

IOTSU® L3 AQ05



The IOTSU L3 AQ05 is a wireless indoor device that measures air quality. The device is powered by a replaceable lithium battery.

The device measures temperature and relative humidity and the concentration of carbon dioxide (CO₂). The measurements are periodically transmitted over a radio network to the cloud.

The configuration parameters such as transmission interval of the device can be adjusted over the air.



Configurability

The product can be configured over the air via downlink messages or during manufacturing phase. Please see downlink documentation for available configuration parameters or contact seller support.

Transmitting logic

The device measures at regular intervals that are a quarter of the transmission interval set by the configuration parameters. The device can make measurements in either single measurement mode or on average measurement mode. In single measurement mode the device makes only one measurement per measurement interval. In average measurement mode the devices makes multiple measurements during the measurement interval and returns the average measurement.

Every measurement set contains temperature, humidity and carbon dioxide.

Calibration

Calibrating the temperature, humidity and volatile organic compound sensors is either not necessary, possible or is automatic.

The carbon dioxide sensor utilises an automatic calibration routine which can be toggled on or off with the configuration parameters. To function properly the calibration requires that the carbon dioxide content of the measurement space regularly reaches outdoor carbon dioxide levels.

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Uplink message contents

1. Battery status
2. Current transmitting and measuring interval
3. Data duplication toggle status
4. Measurement mode (single/average)
5. Four measurement sets (one set contains one temperature, humidity and carbon dioxide measurement)
6. If data duplication is toggled on, the message also contains previous four measurement sets.

Measurement ranges and resolutions

- Temperature, T
Range: 0-50 deg C
Resolution: 0.1 deg C
- Relative humidity, rH
Range: 0-100 %rH
Resolution: 1 %rH
- Carbon dioxide, CO₂
Range: 400-2940 ppm
Resolution: 10 ppm
- Battery voltage:
Range: 0-5.1 V
Resolution: 20 mV

Parameters and factory defaults (defaults are underlined>)

1. Transmitting interval: [10 min / 15 min / 30 min / 1h / 2h / 4h / 6 h / 12 h]
2. Measurement mode: [Single measurement mode / Average measurement mode]
3. Data duplication: [On / Off]
4. Network rejoin delay: [1 d / 2 d / ... / 7 d / ... / 30 d / 31 d]
5. Carbon dioxide calibration: [On / Off]

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Use cases

This product is designed to provide solutions to use cases in various fields, which include:

1. Long time monitoring of indoor air quality of a living space
2. More accurate air quality inspection analysis with high sample rate measuring
3. Long time monitoring of indoor air quality of a constantly occupied living space

Some of the main device features and parameters per use case include:

	Downlink available	Transmit interval	Measurement mode	Data duplication	Network rejoin delay	Carbon dioxide calibration	Replaceable battery	Battery life estimate (years)
Use case #1	Yes	2 hours	Average	On	7 days	On	Yes	5 years
Use case #2		10 minutes		On	7 days	On		5 months*
Use case #3		2 hours		On	7 days	Off		5 years

*In continuous use. It is advised to reduce the sample rate via downlink messages when the device is not in use.

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Uplink frame

Offset	Bit length	Data		Description	Formula	
0 - 1	8	Battery voltage	Information	Device battery voltage	RAW * 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 receive		
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.	RAW %rH	
2.7 - 3.7	9	Temperature #1		1st period	Temperature at the end of the first measurement period.	(RAW / 10) °C
4	8	CO ₂ #1		CO ₂ at the end of the first measurement period.	(RAW * 10) ppm + 400	
5.0 - 5.6	7	Humidity #2		2nd period	Humidity at the end of the second measurement period.	RAW %rH
5.7 - 6.7	9	Temperature #2		Temperature at the end of the second measurement period.	(RAW / 10) °C	
7	8	CO ₂ #2		CO ₂ at the end of the second measurement period.	(RAW * 10) ppm + 400	
8.0 - 8.6	7	Humidity #3		3rd period	Humidity at the end of the third measurement period.	RAW %rH
8.7 - 9.7	9	Temperature #3		Temperature at the end of the third measurement period.	(RAW / 10) °C	
10	8	CO ₂ #3		CO ₂ at the end of the third measurement period.	(RAW * 10) ppm + 400	
11.0 - 11.6	7	Humidity #4		4th period	Humidity at the end of the fourth measurement period.	RAW %rH
11.7 - 12.7	9	Temperature #4		Temperature at the end of the fourth measurement period.	(RAW / 10) °C	
13	8	CO ₂ #4		CO ₂ at the end of the fourth measurement period.	(RAW * 10) ppm + 400	
14.0 - 14.6	7	Humidity #1	Duplicate payload	Humidity at the end of the first measurement period of the previous transmission.	RAW %rH	
14.7 - 15.7	9	Temperature #1		1st period	Temperature at the end of the first measurement period of the previous transmission.	(RAW / 10) °C
16	8	CO ₂ #1		CO ₂ at the end of the first measurement period of the previous transmission.	(RAW * 10) ppm + 400	
17.0 - 17.6	7	Humidity #2		2nd period	Humidity at the end of the second measurement period of the previous transmission.	RAW %rH
17.7 - 18.7	9	Temperature #2		Temperature at the end of the second measurement period of the previous transmission.	(RAW / 10) °C	
19	8	CO ₂ #2		CO ₂ at the end of the second measurement period of the previous transmission.	(RAW * 10) ppm + 400	
20.0 - 20.6	7	Humidity #3		3rd period	Humidity at the end of the third measurement period of the previous transmission.	RAW %rH
20.7 - 21.7	9	Temperature #3		Temperature at the end of the third measurement period of the previous transmission.	(RAW / 10) °C	
22	8	CO ₂ #3		CO ₂ at the end of the third measurement period of the previous transmission.	(RAW * 10) ppm + 400	
23.0 - 23.6	7	Humidity #4		4th period	Humidity at the end of the fourth measurement period of the previous transmission.	RAW %rH
23.7 - 24.7	9	Temperature #4		Temperature at the end of the fourth measurement period of the previous transmission.	(RAW / 10) °C	
25	8	CO ₂ #4		CO ₂ at the end of the fourth measurement period of the previous transmission.	(RAW * 10) ppm + 400	

*Transmit interval: 0 = 10 minutes, 1 = 15 minutes, 2 = 30 minutes, 3 = 1 h, 4 = 2 h, 5 = 4 h, 6 = 6 h, 7 = 12 h

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Downlink frame

App port	Command	Data length (bytes)	Description	Values
1	0x0101	1	Transmit interval	0: 10 minutes 1: 15 minutes 2: 30 minutes 3: 1 hours 4: 2 hours (default) 5: 4 hours 6: 6 hours 7: 12 hours
1	0x0102	1	Measurement mode	0: Single measurement (default) 1: Average mode
1	0x0103	1	Data duplicated	0: No data duplication 1: Data duplicated (default)
1	0x020D	1	Rejoin delay (default 7 days)	0: Disabled 1: 1 days 2: 2 days 3: 3 days 4: 4 days 5: 5 days ... 31: 31 days
1	0x0301	1	CO ₂ sensor ABC calibration state	CO ₂ sensor ABC calibration state 0: Disabled, 1: Enabled (default)

How to utilise

This guide expects that the devices are provisioned to a downlink-compatible LoRaWAN network.

The downlink messages consist of a Command-prefix (length two bytes) and a Data-suffix (length defined in table). When the device successfully receives a downlink payload, the Command informs the device of which parameters are incoming and the Data informs the values to be adopted.

The device accepts multiple commands in one downlink message.

The complete downlink payloads are placed in the network server's downlink queue for delivery to the device.

Examples

- Change device transmit interval to 10 minutes:
 Command for Transmit interval: 0x0101
 Value for Transmit interval: 0
 -> Complete downlink payload: 0x010100
- Change device transmit interval to 12 hours and activate average mode:
 Command for Transmit interval: 0x0101
 Value for Transmit interval: 7
 Command for Measurement mode: 0x0102
 Value for Measurement mode: 1
 -> Complete downlink payload: 0x010107010201

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Parsing examples

Payload: 0xB74426C3032E28C30328C20228C20226C40326C30226C40326C303
Time: 17:36:00

The data is easier to process when converted to binary format and split into blocks according to the frame descriptor:

```

[ byte 1 ] [ byte 2 ] [ byte 3 ] [ byte 4 ] [ byte 5 ] [ byte 6 ] [ byte 7 ] [ byte 8 ] [ byte 9 ] [ byte 10 ]
| 10111000 | 0110100100 | 001001110 | 11000011 | 00000011 | 00101000 | 11000011 | 00000011 | 00101000 | 11000010 |
| Battery | Humidity #1 | Temperature #1 | CO2 #1 | Humidity #2 | Temperature #2 | CO2 #2 | Humidity #3 | Temperature #3 |

[ byte 11 ] [ byte 12 ] [ byte 13 ] [ byte 14 ] [ byte 15 ] [ byte 16 ] [ byte 17 ] [ byte 18 ] [ byte 19 ] [ byte 20 ]
| 00000010 | 00101011 | 11000010 | 00000010 | 00100110 | 11000100 | 00000011 | 00100110 | 11000011 | 00000010 |
| CO2 #3 | Humidity #4 | Temperature #4 | CO2 #4 | Dup. Hum #1 | Dup. Temperature #1 | Dup. CO2 #1 | Dup. Hum #2 | Dup. Temperature #2 | Dup. CO2 #2 |

[ byte 21 ] [ byte 22 ] [ byte 23 ] [ byte 24 ] [ byte 25 ] [ byte 26 ]
| 00100110 | 11000100 | 00000011 | 00100110 | 11000011 | 00000011 |
| Dup. Hum #3 | Dup. Temperature #3 | Dup. CO2 #3 | Dup. Hum #4 | Dup. Temperature #4 | Dup. CO2 #4 |
    
```

From here the data can be read and converted. Bytes 15 to 26 are only sent when data duplication is enabled. Please note the endianness of the data.

Battery voltage: 10111000	Decimal 184 * 20 mV = 3680 mV	
Measurement mode: 0	Single measurement mode	
Data duplication: 1	Data duplicated	
Reserved: 0		
Downlink command ack: 0		
Reserved: 0		
Transmit interval: 100	Decimal 4 = 2 hours	
Humidity #1: 0010011	Decimal 19 %rH = 19 %rH	Time: 16:06:00
Temperature #1: 011000011	(Decimal 189 / 10) °C = 19,5 °C	Time: 16:06:00
CO2 #1: 00000011	(Decimal 3 * 10) ppm + 400 ppm = 430 ppm	Time: 16:06:00
Humidity #2: 0010100	Decimal 19 %rH = 20 %rH	Time: 16:36:00
Temperature #2: 011000011	(Decimal 189 / 10) °C = 19,5 °C	Time: 16:36:00
CO2 #2: 00000011	(Decimal 3 * 10) ppm + 400 ppm = 430 ppm	Time: 16:36:00
Humidity #3: 0010100	Decimal 19 %rH = 20 %rH	Time: 17:06:00
Temperature #3: 011000010	(Decimal 189 / 10) °C = 19,4 °C	Time: 17:06:00
CO2 #3: 00000010	(Decimal 2 * 10) ppm + 400 ppm = 420 ppm	Time: 17:06:00
Humidity #4: 0010100	Decimal 19 %rH = 20 %rH	Time: 17:36:00
Temperature #4: 011000010	(Decimal 189 / 10) °C = 19,4 °C	Time: 17:36:00
CO2 #4: 00000010	(Decimal 2 * 10) ppm + 400 ppm = 420 ppm	Time: 17:36:00
Humidity duplicate #1: 0010011	Decimal 19 %rH = 19 %rH	Time: 14:06:00
Temperature duplicate #1: 011000100	(Decimal 189 / 10) °C = 19,6 °C	Time: 14:06:00
CO2 duplicate #1: 00000011	(Decimal 3 * 10) ppm + 400 ppm = 430 ppm	Time: 14:06:00
Humidity duplicate #2: 0010011	Decimal 19 %rH = 19 %rH	Time: 14:36:00
Temperature duplicate #2: 011000011	(Decimal 189 / 10) °C = 19,5 °C	Time: 14:36:00
CO2 duplicate #2: 00000010	(Decimal 2 * 10) ppm + 400 ppm = 420 ppm	Time: 14:36:00
Humidity duplicate #3: 0010011	Decimal 19 %rH = 19 %rH	Time: 15:06:00
Temperature duplicate #3: 011000100	(Decimal 189 / 10) °C = 19,6 °C	Time: 15:06:00
CO2 duplicate #3: 00000011	(Decimal 3 * 10) ppm + 400 ppm = 430 ppm	Time: 15:06:00
Humidity duplicate #4: 0010011	Decimal 19 %rH = 19 %rH	Time: 15:36:00
Temperature duplicate #4: 011000011	(Decimal 189 / 10) °C = 19,5 °C	Time: 15:36:00
CO2 duplicate #4: 00000011	(Decimal 3 * 10) ppm + 400 ppm = 430 ppm	Time: 15:36:00