31
R	869,700 MHz to 870,000 MHz	25 mW	≤ 1 % duty cycle or polite spectrum access	The whole band	Analogue audio and video applications are excluded.	56b	69
K	863 MHz to 865 MHz	25 mW	≤ 0,1 % duty cycle or polite spectrum access	The whole band except for audio & video applications limited to 300 kHz		46a	66
L	865 MHz to 868 MHz	25 mW Power density: -4,5 dBm/100 kHz The power density can be increased to +6,2 dBm/100 kHz if the band of operation is limited to 865 MHz to 868 MHz	≤ 0,1 % duty cycle or polite spectrum access	The whole band except for audio & video applications limited to 300 kHz	DSSS and any techniques other than FHSS.	47	67

LoRaWAN™ devices are best implemented in operational frequency band (referred as “sub-band”):

- Sub-band M for the mandatory “Join channels”
- Sub-band P for the “Rx2”, 500 mW, mostly downlink-favorable, channel
- Sub-band N and R with decent DC and power restrictions
- Sub-band L

Note:

Sub-band K isn’t considered (stringent DC restriction and proximity with LTE band 20).

At the time of writing [2], the access to band L is restricted to devices exhibiting a power spectral density lower than +6.2 dBm/100 kHz, which in turns limits the e.r.p. or a LoRa® device to about 4 mW, when nominally connected objects could use 25 mW.

These sub-bands in annex B are harmonized in Europe, but Annex C also lists the sub-bands who “might be available in some EU countries”. In other words the applicant should refer to each national radio-communication office (such as the ANFR Annex 7 in France for SRDs) to know the ratification status of the specific frequency band, a tedious job, even if [4], published by the ERO, provides an indicative status of ratification of the sub-bands for all involved countries.

Specifically, as of May 2017, it would in principle possible to simplify everything and create any channel in the 863-870 MHz space, with sub-band X (line 2 within the brackets). Note however that there’s here a limitation of 0.1% in duty cycle, to be shared amongst all channels created. This may be overly restrictive for some use cases.

Table 2: 863 to 870 MHz Channel Characteristics, excerpt of Table B.1

Operational Frequency Band	Maximum Effective Radiated Power	Channel access and occupation rules	Additional/other spectrum access parameters	Maximum Occupied Bandwidth	Other Usage Restrictions	Notes	CEPT/ERC/REC70-03 [i.1] Implementation Status
X 863MHz to 870 MHz	25 mW e.r.p.	≤ 0,1 % duty cycle or polite spectrum access	≤ 1 % Duty Cycle if the band is limited to 865 MHz to 868 MHz	100 kHz for 47 or more channels	FHSS	Sub-bands for alarms [868,6 MHz to 868,7 MHz], [869,250 - 869,4 MHz], [869,650 MHz to 869,700 MHz] are excluded.	90%
	25 mW e.r.p. Power density: -4,5 dBm/100 kHz. The power density can be increased to +6,2 dBm/100 kHz if the band of operation is limited to 865 MHz to 868 MHz. The power density can be increased to -0,8 dBm/100 kHz, if the band of operation is limited 865 MHz to 870 MHz.	≤ 0,1 % duty cycle or polite spectrum access	Duty cycle may be increased to 1 % if the band is limited to 865 MHz to 868 MHz and power limited to 10 mW e.r.p.	The whole band except for audio & video applications limited to 300 kHz and voice limited to 25 kHz		DSSS and any techniques other than FHSS Sub-bands [868,6 MHz to 868,7 MHz], [869,250 MHz to 869,4 MHz], [869,650 MHz to 869,700 MHz] for alarms are excluded.	90%
	25 mW e.r.p.	≤ 0,1 % duty cycle or polite spectrum access		300 kHz except for voice limited to 25 kHz		Sub-bands [868,6 MHz to 868,7 MHz], [869,250 - 869,4 MHz], [869,650 MHz to 869,700 MHz] for alarms are excluded.	90%

1.3 New Decision of the EC

The EC has recently (August 8th 2017) issued a decision, changing a couple of things and harmonizing the spectral usage for SRDs [\[5\]](#). It makes obsolete the previous regulatory framework and provides a raft of new good options for our LoRaWAN™ SRDs. In particular, gateways have more capability.

The reader should refer to the latest EC decision published at the EU's Official Journal [\[5\]](#), and more specifically focus on Operational Frequency Bands number 48, 50, 54, 56b, 46a, and 47, as well as band 84 for gateways and access points.

2. What Applies for my LoRaWAN™-enabled Devices?

2.1 For End-Devices

Table 3: Excerpt of Harmonized Frequency Bands and Technical Parameters for Short-Range Devices

Band per EC Decision [5]	Frequency Range (MHz)	Duty Cycle Limit ¹	Maximum e.r.p.	Implementation Deadline	Comment in regards to LoRaWAN™
48	868 – 868.6	1 %	25 mW	July 1 st 2014	Join channels, mandatory
50	868.7 – 869.2	0.1 %	25 mW	July 1 st 2014	Low Duty Cycle
54	869.4 – 869.65	10 %	500 mW	July 1 st 2014	May not be used for uplink, only downlink
56b	869.7 - 870	1 %	25 mW	July 1 st 2014	
46a	863 – 865	0.1 %	25 mW	January 1 st 2018	New band, low duty-cycle
47	865 – 868	1 %	25 mW	July 1 st 2014	
47b	865 – 868	2.5 %	500 mW	January 1 st 2018	Only specific channels ²

¹ Averaged over 1 hour and summing the time on air of all channels declared within the sub-band

² Transmissions only permitted within the bands 865,6- 865,8 MHz, 866,2-866,4 MHz, 866,8-867,0 MHz and 867,4- 867,6 MHz. Adaptive Power Control (APC) required.

To conclude, end-devices intending to connect to LoRaWAN™ networks should seek certification for sub-bands 48, 56b and 47 at least.

Other bands offer either a very low DC capability, or exploit e.r.p. levels which are typically beyond the capability of the end-devices (band 47b). The device integrator should however discuss with their network carrier to seek guidance as to which sub-band is intended to be used now or in the future.

2.2 For Gateways or Access Points

Table 4: 865 to 868 MHz Channel Characteristics

Band Number	Frequency Band	Category of short-range devices	Transmit power limit/field strength limit/power density limit	Additional parameters (channelling and/or channel access and occupation rules)	Other usage restrictions	Implementation deadline
47b	865 -868 MHz	Non-specific short- range devices	500 mW e.r.p. Transmissions only permitted within the bands 865,6- 865,8 MHz, 866,2- 866,4 MHz, 866,8-867,0 MHz and 867,4- 867,6 MHz. Adaptive Power Control (APC) required. Alternatively other mitigation technique with at least an equivalent level of spectrum compatibility.	Techniques to access spectrum and mitigate interference that provide at least equivalent performance to the techniques described in harmonized standards adopted under Directive 2014/53/EU must be used. Bandwidth: ≤ 200 kHz Duty cycle [vi]: ≤ 10 % for network access points Duty cycle ≤ 2,5 % otherwise	This set of usage conditions is only available for data networks	January 1 st 2018

The introduction of band 47b is very good news, un-locking 4 channels with up to 500 mW e.r.p., assuming power control is implemented (which can be implemented in a LoRaWAN™ system). Up to 10 % duty cycle, or 360 seconds per hour, may be used for transmission, shared amongst all 4 channels for network access points.

Most probably these channels will be used for downlink-only, allowing for more high-speed downlink communications, even using the first receive window (Rx1). For these new capabilities, it is better to check with national frequency regulation authorities to verify the implementation status.

3. Conclusion

The much awaited EC decision of August 2017, related to SRDs, clarifies the access to all frequency bands used in LoRaWAN™, and confirms the 1% duty-cycle available in the 865 - 868 MHz space. It also sets an implementation deadline on January 1st 2018 for 4 additional 500 mW channels. Individual countries in the European Union will consider and implement these new sub-bands until the end of the year.

4. Revision History

Version	Date	Modifications
1.0	February 2018	First Release

5. References

[1] ETSI EN 300 220-1 (V3.1.1) (02-2017): "Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 1: Technical characteristics and methods of measurement"

[2] ETSI EN 300 220-2 (V3.1.1) (02-2017): "Short Range Devices (SRD) operating in the frequency range 25 MHz to 1 000 MHz; Part 2: Harmonized Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU for non-specific radio equipment"

[3] RED replacing R&TTE: impact on LoRaWAN devices, Semtech White Paper

[i.3] Commission Decision 2013/752/EU on harmonization of the radio spectrum for use by short-range devices as amended by subsequent Commission Decisions

[4] ERC Recommendation 70-03 Relating to the Use of Short Range Devices (SRD) – Edition of October 2017

[5] Commission Implementing Decision (EU) 2017/1483 of 8 August 2017 amending Decision 2006/771/EC on harmonization of the radio spectrum for use by short-range devices and repealing Decision 2006/804/EC



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