

WiMOD LoRaWAN EndNode Modem HCI Specification (RU868)

Specification Version 0.2

Document ID: 4000/40140/0130

IMST GmbH

Carl-Friedrich-Gauß-Str. 2-4
47475 KAMP-LINTFORT
GERMANY



Document Information

File name	WiMOD_LoRaWAN_EndNode_Modem_RU868_HCI_Spec.docx
Created	2017-11-10
Total pages	20

Revision History

Version	Note
0.1	Created, Initial Version Reference: WiMOD LoRaWAN EndNode Modem HCI Spec V1.20
0.2	Reference: WiMOD LoRaWAN EndNode Modem HCI Spec V1.22 Chapter 2 added for Additional Services Chapter 3.1 updated for EU 868 MHz Band Chapter 3.2 added for List of Constants

Aim of this Document

This document describes the changes of the Host Controller Interface (HCI) protocol which is part of the WiMOD LoRaWAN EndNode Modem firmware which supports the Russia band configuration. This firmware can be used in combination with the WiMOD LoRa radio module family.

Table of Contents

1. INTRODUCTION	4
1.1 Overview	4
2. ADDITIONAL FIRMWARE SERVICES	4
2.1 LoRaWAN Services	4
2.1.1 RF Sub-band Configuration	4
3. APPENDIX	7
3.1 Multi Band Support	7
3.1.1 Radio Band Indices	7
3.1.2 Europe 868 MHz Band	8
3.1.3 Europe 868 MHz (RX2: SF9) Band	9
3.1.4 Russia 868 MHz Band (1 st configuration)	10
3.1.5 Russia 868 MHz Band (2 nd configuration)	11
3.1.6 Russia 868 MHz Band (3 rd configuration)	12
3.1.7 Russia 868 MHz Band (4 th configuration)	13
3.1.8 Russia 868 MHz Band (5 th configuration)	14
3.1.9 Russia 868 MHz Band (6 th configuration)	15
3.1.10 Russia 868 MHz Band (7 th configuration)	16
3.2 List of Constants	17
3.2.1 List of Endpoint Identifier	17
3.2.2 LoRaWAN Endpoint Identifier	17
3.3 List of Abbreviations	18
3.4 List of References	18
4. REGULATORY COMPLIANCE INFORMATION	19
5. IMPORTANT NOTICE	20
5.1 Disclaimer	20
5.2 Contact Information	20

1. Introduction

1.1 Overview

This document is an extension to the WiMOD LoRaWAN EndNode Modem HCI document [1], covering the changes included in the WiMOD LoRaWAN EndNode Modem firmware supporting the Russia band configuration.

2. Additional Firmware Services

This chapter describes the message format for the additional firmware services in detail. The services are ordered according to their corresponding endpoint.

2.1 LoRaWAN Services

2.1.1 RF Sub-band Configuration

The following parameters related to the RF sub-bands can be configured via HCI:

- **Tx Power Limit**

a transmit power limit could be configured for each sub-band included in the operating ISM band. If the status flag is activated, the configured transmit power limit value will be applied, otherwise the default values will be used.

The firmware provides the following services for read-out and configuration.

Note: after a Factory Reset the RF Sub-band configuration will always be reset to its default setting (see 2.1.1.3).

2.1.1.1 Read Tx Power Limit Configuration

This message can be used to read the transmit power limit configuration parameters.

Note: this message is only available for the regions supporting different RF sub-bands definitions (see appendix).

Command Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_GET_TXPOWER_LIMIT_CONFIG_REQ	Get Tx Power Limit Configuration Request
Length	0	no payload

Response Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_GET_TXPOWER_LIMIT_CONFIG_RSP	Get Tx Power Limit Configuration Response
Length	1+3*n	1+3*n octets
Payload[0]	Status Byte	see appendix
Payload[1]	Sub-band Index 0	Sub-band Index 0 (see appendix)
Payload[2]	Tx Power Limit Flag for Sub-band Index 0	Transmit Power Limit Flag for Sub-band Index 0 0: deactivated 1: activated
Payload[3]	Tx Power Limit Value for Sub-band Index 0	Transmit Power Limit Value in EIRP for Sub-band Index 0 in dBm
Payload[1+3*n]	Sub-band Index n	Sub-band Index n (see appendix)
Payload[2+3*n]	Tx Power Limit Flag for Sub-band Index n	Transmit Power Limit Flag for Sub-band Index n 0: deactivated 1: activated
Payload[3+3*n]	Tx Power Limit Value for Sub-band Index n	Transmit Power Limit Value in EIRP for Sub-band Index n in dBm

2.1.1.2 Set Tx Power Limit Configuration

This message can be used to configure the transmit power limit configuration parameters.

Note: this parameter can only be written in "Customer Mode" (see "System Operation Modes") and this message is only available for the regions supporting different RF sub-bands definitions (see appendix).

Command Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_SET_TXPOWER_LIMIT_CONFIG_REQ	Set Tx Power Limit Configuration Request
Length	3	3 octets
Payload[0]	Sub-band Index	Sub-band Index (see appendix)
Payload[1]	Tx Power Limit Flag for Sub-band Index	Transmit Power Limit Flag for Sub-band Index 0: deactivated 1: activated
Payload[2]	Tx Power Limit Value for Sub-band Index	Transmit Power Limit Value in EIRP for Sub-band Index in dBm

Response Message

Field	Content	Description
Endpoint ID	LORAWAN_ID	Endpoint Identifier
Msg ID	LORAWAN_MSG_SET_TXPOWER_LIMIT_CONFIG_RSP	Set Tx Power Limit Configuration Response
Length	1 (+1)	1 (+1) octet
Payload[0]	Status Byte	see appendix
Payload[1]	Wrong Parameter Error Code	Bit 0: 0 = Correct Sub-band Index 1 = Wrong Sub-band Index Bit 1: not used Bit 2: 0 = Correct Tx Power Value 1 = Wrong Tx Power Value (e.g. > max. EIRP) Only sent if status byte contains LORAWAN_STATUS_WRONG_PARAMETER

2.1.1.3 Default Tx Power Limit Configuration

In the default transmit power limit configuration the flags are deactivated and the default transmit power limit values are used (see appendix).

3. Appendix

3.1 Multi Band Support

3.1.1 Radio Band Indices

Index	Band Description	Comments
1	EU 868 MHz - Europe	Default settings
30	RU 868 MHz - Russia (1 st configuration)	
31	RU 868 MHz - Russia (2 nd configuration)	
32	RU 868 MHz - Russia (3 rd configuration)	
33	RU 868 MHz - Russia (4 th configuration)	
34	RU 868 MHz - Russia (5 th configuration)	
35	RU 868 MHz - Russia (6 th configuration)	
36	RU 868 MHz - Russia (7 th configuration)	
129	EU 868 MHz - Europe (RX2: SF9)	

3.1.2 Europe 868 MHz Band

Note that this band is divided in several frequency sub-bands with different regulatory limitations (e.g. transmitted power and duty-cycle).

3.1.2.1 Data Rate Indices

Index	Data Rate / Spreading Factor	Bandwidth	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 / 50kbps		50000

3.1.2.2 Channel Indices

Index	Frequency Channel	Comments
0	868 100 000 Hz	Data Rates 0 - 5
1	868 300 000 Hz	Data Rates 0 - 5
2	868 500 000 Hz	Data Rates 0 - 5
128	869 525 000 Hz	Default Frequency for Rx2 Default Data Rate: 0

3.1.2.3 RF Sub-bands

Index	Frequencies	Duty Cycle	Default EIRP Limit	Comments
0	863 MHz to 865 MHz	0.1 %	16 dBm	Sub-band K
1	865 MHz to 868 MHz	1 %	16 dBm ¹	Sub-band L
2	868 MHz to 868.6 MHz	1 %	16 dBm	Sub-band M
3	868.7 MHz to 869.2 MHz	0.1 %	16 dBm	Sub-band N
4	869.4 MHz to 869.65 MHz	10 %	16 dBm	Sub-band P
5	869.7 MHz to 870 MHz	1 %	16 dBm	Sub-band R

¹ In some countries this value needs to be modified in order to achieve 6.2dBm/100kHz in this sub-band.

3.1.3 Europe 868 MHz (RX2: SF9) Band

This band has the same settings as the Europe 868 MHz band (described in 3.1.2), excluding the data rate used for Rx2.

Note that this band is not compliant to the LoRaWAN specification.

3.1.3.1 Data Rate Indices

Index	Data Rate / Spreading Factor	Bandwidth	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 / 50kbps		50000

3.1.3.2 Channel Indices

Index	Frequency Channel	Comments
0	868 100 000 Hz	Data Rates 0 - 5
1	868 300 000 Hz	Data Rates 0 - 5
2	868 500 000 Hz	Data Rates 0 - 5
128	869 525 000 Hz	Default Frequency for Rx2 Default Data Rate: 3

3.1.3.3 RF Sub-bands

Index	Frequencies	Duty Cycle	Default EIRP Limit	Comments
0	863 MHz to 865 MHz	0.1 %	16 dBm	Sub-band K
1	865 MHz to 868 MHz	1 %	16 dBm ¹	Sub-band L
2	868 MHz to 868.6 MHz	1 %	16 dBm	Sub-band M
3	868.7 MHz to 869.2 MHz	0.1 %	16 dBm	Sub-band N
4	869.4 MHz to 869.65 MHz	10 %	16 dBm	Sub-band P
5	869.7 MHz to 870 MHz	1 %	16 dBm	Sub-band R

¹ In some countries this value needs to be modified in order to achieve 6.2dBm/100kHz in this sub-band.

3.1.4 Russia 868 MHz Band (1st configuration)

Note that this band is divided in several frequency sub-bands with different regulatory limitations (e.g. duty-cycle).

3.1.4.1 Data Rate Indices

Index	Data Rate / Spreading Factor	Bandwidth	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 / 50kbps		50000

3.1.4.2 Channel Indices

Index	Frequency Channel	Comments
0	868 780 000 Hz	Data Rates 0 - 5
1	868 950 000 Hz	Data Rates 0 - 5
2	869 120 000 Hz	Data Rates 0 - 5
3	864 100 000 Hz	Data Rates 0 - 5
4	864 300 000 Hz	Data Rates 0 - 5
5	864 500 000 Hz	Data Rates 0 - 5
6	864 700 000 Hz	Data Rates 0 - 5
128	864 900 000 Hz	Default Frequency for Rx2 Default Data Rate: 0

Note that the first three channels (channels 0-2) are used to broadcast the Join Request message.

3.1.5 Russia 868 MHz Band (2nd configuration)

Note that this band is divided in several frequency sub-bands with different regulatory limitations (e.g. duty-cycle).

3.1.5.1 Data Rate Indices

Index	Data Rate / Spreading Factor	Bandwidth	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 / 50kbps		50000

3.1.5.2 Channel Indices

Index	Frequency Channel	Comments
0	868 900 000 Hz	Data Rates 0 - 5
1	868 700 000 Hz	Data Rates 0 - 5
128	869 100 000 Hz	Default Frequency for Rx2 Default Data Rate: 0

3.1.6 Russia 868 MHz Band (3rd configuration)

Note that this band is divided in several frequency sub-bands with different regulatory limitations (e.g. duty-cycle).

3.1.6.1 Data Rate Indices

Index	Data Rate / Spreading Factor	Bandwidth	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 / 50kbps		50000

3.1.6.2 Channel Indices

Index	Frequency Channel	Comments
0	868 780 000 Hz	Data Rates 0 - 5
1	868 950 000 Hz	Data Rates 0 - 5
128	869 120 000 Hz	Default Frequency for Rx2 Default Data Rate: 0

3.1.7 Russia 868 MHz Band (4th configuration)

Note that this band is divided in several frequency sub-bands with different regulatory limitations (e.g. duty-cycle).

3.1.7.1 Data Rate Indices

Index	Data Rate / Spreading Factor	Bandwidth	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 / 50kbps		50000

3.1.7.2 Channel Indices

Index	Frequency Channel	Comments
0	864 100 000 Hz	Data Rates 0 - 5
1	864 300 000 Hz	Data Rates 0 - 5
2	864 500 000 Hz	Data Rates 0 - 5
3	864 640 000 Hz	Data Rates 0 - 5
4	864 780 000 Hz	Data Rates 0 - 5
5	868 780 000 Hz	Data Rates 0 - 5
6	868 950 000 Hz	Data Rates 0 - 5
7	869 120 000 Hz	Data Rates 0 - 5
128	864 920 000 Hz	Default Frequency for Rx2 Default Data Rate: 0

3.1.8 Russia 868 MHz Band (5th configuration)

Note that this band is divided in several frequency sub-bands with different regulatory limitations (e.g. duty-cycle).

3.1.8.1 Data Rate Indices

Index	Data Rate / Spreading Factor	Bandwidth	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 / 50kbps		50000

3.1.8.2 Channel Indices

Index	Frequency Channel	Comments
0	864 500 000 Hz	Data Rates 0 - 5
1	864 700 000 Hz	Data Rates 0 - 5
2	864 900 000 Hz	Data Rates 0 - 5
3	864 100 000 Hz	Data Rates 0 - 5
4	864 300 000 Hz	Data Rates 0 - 5
5	868 800 000 Hz	Data Rates 0 - 5
128	869 050 000 Hz	Default Frequency for Rx2 Default Data Rate: 0

3.1.9 Russia 868 MHz Band (6th configuration)

Note that this band is divided in several frequency sub-bands with different regulatory limitations (e.g. duty-cycle).

3.1.9.1 Data Rate Indices

Index	Data Rate / Spreading Factor	Bandwidth	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 / 50kbps		50000

3.1.9.2 Channel Indices

Index	Frequency Channel	Comments
0	868 900 000 Hz	Data Rates 0 - 5
1	869 100 000 Hz	Data Rates 0 - 5
2	864 100 000 Hz	Data Rates 0 - 5
3	864 300 000 Hz	Data Rates 0 - 5
4	864 500 000 Hz	Data Rates 0 - 5
5	864 700 000 Hz	Data Rates 0 - 5
6	864 900 000 Hz	Data Rates 0 - 5
128	869 100 000 Hz	Default Frequency for Rx2 Default Data Rate: 0

Note that the first two channels (channels 0-1) are used to broadcast the Join Request message.

3.1.10 Russia 868 MHz Band (7th configuration)

Note that this band is divided in several frequency sub-bands with different regulatory limitations (e.g. duty-cycle).

3.1.10.1 Data Rate Indices

Index	Data Rate / Spreading Factor	Bandwidth	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 / 50kbps		50000

3.1.10.2 Channel Indices

Index	Frequency Channel	Comments
0	868 900 000 Hz	Data Rates 0 - 5
1	869 100 000 Hz	Data Rates 0 - 5
128	869 100 000 Hz	Default Frequency for Rx2 Default Data Rate: 0

3.2 List of Constants

3.2.1 List of Endpoint Identifier

Name	Value
LORAWAN_ID	0x10

3.2.2 LoRaWAN Endpoint Identifier

3.2.2.1 LoRaWAN Endpoint Message Identifier

Name	Value
LORAWAN_MSG_SET_TXPOWER_LIMIT_CONFIG_REQ	0x37
LORAWAN_MSG_SET_TXPOWER_LIMIT_CONFIG_RSP	0x38
LORAWAN_MSG_GET_TXPOWER_LIMIT_CONFIG_REQ	0x39
LORAWAN_MSG_GET_TXPOWER_LIMIT_CONFIG_RSP	0x3A

3.2.2.2 LoRaWAN Endpoint Status Byte

Name	Value	Description
LORAWAN_STATUS_OK	0x00	Operation successful
LORAWAN_STATUS_ERROR	0x01	Operation failed
LORAWAN_STATUS_CMD_NOT_SUPPORTED	0x02	Command is not supported
LORAWAN_STATUS_WRONG_PARAMETER	0x03	HCI message contains wrong parameter
LORAWAN_STATUS_WRONG_DEVICE_MODE	0x04	Stack is running in a wrong mode
LORAWAN_STATUS_DEVICE_NOT_ACTIVATED	0x05	Device is not activated
LORAWAN_STATUS_DEVICE_BUSY	0x06	Device is busy, command rejected
LORAWAN_STATUS_QUEUE_FULL	0x07	Message queue is full, command rejected
LORAWAN_STATUS_LENGTH_ERROR	0x08	HCI message length is invalid or radio payload size is too large
LORAWAN_STATUS_NO_FACTORY_SETTINGS	0x09	Factory Settings EEPROM block missing
LORAWAN_STATUS_CHANNEL_BLOCKED	0x0A	Channel blocked by Duty Cycle
LORAWAN_STATUS_CHANNEL_NOT_AVAILABLE	0x0B	No channel available (e.g. no channel defined for the configured spreading factor)

3.3 List of Abbreviations

FW	Firmware
HCI	Host Controller Interface
LR	Long Range
LoRa	Long Range
RAM	Random Access Memory
RF	Radio Frequency
RSSI	Received Signal Strength Indicator
RTC	Real Time Clock
SLIP	Serial Line Internet Protocol
SNR	Signal to Noise Ratio
UART	Universal Asynchronous Receiver/Transmitter
WiMOD	Wireless Module by IMST

3.4 List of References

[1] WiMOD_LoRaWAN_EndNode_Modem_HCI_Spec.pdf.

4. Regulatory Compliance Information

The use of radio frequencies is limited by national regulations. The radio module has been designed to comply with the European Union's R&TTE (Radio & Telecommunications Terminal Equipment) directive 1999/5/EC and can be used free of charge within the European Union. Nevertheless, restrictions in terms of maximum allowed RF power or duty cycle may apply.

The radio module has been designed to be embedded into other products (referred as "final products"). According to the R&TTE directive, the declaration of compliance with essential requirements of the R&TTE directive is within the responsibility of the manufacturer of the final product. A declaration of conformity for the radio module is available from IMST GmbH on request.

The applicable regulation requirements are subject to change. IMST GmbH does not take any responsibility for the correctness and accuracy of the aforementioned information. National laws and regulations, as well as their interpretation can vary with the country. In case of uncertainty, it is recommended to contact either IMST's accredited Test Center or to consult the local authorities of the relevant countries.

5. Important Notice

5.1 Disclaimer

IMST GmbH points out that all information in this document is given on an “as is” basis. No guarantee, neither explicit nor implicit is given for the correctness at the time of publication. IMST GmbH reserves all rights to make corrections, modifications, enhancements, and other changes to its products and services at any time and to discontinue any product or service without prior notice. It is recommended for customers to refer to the latest relevant information before placing orders and to verify that such information is current and complete. All products are sold and delivered subject to “General Terms and Conditions” of IMST GmbH, supplied at the time of order acknowledgment.

IMST GmbH assumes no liability for the use of its products and does not grant any licenses for its patent rights or for any other of its intellectual property rights or third-party rights. It is the customer’s duty to bear responsibility for compliance of systems or units in which products from IMST GmbH are integrated with applicable legal regulations. Customers should provide adequate design and operating safeguards to minimize the risks associated with customer products and applications. The products are not approved for use in life supporting systems or other systems whose malfunction could result in personal injury to the user. Customers using the products within such applications do so at their own risk.

Any reproduction of information in datasheets of IMST GmbH is permissible only if reproduction is without alteration and is accompanied by all given associated warranties, conditions, limitations, and notices. Any resale of IMST GmbH products or services with statements different from or beyond the parameters stated by IMST GmbH for that product/solution or service is not allowed and voids all express and any implied warranties. The limitations on liability in favor of IMST GmbH shall also affect its employees, executive personnel and bodies in the same way. IMST GmbH is not responsible or liable for any such wrong statements.

Copyright © 2018, IMST GmbH

5.2 Contact Information

IMST GmbH

Carl-Friedrich-Gauss-Str. 2-4
47475 Kamp-Lintfort
Germany

T +49 2842 981 0

F +49 2842 981 299

E wimod@imst.de

I www.wireless-solutions.de