O_2 SENSORS – LuminOx Evaluation Interface Board User's Guide

This document describes the LuminOx evaluation interface board and its three output channels.

The LuminOx family (LOX) is a range of factory calibrated oxygen sensors which measure ambient oxygen partial pressure (ppO_2) or volume O_2% levels using the principle of fluorescence quenching by oxygen.

The LuminOx Evaluation Interface Board has been designed to allow quick and easy evaluation of the LuminOx O_2 sensor with the minimum of effort and design work.

The interface simultaneously provides three outputs:

- RS232 (serial interface voltage levels)
- RS485 (Modbus RTU) port allows multiple sensors to be addressed on a bus
- 0 – 5V analogue output for basic measurements of oxygen only

Contents

1 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.

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 TECHNICAL SPECIFICATIONS

Electrical Specifications

- Supply voltage; 4.75 to 5.5V_{DC}
- Supply current; <50mA

Output Options

- Digital output; RS232 and RS485
- Analogue output; 0—5V

Performance Specifications

- LuminOx sensor compatibility; 0 – 25% (O_2% version)
  0 – 300mbar (ppO_2 version)
- Resolution; 0.01% / 0.1mbar (digital outputs)
  0.01V (0—5V analogue output)

Environmental Specifications

- Operating temperature; 0 to +50°C
- Storage temperature; 0 to +60°C

Mechanical Specifications

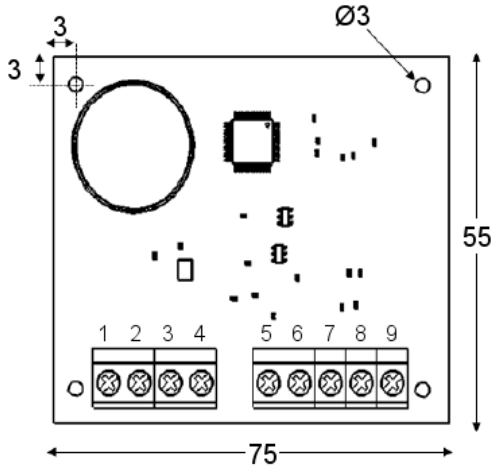
- Connection; 9 screw terminals
- PCB dimensions; 75 x 55mm (±0.5mm)

3 INSTALLATION

The LuminOx interface board and LuminOx sensors should be treated as electronic components and handled using the correct ESD handling precautions.

$5V_{DC}$ is required to operate the LuminOx interface board. With power supplied correctly the green LED on the interface will illuminate. The minimum and maximum allowable supply voltage range is 4.75 to $5.5V_{DC}$.

CAUTION: Ensure the 5V and 0V connections are NOT connected the wrong way round as this may damage the interface.



PINOUT:

Pin 1: Vs (+$5V_{DC}$)
Pin 2: GND (0V)
Pin 3: 0 – 5V GND (0V)
Pin 4: 0 – 5V Signal
Pin 5: RS232 Rx
Pin 6: RS232 Tx
Pin 7: RS232/RS485 GND (0V)
Pin 8: RS485 A (+)
Pin 9: RS485 B (-)

NOTES:

1. RS232 Rx and Tx and RS485 A and B (pins 5, 6, 8 and 9) are referenced to the RS232/RS485 GND (pin 7). A connection should be made between pin 7 and the reference or common connection of the RS232 serial port or RS485 Bus.
2. Care should be taken when connecting the RS485 A and B connections to your system. The EIA-485 signalling specification states that signal A is the inverting or '-' pin and signal B is the non-inverting or '+' pin. This is in conflict with the A and B naming used by a number of differential transceiver manufacturers, including the transceiver used in the interface board. Therefore, always ensure the '+' of the interface board is connected to the '+' input of the RS485 Bus and the '-' of the interface board is connected to the '-' input of the RS485 Bus.

3.1 RS232 Output

The RS232 port on the interface board converts the TTL level RS232 to serial levels compatible with the industry standard, allowing direct connection to industrial RS232 interfaces.

3.1.1 RS232 Setup

The following setup should be used when using the RS232 interface.

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

3.1.2 RS232 Command Set

All RS232 communication is preformed using ascii characters; Table 1 shows the legal characters for each description block.

Table 1 - RS232 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.

3.1.2.1 Poll Mode (M1)

Each request is built using a combination of the description blocks, refer to Table 1 on page 6.
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>

Table 2 provides a description of all commands and the valid arguments that can be applied to the interface when in Poll Mode (M1). Examples of requests and responses given below Table 2; note, all commands are case sensitive.

Table 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_2 value	N/A	"O xxxx.x\r\n" Where xxxx.x equals the ppO_2 in mbar
"%"	Request current O_2 value[a]	N/A	"% xxx.xx\r\n" Where xxx.xx equals the O_2 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[a]	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 SST Sensing for advice
"A"	Request all values (see above: O, %, T, P and e)	N/A	See Stream Mode (M0) on page 8
"#"	Sensor Information	0 = Date of manufacture 1 = Serial Number 2 = Software Revision	"# YYYYY 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"
- Response (210.3mbar):
  "O 210.3\r\n" "0x4F 0x20 0x30 0x32 0x31 0x30 0x2E 0x33 0x0D 0x0A"

[a] Only valid for sensors fitted with barometric pressure sensor. Otherwise returns "- - - - - -".

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"

3.1.2.2 Error Codes

When a request has been unsuccessfully received, an error code may appear in a response format. Table 3 provides more information on possible causes and actions.

Table 3 - Error Codes

Response	Description	Possible Cause	Action
"E 00\r\n"	RS232 Receiver Overflow	No <Terminator> received before overflow	•Check RS232 Setup •Confirm correct termination
"E 01\r\n"	Invalid Command	Unrecognised <Command> received	•Check command is valid •Check command is uppercase "M" instead of "m"
"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	•Check Argument is no longer the 6 characters •Check Argument is within limits •Check Argument is available for command

3.1.2.3 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_2, Temperature, Pressure, O_2 and sensor status. The format is shown below, for more details on the Argument see Table 2 on page 7.

"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>"

3.1.2.4 Off Mode (M2)

Off mode is currently not active and should not be used.

3.2 RS485 Modbus Output

The Modbus port on the interface board allows multiple sensors to be connected on a single bus and individually addressed.

NOTE: Background reading is strongly recommended if there is no prior knowledge of Modbus. A good place to start is www.modbus.org, where the specification and resources can be obtained in the technical resources page.

3.2.1 RS485 Modbus Setup

The Modbus interface is configured using the following setup:

- **Modbus mode:** RTU
- **Address:** One
- **Baudrate:** 9600
- **Parity:** None
- **Stopbits:** One

3.2.2 Modbus Registers

Table 4 provides a list of all current registers.

Table 4 - Modbus Register Set

Name	Register Address	Register Type	Description
ppO_2	0x7531	Input Register	= x/10 ppO_2 (Where: 0 = 0 ppO_2, 2105 = 210.5 ppO_2)
Temperature	0x7532	Input Register	= x (signed) / 10°C (Where: 65231 = -30.5°C, 201 = 20.1°C)
O_2	0x7533	Input Register	= x/ 100 (Where: 0 = 0%, 2070 = 20.70%)
Pressure	0x7534	Input Register	= x mbar (Where: 1017 = 1017 mbar)
Sensor Status	0x7535	Input Register	0 = Sensor Status Good Anything else contact SST Sensing for guidance
LuminOx Day	0x7536	Input Register	Day (Number) of Manufacture
LuminOx Year	0x7537	Input Register	Year of Manufacture
LuminOx ID 0	0x7538	Input Register	Serial Number 0
LuminOx ID 1	0x7539	Input Register	Serial Number 1
Address	0x9C41	Holding Register	Range = 1 to 247 (0x01 to 0xF7) Default = 1
Baudrate	0x9C42	Holding Register	0 (0x00) = 2400 1 (0x01) = 4800 2 (0x02) = 9600 (Default) 3 (0x03) = 19200 4 (0x04) = 38400 5 (0x05) = 57600 6 (0x06) = 115200
Parity	0x9C43	Holding Register	0 (0x00) = None (Default) 1 (0x01) = Odd 2 (0x02) = Even

Name	Register Address	Register Type	Description
Stopbits	0x9C44	Holding Register	0 (0x00) = 1 (Default) 1 (0x01) = 2
Reset and Apply Changes to Communication Settings	0x9C45	Holding Register	0 (0x00) = No Action 1 (0x01) = Reset and Apply Changes to Modbus Communication Settings (See Note 1)
0–5V Output Representation	0x9C46	Holding Register	0 (0x00) = Auto Detect (Default) 1 (0x01) = ppO_2 2 (0x02) = O_2% (See Note 2)

NOTES:

1. If any changes are made to the holding registers 0x9C41 to 0x9C44 the changes will not be applied until 0x9C45 is set to "1". At this point, if the changes made are valid, the new settings will be committed to memory and communication will be lost until the RS485 master is reconfigured to the same settings.
2. The 0 – 5V analogue output, by default, represents the variant of LuminOx sensor connected to the interface, so if the sensor attached is a ppO_2 variant the 0 – 5V output will represent 0 – 300mbar or if the sensor attached is an O_2% variant the 0 – 5V output will represent 0 – 25% O_2. However, when the attached sensor is an O_2% variant the auto detect setting can be overridden so the 0 – 5V output can represent either ppO_2 or O_2%. This feature is not compatible with the ppO_2 variant of LuminOx so if this register is changed to "2" in this instance the 0 – 5V output will remain at 0V.

3.3 Analogue Output

The analogue output on the interface board simply provides a 0 – 5V representation of the primary oxygen reading provided by the attached LuminOx sensor.

If a ppO_2 sensor is attached, then the output voltage will represent ppO_2. If an O_2% sensor is attached, then the voltage will represent O_2%.

3.3.1 PPO_2 Variant

The current ppO_2 level can be calculated using Equation 1.

$$ppO2 = \frac{300}{Vs} \times V = \frac{300}{5} \times V = 60 \times V \quad (1)$$

ppO_2	Current ppO_2 in mbar
Vs	5 volts
V	Current voltage on the signal output

PPO_2 Examples:

Signal Output (Volts)	ppO_2 (mbar)
0	0
3.5	210
5	300

3.3.2 O_2 Variant

The current O_2% level can be calculated using Equation 2.

$$O2\% = \frac{25}{Vs} \times V = \frac{25}{5} \times V = 5 \times V \quad (2)$$

O_2%	Current O_2 concentration (%)
Vs	5 volts
V	Analogue voltage on the signal output

O_2 Examples:

Signal Output (Volts)	O_2 (%)
0	0
3.5	17.5
5	25

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-0030	LuminOx O_2 Sensor Datasheet
DS-0059	LuminOx O_2 Sensor Evaluation Interface Board Datasheet
UG-001	LuminOx O_2 Sensor 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

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