

## 1. LoRaWAN Regional Parameters.

The following synchronization words should be used:

| Modulation | Sync word | Preamble length |
|------------|-----------|-----------------|
| LoRa       | 0x34      | 8 symbols       |
| GFSK       | 0xC194C1  | 5 bytes         |

Table 1. Synchronization words.

## 2. 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 RU868 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             | 864.1<br>864.3<br>864.5 | DR0 to DR5/0.3-5 kbps          | 3           | < 0,1 %    |

Table 2. RU863-870 default channels.

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

RU868 MHz ISM band end-devices should use the following default parameters

- ✓ default ERP: 14 dBm.

RU868 MHz end-devices should be capable of operating in the 863 to 870 MHz frequency band and should feature a channel data structure to store the parameters

of at least 16 channels. A channel data structure corresponds to a frequency and a set of data rates usable on this frequency. The first three channels correspond to 868.1, 868.3, and 868.5 MHz/DR0 to DR5 and must be implemented in every end-device. Those default channels cannot be modified through the NewChannelReq command and guarantee a minimal common channel set between end-devices and network gateways. The following table gives the list of frequencies that should be used by end-devices to broadcast the JoinReq message. The JoinReq message transmit duty-cycle shall follow the rules described in chapter “Retransmissions back-off” of the LoRaWAN specification document.

| Modulation | Bandwidth (kHz) | Channel Frequency (MHz) | FSK Bitrate or LoRa DR/Bitrate | Nb Channels |
|------------|-----------------|-------------------------|--------------------------------|-------------|
| LoRa       | 125             | 864.1<br>864.3<br>864.5 | DR0 to DR5<br>/ 0.3-5 kbps     | 3           |

Table 3. JoinReq Channel List.

### 3. Data Rate and End-device Output Power encoding.

There is no dwell time limitation for the RU863-870 PHY layer. The TxParamSetupReq MAC command does not have to be implemented by RU863-870 devices. The following encoding is used for Data Rate (DR) and End-device Output Power (TXPower) in the RU863-870 band:

| DataRate | Configuration      | Indicative physical bit rate (bit/s) |
|----------|--------------------|--------------------------------------|
| 0        | LoRa: SF12/250 kHz | 250                                  |
| 1        | LoRa: SF11/250 kHz | 440                                  |
| 2        | LoRa: SF10/250 kHz | 980                                  |
| 3        | LoRa: SF9/250 kHz  | 1760                                 |
| 4        | LoRa: SF8/250 kHz  | 3125                                 |
| 5        | LoRa: SF7/250 kHz  | 5470                                 |
| 6        | LoRa: SF7/250 kHz  | 11000                                |
| 7        | FSK: 50 kbps       | 50000                                |
| 8...10   | RFU                |                                      |

Table 4. TX Data rate table.

| <b>TXPower</b> | <b>Configuration (ERP)</b> |
|----------------|----------------------------|
| 0              | 20 dBm                     |
| 1              | 14 dBm                     |
| 2              | 11 dBm                     |
| 3              | 8 dBm                      |
| 4              | 5 dBm                      |
| 5              | 2 dBm                      |
| 6...10         | RFU                        |

Table 5. TX power table.

## 4. JoinAccept CFList.

The RU863-870 ISM band LoRaWAN implements an optional channel frequency list (CFList) of 16 octets in the JoinAccept message. In this case the CFList is a list of five channel frequencies for the channels four to eight whereby each frequency is encoded as a 24 bits unsigned integer (three octets). All these channels are usable for DR0 to DR5 125 kHz LoRa modulation. The list of frequencies is followed by a single RFU octet for a total of 16 octets.

| <b>Size(bytes)</b> | 3        | 3        | 3        | 3        | 3        | 1   |
|--------------------|----------|----------|----------|----------|----------|-----|
| <b>CFList</b>      | Freq Ch4 | Freq Ch5 | Freq Ch6 | Freq Ch7 | Freq Ch8 | RFU |

The actual channel frequency in Hz is 100 x frequency whereby values representing frequencies below 100 MHz are reserved for future use. This allows setting the frequency of a channel anywhere between 100 MHz to 1.67 GHz in 100 Hz steps. Unused channels have a frequency value of 0. The CFList is optional and its presence can be detected by the length of the join-accept message. If present, the CFList replaces all the previous channels stored in the end-device apart from the three default channels as defined in Chapter Error! Reference source not found.. The newly defined channels are immediately enabled and usable by the end-device for communication.



### LinkAdrReq command.

The RU863-870 LoRaWAN only supports a maximum of 16 channels. When ChMaskCntl field is 0 the ChMask field individually enables/disables each of the 16 channels.

| ChMaskCntl | ChMask applies to   |
|------------|---|
| 0          | Channels 1 to 10  |
| 1          | RFU   |
| ...        | ...   |
| 4          | RFU   |
| 5          | RFU   |
| 6          | All channels ON<br>The device should enable all currently defined channels independently of the ChMask field value. |
| 7          | RFU   |

Table 6. ChMaskCntl value table.

## 6. Maximum payload size.

The maximum MACPayload size length (M) is given by the following table. It is derived from limitation of the PHY layer depending on the effective modulation rate used taking into account a possible repeater encapsulation layer. The maximum application payload length in the absence of the optional FOpt control field (N) is also given for information only. The value of N might 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        | 230 | 222 |
| 7        | 230 | 222 |

|   |             |
|---|-------------|
| 8 | Not defined |
|---|-------------|

Table 7. Maximum payload size.

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

| 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        | Not defined |     |

Table 8. Maximum payload size (not repeater compatible).

## 7. Receive windows.

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

| RX1DROffset<br>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 |
|-----|-----|-----|-----|-----|-----|-----|

The RX2 receive window uses a fixed frequency and data rate. The default parameters are  
15 869.525 MHz/DR0 (SF12, 125 kHz).

## 8. Default Settings.

The following parameters are recommended values for the RU863-870MHz band.

|                    |  |
|--------------------|--|
| RECEIVE_DELAY1     | 1 s  |
| RECEIVE_DELAY2     | 2 s (must be RECEIVE_DELAY1 + 1s)              |
| JOIN_ACCEPT_DELAY1 | 5 s  |
| JOIN_ACCEPT_DELAY2 | 6 s  |
| MAX_FCNT_GAP       | 16384  |
| ADR_ACK_LIMIT      | 64   |
| ADR_ACK_DELAY      | 32   |
| ACK_TIMEOUT        | +/- 1 s (random delay between 1 and 3 seconds) |

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