



XZR500ST Oxygen Analyzer User Manual



97137 Issue 8.2
June 2022

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

Use this information when contacting Michell Instruments for service purposes.

Product Name	
Order Code	
Serial Number	
Invoice Date	
Installation Location	
Tag Number	

Product Name	
Order Code	
Serial Number	
Invoice Date	
Installation Location	
Tag Number	

Product Name	
Order Code	
Serial Number	
Invoice Date	
Installation Location	
Tag Number	



XZR500

For Michell Instruments' contact information please go to
www.michell.com

© 2022 Michell Instruments

This document is the property of Michell Instruments Ltd and may not be copied or otherwise reproduced, communicated in any way to third parties, nor stored in any Data Processing System without the express written authorization of Michell Instruments Ltd.

Contents

Safetyvii
 Electrical Safetyvii
 Pressure Safetyvii
 Temperaturevii
 Toxic Materialsvii
 Repair and Maintenancevii
 Calibrationvii
 Safety Conformityvii
 Abbreviationsviii
 Warningsviii

1 INTRODUCTION1
 1.1 System Description 1
 1.1.1 Measurement Principle 1
 1.1.2 Zirconia 1
 1.1.3 The MSRS 2
 1.1.4 XZR500 MSRS Assembly 2
 1.2 General Remarks 3
 1.2.1 Sensor Head and Probe 3
 1.2.2 Control Unit 4
 1.3 Specifications 6
 1.3.1 General 6
 1.3.2 Optional Equipment 8
 1.3.3 Options 8

2 INSTALLATION9
 2.1 General Mounting Precautions 9
 2.2 Probe Mechanical Installation 10
 2.3 Control Unit Mechanical Installation 13
 2.4 Wiring 13
 2.4.1 Cable Specifications 13
 2.4.2 Connection of the Cable (supplied) to the Control Unit 13
 2.4.2.1 Connection to the Mains 14
 2.4.2.2 Connection of the 0/4...20 Output 14
 2.4.2.3 Connection of the Alarms 14
 2.4.3 Connection of the Cable to the Sensor Head 14

3 OPERATION16
 3.1 Outputs 16
 3.1.1 Analog Output 16
 3.1.2 Alarms 16
 3.2 Start-Up 17
 3.3 Display, Configuration and Adjustment 18
 3.3.1 Visualization Menu [*] 18
 3.3.2 Set-up [-] 21
 3.3.2.1 Access code 0.12 - quick settings 22
 3.3.2.2 Access code 0.20 - advanced settings 24
 3.3.3 Calibration [+] 29
 3.3.3.1 Recommended Calibration Gas 29
 3.3.3.2 Regulating the Calibration Flow Rate 29
 3.3.3.3 Calibration Procedure 30

4	MAINTENANCE	34
4.1	Preventative Maintenance - Cleaning.....	34
4.2	Replacement Of The XZR500 MSRS	35
4.3	Replacement of the Furnace.....	37
4.4	Replacement of the XZR500 Microcontroller Card	38
4.5	Replacement of Fuses.....	38
4.6	Error Messages	39
5	SPARE PARTS.....	41

Figures

Figure 1	Zirconia Principle.....	1
Figure 2	The MSRS and its K Thermocouple	2
Figure 3	XR500 MSRS.....	2
Figure 4	XZR500 Sensor Head & Probe	3
Figure 5	Digital Display Panel	4
Figure 6	Main Display	4
Figure 7	Control Unit	5
Figure 8	Probe Installation	10
Figure 9	Probe Head Orientation.....	10
Figure 10	Flange Gasket Orientation.....	11
Figure 11	Tubular Counter Flange Position	11
Figure 12	Inner Tube Orientation.....	12
Figure 13	Hex Screw Locations.....	14
Figure 14	Probe Wiring Diagram.....	15
Figure 15	Calibration Flow-Chart.....	33
Figure 16	XZR500 MSRS Mounting Diagram	35
Figure 17	XZR500 Top View	36
Figure 18	XZR500 Side View	36
Figure 19	XZR500 Sensor Head & Probe General Dimensions	50
Figure 20	Position of the Probe	52
Figure 21	Installation of the Ejector/Heating System.....	55
Figure 22	Enclosure for Controlling the Ejector Heating - General Wiring Diagram.....	56
Figure 23	System diagram	59
Figure 24	Timing diagram.....	59
Figure 25	Exploded analyzer view.....	62
Figure 26	XZR500 Flange and Back Flange (Optional)	64
Figure 27	Insulators (Flange and Rear Sealing Screw).....	64
Figure 28	Mounting Plate Dimensions	65
Figure 29	Wiring of the Second 4...20 mA Output.....	67

Tables

Table 1	Control Keys.....	5
Table 2	Maximum Temperature of Gases.....	7
Table 3	Cable Specifications.....	13
Table 4	Connection of the Control Unit.....	13
Table 5	Access codes 0.12 & 0.20.....	21
Table 6	Alarm Set-Point Examples.....	23
Table 7	Fuse Replacement.....	38

Appendices

Appendix A	Technical Specifications.....	43
Appendix B	Configuration for the RS232 Port (Optional).....	45
Appendix C	Calculation of CO ₂	48
Appendix D	XZR500 Sensor Head and Probe General Dimensions.....	50
Appendix E	Back Flushing System (optional).....	52
Appendix F	Heated Flue Gas Ejection System (Optional).....	55
Appendix G	Combined Air Ejector / Back-Flushing System.....	59
Appendix H	Mounting Options.....	64
	H.1 Tubular Counter Flange and Insulators.....	64
	H.2 Mounting Plate Dimensions.....	65
Appendix I	Second 4...20 mA Output.....	67
Appendix J	Automatic Calibration (Optional).....	69
	J.1 Adjusting the Sequence Parameters.....	71
Appendix K	Quality, Recycling & Warranty Information.....	73
Appendix L	Return Document & Decontamination Declaration.....	75

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 230 V AC or 115 V AC, 50/60 Hz. Refer to labels on instrument or calibration certificate.

Pressure Safety

DO NOT permit pressures greater than the safe working pressure to be applied to the instrument. The specified safe working pressure, for all versions of this instrument, is 10 bar.

Temperature

Some parts of the analyzer can be at a very high temperature. DO NOT open the enclosure of the probe during operation. Switch off the analyzer first and wait for at least 30 minutes.

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. Long exposure or breathing of the calibration gases may be dangerous.

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 analyzer is 6 to 12 months depending on the application in which the instrument is used.

Safety Conformity

This product carries the CE/UKCA mark and meets the requirements of relevant European safety directives.

Abbreviations

The following abbreviations are used in this manual:

AC	alternating current
A	Ampere
°C	degrees Celsius
°F	degrees Fahrenheit
Hz	hertz
kg	kilogram(s)
l/hour	liters per hour
mA	milli Ampere
mbars	millibars
mm	millimeter(s)
ppm	parts per million
T	Temperature
V	Volt
W	Watts

Warnings

The following general warnings listed below are applicable to this instrument. They are repeated in the text in the appropriate locations.



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.



Where this symbol appears in the following sections it is used to indicate areas of potential risk of electric shock.

1 INTRODUCTION

XZR500 Series Oxygen Analyzers are designed to measure the oxygen content in flue gases between 0.01 % and 25 % O₂. They allow for the improvement of a boiler’s performance, increasing equipment service life and surveying emissions, thereby contributing to protecting the environment.

XZR500 Oxygen Analyzers can be used for several applications such as monitoring combustion in power plants, incineration of industrial or domestic waste, incineration of VOC, control of processes, etc.

Please read this manual carefully before starting up the analyzer. It is recommended that you go through this manual again after the first use to enable optimal use of the XZR500.

1.1 System Description

1.1.1 Measurement Principle

Michell Instruments’ aim is to provide the best measurement solutions for any given industrial process or laboratory application. In the case of oxygen control and measurement we have developed a highly advanced and miniaturized oxygen sensor, the MSRS. This innovative sensor is at the heart of the XZR500 analyzer. A key strength of the MSRS is that it has a built-in metal reference, this means it can operate for very long periods without any requirement for re-calibration against a reference gas. As a result the XZR500 has very low lifetime costs compared to other oxygen analyzers.

In addition to providing reliable and hassle free operation, the MSRS also delivers excellent accuracy, class-leading linearity and, due to its small size, has a superior response speed.

The operating principle of the MSRS is explained in detail as follows:

1.1.2 Zirconia

Zirconia is a solid electrolyte. At high temperatures it conducts oxygen ions. An electrochemical voltage develops between the two platinum-plated surfaces of the zirconia in contact with two different gaseous oxygen partial pressure (Pp) atmospheres. This voltage follows the Nernst equation, expressed as:

$$E = \frac{RT}{4F} \ln \frac{Pp_{meas.}}{Pp_{ref.}}$$

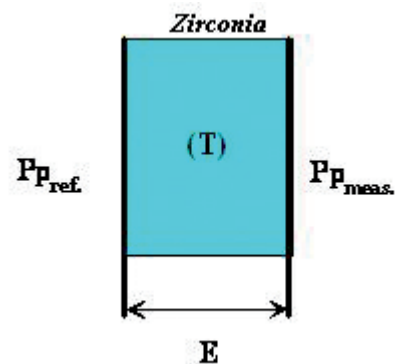


Figure 1 Zirconia Principle

where R and F are constants

E = Nernst voltage (V)

T = temperature (°K)

Pp = oxygen partial pressures

By setting the oxygen reference pressure and measuring voltage E and temperature T, you can deduce the oxygen partial pressure you want to measure.

The volumetric concentration (expressed here in O₂ %vol.) is determined by the ratio between the oxygen partial pressure (Pp_{meas}) and the atmospheric pressure (P_{tot}).

$$O_2 \text{ %vol.} = \frac{Pp_{meas.}}{P_{tot.}}$$

There is an optional ambient pressure sensor available for higher accuracy measurements.

1.1.3 The MSRS

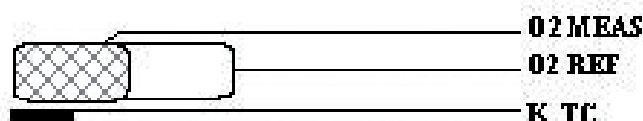


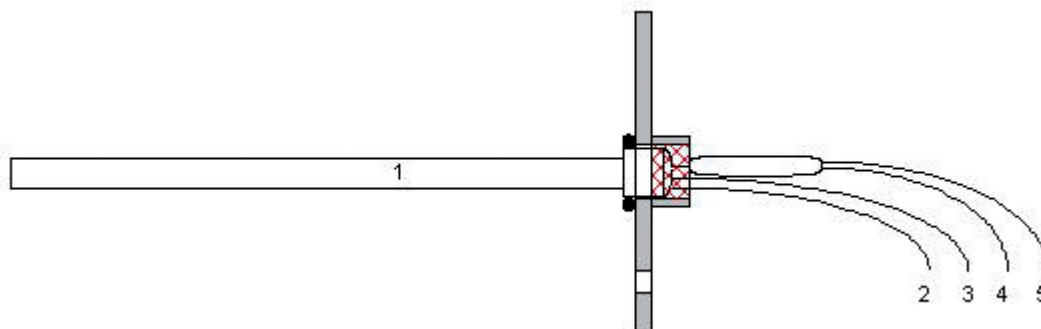
Figure 2 The MSRS and its K Thermocouple

Unlike conventional “air reference” zirconia sensors the MSRS uses the equilibrium status of an internal metal oxide to provide a reference. Therefore, this built-in metallic reference sensor does not require any reference gas.

The MSRS is a very small cylinder, 3 mm in diameter and 10 mm long. A K thermocouple, placed closed to the MSRS, measures its temperature with great precision. This design leads to extremely high accuracy and very good resistance to thermal shocks. It also increases the lifetime of the sensor.

1.1.4 XZR500 MSRS Assembly

The MSRS and its K thermocouple are placed inside an aluminum tube. The MSRS head is attached to an assembly plate to allow for easier field servicing, see Figure 3 below.



- 1. aluminum tube
- 2. O₂ reference wire with blue mark
- 3. O₂ reference wire with red mark
- 4. + thermocouple wire with green mark
- 5. - thermocouple wire with white mark

Figure 3 XR500 MSRS

1.2 General Remarks

The analyzer is made up of a measurement probe and a Control Unit.

1.2.1 Sensor Head and Probe

The semi in-situ arrangement consists of the following elements:

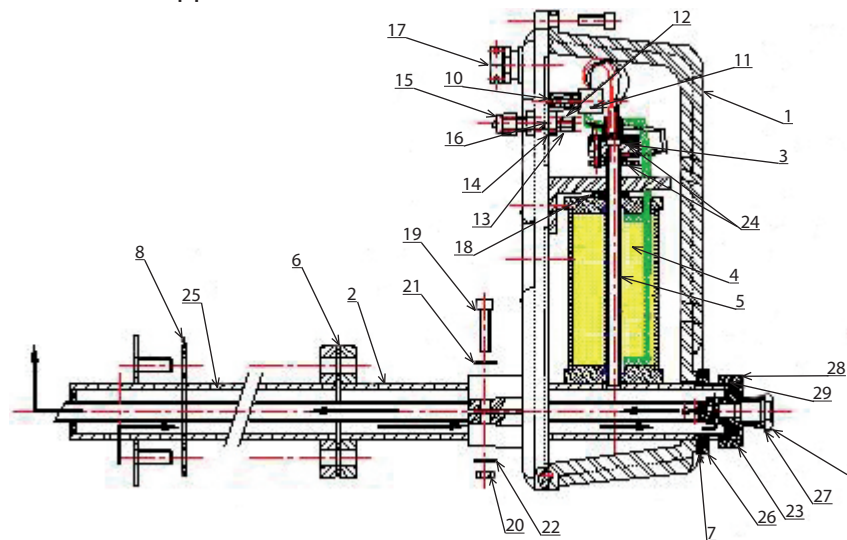
- Sensor head, containing MSRS, sensor furnace, cable connection & calibration port.
- Probe, comprising of an inner and outer tube to allow flow of sample from flue to sensor.

The sample gas is returned to the flue practically unchanged in composition and condition. This is due to the very small amount of sample required to diffuse into the sensor furnace.

The gas flow is shown by the arrows in *Figure 4* below. In this example, the stack is vertical and the flue gas flow direction is upwards.

Using the Pitot tube effect, gases enter through the hole near the tip of the outer tube and circulate in the space between the outer tube (25, 2) and the inner tube (23). During this process the gases contact the sensor through diffusion. They then flow into the inner tube and to the flue via the bevelled edge.

The tubes are fitted so that the bevelled edge of the inner tube and the holes of the outer tube face in opposite directions.



1	Sensor housing	11	XZR500 connector block	20	M6 Nut for fixing XZR500 probe plate
2	Outer tube	12	SS bulkhead union for cal.gas	21	M6 washer
3	Sealing head	13	2 sealing ferrules	22	M6 lock washer
4	XZR500 furnace	14	Nut for fixing bulkhead union	23	Inner tube
5	XZR500 MSRS	15	Stainless steel plug	24	VITON 8 x 2.5 O-ring
6	Gasket for flange (x2)	16	M8 lock washer	25	Outer tube
7	Gasket for wheel	17	Cable gland	26	Locking ring
8	Inter-tubes gasket	18	M8 spacer	27	Gasket for plug
9	Gasket for sealing screw	19	CHC 6x25 screw for fixing XZR500 sensor attachmt plate	28	Big rear nut
10	TRF 3x16 screw for connector			29	Inter-tube gasket

Figure 4 XZR500 Sensor Head & Probe

The XZR500 MSRS (5) assembly is placed perpendicular to the tubing system. The XZR500 furnace (4) and the XZR500 MSRS (5) are placed inside a cast aluminum enclosure which is made of two parts sealed with a 5 mm diameter viton O-ring. It is dust proof and waterproof and can be mounted outdoors. The cable gland (17) is made of brass.

The whole set is mounted on the stack with a steel flange which is welded on the XZR500 outer tube. Michell Instruments can provide an optional mounting kit containing a counter flange with threaded rods (if needed please refer to Appendix G).

All the gaskets (6, 7, 8 and 9) placed on the tubes are made of carbon fiber.

A high temperature "gasket box" type device guarantees that the sealing head is airtight.

For dimensions of the measuring probe see Appendix D.

1.2.2 Control Unit

The Control Unit provides the Human Machine Interface (HMI) for the XZR500 analyzer. It is housed in a metal case with a screen and three touch buttons to allow access to menus. Inside there is a motherboard, a micro-controller and a display PCB. The output signals and alarms are all accessed through the Control Unit.

Oxygen concentration is displayed on the screen as default and has one decimal point as standard (a second decimal place can be requested as an option). Other parameters available through the HMI are Furnace Temperature, Thermocouple Junction Temperature, MSRS Voltage and Ambient Pressure (in mbars), if the optional pressure sensor is ordered.

Configuration of alarms and output signals as well as calibration functions are all carried out through the HMI of the Control Unit.

The digital display panel of the analyzer is shown in *Figure 5*.

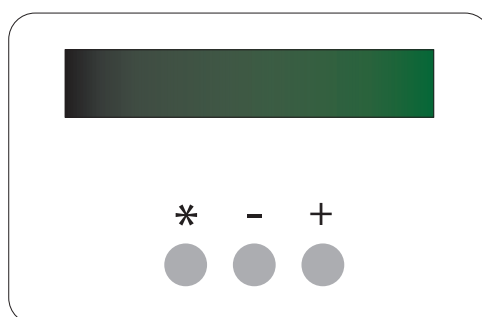


Figure 5 *Digital Display Panel*

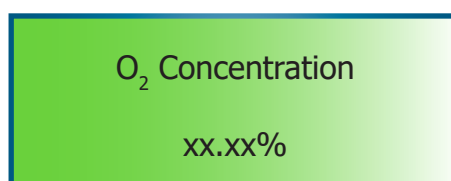


Figure 6 *Main Display*

The instrument display is divided into two lines. The upper line is the descriptive line and the bottom line displays the measured values or the function keys.

The function keys are located below the display and are used to select operations from the main menu level, to enter sub-menu levels and to select and enter parameter variables within those menu levels. The function key panels are shown in *Figure 5* and Table 1 describes the operation of the keys.

Key	Function
[*]	Enter or select key. Operation of this key from the front-page display causes the selection menu to be displayed
[+]	Value up key. Used to change the value. Access key to the Calibration menu
[-]	Value down key. Used to change the value. Access key to the Set-up menu

Table 1 Control Keys

The analog output signal can be set in 0...20 mA or 4...20 mA. The scale is configurable in the range of 0.01...25 % O₂.

The system provides three alarms on relay contact: a general failure alarm and two threshold alarms with user-configurable set-point (action high and low) and hysteresis.

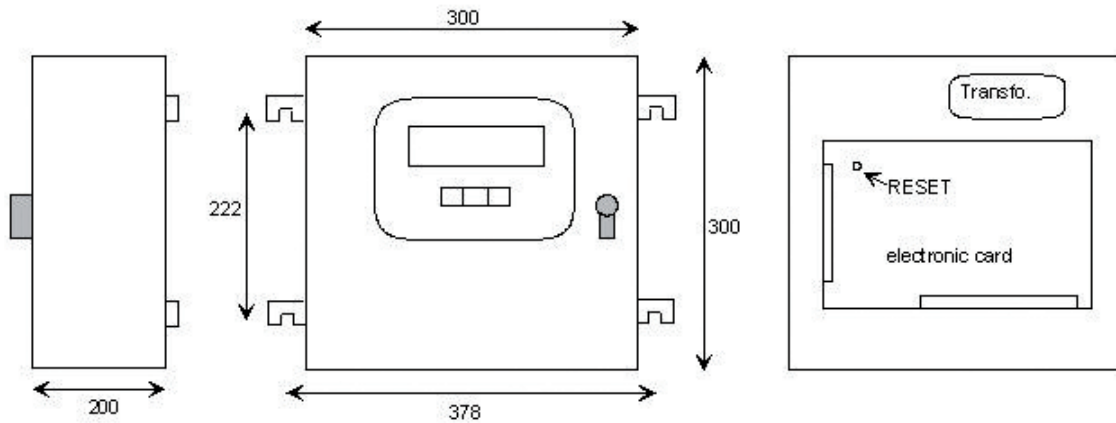


Figure 7 Control Unit

Cable

The cable connecting the control unit and the probe supplies the furnace with power and it relays the MSRS temperature and voltage measurements to the Control Unit.

The standard cable length is 6 meters long (optional, up to 100 meters).

1.3 Specifications

1.3.1 General

- **Microcontroller:** Motorola 68HC12
- **Inlet converter:** analog, 16 bits resolution, 0.0015 % linearity error, with filter and embedded calibrator
- **Outlet converter:** analog, 12 bits resolution, ± 1 bit linearity error
- **Display resolution:** 0.1 % O₂ (or 0.01 % on request and during calibration)
- **The 3-button keypad and digital interface allow:**

Reading

Continuous display of the oxygen concentration to one decimal place (option of second dp). Other parameters available through the HMI are Furnace Temperature, Thermocouple Junction Temperature, MSRS Voltage and Ambient Pressure (in mbars), if the optional pressure sensor is ordered.

Configuration

Configuring of the test gas value, activation direction of the alarms (high or low) and hysteresis level, the fail safe value (output value sent by the electronics in case of general failure), language (English, French or Italian), the output analog signal, the associated scale and the factory settings. (For other parameters see specific Appendix.)

- **Output signal:** 0...20 mA or 4...20 mA (user-selectable) galvanic isolation (500 V), linear and programmable, output range can be selected between 0.01 % and 25 % O₂
- **Output impedance:** > 1 k Ω
- **Alarms:** contacts are normally closed, dry and potential-free, the cutting power is max. 10 W (up to 100 V or up to 0.5 A):
 1. General failure alarm warning of furnace under temperature (20 °C below the instruction), thermocouple separation, problems with RAM backup after a re-set or adjustment error
 2. Threshold alarms, with programmable activation direction and hysteresis
- **Consumption:** 110 VA
- **Ingress and impact protection:**

Electronic enclosure: IP52 and IK05
Probe: IP53 and IK05
- **Storage temperature:** between -10 and +70 °C

- **Dimensions (mm):**

Control Unit: 300 x 300 x 200 (w x h x d)
 Sensor Head: 135 x 290 x 670 (w x h x d) (standard model)
 Probe: 400, 600 or 900 mm in length, with an outer diameter of 40 mm

- **Weight:**

Control Unit: Approximately 7 kg
 Sensor Head: Approximately 3 kg
 Probe: Approximately 2...6 kg (dependant upon length & material of construction)

- **Power requirements:** 230 or 115 V, -15 %/+10 %, 50/60 Hz

- **Operating ambient temperature and moisture:**

Temperature from 0 to 55 °C
 Relative moisture from 5 % to 90 % (non-condensing)

- **Maximum temperature of the sample gases** (Table 2):

Model	Tubing Materials	Gas Properties
XZR500 /SS	304 L stainless steel	Tmax = 700 °C
XZR500 /IL	Inconel 600	Tmax = 1000 °C
XZR500 /HR	HR160	Tmax = 1000 °C and corrosive gases
XZR500 /HC	Hastelloy C2000	Tmax = 600 °C and corrosive gases
XZR500 /CC	Ceramic	Tmax = 1300 °C
XZR500 /HL	Halar coating	Tmax = 150 °C

Table 2 Maximum Temperature of Gases

- **Minimum speed of the sample gases:** 0.5 m/s

1.3.2 Optional Equipment

- Tubular counter-flange for fixing the probe to the stack (see Appendix H)
- Flange insulation (to prevent condensation forming)
- Extra length of cable (up to 100 meters)
- Calibration and verification kit
- Back flushing system: for cleaning the probe tubes when flue gases are very dusty (see Appendix E)
- Flue gas ejector system with heating (see Appendix F)
- Rear insulation

1.3.3 Options

- Self-calibration
- 115 V / 60 Hz power supply
- RS232 interface (see Appendix B)
 1. Transmits all data straight from/to a computer terminal, i.e: O₂ concentration, furnace temperature, MSRS voltage, ambient temperature and pressure.
 2. Allows the setting of test gas value and starting the analyzer calibration sequence.
 3. Allows the changing of the alarm type, level and hysteresis, the fail safe value, setting of the furnace temperature, the upper scale adjustment, the signal output and scale, and starting the self cleaning.

2 INSTALLATION

2.1 General Mounting Precautions

- Place the probe as close as possible to the process (without breaching the flame front).
- Prevent ambient air from entering the stack upstream or at the probe tapping point and interfering with the measurement. Make sure all the gaskets are placed and tightened (*Figure 4*), and tighten-up the SS plug for calibration gas inlet (*Figure 4 (15)*).

NOTE: The stainless steel plug – or any 1/8" sealing ferrule – should be tightened up by hand and then tightened again using a 7/16" spanner, turning only 1/8th of a turn so as not to damage the connection.

- Avoid placing the probe near cleaning devices or elements that create vibrations and are liable to disturb the measurement.
- Voltage should be applied to the analyzer immediately after the instrument is fixed on the stack so that the furnace can start heating. This will avoid condensation at cold points where dirt could aggregate and clog up the probe tubes. For the same reason, we recommend leaving the analyzer powered up 24 hours a day, 365 days a year.
- The part of the tubing situated between the stack and the probe head should be very well insulated - or even heated. If necessary, Michell Instruments can manufacture a complete insulating cover for the outside part of the probe (optional).

NOTE:



**Ceramic probes require special handling.
Please read the following note carefully.**

Ceramic Probes:

Special care must be taken when handling ceramic probes due to their fragile nature. Inspect the probes thoroughly before inserting into stack. If they have been damaged in transit, contact your Michell office or distributor immediately and inform them of the situation. Take photographic evidence of the damage to the probe, and of the packaging, on the day of delivery.

On insertion ensure that the probe does not impact with the side of the orifice. Once installed, it is not recommended to remove the probe. If removal is unavoidable due to maintenance, then allow the probe several hours to fully cool to ambient temperature and extract slowly.

Consideration for placement of the probe is essential. Avoid the flame front, violently turbulent sections of the duct/flue, proximity to dampers, or where falling refractory could strike the probe. Excessive vibrations must be avoided as ceramic is a brittle material.

Incorrect handling or placement of the probe will invalidate the warranty.

2.2 Probe Mechanical Installation

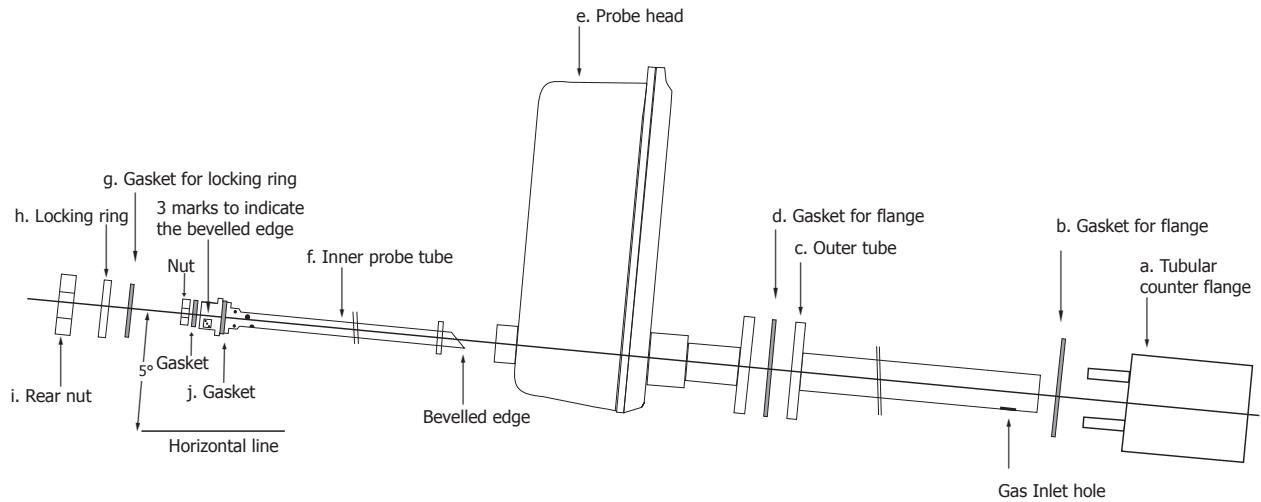


Figure 8 Probe Installation

The XZR500 is simple to set-up. Follow the instructions below:

1. Weld the tubular counter-flange (a) onto the stack. Follow the orientation shown below to ensure that the probe head is set in a vertical position. Slope the tubular counter-flange (a) slightly (maximum 5 degrees) so that condensed water can go back to the process. The probe is fitted with a PN6 DN15 type flange (4 x 11 mm diameter holes, placed on a 55 mm diameter circle). Pay special attention to the orientation and slope especially if the counter flange/nozzle with flange is provided by the customer.

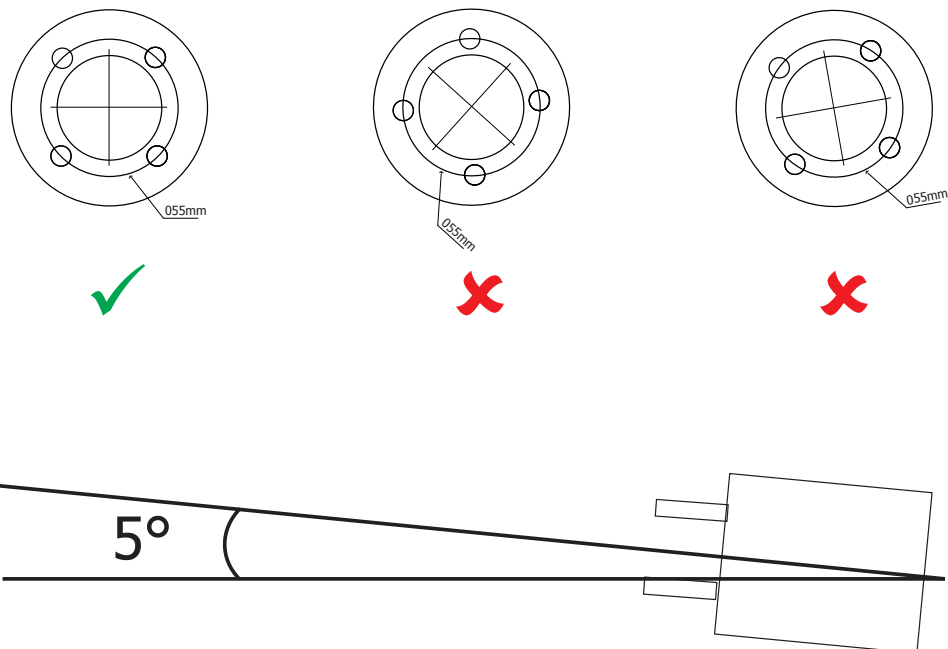


Figure 9 Probe Head Orientation

- Place the outer probe (c) with the flange gasket (b) according to the drawing in *Figure 8*. The gas inlet hole should face the process flow.

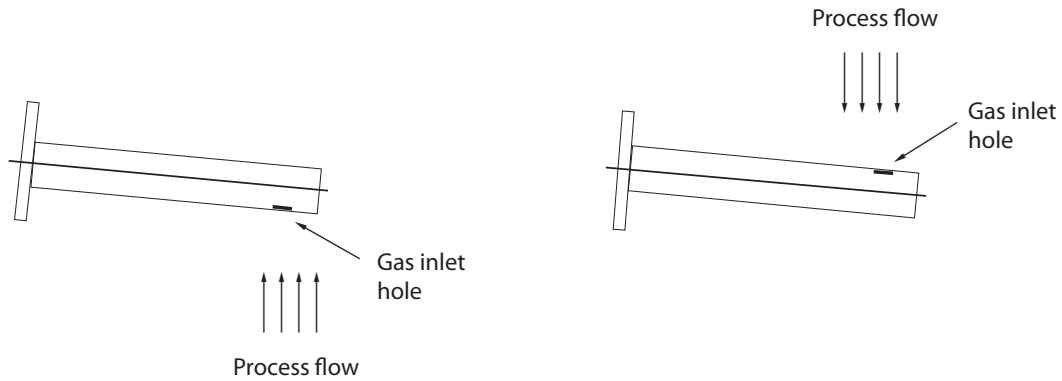


Figure 10 *Flange Gasket Orientation*

- Mount the probe head (e) with the flange gasket (d) on to the tubular counter-flange (a). Secure the tubular counter flange, flange for outer tube and flange of the probe head together by secure nuts onto four bolts on the counter flange.

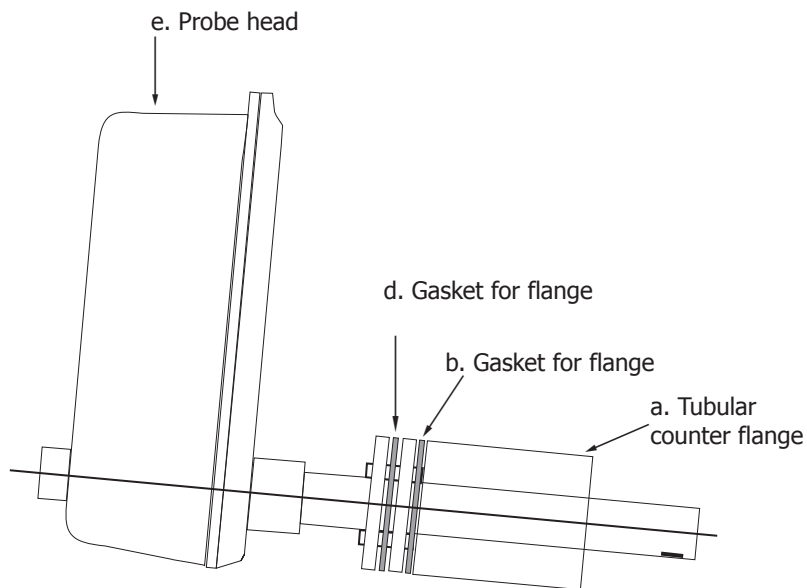


Figure 11 *Tubular Counter Flange Position*

4. Place the gasket onto the inner tube (f) and insert into the probe head (e) (see *Figure 8*). Make sure the bevelled edge of the inner tube tip faces the opposite direction to the gas inlet hole on the outer tube (c) as shown below. There are three marks on the other end of the inner tube to indicate the orientation of the bevelled edge (see *Figure 12*).

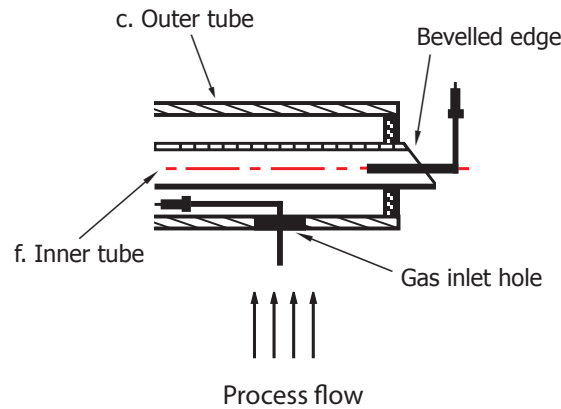


Figure 12 *Inner Tube Orientation*

5. Place the locking ring (h) with the locking ring gasket (g), the rear nut (i) and the inner tube gasket (j) accordingly on the rear of the probe head. (See *Figure 8*)
6. Put insulation between process and the probe head if necessary.



If the back flush option is chosen, then the orientation must be reversed. This is because the inner tube becomes the inlet so any dust build up will happen in the inner tube. When the back flush is operated, it clears the tube more efficiently.

2.3 Control Unit Mechanical Installation

The Control Unit is supplied with lugs for fitting on the wall (see Figure 7).

2.4 Wiring



Only authorized personnel should open the control unit. Take all precautionary measures to avoid accidents related to electrostatic shocks.

2.4.1 Cable Specifications

The standard analyzer is supplied with 6 meters of cable. Longer cable lengths are available up to 100 meters. The electrical connections are as follows:

brown		}	2 wires to supply the power to the furnace
brown			
green	(+)	}	2 wires for measuring the thermocouple voltage
white	(-)		
blue	(reference)	}	2 wires for measuring the MSRS voltage
red	(measurement)		

Table 3 Cable Specifications

The wires should be stripped to 8 mm at each end. There is a ground wire at one end of the supplied cable. This end should be connected to the Control Unit.

2.4.2 Connection of the Cable (supplied) to the Control Unit

Connect the supplied cable - using the end with 7 wires (including ground wire) - as follows:

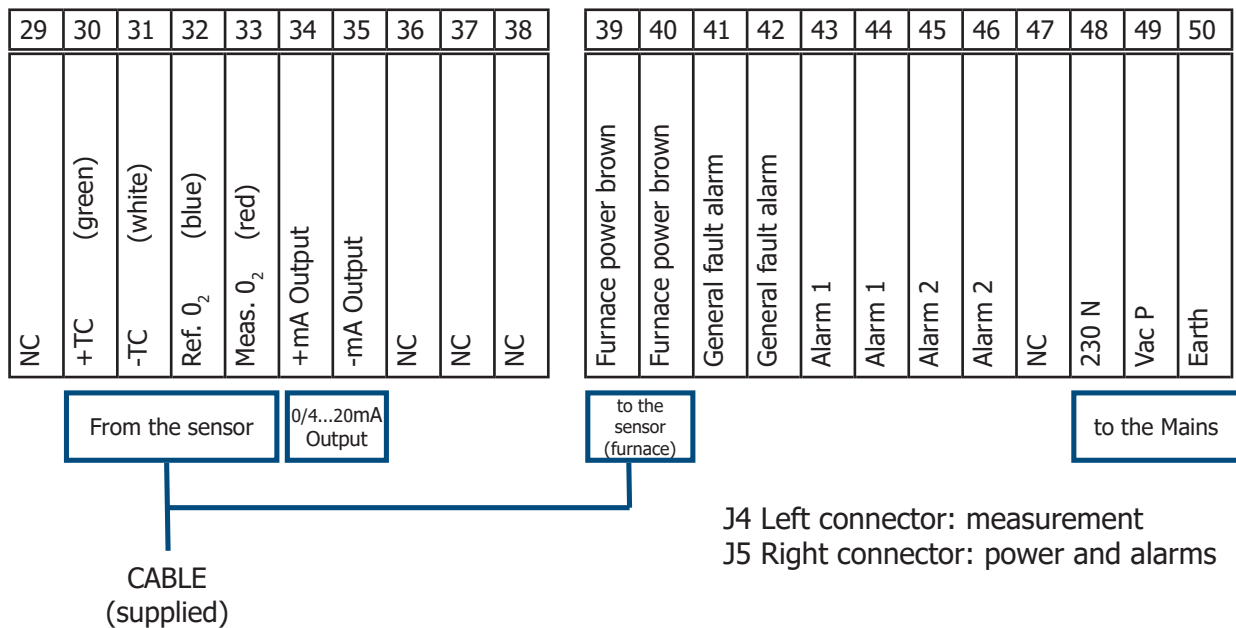


Table 4 Connection of the Control Unit

Both the ground wire of the supplied cable and the earth wire from the mains must be connected to the copper bar near the cable gland.

2.4.2.1 Connection to the Mains

Use shielded cable (2 x 1.5 mm² max.) that is terminated appropriately. Follow the Table 4 wiring diagram (pins 48, 49 and 50).

Connect both the screen and the earth wire to the copper bar near the cable gland.

2.4.2.2 Connection of the 0/4...20 Output

We suggest that shielded cable (2 x 0.75 mm²) is used and terminated appropriately. Follow the Table 4 wiring diagram (pins 34 and 35).

Connect the braid to the copper bar near the cable gland.

2.4.2.3 Connection of the Alarms

We suggest that shielded cable is used and terminated appropriately. Follow the Table 4 wiring diagram (pins 41...46).

Connect the screen and the earth wire to the copper bar near the cable gland.

2.4.3 Connection of the Cable to the Sensor Head

Unscrew the three hex head screws at locations shown below to open the case of the XZR500 probe head and access the terminal block.



Figure 13 *Hex Screw Locations*

Connect the end of the cable - using the end with 6 wires - according to the *Figure 14* wiring diagram.

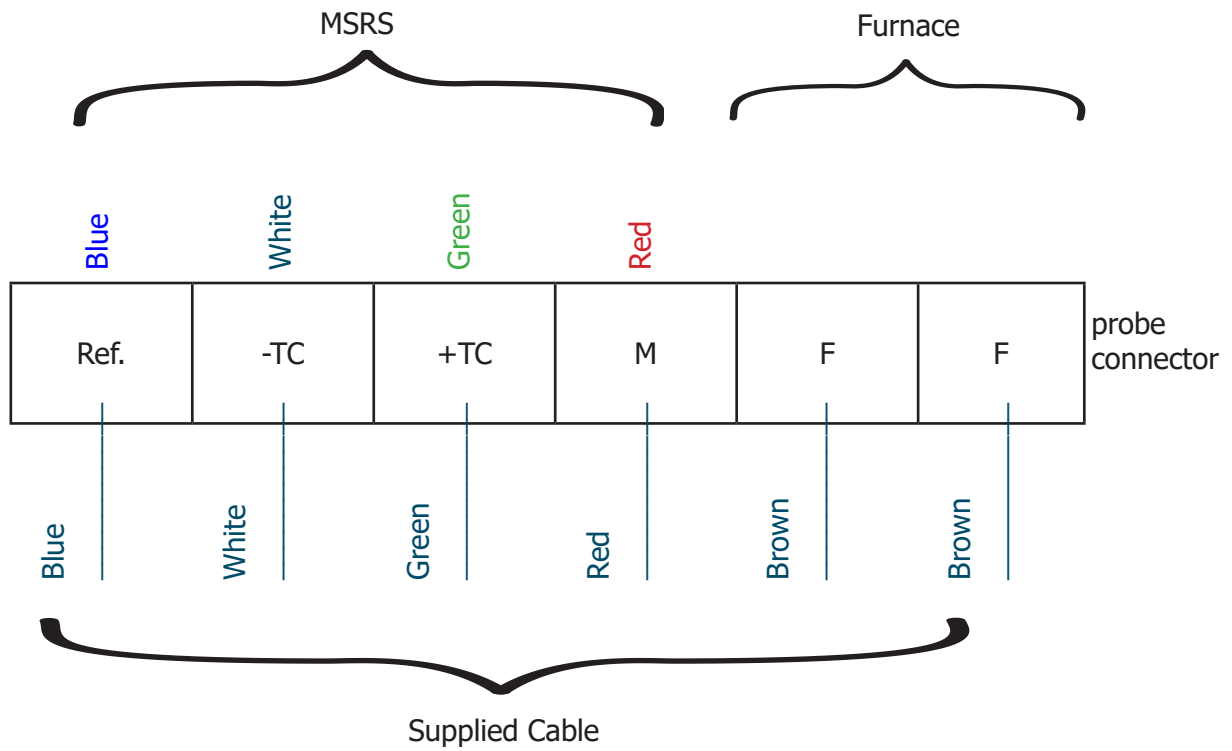


Figure 14 Probe Wiring Diagram

3 OPERATION



The MSRS is a fragile element - keep the sensor free from any shock. Any measurements that need to be done at the MSRS terminals must be done very carefully in order to prevent irreversible damage to the sensor.



NEVER attempt to measure the resistance between the MSRS reference terminal and another terminal

Use a voltmeter with impedance >1000 MΩ for measuring the voltage between the MSRS measurement and reference terminals

3.1 Outputs

3.1.1 Analog Output

The output signal is selectable to be either 0...20 mA or 4...20 mA.

The range is selectable between 0 and 25 %.

3.1.2 Alarms

The system has 3 alarm contacts:

- 1 general failure alarm warning of furnace under temperature (20 °C below the set temperature), thermocouple separation, problem with RAM backup after a re-set or adjustment error.
- 2 threshold alarms, with programmable activation direction and hysteresis.

The activation of a threshold alarm can be identified when the corresponding green LED turns off on the Control Unit.

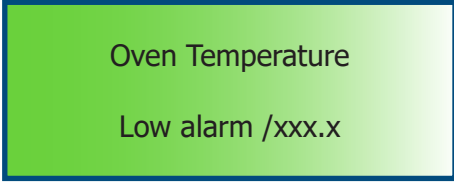
The activation of the general fault alarm can be identified when all the three green LEDs turn off on the Control Unit.

The contacts are normally closed, dry and potential-free. The maximum switched load is 10 W for each contact (up to 100 V or up to 0.5 A).

3.2 Start-Up

After finishing and verifying the connections, power up the analyzer.

During warm-up, the display shows:

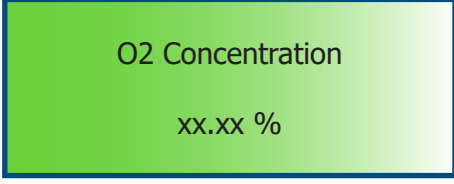


Oven Temperature
Low alarm /xxx.x

The measured temperature value alternates with the message "Low alarm" during one second in every two seconds.

When the temperature is within 30 °C of the required temperature (after about 15 minutes), the system calculates the oxygen concentration and the result will appear on the display.

Then the following default message appears:



O2 Concentration
xx.xx %

3.3 Display, Configuration and Adjustment



During configuration there is no data communication between the Control Unit and the Sensor Head and this could disturb the stability of the furnace temperature. Make sure that the furnace temperature is stable before configuration and allow the analyzer's temperature to stabilize after configuration.

To display the main selection menu, press and hold the [*] **Enter** key until the menu appears. You can now select the option you need by pressing one of the following keys:

Your selection?

Visu * Cal + Set -

- [*] Enter key cycles displayed parameters
- [-] Minus key to enter the set-up mode
- [+] Plus key to enter the calibration mode

3.3.1 Visualization Menu [*]

The visualization menu displays the following parameters:

- O₂ concentration
- Oven temperature in °C
- Temperature of the thermocouple cold junction in °C (ambient temperature)
- MSRS voltage
- Pressure value

Proceed as described above to enter the main selection menu. To scroll through the parameter list use the [*] **Enter** key as shown below.

It is not possible to change any values in the visualization menu. To change values go to the set-up menu.

1. From the main menu, press and hold the [*] **Enter** key until the main selection menu appears

Your selection?

Visu * Cal + Set -

2. Press the [*] **Enter** key from the main selection menu to show the first parameter: O₂ concentration

O2 Concentration

xx.xx %

3. Press and hold the [*] **Enter** key again to re-enter the main selection menu

Your selection?
Visu * Cal + Set -

4. Press the [*] **Enter** key from the main selection menu to show the second parameter: Oven temperature

Oven temperature
xxx.x °C

5. Press and hold the [*] **Enter** key to re-enter the main selection menu

Your selection?
Visu * Cal + Set -

6. Press the [*] **Enter** key from the main selection menu to show the third parameter: Ambient temperature

Ambient temperature
xx.x °C

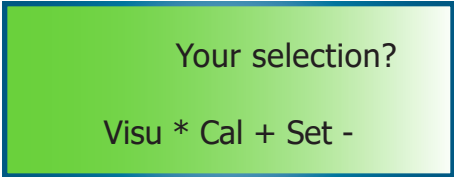
7. Press and hold the [*] **Enter** key to re-enter the main selection menu

Your selection?
Visu * Cal + Set -

8. Press the [*] **Enter** key from the main selection menu to show the fourth parameter: Cell voltage

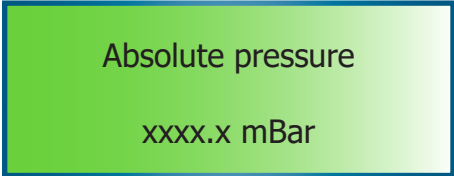
Cell voltage
xx.xx mV

9. Press and hold the [*] **Enter** key to re-enter the main selection menu



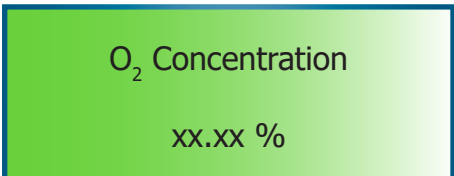
Your selection?
Visu * Cal + Set -

10. Press the [*] **Enter** key from the main selection menu to show the fifth parameter: Absolute pressure



Absolute pressure
xxxx.x mBar

11. Repeating the process again will return to the default displayed parameter: O₂ concentration



O₂ Concentration
xx.xx %

NOTE: If you do not press the [*] Enter key within 30 seconds, while showing one of the parameters, the display will automatically return to the default display of O₂ concentration.

3.3.2 Set-up [-]

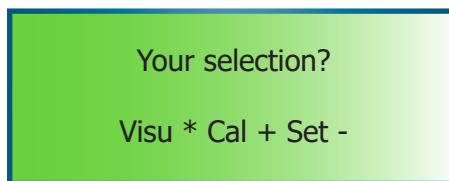
The set-up mode is used for changing system control parameters, each of which are selected from the set-up configuration table. There are two different sets of setting parameters. Quick settings are accessible under code 0.12, while advance settings are accessible under access code 0.20.

Access Code	Function	Default Setting	Unit	Remarks
0.12	Std config. 0.30	0.00	N/A	Resets the system to standard configuration. The default configuration is restored. The current parameters will be deleted. Usually necessary after replacement of the micro controller card. Do not change without consulting factory
	Test gas value	8.00	%	Sets the value of the calibration gas
	Type Alarm 1	2.00	N/A	Sets alarm type. If value >1.00 high Alarm 1, if value <1.00 low Alarm 1
	Level of Alarm 1	30.00	% of the measurement range	Sets process trigger point for Alarm 1
	Type Alarm 2	2.00		Sets alarm type. If value >1.00 high Alarm 2, if value <1.00 low Alarm 2
	Level of Alarm 2	30.00	% of the measurement range	Sets process trigger point for Alarm 2
	Hysteresis	1.00	% of the measurement range	Sets relay hysteresis
	Fail safe value	0.00	% of the output scale	Sets the fault alarm. If released, the output signal switches to the selected value
0.20	Oven temp set pt	700.00	°C	Sets the oven temperature. Do not change without consulting factory
	Francais English Italiano	English	N/A	Sets display language
	Offset room temp	3.00	N/A	Sets the offset set point for the MSRS T/C cold junction. Do not change without consulting factory
	Room temp. grad.	10.00	N/A	Sets the span set point. Do not change without consulting factory
	High adjust	0.00		Adjusts reading near 21 %
	0 or 4 - 20 mA output	4.00	N/A	Sets the analog output signal
	Rec. range low	0.01	%	Sets the measuring range lower limit
	Rec. range high	10.00	%	Sets the measuring range higher limit
	CO2 factor	0.00	%	Enter the CO2 value
	Gr	10.00		Factory setting. Do not change without consulting factory
	Ti	10.00		Factory setting. Do not change without consulting factory
	Offset pressure	Pre-set	mbar	Sets the offset pressure. Do not change without consulting factory
	Absolute pressure	Pre-set	mbar	Sets the absolute pressure. Do not change without consulting factory
	Cell cleaning			Start the cell self-cleaning process

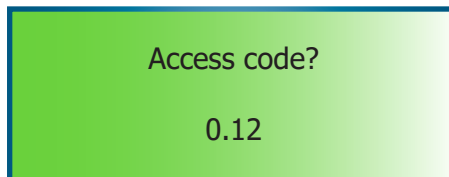
Table 5 Access codes 0.12 & 0.20

3.3.2.1 Access code 0.12 - quick settings

From the main menu page, press and hold the [*] Enter key until the main selection menu appears.



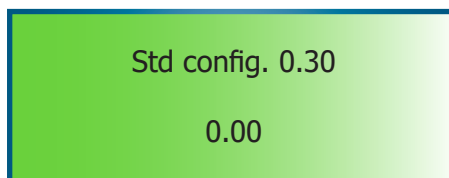
Press the [-] (Set-up menu) from the main selection menu to show the Access code page.



Using the [-] and [+] keys enter the 0.12 code to access the quick settings and press the [*] Enter key to confirm the selection.

Standard Configuration

The first page under access code 0.12 is for restoring the factory default standard configurations.



A standard configuration should be restored after replacing the microcontroller card.

Consequences: All the parameters change to the default value. The analyzer is no longer calibrated.



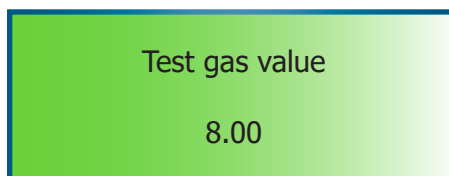
DO NOT change the value from 0.00 without consulting the factory. Restoring to standard configuration will change all the parameters of the last set-up. Make sure you note down all parameter values before executing the operation. After re-set the analyzer is no longer calibrated.

If a standard configuration is not necessary leave the value as 0.00 and press the [*] Enter key to go to the next page.

If a standard configuration is necessary, enter 0.30 and press the [*] Enter key to activate the restoring process.

Calibration gas value

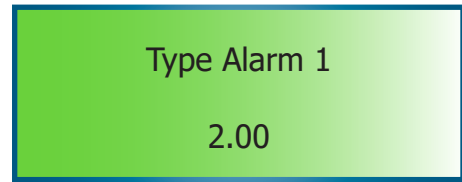
This page shows the current calibration gas value. Use the [+] and [-] keys to modify the value and press the [*] Enter key to confirm the selection and move to the next parameter.



NOTE: This value is in %. For example, 8.00 equals 8 %.

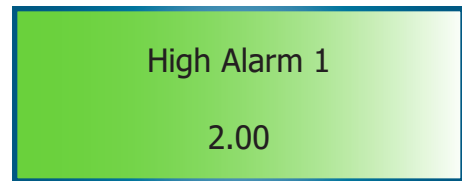
Alarm 1

1. The 'type of alarm' screen is used to set-up the direction for the Alarms 1 and 2 to the values 'High' and 'Low'. The 'High' alarm will be activated when increasing the signal value to above the set-point level. The 'Low' alarm will be activated by decreasing the signal value to below the set-point level.



Values higher than 1.00 indicate that the alarm type will be 'High'. Values lower than 1.00 indicate that the alarm type will be 'Low'. Press the [+] and [-] keys to modify the value. Press the [*] **Enter** key to confirm the selection and move to the next parameter.

2. Depending on the selection in step 1, the next page shows High/Low set-point of Alarm 1. Press the [+] and [-] keys to modify the set-point and press the [*] **Enter** key to confirm the selection and move to the next parameter.



NOTE: If the alarm is set as Low alarm this page will display 'Low Alarm 1' accordingly

NOTE: This set-point value is in %. For example, 2.00 equals 2 %. The value can be set between 0 and 200 %.

Alarm set-point = (alarm level/max value of the scale) x 100		
Example 1: Selected range is 1-1,000 ppm. The desired alarm is at 600 ppm.	Calculation: % = (600 ppm*100) /1000 ppm = 60	The set value has to be 60 as 600 ppm represents 60 % of the range
Example 2: Selected range is 10-10,000 ppm. The desired alarm is at 600 ppm.	Calculation: % = (600 ppm*100) /10,000 ppm = 6	The set value has to be 6 as 600 ppm represents 6 % of the range
Example 3: Selected range is 1 ppm to 25 % logarithmic. The desired alarm is at 600 ppm.	Calculation: % = (600 ppm*100) /250,000 ppm = 0.24	The set value has to be 0.24 as 600 ppm represents 0.24 % of the range

Table 6 Alarm Set-Point Examples

Alarm 2

To configure Alarm 2, repeat steps 1 and 2 as shown in Alarm 1.

Alarm hysteresis

This page shows the value for the relay hysteresis that is expressed in percentage oxygen. Press the [+] and [-] keys to adjust the value. Press the [*] **Enter** key to confirm the selection and move to the next parameter.

Relay hysteresis

0.10

Fail safe value

This page shows, in percentage, the fail-safe value of the measurement range. This is the percentage value that the 4...20 mA output will go to under fault conditions. E.g. 100.00 means the output will be 20mA (100 %) under fault conditions.

Fail safe value

0.00

Press the [+] and [-] keys to adjust the value. Press the [*] **Enter** key to confirm the selection. The Access code page will appear.

3.3.2.2 Access code 0.20 - advanced settings

At the Access code page, use the [-] and [+] keys to enter the 0.20 code to access the advance settings and press the [*] **Enter** key to confirm the selection.

Access code?

0.20

Oven temperature set-point

This first page under access code 0.20 is used to set the temperature of the sensor oven.

Oven temp set pt

700.00

CAUTION: Do not change the value without consulting the factory.

Press the [*] **Enter** key to move to the next parameter.

Languages

English, French or Italian can be selected as the display language. There are separate pages for each language.

English ?

No * Yes -

Press the [*] **Enter** key to stay with the current language in use

French ?

Non * Oui -

Press the [-] key to change to the chosen language

Italiano ?

No * Si -

Offset compensation MSRS cold junction

This page shows the offset value for compensation of the MSRS thermocouple cold junction. The value is factory pre-set and may vary for individual analyzers.

Offset room temperature

3.00

CAUTION: Do not change the value without consulting the factory.

Press the [*] Enter key to move to the next parameter.

Span compensation MSRS cold junction

This page shows the span value for compensation of the MSRS thermocouple cold junction. The value is factory pre-set and may vary for individual analyzers.

Room temp. grad.

10.00

CAUTION: Do not change the value without consulting the factory.

Press the [*] Enter key to move to the next parameter.

High Adjust

This page shows the 'High adjust' function that allows the user to adjust the reading around 21 % oxygen. The value is factory pre-set and may vary for individual analyzers.

High adjust

2.00

NOTE: The value is factory pre-set. It can be changed when different calibration is required.

After a calibration, let the air circulate for approximately 15 minutes, and then adjust this value to give a 21 % oxygen reading. If the calibration is done with air, set the value to 0.00.

The equation to calculate the high adjust is:

$$HA = ((20.9 - O_2\text{reading}) / O_2\text{ reading}) * 100$$

e.g. If the analyzer display is 20.4 %
 $HA = ((20.9 - 20.4) / 20.4) * 100 = 2.5$

Press the [+] and [-] keys to adjust the value. Press the [*] Enter key to confirm the selection and move to the next parameter.

Output Signal

This page shows the available current ranges for the signal output. Enter 0.00 for 0...20 mA and 4.00 for 4...20 mA. Press the [+] and [-] keys to adjust the value. Press the [*] **Enter** key to confirm the selection and move to the next parameter.

0 or 4...20 mA
4.00

Measurement range – lower limit

This page shows the selected lower limit of the measurement range. Press the [+] and [-] keys to adjust the value. Press the [*] **Enter** key to confirm the selection and move to the next parameter.

Rec. range low
0.01

NOTE: This value is in %. For example, 0.01 equals 0.01 % O₂.

Measurement range – upper limit

This page shows the selected upper limit of the measurement range. Press the [+] and [-] keys to adjust the value. Press the [*] **Enter** key to confirm the selection and move to the next parameter.

Rec. range up
10.00

NOTE: This value is in %. For example, 10.00 equals 10 % O₂.

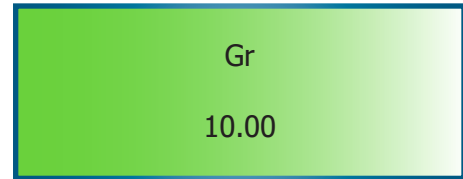
CO₂ factor

This page is used to enter the CO₂ maximum theoretical value of the fuel gas for CO₂ calculation. Press the [+] and [-] keys to adjust the value. Press the [*] **Enter** key to confirm the selection and move to the next parameter. (See Appendix C)

CO₂ factor
0.00

Gr value

This value is for factory settings only.

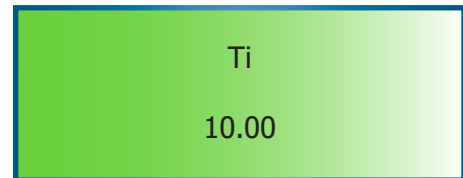


CAUTION: Do not change the value without consulting the factory.

Press the [*] Enter key to move to the next parameter.

Ti value

This value is for factory settings only.

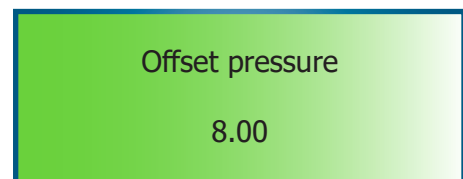


CAUTION: Do not change the value without consulting the factory.

Press the [*] Enter key to move to the next parameter.

Offset pressure

This page displays the offset pressure. The value is factory pre-set and may vary for individual analyzers.

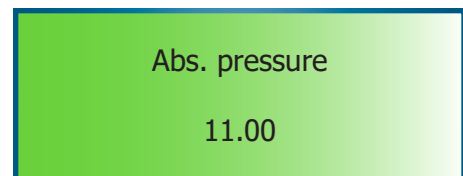


CAUTION: Do not change the value without consulting the factory.

Press the [*] Enter key to move to the next parameter.

Absolute pressure

This page displays the absolute pressure. The value is factory pre-set and may vary for individual analyzers.



CAUTION: Do not change the value without consulting the factory.

Press the [*] Enter key to move to the next parameter.

Cell self-cleaning

This function allows the analyzer to self-clean the sensor cell. The cleaning process lasts for one hour. The furnace is heated to 780 °C in order to clean itself and the MSRS. Remove the inner probe tube to make the self-cleaning more efficient.

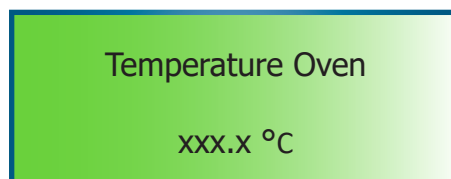
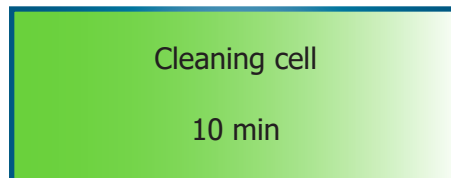
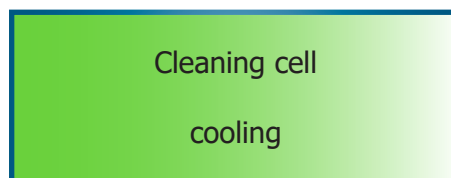
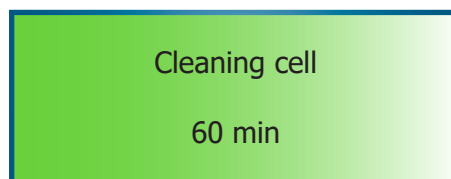
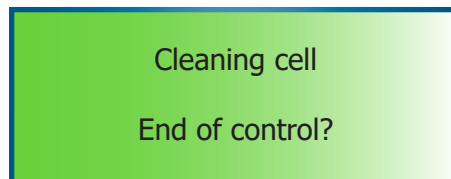
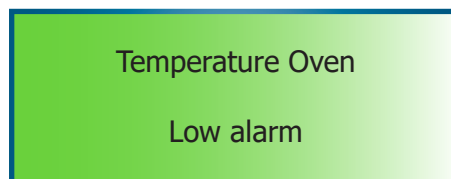
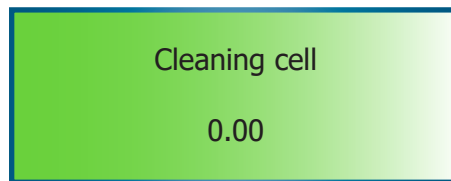
NOTE: During self-cleaning, the output signal will be locked at the fail-safe value

If cell cleaning is **not** required, leave the value at 0.00 and press the [*] **Enter** key to skip this procedure and go back to the default display.

If cell cleaning is required, press the [+] and [-] keys to adjust the value to 0.10 and press the [*] **Enter** key to start the process. The following messages will appear:

The process can be stopped by pressing and holding the [*] **Enter** key or it will stop automatically after the above 60 minute process is completed. Once the cleaning process is finished the furnace will start to cool down.

After about 10 minutes the temperature will return to the set temperature.



3.3.3 Calibration [+]

The XZR500 has been designed for simple operation. The calibration procedure is extremely easy and can be performed within minutes. The analyzer is self-adjusting during calibration. There are only a few steps that need to be carried out for the actual calibration procedure.

3.3.3.1 Recommended Calibration Gas

NOTE: Please make sure that only gas of a known composition is used for calibration of the XZR500. The gas cylinder must be certified as to the exact composition of the calibration gas.

Michell recommends the following calibration gas concentrations that can be ordered from your analyzer vendor.

- 1G Calibration Kit with one gas cylinder (nitrogen with 8 % oxygen concentration)
- 2G Calibration Kit with two gas cylinders (nitrogen with 8 % oxygen concentration for calibration and nitrogen with 2 % oxygen concentration for verification)



CALIBRATION GAS UNCERTAINTY:
Observe the uncertainties of the calibration gas when calculating the overall analyzer uncertainty. Any uncertainty of the oxygen content of the calibration gas may introduce considerable error in the calibration of the analyzer.



NOTE: Prior to calibration, make sure that the 'Test gas value' in the access code 0.12 of the analyzer menu is the same as the calibration gas value.

3.3.3.2 Regulating the Calibration Flow Rate

In order to perform the calibration it is recommended to arrange a temporary connection with a regulator and isolation valve located at the calibration gas inlet on the analyzer. Make sure the connection is as short as possible. A regulator and isolation valve are supplied in the calibration kit.

Connect the calibration kit or your test gas cylinder to the calibration gas inlet (*Figure 4 (12)*). Use 1/8" tube and fitting. **NOTE: Ensure a flow of 7 l/hour (± 2 l/hour) (0.12 to 0.18 l/min).**

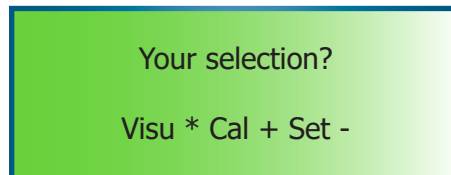
NOTE: Tighten up the stainless steel locking nut by hand and then tighten again using a 7/16" spanner, for 1/8th turn so as not to damage the connection.

NOTE: During calibration the output signal is frozen at the last value measured before the beginning of the calibration procedure.

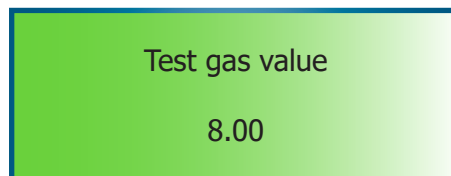
3.3.3.3 Calibration Procedure

Follow Sections 3.3.3.1 and 3.3.3.2 to connect the calibration gas to the analyzer (8 % oxygen bottle, if 1G or 2G is ordered). Do not switch on the calibration gas flow at this time.

1. From the main page, press and hold the [*] (Enter key) until the main selection menu appears.



2. Press the [+] key from the main selection menu to enter the calibration mode. The first page displays the 'Test gas value'. Make sure that the displayed value is the same as the calibration gas.



NOTE: This value is in %. For example, 8.00 equals 8 %.

If the displayed value is not the same value as the calibration gas, exit the calibration mode from next page ('Inject gas') and then go to 'Test gas value' under 'Set-up menu' Access code 0.12 to adjust it. (Please refer to details in Section 3.3.2.1)

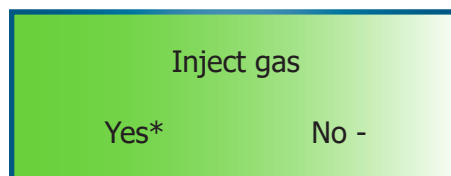
Press the [*] (Enter key) to move to the next page.

3. This page shows the calibration start command.

[*] – Starts the calibration process (go to step 4)

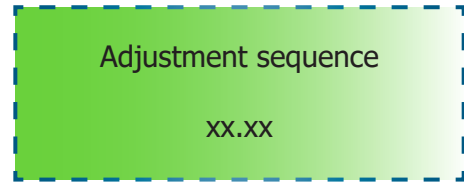
[-] key – Cancels the calibration process and exits the calibration mode. If the 'Test gas value' needs to be modified, then go to 'Test gas value' under 'Set-up menu' Access code 0.12 to adjust it.

NOTE: Once the calibration process starts (after pressing the [*] key), the 4...20 mA output will be frozen from this step until the end of the purge procedure and will show the last measured value.

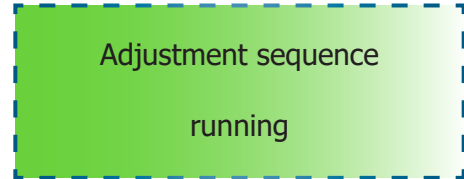


4. Open the test gas cylinder to introduce the gas into the analyzer. Adjust the flow to the recommended level of 7 l/hour (± 2 l/hour) and ensure that the flow is stable. Higher or lower flow rates could affect the accuracy of the calibration as well as further measurements.

- The calibration process takes about 10 minutes. During calibration the screen alternates, displaying two messages - 'running' and the current value of calibration.

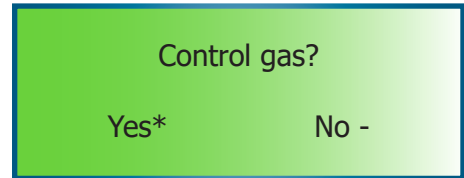


Press the [*] key to finish the calibration once this value is stabilized, otherwise the calibration process will end automatically after the 10 minutes time limit is reached.



The screen will then change to the following:

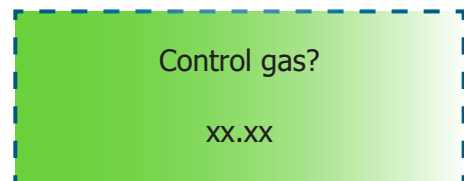
- After the calibration process the quality of the calibration can be verified by starting the verification process with a control gas. Assure that the control gas has a different oxygen concentration from the gas used for calibration (e.g. 2 % if the calibration gas was at 8 %). The Calibration kit with both gases is available - order code 2G.



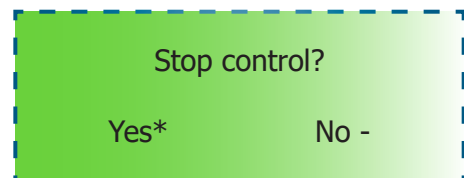
[*] key – continues with the verification process (go to step 7)

[-] key – skips the validation and completes the calibration process (go to step 8)

- If the [*] key is pressed in step 6 this screen is used to verify the calibration. The page alternates between real-time reading of the control gas and the option to end the verification.



Introduce the control gas to the inlet of the analyzer. The calibration can then be verified simply by comparing the reading with the real oxygen content of the control gas.



[*] key – Ends the verification process and moves to the next page

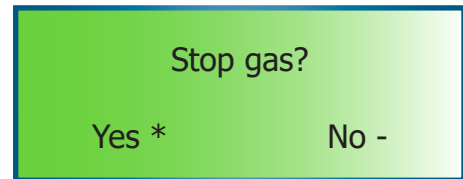
[-] key – No effect

8. Once the verification step is completed or skipped, the screen shows 'Stop gas?' to remind the user to switch off the calibration/control gas.

Confirm the finish of the calibration with the [*] key and move to next page.

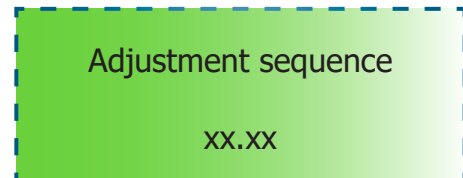
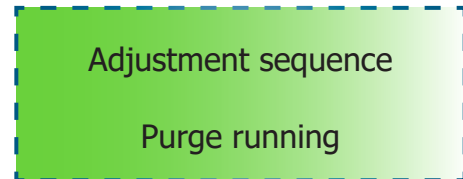
The calibration/control gas should now be switched off and, if necessary, the process gas reconnected back to the analyzer.

[-] key – No effect



9. After the analyzer leaves the calibration mode the screen alternates, displaying two messages - 'Purge running' and the real live measurement of the purge (process) gas. This procedure cleans all the calibration gas in the analyzer. It takes about 3 minutes.

At the end of the purge the 4...20 mA output will be released.

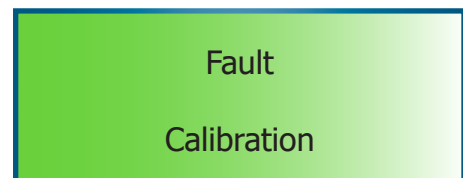


10. The purging process can be stopped after one minute. Press the [*] key and hold until the default main page appears.

If the following message is displayed the analyzer calibration was not successful. Press RESET (Figure 7) or press the [+] and [-] keys to cancel the message.

This may occur when:

- The O₂ concentration of the calibration gas is different from the value set in 'Set-up menu' Access code 0.12. Go to 'Test gas value' under 'Set-up menu' Access code 0.12 to adjust it. (Refer to details in Section 3.3.2.1).
- The MSRS is faulty. It should be replaced.



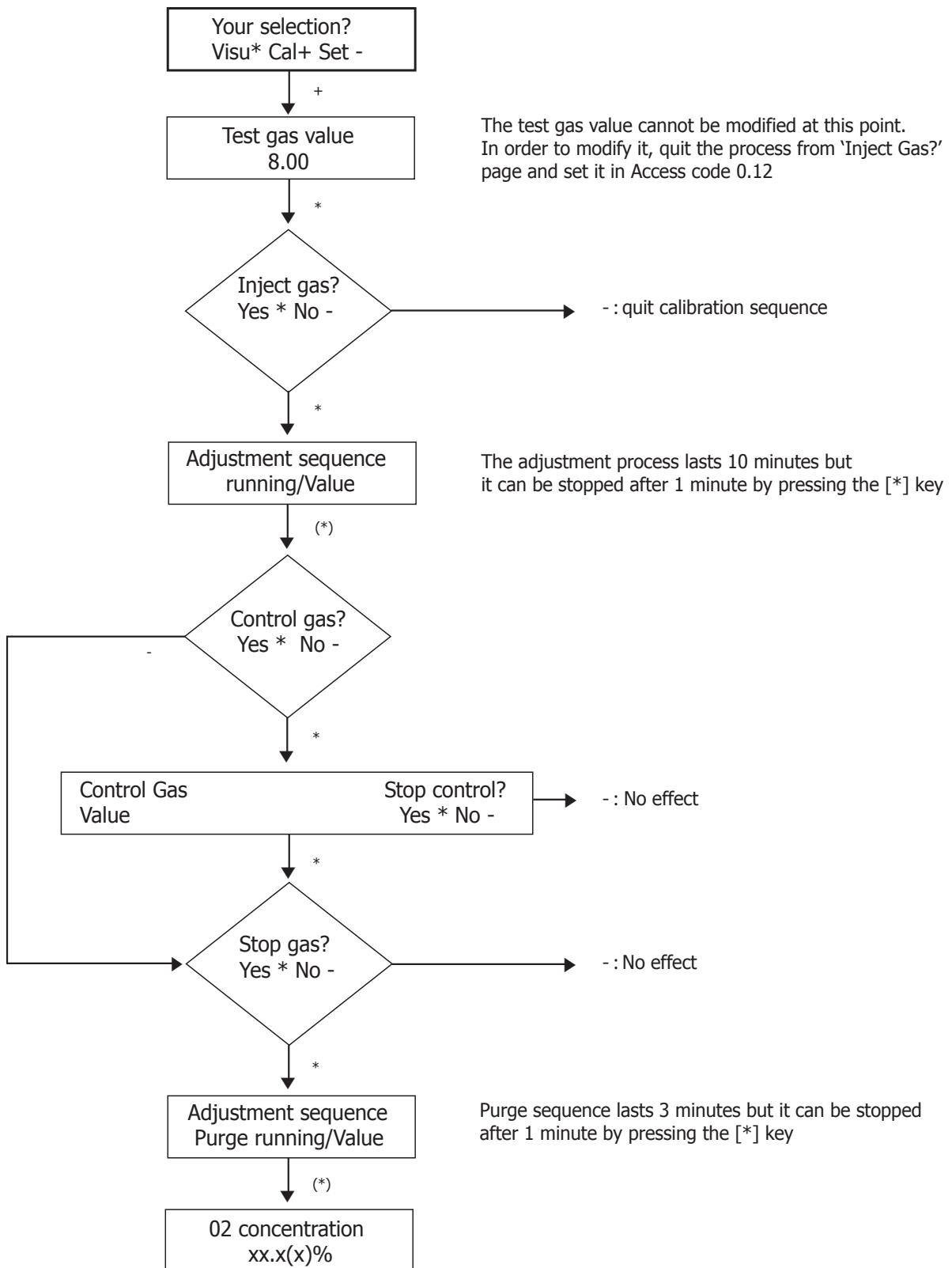


Figure 15 Calibration Flow-Chart

4 MAINTENANCE

4.1 Preventative Maintenance - Cleaning

The XZR500 should be periodically cleaned. The frequency of cleaning will depend upon your application.

- Identify the 3 orientation marks on the inner tube and remove it (*Figure 4 (23)*).
- Clean the inside of the outer tube (*Figure 4 (2)*) by moving the inner tube backwards and forwards - the tip disk on the inner tube will sweep the inside of the outer tube.
- Clean the inner tube with a long metal brush or abrasive cloth. It should then be cleaned with hot water and afterwards have pressurized air blown through the tube. Fit the inner tube of the probe back into the correct position.
- Change the gaskets and tighten-up all the nuts frequently to prevent contamination from outside air entering the stack.
- The probe should be removed at least once a year, e.g. during a factory shutdown, to inspect the probe tubes. Clean them as necessary.

4.2 Replacement Of The XZR500 MSRS

- Remove the probe inner tube (*Figure 4 (23)*).
- Turn off the analyzer and disconnect the power lead.
- Wait until the furnace and sensor housing cool down (at least 45 minutes).
- Remove the cover of the sensor housing.
- Disconnect the cable.
- Disconnect the sealing head (*Figure 4 (3)*).
- Remove the MSRS (*Figure 4 (5)*).
- Clean the sealing head if necessary.
- Re-insert the clean sealing head, the new MSRS (Ref 204 011) and new o-rings (Ref 108 006) (see *Figures 17 and 18*).
- Replace the screws and tighten-up.
- Connect the MSRS and the cable according to the diagram (*Figure 16*).
- Power up the analyzer.
- Wait for one hour.
- Re-fit the probe inner tube.
- Set self-cleaning (0.10 code).
- Wait for few hours before calibrating the analyzer (see Section 3.3.3).

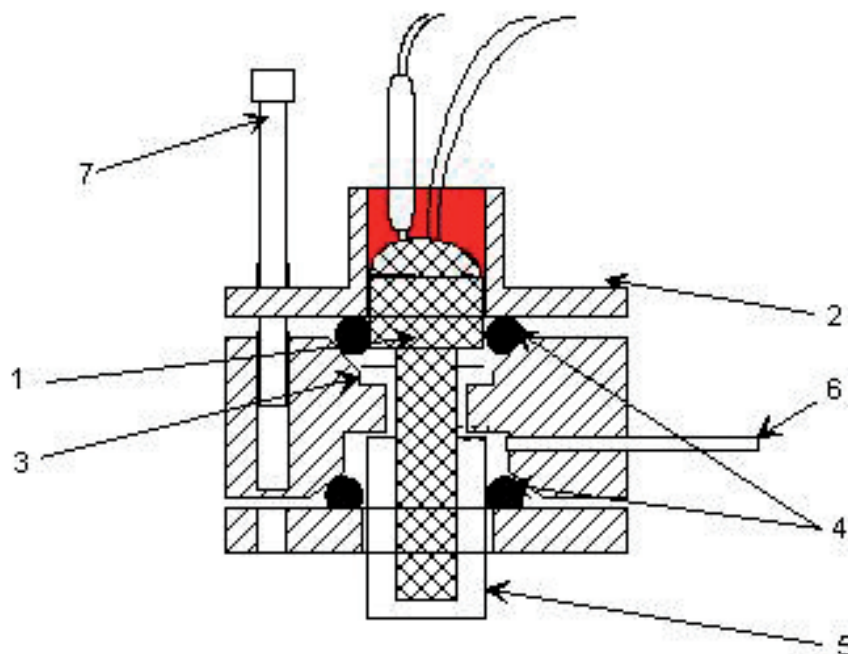


Figure 16 XZR500 MSRS Mounting Diagram

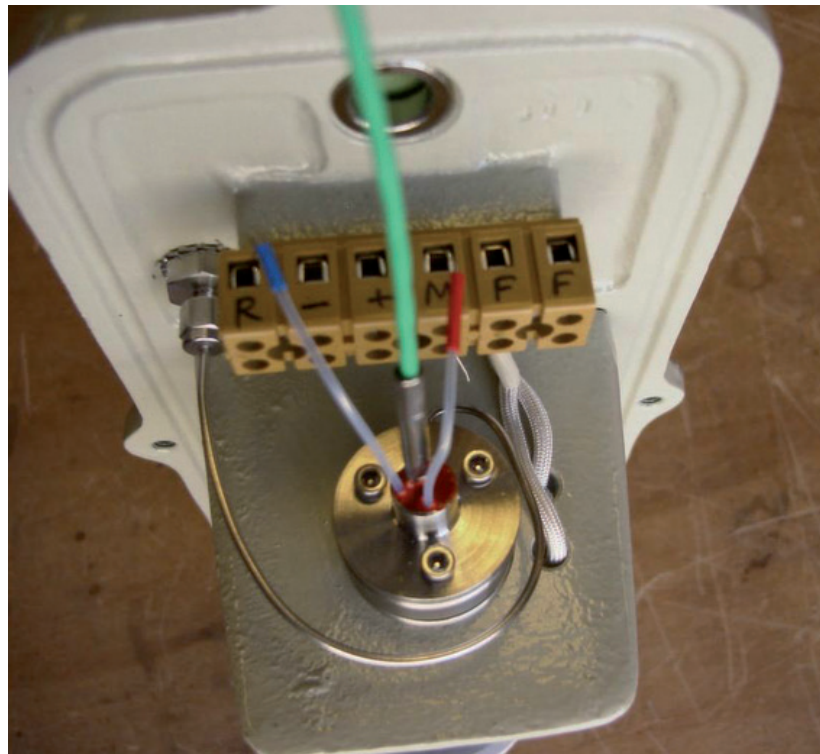


Figure 17 XZR500 Top View

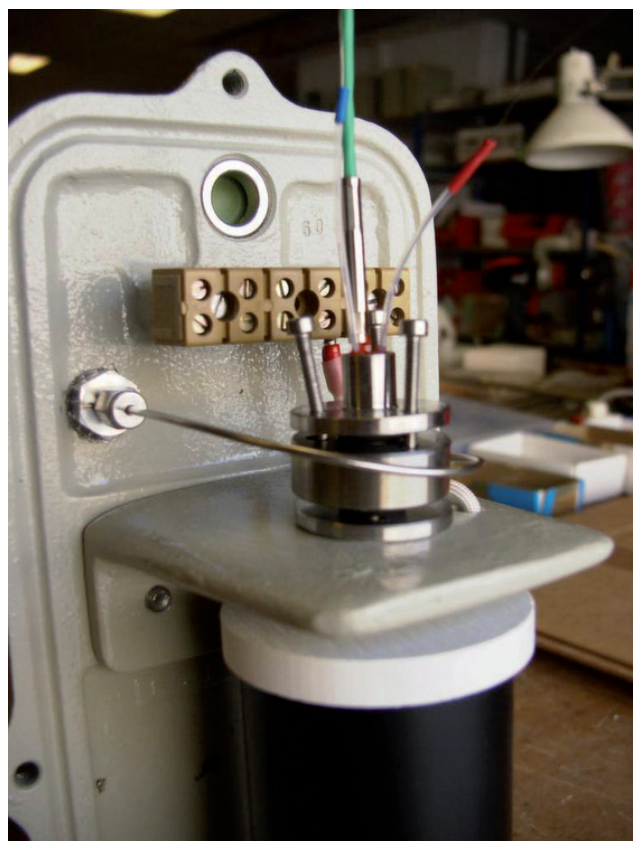
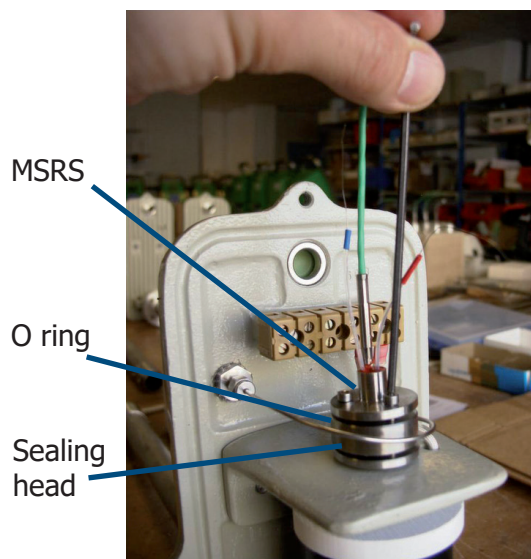


Figure 18 XZR500 Side View

4.3 Replacement of the Furnace

- Remove the probe inner tube (*Figure 4 (23)*).
- Turn off the analyzer and disconnect the power lead.
- Wait until the furnace and the sensor housing cool down (around 45 minutes).
- Remove the cover of the sensor housing.
- Disconnect the cable.
- Disconnect all the wires from the MSRS, the furnace and the connector block (*Figure 4 (11)*).
- Remove the MSRS (*Figure 4 (5)*).
- Remove the sealing head (*Figure 4 (3)*).



- Clean the sealing head if necessary.
- Loosen the probe mounting plate fastener (*Figure 4 (19, 20)*).
- Unscrew the corner plate (2 CHC screws M6).
- Draw back the mounting plate.
- Remove the furnace.
- Place the new furnace (you may have to enlarge the holes in the corner plate to allow the furnace wire's terminals to pass).
- Replace the stop washers.
- Replace the corner plate.
- Bring the attachment plate close to the corner plate.
- Fasten the corner plate by pushing it down so that the lock washers lay against the furnace upper cheek.
- Tighten up the probe mounting plate fastener.
- Re-insert the clean sealing head with the new MSRS (Ref 204 011) and new o-rings (Ref 108 006) (**CAUTION: the head of the MSRS (1) has to stop against the bearing of the sealing head body (3)**). (See *Figure 16*.)
- Connect the MSRS and the cable according to the diagram (*Figure 16*).
- Replace the cover.
- Power up the analyzer.
- Wait for one hour.
- Re-fit the probe inner tube.
- Set self-cleaning (0.10 code).
- Wait for a few hours before calibrating the analyzer (see Section 3.3.3).

4.4 Replacement of the XZR500 Microcontroller Card

1. While the power is on, note down the values of all the parameters (see Section 3.3.2). All settings and parameters will be lost when the faulty microcontroller card is changed.
2. Turn off the power and disconnect the lead from the mains.
3. Disconnect the flat cable from the microcontroller card.
4. Remove the faulty microcontroller card.
5. Fit the new microcontroller card.
6. Connect the flat cable to the new card.
7. Plug the analyzer to the mains and switch the power on.
8. Restore the standard configuration (see Section 3.3.2).
9. Re-set the parameter values you noted down.
10. Wait for few hours before adjusting the analyzer with test gas (see Section 3.3.3).

4.5 Replacement of Fuses

Replace the fuses according to the following chart:

Power Supply	F1 fuse (right)	F2 fuse (left)
230V	T 160 mA	T 1 A
115V	T 400 mA	T 2 A

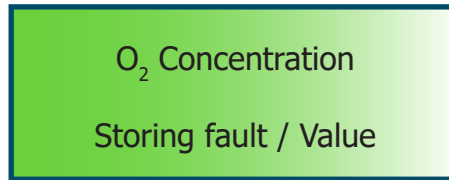
Table 7 Fuse Replacement

T xxx mA means that a kick fuse must be used.

4.6 Error Messages

This section explains the most common error messages that could appear during operation:

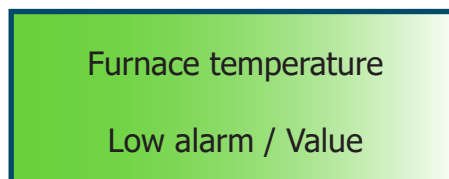
1.



This message appears when the content of the EEPROM is corrupted. This problem can occur when the microcontroller card is replaced with a non-compatible version. All the adjustment parameters are lost. Press RESET (*Figure 7*) to cancel the message.

- If the message does not disappear after RESET has been activated check the microcontroller card (see Section 4.4).

2.

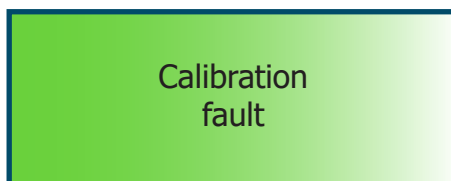


The message "Low alarm" alternates every 2 seconds with the value of the temperature measured. It will appear when the furnace temperature is 20 °C below the set temperature.

Probable cause(s):

- The analyzer was just powered up so the furnace is warming up.
Wait until the right temperature is reached.
- There is a short-circuit between the thermocouple's threads, causing the analyzer to measure the temperature of the short-circuit instead of the furnace temperature.
Check the thermocouple threads to make sure they are not short-circuiting.
- If the red LED (heating indicator) is lit continuously, the furnace is under-powered.
Verify the analyzer's power supply voltage.
- Faulty furnace.

3.

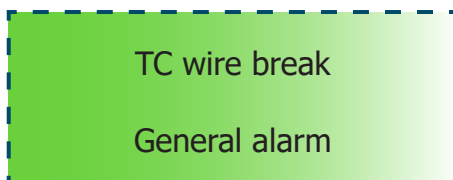


Calibration error.

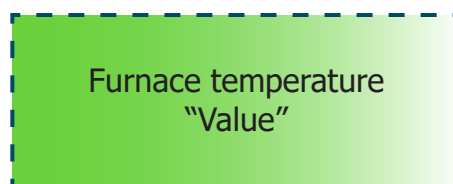
Probable cause(s):

- The calibration gas value that was stated in the parameter's sequence in Access Code 0.12 does not correspond to the actual calibration gas value.
Press RESET (*Figure 7*) or check that the test gas value in Access Code 0.12 is the same as the actual calibration gas value (refer to Section 3.3.2.1).
- Faulty MSRS - this must be replaced

4.



Alternately with



This message appears when there is a problem with the thermocouple or the thermocouple wire.

Probable cause(s):

- The thermocouple's connection between the electronic system and the sensor is cut.
- Faulty thermocouple - replace the MSRS.

5 SPARE PARTS

XZR-CKNG	Calibration kit without gas cylinder
XZR-CK1G	Calibration kit with one gas cylinder (<i>approximately 8 %</i>)
XZR-CK2G	Calibration kit with two gas cylinders (<i>approximately 2 % and 8 %</i>)
XZR-CYL-02 %	2 % O ₂ bal. N ₂ gas cylinder as spare
XZR-CYL-08 %	8 % O ₂ bal. N ₂ gas cylinder as spare
XZR500-FUR	Spare part furnace for flue MSRS sensor
XZR500-SMP	Spare MSRS sensor
XZR500-209002	Complete Gasket Kit
XZR500-KD	Keyboard display with cable
XZR500-205010	Earthing braid for XZR500
XZR500-201002	XZR500 Control Unit
XZR500-103002	Microcontroller card (% K)
XZR500-108001	Gasket for XZR500 flange (x2)
XZR500-209154	Gasket for XZR500 flange (x10)
XZR500-108002	Gasket for XZR500 wheel
XZR500-209143	Inner Tube Gaskets (x10)
XZR500-209144	Rear Nut Gaskets (x10)
XZR500-104003	XZR500 Cable (per meter)
XZR500-203006	XZR500 furnace
XZR500-109015	SS bulkhead union
XZR500-109004	1/8" SS plug

Appendix A

Technical Specifications

Appendix A Technical Specifications

Sensor Type	
Measurement Principle	Zirconium oxide sensor with metallic sealed reference and K Type T/C
Performance	
Gas Requirements	Typical exhaust gas
Measurement Range	0.01...25 % Oxygen
Accuracy	Better than ± 2 % of reading
Response Time	Gas speed 0.8m/s: T90 <100s Gas speed 2m/s: T90 <60s
Repeatability	± 0.1 %
Fidelity	1 % per month
Linearity	Better than ± 1 %
Sample Flow Rate	Flue gas at 0.5 m/sec (17.65 ft/s) minimum rate
Maximum Sample Pressure	Depending on application
Dust Loading	The back flush option is required for any sample containing > 250 mg/m ³ particulates
Maximum Sample Temperature	1300 °C (2372 °F) (see probe selection in Wetted Materials below)
Outputs	
Output Signal	One 0/4...20 mA linear with galvanic insulation output 2nd optional output
Output Load	Over 1000 Ω
Self-diagnostics	Included in readout
Output Ranges	Freely configured between 0.01 and 25 %
Alarms	2 alarms; user adjustable (10W) 1 fault alarm
Display Resolution	0.1 % in standard (0.01 % on request)
Power Supply	110 V (100...120) 50/60 Hz or 220 V (190...240) 50 Hz
Power Consumption	110 VA
Ambient Temperature Range	0...+55 °C (+32...+131 °F)
Sensor Temperature	700 °C (1292 °F)
Operating Humidity	5...90 % rh without condensation
Physical	
Dimensions	300 x 300 x 200 mm (control) 290 x 135 x 650 mm (sensor)
Weight	10...15 kg depending on application
Wetted Materials (Maximum temperature)	316 L Stainless steel (700 °C) (1292 °F) Inconel 600 (1000 °C) (1832 °F) HR160 (600...1000 °C) (1112...1832 °F) C2000 (600 °C) (1112 °F) Halar coating (120 °C) (248 °F) Ceramic (1300 °C) (2372 °F)
Probe Lengths	0.4, 0.6 and 0.9 m (15.75, 23.62, 35.43")
Installation	Stack and wall mounting
Housing Ingress Protection	Weather-proof enclosure to sensor: IP53 Control unit: IP52

Appendix B

Configuration for the RS232 Port (Optional)

Appendix B Configuration for the RS232 Port (Optional)

RS232 interface features are:

- Speed: 9600 bauds
- No parity
- 8 bits
- 1 stop

The wiring cable should be equipped with 2 DB9 female plugs and connected as follows:

- pin 2 pin 2
- pin 3 pin 3
- pin 5 pin 5
- strap 7-8 strap 7-8

Commands:

- _ corresponds to the spacing bar
- ↵ corresponds to the return key

Mnemonic	ASCII Value	
_OXY↵	O ₂ concentration	XX.XX or X.XXE XX
_TEM↵	Furnace temperature	XXX.XX
_UMV↵	MSRS voltage	XXX.XX
_ANV↵	Ambient temperature	XX.XX
_ALR↵	K1, K2, K3 Relay status K1 + K2 + K3 = from 0 to 7 (1) (2) (4)	X
_CAL↵	Sets self-calibration after 10 minutes bleed	RECEIPT PURGE?
_FIN↵	Sets a 5 minutes bleed in case of failure in calibration	RECEIPT DEFAULT
_ACQ↵	Acknowledges the alarms	RECEIPT
_ETA↵	Display of calibration gas value	XX.XX
E_ETA_X.XX↵	Sets calibration gas value	X.XX
_STP↵	Display of furnace temperature set point	XXX.XX
E_STP_XXX.XX↵	Sets furnace temperature	XXX.XX
_AL1↵	Displays first alarm level	XXX.XX
E_AL1↵	Sets first alarm level	XX.XX
_AL2↵	Displays second alarm level	XXX.XX
E_AL2↵	Sets second alarm level	XX.XX
_NET↵	Starts self cleaning	RECEIPT
_YYY↵	Unknown entry	ERROR
_TCA↵	Measured furnace temperature + coef. due to adjustment	XX.XX
_BRK↵	Allows: Ending the bleed during calibration Ending self-cleaning and starting cooling down	XX.XX
_PAB↵	Value of atmospheric pressure	XXXX.XX

Appendix C

Calculation of CO₂

Appendix C Calculation of CO₂

The formula below shows how to calculate CO₂ knowing the oxygen content and the fuel burned:

$$\text{CO}_2 = \text{K2} * (20.9 - \text{O}_2) / 20.9$$

where K2 is absolute max CO₂

Set K2 factor in Access code 0.20, pressing the + and - keys, i.e., for coal, capture 18.39. (Consult Michell for K2 value).

When not otherwise specified, CO₂ factor equals 0. When this factor is more than 10, the display will indicate the calculated CO₂.

In measuring mode, the display will show:

Concentration CO₂ xx.x %

Concentration O₂ xx.x %

Appendix D

XZR500 Sensor Head and Probe General Dimensions

Appendix D XZR500 Sensor Head and Probe General Dimensions

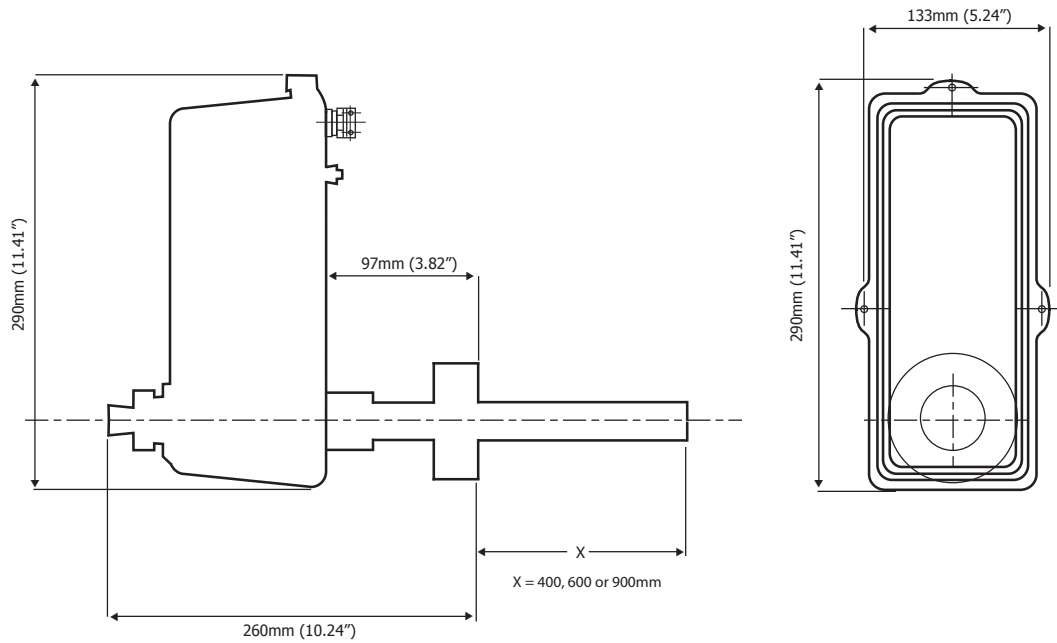


Figure 19 XZR500 Sensor Head & Probe General Dimensions

Probe Version	Outer Tube Dimensions Outer Diameter x Wall Thickness	Inner Tube Dimensions Outer Diameter x Wall Thickness
Stainless Steel	33.4 x 3.37 mm (1.31 x 0.13")	13.7 x 1.65 mm (0.54 x 0.06")
Inconel	33.4 x 2.77 mm (1.31 x 0.11")	13.7 x 2.24 mm (0.54 x 0.08")
HR160 & C2000	33.4 x 3.38 mm (1.31 x 0.13")	13.7 x 1.65 mm (0.54 x 0.06")
Ceramic	30 x 2.5 mm (1.18 x 0.09")	14 x 5 mm (0.55 x 0.19")
Silicon Carbide	30 x 4 mm (1.18 x 0.16")	N/A

Appendix E

Back Flushing System (Optional)

Appendix E Back Flushing System (optional)

The back flush option is required for any sample containing more than 250 mg/m³ particulates.

The pressurized probe cleaning system comprises:

- A steel housing containing electronics and a connector block.
- A CD Rom for programming the automaton.
- An electro-valve with a connection to place on the back of the probe, in place of the sealing screw, a cable (standard length = 6 meters) for connecting the electro-valve.
- A hose for compressed air (standard length = 6 meters).

For positioning the probe tubes, see the drawing below:

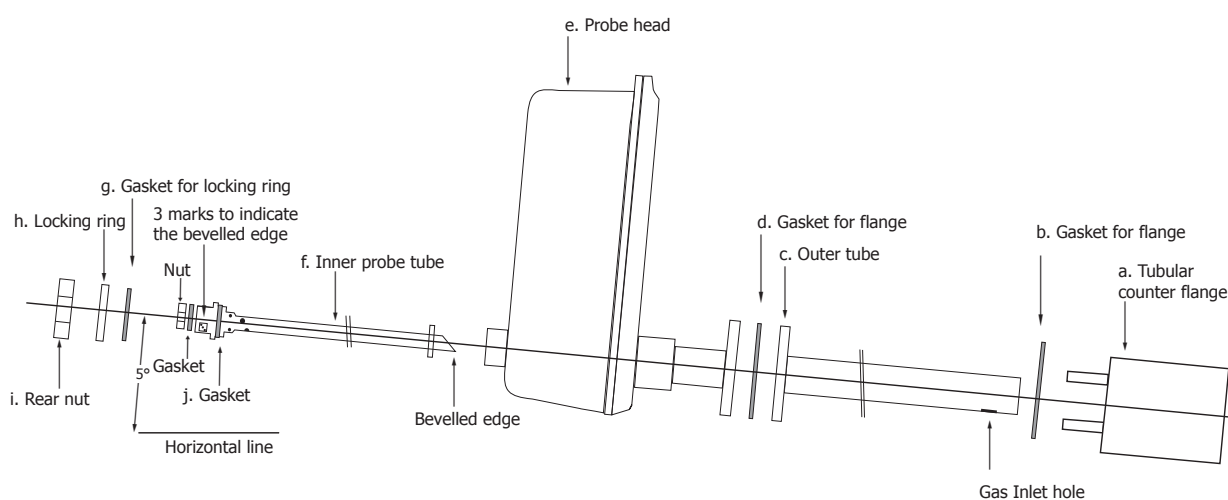


Figure 20 *Position of the Probe*

The output signal is frozen when the flushing sequence starts, it is free after t3.

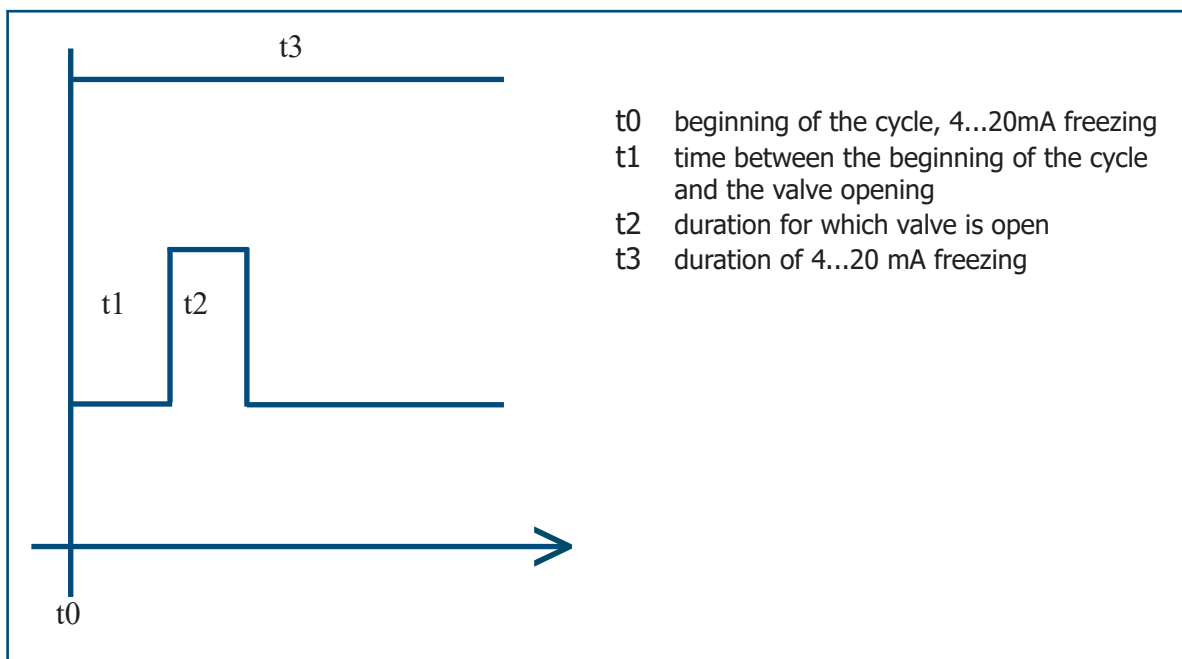
The electro-valve opens after t1 during t2. Factory settings are:

- t1 = 2 seconds
- t2 = 3 seconds
- t3 = 20 seconds

Apply pressure (5-6 bars) during a short time (t2). The operator will decide the frequency of cleaning, once every hour to once a month, according to the conditions of use (factory setting = see the notice of the automaton).

NOTE: t2 should be short. Instead of leaving the electro-valve open for a longer time, it is better to increase the frequency of cleaning.

If the electro-valve stays open too long, the flow of cold air would cool the inside of the probe and this might encourage corrosion.



Make the connections as follows:

- terminals 1 & 2: 230V-50Hz mains power supply
- terminals 3 & 4: wiring of electro-valve
- terminals 5 & 6: to connect with terminals 37 and 38 in the Control Unit

To modify the monitoring sequence of the flushing system, please refer to the manual supplied with the automaton.

Appendix F

Heated Flue Gas Ejection System (Optional)

Appendix F Heated Flue Gas Ejection System (Optional)

The optional flue gas ejection system with heating is suitable for particularly severe conditions of measurement. i.e. high stack gas temperature and high dust content. In these cases a version without the inner probe tube can be used. A compressed air ejection system draws the flue gases through the probe tube and heating minimizes probe clogging. The system must be supplied with dry and de-oiled compressed air at a pressure that can be adjusted between 0 and 3 relative bars.

The synoptic diagram of the installation follows. The system comprises:

- An XZR500 Sensor Head, without inner probe tube
- An air-ejector with adjustable flow placed at the sensor rear side. It is heated and insulated
- An enclosure for controlling the ejector heating
- An intermediate junction box in case there is a large distance between the probe and the regulation enclosure
- A compressed air connecting system
- Michell Instruments does not supply the system for cleaning the compressed air and regulating the inlet pressure: the pressure regulator should supply pressure between 0 and 3 bar.

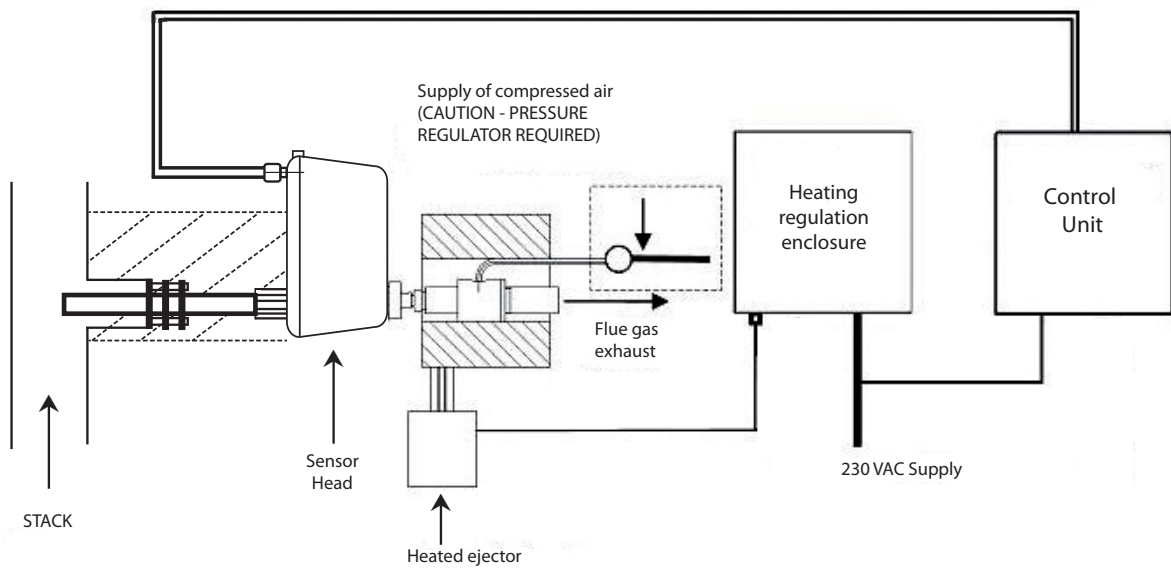


Figure 21 *Installation of the Ejector/Heating System*

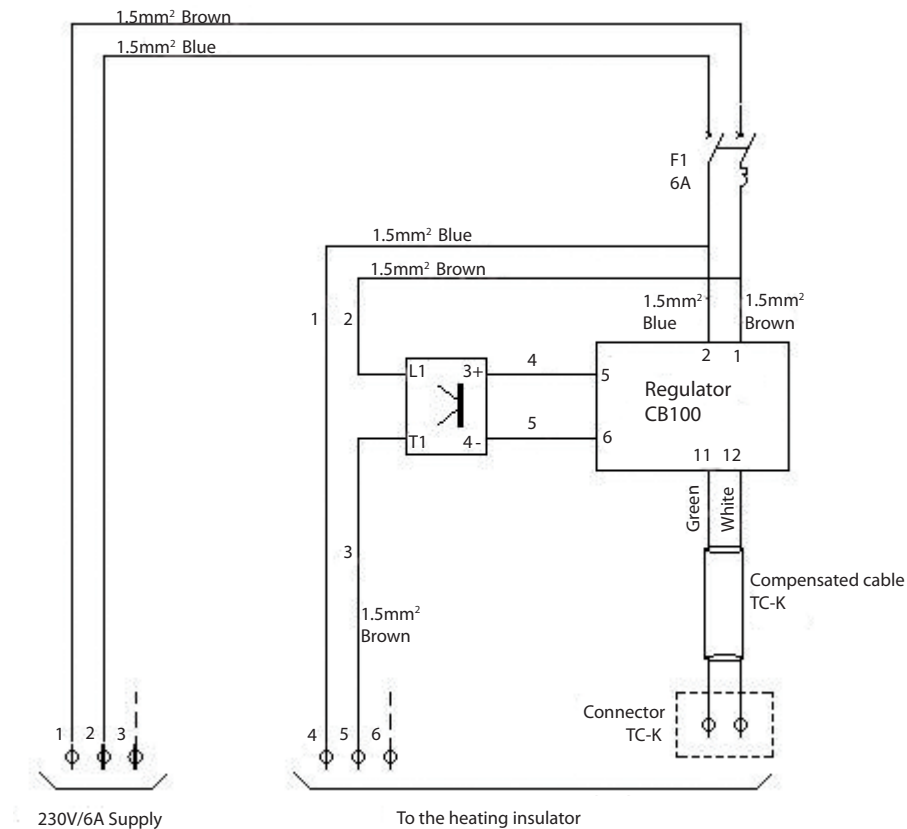


Figure 22 Enclosure for Controlling the Ejector Heating - General Wiring Diagram

Configuring the CB100 temperature regulator:

- Verify the display when powering up the regulator.
- To adjust the set point at 200 °C, press the SET key and scroll with the scroll keys.
- Cancellation of the alarms:
 - Press the "SET" key during 2 seconds
 - Get to "LCY", enter code "1000"
 - Press the "SET" key during 2 seconds
 - Press the "SET" and R/S" keys: at "CODE", enter code "0000"
 - Get to S L 4, enter code "0000"
 - Get to S L 5, enter code "0000"
- Adjustment of high threshold, still in the configuration menu:
 - Validate with the "SET" key up to "CODE", enter code "1"
 - Press the "SET" key
 - At "SLH", set the high-temperature maxi=203 °C (using the scroll keys and the "SET" key)
 - At "SLL", set the low-temperature (mini 150 °C)
 - Validate with the "SET" key up to "CODE", enter code "0" and set back S L 4 and S L 5 at 1
 - To exit press "SET" and "R/S" keys

Specific preventive maintenance for the optional heated ejector:

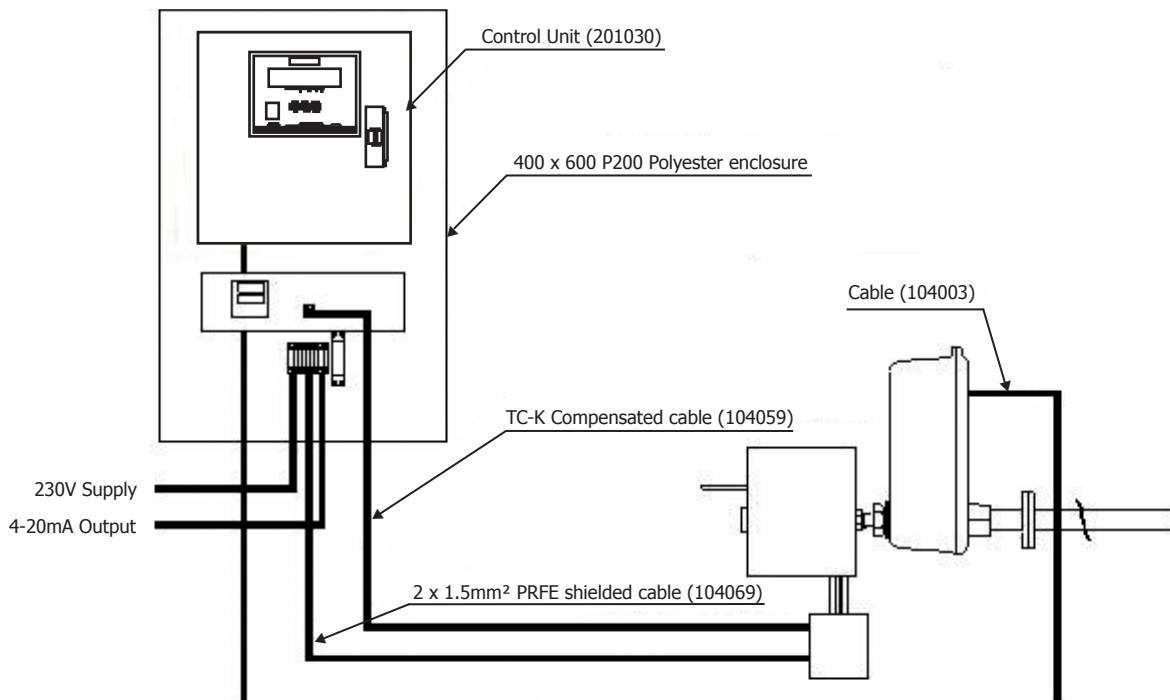
Because of the high rate of dust present in this kind of application, regular preventive maintenance is essential.

Because blocking is likely to occur in the heated ejector it should be cleaned out regularly to prevent it from getting completely clogged up. A small stick (like a welding stick) or a metal swab should be used if the dust is minimal. In the case of the ejector being completely clogged up it should be washed with hot water.

We advise that you have a complete ejector (ref. 205 021) as a spare.

In order to optimize the installation and reduce the risk of clogging, mount the probe on a small flange. We recommend Michell Instruments' optional counter-flange – see Appendix H). Provide proper insulation for both the flange and the ejector.

Application and wiring examples:



Appendix G

Combined Air Ejector / Back-Flushing System

Appendix G Combined Air Ejector / Back-Flushing System

When the back-flushing system is installed on an XZR500 with an air ejector, a compressed air supply is used in alternating cycles to clean particulate from the probe intake, and from the ejector system.

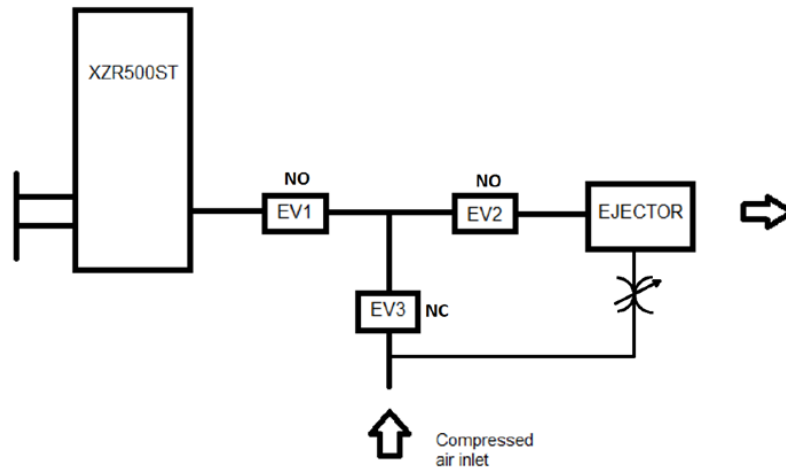


Figure 23 System diagram

Description of the flushing sequence

- T1: Period between flushing cycles
- T2: Duration to hold analog output values
- T3: Delay before opening electro-valve for back-flushing of probe
- T4: Duration to open electro-valve for back-flushing of probe
- T5: Delay before opening electro-valve for ejector
- T6: Duration to open electro-valve for ejector

The default factory settings are:

- ☞ t1 = 14400 seconds i.e. 4 h
- ☞ t2 = 40 seconds
- ☞ t3 = 2 seconds
- ☞ t4 = 3 seconds
- ☞ t5 = 2 seconds
- ☞ t6 = 3 seconds

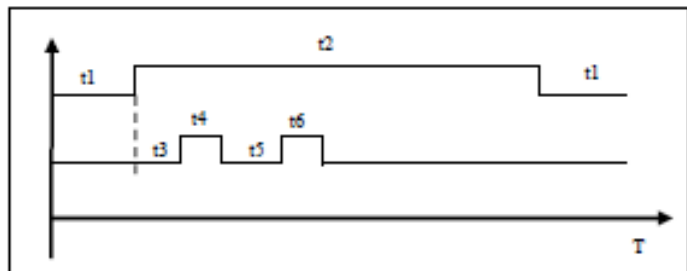


Figure 24 Timing diagram

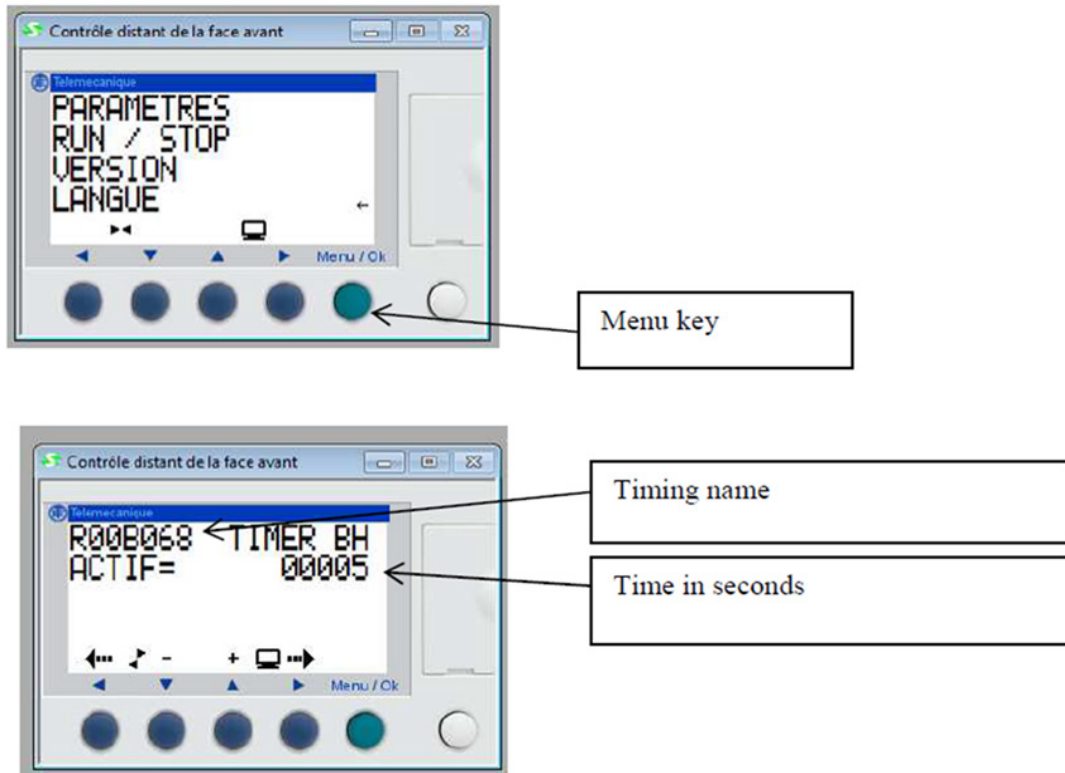
The compressed air supply should be normal factory air around 5...6 bar.

Increasing the cleaning frequency (T1) is far better than letting opening the electro-valve longer.

When the electro-valve is opened too long, the flow of cold air will cool down the inside of the probe, which can lead to corrosion of the probe tubes.

Adjusting timings in the controller

T1/T2 can be adjusted in the controller. It's not normally necessary to adjust the other timings, which must be adjusted using the supplied software.



1. Press the Menu key, then enter the "Parameters" menu.
2. Scroll through the parameter names until the correct timer has been selected.
3. Adjust the timing, in seconds, then press the Menu key again to confirm.

Timer parameter names: back-flushing of the XZR500 probe

R00B018: Inactive = t1=14400s ; (Active = 10s, do not adjust)

R00B022: Active = t2 = 40s

Timer parameter names: back-flushing of the ejector system

R00B006: Inactive = t1=14400s ; (Active = 10s, do not adjust)

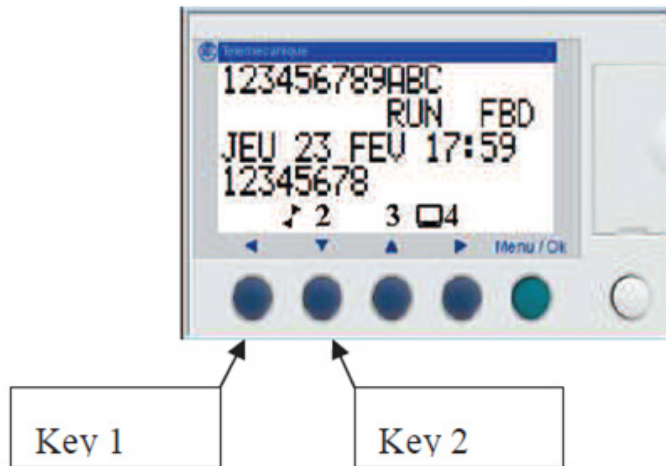
R00B011: Active = t2 = 20s

Manual Activation

The controller can be used to manually activate the back-flushing. While the appropriate key is pushed, 4...20 mA signals are held.

Key 1 is used to manually flush the probe.

Key 2 is used to manually flush the ejector.



Controller Wiring

Terminals	Function
1+2	Incoming Mains Supply 230 V
3+4	Outgoing 230 V to EV1
5+6	Outgoing 230 V to EV2
7+8	Outgoing 230 C to EV3
9+10	Connect to terminals 37+38 of XZR500 analyzer control unit

Probe Tube Orientation

When using the back-flushing system, it is advised that the combustion gases circulate the other way inside the probe tubes for optimal cleaning efficiency – according to the diagram below.

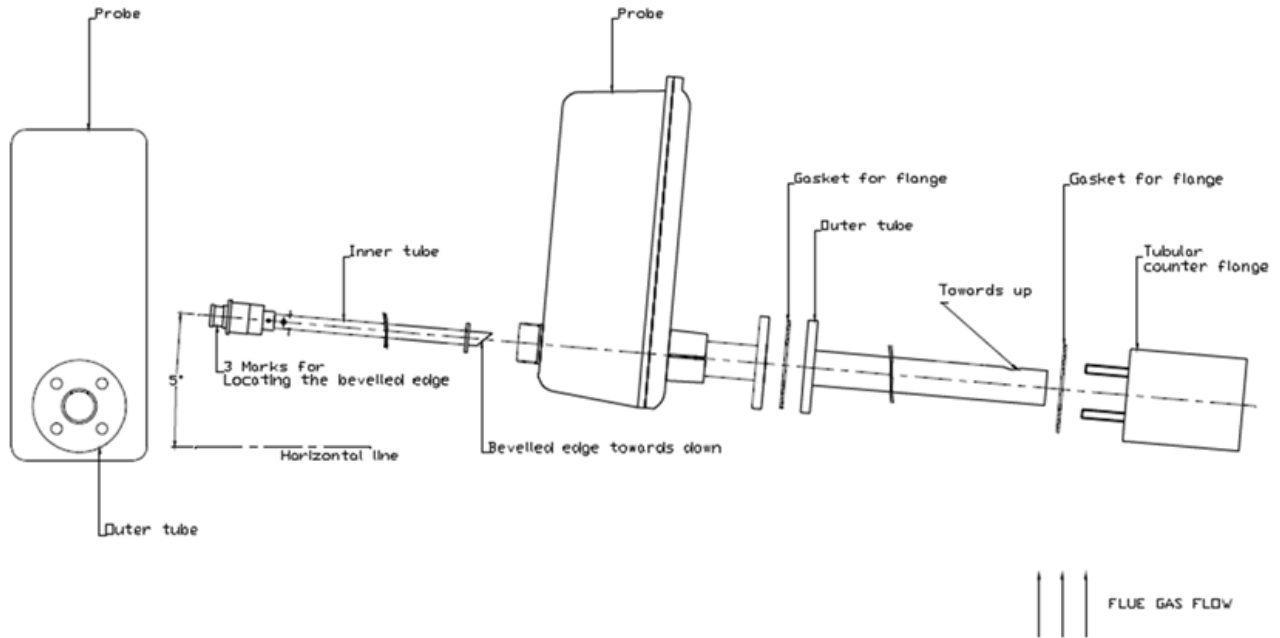


Figure 25 *Exploded analyzer view*

Appendix H

Mounting Options

Appendix H Mounting Options

H.1 Tubular Counter Flange and Insulators

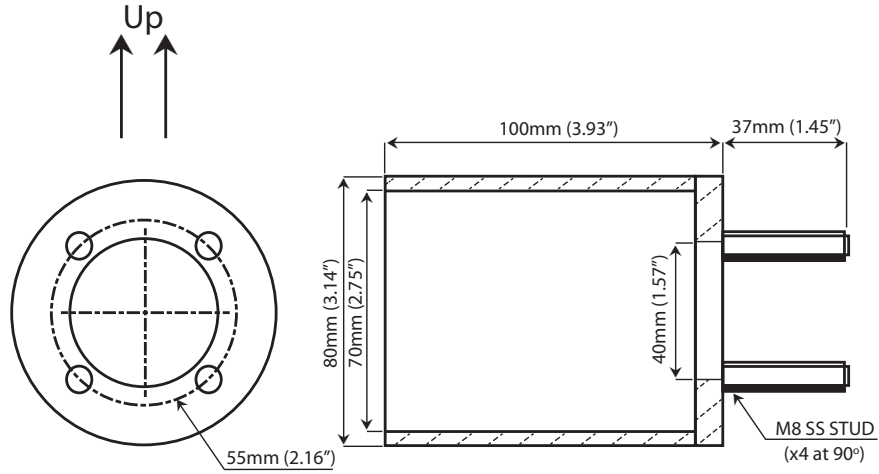
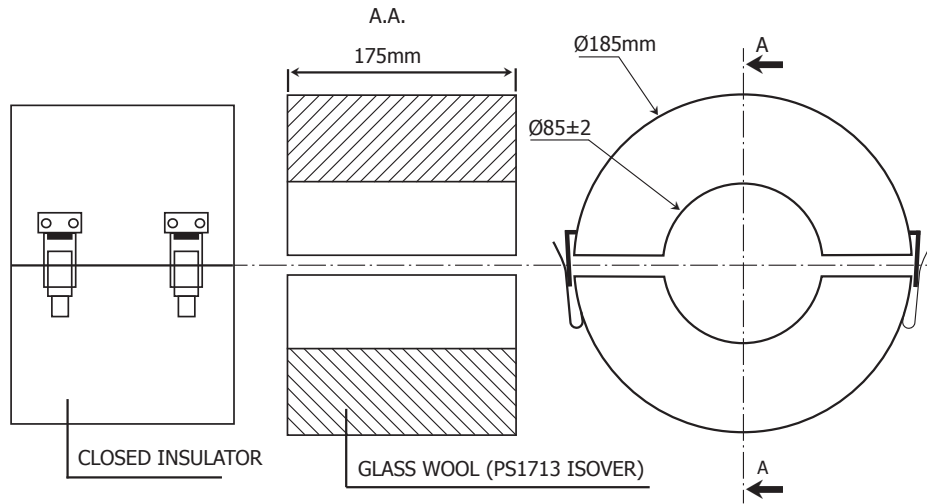


Figure 26 XZR500 Flange and Back Flange (Optional)

MADE OF TWO HALF-SHELLS ALUMINUM PROTECTIVE COVER (ISOXAL 8/10)



Aluminum protective cover (ISOXAL 8/10)

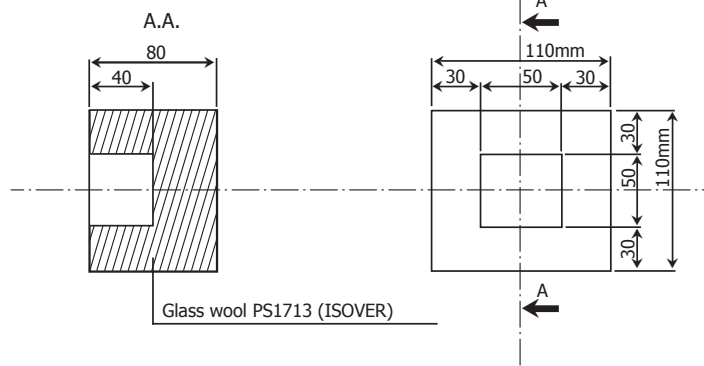


Figure 27 Insulators (Flange and Rear Sealing Screw)

H.2 Mounting Plate Dimensions

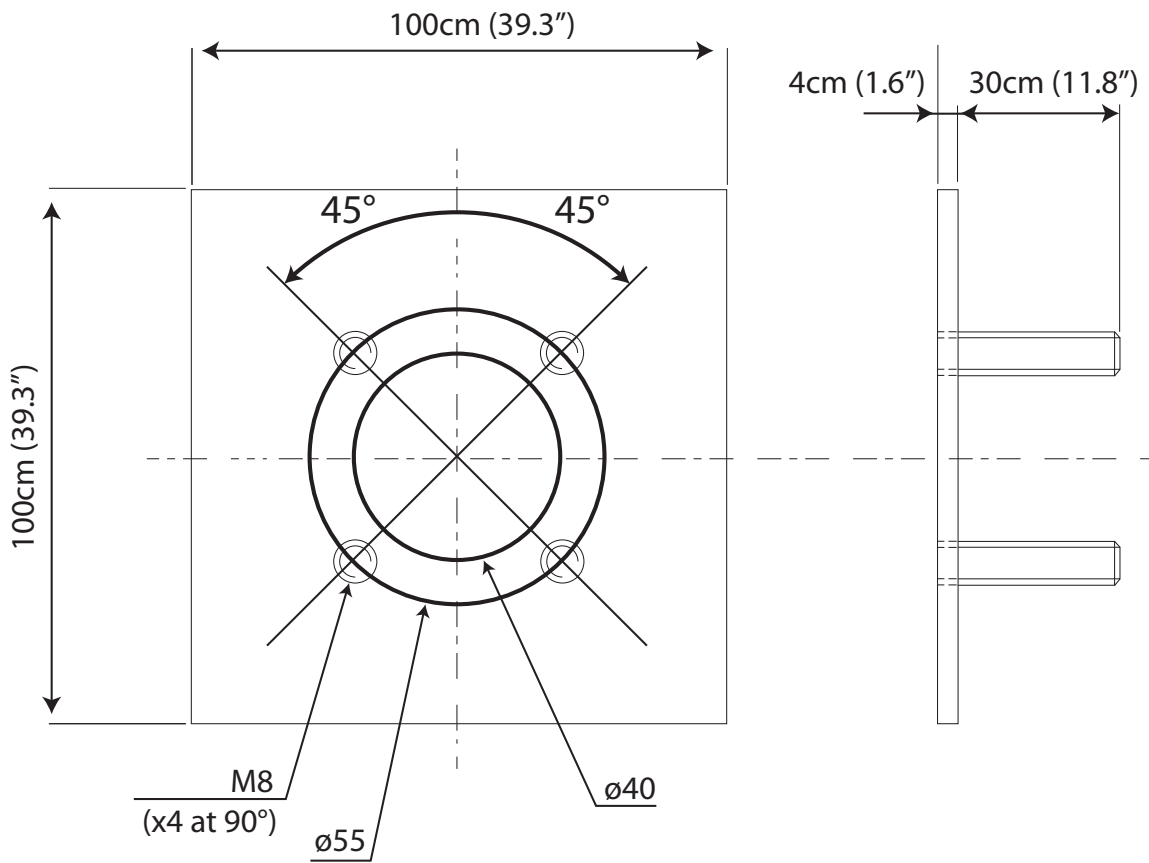


Figure 28 Mounting Plate Dimensions

Appendix I

Second 4...20 mA Output

Appendix I Second 4...20 mA Output

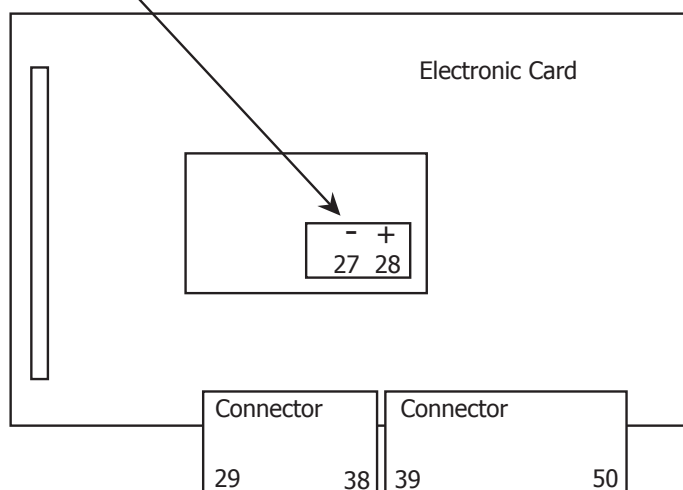
The optional 2nd analog output allows acquisition of a linear 4...20 mA current corresponding to the 0.1 %...25 % scale (this scale cannot be changed).

This 4...20 mA output is galvanic isolated (500 V).

Wiring of the 2nd 4...20 mA output on the connector (on the electronic card) is as follows:

- terminal 27 = "-" 4...20 mA
- terminal 28 = "+" 4...20 mA

2nd 4-20 mA Output Connector



For the connection use shielded cable 2 x 0.75 mm². Bare 8 mm of the wire end on the terminal's side and connect the braid to the copper bar near the cable gland.

Figure 29 *Wiring of the Second 4...20 mA Output*

Appendix J

Automatic Calibration (Optional)

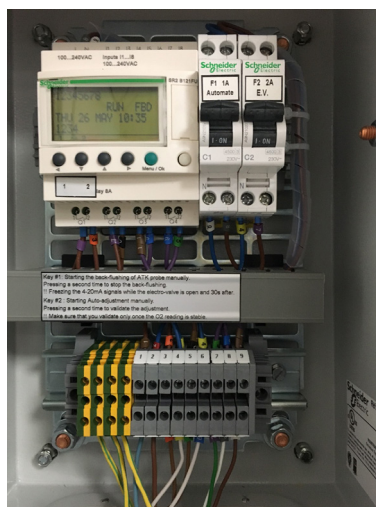
Appendix J Automatic Calibration (Optional)

The analyzer can be automatically calibrated, if this function has been purchased, and can be as simple as pressing a button to start up the sequence. This assumes that the calibration gas is connected permanently and the cal gas value is properly configured in the electronics.

The sequence can be initiated by either using the keys at on the control unit or via your computer with RS232 interface (refer to Appendix B).

The calibration sequence lasts 5 minutes.

The output signal is frozen at its last value before setting the sequence and is unfrozen at the end of the purging sequence.



The Auto adjustment system comprises:

- A wall-mount box of dimensions 300 x 200 x 150 mm containing the control automation of the adjustment sequences
- An electro-valve (220 V AC) at the standard gas inlet
- 6 meters of cable for connecting the control box to the electro-valve
- 2 meters of cable for connecting the kit to the analyzer's electronic box which manages the sequence.

NB: Standard gas not supplied by Michell Instruments.

The adjustment sequence lasts 10 minutes. The output signal remains blocked at its last value before setting the sequence. The signal is free at the end of the purging sequence.

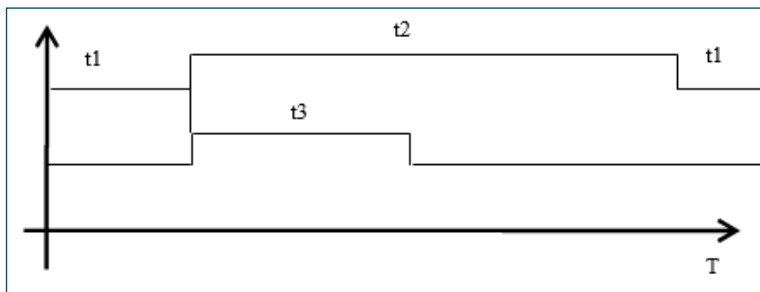
This assumes that the adjustment gas value is properly configured on the electronics. Either press the keys on the enclosure front panel or configure through your computer with the RS232 interface (please see Appendix B).

The instrument has been factory set to make a weekly adjustment cycle (t1). The cycle comprises different timings:

- Resting time between two cycles (t1).
- The analog output signals are frozen during the sequence (t2).
- The automatic adjustment of the analyzer is active during (t3).

The default factory settings are:

- t1 = 1 week
- t2 = 20 minutes
- t3 = 10 minutes



During a short interval (t3), the gas flow should be at 7l/h +/- 2l/h. You can set the frequency of auto-adjustment (daily, monthly, yearly or customized) according to the operating conditions.

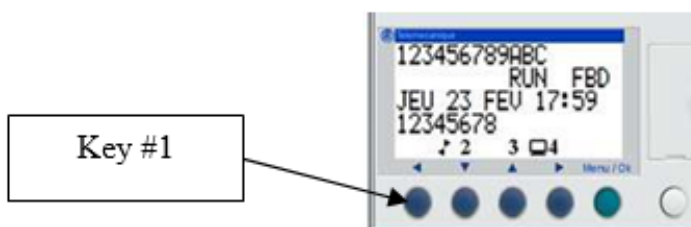
Please refer to the manufacturing sheet of the auto-adjustment kit for the factory settings.

Wiring Information:

- Terminals 1 & 2 : mains 230 V AC, 50 Hz
- Terminals 3 & 4: 230 V AC supply of electro-valve
- Terminals 5 & 6: to be connected to terminals 36 & 37 of the ATK2020 electronic system.

Auto-adjustment may also be started manually by the user by pressing key no.1 of the automaton.

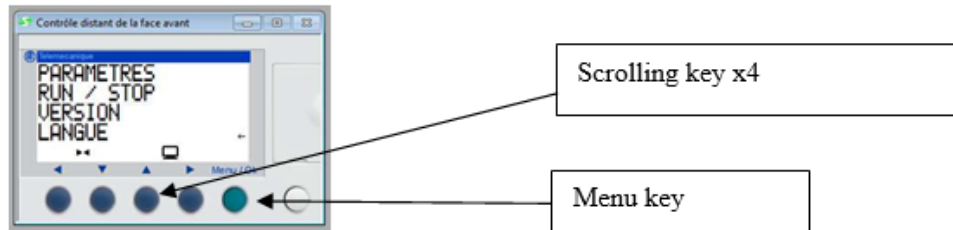
Pressing key no.1 a second time validates the adjustment before the completion of the 10-minute timing. Make sure you validate only once the reading is stable.



Refer to the automaton’s software to modify the monitoring sequence and the adjustment sequence (daily, monthly, yearly, or customized frequency, and durations).

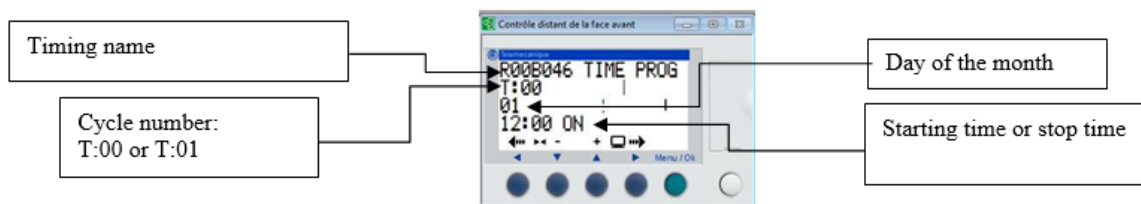
J.1 Adjusting the Sequence Parameters

Some timing can be changed manually on the automaton (see below). To do so, press the menu key and then use the same key to select the Parameters menu:



This gives access to the timing parameters.

Modification of PERIODICAL TIMING R00B046



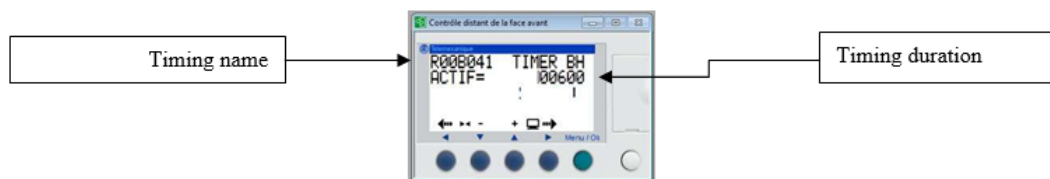
When the timing name R00B046 is blinking, use the (→) and (←) keys to bring the cursor to the number of the cycle you want to change and select it with the (+) and (-) keys:

- T :00 = time when the auto-adjustment starts
- T :01 = time when the auto-adjustment stops

Then use the (→) and (←) keys to move the cursor and select the parameters you want to change (day, starting time for T00, stop time for T01), with the (+) and (-) keys.

Validate by pressing the Menu key.

Modification of manual temporization R00B041 (key no. 1)



When the timing name R00B041 is blinking, use the (→) and (←) keys to bring the cursor to the duration and change it with the (+) and (-) keys.

Validate by pressing the Menu key.

Appendix K

Quality, Recycling & Warranty Information

Appendix K 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:

- Anti-Facilitation of Tax Evasion Policy
- ATEX Directive
- Calibration Facilities
- Conflict Minerals
- FCC Statement
- Manufacturing Quality
- Modern Slavery Statement
- Pressure Equipment Directive
- REACH
- RoHS3
- WEEE2
- Recycling Policy
- Warranty and Returns

This information is also available in PDF format.

Appendix L

Return Document & Decontamination Declaration

Appendix L 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	



NOTES

www.ProcessSensing.com



<http://www.michell.com>