



Manual

IOTSU® AQ09 Combo for LoRaWAN®

IOTSU_L7_AQ09





Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

Table of Contents

1	Safety Notes	4
2	Device commissioning	5
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	Removal from the wall	8
2.5	Battery	9
2.5.1	Installing and changing the batteries	10
3	Product disposal	11
4	Device specifications	12
4.1	Dimensions	12
4.2	Device label	12
4.3	Appkey	13
4.4	Manufacturer	13
4.5	Error and malfunction situations	13
5	Datasheet	14
6	Functional description	15
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	18
6.4	Data duplication	18
6.5	Button	18
6.6	Alerts	18
6.6.1	Alert And/Or	19



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

6.6.2	Alert LED blinking	19
6.7	Device LEDs	20
6.7.1	Startup	20
6.7.2	Button	20
6.7.3	Alert20	
7	Sensors	21
7.1	Temperature and humidity sensors	21
7.2	CO ₂ sensor	21
7.2.1	Sensor calibration	21
7.3	tVOC sensor	22
7.4	PM sensor	22
7.4.1	Stabilation algorithm	22
8	Uplinks	23
8.1	Measurement ranges and resolutions	23
8.2	Normal (Fport 1) and delayed uplink (Fport 3)	24
8.3	Alert uplink (Fport 2)	25
8.4	Single uplink (Fport 4)	25
8.5	Parsing example for normal frame	26
9	Downlinks	28
10	Legal notices	34



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

1 Safety Notes

This manual is intended only for IOTSU® AQ09 Combo 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.



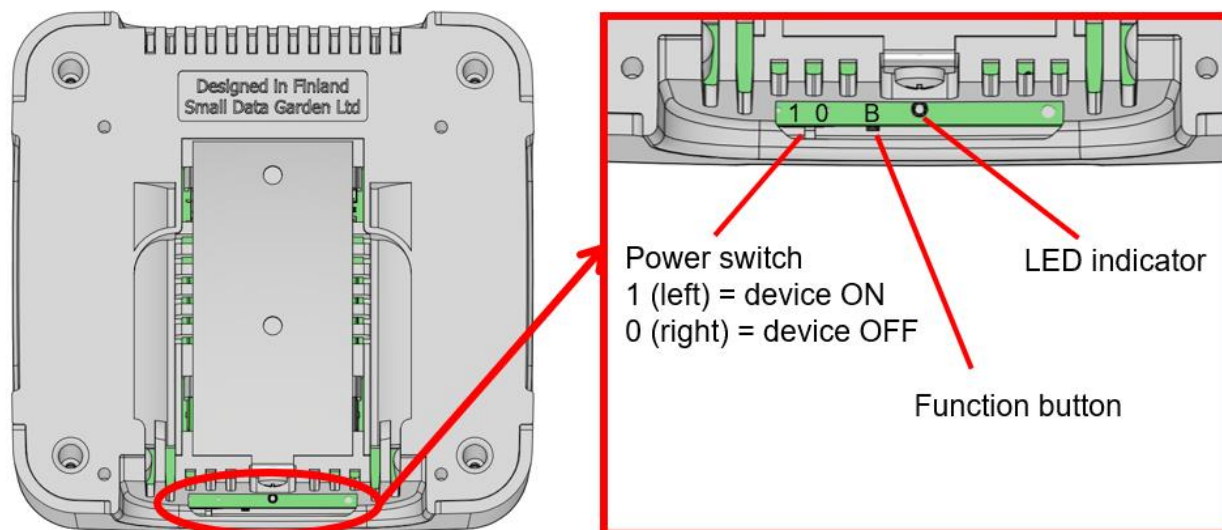


Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

2 Device commissioning

2.1 Powering the device

Devices are delivered power OFF. To power on the device, use a small tool, such as a small screwdriver, to slide the power switch to the ON position. 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® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th 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	Restart the device by sliding the power switch to the OFF position for about one minute and power on the device. When the LED lights up and stays on for 1—2 seconds you can continue installing the device. (See 2.1 Powering the device).
The LED does not light up after restarting the device	If the LED does not light up at all, batteries is empty or the device is broken. Replace the batteries with new ones. If changing the batteries 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. Restart the device by sliding the power switch to the OFF position for about one minute and power on the device. If the error persists, please contact the seller of the device.

2.3 Installation

IOTSU® L7 can be wall mounted with adhesive tape or screws. Please note during installation that IOTSU® L7 uses radio signals for cloud communication and therefore large metal objects such as metal walls and enclosures near the device may negatively impact the radio performance of the device.

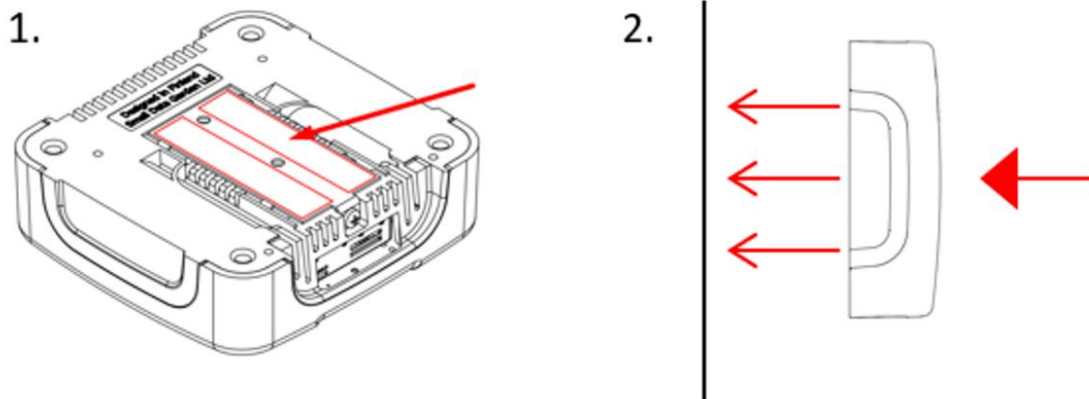


Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

2.3.1 Using double-sided tape

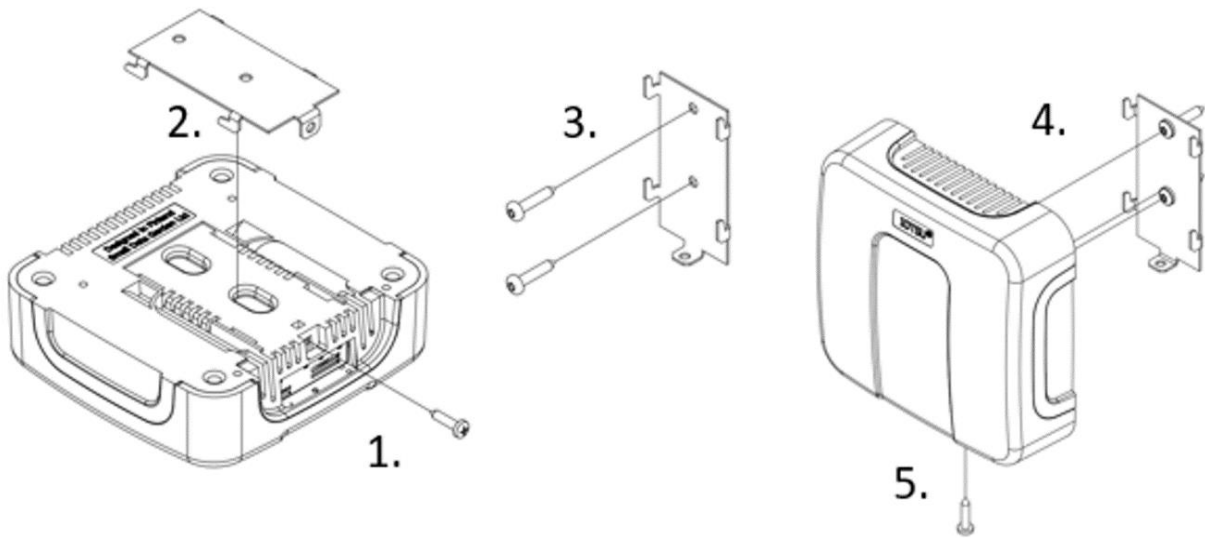
Use low VOC double-sided tape to mount the device. Please note that using other than low VOC tape may affect tVOC measurement values.

1. Place tape on the metal mounting plate.
 - a. Tape size: 19 x 70 mm (2 pcs).
2. Clean the installation surface well before starting. Install the device at a height of ≤ 2 meters. Remove the covers from the installation tapes. Press the device firmly on the wall and hold for 10 seconds.



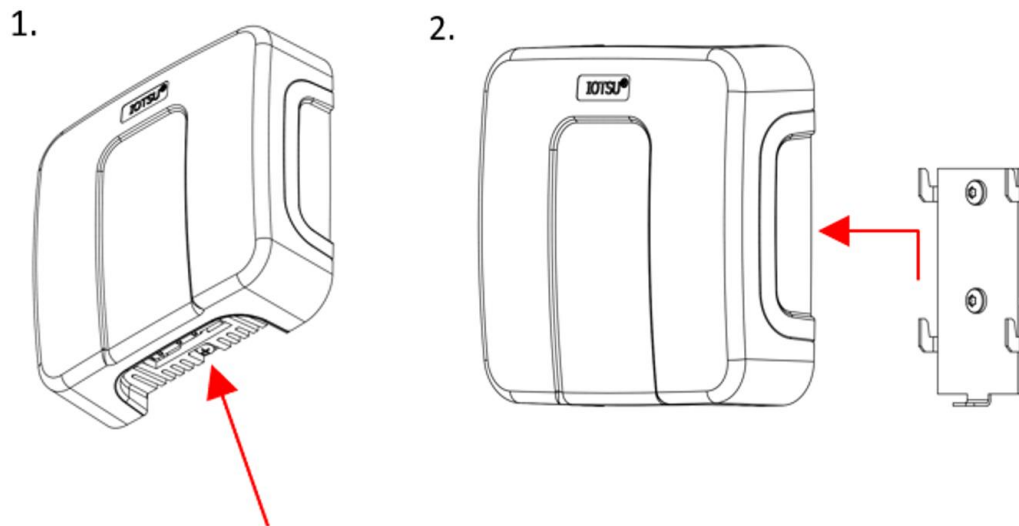
2.3.2 Using screws

1. Remove the T20 securing screw.
2. Slide the mounting plate off.
3. Install the mounting plate to the wall at height ≤ 2 meters using suitable mounting screws. The screws are not included with the device.
4. Place the IOTSU® device on the mounting plate.
5. Secure using the T20 securing screw.



2.4 Removal from the wall

1. Locate the T20 securing screw and remove it.
2. Slide the device slightly upwards and pull away from the wall.





Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

2.5 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.

Recommended battery type: EVE ER34615S

Battery quantity: 2 pcs

The device can operate with other comparable size D 3.6V Lithium (Li-SOCL₂) 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 from same production batch. Using other than recommended batteries or not following manufacturer's battery instructions can cause serious risk to life and material.

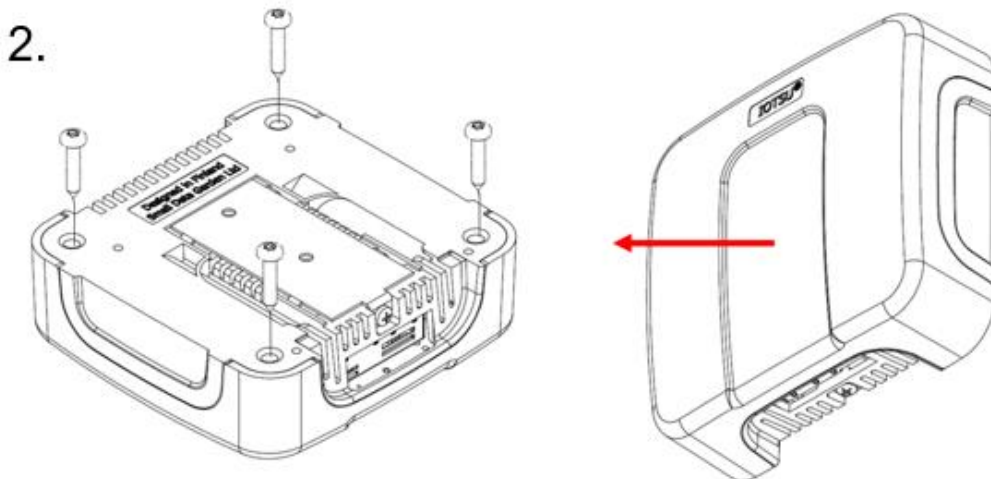
Battery replacement may only be performed by a sufficiently skilled person following the instructions found in the user manual or manufacturer's authorized service representative.

The two lithium batteries inside the device are wired in series, which means that the initial battery voltage of the device is around 7,4 volts. Due to the nature of lithium primary batteries the discharge curve is not linear. The voltage stays very close to the initial voltage level for most of the lifetime of the battery, and the voltage starts to drop rapidly only once the batteries are almost empty. The battery is almost empty when the battery voltage decreases to around 5 volts.

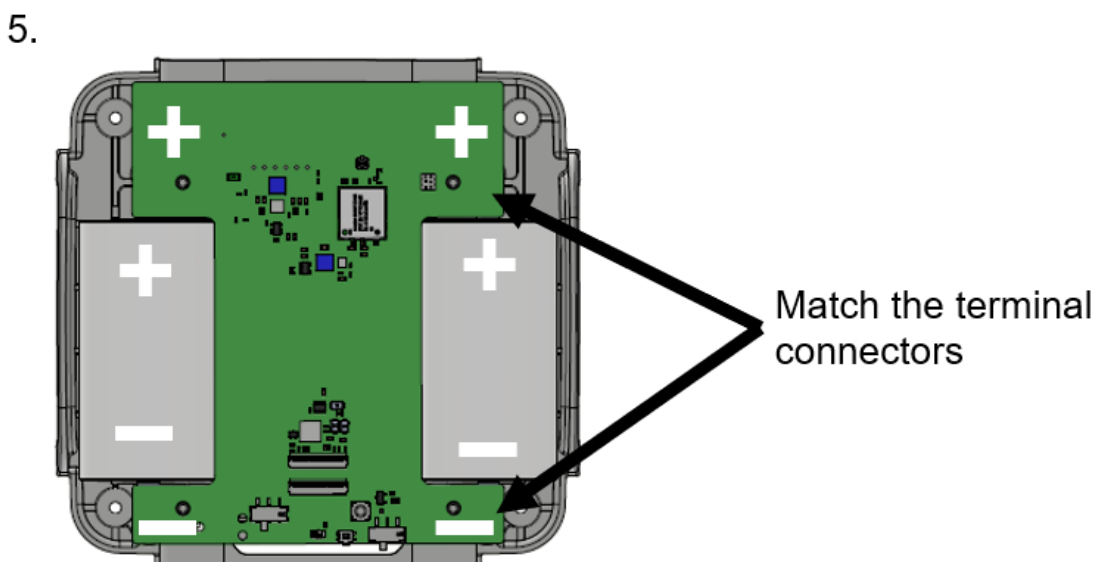
The battery voltage information can be found in all the uplink messages sent by the device.

2.5.1 Installing and changing the batteries

1. Ensure that you are using the recommended battery type by the manufacturer.
2. Remove four screws behind the device and remove the cover.



3. Turn OFF the device (See [2.1 Powering the device](#)).
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. Install new batteries. Use only fresh batteries from same production batch. Pay attention to the polarity of the batteries and match the terminal connectors. **NOTE!** Installing batteries incorrectly may damage the device and cause serious risk to life and material.



6. Wait for 1 minute and turn ON the device. LED indicator stays on for 1—2 seconds and goes out (See [2.1 Powering the device](#)).
7. Close the enclosure and secure using the four removed screws.
8. Dispose of used batteries 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® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th 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. The product's packaging can be recycled for carton waste collection.

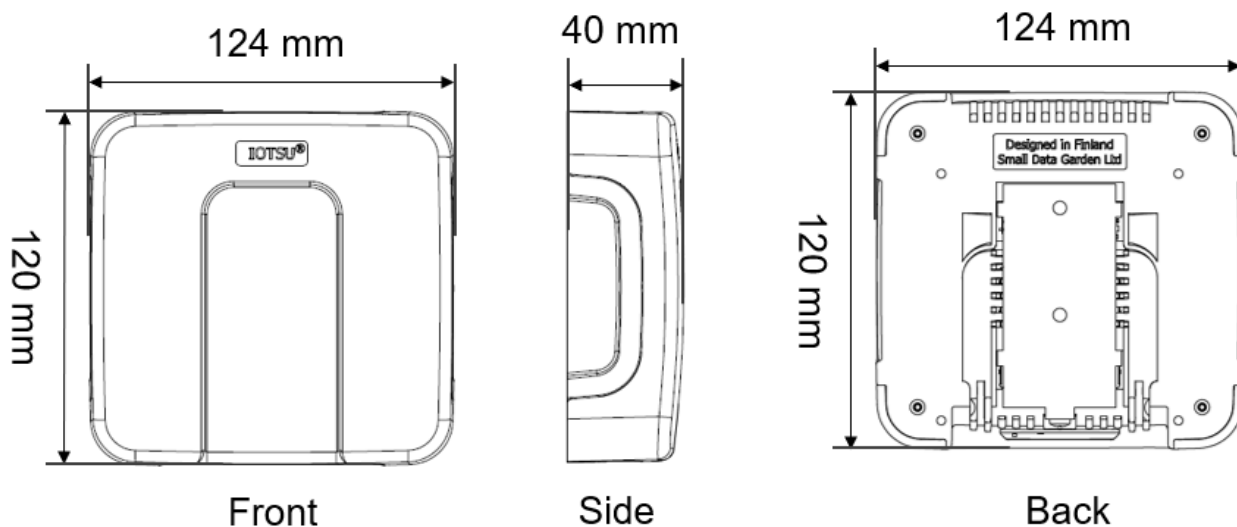


Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

4 Device specifications

4.1 Dimensions

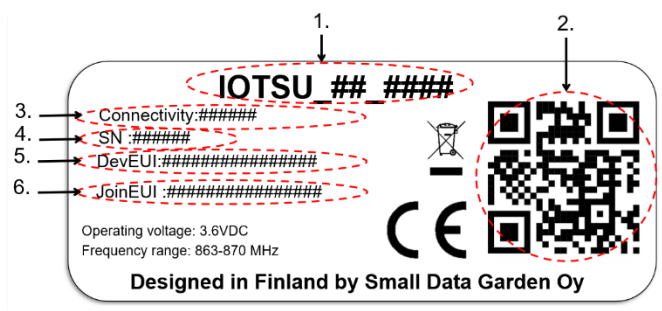
The dimensions of the device can be found in the picture below.



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



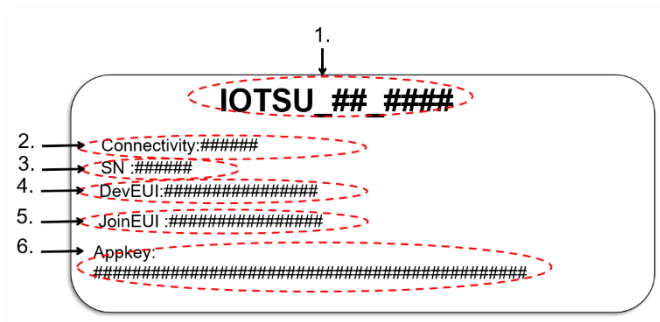


Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

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
 E-mail address 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® AQ09 Combo for LoRaWAN®
Product code: IOTSU®L7 AQ09
Rev: 1.2_21stDec 2023



IOTSU® AQ09 Combo for LoRaWAN®

IOTSU® AQ09 Combo is a wireless indoor device designed for measuring and recording of changes in air quality. Air quality is assessed as a combination of particulate matter, temperature, humidity, and the concentration of carbon dioxide (CO₂) and volatile organic compounds (tVOC).

The device can be mounted on any surface within the monitored space. Installation of this maintenance-free device is quick and easy. Transmission and measurement cycles can be adjusted according to the need.

IOTSU® AQ09 Combo 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
- CO₂, tVOC & PM

TECHNICAL SPECIFICATIONS:

Dimensions	:	124 x 120 x 40 mm
Weight	:	445 g with battery
Sensors	:	Particulate Matter, CO ₂ , tVOC, Temperature, Humidity
Transmission cycle	:	1 h, adjustable
Measurement cycle	:	Transmission cycle /2, adjustable
Connectivity	:	LoRaWAN®
Battery	:	2 x Size D, 3.6 V, lifetime with default settings 5 years, replaceable
Operating Conditions	:	0 °C...50 °C, Relative humidity 20...80 % (Non-condensing)
Typical Accuracy	:	Temperature: ±0.2 °C Humidity: ±2 %, CO ₂ : ±30 ppm ±3 % of reading, tVOC: ±15 %, PM2.5: ±10 µg/m ³ , PM10: ±25 µg/m ³
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.

// SOLUTIONS FOR REAL ESTATE AND APARTMENTS MANAGEMENT://



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th 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® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th 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® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

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

An exception to this is sensors with static measurement intervals (tVOC). The sensor sampling interval on these sensors cannot be changed and, with those sensors, the latest successful measurement made inside the measurement slot will be used as the current measurement slot value. If there are no measurements made in the measurement slot, an error value is sent instead.

Some sensors require a brief moment of time to capture the measurement. This has been taken into account by aligning the actual capture time with the measurement slot changing time. For example, the PM sensor requires a few seconds to capture a measurement and is thus started before slot change to get the reading as close as possible to the measurement slot change.

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.



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

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.

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 Button

The device might have a button which the user can use. There are four options for button function: “No action”, “Reset”, “Transmit message” and “Measure and send message”. In “No action” mode button doesn’t do anything. In “Reset” mode device resets itself after button has been released. Last two options are “Transmit message” and “Measure and send message”. Difference between the two is that in “Transmit message” the button press makes the device send an uplink message containing the previous measurements. In “Measure and send message” mode the device first captures new measurements and then sends them out. The measurement triggered by the latter is not considered for alert validation or average calculation.

6.6 Alerts

Device has an alert function which allows to configure value thresholds for the sensors, and after a measurement exceeds that limit the device sends a dedicated alert uplink. This function enables, for instance, setting a long standard transmission interval for battery conservation, but still having a fast response time when a change occurs in the measured values.



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

Alerts are checked after each measurement sample. The device provides both a high and a low limit for each measured value. On the other hand, each alert has a configurable limit, hysteresis, trigger count, release count, message limit and command type. Limit is the absolute threshold limit when an alert is triggered. In high limit if current measurement value is higher than limit, an alert will be triggered. If current value is lower than the limit, minus hysteresis, an alert release will be issued. Low limit works vice versa.

The trigger count and release count can be used to check if the alert conditions have been triggered multiple times before actually setting or releasing an alert. If the alarm is triggered more than the trigger count, then an alert will be triggered. If the release is triggered more than the release limit, then an alert will be released and the alert cleared.

Once an alert is activated and the device is configured to send an uplink message, the alert uplink message will be sent one or more times. The message limit dictates how many times the alert message will be sent. If message limit is 0 alert is transmitted when the alert is triggered, and the device will stop transmitting alert messages only when the alert is released. The alert transmit interval can be configured independently of standard transmit interval.

6.6.1 Alert And/Or

In “OR” state any triggered alert starts an alert message transmission. In “AND” state all enabled alerts need to be in triggered state to allow alert message transmission.

6.6.2 Alert LED blinking

There is a two-step blink sequence which can be used for indicating alert by blinking the indication LED. When an alert is triggered, the device will start the first blinking routine, and when the first blink sequence has ended the device moves to the second routine. After finishing the second blink sequence the LED is turned off. This enables, for instance, having the device start by blinking fast and “aggressively” when an alert is initially triggered and then move to a more subtle and “calm” blinking sequence to conserve battery life.



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

6.7 Device LEDs

Device has an LED light which is used during device start-up sequence, when the device button is pressed, or when an alert is indicated.

6.7.1 Startup

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

6.7.2 Button

When the button is pressed the LED lights up to indicate that the button press has been registered.

6.7.3 Alert

Please see section: [Alert LED blinking](#).



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

7 Sensors

7.1 Temperature and humidity sensors

Sensirion SHT40 is used as temperature sensor.

7.2 CO₂ sensor

The device uses the Senseair Sunrise CO₂ (Carbon Dioxide) sensor. This sensor default measurement interval is 120s. The device utilises the sensor's filtered CO₂ measurement.

7.2.1 Sensor calibration

CO₂ sensor has multiple calibration options. ABC (Automatic Baseline Correction), target calibration, background calibration, zero calibration, and factory calibration.

ABC calibration is enabled by default, and it is utilised to minimise effects of sensor aging. ABC assumes that lowest value measured in ABC correction interval is equivalent to known outdoor CO₂ level. If the device is often not exposed to outdoor CO₂ level in ABC period, the ABC correction should be disabled to prevent CO₂ value offsetting from correct value. If ABC calibration is disabled device CO₂ sensor might need recalibration in certain intervals to ensure correct CO₂ measurements.

Target calibration is intended for performing a manual calibration in a controlled calibration environment. The device needs to be supplied with the known target value while the device is in the controller environment.

Background calibration is intended for performing a manual calibration in a controlled calibration environment. During the calibration the device uses the ABC target as the known target value. The device needs to be in a controlled environment where the CO₂ level is equivalent to known outdoor CO₂ level.



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

Zero calibration is intended for performing a manual calibration in a controlled calibration environment. During the calibration the device uses zero as the known target value. The device needs to be in a controlled environment where the CO₂ concentration is zero, such as, for example, in a nitrogen-filled test enclosure.

Factory calibration returns the sensor calibration to the same values it was at factory.

7.3 tVOC sensor

Renesas ZMOD4410 is used as tVOC sensor. tVOC sensor has static measurement interval. Sensor does not save any calibration parameters between device power cycles and need time to stabilize after the device power has been reset.

7.4 PM sensor

Sensirion SPS30 is used as PM (Particulate Matter) sensor.

7.4.1 Stabilisation algorithm

Device has PM stabilisation algorithm which helps sensor to determine when it has reached final value and sensor can be powered down.

Algorithm compares current and previous PM2.5 measurement and checks if absolute change or percentage change is in preset limits. If PM2.5 value change is in either one of two limits sensor is powered down. If algorithm is used measurement time is at least 9 seconds because sensor startup time is 8 seconds and new measurement comes in every second.

Absolute pressure sensor is used for pressure correction of CO₂ sensor.



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

8 Uplinks

8.1 Measurement ranges and resolutions

- Temperature
 - Range: -40 - +80°C
 - Resolution: 0.1°C
- Relative humidity
 - Range: 0-100 %rH
 - Resolution: 0.1 %rH
- Carbon dioxide, CO₂
 - Range: 200-5000 ppm
 - Resolution: 1 ppm
- Total Volatile Organic Compounds, tVOC
 - Range: 0-2000 µg/m³
 - Resolution: 1 µg/m³
- Particulate matter, PM2.5 and PM10
 - Range: 0-1000 µg/m³
 - Resolution: 1 µg/m³



Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

8.2 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 50 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 receive		
1.4	1	Reserved		Reserved for future use		
1.5 - 1.7	3	Transmit interval		Current transmit interval	*	
2.0 - 3.1	10	Humidity #1	Standard payload	Humidity at the end of the second measurement period (newest data).	LSB 0.1%rH	
3.2 - 4.7	14	Temperature #1		2nd period	Temperature at the end of the second measurement period (newest data). Two's complement.	LSB 0.1°C
5.0 - 6.7	16	CO ₂ #1		CO ₂ at the end of the second measurement period (newest data).	LSB 1 + 200 ppm	
7.0 - 8.7	16	tVOC #1		tVOC at the end of the second measurement period (newest data).	LSB 1 µg/m ³	
9.0 - 10.3	12	PM2.5 #1		PM2.5 at the end of the second measurement period (newest data).	LSB 1 µg/m ³	
10.4 - 11.7	12	PM10 #1		PM2.5 at the end of the second measurement period (newest data).	LSB 1 µg/m ³	
12.0 - 13.1	10	Humidity #2		1st period	Humidity at the end of the first measurement period (oldest data).	LSB 0.1%rH
13.2 - 14.7	14	Temperature #2		Temperature at the end of the first measurement period (oldest data). Two's complement.	LSB 0.1°C	
15.0 - 16.7	16	CO ₂ #2		CO ₂ at the end of the first measurement period (oldest data).	LSB 1 ppm + 200	
17.0 - 18.7	16	tVOC #2		tVOC at the end of the first measurement period (oldest data).	LSB 1 µg/m ³	
19.0 - 20.3	12	PM2.5 #2	PM2.5 at the end of the first measurement period (oldest data).	LSB 1 µg/m ³		
20.4 - 21.7	12	PM10 #2	PM10 at the end of the first measurement period (oldest data).	LSB 1 µg/m ³		
22.0 - 23.1	10	Humidity #1	Standard payload	Humidity at the end of the second measurement period of the previous transmission.	LSB 0.1%rH	
23.2 - 24.7	14	Temperature #1		2nd period	Temperature at the end of the second measurement period of the previous transmission. Two's complement.	LSB 0.1°C
25.0 - 26.7	16	CO ₂ #1		CO ₂ at the end of the second measurement period of the previous transmission.	LSB 1 + 200 ppm	
27.0 - 28.7	16	tVOC #1		tVOC at the end of the second measurement period of the previous transmission.	LSB 1 µg/m ³	
29.0 - 30.3	12	PM2.5 #1		PM2.5 at the end of the second measurement period of the previous transmission.	LSB 1 µg/m ³	
30.4 - 31.7	12	PM10 #1		PM2.5 at the end of the second measurement period of the previous transmission.	LSB 1 µg/m ³	
32.0 - 33.1	10	Humidity #2		1st period	Humidity at the end of the first measurement period of the previous transmission.	LSB 0.1%rH
33.2 - 34.7	14	Temperature #2		Temperature at the end of the first measurement period of the previous transmission. Two's complement.	LSB 0.1°C	
35.0 - 36.7	16	CO ₂ #2		CO ₂ at the end of the first measurement period of the previous transmission.	LSB 1 + 200 ppm	
37.0 - 38.7	16	tVOC #2		tVOC at the end of the first measurement period of the previous transmission.	LSB 1 µg/m ³	
39.0 - 40.3	12	PM2.5 #2	PM2.5 at the end of the first measurement period of the previous transmission.	LSB 1 µg/m ³		
40.4 - 41.7	12	PM10 #2	PM10 at the end of the first measurement period of the previous transmission.	LSB 1 µg/m ³		



Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

8.3 Alert uplink (Fport 2)

Alert uplinks are transmitted when alert is triggered.

Bits	Bit length	Data		Description	Formula
0.0-0.7	8	Battery voltage	Information	Device battery voltage	LSB 50 mV
1.0-1.2	1	Reserved		Reserved for future use	
1.3	1	Downlink command ack		Alternates on each successful downlink receive	
1.4 – 1.7	1	Reserved		Reserved for future use	
2.0 - 3.1	10	Humidity		Humidity	LSB 0.1%RH
3.2 - 4.7	14	Temperature		Temperature. Two's complement.	LSB 0.1°C
5.0 – 6.7	16	CO ₂		CO ₂	LSB 1 + 200 ppm
7.0 – 8.7	16	tVOC		tVOC	LSB 1 µg/m ³
9.0 – 10.3	12	PM2.5		PM2.5	LSB 1 µg/m ³
10.4 – 11.7	12	PM10		PM10	LSB 1 µg/m ³

8.4 Single uplink (Fport 4)

Uplink is transmitted when button is pushed, and function is selected.

Bits	Bit length	Data		Description	Formula
0.0-0.7	8	Battery voltage	Information	Device battery voltage	LSB 50 mV
1.0-1.2	1	Reserved		Reserved for future use	
1.3	1	Downlink command ack		Alternates on each successful downlink receive	
1.4 – 1.7	1	Reserved		Reserved for future use	
2.0 - 3.1	10	Humidity		Humidity	LSB 0.1%RH
3.2 - 4.7	14	Temperature		Temperature. Two's complement.	LSB 0.1°C
5.0 – 6.7	16	CO ₂		CO ₂	LSB 1 + 200 ppm
7.0 – 8.7	16	tVOC		tVOC	LSB 1 µg/m ³
9.0 – 10.3	12	PM2.5		PM2.5	LSB 1 µg/m ³
10.4 – 11.7	12	PM10		PM10	LSB 1 µg/m ³



Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

8.5 Parsing example for normal frame

Payload 0x8E436440DC00DC049C0020026400DC00DC04F60020026400DC00DC04E000100163C0DC00DC0486001001

Byte	1	2
	8E	43
Offset	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7
Bit	1 1 1 1	1 1 1 1
	Battery	

Byte	3	4	5	6	7	8	9	10	11	12
	64	40	DC	00	DC	04	9C	00	20	02
Offset	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7
Bit	1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1	1	1
	Humidity #1	Temperature #1		CO2 #1		tVOC #1		PM2.5 #1		PM10 #1

Byte	13	14	15	16	17	18	19	20	21	22
	64	00	DC	00	DC	04	F6	00	20	02
Offset	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7
Bit	1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1 1 1	1 1 1 1 1 1 1	1	1	1
	Humidity #2	Temperature #2		CO2 #2		tVOC #2		PM2.5 #2		PM10 #2

Byte	23	24	25	26	27	28	29	30	31	32
	64	00	DC	00	DC	04	E0	00	10	01
Offset	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7
Bit	1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1 1 1	1	1	1
	Duplicated Humidity #1	Duplicated Temperature #1		Duplicated CO2 #1		Duplicated tVOC #1		Duplicated PM2.5 #1		Duplicated PM10 #1

Byte	33	34	35	36	37	38	39	40	41	42
	63	C0	DC	00	DC	04	86	00	10	01
Offset	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7	0 1 2 3 4 5 6 7
Bit	1 1 1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1	1 1 1 1 1 1 1	1 1 1 1 1 1 1	1	1	1
	Duplicated Humidity #2	Duplicated Temperature #2		Duplicated CO2 #2		Duplicated tVOC #2		Duplicated PM2.5 #2		Duplicated PM10 #2



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

Battery voltage: 10001110
Measurement mode: 0
Data duplication: 1
Reserved: 0
Downlink command ack: 0
Reserved: 0
Transmit interval: 011
Humidity #1: 0110010001
Temperature #1: 0000011011100
CO2 #1: 000000011011100
tVOC #1: 0000010010011100
PM2.5 #1: 000000000010
PM10 #1: 000000000010
Humidity #2: 0110010001
Temperature #2: 0000011011100
CO2 #2: 000000011011100
tVOC #2: 0000010010011100
PM2.5 #2: 000000000010
PM10 #2: 000000000010
Duplicated Humidity #1: 01 10010000
Duplicated Temperature #1: 000000 11011100
Duplicated CO2 #1: 00000000 11011100
Duplicated tVOC #1: 00000100 11100000
Duplicated PM2.5 #1: 0000 00000001
Duplicated PM10 #1: 0000 00000001
Duplicated Humidity #2: 01 10001111
Duplicated Temperature #2: 000000 11011100
Duplicated CO2 #2: 00000000 11011100
Duplicated tVOC #2: 00000100 10000110
Duplicated PM2.5 #2: 0000 00000001
Duplicated PM10 #2: 0000 00000001

Decimal 142 * 50 mV = **7100 mV**

Single measurement mode

Data duplicated

Decimal 3 = **1 hour**

Decimal 401 / 10 = **40.1 %rH**

Decimal 220 / 10 = **22,0 °C**

Decimal 220 + 200 = **420 ppm**

Decimal 1180 = **1180 µg/m3**

Decimal 2 = **2 µg/m3**

Decimal 2 = **2 µg/m3**

Decimal 400 / 10 = **40.0 %rH**

Decimal 220 / 10 = **22,0 °C**

Decimal 220 + 200 = **420 ppm**

Decimal 1270 = **1270 µg/m3**

Decimal 2 = **2 µg/m3**

Decimal 2 = **2 µg/m3**

Decimal 400 / 10 = **40.0 %rH**

Decimal 220 / 10 = **22,0 °C**

Decimal 220 + 200 = **420 ppm**

Decimal 1248 = **1248 µg/m3**

Decimal 1 = **1 µg/m3**

Decimal 1 = **1 µg/m3**

Decimal 399 / 10 = **39.9 %rH**

Decimal 220 / 10 = **22,0 °C**

Decimal 220 + 200 = **420 ppm**

Decimal 1158 = **1270 µg/m3**

Decimal 1 = **1 µg/m3**

Decimal 1 = **1 µg/m3**

Time: Transmit time

Time: Transmit time

Time: Transmit time

Time: Transmit time

Time: Transmit time

Time: Transmit time

Time: Transmit time – 30min

Time: Transmit time – 30min

Time: Transmit time – 30min

Time: Transmit time – 30min

Time: Transmit time – 30min

Time: Transmit time – 30min

Time: Transmit time – 1h

Time: Transmit time – 1h

Time: Transmit time – 1h

Time: Transmit time – 1h

Time: Transmit time – 1h

Time: Transmit time – 1h

Time: Transmit time – 1.5h

Time: Transmit time – 1.5h

Time: Transmit time – 1.5h

Time: Transmit time – 1.5h

Time: Transmit time – 1.5h

Time: Transmit time – 1.5h



Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

9 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	3 (1h)	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.
0x0009	Restore default settings					Send hex string to reset device 0x524553544f5245 Device resets after this command has been issued.



Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

0x0006	Restart device					Send hex string to reset device 0x5245534554 Device resets after this command has been issued.
0x0104	Button mode	1 byte	0	3	0	0: No action 1: Reset device 2: Transmit 3: Measure and transmit
0x0110	Tx setting 0 time	2 bytes	10	1440	1	Tx setting 0 time LSB: 1min
0x0120	Tx Setting 0 ADR Ack Limit	1 byte	8	15	0	ADR ACK Limit for TX 0 setting. Limit = value ^ 2
0x0130	Tx Setting 0 ADR Ack Delay	1 byte	4	15	0	ADR ACK Delay for TX 0 setting. Limit = value ^ 2
0x013A	Measurement slots	1 byte	2	4	1	Measurement slots on each TX interval
0x0156	Send empty uplink frame	No data				Device sends an empty uplink frame if no other frame transmission is pending.
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
0x010C	Alert Tx interval	2 bytes	600 (10min)	65535	10 (10s)	Alert tx interval LSB: 1s
0x013B	Confirmed alert frames	1 byte	0	1 (Confirmed frames)	0 (Unconfirmed frames)	Currently no useful because device doesn't retry transmission if failed.
0x0158	Alert value selection	1 byte	1	1 (Maximum value)	0 (Current value)	
0x0157	Alert frames stop tx after downlink	1 byte	1	1 (Stop)	0 (Don't stop)	
0x0148	Alert And / Or	1 byte	0 (OR)	1 (AND)	0 (OR)	Selection if all enabled alerts or single enabled alert causes transmission or led blinkin
0x0149	Alert AND Function	1 byte	0			0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x0159	Alert AND Message limit	1 byte	1	5 (5 messages)	0 (No limit)	
0x013E	Alert blink 1 sequences	2 bytes	0	65535	0 (Unlimited)	Number of blink sequences after moving to next blink setting
0x013F	Alert blink 1 on time	2 bytes	100	65535	0 / 25	Blink on time in milliseconds. If value is less than 25 then blink setting is disabled. LSB: 1ms
0x0140	Alert blink 1 off time	2 bytes	900	65535	0 / 25	Blink off time in milliseconds. If time less than 25 then led is constantly on and off time is skipped. On this situation time is calculated sequences*dead_time on time in seconds. LSB: 1ms
0x0141	Alert blink 1 count	2 bytes	5	65535	1	Number of blinks in each sequence
0x0142	Alert blink 1 dead time	2 bytes	15	65535	0	Dead time between sequences. LSB: 1s



Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

0x0143	Alert blink 2 sequences	2 bytes	0	65535	0 (Unlimited)	Number of blink sequences after moving to next blink setting
0x0144	Alert blink 2 on time	2 bytes	100	65535	0 / 25	Blink on time in milliseconds. LSB: 1ms
0x0145	Alert blink 2 off time	2 bytes	900	65535	0 / 25	Blink off time in milliseconds. LSB: 1ms
0x0146	Alert blink 2 count	2 bytes	5	65535	1	Number of blinks in each sequence
0x0147	Alert blink 2 dead time	2 bytes	15	65535	0	Dead time between sequences. LSB: 1s
0x014B	Temperature measurement interval	2 bytes	120	65535	5	Temperature (also humidity it is measured) measurement interval in seconds
0x040D	Temperature alert command high	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x040E	Temperature alert command low	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x0401	Temperature high limit	2 bytes	-32768	32767	-32768	Depends on maximum and minimum values. Max is max value- 1LSB. Min is min value + 1LSB. LSB. 0.1
0x0403	Temperature high trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.
0x0404	Temperature high release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x0409	Temperature high message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0402	Temperature low limit	2 bytes	-32768	32767	-32768	Depends on maximum and minimum values. Max is max value- 1LSB. Min is min value + 1LSB. LSB. 0.1
0x0405	Temperature low trigger count	1 byte	0: 1 sample	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.
0x0406	Temperature low release count	1 byte	0: 1 sample	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x040A	Temperature low message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x040B	Temperature high hysteresis	2 byte	0	65535	0	Hysteresis between alert trigger and release limits.
0x040C	Temperature low hysteresis	2 byte	0	65535	0	Hysteresis between alert trigger and release limits.
0x041B	Humidity alert command high	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x041C	Humidity alert command low	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x0411	Humidity high limit	1 bytes	255	255	0	Depends on maximum and minimum values. Max is max value- 1LSB. Min is min value + 1LSB
0x0413	Humidity high trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.



Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

0x0414	Humidity high release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x0419	Humidity high message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0412	Humidity low limit	1 byte	255	255	0	Depends on maximum and minimum values. Max is max value- 1LSB. Min is min value + 1LSB
0x0415	Humidity low trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.
0x0416	Humidity low release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x041A	Humidity low message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0417	Humidity high hysteresis	1 byte	0	255	0	Hysteresis between alert trigger and release limits.
0x0418	Humidity low hysteresis	1 byte	0	255	0	Hysteresis between alert trigger and release limits.
0x0151	CO2 measurement interval	2 bytes		65535	10	Measurement interval in seconds
0x042B	CO2 alert command high	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x042C	CO2 alert command low	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x0421	CO2 high limit	2 bytes	65535	65535	0	
0x0423	CO2 high trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.
0x0424	CO2 high release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x0429	CO2 high message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0422	CO2 low limit	2 bytes	65535	65535	0	
0x0425	CO2 low trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.
0x0426	CO2 low release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x042A	CO2 low message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0427	CO2 high hysteresis	2 byte	0	65535	0	Hysteresis between alert trigger and release limits.
0x0428	CO2 low hysteresis	2 byte	0	65535	0	Hysteresis between alert trigger and release limits.
0x0301	CO2 sensor ABC calibration state	1 byte	1	1	0	CO2 sensor ABC calibration state Default: 1 Enabled 0: Disabled 1: Enabled
0x0302	CO2 sensor ABC period	2 bytes	180	65534	1	ABC period in hours
0x0303	CO2 sensor Background and ABC level	2 bytes	400	65535	0	Background and ABC calibration level in PPM
0x0304	CO2 sensor Target level	2 bytes	0	65535	0	Target level in PPM
0x0324	CO2 sensor Pressure correction	1 byte	1	1	0	Pressure correction enabled



Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

0x0305	CO2 sensor Offset	2 bytes	0	32767	-32768	CO2 sensor value offset
0x0322	CO2 calibrate	1 byte				Starts sensor calibration at beginning of next measurement. 2: Factory 3: ABC 4: Target 5: Background 6: Zero
0x0325	Static IIR Filter state	1 byte	1 (Enabled)	1 (Enabled)	0 (Disabled)	Check Senseair Sunrise datasheet.
0x0326	Dynamic IIR Filter state	1 byte	1 (Enabled)	1 (Enabled)	0 (Disabled)	Check Senseair Sunrise datasheet.
0x0327	Static IIR Filter value	1 byte		10	2	Check Senseair Sunrise datasheet.
0x0328	CO2 info message types	1 byte	0	2	0	0: Disabled 1: Calibrations (user triggered) 2: Settings and calibrations (user triggered) 3: Settings and all calibrations
0x043B	tVOC alert command high	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x043C	tVOC alert command low	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x0431	tVOC high limit	2 bytes	65535	65535	0	
0x0433	tVOC high trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.
0x0434	tVOC high release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x0439	tVOC high message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0432	tVOC low limit	2 bytes	65535	65535	0	
0x0435	tVOC low trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.
0x0436	tVOC low release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x043A	tVOC low message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0437	tVOC high hysteresis	2 byte	0	65535	0	Hysteresis between alert trigger and release limits.
0x0438	tVOC low hysteresis	2 byte	0	65535	0	Hysteresis between alert trigger and release limits.
0x0155	Particle measurement interval	2 bytes		65535	30	Measurement interval in seconds
0x049B	Particle PM2.5 alert command high	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x049C	Particle PM2.5 alert command low	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x0491	Particle PM2.5 high limit	2 bytes	65535	65535	0	
0x0493	Particle PM2.5 high trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.



Company: Small Data Garden Oy
 Product name: IOTSU® AQ09 Combo for LoRaWAN®
 Product code: IOTSU_L7_AQ09
 Revision: 2.0_20th May 2024

0x0494	Particle PM2.5 high release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x0499	Particle PM2.5 high message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0492	Particle PM2.5 low limit	2 bytes	65535	65535	0	
0x0495	Particle PM2.5 low trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.
0x0496	Particle PM2.5 low release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x049A	Particle PM2.5 low message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0497	Particle PM2.5 high hysteresis	2 byte	0	65535	0	Hysteresis between alert trigger and release limits.
0x0498	Particle PM2.5 low hysteresis	2 byte	0	65535	0	Hysteresis between alert trigger and release limits.
0x048B	Particle PM10 alert command high	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x048C	Particle PM10 alert command low	1 byte	0	2	0	0: Transmit alert frame 1: Blink LED 2: Transmit alert frame and blink LED
0x0481	Particle PM10 high limit	2 bytes	65535	65535	0	
0x0483	Particle PM10 high trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.
0x0484	Particle PM10 high release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x0489	Particle PM10 high message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0482	Particle PM10 low limit	2 bytes	65535	65535	0	
0x0485	Particle PM10 low trigger count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples over the limit before alert is triggered.
0x0486	Particle PM10 low release count	1 byte	0	29 (30 samples)	0 (1 sample)	Number of consecutive samples under the limit before alert is released.
0x048A	Particle PM10 low message limit	1 byte	1	5 (5 messages)	0 (No limit)	Number of alert frames to be transmitted when alert is triggered.
0x0487	Particle PM10 high hysteresis	2 byte	0	65535	0	Hysteresis between alert trigger and release limits.
0x0488	Particle PM10 low hysteresis	2 byte	0	65535	0	Hysteresis between alert trigger and release limits.
0x0B02	Particulate matter start time	1 byte	0	24	0	Time before stablilation
0x0B03	Partifuculate matter stablilation time	1 byte	0	24	0	Stablilation time
0x0B04	Particulate matter stablilation value	1 byte	5	255	0 (Disabled)	Maximum difference between current and previous value to mark sensor output as stablilated. Resolution: 0.1
0x0B05	Particulate matter stablilation percentage	1 byte	10	255	0 (Disabled)	Maximum difference in percentage current and previous value to mark sensor output as stablilated. Resolution: 0.1



Company: Small Data Garden Oy
Product name: IOTSU® AQ09 Combo for LoRaWAN®
Product code: IOTSU_L7_AQ09
Revision: 2.0_20th May 2024

10 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.