

OXY-Flex Oxygen Analyser

FEATURES

- High accuracy linear output
- Configurable outputs:
4-20mA and 0-10V_{DC} or RS232 comms interface
- Selectable output measurement ranges:
Standard ranges of 0-25% O₂ and 0-100% O₂ or fully adjustable via RS232 when configured in 0-100% O₂ mode
- Externally triggered automatic or manual calibration
- Can be calibrated in normal air (20.7% O₂) or in any other known O₂ concentration
- Cycling 3.3V_{DC} logic output allows direct monitoring of the O₂ sensor pump cycle for diagnostic purposes
- Selectable output filtering allows adaptive, fast and dynamic or slow and stable output

SPECIFICATIONS

Maximum ratings

Supply voltage	24V _{DC} ± 10%
Current consumption	500mA max @ 24V _{DC}
4-20mA Load	100 to 600Ω
Temperature limits (electronics enclosure)	
Storage	-10 to 85°C
Operating	-10 to 85°C
Temperature limits (permissible gas temperature at sensor tip)	
Operating (Standard Temp)	-100 to 250°C
(High Temp)	-100 to 400°C
Gas flow rate	0 to 10 m/s
Weight	<450g
Incidental permissible acceleration	30g
Repetitive permissible acceleration	5g
Sealing Rating	IP65



APPLICATIONS

- Combustion control including oil, gas and biomass boiler applications
- Composting
- Laboratory & building air quality monitoring including confined space personnel safety
- Industrial process control i.e. gas mixing for welding and steel making
- Oxygen generation systems
- Medical
- Scientific including respiratory studies of a community or an organism, plants and animals
- Food and beverage packaging
- Applications where low oxygen is key including fermentation, rust and corrosion prevention, inerting and purging

OXY-Flex Oxygen Analyser

DESCRIPTION

The OXY-FLEX-X Series Standard Temperature Oxygen Analyser is designed to determine the oxygen concentration in air or inert gas mixtures with temperatures of -100 to +250°C max.

The OXY-FLEX-X-H Series High Temperature Oxygen Analyser is designed to determine the oxygen concentration in air or inert gas mixtures with temperatures of -100 to +400°C max.

These products are particularly suitable for measuring oxygen in areas that are not easily accessible, or in closed systems, such as ventilation pipes, flues and containers.

The OXY-FLEX Series can be user configured to output measuring ranges of 0-25% O₂ and 0-100% O₂. The entire measurement range is linear in both cases. Factory default is 0-25% O₂. When configured for 0-100% O₂ the user can also customise the analogue output ranges to suit their application.

The outputs can be configured to either 4-20mA and 0-10V_{DC} or RS232 interface. Prior to shipping all OXY-FLEX's are preconfigured with a measuring range of 0.1% to 25% Vol. O₂ with linear 4-20mA and 0-10V_{DC} outputs.

All settings can be changed by the customer should their measurement or interface requirements change by simply altering the position of jumper links on the PCB.

The actual oxygen sensor is mounted in the tip of the stainless steel probe and is protected by a stainless-steel sintered cap which acts as both a large particulate filter and also as a flame trap. The IP65 waterproof die-cast aluminium housing accommodates the electronics and is mechanically connected to the sensor probe.

The OXY-FLEX outputs the measured values simultaneously via 2 output channels (4-20mA and 0-10V_{DC} or RS232 Rx and Tx) both channels are referenced to the system GND.

A digital 3.3V_{DC} logic output cycles at the same frequency as the electrochemical pumping action of the oxygen sensing cell during normal operation, thus providing a real time sensor health check, if the output ceases to cycle the sensor has entered a start-up or error state. This provides fault proof operation. The digital output is also used during the calibration process to indicate the interface status.

A green on-board LED mirrors the CYCLE output and can be used to visually determine the sensor status or during the calibration process. A red LED indicates the unit has power applied.

SST's range of oxygen sensors do not directly measure the oxygen concentration but instead measure the partial pressure of oxygen within the measurement gas. In order to output an oxygen concentration (%) the OXY-FLEX must be calibrated, or more specifically, re-referenced in a known gas concentration, typically normal air.

Calibration, or re-referencing, is achieved by connecting the calibration input to GND and monitoring the status of the digital cycle output or by visually monitoring the on-board green LED. During the calibration process the output will either automatically calibrate to a fixed reference or can be manually calibrated to any output by way of a PCB mounted potentiometer. The fixed reference is factory set to 20.7% O₂ for calibration in normal air though this value may be altered via the RS232 interface for calibration with a reference gas of any known oxygen concentration. Calibration is stored on power loss.

Again the auto or manual calibrate function is user configurable. Regular calibration removes the effects of application and atmospheric pressure changes and also eliminates any sensor drift that may occur during the first few hundred hours of operation.

For more detailed information on the operation of SST Sensing Oxygen Sensors please refer to the following application note via our website:

AN0043 Operation Principle and Construction of Zirconium Dioxide Oxygen Sensor.

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PERFORMANCE CHARACTERISTICS

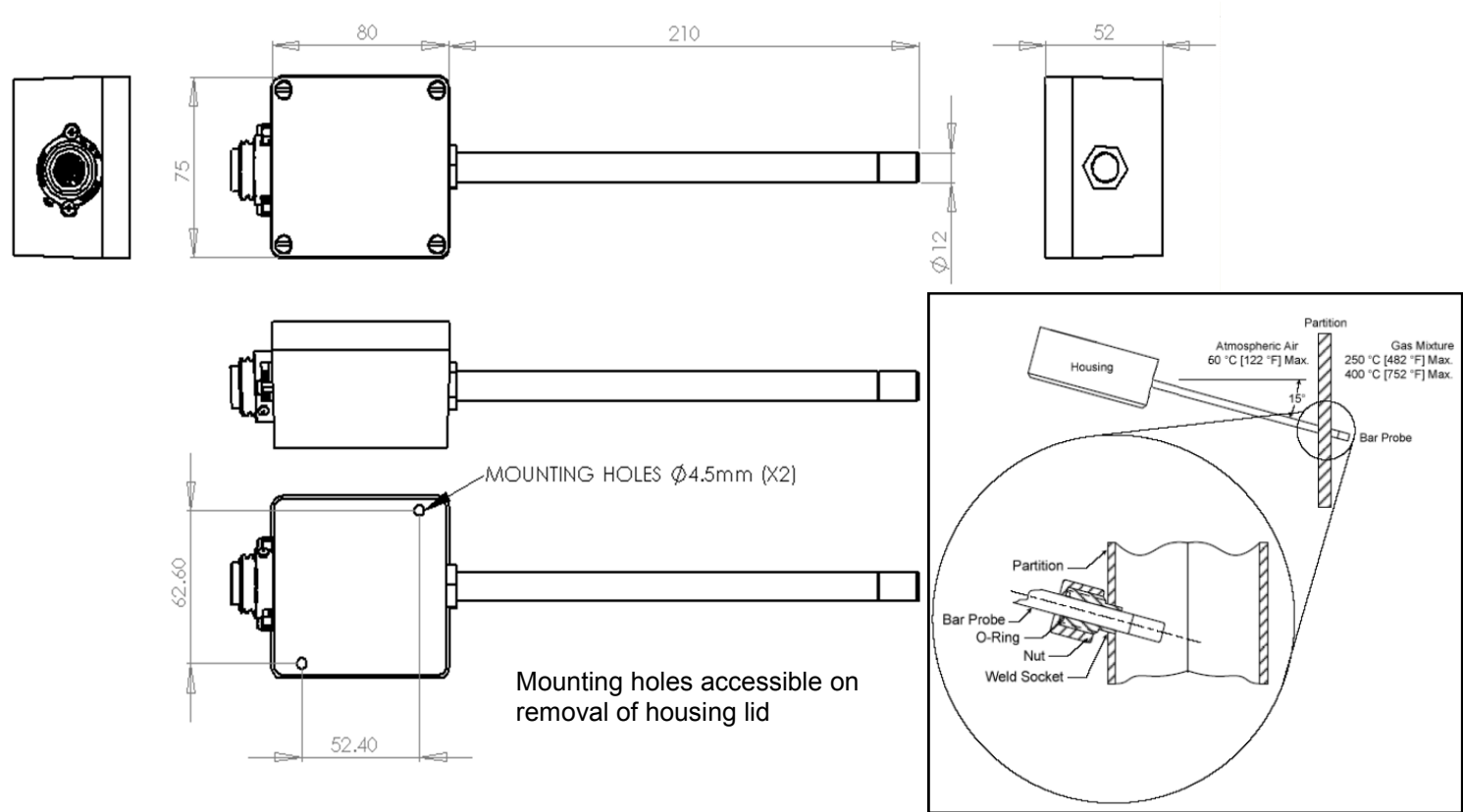
Characteristics	Min.	Typ.	Max.	Unit
Output inactive start up delay (heater warm up)		60		s
Initial warm up time (till stable output)	5	10		min
<u>Measuring ranges</u> 25% Configuration 100% Configuration	0.1 ⁽¹⁾ 0.1 ⁽¹⁾		25 100	% O ₂
Accuracy After Calibration ^{(2) (3)}			1	% O ₂
Repeatability After Calibration ⁽²⁾			0.5	% O ₂
0-10 V _{DC} Output Resolution			0.01	V
4-20mA Output Resolution			0.01	mA
RS232 Output Resolution			0.01	% O ₂
Reaction time (adaptive output filtering in normal air)		1		s

Notes:

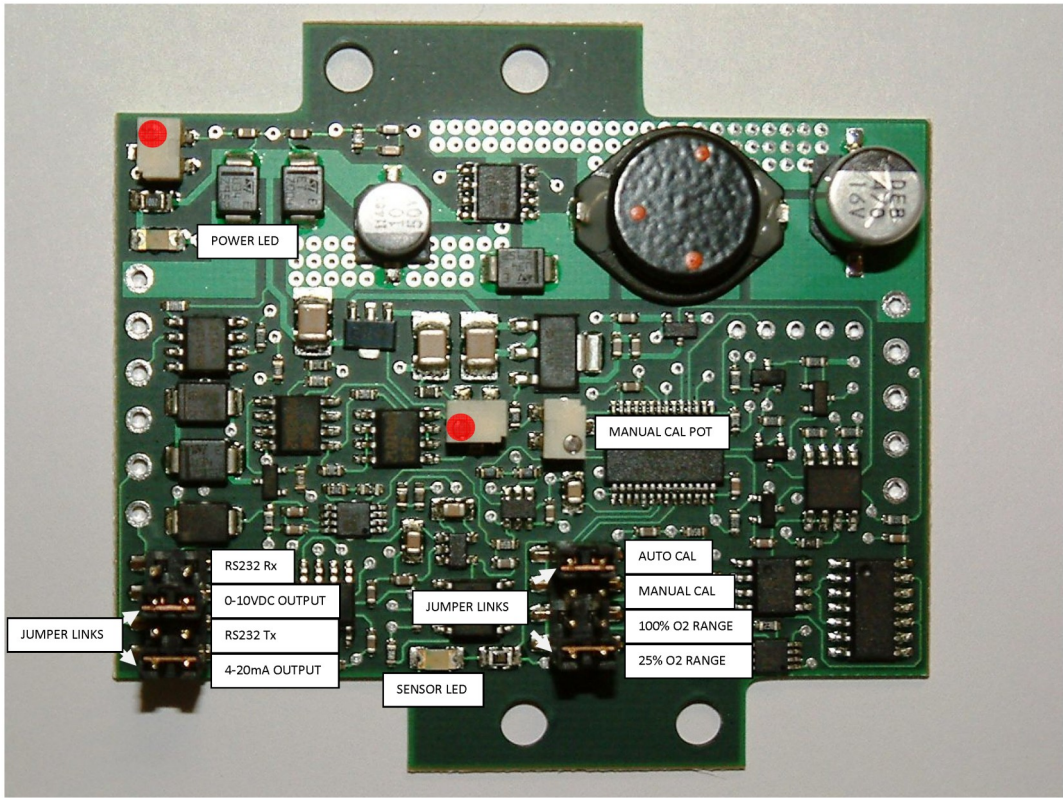
- (1) Prolonged operation below 0.1% O₂ can damage the sensing element.
- (2) Assuming barometric pressure remains constant.
- (3) As the O₂ sensor measures the partial pressure of oxygen (PPO₂) within the measurement gas deviations in the Barometric Pressure (BP) from that present during calibration will cause readout errors proportional to the change. For example if the sensor was reading 21% O₂ at 1013.25mbar and the BP increased by 1% the sensor readout would also increase by 1% to 21.21% O₂.

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OUTLINE DRAWING AND MOUNTING INFORMATION

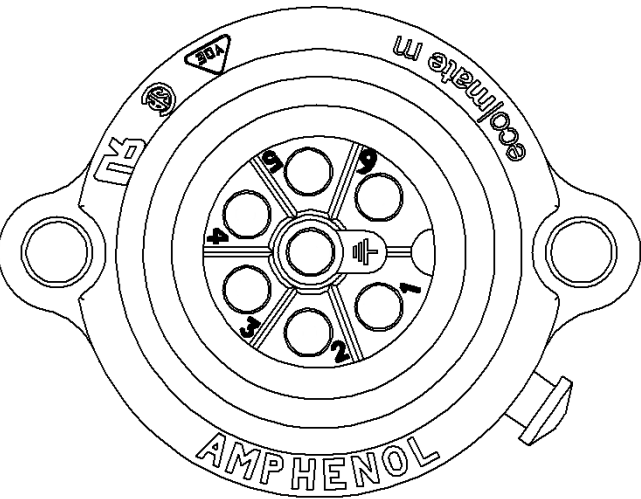


PCB LAYOUT (REMOVE HOUSING LID TO VIEW)



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ELECTRICAL CONNECTIONS

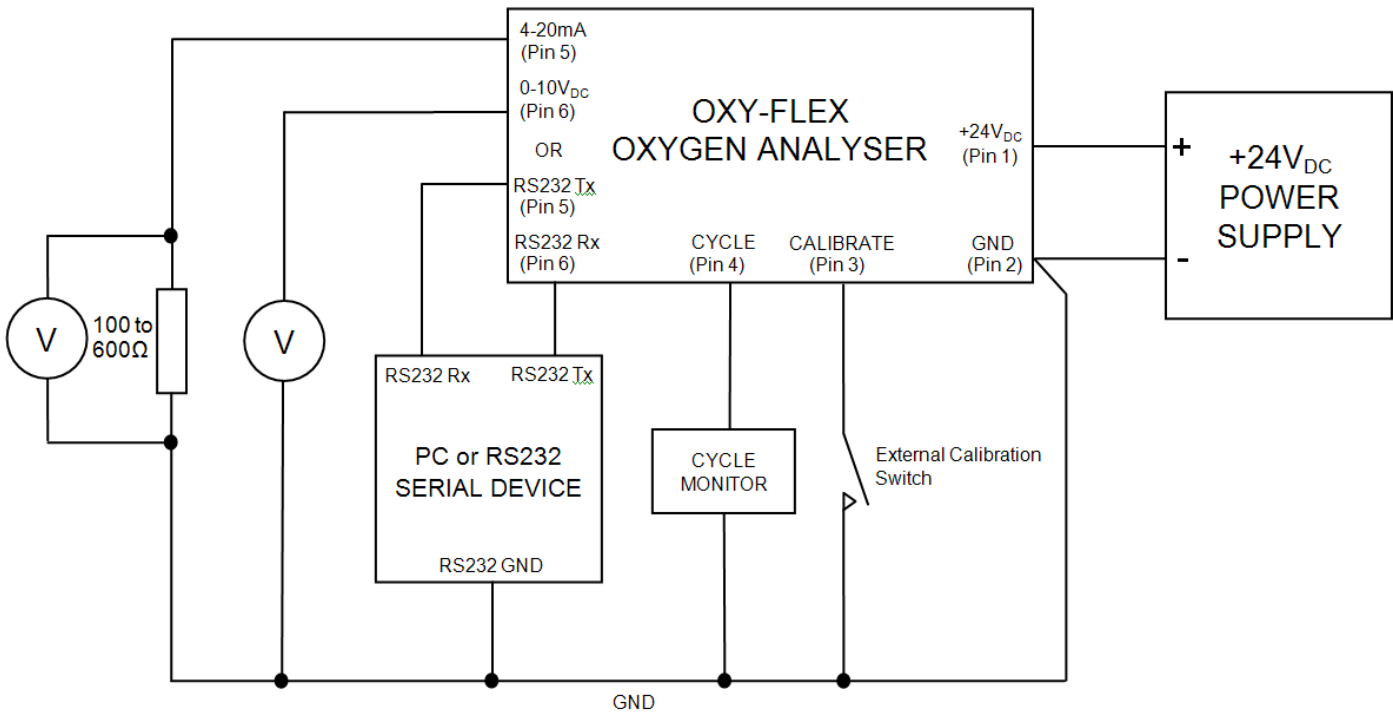


PIN	Description
1	24V _{DC} ± 10%
2	GND
3	Calibrate
4	Cycle
5	4-20mA/RS232 Tx
6	0-10V _{DC} /RS232 Rx
CENTRE	Housing/Probe Earth

Housing Connector: Amphenol Ecomate C016 30C006 100 12
Mating Connector: Binder 99-4218-00-07
(Mating Connector supplied with each product)

Output pins 5 and 6 are both referenced to the supply GND (pin 2). Due to high current flow in the supply GND, when monitoring the 0-10V_{DC} output (pin 6) it is recommended that a separate GND wire for the measurement system is taken from PIN 2. This removes errors due to voltage drops in the power supply connections.

SYSTEM BLOCK DIAGRAM



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RS232 COMMUNICATION SETTINGS

When connecting the OXY-FLEX via the RS232 connections ensure Tx goes to Rx of the PC and Rx goes to Tx of the PC.

The OXY-Flex communicates via standard COM port settings that are default on most PCs and many other RS232 compatible devices. If however communication problems are occurring use the settings below to configure the PC or device COM Port.



The image shows a Windows-style dialog box titled "COM1 Properties". It has a blue title bar with a question mark icon and a close button (X). The "Port Settings" tab is selected. Inside the dialog, there are five settings, each with a label and a dropdown menu:

- Bits per second: 9600
- Data bits: 8
- Parity: None
- Stop bits: 1
- Flow control: None

Below these settings is a "Restore Defaults" button. At the bottom of the dialog are three buttons: "OK", "Cancel", and "Apply".

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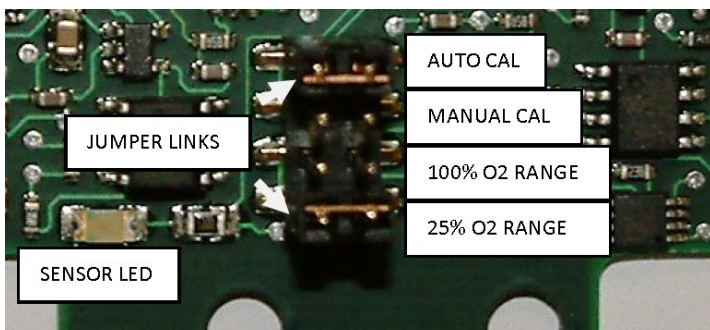
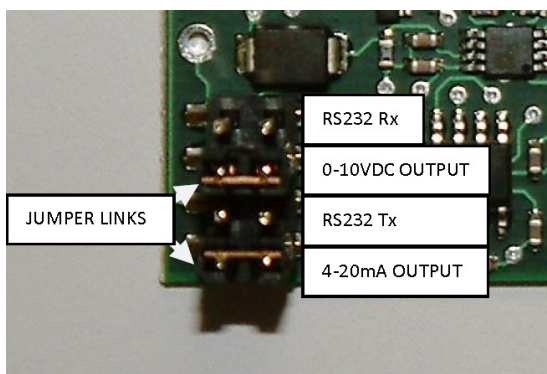
CONFIGURATION

The OXY-FLEX may be reconfigured at any time by adjusting the position of the header pin jumper links on the interface PCB.

WARNING: Prior to re-configuration the OXY-FLEX **MUST** be powered down. The jumper links **MUST** also be repositioned correctly and in the correct orientation. Failure to adhere to the above could result in product damage. Products damaged due to incorrect configurations will not be covered under warranty.

- Power down the OXY-FLEX
- Remove the lid using a Philips screwdriver
- Adjust the position of the jumper links to the desired configuration. The diagrams below and on Page 4 show the correct positioning for each user configurable option. Thin nosed pliers should be used to remove and replace the Jumper Links. Ensure the Jumper Links are correctly seated before reapplying the power

NOTE: Each Jumper Link must be placed in one of the two positions. When selecting the output, you must choose either 4-20mA and 0-10V_{DC} or RS232 Tx and Rx. Ensure the Jumper Links are always inserted horizontally between 2 adjacent pins.



RS232 OPERATION

With the OXY-FLEX RS232 outputs connected to a PC or any other RS232 compatible device the user has the ability to access two modes of operation, continuous data streaming and the menu screens. Recommended programs for communicating via PC serial RS232 are Hyperterminal (windows default), Teraterminal and PuTTY. A freeware PuTTY link can be found below;

<http://the.earth.li/~sgtatham/putty/latest/x86/putty.exe>

Continuous Data Streaming

On power up, after the initial 60s heater delay, the OXY-FLEX will automatically begin outputting the measured O₂ concentration and sensor Td as both an averaged and raw value. The averaged values give a stable output with the amount of averaging user variable whilst the raw un-averaged values allow the user to detect sudden oxygen changes. The averaged value is the measurement output on both the 4-20mA and 0-10V_{DC} outputs. The sensor Td value is the measure of the partial pressure of oxygen in the measurement gas. The O₂ concentration (%) is the Td value scaled by the stored calibration value.

To stop or restart the data streaming 's' (lower or upper case) should be sent to the unit. Data streaming automatically ceases during calibration.

Menu Screens

If the OXY-FLEX receives an enter character from the connected PC or device it automatically enters the menu password screen and stops outputting O₂ % and Td values. After the correct password is entered followed by the enter character, the menu screens are accessed. The menu screens are primarily for diagnostics and information although there are user configurable options that may be changed. These are the automatic O₂ calibration %, the amount of output filtering (averaging) and the analogue output ranges. All three processes are further described on Page 7. The menu access password may also be changed by the user.

Changing the Menu Access Password

The password is factory set to 'default'. This however may be changed to a user specific password.

- Connect the OXY-FLEX via the RS232 interface to the PC.
- Press Enter then enter your current security password. Press Enter to access the menu screen.
- In the Configuration menu (menu 2) enter '3' to access the password menu screen.
- Enter the new password then press Enter to save.
- The new password is now stored in memory and is retained on power loss.

Pressing ESC returns the screen to the previous menu.

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RS232 USER CONFIGURABLE OPTIONS

Changing the Automatic Calibration Value

The system is factory set to automatically calibrate to 20.7% O₂ to allow simple calibration in normal air. The auto calibration value is factory set to 20.7% to take into account average humidity in the atmosphere. If a calibration with a gas of a different known O₂ concentration is required the factory set value may be changed via the RS232 interface.

- Connect the OXY-FLEX via the RS232 interface to the PC. See CONFIGURATION on Page 6.
- Press Enter then enter your security password. Press Enter to access the menu screen.
- In the Configuration menu (menu 2) enter the auto calibration value screen (option 1 - Enter Auto Calib).
- The number entered should be the oxygen concentration (%) of the calibration gas to 2 decimal places. Press Enter to save.
- The new Automatic Calibration value is now stored in memory. This value is retained on power loss.

If calibration is required with a different gas of known O₂ concentration and access to the RS232 menus with a PC is not available in order to change the calibration percentage, a manual calibration must be performed.

Variable Output Filtering (Td Averaging)

The OXY-FLEX is factory default to use adaptive output filtering to give an optimum balance between output stability and response to oxygen changes. However this balance may be altered by the customer to suit the needs of the application.

- Connect the OXY-FLEX via the RS232 interface to the PC. See CONFIGURATION on Page 6.
- Press Enter then enter your security password. Press Enter to access the menu screen.
- In the Configuration menu (menu 2) enter the Td average screen (option 2 - Enter Td Averaging).
- The number entered should be between 0 and 200. 0 for adaptive filtering (recommended), 1 for very fast and dynamic output response but relatively unstable to 200 for an extremely stable output but very slow response to oxygen changes.
- Press Enter to save.
- The new averaging value is now stored in memory. This value is retained on power loss.

Adjusting the Minimum and Maximum Ranges of the Analogue Outputs (4-20mA and 0-10V_{DC})

The OXY-FLEX is factory default to output a range of 0-25% O₂ via its two analogue outputs. This range can be expanded to 0-100% O₂ as described on Page 6. When the unit is reconfigured to output 0-100% O₂ the user also has the option to fully customise the output ranges via RS232. This is extremely useful in applications where the O₂ variation is within a narrow band as it allows the analogue outputs to be tailored to this limited range.

- Ensure the OXY-Flex is configured for 0-100% and RS232 operation, See CONFIGURATION on Page 6.
- Connect the OXY-FLEX via the RS232 interface to the PC.
- Press Enter then enter your security password. Press Enter to access the menu screen.
- In the Configuration menu (menu 2) enter the maximum range screen (option 3 - Enter O2 Max Range).
- The number entered should be between 1.00 and 100.00 to represent the maximum output range. The number must also be greater than the saved minimum range.
- Press Enter to save the ESC to return to the configuration menu.
- Enter the minimum range screen (option 4 - Enter O2 Min Range).
- The number entered should be between 0.00 and 99.00 to represent the minimum output range. The number must also be less than the saved maximum range.
- Press enter to save.
- The new ranges are now stored in memory and are retained on power loss.

An example of changing the min and max output ranges would be in an normal air atmosphere where the O₂ range is between 20-21%. The user could set the minimum output range to 19% and the maximum output range to 22% and the outputs would vary linearly in between. The min and max ranges lock out the outputs at the set limits so 19% O₂ or lower would set the analogue outputs to 0V_{DC}/4mA and 22% O₂ or higher would set the analogue outputs to 10V_{DC}/20mA.

The min and max range adjustment does not apply to the RS232 output and is overruled if the unit is reconfigured for 0-25% operation.

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CALIBRATION PROCEDURES

Automatic Calibration

- Ensure the OXY-FLEX is configured for automatic calibration. See CONFIGURATION on Page 6.
- Place the sensor probe in the calibration gas, typically normal air.
- Allow the output to stabilise for at least 5 mins. 10 mins if powering from cold.
- Apply GND to the CALIBRATE input (PIN 3) for a minimum 12s. During the 12s the CYCLE output (PIN 4) and the green LED will go high/on, blink rapidly, go high/on, go low/off then return to cycling normally to indicate normal operation has resumed. At this point remove GND from PIN 3.
- The output will now track to the correct value for the calibration gas.
- Calibration is complete. Calibration values are retained on power loss.

Manual Calibration

- Ensure the OXY-FLEX is configured for manual calibration. See CONFIGURATION on Page 6.
- Place the sensor probe in the calibration gas, typically normal air.
- Allow the output to stabilise for at least 5 mins. 10 mins if powering from cold.
- Apply GND to the CALIBRATE input (PIN 3) for a minimum 5s or until the CYCLE output and green LED blink at a steady 1Hz. Remove GND from PIN 3. Manual Calibration is now initialised.
- Adjust the MANUAL CAL POT until the output equals the correct value of the calibration gas concentration.
- Re-apply GND to PIN 3 for a minimum 5s. During the 5s the CYCLE output/LED will blink rapidly, go high/on, go low/off then return to cycling normally to indicate normal operation has resumed. At this point remove GND from PIN 3.
- The output will now track to the correct value for the calibration gas.
- Calibration is complete. Calibration values are retained on power loss.

ERROR CONDITIONS

If the oxygen sensor is damaged the OXY-Flex will highlight this by blinking the CYCLE output (pin 4) and green LED in a 3 short blinks 1 long blink pattern or continuously OFF. An error code is also displayed on the RS232 output and the analogue outputs will go to 4mA and 0V.

**SEE PAGE 4 FOR THE LOCATION OF THE SENSOR/
POWER LEDs AND THE MANUAL CAL POT.**

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SENSOR OPERATING TIPS

To get the best performance from the OXY-Flex analyser it is important that the oxygen probe is installed and maintained in the correct manner. The following two pages outline some useful sensor operating tips and a list of gases and materials that must be avoided to ensure a long sensor life.

Operating the Sensor in Aggressive Humid Environments:

When operating the sensor in warm, humid environments it is important the sensor remains at a higher temperature than it's surroundings, especially if there are corrosive components in the measurement gas. During operation this is not a problem due the 700°C generated by the heater, but this means when the sensor or application is being powered down the sensor heater must be the last thing to be turned off after the temperature of the surroundings have suitably cooled. Ideally the sensor should be left powered at all times in very humid environments.

Failure to adhere to the above will result in condensation forming on the heater and sensing cell as these will be the first components to cool due to their connections to the outside world. When the sensor is re-powered the condensation will evaporate, leaving behind corrosive salts which very quickly destroy the heater and cell as illustrated below. Note how the sensor's external metalwork looks completely normal.



Protecting from Water Droplets:

In environments where falling water droplets are likely the sensor should be protected from water falling directly onto the very hot sensor cap as this can cause massive temperature shocks to the cell and heater. Popular methods include a hood over the sensor cap or for the sensor to be mounted in a larger diameter cylinder.

At a very minimum the sensor cap should be angled downwards in the application as this will deflect any falling moisture and prevent the sensor cap from filling with water.

Using the Sensor With Silicones:

SST Sensing's oxygen sensors, like all other Zirconium Dioxide sensors, are damaged by the presence of silicone in the measurement gas. Vapours (organic silicone compounds) of RTV rubbers and sealants are the main culprits and are widely used in many applications. These materials which are often applied as a liquid or gel still outgas silicone vapours into the surrounding atmosphere even after they have cured. When these vapours reach the sensor the organic part of the compound will be burned at hot sensor parts, leaving behind a very fine divided Silicon Dioxide (SiO_2). This SiO_2 completely blocks the pores and active parts of the electrodes.

If silicone cannot be avoided in the application we advise using high quality, high temperature cured materials which do not outgas when subsequently heated. SST can provide guidance if there is concern about use of silicone within the application.

When installing the sensor do not use any lubricants or grease which may contain silicone.

In addition to silicones other gases which may interfere with the sensor are listed overleaf.

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SENSOR OPERATING TIPS continued

Cross sensitivity with other gases:

Gases or chemicals that will have an influence on the life of the sensor or on the measuring results are:

1. Combustible Gases

Small amounts of combustible gases will be burned at the hot Pt-electrode surfaces or Al_2O_3 filters of the sensor. In general combustion will be stoichiometric as long as enough oxygen is available, the sensor will measure the residual oxygen pressure which leads to a measurement error. The sensor is not recommended for use in applications where there are large amounts of combustible gases present and an accurate O_2 measurement is required.

Investigated gases were:

- H_2 (Hydrogen) up to 2%; stoichiometric combustion
- CO (Carbon Monoxide) up to 2%; stoichiometric combustion
- CH_4 (Methane) up to 2.5%; stoichiometric combustion
- NH_3 (Ammonia) up to 1500 ppm; stoichiometric combustion

2. Heavy Metals

Vapours of metals like Zn (Zinc), Cd (Cadmium), Pb (Lead), Bi (Bismuth) will have an effect on the catalytic properties of the Pt- electrodes. Exposure to these metal vapours must be avoided.

3. Halogen and Sulphur Compounds

Small amounts (< 100ppm) of Halogens and/or Sulphur compounds have no effect on the performance of the oxygen sensor. Higher amounts of these gases will in time cause readout problems or, especially in condensing atmospheres, corrosion of sensor parts. These gases often outgas from plastic housings and tubes when hot.

Investigated gases were:

- Halogens, F_2 (Flourine), Cl_2 (Chlorine)
- HCL (Hydrogen Chloride), HF (Hydrogen Fluoride)
- SO_2 (Sulphur Dioxide)
- H_2S (Hydrogen Sulphide)
- Freons
- CS_2 (Carbon Disulfide)

4. Reducing Atmospheres

Long time exposure to reducing atmospheres may in time impair the catalytic effect of the Pt-electrodes and has to be avoided. Reducing atmospheres are defined as an atmosphere with very little free oxygen and where combustible gases are present. In this type of atmosphere oxygen is consumed as the combustible gases are burned.

5. Others

- Dust. Fine dust (Carbon parts/soot) might cause clogging of the porous stainless steel filter and might have an effect on the response of the sensor to oxygen changes.
- Heavy shocks or vibrations may alter sensor properties resulting in the need for a recalibration.

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ORDERING INFORMATION

Part number	Output Type	Probe Length	Measuring Range	Gas Temperature
OXY-FLEX-0	4 to 20mA and 0 to 10V or RS232	220mm	0.1 to 25% Vol. O ₂ or 0.1 to 100% Vol. O ₂	-100 to 250°C
OXY-FLEX-1	4 to 20mA and 0 to 10V or RS232	400mm	0.1 to 25% Vol. O ₂ or 0.1 to 100% Vol. O ₂	-100 to 250°C
OXY-FLEX-0-H	4 to 20mA and 0 to 10V or RS232	220mm	0.1 to 25% Vol. O ₂ or 0.1 to 100% Vol. O ₂	-100 to 400°C
OXY-FLEX-1-H	4 to 20mA and 0 to 10V or RS232	400mm	0.1 to 25% Vol. O ₂ or 0.1 to 100% Vol. O ₂	-100 to 400°C

NOTE: All variants can have their Output Type and Measuring Range reconfigured at any time using the CONFIGURATION guide on Page 6.

WARNING The sensor tip becomes very HOT during operation and may cause injury if touched. Personal Injury DO NOT USE these products as safety or Emergency Stop devices or in any other application where failure of the product could result in personal injury. Failure to comply with these instructions could result in death or serious injury.	CAUTION Do not exceed maximum ratings and ensure sensor is operated in accordance with all requirements of AN0043 Failure to comply with these instructions may result in product damage.
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