



Willow Sensors Outdoor Air Quality (CO₂) Sensor User Manual

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Overview

The user manual explains the features of the WS-O-X-AI-AQC-1 LoRaWAN Outdoor Air Quality Sensor. WS-O-X-AI-AQC-1 uses the popular STM32WL55 Cortex-M4 microcontroller of STMicroelectronics. This microcontroller combines a computer unit and a LoRaWAN radio on a single chip. WS-O-X-AI-AQC-1 is fully backed by a 3-year warranty, technical support, and application assistance by BiPOM Electronics, Inc.



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Sensor Features

Sensor Accessories

The sensor consists of 2 parts: Magnet and Main LoRaWAN Sensor Module:





Specifications

LoRaWAN

- Ultra-Low Power
- Suitable for battery operation
- User-programmable
- Configurable power output
- Maximum output power: 22 dBm
- Frequency Bands: US915 /AS915/ AU915/ EU868/CN779/EU433/KR920/IN865/RU86
(Supported but not officially certified in all regions)
- 64 KB of RAM and 256 KB of Flash available for user applications.

Outdoor Air Quality Sensor

- CO2 Measurement Range: 400 to 40000 ppm
- CO2 Accuracy: ± 50 ppm
- Humidity Accuracy: 6 RH%
- Temperature Accuracy: 0.8 °C



Operating Modes

The sensor has two different modes as Deep Sleep Mode and Working Mode.

Idle Mode

In idle mode, the sensor does not have any measurement and LoRaWAN activity. This mode is used to increase battery life.

Working Mode

In this mode, the sensor operates as a LoRaWAN end node and sends out the sensor data to a LoRaWAN server. Between each measurement and transmitting period, the sensor will be in the idle mode.



Sensor Activation

The sensor does not send any LoRaWAN packets after shipping. The user needs to wake up the sensor with a magnet. Then, the sensor starts sending LoRaWAN join-request for 10 times until it joins to the LoRaWAN network. If the sensor cannot join to the LoRaWAN network after 10 attempts, the sensor will switch to Deep Sleep mode to save battery. The user should use magnet again to activate sensor once again.

Note: The magnet should keep for 5 seconds to magnet area.

Note: Use magnet again to deactivate sensor manually.





Payload (Uplink Message) Structure

Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
Battery Level	Internal Temp	CO2 LSB	CO2 MSB	Temp LSB	Temp MSB	Humidity LSB	Humidity MSB

Uplink message consists of 8 bytes which are indicates Battery Level, MCU Temperature, Environment CO2, Environment Temperature, and Humidity, respectively.

- Battery Level (1 byte / 8-bit)
- Internal (MCU) Temperature in Celsius (1 byte / 8-bit)
- CO2 in ppm (2 byte / 16-bit)
- Temperature in Celsius (2 byte / 16-bit)
- Humidity in RH% (2 byte / 16-bit)

Example Payload:

0x64 0x23 0x02F2 0x09C6 0x0F8C

Battery Level: 0x64 equals to 100 in decimal which indicates 100%

Internal Temperature: 0x0023 equals to 35 in decimal which indicates 35 Celsius.

CO2: 0x02F2 equals to 754 in decimal which indicates 754 ppm.

Temperature: 0x09C6 equals to 2502 in decimal which indicates 25.02 Celsius

Humidity: 0x0F8C equals to 3980 in decimal which indicates 39.80 RH%



Downlink Message Structure

The sensor supports downlink messages to perform software reset and to set data transmission interval. The sensor can receive downlink messages only after the sensor sends an uplink message to the LoRaWAN server.

Software Reset Downlink Command

By sending below command one can perform software reset.

Port	Payload
0x0A	0x11

Setting Data Transmission Interval

User can change data transmission interval with the following command to related port address.

Payload indicates time interval in millisecond.

Port	Payload
0x08	0x0A *

* Example payload, means 10 minutes)



Battery Life

Data Rate	Payload Size (Byte)	Interval (minute)	Battery life (25 °C)
DR_0 (SF-10 EU868)	5 Byte	1 minutes	1.5 Year
DR_0 (SF-12 EU868)	5 Byte	5 minutes	5 Years
DR_0 (SF-12 EU868)	5 Byte	10 minutes	10 Years