

# O<sub>2</sub> SENSORS – LuminOx User's Guide

This document describes the LuminOx sensor installation and operation processes.



The LuminOx family (LOX) is a range of factory calibrated oxygen sensors which measure ambient oxygen partial pressure (ppO<sub>2</sub>) levels using the principle of luminescence quenching by oxygen.

LuminOx measures ppO<sub>2</sub> (mbar) and temperature (°C). A pressure sensor enables LuminOx to also measure barometric pressure (mbar) and to convert the ppO<sub>2</sub> reading to an oxygen concentration (O<sub>2</sub>%).

The sensor benefits from low power operation, traditionally associated with electrochemical and galvanic sensors, while providing a much longer lifetime due to the non-depleting sensing principle.

LuminOx is ppO<sub>2</sub> and temperature compensated, enabling linear operation over a wide environmental range without the need for additional system components. LuminOx does not contain lead or any other hazardous materials and has negligible cross sensitivity to other gases.

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## 1 DEFINITIONS

The following definitions apply to WARNINGS, CAUTIONS and NOTES used throughout this manual.



### **WARNING:**

The warning symbol is used to indicate instructions that, if they are not followed, can result in minor, serious or even fatal injuries to personnel.



### **CAUTION:**

The caution symbol is used to indicate instructions that, if they are not followed, can result in damage to the equipment (hardware and/or software), or a system failure occurring.

**NOTE:** Highlights an essential operating procedure, condition or statement.

## 2 SAFETY INSTRUCTIONS

- This equipment may only be installed by a suitably qualified technician in accordance with the instructions in this manual and any applicable standards associated with the country or industry.
- This equipment may only be operated and maintained by trained technical personnel. The technical personnel must strictly adhere to the instructions given in this manual, and any prevailing standards/certificates (depending on application).
- Where instructed, you must read the User Guides and Datasheets referenced within this manual. There, you can find detailed information on the equipment.
- The operator may only perform modifications and repairs to the equipment/system with written approval of the manufacturer.
- Do NOT operate damaged equipment.
- If faults cannot be rectified, the equipment must be taken out of service and secured against unintentional commissioning.

### 3 TECHNICAL SPECIFICATIONS

#### Electrical Specifications

- Supply voltage; 4.5 to 5.5V<sub>DC</sub>
- Supply current; <7.5mA (streaming 1 sample per second)  
<20mA peak

#### Output Options

- Digital output; 3.3V TTL level USART

#### Performance Specifications<sup>a</sup>

- Oxygen measuring range;
  - ppO<sub>2</sub>; 0 – 300mbar
  - O<sub>2</sub>%; 0 – 25%
- Response time; T90 <30s (typical)
- Accuracy;
  - ppO<sub>2</sub>; <2% FS
  - Temperature; indication only
  - Pressure; ±5mbar
  - O<sub>2</sub>%; determined by ppO<sub>2</sub> and pressure accuracy
- Resolution;
  - ppO<sub>2</sub>; 0.1mbar
  - Temperature; 0.1°C
  - Pressure; 1mbar
  - O<sub>2</sub>%; 0.01%

#### Environmental Specifications

- Operating temperature; -30 to +60°C
- Storage temperature; -30 to +60°C
- Humidity; 0 – 99% Rh (non-condensing)
- Barometric pressure range; 500 – 1200mbar

#### Mechanical Specifications

- Housing type; diffusion-type, sealed
- Housing dimensions; 20mm maximum diameter x 14mm high
- Connections; 4 gold-plated pins (0.64mm<sup>2</sup>) on a 2.54mm grid for PCB mounting via sockets or hand soldering with a no-clean flux<sup>b</sup>

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<sup>a</sup> At ambient conditions. All performance measurements are at STP unless otherwise stated. Following extreme temperature fluctuations, recalibration may be required.

<sup>b</sup> Do NOT put the sensor through a PCB washing process.

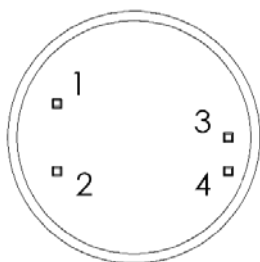
## 4 INSTALLATION



LuminOx sensors should be treated as an electronic component and handled using the correct ESD handling precautions.

LuminOx requires no additional signal conditioning circuitry and connects directly to the interfacing microcontroller via a 3.3V-level USART link.

The minimum and maximum allowable supply voltage range is 4.5 to 5.5V<sub>DC</sub>.



### PINOUT:

Pin 1: Vs (+5V<sub>DC</sub>)

Pin 2: GND (0V)

Pin 3: 3.3V USART Sensor Transmit

Pin 4: 3.3V USART Sensor Receive



**CAUTION:** Always apply power to the sensor pins 1 and 2 before attempting to communicate on pins 3 and 4.

### 4.1 USART Setup

The following setup should be used when using the USART interface:

- **Baudrate:** 9600
- **Flow Control:** None
- **Parity:** None
- **Stop bits:** One
- **Data Length:** 8 bits

### 4.2 USART Command Set

All USART communication is preformed using ascii characters; [Table 4-1](#) shows the legal characters for each description block.

Table 4-1 - USART Command Set

Description Block	Legal Character(s)	Hex
<Command>	"M", "O", "%", "T", "P", "A", "#", "e"	0x4D, 0x4F, 0x25, 0x54, 0x50, 0x41, 0x23, 0x65
<Argument>	"0" – "9"	0x30 – 0x39
<Separator>	" "	0x20
<Terminator>	"\r\n"	0x0D 0x0A

There are three modes available; Poll Mode, Stream Mode and Off Mode.

### 4.2.1 Poll Mode (M1)

Each request is built using a combination of the description blocks, refer to [Table 4-1](#) on [page 4-1](#). A typical arrangement will be one of the following formats:

- <Command><Terminator>
- <Command><Separator><Argument><Terminator>

Each response will reply in the following format:

<Command>< Separator><Argument><Terminator>

**NOTE:** Use the frame terminator “\r\n” to detect that the response has been received before sending the next request. A timeout should also be included and should be no less than one second.

[Table 4-2](#) provides a description of all commands and the valid arguments that can be applied to the interface when in Poll Mode (M1).

**NOTE:** All commands are case sensitive.

**Table 4-2 - Poll Mode (M1)**

Command	Description	Arguments	Response
“M”	Output Mode	0 = Stream 1 = Poll 2 = Off	“M xx\r\n” Where xx equals the Argument of the command
“O”	Request current ppO <sub>2</sub> value	N/A	“O xxxx.x\r\n” Where xxxx.x equals the ppO <sub>2</sub> in mbar
“%”	Request current O <sub>2</sub> value <sup>c</sup>	N/A	“% xxx.xx\r\n” Where xxx.xx equals the O <sub>2</sub> in percent %
“T”	Request current temperature inside sensor	N/A	“T yxx.x\r\n” Where y equals the sign “-” or “+” and xx.x equals the temperature in °C
“P”	Request current barometric pressure <sup>c</sup>	N/A	“P xxxx\r\n” Where xxxx equals the pressure in mbar
“e”	Sensor Status	N/A	“e 0000\r\n” = Sensor Status Good “e xxxx\r\n” = Any other response, contact <a href="#">SST Sensing</a> for advice
“A”	Request all values (see above: O, %, T, P and e)	N/A	See <a href="#">Stream Mode (M0)</a> on <a href="#">page 4-3</a>
“#”	Sensor Information	0 = Date of manufacture 1 = Serial Number 2 = Software Revision	“# YYYY DDDDD\r\n” “# xxxxx xxxxx\r\n” “# xxxxx\r\n”

#### Example 1:

- Request (What is the current oxygen partial pressure?):  
“O\r\n”                      “0x4F 0x0D 0x0A”

<sup>c</sup> Only valid for sensors fitted with barometric pressure sensor. Otherwise returns “- - - - -”.

- Response (210.3mbar):  
"O 210.3\r\n"                      "0x4F 0x20 0x30 0x32 0x31 0x30 0x2E 0x33 0x0D 0x0A"

#### Example 2:

- Request (Put LuminOx into streaming mode):  
"M 0\r\n"                      "0x4D 0x20 0x30 0x0D 0x0A"
- Response (LuminOx is now in streaming mode):  
"M 00\r\n"                      "0x4D 0x20 0x30 0x30 0x0D 0x0A"

#### 4.2.2 Error Codes

When a request has been unsuccessfully received, an error code may appear in a response format.

Table 4-3 provides more information on possible causes and actions.

Table 4-3 - Error Codes

Response	Description	Possible Cause	Action
"E 00\r\n"	USART Receiver Overflow	No <Terminator> received before overflow	<ul style="list-style-type: none"> <li>•Check USART Setup</li> <li>•Confirm correct termination</li> </ul>
"E 01\r\n"	Invalid Command	Unrecognised <Command> received	<ul style="list-style-type: none"> <li>•Check command is valid</li> <li>•Check command is uppercase "M" instead of "m"</li> </ul>
"E 02\r\n"	Invalid Frame	Incorrect character in frame <Separator>	Check correct separator is used
"E 03\r\n"	Invalid Argument	<Argument> not allowed or in limits	<ul style="list-style-type: none"> <li>•Check Argument is no longer the 6 characters</li> <li>•Check Argument is within limits</li> <li>•Check Argument is available for command</li> </ul>

#### 4.2.3 Stream Mode (M0)

By default, stream mode is initiated on sensor power-up and will supply an output string approximately once every second. This provides the data for ppO<sub>2</sub>, Temperature, Pressure, O<sub>2</sub> and sensor status. Format is shown below, for more details on the Argument see Table 4-2 on page 4-2.

"O xxxx.x T yxx.x P xxxx % xxx.xx e xxxx\r\n"

or the equivalent block description:

"<Command>< Separator><Argument>< Separator><Command>< Separator><Argument>< Separator><Command>< Separator><Argument>< Separator><Command>< Separator><Argument>< Separator><Command>< Separator><Argument>< Terminator>"

#### 4.2.4 Off Mode (M2)

In this mode, LuminOx stops taking measurements and current consumption reduces to less than 6mA constantly.



## 5 OPERATION

The LuminOx range has been designed as an alternative to electrochemical sensors but with the benefits of RoHS compliance, long life and complete environmental compensation built-in.

The sensor has a built-in barometric pressure sensor. LuminOx's native measurement is partial oxygen pressure (ppO<sub>2</sub>) in mbar. By incorporating a barometric pressure sensor, LuminOx is able to measure O<sub>2</sub> vol. % in addition to ppO<sub>2</sub>. LuminOx is designed to measure ambient oxygen levels, therefore the entire sensor must be in the measurement gas for correct operation.

### 5.1 Cross Sensitivity

The list below details the gases that have been tested for cross sensitivity with the LuminOx range.

The list below is not exhaustive. Compatibility with gases not on this list needs to be tested by the customer; refer to [5.2 Gas Compatibility Process](#) on [page 5-2](#). The luminescence technology used in LuminOx is inherently extremely selective to O<sub>2</sub> so cross sensitivity is generally unlikely.

Gas Measured	Cross Sensitivity
200 ppm NO in N <sub>2</sub>	None
100 ppm Acetaldehyde	None
100 ppm SO <sub>2</sub> in N <sub>2</sub>	None
100 ppm H <sub>2</sub> S in N <sub>2</sub>	None
100 ppm HCl in N <sub>2</sub>	None
5 ppm Ethylene	None
1% methane in N <sub>2</sub>	None
0.5% CO	None
100% CO <sub>2</sub>	None
100 ppm NO <sub>2</sub> in air	No result observed due to instability of NO <sub>2</sub> sample gas

## 5.2 Gas Compatibility Process

The cross sensitivity list on [page 5-1](#) is not exhaustive and customers often want to use the sensors with gases that have not been approved before. In this case, a compatibility test should be performed using a sensor of the specification you wish to use.

If unsure, please contact [technical@sstsensing.com](mailto:technical@sstsensing.com) for guidance when using the sensor with gases not on the cross-sensitivity list, we can advise on a suitable test procedure.

Once compatibility testing is complete, the sensor should be tested in accordance with its operating procedure to ensure it remains functional and within specification. If the sensor passes its functional test, then the gas can be considered to be compatible with the sensor.

## 6 MAINTENANCE

### 6.1 Cleaning

If necessary, clean the outer surfaces of the sensor housing using a damp cloth.

**NOTE:** Do NOT immerse the sensor in any cleaning media.

**NOTE:** Do NOT use alcohols.

### 6.2 Disposal

LuminOx sensors contain no hazardous materials therefore are RoHS compliant; they should be disposed of as electronic waste. Please observe your local regulations.

## REFERENCE DOCUMENTS

Other documents in the LuminOx product range are listed below; this list is not exhaustive, always refer to the [SST website](#) for the latest information.

Part Number	Title
DS-0144	LuminOx O <sub>2</sub> Sensor Datasheet
DS-0059	LuminOx O <sub>2</sub> Sensor Evaluation Interface Board Datasheet
UG-002	LuminOx O <sub>2</sub> Sensor Evaluation Interface Board User's Guide

### CAUTION

Do not exceed maximum ratings and ensure sensor(s) are operated in accordance with their requirements.  
Carefully follow all wiring instructions. Incorrect wiring can cause permanent damage to the device.  
Do NOT use chemical cleaning agents.

**Failure to comply with these instructions may result in product damage.**

### INFORMATION

As customer applications are outside of SST Sensing Ltd.'s control, the information provided is given without legal responsibility. Customers should test under their own conditions to ensure that the equipment is suitable for their intended application.

For technical assistance or advice, please email: [technical@sstsensing.com](mailto:technical@sstsensing.com)

**General Note:** SST Sensing Ltd. reserves the right to make changes to product specifications without notice or liability. All information is subject to SST Sensing Ltd.'s own data and considered accurate at time of going to print.

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