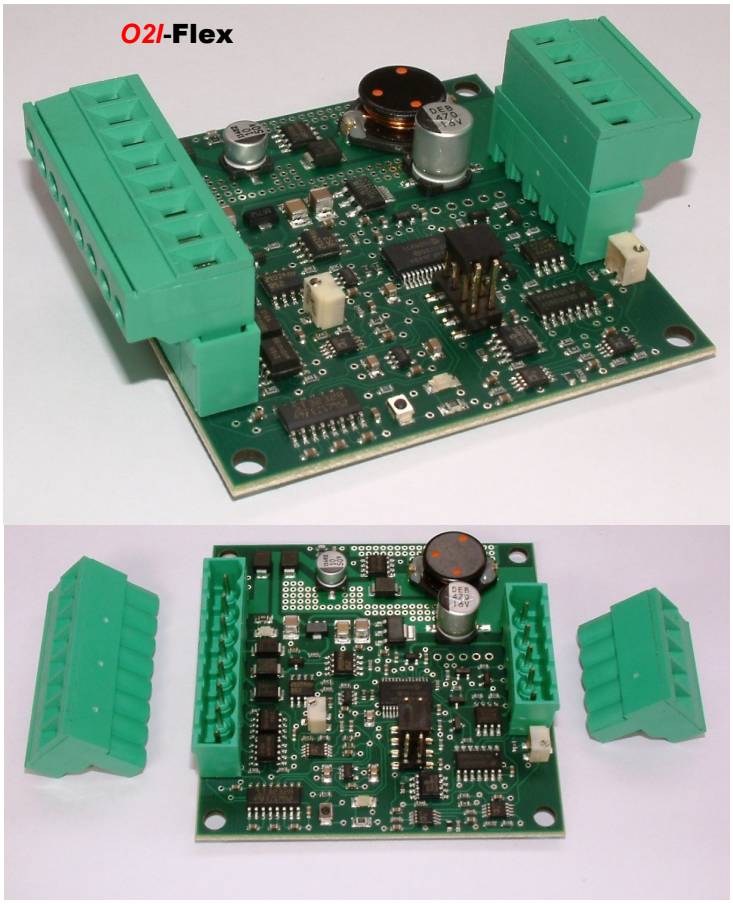
O2I-Flex Oxygen Interface

FEATURES

- Provides the electronics necessary to power and control SST's range of dynamic oxygen sensors
- High accuracy linear output
- Selectable output measurement ranges: Standard ranges of 0-25% O_2 and 0-100% O_2 or fully adjustable via RS232 when configured in 0-100% O_2 mode
- Multiple outputs: 4-20mA, 0-10V_{DC} and RS232 comms interface
- Externally triggered automatic or manual calibration. Calibration can also be initiated via an on-board push button switch
- Can be calibrated in normal air (20.7% O_2) or in any other known O_2 concentration
- Cycling 3.3V_{DC} logic output allows direct monitoring of the O_2 sensor pump cycle for diagnostic purposes
- Selectable output filtering allows adaptive, fast and dynamic or slow and stable output response
- Power and Sensor Operating LEDs
- Removable polarised screw terminals for easy wiring



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

SPECIFICATIONS

Maximum ratings

Supply voltage	24V_{DC} ± 10%
Current consumption	600mA max @ 24V_{DC}
4-20mA Load	100-600Ω
Temperature limits	
Storage	-10 to 70°C
Operating	-10 to 70°C

O2I-Flex Oxygen Interface

DESCRIPTION

The O2I-FLEX Interface provides all necessary electronics to power and control SST Sensing's range of dynamic Oxygen Sensors.

The O2I-FLEX Interface can be user configured to output measuring ranges of 0-25% O_2 and 0-100% O_2. The entire measurement range is linear in both cases. Factory default is 0-25% O_2. When configured for 0-100% O_2 the user can also customise the analogue output ranges to suit their application.

The interface outputs the measured values simultaneously via 4 output channels, 4-20mA, 0-10V_{DC} and RS232 (Rx and Tx), all outputs 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 O2I-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 or by pressing the on-board calibration switch 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% O_2 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.

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.

O2I-Flex Oxygen Interface

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
Measuring ranges 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% O_2 can damage the sensing element.

(2) Assuming barometric pressure remains constant.

(3) As the O_2 sensor measures the partial pressure of oxygen (PPO_2) 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% O_2 at 1013.25mbar and the BP increased by 1% the sensor readout would also increase by 1% to 21.21% O_2.

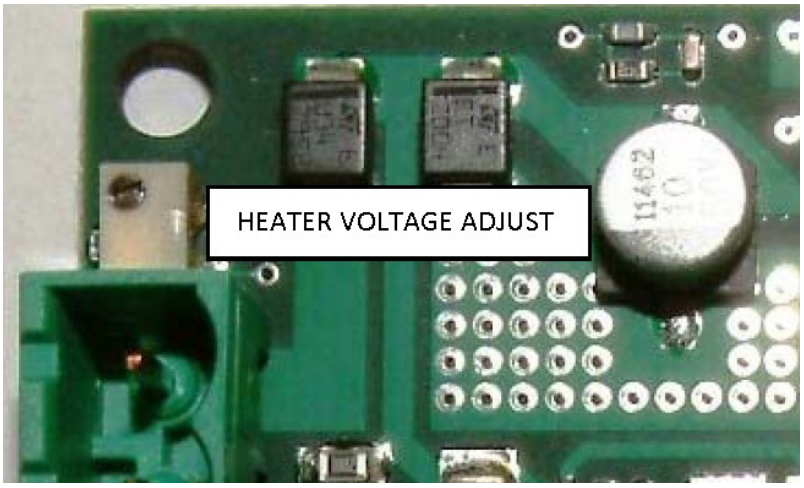
OXYGEN SENSOR HEATER ADJUSTMENT

The Oxygen Sensor heater must be adjusted to the correct heater voltage depending on the variant of sensor.

For a sensor with a full porous cap the heater voltage should be adjusted to 4.35V_{DC} measured as close as possible to the sensor heater connections.

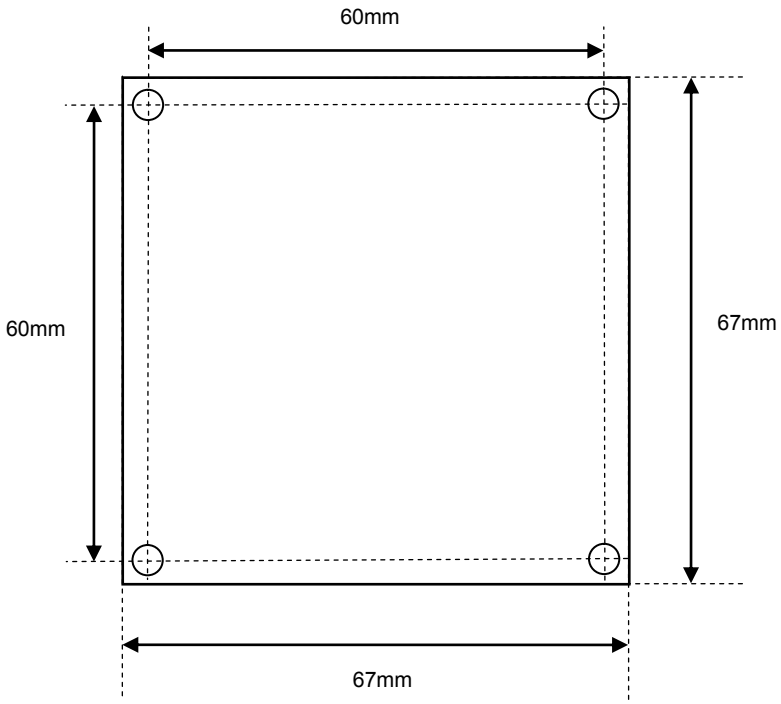
For a sensor with a porous lid the heater voltage should be adjusted to 4.00V_{DC} measured as close as possible to the sensor heater connections.

The heater voltage is set by adjusting the HEATER VOLTAGE ADJUST pot, highlighted below and on page 4.



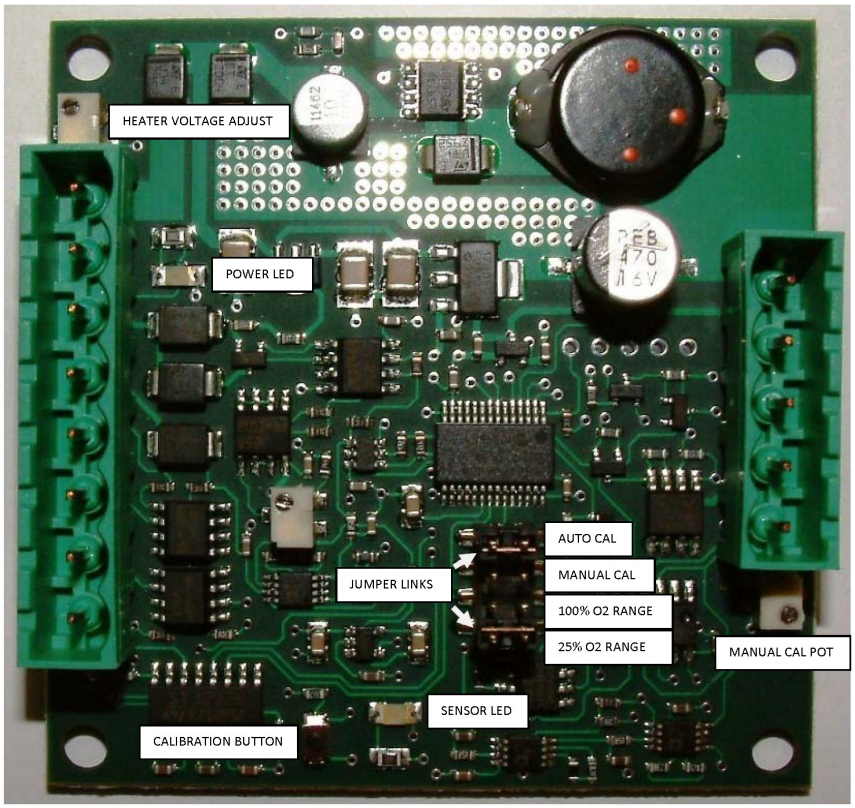
O2I-Flex Oxygen Interface

OUTLINE DRAWING AND MOUNTING INFORMATION



4 x M4 Mounting holes on industry standard 60x60mm pitch

PCB LAYOUT



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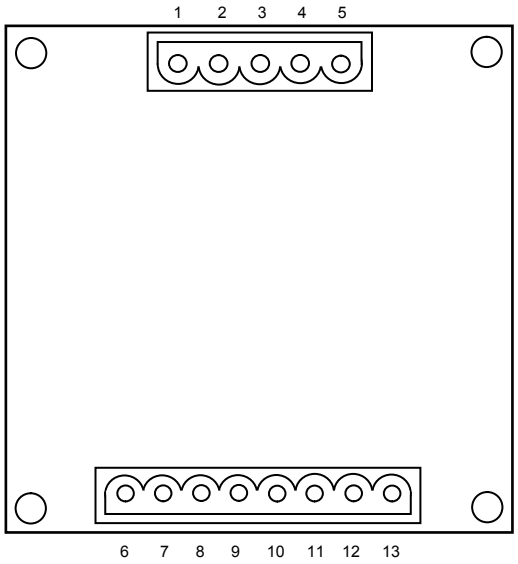
ELECTRICAL CONNECTIONS

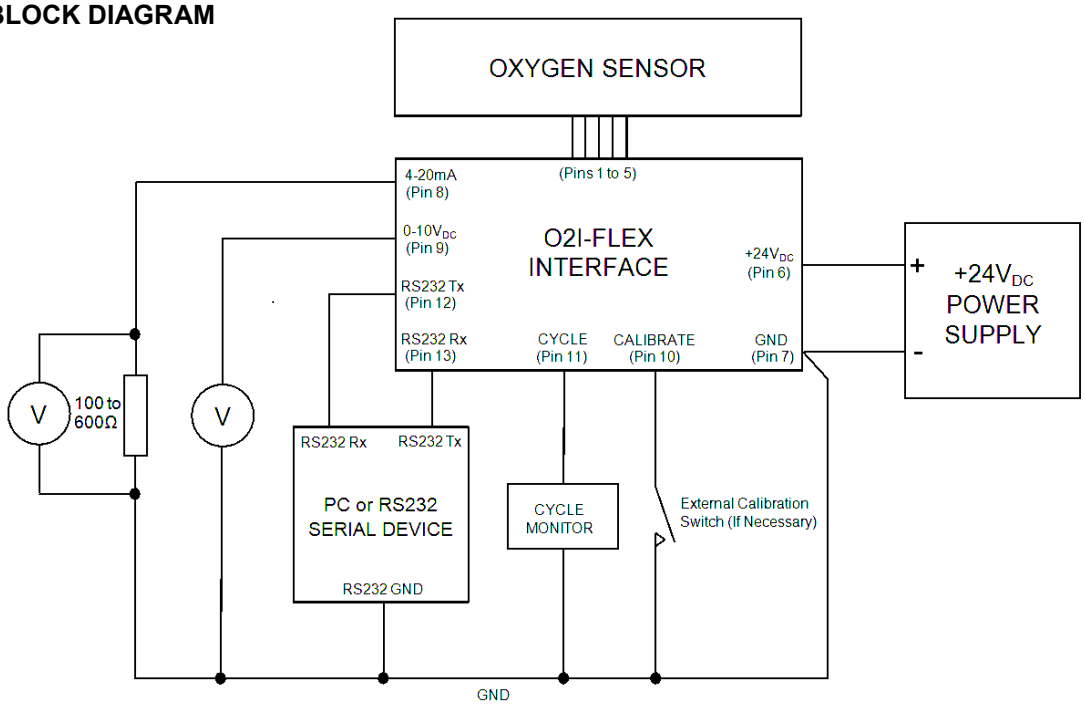


PIN	Description
1	Sensor Heater GND (Yellow, H)
2	Sensor Heater + (Yellow, H)
3	Sensor Sense (Blue, S)
4	Sensor Common (Black, C)
5	Sensor Pump (Red, P)
6	$24V_{DC}$ ± 10%
7	GND
8	4-20mA Output
9	0-$10V_{DC}$ Output
10	Calibrate
11	Cycle
12	RS232 Tx
13	RS232 Rx

Output pins 8, 9, 12 & 13 are all referenced to the supply GND (pin 7). Due to high current flow in the supply GND, when monitoring the 0-$10V_{DC}$ output (pin 9) it is recommended that a separate GND wire for the measurement system is taken from PIN 7. This removes errors due to voltage drops in the power supply connections.

Every SST oxygen sensor has two heater connections which should be connected to pins 1 & 2 of the O2I-Flex, the heater coil has no polarity. However when connecting to a sensor where the sensor housing is one of the heater connections, pin 1 of the O2I-Flex should be connected to the housing.

SYSYEM BLOCK DIAGRAM

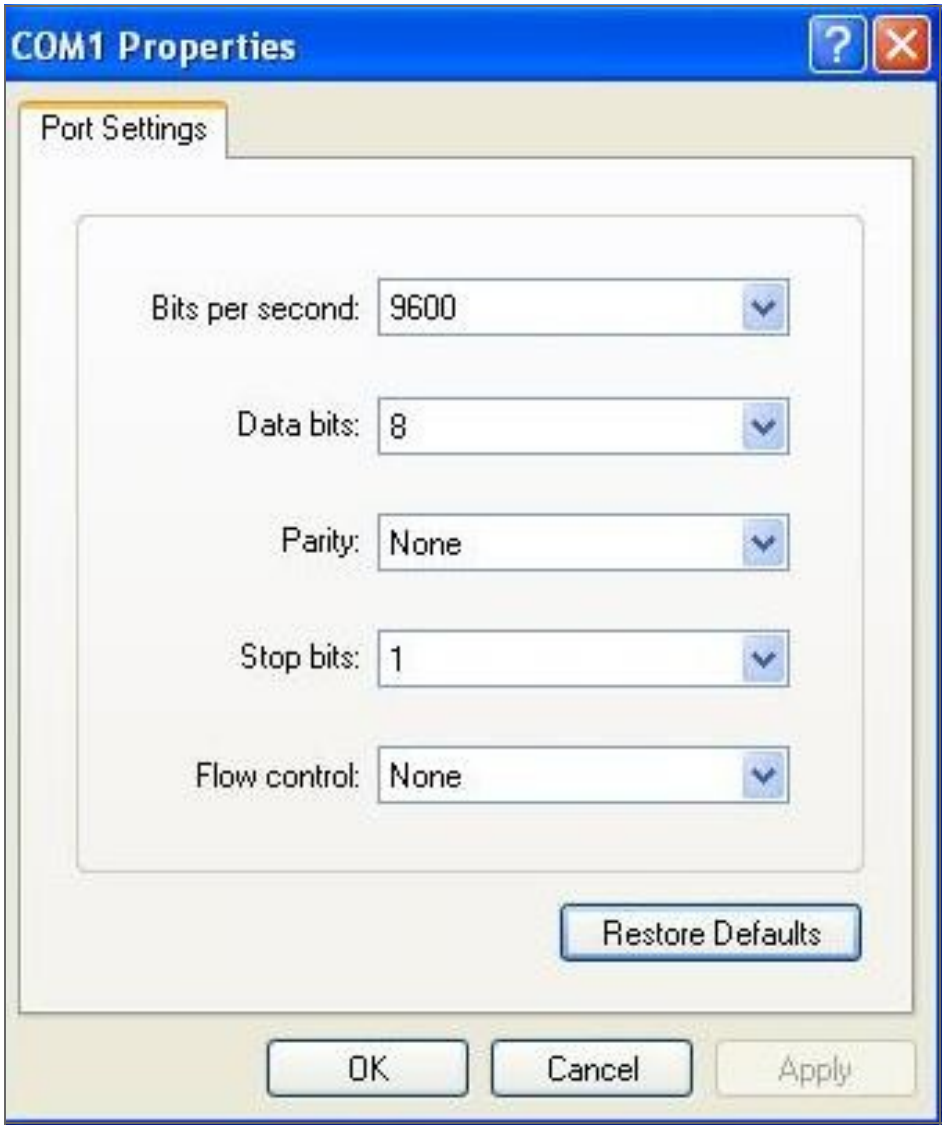


O2I-Flex Oxygen Interface

RS232 COMMUNICATION SETTINGS

When connecting the O2I-FLEX via the RS232 connections ensure Tx goes to Rx of the PC and Rx goes to Tx of the PC.

The O2I-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.



O2I-Flex Oxygen Interface

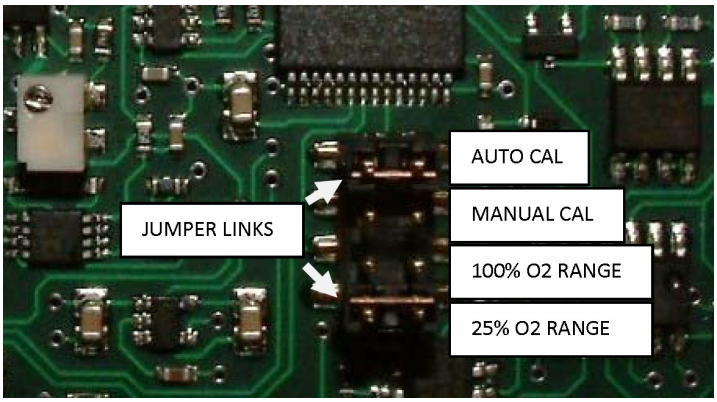
CONFIGURATION

The O2I-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 O2I-FLEX **MUST** be powered down. The jumper links **MUST** also be repositioned correctly and in the correct orientation.

- Power down the O2I-FLEX
- Adjust the position of the jumper links to the desired configuration. The diagram below shows the Interface PCB and the correct orientation of the Jumper Links. 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, either Manual (MANUAL CAL) or Automatic (AUTO CAL) Calibration and 100% or 25% Measuring Range.



RS232 OPERATION

With the O2I-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 O2I-FLEX will automatically begin outputting the measured O_2 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 O_2 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 O2I-FLEX receives an enter character from the connected PC or device it automatically enters the menu password screen and stops outputting O_2 % 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 O_2 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 O2I-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.

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Pressing ESC returns the screen to the previous menu.

O2I-Flex Oxygen Interface

RS232 USER CONFIGURABLE OPTIONS

Changing the Automatic Calibration Value

The system is factory set to automatically calibrate to 20.7% O_2 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 O_2 concentration is required the factory set value may be changed via the RS232 interface.

- Connect the O2I-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 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 O_2 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 O2I-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 O2I-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 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 O2I-FLEX is factory default to output a range of 0-25% O_2 via its two analogue outputs. This range can be expanded to 0-100% O_2 as described on Page 6. When the unit is reconfigured to output 0-100% O_2 the user also has the option to fully customise the output ranges via RS232. This is extremely useful in applications where the O_2 variation is within a narrow band as it allows the analogue outputs to be tailored to this limited range.

- Ensure the O2I-Flex is configured for 0-100% operation, see Page 6.
- Connect the O2I-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 O_2 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% O_2 or lower would set the analogue outputs to 0V_{DC}/4mA and 22% O_2 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.

O2I-Flex Oxygen Interface

CALIBRATION PROCEDURES

Automatic Calibration

- Ensure the O2I-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 10) or press the on-board calibration switch for a minimum 12s. During the 12s the CYCLE output (PIN 11) 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 10 or release the calibration switch.
- 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 O2I-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 10) or press the on-board calibration switch for a minimum 5s or until the CYCLE output and green LED blink at a steady 1Hz. Remove GND from PIN 10 or release the calibration switch. 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 10 or press the calibration switch 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 10 or release the calibration switch.
- The output will now track to the correct value for the calibration gas.
- Calibration is complete. Calibration values are retained on power loss.

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

ERROR CONDITIONS

If the oxygen sensor is not connected up correctly or is damaged the O2I-Flex will highlight this by blinking the CYCLE output (pin 11) 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.

If an error condition occurs the unit should be powered down and all wiring checked before reapplying the power. If the error condition remains the O2 sensor is damaged and should be replaced.

O2I-Flex Oxygen Interface

SENSOR OPERATING TIPS

To get the best performance from the O2I-Flex interface it is important that the attached oxygen sensor 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 will the sensor are listed overleaf.

O2I-Flex Oxygen Interface

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.

WARNING **Due to the power requirements of the sensor heater the PCB becomes HOT during operation.** **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.**