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ZMT Zirconia Oxygen Analyzer Systems

- **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.**
- **User programmable for maximum flexibility.**
- **Two levels of program security to reduce accidental changes.**
- **High levels of accuracy, resolution and RFI immunity.**
- **CEGB approved.**

ABB Instrumentation

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General Information

The ZMT Zirconia Indicating Transmitter/Alarm Unit is a versatile microprocessor based oxygen analyzer designed primarily to meet the requirements of the boiler market, utilizing zirconia oxygen probes for energy management.

The ZMT is suitable for use with two types of zirconia oxygen probe (ZFG2 and ZGP2) and can be provided in standard and advanced efficiency form.

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 with high/low cell fault indication, thermocouple failure fault indication, a provision to measure cell impedance, calibration of cell using test gases and the 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 = Partial pressure reference gas (air)
P_1 = Partial pressure sample gas
C = Cell constant
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:

$$\text{Efficiency} = 100 - \left[\frac{K(T_1 - T_2)}{20.8 - \%O_2}\right]$$

where T_1 = Flue temperature (at economizer or boiler output)
T_2 = 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 flue gas temperature as required.

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°C to 1400°C (1112° to 2552°F) when used with the ZGP2 probe. The temperature of the probe heater is automatically controlled by the ZMT when used with the ZFG2 zirconia 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, having 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 and calibration. The $\%O_2$, efficiency and CO_2/CO switches are dedicated push buttons, i.e. when depressed only the required monitored value 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, is an internal switch.

Single fuel and dual fuel boiler operation is monitored by programmable selections from seventeen different fuel types. On dual boilers fuel changeover is implemented either manually of 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.

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Identification Table for ZMT

Basic Type Ref.	Probe Type	Ref. Air Supply (See Note 2)	Probe Temp. Control	Fuel Option (See Note 1)		Efficiency	Unused	Output Module 1	Output Module 2	Output Module 3	Mains Voltage
Code Digit Nos. 1,2,3	/4	5	/6	7,8,9,10		11	12	/13	14	15	16
ZMT	1 ZGP2	0 None 1 Pump+Air Gauge 4 Regulator	0 None	1st 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17	2nd 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17	0 None	0 None	0 None 4 Analog + Relay	0 None 1 One Relay 4 Analog + Relay	0 None 1 One relay 2 Two relays	1 110V 50/60Hz 2 230V 50/60Hz
	2 ZFG2	0 None 2 Regulator 3 Pump	1 Temp. Control			1 Efficiency 2 Humidity	0 None	0 None 4 Analog + Relay	0 None 1 One Relay 4 Analog + Relay	0 None 1 One Relay 2 Two Relays 4 Analog + Relay	
	3 Other	0 None 1 Pump+Air Gauge 4 Regulator	0 None 1 Temp. control								

Note 1.

Fuel options available:

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

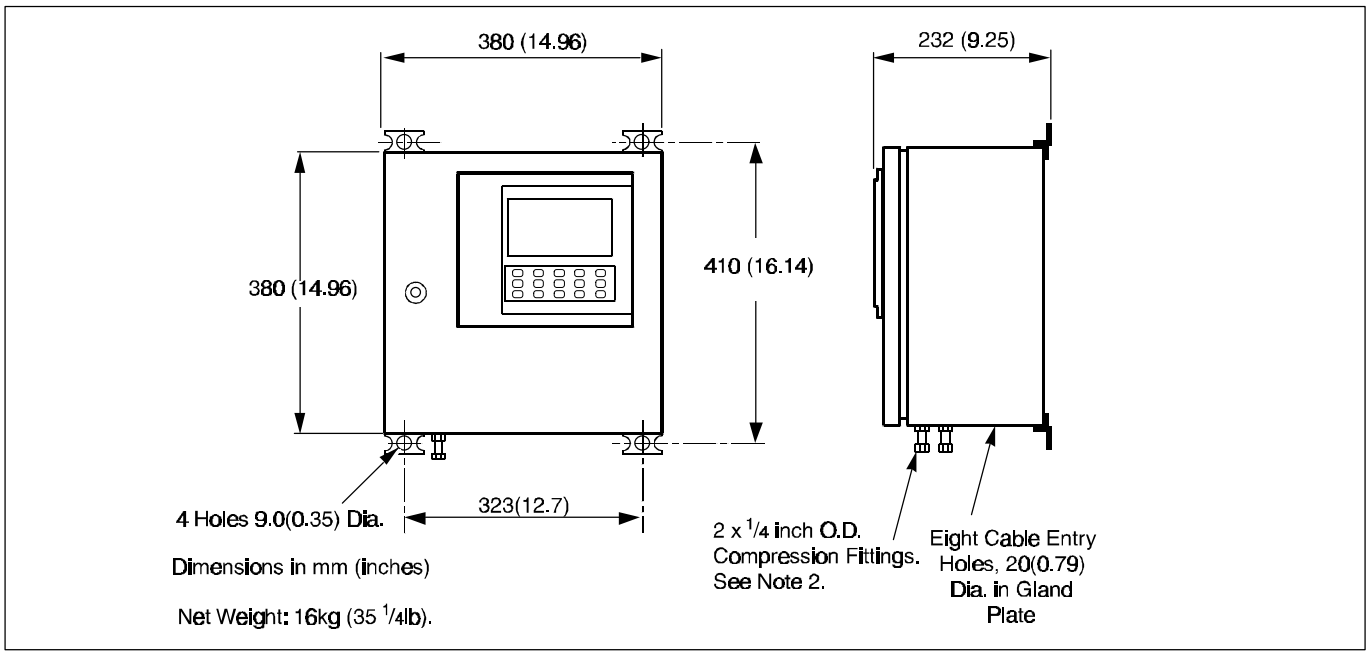
Note 2.

Reference air options 2 and 3 have the air outlet inside the enclosure to suit ZFG2 probe type. Flow rate 500 to 1000 ml/min (0.11 to 0.22 gal/min.) approx.

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

Approvals

CEGB Approval Number 51042A0114 (5124A24) Issue 5.
Lloyds Approval for shipboard use obtained and awaiting certificate.
Quality Assurance to BS5750 Part 1. Certificate number Q5907.



ZMT Dimensional Details

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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 (ZMT only)

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 (ZMT + either ZFG2 or ZGP2 probe when calibrated with certified test gas).

Display:
≤±2% of reading (ZFG2) - ±5% of reading (ZGP2) or ±0.1% O_2 whichever is the greater.

Retransmission error:
≤2% of reading (ZFG2) - ±5% of reading (ZGP2).

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.

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 Group B, C, and D requiring Z purge.

Power Supply

Voltage requirements:
110V or 230V (±15%) 50/60Hz.

Power consumption:
150VA.

Insulation, mains to earth (line to ground):
2kV r.m.s.

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 255°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.

Output Module 3 programmable:
for any of the retransmissions as for modules 1 and 2.
*Only available when Combustion Efficiency option selected.

Relay outputs:
Maximum of four available.

Set points adjustment:
Programmable.

Relay contacts:
Single pole changeover

Rating:	250V a.c.	250V d.c.
	3A a.c.	3A d.c. max.
Loading (non-inductive):	750VA	30W max.

Insulation:
Contacts to earth 2kV r.m.s.

Display Function

O_2%
Temperature – Cell temperature, Flue temperature, Air temperature } Efficiency version

% Combustion Efficiency
Inferred CO_2
PPM CO.

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

Standard 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 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.

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

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ZFG2 Flue Gas Oxygen Probe

Introduction

The ZFG2 Flue Gas Oxygen Probe is one of the most advanced in the world. A simplified design makes all the component parts easily accessible and field serviceable. The new universal probe construction gives the ultimate system flexibility while retaining all the features, benefits and reliability of the previous generation.

Fully interchangeable with previous model, and the ability to upgrade from other manufacturer's products, the probe, in common with earlier models of the in situ type, inserted directly into the boiler smoke box, or flue duct, eliminating the need for costly sampling installations.

Operating in the process temperature range of 20°C to 600°C (68° to 1112°F) the system gives true wet analysis of net excess oxygen in combustion gases. The probes can be fitted with a flame trap, thereby extending their use to measurement on gas fired boilers.

Installation and commissioning are particularly easy and the level of in-service maintenance is extremely low.

Principle of Operation

The detector cell is constructed from stabilized zirconia employing integral platinum electrodes and is specific to oxygen. Air is supplied to the internal (reference) electrode to provide a constant partial pressure of oxygen while the measured gases are in contact with the outer electrode producing a potential proportional to O_2 concentration.

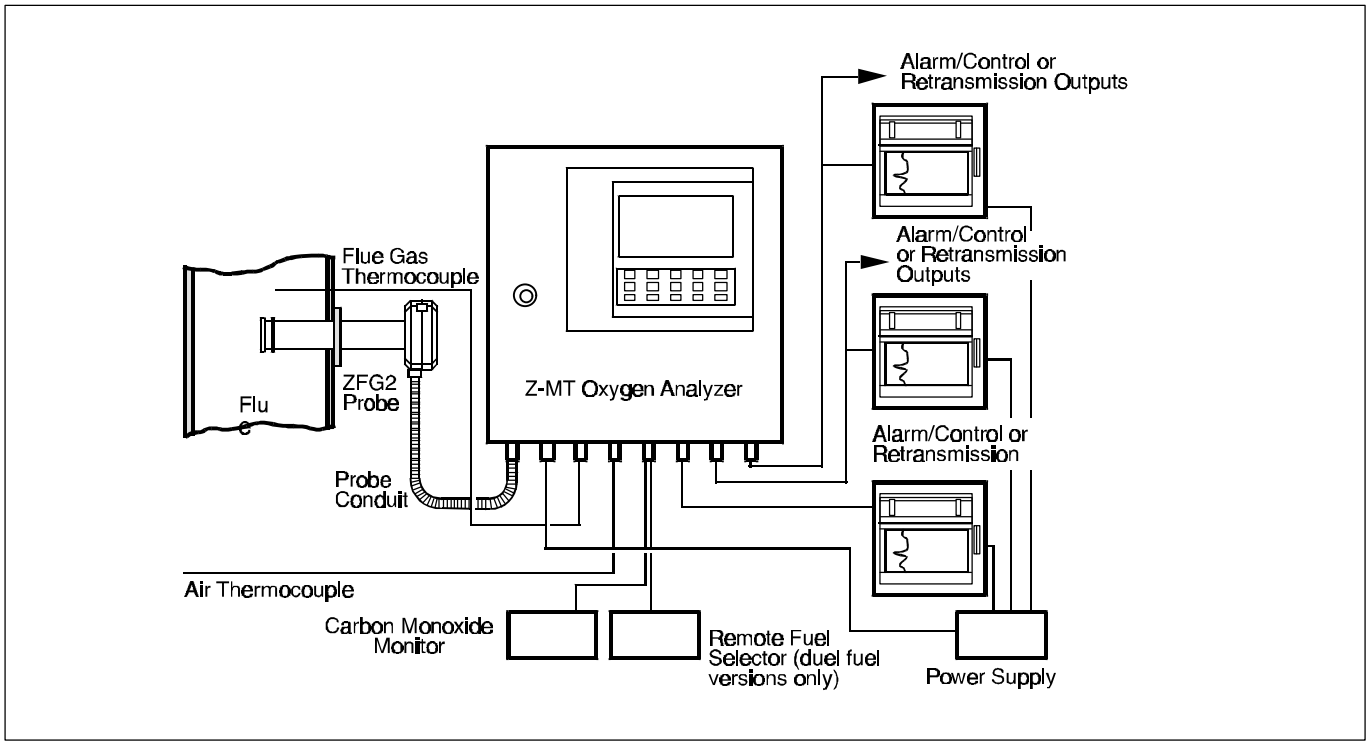
The Probe

The zirconia probes, constructed from 316 stainless steel, house a ceramic dust filter and flame trap, the detector cell, cell heater and thermocouple. Wiring between the electronics unit and the probe can be carried in a single 6m (20ft) flexible conduit, which is PVC coated for IP65 (NEMA4) rated probes. The conduit also contains the tubing for the reference air supply. The standard probe insertion lengths available are 0.4, 1.0, 1.5 and 2.0m (16, 39, 58 and 78 inches) and fixing to the duct or smoke box is by means of a drilled flange. Stand-off fixings can be used to reduce the insertion length for smaller ducts. A screwed bush is available for fixing the 0.4m probe to the duct or smoke box. Longer length probes are available.

All components of the probe are easily removable and can be replaced on site without the use of special tools or bonding agents. Replacement of the zirconia oxygen sensor can be made without the need for recalibration of the electronics unit.

A calibration gas inlet port is fitted to the probes to enable accuracy checks to be made without removal of the probes from their mountings.

The site-replaceable cell carries a 27 month warranty.



System Schematic Diagram, ZFG2 Probe

SPECIFICATION

Calibration (in situ):
One point using clean air
Two point using certified test gas.

Flue Temperature:
20° to 600°C (68° to 1112°F)

Pressure:
Suitable for all normal positive or negative flue pressures.

Dimensions:
See dimension details diagram.

Probe Fixing:
Flange (or $2^1/_2$ in NPT screwed fitting ZFG2 0.4m).

Probe Insertion:
0.4, 1.0, 1.5 or 2.0m (standard). Specials up to 4.0m max.

Flange Options:
0.4m ZFG2 Standard
6.0 ±0.4 thick x 101.0 ±1 dia.
6 holes 7.3 dia. equispaced on 80.0 ±0.2 P.C.D.
1.0, 1.5 and 2.0m ZFG2 Standard
12.0 ±1 thick x 165.0 ±dia.
6 holes 12.5 ±0.5 dia. equispaced on 140 P.C.D.
Westinghouse Model 132 equivalent
6.0 ±0.4 thick x 127.0 ±1 dia.
4 holes 9.5 (0.375") dia. equispaced on 99.0 ±0.2 P.C.D.
Westinghouse DIN equivalent
12.0 ±1 thick x 185.0 ±0.5 dia.
4 holes 18 dia. equispaced on 145.0 ±0.2 P.C.D.
Westinghouse ANSI equivalent
12.0 ±1 thick x 153 ±0.5 dia.
4 holes 20.0 ±0.2 equispaced on 121.0 ±0.2 P.C.D.
Westinghouse JIS equivalent
12.0 ±1 thick x 155.0 ±0.5 dia.
4 holes 15 equispaced on 130.0 ±0.2 P.C.D.

Cable Length:
10m or 6m (32 or 20ft) as fitted. Max. distance probe to electronics unit 69m (224ft) using terminal box (Part no. 003000060) and additional cable.

Probe Weight:
0.4m (16in) – 6kg (13.2lb) [including 6m (20ft) cable]
1.0m (39in) – 10.8kg (23.7lb) [including 6m (20ft) cable]
1.5m (58in) – 11.6kg (25.5lb) [including 6m (20ft) cable]
2.0m (78in) – 12.5kg (27.5lb) [including 6m (20ft) cable]

ERA Citation of suitability for gas fired installations where Group IIB equipment is applicable.

Measuring Range

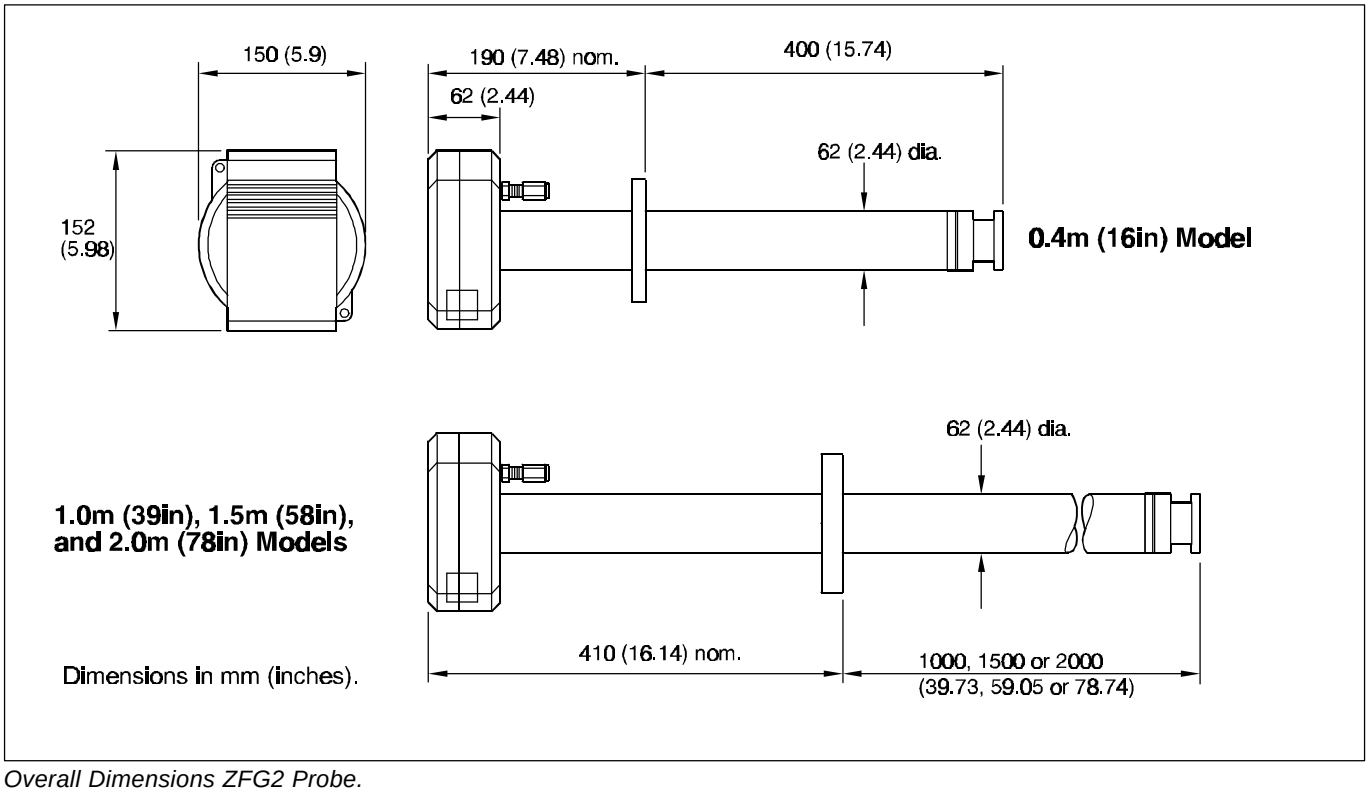
Response Rate:
< 40s to 63% of final value < 1 minute to 90% of final value (typical).

Reference Gas:
Clean, oil-free air. Any stable flow in the range 100 to 1000 cc/minute.

Thermocouple:
NiCr/NiAl Pt. 4 BS4937 Type K.

Insertion Length:
0.4m, 1.0m, 1.5m or 2.0m.

Protection Class:
Meets requirements of NEMA 4x
NEC Class 1 Div. 2 Gases B, C, D – IP65



Overall Dimensions ZFG2 Probe.

Identification Table for ZFG2

Code Digits 1,2,3,4	5	6	7	8	9	10	11	12	13
Basic Type Number	**Insertion Length**	**Flange Type**	**Conduit Entry Type**	**Conduit No. Off**	**Conduit Length**	**Cell**	**Flame Arrester**	**Reference Air**	**Mounting Plate Assembly**
ZFG2 Zirconia Oxygen Probe	1 0.4m (16in) 2 1.0m (39in) 3 1.5m (58in) 4 2.0m (78in)	1 STD 2 DIN 3 ANSI 4 JIS 5 Model 132 9 Special	1 20mm (0.78in) 2 1/2in NPT	0 None 1 One Std. 2 Two Std. 3 One IP65 4 Two IP65	0 None 1 6m (20ft) 2 10m (32ft)	1 Standard Cell 2 Flow Through Cell	0 None 1 Flame Arrester	1 Internal 2 External	0 None 1 Standard [0.4m (16in) probes] 2 Standard (long probes)

ZGP2 General Purpose 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 atmosphere condition in situ at the plant operating temperature and 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 or in Incoloy 800.

An integral thermocouple is mounted within the probe enabling temperature monitoring or automatic temperature compensation to be made.

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

ZGP2 General Purpose Probe

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 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.

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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 0.1 seconds.

Reference Gas:

Clean oil-free air. Flow rate 500 to 1000ml/min (0.22gal/min).

Protective Sheath:

Aluminous porcelain or Incoloy 800.

Mounting:

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

Connecting Cables:

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

Thermocouple:

Pt/Pt 13% Rh – Pt. 2 BS4937 Type R.

NiCr/NiAl – Pt. 4 BS4937 Type K.

Insertion Length:

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

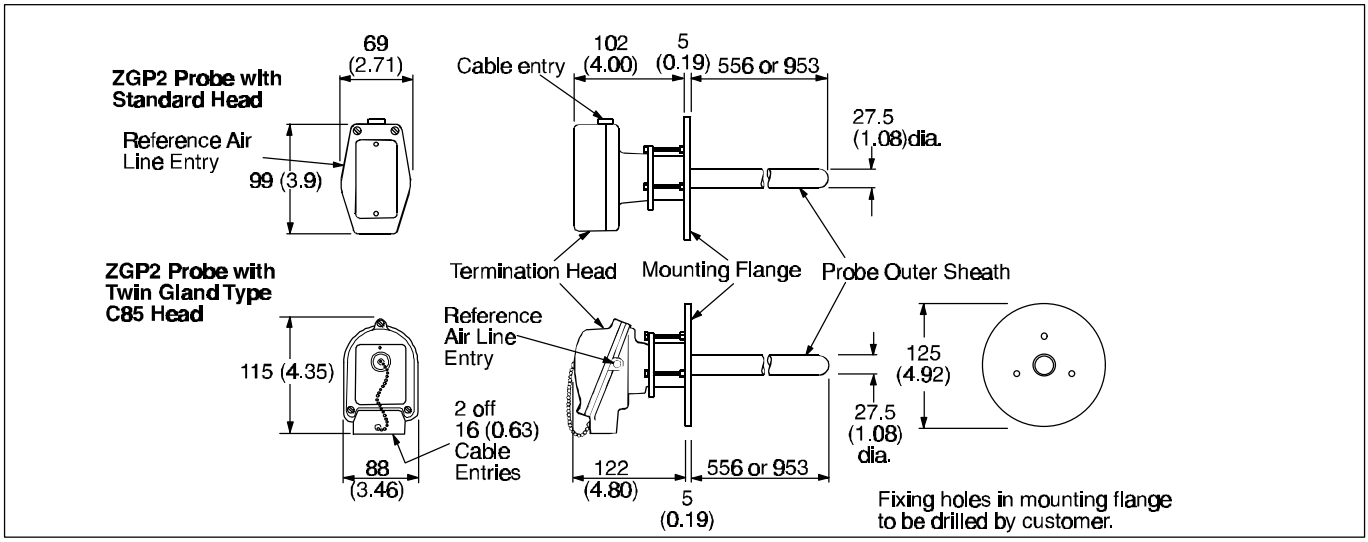
Weight:

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

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

Identification Table for ZGP2

Code Digits	Insertion Length	Thermocouple	Sheath	Mounting	Connector Head
1,2,3,4 -	6	7	8	9	10
ZGP2 Zirconia Oxygen Probe	1 600mm (24in) 2 1000mm (39in) 9 Special	1 Pt/Pt13% Rh BS4937 Part 2 Type R 2 NiCr/NiAl BS4937 Part 4 Type K 9 Special	1 Aluminous Porcelain (Standard) Incoloy 800 2 Special 3	1 Flange	0 Standard 1 Twin Gland Type C95 Head



Overall Dimensions ZGP2 Probe.

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ORDERING INFORMATION

ZIRCONIA ZMT OXYGEN ANALYZER SYSTEM

Select one character or set of characters from each category and specify complete catalog number per sample below.

Code No.	Description
	BASE NUMBER - 1st thru 3rd characters
ZMT	ZMT Oxygen Analyzer
	PROBE TYPE - 4th character
1	ZGP2 (Probe to be ordered separately)
2	ZFG (Probe to be ordered separately)
3	Other
	REFERENCE AIR SUPPLY - 5th character
0	None
1	Pump+Air Gauge (available only with Probe ZGP)
2	Regulator (ZFG) (available only with Probe ZFG)
3	Pump (ZFG) (available only with Probe ZFG)
4	Regulator (available only with Probe ZGP)
	PROBE TEMPERATURE CONTROL - 6th character
0	None (ZGP2 option only)
1	Temperature Control (ZFG option only)
	1st FUEL OPTION - 7th and 8th characters
_ _	See Table A.
	2nd FUEL OPTION - 9th and 10th characters
_ _	See Table A.
	PROGRAM - 11th character
0	Basic
1	Efficiency
2	Humidity in air
3	Auto Cal. - Basic (see Note 1)
4	Auto Cal. - Efficiency (see Note 1)
	UNUSED - 12th character
0	None
	OUTPUT MODULE 1 - 13th character
0	None
4	Analog+relay
	OUTPUT MODULE 2 - 14th character
0	None
1	One relay
4	Analog+relay
	OUTPUT MODULE 3 - 15th character
0	None
1	One relay
2	Two relays (Required with 11th character 3 or 4)
4	Analog+Relay **-** Not available with Probe ZGP (see Note 2)
	MAINS VOLTAGE - 16th character
1	110V 50/60 Hz
2	230V 50/60 Hz
	ZMT2310000014001 SAMPLE CATALOG NUMBER

Table A

Code	Option	Code	Option
00	No Fuel Specification	**09**	Distillate Oil
01	Natural Gas	**10**	No. 4 Fuel Oil
02	Propane	**11**	No. 5 Fuel Oil
03	Butane	**12**	No. 6 Fuel Oil
04	Medium Oil	**13**	Coal (general)
05	Heavy Oil	**14**	Bituminous Coal
06	General Fuel Oil	**15**	Steam Coal
07	Naphtha	**16**	Anthracite
08	Kerosene	**17**	Coke

Notes: 1. 11th character Auto Cal. Selection requires the selection of two relays in Output Module 3.
2. May be selected when using efficiency program (11th character) to provide second analog output.

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SS ZMT 97.5

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