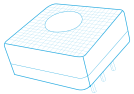
EC Sense
Easy Gas Sensors

Oxygen Gas Module 0 ~ 25%vol.

TB200B-ES1/ES4-O_2-25-01

Technical Specification



Pringting Solid Polymer Electrochemical Gas Technology

Small size | Long life | Low cost | High accuracy | Fast response | Lower power consumption

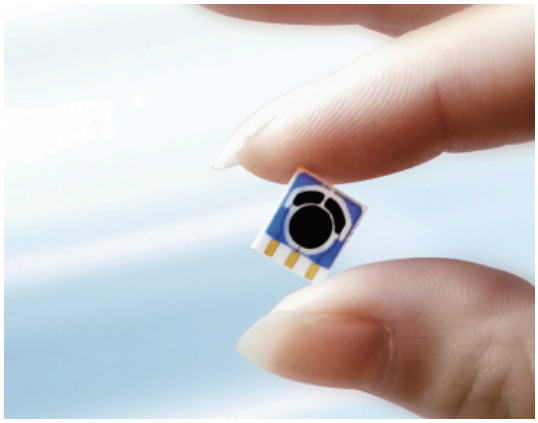
Product Overview

TB200B Series Oxygen Gas Module is the perfect combination of state of the art sensing device with a sophisticated circuit board. The EC Sense gas sensor is a solid polymer sensor featuring long lifetime, robustness, low power consumption, and many other advantages based on electrochemical principles.

The Oxygen Gas Module is equipped with a standard UART Digital output for ease of use without the need for customers to understand the sensor application and the tedious work of calibration.

Features

- Sleeping function good for low power request IOT applications
- Combined with intelligent algorithms, it has stronger adaptability to the environment, more accurate detection, and stable zero point
- Good anti-toxicity, suitable for CO_2 gas environment, no consumption of chemical materials
- More than 2 years Life time, stable detection and higher reliability
- New micro circuit design, strong anti-electromagnetic interference ability
- Fast response, fast return to zero, plug and play
- Independent temperature and humidity digital sensor output
- The smallest size and lowest power consumption in the electrochemical field
- RoHS Eco-friendly design



Application

- Hypoxia and oxygen enrichment monitoring
- Mine
- Industrial emissions monitoring
- Vehicle exhaust emission monitoring
- Industrial process analysis
- 3D printing
- Gas production
- Biological incubator, compost, fermentation
- Refrigeration, greenhouse
- Underground pipeline oxygen monitoring
- Medical

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Principle

Solid polymer electrochemical technology is a revolutionary innovation in the field of electrochemical detection. This technology is based on the principle of electrochemical catalytic reaction caused by the target gas leading to a electrical signal that is direct proportional to the gas concentration.

The sensor is composed of three catalytic electrodes, a solid electrolyte, and gas diffusion holes. The gas reaches the working electrode of the sensor through the diffusion holes, an electrochemical redox reaction occurs on the porous micro-surface of the electrode, the solid electrolyte conducts electron transfer, and generate a current signal as an output. The current signal can characterize the gas concentration.

Cross Sensitivity

Gas	Formula	Concentration (ppm)	Response(ppm)
Carbon Dioxide	CO_2	5000	0
Carbon Monoxide	CO	50	0
Nitrogen Dioxide	NO_2	10	0
Hydrogen Cyanide	HCN	10	0
Sulfur Dioxide	SO_2	20	0
Hydrogen	H_2	100	0
Isopropanol	C_3H_7OH	1000	0
Hydrocarbons	/	1%vol.	0
Ammonia	NH_3	20	0
Ozone	O_3	0.5	0
Chlorine	Cl_2	1	0
Nitrogen Monoxide	NO	25	0

Note: 1) The above interference factors may vary due to different sensors and service life. Please refer to the actual test results.
2) This table is not complete for all gases, and the sensor may be sensitive to other gases.
3) Based on O2 oxygen calibration.

Order Informations

Product Name	Part Number	Range	Resolution
Oxygen Gas Module	04-TB200B-ES1-O_2-25-01	0-25%vol.	0.01%vol.
Oxygen Gas Module	04-TB200B-ES4-O_2-25-01	0-25%vol.	0.01%vol.
4Pin Cable	02-MOD-CABLE-4PIN-01		

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Specification

Principle	Solid Polymer Electrochemical Sensing Technology
Detection of gas	Oxygen
Detection Range	0-25% vol., Maximum overload to 30% vol.; Resolution: 0.01% vol.
Lowest Detection Limit	0.5% vol .;
Full-scale accuracy error	± 5% F.S
Repeatability	≤1%
Warm-up time	Store under clean air power on for the first time <20 minutes
	Note: Exposure to harsh chemicals, high concentrations of alcohol, acetone, and ethanol gas during storage may lead to extended warm-up time
Response time	T50: <5 seconds; T90: <10 seconds
Return Zero time	<30 seconds
	Note: The time when the module leaves the oxygen-enriched or hypoxic environment, and the indication value returns (20.9 ± 0.1)% vol. In clean air
Calibration Gas	99.99% Nitrogen as standard gas calibration zero, Clean air calibration 20.9% vol. Sensitivity
	Note: users are not recommended to use over-range
Sensor expected life time	Relatively clean air, Temperature (0 ~ 25) ℃, Humidity (30 ~ 70)% RH, expected life time more than 2 years
	Note: It is not recommended for users to use over-range
Output	3.3V UART digital signal (see below for communication protocol) or RS485 output signal
	Interface definition: VCC- Red, GND- Black, RX- Yellow, TX- Green;
	Baud rate: 9600 Data bits: 8 bits Stop bits: 1 bit
Get data command	The communication is divided into active uploading and Q & A. The default is Q & A mode after power-on. You can use instructions to switch between the two modes.
	Return to Q & A mode after power off or switch power mode
	See next page for details
Working Voltage	3.3-5.5V DC
Working Current	< 5mA
Power Consumption	25mW @ 5V DC
Working temperature	(-40 ~ 55) ℃
Optimal working temperature	25℃
Working humidity	(15-95) % RH
Optimum working humidity	50% RH
Working pressure	Atm ± 10%
Circuit board size	40X30X5.6 (mm)
Module size	With ES1 sensor: 40X30X12 (mm); With ES4 sensor: 40X30X22.45 (mm)
Weight	TB200B-ES1-O_2-25-01 < 15g; TB200-ES4-O_2-25-01 < 25g
Temperature and humidity sensor Data	Temperature Range: (-40 ~ 55) ℃ Resolution: 0.1 ℃ Relative error: ± 0.2 ℃
	Humidity measurement range: (15 ~ 95)% RH non-condensing Resolution: 0.1% RH Relative error: ± 2%
Warranty	12 months from the date of shipment

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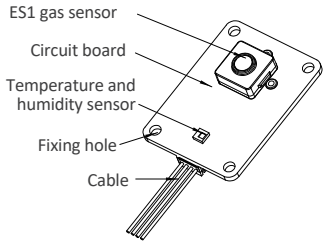
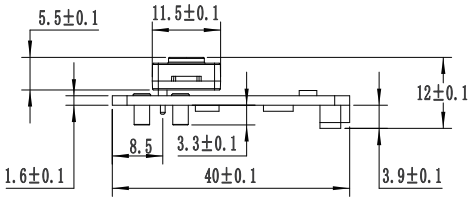
Structure Diagram (unit: mm)

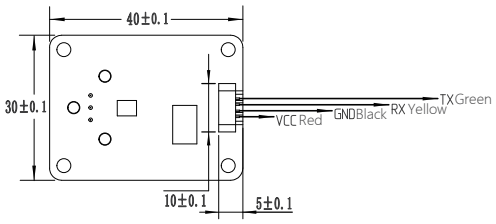
TB200B-ES1-O_2-25-01 Dimension diagram



Product Schematic

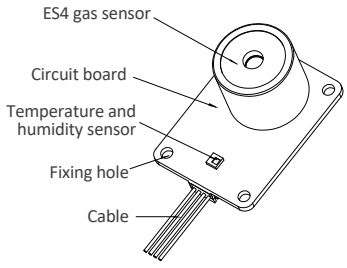


Side View

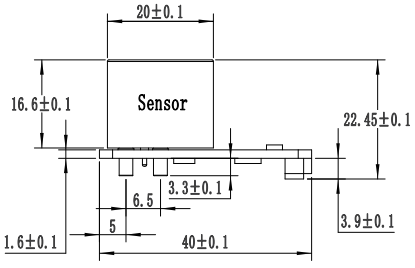


Bottom View

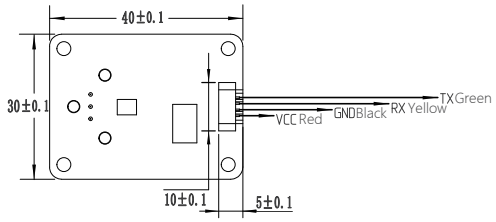
TB200B-ES4-O_2-25-01 Dimension diagram



Product Schematic

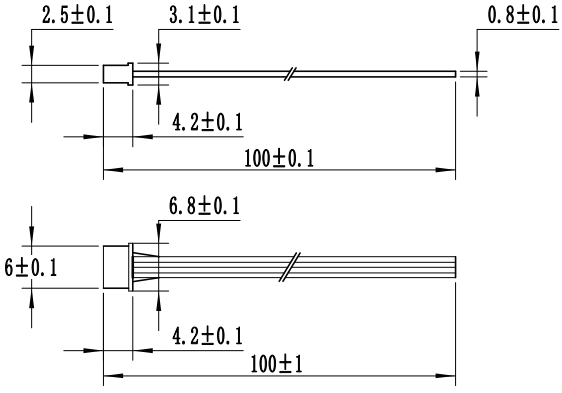


Side View



Bottom View

4Pin cable size diagram



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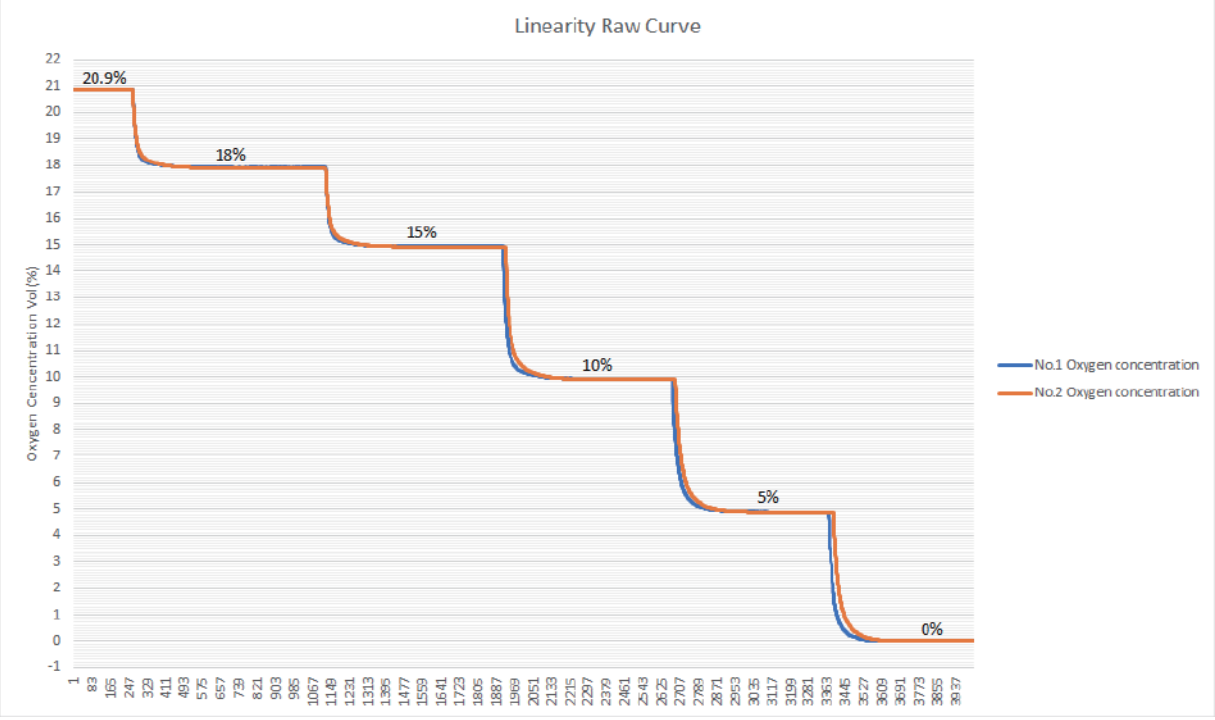
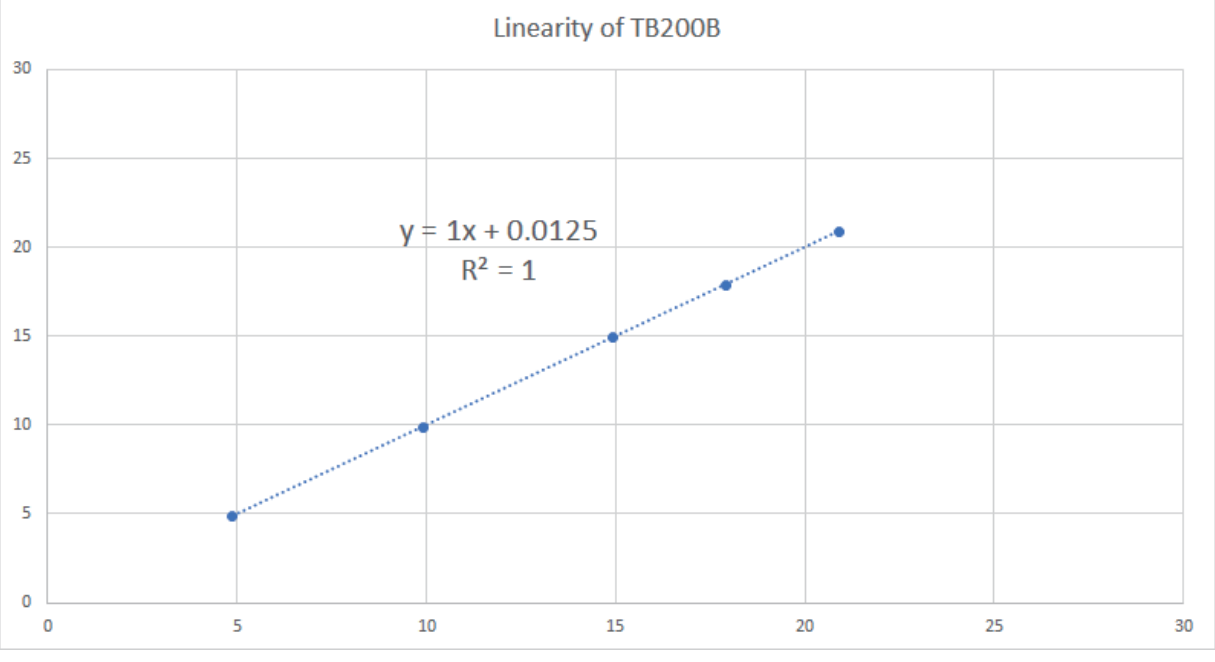
Linearity

Temperature environment: 26 ℃; Humidity environment: 55%; Air chamber space: 0.03m³; Ventilation flow of air distribution system: 3000sccm





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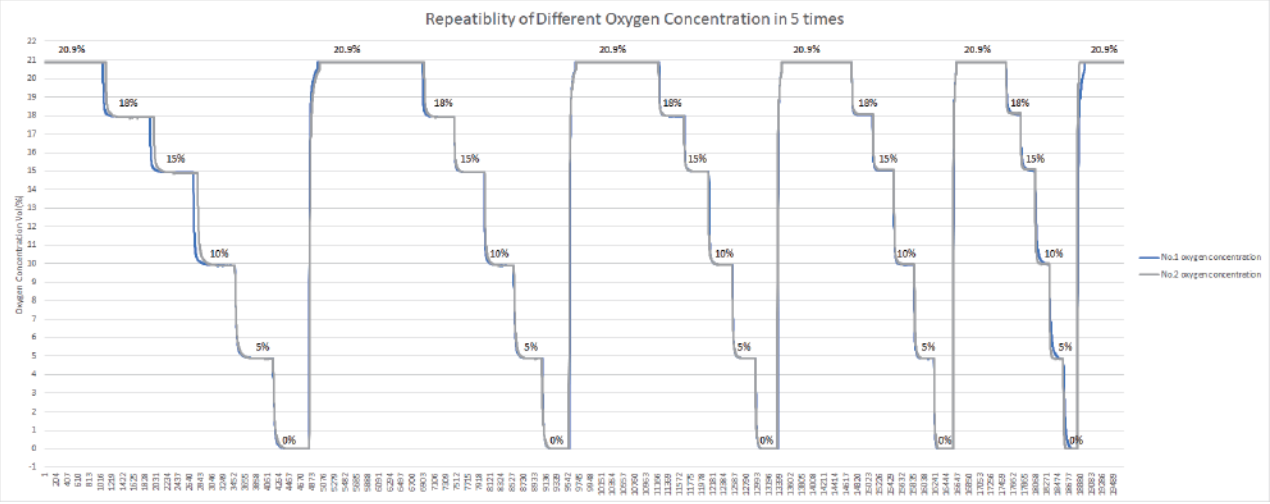
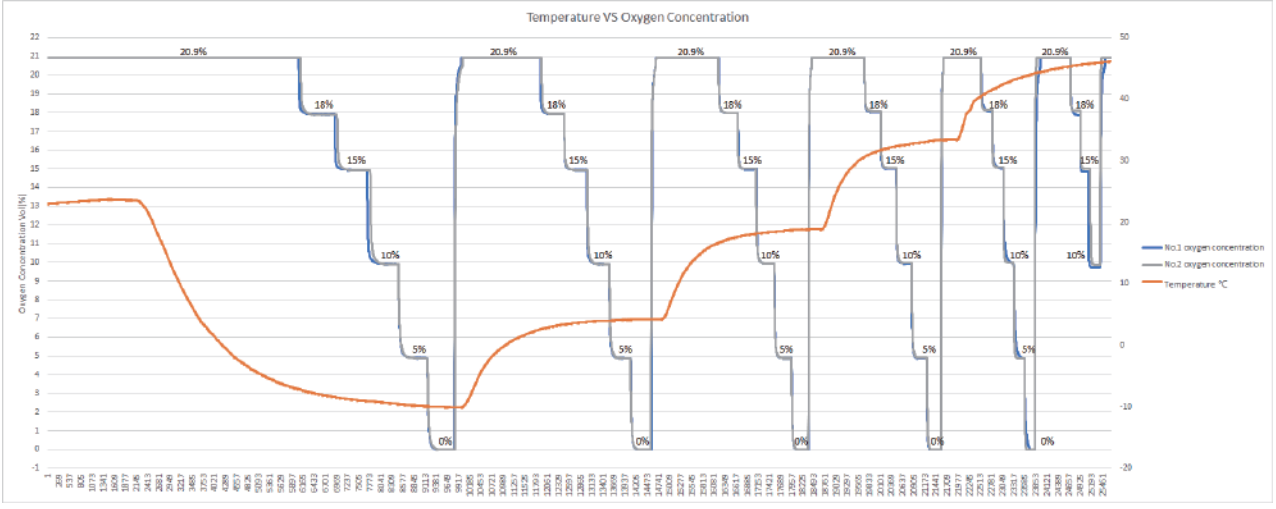
Repeatability

Temperature environment: 26 ℃; Humidity environment: 55%; Air chamber space: 0.03m³; Ventilation flow of air distribution system: 3000sccm



Temperature

Temperature environment: -15, -5, 10, 30, 50 ° C; air chamber space: 0.03m³; ventilation flow of gas distribution system: 3000sccm, oxygen sensor is negative reaction



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User Guide

Thank you for choosing EC Sense Gas module. Before using it, please read this document in detail in order to use our products correctly and effectively.

Storage

1. The best storage environment is: temperature (0-20) ℃, relative humidity 50% RH (non-condensing);
2. The storage environment should keep the air clean, no pollution gas, no acetone, no high concentration organic gas, no dust, no smoke;
3. Avoid storage with alcohol (ethanol), perfume, sodium silicate and polyurethane liquids or solids;
4. Avoid high temperature and low humidity storage.

Packing and shipping

1. Avoid prolonged direct sunlight during transportation , prevent rainwater penetration;
2. Transport packaging should be protected with shock-proof bubble film or non-odor environmentally friendly sponge;
3. During long-distance transportation, the temperature inside the sensor package should be kept within 40 ℃ as much as possible, and the maximum temperature should not exceed 55 ℃ (can not be stored or used at this temperature for a long time), and the humidity should not be less than 15% RH;

Steps for usage

1. Warm-up

- The Oxygen Gas Module is designed with plug-and-play function, but because the oxygen sensor has its own bias voltage, by calibrated finished product, it still takes about 20 minutes to warm up prior first time use. When the output signal is constant, the warm-up is complete.
  (Note: under different storage and measurement environments, the first electrode stabilization time is different)
- For warming up it is recommended to power the Oxygen Gas Module in a normal atmosphere (where you expect "normal" Oxygen concentrations of 20.9 - 21.0 %vol.). After confirming that the Oxygen Gas Module shows normal readings, it can be placed in the measurement environment, warm up for about 20 minutes, and allow the sensor to adapt to its environment. At this time, you can obtain valid data.

2. Connection

- Please refer to the 4Pin cablel in the "Structure Diagram" above. For the power supply, see the voltage and current ranges marked in the performance indicators. Note: incorrect wiring will cause the module to malfunction or damage the module.

3. Diffusion use

- When using in a closed environment, it is necessary to ensure a constant pressure and the working pressure range is within ± 10% of atmospheric pressure. to ensure accurate measurement data , when using under different pressure environments, re-sensitivity calibration should be performed according to the pressure of the use environment.
- Usually the change of pressure will cause the output signal to change.if The pressure increase, the signal will increase, the pressure change suddenly, and the sensor signal will have a sudden change in peak value.

4. Pump suction use

- When using the sensor in the pumping detection mode, the gas flow rate must be controlled within 500ml per minute, and the flow rate must be stable. The change of flow will cause the signal to fluctuate. When the flow is large, it will bring the change of pressure, which will cause the sensor signal value to change.
- When using the pump suction mode, it is best to add a flow sensor or an air pump control according to the product design to avoid negative pressure and physical damage to the sensor that cannot be recovered.
- The design of the gas path should avoid direct gas flow to the front of the sensor. An optional flow cap should be used, while the air is inlet and the air is outlet (normally small in and large out). The inlet and outlet gas is designed to be 90 degrees or straight-through with a barrier type to ensure that the gas can fully contact the oxygen sensor.

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User Guide

5. Temperature and humidity effects

- The oxygen Gas module has been corrected for temperature compensation through an intelligent algorithm, which is suitable for the detection environment of -40 ~ 55 ℃.
- The oxygen sensor module must not be used and stored for a long time in a high-temperature and low-humidity environment with a humidity below 10% or a temperature above 55 ℃. Failure to do so will result in reduced sensor life,Either failure or test data is invalid.
- The frequent and rapid changes in temperature or humidity will affect the chemical material and cause an unexpected decrease in the sensor life.
- Oxygen sensors are generally not affected by humidity, but during use, it is necessary to avoid condensation blocking the air inlet holes on the surface of the filter membrane, resulting in the inability of oxygen to diffuse into the sensor and no signal output.
- Impact of environmental changes on sensors: Due to the principle and characteristics of electrochemical sensors, environmental changes have varying degrees of influence on the chemical electrolytes inside the sensors.The TB200B oxygen detection module analyzes the changes in the current data of the sensor in detail through different environmental temperature and humidity effects tests, and combines the temperature and humidity sensor data to perform algorithmic compensation to correct the resulting deviations. Sudden changes in temperature and humidity will cause abnormal fluctuations in the trace data of the sensor, but generally it can fully adapt to the new environment and be stable within 5-10 minutes.

6. Maintain

- The maintenance of the oxygen detection module is mainly for accuracy calibration. Generally, the solid polymer oxygen sensor does not consume chemical electrolyte, but it can be affected by temperature, humidity, dust, and other gases used in the environment. The sensitivity of the sensor will shift, and the oxygen sensor needs to be re-calibrated. The better the use environment, the longer the maintenance cycle and less maintenance workload.
- In case a calibration is needed the user may make sure that clean air is available or the module can be sent back to the factory for recalibration.

Precautions

1. The main function of the gas sensor is to detect the gas composition and content. Please make sure that the sensor is not getting in touch with any liquid;
2. Different gas sensors have different measurement concentration ranges (ranges), and should not be exposed to over-range/high concentrations for a longer time;
3. The sensor is covered with a waterproof and breathable filter (on the top of the sensor), which should not be damaged, scratched or pulled of;
4. Please make sure that the ventilation (filter) surface of the sensor is not blocked or contaminated. Blockage of the filter may lead to a reduced sensitivity, slow response time, or no response.
5. Please do not exchange the sensors of different gas detection modules, this will cause measurement errors, because all the parameters of each sensor and each circuit board are matched and calibrated, there will be deviations after the exchange;
6. Once the ES1 oxygen sensor is unplugged and reinserted into the circuit board, please check that the three electrodes of ES1 correspond to the sockets on the circuit board to avoid irreversible damage to the sensor after reverse insertion;
7. Avoid excessive impact or vibration, such as the shell rupture, reveal the internal structure, the output will not guarantee the effectiveness.

Disclaimer

EC Sense Performance data stated is based on test conditions with new sensors at 26°C, 55%rH and 1 atm, flow rate 3000sccm using EC-Sense calibration Systems and AQS Testing System. Cross sensitivity gases are not target gases. Relations and performance can change, also with ageing of the sensor. In the interest of continued product improvement, EC-Sense reserves the right to change design features and specifications without prior notification. We do not accept any legal responsibility for customer applications of our sensors. EC-Sense accepts no liability for any consequential losses, injury or damage resulting from the use of this document, the information contained within or from any omissions or errors herein. This document does not constitute an offer for sale and the data contained is for guidance only and may not be taken as warranty. Any use of the given data must be assessed and determined by the user thereof to be in accordance with federal, state and local laws and regulations. All specifications outlined are subject to change without notice.

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User Guide

Warning

EC-Sense sensors are designed to operate in a wide range of harsh conditions. It is nevertheless essential to prevent exposure to high concentrations of solvent vapours during storage, assembly and operation. When using sensors on printed circuit boards (PCB's), degreasing agents should be used prior to the sensor being fitted. Please note that gluing or soldering direct to the pins of EC-Sense gas sensors will void any warranty. Please use PCB sockets when connecting EC-Sense sensors. Any electrochemical EC-Sense gas sensor can potentially fail to meet specification without warning. Despite the high reliability of our products, we recommend checking all sensors and instruments for response to gas before use, especially where life safety is a performance requirement of the product. At the end of the product's life, do not dispose of any electronic sensor, component or instrument in the domestic waste but contact EC-Sense or their distributor for disposal instructions. Customers should test under their own conditions to ensure that the sensors are suitable for their specific requirements.

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Communication Protocol

General settings

The sensor module uses serial communication. The communication configuration parameters are as follows:

Baud rate	9600
Data bits	8 bits
Stop bit	1 bit
Parity bit	None

Note: The communication is divided into active uploading and Q & A mode. The default mode is Q & A mode after power-on. You can use commands to switch between the two modes. After power-off or switching power consumption mode, the mode is restored.

Transmission mode switching instruction

Command 1 Instruction one switches to active upload. The command line format is as follows:

0	1	2	3	4	5	6	7	8
Start bit	Retain	Switch command	Automatic upload	Retain	Retain	Retain	Retain	Proof test value
0 x FF	0 x 01	0 x 78	0 x 40	0 x 00	0 x 00	0 x 00	0 x 00	0 x 47

Note: This format is fixed

Command 2 Switch to passive upload. The command line format is as follows:

0	1	2	3	4	5	6	7	8
Start bit	Retain	Switch command	Answer	Retain	Retain	Retain	Retain	Proof test value
0 x FF	0 x 01	0 x 78	0 x 41	0 x 00	0 x 00	0 x 00	0 x 00	0 x 46

Note: This format is fixed

Get module information instruction

Command 3 Gets sensor type, maximun range, unit,unit decimal places command: 0xD1

Returned value:

0	1	2	3	4	5	6	7	8
Sensor type	Maximum range high	Maximum range low	Unit	Retain	Retain	Retain	Number of decimal places (bit[4]~bit[7]) Data sign (bit[0]~bit[3])	Parity bit
0 x 19	0 x 00	0 x CB	0 x 02	0 x 00	0 x 00	0 x 00	0 x 00	0 x 33

Note:

Max range = (Max range high << 8) | Max range low

Units: 0x02 (ppm and mg / m^3) 0x04 (ppb and ug / m^3)

Signs: 0 (positive number) 1 (negative number)

Decimal places: how many decimal places to read the concentration value, the maximum number of decimal places is 3

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Communication Protocol

Command 4 Get the sensor type, maximum range, unit, and decimal places command: 0xD7

0	1	2	3	4	5	6	7	8
Command header 1	Command header 2	Sensor type	Maximum range high	Maximum range low	Unit	Number of decimal places (bit[4]~bit[7]) Data sign (bit[0]~bit[3])	Retain	Parity bit
0 x FF	0 x D7	0 x 19	0 x 00	0 x C8	0 x 02	0 x 01	0 x 00	0 x 45

Explanation:

Checksum: 1 ~ 7 bits of data are added to generate an 8-bit data.invert every bit and add 1 to the end

Decimal places bit [4] ~ bit [7]:

(bit[7]<<3) | (bit[6]<<2) | (bit[5]<<1) | bit[4] = decimal places

Data sign (bit[0]~bit[3]):

(bit[3]<<3) | (bit[2]<<2) | (bit[1]<<1) | bit[0] = 0 Negative inhibition

(bit[3]<<3) | (bit[2]<<2) | (bit[1]<<1) | bit[0] = 1 Positive inhibition

Unit :

0x02: unit is mg/m³ and ppm

0x04: unit is um/m³ and ppb

0x08: unit is 10g/m³ and %

Command 5 The format for actively reading the gas concentration value is as follows :

0	1	2	3	4	5	6	7	8
Start bit	Retain	Command	Retain	Retain	Retain	Retain	Retain	Parity bit
0 x FF	01	0 x 86	0 x 00	0 x 00	0 x 00	0 x 00	0 x 00	0 x 79

Returned value:

0	1	2	3	4	5	6	7	8
Start bit	Command	High gas concentration (ug/m³)	Low gas concentration (ug/m³)	Full range high	Full range low	High gas concentraiton (ppb)	Low gas concentraiton (ppb)	Parity bit
0 x FF	0 x 86	0 x 00	0 x 2A	0 x 00	0 x 00	0 x 00	0 x 20	0 x 30

Description:

Checksum: 1 ~ 7-bit data is added to generate an 8-bit data.invert every bit and add 1 to the end

Gas concentration value = high gas concentration *256 + low gas concentration ;

(The high and low concentrations need to be converted from hexadecimal to decimal and then brought into this formula to calculate

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Communication Protocol

Command 6 Gas concentration value and temperature and humidity combined reading instruction

0	1	2	3	4	5	6	7	8
Start bit	Retain	Command	Retain	Retain	Retain	Retain	Retain	Parity bit
0 x FF	0 x 00	0 x 87	0 x 00	0 x 00	0 x 00	0 x 00	0 x 00	0 x 79

Returned value:

0	1	2	3	4	5	6	7	8	9	10	11	12
Start bit	Command	High gas concentration (ug/m³)	Low gas concentration (ug/m³)	Full range high	Full range low	High gas concentration (ppb)	Low gas concentration (ppb)	Temperature high	Temperature low	Humidity high	Humidity low	Parity bit
0 x FF	0 x 87	0 x 00	0 x 2A	0 x 03	0 x E8	0 x 00	0 x 20	0 x 09	0 x C4	0 x 13	0 x 88	0 x DC

Description:

Checksum: 1 ~ 11 bits of data are added to generate an 8-bit data, each bit is inverted, and 1 is added at the end.

Gas concentration value = high gas concentration * 256 + low gas concentration;

(The high and low concentrations need to be converted from hex) adecimal to decimal and then brought into this formula to calculate

Temperature is signed data withTwo decimal places (℃-Celsius) Pseudo code calculation formula:

T = (float)((int)((0x0A<<8)|0x09))/100

Humidity is data without signs and two decimal places.The unit is (rh%). Pseudo code calculation formula:

Rh = (float)((uint)((0x0A<<8)|0x09))/100

Command 7 Get the current temperature and humidity

Returned value:

0	1	2	3
Temerature high 8 bit	Temperature low 8 bit	Humidity high 8 bit	Hunidity low 8 bit
0 x 0A	0 x 09	0 x 11	0 x F4

Description:

Temperature is signed data with two decimal plac)es and the unit is (℃-Celsius)

Pseudo code calculation formula:

T = (float)((int)((0x0A<<8)|0x09))/100

Humidity is data without sign and two decimal places, the unit is (rh%)

Pseudo code calculation formula:

Rh = (float)((uint)((0x0A<<8)|0x09))/100

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Communication Protocol

Command 8 Get the current temperature and humidity with calibration
Returned value:

0	1	2	3	4
Temerature high 8 bit	Temperature low 8 bit	Humidity high 8 bit	Hunidity low 8 bit	Checksum
0 x 0A	0 x 09	0 x 11	0 x F4	0 x E8

Description:
Checksum: 0 ~ 3 digits of data are added to generate an 8-bit data. Each bit is inverted, plus 1 at the end
Temperature is data with a sign and two decimal places. The unit is (℃-Celsius)
Pseudo code calculation formula:
T = (float)((int)((0x0A<<8)|0x09))/100
Humidity is data with no sign and two decimal places in units (rh%).
Pseudo code calculation formula:
Rh = (float)((uint)((0x0A<<8)|0x09))/100

Command 9 Get the current version number
Returned value:

0	1	2	3	4	5
0 x 19	0 x 05	0 x 27	0 x 00	0 x 10	0 x 01

Data in active upload mode
The upload data format is as follows:

0	1	2	3	4	5	6	7	8
Start bit	Command	High gas concentration (ug/m^3)	Low gas concentration (ug/m^3)	Full range high	Full range low	High gas concentration (ppb)	Low gas concentration (ppb)	Parity bit
0 x FF	0 x 86	0 x 00	0 x 2A	0 x 00	0 x 00	0 x 00	0 x 20	0 x 30

Note:
Checksum: Add 1 to 11 digits of data to generate 8 digits of data, invert each bit, add 1 at the end
Gas concentration value = high gas concentration * 256 + low gas concentration
(The high and low concentrations need to be converted from hexadecimal to decimal and then brought into this formula to calculate)

Low power switching

Enter sleep mode

0	1	2	3	4	5
0 x AF	0 x 53	0 x 6C	0 x 65	0 x 65	0 x 70

Returned value :

0	1
0 x 4F	0 x 4B

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Communication Protocol

Exit sleep mode

0	1	2	3	4
0 x AE	0 x 45	0 x 78	0 x 69	0 x 74

Returned value :

0	1
0 x 4F	0 x 4B

Note: after exiting sleep mode, it takes 5 seconds to recover, no data within 5 seconds

Enter sleep mode

0	1	2	3	4	5	6
0 x A1	0 x 53	0 x 6C	0 x 65	0 x 65	0 x 70	0 x32

Returned value :

0	1	2	3	4	5	6	7	8
0 x FF	0 x A1	0 x 00	0 x 00	0 x 00	0 x 00	0 x 00	0 x 00	5F

Exit sleep mode

0	1	2	3	4	5
0 x A2	0 x 45	0 x 78	0 x 69	0 x 74	0 x 32

Returned value :

0	1	2	3	4	5	6	7	8
0 x FF	0 x A2	0 x 00	0 x 00	0 x 00	0 x 00	0 x 00	0 x 00	5E

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Communication Protocol

Turn off the running lights

0	1	2	3	4	5	6	7	8
Start bit	Retain	Command	Retain	Retain	Retain	Retain	Retain	Checksum
0 x FF	0 x 01	0 x 88	0 x 00	0 x 00	0 x 00	0 x 00	0 x 00	0 x 77

Return :

0	1
0 x 4F	0 x 4B

Turn on the running lights

0	1	2	3	4	5	6	7	8
Start bit	Retain	Command	Retain	Retain	Retain	Retain	Retain	Checksum
0 x FF	0 x 01	0 x 89	0 x 00	0 x 00	0 x 00	0 x 00	0 x 00	0 x 76

Return :

0	1
0 x 4F	0 x 4B

Query the running light status

0	1	2	3	4	5	6	7	8
Start bit	Retain	Command	Retain	Retain	Retain	Retain	Retain	Checksum
0 x FF	0 x 01	0 x 8A	0 x 00	0 x 00	0 x 00	0 x 00	0 x 00	0 x 75

Return :

0	1	2	3	4	5	6	7	8
Start bit	Command	State value	Retain	Retain	Retain	Retain	Retain	Checksum
0 x FF	0 x 8A	0 x 01	0 x 00	0 x 00	0 x 00	0 x 00	0 x 00	0 x 75

Note: Status value 1 (light on), 0 (light off)

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