
AQS01-L -- LoRaWAN CO2 Sensor User Manual

last modified by Saxer Lin
on 2024/09/06 09:06

Table of Contents

1.Introduction	3
1.1 What is AQS01-L LoRaWAN CO2 Sensor	3
1.2 Features	3
1.3 Specification	4
1.4 Applications	5
1.5 Sleep mode and working mode	5
1.6 BLE connection	5
2.Configure AQS01-L to connect to LoRaWAN network	5
2.1 How it works	5
2.2 Quick guide to connect to LoRaWAN server (OTAA)	5
2.3 Uplink Payload	7
2.3.1 Device Status, FPORT=5	7
2.3.2 Sensor Data. FPORT=2	9
2.4 Payload Decoder file	10
2.5 Datalog Feature	10
2.5.1 Ways to get datalog via LoRaWAN	10
2.5.2 Unix TimeStamp	11
2.5.3 Set Device Time	11
2.5.4 Datalog Uplink payload (FPORT=3)	12
2.6 Frequency Plans	13
2.7 Firmware Change Log	14
3.Configure AQS01-L	14
3.1 Configure Methods	14
3.2 General Commands	14
3.3 Commands special design for AQS01-L	14
3.3.1 Set Transmit Interval Time	14
3.3.2 Get Device Status	15
3.3.3 Set Temperature Alarm Threshold	15
3.3.4 Set CO2 Alarm Threshold	15
3.3.5 Set Alarm Interval	15
3.3.6 Set Time Sync Mode	16
3.3.7 Request the server to send an ACK	16
3.4 Calibration command	16
3.4.1 Restore factory Calibration (AT+CALCMD=0)	16
3.4.2 Forced ABC Calibration (AT+CALCMD=1)	16
3.4.3 Target Calibration (AT+CALCMD=2 Equivalent to AT+CALCMD=2,400)	17
3.4.4 Background Calibration (AT+CALCMD=3)	17
3.4.5 Zero Calibration (AT+CALCMD=4)	17
3.5 calibration mode	17
3.5.1 Enabled ABC Calibration (AT+CALMOD=1, default)	17
3.5.2 Disabled ABC Calibration (AT+CALMOD=0)	17
3.5.3 Button CO2 calibration function (Equivalent to AT+CALCMD=3)	18
4.Battery & Power Consumption	18
4.1 Battery Life	18
4.2 Replace Battery	18
5.OTA Firmware update	19
6.FAQ	19
6.1 Do i need to calibrate the CO2 reading of AQS01-L?	19
7.Order Info	20
8.Packing Info	20
9.Support	20

1. Introduction

1.1 What is AQS01-L LoRaWAN CO2 Sensor

The Dragino AQS01-L is an **Indoor LoRaWAN Air Quality Sensor** for the Internet of Things solution. It is designed to measure the surrounding environment parameters include: **CO2, Temperature , Relative Air Humidity and Air pressure**, and then upload to IoT server via LoRaWAN wireless protocol.

AQS01-L is powered by a **ER18505 4000mAh battery**. The battery can last more than 2 years and is easy to change.

AQS01-L **supports BLE configure** and **wireless OTA update** which make user easy to use.

AQS01-L supports **CO2 Alarm and Temperature Alarm* features**, users can get an alarm for instant notice.

AQS01-L supports **Datalog feature**, User can retrieve the sensor data from LoRaWAN commands.

Note*: CO2 Alarm and temperature Alarm will decrease a lot the battery life.

1.2 Features

- LoRaWAN 1.0.3 Class A
- Monitor CO2/Temperature/Relative Humidity/Pressure
- Support CO2 alarm
- Support Datalog Feature
- Bands: CN470/EU433/KR920/US915/EU868/AS923/AU915/IN865
- Support Bluetooth and LoRaWAN remote configure

- Support wireless OTA update firmware
- Uplink on periodically
- Downlink to change configure
- 4000mAh batteries powered

1.3 Specification

Common DC Characteristics:

- Supply Voltage: built in 4000mAh Li-SOCl2 battery , 2.5v ~ 3.6v
- Operating Temperature: -20 ~ 65 °C

CO2 Sensor:

- Sensor: [Senseair Sunrise Article No. 006-0-0008](#)
- Target gas: Carbon dioxide(CO2)
- Operating principle: Non-dispersiveinfrared(NDIR)
- Operating range: 0-50 °C, 0-85% RH(non-condensing)
- Measurement range: 400ppm to 5000 ppm (extended range up to 10000 ppm)
- Accuracy:
 - 400-1500ppm $\pm(30 \text{ ppm} + 3\% \text{ of reading})$
 - 1501-2500ppm $\pm 75 \text{ ppm}$
 - 2501-5000ppm $\pm(30 \text{ ppm} + 3\% \text{ of reading})$
- Pressure Compensation

Temperature Sensor:

- Sensor: [bme280](#)
- Range: -20 ~ 65 °C
- Accuracy: Typ ± 1.0 @ 0-65 °C
- Resolution: 0.1 °C

Hardware v1.2 and later

- Sensor: [sht41](#)
- Range: -40 ~ 125 °C
- Accuracy: ± 0.2 °C
- Resolution: 0.01 °C

Humidity Sensor:

- Sensor: [bme280](#)
- Range: 0 ~ 99.9% RH
- Accuracy: $\pm 3\%$ RH (20 ~ 80%RH)
- Resolution: 0.1% RH
- Long term stability: 0.5 %RH/yr

Hardware v1.2 and later

- Sensor: [sht41](#)
- Range: 0 ~ 99.9% RH
- Accuracy: $\pm 1.8\%$ RH
- Resolution: 0.1% RH

Air Pressure:

- Sensor: [bme280](#)
- Range: 300~1100hPa
- Accuracy: ± 1.0 hPa (0-65 °C)
- Resolution: 0.18Pa
- Long term stability: ± 1.0 hPa/yr

LoRa Spec:

- Frequency Range, Band 1 (HF): 862 ~ 1020 Mhz
- RX sensitivity: down to -139 dBm.
- Excellent blocking immunity

Battery:

- Li/SOCI2 un-chargeable battery
- Capacity: 4000mAh
- Self-Discharge: <1% / Year @ 25°C

Power Consumption

- Sleep Mode: 6uA @ 3.3v
- LoRa Transmit Mode: 125mA @ 20dBm, 82mA @ 14dBm

1.4 Applications

- Smart Building
- Industrial Monitoring and Control

1.5 Sleep mode and working mode

Deep Sleep Mode: Sensor doesn't have any LoRaWAN activity. This mode is used for storage and shipping to save battery life.

Working Mode: In this mode, Sensor will work as LoRaWAN Sensor to Join LoRaWAN network and send out sensor data to server. Between each sampling/tx/rx periodically, sensor will be in IDLE mode, in IDLE mode, sensor has the same power consumption as Deep Sleep mode.

1.6 BLE connection

AQS01-L supports BLE remote configure.

BLE can be used to configure the parameter of AQS01-L or see the console output from AQS01-L. BLE will be only activate on below case:

- Press button to send an uplink.
- Press button to active AQS01-L.
- Device Power on or reset.

If there is no activity connection on BLE in 60 seconds, AQS01-L will shut down BLE module to enter low power mode.

2. Configure AQS01-L to connect to LoRaWAN network

2.1 How it works

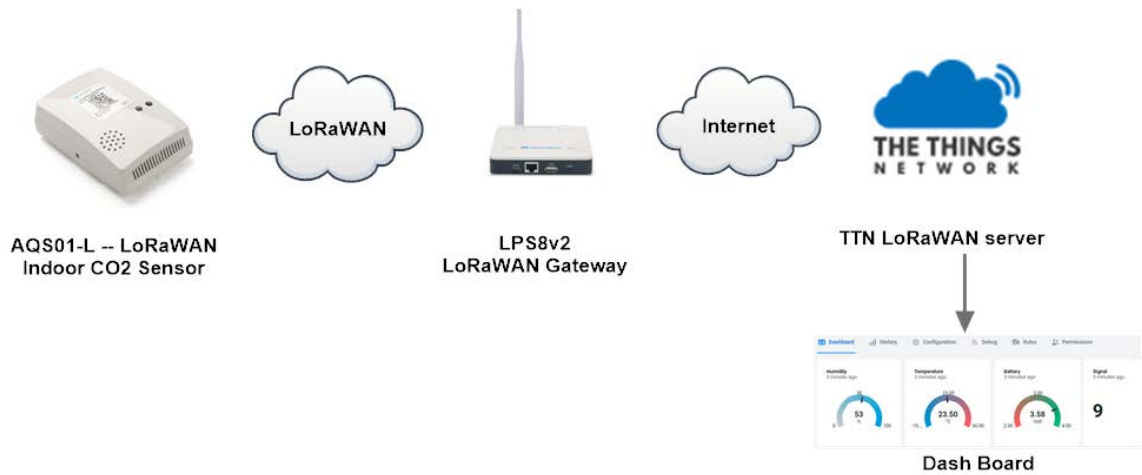
The AQS01-L is configured as **LoRaWAN OTAA Class A** mode by default. It has OTAA keys to join LoRaWAN network. To connect a local LoRaWAN network, you need to input the OTAA keys in the LoRaWAN IoT server and press the button to activate the AQS01-L. It will automatically join the network via OTAA and start to send the sensor value. The default uplink interval is 20 minutes.

2.2 Quick guide to connect to LoRaWAN server (OTAA)

Following is an example for how to join the [TTN v3 LoRaWAN Network](#). Below is the network structure; we use the [LPS8v2](#) as a LoRaWAN gateway in this example.

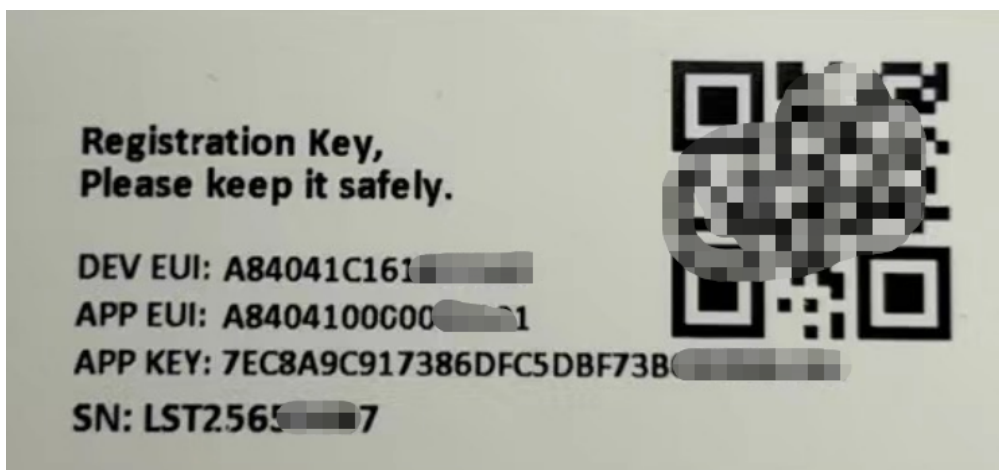
The LPS8V2 is already set to connected to [TTN network](#), so what we need to now is configure the TTN server.

AQS01-L in a LoRaWAN Network



Step 1: Create a device in TTN with the OTAA keys from AQS01-L.

Each AQS01-L is shipped with a sticker with the default device EUI as below:



You can input these keys in the LoRaWAN Server portal. Below is TTN screen shot:

[Register the device](#)

Add APP EUI and DEV EUI

Add APP EUI in the application

Add APP KEY

Step 2: Activate on AQS01-L

Press the button for 5 seconds to activate the AQS01-L.

Green LED will fast blink 5 times, device will enter **OTA mode** for 3 seconds. And then start to JOIN LoRaWAN network. **Green LED** will solidly turn on for 5 seconds after joined in network.

After join success, it will start to upload messages to TTN and you can see the messages in the panel.

Step 3: Calibration AQS01-L

Button CO2 calibration function (Equivalent to AT+CALCMD=3)

The first step is to put your device into sleep mode. Press the button five times quickly and the device will light up solid red for 5 seconds.

In the second step, take the device outside to an environment without combustion sources and people, let it sit for a few minutes, and then press the button three times quickly. The calibration is complete after the blue light stays on for 5 seconds.

The last step is to reset the device, press and hold the button until the green light flashes.

For more calibration methods, please refer to this link: [Calibration AQS01-L](#)

2.3 Uplink Payload

2.3.1 Device Status, FPORT=5

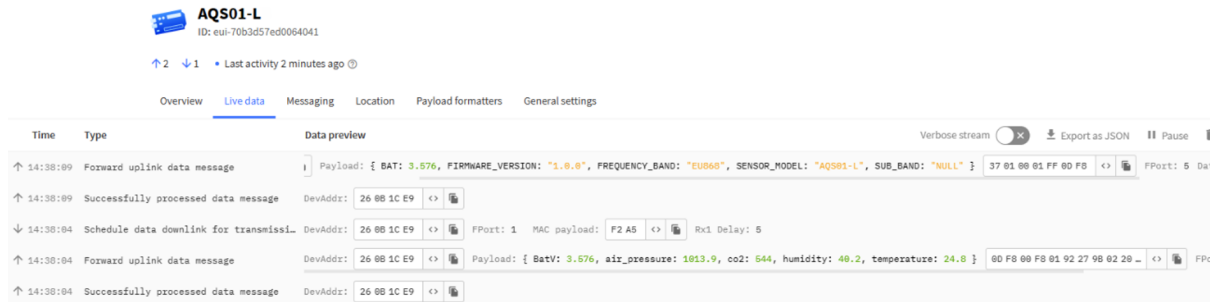
Users can use the downlink command(**0x26 01**) to ask AQS01-L to send device configure detail, include device configure status. AQS01-L will uplink a payload via FPort=5 to the server.

The Payload format is as below.

Device Status (FPORT=5)					
Size (bytes)	1	2	1	1	2
Value	Sensor Model	Firmware Version	Frequency Band	Sub-band	BAT

Example parse in TTNv3

User Manual for LoRaWAN /NB -IoT End Nodes - AQS01-L -- LoRaWAN CO2 Sensor User Manual



Sensor Model: For AQS01-L, this value is 0x37

Firmware Version: 0x0100, Means: v1.0.0 version

Frequency Band:

0x01: EU868

0x02: US915

0x03: IN865

0x04: AU915

0x05: KZ865

0x06: RU864

0x07: AS923

0x08: AS923-1

0x09: AS923-2

0x0a: AS923-3

0x0b: CN470

0x0c: EU433

0x0d: KR920

0x0e: MA869

Sub-Band:

AU915 and US915: value 0x00 ~ 0x08

CN470: value 0x0B ~ 0x0C

Other Bands: Always 0x00

Battery Info:

Check the battery voltage.

Ex1: 0x0B45 = 2885mV

Ex2: 0x0B49 = 2889mV

2.3.2 Sensor Data. FPORT=2

Sensor Data is uplink via FPORT=2

Size(bytes)	2	2	2	2	2	1
Value	Battery	Temperature	Humidity	Pressure	CO2	Alarm flag&Other flag

Alarm flag & Other flag:

Size(bit)	[bit7:bit5]	bit4	bit3	bit2	bit1	bit0
Value	Reserve	SHT41_sensor	TEMPL_flag	TEMPH_flag	CO2L_flag	CO2H_flag

Battery

Sensor Battery Level.

Ex1: 0x0B45 = 2885mV

Ex2: 0x0B49 = 2889mV

Temperature

The temperature collection before hardware v1.2 comes from bme280. The following is the payload analysis.

If payload is: 0105H: (0105 & 8000 == 0), temp = 0105H /10 = 26.1 degree

If payload is: FF3FH : (FF3F & 8000 == 1) , temp = (FF3FH - 65536)/10 = -19.3 degrees.

(FF3F & 8000: Judge whether the highest bit is 1, when the highest bit is 1, it is negative)

The temperature collection after hardware v1.2(Includes v1.2) comes from sht41. The following is the payload analysis.

If payload is: 0A32H: (0A32 & 8000 == 0), temp = 0A32H /100 = 26.10 degree

If payload is: F876H : (F876 & 8000 == 1) , temp = (F876H - 65536)/100 = -19.30 degrees.

(F876 & 8000: Judge whether the highest bit is 1, when the highest bit is 1, it is negative)

Humidity

Before hardware v1.2, the humidity comes from bme280, and after hardware v1.2(Includes v1.2), the humidity comes from sht41.

Read:0x(018F)=399 Value: 399 / 10=39.9, So 39.9%

Pressure

Example:

If payload is: 279BH, Pressure = 279BH /10 = 1013.9 hPa

CO2

Example:

If payload is: 01FDH, CO2 = 01FDH= 509ppm

Alarm flag

TEMPH_flag: When it is True, the actual temperature exceeds the set alarm temperature.

TEMPL_flag: When it is True, the actual temperature lower than the set alarm temperature.

CO2H_flag: When it is True, the actual CO2 concentration exceeds the set alarm CO2 concentration.

CO2L_flag: When it is True, the actual CO2 concentration lower than the set alarm CO2 concentration.

Example:

AT+TEMPALARM=25,60 -----> temperature: 23.1, TEMPH_flag: "False", TEMPL_flag: "True"

AT+CO2ALARM=400,2000 -----> co2: 2368, CO2H_flag:"True", CO2L_flag:"False"

SHT41_sensor

Using SHT41 sensors after and including hardware v1.2, this flag is 1, and before hardware v1.2, this flag is 0.

2.4 Payload Decoder file

In TTN, user can add a custom payload so it shows friendly reading

In the page [Applications --> Payload Formats --> Custom --> decoder](#) to add the decoder from:

<https://github.com/dragino/dragino-end-node-decoder/tree/main>

2.5 Datalog Feature

Datalog Feature is to ensure IoT Server can get all sampling data from AQS01-L even if the LoRaWAN network is down. For each sampling, AQS01-L will store the reading for future retrieving purposes.

2.5.1 Ways to get datalog via LoRaWAN

Set PNACKMD=1, AQS01-L will wait for ACK for every uplink, when there is no LoRaWAN network, AQS01-L will mark these records with non-ack messages and store the sensor data, and it will send all messages (10s interval) after the network recovery.

- a) AQS01-L will do an ACK check for data records sending to make sure every data arrive server.
- b) AQS01-L will send data in **CONFIRMED Mode** when PNACKMD=1, but AQS01-L won't re-transmit the packet if it doesn't get ACK, it will just mark it as a NONE-ACK message. In a future uplink if AQS01-L gets a ACK, AQS01-L will consider there is a network connection and resend all NONE-ACK messages.

2.5.2 Unix TimeStamp

AQS01-L uses Unix TimeStamp format based on

User can get this time from link: <https://www.epochconverter.com/> :

Below is the converter example

So, we can use AT+TIMESTAMP=1611889405 or downlink 3060137afd00 to set the current time 2021 - Jan -- 29 Friday 03:03:25

2.5.3 Set Device Time

User need to set **SYNCTDC=1** to enable sync time via MAC command.

Once AQS01-L Joined LoRaWAN network, it will send the MAC command (DeviceTimeReq) and the server will reply with (DeviceTimeAns) to send the current time to AQS01-L. If AQS01-L fails to get the time from the server, AQS01-L will use the internal time and wait for next time request (AT+SYNCTDC to set the time request period, default is 10 days).

Note: LoRaWAN Server need to support LoRaWAN v1.0.3(MAC v1.0.3) or higher to support this MAC command feature, Chirpstack,TTN V3 and Ioriot support but TTN v2 doesn't support. If server doesn't support this command, it will through away uplink packet with this command, so user will lose the packet with time request for TTN v2 if SYNCMOD=1.

2.5.4 Datalog Uplink payload (FPORT=3)

The Datalog uplinks will use below payload format.

Retrieval data payload:

Size(bytes)	2	2	2	1	4
Value	CO2	Humidity	Temperature	Poll message flag	Unix Time Stamp

Poll message flag :

Bits	7	6	[5:0]
mean	No ACK Message	Poll Message Flag	Reserved

No ACK Message: 1: This message means this payload is fromn Uplink Message which doesn't get ACK from the server before (for **PNACKMD=1** feature)

Poll Message Flag: 1: This message is a poll message reply.

- Poll Message Flag is set to 1.
- Each data entry is 11 bytes, to save airtime and battery, devices will send max bytes according to the current DR and Frequency bands.

For example, in US915 band, the max payload for different DR is:

- a) DR0:** max is 11 bytes so one entry of data
- b) DR1:** max is 53 bytes so devices will upload 4 entries of data (total 44 bytes)
- c) DR2:** total payload includes 11 entries of data
- d) DR3:** total payload includes 22 entries of data.

If devise doesn't have any data in the polling time. Device will uplink 11 bytes of 0

Example:

If AQS01-L has below data inside Flash:

Stop Tx events when read sensor data

```
0001 2024/1/11 16:02:54 3744 temp:24.1 hum:42.0 pres:1013.8 co2:484
0002 2024/1/11 16:03:27 3750 temp:24.1 hum:42.1 pres:1013.7 co2:462
0003 2024/1/11 16:04:26 3750 temp:24.1 hum:42.0 pres:1013.7 co2:452
0004 1970/1/1 00:00:11 3756 temp:24.3 hum:45.2 pres:1013.8 co2:994
0005 2024/1/11 16:12:50 3756 temp:24.2 hum:43.5 pres:1013.9 co2:748
0006 2024/1/11 16:14:44 3762 temp:24.3 hum:43.3 pres:1013.9 co2:752
0007 2024/1/11 16:15:47 3762 temp:24.2 hum:42.9 pres:1014.0 co2:568
0008 2024/1/11 16:18:30 3762 temp:24.2 hum:44.4 pres:1013.9 co2:747
0009 2024/1/11 16:22:43 3768 temp:24.1 hum:44.1 pres:1013.9 co2:983
0010 1970/1/1 00:01:18 3768 temp:25.0 hum:43.7 pres:1013.9 co2:713
Start Tx events
```

OK

If user sends below downlink command: 3165A010F865A015E405

Where : Start time: 65A010F8 = time 24/1/11 16:02:00

Stop time: 65A015E4 = time 24/1/11 16:23:00

AQS01-L will uplink this payload.



↑ 75 ↓ 18 • Last activity 53 seconds ago

Overview **Live data** Messaging Location Payload formatters General settings

Time	Type	Data preview	
↓ 09:21:43	Schedule data downlink for transmissi...	DevAddr: 26 0B 98 7F Rx1 Delay: 5	
↑ 09:21:42	Forward uplink data message	DATALOG: "[24.1,42,484,2024-01-11 16:02:54],[24.1,42.1,462,2024-01-11 16:03:27],[24.1,42,452,2024-01-11 16:04:26]"	

01E401A400F14065A0112E01CE01A500F14065A0114F01C401A400F14065A0118A02EC01B300F24065A0138202F001B100F

Where the first 11 bytes is for the first entry: 01 E4 01 A4 00 F1 40 65 A0 11 2E

- **CO2**=0x01E4=484 ppm
- **Hum**=0x01A4/10=42 %
- **Temp**=0x00F1/10=24.1 °C
- **poll message flag** =0x40,means reply data,sampling uplink message.
- **Unix time** is 0x65A0112E=1704888040s=24/1/11 16:02:54

2.6 Frequency Plans

The AQS01-L uses OTAA mode and below frequency plans by default. Each frequency band use different firmware, user update the firmware to the corresponding band for their country.

<http://wiki.dragino.com/xwiki/bin/view/Main/End%20Device%20Frequency%20Band/>

2.7 Firmware Change Log

Firmware download link: <https://www.dropbox.com/scl/fo/o5v6j7qewlks12eso98kl/h?rlkey=v1ian3hmva65924j4h4n0yfz8&dl=0>

3. Configure AQS01-L

3.1 Configure Methods

AQS01-L supports below configure method:

- AT Command via Bluetooth Connection (**Recommended**): [BLE Configure Instruction](#).
- AT Command via UART Connection : See [UART Connection](#).
- LoRaWAN Downlink. Instruction for different platforms: See [IoT LoRaWAN Server](#) section.

3.2 General Commands

These commands are to configure:

- General system settings like: uplink interval.
- LoRaWAN protocol & radio related command.

They are same for all Dragino Devices which support DLWS-005 LoRaWAN Stack. These commands can be found on the wiki:

<http://wiki.dragino.com/xwiki/bin/view/Main/End%20Device%20AT%20Commands%20and%20Downlink%20Command/>

3.3 Commands special design for AQS01-L

These commands only valid for AQS01-L, as below:

3.3.1 Set Transmit Interval Time

Feature: Change LoRaWAN End Node Transmit Interval.

AT Command: AT+TDC

Command Example	Function	Response
AT+TDC=?	Show current transmit Interval	30000 OK the interval is 30000ms = 30s
AT+TDC=60000	Set Transmit Interval	OK Set transmit interval to 60000ms = 60 seconds

Downlink Command: 0x01

Format: Command Code (0x01) followed by 3 bytes time value.

If the downlink payload=0100003C, it means set the END Node's Transmit Interval to 0x00003C=60(S), while type code is 01.

- Example 1: Downlink Payload: 0100001E // Set Transmit Interval (TDC) = 30 seconds
- Example 2: Downlink Payload: 0100003C // Set Transmit Interval (TDC) = 60 seconds

3.3.2 Get Device Status

Send a LoRaWAN downlink to ask device send Alarm settings.

Downlink Payload: 0x26 01

Sensor will upload Device Status via FPORT=5. See payload section for detail.

3.3.3 Set Temperature Alarm Threshold

- **AT Command:**

AT+TEMPALARM=min,max (Among them, 100 is an invalid value, which means not set)

- When min=100, and max≠100, Alarm higher than max
- When min≠100, and max=100, Alarm lower than min
- When min≠100 and max≠100, Alarm higher than max or lower than min

Example:

AT+TEMPALARM=100,30 // Alarm when temperature higher than 30.

- **Downlink Payload:**

0x(0C 01 64 1E) // Set AT+TEMPALARM=100,30

(note: 3rd byte= 0x64 for low limit(not set), 4th byte = 0x1E for high limit: 30)

3.3.4 Set CO2 Alarm Threshold

The CO2 alarm function detects CO2 once every minute, so it consumes more power.

- **AT Command:**

AT+CO2ALARM=min,max (Among them, 0 is an invalid value, which means not set)

- When min=0, and max≠0, Alarm higher than max
- When min≠0, and max=0, Alarm lower than min
- When min≠0 and max≠0, Alarm higher than max or lower than min

Example:

AT+CO2ALARM=400,0 // Alarm when humidity lower than 400.

- **Downlink Payload:**

0x(0C 02 01 90 00 00) // Set AT+CO2ALARM=400,0

(note: 3rd byte+4rd byte= 0x0190 for low limit (400ppm), 5th byte+6rd byte = 0x00 for high limit (not set))

3.3.5 Set Alarm Interval

The shortest time of two Alarm packet. (unit: min)

- **AT Command:**

AT+ATDC=20 // The shortest interval of two Alarm packets is 20 minutes, Means if there is an alarm packet uplink, there won't be another one in the next 20 minutes.

- **Downlink Payload:**

0x(0D 14) ---> Set AT+ATDC=0x 14 = 20 minutes

3.3.6 Set Time Sync Mode

Feature: Enable/Disable Sync system time via LoRaWAN MAC Command (DeviceTimeReq), LoRaWAN server must support v1.0.3 protocol to reply to this command.

SYNCMOD is set to 1 by default. If user wants to set a different time from the LoRaWAN server, the user needs to set this to 0.

AT Command:

Command Example	Function	Response
AT+SYNCMOD=1	Enable Sync system time via LoRaWAN MAC Command (DeviceTimeReq) The default is zero time zone.	OK
AT+SYNCMOD=1,8	Enable Sync system time via LoRaWAN MAC Command (DeviceTimeReq) Set to East eight time zone.	OK
AT+SYNCMOD=1,-12	Enable Sync system time via LoRaWAN MAC Command (DeviceTimeReq) Set to West Twelve Time Zone.	OK

Downlink Command:

0x28 01 // Same As AT+SYNCMOD=1
0x28 01 08 // Same As AT+SYNCMOD=1,8
0x28 01 F4 // Same As AT+SYNCMOD=1,-12
0x28 00 // Same As AT+SYNCMOD=0

3.3.7 Request the server to send an ACK

AT Command: AT+PNACKMD

Command Example	Function	Response
AT+PNACKMD=1	If the node uploads the ACK as confirm, it will request the server to send an ACK. If the server ack is not received, the node will upload the packets that have not received the ACK the next time it receives the ACK	1 OK
AT+PNACKMD=0	off request the server to send an ACK	0 OK

Downlink Command: 0x34

0X34 01 //Same As AT+PNACKMD=1
0x34 00 //Same As AT+PNACKMD=0

3.4 Calibration command

Note: If the device is not calibrated for the first time, there will be a certain degree of drift.

After having performed the calibration,all following measurements will use the adjusted calibration parameters.

3.4.1 Restore factory Calibration (AT+CALCMD=0)

Restores calibration parameters factory calibration values.

Downlink Payload: 0x0F 00

3.4.2 Forced ABC Calibration (AT+CALCMD=1)

Sensor will perform an ABC calibration after receiving this command if sensor has valid ABC data. The command can be used if one for some reason wants to do an ABC adjustment before one ABC period has passed (when a normal ABC calibration is done).

Downlink Payload: 0x0F 01

3.4.3 Target Calibration (AT+CALCMD=2 Equivalent to AT+CALCMD=2,400)

Target concentration calibration assumes that sensor is put into a target environment with a known CO2 concentration. Such as outdoor fresh air 400ppm.

Downlink Payload: 0x0F 02 ==> AT+CALCMD=2

0x0F 02 01 90 ==> AT+CALCMD=2,400

0x0F 02 01 F4 ==> AT+CALCMD=2,500

3.4.4 Background Calibration (AT+CALCMD=3)

A “fresh air” baseline environment is by default 400 ppm at normal ambient atmospheric pressure by sea level. It can be referenced in a crude way by placing the sensor in direct proximity to outdoor air, free of combustion sources and human presence, preferably during either by open window or fresh air inlets or similar. Calibration gas by exactly 400ppm can be purchased and used. Background calibration and ABC calibration share the same target value (fresh air = 400ppm).

Downlink Payload: 0x0F 03

3.4.5 Zero Calibration (AT+CALCMD=4)

Zero-calibrations are the most accurate recalibration routine. A zero-ppm environment is most easily created by flushing the optical cell of the sensor module and filling up an encapsulating enclosure with nitrogen gas, N2, displacing all previous air volume concentrations. Another less reliable or accurate zero reference point can be created by scrubbing an airflow using e.g. Soda lime.

Downlink Payload: 0x0F 04

3.5 calibration mode

3.5.1 Enabled ABC Calibration (AT+CALMOD=1, default)

The Automatic Baseline Correction algorithm is a proprietary Senseair method for referencing to “fresh air” as the lowest, but required stable, CO2-equivalent internal signal the sensor has measured during a set time period. This time period by default is 180hrs as to catch low-occupancy and other lower-emission time periods and favourable outdoor wind-directions and similar which can plausibly and routinely expose the sensor to the most true fresh air environment. If such an environment can never be expected to occur, either by sensor locality or ever-presence of CO2 emission sources, or exposure to even lower concentrations than the natural fresh air baseline, then ABC recalibration can't be used. In each new measurement period, the sensor will compare it to the stored one at the ABC parameters registers, and if new values show a lower CO2-equivalent raw signal while also in a stable environment, the reference is updated with these new values. The ABC algorithm also has a limit on how much it is allowed to change the baseline correction offset with, per each ABC cycle, meaning that self-calibrating to adjust to bigger drifts or signal changes may take more than one ABC cycle.

Downlink Payload: 0x0E 01

3.5.2 Disabled ABC Calibration (AT+CALMOD=0)

If the device is in a greenhouse or enclosed environment, it is recommended to turn off ABC calibration. And use Target Calibration for calibration.

Downlink Payload: 0x0E 00

3.5.3 Button CO2 calibration function (Equivalent to AT+CALCMD=3)

The first step is to put your device into sleep mode. Press the button five times quickly and the device will light up solid red for 5 seconds.

In the second step, take the device outside to an environment without combustion sources and people, let it sit for a few minutes, and then press the button three times quickly. The calibration is complete after the blue light stays on for 5 seconds.

The last step is to reset the device, press and hold the button until the green light flashes.

4. Battery & Power Consumption

4.1 Battery Life

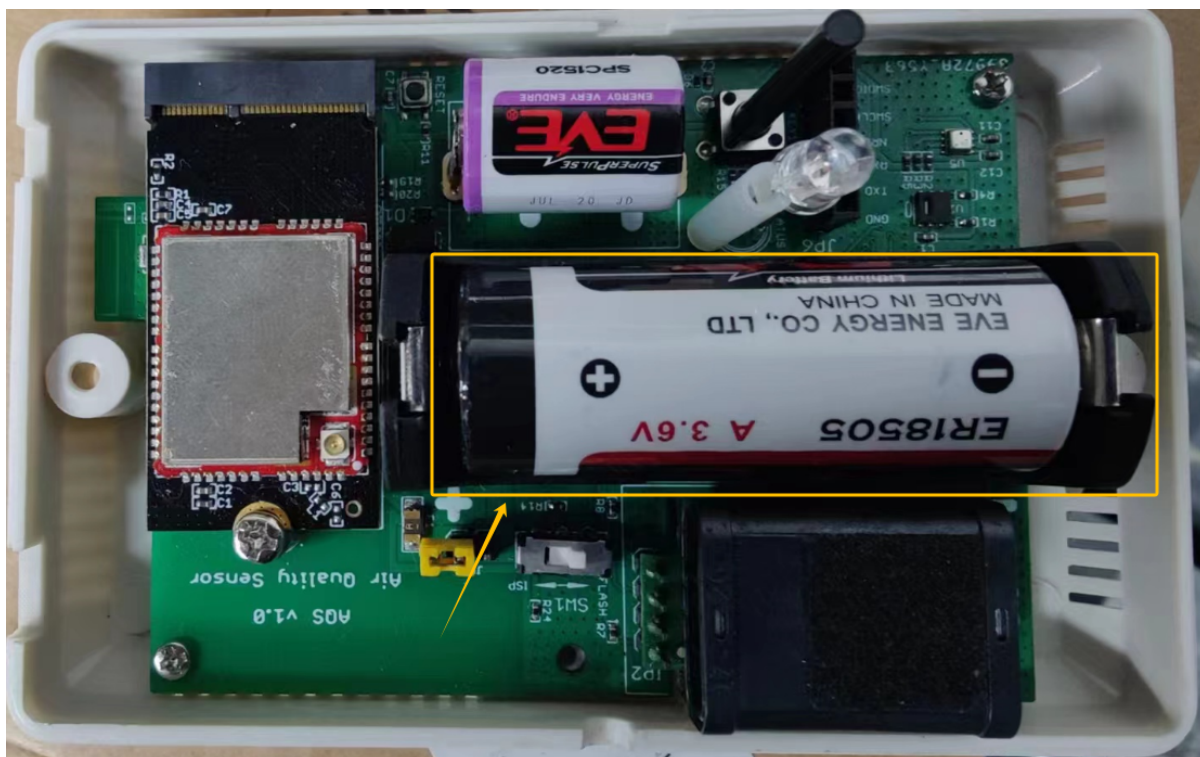
In a normal 20 minutes uplink situation , the battery life can last from 2 ~ 8 years depends on signal environment. The Alarm feature will reduce the battery life a lot .

See below link for detail information about the battery life calculation.

[Battery Info & Power Consumption Analyze](#) .

4.2 Replace Battery

AQS01-L uses an ER18505 battery. If the battery is running out, User can purchase an ER18505 battery and replace. Make sure don't mess the + & - position.



5. OTA Firmware update

User can change firmware AQS01-L to:

- Change Frequency band/ region.
- Update with new features.
- Fix bugs.

Firmware and changelog can be downloaded from : [Firmware download link](#)

Methods to Update Firmware:

- (Recommended way) OTA firmware update via wireless : <http://wiki.dragino.com/xwiki/bin/view/Main/Firmware%20OTA%20Update%20for%20Sensors/>
- Update through UART TTL interface : [Instruction](#).

6. FAQ

6.1 Do i need to calibrate the CO2 reading of AQS01-L?

The Operating principle for CO2 measurement used in AQS01-L is Non-dispersive infrared (NDIR). There is no need Calibration for this method.

7. Order Info

Part Number: **AQS01-L-XX**

XX: The default frequency band

- **AS923**: LoRaWAN AS923 band
- **AU915**: LoRaWAN AU915 band
- **EU433**: LoRaWAN EU433 band
- **EU868**: LoRaWAN EU868 band
- **KR920**: LoRaWAN KR920 band
- **US915**: LoRaWAN US915 band
- **IN865**: LoRaWAN IN865 band
- **CN470**: LoRaWAN CN470 band

8. Packing Info

Package Includes:

- AQS01-L LoRaWAN CO2 Sensor

Dimension and weight:

- Device Size: cm
- Device Weight: g
- Package Size / pcs : cm
- Weight / pcs : g

9. Support

- Support is provided Monday to Friday, from 09:00 to 18:00 GMT+8. Due to different timezones we cannot offer live support. However, your questions will be answered as soon as possible in the before-mentioned schedule.
- Provide as much information as possible regarding your enquiry (product models, accurately describe your problem and steps to replicate it etc) and send a mail to Support@dragino.cc.

FCC Caution:

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.