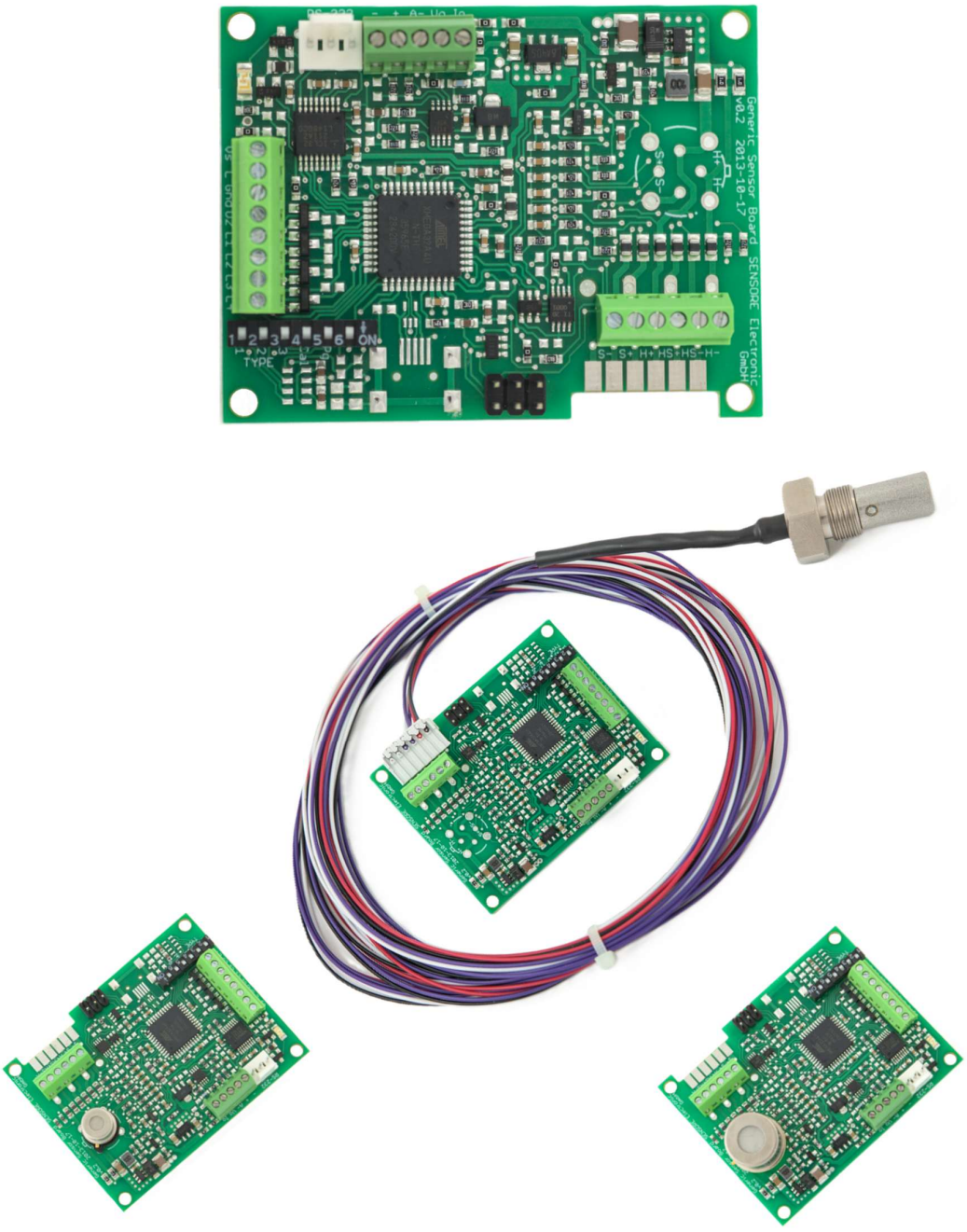
GSB (Generic Sensor Board) and GSB-Systems

User Manual



Revision History

Issue No.	Description	Date	Author Initials
00	New document	07/2014	PS
01	Update of 96% parameter	03/2025	PS
02	New layout /structure	12/2025	PS

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Before using your GSB System

GSB systems are typically pre-calibrated. Do not manipulate the DIP-switch settings as this could override the factory calibration. Each system is calibrated individually, if the GSB is paired with a different sensor a recalibration will be necessary.

Safety Information

Necessary safety precautions are described in the following chapters and also highlighted using pictographic warnings on yellow background (as above).

The GSB must not be used for safety critical applications.

The GSB must not be connected to hazardous voltages, it must only be operated with PELV, SELV, or NEC Class 2 compliant circuits.

For integration into a larger device, the system developer must ensure the correct installation according to this manual and verify the sensor function under application conditions. Installation, initial commissioning, inspection, maintenance, and servicing must be carried out by trained specialists.

Abbreviations

AM	Additive Manufacturing
Ar	Argon
CO_2	Carbon Dioxide
DC	Direct Current
^oC	Degrees Celsius
EEPROM	Electrically Erasable Programmable Read-only Memory
ESD	Electrostatic Discharge
FW	Firmware (Software running on the microcontroller of the GSB)
GND	Ground
GSB	Generic Sensor Board (the PCB without sensor)
GSB-System	Generic Sensor Board with a mounted/connected sensor, usually pre-calibrated systems
LED	Light Emitting Diode
LDL	Lower Detection Limit
mA	Milliamp
N_2	Nitrogen
O_2	Oxygen
PPM	Parts per Million
PELV	Protective Extra Low Voltage
SELV	Safety Extra Low Voltage
VOCs	Volatile Organic Compounds
ZrO_2	Zirconium Dioxide

Contents

1 Introduction

The GSB (Generic Sensor Board) is usually distributed with a pre-installed and pre-calibrated oxygen sensor, the factory calibration of the sensor is stored on the GSB and thereby creating a calibrated O_2 measurement system. The sensors are based on zirconium dioxide (ZrO_2) and use an amperometric diffusion limiting principle to measure the volumetric O_2 concentration in gas mixtures.

1.1 Scope of Use

The sensors are calibrated and specified for **nitrogen** (N_2) balance gas. **Argon** (Ar) can also be used as a balance gas; this will slightly affect the system accuracy.

The GSB system is ideal for integration in the following applications:

- Laboratory / Measuring instrumentation
  - Oxygen meter
  - Measurements under controlled O_2 content
- Inert gas processing cabinets (glove boxes)
  - Incubators (controlled bacterial growth)
  - Nitrogen concentrators
- Food industry:
  - Packaging and controlled food testing
- Medical:
  - Oxygen concentrators

The GSB also serves as an evaluation platform for most sensor types and allows HW/FW-customizations to meet special application requirements.

1.1.1 Application limitations

- The system must not be used in safety critical applications
- The system is **not** ATEX-approved because its internal sensor achieves elevated temperatures during normal use (up to ca. 600 °C)
- The use in deviating balance gases e.g. carbon dioxide (CO_2) is possible, but potential cross-sensitivities must be considered, please contact SENSORE for more information.
- The sensor is not recommended for use in burnable gases, as local combustion can cause inaccurate (reduced) O_2 concentration readings. If used in burnable gases, the concentration of combustible gases must be negligible to the O_2 concentration.
- The sensor is not suitable for use with AM plastic powders or filaments.
- The sensor is not suitable for conditions with condensing humidity, and therefore not suitable for outdoor use.

1.1.2 Alternative product choice for industrial applications - OxyPro-XT

For the integration in industrial application please consider the OxyPro-XT product range, which is optimized for industrial environments (24Vdc supply, RS485/Modbus interface, 4-20mA output, isolated relay contacts for alarm level indication, DIN-Rail Housing). The OxyPro-XT will comply with the EU machinery directive (CE-mark) and with EN 61010-1.

1.2 Feature Overview

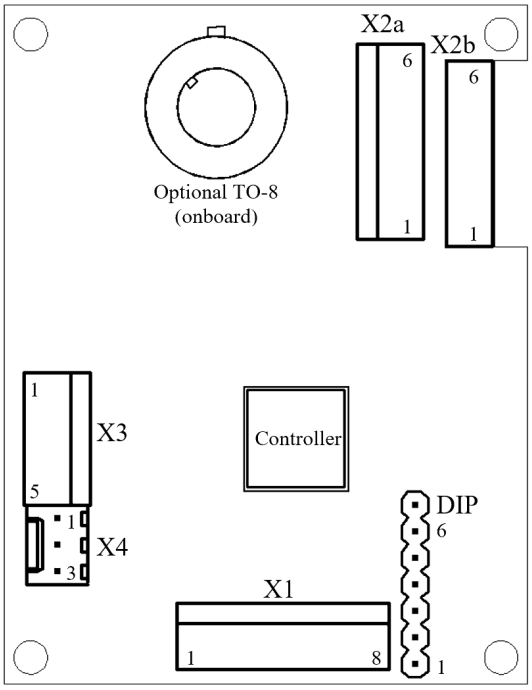
- External supply voltage: 12Vdc
- Output options:
  - analog 0-5V (Vout)
  - analog 4-20mA (Iout)
  - digital via RS232
  - linear characteristic for all output options
- Compatible O2-sensor types:
  - SO-Ex-xxx and SO-Bx-xxx: TO-8 housing sensor directly soldered onto the GSB PCB
  - SO-Ax: TO-39 housing sensor: mounted in an optional TO-39 socket on the GSB
  - O2-sensors with a 6-pole cable and an RAST 2.5 connector (e.g. SO-Dx-250-A100C)
- Active heater temperature control
  - Control circuit to keep the sensor chip temperature stable
  - Optimized accuracy for extended temperature range, e.g. Dx sensor for up to 200°C gas temperature
- Calibration options
  - Standard delivery is a pre-calibrated system, if order in combination with a sensor
  - (re-)calibration by the customer via DIP-Switches, e.g. if ordered as PCB without sensor

1.3 System Overview

X3 (Power/analog):
1… [Io] 4-20mA output
2… [Uo] 0-5V output
3… [A-] analog GND
4… [+] +12Vdc supply
5… [-] GND suppl<

X4 (RS232):
1… TXD
2… RXD
3… GND

X1 (General IO)
1… [Vs] option +12V
2… [L] LED output
3… [Gnd] GND
4… [O2] 0-5V output
5… [L1] threshold switch 1
6… [L2] threshold switch 2
7… [L3] threshold switch 3
8… [L4] threshold switch 4



X2a/X2b Sensor extern:
1… [S-]
2… [S+]
3… [H+]
4… [HS+]
5… [HS-]
6… [H-]

DIP Switch
1… [1] sensor selection Bit 1
2… [2] sensor selection Bit 2
3… [3] sensor selection Bit 3
4… [Cal] calibration switch
5… [Pg] program switch
OFF during normal operation!
6 … not used

Figure 1 GSB Inputs / Outputs

2 Oxygen Monitoring Functions

2.1 O2 measurement ranges

The oxygen sensors are offered with different measurement ranges, to offer optimal accuracy for different applications. The measurement ranges are physically defined by the sensor design (diffusion hole size). So, the selected GSB preset must match the O2 range of the sensor. Precalibrated system will be delivered with correct range setting, please do not manipulate the DIP-switches.

Table 1: preinstalled sensor settings

O2 range (min / max)	GSB preset	DIP switch bit			GSB full scale (output)	O2-calibration concentration	Typical Accuracy	Sensor Voltage
		1	2	3				
10-1000ppm	1	OFF	ON	ON	1000 vol.-ppm	1000 vol.-ppm	+/- 20ppm	0.70 Vdc
0.01-1vol.%	2	ON	OFF	ON	1 vol.-%	1 vol.%	+/- 0.01vol.%	0.75 Vdc
0.01-2vol.%	3	OFF	OFF	ON	2 vol.-%	2 vol.%	+/- 0.2vol.%	0.75 Vdc
0.05-5vol.%	4	ON	ON	OFF	5 vol.-%	5 vol.%	+/- 0.5vol.%	0.80 Vdc
0.1-25vol.%	5	OFF	ON	OFF	25 vol.-%	20.9 vol.%	+/- 0.5vol.%	0.85 Vdc
50-96vol.%*	6	ON	OFF	OFF	100 vol.-%**	20.9 vol.%	+/- 1vol.%	1.60 Vdc
1-96vol.%	7	OFF	OFF	OFF	100 vol.-%**	20.9 vol.%	+/- 1vol.%	1.00 Vdc

* Legacy setting, GSB preset 7 is now standard for 96%
** The specified sensor full scale concentration is 96%

2.2 Analog Current Output 4...20mA (overrange up to 24mA)

The nominal range (0 to full scale) of the analog current output is 4…20mA. If the sensor is operated in overrange the output will be cutoff at 24mA. Sensor operation beyond full scale is not recommended.

Calculation for 4…20mA:

$$\text{Measured } O2 = \frac{Iout\ [mA] - 4mA}{16mA} \times \text{full scale output}$$

2.3 Analog Voltage Output 0...5V (overrange up to 6V)

The nominal range (0 to full scale) of the analog current output is 0…5V. If the sensor is operated in overrange the output will be cutoff at 6V. Sensor operation beyond full scale is not recommended

Calculation for 0…5V:

$$\text{Measured } O2 = \frac{Uout\ [V]}{5\text{V}} \times \text{full scale output}$$

2.4 Digital Interface (RS232)

$$\text{Measured } O2 = \frac{O2n}{1000} \times \text{full scale output}$$

- The digital value requested via "O2n" command
- The digital value range is cut off at 1250, so also the digital interface output allows some overrange
- Special states can be detected via “Sta” command
- Further details on RS232/Modbus communication can be found in section 9.

2.5 O_2 Threshold Detection (Alarm Levels)

O_2 threshold values to control the open collector outputs L1-L4 can be programmed during factory calibration. Please contact SENSORE for more information about this feature.

2.6 GSB System States

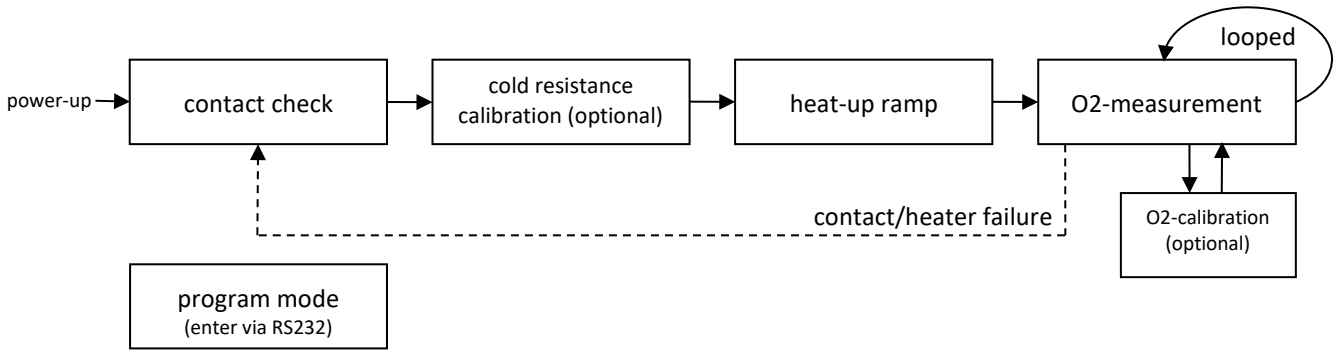


Figure 2 GSB State machine diagram

2.7 Status LED

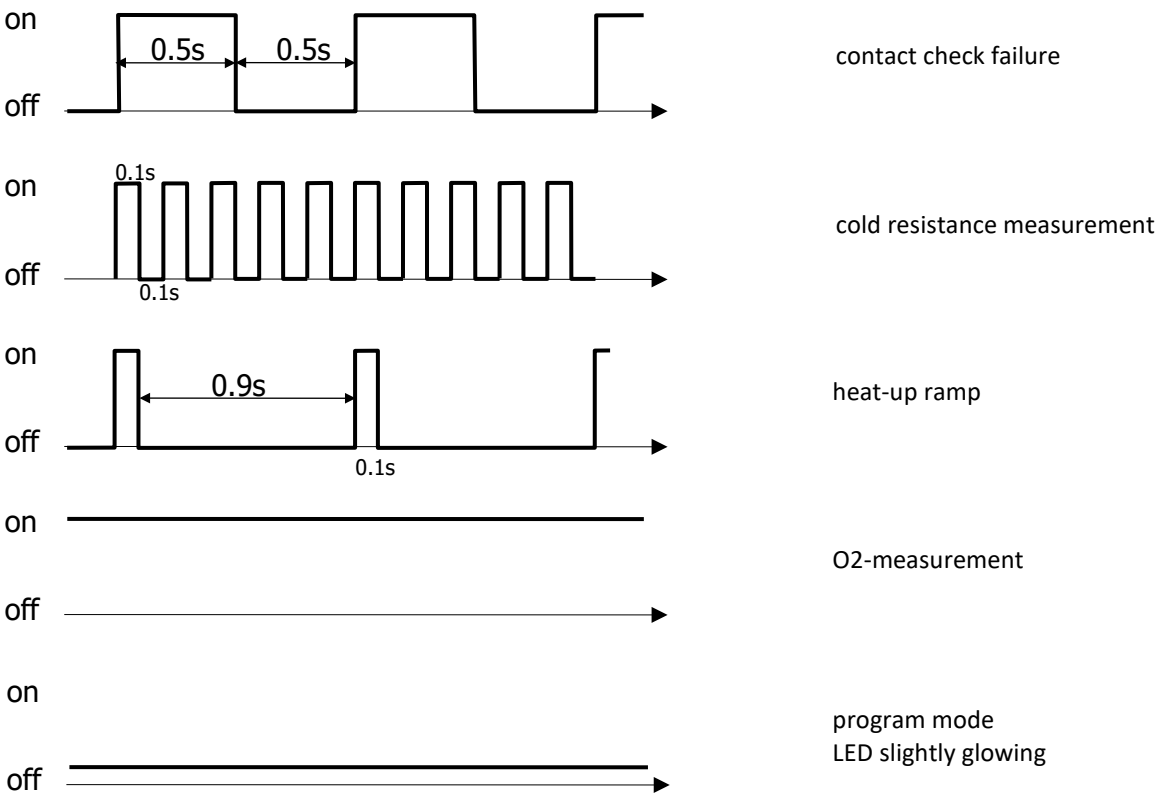


Figure 3 different GSB states indicated by LED signal

3 Installation

Only assemble and install the system when it is powered off and disconnected from the electricity supply.

3.1 Sensor installation in a Process Chamber

- Silicone-free materials must be provided for sealing.
- The system has been evaluated for applications within gas temperatures ranging from 10…100 °C (50...212 °F) and pressures from 700…1300mbara. Monitoring oxygen at higher gas temperatures or deviating pressures is often feasible, but should be discussed with the application engineering team, please contact SENSORE.

Positioning the sensors incorrectly in the process chamber can negatively impact measurement. To avoid this:

- Do not mount sensors in the immediate vicinity of gas inlets or outlets
- Do not place them near heaters/fans or in direct airflow
- Mount on surfaces that will not vibrate.

For oxygen measurement, the gas must pass the sensor's porous sinter cap/disc or the inlet mesh. To facilitate this:

- The sinter cap/disc or the mesh should protrude into the process chamber as much as possible
- Contamination/encrustation of the sinter cap/disc or the inlet mesh must be avoided
- Mounting the sensor upside down should reduce contamination risks.

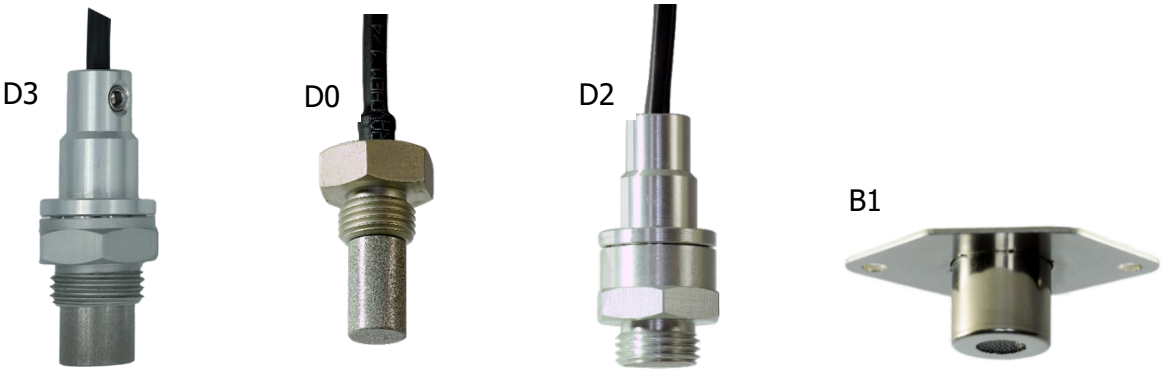


Figure 4 Sensor's porous sinter cap/disc or inlet mesh

If the sensor is located so that its housing is easily accessible to end-users, please note the following:

- During operation, the sensor housing's temperature might exceed 60 °C (140 °F)
  - Sensor housing temperature depends on the selected sensor head design (Figure 4) and the thermal connection to the process chamber.
- Use appropriate warning labels, e.g. "hot surface"

- When the sensor's metal housing is screwed directly into the grounded metal wall of the process chamber, such grounding will provide adequate electrostatic discharge (ESD) protection. During the sensor installation please observe standard ESD precautions.

3.2 Installation of systems with PCB mounted sensor

Systems with PCB mounted sensors are typically used as evaluation kits for lab use. For certain applications it might be possible to mount the complete GSB inside a process chamber.

In either case, please note the following

- During operation, the sensor housing's temperature might exceed 60 °C (140 °F)
- Use appropriate warning labels, e.g. "hot surface"

- For protection against electrostatic discharge (ESD), touching of the electronic circuit or the sensor should be avoided / prevented in general.
  - In case of probing electrical signals directly on the board for evaluation purposes, please observe standard electrostatic discharge (ESD) precautions.

3.3 Installation of the GSB (PCB)

The GSB is delivered without housing and is therefore not sufficiently protected against ESD. If the GSB is incorporated into a larger device, it is strongly recommended to ensure sufficient ESD protection, e.g. by placing the GSB within the housing of the larger device. For mechanical mounting of the GSB the use of plastic PCB holders (M3) is recommended, see example in Figure 6 on the next page.

3.4 Basic connection at the GSB

The GSB must only be connected to power supplies, which ensure safe voltages and currents. E.g. SELV or PELV power supplies with limited power/current, or NEC class 2 power supplies.

The recommended supply voltage is 12Vdc ± 2Vdc / 500mA. The external power supply must be connected via terminal X3 (see Figure 5).

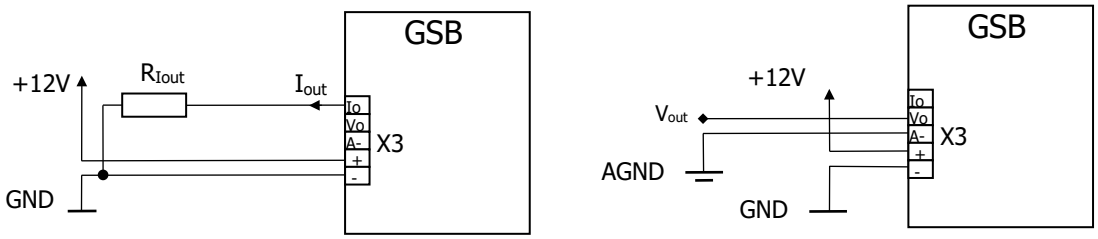


Figure 5 Connection of analog current output or analog voltage output

AGND and GND are internally connected on the GSB, load current over AGND should be avoided. The recommended analog output option is 4-20mA to avoid ground loops. For the 0-5V output option ground loops can be avoided by using a high impedance differential input to measure the 0-5V signal

Operation with deviating supply voltages:

Measurement performance and reliability of the GSB have been only verified for the recommended supply voltage (12Vdc). Operation beyond the recommended supply voltage is possible, but absolute maximum ratings (6Vdc -25Vdc) must not be violated. An operation on a 24Vdc rail is not recommended as typical 24V supply tolerances might violate the absolute maximum rating of the GSB.
Please refer to SENSORE's OxyPro-XT Range which is specified for 24Vdc.

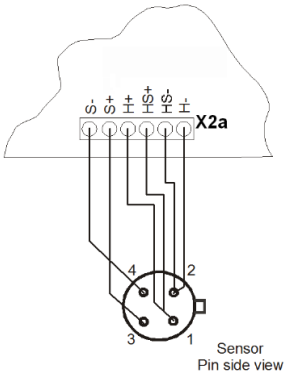
3.5 Sensor connection

Depending on the sensor type it will be connected via screw terminal X2a for bare wires, PCB edge contacts X2b for RAST 2.5, directly soldered to the PCB (TO8 housings) or mounted via optional TO-39 socket.

3.5.1 Sensor connection via cable

For the sensor operation via cable a 6-pole configuration is mandatory, as the heater resistance is measured via 4-wire setup. The connection via X2a is shown in Figure 6, X2b for Rast 2.5 is basically the same.

The GSB features only electrical polarity protection. So, Rast 2.5 connectors must be connected with the correct mechanical orientation, see Figure 6.



Nr.	function	6 pole cable
1	Heater H+ HS+ (sense)	violet 1 violet 2
2	Heater H- HS- (sense)	white 1 white 2
3	Sensor S+	red
4	Sensor S-	black

Figure 6 pin allocation of sensor, connection via 6 pole wire and correct Rast 2.5 orientation

3.5.2 TO-8 (SO-B0-xxx, SO-Ex-xxx) directly soldered on the PCB

For soldering a TO-8 sensor directly onto the PCB, it is recommended to ensure 2-3mm between PCB and the base of the housing. The air gap will ensure better thermal insulation of the sensor, reduce the PCB-temperature, and it will also avoid the risk of short circuits between PCB pads and sensor housing. The orientation of the housing “nose” must match the indication on the PCB, see blue arrow in **Figure 8**

3.5.3 TO-39 (SO-A0-xxx) mounted on the PCB via socket

SO-A0-xxx will reach housing temperatures of up to 250°C. For optimal thermal insulation SO-A0-xxx are not directly soldered onto the GSB but are mounted via a TO-39 socket. The orientation of the housing “nose” must match the indication on the PCB-socket, see yellow arrow in **Figure 7Figure 8**

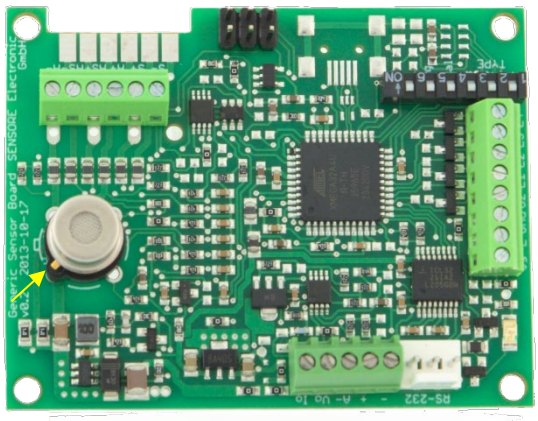


Figure 7 GSB with TO-39 in socket

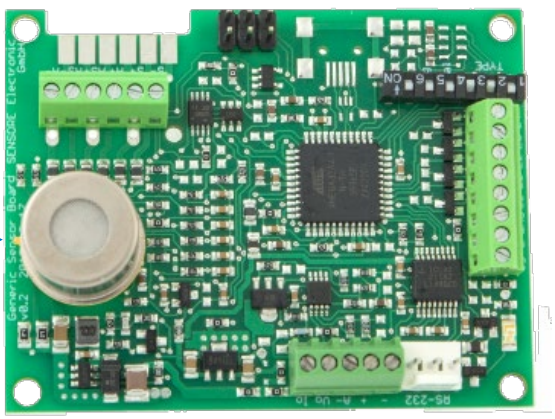


Figure 8 GSB with TO-8 soldered onto the PCB

4 Commissioning

A basic function test should be carried out after integrating the GSB into the target application/device (see 5.2), but this requires a successful initial power up of the GSB.

4.1 Initial Power-up

- The system will power-up as soon as the supply voltage is connected/powered up, so make sure the GSB is correctly installed before applying power.
- See section 4.5, for the expected behavior after power-up.
- After completion of initial power-up, the basic function test (see 5.2) should be carried out.

4.2 Power-up after Maintenance

- After completion of power-up following maintenance, the basic function test (see 5.2) should be carried out.

4.3 Decommissioning

- The system can be safely powered down just by disconnecting the supply voltage.

4.4 Recommissioning

- The system will restart as soon as the supply voltage is connected.
- For recommissioning after a malfunction, please refer to section 8.

4.5 System Behavior During Commissioning / after power up

- The LED is supposed to flash during heat-up of the O2-Sensor
- After 30 seconds the LED will be permanently on
- To wait for signal stabilization the analog output is suppressed for another 10 seconds
- See **Figure 9** below for analog out behavior after power up, the actual O2-values after heat-up and stabilization will depend on the applied O2-concentration

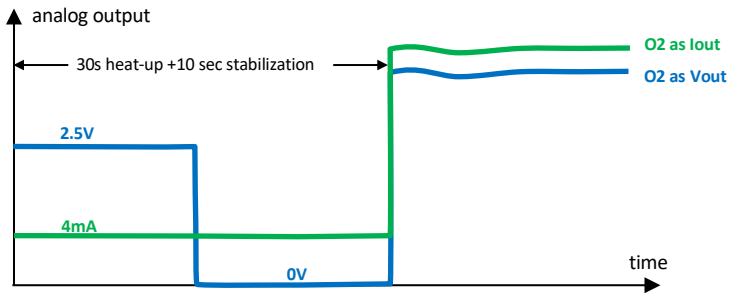


Figure 9 behavior of analog outputs after power up

5 Maintenance

5.1 Inspect Your Sensors/Sensor Cleaning

The sinter caps/discs or meshes of the sensor must be checked for visible contamination.

The sensors must only be cleaned mechanically (brushing), no chemical cleaning agents or water must be used for cleaning.

5.2 Inspect Your GSB-System – Basic Function Test

The basic function test is a plausibility check of the complete system by exposing the sensor to air.

- 25% and 96% sensor are supposed to show a value around 20.7 vol % O2
- Sensors with lower ranges are supposed to show reading beyond full scale, the analog outputs should be at the end of the overrange capability (~24mA or ~6V). Remark: lower range sensors should not be permanently exposed to air (20.7 vol % O2) as this will accelerate sensor aging. Short-time exposure (hours) to air to check signal plausibility is ok.

5.3 Full Function Test – Ensure Process Measurement Accuracy

Heater self-monitoring and basic function test (5.2) will detect various fault conditions of the system. But only a full function test can ensure the process measurement accuracy. Please see below recommendation for possible test procedures.

Full Function Test (as typically performed during final test of GSB-Systems in the Factory):

- Check O2-measurement performance of the GSB-System at different O2-levels, which are derived from certified gas cylinders or are generated by reliable separation or mixing methods (e.g. N2-generator, gas mixing based on mass flow controllers):
  - Check at or near full scale (e.g. 20.9% for 25% sensors)
  - Check at roughly half scale (e.g. 10% for 25% sensors)
  - Check at or below the lower detection limit (e.g. pure N2 for 25% sensors with LDL 0.1%)
  - Check outputs (digital, RS232) at all listed O2-levels

Comparison with a reference O2-measurement system

- Check the GSB-System by comparison with a reference O2 measurement system
- The reference system could be a GSB-System, which is only used for reference measurements and is otherwise stored under stable conditions.
- This method relies on the long-time stability of the reference O2-measurement system, so the reference measurement system itself should be subject to a periodical full function test

Limited Function Test

- Check O2-measurement performance of the GSB-System at a single O2-concentration of interest
  - The single O2-concentration should not be pure N2, as the underlying sensor current under this condition is 0 and therefore hard to distinguish from a broken wire.
  - Check outputs (digital, RS232) at a single O2-level, which should be a reliable O2 reference

6 Repairs and Replacements

In the case of a defect sensor or defect GSB it is recommended to replace the complete system with a new pre-calibrated system. If only GSB or sensor is replaced a system calibration is necessary.

6.1 Sensor Replacement Interval

The typical sensor replacement interval depends on several external factors.

- Application conditions, especially:
  - Contamination load and type (e.g.: VOCs, some chemicals/gases)
  - Mechanical and thermal stress (vibrations, ambient temperature)
  - Other environmental factors (e.g. operating pressure, condensation risks)
- Use case:
  - Sensor operating parameters (high/low O2 concentrations)
  - Operating hours (e.g., continuous 24/7 vs. intermittent use)
- Customer-specific requirements / conditions (e.g. accuracy requirements)

6.2 GSB-System Calibration

If only an O2 recalibration should be performed for an already paired and calibrated sensor, it is possible to start with the GSB in measurement mode at instruction point 6.

0. GSB must be disconnected from the external power supply and the sensor must have cooled down from prior operation (15 minutes), without cool-down the cold resistance calibration might be inaccurate.
1. Connection of the Sensor (see section 3.5)
   - For correct cold resistance calibration, the ambient sensor temperature should be about 25°C
2. Selection of the correct sensor measurement range (96%, 25%, 5%, 2%, 1% or 1000ppm)
   - Range selection via DIP-Switch (see Table 1 in section2.1)
   - Attention: DIP Switch „Pg“ has to be OFF, meaning program mode is not active
3. For activation of cold resistance calibration upon power-up, the DIP Switch „Cal“ must be set to ON
4. Power-up the GSB by applying 12Vdc to initiate the cold resistance calibration, see ***Figure 2***
   - The GSB will perform a contact check and will then start the measurement of the cold resistance
   - The GSB checks the cold resistance for about 1 minute, in case of insufficient temperature stability (e.g. sensor is still cooling down) the test time will be increased.
   - At the end of the cold resistance measurement the result will be stored permanently (EEPROM)
5. Heat-up: GSB automatically switches to the heat-up sequence (~30 sec)
   - DIP Switch „Cal“ has to be set to OFF during the heat-up sequence
6. Start of measurement operation is indicated by permanent light up of the LED
7. For O2-calibration the sensor must be exposed to the correct O2-calibration concentration (see Table 1).
   - It is recommended to wait ~5 minutes at stable O2 calibration concentration, to achieve accurate calibration conditions
   - Then the DIP Switch „Cal“ has to be switch to ON for a short period of time (3-5 seconds).
   - The calibration will be permanently stored (EEPROM) as soon as the DIP Switch „Cal“ is set to OFF
   - The analog outputs should now show the expected calibration
8. The sensor is calibrated and ready for measurements

7 Disposal and Recycling

Dismantling the GSB-system must be carried out when it is powered off.

The system must be disposed of appropriately, and sensors must be disposed of as electronic waste.

8 Troubleshooting

8.1 GSB does not enter the O2-measurement mode

Typical root causes:

- no sensor connected
  => Please connect sensor
- incorrect mounting of sensor or incorrect orientation of Rast 2.5 connector
  => Check the sensor connection (see Figure 6)
- defect sensor heater
  => Please double-check via Ohmmeter, the heater resistance at 25°C is supposed to be between 3.0 and 3.5 Ohm (assuming a 4-wire resistance measurement, 2-wire measurements will be a bit higher)

8.2 Unintended restarts of the GSB

Typical root causes:

- Interruption in the 12Vdc power supply
  => check 12Vdc wiring and power supply (e.g. current limit setting/behavior)
- Contact problems of the sensor (cable). During O2-measurement the GSB is monitoring the sensor heater. If the GSB detects a heater contact error, it will restart the sensor.
  => check the sensor connection

8.3 Overflow of analog output (>5V or >20mA)

Typical root causes:

- Sensor overrange condition, to high O2-concentration
  => check gas supply, check correct sealing of the O2 sensor
- Short circuits in the sensor connection
  => In case of PCB mounted TO-8 sensors check air gap between sensor base and PCB.
  => in case of wire connected sensor, check wiring.

8.4 (Unexpected) low analog output (~0V or ~4mA)

Typical root causes:

- Open circuit in sensor wiring
  => check the sensor connection/wiring
- Heater issue, which is normally detected by the GSB heater monitoring
  => Double check if sensor is hot (Caution: risk of burn)
- Operation in pure N2, in this case a low analog output would be expected
  => Can be double checked by exposing the sensor to higher O2-concentrations

8.5 Interference with O2 Measurement

GSB-Systems are designed for measurement in O_2/N_2 or O_2/Ar atmospheres, i.e. it is assumed that other gases only occur in trace amounts (< 1000 ppm).

8.5.1 Temporary Impairment of O_2 Measurement

- Rapid pressure fluctuations can lead to a short-term disturbance of the O_2 measurement, such influences can be reduced by averaging the output measured analog signal over time
- Operating below the lower detection limit increases the cross-sensitivity to oxygen containing gases such as H_2O (water vapor) or CO_2, which leads to an increase in the O_2 measurement signal.
- Traces of burnable gases can lead to a reduction in the O_2 measurement signal as oxygen will be consumed by burning processes at the heated sensor chip (550-600°C). The impact on the O_2 measurement accuracy directly correlates with the concentration of burnable gases.

8.5.2 Permanent Impairment of O_2 Measurement

- When the Pt-ZrO_2 electrode is damaged by chemical substances, the sensor aging may accelerate, leading to permanent reduction in the O_2 measurement signal.
  - Volatile silicone compounds (silanes), e.g. generated by the out-gassing of silicone seals, are particularly harmful to the sensors' measurement performance
- When used in chemically aggressive environments, a damaged glass seal of the sensor cell can cause leakages, leading to a permanent increase in the O2 measurement signal.
  - e.g. environments that try to reduce O2 by chemical means.
- Condensing environments can lead to destruction of the sensor cell, due to rapid evaporation of condensed substances during the heat-up of the sensor.
- It is recommended to periodically perform a basic function test (see 5.2) or in best case even a full function test to detect a permanent impairment .

9 RS232 Modbus Interface

9.1 RS232 Parameters

Baud Rate	19200
Start Bits	1
Data Bits	8
Stop Bits	1
Parity	None

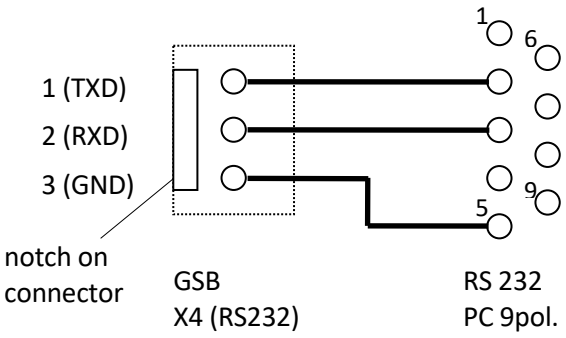


Figure 10 RS232 Parameters and RS232 connections to the GSB

9.2 Standard commands / requests

All standard commands have a simple protocol:

Req1	Req2	Req3

standard command (Request) to GSB has always 3 ASCII-characters and no termination

Resp1 /sign	Resp2 / digit	Resp3 / digit	Resp4 / digit	Resp5 / digit	Resp6 / digit	Resp7 0xD

Response from the GSBs always within 100ms and always 7 characters

- Resp1 /sign contains possible sign
- Either ASCII „-“ for negative or space for positive sign
- Resp 2-6 /digit contains 5 digits in ASCII
- Resp 7 contains 0xD (CR) as termination

Table 2: Standard commands (requests) - overview

			Command availability during different sequences				
Request	description	Response	contact check	R cold measurement	heat-up ramp	O2-measurement	program mode
Sta	?GSB – Status request	yyyyy … 2-6 (see on the right)	x (2)	x (3)	x (4)	x (5)	x (6)
Prg	Switch to program mode	00001 … if successful	x	x	x	x	
Run	Switch to measurement mode	00001 … if successful					x
Cal	new O2-calibration	yyyyy … cal. current in 0,1uA				x	
O2n	?actual O2-value	yyyyy … 0-1000 (normalized)				x	
Ise	?actual sensor current	yyyyy …current in 0,1uA				x	
Vse	?actual sensor voltage	yyyyy …voltage in mV				x	
Vhe	?actual heater voltage	yyyyy …voltage in mV			x	x	
Ihe	?actual heater current	yyyyy … current in 0,1mA				x	
Tmp	?actual sensor temperature	yyyyy … in °C				x	
Rco	?cold resistance	yyyyy … in mΩ		x		x	

9.2.1 Example for a basic status request „Sta“:

- The following ACSII sequence is sent to the GSB:

„S“	„t“	„a“

- GSB is responding within 100ms:

„ „	„0“	„0“	„0“	„0“	„5“	0xD

- „00005“ => the GSB is in sequence „O2-measurement“

10 Appendices

10.1 Appendix A - Technical Specifications

10.1.1 Appendix A - Absolute maximum ratings

Values beyond these limits might cause permanent damage

Symbol	Parameter	min.	typ.	max	Unit
V_{cc}	External power supply voltage	0		25	Vdc
T_{op}	GSB operating temperature range	0		50	°C
R_{Iout}	Load on Iout	0		270	Ω
I_{Vout}	load current on Vout	0		1	mA
I_{oc}	Open collector sink current (each)	0		50	mA
V_{oc}	Open collector voltage	0		30	Vdc
V_{inR232}	Input voltage range R232	-25		25	V

10.1.2 Appendix A - Recommended operating conditions

For optimal measurement performance the GSB should be operated at recommended conditions.

Symbol	Parameter	min.	typ.	max	Unit
V_{cc}	External power supply voltage	10	12	14	Vdc
T_{op}	GSB operating temperature range	15	25	35	°C
I_{ocsum}	Open collector sink current (sum)	0		100	mA

Remarks:

- T_{op} refers only to the GSB ambient temperatures, not the permissible sensor ambient temperature, for boards

10.1.3 Appendix A - Analog output accuracy

Under recommended operating conditions the analog outputs have the following accuracy

Symbol	Output level	min.	typ.	max	Unit
V_{out}	Voltage output - Full scale 5V	4.975	5.000	5.025	V
	Voltage output - Zero-point 0V	0.000	0.010	0.025	V
I_{out}	Current output - Full scale 20mA	19.95	20.00	20.05	mA
	Current output - Zero-point 4mA	3.95	4.00	4.05	mA

10.1.4 Appendix A – GSB-System O2-measurement accuracy

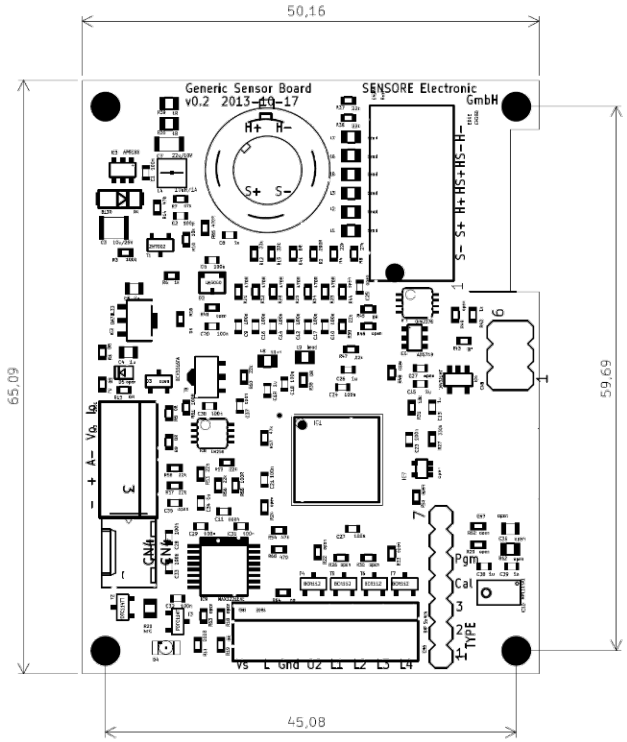
Overall O2 measurement accuracy for a GSB-System is mainly based on the sensor specification, it is typically 1% FS (Full Scale) for the digital output, for the analog output the deviations from 10.1.3 come on top

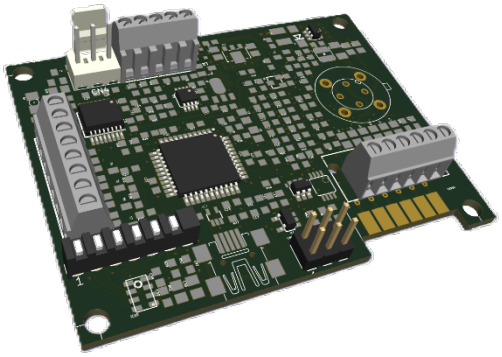
The following common environmental parameter must be considered:

- Background gas: the sensor calibration is based on O2/N2 mixtures, deviating background gases (Ar, CO2) might reduce the accuracy.
- Absolute static pressure: Between 700-1300mbara (quasi) static pressure change will be negligible. For operation outside this pressure range please contact SENSORE.
- Sensor ambient temperature and thermal environment: The GSB features an active heater temperature control to minimize thermal influence, high air flows (> 6m/s) or high ambient temperatures. For cabled sensors the maximum ambient temperature according to the sensor datasheet must be observed.

Please also check section 8.5 (Interference with O2 Measurement) which covers a broader range of external influences, including harmful conditions which have to be avoided.

10.2 Appendix B - Technical Drawings GSB only (mm)





4 mounting holes: ~3,2mm diameter

approximate height of the GSB: 15mm
approximate weight of the GSB: 20g
(without mounted sensor or connector)

10.3 Appendix C - Compliance Information

SENSORE Electronic GmbH. is part of the DwyerOmega Group and complies with applicable national and international standards and directives.

The following regulations have been considered:

- CE (only RoHS will fully apply as GSB system are considered as subassemblies)
- REACH (Registration, Evaluation, Authorization, and Restriction of Chemicals)
- Recycling policy
- RoHS (Restriction of Hazardous Substances in electrical and electronic equipment)
- WEEE (Waste Electrical and Electronic Equipment recycling)

For integration of the GSB-system into larger devices please consider following restriction and recommendations to achieve compliance with harmonized CE standards:

- Protection against hazardous voltages:
  - The GSB must not be connected to hazardous voltages, it must only be operated with PELV, SELV, or NEC Class 2 compliant circuits.
- Protection against fire risk:
  - The recommended compliance approach is to operate the GSB with a limit power supply/source, e.g. NEC Class 2 and follow the related requirements of the applied safety standard.
  - The sensor chip inside the sensor housing can reach temperatures up to 600°C. So, the GSB-System must not be used in ignitable or explosive atmospheres. The metal housing of the sensor is acting as fire protection enclosure for the 600°C sensor chip to achieve compliance with product safety standards.
- Protection against burns / hot surface warning:
  - The metal housing of the sensor might reach temperatures, where safety standards demand warning labels if the user can access the sensor housing.

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