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iOKE868 LoRaWAN®

User Manual

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History

Version	Date	Comment
1.0	October 2020	Initial Version
1.1	April 2021	Chapters Automatic Power Saving and Default Settings added

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General User Information

The content must not be published, duplicated or passed to third parties without our express permission. Read this documentation carefully before initial operation or use of the kit iOKE868 with integrated LoRaWAN® technology.

Observe the safety instructions and warnings in this documentation.

Keep the user manual for future reference.

General Notes

The iO881A and the antenna contain magnets.

Be careful when you remove the antenna connector from the iO881A. Avoid tilting the connector when you remove it.

The iO881A is also designed for battery operation. Therefore, the USB chip is always about 30s after a power cycle in order to save electricity. Please refer to the chapter Automatic Power Saving for further details.

Product Information

Kit name: iOKE868 LoRaWAN®

Kit content:


- iO881A for LoRaWAN®
- Antenna
- Micro-USB cable

Order Number: 404620

Manufacturer:

IMST GmbH

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

Disposal of the Device	
	Do not dispose this product at the end of its life in the household waste, but in the designated places for recycling old electrical equipment.
	Do not dispose the battery cell in the household waste, but in the designated areas for recycling old batteries.

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Hardware Overview

This chapter provides an overview about the hardware of iOKE868. iOKE868 LoRaWAN consist of:

- iO881A for LoRaWAN
- antenna
- micro USB cable

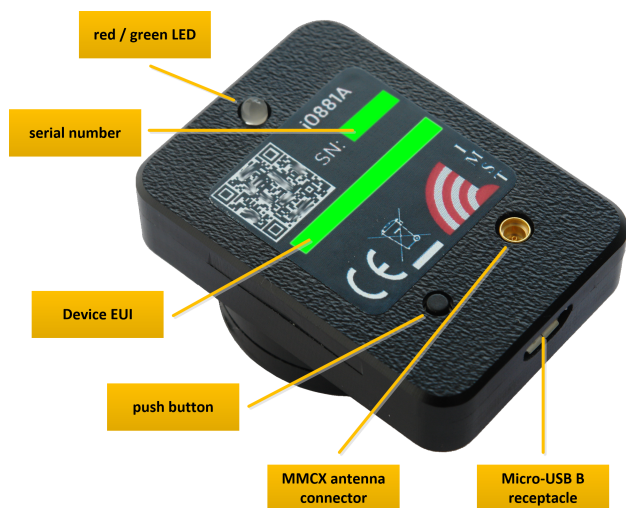


Figure: iO881A for LoRaWAN®, antenna and USB cable

Features of iO881A

- USB-interface for generic power supply (power plug or battery pack)
- USB-interface for configuration and direct mode
- Additional data memory
- LED and push button as user interface
- External antenna connector offers maximum installation flexibility and enables installations in difficult RF environments

Power Supply

The iO881A is supplied via the Micro-USB interface. The configured iO881A can be supplied by an additional USB power supply or battery pack.

Interfaces of iO881A

Push button for status request and initial configuration.

LED for signalling.

Micro USB connector for configuration, optional direct mode and power supply.

MMCX antenna connector for connecting the provided external antenna.

iO881A Startup

After a power cycle or reset the iO881A performs a startup procedure which includes the following steps:

- **Step 1: System Startup & Module Configuration**

After successful system startup the iO881A reads and validates the required configuration settings. In case of valid settings the following hardware and firmware modules will be configured:

- RTC with time-stamp from NVM, stored during last synchronization via PC or LoRaWAN® network
- LoRaWAN® Stack
- OBIS-ID Filter
- Event Calendar

In case of missing LoRaWAN® settings the iO881A enters a sleep mode and waits for further configuration (**Step 2**).

Every LoRaWAN® device must be activated at least once before usage. If not already activated, the iO881A enters sleep mode and waits for a HCI message from a PC-Tool to start the LoRaWAN® activation procedure (**Step 3**).

- **Step 2: iO881A Configuration**

The initial configuration must be handled via serial connection and PC-Tool. During configuration phase several parameters for LoRaWAN® activation, Calendar Events and OBIS-ID Filter have to be set to change the iO881A behavior.

Note: the LoRaWAN® Stack can be deactivated and reactivated again.

- **Step 3: LoRaWAN® Stack Activation (OTAA or ABP)**

In case of Over The Air Activation (OTAA) the iO881A initiates the LoRaWAN® join procedure. On success the device continues with the next step. The join procedure and its final result will be signalized via **LED**. If Activation By Personalization (ABP) is selected the LoRaWAN® Stack will be activated and the next step is directly initiated.

- **Step 4: Real Time Clock Synchronization**

For proper calendar operation the iO881A requests the LoRaWAN® network time and synchronizes the internal real time clock (RTC). At first the time will be requested by means of a LoRaWAN MAC command. In case of no MAC response, a defined application command is used to retrieve the current date and time from the application server (refer also to [Real Time Clock Synchronization](#)).

- **Step 5: Time Correction of Calendar**

In this final step the calendar unit is updated to handle the configured events which control the subsequent application behavior.

The following flow chart outlines the iO881A startup procedure and it's single steps.

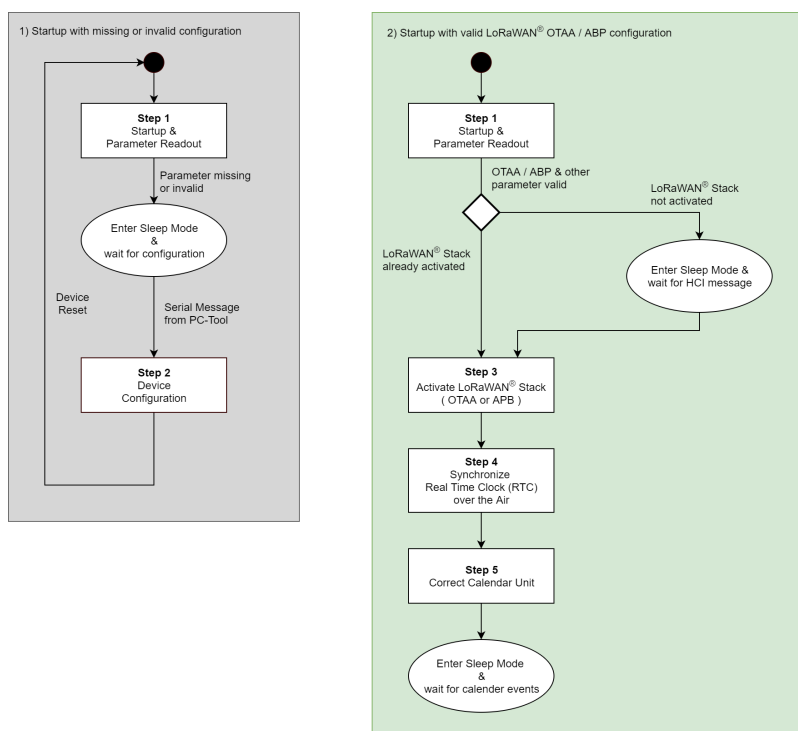


Figure : iO881A startup with invalid & valid configuration

Reader Functions

The iO881A includes a smart meter reader firmware which provides the following functions for meter reading via optical infrared interface:

- **Direct Output Mode (Local output: set to '1 to 1 output')**

In this mode of operation the incoming meter data on the infrared interface is simply repeated on the wired local serial interface with a baudrate of 115200 bps (8/N/1 for SML protocol or 7/E/1 for IEC protocol). This mode can be used to forward the original meter data stream to a PC-Tool for further processing.

While Direct Output Mode is selected the LoRaWAN® Radio Stack and all further reader functionalities are disabled and the internal FTDI USB to UART converter remains enabled.

- **HCI Output Mode (Local output: set to 'Via HCI message')**

In this mode the incoming meter data is filtered and forwarded as HCI (Host Controller Interface) message in the same application protocol format which is used on the LoRaWAN radio link. This is the default setting.

While HCI Output Mode is selected the internal FTDI USB to UART converter remains enabled. In case the LoRaWAN Stack is activated, the meter data is also sent to a LoRaWAN Server.

- **Meter Pairing Mode**

This mode allows to pair the iO881A with the current connected meter. The pairing is done by reading the unique Meter ID which will afterwards be stored in the internal non-volatile memory. After successful pairing the iO881A will only accept meter data which include the saved Meter ID. The pairing state can be reseted by command at any time.

- **OBIS-ID Scan Mode (Detect OBIS IDs)**

Meter data is always transmitted by means of files which consist of multiple data records. Every data record includes a unique OBIS-ID which identifies the kind of measurement value within this record. The OBIS-ID Scan Mode can be activated to read and forward only the published OBIS-IDs of the connected meter. The captured OBIS-IDs will be sent as a list via wired local serial interface to the connected PC. This list of OBIS-IDs is helpful to configure the supported OBIS-ID Filter (see below).

- **Single Capture Mode (Calendar Event: Read out a single block of values)**

The Single Capture Mode performs a single meter readout. The readout results will finally be forwarded via local serial interface or LoRaWAN® depending on the initiating command source (e.g. PC-Tool, Calendar Event) and iO881A configuration. The desired OBIS-ID can be selected from the list of all recognized OBIS-IDs.

- **Continuous Capture Mode**

In contrast to the **Single Capture Mode** the reader and interface will remain active after end of file or error detection. The readout results will be forwarded as soon as possible. The Continuous Capture Mode can be deactivated by a Stop command, or by activating the Single Capture Mode. Again the OBIS-ID Filter will be used to focus on the wanted specific data.

Real Time Clock Synchronization

The iO881A features an embedded Real Time Clock (RTC) which is used to schedule several Calendar Events for meter reading and other functionalities. For proper operation it is highly recommended to synchronize the RTC. The initial synchronization can be done by means of the WS-Configurator PC-Tool. On every synchronization the current time stamp is stored in the non volatile memory of the iO881A. After a power-cycle or system reset this stored value is used to initialize the RTC. If the value is invalid or less than 01.01.2000 00:00:00 the RTC will start at 01.01.2000 00:00:00.

After startup the device starts with a LoRaWAN® activation procedure (OTAA or ABP) and initiates a LoRaWAN® uplink MAC command to get the current data and time from the LoRaWAN® operator. On success the received value is used to configure the RTC and is finally stored in the NVM for later usage after a system reset.

Due to the fact that some LoRaWAN server do not support the "Get Time MAC Command" a fall back mechanism is implemented. In case of no MAC command response the firmware transmits a "Get Date Time Request" application command via LoRaWAN® to the connected Application Server which might be able to answer this request. This request is repeated 5 times.

The new "Get Date Time Request" looks as follows;

LoRaWAN Port: 32

LoRaWAN Payload Syntax:

Request < Get > < Resource ID >

Example:

< Get > < DateTime >

< 01_h > < 01_h >

The corresponding Get Date Time response must look like this:

LoRaWAN Port: 32

LoRaWAN Payload Syntax:

Response < Get Response > < Resource ID > < data >

Example:

< Get Response > < DateTime > < current date time as seconds since 01.01.1970, 00:00:00 as **unsigned** 32-Bit integer, LSB first , e.g.: "2020-09-18 11:46:33 >

< 02_h > < 01h > < (19 9E 64 5F)_h >

Due to the fact that the clock crystal frequency can drift over temperature it is recommended to synchronize the RTC via LoRaWAN® from time to time (e.g. once per week).

Automatic Power Saving

The firmware features automatic power saving which let the system enter a low power mode whenever it is possible in order to achieve low current consumption and long battery lifetime.

FTDI USB to UART Converter Control

The iO881A features an internal FTDI USB to UART converter for connection with external host controller via USB.

For achieving the lowest current consumption this unit is automatically switched off 30 seconds after powering except for the following cases:

- Local Output Mode is set to either '1 to 1 outout' or 'Via HCI message'
- Pushbutton is pressed during powering
- A valid HCI message has been received within the USB-Off timeout of 30s
- An invalid or incomplete LoRaWAN configuration has been detected

Note: For lowest current consumption and longest battery lifetime select Local Output Mode to "No output".

LED and Push Button Usage

The iO881A features a dual color led which is used to signalize multiple states and activities. Most of the time the device will stay in a power saving state in which the LED is switched off to save power.

Pressing the Push Button while connecting the iO881A to a PC activates the HCI interface independent from any firmware settings.

Pressing the Push Button later on will show the internal firmware state as a blinking pattern on the dual color LED.

The following table outlines the firmware states and corresponding LED signals:

LED Pattern	Infrared Interface State	LoRaWAN® State	Recommended Action
Red 1 x	Not used	LoRaWAN® configuration invalid or not activated	Connect iO881A to PC and start configuration and LoRaWAN® activation
Green 1 x	Not used	LoRaWAN® stack activated	Nothing, iO881A is ready for meter data reading
Red 2 x	Read error or no data	LoRaWAN® configuration invalid or not activated	Connect iO881A to PC and start configuration and LoRaWAN® activation
Red 1 x, Green 1 x	Read error or no data	LoRaWAN® stack activated	Verify iO881A mechanical position
Green 1 x, Red 1 x	Reading ok	LoRaWAN® configuration invalid or not activated	Connect iO881A to PC and start configuration and LoRaWAN® activation
Green 2 x	Reading ok	LoRaWAN® stack activated	Nothing, last meter reading and LoRaWAN transmission were successful

Table : Firmware states and LED signals

The following table outlines additional LED usage during firmware startup:

LED Pattern	Activity
Off	Startup
Red, continuously blinking	LoRaWAN® activation
Green 2 x	LoRaWAN® activation successful
Red, continuously blinking	LoRaWAN® network time synchronization
Green 2 x	LoRaWAN® network time synchronization successful
Off	Power saving in sleep mode

Table : Firmware activities an LED signals

Initial Setup

The iO881A requires an initial configuration before usage. This configuration can be done by means of a PC-Tool called **WS-Configurator** which is connected via serial interface (USB) to the device.

For further information howto configure the iO881A please refer to the corresponding QuickStartGuide

Default Settings

The following table lists the default factory settings:

Parameter	Value
Local Output	Via HCI message
Reader Protocol	SML
Reader Baudrate	9600 bps
Paired Meter ID	none
Radio Packet Format Options <ul style="list-style-type: none"> • Include Meter ID • Include Status Field • Include Reader Time Field • Omit Unit Field 	no no no no
Special IEC Mode Options <ul style="list-style-type: none"> • Try ASCII to integer number conversion • Send fast wakeup sequence to battery powered meter device 	no no
Calendar Event List	empty
OBIS-ID Filter List	empty
LoRaWAN Settings <ul style="list-style-type: none"> • 64-bit Device EUI • Application EUI / Join EUI • 128-bit Device Key 	pre-programmed valid IEEE Device EUI 00-00-00-00-00-00-00-00 _h 00-00-00-00-00-00-00-00-00-00-00-00-00-00-00-00 _h

Technical Characteristics

All characteristics are applied for T = 25°C, Supply via USB. Typical values unless otherwise stated.

Electrical Characteristics	
Power Supply (VDD)	4.5 - 5.25V
Current Consumption (typ.)	Sleep mode: 4µA (RTC on) Infrared receive: 5mA HCI active: 10mA Transmit mode: 30mA
Data Memory	8 MBit Flash
RF Characteristics	
Frequency range	863 MHz to 870 MHz
RF output power	+13 dBm ERP with supplied antenna
Modulation	LoRa® Spread-Spectrum (G)FSK
Antenna	Via MMCX connector
LoRa® Protocol Characteristics	
LoRaWAN®	Certified and compliant to V.1.0.2
Activation type	ABP (activation by personalization) OTAA (over the air activation)
Frequencies	Standard LoRaWAN frequencies Additional frequencies depend on LoRaWAN® network server
Supported Energy Meter Protocols/Standards	
SML	Smart Meter Language Protocol Version 1.04
IEC62056-21	IEC mode A, B and D (on request)
General Characteristics	
Product	iO881A
Storage Temperature	-40°C to +85°C
Operating Temperature	Typical +5°C to +55°C
Mounting	Via integrated magnet
Housing	Material: ABS, black Dimension: 47mm x 34mm x 22mm (without connectors)
Certification	RED (2014/53/EC) RoHS Directive (2011/65/EC) LoRaWAN® 1.0.2