XZR250
Oxygen Analyzer
User's Manual

97528 Issue 5
May 2019

Please fill out the form(s) below for each instrument that has been purchased.

Use this information when contacting Michell Instruments for service purposes.

Instrument	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

Instrument	
Code	
Serial Number	
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Tag No	

Instrument	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

XZR250

For Michell Instruments' contact information please go to
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Safety

The manufacturer has designed this equipment to be safe when operated using the procedures detailed in this manual. The user must not use this equipment for any other purpose than that stated. Do not apply values greater than the maximum value stated.

This manual contains operating and safety instructions, which must be followed to ensure the safe operation and to maintain the equipment in a safe condition. The safety instructions are either warnings or cautions issued to protect the user and the equipment from injury or damage. Use qualified personnel and good engineering practice for all procedures in this manual.

Electrical Safety

The instrument is designed to be completely safe when used with options and accessories supplied by the manufacturer for use with the instrument. The input power supply voltage is 24 V ±10% via limited power supply.

Pressure Safety

The XZR250 is designed to be operated at atmospheric pressures.

Toxic Materials

The use of hazardous materials in the construction of this instrument has been minimized. During normal operation it is not possible for the user to come into contact with any hazardous substance which might be employed in the construction of the instrument. Care should, however, be exercised during maintenance and the disposal of certain parts.

Repair and Maintenance

The instrument must be maintained either by the manufacturer or an accredited service agent. Refer to www.michell.com for details of Michell Instruments' worldwide offices contact information.

Calibration

The recommended calibration interval for the XZR250 is between one and three months. This duration may be shorter or longer dependent on installation, application and customer preferences.

Safety Conformity

This product meets the essential protection requirements of the relevant EU directives.

Abbreviations

The following abbreviations are used in this manual:

°C	degrees Celsius
°F	degrees Fahrenheit
DC	direct current
EU	European Union
kg	kilogram(s)
l/min	liters per minute
lb	pound
mA	milliampere
max	maximum
min	minute(s)
scfh	standard cubic feet per hour
Td	cycle time to evacuate and re-pressurize the sealed cell
Td averaging	counting x number of cycles and averaging the result
V	Volts
%	Percentage
"	Inches

Warnings

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

Where this hazard warning symbol appears in the following sections, it is used to indicate areas where potentially hazardous operations need to be carried out.

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

CAUTION	**INFORMATION**
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. Zirconium oxide sensors are damaged by the presence of silicone. Vapors (organic silicone compounds) from RTV rubbers and sealants are known to poison oxygen sensors and MUST be avoided. Do NOT use chemical cleaning agents. **Failure to comply with these instructions may result in product damage.**	As customer applications are outside of Michell Instruments 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 contact the manufacturer.

General Note: The manufacturer reserves the right to make changes to product specifications without notice or liability.

All information is subject to the manufacturer's own data and considered accurate at time of going to print.

1 PRODUCT OVERVIEW

The XZR250 is a pressure compensated oxygen analyser designed to monitor the oxygen concentration of the gas during combustion in boilers and industrial furnaces.

The XZR250 is designed to allow direct installation of the probe in the wall of a flue or furnace to measure the concentration of oxygen in the stack gas with temperatures up to 700°C. The sensor is located in the sensor head and not the probe, this ensures a more stable measurement and longer sensor life.

The XZR250 uses a zirconium oxide (ZrO_2) sensor which should last for up to 7 years in natural gas fired boilers. It can be replaced without the need to remove the probe from its installation.

Single-point calibration can be simply performed using fresh air or a known reference gas.

1.1 Components

1. Sensor Head
2. Clamp
3. Mounting flange
4. Probe body
5. Gas sampling tubes
6. Gasket (see figure 8)

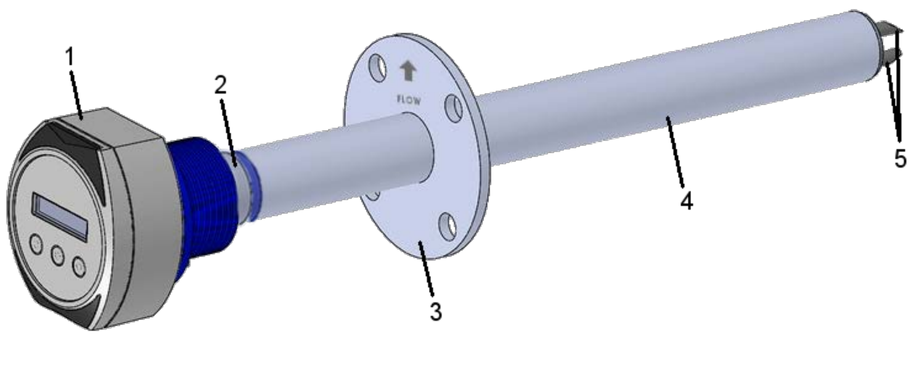


Figure 1 *Main Components*

The instrument is supplied with a quick start guide, however this full manual should be read carefully before work commences: **XZR250 97529 Quick Start Guide.**

2 INSTALLATION

To ensure the best performance from your equipment, it must be installed correctly.

2.1 General Guidelines

Mount the probe so that the tip is in the main stream of gas (within the flue), as close to the burner as possible, but not within the flame. Ensure the maximum temperature is within the temperature limits of the probe.

WARNING: All wiring MUST be in accordance with the national and/or any local codes, ordinances, and regulations. Disconnect and lock out power before connecting the equipment to the power supply.

CAUTION:

- **Do NOT install the device suspended from the cable.**
- **Do NOT twist the cable(s).**
- **Avoid exerting excessive tensile force on the cable (e.g. tugging).**
- **Do NOT leave any wires loose: accidental shorting may cause product damage.**
- **Make sure the terminals are wired as shown in Figure 4 as failure to connect power correctly could result in irreversible product damage that is NOT covered by warranty.**

Always handle the interface board using the correct ESD handling precaution

2.2 Electrical Connections

1. Remove the front panel:

   a. If fitted, carefully remove the two screw covers (2) from the front panel (1).

   b. Remove the four screws securing the front panel (1) to the housing.

   c. Carefully ease the front panel (1) from the housing.

CAUTION: Do NOT pull forcefully.

   d. Disconnect the ribbon cable from the panel and remove panel.

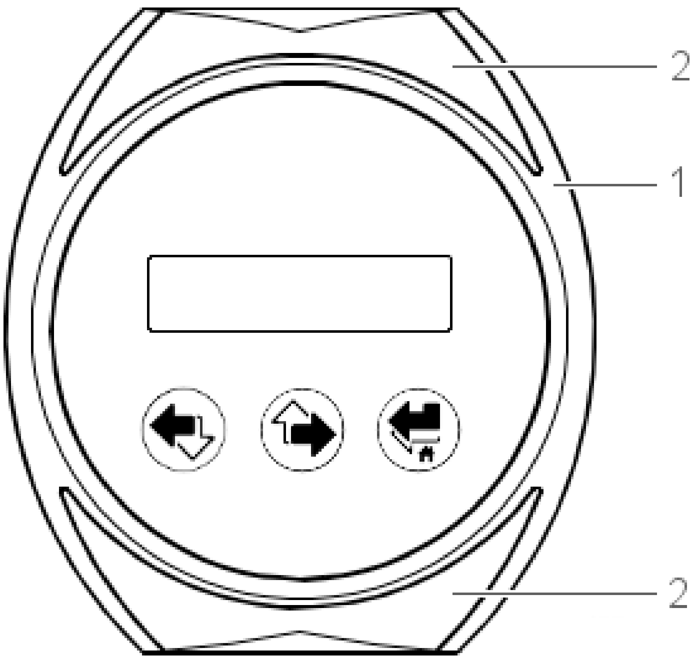


Figure 2 *Front Panel*

2. Select a suitable cable with the correct number of cores for your model that conforms to site standards. The cable gland fitted as standard is M20 x 1.5, which will accept cables with diametres from 7.0 mm to 12.5 mm.

3. Ensure your cable is prepared and ready for connection: shielding should be exposed and wire ends trimmed.

4. Carefully feed the cable through the cable gland at the bottom of the sensor head: pull through enough length to allow easy fitting of the terminal block connector.

CAUTION: Make sure the shielding is intact and correctly positioned to ensure the device is grounded properly as shown below.

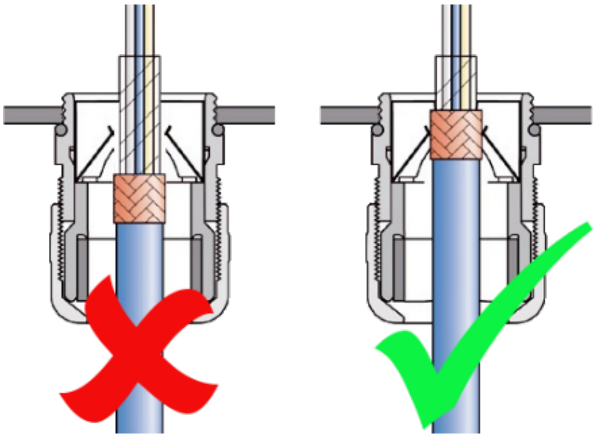


Figure 3 *Cable Shielding*

5. Using a 20mm spanner, tighten the cable gland to secure the cable in place.

NOTE:
Be careful not to over-tension the wires or over-tighten the gland.

6. Reconnect the ribbon cable to the front panel (1).
7. Re-fit the front panel (1) to the housing and secure in place using the four screws.
8. Fit the two screw covers (2).

CAUTION: Do NOT force the module otherwise you may damage the terminals or other components within the housing.

9. Connect the wires as follows (refer to Figure 4 below):

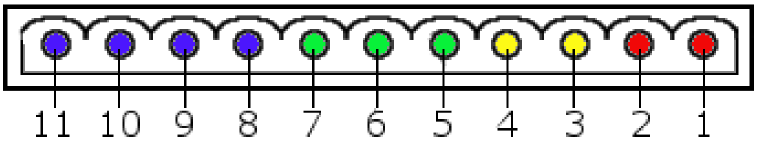


Figure 4 *Connector Pins*

Power Supply

PIN 1: 24V DC

PIN 2: OV

RS485 Output

PIN 3: A

PIN 4: B

Analog Output

The mA outputs are powered with 24V excitation voltage and the maximum loop load resistance for mA output 550 Ω

PIN 5: Analog GND

PIN 6: Analog Out1

PIN 7: Analog Out2 (If fitted)

Relay (alarm) Contacts

PIN 8: Relay 1 N/O

PIN 9: Relay 1 Common

PIN 10: Relay 2 (Fault alarm) N/O

PIN 11: Relay 2 (Fault alarm) Common

NOTE:
Relays are supplied normally open (N/O) as standard but can be ordered as normally closed (N/C) if preferred.

10. Carefully pull the cable back though the gland until the connector and board are aligned.

11. Fit the connector to the board.

2.3 Mounting Instructions

The probe should be mounted such that the alignment arrow on the flange is in the same direction as the sample gas flow. Refer to Figure 5 showing alignment arrow.

Avoid positions where:

- Obstructions or bends create turbulence in the gas flow and/or hinder probe insertion and removal.
- Excessive vibration induced by other equipment could result in damage or mechanical failure of the product.
- Excessive contamination or dust flows are likely. A particulate shield to prevent contamination build-up in the gas sampling tubes may be required.

Select a position that is accessible for maintenance purposes and make allowances for access to the wiring and piping inlets, which are at the base of the sensor head.

The device must be securely fitted to a suitable surface using the 2" 150lb ANSI mounting flange incorporated into the probe.

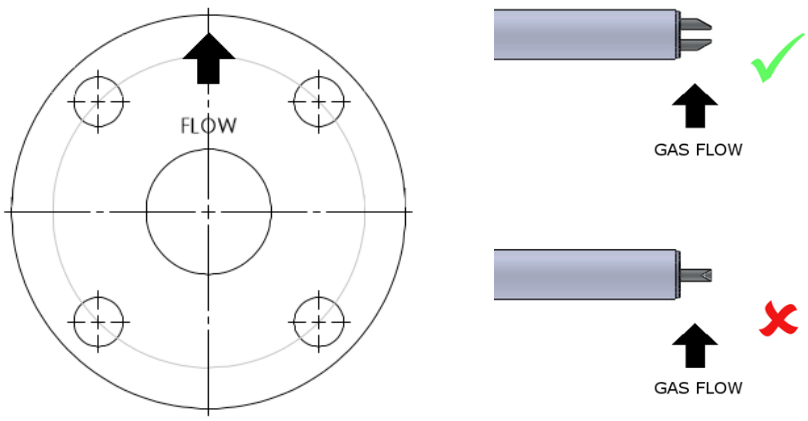


Figure 5 *Gas Flow Alignment*

The device should be installed in a suitable location, taking into account factors including those detailed in Section 2.1 General Guidelines.

The probe must be installed in a horizontal or slightly downward angled position.

Do:

- Ensure the sensor head is oriented so that the cable gland is facing downwards.
- Ensure the sensor head is shielded from radiated heat in excess of 55°C

Do Not:

- Mount with the probe vertically or with the tip higher than the sensor head (i.e. angled upwards) as this can lead to condensate entering the probe.
- Allow the gas flow straight into the gas sampling tubes: refer to figure 7.

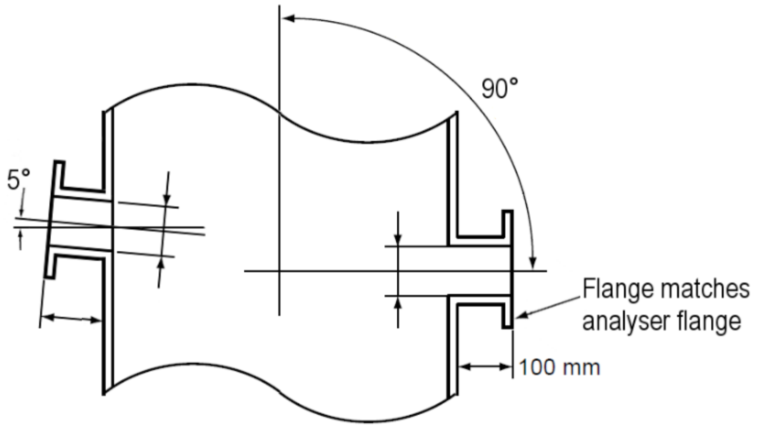


Figure 6 *Mounting Adaptor Details*

NOTE:
The probe should be mounted horizontally, or ideally at an angle of approximately 5° to the flue wall as shown in figure 6.

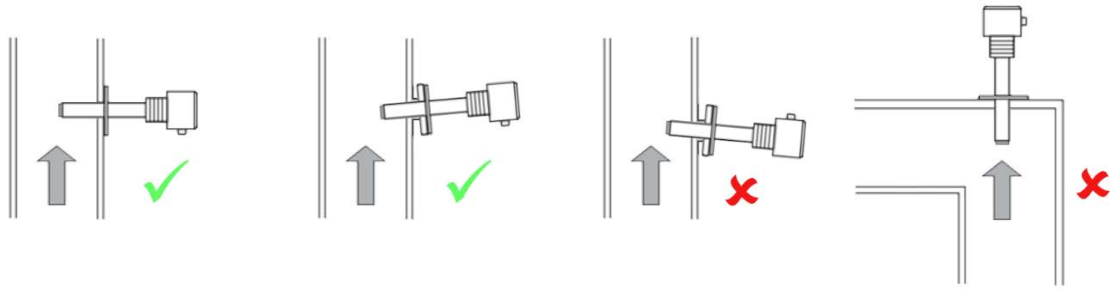


Figure 7 *Mounting Examples*

CAUTION: The gas temperature must not exceed 700°C for prolonged periods. Short term excursions (less than 30 min) to 750°C will not damage the probe.

2.4 Probe Installation

CAUTION: Do not mount the probe at an angle that would allow liquid to run down towards the sensor head, as this may cause blockage or damage.

I

NOTE:
A suitable 2" ANSI flange mounting adaptor is required. If the application temperatures will exceed 200°C, use an anti-seize compound on any mounting threads to ease future removal of the probe.

1. Cut a 50mm (2" nom. pipe) diameter hole in the flue wall (or other mounting position).
2. Either:
   - Weld the mounting adaptor into place, concentric with the hole in the flue.
   - Drill and bolt the mounting adaptor to the flue.
3. Before bolting in place, fit a suitable gasket between the adaptor and the flue wall. A gasket is supplied with each analyzer. (Order code: **XZR250A1-GASKET01)**
4. Carefully insert the probe into the hole in the flue (or other mounting position).
5. Ensure the probe is in the correct orientation using the flow direction indicator on the probe's flange.
6. Secure the probe into place using suitable bolts and washers.

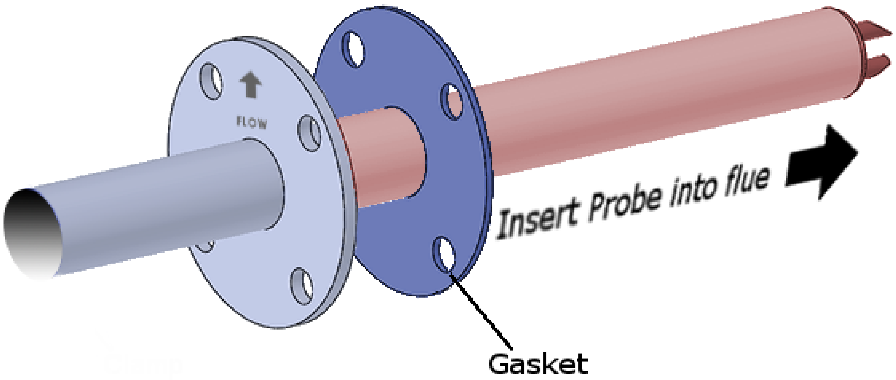


Figure 8 *Probe Installation*

CAUTION: Always install a suitable gasket between the mating flanges to prevent gas leakage. The wrong type of gasket may lead to accidental poisoning of the zirconia sensor: refer to 5.1.3

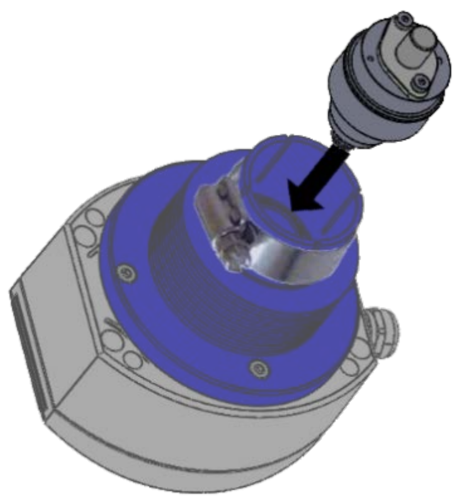


Figure 9 *Insert Sensing Module*

1. Ensure housing is wired correctly; refer to section 2.2 Electrical Connections.
2. Hold the sensor head with the display facing downwards.
3. Fit sensing module to the sensor head and gently push to secure the module in place; refer to Figure 9. The connector is keyed to aid alignment.
4. Keep the sensor head oriented with the sensor upwards until just before fitting the probe to avoid dropping the sensor during installation.
5. With the clamp fitted over the sensor head shoulder carefully slide the head onto the probe; refer to Figure 10. Ensuring the probe is inserted fully.
6. Ensuring the display is correctly oriented, tighten the clamp: torque to 5Nm.

CAUTION: Take care not to bump or shock the probe and ensure the gasket is not damaged when inserting the probe.

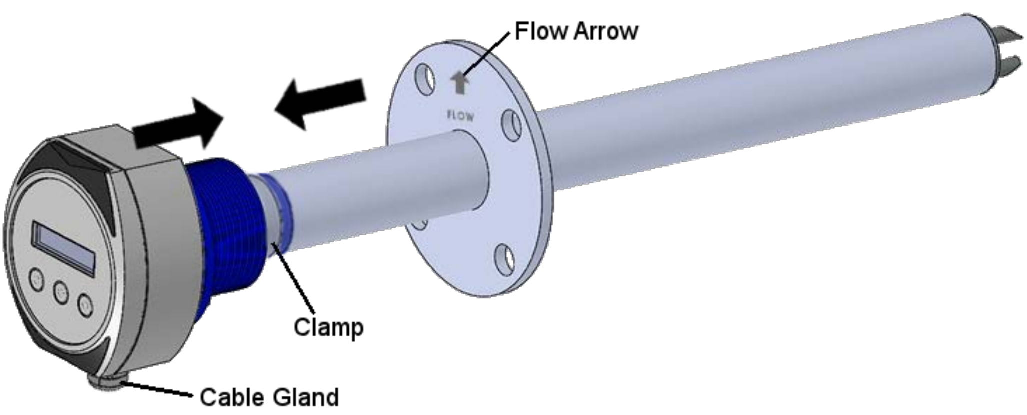


Figure 10 *Fit sensor Sensor head to Probe Body*

3 INITIAL STARTUP

3.1 Commissioning Checks

Before commissioning the equipment please read safety instructions.

Complete the following essential tasks BEFORE switching the system ON for the first time:

- Ensure the analyzer is installed in the correct orientation.
- Verify the device is mounted securely and sealed correctly.
- Verify the device, wiring connector and calibration gas inlet port are all undamaged.
- Ensure the cables are strain-free and not twisted.
- Ensure the device is connected properly, with all its inputs and outputs complete. All screw terminals are properly tightened.

CAUTION: Test the power supply to ensure it is 24VDC ±10% via a limited power supply before wiring to the probe. Failure to do so may result in damage to the product and invalidate your warranty

3.2 Switching ON

When the device is powered up, the screen below is displayed on the LCD until the internal zirconia sensing element reaches operating temperature. This should take approximately 90 seconds:

3.3 First-time Calibration (field adjustment)

Calibration is required when the device is powered ON for the first time or when the sensing module is replaced. Refer to 6.2 Calibrating.

4 SYSTEM ELEMENTS

The XZR250 combustion control analyzer consists of three main elements:

- A probe to extract the sample.
- A sensor block to measure the gas (contains O_2, pressure & temperature sensors)
- A sensor head to house the sensor, provides electrical outputs and an HMI for local configuration.

4.1 Human Machine Interface (HMI)

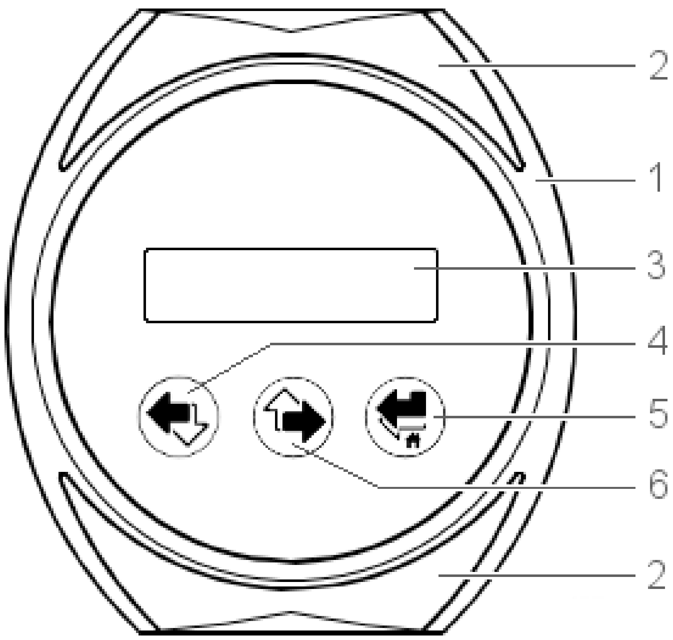


Figure 11 *HMI*

Number	Description
1	Front panel
2	Screw cover
3	Backlit LCD screen
4	Left / Down button
5	Enter / Back / Home button
6	Right / Up button

Table 1 HMI

The buttons are multifunctional:

	Primary	Secondary	Tertiary
	Scroll left	Scroll down	n/a
	Scroll right	Scroll up	n/a
	Enter	Back one level. Press and hold until screen flashes twice	Return to the home screen. Press and hold until screen flashes three times

Table 2 Operator Panel Multifunctional Buttons

NOTE:
Screen flashes once on every button press unless otherwise specified.

Throughout this guide the following conventions apply:

- Left / Down button press is shown as <LEFT> or <DOWN>
- Right / Up button press is shown as <RIGHT> or <UP>
- Enter / Back / Home button press is shown as <ENTER>, <BACK> or <HOME>

The following on-screen conventions are used:

*	Menu option can be edited.
>	Additional options available within the menu structure; press the right arrow button to scroll through the menu options.
<	Last entry of the menu structure has been reached; press the left arrow button to scroll back through the menu options.
<>	Cursor position, i.e. digit is highlighted.
<<>>	Digit is in edit mode.

NOTE:
The numeric value given before the ">" denotes the menu number for that option

4.2 On-Screen Settings

The following parameters are displayed on-screen:

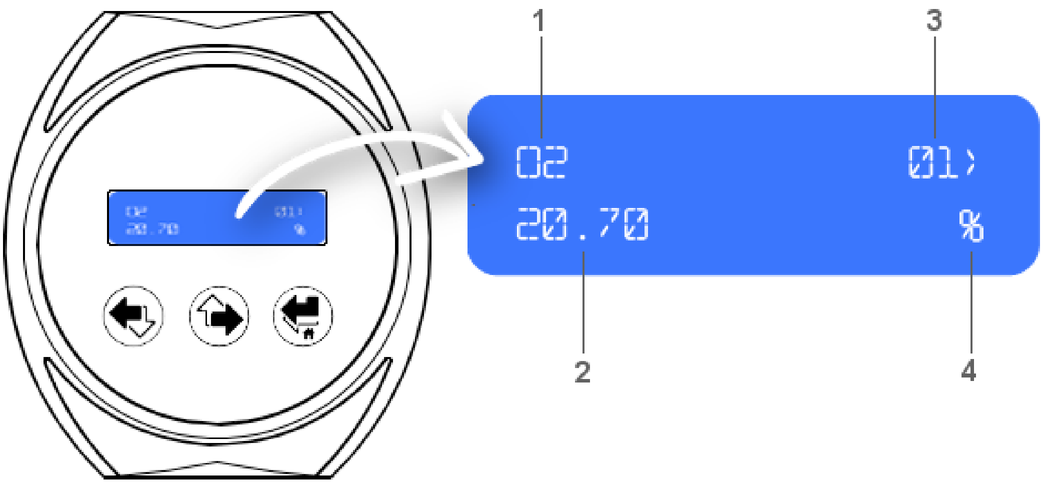


Figure 12 *LCD Layout*

1. Top left: Measured parameter
2. Lower left: Measurement value
3. Top right: Position within the menu structure
4. Lower right: Unit of measure

NOTE:
From the main screen it is possible to scroll up to view pressure and temperature.

4.3 Menu Structure

HOME SCREEN	DESCRIPTION
O_2 01>	Displays the O_2 concentration level (%)
Pressure <02>	Displays the pressure (mbar) at the sensing element
Temperature <03	Displays the gas temperature (°C) at the sensing element
Enter password to access below (default password is 0000)	

LEVEL 1	LEVEL 2	LEVEL 3	DESCRIPTION
CALIBRATE 01>			Calibration menu
	O_2		O_2 concentration (%)
		GAIN *	Set O_2 concentration level (%)
CONFIGURE <02>			Configuration menu
	Relay 01>		Relay1 parameters
		LOWER *	Set lower limit
		UPPER *	Set upper limit
		HYSTERESIS *	Set hysteresis
	Current <02		Current parameters
			Set lower limit
			Set upper limit
INTERFACE <03>	UNAVAILABLE		Interface menu
TEST <04>			Test menu
	Relay 01>		Relay test parameters
		START *	Set start value
		STOP *	Set stop value
	Current <02		Current test parameters
		START *	Set start value
		STOP *	Set stop value
SYSTEM <05			System menu
	SERIAL NUM 01>		Serial number
	PART NUM <02>		Part number
	DATE CODE <03>		Date code
	REVISION <04>		Software revision
	PASSWORD <05>	0000 *	Change password
	HOME SETUP <06		Display layout
		Single *	Set to single line display
		Multiple *	Set to multiple line display

* - Denotes the value can be edited.

Table 3 Menu Structure

NOTE:
To access the menu items press the enter button and enter password.

4.4 Configurable Options

The menu screens are primarily for information although there are user configurable options that may be changed. These are as follows:

- Password
- Calibration gas concentration
- Analog output ranges
- Alarm relay 1
- Single or dual line display

4.5 Security Password

The analyzer is supplied with the password factory set to "0000".

If you wish to change the password follow the instructions below.

1. Press <ENTER>: the ENTER PASSWORD screen is displayed.

2. To input the current security password simply use the right arrow until <*> is selected:

   a. Press <ENTER> to access edit mode (double arrows "<< >>" displayed around first digit as shown below).

3. Press <ENTER> to access the menu screens (this brings you to menu item 01> CALIBRATE).

4. Now use the up arrow to ge to menu item <05 SYSTEM press <ENTER> this brings you to the next level down and will display SERIAL NUM 01>.

5. Scroll up to PASSWORD <05> and press <ENTER>.

6. Enter the new password by highlighting the characters using the enter button and the up and down arrows to select the numbers. the number will have two brackets around it as shown below.

7. Deselect each number by pressing the enter button again and moving on to the next character by using the right arrow.

8. Repeat until password is entered.

NOTE:
The new password is now stored in memory and is retained on power loss.

9. Press and hold the <HOME> button to return to the HOME screen; display will flash three times.

4.6 Analog Output Ranges

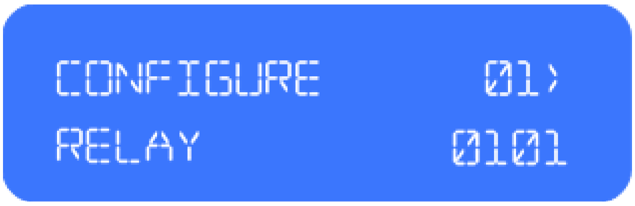
The device is factory set to output a range of 0 – 25% O_2 via its analog output. The output ranges can be fully customised; this is extremely useful in applications where the O_2 variation is within a narrow band as it allows the analog outputs to be tailored to this limited range.

For example the user could change the range to between 2 – 8% O_2 to obtain greater resolution on the mA output in the combustion region. The lower and upper ranges lock the output at the set limits, therefore at 2% O_2 or below the analyzer would output 4mA and 8% O_2 or above it would output 20mA.

1. Press <ENTER>: the ENTER PASSWORD screen is displayed.

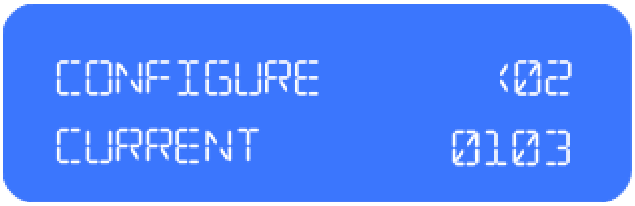
2. Input your current security password.
3. The CALIBRATE menu is the first menu option displayed.

4. Press <ENTER> to access the CONFIGURE menu. From here you can access the Relay and Current configuration options.
5. Set the Relay limitations:



   a. Press <ENTER> to access edit mode.
   b. Input the Lower range value; the number must be less than the intended upper range value. Press <ENTER> to save.
   c. Input the Upper range value; the number must be greater than the saved lower value. Press <ENTER> to save.
   d. Input the Hysteresis value. Press <ENTER> to save.

6. Set the Current limitations:



a. Press <ENTER> to access edit mode.

b. Input the Lower range value: the number must be less than the intended upper range value. Press <ENTER> to save.

c. Input the Upper range value: the number must be greater than the saved lower value. Press <ENTER> to save.

7. Press <ENTER> again to apply the new values.

NOTE:
The new range values are now stored in memory and are retained on power loss.

8. Press and hold the <HOME> button to return to the HOME screen; display will flash three times.

4.6.1 Display Output

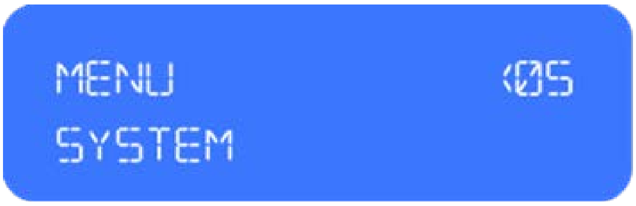
The analyzer is factory set to display O_2 percentage on the main page and can also display pressure on screen 2 and temperature on screen 3 by pressing the up arrow. Alternatively the display can be set up to display oxygen and pressure on the main page and pressure and temperature on the second page. To make the change, follow the instructions below.

1. Press <ENTER>: the ENTER PASSWORD screen is displayed.

2. Input your current security password.

3. The CALIBRATE menu is the first menu option displayed.

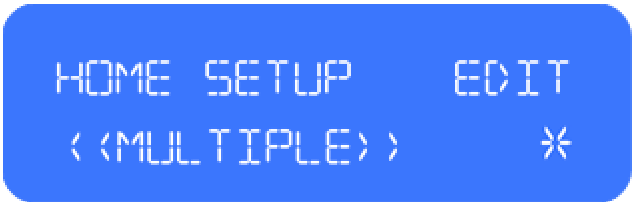
4. Press the <RIGHT> button five times until the SYSTEM screen is displayed.



5. Press <ENTER> to access the SYSTEM menu.
6. Press <RIGHT> 6 times until the HOME SETUP screen is displayed.

7. Press <ENTER> to access edit mode.
8. Press <ENTER> to edit the default value.

9. Press <RIGHT> to change the output value from Single to Multiple.



10. Press <ENTER> to save.
11. Press <RIGHT> to tab along to the asterisk (*).
12. Press <ENTER> to apply the new value.

NOTE:
The new display output is now stored in memory and is retained on power loss.

13. Press and hold the <HOME> button to return to the HOME screen; display will flash three times.

5 OPERATIONAL CONSIDERATIONS

5.1 Environments

The application in which the zirconium oxide oxygen sensor is operating influences the life of the sensor. To ensure the sensor does not fail prematurely, the following should be noted:

5.1.1 Operating in Aggressive and Humid Environments

When operating the sensor in warm, humid environments it is important the sensor remains at a higher temperature than its surroundings, especially if there are corrosive components in the measurement gas. During operation this is not an issue as the heater operates at 700°C, however this means when the sensor or process 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.

Failure to adhere to these rules will result in condensation forming on the sensing element. When the sensor is re-powered the water will evaporate, leaving behind corrosive salts which very quickly destroy the sensing element.

5.1.2 Protecting from Excessive Moisture

In environments where excessive moisture is likely the sensor should be protected from water reaching the very hot sensor cap as this can cause massive temperature shocks to the cell and heater. For this reason, the probe must be installed in a horizontal or downward angled position to prevent moisture from filling the gas sampling tubes and coming into contact with the sensor. This is also true when the sensor head is removed for inspection or maintenance.

5.1.3 Using the Sensor with Silicones

Zirconium oxide oxygen sensors are damaged by the presence of silicone in the measurement gas. Vapors (organic silicone compounds) of RTV rubbers and sealants are the main culprits and are widely used in many applications. These materials are often made of cheaper silicones, that when heated still outgas silicone vapors into the surrounding atmosphere. When these vapors 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 RTV rubbers are used we advise using high quality, well cured materials. Guidance can be provided on request.

5.2 Cross Sensitivity

Gases or chemicals that have an influence on the life of the sensor or on the measuring results are listed in the following sub-sections.

5.2.1 Combustible Gases

Small amounts of combustible gases will be burned at the hot Pt-electrode surfaces or $Al2O_3$ 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. Gases investigated:

- 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

5.2.2 Heavy Metals

Vapors from metals like Zn (Zinc), Cd (Cadmium), Pb (Lead), Bi (Bismuth) will have an effect on the catalytic properties of the Pt– electrodes. Exposures to these metal vapors must be avoided.

5.2.3 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 environments, corrosion of sensor parts. Gases investigated:

- Halogens: F_2 (Fluorine): Cl_2 (Chlorine)
- HCl (Hydrogen Chloride), HF (Hydrogen Fluoride)
- SO_2 (Sulphur Dioxide)
- H_2S (Hydrogen Sulphide)
- Freon gases
- CS_2 (Carbon Disulfide)

5.2.4 Reducing Atmospheres

Long time exposure to reducing atmospheres may in time impair the catalytic effect of the Pt-electrodes and must 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.

5.2.5 Other

- Fine dust (carbon parts/soot) may cause clogging of the porous stainless steel (5µm) filter and could have an effect on the response speed of the sensor.
- Heavy shocks or vibrations may alter sensor properties resulting in the need for recalibration.

6 MAINTENANCE

WARNING: BEFORE performing any type of maintenance on the equipment read the safety instructions.
Ensure the device has cooled down completely before attempting to touch or service the equipment.

6.1 Cleaning

6.1.1 Outer Surfaces

Inspect the outer surfaces of the sensor head regularly, and clean with non-abrasive materials to prevent a buildup of contaminants. Isopropyl alcohol (IPA) and a lint-free cloth are recommended.

CAUTION: Never use any of the following for cleaning purposes:

- Chemical cleaning agents
- High-pressure water or steam

6.1.2 Inner (sampling) tubes

The gas sampling tubes allow the sample gas from the boiler to flow past the zirconia sensing element.

Inspect and clean (if required) the inner tubes regularly to prevent a buildup of contaminants or clogging. These can be cleaned with compressed air or a pipe brush.

CAUTION: NEVER use the calibration port as this will damage the sensing module.

1. Remove the sensor head; refer to Section 9 Replacing parts.
2. Using a suitable pipe brush, clear out any contaminants from the sampling tubes.

NOTE:
Alternatively, clear out the sampling tubes using a high-pressure air supply.

CAUTION: ALWAYS use silicone-free gas. Silicone vapors will damage the zirconia sensor; refer to section 5.1.3 Using the Sensor with Silicones.

3. Replace the sensor head: refer to Section 9 Replacing Parts.

6.2 Calibrating

Due to the zirconia technology used in this device, no "zero" calibration is required and only a "span" calibration needs to be performed.

Calibration is achieved by initiating a calibration routine via the digital display, and monitoring the status of the output. The fixed reference is factory set to 20.7% O_2 for calibration with air however this value may be altered via the digital display for calibration with a reference gas of any known oxygen concentration 1-21%. Any new calibration value will be stored on power loss.

For optimum performance it is recommended that the sensor is calibrated close to the oxygen concentration expected during normal operation.

A software delay prevents calibration from being completed before the zirconia sensor has been powered ON for 5 minutes. If a calibration is initialised during this delay the unit will calibrate after the 5 minutes have elapsed.

NOTE:
The sensor has a finite life span ranging from 1-7 years depended on the fuel type used in the boiler. Michell Instruments operates a service exchange program, for more details please contact your local Michell office or representative.

NOTE:
If you notice during routine calibration that you require a higher pressure then previously to achieve a specified flow rate, the sampling tubes may have become clogged and should be cleaned thoroughly. Refer to section 6.1.2.

6.2.1 Calibration gas requirements

Clean dry gas (dew point <-20°C) with an oxygen content between 2% and 21% at a nominal flow rate of 150ml/min.

1. Remove the plug from the gas inlet port on the sensor head and connect the calibration gas supply with 4mm tubing via a push fit connection.

WARNING: Do NOT leave the port open for extended periods during operation as ambient air could be drawn into the analyzer and raise the oxygen readings.

2. Turn the calibration gas ON and set the flow to approximately 150ml/min.
3. Press <ENTER>: the ENTER PASSWORD screen is displayed.

4. Input your current security password: refer to section 4.5 Security Password.

5. Press <ENTER> to access the CALIBRATE menu.
6. Press <ENTER> to access the O_2 level setting.
7. Press <ENTER> to access the Gain menu.

8. The factory default is set to 20.70% O_2; if calibrating with air then press <RIGHT> to select the asterisk (*).
9. Press <ENTER> to set.
10. Allow the reading to stabilise before continuing.

11. Press <ENTER> again to apply. The device will run through the calibration routine and return the following status message when complete.

12. The output will now track to the correct value for the calibration gas.

13. The new calibration value is now stored in memory and is retained on power loss.

14. Press and hold the <HOME> button to return to the HOME screen; display will flash three times.

15. Turn the calibration gas supply OFF.

16. Remove the hose from the gas inlet port and replace the inlet plug securely.

7 RELAY AND CURRENT TESTING

During commissioning and annual maintenance it is advisable to check the relays and 4-20mA are working and correctly set. The following test procedures allow the user to perform these function tests.

7.1 Relay test

Its possible to test the relay outputs following the procedure below:

1. Press <ENTER>: the ENTER PASSWORD screen is displayed.

2. Input your current security password; refer to section 4.5 Security Password. The CALIBRATE menu is the first menu option displayed.
3. Press <RIGHT> four times until the TEST screen is displayed.

4. Press <ENTER> to access the TEST menu. From here you can access the Relay and Current test options.
5. Set the Relay test values to check the user configured relay (R1) is switching ON and OFF correctly:
   a. Press <ENTER> to access relay edit mode.
   b. Input the START value, then press <RIGHT> to tab along to the asterisk (*).

NOTE:
Input value 0.00 or 1.00 to switch the relay ON.

   c. Press <ENTER> to start the relay test process.

d. With the STOP screen displayed, press <RIGHT> to tab along to the asterisk (*):

e. Press <ENTER> to stop the test process and switch the relay OFF.

7.2 Current Test

Its possible to test the current outputs following the procedure below:

1. Press <ENTER>: the ENTER PASSWORD screen is displayed.

2. Input your current security password; refer to section 4.5 Security Password. The CALIBRATE menu is the first menu option displayed.
3. Press <RIGHT> four times until the TEST screen is displayed.

4. Press <ENTER> to access the TEST menu. From here you can access the Relay and Current test options.

5. Set the Current test values to check the current output is reading correctly:

   a. Press <RIGHT> until the TEST CURRENT screen is displayed.

   b. Press <ENTER> to access edit mode.

c. Input the START value (between 4 and 20mA), then press <RIGHT> to tab along to the asterisk (*).

d. Press <ENTER> to start testing.

e. With the STOP screen displayed, press <RIGHT> to tab along to the asterisk (*).

f. Press <ENTER> to stop testing.

6. Press <ENTER> again to exit edit mode.

7. Press and hold the <HOME> button to return to the HOME screen; display will flash three times.

NOTE:
The test values are stored in memory and are retained on power loss.

8 ERROR CONDITIONS

If an error is detected, an error code appears on the digital display.

If the zirconia sensor is incorrectly connected or is damaged, in addition to the error message, the analog output will default to 4mA.

If an error condition occurs the device should be powered down and all wiring checked before reapplying the power. If the error condition remains, the sensor is damaged and should be replaced. Refer to section 9.3 Replacing the Zirconia Sensor block.

CAUTION: If any of the following errors/warnings occur, contact the manufacturer.

8.1 O_2 Error and Warning Codes

Error Code	Description	Warning Code	Description
00001	Pump error	**00001**	Asymmetry warning
00002	Heater error	**00002**	O_2 less than 0.1% oxygen
00004	Over temperature	**16384**	Out of range, greater than 100%
32768	Internal network error	**32768**	Out of range, less than 0%

8.2 Pressure Error and Warning Codes

Error Code	Description	Warning Code	Description
00001	I2C communication failure	**16384**	Out of range, greater than 1260mbar
32768	Sensor element failure	**32768**	Out of range, less than 0mbar

8.3 Temperature Error and Warning Codes

Error Code	Description	Warning Code	Description
00001	SPI communication failure	**00001**	Out of range, greater than 1800°C
00002	SVG (temperature sensor)	**00002**	Out of range, less than -170°C
00004	SCG (temperature sensor)	**16384**	
00008	OG (temperature sensor)	**32768**	

NOTE:
Error combinations can occur, for example, Error 00003 = Pump and Heater errors.

9 REPLACING PARTS

WARNING: BEFORE performing any type of maintenance on the equipment read the safety instructions.

WARNING: Ensure the probe has cooled down completely before attempting to dismantle.

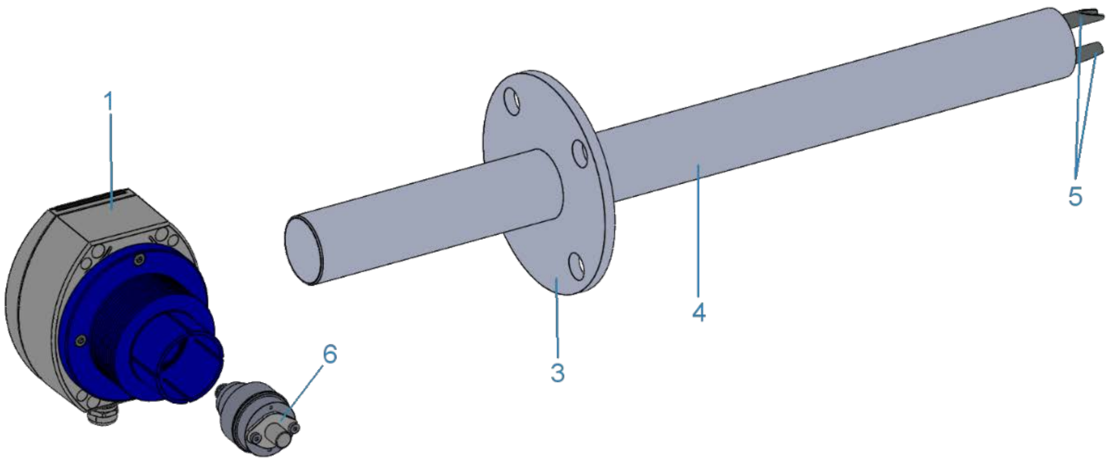


Figure 13 *Components*

Parts List

1. Sensor Head
2. Clamp
3. Mounting flange
4. Probe body
5. Gas sampling tubes
6. Zirconia sensing module

Tools (If necessary)

- Small, flat-blade (terminal) screwdriver
- Phillips screwdriver
- 10mm socket (or spanner)
- 20mm spanner

NOTE:
Before dismantling the device, thoroughly clean the outer surfaces to prevent contamination of the inner assemblies. Refer to section 6.1 Cleaning.

NOTE:
The probe body can remain in situ.

9.1 Removing the Sensor head from the Probe

Refer to Figure 13; component numbers given in parenthesis.

1. Shut-down and isolate the power supply and allow the probe to cool down.

WARNING: Ensure the probe has cooled down completely before trying to remove the sensor head. The zirconia sensing module (6) has a PTFE seal which may be damaged if you try to force the sensor head.

2. If required, remove the front panel and disconnect the wiring: refer to section 2.2 Electrical Connections. Tie back the cable securely and re-fit the front panel to prevent ingress of contaminants.
3. Loosen clamp (2) and carefully withdraw sensor head (1) from the probe body (4).

WARNING: The sensor head (1) is a tight fit to the probe body (4): adjust your stance to ensure you are safe and stable before trying to remove the housing.

NOTE:
Carefully rotate sensor head (1) to assist with removal.

CAUTION: Keep the housing level to avoid accidental damage of the sensing module (6).

9.2 Replacing the Sensor head onto the Probe

Refer to Figure 13; component numbers given in parenthesis.

1. Ensuring the clamp (2) is fitted over the sensor head (1) shoulder and with the flow arrow on the flange pointing upwards, carefully slide the probe body (4) into the sensor head (1).

CAUTION: Keep the housing level to avoid accidental damage of sensing module (6).

2. Ensure the probe body (4) is inserted fully (housing shoulder aligns with the indicator line on the probe).

CAUTION: The sensor head (1) is a tight fit to the probe body (4): do NOT use tooling of any kind to drive it home. NEVER strike the housing, this may cause irreparable damage.

3. With the cable gland at the base of the sensor head (1) facing downwards, tighten clamp (2) to secure the sensor head (1) in place. Torque to 5Nm.
4. If required, reconnect the wiring and re-fit the front panel: refer to section 2.2 Electrical Connections.

9.3 Replacing the Zirconia Sensor block

WARNING: BEFORE performing any type of maintenance on the equipment read the safety instructions.

Sensing module replacement may be necessary if the sensor is no longer responding correctly to the target gas or has reached its end of life.

NOTE:
Replacement sensing modules can be obtained by contacting the manufacturer. The old sensing module can be returned to the manufacturer for recycling.

Refer to Figure 13: component numbers given in parenthesis.

CAUTION: Take care when disassembling to avoid accidental damage to the electrical connector within the sensor head (1).

1. Remove the sensor head (1) as described in Section 9.1 and transfer to a clean bench.
2. Gently pull the sensing module (6) to ease it out from the sensor head (1).

CAUTION: Do NOT twist the module as this will damage the connector within the sensor head.

3. Either discard the zirconia sensing module (6) or return to Michell for a credit (subject to condition): refer to section 9.5 Disposal.

4. Thoroughly clean the surfaces of the housing body to prevent contamination entering the inner assemblies.

5. Align and install the new zirconia sensing module (6) to the sensor head (1). Gently push to secure the module in place: refer to Figure 14.

NOTE:
The connector is keyed to aid alignment.

CAUTION: Do NOT force the module otherwise you may damage the terminals or other components within the housing.

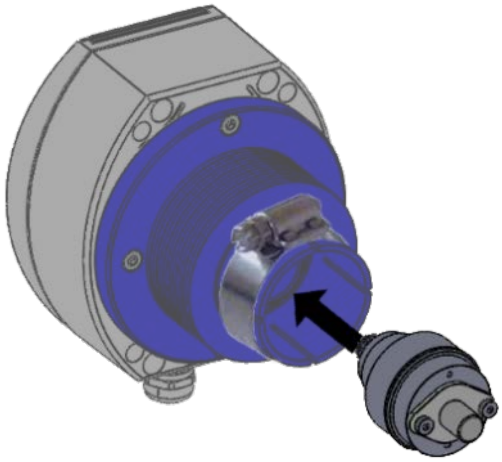


Figure 14 *Insert Sensor block*

6. Replace the sensor head as described in Section 9.2.

7. Reapply the power.

8. Calibrate the new sensing module: refer to section 6.2.

9.4 Removing / Replacing the Front Panel

Refer to Figure 2.

1. If fitted, carefully remove the two screw covers (2) from the front panel (1).

2. Remove the four screws securing the front panel (1) to the housing

3. Carefully ease the front panel (1) from the housing.

CAUTION: Do NOT pull forcefully.

4. Disconnect the ribbon cable from the old panel and connect to the new front panel.
5. Re-fit the front panel (1) to the housing and secure in place using the four screws.
6. Re-fit the two screw covers (2).

9.5 Disposal

The device contains both electrical and mechanical components. For this reason, the sensor head should be removed and disposed of as electrical waste.

NOTE:
The sensor block can be returned to the manufacturer for recycling.

Appendix A

Technical Specifications

Appendix A Technical Specifications

Performance	
Measurement technology	Zirconium Oxide
Gas	Oxygen
Measurement range	0.1-25%
Output resolution	0.01 V, 0.01 mA or 0.01% O_2
Accuracy (0.25-25%)	< 0.25% O_2
Response time (T90)	< 15 seconds
Repeatability	< 0.25%
Sample flow effect	±0.5% of full scale
Temperature measurement	PT100
Display	16 Character, 2 Line, with backlight
Electrical Input/Output	
Power supply	24 V DC, ±10% (limited power source)
Power consumption	700 mA maximum @ 24 V DC
Analog outputs	Single or Dual 4-20 mA (550 Ω maximum loop load resistence)
Output range (oxygen)	0-25% O_2
Output range (pressure)*	760 - 1260 mbara (10.9 to 18.1 psia)
Output range (temperature)*	-50 °C - +300 °C (-58 °F - +572 °F)
Relays	1 x System alarm (SPST, N/O as standard) 1 x User configurable process alarm (SPST, N/O as standard)
Digital communications	RS485 protocol
Cable Gland	M12 x 1.5
Cable size	7mm to 12.5 mm outer diameter 4 to 11 cores with overall screen
Operating Specifications	
Ambient temperature	-20 °Cto +55 °C (-4 °F to +131 °F)
Ambient relative humidity	0-95% RH
Background gas	Combustion gas from natural gas, biogas or oil
Sample gas temperature**	+700 °C (1292 °F)
Sample pressure	760 - 1260 mbara Absolute
Mechanical Specifications	
Warm-up time	< 90 seconds
Stabilization time	< 5 minutes
Dimensions	130 x 120 x 150 mm (h x w x d) excluding probe
Probe dimensions	Nominally 50 mm OD with 435 mm insertion length
Weight: head	1.6 kg (3.5 lbs)
Weight: probe	4.8 kg (Stainless steel: 435 mm) (10.5 lbs)
Wetted materials	Stainless steel, Macor®, aluminium, platinum & PTFE
Process connection	2” 150 lbs ANSI flange
Ingress protection	IP65
Housing material	Painted aluminium

*Measurement chamber temperature and pressure can be displayed on the main screen but can also be output via the MODBUS. The second mA output can be factory configured for pressure or as a second O_2 output.

**Temporary excursions up to 750°C for 30 minutes will not damage the probe.

Dimensions

Dimensions in mm unless otherwise stated; tolerance ±1mm.

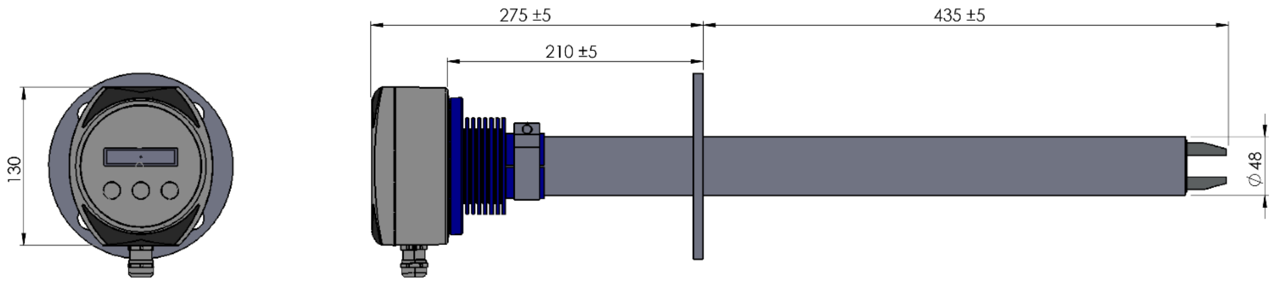


Figure 15 *External Dimensions*

Flange Dimensions

Dimensions in mm unless otherwise stated.

Flange profile to match ANSI Class 150 lb.

Nominal pipe size	2″
External diameter	6.000″ (152.40)
PCD	4.750″ (120.65)
Flange thickness	0.75″ (19.05)
No. of holes	4
Bolt hole diameter	0.750″ (19.05)

NOTE:
The flange is NOT pressure retaining.

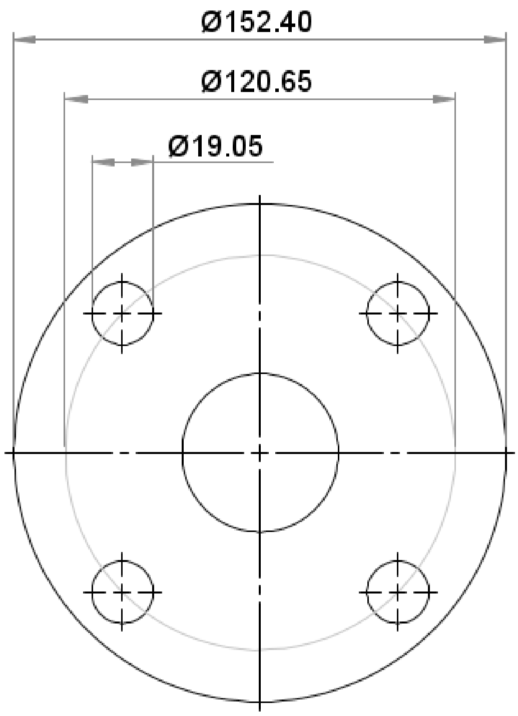


Figure 16 *2″ ANSI Class 150 lb. Flange*

Appendix B

Theory of Operation

Appendix B Theory of Operation

The sensor employs a well-proven, small Zirconium oxide-based element at its heart that does not require a reference gas. This removes limitations in the environments in which the sensor can be operated, making high temperatures, humidity and oxygen pressures all possible.

Background Physics:

The partial pressure is defined as the pressure of a single gas component in a mixture of gases. It corresponds to the total pressure which the single gas component would exert if it alone occupied the whole volume.

Dalton's Law:

The total pressure (*ptotal*) of a mixture of ideal gases is equal to the sum of the partial pressures (*pi*) of the individual gases in that mixture.

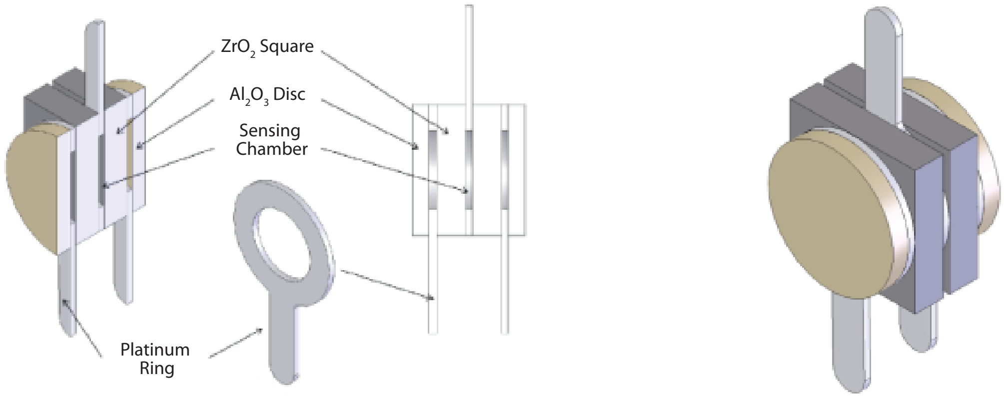
$$P_{total} = \sum_{i=1}^{k} P_i$$

From the equation above it can be derived that the ratio of the number of particles (*ni*) of an individual gas component to the total number of particles (*ntotal*) of the gas mixture equals the ratio of the partial pressure (*pi*) of the individual gas component to the total pressure (*ptotal*) of the gas mixture.

$$\frac{n_i}{n_{total}} = \frac{P_i}{P_{total}}$$

ni	Number of particles in gas i
ntotal	Total number of particles
pi	Partial pressure of gas i
ptotal	Total pressure

Sensor Function:



At the core of the XZR250 oxygen analyzer is a cell consisting of two Zirconium oxide (ZrO_2) squares coated with a thin porous layer of platinum which serve as electrodes. The platinum electrodes provide the catalyst necessary for the measured oxygen to dissociate, allowing the oxygen ions to be transported through the ZrO_2.

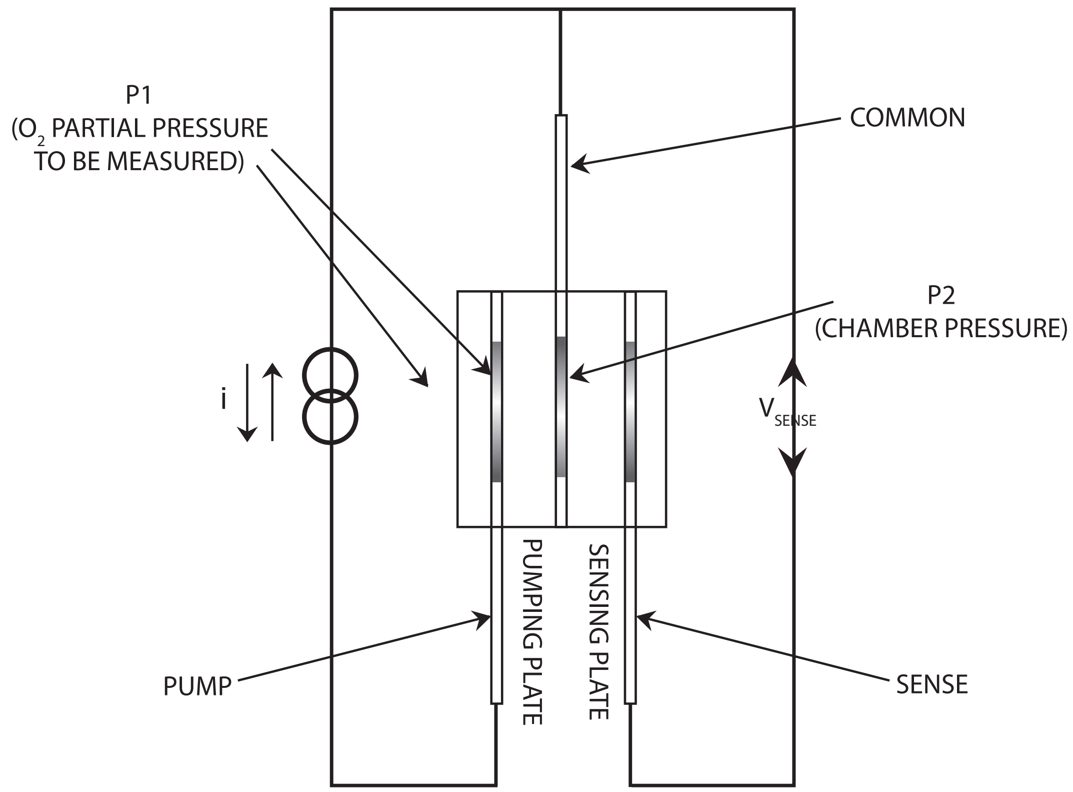
The two ZrO_2 squares are separated by a platinum ring which forms a hermetically sealed sensing chamber. At the outer surfaces there are two further platinum rings which, along with a center platinum ring, provide the electrical connections to the cell.

Two outer alumina (Al_2O_3) discs filter and prevent any particulate matter from entering the sensor and also remove any unburnt gases. This prevents contamination of the cell which may lead to unstable measurement readings. The above figure shows a cross-section of the sensing cell with all the major components highlighted.

A heater coil which produces the necessary 700°C (1292°F) required for operation, surrounds the sample cell. Both are housed within a porous stainless steel cap to filter larger particles and dust. The filter cap also protects the sensor from mechanical damage.

Pumping Plate:

The first ZrO_2 square works as an electrochemical oxygen pump, evacuating or re-pressurising the hermetically sealed chamber. Depending on the direction of the reversible DC constant current source the oxygen ions move through the plate from one electrode to the other. This in turn changes the oxygen concentration and therefore the pressure (P_2) inside the chamber. As we only evacuate then re-pressurize the chamber using the gas around the sensor, the pressure inside the chamber is always less than the ambient pressure outside the chamber. The electrical connections to the cell are shown in the figure below.



Sensing Plate:

A difference in oxygen pressure across the second ZrO_2 square generates a Nernst voltage which is logarithmically proportional to the ratio of the oxygen ion concentrations (see Nernst Voltage). As the pressure inside the chamber (P2) is always kept less than the pressure outside of the chamber (P1), the voltage at SENSE with respect to the common is always positive.

This voltage is sensed and compared with two reference voltages and every time either of these two references is reached, the direction of the constant current source is reversed. When the PPO_2 is high, it takes longer to reach the pump reversal voltages than it does in a low PPO_2 atmosphere. This is because a greater number of oxygen ions are required to be pumped in order to create the same ratio-metric pressure difference across the sensing disc.

Nernst Voltage:

Two different ion concentrations on either side of an electrolyte generate an electrical potential known as the Nernst Voltage. This voltage is proportional to the natural logarithm of the ratio of the two different ion concentrations.

$$\Delta V = -\frac{k_B T}{e_O} \cdot \ln\left(\frac{c_1}{c_2}\right)$$

kB	Boltzmann constant (kB = 1.3x10-23J/K)
T	Temperature in K
e_0	Elementary charge (e_0 = 1.602x10-19C)
ci	Ion concentration in mol/kg

Appendix C

Quality, Recycling & Warranty Information

Appendix C Quality, Recycling & Warranty Information

Michell Instruments is dedicated to complying to all relevant legislation and directives. Full information can be found on our website at:

www.michell.com/compliance

This page contains information on the following directives:

- ATEX Directive
- Calibration Facilities
- Conflict Minerals
- FCC Statement
- Manufacturing Quality
- Modern Slavery Statement
- Pressure Equipment Directive
- REACH
- RoHS2
- WEEE2
- Recycling Policy
- Warranty and Returns

This information is also available in PDF format.

Appendix D

Analyzer Return Document & Decontamination Declaration

Appendix D Analyzer Return Document & Decontamination Declaration

Decontamination Certificate

IMPORTANT NOTE: Please complete this form prior to this instrument, or any components, leaving your site and being returned to us, or, where applicable, prior to any work being carried out by a Michell engineer at your site.

Instrument			Serial Number	
Warranty Repair?	YES	NO	Original PO #	
Company Name			Contact Name	
Address				
Telephone #			E-mail address	
Reason for Return /Description of Fault:				

Has this equipment been exposed (internally or externally) to any of the following? Please circle (YES/NO) as applicable and provide details below		
Biohazards	YES	NO
Biological agents	YES	NO
Hazardous chemicals	YES	NO
Radioactive substances	YES	NO
Other hazards	YES	NO
Please provide details of any hazardous materials used with this equipment as indicated above (use continuation sheet if necessary)		
Your method of cleaning/decontamination		
Has the equipment been cleaned and decontaminated?	YES	NOT NECESSARY

Michell Instruments will not accept instruments that have been exposed to toxins, radio-activity or bio-hazardous materials. For most applications involving solvents, acidic, basic, flammable or toxic gases a simple purge with dry gas (dew point <-30°C) over 24 hours should be sufficient to decontaminate the unit prior to return.
Work will not be carried out on any unit that does not have a completed decontamination declaration.

Decontamination Declaration

I declare that the information above is true and complete to the best of my knowledge, and it is safe for Michell personnel to service or repair the returned instrument.

Name (Print)		Position	
Signature		Date	

MICHELL Instruments

F0121, Issue 2, December 2011

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