# SPECIFICATION

**Product Name: Ultrasonic Oxygen Senor**

**Sensor Item No.: Gasboard-8500FS-L240**

**Gasboard-8500FS-L240H**

**Gasboard-8500FS-L240HL**

**Version: V0.2**

**Date: March 28, 2022**

# Revision

| No. | Version | Content | Date |
|---|---|---|---|
| 1 | V0.1 | First Edition | 2021-11-19 |
| 2 | V0.2 | Changes on specifications and communication protocol. | 2022-03-28 |

# Ultrasonic Oxygen Sensor Gasboard-8500FS Series

## Applications

- ✧ Family and Medical Ventilator
- ✧ High-flow Oxygen Therapy Device
- ✧ Respiratory Device, Anesthetic Machine and Vaporizer
- ✧ Gas Detection in Binary Gas (Including O2)

## Description

Gasboard-8500FS-L240 series are ultrasonic technology 5-in-1 combined sensor solutions to measure flow rate, oxygen concentration, ambient pressure, temperature and humidity simultaneously with both analog and digital outputs. The flow rate range of Gasboard-8500FS-L240 series can be up to 240L/min. Benefit from ultrasonic technology and principle of TOF (time of flight) measurement, Gasboard-8500FS-L240 series have excellent performances with advantages of high accuracy, fast response, no drift, no need for routine calibration, maintenance-free and long life, etc. The interface design is according to ISO5356 with sealing rings to better meet the customers' installation and use requirements. Gasboard-8500FS-L240 series can be widely used in high-flow nasal cannula oxygen therapy ventilation, positive airway pressure ventilation, anesthetic ventilator and other medical equipment related to breath.

## Principle

Flow rate measurement principle: measure the TOF (time of flight) difference between the pulses of ultrasound propagating into and against the direction of the flow to calculate the flow rate.

Concentration measurement principle: when there is a molecular mass difference between the components of binary gas mixture, the sound propagation velocity varies with the composition of the two gases.

## Features

- ✧ Ultrasonic measurement technology, 5-in-1 combined sensor solution to measure flow rate, oxygen concentration, ambient pressure, temperature and humidity simultaneously
- ✧ Flow rate up to 240L/min
- ✧ Ensured accuracy in the full temperature range
- ✧ Continuous monitoring, no drift, no need routine calibration, maintenance-free.
- ✧ Excellent stability, high accuracy, fast response
- ✧ With temperature, humidity and atmosphere pressure compensation
- ✧ No-consuming parts, long lifespan
- ✧ Data update time up to 2ms which meets the requirement of fast response to flow for ventilators
- ✧ Support both analog and serial (UART and IIC) outputs
- ✧ CMC, CE, EMC,ROHS, REACH compatibility
- ✧ Biocompatibility with ISO10993, ISO 18562:2017 and USP graded

# Specification

| Ultrasonic Oxygen Sensor Gasboard 8500FS-L240 Series Specifications | | | |
|---|---|---|---|
| **Model** | **8500FS-L240** | **8500FS-L240H** | **8500FS-L240HL** |
| **Detect Principle** | Ultrasonic Technology | | |
| **Detection Range** [1)] | O2 Concentration: 0%~100% vol | | |
| | Flow Rate: 0~240L/min | | |
| **Sampling Interval** [2)] | 10ms (100 samples per second) | < 2ms (500 samples per second) | |
| **Detection Accuracy** [3)] | O2 Concentration: ±3%FS | | |
| | Flow Rate: ±0.2L/min (<10L/min); ±2.0% reading (≥10L/min) | | |
| **Resolution** | O2 Concentration: 0.1% vol | | |
| | Flow Rate: 0.1L/min | Flow Rate: 0.01L/min | |
| **Data Update Time** | O2 Concentration: 10ms | O2 Concentration: < 2ms | |
| | Flow Rate: 10ms | Flow Rate: < 2ms | |
| **Pressure Drop** | <600Pa (2.41in $H_2O$) @240L/min flow rate | | |
| **Working Condition** | 5~60℃; 0~95%RH (Non-condensing) | | -20~60℃; 0~95%RH (Non-condensing) |
| **Storage Condition** | Long term: -20~70℃; 0~95%RH (Non-condensing) | | |
| | Short term [4)]: -30~70℃; 0~95%RH (Non-condensing) | | |
| **Power Supply** | DC 4.75-5.25V, Ripple Wave ≤100mV | | |
| **Work Current** | Average Current <20mA; Peak Current <50mA | | |
| **Analog output** [5)] | O2 Concentration: 200mV~2500mV (0%~100% vol) | | |
| | Flow Rate: 200mV~2500mV (0~240L/min) | | |
| **Communication** | UART_TTL (3.3V) / IIC (IIC is reserved) | | |
| **Dimension** [6)] | L80*W48*H30mm | | |
| **IP Grade** | IP54 | | |
| **Life Span** | >10 Years (continuous operation) | | |

*Note:*

*1) 8500FS-L240 series are calibrated with pure oxygen source and the concentration output is for pure oxygen. In case of a PSA oxygen source, the concentration should be converted using formula (transfer relationship is: sensor reading = (target concentration*1.142)-3.42%, in which target concentration is for PSA oxygen source). Concentration measuring range for PSA oxygen source is 20.5% to 95.6%.*

*2) Sampling interval and data update time is typically 1.5ms for 8500FS-L240H and 8500FS-L240HL.*

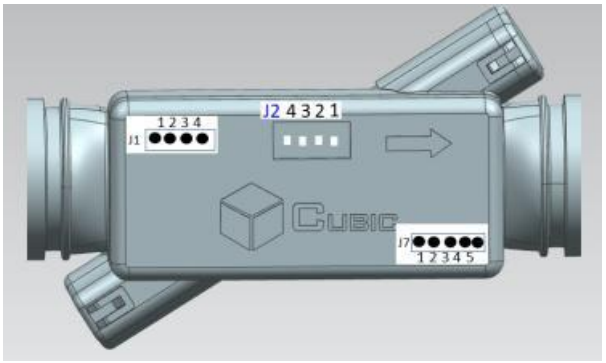
*3) The accuracy is defined at temperature range of 10 ℃ to 40 ℃.*

*4) Short term storage refers to temporary conditions for some special scenarios like short distance transportation, no longer than 2 hours.*

*5) Sensor's analog output of concentration is for pure oxygen that 200mV corresponds to concentration 0%, 2500mV corresponds to 100% and 683mV in air by default corresponds to oxygen concentration 21%. In case of a PSA oxygen source, first convert the analog output to pure oxygen concentration in percentage by the linear relationship between the output voltage and concentration, then transfer the pure oxygen concentration to PSA oxygen concentration using formula mentioned in note 1).*

*6) Outside diameter of the connector is 22mm which meets the requirement of ISO 5356.*

# Pin Definition




**Drawing 1 Gasboard-8500FS-L240 Pin Definition**

**Table 2 Connector Pin Definition**

| J2 | | | J1 | | |
|---|---|---|---|---|---|
| **No.** | **Pin** | **Description** | **No.** | **Pin** | **Description** |
| 1 | Vcc | 5V±5%, External Power Supply Input Pin | 1 | GND | Power Ground |
| 2 | Rx / SDA | UART Receive / IIC Data (3.3V) | 2 | O2 | 200mV – 2500mV output pin,<br>200mV corresponds to 0% Vol<br>2500mV corresponds to 100% Vol |
| 3 | Tx / SCL | UART Send / IIC Clock (3.3V) | 3 | Flow | 200mV – 2500mV output pin,<br>200mV corresponds to 0 L/min<br>2500mV corresponds to 240 L/min |
| 4 | GND | Power Ground | 4 | Vcc | 5V±5%, External Power Supply Input Pin |
| Remark：IIC is reserved | | | Remark：The function is customized | | |

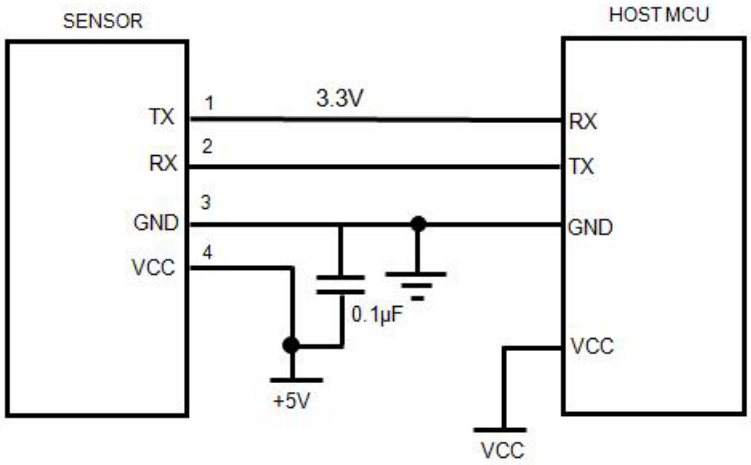
| J7 | | |
|---|---|---|
| **No.** | **Pin** | **Description** |
| 1 | GND | Power Ground |
| 2 | LED1 | Alarm Output 1 |
| 3 | LED2 | Alarm Output 2 |
| 4 | LED3 | Alarm Output 3 |
| 5 | Vcc | Power Output：3.3V |
| Remark：This function is customized | | |

**Table 3 Connector Description**

| Port | Terminal | Connector | Pin Pitch |
|---|---|---|---|
| J1 | PH2.0-4A | PH2.0-4P | 2.00mm |
| J2 | PH2.0-4A | PH2.0-4P | 2.00mm |
| J7 | PH2.0-5A | PH2.0-5P | 2.00mm |

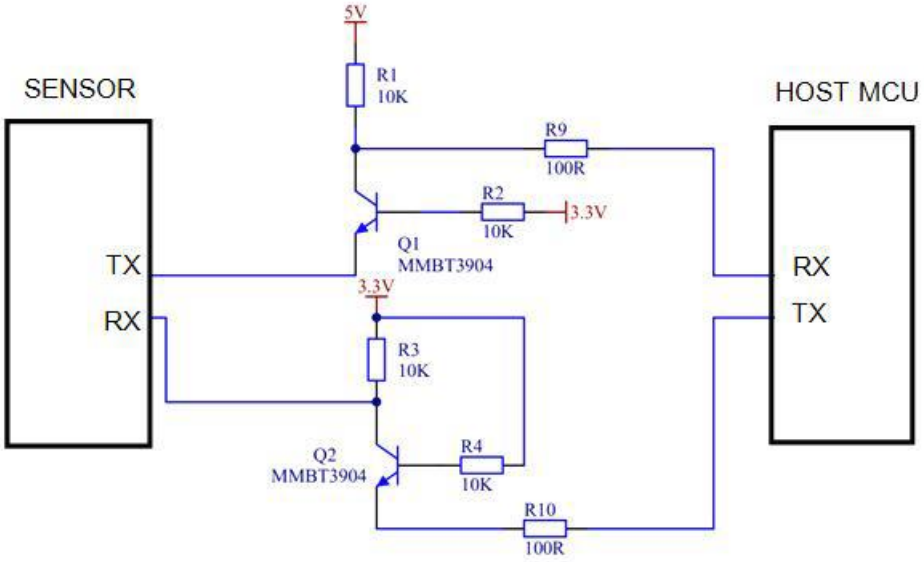
# Reference Circuit

## Application Scenario 1: UART TTL 3.3V Output




**Drawing 2 UART Communication Connection Circuit**

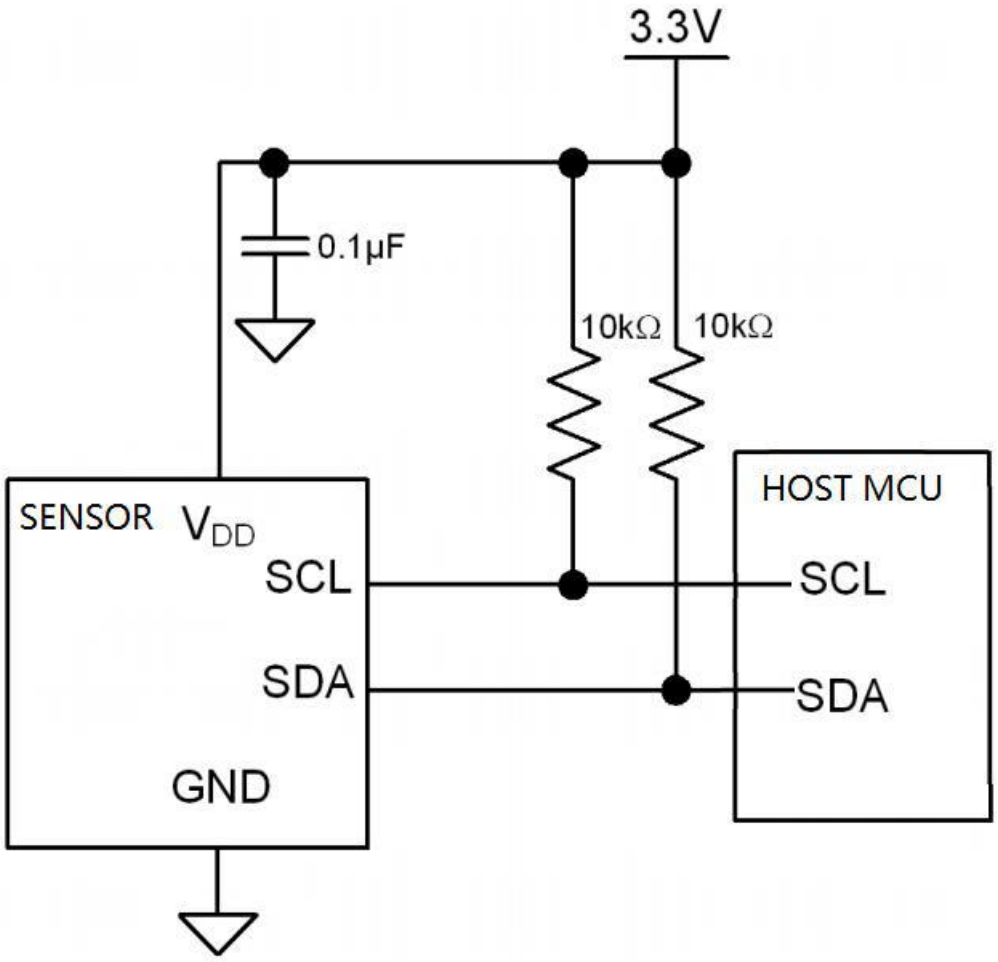
## Application Scenario 2: UART TTL 3.3V to 5V Communication Circuit




**Drawing 3 UART 3.3V to 5V Communication Connection Circuit**

# Reference Circuit

**Application Scenario 3: IIC communication Circuit**




**Drawing 4 IIC 3.3V Communication Connection Circuit**

# Communication Protocol

## UART Communication Protocol

### 1. Protocol Overview

(1) Baud Rate: 1,000,000 bps by default, Data Bits: 8, Stop Bits: 1, Parity: No, Flow Control: No

Note: Some device may lose data when receiving data, in this case, the user can send change baud rate command to switch to low-speed mode: baud rate 9600 bps;

(2) The protocol data are hexadecimal data. For example, “46” is [70] in decimal;

(3) [xx] is single- byte data (unsigned,0-255); For double- byte data, the higher byte is ahead of lower byte;

(4) The sensor will send data actively by default.

### 2. Serial Communication Protocol Format

**Host Send Format**

| Start Symbol | Length | Command No | Data 1 | …… | Data n | Check Sum |
|---|---|---|---|---|---|---|
| HEAD | LEN | CMD | DATA1 | …… | DATAn | CS |
| 11H | XXH | XXH | XXH | …… | XXH | XXH |

**Protocol Format Description**

| Protocol Format | Description |
|---|---|
| Start Symbol | PC sending is fixed to [11H], module response is fixed to[16H] |
| Length | Byte length of the frame, =data length+1 (include CMD+DATA) |
| Command No | Command number |
| Data | Read or written data, the length is variable |
| Check Sum | The sum of data accumulation, =256-(HEAD+LEN+CMD+DATA) |

### 3. Serial Protocol Command List

| No | Functions | Command |
|---|---|---|
| 1 | Actively send data by default | / |
| 2 | Read the measurement result | 0x01 |
| 3 | Read the software version number | 0x1E |
| 4 | Inquiry instrument serial number | 0x1F |
| 5 | Change baud rate | 0x08 |
| 6 | Read temperature, humidity and ambient pressure | 0x03 |

### 4. Detailed Description

**4.1 Default Active Data**

The sensor will send data actively by default.

**Response:** 16 09 01 DF1 DF2 DF3 DF4 DF5 DF6 DF7 DF8 [CS]

**Function:** Read the measurement results

**Description:**

O2 Concentration = (DF1*256 + DF2) /10 (Vol %)

Gas Flow Value = (DF3*256 + DF4) /10 (L/min) (For 8500FS-L240)

Gas Flow Value = (DF3*256 + DF4) /100 (L/min) (For 8500FS-L240H and 8500FS-L240HL)

Gas Temperature Value = (DF5*256 + DF6) /10 (℃) (For 8500F-L240H, temperature in the sensor chamber)

Gas Temperature Value = (DF5*256 + DF6) /10 – 50 (℃) (For 8500FS-L240HL, temperature in the sensor chamber)

Humidity value = (DF7*4)/10 (RH%) (Humidity in the sensor’s gas chamber)

Ambient Pressure value = (DF8*5) / 10 (KPa) (The ambient pressure outside of the chamber)

**Response Example：**

Response：16 09 01 00 CD 00 FF 00 C2 4B CA 3C

**Remark:**

Hexadecimal Convert into Decimal: CD is 205; C2 is194; 4B is 75; CA is 202

O2 Concentration = (0*256 + 205)/10 = 20.5 (20.5%)

O2 Flow Value = (0*0+0)/10 = 0 (L/min)

O2 Temperature Value = (0*256+194)/10 = 19.4 (19.4℃)

O2 Humidity Value = (75*4) / 10 = 30 (30%RH)

Ambient Pressure value = (202*5) / 10 = 101 (101Kpa)

### 4.2 Read the Measurement Result

**Send:** 11 01 01 ED

**Response:** 16 09 01 DF1 DF2 DF3 DF4 DF5 DF6 DF7 DF8 [CS]

**Function:** Read the measurement results

**Description:**

O2 Concentration = (DF1*256 + DF2) /10 (Vol %)

Gas Flow Value = (DF3*256 + DF4) /10 (L/min) (For 8500FS-L240)

Gas Flow Value = (DF3*256 + DF4) /100 (L/min) (For 8500FS-L240H and 8500FS-L240HL)

Gas Temperature Value = (DF5*256 + DF6) /10 (℃) (For 8500F-L240H, temperature in the sensor chamber)

Gas Temperature Value = (DF5*256 + DF6) /10 – 50 (℃) (For 8500FS-L240HL, temperature in the sensor chamber)

Humidity value = (DF7*4)/10 (RH%) (Relative humidity in the sensor's gas chamber)

Ambient Pressure value = (DF8*5) / 10 (KPa) (The ambient pressure outside of the sensor chamber)

**Remark:**

The O2 concentration here is for pure oxygen source, for PSA oxygen source, then the transfer relationship is:

Sensor reading = (target concentration*1.142)-3.42%, in which target concentration is for PSA oxygen source.

### 4.3 Read the Software Version Number

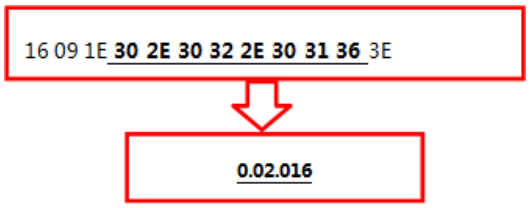
**Send:** 11 01 1E D0

**Response:** 16 09 01 DF1 DF2 DF3 DF4 DF5 DF6 DF7 DF8 [CS]

**Function:** Read the module's firmware version

**Description:** DF1-DF8 refers to the ASCII code of particular version number

**For example：** When module's firmware version number is 0.02.016, response data:



### 4.4 Inquiry Instrument Serial Number

**Send:** 11 01 1F CF

**Response:** 16 0B 1F (SN1) (SN2) (SN3) (SN4) (SN5) [CS]

**Function:** Read the module's serial number

**Description:** Outputs the module's serial number. SNn range is 0~9999, 5 integers constitute a 20-bit serial number.

### 4.5 Change Baud Rate

**Send**：11 02 08 0X [CS]

**Response:** [ACK] 02 08 0X [CS]

**Function:** Change baud rate of the serial output

**Description:**

When 0X=00, change baud rate from 1,000,000 bps to 9600 bps；

When 0X=02, change baud rate from 9600 bps to 1,000,000 bps;

Command will take effective after a power off and on operation.

### 4.6 Read Temperature, Humidity, Ambient Pressure

**Send**：11 01 03 EB

**Response:** 16 07 03 DF1 DF2 DF3 DF4 DF5 DF6 [CS]

**Function:** Read temperature, humidity and ambient pressure results

**Description:**

Temperature value = (DF1*256 + DF2) / 10 (℃)

Humidity value = (DF3*256 + DF4) / 10 (%)

Ambient pressure value = (DF5*256 + DF6) / 10 (kPa)

**Response Example:**

**Response:** 16 07 03 00 C8 01 67 03 FD B0

Remark: Hexadecimal Convert into Decimal: C8 is 200, [67] is 103, FD is 253;

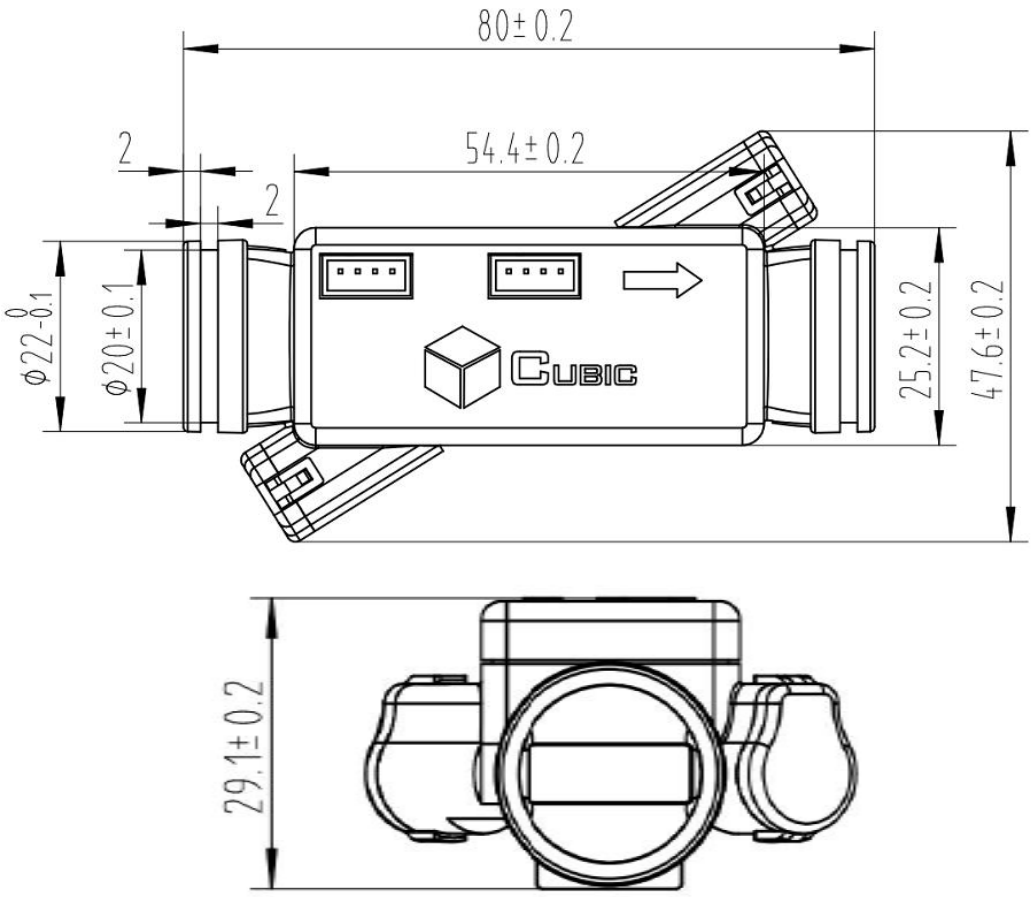
Temperature = (0*256 + 200) / 10 = 20 (20 ℃)

Humidity = (1*256 + 103) / 10 = 35.9 (35.9%RH)

Ambient Pressure = (3*256 + 253) / 10 = 102.1 (102.1kPa)

# Dimensions and Installation

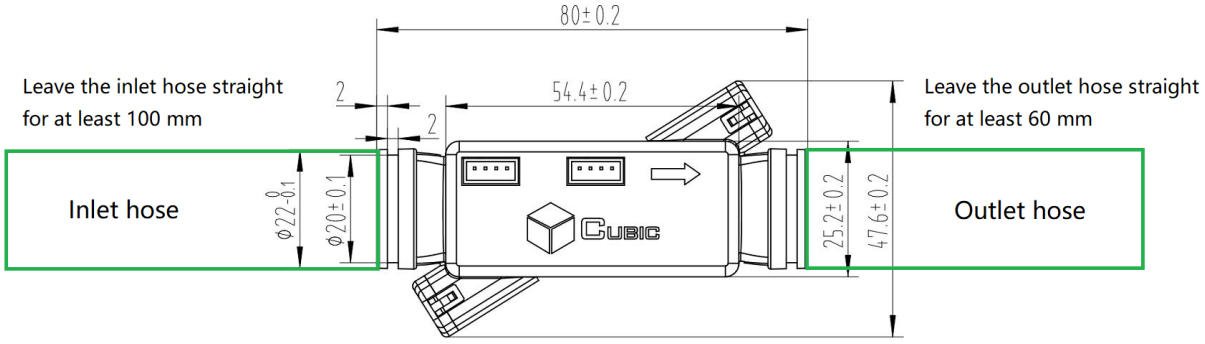
## Dimensions




**Drawing 5** Product Dimensions of 8500FS Series

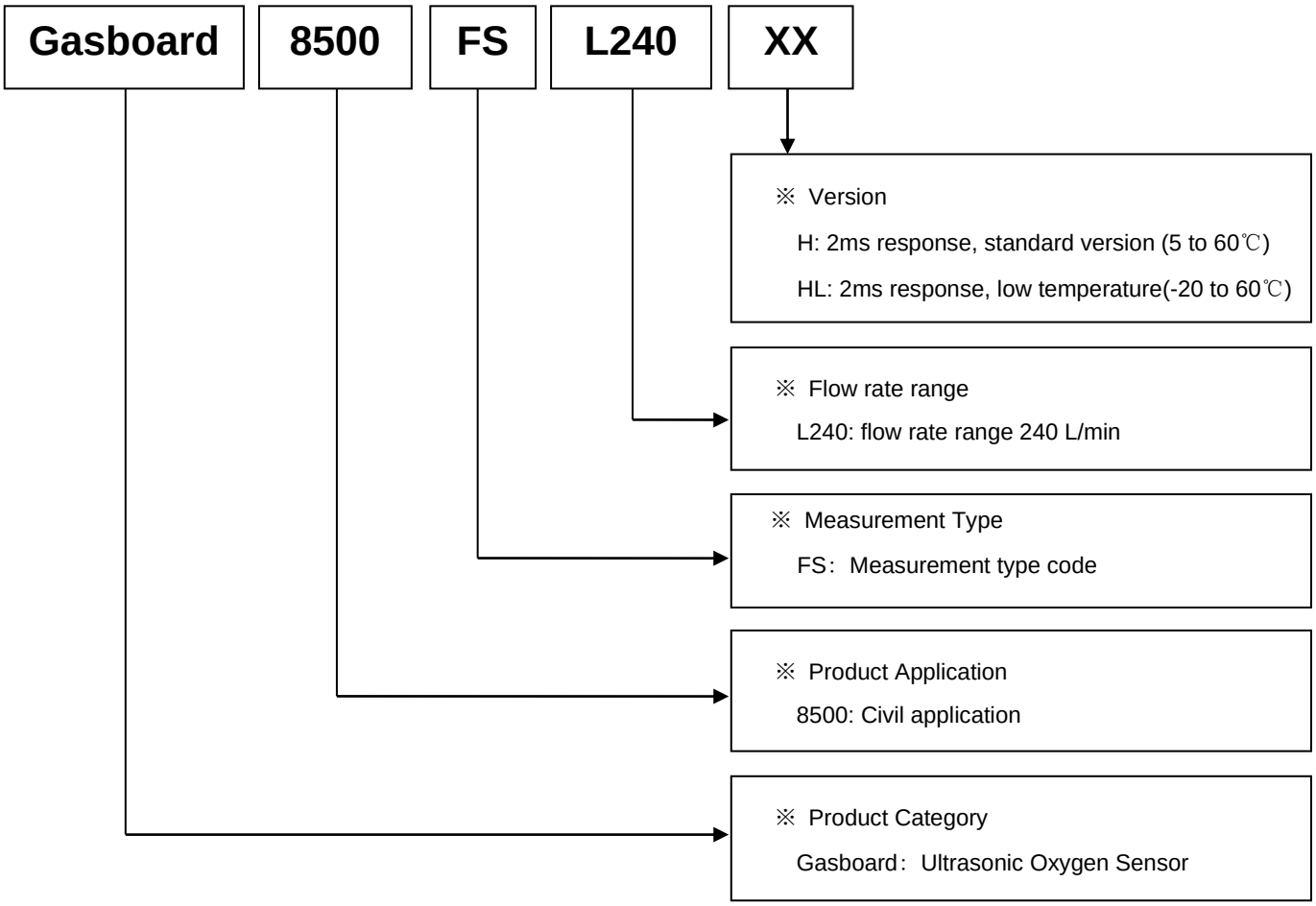
## Installation

1. Leave the hose straight at least 100 mm from sensor's inlet and 6 mm from the sensor outlet side.
2. Make sure that there is no leakage.
3. Oxygen source should be input from the correct direction as indicated on the housing of the sensor (an arrow sign).

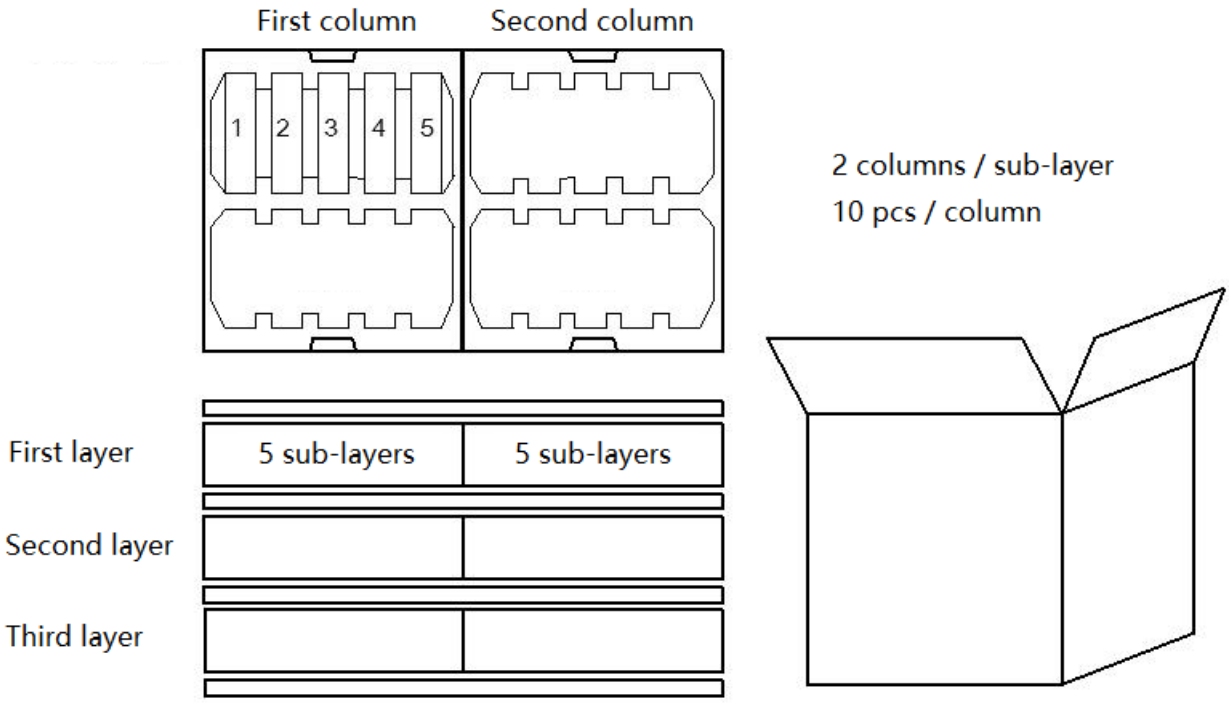



**Drawing 6** Installation Guide for 8500FS Series

# Product Code Instruction



# Packing Information




**Drawing 6 Packing information**

| Qty/Layer | Small Tray Qty | Big Tray Qty | Sensor per Carton | Carton Dimension | Packing Material |
|---|---|---|---|---|---|
| 20pcs | 5 sub-layers | 3 layers | 150pcs | W395 * L320 * H470mm | Anti-static Plastic Tray |

Remark:

Packing specification might be updated without prior notice.

# User Attention

Please pay attention to below:

(1) Install the sensor as far away as possible from the heat source and heat dissipation outlet of the compressor, and install the sensor as close as possible to the oxygen outlet, and install a one-way valve to prevent the water from humidifying glass from entering sensor.

(2) In order to ensure reliability and long service life, do not use or store the sensor in a place where the temperature is higher than the rated temperature, and do not use the sensor in an environment where the voltage is higher than the rated voltage of the sensor.

(3) Without necessary compensations, please do not use the sensor in the environments of high humidity water steam, abnormal pressure, and low temperature.

(4) The product shall not be used or stored in a place with corrosive gas, especially hydrogen sulfide gas, acid, alkali, salt or similar. The products stored in the warehouse should be stored in normal temperature and humidity, and avoid direct sunlight.

(5) When there is a problem with the Cubic's products, please contact Cubic team in time; the sensor must not be disassembled privately, and Cubic will not bear any consequences if it is damaged by disassembled privately.

# Consultancy & After-sales Service

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