

# **ProLink LoRaWAN EndNode Modem HCI Specification - Migration Guide iM891A-XL**

**Version 1.0**

**Document ID:** 4000/40140/0194

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## Document Information

File name	ProLink_LoRaWAN_EndNode_Modem_HCI_Spec_Migration_Guide_iM891A-XL.docx
Created	2024-09-05
Total pages	19

## Revision History

Version	Note
1.0	Created, initial version Valid from firmware V1.0, Build Count 41

## Aim of this Document

This document describes the additional changes of the PoLink LoRaWAN® EndNode Modem Host Controller Interface (HCI) protocol required for the iM891A-XL/iU891A-XL support. This firmware can be used in combination with both radio units.



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# 1. Introduction

## 1.1 Overview

This document is an extension to the ProLink LoRaWAN EndNode Modem HCI document [1], covering the additional services and changes included in the firmware version supported by the iM891A-XL and iU891A-XL.

## 1.2 Change Summary

This chapter contains an overview of the modified HCI messages:

HCI Message Identifier	Change
DEVMGMT_MSG_GET_DEVICE_INFO_RSP	"Device Information Field" updated (see 3.1.1.2)
DEVMGMT_MSG_SET_RTC_ALARM_REQ	Unsupported
DEVMGMT_MSG_CLEAR_RTC_ALARM_REQ	Unsupported
DEVMGMT_MSG_GET_RTC_ALARM_REQ	Unsupported
DEVMGMT_MSG_RTC_ALARM_IND	Unsupported
DEVMGMT_MSG_SET_HCI_CFG_REQ	Unsupported
DEVMGMT_MSG_GET_HCI_CFG_REQ	Unsupported
RADIOLINK_MSG_SET_RADIO_CONFIG_REQ	Identifier changed (see 4.1.3.1) "Radio Configuration Field" updated (see 3.3.1.3)
RADIOLINK_MSG_SET_RADIO_CONFIG_RSP	Identifier changed (see 4.1.3.1) "Radio Configuration Field" updated (see 3.3.1.3)
RADIOLINK_MSG_GET_RADIO_CONFIG_REQ	Identifier changed (see 4.1.3.1) "Radio Configuration Field" updated (see 3.3.1.3)
RADIOLINK_MSG_GET_RADIO_CONFIG_RSP	Identifier changed (see 4.1.3.1) "Radio Configuration Field" updated (see 3.3.1.3)
RADIOLINK_MSG_RESET_RADIO_CONFIG_REQ	Identifier changed (see 4.1.3.1)
RADIOLINK_MSG_RESET_RADIO_CONFIG_RSP	Identifier changed (see 4.1.3.1)
LORAWAN_MSG_SEND_MAC_CMD_REQ	Unsupported (see 3.2)
LORAWAN_MSG_SET_BATTERY_LEVEL_REQ	Unsupported (see 3.2)



## 2. Functional Description

### 2.1.1 Automatic Power Saving

In case the Automatic Power Saving is enabled, the end-device will enter low power mode whenever possible and the current consumption will be reduced to a typical low power current depending on the given hardware module.

As an improvement of this firmware, if the LoRaWAN® stack is selected, the end-device will enter low power mode even between the transmissions and the reception windows.

The following picture shows an example of a current graph measured with a Keithley DMM7510 7 1/2 DIGIT MULTIMETER on an iM891A-XL module, including a LoRaWAN® Join Request transmission in SF9BW125 and both reception windows.

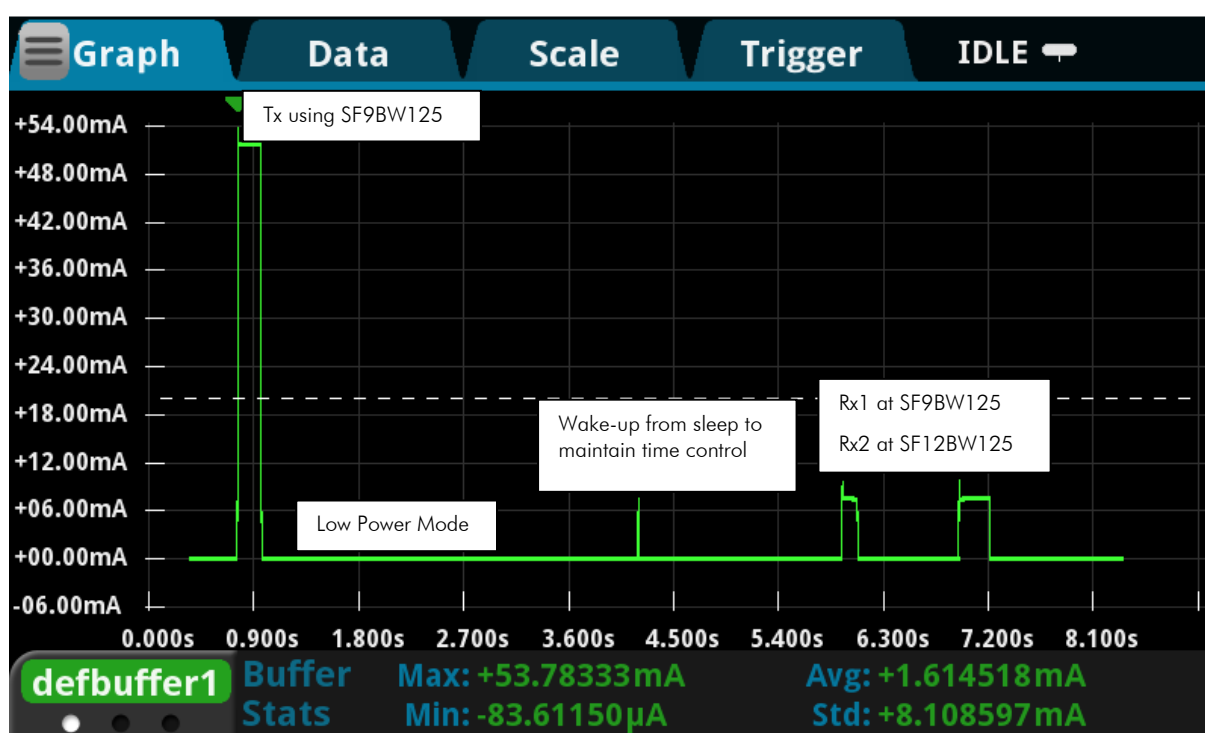


Fig. 2-1: Exemplary current consumption diagram – iM891A-XL

## 3. Additional/modified Firmware Services

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

### 3.1 Device Management Services

The Device Management endpoint provides general services for module configuration, module identification, and everything which is not related to the data exchange via radio link.

Following services are not supported:

- RTC Alarm Support
- Device HCI Settings

#### 3.1.1 Device Information

The radio firmware provides a service to readout some information elements for identification purposes.

##### 3.1.1.1 Get Device Information

This message can be used to identify the local connected device. As a result the device sends a response message which contains a Device Information Field.

##### Command Message

Field	Content	Description
Endpoint ID	DEVMGMT_ID	Endpoint Identifier
Msg ID	DEVMGMT_MSG_GET_DEVICE_INFO_REQ	Get Device Info Request
Length	0	no payload

##### Response Message

The response message contains the requested Device Information Field.

Field	Content	Description
Endpoint ID	DEVMGMT_ID	Endpoint Identifier
Msg ID	DEVMGMT_MSG_GET_DEVICE_INFO_RSP	Get Device Info Response
Length	10	10 octets
Payload[0]	Status Byte	see appendix (4.1.2.2)
Payload[1..9]	Device Information Field	see below



### 3.1.1.2 Device Information Field

The Device Information Field contains the following elements:

Offset	Size	Name	Description
0	1	ModuleType	Radio Module Identifier 0x6D = iM891A-XL 0x6E = iU891A-XL
1	4	Reserved	Reserved
5	4	Device ID	32-Bit Device ID for identification purpose

## 3.2 LoRaWAN® Radio Link Services

The LoRaWAN® Service Access Point provides several services for radio communication according to the LoRaWAN® specification.

Following services are not supported:

- **Battery Level Status:** The firmware will send the battery level status set to 0xFF (undefined) in the reply to the DevStatusReq MAC command requested by the LoRaWAN® server.
- **Send MAC Command:** Any MAC command initiated by the end-device can be sent as a data transmission using Port 0. For this the available HCI messages (LORAWAN\_MSG\_SEND\_UDATA\_REQ / LORAWAN\_MSG\_SEND\_CDATA\_REQ) can be used.



### 3.3 Proprietary LoRa® Link Services

The Proprietary LoRa® Link Service Access Point provides functions for configuration and transmission and reception of radio link messages. These services apply only to the proprietary stack.

The radio firmware part operates in Standard Mode, including support for unreliable radio message exchange with address filtering.

#### 3.3.1 Radio Configuration

The radio firmware supports several configurable parameters which are stored in the non-volatile flash memory. The following items can be configured:

Item	Description
Radio Mode	Determines the radio module operation. Limited to <b>Standard</b> mode.
Group Address	Used to separate groups of radio modules. This value is compared against the <b>TxGroupAddress</b> field of a received radio message to filter radio packets in <b>Standard</b> mode (0xFF = BROADCAST address).
Device Address	Used to address a specific radio device. This value is compared against the <b>TxDeviceAddress</b> field of a received radio message to filter radio packets in <b>Standard</b> mode (0xFFFF = BROADCAST address).
Modulation	0 = LoRa®, 1 = FSK
RF Carrier Frequency	Defines the used radio frequency.
LoRa® Signal Bandwidth	Defines the LoRa® signal bandwidth 0 = 125 kHz, 1 = 250 kHz, 2 = 500 kHz, 3 = 7.8 kHz, 4 = 10.4 kHz, 5 = 15.6 kHz, 6 = 20.8 kHz, 7 = 31.25 kHz, 8 = 41.7 kHz, 9 = 62.5 kHz
LoRa® Spreading Factor	Defines the LoRa® spreading factor 7 = SF7, 8 = SF8, 9 = SF9, 10 = SF10, 11 = SF11, 12 = SF12
FSK Datarate	Determines the datarate if FSK modulation is enabled 0 = 50000bps
Error Coding	Defines the radio error coding format 0 = 4/5, 1 = 4/5, 2 = 4/6, 3 = 4/7, 4 = 4/8
Power Level (ERP)	Defines the transmit power level from 5 dBm to 20 dBm: 0 – 5 = 5 dBm, 6 = 6 dBm, ..., 20 = 20 dBm
Rx Control	Receiver Control Option: 0 = Receiver off 1 = Receiver always on (except during packet transmission) 2 = Receiver on for limited time defined by Rx Window parameter
Rx Window Time	Configurable time for radio receive mode after radio packet transmission. Note: Rx Window option must be enabled in the <b>Rx Control</b> parameter. A value of zero (0) disables the receive mode.





Misc. Options	<p>Bit field to configure further radio firmware options:</p> <p>Bit 0: 0 = standard RF packet output format 1 = extended RF packet output format: attached RSSI, SNR and Timestamp</p> <p>Bit 2: HCI Tx Indication - this message is sent to the host after an RF message was sent over the air. 0 = disabled 1 = enabled</p> <p>Bit 5: 0 = AES Encryption/Decryption off 1 = AES Encryption/Decryption on</p>
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### 3.3.1.1 Get Radio Configuration

This message can be used to read the configuration parameters.

#### Command Message

Field	Content	Description
Endpoint ID	RADIOLINK_ID	Endpoint Identifier
Msg ID	RADIOLINK_MSG_GET_RADIO_CONFIG_REQ	Get Radio Configuration Request
Length	0	no payload

#### Response Message

The response message contains the current radio configuration. The Radio Configuration Field is described in more detail below.

Field	Content	Description
Endpoint ID	RADIOLINK_ID	Endpoint Identifier
Msg ID	RADIOLINK_MSG_GET_RADIO_CONFIG_RSP	Get Radio Configuration Response
Length	19	19 octets
Payload[0]	Status Byte	see appendix (4.1.3.2)
Payload[1..18]	Radio Configuration Field	see Radio Configuration Field



### 3.3.1.2 Set Radio Configuration

This function can be used to change several radio parameters. The function allows to change parameter directly and to save them optionally in the non-volatile flash memory.

#### Command Message

Field	Content	Description
Endpoint ID	RADIOLINK_ID	Endpoint Identifier
Msg ID	RADIOLINK_MSG_SET_RADIO_CONFIG_REQ	Set Radio Configuration Request
Length	19	19 octets
Payload[0]	Store NVM Flag 0x00 : change configuration only temporary (RAM) 0x01 : save configuration also in NVM	non-volatile memory flag
Payload[1..18]	Radio Configuration Field	see Radio Configuration Field

#### Response Message

This message acknowledges the Set Radio Configuration Request message.

Field	Content	Description
Endpoint ID	RADIOLINK_ID	Endpoint Identifier
Msg ID	RADIOLINK_MSG_SET_RADIO_CONFIG_RSP	Get Radio Configuration Response
Length	1	1 octet
Payload[0]	Status Byte	see appendix (4.1.3.2)

### 3.3.1.3 Radio Configuration Field

The Radio Configuration Field contains the following configurable radio parameters:

Offset	Size	Name	Description
0	1	Radio Mode	0x00 = Standard mode: Device & Group address used for packet filtering
1	1	Group Address	Own group address (0x01 – 0xFE) for packet filtering (0xFF reserved as BROADCAST address)
2	2	Device Address	Own device address (0x0001 – 0xFFFE) for packet filtering (0xFFFF reserved as BROADCAST address)
4	4	RF Carrier Frequency	Defines the used radio frequency.
8	1	Modulation	0 = LoRa <sup>®</sup> , 1 = FSK (50000 bps)  <i>Note: refer to the corresponding regional HCl specification, [4] for the allowed configuration.</i>



9	1	LoRa <sup>®</sup> Spreading Factor	7 = SF7 8 = SF8 9 = SF9 10 = SF10 11 = SF11 12 = SF12  <i>Note: refer to chapter 3 for the allowed configuration.</i>
10	1	LoRa <sup>®</sup> Signal Bandwidth	0 = 125 kHz 1 = 250 kHz 2 = 500 kHz 3 = 7.8 kHz 4 = 10.4 kHz 5 = 15.6 kHz 6 = 20.8 kHz 7 = 31.25 kHz 8 = 41.7 kHz 9 = 62.5 kHz  <i>Note: refer to the corresponding regional HCl specification, [4] for the allowed configuration.</i>
11	1	Error Coding	0 = 4/5 1 = 4/5 2 = 4/6 3 = 4/7 4 = 4/8
12	1	FSK Datarate	0 = 50000 bps  <i>Note: refer to the corresponding regional HCl specification, [4] for the allowed configuration.</i>
13	1	Power Level	0 – 5 = 5 dBm 6 = 6 dBm 7 = 7 dBm  ... 20 = 20 dBm
14	1	Rx Control	Receiver Control Option: 0 = Receiver off 1 = Receiver always on (except during packet transmission) 2 = Receiver on for limited time defined by Rx Window parameter
15	2	Rx Window Time	0 = receiver disabled, no Rx Window 1 – 65535 = 1 - 65535 ms
17	1	Misc. Options	Bit 0: 0 = standard RF packet output format 1 = extended RF packet output format: attached RSSI, SNR and Timestamp  Bit 2: 0 = HCl Tx Indication disabled 1 = HCl Tx Indication enabled  Bit 5: 0 = AES Encryption/Decryption off 1 = AES Encryption/Decryption on



### 3.3.1.4 Reset Radio Configuration

This message can be used to restore the default radio settings.

#### Command Message

Field	Content	Description
Endpoint ID	RADIOLINK_ID	Endpoint Identifier
Msg ID	RADIOLINK_MSG_RESET_RADIO_CONFIG_REQ	Reset Radio Config Request
Length	0	no payload

#### Response Message

This message acknowledges the Reset Radio Configuration Request message.

Field	Content	Description
Endpoint ID	RADIOLINK_ID	Endpoint Identifier
Msg ID	RADIOLINK_MSG_RESET_RADIO_CONFIG_RSP	Reset Radio Config Response
Length	1	1 octet
Payload[0]	Status Byte	see appendix (4.1.3.2)



### 3.3.1.5 Default Configuration

The following table lists the default configuration for some parameters (refer to the corresponding regional HCI specification, [4] for the specific default parameters for each region).

Parameter	Value EU868	Value US915	Value AU915
Radio Mode	0 = Standard Mode		
Group Address	0x10		
Device Address	0x1234		
Rx Control	1 = Rx always on		
Rx Window Time	3 s		
Misc. Options	0x01: - extended RF packet output format enabled - HCI Tx Indication disabled - AES Encryption/Decryption off		



## 4. Appendix

### 4.1 List of Constants

#### 4.1.1 List of Endpoint Identifier

Name	Value
DEVMGMT_ID	0x01
RADIOLINK_ID	0x03
LORAWAN_ID	0x10

#### 4.1.2 Device Management Endpoint Identifier

##### 4.1.2.1 Device Management Endpoint Message Identifier

Name	Value
DEVMGMT_MSG_GET_DEVICE_INFO_REQ	0x03
DEVMGMT_MSG_GET_DEVICE_INFO_RSP	0x04
DEVMGMT_MSG_SET_RTC_ALARM_REQ	0x31
DEVMGMT_MSG_SET_RTC_ALARM_RSP	0x32
DEVMGMT_MSG_CLEAR_RTC_ALARM_REQ	0x33
DEVMGMT_MSG_CLEAR_RTC_ALARM_RSP	0x34
DEVMGMT_MSG_GET_RTC_ALARM_REQ	0x35
DEVMGMT_MSG_GET_RTC_ALARM_RSP	0x36
DEVMGMT_MSG_RTC_ALARM_IND	0x38
DEVMGMT_MSG_SET_HCI_CFG_REQ	0x41
DEVMGMT_MSG_SET_HCI_CFG_RSP	0x42
DEVMGMT_MSG_GET_HCI_CFG_REQ	0x43
DEVMGMT_MSG_GET_HCI_CFG_RSP	0x44

##### 4.1.2.2 Device Management Endpoint Status Byte

Name	Value	Description
DEVMGMT_STATUS_OK	0x00	Operation successful
DEVMGMT_STATUS_ERROR	0x01	Operation failed
DEVMGMT_STATUS_CMD_NOT_SUPPORTED	0x02	Command is not supported
DEVMGMT_STATUS_WRONG_PARAMETER	0x03	HCI message contains wrong parameter



### 4.1.3 Radio Link Endpoint Identifier

#### 4.1.3.1 Radio Link Endpoint Message Identifier

Name	Value
RADIOLINK_MSG_SEND_U_DATA_REQ	0x01
RADIOLINK_MSG_SEND_U_DATA_RSP	0x02
RADIOLINK_MSG_U_DATA_RX_IND	0x04
RADIOLINK_MSG_U_DATA_TX_IND	0x06
RADIOLINK_MSG_SET_RADIO_CONFIG_REQ	0x31
RADIOLINK_MSG_SET_RADIO_CONFIG_RSP	0x32
RADIOLINK_MSG_GET_RADIO_CONFIG_REQ	0x33
RADIOLINK_MSG_GET_RADIO_CONFIG_RSP	0x34
RADIOLINK_MSG_RESET_RADIO_CONFIG_REQ	0x35
RADIOLINK_MSG_RESET_RADIO_CONFIG_RSP	0x36
RADIOLINK_MSG_SET_AES_KEY_REQ	0x21
RADIOLINK_MSG_SET_AES_KEY_RSP	0x22
RADIOLINK_MSG_GET_AES_KEY_REQ	0x23
RADIOLINK_MSG_GET_AES_KEY_RSP	0x24

#### 4.1.3.2 Radio Link Endpoint Status Byte

Name	Value	Description
RADIOLINK_STATUS_OK	0x00	Operation successful
RADIOLINK_STATUS_ERROR	0x01	Operation failed
RADIOLINK_STATUS_CMD_NOT_SUPPORTEDED	0x02	Command is not supported (check system operation mode)
RADIOLINK_STATUS_WRONG_PARAMETER	0x03	HCI message contains wrong parameter
RADIOLINK_STATUS_WRONG_RADIO_MODE	0x04	Module operates in wrong radio mode
RADIOLINK_STATUS_BUFFER_FULL	0x07	No buffer for radio transmission available
RADIOLINK_STATUS_LENGTH_ERROR	0x08	Radio packet length invalid



## 4.1.4 LoRaWAN® Endpoint Identifier

### 4.1.4.1 LoRaWAN® Endpoint Message Identifier

Name	Value
LORAWAN_MSG_SEND_MAC_CMD_REQ	0x2B
LORAWAN_MSG_SEND_MAC_CMD_RSP	0x2C
LORAWAN_MSG_SET_BATTERY_LEVEL_REQ	0x2E
LORAWAN_MSG_SET_BATTERY_LEVEL_RSP	0x2F





## 4.2 List of References

[1] ProLink\_LoRaWAN\_EndNode\_Modem\_HCI\_Spec.pdf.



## 5. 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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