



# Manual

IOTSU® CO<sub>2</sub> for LoRaWAN®

IOTSU\_L3\_AQ05





Company: Small Data Garden Oy  
 Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
 Product code: IOTSU\_L3\_AQ05  
 Revision: 1.3\_20<sup>th</sup> May 2024

## Table of Contents

<b>1</b>	<b>Safety Notes</b> .....	<b>4</b>
<b>2</b>	<b>Device commissioning</b> .....	<b>5</b>
2.1	Powering the device .....	5
2.2	Troubleshooting .....	6
2.3	Installation .....	6
2.3.1	Using double-sided tape .....	7
2.3.2	Using screws .....	7
2.4	Battery .....	8
2.4.1	Changing the batteries .....	9
<b>3</b>	<b>Product disposal</b> .....	<b>11</b>
<b>4</b>	<b>Device specifications</b> .....	<b>12</b>
4.1	Dimensions .....	12
4.2	Device label .....	12
4.3	Appkey .....	13
4.4	Manufacturer .....	13
4.5	Error and malfunction situations .....	13
<b>5</b>	<b>Datasheet</b> .....	<b>14</b>
<b>6</b>	<b>Functional description</b> .....	<b>15</b>
6.1	Device startup .....	15
6.2	LoRaWAN® join procedure .....	15
6.2.1	Initial join .....	15
6.2.2	Rejoin .....	15
6.2.3	Link check .....	16
6.3	Measurements .....	16
6.3.1	Measurement and transmit interval .....	16
6.3.2	Measurement errors .....	17
6.3.3	Measurement mode .....	17
6.4	Data duplication .....	18
6.5	Device LEDs .....	18
6.5.1	Startup .....	18
<b>7</b>	<b>Uplinks</b> .....	<b>19</b>
7.1	Normal (Fport 1) and delayed uplink (Fport 3) .....	19



Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

8	Downlinks.....	22
9	Legal notices.....	23



Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

## 1 Safety Notes

This manual is intended only for IOTSU® CO<sub>2</sub> for LoRaWAN®. The device is intended for professional corporate handling, installation, and maintenance use only. Read this manual carefully before installing and using the device.

**CAUTION** - The battery used in this device may present a risk of fire or chemical burn if mistreated. Do not recharge, disassemble, heat above 100 °C, or incinerate. Replace battery with recommended battery only and follow manufacturer's all other instructions for Installing and changing the batteries. Use of another battery may present a risk of fire or explosion.

### Handling

The device cannot tolerate shocks or hits. Store the device in appropriate temperatures. Do not use solvents or powerful cleaning agents and do not attempt repairs. Clean the outer surface of the device with a moist cleaning cloth if any visible dust is present. Use the device only in its intended use defined by Small Data Garden. If the device does not work, please contact the seller of the device.



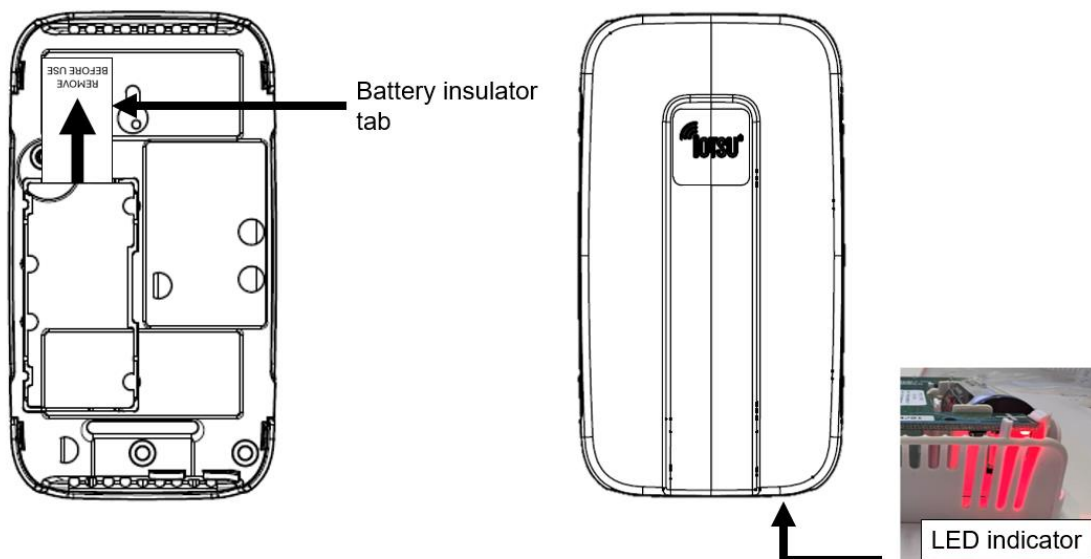


Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

## 2 Device commissioning

### 2.1 Powering the device

Devices are delivered power OFF. Power on the device by removing the battery insulator tab between the battery and the battery holder on the back of the device. LED indicator stays on for 1—2 seconds and goes out. The device is now powered on, and the installation can continue.



IOTSU® performs a self-diagnostic cycle every time the device is turned ON. The LED light on the circuit board shines when diagnostic cycle is being performed. After the cycle is completed successfully the LED is switched off and the device starts normal operation. Any errors found during diagnostic period are indicated by the constant blinking of the LED light. If an error occurs turn OFF the device for one minute and turn the device ON. If the error persists, please contact the seller of the device.

The device is immediately ready for use after a successful start and will start sending data after joining the network. The device automatically calibrates the sensors to reach high accuracy levels. The calibration time depends on the configuration parameters of the device.



Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

## 2.2 Troubleshooting

The LED functions that take place when the device is powered on can be found in the table below.

Description	Solution
The LED lights up	LED indicator stays on for 1—2 seconds and goes out. The device is now powered on, and you can continue installing the device.
The LED does not light up	Open the cover of the device and remove the battery for about one minute. Reinstall the battery. Pay attention to the polarity of the battery (marked on the surface of the circuit board). When the LED lights up and stays on for 1—2 seconds you can continue installing the device. (See 2.4.1 Changing the batteries).
The LED does not light up after re-installing the battery	If the LED does not light up at all, the battery is empty or the device is broken. Replace the battery with a new one. If changing the battery does not help, please contact the seller of the device.
The LED lights up and starts blinking	The device is in fault mode and does not try to connect to the network and does not send measurement data. Remove the device's battery for about one minute and re-install it. If the error persists, please contact the seller of the device.

## 2.3 Installation

IOTSU® L3 can be wall mounted with adhesive tape or screws. Please note during installation that IOTSU® L3 uses radio signals for cloud communication and therefore large



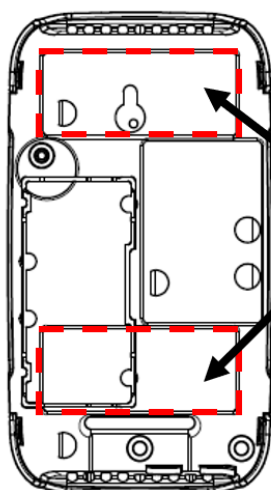
Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

metal objects such as metal walls and enclosures near the device may negatively impact the radio performance of the device.

IOTSU® L3 has an automatic power control, which adapts the wireless transmission power used to the coverage of the radio network of the installation location. Therefore, it is important that the device is only powered ON (the pull tab is removed) at the installation site (See [2.1 Powering the device](#)). If the location of the device is changed or the device has otherwise been powered ON before the installation location, the device must be restarted during installation to reset the power control by removing the battery from the device for about one minute (See [2.4.1 Changing the batteries](#)).

### 2.3.1 Using double-sided tape

1. Place tapes in the recesses on the back of the device.
  - a. Tape size: 19 x 45 mm (2 pcs).
2. Clean the installation surface well before starting. Install the device at a height of  $\leq 2$  meters. Remove the covers from the installation tapes. Press the device firmly on the wall and hold for 10 seconds.

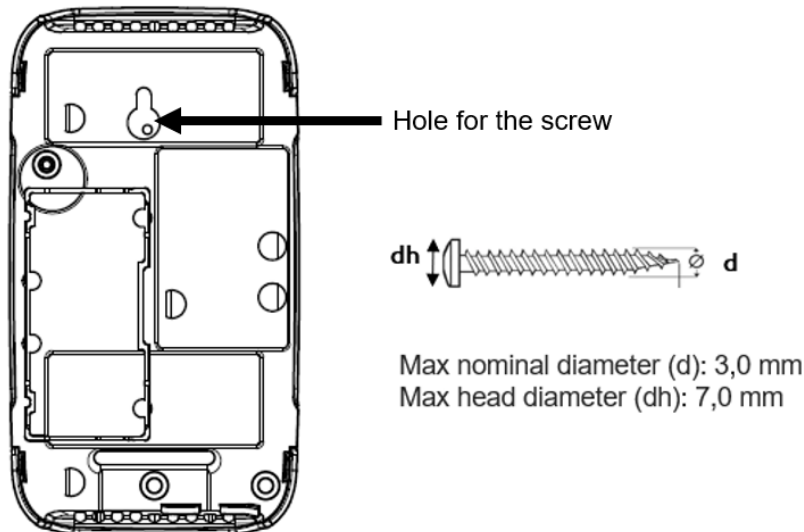


Tape size: 19 x 42 mm (2 pcs)

### 2.3.2 Using screws

1. Install a suitable mounting screw on the wall at a height of  $\leq 2$  meters. Don't drive it in all the way. Leave the head of the screw slightly away from the wall. The screw is not included with the device.

- The keyhole for the screw is on the back of the device. Attach the device to the screw by pushing the head of the screw through the hole and slide the device down to secure it.



## 2.4 Battery

**CAUTION** - The battery used in this device may present a risk of fire or chemical burn if mistreated. Do not recharge, disassemble, heat above 100 °C, or incinerate. Replace battery with recommended battery only and follow manufacturer's all other instructions for Installing and changing the batteries. Use of another battery may present a risk of fire or explosion.

Suggested battery type: EVE ER26500 S/STD

Battery quantity: 1

The device can operate with other comparable size C 3.6V Lithium (Li-SOCL<sub>2</sub>) batteries. Only recommended batteries are allowed to be installed to the device. Consult always the manufacturer before using other than recommended batteries. When changing batteries use only fresh batteries. Using other than recommended batteries or not following manufacturer's battery instructions can cause serious risk to life and material.

Battery replacement may only be performed by a sufficiently skilled person following the instructions found in the user manual or manufacturer's authorized service representative.





Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

The battery voltage information can be found in all the uplink messages sent by the device.

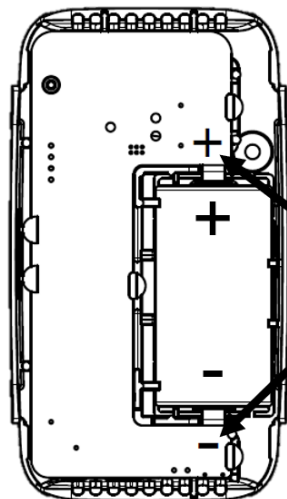
### 2.4.1 Changing the batteries

1. Start opening the enclosure from top part of the cover. Pull the first corner of the cover to the side until the snap on the cover come over the groove in the base.
2. Pull the second corner of the cover to the side until the snap on the cover come over the groove in the base.
3. Pull off the entire cover.



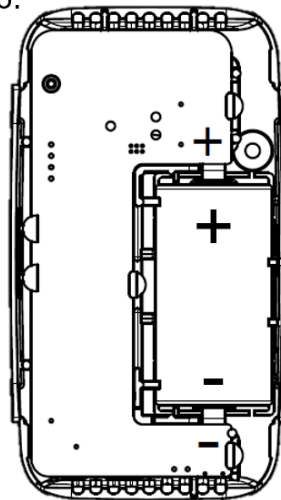
4. Lift the empty batteries straight out of the enclosure. To prevent damage to the battery holders, do not twist the battery while lifting it.
5. Wait for 1 minute and install the new battery straight. Use only fresh batteries. Pay attention to the polarity of the battery and match the terminal connectors. **NOTE!** Installing batteries incorrectly may damage the device and cause serious risk to life and material.
6. LED indicator stays on for 1—2 seconds and goes out. The device is now powered on.

4.-5.



Match the terminal connectors

6.



LED indicator

7. Press the cover against the enclosure until you hear that it clicks into place. Make sure that the side tabs are positioned correctly as in the picture.



8. Dispose of used battery properly without delay. Keep away from children. Do not disassemble and do not dispose of in fire.



Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

### 3 Product disposal

First remove the battery from the device and dispose of the battery and the device properly.

Dispose of the battery properly. For safety precaution, the battery should be insulated in proper manner by covering both terminals by tape, or wrapping the battery in insulative bag in order to prevent ignition due to short-circuit.

The device without the battery must be delivered to a collection point that accepts electronic waste. It must not be put in mixed waste. Discarded device is accepted free of charge in more than 400 regional WEEE collection points. Their addresses can be found at [www.kierratys.info](http://www.kierratys.info). The product's packaging can be recycled for carton waste collection.

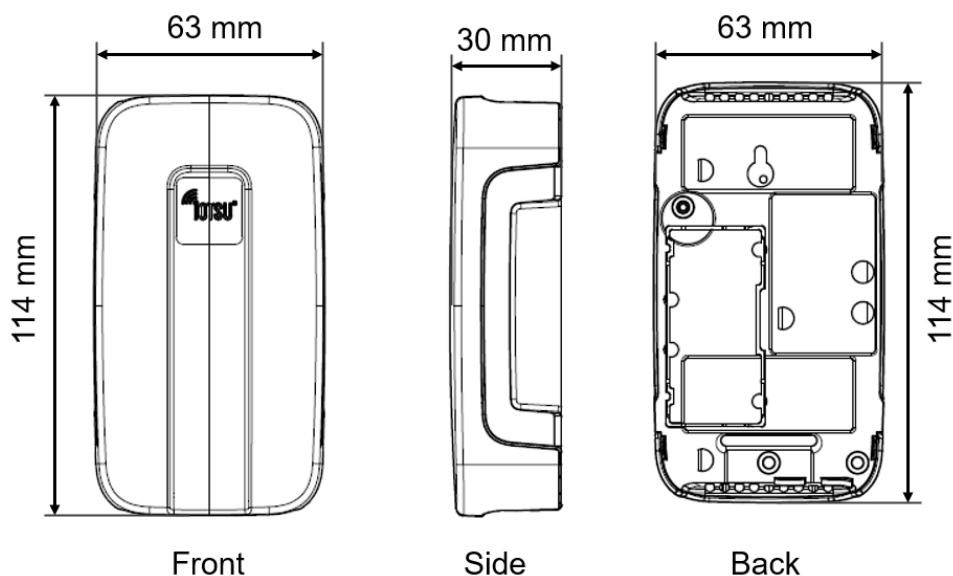


Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

## 4 Device specifications

### 4.1 Dimensions

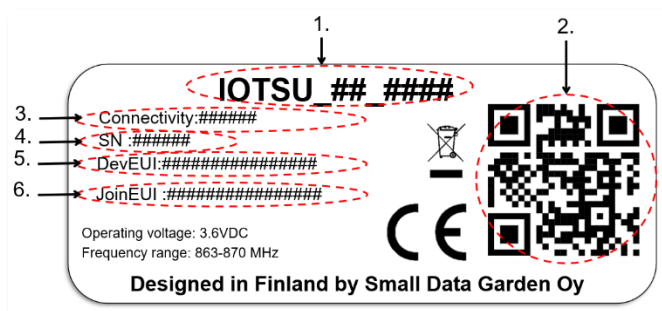
The dimensions of the device can be found in the picture below.



### 4.2 Device label

The nameplate can be found in the device packaging and on the back of the device, the markings of which are explained below.

1. Model
2. QR-code, contains device's serial number and the DevEUI
3. Connectivity
4. Manufacturer's serial number for the device
5. Device's DevEUI
6. JoinEUI



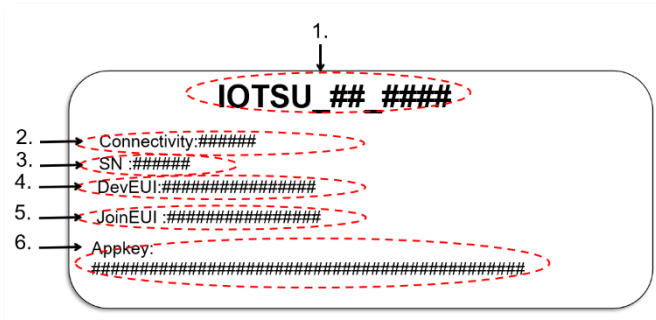


Company: Small Data Garden Oy  
 Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
 Product code: IOTSU\_L3\_AQ05  
 Revision: 1.3\_20<sup>th</sup> May 2024

### 4.3 Appkey

You can get the information needed to provision the device to network from the party that sold the device to you or from the label on the back of the device (available as option). Label's markings are explained below.

1. Model
2. Connectivity
3. Manufacturer's serial number for the device
4. Device's DevEUI
5. JoinEUI
6. Device's AppKey



### 4.4 Manufacturer

Company name Small Data Garden Oy  
 Address Maantie 1, 11130 Riihimäki, Finland  
 Webpage [www.smalldatagarden.fi](http://www.smalldatagarden.fi)  
 E-mail address [info@smalldatagarden.fi](mailto:info@smalldatagarden.fi)

### 4.5 Error and malfunction situations

Use the device only in its intended use defined by Small Data Garden Oy. If the device does not work, please contact the seller of the device. Do not attempt repairs.

# 5 Datasheet



Company: Small Data Garden  
 Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
 Product code: IOTSU® L3 AQ05  
 Rev: 1.8\_21<sup>st</sup>Dec 2023



## IOTSU® CO<sub>2</sub> for LoRaWAN®

IOTSU® CO<sub>2</sub> is a wireless indoor device designed for measuring air quality for monitoring purposes. Air quality is assessed as a combination of temperature, humidity, and the concentration of carbon dioxide.

The device can be mounted using screws or adhesive tape. Installation of this maintenance-free device is quick and easy. Transmission and measurement cycles can be adjusted according to the need using downlinks.

IOTSU® CO<sub>2</sub> uses the global LoRaWAN® network connection. There is no need for external power supply. Depending on transmission settings and environmental factors the battery of the device can last 5 years.

### MEASURING AND RECORDING:

- Temperature, Humidity
- CO<sub>2</sub>

### TECHNICAL SPECIFICATIONS:

Dimensions	: 63 x 114 x 30 mm
Weight	: 117 g with battery
Sensors	: CO <sub>2</sub> , temperature, humidity
Transmission cycle	: 2 h, configurable via downlink
Measurement cycle	: Transmission cycle /4
Connectivity	: LoRaWAN® 1.0.4
Battery	: Size C, 3.6 V, replaceable
Expected battery life	: 5 years with default setting, Transmissions at SF12/DR0
Operating Conditions	: 0 °C...+50 °C, Relative humidity 10...85 % (Non-condensing)
Typical Accuracy	: Temperature: ±0.2 °C Humidity: ±2 %, CO <sub>2</sub> : ±30 ppm ±3 % of reading
Certifications	: CE
Mounting	: Screws, adhesive tape

Small Data Garden Oy's (SDG) products (IOTSU® Products) shall be used according to the manual and other instructions and not be used in any other way than their intended use defined by SDG. IOTSU® Products are designed for LPWAN technologies collecting non-critical information. SDG will not be held liable for any damage which may result from inaccurate readings and delayed data transmission. In case regular calibration of IOTSU® Products is needed, SDG shall not be responsible for this, and it is the Customer's responsibility to obtain calibration from a suitable service provider. For more information see SDG's General Terms and conditions for the supply of products and Legal Notices.



Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

## 6 Functional description

### 6.1 Device startup

Device starts after battery has been inserted to the device and power switch is turned on. Device LED turns on immediately during the start-up sequence.

During the start-up sequence the device initialises all onboard sensors. Once all sensors are verified the device measures battery voltage. If the voltage is in specified limits device turns off the LED and starts the LoRaWAN® join procedure. If voltage is lower than specified device enters to low power sleep mode and tries to measure voltage after 1 hour of sleeping. After 1 hour device turns on the LED for 10 seconds and after that measure's battery voltage. If the voltage is higher than start-up limit the device begins the LoRaWAN® join procedure, otherwise it repeats the 1-hour sleep procedure.

### 6.2 LoRaWAN® join procedure

#### 6.2.1 Initial join

After all sensors have been initialised, battery voltage is in correct level and the device is in OTAA (Over-The-Air Activation) mode it starts LoRaWAN® join procedure. If the device is in ABP (Activation by Personalization) device starts measuring directly without the need of the join procedure. After successfully joining a network, the device starts the measuring routine. Before successful join the device does not perform any measurement related activities.

#### 6.2.2 Rejoin

If the device does not connect to a network during initial join, it begins a network rejoin. On rejoin the device sends a join message and expects a downlink response from the network to confirm a successful rejoin. In case the rejoin fails, the device continues to retry joining in 12 hour  $\pm$  1 hour interval with data rate DR0. Time intervals and other rejoin-specific parameters of the device can be adjusted in the device configuration.



Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

### 6.2.3 Link check

If the device has not received downlink messages for a predetermined time it includes a link check request to the next uplink payload, which then requests a downlink from the network to confirm the network connectivity. Link check requests are done automatically in the background, and do not affect the uplink message count or measurements sent by the device.

## 6.3 Measurements

Normal measurement cycle of the device is started after it has successfully joined a network.

### 6.3.1 Measurement and transmit interval

A transmit interval is the time between two transmission and it is the time during which the device makes measurements. Each transmit interval is divided into one or more measurement slots, where one measurement slot equals one reading from each of the onboard sensors.

$$\frac{\textit{Transmit interval}}{\textit{Measurement slots}} = \textit{Measurement slot time}$$

The onboard sensors are sampled one or more times during each measurement slot, dictated by the configuration parameters set for each individual sensor. Taking multiple samples per measurement slot enables for instance the sensor to send averaged data.

To get the sample count for each slot, the slot time is divided by sensor measurement interval and the result is rounded down to nearest integer in seconds. If the sensor measurement interval is longer than measurement slot time, then single measurement is made at the end of measurement slot instead.





Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

$$\text{floor}\left(\frac{\text{Measurement slot time}}{\text{Sensor measurement interval}}\right) = \text{Measurements in each measurement slot}$$

$$\frac{\text{Measurements slot time}}{\text{Measurements in each measurement slot}} = \text{Measurement interval}$$

### 6.3.2 Measurement errors

The device can detect if an onboard sensor has malfunctioned, and in such situations, it will try to perform self-correcting routines to reinitialise the sensor. If it is incapable of correcting the situation it will send error values in the sensors' measurement slot. Sensor malfunctions may occur in situations where, for example, the device is not used in the way it is intended to be used, if the device has been dropped, or if it has suffered moisture damage.

In case there are multiple samples in a measurement slot and any one of those samples contain an error value, the entire slot is discarded, and an error value is sent instead.

If the device has been configured so that there are no measurements made during the measurement slot time, an error value is sent in that slot instead.

### 6.3.3 Measurement mode

Device measurement mode can be changed between spot measurement and averaging measurement. On spot measurement latest measurement on current slot is used for slots value. In averaging measurement an average of all measurements made during a slot time is taken and the resulting average value is sent.



Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

## 6.4 Data duplication

Measurement data can be duplicated. In each message previous measurement data is appended to the end of the message. This feature helps to mitigate the data loss effect when packet loss occurs.

## 6.5 Device LEDs

Device has an LED light which is used during device start-up sequence.

### 6.5.1 Startup

Please see section: [Device startup](#).



Company: Small Data Garden Oy  
 Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
 Product code: IOTSU\_L3\_AQ05  
 Revision: 1.3\_20<sup>th</sup> May 2024

## 7 Uplinks

### 7.1 Normal (Fport 1) and delayed uplink (Fport 3)

Delayed uplink is normal uplink from previous transmit cycle which was not transmitted at the end of previous transmit cycle.

Bits	Bit length	Data		Description	Formula	
0.0-0.7	8	Battery voltage	Information	Device battery voltage	LSB 20 mV	
1.0	1	Measurement mode		0 = single measurement mode, 1 = averaging measurement mode		
1.1	1	Data duplication		0 = single data, 1 = data duplicated		
1.2	1	Reserved		Reserved for future use		
1.3	1	Downlink command ack		Alternates on each successful downlink receipt		
1.4	1	Reserved		Reserved for future use		
1.5 - 1.7	3	Transmit interval		Current transmit interval	*	
2.0 – 2.6	7	Humidity #1	Standard payload	Humidity at the end of the first measurement period (oldest data).	LSB 1%rH	
2.7 – 3.7	9	Temperature #1		1st period	Temperature at the end of the first measurement period (oldest data).	LSB 0.1°C
4.0 – 4.7	8	CO <sub>2</sub> #1			CO2 at the end of the first measurement period (oldest data).	LSB 10 + 2940 ppm
5.0 – 5.6	7	Humidity #2		2nd period	Humidity at the end of the second measurement period.	LSB 1%rH
5.7 – 6.7	9	Temperature #2			Temperature at the end of the second measurement period.	LSB 0.1°C
7.0 – 7.7	8	CO <sub>2</sub> #2			CO2 at the end of the second measurement period.	LSB 10 + 2940 ppm
8.0 – 8.6	7	Humidity #3		3rd period	Humidity at the end of the third measurement period.	LSB 1%rH
8.7 – 9.7	9	Temperature #3			Temperature at the end of the third measurement period.	LSB 0.1°C
10.0 – 10.7	8	CO <sub>2</sub> #3			CO2 at the end of the third measurement period.	LSB 10 + 2940 ppm
11.0 – 11.6	7	Humidity #4		4th period	Humidity at the end of the fourth measurement period (newest data).	LSB 1%rH
11.7 – 12.7	9	Temperature #4			Temperature at the end of the fourth measurement period (newest data).	LSB 0.1°C
13.0 – 13.7	8	CO <sub>2</sub> #4			CO2 at the end of the fourth measurement period (newest data).	LSB 10 + 2940 ppm
14.0 – 14.6	7	Humidity #1	Duplicated payload	Humidity at the end of the first measurement period of the previous transmission.	LSB 1%rH	
14.7 – 15.7	9	Temperature #1		1st period	Temperature at the end of the first measurement period of the previous transmission.	LSB 0.1°C
16.0 – 16.7	8	CO <sub>2</sub> #1			CO2 at the end of the first measurement period of the previous transmission.	LSB 10 + 2940 ppm
17.0 – 17.6	7	Humidity #2		2nd period	Humidity at the end of the second measurement period of the previous transmission.	LSB 1%rH
17.7 – 18.7	9	Temperature #2			Temperature at the end of the second measurement period of the previous transmission.	LSB 0.1°C
19.0 – 19.7	8	CO <sub>2</sub> #2			CO2 at the end of the second measurement period of the previous transmission.	LSB 10 + 2940 ppm
20.0 – 20.6	7	Humidity #3		3rd period	Humidity at the end of the third measurement period of the previous transmission.	LSB 1%rH
20.7 – 21.7	9	Temperature #3			Temperature at the end of the third measurement period of the previous transmission.	LSB 0.1°C
22.0 – 22.7	8	CO <sub>2</sub> #3			CO2 at the end of the third measurement period of the previous transmission.	LSB 10 + 2940 ppm
23.0 – 23.6	7	Humidity #4		4th period	Humidity at the end of the fourth measurement period of the previous transmission.	LSB 1%rH
23.7 – 24.7	9	Temperature #4			Temperature at the end of the fourth measurement period of the previous transmission.	LSB 0.1°C
25.0 – 25.7	8	CO <sub>2</sub> #4			CO2 at the end of the fourth measurement period of the previous transmission.	LSB 10 + 2940 ppm



Company: Small Data Garden Oy  
Product name: IOTSU<sup>®</sup> CO<sub>2</sub> for LoRaWAN<sup>®</sup>  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

Example data: B8 50 6FF039 46F435 2CEB32 32CA30 4EEC3b 48EE36 48F132 48F331

Voltage: B8<sub>hex</sub> -> 179<sub>dec</sub> -> 179 \* 20 = 3580mV

Info byte: 50 <sub>hex</sub>					
0		1		000 <sub>bin</sub>	
Measurement mode. 0: Single measurement					
Data duplication. 1: Data duplicated					
Reserved					
Downlink ack. 1					
Reserved					
Transmit interval. 0: 10min					



Company: Small Data Garden Oy  
 Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
 Product code: IOTSU\_L3\_AQ05  
 Revision: 1.3\_20<sup>th</sup> May 2024

### Measurement values

Data	Parsing	Data age
6FF039 <sub>hex</sub>	Humidity: 37 <sub>hex</sub> -> 55 <sub>dec</sub> = 55 %RH Temperature: 1F0 <sub>hex</sub> -> 496 <sub>dec</sub> / 10 = 49.6 °C CO <sub>2</sub> : 39 <sub>hex</sub> -> 57 <sub>dec</sub> * 10 + 400 = 970 ppm	Transmit time – ((transmit interval / 4) * 3) = T – 7.5min
46F435 <sub>hex</sub>	Humidity: 23 <sub>hex</sub> -> 35 <sub>dec</sub> = 35 %RH Temperature: 0FE <sub>hex</sub> -> 254 <sub>dec</sub> / 10 = 25.4 °C CO <sub>2</sub> : 35 <sub>hex</sub> -> 53 <sub>dec</sub> * 10 + 400 = 930 ppm	Transmit time – ((transmit interval / 4) * 2) = T – 5min
2CEB32 <sub>hex</sub>	Humidity: 16 <sub>hex</sub> -> 22 <sub>dec</sub> = 22 %RH Temperature: 0EB <sub>hex</sub> -> 235 <sub>dec</sub> / 10 = 23.5 °C CO <sub>2</sub> : 32 <sub>hex</sub> -> 50 <sub>dec</sub> * 10 + 400 = 900 ppm	Transmit time – ((transmit interval / 4) * 1) = T – 2.5min
32CA30 <sub>hex</sub>	Humidity: 19 <sub>hex</sub> -> 25 <sub>dec</sub> = 25 %RH Temperature: 0CA <sub>hex</sub> -> 202 <sub>dec</sub> / 10 = 20.2 °C CO <sub>2</sub> : 30 <sub>hex</sub> -> 48 <sub>dec</sub> * 10 + 400 = 880 ppm	Transmit time
4EEC3B <sub>hex</sub>	Humidity: 27 <sub>hex</sub> -> 39 <sub>dec</sub> = 39 %RH Temperature: 0EC <sub>hex</sub> -> 236 <sub>dec</sub> / 10 = 23.6 °C CO <sub>2</sub> : 3b <sub>hex</sub> -> 59 <sub>dec</sub> * 10 + 400 = 990 ppm	Duplicated data. Transmit time – ((transmit interval / 4) * 7) = T – 17.5min
48EE36 <sub>hex</sub>	Humidity: 24 <sub>hex</sub> -> 36 <sub>dec</sub> = 36 %RH Temperature: 0EE <sub>hex</sub> -> 238 <sub>dec</sub> / 10 = 23.8 °C CO <sub>2</sub> : 36 <sub>hex</sub> -> 54 <sub>dec</sub> * 10 + 400 = 940 ppm	Duplicated data. Transmit time – ((transmit interval / 4) * 6) = T – 15min
48F132 <sub>hex</sub>	Humidity: 24 <sub>hex</sub> -> 36 <sub>dec</sub> = 36 %RH Temperature: 0F1 <sub>hex</sub> -> 241 <sub>dec</sub> / 10 = 24.1 °C CO <sub>2</sub> : 32 <sub>hex</sub> -> 50 <sub>dec</sub> * 10 + 400 = 900 ppm	Duplicated data. Transmit time – ((transmit interval / 4) * 5) = T – 12.5min
48F331 <sub>hex</sub>	Humidity: 24 <sub>hex</sub> -> 36 <sub>dec</sub> = 36 %RH Temperature: 0F3 <sub>hex</sub> -> 243 <sub>dec</sub> / 10 = 24.3 °C CO <sub>2</sub> : 31 <sub>hex</sub> -> 49 <sub>dec</sub> * 10 + 400 = 890 ppm	Duplicated data. Transmit time – ((transmit interval / 4) * 4) = T – 10min



Company: Small Data Garden Oy  
 Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
 Product code: IOTSU\_L3\_AQ05  
 Revision: 1.3\_20<sup>th</sup> May 2024

## 8 Downlinks

Device configuration can be changed using downlinks. All downlinks are sent to FPort 1. Downlinks sent to other FPorts are discarded. Each downlink command consists of command and data part. Data part is little endian.

Multiple downlink commands can be put on single downlink frame.

Downlinks are acknowledged using DownlinkAck bit in uplink frame. It changes state from 0 to 1 and vice versa when device has received valid uplink. DownlinkAck doesn't change if all parts of downlink are not valid. Only limitation how many commands can be put in single frame is maximum length of downlink message which depends on devices data rate.

Example downlink 0101010226E204 consists of two commands 010101 and 0226E204. On first transmit interval is changed to 15 minutes. On second part link check interval is changed to 1250 minutes.

Command	Data	Data Length	Default	Max	Min	Description
0x0101	Transmit interval	1 byte	4 (2h)	0	7	Transmission interval in minutes Range: 10min – 12h  0: 10 minutes 1: 15 minutes 2: 30 minutes 3: 1h 4: 2h 5: 4h 6: 6h 7: 12h
0x0102	Measurement mode	1 byte	0	1 (Average mode)	0 (Single mode)	Measurement mode
0x0103	Data duplicated	1 byte	1	1 (Enabled)	0 (Disabled)	Previous measurement data is appended to end of current frame. When current data ends to partial byte the duplicated data starts on next full byte.
0x020D	Rejoin delay	2 byte	10080 (7d)	43200 (31d)	0 (Disabled)	Rejoin delay. Time after device rejoins if no downlinks from network has been received. LSB: 1min
0x0226	Link check interval	2 bytes	1440 (1d)	43200 (31d)	0 (Disabled)	Start time for link checking if no downlink frames has been received (Doesn't need to be downlink data frame). LSB: 1min



Company: Small Data Garden Oy  
Product name: IOTSU® CO<sub>2</sub> for LoRaWAN®  
Product code: IOTSU\_L3\_AQ05  
Revision: 1.3\_20<sup>th</sup> May 2024

## 9 Legal notices

Small Data Garden Oy's (SDG) products (IOTSU® Products) shall be used according to the manual and other instructions and not be used in any other way than their intended use defined by SDG.

The user right of the firmware of SDG is limited to the version and specifications confirmed by SDG. Any unauthorised usage of device is prohibited and must be suspended by request of SDG. In addition, SDG is entitled to charge for unauthorised usage including administrative and solving cost. SDG shall not be responsible for damages caused by the user connecting the SDG's products (IOTSU® Products) and/or using the IOTSU® Products in any other way than their intended use nor for any damages caused by materials or product design defined by the client or by the working or manufacturing processes the client has determined.

IOTSU® Products are designed for collecting non-critical situational data and the IOTSU® Products are not intended to be used for life and security critical solutions. We rely on high-quality sensor, component and software suppliers and manufacturers and IT, LP-WAN and cloud service providers. However, for the reason that the accuracy and redundancy is depended among other things on operating circumstances, radiotechnology specifications and coverage, and because SDG relies on specifications provided by its suppliers, SDG will not be held liable for any damage which may result from inaccurate readings.

All information, including product design and specifications, in this document is subject to change without notice. SDG reserves all rights to revise or update information in this document without prior notice. SDG assumes no responsibility for any errors that may appear in this document.

In case regular calibration of IOTSU® Products is needed, SDG shall not be responsible for this, and it is the customer's responsibility to obtain calibration from a suitable service provider. For more information see SDG's General Terms and conditions for the supply of products.