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iOKE868 LoRaWAN®

AN035 - Radio Protocol

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History

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Aim of this document

This document outlines the radio protocol including the application message formats which are supported by iOKE868 LoRaWAN.

Notation Info

Suffix "b" = binary data

Suffix "h" = hexadecimal data

Without suffix = decimal data

Multi byte / octet fields are considered to be treated as unsigned integers with **L**east **S**ignificant **B**yte first unless explicitly noted

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Introduction

The iOKE868 LoRaWAN® includes an optical meter readout unit iO881A which is able to transmit sampled meter data to a LoRaWAN® network.

The following chapters explain the implemented Application Protocol and Tiny Transport Protocol which is used above the LoRaWAN® Protocol.

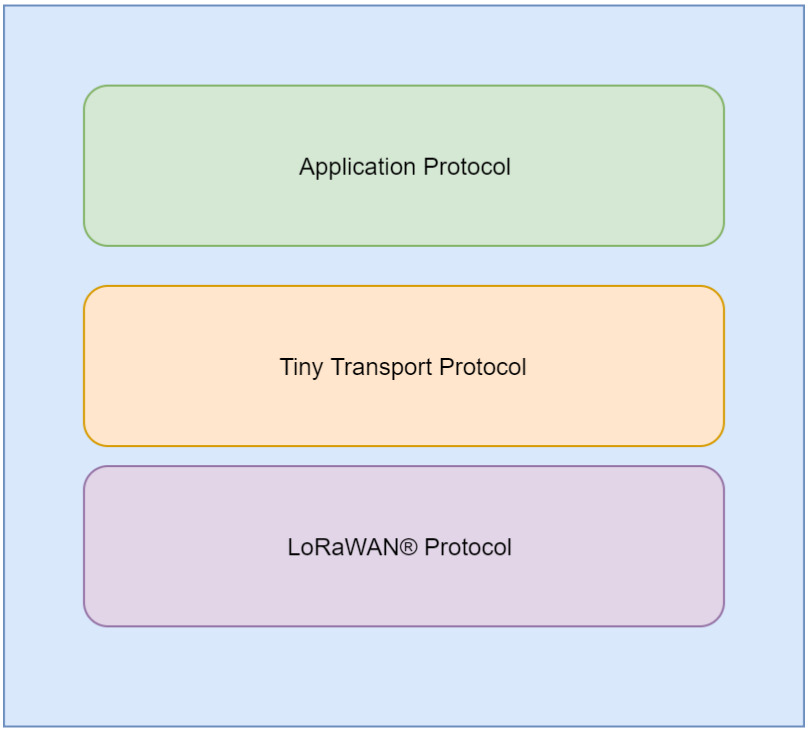

Figure : Radio Protocol Stack

LoRaWAN Protocol®

Activation

The LoRaWAN Protocol® offers two types of activation which need to be performed before any application data exchange with a network server can be started. Both versions OTAA (Over The Air Activation) and ABP (Activation by Personalization) are supported and can be configured with the required parameters.

Time Synchronization

The implemented LoRaWAN® Stack is compliant to LoRaWAN version 1.0.2 and extends the defined functionality with some features of version 1.0.3. One featue is the network time synchronization which is implemented by means of a specific LoRaWAN MAC command. Network time synchronization is done automatically after activation and every device restart. Due to the fact that LoRaWAN server based on protocol version 1.0.2 do not support the newer LoRaWAN MAC command a fallback mechanism is supported by means of an proprietary application command. The current time synchroniation state is signaled in the iO881A system status which can be uploaded to the network server.

Confirmed Data Upload

Uploading of any application data uses the confirmed data exchange service i.e. a single radio packet have to be acknowledged from a LoRaWAN network server before a next packet can be sent.

Upload of Application Data

The reliable upload of application data like captured meter data or firmware status is implemented by means of confirmed LoRaWAN® uplink packets and a simple segmentation protocol with minimal overhead of one single byte. In case of insufficient LoRaWAN® payload capacity the meter readout results will be transmitted by means of multiple LoRaWAN® packets. Note: Application data which will fit into a single LoRaWAN packet is transmitted without the transport protocol header. The given LoRaWAN Port indicates if the current LoRaWAN packet contains segmented or unsegmented data.

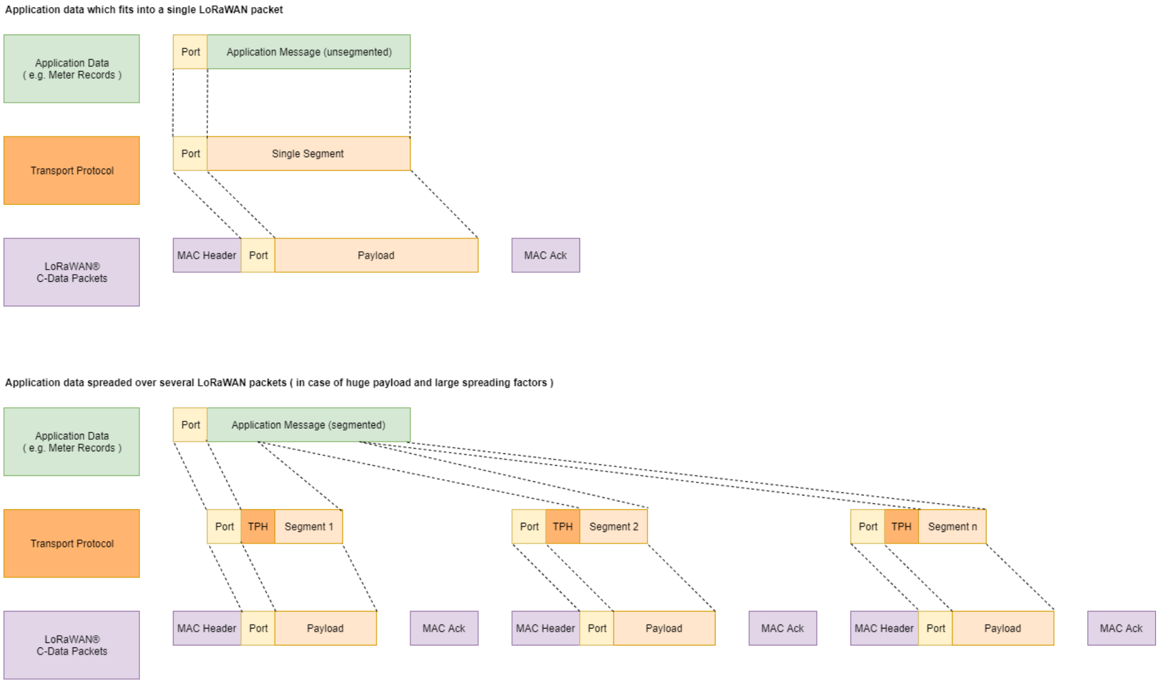

Figure : Unsegmented and segmented application data upload

Transport Protocol Details

The transport protocol is used in uplink- and downlink direction on several LoRaWAN® ports which indicate the type of message content. The protocol uses a single octet header field with following format:

TP Header	
Bit 7	Bit 6 ... Bit 0
Last Segment	Segment Number 0 .. 127

Figure : Transport Protocol Header

- Last Segment Indicator (Bit 7)
  This bit indicates the last segment of a transmission if set to "1".
- Segment Number (Bit 0 .. 6)
  The segment number starts at zero for every new transmission and will be incremented by "1" for every new segment. On receiver side it might happen that duplicated segment numbers will appear. In this case the receiver should simply ignore the duplicate segments. The segment number can wrap around from 127 to 0 in case of very large transmissions and tiny segments.

The following figure outlines a transmission consisting of four different segments and one re-transmitted segment.

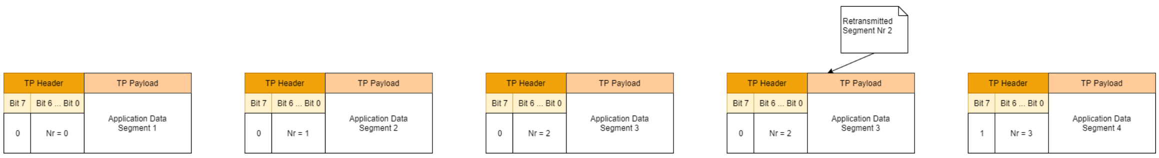

Figure : Example transmission sequence with four segments and one retransmission

Application Messages and LoRaWAN® Ports

The LoRaWAN® Protocol supports port numbers which are used within this application to identify different kind of messages. Please note that the same application message type can be transmitted either unsegmented or segmented, depending on the current LoRaWAN payload capacity.

The following ports are used for unsegmented messages:

LoRaWAN® Port	Message Type
03_h	Status Message
05_h	Meter Data Message
32_h	Time Synchronization

The following ports are used for segmented messages:

LoRaWAN® Port	Message Type
43_h	Status Message
45_h	Meter Data Message

Implemented Application Messages

- Status Message
- Meter Data Message
- Time Synchronization Message

Status Message

The iO881A maintains some status information elements which can be transmitted over LoRaWAN® or requested via local serial interface. The transmission can be initiated by means of a calendar event.

Status Message								
System Time	Firmware Version		Last Sync	Status		Meter Data Packet Counter		
UTC Format LSB first	Minor Version	Major Version	UTC Format LSB first	Reset Counter LSB first	Status Bits	Correct received Meter Files LSB first	Incorrect received Meter Files LSB first	Uploaded Meter Data Messages LSB first
32 Bit	8 Bit	8 Bit	32 Bit	32 Bit	16 Bit	32 Bit	32 Bit	32 Bit

Figure : iO881A Status Message Format

The iO881A Status Message consists of the following elements:

- iO881A System Time (from embedded RTC)
- Firmware Version
- Time of last Synchronization
- Reset Counter
- Status / Error Bits
  - Bit 0: LoRaWAN® Activation State
    1 = LoRaWAN® Stack is not activated
    0 = Stack is activated

  - Bit 1: Network Time Synchronization State
    1 = No synchronization via LoRaWAN®
    0 = Synchronized via LoRaWAN®

  - Bit 2: System Time Synchronization State
    1 = RTC not synchronized at all
    0 = RTC synchronized (via local serial interface or LoRaWAN®)

  - Bit 3: Over The Air Activation Procedure State
    1 = OTAA procedure active
    0 = OTAA procedure not active

  - Bit 4: LoRaWAN Configuration State
    1 = Configuration is invalid Activation not possible
    0 = Configuration is valid

  - Bit 5: Reserved

  - Bit 6: Calendar Event List Configuration State
    1 = List is empty in this case a default "Get Network Time" event is scheduled every hour at 05:00min for RTC synchronization
    0 = List contains at least one item

  - Bit 7: OBIS ID Filter List Configuration State
    1 = List is empty
    0 = List contains at least one filter item

- Reader Counters
  - Number of correctly received meter files
  - Number of faulty received meter files with read / CRC errors
  - Number of uploaded meter data messages
    Note: These counters can be reseted via local serial interface

Meter Data Message

The following figure outlines the Meter Data Message format in more detail:

Note: The presence of optional fields like Status Field, Time Field or Meter ID Field is configurable!

Meter Data Message					
Status Field (optional)	Time Field (optional)	Meter ID Field (optional)	Meter Object Field #1	...	Meter Object Field #n
4 Byte	6 Byte	3 - 18 Bytes	6 - 59 Byte	...	6 - 59 Byte

Figure : Meter Data Message Format

Format Description of Message Fields

- Meter Data Message - General Message Field Format
- Meter Data Message - Status Field
- Meter Data Message - Time Field
- Meter Data Message - Meter ID Field
- Meter Data Message - Meter Object Field with Number and Unit
- Meter Data Message - Meter Object Field with Number only (no Unit)
- Meter Data Message - Meter Object Field with String
- Meter Data Message - OBIS-ID Field

Meter Data Message - General Message Field Format

All defined message fields have the following common format:

General Message Field Format		
Type Field	Length Field	Data Field
1 Byte	1 Byte	1 - 57 Bytes

Figure: General Message Field Format

Every Message Field consist of three sub fields: Type Field, Length Field and Data Field

Type Field

The Type Field defines the type of data which is included in the data field.

Type	Message Field
00h	Status Field
01h	Time Field
10h	Meter ID Field
40h	Meter Object with Number and Unit
41h	Meter Object with Number (no Unit)
42h	Meter Object with String

Length Field

The Length Field indicates the number of bytes which are present in the data field.

Data Field

The Data Field contains the specific data.

Meter Data Message - Status Field

The Meter Status Field is an optional field which includes some status information about the incoming meter data stream

Status Field			
Type Field 00_h	Length Field 02_h	Data Field	
		Info Field	Error / Status
1 Byte	1 Byte	1 Byte	1 Byte

Figure: Status Field Format

Info Field

This sub field includes some information about the kind of meter data input:

Bits 7 .. 4 : reserved

Bits 3 .. 2 : Protocol Type

- 0 = unknown
- 1 = SML
- 2 = IEC
- 3 = reserved

Bits 1 .. 0: Meter Type

- 0 = unknown
- 1 = Import Meter (Consumption)
- 2 = Export Meter (Production)
- 3 = Import and Export Meter

Error / Status Field

This sub field contains an error code:

- 0 = ok, no error
- 1 = no input data
- 2 = read error / CRC error occurred while reading input data
- 3 = input file seems to be incomplete
- 4 = pairing error, incoming meter ID doesn't match with paired one

Meter Data Message - Time Field

The Meter Time Field is an optional field which includes a 32-Bit timestamp derived from the reader internal RTC when an incoming meter file gets parsed.

Time Field		
Type Field 01_h	Length Field 04_h	32 Bit Time Stamp (UTC format, LSB first)
1 Byte	1 Byte	4 Byte

Figure: Time Field Format

Meter Data Message - Meter ID Field

The Meter ID Field is an optional field which includes the Meter ID of the connected Smart Meter.

Meter ID Field		
Type Field 10_h	Length Field 1 - max. 16	Meter ID String
1 Byte	1 Byte	1 - max. 16 Bytes

Figure : Meter ID Field Format

Meter Data Message - Meter Object Field with Number and Unit

This Field includes a meter data record which consists of an OBIS-ID Field, a Unit Field, a Scaler Field and the final Mantissa Field:

Meter Object Field with Number and Unit						
Type Field 40_h	Length Field 5 - max. 57	OBIS-ID Field		Unit Field	Scaler Field (signed Integer)	Mantissa Field
		Group Mask	OBIS-ID Value			
1 Byte	1 Byte	1 Byte	1 - max. 6 Bytes	1 Byte	1 Byte	1 - typ. 8 Bytes, max. 48 Bytes, MSB first

Figure : Meter Object Field with Number and Unit

Meter Data Message - Meter Object Field with Number only (no Unit)

This message field format is an alternativ to the previous one. In cases where keeping the radio payload as short as possible is more import than the knowledge of the unit, one can configure the usage of this message field format.

This field includes a meter data record which consists of an OBIS-ID Field, a Scaler Field and the final Mantissa Field. The Unit field is simply omitted.

Meter Object Field with Number only (no Unit)					
Type Field 41_h	Length Field 4 - max. 56	OBIS-ID Field		Scaler Field (signed Integer)	Mantissa Field
		Group Mask	OBIS-ID Value		
1 Byte	1 Byte	1 Byte	1 - max. 6 Bytes	1 Byte	1 - typ. 8 Bytes, max. 48 Bytes, MSB first

Figure : Meter Object Field with Number only (no Unit)

Meter Data Message - Meter Object Field with String

This message field format is used in cases where the meter data record contains a string and not a number with scaler (exponent) and mantissa.

Meter Object Field with String				
Type Field 42_h	Length Field 3 - max. 55	OBIS-ID Field		String
		Group Mask	OBIS-ID Value	
1 Byte	1 Byte	1 Byte	1 - max. 6 Bytes	1 - max. 48 Bytes

Figure : Meter Object Field with String

Meter Data Message - OBIS-ID Field

The OBIS ID Field which is used in several meter data messages consists of the following subfields:

OBIS-ID Field	
Group Mask	OBIS-ID Value
1 Byte	1 - max. 6 Bytes

Figure : OBIS-ID Field

The Group Mask indicates which of the six possible OBIS-ID Group values A-F is included in the following OBIS-ID Value Field.

The Bit-Mapping is as follows:

- Bit 7 = 1 OBIS-ID Group A attached
- Bit 6 = 1 OBIS-ID Group B attached
- Bit 5 = 1 OBIS-ID Group C attached
- Bit 4 = 1 OBIS-ID Group D attached
- Bit 3 = 1 OBIS-ID Group E attached
- Bit 2 = 1 OBIS-ID Group F attached
- Bit 1 : used
- Bit 0 : not used

The OBIS ID Value Field includes up to six octets which contain the corresponding OBIS-ID Group values.

Example 1

GroupMask = 11111100_b = FC_h (all 6 OBIS ID values attached)

OBIS-ID Value = 01 00 01 08 00 FF "1-0:1.8.0*255"

Example 2

GroupMask = 00111000_b = 38_h (OBIS ID Groups C, D, E attached)

OBIS-ID Value = 01 08 00   "?-?:1.8.0*?"

Time Synchronization Message

The following figure outlines the Time Synchronization Message format which is used in case the LoRWAN server does not support a corresponding LoRaWAN MAC Layer service.

This message type follows a generic format which is also used for other purposes. The uplink request message looks as follows:

Get Date Time Request	
Request Type "Get" (01_h)	Resource ID "DateTime" (01_h)
1 Byte	1 Byte

Figure : Get Date Time Request Message Format

The expected server downlink response must be transmited to the same LoRaWAN Port 32_h and should include the current date and time as seconds since epoch (UTC) .

Get Date Time Response		
Request Type "Get Response" (02_h)	Resource ID "DateTime" (01_h)	Seconds since epoch (UTC) unsigned 32-Bit integer, LSB first (e.g. 19 9E 64 $5F_h$)
1 Byte	1 Byte	4 Byte

Figure : Get Date Time Response Message Format

Timestamp conversion can be easily verified online (see https://www.epochconverter.com/).

In this example: 19 9E 64 $5F_h$ => swap LSB first to MSB first => $5F649E19_h$ => convert from hey to decimal => 1600429593 => copy to web site => results to

GMT: Friday, 18. September 2020 11:46:33
Your time zone: Freitag, 18. September 2020 13:46:33 GMT+02:00 DST

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