WiMOD LoRaWAN EndNode Modem HCI Specification (EU868)

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IMST GmbH

Carl-Friedrich-Gauß-Str. 2-4

47475 KAMP-LINTFORT

GERMANY

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Version	Note
0.1	Created, Initial Version
	Reference: WiMOD LoRaWAN EndNode Modem HCI Spec V1.22
0.2	Chapter 4 updated

Aim of this Document

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

Table of Contents

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 for EU 863-870 MHz ISM Band.

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 setting
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

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[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
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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
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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

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

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 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.

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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