Data Sheet
SS/ZMT/HI_6

Zirconia Oxygen Analyzer Systems

ZMT & ZGP2/EXGP Series

- **Integral reference air supply option**
  – avoids necessity for additional equipment
- **Dual-fuel data input with manual or automatic selection from up to 17 different fuels**
  – extends the operating range of the system
- **User programmable**
  – enables maximum flexibility of control
- **Two levels of program security**
  – reduces possibility of accidental changes
- **High levels of accuracy, resolution and RFI immunity**
  – provides customer confidence in operation
- **Choice of protective sheath**
  – to suit different temperature ranges
- **Probes include built-in thermocouple**
  – enables automatic temperature compensation

Controlled energy management at your fingertips for the boiler industry

ZMT Transmitter

The ZMT Zirconia Indicating Transmitter/Alarm Unit is a versatile oxygen analyzer designed primarily to meet the requirements for energy management in the boiler market.

The ZMT is designed for use with the ZGP2 high temperature probe and can be supplied in basic and efficiency forms. It can also be used with the EXGP probe which is designed for use in hazardous areas (Zone 1).

When the ZMT is used with the EXGP probe, zener safety barriers must be fitted in the cell and thermocouple signal lines. These barriers can be fitted on the internal cover of the power supply, where the reference-air supply pump, or regulator, is normally mounted. A reference-air supply can be from a separately-mounted instrument-air regulator set.

The standard analyzer has high/low alarms and isolated retransmission. Display features include:

- probe mV
- probe temperature
- cell constant
- retransmission range
- cell 'warming up' indication
- high/low cell temperature fault indication
- thermocouple failure fault indication
- provision to measure cell impedance
- calibration of cell using test gases
- ability to display a calculated inferred CO_2 value

The standard unit also accepts inputs of probe mV and thermocouples, with the facility to program a temperature for use when the probe has no thermocouple of its own, but the operating temperature is known.

The standard analyzer provides oxygen readout with computation based on the probe output voltage. The voltage output is Nernstian in form and follows the equation:

$$E(mV) = 0.0496\ T\ (\log_{10}\frac{P_0}{P_1}) \pm C\ (mV)$$

Where: T = Absolute temperature (°K)

$P_0 = O_2$ Partial pressure reference gas (air)

$P_1 = O_2$ Partial pressure sample gas

C = Cell constant (zero offset)

0.0496 = Faraday's Gas Constant

The advanced analyzer, in addition to the facilities offered by the standard analyzer, provides an efficiency calculation readout by application of the Siegert formula:

$$\text{Efficiency} = 100 - \left[\frac{K(T1 - T2)}{20.8 - \%O_2}\right]$$

Where: T1 = Flue temperature
(at economizer or boiler outlet)
T2 = Inlet-air temperature
$\%O_2$ = Measured $\%O_2$ in flue gas
K = Fuel constant dependent on fuel type
e.g. Natural gas K = 0.66
Fuel oil K = 0.70
Bituminous coal K = 0.73

The efficiency is displayed as a percentage, with the facility to display inlet air temperature and process temperature as required.

Further options are available for serial communications (RS485 ABB protocol) and Auto-calibration.

Auto-calibration requires the addition of the gas panel and test gas cylinders. The test gases are selected by solenoid valves on the gas panel, the valves being switched by relays within the ZMT.

The ZMT can accept a carbon monoxide signal transmitted from another analyzer unit. This signal can be displayed as 'ppm CO'.

The ZMT compensates for process temperatures in the range of 600 to 1400°C (1112 to 2552°F) when used with the ZGP2 probe.

Probe reference air supply is available, either through pump units or by use of an air-regulator operated from the customer's instrument air-line.

Construction and Operation

The ZMT zirconia analyzer is housed in a sheet steel enclosure, environmentally protected to IP55. It has a hinged front door fitted with a 15-button tactile membrane switch panel and display window.

There are two blue-filtered, vacuum fluorescent displays visible through the door window. The upper, five-digit display is used for monitoring process values. The lower, 20-character dot matrix display is used during setting, operating and programming.

Membrane switches on the ZMT unit include:

- $\%O_2$
- Temperature
- Alarm
- Efficiency
- CO_2/CO
- Calibration

The $\%O_2$, efficiency and CO_2/CO switches are dedicated push buttons, i.e. when depressed only the required monitored value is displayed. The units of measurement are indicated on the dot matrix display.

Temperature, alarms and calibration switches, in conjunction with the switch, permit programming and setting up of the various parameters for system operation. Additional pages are available through operation of the switch, such as the Analog Retransmission page, the Relay Allocation page, Diagnostic page and Commissioning page.

Two levels of security are provided to protect various stages of the programming. The first involves operation of the front panel switches; the second, more secure level, is an internal switch.

Single-fuel and dual-fuel boiler operation is monitored by programmable selections from seventeen different fuel types. On dual-fuel applications, changeover is implemented either manually or automatically.

The instrument uses a CMOS 6303 microprocessor, a switch mode power supply with pulse-width modulation circuitry for analog retransmission and offers up to three analog outputs (isolated) plus up to four relay outputs in combinations of up to six outputs total.

ZMT Transmitter – Specification

Displays

Measured value

Five-digit, seven-segment, blue-filtered, vacuum fluorescent

Information

20-character, single-line, dot matrix, blue-filtered, vacuum fluorescent

Ranges

Oxygen	programmable within the limits of 0 to 25% O_2 to a minimum span of 5% O_2 linear
Probe temperature	0 to 1400°C (32 to 2552°F) (200°C [392°F] span min. for retransmission)

Accuracies

Oxygen concentration

≤2% of reading or ±0.1% O_2, whichever is the greater

Display and Retransmission

Measurement resolution

Thermocouple, mV, V and mA	<0.1% span
ACJC error	0.05°C/°C (0.09°F/°F) change in ambient temperature
Thermocouple linearizer	±0.2°C (±0.36°F)

Display resolution

±1 digit

O_2 System accuracy (typical)

(ZMT + ZGP2 or EXGP probe when calibrated with certified test gas)

Display

≤±2% of reading or ±0.1% O_2 whichever is the greater

Retransmission error

≤±2% of reading

Error due to ambient temperature variation

±0.02% span/°C (±0.36% span/°F) typical

Error due to power supply voltage regulation

None for ±15% variation

Interference suppression

Tested and passed for a field intensity of 10V/m over the frequency range of 27MHz to 1GHz in accordance with BS 6667

Line interruption

<50ms loss, no effect

>50ms loss, instrument returns to operation after automatic reset

Line interference

<500V input pulse width up to 125µs, no effect and as indicated in BS6667

Power Supply

Voltage requirements

110V or 230V (±15%) 50/60Hz

Power consumption

150VA

Insulation, mains to earth (line to ground)

2kV RMS

Outputs and Set Points

Analog outputs (isolated)

0 to 10mA, 0 to 20mA or 4 to 20mA – up to three max. into 1kΩ max. load

Output Modules 1 and 2 programmable

$\%O_2$	any range (5% min. span within the range of 0 to 25% O_2 i.e. dual ranging possible)
Temperature	any range (200°C [392°F] min. span) within the ranges: Cell temp. 0 to 1400°C (32 to 2552°F) Flue temp. 0 to 700°C (32 to 1292°F)* Air temp. –40 to 400°C (–40 to 752°F)* 0 to 100% combustion efficiency*

*Available only when Combustion Efficiency option is selected

Output Module 3 programmable

For any of the retransmissions as for Modules 1 and 2

Relay outputs

Maximum of four available

Set points adjustment

Programmable

Relay contacts

Single pole changeover

Rating	250V AC	250V DC
	3A AC	3A DC max.
Loading (non-inductive)	750VA	30W max.

Insulation

Contacts to earth 2kV RMS

Display Function

%O_2

Temperature — Cell temperature

Flue temperature, Air temperature } Efficiency version

% Combustion efficiency

Inferred CO_2

PPM CO

Environmental Data

Operating temperature limits

0 to 55°C (32 to 131°F)

Operating humidity limits

0 to 80% RH

Protection

IP55

Meets requirements of NEC Class I Div. 2 Groups B, C, and D requiring Z purge

Weight

16.5kg (36lb)

Programming

Unless specified otherwise at the time of ordering all instruments are set up as follows:

Standard programming – basic version

Output Module 1	O_2 range 0 to 25%
Output Module 2	O_2 range 0 to 25% (optional)
Alarms set at 5% O_2	5% O_2 EB (Module 1) 15% O_2 EA (Module 2) (supplied disabled)
Module 3 (optional) alarms allocated to cell temperature	
Alarm 3	low temperature
Alarm 4	high temperature

Standard programming – advanced efficiency version

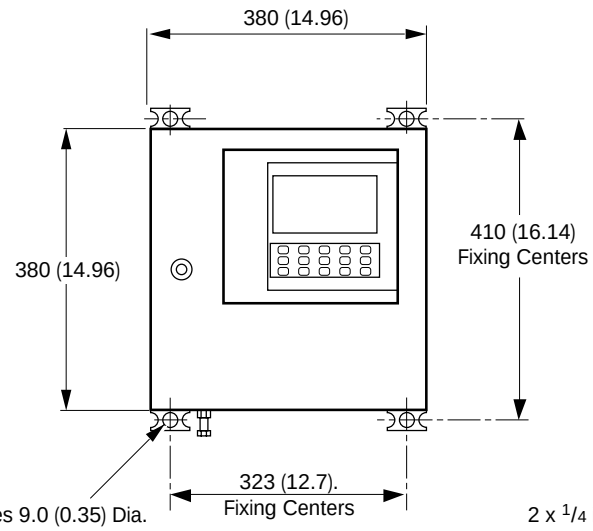
As basic version plus	
Output Module 3	ranged 0 to 100% Efficiency
Output	4 to 20mA

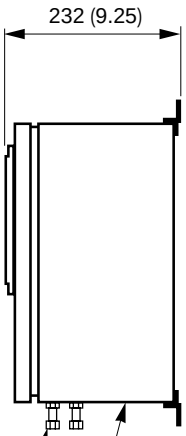
For either version

Fuel 1	Gas (selected in manual mode)
Fuel 2	No. 6 oil
CO Display	0 to 4000 ppm (max. range)
CO input	4 to 20mA

ZMT Transmitter – Overall Dimensions

Dimensions in mm (in.)





Net Weight
16kg (35 1/4lb).

4 Holes 9.0 (0.35) Dia.

2 x 1/4 inch OD
Compression Fittings.
See Note 2 on Page 3

Eight Cable Entry
Holes, 20 (0.79) Dia. in
Gland Plate

ZMT Transmitter – Ordering Information

ZMT Zirconia Indicating Transmitter/Alarm Unit	ZMT	/ X	X	/ X	XX	XX	X	X	/ X	X	X	X
For use with Probe Type (see Note 3)												
ZGP2/EXGP		1										
Reference Air Supply (see Note 2)												
None			0									
Pump + air gauge			1									
Regulator			4									
Probe Temperature Control												
None				0								
1st Fuel Option (see Note 1)					00 01 ↓ 16 17							
2nd Fuel Option (see Note 1)						00 01 ↓ 16 17						
Program												
Basic							0					
Efficiency							1					
Humidity in air							2					
Auto-cal basic							3					
Auto-cal efficiency							4					
Program												
None								0				
RS485 ABB protocol								3				
Output Module 1												
None									0			
Analog + relay									4			
Output Module 2												
None										0		
One relay										1		
Analog + relay										4		
Output Module 3												
None											0	
One relay											1	
Two relays (auto-cal or alarms)											2	
Analog + relay											4	
Serial output											5	
Mains Voltage												
110V 50/60Hz												1
230V 50/60Hz												2

Note 1

Fuel options available:

00 No fuel specification
01 Natural gas
02 Propane
03 Butane
04 Medium oil
05 Heavy oil
06 General fuel oil
07 Naphtha
08 Kerosene
09 Distillate oil
10 No. 4 fuel oil
11 No. 5 fuel oil
12 No. 6 fuel oil
13 Coal (general)
14 Bituminous coal
15 Steam coal
16 Anthracite
17 Coke

Note 2

Reference air options 1 and 4 for use on ZGP2 probe types have both inlet and outlet connections external to the enclosure.

For EXGP probes a separate regulator for use with instrument air is required (part no. 003000241).

Note 3

The ZMT is intended for use in safe area location only.
When installation is required in a hazardous area the unit must be fitted with a suitable 'Z' purge system.
Zener Safety Barriers must be installed when used with the EXGP probe.

ZGP2 High Temperature Zirconia Oxygen Probe

Introduction

The ZGP2 Oxygen Probe has a high temperature oxygen concentration cell using zirconium oxide as a solid electrolyte. It is a second generation product developed as a result of extensive experience in zirconia oxygen sensing systems.

The Probe is designed to measure excess O_2 concentration in furnace atmospheres and is installed directly in the furnace. It provides a true wet measurement of the atmospheric conditions in situ at the plant operating temperature. This permits continuous and accurate measurement over a wide range of temperatures without the frequent maintenance and cleaning associated with external sampling systems.

It eliminates the 'equilibrium shift' common to other systems in which gas samples have to be cooled before measurements can be taken and has an extremely rapid response to changes in atmosphere, enabling fast, corrective action to be taken (particularly important in automatic control situations).

The probe can be mounted vertically or horizontally, although for high temperature operation the vertical position is preferred. The outer protection sheath may be supplied in aluminous porcelain, recrystallized alumina or Incoloy 800.

A thermocouple is mounted within the probe to enable temperature monitoring or automatic temperature compensation.

A gas calibration port is provided to allow the probe output to be checked using test gas mixtures without removing the probe from the process. Reference-air is required for accurate operation.

Principle of Operation

The detector cell is constructed from stabilized zirconia with inner and outer electrodes attached and is specific to oxygen.

Air is supplied to the inner reference electrode to provide a constant reference partial pressure of oxygen, while the process gas to be measured is in contact with the outer electrode.

A voltage is generated across the electrodes which is a function of the ratio of the oxygen partial pressures at the two electrodes.

For oxygen concentration measurement, correction for the absolute temperature of the probe is required.

See leaflet SS/ZGP2 for more detailed information.

ZGP2 Probe – Specification

Temperature range

600 to 1000°C (1112 to 1832°F)
NiCr/NiAl thermocouple BS4937 Pt. 4 Type K

600 to 1250°C (1112 to 2282°F)
Pt/Pt 13% Rh thermocouple BS4937 Pt. 2 Type R

Measuring range

Response rate

Estimated to be 0.1s

Reference gas

Clean oil-free air
Flow rate 500 to 1000ml/min (0.02 to 0.04 cu ft/min)

Protective sheath

Aluminous porcelain, recrystallized alumina or Incoloy 800

Mounting

Vertical or horizontal, 42mm (1.65 in.) hole size

Connecting cables (not supplied)

2-core copper, overall screened for probe output
2-core compensating cable to suit thermocouple fitted (NiCr/NiAl or Pt/Pt 13% Rh)

Thermocouple

NiCr/NiAl	Pt. 4 BS4937 Type K
Pt/Pt 13% Rh	Pt. 2 BS4937 Type R

Insertion length

556mm (21.9 in.) or 953mm (37.5 in.)

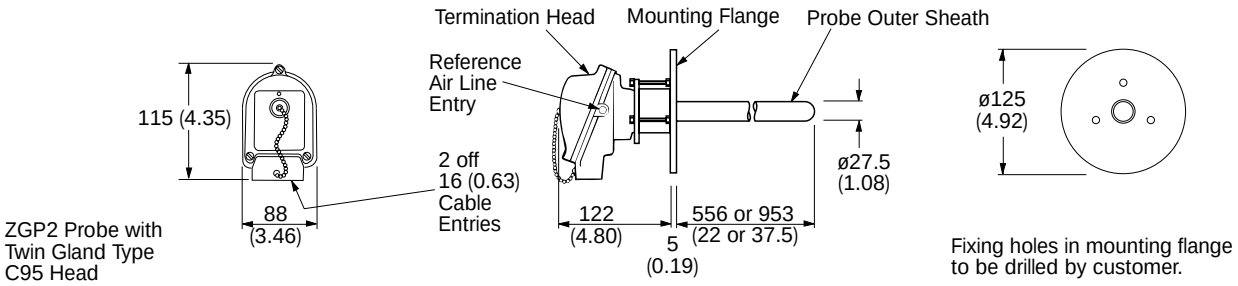
Weight

2.5kg (5.5lb) nett. 600mm (24 in.) probe

2.8kg (6.16lb) nett. 1000mm (39 in.) probe

ZGP2 Probe – Overall Dimensions

Dimensions in mm (in.)



ZGP2 Probe – Ordering Information

ZGP2 Zirconia Oxygen Probe	ZGP2/	X	X	X	X	X
Insertion Length						
600mm (24 in.)		1				
1000mm (39 in.)		2				
1250mm (49 in.)		3				
Thermocouple						
P/Pr13% TC BS4937 Type R			1			
CA BS4937 Type K			2			
Special			9			
Sheath						
Aluminous porcelain (standard)				1		
Incoloy 800				2		
Recrystallized alumina				3		
Special				9		
Mounting						
Flange					1	
1 in. NPT					2	
Special					9	
Connector Head						
Twin Gland Type C95 Head (M16 cable entry)						1

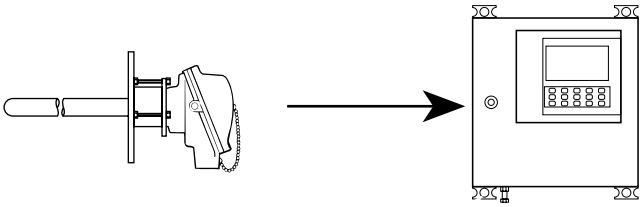
EXGP Probe (Process Temperatures 600 to 1400°C)

The probe comprises a ceramic detector housed in a protective sheath. A thermocouple is fitted within the probe to enable the process temperature to be monitored and automatic temperature compensation to be provided. The sheath material may be either aluminous porcelain (recommended for oxidizing atmospheres) or Incoloy 800 (recommended for reducing atmospheres) for use at maximum temperatures of 1250°C (2282°F) and 1000°C (1832°F) respectively. Special sheaths are available for use up to 1400°C (2552°F). A connector head facilitates connection of the cell output, thermocouple and reference air.

Cable and Gland Specifications

All cables must conform to BS5345 for flameproof 'd' type enclosure for mechanical construction only. The specifications below are the system electrical requirements.

The M20 gland entries at the ZMT must conform to BS5501 Parts 1 and 5 (EN5014 and EN5018) for 'd' flameproof enclosures if mounted in a hazardous area.



Gland Specification (non ABB supply)	Signal	Cable Specification (non ABB supply)
Probe – M16 non-certified Transmitter – M20 certified 'd'	R type thermocouple (mV) input signal	16/0.2mm^2, 2-core, overall screened, R type thermocouple compensating cable conforming to BS4937
Probe – M16 non-certified Transmitter – M20 certified 'd'	Oxygen (mV) input signal	16/0.2mm^2, 2-core copper, overall screened

EXFG Probe – Cable and Gland Specifications

EXGP Probe (Simple Device) – Specification

North America classification

Class 1 Division I Group C

Temperature range

600 to 1250°C (1112 to 2282°F)
or 1400°C (2552°F) with reduced life

Oxygen range

0 to 25% O_2

Response rate – typical values

Cell speed of response <1ms

<42s to 63% of final value

<47s to 90% of final value

Reference air supply

Clean oil-free air
Flow rate 500 to 1000ml/minute (1 to 2 ft^3/hr)

Construction

Solid electrolyte	stabilized zirconia oxide
Protective sheath	aluminous porcelain or Incoloy 800

Head

Type C95 twin entry (2 x 16mm entries)

Mounting

Vertical or horizontal 42mm (1.65 in.) minimum hole diameter

Connecting cable

Not supplied

2-core copper, overall screened for probe output

2-core compensating cable to suit thermocouple

Thermocouple

Pt/Pt 13% Rh – Pt4 BS4937 type R
(600° to 1250°C [1112° to 2282°F])

Insertion length

556mm or 953mm (22 in. or 37.5 in.)

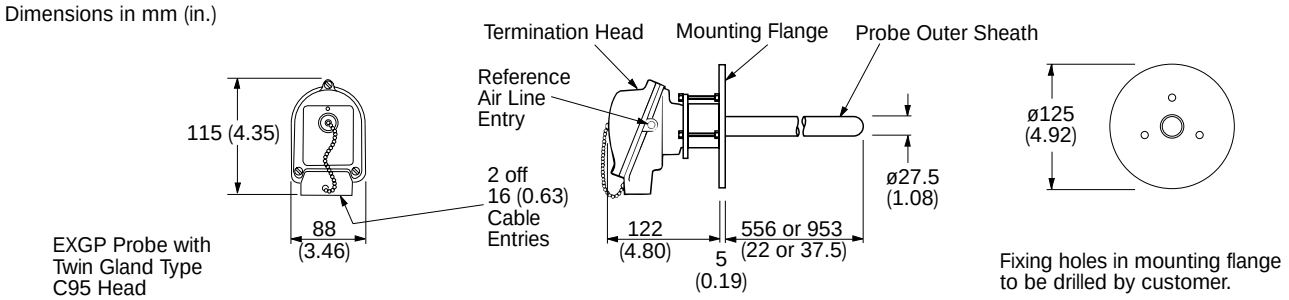
Shipping weight

5.5kg (12lb) 600mm (22 in.) probe

6.0kg 13.2lb 1000mm (37.5 in.) probe

See data sheet SS/EXFG/GP for more detailed information.

EXGP Probe – Overall Dimensions



EXGP Probe – Ordering Information

EXGP Zirconia Oxygen Probe	EXGP /	X	X	X	0	0	0
Length							
None		0					
600mm (23.6 in.)		1					
1000mm (39.4 in.)		2					
Special		9					
Sheath							
None			0				
Incoloy 800			1				
Aluminous porcelain			2				
Special			9				
Standard Items							
None				0			
Twin gland Type C95 (Flange 'R' type Pr/Pt 13% Rh BS4937)				1			

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