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**LoRaWAN 1.1 Regional Parameters**

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# LoRaWAN™ 1.1 Regional Parameters

**This document is a companion document to the LoRaWAN 1.1 protocol specification**

**Authors:**  
LoRa Alliance Technical Committee Regional Parameters Workgroup

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## 268 **1 Introduction**

269

270 This document describes the LoRaWAN™ regional parameters for different regulatory  
271 regions worldwide. This document is a companion document to the LoRaWAN 1.1 protocol  
272 specification [LORAWAN]. Separating the regional parameters from the protocol  
273 specification allows addition of new regions to the former without impacting the latter  
274 document.

275

276 It must be noted here that, regardless of the specifications provided, at no time is any LoRa  
277 equipment allowed to operate in a manner contrary to the prevailing local rules and  
278 regulations where it is expected to operate. It is the responsibility of the LoRa device to  
279 insure that compliant operation is maintained without any outside assistance from a LoRa  
280 network or any other mechanism.

### 281 **1.1 Conventions**

282

283 The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD",  
284 "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be  
285 interpreted as described in RFC 2119.

286

### 287 **1.2 Quick cross reference table**

288

289 In order to support the identification of LoRaWAN channel plans for a given country, the  
290 table below provides a quick reference of suggested channel plans listed in priority order for  
291 each country.

292

293

Country name	Band / channels	Channel Plan
Afghanistan		None
Albania	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
Algeria	433.05 - 434.79 MHz	EU433
	870-876MHz	Other
	880-885MHz	Other
	915 - 921 MHz	Other
	925 - 926 MHz	Other
Andorra	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Armenia	863 - 870 MHz	EU863-870
	433.05 - 434.79 MHz	EU433
Argentina	902 - 928 MHz (915-928 MHz usable)	AU915-928, US902-928
Austria	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Australia	915 - 928 MHz	AU915-928, AS923
Azerbaijan	433.05 - 434.79 MHz	EU433
	863 - 868 MHz	Others
Bahrain	862 - 870MHz	EU863-870
Bangladesh	433.05 - 434.79 MHz	EU433
	818 - 824 MHz	Other
	863 - 869 MHz	EU863-870
	925.0 - 927.0 MHz	Other
Belarus	433.05 - 434.79 MHz	EU433
	864.4 - 868.6 MHz	EU863-870
	869-869.2MHz	EU863-870
Belgium	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Burma (Myanmar)	433 - 435 MHz	EU433
	866 - 869MHz	EU863-870
	919 - 923 MHz	Other
Bolivia	915 - 930 MHz	AU915-928, AS923
Bosnia and Herzegovina	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Botswana		None
Brazil	902 - 907.5 MHz	Other
	915 - 928 MHz	AU915-928
	433 - 435 MHz	EU433
Brunei Darussalam	866 - 870 MHz	EU863-870
	920 - 925 MHz	AS923



	433 - 435 MHz	EU433
Bulgaria	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Cambodia	866 - 869 MHz	EU863-870
	923 - 925 MHz	AS923
Cameroon		None
Canada	902 - 928 MHz	US902-928, AU915-928
Chile	902 - 928 MHz (915-928MHz usable)	AU915-928, AS923, US902-928
China	920.5 - 924.5 MHz	AS923
	779 - 787 MHz	CN779-787
	470 - 510 MHz	CN470-510
	433.05 - 434.79 MHz	EU433
	314-316 MHz	Other
	430 - 432 MHz	Other
	840 - 845 MHz	Other
Colombia	902 - 928 MHz	AU915-928, US902-928
Congo Rep.		None
Costa Rica	920.5 - 928 MHz	AS923
Croatia	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Cuba	433.05 - 434.79 MHz	EU433
	915 - 921 MHz	Other
Cyprus	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Czech Republic	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Denmark	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
Dominican Republic	915 - 928 MHz	AU915-928
Ecuador	902 - 928 MHz	AU915-928, US902-928, AS923
Egypt	433.05 - 434.79 MHz	EU433
	863 - 876 MHz	EU863-870
Estonia	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
Finland	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
France	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Georgia		None
Germany	433.05 - 434.79 MHz	EU433

	863 - 870 MHz	EU863-870
Ghana		None
Greece	433.05 - 434.79 MHz	EU433
	868 - 870 MHz	EU863-870
Guatemala	902 - 928 MHz (915-928 MHz usable)	AU915-928, AS923, US902-928
Haiti		None
Honduras	915-928 MHz	AU915-928
Hong Kong	433.05 - 434.79 MHz	EU433
	865 - 868 MHz	Other
	920 - 925 MHz	AS923
Hungary	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
Iceland	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
India	865 - 867 MHz	IN765-867
Indonesia	923 - 925 MHz	AS923
Iraq		None
Iran	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	915 - 918 MHz	Other
Ireland	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
Israel	433.05 - 434.79 MHz	EU433
	915 - 917 MHz	Other
Italy	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Ivory Coast		None
Jamaica	902 - 928 MHz (915-928 MHz usable)	AU915-928, US902-928
Japan	920.6 - 928.0 MHz (steps of 200kHz)	AS923
	920.8 - 927.8 MHz (steps of 600kHz)	AS923
Jordan	865 - 868 MHz	Other
Kazakhstan	433.05 - 434.79 MHz	EU433
Kenya		None
Korea (DPR)		None
Kuwait	433.05 - 434.79 MHz	EU433
Kyrgyz Republic		None
Laos	433 - 435 MHz	EU433
	862 - 875 MHz	EU863-870
	923 - 925 MHz	AS923
Latvia	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870

Lebanon	433 - 435 MHz	EU433
	862 - 870 MHz	EU863-870
Liechtenstein	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
Libya		None
Lithuania	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Luxembourg	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
Macao		None
Macedonia, FYR	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Malaysia	433 - 435 MHz	EU433
	919 – 924 MHz	AS923
Maldives		None
Malta	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Mauritius		None
Mexico	902 - 928 MHz	US902-928, AU915-928
Moldova	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Mongolia		None
Montenegro	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Morocco	433.05 - 434.79 MHz	EU433
	867.6 - 869 MHz	EU863-870
Netherlands	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
New-Zealand	915 - 928 MHz	AS923, AU915-928
	819 - 824 MHz	Other
	864 - 870MHz	EU863-870
	433.05 - 434.79 MHz	EU433
Nicaragua	902 - 928 MHz (915-928 MHz usable)	AU915-928, US902-928
Nigeria	863 - 870 MHz	EU863-870
Norway	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
Oman	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Pakistan	433.05 - 434.79 MHz	EU433
	865 - 869 MHz	EU863-870
	900 - 925 MHz	AS923

Panama	902 - 928 MHz	AU915-928, US902-928, AS923
Paraguay	433.05 - 434.79 MHz	EU433
	915 - 928 MHz	AU915-928, AS923
Peru	915 - 928 MHz	AU915-928, AS923
Papua New Guinea	915 - 925 MHz	AU915-928
Philippines	915 - 918 MHz	Other
	868 – 869.2 MHz	EU863-870
	869.7 - 870 MHz	EU863-870
	433.05 - 434.79 MHz	EU433
Poland	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
Portugal	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Qatar	433.05 - 434.79 MHz	EU433
	868 - 868.6 MHz	EU863-870
	868.7 - 869.2 MHz	EU863-870
	869.4 - 869.65 MHz	EU863-870
	869.7 - 870 MHz	EU863-870
Romania	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Russian federation	866 - 868 MHz (Licensed)	RU864-870
	864 - 865 MHz	RU864-870
	868.7 - 869.2 MHz	RU864-870
	433.075 - 434.75 MHz	EU433
	916 - 921 MHz (Licensed)	Other
Salvador	915-928	AU915-928, AS923
Saudi Arabia	863 - 870 MHz	EU863-870
	433.05 - 434.79 MHz	EU433
Senegal		None
Serbia	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Singapore	920 - 925 MHz	AS923
	433.05 - 434.79 MHz	EU433
	866 - 869 MHz	EU863-870
Slovak Republic	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
Slovenia	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
South Africa	433.05 - 434.79 MHz	EU433
	865 – 868.6 MHz	EU863-870

	868.7 – 869.2 MHz	EU863-870
	869.4 – 869.65 MHz	EU863-870
	869.7 – 870 MHz	EU863-870
	915 - 921 MHz	Other
South Korea	917 - 923.5 MHz	KR920-923
Spain	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Sri Lanka	433.05 - 434.79 MHz	EU433
Sudan		None
Sweden	433.05 - 434.79 MHz	EU433
	868 - 870 MHz	EU863-870
Switzerland	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
Syrian Arab Rep.		None
Taiwan	920 - 925 MHz	AS923
Tajikistan		None
Tanzania		None
Thailand	433.05 - 434.79 MHz	EU433
	920 - 925 MHz	AS923
Trinidad and Tobago		None
Tunisia	433.05 - 434.79 MHz	EU433
	868 – 868.6 MHz	EU863-870
	868.7 – 869.2 MHz	EU863-870
	869.4 – 869.65 MHz	EU863-870
	869.7 – 870 MHz	EU863-870
Turkey	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
Turkmenistan		None
Uganda	433.05 - 434.79 MHz	EU433
	865 - 867.6 MHz	Other
	869.25 - 869.7 MHz	Other
	923 - 925 MHz	AS923
Ukraine	433.05 - 434.79 MHz	EU433
	863 - 865 MHz	EU863-870
	868 - 868.6 MHz	EU863-870
United Arab Emirates	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
	870 - 875.8 MHz	Other
	915 - 921 MHz	Other
United Kingdom	433.05 - 434.79 MHz	EU433
	863 - 873 MHz	EU863-870
	918 - 921 MHz	Other
United States	902 - 928 MHz	US902-928, AU915-928

Uruguay	902 - 928 MHz (915 - 928 MHz usable)	AU915-928, AS923, US902-928
Uzbekistan	433.05 - 434.79 MHz	EU433
Venezuela	922 - 928 MHz	AS923
Vietnam	433.05 - 434.79 MHz	EU433
	863 - 870 MHz	EU863-870
	918 - 923 MHz	Other
Yemen, Rep.		None
Zimbabwe		None

294

Table 1: Channel Plan per Country

## 2 LoRaWAN Regional Parameters

### 2.1 Regional Parameter Common Names

In order to support the identification of LoRaWAN channel plans referenced by other specification documents, the table below provides a quick reference of common channel plans listed for each formal plan name.

Channel Plan	Common Name
EU863-870	EU868
US902-928	US915
CN779-787	CN779
EU433	EU433
AU915-928	AU915
CN470-510	CN470
AS923	AS923
KR920-923	KR920
IN865-867	IN865
RU864-870	RU864

### 2.2 EU863-870MHz ISM Band

#### 2.2.1 EU863-870 Preamble Format

The following synchronization words SHOULD be used:

Modulation	Sync word	Preamble length
LORA	0x34	8 symbols
GFSK	0xC194C1	5 bytes

Table 2: EU863-870 synch words

#### 2.2.2 EU863-870 ISM Band channel frequencies

This section applies to any region where the ISM radio spectrum use is defined by the ETSI [EN300.220] standard.

The network channels can be freely attributed by the network operator. However the three following default channels MUST be implemented in every EU868MHz end-device. Those channels are the minimum set that all network gateways SHOULD always be listening on.

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels	Duty cycle
LoRa	125	868.10 868.30 868.50	DR0 to DR5 / 0.3-5 kbps	3	<1%

315

**Table 3: EU863-870 default channels**

316 In order to access the physical medium the ETSI regulations impose some restrictions such  
 317 maximum time the transmitter can be on or the maximum time a transmitter can transmit per  
 318 hour. The ETSI regulations allow the choice of using either a duty-cycle limitation or a so-  
 319 called **Listen Before Talk Adaptive Frequency Agility** (LBT AFA) transmissions  
 320 management. The current LoRaWAN specification exclusively uses duty-cycled limited  
 321 transmissions to comply with the ETSI regulations.

322 EU868MHz end-devices SHALL be capable of operating in the 863 to 870 MHz frequency  
 323 band and SHALL feature a channel data structure to store the parameters of at least 16  
 324 channels. A channel data structure corresponds to a frequency and a set of data rates  
 325 usable on this frequency.

326 The first three channels correspond to 868.1, 868.3, and 868.5 MHz / DR0 to DR5 and  
 327 MUST be implemented in every end-device. Those default channels cannot be modified  
 328 through the **NewChannelReq** command and guarantee a minimal common channel set  
 329 between end-devices and network gateways.

330 The following table gives the list of frequencies that SHALL be used by end-devices to  
 331 broadcast the JoinReq message. The JoinReq message transmit duty-cycle SHALL follow  
 332 the rules described in chapter “Retransmissions back-off” of the LoRaWAN specification  
 333 document.

334

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels
LoRa	125	868.10 868.30 868.50	DR0 – DR5 / 0.3-5 kbps	3

335

**Table 4: EU863-870 JoinReq Channel List**

336 **2.2.3 EU863-870 Data Rate and End-device Output Power encoding**

337 There is no dwell time limitation for the EU863-870 PHY layer. The **TxParamSetupReq**  
 338 MAC command is not implemented in EU863-870 devices.

339 The following encoding is used for Data Rate (DR) and End-device EIRP (TXPower) in the  
 340 EU863-870 band:

341

DataRate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	LoRa: SF7 / 250 kHz	11000
7	FSK: 50 kbps	50000
8..14	RFU	



15	Defined in LoRaWAN <sup>1</sup>
----	---------------------------------

Table 5: EU863-870 TX Data rate table

342  
343  
344  
345  
346

EIRP<sup>2</sup> refers to the Equivalent Isotropically Radiated Power, which is the radiated output power referenced to an isotropic antenna radiating power equally in all directions and whose gain is expressed in dBi.

TXPower	Configuration (EIRP)
0	Max EIRP
1	Max EIRP – 2dB
2	Max EIRP – 4dB
3	Max EIRP – 6dB
4	Max EIRP – 8dB
5	Max EIRP – 10dB
6	Max EIRP – 12dB
7	Max EIRP – 14dB
8..14	RFU
15	Defined in LoRAWAN

Table 6: EU863-870 TX power table

347  
348  
349  
350  
351  
352  
353  
354

By default MaxEIRP is considered to be +16dBm. If the end-device cannot achieve 16dBm EIRP, the Max EIRP SHOULD be communicated to the network server using an out-of-band channel during the end-device commissioning process.

#### 355 2.2.4 EU863-870 JoinAccept CFList

356

357 The EU 863-870 ISM band LoRaWAN implements an optional **channel frequency list**  
358 (CFList) of 16 octets in the JoinAccept message.

359 In this case the CFList is a list of five channel frequencies for the channels three to seven  
360 whereby each frequency is encoded as a 24 bits unsigned integer (three octets). All these  
361 channels are usable for DR0 to DR5 125kHz LoRa modulation. The list of frequencies is  
362 followed by a single CFListType octet for a total of 16 octets. The CFListType SHALL be  
363 equal to zero (0) to indicate that the CFList contains a list of frequencies.

364

Size (bytes)	3	3	3	3	3	1
<b>CFList</b>	Freq Ch3	Freq Ch4	Freq Ch5	Freq Ch6	Freq Ch7	CFListType

365 The actual channel frequency in Hz is 100 x frequency whereby values representing  
366 frequencies below 100 MHz are reserved for future use. This allows setting the frequency of  
367 a channel anywhere between 100 MHz to 1.67 GHz in 100 Hz steps. Unused channels have  
368 a frequency value of 0. The **CFList** is optional and its presence can be detected by the  
369 length of the join-accept message. If present, the **CFList** SHALL replace all the previous  
370 channels stored in the end-device apart from the three default channels. The newly defined  
371 channels are immediately enabled and usable by the end-device for communication.

<sup>1</sup> DR15 and TXPower15 are defined in the LinkADRReq MAC command of the LoRaWAN1.1 specification

<sup>2</sup> ERP = EIRP – 2.15dB; it is referenced to a half-wave dipole antenna whose gain is expressed in dBd

### 372 2.2.5 EU863-870 LinkAdrReq command

373 The EU863-870 LoRaWAN only supports a maximum of 16 channels. When **ChMaskCntl**  
 374 field is 0 the ChMask field individually enables/disables each of the 16 channels.  
 375

ChMaskCntl	ChMask applies to
0	Channels 0 to 15
1	RFU
..	..
4	RFU
5	RFU
6	All channels ON The device SHALL enable all currently defined channels independently of the ChMask field value.
7	RFU

376 **Table 7: EU863-870 ChMaskCntl value table**

377 If the ChMaskCntl field value is one of values meaning RFU, the end-device SHALL reject  
 378 the command and unset the “**Channel mask ACK**” bit in its response.

### 379 2.2.6 EU863-870 Maximum payload size

380 The maximum **MACPayload** size length ( $M$ ) is given by the following table. It is derived from  
 381 limitation of the PHY layer depending on the effective modulation rate used taking into  
 382 account a possible repeater encapsulation layer. The maximum application payload length in  
 383 the absence of the optional **FOpt** control field ( $N$ ) is also given for information only. The  
 384 value of  $N$  MAY be smaller if the **FOpt** field is not empty:  
 385

DataRate	$M$	$N$
0	59	51
1	59	51
2	59	51
3	123	115
4	230	222
5	230	222
6	230	222
7	230	222
8:15	Not defined	

386 **Table 8: EU863-870 maximum payload size**

387 If the end-device will never operate with a repeater then the maximum application payload  
 388 length in the absence of the optional **FOpt** control field SHOULD be:  
 389

DataRate	$M$	$N$
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242
7	250	242
8:15	Not defined	

390 **Table 9 : EU863-870 maximum payload size (not repeater compatible)**

391 **2.2.7 EU863-870 Receive windows**

392 The RX1 receive window uses the same channel as the preceding uplink. The data rate is a  
 393 function of the uplink data rate and the RX1DROffset as given by the following table. The  
 394 allowed values for RX1DROffset are in the [0:5] range. Values in the [6:7] range are  
 395 reserved for future use.  
 396

RX1DROffset Upstream data rate	0	1	2	3	4	5
	Downstream data rate in RX1 slot					
DR0	DR0	DR0	DR0	DR0	DR0	DR0
DR1	DR1	DR0	DR0	DR0	DR0	DR0
DR2	DR2	DR1	DR0	DR0	DR0	DR0
DR3	DR3	DR2	DR1	DR0	DR0	DR0
DR4	DR4	DR3	DR2	DR1	DR0	DR0
DR5	DR5	DR4	DR3	DR2	DR1	DR0
DR6	DR6	DR5	DR4	DR3	DR2	DR1
DR7	DR7	DR6	DR5	DR4	DR3	DR2

397 **Table 10: EU863-870 downlink RX1 data rate mapping**

398  
 399 The RX2 receive window uses a fixed frequency and data rate. The default parameters are  
 400 869.525 MHz / DR0 (SF12, 125 kHz)  
 401

402 **2.2.8 EU863-870 Class B beacon and default downlink channel**

403 The beacons SHALL be transmitted using the following settings

<b>DR</b>	3	Corresponds to SF9 spreading factor with 125 kHz BW
<b>CR</b>	1	Coding rate = 4/5
<b>Signal polarity</b>	Non-inverted	As opposed to normal downlink traffic which uses inverted signal polarity

404 **Table 11: EU863-870 beacon settings**

405  
 406 The beacon frame content is:

Size (bytes)	2	4	2	7	2
<b>BCNPayload</b>	RFU	Time	CRC	GwSpecific	CRC

407 The beacon default broadcast frequency is 869.525MHz.  
 408 The Class B default downlink pingSlot frequency is 869.525MHz  
 409

410 **2.2.9 EU863-870 Default Settings**

411 The following parameters are recommended values for the EU863-870MHz band.

412	RECEIVE_DELAY1	1 s
413	RECEIVE_DELAY2	2 s (MUST be RECEIVE_DELAY1 + 1s)
414	JOIN_ACCEPT_DELAY1	5 s
415	JOIN_ACCEPT_DELAY2	6 s
416	MAX_FCNT_GAP	16384

417 ADR\_ACK\_LIMIT 64  
418 ADR\_ACK\_DELAY 32  
419 ACK\_TIMEOUT 2 +/- 1 s (random delay between 1 and 3 seconds)

420 If the actual parameter values implemented in the end-device are different from those default  
421 values (for example the end-device uses a longer RECEIVE\_DELAY1 and  
422 RECEIVE\_DELAY2 latency), those parameters MUST be communicated to the network  
423 server using an out-of-band channel during the end-device commissioning process. The  
424 network server may not accept parameters different from those default values.  
425

426 **2.3 US902-928MHz ISM Band**

427 This section defines the regional parameters for the USA, Canada and all other countries  
 428 adopting the entire FCC-Part15 regulations in 902-928 ISM band.

429 **2.3.1 US902-928 Preamble Format**

430 The following synchronization words SHOULD be used:  
 431

Modulation	Sync word	Preamble length
LORA	0x34	8 symbols

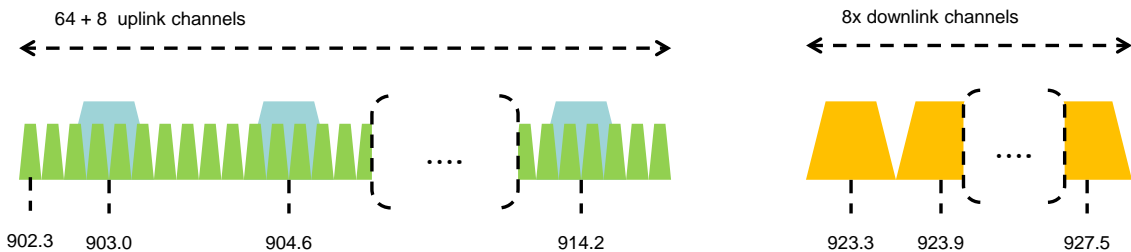
432

433 LoRaWAN does not make use of GFSK modulation in the US902-928 ISM band.

434 **2.3.2 US902-928 Channel Frequencies**

435 The 915 MHz ISM Band SHALL be divided into the following channel plans.

- 436 • Upstream – 64 channels numbered 0 to 63 utilizing LoRa 125 kHz BW varying from  
 437 DR0 to DR3, using coding rate 4/5, starting at 902.3 MHz and incrementing linearly  
 438 by 200 kHz to 914.9 MHz
- 439 • Upstream – 8 channels numbered 64 to 71 utilizing LoRa 500 kHz BW at DR4  
 440 starting at 903.0 MHz and incrementing linearly by 1.6 MHz to 914.2 MHz
- 441 • Downstream – 8 channels numbered 0 to 7 utilizing LoRa 500 kHz BW at DR8 to  
 442 DR13, starting at 923.3 MHz and incrementing linearly by 600 kHz to 927.5 MHz  
 443



444  
 445

Figure 1: US902-928 channel frequencies

446 915 MHz ISM band end-devices are required to operate in compliance with the relevant  
 447 regulatory specifications, The following note summarizes some of the current (March 2017)  
 448 relevant regulations.

449 Frequency-Hopping, Spread-Spectrum (FHSS) mode, which requires  
 450 the device transmit at a measured conducted power level no greater  
 451 than +30 dBm, for a period of no more than 400 msec and over at least  
 452 50 channels, each of which occupy no greater than 250 kHz of  
 453 bandwidth.

454 Digital Transmission System (DTS) mode, which requires that the  
 455 device use channels greater than or equal to 500 kHz and comply to a  
 456 conducted Power Spectral Density measurement of no more than +8  
 457 dBm per 3kHz of spectrum. In practice, this limits the conducted  
 458 output power of an end-device to +26 dBm.

459 Hybrid mode, which requires that the device transmit over multiple  
 460 channels (this may be less than the 50 channels required for FHSS  
 461 mode, but is recommended to be at least 4) while complying with the

462 Power Spectral Density requirements of DTS mode and the 400 msec  
 463 dwell time of FHSS mode. In practice this limits the measured  
 464 conducted power of the end-device to 21 dBm.

465 Devices which use an antenna system with a directional gain greater  
 466 than +6 dBi, but reduce the specified conducted output power by the  
 467 amount in dB of directional gain over +6 dBi.

468 US902-928 end-devices MUST be capable of operating in the 902 to 928 MHz frequency  
 469 band and MUST feature a channel data structure to store the parameters for 72 channels.  
 470 This channel data structure contains a list of frequencies and the set of data rates available  
 471 for each frequency.

472  
 473 If using the over-the-air activation procedure, the end-device SHALL transmit the Join-  
 474 request message on random 125 kHz channels amongst the 64 125kHz channels defined  
 475 using **DR0** and on 500 kHz channels amongst the 8 500kHz channels defined using **DR4**.  
 476 The end-device SHALL change channels for every transmission.

477 For rapid network acquisition in mixed gateway channel plan environments, the device  
 478 SHOULD follow a random channel selection sequence which efficiently probes the octet  
 479 groups of eight 125 kHz channels followed by probing one 500 kHz channel each pass.  
 480 Each consecutive pass SHOULD NOT select a channel that was used in a previous pass,  
 481 until a Join-request is transmitted on every channel, after which the entire process can  
 482 restart.

483 Example: First pass: Random channel from [0-7], followed by [8-15]... [56-63], then 64  
 484 Second pass: Random channel from [0-7], followed by [8-15]... [56-63], then  
 485 65  
 486 Last pass: Random channel from [0-7], followed by [8-15]... [56-63], then 71

487 Personalized devices SHALL have all 72 channels enabled following a reset and shall use  
 488 the channels for which the device's default data-rate is valid.

### 489 2.3.3 US902-928 Data Rate and End-device Output Power encoding

490 FCC regulation imposes a maximum dwell time of 400ms on uplinks. The  
 491 **TxParamSetupReq** MAC command MUST not be implemented by US902-928 devices.

492 The following encoding is used for Data Rate (**DR**) and End-device conducted Power  
 493 (**TXPower**) in the US902-928 band:

494

DataRate	Configuration	Indicative physical bit rate [bit/sec]
0	LoRa: SF10 / 125 kHz	980
1	LoRa: SF9 / 125 kHz	1760
2	LoRa: SF8 / 125 kHz	3125
3	LoRa: SF7 / 125 kHz	5470
4	LoRa: SF8 / 500 kHz	12500
5:7	RFU	
8	LoRa: SF12 / 500 kHz	980
9	LoRa: SF11 / 500 kHz	1760
10	LoRa: SF10 / 500 kHz	3900
11	LoRa: SF9 / 500 kHz	7000
12	LoRa: SF8 / 500 kHz	12500

13	LoRa: SF7 / 500 kHz	21900
14	RFU	
15	Defined in LoRaWAN <sup>1</sup>	

495

**Table 12: US902-928 TX Data rate table**

496

497

498

Note: DR4 is purposely identical to DR12, DR8..13 MUST be implemented in end-devices and are reserved for future applications

TXPower	Configuration (conducted power)
0	30 dBm – 2*TXpower
1	28 dBm
2	26 dBm
3 : 13	....
14	2 dBm
15	Defined in LoRaWAN

499

**Table 13: US902-928 TX power table**

### 500 2.3.4 US902-928 JoinAccept CFList

501

502

503

504

505

506

507

508

The US902-928 LoRaWAN supports the use of the optional **CFList** appended to the JoinResp message. If the **CFList** is not empty then the **CFListType** field SHALL contain the value one (0x01) to indicate the **CFList** contains a series of ChMask fields. The ChMask fields are interpreted as being controlled by a virtual ChMaskCntl that initializes to a value of zero (0) and increments for each ChMask field to a value of four (4). (The first 16 bits controls the channels 0 to 15, ..)

Size (bytes)	[2]	[2]	[2]	[2]	[2]	[2]	[3]	[1]
CFList	ChMask0	ChMask1	ChMask2	ChMask3	ChMask4	RFU	RFU	CFListType

509

510

### 511 2.3.5 US902-928 LinkAdrReq command

512

513

514

For the US902-928 version the **ChMaskCntl** field of the **LinkADRReq** command has the following meaning:

ChMaskCntl	ChMask applies to
0	Channels 0 to 15
1	Channels 16 to 31
..	..
4	Channels 64 to 71
5	8LSBs controls Channel Blocks 0 to 7 8MSBs are RFU
6	All 125 kHz ON ChMask applies to channels 64 to 71
7	All 125 kHz OFF ChMask applies to

<sup>1</sup> DR15 is defined in the LinkADRReq MAC command of the LoRaWAN1.1 specification

ChMaskCntl	ChMask applies to
	channels 64 to 71

Table 14: US902-928 ChMaskCntl value table

515

516 If **ChMaskCntl** = 5 then the corresponding bits in the ChMask enable and disable a bank of  
 517 8 125kHz channels and the corresponding 500kHz channel defined by the following  
 518 calculation:  $[\text{ChannelMaskBit} * 8, \text{ChannelMaskBit} * 8 + 7], 64 + \text{ChannelMaskBit}$ .

519

520 If **ChMaskCntl** = 6 then 125 kHz channels are enabled, if **ChMaskCntl** = 7 then 125 kHz  
 521 channels are disabled. Simultaneously the channels 64 to 71 are set according to the  
 522 **ChMask** bit mask. The DataRate specified in the command need not be valid for channels  
 523 specified in the ChMask, as it governs the global operational state of the end-device.

524

525 **Note:** FCC regulation requires hopping over at least 50 channels when  
 526 using maximum output power. It is possible to have end-devices with  
 527 less channels when limiting the end-device conducted transmit power  
 528 to 21 dBm.

529 **Note:** A common network server action may be to reconfigure a device  
 530 through multiple LinkAdrReq commands in a contiguous block of MAC  
 531 Commands. For example to reconfigure a device from 64 channel  
 532 operation to the first 8 channels could contain two LinkAdrReq, the first  
 533 (**ChMaskCntl** = 7) to disable all 125kHz channels and the second  
 534 (**ChMaskCntl** = 0) to enable a bank of 8 125kHz channels.  
 535

### 536 2.3.6 US902-928 Maximum payload size

537 The maximum **MACPayload** size length ( $M$ ) is given by the following table. It is derived from  
 538 the maximum allowed transmission time at the PHY layer taking into account a possible  
 539 repeater encapsulation. The maximum application payload length in the absence of the  
 540 optional **FOpt** MAC control field ( $N$ ) is also given for information only. The value of  $N$  MAY  
 541 be smaller if the **FOpt** field is not empty:

542

543

DataRate	$M$	$N$
0	19	11
1	61	53
2	133	125
3	250	242
4	250	242
5:7	Not defined	
8	41	33
9	117	109
10	230	222
11	230	222
12	230	222
13	230	222
14:15	Not defined	

Table 15: US902-928 maximum payload size (repeater compatible)

544

545



546 The greyed lines correspond to the data rates that may be used by an end-device behind a  
547 repeater.

548 If the end-device will never operate under a repeater then the maximum application payload  
549 length in the absence of the optional **FOpt** control field SHOULD be:

550

DataRate	<i>M</i>	<i>N</i>
0	19	11
1	61	53
2	133	125
3	250	242
4	250	242
5:7	Not defined	
8	61	53
9	137	129
10	250	242
11	250	242
12	250	242
13	250	242
14:15	Not defined	

551

Table 16 : US902-928 maximum payload size (not repeater compatible)

### 552 2.3.7 US902-928 Receive windows

553 • The RX1 receive channel is a function of the upstream channel used to initiate the  
554 data exchange. The RX1 receive channel can be determined as follows.

555 ○ RX1 Channel Number = Transmit Channel Number modulo 8

556 • The RX1 window data rate depends on the transmit data rate (see Table 16 below).

557 • The RX2 (second receive window) settings uses a fixed data rate and frequency.

558 Default parameters are 923.3MHz / DR8

559

Upstream data rate RX1DROffset	Downstream data rate			
	0	1	2	3
DR0	DR10	DR9	DR8	DR8
DR1	DR11	DR10	DR9	DR8
DR2	DR12	DR11	DR10	DR9
DR3	DR13	DR12	DR11	DR10
DR4	DR13	DR13	DR12	DR11

560

Table 17: US902-928 downlink RX1 data rate mapping

561 The allowed values for RX1DROffset are in the [0:3] range. Values in the range [4:7] are  
562 reserved for future use.

### 563 2.3.8 US902-928 Class B beacon

564 The beacons SHALL BE transmitted using the following settings:

<b>DR</b>	8	Corresponds to SF12 spreading factor with 500kHz bw
<b>CR</b>	1	Coding rate = 4/5
<b>Signal polarity</b>	Non-inverted	As opposed to normal downlink traffic which uses inverted signal polarity
<b>frequencies</b>	923.3 to 927.5MHz with 600kHz steps	Beaconing is performed on the same channel that normal downstream traffic as defined in the Class A specification

565 **Table 18: US902-928 beacon settings**

566 The downstream channel used for a given beacon is:

567 
$$\text{Channel} = \left[ \text{floor} \left( \frac{\text{beacon\_time}}{\text{beacon\_period}} \right) \right] \text{ modulo } 8$$

- 568
- whereby beacon\_time is the integer value of the 4 bytes “Time” field of the beacon frame
  - whereby beacon\_period is the periodicity of beacons , 128 seconds
  - whereby floor(x) designates rounding to the integer immediately inferior or equal to x

 573 

574 Example: the first beacon will be transmitted on 923.3Mhz , the second
 575 on 923.9MHz, the 9<sup>th</sup> beacon will be on 923.3Mhz again.

Beacon channel nb	Frequency [MHz]
0	923.3
1	923.9
2	924.5
3	925.1
4	925.7
5	926.3
6	926.9
7	927.5

 577  
 578  
 579 The beacon frame content is:

Size (bytes)	5	4	2	7	3	2
BCNPayload	RFU	Time	CRC	GwSpecific	RFU	CRC

 580  
 581 **2.3.9 US902-928 Default Settings**

582 The following parameters are recommended values for the US902-928 band.

583	RECEIVE_DELAY1	1 s
584	RECEIVE_DELAY2	2 s (MUST be RECEIVE_DELAY1 + 1s)
585	JOIN_ACCEPT_DELAY1	5 s
586	JOIN_ACCEPT_DELAY2	6 s
587	MAX_FCNT_GAP	16384
588	ADR_ACK_LIMIT	64
589	ADR_ACK_DELAY	32
590	ACK_TIMEOUT	2 +/- 1 s (random delay between 1 and 3 seconds)

591 If the actual parameter values implemented in the end-device are different from those default
 592 values (for example the end-device uses a longer RECEIVE\_DELAY1 &amp; 2 latency), those
 593 parameters MUST be communicated to the network server using an out-of-band channel
 594 during the end-device commissioning process. The network server may not accept
 595 parameters different from those default values.

596

597 **2.4 CN779-787 MHz ISM Band**

598 **2.4.1 CN779-787 Preamble Format**

599 The following synchronization words SHOULD be used :

600

Modulation	Sync word	Preamble length
LORA	0x34	8 symbols
GFSK	0xC194C1	5 bytes

601

Table 19: CN779-787 synch words

602 **2.4.2 CN779-787 ISM Band channel frequencies**

603

604 The LoRaWAN can be used in the Chinese 779-787MHz band as long as the radio device  
605 EIRP is less than 12.15dBm.

606 The end-device transmit duty-cycle SHOULD be lower than 1%.

607 The LoRaWAN channels center frequency MAY be in the following range:

- 608 • Minimum frequency : 779.5MHz
- 609 • Maximum frequency : 786.5 MHz

610 CN780MHz end-devices SHALL be capable of operating in the 779 to 787 MHz frequency  
611 band and SHALL feature a channel data structure to store the parameters of at least 16  
612 channels. A channel data structure corresponds to a frequency and a set of data rates  
613 usable on this frequency.

614 The first three channels correspond to 779.5, 779.7 and 779.9 MHz with DR0 to DR5 and  
615 MUST be implemented in every end-device. Those default channels cannot be modified  
616 through the **NewChannelReq** command and guarantee a minimal common channel set  
617 between end-devices and gateways of all networks. Other channels can be freely distributed  
618 across the allowed frequency range on a network per network basis.

619 The following table gives the list of frequencies that SHALL be used by end-devices to  
620 broadcast the JoinReq message The JoinReq message transmit duty-cycle SHALL follow  
621 the rules described in chapter "Retransmissions back-off" of the LoRaWAN specification  
622 document.

623

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels	Duty cycle
LoRa	125	779.5 779.7 779.9 780.5 780.7 780.9	DR0 – DR5 / 0.3-5 kbps	6	<0.1%

624

Table 20: CN779-787 JoinReq Channel List

625

626 **2.4.3 CN779-787 Data Rate and End-device Output Power encoding**

627 There is no dwell time limitation for the CN779-787 PHY layer. The **TxParamSetupReq**  
628 MAC command is not implemented by CN779-787 devices.

629 The following encoding is used for Data Rate (DR) and End-device EIRP (TXPower) in the  
630 CN780 band:

631

DataRate	Configuration	Indicative physical bit rate [bit/s]	TXPower	Configuration (EIRP)
0	LoRa: SF12 / 125 kHz	250	0	Max EIRP
1	LoRa: SF11 / 125 kHz	440	1	Max EIRP – 2dB
2	LoRa: SF10 / 125 kHz	980	2	Max EIRP – 4dB
3	LoRa: SF9 / 125 kHz	1760	3	Max EIRP – 6dB
4	LoRa: SF8 / 125 kHz	3125	4	Max EIRP – 8dB
5	LoRa: SF7 / 125 kHz	5470	5	Max EIRP – 10dB
6	LoRa: SF7 / 250 kHz	11000	6..14	RFU
7	FSK: 50 kbps	50000		
8..14	RFU			
15	Defined in LoRaWAN		15	Defined in LoRaWAN

Table 21: CN779-787 Data rate and TX power table

632

633

634 EIRP refers to the Equivalent Isotropically Radiated Power, which is the radiated output  
635 power referenced to an isotropic antenna radiating power equally in all directions and whose  
636 gain is expressed in dBi.

637

638 By default MAXEIRP is considered to be +12.15dBm. If the end-device cannot achieve  
639 12.15dBm EIRP, the Max EIRP SHOULD be communicated to the network server using an  
640 out-of-band channel during the end-device commissioning process.

641

642 **2.4.4 CN779-787 JoinAccept CFList**

643 The CN780 ISM band LoRaWAN implements an optional **channel frequency list** (CFList) of  
644 16 octets in the JoinAccept message.

645 In this case the CFList is a list of five channel frequencies for the channels three to seven  
646 whereby each frequency is encoded as a 24 bits unsigned integer (three octets). All these  
647 channels are usable for DR0 to DR5 125kHz LoRa modulation. The list of frequencies is  
648 followed by a single CFListType octet for a total of 16 octets. The CFListType SHALL be  
649 equal to zero (0) to indicate that the CFList contains a list of frequencies.

650

Size (bytes)	3	3	3	3	3	1
CFList	Freq Ch3	Freq Ch4	Freq Ch5	Freq Ch6	Freq Ch7	CFListTYpe

651 The actual channel frequency in Hz is 100 x frequency whereby values representing  
652 frequencies below 100 MHz are reserved for future use. This allows setting the frequency of  
653 a channel anywhere between 100 MHz to 1.67 GHz in 100 Hz steps. Unused channels have  
654 a frequency value of 0. The **CFList** is optional and its presence can be detected by the  
655 length of the join-accept message. If present, the **CFList** SHALL replace all the previous  
656 channels stored in the end-device apart from the three default channels.

657 The newly defined channels are immediately enabled and usable by the end-device for  
658 communication.

659 **2.4.5 CN779-787 LinkAdrReq command**

660

661 The CN780 LoRaWAN only supports a maximum of 16 channels. When **ChMaskCntl** field is  
 662 0 the ChMask field individually enables/disables each of the 16 channels.

663

ChMaskCntl	ChMask applies to
0	Channels 0 to 15
1	RFU
..	..
4	RFU
5	RFU
6	All channels ON The device should enable all currently defined channels independently of the ChMask field value.
7	RFU

Table 22: CN779-787 ChMaskCntl value table

664

665

666 If the ChMask field value is one of values meaning RFU, then end-device SHALL reject the  
 667 command and unset the “**Channel mask ACK**” bit in its response.

668 **2.4.6 CN779-787 Maximum payload size**

669 The maximum **MACPayload** size length ( $M$ ) is given by the following table. It is derived from  
 670 limitation of the PHY layer depending on the effective modulation rate used taking into  
 671 account a possible repeater encapsulation layer. The maximum application payload length in  
 672 the absence of the optional **FOpt** control field ( $N$ ) is also given for information only. The  
 673 value of  $N$  MAY be smaller if the **FOpt** field is not empty:

674

DataRate	$M$	$N$
0	59	51
1	59	51
2	59	51
3	123	115
4	230	222
5	230	222
6	250	242
7	230	222
8:15	Not defined	

Table 23: CN779-787 maximum payload size

675

676

677 If the end-device will never operate with a repeater then the maximum application payload  
 678 length in the absence of the optional **FOpt** control field SHOULD be:

679

DataRate	$M$	$N$
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242
7	250	242

8:15	Not defined
------	-------------

 680 **Table 24 : CN779-787 maximum payload size (not repeater compatible)**

 681 **2.4.7 CN779-787 Receive windows**

 682 The RX1 receive window uses the same channel than the preceding uplink. The data rate is  
 683 a function of the uplink data rate and the RX1DROffset as given by the following table. The  
 684 allowed values for RX1DROffset are in the [0:5] range. Values in the range [6:7] are  
 685 reserved for future use

686

RX1DROffset	0	1	2	3	4	5
Upstream data rate	Downstream data rate in RX1 slot					
DR0	DR0	DR0	DR0	DR0	DR0	DR0
DR1	DR1	DR0	DR0	DR0	DR0	DR0
DR2	DR2	DR1	DR0	DR0	DR0	DR0
DR3	DR3	DR2	DR1	DR0	DR0	DR0
DR4	DR4	DR3	DR2	DR1	DR0	DR0
DR5	DR5	DR4	DR3	DR2	DR1	DR0
DR6	DR6	DR5	DR4	DR3	DR2	DR1
DR7	DR7	DR6	DR5	DR4	DR3	DR2

 687 **Table 25: CN779-787 downlink RX1 data rate mapping**

 688 The RX2 receive window uses a fixed frequency and data rate. The default parameters are  
 689 786 MHz / DR0.

 690 **2.4.8 CN779-787 Class B beacon and default downlink channel**

691 The beacons SHALL be transmitted using the following settings

<b>DR</b>	3	Corresponds to SF9 spreading factor with 125 kHz BW
<b>CR</b>	1	Coding rate = 4/5
<b>Signal polarity</b>	Non-inverted	As opposed to normal downlink traffic which uses inverted signal polarity

 692 **Table 26: CN779-787 beacon settings**

693 The beacon frame content is:

<b>Size (bytes)</b>	2	4	2	7	2
<b>BCNPayload</b>	RFU	Time	CRC	GwSpecific	CRC

694 The beacon default broadcast frequency is 785MHz.

695 The class B default downlink pingSlot frequency is 785MHz

696

 697 **2.4.9 CN779-787 Default Settings**

698 The following parameters are recommended values for the CN779-787MHz band.

699	RECEIVE_DELAY1	1 s
700	RECEIVE_DELAY2	2 s (MUST be RECEIVE_DELAY1 + 1s)
701	JOIN_ACCEPT_DELAY1	5 s
702	JOIN_ACCEPT_DELAY2	6 s
703	MAX_FCNT_GAP	16384
704	ADR_ACK_LIMIT	64

705	ADR_ACK_DELAY	32
706	ACK_TIMEOUT	2 +/- 1 s (random delay between 1 and 3 seconds)
707	If the actual parameter values implemented in the end-device are different from those default	
708	values (for example the end-device uses a longer RECEIVE_DELAY1 and	
709	RECEIVE_DELAY2 latency), those parameters MUST be communicated to the network	
710	server using an out-of-band channel during the end-device commissioning process. The	
711	network server may not accept parameters different from those default values.	



## 712 2.5 EU433MHz ISM Band

### 713 2.5.1 EU433 Preamble Format

714 The following synchronization words SHOULD be used :

715

Modulation	Sync word	Preamble length
LORA	0x34	8 symbols
GFSK	0xC194C1	5 bytes

716

Table 27: EU433 synch words

### 717 2.5.2 EU433 ISM Band channel frequencies

718 The LoRaWAN can be used in the ETSI 433-434 MHz band as long as the radio device  
719 EIRP is less than 12.15dBm.

720 The end-device transmit duty-cycle SHALL be lower than 10%<sup>1</sup>

721 The LoRaWAN channels center frequency can be in the following range:

- 722 • Minimum frequency : 433.175 MHz
- 723 • Maximum frequency : 434.665 MHz

724 EU433 end-devices SHALL be capable of operating in the 433.05 to 434.79 MHz frequency  
725 band and SHALL feature a channel data structure to store the parameters of at least 16  
726 channels. A channel data structure corresponds to a frequency and a set of data rates  
727 usable on this frequency.

728 The first three channels correspond to 433.175, 433.375 and 433.575 MHz with DR0 to DR5  
729 and MUST be implemented in every end-device. Those default channels cannot be modified  
730 through the **NewChannelReq** command and guarantee a minimal common channel set  
731 between end-devices and gateways of all networks. Other channels can be freely distributed  
732 across the allowed frequency range on a network per network basis.

733 The following table gives the list of frequencies that SHALL be used by end-devices to  
734 broadcast the JoinReq message. The JoinReq message transmit duty-cycle SHALL follow  
735 the rules described in chapter "Retransmissions back-off" of the LoRaWAN specification  
736 document.

737

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels	Duty cycle
LoRa	125	433.175 433.375 433.575	DR0 – DR5 / 0.3-5 kbps	3	<1%

738

Table 28: EU433 JoinReq Channel List

739

<sup>1</sup> The EN300220 ETSI standard limits to 10% the maximum transmit duty-cycle in the 433MHz ISM band. The LoRaWAN requires a 1% transmit duty-cycle lower than the legal limit to avoid network congestion.

### 740 2.5.3 EU433 Data Rate and End-device Output Power encoding

741 There is no dwell time limitation for the EU433 PHY layer. The **TxParamSetupReq** MAC  
742 command is not implemented by EU433 devices.

743 The following encoding is used for Data Rate (DR) and End-device EIRP (TXPower) in the  
744 EU433 band:

745

DataRate	Configuration	Indicative physical bit rate [bit/s]	TXPower	Configuration (EIRP)
0	LoRa: SF12 / 125 kHz	250	0	Max EIRP
1	LoRa: SF11 / 125 kHz	440	1	Max EIRP – 2dB
2	LoRa: SF10 / 125 kHz	980	2	Max EIRP – 4dB
3	LoRa: SF9 / 125 kHz	1760	3	Max EIRP – 6dB
4	LoRa: SF8 / 125 kHz	3125	4	Max EIRP – 8dB
5	LoRa: SF7 / 125 kHz	5470	5	Max EIRP – 10dB
6	LoRa: SF7 / 250 kHz	11000	6..14	RFU
7	FSK: 50 kbps	50000		
8..14	RFU			
15	Defined in LoRaWAN		15	Defined in LoRaWAN

Table 29: EU433 Data rate and TX power table

746

747

748 EIRP refers to the Equivalent Isotropically Radiated Power, which is the radiated output  
749 power referenced to an isotropic antenna radiating power equally in all directions and whose  
750 gain is expressed in dBi.

751

752 By default MAXEIRP is considered to be +12.15dBm. If the end-device cannot achieve  
753 12.15dBm EIRP, the Max EIRP SHALL be communicated to the network server using an  
754 out-of-band channel during the end-device commissioning process.

755

756

### 757 2.5.4 EU433 JoinAccept CFList

758

759 The EU433 ISM band LoRaWAN implements an optional **channel frequency list** (CFList) of  
760 16 octets in the JoinAccept message.

761 In this case the CFList is a list of five channel frequencies for the channels three to seven  
762 whereby each frequency is encoded as a 24 bits unsigned integer (three octets). All these  
763 channels are usable for DR0 to DR5 125 kHz LoRa modulation. The list of frequencies is  
764 followed by a single CFListType octet for a total of 16 octets. The CFListType SHALL be  
765 equal to zero (0) to indicate that the CFList contains a list of frequencies.

766

Size (bytes)	3	3	3	3	3	1
CFList	Freq Ch3	Freq Ch4	Freq Ch5	Freq Ch6	Freq Ch7	CFListType

767 The actual channel frequency in Hz is 100 x frequency whereby values representing  
768 frequencies below 100 MHz are reserved for future use. This allows setting the frequency of  
769 a channel anywhere between 100 MHz to 1.67 GHz in 100 Hz steps. Unused channels have  
770 a frequency value of 0. The **CFList** is optional and its presence can be detected by the  
771 length of the join-accept message. If present, the **CFList** MUST replace all the previous  
772 channels stored in the end-device apart from the three default channels.

773 The newly defined channels are immediately enabled and usable by the end-device for  
774 communication.

### 775 2.5.5 EU433 LinkAdrReq command

776 The EU433 LoRaWAN only supports a maximum of 16 channels. When **ChMaskCntl** field is  
777 0 the ChMask field individually enables/disables each of the 16 channels.  
778

ChMaskCntl	ChMask applies to
0	Channels 0 to 15
1	RFU
..	..
4	RFU
5	RFU
6	All channels ON The device SHOULD enable all currently defined channels independently of the ChMask field value.
7	RFU

779 **Table 30: EU433 ChMaskCntl value table**

780 If the ChMask field value is one of the values meaning RFU, then end-device SHALL reject  
781 the command and unset the “**Channel mask ACK**” bit in its response.

### 782 2.5.6 EU433 Maximum payload size

783 The maximum **MACPayload** size length ( $M$ ) is given by the following table. It is derived from  
784 limitation of the PHY layer depending on the effective modulation rate used taking into  
785 account a possible repeater encapsulation layer. The maximum application payload length in  
786 the absence of the optional **FOpt** control field ( $N$ ) is also given for information only. The  
787 value of  $N$  might be smaller if the **FOpt** field is not empty.  
788

DataRate	$M$	$N$
0	59	51
1	59	51
2	59	51
3	123	115
4	230	222
5	230	222
6	230	222
7	230	222
8:15	Not defined	

789 **Table 31: EU433 maximum payload size**

790  
791 If the end-device will never operate with a repeater then the maximum application payload  
792 length in the absence of the optional **FOpt** control field SHOULD be:  
793

DataRate	$M$	$N$
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242

7	250	242
8:15	Not defined	

Table 32 : EU433 maximum payload size (not repeater compatible)

794  
795

796 **2.5.7 EU433 Receive windows**

797 The RX1 receive window uses the same channel than the preceding uplink. The data rate is  
798 a function of the uplink data rate and the RX1DROffset as given by the following table. The  
799 allowed values for RX1DROffset are in the [0:5] range. Values in the range [6:7] are  
800 reserved for future use.

801

RX1DROffset	0	1	2	3	4	5
<b>Upstream data rate</b>	<b>Downstream data rate in RX1 slot</b>					
DR0	DR0	DR0	DR0	DR0	DR0	DR0
DR1	DR1	DR0	DR0	DR0	DR0	DR0
DR2	DR2	DR1	DR0	DR0	DR0	DR0
DR3	DR3	DR2	DR1	DR0	DR0	DR0
DR4	DR4	DR3	DR2	DR1	DR0	DR0
DR5	DR5	DR4	DR3	DR2	DR1	DR0
DR6	DR6	DR5	DR4	DR3	DR2	DR1
DR7	DR7	DR6	DR5	DR4	DR3	DR2

Table 33 : EU433 downlink RX1 data rate mapping

802

803 The RX2 receive window uses a fixed frequency and data rate. The default parameters are  
804 434.665MHz / DR0 (SF12, 125kHz).

805

806 **2.5.8 EU433 Class B beacon and default downlink channel**

807 The beacons SHALL be transmitted using the following settings

<b>DR</b>	3	Corresponds to SF9 spreading factor with 125 kHz BW
<b>CR</b>	1	Coding rate = 4/5
<b>Signal polarity</b>	Non-inverted	As opposed to normal downlink traffic which uses inverted signal polarity

Table 34 : EU433 beacon settings

808

809 The beacon frame content is:

<b>Size (bytes)</b>	2	4	2	7	2
<b>BCNPayload</b>	RFU	Time	CRC	GwSpecific	CRC

810 The beacon default broadcast frequency is 434.665MHz.

811 The class B default downlink pingSlot frequency is 434.665MHz

812

813 **2.5.9 EU433 Default Settings**

814 The following parameters are recommended values for the EU433band.

- 815 RECEIVE\_DELAY1 1 s
- 816 RECEIVE\_DELAY2 2 s (MUST be RECEIVE\_DELAY1 + 1s)
- 817 JOIN\_ACCEPT\_DELAY1 5 s

818	JOIN_ACCEPT_DELAY2	6 s
819	MAX_FCNT_GAP	16384
820	ADR_ACK_LIMIT	64
821	ADR_ACK_DELAY	32
822	ACK_TIMEOUT	2 +/- 1 s (random delay between 1 and 3 seconds)
823		
824	If the actual parameter values implemented in the end-device are different from those default	
825	values (for example the end-device uses a longer RECEIVE_DELAY1 & 2 latency) , those	
826	parameters MUST be communicated to the network server using an out-of-band channel	
827	during the end-device commissioning process. The network server may not accept	
828	parameters different from those default values.	
829		

830 **2.6 AU915-928MHz ISM Band**

831  
 832 This section defines the regional parameters for Australia and all other countries whose ISM  
 833 band extends from 915 to 928MHz spectrum.  
 834

835 **2.6.1 AU915-928 Preamble Format**

836 The following synchronization words SHOULD be used:  
 837

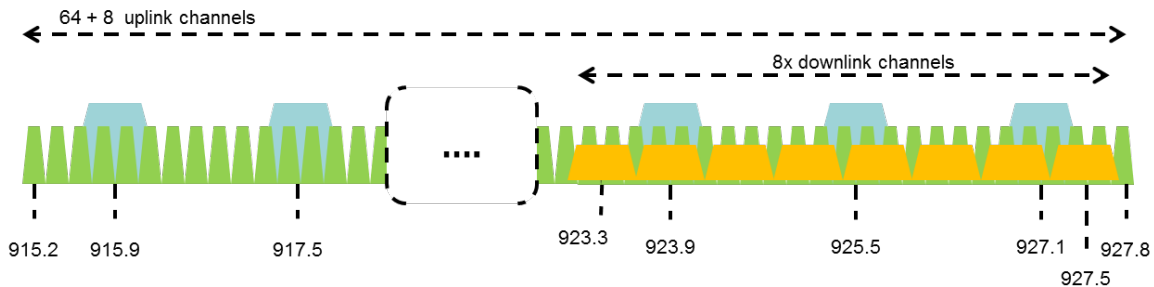
Modulation	Sync word	Preamble length
LORA	0x34	8 symbols

838 LoRaWAN does not make use of GFSK modulation in the AU915-928 ISM band.

839 **2.6.2 AU915-928 Channel Frequencies**

840 The AU ISM Band SHALL be divided into the following channel plans.

- 841 • Upstream – 64 channels numbered 0 to 63 utilizing LoRa 125 kHz BW varying from  
 842 DR0 to DR5, using coding rate 4/5, starting at 915.2 MHz and incrementing linearly  
 843 by 200 kHz to 927.8 MHz
- 844 • Upstream – 8 channels numbered 64 to 71 utilizing LoRa 500 kHz BW at DR6  
 845 starting at 915.9 MHz and incrementing linearly by 1.6 MHz to 927.1 MHz
- 846 • Downstream – 8 channels numbered 0 to 7 utilizing LoRa 500 kHz BW at DR8 to  
 847 DR13) starting at 923.3 MHz and incrementing linearly by 600 kHz to 927.5 MHz  
 848



849 **Figure 2: AU915-928 channel frequencies**

850  
 851 AU ISM band end-devices may use a maximum EIRP of +30 dBm.

852 AU915-928 end-devices SHALL be capable of operating in the 915 to 928 MHz frequency  
 853 band and SHALL feature a channel data structure to store the parameters of 72 channels. A  
 854 channel data structure corresponds to a frequency and a set of data rates usable on this  
 855 frequency.

856 If using the over-the-air activation procedure, the end-device SHALL broadcast the JoinReq  
 857 message alternatively on a random 125 kHz channel amongst the 64 channels defined using  
 858 **DR2** and a random 500 kHz channel amongst the 8 channels defined using **DR6**. The end-  
 859 device SHOULD change channel for every transmission.

860 Personalized devices SHALL have all 72 channels enabled following a reset.

861

862 The default JoinReq Data Rate is DR2 (SF10/125KHz), this setting  
 863 ensures that end-devices are compatible with the 400ms dwell time  
 864 limitation until the actual dwell time limit is notified to the end-device by  
 865 the network server via the MAC command **TxParamSetupReq**.

866 AU915-928 end-devices MUST consider UplinkDwellTime = 1 during  
867 boot stage until reception of the **TxParamSetupReq** command.

868 AU915-928 end-devices MUST always consider DownlinkDwellTime =  
869 0, since downlink channels use 500KHz bandwidth without any dwell  
870 time limit.

871

### 872 2.6.3 AU915-928 Data Rate and End-point Output Power encoding

873 The “TxParamSetupReq/Ans” MAC commands MUST be implemented by AU915-928  
874 devices.

875 If the field UplinkDwellTime is set to 1 by the network server in the  
876 **TxParamSetupReq** command, AU915-928 end-devices SHALL adjust  
877 the time between two consecutive uplink transmissions to meet the  
878 local regulation. Twenty seconds (20s) are recommended between 2  
879 uplink transmissions when UplinkDwellTime = 1 but this value MAY be  
880 adjusted depending on local regulation.

881 There is no such constraint on time between two consecutive  
882 transmissions when UplinkDwellTime = 0.

883

884 The following encoding is used for Data Rate (**DR**) and End-point EIRP (**TXPower**) in the  
885 AU915-928 band:

886

DataRate	Configuration	Indicative physical bit rate [bit/sec]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	LoRa: SF8 / 500 kHz	12500
7	RFU	
8	LoRa: SF12 / 500 kHz	980
9	LoRa: SF11 / 500 kHz	1760
10	LoRa: SF10 / 500 kHz	3900
11	LoRa: SF9 / 500 kHz	7000
12	LoRa: SF8 / 500 kHz	12500
13	LoRa: SF7 / 500 kHz	21900
14	RFU	
15	Defined in LoRaWAN	

Table 35: AU915-928 Data rate table

887

888

889 DR6 is identical to DR12, DR8...13 MUST be implemented in end-devices and are reserved  
890 for future applications.

891

892

893

894

895

TXPower	Configuration (EIRP)
0	Max EIRP
1:14	Max EIRP – 2*TXPower
15	Defined in LoRaWAN

Table 36 : AU915-928 TX power table

896  
897  
898  
899  
900  
901

EIRP refers to the Equivalent Isotropically Radiated Power, which is the radiated output power referenced to an isotropic antenna radiating power equally in all directions and whose gain is expressed in dBi.

902  
903  
904  
905

By default MaxEIRP is considered to be +30dBm. The Max EIRP can be modified by the network server through the **TxParamSetupReq** MAC command and SHOULD be used by both the end-device and the network server once **TxParamSetupReq** is acknowledged by the device via **TxParamSetupAns**.

906

### 907 2.6.4 AU915-928 JoinAccept CFList

908  
909  
910  
911  
912  
913  
914

The AU915-928 LoRaWAN supports the use of the optional **CFList** appended to the JoinResp message. If the **CFList** is not empty then the CFListType field SHALL contain the value one (0x01) to indicate the CFList contains a series of ChMask fields. The ChMask fields are interpreted as being controlled by a virtual ChMaskCntl that initializes to a value of zero (0) and increments for each ChMask field to a value of four(4). (The first 16 bits controls the channels 1 to 16, ..)

Size (bytes)	[2]	[2]	[2]	[2]	[2]	[2]	[3]	[1]
CFList	ChMask0	ChMask1	ChMask2	ChMask3	ChMask4	RFU	RFU	CFListType

915

### 916 2.6.5 AU915-928 LinkAdrReq command

917  
918  
919  
920

For the AU915-928 version the **ChMaskCntl** field of the **LinkADRReq** command has the following meaning:

ChMaskCntl	ChMask applies to
0	Channels 0 to 15
1	Channels 16 to 31
..	..
4	Channels 64 to 71
5	8LSBs controls Channel Blocks 0 to 7 8MSBs are RFU
6	All 125 kHz ON ChMask applies to channels 64 to 71
7	All 125 kHz OFF ChMask applies to channels 64 to 71

Table 37: AU915-928 ChMaskCntl value table

921  
922  
923  
924

If **ChMaskCntl** = 5 then the corresponding bits in the ChMask enable and disable a bank of 8 125kHz channels and the corresponding 500kHz channel defined by the following calculation: [ChannelMaskBit \* 8, ChannelMaskBit \* 8 +7],64+ChannelMaskBit.



925 If **ChMaskCntl** = 6 then 125 kHz channels are enabled, if **ChMaskCntl** = 7 then 125 kHz  
 926 channels are disabled. Simultaneously the channels 64 to 71 are set according to the  
 927 **ChMask** bit mask. The DataRate specified in the command need not be valid for channels  
 928 specified in the ChMask, as it governs the global operational state of the end-device.

929

### 930 2.6.6 AU915-928 Maximum payload size

931 The maximum **MACPayload** size length ( $M$ ) is given by the following table for both uplink  
 932 dwell time configurations: No Limit and 400ms. It is derived from the maximum allowed  
 933 transmission time at the PHY layer taking into account a possible repeater encapsulation.  
 934 The maximum application payload length in the absence of the optional **FOpt** MAC control  
 935 field ( $N$ ) is also given for information only. The value of  $N$  might be smaller if the **FOpt** field is  
 936 not empty:

937

DataRate	UplinkDwellTime=0		UplinkDwellTime=1	
	$M$	$N$	$M$	$N$
0	59	51	N/A	N/A
1	59	51	N/A	N/A
2	59	51	19	11
3	123	115	61	53
4	230	222	133	125
5	230	222	250	242
6	230	222	250	242
7	Not defined		Not defined	
8	41	33	41	33
9	117	109	117	109
10	230	222	230	222
11	230	222	230	222
12	230	222	230	222
13	230	222	230	222
14:15	Not defined		Not defined	

949

950

**Table 38: AU915-928 maximum payload size**

951 The greyed lines correspond to the data rates that may be used by an end-device behind a  
 952 repeater.

953 For AU915-928, DownlinkDwellTime MUST be set to 0 (no limit). The  
 954 400ms dwell time MAY only apply to uplink channels depending on the  
 955 local regulations.

956 If the end-device will never operate with a repeater then the maximum application payload  
 957 length in the absence of the optional **FOpt** control field SHOULD be:

958

DataRate	UplinkDwellTime=0		UplinkDwellTime=1	
	$M$	$N$	$M$	$N$
0	59	51	N/A	N/A
1	59	51	N/A	N/A
2	59	51	19	11
3	123	115	61	53
4	250	242	133	125
5	250	242	250	242
6	250	242	250	242

959  
960  
961  
962  
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964  
965  
966  
967  
968  
969  
970

7	Not defined		Not defined	
8	61	53	61	53
9	137	129	137	129
10	250	242	250	242
11	250	242	250	242
12	250	242	250	242
13	250	242	250	242
14:15	Not defined		Not defined	

Table 39: AU915-payload size (not

compatible)

928 maximum repeater

### 971 2.6.7 AU915-928 Receive windows

- 972 • The RX1 receive channel is a function of the upstream channel used to initiate the
- 973 data exchange. The RX1 receive channel can be determined as follows.
- 974 ○ RX1 Channel Number = Transmit Channel Number modulo 8
- 975 • The RX1 window data rate depends on the transmit data rate (see Table 16 below).
- 976 • The RX2 (second receive window) settings uses a fixed data rate and frequency.
- 977 Default parameters are 923.3Mhz / DR8
- 978

Upstream data rate RX1DROff set	Downstream data rate					
	0	1	2	3	4	5
DR0	DR8	DR8	DR8	DR8	DR8	DR8
DR1	DR9	DR8	DR8	DR8	DR8	DR8
DR2	DR10	DR9	DR8	DR8	DR8	DR8
DR3	DR11	DR10	DR9	DR8	DR8	DR8
DR4	DR12	DR11	DR10	DR9	DR8	DR8
DR5	DR13	DR12	DR11	DR10	DR9	DR8
DR6	DR13	DR13	DR12	DR11	DR10	DR9

Table 40 : AU915-928 downlink RX1 data rate mapping

979  
980

981 The allowed values for RX1DROffset are in the [0:5] range. Values in the range [6:7] are  
982 reserved for future use.

983

### 984 2.6.8 AU915-928 Class B beacon

985 The beacons are transmitted using the following settings:

<b>DR</b>	8	Corresponds to SF12 spreading factor with 500kHz bw
<b>CR</b>	1	Coding rate = 4/5
<b>Signal polarity</b>	Non-inverted	As opposed to normal downlink traffic which uses inverted signal polarity
<b>frequencies</b>	923.3 to 927.5MHz with 600kHz steps	Beaconing is performed on the same channel that normal downstream traffic as defined in the Class A specification

Table 41 : AU915-928 beacon settings

986

987 The downstream channel used for a given beacon is:

988 
$$\text{Channel} = \left[ \text{floor} \left( \frac{\text{beacon\_time}}{\text{beacon\_period}} \right) \right] \text{ modulo } 8$$

- 989 • whereby beacon\_time is the integer value of the 4 bytes “Time” field of the beacon
- 990 frame
- 991 • whereby beacon\_period is the periodicity of beacons , 128 seconds
- 992 • whereby  $\text{floor}(x)$  designates rounding to the integer immediately inferior or equal to x
- 993

994 Example: the first beacon will be transmitted on 923.3Mhz , the second  
 995 on 923.9MHz, the 9<sup>th</sup> beacon will be on 923.3Mhz again.  
 996  
 997

Beacon channel nb	Frequency [MHz]
0	923.3
1	923.9
2	924.5
3	925.1
4	925.7
5	926.3
6	926.9
7	927.5

998  
 999

1000 The beacon frame content is:

Size (bytes)	3	4	2	7	1	2
BCNPayload	RFU	Time	CRC	GwSpecific	RFU	CRC

1001

### 1002 2.6.9 AU915-928 Default Settings

1003 The following parameters are recommended values for the AU915-928 band.

- 1004 RECEIVE\_DELAY1 1 s
- 1005 RECEIVE\_DELAY2 2 s (MUST be RECEIVE\_DELAY1 + 1s)
- 1006 JOIN\_ACCEPT\_DELAY1 5 s
- 1007 JOIN\_ACCEPT\_DELAY2 6 s
- 1008 MAX\_FCNT\_GAP 16384
- 1009 ADR\_ACK\_LIMIT 64
- 1010 ADR\_ACK\_DELAY 32
- 1011 ACK\_TIMEOUT 2 +/- 1 s (random delay between 1 and 3 seconds)

1012 If the actual parameter values implemented in the end-device are different from those default  
 1013 values (for example the end-device uses a longer RECEIVE\_DELAY1 & 2 latency), those  
 1014 parameters MUST be communicated to the network server using an out-of-band channel  
 1015 during the end-device commissioning process. The network server may not accept  
 1016 parameters different from those default values.  
 1017

1018 **2.7 CN470-510MHz Band**

1019 **2.7.1 CN470-510 Preamble Format**

1020 The following synchronization words SHOULD be used:

1021

Modulation	Sync word	Preamble length
LORA	0x34	8 symbols

1022 **2.7.2 CN470-510 Channel Frequencies**

1023

1024 In China, this band is defined by SRRC to be used for civil metering applications.

1025 The 470 MHz ISM Band SHALL be divided into the following channel plans:

1026

- Upstream – 96 channels numbered 0 to 95 utilizing LoRa 125 kHz BW varying from DR0 to DR5, using coding rate 4/5, starting at 470.3 MHz and incrementing linearly by 200 kHz to 489.3 MHz.

1027

1028

1029

1030

1031

1032

1033

Channel Index 6 to 38 and 45 to 77 are mainly used by China Electric Power. In the areas where these channels are used by China Electric Power, they should be disabled.

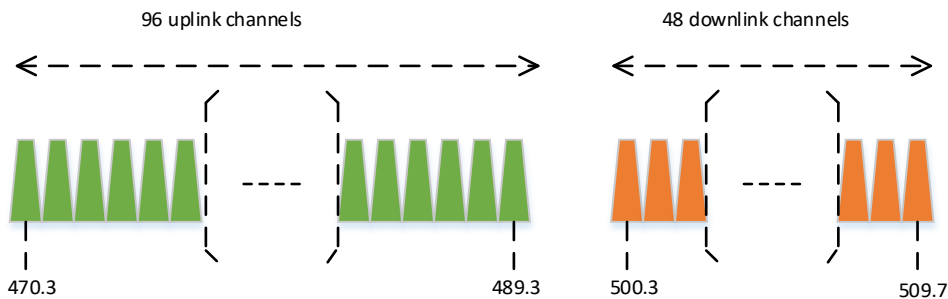
1034

- Downstream – 48 channels numbered 0 to 47 utilizing LoRa 125 kHz BW varying from DR0 to DR5, using coding rate 4/5, starting at 500.3 MHz and incrementing linearly by 200 kHz to 509.7 MHz

1035

1036

1037



1038

1039

Figure 3: CN470-510 channel frequencies

1040

1041 The LoRaWAN can be used in the Chinese 470-510MHz band as long as

1042

- The radio device EIRP is less than 19.15dBm
- The transmission never lasts more than 5000 ms.

1043

1044

1045

1046

1047 CN470-510 end-devices SHALL be capable of operating in the 470 to 510 MHz frequency  
 1048 band and SHALL feature a channel data structure to store the parameters of 96 uplink  
 1049 channels. A channel data structure corresponds to a frequency and a set of data rates  
 1050 usable on this frequency.

1051 If using the over-the-air activation procedure, the end-device SHALL broadcast the JoinReq  
 1052 message on a random 125 kHz channel amongst the 96 uplink channels defined using **DR5**  
 1053 **to DR0.**

1054 Personalized devices SHALL have all 96 channels enabled following a reset.

1055

### 1056 2.7.3 CN470-510 Data Rate and End-point Output Power encoding

1057 There is no dwell time limitation for the CN470-510 PHY layer. The *TxParamSetupReq*  
1058 MAC command is not implemented by CN470-510 devices.

1059 The following encoding is used for Data Rate (**DR**) and End-point EIRP (**TXPower**) in the  
1060 CN470-510 band:

1061

DataRate	Configuration	Indicative physical bit rate [bit/sec]	TXPower	Configuration (EIRP)
0	LoRa: SF12 / 125 kHz	250	0	Max EIRP
1	LoRa: SF11 / 125 kHz	440	1	Max EIRP – 2dB
2	LoRa: SF10 / 125 kHz	980	2	Max EIRP – 4dB
3	LoRa: SF9 / 125 kHz	1760	3	Max EIRP – 6dB
4	LoRa: SF8 / 125 kHz	3125	4	Max EIRP – 8dB
5	LoRa:SF7 / 125 kHz	5470	5	Max EIRP – 10dB
6:14	RFU		6	Max EIRP – 12dB
			7	Max EIRP – 14dB
			8...14	RFU
15	Defined in LoRaWAN		15	Defined in LoRaWAN

Table 42: CN470-510 Data rate and TX power table

1062

1063

1064 EIRP refers to the Equivalent Isotropically Radiated Power, which is the radiated output  
1065 power referenced to an isotropic antenna radiating power equally in all directions and whose  
1066 gain is expressed in dBi.

1067

1068 By default MaxEIRP is considered to be +19.15dBm. If the end-device cannot achieve  
1069 19.15dBm EIRP, the Max EIRP SHOULD be communicated to the network server using an  
1070 out-of-band channel during the end-device commissioning process.

1071

### 1072 2.7.4 CN470-510 JoinResp CFList

1073

1074 The CN470-510 LoRaWAN supports the use of the optional **CFList** appended to the  
1075 JoinResp message. If the **CFList** is not empty then the CFListType field SHALL contain the  
1076 value one (0x01) to indicate the CFList contains a series of ChMask fields. The ChMask  
1077 fields are interpreted as being controlled by a virtual ChMaskCntl that initializes to a value of  
1078 zero (0) and increments for each ChMask field to a value of five (5). (The first 16 bits  
1079 controls the channels 1 to 16, ..)

1080

Size (bytes)	[2]	[2]	[2]	[2]	[2]	[2]	[3]	[1]
CFList	ChMask0	ChMask1	ChMask2	ChMask3	ChMask4	ChMask5	RFU	CFListType

1081 **2.7.5 CN470-510 LinkAdrReq command**

 1082 For the CN470-510 version the **ChMaskCntl** field of the **LinkADRReq** command has the  
 1083 following meaning:

1084

ChMaskCntl	ChMask applies to
0	Channels 0 to 15
1	Channels 16 to 31
2	Channels 32 to 47
3	Channels 48 to 63
4	Channels 64 to 79
5	Channels 80 to 95
6	All channels ON The device SHOULD enable all currently defined channels independently of the ChMask field value.
7	RFU

1085

Table 43: CN470-510 ChMaskCntl value table

 1086 If the ChMask field value is one of the values meaning RFU, then end-device SHOULD  
 1087 reject the command and unset the “**Channel mask ACK**” bit in its response.

 1088 **2.7.6 CN470-510 Maximum payload size**

 1089 The maximum **MACPayload** size length ( $M$ ) is given by the following table. It is derived from  
 1090 the maximum allowed transmission time at the PHY layer taking into account a possible  
 1091 repeater encapsulation. The maximum application payload length in the absence of the  
 1092 optional **FOpt** MAC control field ( $N$ ) is also given for information only. The value of  $N$  might  
 1093 be smaller if the **FOpt** field is not empty:

DataRate	$M$	$N$
0	59	51
1	59	51
2	59	51
3	123	115
4	230	222
5	230	222
6:15	Not defined	

1094

Table 44: CN470-510 maximum payload size

 1095 If the end-device will never operate with a repeater then the maximum application payload  
 1096 length in the absence of the optional **FOpt** control field SHOULD be:

1097

DataRate	$M$	$N$
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6:15	Not defined	

1098

Table 45 : CN470-510 maximum payload size (not repeater compatible)

1099

 1100 **2.7.7 CN470-510 Receive windows**

- 1101
- The RX1 receive channel is a function of the upstream channel used to initiate the  
 1102 data exchange. The RX1 receive channel can be determined as follows.

- 1103 ○ RX1 Channel Number = Uplink Channel Number modulo 48, for example,
- 1104 when transmitting channel number is 49, the rx1 channel number is 1.
- 1105 • The RX1 window data rate depends on the transmit data rate (see Table below).
- 1106 • The RX2 (second receive window) settings uses a fixed data rate and frequency.
- 1107 Default parameters are 505.3 MHz / DR0
- 1108

RX1DROffset	0	1	2	3	4	5
Upstream data rate	Downstream data rate in RX1 slot					
DR0	DR0	DR0	DR0	DR0	DR0	DR0
DR1	DR1	DR0	DR0	DR0	DR0	DR0
DR2	DR2	DR1	DR0	DR0	DR0	DR0
DR3	DR3	DR2	DR1	DR0	DR0	DR0
DR4	DR4	DR3	DR2	DR1	DR0	DR0
DR5	DR5	DR4	DR3	DR2	DR1	DR0

Table 46: CN470-510 downlink RX1 data rate mapping

1109  
1110

1111 The allowed values for RX1DROffset are in the [0:5] range. Values in the range [6:7] are  
1112 reserved for future use.

### 1113 2.7.8 CN470-510 Class B beacon

1114 The beacons are transmitted using the following settings:

<b>DR</b>	2	Corresponds to SF10 spreading factor with 125kHz bw
<b>CR</b>	1	Coding rate = 4/5
<b>Signal polarity</b>	Non-inverted	As opposed to normal downlink traffic which uses inverted signal polarity
<b>frequencies</b>	508.3 to 509.7MHz with 200kHz steps	

Table 47 : CN470-510 beacon settings

1115  
1116

1117 The downstream channel used for a given beacon is:

$$1118 \text{ BeaconChannel} = \left[ \text{floor} \left( \frac{\text{beacon\_time}}{\text{beacon\_period}} \right) \right] \text{ modulo } 8$$

- 1119 • whereby beacon\_time is the integer value of the 4 bytes “Time” field of the beacon
- 1120 frame
- 1121 • whereby beacon\_period is the periodicity of beacons , 128 seconds
- 1122 • whereby  $\text{floor}(x)$  designates rounding to the integer immediately inferior or equal to x
- 1123

1124 Example: the first beacon will be transmitted on 508.3Mhz, the second  
1125 on 508.5MHz, the 9<sup>th</sup> beacon will be on 508.3Mhz again.

1126  
1127

Beacon channel nb	Frequency [MHz]
0	508.3
1	508.5
2	508.7
3	508.9
4	509.1
5	509.3
6	509.5

7	509.7
---	-------

1128  
1129  
1130

The beacon frame content is:

Size (bytes)	3	4	2	7	1	2
<b>BCNPayload</b>	<b>RFU</b>	Time	CRC	GwSpecific	<b>RFU</b>	CRC

1131

1132 **2.7.9 CN470-510 Default Settings**

1133 The following parameters are recommended values for the CN470-510 band.

- 1134 RECEIVE\_DELAY1 1 s
- 1135 RECEIVE\_DELAY2 2 s (MUST be RECEIVE\_DELAY1 + 1s)
- 1136 JOIN\_ACCEPT\_DELAY1 5 s
- 1137 JOIN\_ACCEPT\_DELAY2 6 s
- 1138 MAX\_FCNT\_GAP 16384
- 1139 ADR\_ACK\_LIMIT 64
- 1140 ADR\_ACK\_DELAY 32
- 1141 ACK\_TIMEOUT 2 +/- 1 s (random delay between 1 and 3 seconds)

1142 If the actual parameter values implemented in the end-device are different from those default  
 1143 values (for example the end-device uses a longer RECEIVE\_DELAY1 & 2 latency), those  
 1144 parameters MUST be communicated to the network server using an out-of-band channel  
 1145 during the end-device commissioning process. The network server may not accept  
 1146 parameters different from those default values.



1147 **2.8 AS923MHz ISM Band**

 1148 **2.8.1 AS923 Preamble Format**

1149 The following synchronization words SHOULD be used:

1150

Modulation	Sync word	Preamble length
LORA	0x34	8 symbols
GFSK	0xC194C1	5 bytes

1151

Table 48: AS923 synch words

 1152 **2.8.2 AS923 ISM Band channel frequencies**

 1153 This section applies to regions where the frequencies [923...923.5MHz] are comprised in the  
 1154 ISM band.

 1155 The network channels can be freely attributed by the network operator. However the two  
 1156 following default channels MUST be implemented in every AS923MHz end-device. Those  
 1157 channels are the minimum set that all network gateways SHOULD always be listening on.

1158

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels	Duty cycle
LoRa	125	923.20 923.40	DR0 to DR5 / 0.3-5 kbps	2	< 1%

1159

Table 49: AS923 default channels

 1160 Those default channels MUST be implemented in every end-device and cannot be modified  
 1161 through the **NewChannelReq** command and guarantee a minimal common channel set  
 1162 between end-devices and network gateways.

1163 AS923MHz ISM band end-devices should use the following default parameters

- 1164
- Default EIRP: 16 dBm

 1165 AS923MHz end-devices SHALL feature a channel data structure to store the parameters of  
 1166 at least 16 channels. A channel data structure corresponds to a frequency and a set of data  
 1167 rates usable on this frequency.

 1168 The following table gives the list of frequencies that SHALL be used by end-devices to  
 1169 broadcast the JoinReq message.

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels	Duty cycle
LoRa	125	923.20 923.40	DR2 to DR5	2	< 1%

1170

Table 50: AS923 JoinReq Channel List

1171

 1172 The default JoinReq Data Rate utilizes the range DR2-DR5 (SF10/125 kHz – SF7/125 kHz),  
 1173 this setting ensures that end-devices are compatible with the 400ms dwell time limitation  
 1174 until the actual dwell time limit is notified to the end-device by the network server via the  
 1175 MAC command "TxParamSetupReq".

1176 The JoinReq message transmit duty-cycle SHALL follow the rules described in chapter  
 1177 “Retransmissions back-off” of the LoRaWAN specification document.  
 1178

### 1179 2.8.3 AS923 Data Rate and End-point Output Power encoding

1180 The “TxParamSetupReq/Ans” MAC command MUST be implemented by the AS923  
 1181 devices.

1182 The following encoding is used for Data Rate (DR) in the AS923 band:

1183

DataRate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	LoRa: SF7 / 250 kHz	11000
7	FSK: 50 kbps	50000
8..14	RFU	
15	Defined in LoRaWAN	

1184

Table 51: AS923 Data rate table

1185

1186 The TXPower table indicates power levels relative to the Max EIRP level of the end-device,  
 1187 as per the following table:

1188

TXPower	Configuration (EIRP)
0	Max EIRP
1	Max EIRP – 2dB
2	Max EIRP – 4dB
3	Max EIRP – 6dB
4	Max EIRP – 8dB
5	Max EIRP – 10dB
6	Max EIRP – 12dB
7	Max EIRP – 14dB
8..14	RFU
15	Defined in LoRaWAN

1189

1190

1191 EIRP refers to the Equivalent Isotropically Radiated Power, which is the radiated output  
 1192 power referenced to an isotropic antenna radiating power equally in all directions and whose  
 1193 gain is expressed in dBi.

1194 By default Max EIRP SHALL be 16dBm. The Max EIRP can be modified by the network  
 1195 server through the **TxParamSetupReq** MAC command and SHOULD be used by both the  
 1196 end-device and the network server once **TxParamSetupReq** is acknowledged by the device  
 1197 via **TxParamSetupAns**,

1198

1199 **2.8.4 AS923 JoinAccept CFList**

1200 The AS923 LoRaWAN implements an optional channel frequency list (CFList) of 16 octets in  
1201 the JoinAccept message.

1202 In this case the CFList is a list of five channel frequencies for the channels two to six  
1203 whereby each frequency is encoded as a 24 bits unsigned integer (three octets). All these  
1204 channels are usable for DR0 to DR5 125 KHz LoRa modulation. The list of frequencies is  
1205 followed by a single CFListType octet for a total of 16 octets. The CFListType SHALL be  
1206 equal to zero (0) to indicate that the CFList contains a list of frequencies.

1207

<b>Size (bytes)</b>	3	3	3	3	3	1
<b>CFList</b>	Freq Ch2	Freq Ch3	Freq Ch4	Freq Ch5	Freq Ch6	CFListType

1208 The actual channel frequency in Hz is 100 x frequency whereby values representing  
1209 frequencies below 100 MHz are reserved for future use. This allows setting the frequency of  
1210 a channel anywhere between 915 and 928MHz in 100 Hz steps. Unused channels have a  
1211 frequency value of 0. The CFList is optional and its presence can be detected by the length  
1212 of the join-accept message. If present, the CFList replaces all the previous channels stored  
1213 in the end-device apart from the two default channels. The newly defined channels are  
1214 immediately enabled and usable by the end-device for communication.

1215 **2.8.5 AS923 LinkAdrReq command**

1216 The AS923 LoRaWAN only supports a maximum of 16 channels. When **ChMaskCntl** field is  
1217 0 the ChMask field individually enables/disables each of the 16 channels.  
1218

<b>ChMaskCntl</b>	<b>ChMask applies to</b>
0	Channels 0 to 15
1	RFU
..	..
4	RFU
5	RFU
6	All channels ON The device SHOULD enable all currently defined channels independently of the ChMask field value.
7	RFU

Table 53: AS923 ChMaskCntl value table

1219

1220 If the ChMask field value is one of values meaning RFU, the end-device SHOULD reject the  
1221 command and unset the “**Channel mask ACK**” bit in its response.

1222

1223 **2.8.6 AS923 Maximum payload size**

1224 The maximum **MACPayload** size length (*M*) is given by the following table for both dwell  
1225 time configurations: No Limit and 400ms. It is derived from the PHY layer limitation  
1226 depending on the effective modulation rate used taking into account a possible repeater  
1227 encapsulation layer.

1228

DataRate	Uplink MAC Payload Size ( <i>M</i> )		Downlink MAC Payload Size ( <i>M</i> )	
	UplinkDwellTime = 0	UplinkDwellTime = 1	DownlinkDwellTime = 0	DownlinkDwellTime = 1
0	59	N/A	59	N/A
1	59	N/A	59	N/A
2	59	19	59	19
3	123	61	123	61
4	230	133	230	133
5	230	250	230	250
6	230	250	230	250
7	230	250	230	250
8:15	RFU		RFU	

1229

Table 54: AS923 maximum payload size

1230 If the end-device will never operate with a repeater then the maximum MAC payload length  
1231 should be:

DataRate	Uplink MAC Payload Size ( <i>M</i> )		Downlink MAC Payload Size ( <i>M</i> )	
	UplinkDwellTime = 0	UplinkDwellTime = 1	DownlinkDwellTime = 0	DownlinkDwellTime = 1
0	59	N/A	59	N/A
1	59	N/A	59	N/A
2	59	19	59	19
3	123	61	123	61
4	250	133	250	133
5	250	250	250	250
6	250	250	250	250
7	250	250	250	250
8:15	RFU		RFU	

1232

Table 55: AS923 maximum payload size (not repeater compatible)

1233 The maximum application payload length in the absence of the optional **FOpt** control field  
1234 (*M*) is eight bytes lower than the MACPayload value in the above table. The value of N might  
1235 be smaller if the **FOpt** field is not empty.

1236

## 1237 2.8.7 AS923 Receive windows

1238 The RX1 receive window uses the same channel than the preceding uplink. The data rate is  
1239 a function of the uplink data rate and the RX1DROffset as following:

1240 Downstream data rate in RX1 slot =  $MIN(5, MAX(\text{MinDR}, \text{Upstream data rate} -$   
1241  $\text{Effective\_RX1DROffset}))$

1242 MinDR depends on the DownlinkDwellTime bit sent to the device in the **TxParamSetupReq**  
1243 command:

- 1244 • Case DownlinkDwellTime = 0 (No limit): MinDR = 0
- 1245 • Case DownlinkDwellTime = 1 (400ms): MinDR = 2

1246 The allowed values for RX1DROffset are in the [0:7] range, encoded as per the below table:

RX1DROffset (Coded value)	0	1	2	3	4	5	6	7
Effective_RX1DROffset	0	1	2	3	4	5	-1	-2

1247 Values in the [6:7] range allow setting the Downstream RX1 data rate higher than Upstream  
1248 data rate.

1249 The RX2 receive window uses a fixed frequency and data rate. The default parameters are  
 1250 923.2 MHz / DR2 (SF10/125KHz).

1251

1252 **2.8.8 AS923 Class B beacon and default downlink channel**

1253 The beacons SHALL be transmitted using the following settings

DR	3	Corresponds to SF9 spreading factor with 125 kHz BW
CR	1	Coding rate = 4/5
Signal polarity	Non-inverted	As opposed to normal downlink traffic which uses inverted signal polarity

1254 **Table 56 : AS923 beacon settings**

1255 The beacon frame content is:

<b>Size (bytes)</b>	<b>2</b>	<b>4</b>	<b>2</b>	<b>7</b>	<b>2</b>
<b>BCNPayload</b>	<b>RFU</b>	Time	CRC	GwSpecific	CRC

1256 The beacon default broadcast frequency is 923.4MHz.

1257 The class B default downlink pingSlot frequency is 923.4MHz

1258

1259 **2.8.9 AS923 Default Settings**

1260 The following parameters are recommended values for the AS923MHz band.

- 1261 RECEIVE\_DELAY1 1 s
- 1262 RECEIVE\_DELAY2 2 s (MUST be RECEIVE\_DELAY1 + 1s)
- 1263 JOIN\_ACCEPT\_DELAY1 5 s
- 1264 JOIN\_ACCEPT\_DELAY2 6 s
- 1265 MAX\_FCNT\_GAP 16384
- 1266 ADR\_ACK\_LIMIT 64
- 1267 ADR\_ACK\_DELAY 32
- 1268 ACK\_TIMEOUT 2 +/- 1 s (random delay between 1 and 3 seconds)

1269 If the actual parameter values implemented in the end-device are different from those default  
 1270 values (for example the end-device uses a longer RECEIVE\_DELAY1 and  
 1271 RECEIVE\_DELAY2 latency), those parameters MUST be communicated to the network  
 1272 server using an out-of-band channel during the end-device commissioning process. The  
 1273 network server may not accept parameters different from those default values.

1274 **2.9 KR920-923MHz ISM Band**

 1275 **2.9.1 KR920-923 Preamble Format**

1276 The following synchronization words SHOULD be used:

1277

Modulation	Sync word	Preamble length
LORA	0x34	8 symbols

 1278 **2.9.2 KR920-923 ISM Band channel frequencies**

 1279 The center frequency, bandwidth and maximum EIRP output power for the South Korea  
 1280 RFID/USN frequency band are already defined by Korean Government. Basically Korean  
 1281 Government allocated LPWA based IoT network frequency band from 920.9 to 923.3MHz.

1282

Center frequency (MHz)	Bandwidth (kHz)	Maximum EIRP output power (dBm)	
		For end-device	For gateway
920.9	125	10	23
921.1	125	10	23
921.3	125	10	23
921.5	125	10	23
921.7	125	10	23
921.9	125	10	23
922.1	125	14	23
922.3	125	14	23
922.5	125	14	23
922.7	125	14	23
922.9	125	14	23
923.1	125	14	23
923.3	125	14	23

1283

Table 57: KR920-923 Center frequency, bandwidth, maximum EIRP output power table

 1284 The three following default channels (922.1, 922.3 and 922.5MHz / DR0 to DR5) determined  
 1285 by the network operator from the set of available channels as defined by the South Korean  
 1286 regulation MUST be implemented in every KR920-923MHz end-device, and cannot be  
 1287 alterable by the **NewChannelReq** command. Those channels are the minimum set that all  
 1288 network gateways SHOULD always be listening on to guarantee a minimal common channel  
 1289 set between end-devices and network gateways.

1290

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels
LoRa	125	922.10 922.30 922.50	DR0 to DR5 / 0.3-5 kbps	3

1291

Table 58: KR920-923 default channels

 1292 In order to access the physical medium the South Korea regulations impose some  
 1293 restrictions. The South Korea regulations allow the choice of using either a duty-cycle  
 1294 limitation or a so-called Listen Before Talk Adaptive Frequency Agility (LBT AFA)  
 1295 transmissions management. The current LoRaWAN specification for the KR920-923 ISM

1296 band exclusively uses LBT channel access rule to maximize MACPayload size length and  
 1297 comply with the South Korea regulations.

1298 KR920-923MHz ISM band end-devices SHALL use the following default parameters

- 1299 • Default EIRP output power for end-device(920.9~921.9MHz): 10 dBm
- 1300 • Default EIRP output power for end-device(922.1~923.3MHz): 14 dBm
- 1301 • Default EIRP output power for gateway: 23 dBm

1302 KR920-923MHz end-devices SHALL be capable of operating in the 920 to 923MHz  
 1303 frequency band and SHALL feature a channel data structure to store the parameters of at  
 1304 least 16 channels. A channel data structure corresponds to a frequency and a set of data  
 1305 rates usable on this frequency.

1306 The following table gives the list of frequencies that SHALL be used by end-devices to  
 1307 broadcast the JoinReq message.

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels
LoRa	125	922.10 922.30 922.50	DR0 to DR5 / 0.3-5 kbps	3

1308 **Table 59: KR920-923 JoinReq Channel List**

### 1309 2.9.3 KR920-923 Data Rate and End-device Output Power encoding

1310 There is no dwell time limitation for the KR920-923 PHY layer. The *TxParamSetupReq*  
 1311 MAC command is not implemented by KR920-923 devices.

1312 The following encoding is used for Data Rate (DR), and EIRP Output Power (TXPower) in  
 1313 the KR920-923 band:

1314

DataRate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6..14	RFU	
15	Defined in LoRAWAN	

**Table 60: KR920-923 TX Data rate table**

1315  
 1316  
 1317

TXPower	Configuration (EIRP)
0	Max EIRP
1	Max EIRP – 2dB
2	Max EIRP – 4dB
3	Max EIRP – 6dB
4	Max EIRP – 8dB
5	Max EIRP – 10dB
6	Max EIRP – 12dB
7	Max EIRP – 14dB
8..14	RFU
15	Defined in LoRAWAN

1318  
1319

Table 61: KR920-923 TX power table

1320 EIRP refers to the Equivalent Isotropically Radiated Power, which is the radiated output  
1321 power referenced to an isotropic antenna radiating power equally in all directions and whose  
1322 gain is expressed in dBi.

1323

1324 By default MaxEIRP is considered to be +14dBm. If the end-device cannot achieve 14dBm  
1325 EIRP, the MaxEIRP SHOULD be communicated to the network server using an out-of-band  
1326 channel during the end-device commissioning process.  
1327 When the device transmits in a channel whose frequency is <922MHz, the transmit power  
1328 SHALL be limited to +10dBm EIRP even if the current transmit power level set by the  
1329 network server is higher.

1330 **2.9.4 KR920-923 JoinAccept CFList**

1331 The KR920-923 ISM band LoRaWAN implements an optional **channel frequency list**  
1332 (CFList) of 16 octets in the JoinAccept message.

1333 In this case the CFList is a list of five channel frequencies for the channels three to seven  
1334 whereby each frequency is encoded as a 24 bits unsigned integer (three octets). All these  
1335 channels are usable for DR0 to DR5 125kHz LoRa modulation.

1336 The list of frequencies is followed by a single CFListType octet for a total of 16 octets. The  
1337 CFListType SHALL be equal to zero (0) to indicate that the CFList contains a list of  
1338 frequencies.

1339

<b>Size (bytes)</b>	3	3	3	3	3	1
<b>CFList</b>	Freq Ch3	Freq Ch4	Freq Ch5	Freq Ch6	Freq Ch7	CFListType

1340 The actual channel frequency in Hz is 100 x frequency whereby values representing  
1341 frequencies below 100 MHz are reserved for future use. This allows setting the frequency of  
1342 a channel anywhere between 100 MHz to 1.67 GHz in 100 Hz steps. Unused channels have  
1343 a frequency value of 0. The **CFList** is optional and its presence can be detected by the  
1344 length of the join-accept message. If present, the **CFList** replaces all the previous channels  
1345 stored in the end-device apart from the three default channels. The newly defined channels  
1346 are immediately enabled and usable by the end-device for communication.

1347 **2.9.5 KR920-923 LinkAdrReq command**

1348 The KR920-923 LoRaWAN only supports a maximum of 16 channels. When **ChMaskCntl**  
1349 field is 0 the ChMask field individually enables/disables each of the 16 channels.

1350

<b>ChMaskCntl</b>	<b>ChMask applies to</b>
0	Channels 0 to 15
1	RFU
..	..
4	RFU
5	RFU
6	All channels ON The device SHOULD enable all currently defined channels independently of the ChMask field value.



ChMaskCntl	ChMask applies to
7	RFU

Table 62: KR920-923 ChMaskCntl value table

1351  
1352

1353 If the ChMaskCntl field value is one of values meaning RFU, the end-device SHOULD reject  
1354 the command and unset the “Channel mask ACK” bit in its response.

1355 **2.9.6 KR920-923 Maximum payload size**

1356 The maximum **MACPayload** size length (*M*) is given by the following table for the regulation  
1357 of dwell time; less than 4 sec with LBT. It is derived from limitation of the PHY layer  
1358 depending on the effective modulation rate used taking into account a possible repeater  
1359 encapsulation layer. The maximum application payload length in the absence of the optional  
1360 **FOpt** control field (*N*) is also given for information only. The value of *N* might be smaller if  
1361 the **FOpt** field is not empty:

1362

DataRate	<i>M</i>	<i>N</i>
0	59	51
1	59	51
2	59	51
3	123	115
4	230	222
5	230	222
6:15	Not defined	

Table 63: KR920-923 maximum payload size

1363

1364 If the end-device will never operate with a repeater then the maximum application payload  
1365 length in the absence of the optional **FOpt** control field SHOULD be:

1366

DataRate	<i>M</i>	<i>N</i>
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6:15	Not defined	

Table 64 : KR920-923 maximum payload size (not repeater compatible)

1367

1368

1369 **2.9.7 KR920-923 Receive windows**

1370 The RX1 receive window uses the same channel than the preceding uplink. The data rate is  
1371 a function of the uplink data rate and the RX1DROffset as given by the following table. The  
1372 allowed values for RX1DROffset are in the [0:5] range. Values in the [6:7] range are  
1373 reserved for future use.

1374

RX1DROffset	0	1	2	3	4	5
Upstream data rate	Downstream data rate in RX1 slot					
DR0	DR0	DR0	DR0	DR0	DR0	DR0
DR1	DR1	DR0	DR0	DR0	DR0	DR0
DR2	DR2	DR1	DR0	DR0	DR0	DR0
DR3	DR3	DR2	DR1	DR0	DR0	DR0

RX1DROffset Upstream data rate	0	1	2	3	4	5
	Downstream data rate in RX1 slot					
DR4	DR4	DR3	DR2	DR1	DR0	DR0
DR5	DR5	DR4	DR3	DR2	DR1	DR0

1375 **Table 65 : KR920-923 downlink RX1 data rate mapping**

1376 The RX2 receive window uses a fixed frequency and data rate. The default parameters are  
1377 921.90MHz / DR0 (SF12, 125 kHz).

1378 **2.9.8 KR920-923 Class B beacon and default downlink channel**

1379 The beacons SHALL be transmitted using the following settings

<b>DR</b>	3	Corresponds to SF9 spreading factor with 125 kHz BW
<b>CR</b>	1	Coding rate = 4/5
<b>Signal polarity</b>	Non-inverted	As opposed to normal downlink traffic which uses inverted signal polarity

1380 **Table 66 : KR920-923 beacon settings**

1381

1382 The beacon frame content is:

<b>Size (bytes)</b>	2	4	2	7	2
<b>BCNPayload</b>	RFU	Time	CRC	GwSpecific	CRC

1383 The beacon default broadcast frequency is 923.1MHz.

1384 The class B default downlink pingSlot frequency is 923.1MHz

1385

1386 **2.9.9 KR920-923 Default Settings**

1387 The following parameters are recommended values for the KR920-923Mhz band.

- 1388 RECEIVE\_DELAY1 1 s
- 1389 RECEIVE\_DELAY2 2 s (MUST be RECEIVE\_DELAY1 + 1s)
- 1390 JOIN\_ACCEPT\_DELAY1 5 s
- 1391 JOIN\_ACCEPT\_DELAY2 6 s
- 1392 MAX\_FCNT\_GAP 16384
- 1393 ADR\_ACK\_LIMIT 64
- 1394 ADR\_ACK\_DELAY 32
- 1395 ACK\_TIMEOUT 2 +/- 1 s (random delay between 1 and 3 seconds)

1396 If the actual parameter values implemented in the end-device are different from those default  
1397 values (for example the end-device uses a longer RECEIVE\_DELAY1 and  
1398 RECEIVE\_DELAY2 latency), those parameters MUST be communicated to the network  
1399 server using an out-of-band channel during the end-device commissioning process. The  
1400 network server may not accept parameters different from those default values.

1401

1402 **2.10 IN865-867 MHz ISM Band**

 1403 **2.10.1 IN865-867 Preamble Format**

1404 The following synchronization words SHOULD be used:

1405

Modulation	Sync word	Preamble length
LORA	0x34	8 symbols
GFSK	0xC194C1	5 bytes

1406

Table 67: IN865-867 synch words

 1407 **2.10.2 IN865-867 ISM Band channel frequencies**

1408 This section applies to the Indian sub-continent.

 1409 The network channels can be freely attributed by the network operator. However the three  
 1410 following default channels MUST be implemented in every India 865-867MHz end-device.  
 1411 Those channels are the minimum set that all network gateways SHOULD always be  
 1412 listening on.

1413

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels
LoRa	125	865.0625 865.4025 865.985	DR0 to DR5 / 0.3-5 kbps	3

1414

Table 68: IN865-867 default channels

 1415 End-devices SHALL be capable of operating in the 865 to 867 MHz frequency band and  
 1416 should feature a channel data structure to store the parameters of at least 16 channels. A  
 1417 channel data structure corresponds to a frequency and a set of data rates usable on this  
 1418 frequency.

 1419 The first three channels correspond to 865.0625, 865.4025, and 865.985 MHz / DR0 to DR5  
 1420 and MUST be implemented in every end-device. Those default channels cannot be modified  
 1421 through the **NewChannelReq** command and guarantee a minimal common channel set  
 1422 between end-devices and network gateways.

 1423 The following table gives the list of frequencies that SHALL be used by end-devices to  
 1424 broadcast the JoinReq message. The JoinReq message transmit duty-cycle SHALL follow  
 1425 the rules described in chapter "Retransmissions back-off" of the LoRaWAN specification  
 1426 document.

1427

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels
LoRa	125	865.0625 865.4025 865.9850	DR0 – DR5 / 0.3-5 kbps	3

1428

Table 69: IN865-867 JoinReq Channel List

 1429 **2.10.3 IN865-867 Data Rate and End-device Output Power Encoding**

 1430 There is no dwell time or duty-cycle limitation for the INDIA 865-867 PHY layer. The  
 1431 **TxParamSetupReq** MAC command is not implemented by INDIA 865-867 devices.

1432 The following encoding is used for Data Rate (DR) and End-device Output Power (TXPower)  
 1433 in the INDIA 865-867 band:

1434

DataRate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	RFU	RFU
7	FSK: 50 kbps	50000
8..14	RFU	
15	Defined in LoRaWAN	

Table 70: IN865-867 TX Data rate table

1435

1436

1437 The TXPower table indicates power levels relative to the Max EIRP level of the end-device,  
 1438 as per the following table:

1439

TXPower	Configuration (EIRP)
0	Max EIRP
1	Max EIRP – 2dB
2	Max EIRP – 4dB
3	Max EIRP – 6dB
4	Max EIRP – 8dB
5	Max EIRP – 10dB
6	Max EIRP – 12dB
7	Max EIRP – 14dB
8	Max EIRP – 16dB
9	Max EIRP – 18dB
10	Max EIRP – 20dB
11..14	RFU
15	Defined in LoRAWAN

Table 71: IN865-867 TxPower table

1440

1441

1442 EIRP refers to the Equivalent Isotropically Radiated Power, which is the radiated output  
 1443 power referenced to an isotropic antenna radiating power equally in all directions and whose  
 1444 gain is expressed in dBi.

1445 By default MaxEIRP is considered to be 30dBm. If the end-device cannot achieve 30dBm  
 1446 EIRP, the Max EIRP SHOULD be communicated to the network server using an out-of-band  
 1447 channel during the end-device commissioning process.

1448

#### 1449 2.10.4 IN865-867 JoinAccept CFList

1450 The India 865-867 ISM band LoRaWAN implements an optional **channel frequency list**  
 1451 (CFList) of 16 octets in the JoinAccept message.

1452 In this case the CFList is a list of five channel frequencies for the channels three to seven  
 1453 whereby each frequency is encoded as a 24 bits unsigned integer (three octets). All these  
 1454 channels are usable for DR0 to DR5 125kHz LoRa modulation.

1455 The list of frequencies is followed by a single CFListType octet for a total of 16 octets. The  
 1456 CFListType SHALL be equal to zero (0) to indicate that the CFList contains a list of  
 1457 frequencies.

1458

<b>Size (bytes)</b>	3	3	3	3	3	1
<b>CFList</b>	Freq Ch3	Freq Ch4	Freq Ch5	Freq Ch6	Freq Ch7	CFListType

1459 The actual channel frequency in Hz is 100 x frequency whereby values representing  
 1460 frequencies below 100 MHz are reserved for future use. This allows setting the frequency of  
 1461 a channel anywhere between 100 MHz to 1.67 GHz in 100 Hz steps. Unused channels have  
 1462 a frequency value of 0. The **CFList** is optional and its presence can be detected by the  
 1463 length of the join-accept message. If present, the **CFList** replaces all the previous channels  
 1464 stored in the end-device apart from the three default channels. The newly defined channels  
 1465 are immediately enabled and usable by the end-device for communication.

1466 **2.10.5 IN865-867 LinkAdrReq command**

1467 The INDIA 865-867 LoRaWAN only supports a maximum of 16 channels. When  
 1468 **ChMaskCntl** field is 0 the ChMask field individually enables/disables each of the 16  
 1469 channels.

1470

ChMaskCntl	ChMask applies to
0	Channels 0 to 15
1	RFU
..	..
4	RFU
5	RFU
6	All channels ON The device SHOULD enable all currently defined channels independently of the ChMask field value.
7	RFU

Table 72: IN865-867 ChMaskCntl value table

1471

1472 If the ChMaskCntl field value is one of values meaning RFU, the end-device SHOULD reject  
 1473 the command and unset the “**Channel mask ACK**” bit in its response.

1474 **2.10.6 IN865-867 Maximum payload size**

1475 The maximum **MACPayload** size length (*M*) is given by the following table. It is derived from  
 1476 limitation of the PHY layer depending on the effective modulation rate used taking into  
 1477 account a possible repeater encapsulation layer. The maximum application payload length in  
 1478 the absence of the optional **FOpt** control field (*N*) is also given for information only. The  
 1479 value of *N* might be smaller if the **FOpt** field is not empty:

1480

DataRate	<i>M</i>	<i>N</i>
0	59	51
1	59	51
2	59	51
3	123	115

4	230	222
5	230	222
6	230	222
7	230	222
8:15	Not defined	

1481

Table 73: IN865-867 maximum payload size

1482 If the end-device will never operate with a repeater then the maximum application payload  
 1483 length in the absence of the optional **FOpt** control field SHOULD be:

1484

DataRate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242
7	250	242
8:15	Not defined	

1485

Table 74 : IN865-867 maximum payload size (not repeater compatible)

1486 **2.10.7 IN865-867 Receive windows**

1487 The RX1 receive window uses the same channel than the preceding uplink. The data rate is  
 1488 a function of the uplink data rate and the RX1DROffset as given by the following table. The  
 1489 allowed values for RX1DROffset are in the [0:7] range. Values in the [6:7] range allow  
 1490 setting the Downstream RX1 data rate higher than Upstream data rate.

1491 The allowed values for RX1DROffset are in the [0:7] range, encoded as per the below table:

RX1DROffset (Coded value)	0	1	2	3	4	5	6	7
Effective_RX1DROffset	0	1	2	3	4	5	-1	-2

1492 Downstream data rate in RX1 slot =  $MIN(5, MAX(0, Upstream\ data\ rate -$   
 1493  $Effective\_RX1DROffset))$

1494 The RX2 receive window uses a fixed frequency and data rate. The default parameters are  
 1495 866.550 MHz / DR2 (SF10, 125 kHz).

1496 **2.10.8 IN865-867 Class B beacon and default downlink channel**

1497 The beacons are transmitted using the following settings

DR	4	Corresponds to SF8 spreading factor with 125 kHz BW
CR	1	Coding rate = 4/5
Signal polarity	Non-inverted	As opposed to normal downlink traffic which uses inverted signal polarity

1498

1499 The beacon frame content is:

Size (bytes)	1	4	2	7	3	2
BCNPayload	RFU	Time	CRC	GwSpecific	RFU	CRC

1500 The beacon default broadcast frequency is 866.550MHz.

1501 The class B default downlink pingSlot frequency is 866.550MHz

1502

### 1503 **2.10.9 IN865-867 Default Settings**

1504 The following parameters are recommended values for the INDIA 865-867MHz band.

1505

1506 RECEIVE\_DELAY1 1 s

1507 RECEIVE\_DELAY2 2 s (MUST be RECEIVE\_DELAY1 + 1s)

1508 JOIN\_ACCEPT\_DELAY1 5 s

1509 JOIN\_ACCEPT\_DELAY2 6 s

1510 MAX\_FCNT\_GAP 16384

1511 ADR\_ACK\_LIMIT 64

1512 ADR\_ACK\_DELAY 32

1513 ACK\_TIMEOUT 2 +/- 1 s (random delay between 1 and 3 seconds)

1514 If the actual parameter values implemented in the end-device are different from those default  
1515 values (for example the end-device uses a longer RECEIVE\_DELAY1 and  
1516 RECEIVE\_DELAY2 latency), those parameters MUST be communicated to the network  
1517 server using an out-of-band channel during the end-device commissioning process. The  
1518 network server may not accept parameters different from those default values.

1519

1520

1521



1522 **2.11 RU864-870 MHz ISM Band**

 1523 **2.11.1 RU864-870 Preamble Format**

1524 The following synchronization words SHOULD be used:

1525

Modulation	Sync word	Preamble length
LORA	0x34	8 symbols
GFSK	0xC194C1	5 bytes

1526

Table 75: RU864-870 synch words

 1527 **2.11.2 RU864-870 ISM Band channel frequencies**

 1528 The network channels can be freely attributed by the network operator in compliance with  
 1529 the allowed sub-bands defined by the Russian regulation. However the two following default  
 1530 channels MUST be implemented in every RU864-870 MHz end-device. Those channels are  
 1531 the minimum set that all network gateways SHOULD always be listening on.

1532

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels	Duty cycle
LoRa	125	868.9 869.1	DR0 to DR5 / 0.3-5 kbps	2	<1%

1533

Table 76: RU864-870 default channels

 1534 RU864-870 MHz end-devices SHALL be capable of operating in the 864 to 870 MHz  
 1535 frequency band and SHALL feature a channel data structure to store the parameters of at  
 1536 least 8 channels. A channel data structure corresponds to a frequency and a set of data  
 1537 rates usable on this frequency.

 1538 The first two channels correspond to 868.9 and 869.1 MHz / DR0 to DR5 and MUST be  
 1539 implemented in every end-device. Those default channels cannot be modified through the  
 1540 **NewChannelReq** command and guarantee a minimal common channel set between end-  
 1541 devices and network gateways.

 1542 The following table gives the list of frequencies that SHALL be used by end-devices to  
 1543 broadcast the JoinReq message. The JoinReq message transmit duty-cycle SHALL follow  
 1544 the rules described in chapter "Retransmissions back-off" of the LoRaWAN specification  
 1545 document.

1546

Modulation	Bandwidth [kHz]	Channel Frequency [MHz]	FSK Bitrate or LoRa DR / Bitrate	Nb Channels
LoRa	125	868.9 869.1	DR0 – DR5 / 0.3-5 kbps	2

1547

Table 77: RU864-870 JoinReq Channel List

 1548 **2.11.3 RU864-870 Data Rate and End-device Output Power encoding**

 1549 There is no dwell time limitation for the RU864-870 PHY layer. The *TxParamSetupReq*  
 1550 MAC command is not implemented in RU864-870 devices.

 1551 The following encoding is used for Data Rate (DR) and End-device EIRP (TXPower) in the  
 1552 RU864-870 band:

1553

DataRate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	LoRa: SF7 / 250 kHz	11000
7	FSK: 50 kbps	50000
8..14	RFU	
15	Defined in LoRaWAN <sup>1</sup>	

Table 78: RU864-870 TX Data rate table

1554

1555

 1556 EIRP<sup>2</sup> refers to the Equivalent Isotropically Radiated Power, which is the radiated output  
 1557 power referenced to an isotropic antenna radiating power equally in all directions and whose  
 1558 gain is expressed in dBi.

TXPower	Configuration (EIRP)
0	Max EIRP
1	Max EIRP – 2dB
2	Max EIRP – 4dB
3	Max EIRP – 6dB
4	Max EIRP – 8dB
5	Max EIRP – 10dB
6	Max EIRP – 12dB
7	Max EIRP – 14dB
8..14	RFU
15	Defined in LoRAWAN

Table 79: RU864-870 TX power table

1559

1560

1561

1562

 1563 By default MaxEIRP is considered to be +16dBm. If the end-device cannot achieve +16dBm  
 1564 EIRP, the Max EIRP SHOULD be communicated to the network server using an out-of-band  
 1565 channel during the end-device commissioning process.

1566

<sup>1</sup> DR15 and TXPower15 are defined in the LinkADRReq MAC command of the LoRaWAN1.1 specification

<sup>2</sup> ERP = EIRP – 2.15dB; it is referenced to a half-wave dipole antenna whose gain is expressed in dBd

### 1567 2.11.4 RU864-870 JoinAccept CFList

1568

1569 The RU 864-870 ISM band LoRaWAN implements an optional **channel frequency list**  
 1570 (CFList) of 16 octets in the JoinAccept message.

1571 In this case the CFList is a list of five channel frequencies for the channels two to six  
 1572 whereby each frequency is encoded as a 24 bits unsigned integer (three octets). All these  
 1573 channels are usable for DR0 to DR5 125kHz LoRa modulation. The list of frequencies is  
 1574 followed by a single CFListType octet for a total of 16 octets. The CFListType SHALL be  
 1575 equal to zero (0) to indicate that the CFList contains a list of frequencies.

1576

Size (bytes)	3	3	3	3	3	1
CFList	Freq Ch2	Freq Ch3	Freq Ch4	Freq Ch5	Freq Ch6	CFListType

1577 The actual channel frequency in Hz is 100 x frequency whereby values representing  
 1578 frequencies below 100 MHz are reserved for future use. This allows setting the frequency of  
 1579 a channel anywhere between 100 MHz to 1.67 GHz in 100 Hz steps. Unused channels have  
 1580 a frequency value of 0. The **CFList** is optional and its presence can be detected by the  
 1581 length of the join-accept message. If present, the **CFList** replaces all the previous channels  
 1582 stored in the end-device apart from the two default channels. The newly defined channels  
 1583 are immediately enabled and usable by the end-device for communication.

### 1584 2.11.5 RU864-870 LinkAdrReq command

1585 The RU864-870 LoRaWAN only supports a maximum of 16 channels. When **ChMaskCntl**  
 1586 field is 0 the ChMask field individually enables/disables each of the 16 channels.  
 1587

ChMaskCntl	ChMask applies to
0	Channels 0 to 15
1	RFU
..	..
4	RFU
5	RFU
6	All channels ON The device SHOULD enable all currently defined channels independently of the ChMask field value.
7	RFU

1588

Table 80: RU864-870 ChMaskCntl value table

1589 If the ChMaskCntl field value is one of values meaning RFU, the end-device SHOULD reject  
 1590 the command and unset the “**Channel mask ACK**” bit in its response.

### 1591 2.11.6 RU864-870 Maximum payload size

1592 The maximum **MACPayload** size length ( $M$ ) is given by the following table. It is derived from  
 1593 limitation of the PHY layer depending on the effective modulation rate used taking into  
 1594 account a possible repeater encapsulation layer. The maximum application payload length in  
 1595 the absence of the optional **FOpt** control field ( $N$ ) is also given for information only. The  
 1596 value of  $N$  might be smaller if the **FOpt** field is not empty:  
 1597

DataRate	$M$	$N$
0	59	51

1	59	51
2	59	51
3	123	115
4	230	222
5	230	222
6	230	222
7	230	222
8:15	Not defined	

1598

Table 81: RU864-870 maximum payload size

1599 If the end-device will never operate with a repeater then the maximum application payload  
 1600 length in the absence of the optional **FOpt** control field SHOULD be:

1601

DataRate	M	N
0	59	51
1	59	51
2	59	51
3	123	115
4	250	242
5	250	242
6	250	242
7	250	242
8:15	Not defined	

1602

Table 82 : RU864-870 maximum payload size (not repeater compatible)

1603 **2.11.7 RU864-870 Receive windows**

1604 The RX1 receive window uses the same channel as the preceding uplink. The data rate is a  
 1605 function of the uplink data rate and the RX1DROffset as given by the following table. The  
 1606 allowed values for RX1DROffset are in the [0:5] range. Values in the [6:7] range are  
 1607 reserved for future use.  
 1608

RX1DROffset	0	1	2	3	4	5
Upstream data rate	Downstream data rate in RX1 slot					
DR0	DR0	DR0	DR0	DR0	DR0	DR0
DR1	DR1	DR0	DR0	DR0	DR0	DR0
DR2	DR2	DR1	DR0	DR0	DR0	DR0
DR3	DR3	DR2	DR1	DR0	DR0	DR0
DR4	DR4	DR3	DR2	DR1	DR0	DR0
DR5	DR5	DR4	DR3	DR2	DR1	DR0
DR6	DR6	DR5	DR4	DR3	DR2	DR1
DR7	DR7	DR6	DR5	DR4	DR3	DR2

1609

Table 83: RU864-870 downlink RX1 data rate mapping

1610

1611 The RX2 receive window uses a fixed frequency and data rate. The default parameters are  
 1612 869.1MHz / DR0 (SF12, 125 kHz)

1613

1614 **2.11.8 RU864-870 Class B beacon and default downlink channel**

1615 The beacons SHALL be transmitted using the following settings

<b>DR</b>	3	Corresponds to SF9 spreading factor with 125 kHz BW
<b>CR</b>	1	Coding rate = 4/5

<b>Signal polarity</b>	Non-inverted	As opposed to normal downlink traffic which uses inverted signal polarity
------------------------	--------------	---------------------------------------------------------------------------

1616

Table 84: RU864-870 beacon settings

1617

1618 The beacon frame content is:

<b>Size (bytes)</b>	<b>2</b>	4	2	7	2
<b>BCNPayload</b>	<b>RFU</b>	Time	CRC	GwSpecific	CRC

1619 The beacon default broadcast frequency is 869.1 MHz.

1620 The class B default downlink pingSlot frequency is 868.9 MHz.

1621

### 1622 2.11.9 RU864-870 Default Settings

1623 The following parameters are recommended values for the RU864-870 MHz band.

1624	RECEIVE_DELAY1	1 s
1625	RECEIVE_DELAY2	2 s (MUST be RECEIVE_DELAY1 + 1s)
1626	JOIN_ACCEPT_DELAY1	5 s
1627	JOIN_ACCEPT_DELAY2	6 s
1628	MAX_FCNT_GAP	16384
1629	ADR_ACK_LIMIT	64
1630	ADR_ACK_DELAY	32
1631	ACK_TIMEOUT	2 +/- 1 s (random delay between 1 and 3 seconds)

1632 If the actual parameter values implemented in the end-device are different from those default  
 1633 values (for example the end-device uses a longer RECEIVE\_DELAY1 and  
 1634 RECEIVE\_DELAY2 latency), those parameters MUST be communicated to the network  
 1635 server using an out-of-band channel during the end-device commissioning process. The  
 1636 network server may not accept parameters different from those default values.

1637

1638

**1639 3 Revisions****1640 3.1 Revision A**

- 1641 • Initial 1.1 revision, the regional parameters were extracted from the LoRaWANv1.0.2
- 1642 revision B
- 1643 • Modified meaning of ChMaskCntl=5 for the US900 region and AU900 (TC11
- 1644 CR1274)
- 1645 • DR=15 and TXPower=15 are now reserved for all regions , meaning is defined in
- 1646 LoRaWAN1.1
- 1647 • Added Latin America draft language
- 1648 • Added Russia draft language
- 1649 • Fixed AU beacon data rate
- 1650 • General cleanup of table names, etc.

**1651 3.2 Revision B**

- 1652 • Moved to Revision B in anticipation of next release
- 1653 • First pass at standardizing regional names using standard country 2 letter
- 1654 abbreviations where applicable
- 1655 • First pass at capitalizing all normative text
- 1656 • Added statement to require LoRa devices to always act in compliance with local rules
- 1657 and regulations.
- 1658 • Added section 1.1 Conventions
- 1659 • Added Country to channel plan cross reference table
- 1660 • Updated as per LoRaWANv1.1 CR TC19.00002.000.20170614
- 1661 • Updated AS923 JoinReq data rates to reflect a range of DR2-DR5
- 1662 • Added in Region Names for use by Back-End specification as per CR
- 1663 TC19.00016.001
- 1664 • Added changes as per CR TC20 00006.001
- 1665

1666 **4 Bibliography**

1667 **4.1 References**

1668

1669 [LORAWAN] LoRaWAN Specification, V1.1, the LoRa Alliance, May 2017.



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