User's Manual

EXAxt

Model ZR202G Integrated type Zirconia Oxygen/Humidity Analyzer

IM 11M12A01-04E

YOKOGAWA

Yokogawa Electric Corporation

IM 11M12A01-04E
11th Edition

Introduction

Thank you for purchasing the ZR202G Integrated type Oxygen/Humidity Analyzer.

Please read the following respective documents before installing and using the ZR202G Integrated type Oxygen/Humidity Analyzer.

The related documents are as follows.

General Specifications

Contents	Document number	Note
Model ZR22G, ZR402G, and ZR202G Direct In Situ Zirconia Oxygen Analyzers and High Temperature Humidity Analyzers	GS 11M12A01-01E	

* the “E” in the document number is the language code.

User’s Manual

Contents	Document number	Note
Model ZR202G Integrated type Oxygen/Humidity Analyzer	IM 11M12A01-04E	(This manual)
Model ZR22A, ZR202A Heater Assembly	IM 11M12A01-21E	
Model EXAxt ZR Series HART Protocol	IM 11M12A01-51E	

* the “E” in the document number is the language code.

An exclusive User’s Manual might be attached to the products whose suffix codes or option codes contain the code “Z” (made to customers’ specifications). Please read it along with this manual.

The EXAxt ZR Integrated type Zirconia Oxygen/Humidity Analyzer is usually the Oxygen Analyzer, but it is to the High Temperature Humidity Analyzer when the option code “/HS (Set for Humidity Analyzer)” is selected.

In this manual, the Oxygen Analyzer is mainly listed. When there are not mentions such as “in the case of Humidity Analyzer”, it becomes same as the Oxygen Analyzer.

The EXAxt ZR Integrated type Zirconia Oxygen/Humidity Analyzer has been developed for combustion control in various industrial processes. There are several version of this analyzer so you can select one that matches your application.

Optional accessories are also available to improve measurement accuracy and automate calibration. An optimal control system can be realized by adding appropriate options.

This instruction manual describes almost all of the equipment related to the EXAxt ZR. You may skip any section(s) regarding equipment which is not included in your system.

Regarding the HART Communication Protocol, refer to IM 11M12A01-51E.

IM 11M12A01-51E has been published as ‘’Model EXAxt ZR series HART protocol’’.

Regarding Separate type Zirconia Oxygen Analyzer, refer to IM 11M12A01-02E.

<Before using the equipment, please read any descriptions in this manual related to the equipment and system that you have, on appropriate use and operation of the EXAxt ZR.>

No. IM 11M12A01-04E 11th Edition : Jul. 2017 (YK)

Models and descriptions in this manual are listed below.

Models and descriptions in this manual

Model	Product Name	Description in this manual				
		Specification	Installation	Operation	Maintenance	CMPL
ZR202G	Integrated type Oxygen Analyzer	○	○	○	○	○
ZO21R	Probe protector	○	○			
ZH21B	Dust protector (only for Humidity analyzer)	○	○			
ZA8F	Flow setting unit (for manual calibration use)	○	○	○		
ZR20H	Automatic Calibration unit	○	○	○		○
-	Case Assembly for calibration gas cylinder (Part No. E7044KF)	○	○			
-	Check valve (Part No. K9292DN, K9292DS)	○	○			
-	Dust filter for the detector (Part No. K9471UA)	○	○			
-	Dust guard protector (Part No. K9471UC)	○	○			
ZO21S	Standard gas unit	○		○	○	○

CMPL: Customer Maintenance Parts List

This manual consists of twelve chapters. Please refer to the reference chapters for installation, operation and maintenance.

Table of Contents

Chapter	Outline	Relates to		
		Installation	Operation	Maintenance
1. Overview	Equipment models and system configuration examples	B	C	B
2. Specifications	Standard specification, model code (or part number), dimension drawing for each equipment	A	B	B
3. Installation	Installation method for each equipment	A		C
4. Piping	Examples of piping in three standard system configurations	A		C
5. Wiring	Wiring procedures such as “Power supply wiring”, “output signal wiring” or others	A		C
6. Components	Major parts and function are described in this manual	C	B	B
7. Startup	Basic procedure to start operation of EXAxt ZR. Chapter 7 enables you to operate the equipment immediately.		A	C
8. Detailed Data Setting	Details of key operations and displays		B	C
9. Calibration	Describes the calibration procedure required in the course of operation.		B	C
10. Other Functions	Other functions described		B	C
11. Inspection and Maintenance	How to conduct maintenance of EXAxt ZR and procedures for replacement of deteriorated parts		B	A
12. Troubleshooting	This chapter describes measures to be taken when an abnormal condition occurs.		C	A
CMPL (parts list)	User replaceable parts list		C	B

A: Read and completely understand before operating the equipment.
B: Read before operating the equipment, and refer to it whenever necessary.
C: Recommended to read it at least once.

For the safe use of this equipment

WARNING

Be sure not to accidentally drop it. Handle safely to avoid injury.

Connect the power supply cord only after confirming that the supply voltage matches the rating of this equipment. In addition, confirm that the power is switched off when connecting power supply.

Some sample gas is dangerous to people. When removing this equipment from the process line for maintenance or other reasons, protect yourself from potential poisoning by using a protective mask or ventilating the area well.

CAUTION

The cell (sensor) at the tip of the probe is made of ceramic (zirconia element). Do not drop the equipment or subject it to pressure stress.

- Do NOT allow the sensor (probe tip) to make contact with anything when installing the analyzer.
- Avoid any water dropping directly on the probe (sensor) of the analyzer when installing it.
- Check the calibration gas piping before introducing the calibration gas to ensure that there is no leakage of the gas. If there is any leakage of the gas, the moisture drawn from the sample gas may damage the sensor.
- The probe (especially at the tip) becomes very hot. Be sure to handle it with gloves.

NOTICE

Specification check

When the instrument arrives, unpack the package with care and check that the instrument has not been damaged during transportation. In addition, please check that the specification matches the order, and required accessories are not missing. Specifications can be checked by the model codes on the nameplate. Refer to Chapter 2 Specifications for the list of model codes.

Details on operation parameters

When the EXAxt ZR Separate type Oxygen Analyzer arrives at the user site, it will operate based on the operation parameters (initial data) set before shipping from the factory.
Ensure that the initial data is suitable for the operation conditions before conducting analysis. Where necessary, set the instrument parameters for appropriate operation.
For details of setting data, refer to chapters 7 to 10.
When user changes the operation parameter, it is recommended to note down the changed setting data.

◆ Safety Precautions

■ Safety, Protection, and Modification of the Product

- In order to protect the system controlled by the product and the product itself and ensure safe operation, observe the safety precautions described in this user's manual. We assume no liability for safety if users fail to observe these instructions when operating the product.
- If this instrument is used in a manner not specified in this user's manual, the protection provided by this instrument may be impaired.
- If any protection or safety circuit is required for the system controlled by the product or for the product itself, prepare it separately.
- Be sure to use the spare parts approved by Yokogawa Electric Corporation (hereafter simply referred to as YOKOGAWA) when replacing parts or consumables.
- Modification of the product is strictly prohibited.
- The following safety symbols are used on the product as well as in this manual.

⚠ WARNING

This symbol indicates that an operator must follow the instructions laid out in this manual in order to avoid the risks, for the human body, of injury, electric shock, or fatalities. The manual describes what special care the operator must take to avoid such risks.

⚠ CAUTION

This symbol indicates that the operator must refer to the instructions in this manual in order to prevent the instrument (hardware) or software from being damaged, or a system failure from occurring.

CAUTION

This symbol gives information essential for understanding the operations and functions.

NOTE

This symbol indicates information that complements the present topic.

This symbol indicates Protective Ground Terminal.

This symbol indicates Function Ground Terminal. Do not use this terminal as the protective ground terminal.

■ Warning and Disclaimer

The product is provided on an "as is" basis. YOKOGAWA shall have neither liability nor responsibility to any person or entity with respect to any direct or indirect loss or damage arising from using the product or any defect of the product that YOKOGAWA can not predict in advance.

Notes on Handling User's Manuals

- Please hand over the user's manuals to your end users so that they can keep the user's manuals on hand for convenient reference.
- Please read the information thoroughly before using the product.
- The purpose of these user's manuals is not to warrant that the product is well suited to any particular purpose but rather to describe the functional details of the product.
- No part of the user's manuals may be transferred or reproduced without prior written consent from YOKOGAWA.
- YOKOGAWA reserves the right to make improvements in the user's manuals and product at any time, without notice or obligation.
- If you have any questions, or you find mistakes or omissions in the user's manuals, please contact our sales representative or your local distributor.

Drawing Conventions

Some drawings may be partially emphasized, simplified, or omitted, for the convenience of description.

Some screen images depicted in the user's manual may have different display positions or character types (e.g., the upper / lower case). Also note that some of the images contained in this user's manual are display examples.

In the figure listed in this manual, the example of the oxygen analyzer is shown mainly.
In the case of the humidity analyzer, unit indication may be different. Please read it appropriately.

Product Disposal

The instrument should be disposed of in accordance with local and national legislation/regulations.

Trademark Acknowledgments

- All other company and product names mentioned in this user's manual are trademarks or registered trademarks of their respective companies.
- We do not use TM or ® mark to indicate those trademarks or registered trademarks in this user's manual.

■ Special descriptions in this manual

This manual indicates operation keys, displays and drawings on the product as follows:

● Operation keys, displays on the panel

Enclosed in [ ]. (Ex. “MODE” key)

(Ex. message display → “BASE”)

(Ex. data display → “102” lit, “102” flashing)

● Drawing for flashing

Indicated by gray characters (Flashing) 102 (lit) 102

● Displays on the LCD display panel

Alphanumerics	LED Display	Alphanumerics	LED Display	Alphanumerics	LED Display
A	A	N	n	0	0
B	b	O	o	1	1
C	C	P	P	2	2
D	d	Q	q	3	3
E	E	R	r	4	4
F	F	S	S	5	5
G	G	T	t	6	6
H	H	U	U	7	7
I	I	V	V	8	8
J	J	W	W	9	9
K	K	Y	y		
L	L	Z	Z		
M	M				

◆ CE marking products

■ Authorised Representative in EEA

The Authorised Representative for this product in EEA is Yokogawa Europe B.V. (Euroweg 2, 3825 HD Amersfoort, The Netherlands).

■ Identification Tag

This manual and the identification tag attached on packing box are essential parts of the product.

Keep them together in a safe place for future reference.

■ Users

This product is designed to be used by a person with specialized knowledge.

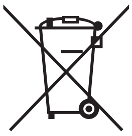
■ How to dispose the batteries:

This is an explanation about the EU Battery Directive. This directive is only valid in the EU.

Batteries are included in this product. Batteries incorporated into this product cannot be removed by yourself. Dispose them together with this product.

When you dispose this product in the EU, contact your local Yokogawa Europe B.V.office. Do not dispose them as domestic household waste.

Battery type: Manganese dioxide lithium battery



Notice:

The symbol (see above) means they shall be sorted out and collected as ordained in the EU Battery Directive.

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Model ZR202G
Integrated type
Oxygen/Humidity Analyzer

IM 11M12A01-04E 11th Edition

CONTENTS

1. Overview

The EXAxt ZR Integrated type Zirconia Oxygen/Humidity Analyzer is used to monitor and control the oxygen concentration in combustion gases, in boilers and industrial furnaces, for wide application in industries which consume considerable energy-such as steel, electric power, oil and petrochemical, ceramics, pulp and paper, food, or textiles, as well as incinerators and medium/small boilers. It can help conserve energy in these industries. The EXAxt ZR also contributes to preservation of the earth's environment in preventing global warming and air pollution by controlling complete combustion to reduce CO_2, SOx and NOx.

The EXAxt ZR Integrated type Zirconia Oxygen/Humidity Analyzer integrates both probe and converter. The analyzers need not use a sampling device, and allow direct installation of the probe in the wall of a flue or furnace to measure the concentration of oxygen in the stack gas of the temperature up to 700°C.

The EXAxt ZR Integrated-type Zirconia High-temperature Humidity Analyzer integrates the detector and the converter in one unit. This analyzer can measure humidity of hot air continuously, so can be used to measure humidity of air in driers which are heated by steam or electricity. It can also be used in a variety of manufacturing applications with humidifiers, as well as with driers, for humidity measurement and control. It can help improve productivity in these application fields.

The probe uses a high-reliability Zirconia sensor and a heater assembly that can be replaced on site.

The analyzer is equipped with three infrared switches, which enable the user to operate the equipment without opening the cover on site. Analyzer calibration can also be fully automated and the automatic calibration unit is provided. Choose the equipment which best suits your needs so that an optimal combustion control system can be obtained.

Some examples of typical system configuration are illustrated below:

1.1 < EXAxt ZR > System Configuration

The system configuration should be determined by the conditions; e.g. whether the calibration is to be automated, and whether flammable gas is present and requires safety precautions. The system configuration can be classified into three basic patterns as follows:

1.1.1 System 1

This is the simplest system consisting of an integrated type analyzer. This system can be implemented for monitoring oxygen concentration in the combustion gases boiler, and can be implemented for monitoring humidity in a production process such as food production.

No piping is required for the reference gas (air) which is fed in at the installation site. The ZO21S standard gas unit is used for calibration.

Zero gas from this unit and span gas (air) is sent to the probe through a tube which is connected during calibration.

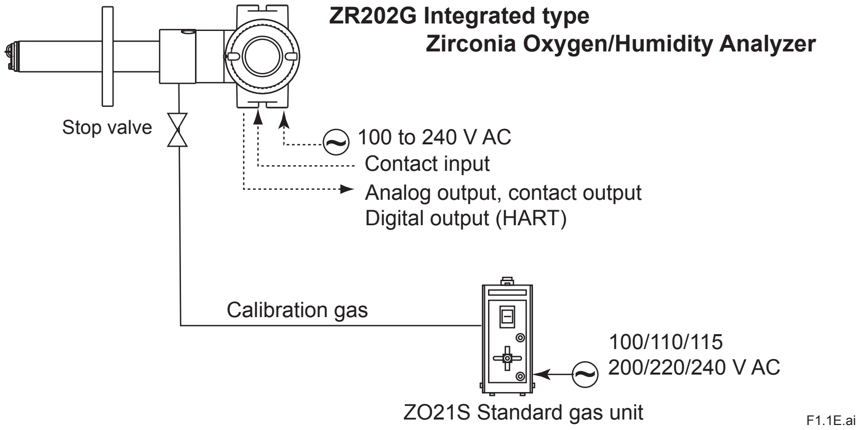


Figure1.1 Example of System 1

NOTE

- As this system uses ambient air for the reference gas, measuring accuracy will be affected by the installation location.
- A stop valve should be connected to the calibration gas inlet of the equipment. The valve should be fully closed unless calibration is in progress.

1.1.2 System 2

This system is for monitoring and controlling oxygen concentration in the combustion gases of a large-size boiler or heating furnace. Instrument air (clean and dry air of oxygen concentration 21%) is used as the reference gas and the span gas for calibration. Zero gas is fed from a cylinder during calibration.

In case of humidity analyzer, this system is for accurate monitoring and controlling humidity when the installation environment is polluted with gases other than the air.

Instrument air (clean and dry air of oxygen concentration 21%) is used for the reference gas and the span gas for calibration.

The gas flow is controlled by the ZA8F flow setting unit (for manual valve operation).

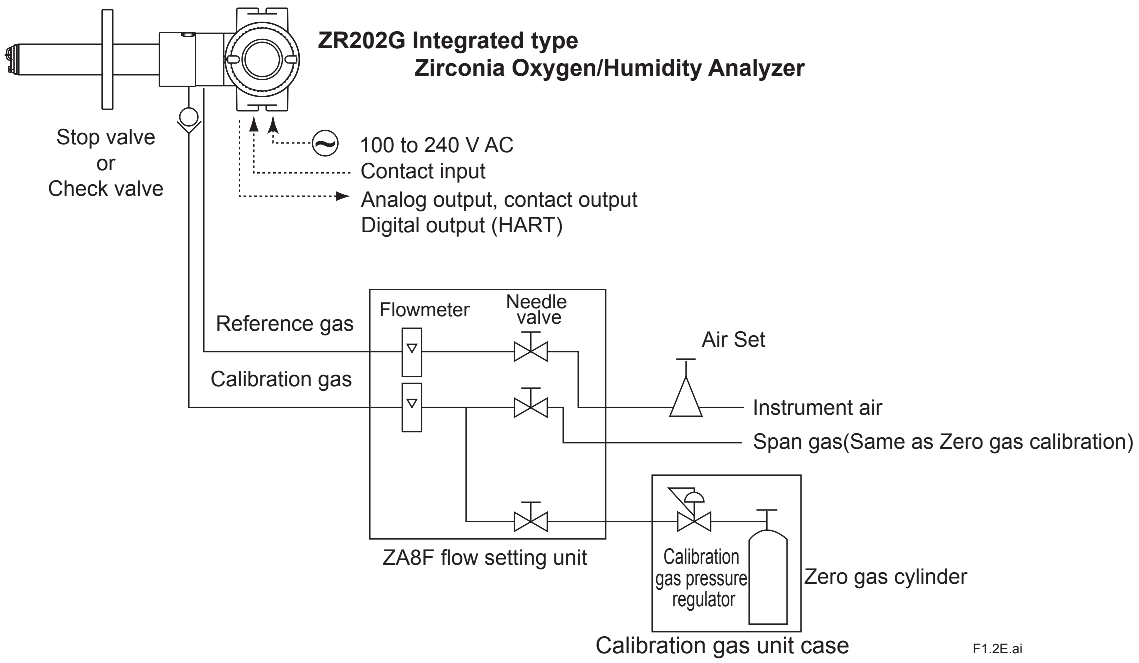


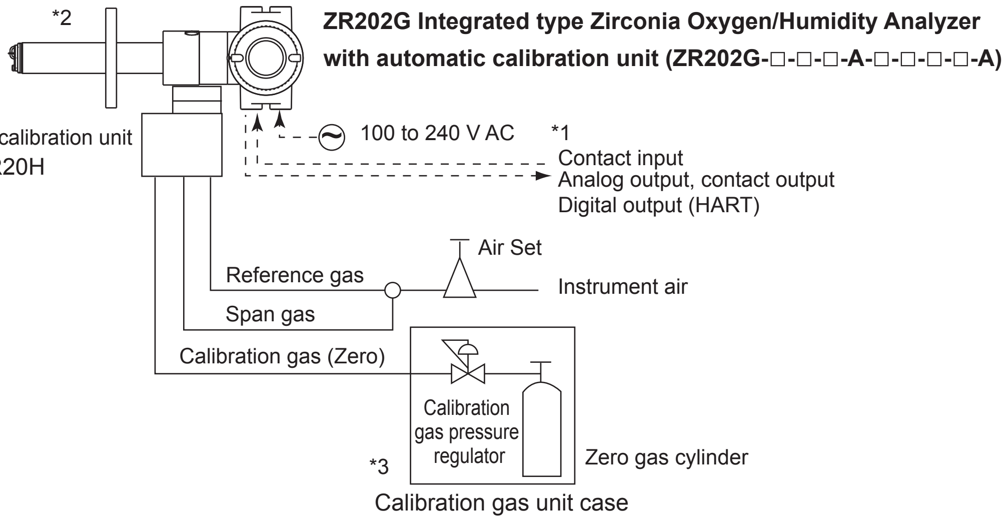
Figure1.2 Example of System 2

1.1.3 System 3

This example, System 3, represents typical applications in large boilers and heating furnaces, where is a need to monitor and control oxygen concentration. The reference gas and calibration-time span gas are (clean, dry) instrument air. Zero gas is supplied from a gas cylinder.

System 3 uses the ZR20H automatic calibration unit, with auto-switching of the calibration gas.

A "combustible gas detected" contact input turns off power to the heater. There's also contact output from the converter that can be used to operate a purge gas valve to supply air to the sensor.



Note:
The installation temperature limits range for integrated type analyzer is -20 to 55°C.

*1 Shield cable:
Use shielded signal cables, and connect the shields to the FG terminal of the converter.
*2 Select the desired probe from the Probe Configuration table on page 1-4.
*3 When a zirconia oxygen analyzer is used, 100% N_2 gas cannot be used as the zero gas.
Use approx. 1 vol% O_2 gas (N_2-based).

Figure1.3 Example of System 3

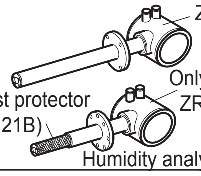
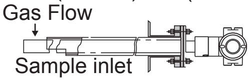
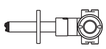
1.2 < EXAxt ZR > System Components

1.2.1 System Components

System Components	Separate type System config. Ex.1	Ex.2	Ex.3	Oxygen Analyzer	Humidity Analyzer
Model ZR202G Integrated type Zirconia Oxygen Analyzers	A	A	A	A	A
Model ZO21R Probe Protector for Zirconia Oxygen Analyzers	B	B	B	B	
K9471UA Dust Filter for Oxygen Analyzer	B	B	B	B	
K9471UC Dust Guard Protector	B	B	B	B	B
ZH21B Dust protector (only for Humidity Analyzer)	B	B	B		B
Model ZO21S Standard Gas Unit	A			B	B
Model ZA8F Flow Setting Unit for manual calibration		A		B	B
Model ZR20H Automatic Calibration Unit for Integrated type Analyzer			A	B	B
L9852CB, G7016XH Stop Valve for Calibration gas line	A	(A)		B	B
K9292DN,K9292DS Check Valve for Calibration gas line		(A)		B	B
G7003XF/K9473XK, G7004XF/K9473XG Air Set		A	A	B	B
G7001ZC Zero gas Cylinder		A	A	B	B
G7013XF, G7014XF Pressure Reducing Valve for Gas Cylinder		A	A	B	B
E7044KF Case Assembly for Calibration gas Cylinder		A	A	B	B
Model ZR202A Heater Assembly (Spare Parts for ZR202G)	B	B	B	B	B

A: Items required for the above system example
B: To be selected depending on each application. For details, refer to corresponding chapter.
(A): Select either

1.2.2 Oxygen/Humidity Analyzer and Accessories

Sample gas temperature 0 to 700°C			
Mounting	Insertion length	General-use Probe	Application
Horizontal to vertical	0.4 to 2 m		• Boiler • Heating furnace
Vertical	2.5 m or more		
Horizontal to vertical	3 m or less		• For pulverized coal boiler with gas flow velocity 10 m/sec or more • Cement Kiln
Horizontal to vertical	0.4 to 2 m	Dust Filter (K9471UA) or Dust Guard Protector (K9471UC) + Detector(ZR202G) 	• Black liquid recovery boiler • Cement Kiln
Vertical	2.5 m or more		

F1.4E.ai

2. Specifications

This chapter describes the specifications for the following:

ZR202G	General-use Integrated type Zirconia Oxygen Analyzer	(See Section 2.1.2)
ZO21R-L	Probe protector	(See Section 2.1.3)
ZH21B	Dust protector	(See Section 2.1.4)
ZA8F	Flow setting unit	(See Section 2.2.1)
ZR20H	Automatic calibration unit	(See Section 2.2.2)
ZO21S	Standard gas unit	(See Section 2.3)
K9471UA	Dust Filter for Oxygen Analyzer	(See Section 2.4)

2.1 General Specifications

2.1.1 Standard Specifications

Measured Object: Oxygen concentration in combustion exhaust gas and mixed gas (excluding inflammable gases). May not be applicable corrosive gas such as ammonia, chlorine is present-check with YOKOGAWA.)
(In case of Humidity Analyzer, Water vapor (in vol%) in mixed gases (air and water vapor))

Measured System: Zirconia system

Measurement Range: 0.01 to 100 vol%O_2
(In case of Humidity Analyzer, 0 to 100 vol% H_2O or 0 to 1.000 kg/kg)

Output Signal: 4 to 20 mA DC (maximum load resistance 550 Ω)

Setting Range: Any setting in the range of 0 to 5 through 0 to 100 vol%O_2 (in 1 vol%O_2), or partial range
In case of Humidity Analyzer,
Moisture quantity: 0 to 25 through 0 to 100 vol% H_2O (in 1 vol% H_2O), or partial range.
Mixture ratio; 0 to 0.2 through 0 to 1.000 kg/kg (in 0.001 kg/kg), or partial range.

Digital Communication (HART): 250 to 550 Ω, depending on number of field devices connected to the loop (multi-drop mode).

Note: HART is a registered trademark of the HART Communication Foundation.

Display Range: Oxygen concentration; 0 to 100 vol%O_2
In case of Humidity Analyzer,
Moisture quantity; 0 to 100 vol% H_2O, Mixture ratio; 0 to 1 kg/kg, Relative humidity; 0 to 100% RH (Note), Dew point; -40 to 370°C (Note)

Note: These values are affected by temperature and absolute pressure, So accurate temperature and pressure values must be inputted to the converter.

Warm-up Time: Approx. 20 min.

These characteristics are calculated by oxygen concentration measured in air which include water vapor.

Repeatability: (Excluding the case where the reference gas is by natural convection)
±0.5% Maximum value of set range; less than 0 to 25 vol%O_2 range
±1% Maximum value of set range; 0 to 25 vol%O_2 or more and up to 0 to 100 vol%O_2 range
In case of Humidity Analyzer, ± 1 vol% H2O; (Sample gas pressure 2 kPa or less)

Linearity: (Excluding standard gas tolerance)
(Excluding the case where the reference gas is by natural convection)
(Use oxygen of known concentration (within the measuring range) as the zero and span calibration gases.)

±1% Maximum value of set range;
less than 0 to 25 vol%O_2 range
(Sample gas pressure: within ±4.9 kPa)

±3% Maximum value of set range;
0 to 25 vol%O_2 or more and less than 0 to 50 vol%O_2 range
(Sample gas pressure: within ±0.49 kPa)

±5% Maximum value of set range;
0 to 50 vol%O_2 or more and up to 0 to 100 vol%O_2 range
(Sample gas pressure: within ±0.49 kPa)

In case of Humidity Analyzer,
± 2 vol% H_2O; (Sample gas pressure: within ± 0.49 kPa)
± 3 vol% H_2O; (Sample gas pressure: 2 kPa or less)

Drift: (Excluding the first two weeks in use)
(Excluding the case where the reference gas is by natural convection.)
Both zero and span ±2% Maximum value of set range/month

In case of Humidity Analyzer,
Both zero and span ± 3 vol% H_2O/month

Response Time: Response of 90% within 5 seconds. (Measured after gas is introduced from calibration gas inlet and analog output start changing.)

Installation Altitude: 2000 m or less

Category based on IEC 61010: II (Note)

Pollution degree based on IEC 61010: 2 (Note)

Note: Installation category, called over-voltage category, specifies impulse withstand voltage. Category II is for electrical equipment. Pollution degree indicates the degree of existence of solid, liquid, gas or other inclusions which may reduce dielectric strength. Degree 2 is the normal indoor environment.

Safety, EMC and RoHS conforming standards the ZR202G

Safety: EN 61010-1, EN 61010-2-030, CAN/CSA-C22.2 No. 61010-1, UL Std. No. 61010-1

EMC: EN 61326-1 Class A*, Table 2,
EN 61326-2-3, EN 61000-3-2
*: Influence of immunity environment (Criteria A): ±20% of F. S.
EMC Regulatory Arrangement in Australia and New Zealand (RCM)
EN61326-1 Class A
Korea Electromagnetic Conformity Standard

Note: This instrument is a Class A product, and it is designed for use in the industrial environment. Please use this instrument in the industrial environment only.

RoHS: EN 50581

2.1.2 ZR202G Integrated type Zirconia Oxygen Analyzer

Can be operated in the field without opening the cover using optical switches.

Display: 6-digit LCD

Switch: Three optical switches

Output Signal: 4 to 20 mA DC, one point (maximum load resistance 550 Ω)

Digital Communication (HART): 250 to 550 Ω, depending on quantity of field devices connected to the loop (multi-drop mode).

Contact Output Signal: Two points (one is fail-safe, normally open)

Contact Input Signal: Two points

Sample Gas Temperature: 0 to 700°C
It is necessary to mount the cell using inconel cell-bolts when the temperature is greater than 600°C.
High temperature service — greater than 700°C — is not available.

Sample Gas Pressure: -5 to +250 kPa (When the pressure in the furnace exceeds 3 kPa, it is recommended to use pressure compensated type. When the pressure in the furnace exceeds 5 kPa, pressure compensated type is required.)
No pressure fluctuation in the furnace should be allowed.

Note: When the detector is used in conjunction with a check valve and the ZA8F Flow Setting Unit, the maximum pressure of sample gas is 150 kPa. When with a check valve and the ZR20H Automatic Calibration Unit, it is 200 kPa. If the pressure of your sample gas exceeds these limits, consult with Yokogawa.

Probe Length: 0.4, 0.7, 1.0, 1.5, 2.0, 2.5, 3.0 m

Probe Material: SUS 316 (JIS)

Ambient Temperature: -20 to +55°C (- 5 to +70°C on the case surface)

Storage Temperature: -30 to +70°C

Humidity Range: 0 to 95%RH (non-condensing)

Power Supply Voltage: Ratings; 100 to 240 V AC
Acceptable range; 85 to 264 V AC

Power Supply Frequency: Ratings; 50/60 Hz
Acceptable range; 45 to 66 Hz

Power Consumption: Max. 300 W, approx. 100 W for ordinary use.

Reference Gas System: Natural Convection, Instrument Air, or Pressure Compensated

Instrument Air System (excluding Natural Convection):
Pressure; 200 kPa + the pressure inside the furnace (It is recommended to use air which is dehumidified by cooling to dew point -20°C or less, and dust or oil mist are removed.)

Consumption; Approx. 1Nl/min

Wetted Material: SUS 316 (JIS), Zirconia, SUS304 (JIS) or ASTM grade 304 (flange), Hastelloy B, (Inconel 600, 601)

Construction: Heater and thermocouple replaceable construction. Non explosion-proof JIS C0920 / equivalent to IP44D. Equivalent to NEMA 4X/IP66 (Achieved when the cable entry is completely sealed with a cable gland in the recirculation pressure compensated version.)

Gas Connection: Rc1/4 or 1/4NPT(F)

Wiring Connection: G1/2, Pg13.5, M20 x 1.5mm, 1/2NPT select one type (4 pieces)

Installation: Flange mounting

Probe Mounting Angle: Horizontal to vertically downward.
When the probe insertion length is 2 m or less, installing at angles from horizontal to vertically downward is available.
When the probe insertion length is 2.5m or more, mount vertically downward (within ± 5°), and if installing at angles from horizontal to vertically downward (within ± 5°), use a probe protector.

Case: Aluminum alloy

Paint Color: Cover; Mint green (Munsell 5.6BG3.3/2.9)
Case; Mint green (Munsell 5.6BG3.3/2.9)

Finish: Polyurethane corrosion-resistance coating

Weight: Insertion length of 0.4m: approx. 8 kg (JIS 5K 65) / approx. 13 kg (ANSI 150 4)
Insertion length of 1.0m: approx. 10 kg (JIS 5K 65) / approx. 15 kg (ANSI 150 4)
Insertion length of 1.5m: approx. 12 kg (JIS 5K 65) / approx. 17 kg (ANSI 150 4)
Insertion length of 2.0m: approx. 14 kg (JIS 5K 65) / approx. 19 kg (ANSI 150 4)
Insertion length of 3.0m: approx. 17 kg (JIS 5K 65) / approx. 22 kg (ANSI 150 4)

Functions (inclused Humidity Analyzer)

Display Function: Displays values of the measured oxygen concentration, moisture quantity, mixture ratio, etc.

Alarm, Error Display: Displays alarms such as “AL-06” or errors such as “Err-01” when any such status occurs.

Calibration Functions:

Automatic calibration; Requires the Automatic Calibration Unit. It calibrates automatically at specified intervals.

Semi-auto Calibration; Requires the Automatic Calibration Unit. Input calibration start signal by optical switch or contact, then it calibrates automatically afterwards.

Manual Calibration; Calibration with opening/closing the valve of calibration gas in operation interactively with the optical switch.

Maintenance Functions: Can operate updated data settings in daily operation and checking. Display data settings, calibration data settings, test settings (current output loop check, input/output contact check).

Setup Functions: Initial settings suit for the plant conditions when installing the converter. Current output data settings, alarm data settings, contact data settings, other settings.

Display and setting content:

Display Related Items: Oxygen concentration (vol% O_2), output current value (mA), air ratio, moisture quantity (in hot gases) (vol% H_2O), mixture ratio(kg/kg), relative humidity(%RH), dew point (°C), Cell temperature (°C), thermocouple reference junction temperature (°C), maximum/minimum/average oxygen concentration (vol% O_2), maximum/ minimum/average moisture quantity (vol% H_2O), maximum/minimum/average mixture ratio (kg/kg), cell e.m.f. (mV), cell internal resistance (Ω), cell condition (in four grades), heater on-time rate (%), calibration record (ten times), time (year/month/day/hour/minute), output 1, 2 current (mA), cell response time (seconds),

Calibration Setting Items: Span gas concentration (vol% O_2), zero gas concentration (vol%O_2), calibration mode (auto, semi-auto, manual), calibration type and method (zero-span calibration, zero calibration only, span calibration only), stabilization time (min.sec), calibration time (min.sec), calibration interval (day/hour), starting time (year/month/day/hour/minute)

Output Related Items: Analog output/output mode selection, output conditions when warming-up/maintenance/calibrating/abnormal, 4 mA/20 mA point oxygen concentration (vol% O_2), time constant, preset values when warming-up/maintenance/calibrating/abnormal, output preset values on abnormal

Alarm Related Items: Oxygen concentration high alarm/high-high alarm limit values (vol% O_2), oxygen concentration low alarm/low-low alarm limit values (vol% O_2), oxygen concentration alarm hysteresis (vol% O_2), moisture quantity high alarm/ high-high alarm limit values (vol% H_2O), moisture quantity low alarm/ low-low alarm limit values (vol% H_2O), mixture ratio high alarm/ high-high alarm limit values (kg/kg), mixture ratio low alarm/ low-low alarm limit values (kg/kg), moisture quantity alarm hysteresis (vol% H_2O), mixture ratio alarm hysteresis (kg/kg), oxygen concentration/ moisture quantity/mixture ratio alarm detection,alarm delay (seconds)

Contact Related Items: Selection of contact input 1 and 2, selection of contact output 1 and 2 (abnormal, high-high alarm, high alarm, low alarm, low-low alarm, maintenance, calibrating, range switching, warming-up, calibration gas pressure decrease, flameout gas detection (answer-back of contact input)

Converter Output: One mA analog output point (4 to 20 mA DC (maximum load resistance of 550Ω)) with mA digital output point (HART) (minimum load resistance of 250Ω).

Oxygen analyzer; Range; Any setting between 0 to 5 through 0 to 100 vol% O_2 in 1 vol% O_2, and partial range is available (Maximum range value/minimum range value 1.3 or more)
For the log output, the minimum range value is fixed at 0.1 vol% O_2.
4 to 20 mA DC linear or log can be selected. Input/output isolation.

Humidity analyzer; Range; Any setting between 0 to 5 through 0 to 100 vol% O_2 in 1 vol% O_2, and partial range is available (Maximum range value/minimum range value 1.3 or more)
For the log output, the minimum range value is fixed at 0.1 vol% O_2.
4 to 20 mA DC linear or log can be selected. Input/output isolation.

Output damping; 0 to 255 seconds.
Hold/non-hold selection, preset value setting possible with hold.

Contact Output: Two points, contact capacity 30V DC 3A, 250V AC 3A (resistive load)
One of the output points can be selected to ether normally energized or normally de-energized status.
Delayed functions (0 to 255 seconds) and hysteresis function (0 to 9.9 vol% O_2) can be added to high/low alarms.
The following functions are programmable for contact outputs.
(1) Abnormal, (2) High-high alarm, (3) High alarm, (4) Low-low alarm, (5) Low alarm, (6) Maintenance, (7) Calibration, (8) Range switching answer-back, (9) Warm-up, (10) Calibration gas pressure decrease (answer-back of contact input), (11) Flameout gas detection (answer-back of contact input).

Contact Input: Two points, voltage-free contacts
The following functions are programmable for contact inputs:
(1) Calibration gas pressure decrease alarm, (2) Range switching (switched range is fixed), (3) External calibration start, (4) Process alarm (if this signal is received, the heater power turns off)

Contact capacity: Off-state leakage current: 3 mA or less

Self-diagnosis: Abnormal cell, abnormal cell temperature (low/high), abnormal calibration, A/D converter abnormal, digital circuit abnormal

Calibration:

Method; zero/span calibration

Calibration mode; Auto, semi-auto and manual (All are operated using optical switches).
Either zero or span can be skipped.

Zero calibration gas concentration setting range;
0.3 to 100 vol% O_2 (minimum setting: 0.01 vol% O_2).

Span calibration gas concentration setting range;
4.5 to 100 vol% O_2 (minimum setting: 0.01 vol% O_2).
Use nitrogen-balanced mixed gas containing 0 to 10 vol% O_2 scale of oxygen for standard zero gas and 80 to 100 vol% O_2 scale of oxygen for standard span gas.

Calibration interval; date/time setting: maximum 255 days

● Model and Codes

Style : S1

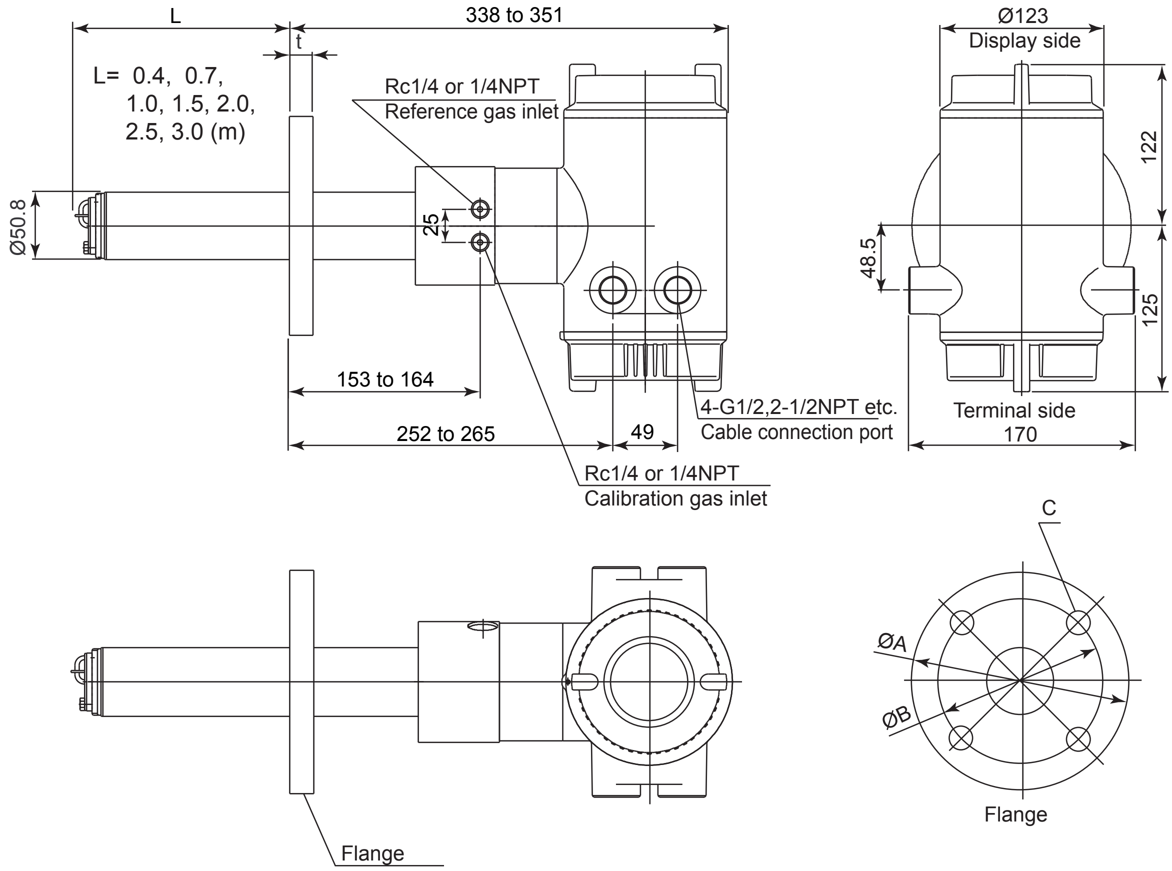
Model	Suffix code	Option code	Description
ZR202G	----------------------------	----------	Integrated type Zirconia Oxygen/ Humidity Analyzer
Length	**-040**	----------	0.4 m
	-070	----------	0.7 m
	-100	----------	1.0 m
	-150	----------	1.5 m
	-200	----------	2.0 m
	-250	----------	2.5 m (*1)
	-300	----------	3.0 m (*1)
Wetted material	**-S**	----------	Stainless steel (SUS316)
	-C	----------	Stainless steel with Inconel calibration gas tube (*10)
Flange (*2)	**-A**	----------	ANSI Class 150 2 RF
	-B	----------	ANSI Class 150 3 RF
	-C	----------	ANSI Class 150 4 RF
	-E	----------	DIN PN10 DN50 A
	-F	----------	DIN PN10 DN80 A
	-G	----------	DIN PN10 DN100 A
	-K	----------	JIS 5K 65 FF
	-L	----------	JIS 10K 65 FF
	-M	----------	JIS 10K 80 FF
	-P	----------	JIS 10K 100 FF
	-R	----------	JPI Class 150 4 RF
	-S	----------	JPI Class 150 3 RF
	-W	----------	Westinghouse
Auto Calibration	**-N**	----------	Not required
	-A	----------	Horizontal mounting (*8)
	-B	----------	Vertical mounting (*8)
Reference gas	**-C**	----------	Natural convection
	-E	----------	External connection (Instrument air) (*11)
	-P	----------	Pressure compensated (*11)
Gas Thread	**-R**	----------	Rc1/4
	-T	----------	1/4NPT (Female)
Connection box thread	**-P**	----------	G1/2
	-G	----------	Pg13.5
	-M	----------	M20 x1.5 mm
	-T	----------	1/2NPT
Instruction manual	**-J**	----------	Japanese
	-E	----------	English
	-C	----------	Chinese
—	**-A**	----------	Always -A
Options		**/C**	Inconel bolt (*3)
		/HS	Set for Humidity Analyzer (*4)
	Valves	**/CV**	Check valve (*5)
		/SV	Stop valve (*5)
		/H	Hood (*9)
	Filter	**/F1**	Dust Filter (*6)
		/F2	Dust Guard Protector (*6)
	Tag plates	**/SCT**	Stainless steel tag plate (*7)
		/PT	Printed tag plate (*7)
	NAMUR NE43 compliant	**/C2**	Failure alarm down-scale: Output status at CPU failure and hardware error is 3.6 mA or less (*12)
		/C3	Failure alarm up-scale: Output status at CPU failure and hardware error is 21.0 mA or more (*12)

*1 For the horizontally installed probe whose insertion length is 2.5 m or more, use the Probe Protector. Be sure to specify ZO21R-L-200-☐. Specify the flange suffix code either -C or -K.
*2 The thickness of the flange depends on its dimensions.
*3 Inconel probe bolts and U shape pipe are used. Use this option for high temperature use (ranging from 600 to 700°C).
*4 For humidity measurements, be sure to specify /HS options. Pressure compensation of reference gas can not be selected.
*5 Specify either /CV or /SV option code.
*6 Not used with the high temperature humidity analyzer.
*7 Specify either /SCT or /PT option code.
*8 No need to specify the option codes, /CV and /SV, since the check valves are provided with the Automatic Calibration Unit. Automatic calibration cannot be used when natural convection is selected as reference air.
*9 Sun shield hood is still effective even if scratched. Hood is necessary for outdoor installation out of sun shield roof.
*10 Recommended if sample gas contains corrosive gas like chlorine.
*11 Piping for reference gas must be installed to supply reference gas constantly at a specifi ed fl ow rate.
*12 Output signal limits: 3.8 to 20.5 mA. Specify either /C2 or /C3 option code.

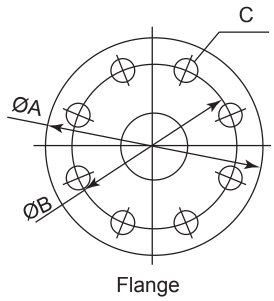
● EXTERNAL DIMENSIONS

Model ZR202G Integrated type Zirconia Oxygen/Humidity Analyzers

Unit: mm



Flange	A	B	C	t
ANSI Class 150 2 RF	152.4	120.6	4 - Ø19	19
ANSI Class 150 3 RF	190.5	152.4	4 - Ø19	24
ANSI Class 150 4 RF	228.6	190.5	8 - Ø19	24
DIN PN10 DN50 A	165	125	4 - Ø18	18
DIN PN10 DN80 A	200	160	8 - Ø18	20
DIN PN10 DN100 A	220	180	8 - Ø18	20
JIS 5K 65 FF	155	130	4 - Ø15	14
JIS 10K 65 FF	175	140	4 - Ø19	18
JIS 10K 80 FF	185	150	8 - Ø19	18
JIS 10K 100 FF	210	175	8 - Ø19	18
JPI Class 150 4 RF	229	190.5	8 - Ø19	24
JPI Class 150 3 RF	190	152.4	4 - Ø19	24
Westinghouse	155	127	4 - Ø11.5	14



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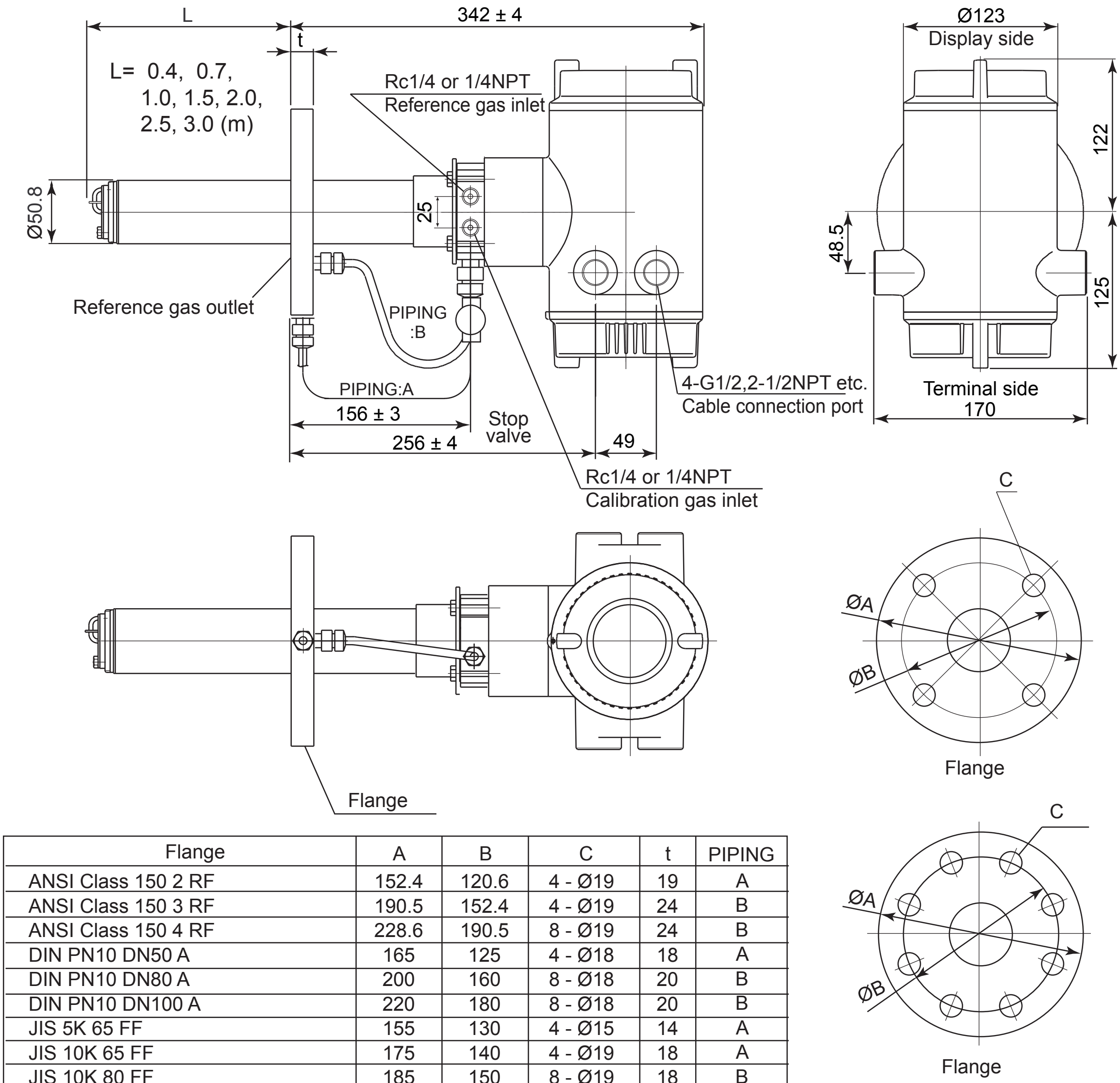
● Standard Accessories

Item	Parts. No.	Q'ty	Description
Fuse	A1113EF	1	3.15 A
Allen wrench	L9827AB	1	For lock screw

Model ZR202G...-P Integrated type Zirconia Oxygen/Humidity Analyzer with pressure compensation

Unit: mm



Flange	A	B	C	t	PIPING
ANSI Class 150 2 RF	152.4	120.6	4 - Ø19	19	A
ANSI Class 150 3 RF	190.5	152.4	4 - Ø19	24	B
ANSI Class 150 4 RF	228.6	190.5	8 - Ø19	24	B
DIN PN10 DN50 A	165	125	4 - Ø18	18	A
DIN PN10 DN80 A	200	160	8 - Ø18	20	B
DIN PN10 DN100 A	220	180	8 - Ø18	20	B
JIS 5K 65 FF	155	130	4 - Ø15	14	A
JIS 10K 65 FF	175	140	4 - Ø19	18	A
JIS 10K 80 FF	185	150	8 - Ø19	18	B
JIS 10K 100 FF	210	175	8 - Ø19	18	B
JPI Class 150 4 RF	229	190.5	8 - Ø19	24	B
JPI Class 150 3 RF	190	152.4	4 - Ø19	24	B
Westinghouse	155	127	4 - Ø11.5	14	A

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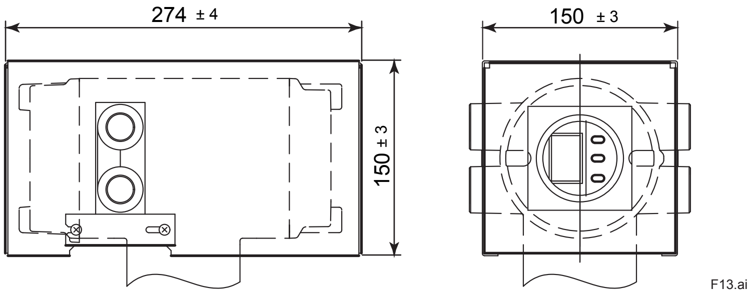
● Standard Accessories

Item	Parts. No.	Q'ty	Description
Fuse	A1113EF	1	3.15 A
Allen wrench	L9827AB	1	For lock screw

● Hood (Option code /H)

Unit: mm



Material of HOOD : Aluminum

Food Weight : Approx. 800g

2.1.3 ZO21R Probe Protector

Used when sample gas flow velocity is approx. 10 m/sec or more and dust particles wears the detector in cases such as pulverized coal boiler of fluidized bed furnace (or burner) to protect the detector from wearing by dust particles.

When probe insertion length is 2.5 m or more and horizontal installation, specify the ZO21R-L-200-□*B to reinforce the probe.

Insertion Length:	1.05 m, 1.55 m, 2.05 m.
Flange:	JIS 5K 65A FF equivalent, ANSI Class 150 4 FF (without serration) equivalent . However, flange thickness is different.
Material:	SUS316 (JIS), SUS304 (JIS) or ASTM grade 304 (Flange)
Weight:	1.05m; Approx. 6/10 kg (JIS/ANSI), 1.55 m; Approx. 9/13 kg (JIS/ANSI), 2.05 m; Approx. 12/16 kg (JIS/ANSI)
Installation:	Bolts, nuts, and washers are provided for detector, probe adapter and process-side flange.

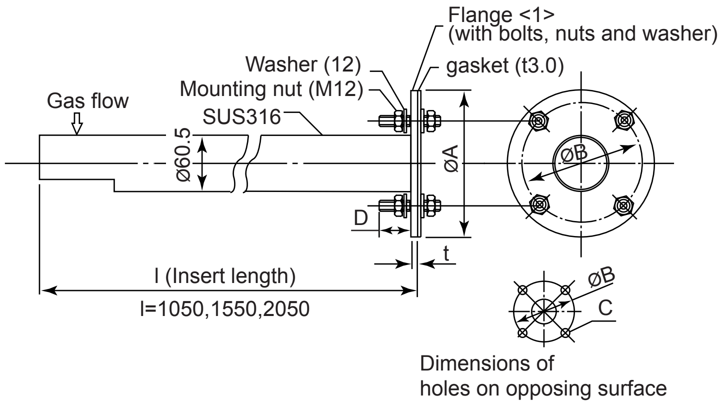
● Model and Codes

Model	Suffix code	Option code	Description
ZO21R	**-L**	------	Probe Protector (0 to 700 °C)
Insertion length	**-100** **-150** **-200**	------ ------ ------	1.05 m 1.55 m 2.05 m
Flange (*1)	**-J** **-A**	------ ------	JIS 5K 65 FF ANSI Class 150 4 FF
Style code	***B**	------	Style B

*1 Thickness of flange depends on dimensions of flange.

● EXTERNAL DIMENSIONS

Unit: mm



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Flange<1>	A	B	C	t	D
JIS 5K 65 FF	155	130	4 - Ø15	5	40
ANSI Class 150 4 FF	228.6	190.5	8 - Ø19	12	50

2.1.4 ZH21B Dust Protector

This protector is designed to protect the probe output from dust agitation (i.e., to prevent combustible materials from entering the probe cell where humidity measurements are made) in a dusty environment.

Insertion length: 0.428m

Flange: JIS 5K 80 FF or ANSI Class 150 4 FF (However, flange thickness is different)

Material: SUS 316(JIS), SUS304 (JIS) or ASTM grade 304 (flange)

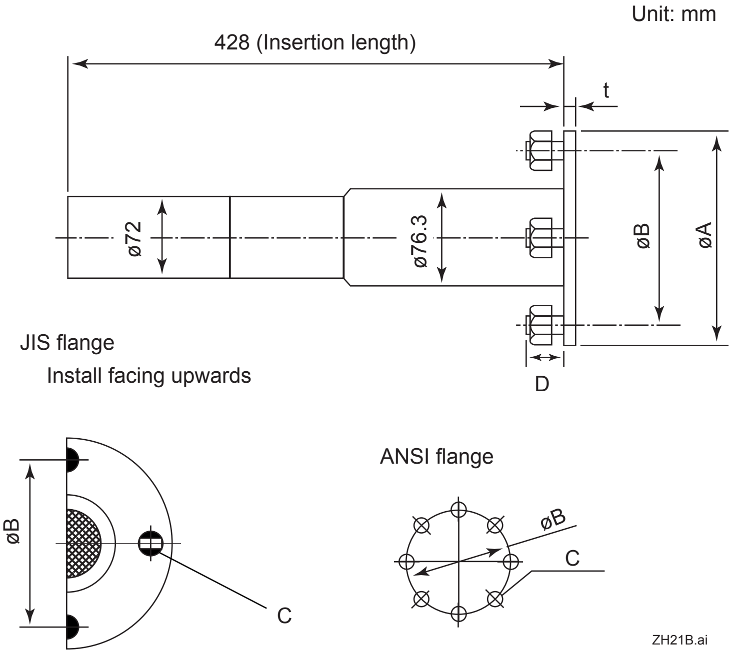
Weight: Approximately 6kg (JIS), approximately 8.5kg (ANSI)

Mounting: Mounted on the probe or process flange with bolts and associated nuts and washers.

● Model and Codes

Model	Suffix code	Option code	Description
ZH21B	- - - - - - - - - - - - -	- - - - - -	Dust Protector (0 to 600 °C)
Insertion length	-40	- - - - - -	0.428 m
Flange (*1)	-J -A	- - - - - - - - - - - -	JIS 5K 80 FF (*1) ANSI Class 150 4B FF (*2)
Style code	*B	- - - - - -	Style B

Note: The flange thickness varies.
(*1) Specify the probe ZR22G-040-h-K
(*2) Specify the probe ZR22G-040-h-C



Flange	A	B	C	t	D
JIS 5K 80 FF	180	145	4 - Ø19	12	40
ANSI Class 150 4B FF	228.6	190.5	8 - Ø19	12	50

2.2 ZA8F Flow Setting Unit and ZR20H Automatic Calibration Unit

2.2.1 ZA8F Flow Setting Unit

This flow setting unit is applied to the reference gas and the calibration gas in a system configuration (System 2). Used when instrument air is provided.

This unit consists of a flowmeter and flow control valves to control the flow of calibration gas and reference gas.

Standard Specifications

Flowmeter Scale: Calibration gas; 0.1 to 1.0 l/min. Reference gas; 0.1 to 1.0 l/min.

Construction: Dust-proof and rainproof construction

Case Material: SPCC (Cold rolled steel sheet)

Painting: Baked epoxy resin, Dark-green (Munsell 2.0 GY 3.1/0.5 or equivalent)

Tube Connections: Rc1/4 or 1/4NPT (Female)

Reference Gas Pressure: Clean air supply of sample gas pressure plus approx. 50 kPa G (or sample gas pressure plus approx.150 kPa when a check valve is used.) Pressure at inlet of the fl ow setting unit. (Max. 300 kPa G)

Air Consumption: Approx. 1.5 l/min

Weight: Approx. 2.3 kg

Calibration gas (zero gas, span gas) Consumption: Approx. 0.7 l/min (at calibration time only)

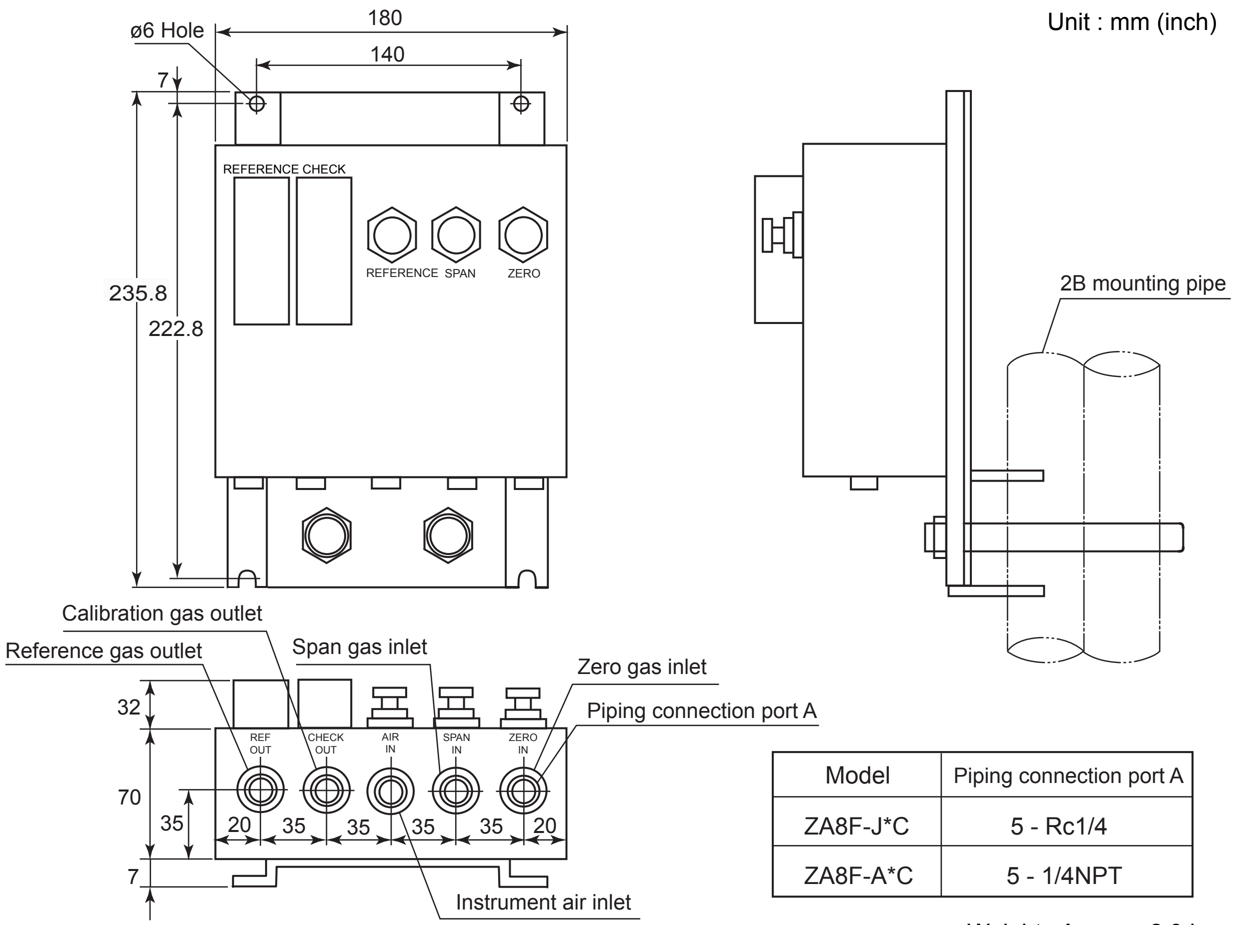
NOTE

Use instrument air for span calibration gas, if no instrument air is available, contact YOKOGAWA.

Model and Codes

Model	Suffix code	Option code	Description
ZA8F	- - - - - - - -	- - - - - - - - -	Flow setting unit
Joint	**-J** **-A**	- - - - - - - - - - - - - - - - - -	Rc 1/4 With 1/4 NPT adapter
Style code	***C**	- - - - - - - - -	Style C

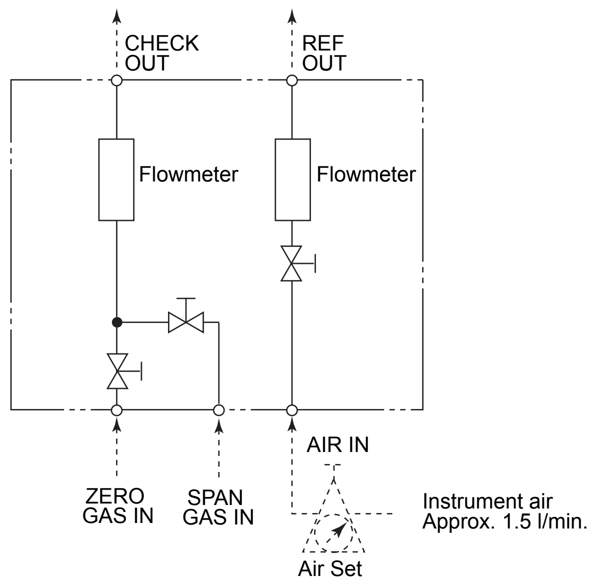
External Dimensions



Model	Piping connection port A
ZA8F-J*C	5 - Rc1/4
ZA8F-A*C	5 - 1/4NPT

Weight : Approx. 2.3 kg

PIPNG INSIDE THE FLOW SETTING UNIT



Air pressure ;
without check valve ; sample gas pressure + approx.50 kPaG
with check valve ; sample gas pressure + approx.150 kPaG

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2.2.2 ZR20H Automatic Calibration Unit

This automatic calibration unit is applied to supply specified flow of reference gas and calibration gas during automatic calibration to the detector in a system configuration (System 3).

● Specifications

Equipped with the analyzer when automatic calibration is specified in the suffix code of the ZR202G Integrated type by selecting either “-A (Horizontal mounting)” or “-B (Vertical mounting)”. The ZR20H should be arranged when automatic calibration is to be required after the ZR202G has been installed. Ask Yokogawa service station for its mounting.

Construction: Dust-proof and rainproof construction; NEMA4X/IP67 (excluding flowmeter)

Mounting: Mounted on ZR202G, no vibration

Materials: Body; Aluminum alloy, Piping; SUS316 (JIS), SUS304 (JIS), Flowmeter; MA (Methacrylate resin), Bracket; SUS304 (JIS)

Finish: Polyurethane corrosion-resistance coating
Case; Mint green (Munsell 5.6 BG3.3 /2.9)
Cover; Mint green (Munsell 5.6 BG3.3/2.9)

Piping Connection: Rc1/4 or 1/4NPT (Female)

Power Supply: 24V DC (from ZR202G), Power consumption: Approx.1.3 W

Reference Gas Pressure: Sample gas pressure plus Approx. 150 kPa (690 kPa max.), (Pressure at inlet of automatic calibration unit)

Air Consumption: Approx. 1.5 l/min

Weight: Approx. 2 kg

Ambient Temperature: -20 to +55°C, no condensing and freezing

Ambient Humidity: 0 to 95% RH

Storage Temperature: -30 to +65°C

● Model and Codes

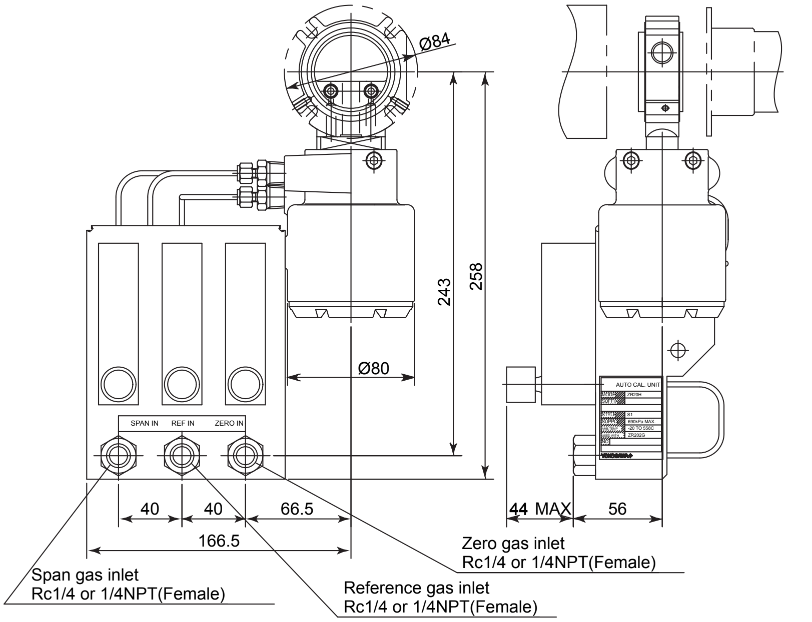
Model	Suffix code	Option code	Description
ZR20H	-------------	--------	Automatic calibration unit for ZR202G *1
Gas piping connection	-R	--------	Rc1/4
	-T	--------	1/4NPT (F)
Reference air *2	-E	--------	Instrument air
	-P	--------	Pressure compensated
Mounting	-A	--------	Horizontal mounting
	-B	--------	Vertical mounting
—	-A	--------	Always -A

*1 Ask Yokogawa service station for additional mounting of ZR20H to the preinstalled ZR202G.
*2 Select the appropriate reference gas of ZR20H according to the one of ZR202G.

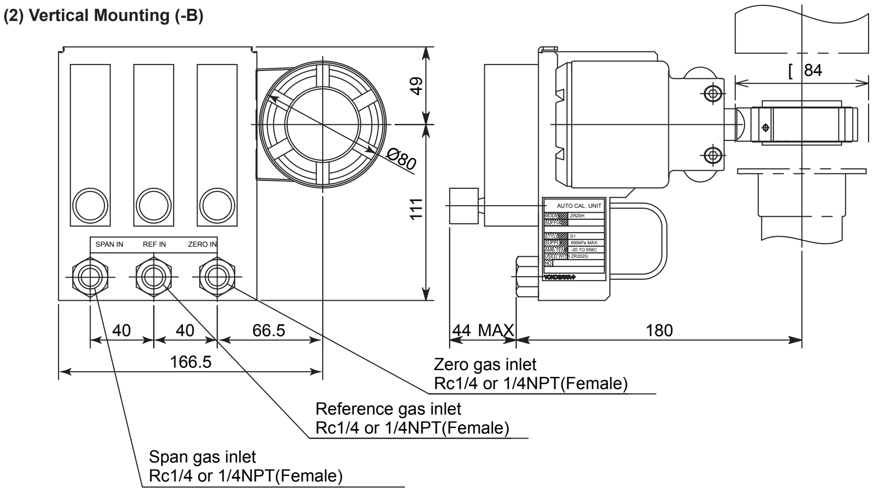
● External Dimensions

(1) Horizontal Mounting (-A)

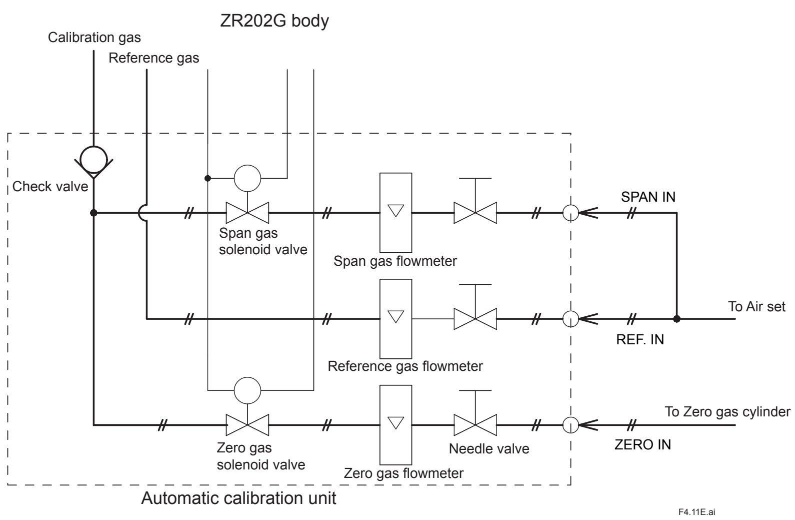
Unit: mm



(2) Vertical Mounting (-B)



PIPNG INSIDE THE AUTOMATIC CALIBRATION UNIT



2.3 ZO21S Standard Gas Unit

This is a handy unit to supply zero gas and span gas to the detector in a system configuration based on System 1. It is used in combination with the detector only during calibration.

The ZO21S does not conform to CE marking.

● Standard Specifications

Function: Portable unit for calibration gas supply consisting of span gas (air) pump, zero gas cylinder with sealed inlet, flow rate checker and flow rate needle valve.

Sealed Zero Gas Cylinders (6 provide): E7050BA

Capacity: 1 l

Filled pressure: Approx. 686 kPa G (at 35 °C)

Composition: 0.95 to 1.0 vol% O_2 (N_2 balanced)

Power Supply: 100, 110, 115, 200, 220, 240V AC± 10%, 50/60 Hz

Power Consumption: Max. 5 VA

Case material: SPCC (Cold rolled steel sheet)

Paint: Epoxy resin, baked

Paint Color: Mainframe; Munsell 2.0 GY3.1/0.5 equivalent
Cover; Munsell 2.8 GY6.4/0.9 equivalent

Piping: Ø6 x Ø4mm flexible tube connection

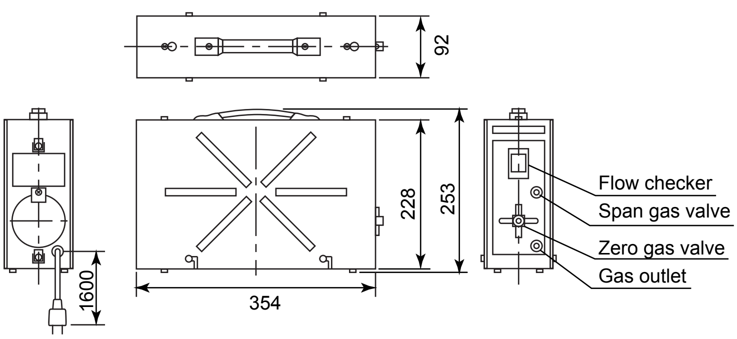
Weight: Approx. 3 kg

Span gas: Internal pump draws in air from atmosphere, and feeds to detector.

● Model and Codes

Model	Suffix code	Option code	Description
ZO21S	-----------	-------------	Standard gas unit
Power supply	-2	-------------	200 V AC 50/60 Hz
	-3	-------------	220 V AC 50/60 Hz
	-4	-------------	240 V AC 50/60 Hz
	-5	-------------	100 V AC 50/60 Hz
	-7	-------------	110 V AC 50/60 Hz
	-8	-------------	115 V AC 50/60 Hz
Panel	-J	-------------	Japanese version
	-E	-------------	English version
Style code	*A	-------------	Style A

● External Dimensions



Zero gas cylinder (6 cylinder): E7050BA

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2.4 Other Equipment

2.4.1 Dust Filter for Oxygen Analyzer (part no. K9471UA)

This filter is used to protect the detector sensor from corrosive dust components or from a high concentration of dust when the oxygen concentration in utility boilers or concrete kilns are to be measured.

This filter requires the measuring gas flow of 1 m/sec or faster to replace gas inside zirconia sensor.

● Standard specification

Applicable detector: Standard-type detector for general use (the sample gas flow should be approximately perpendicular to the probe.)

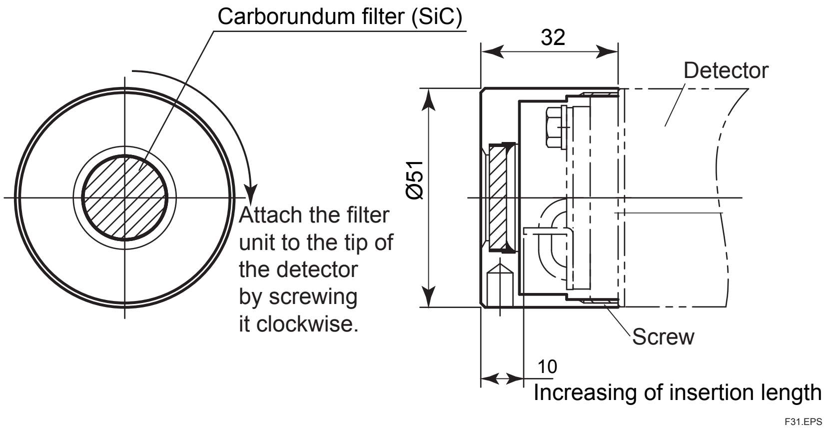
Mesh: 30 microns

Material: SiC (Filter), SUS316 (JIS)

Weight: Approx. 0.2 kg

Part No.	Description
K9471UA	Filter
K9471UX	Tool

Unit: mm



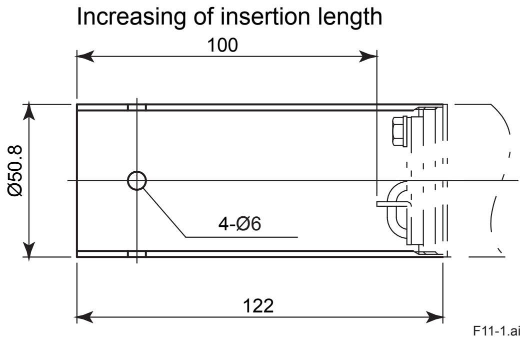
2.4.2 Dust Guard Protector (K9471UC)

Recommended to be used when sample gas is likely to flow directly into the cell due to its flow direction in the stack or the like, flammable dust may go into the cell, or water drops are likely to fall and remain in the cell during downtime or the like due to the installation position.

Material: SUS316

Weight: Approx. 0.3 kg

Unit: mm



2.4.3 Stop Valve (part no. L9852CB or G7016XH)

This valve is mounted on the calibration gas line in the system to allow for manual calibration. This is applied to a system configuration (System 1).

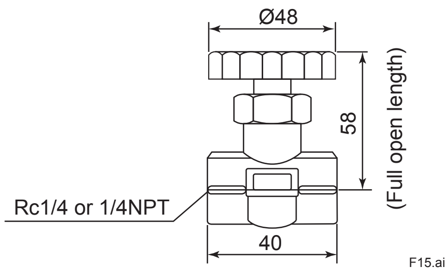
Standard Specifications

Connection: Rc1/4 or 1/4NPT (Female)

Material: SUS 316 (JIS)

Weight: Approx. 150 g

Part No.	Description
L9852CB	Joint: Rc1/4, Material: SUS316 (JIS)
G7016XH	Joint: 1/4NPT (F), Material: SUS316 (JIS)



2.4.4 Check Valve (part no. K9292DN or K9292DS)

This valve is mounted on the calibration gas line (directly connected to the detector). This is applied to a system based on the system configuration (System 2 and 3).

This valve prevents the sample gas from entering the calibration gas line. Although it functions as the stop valve, operation is easier as it does not require opening/closing at each calibration.

Screw the check valve into the calibration gas inlet of the detector instead of the stop valve.

- **Standard Specifications**

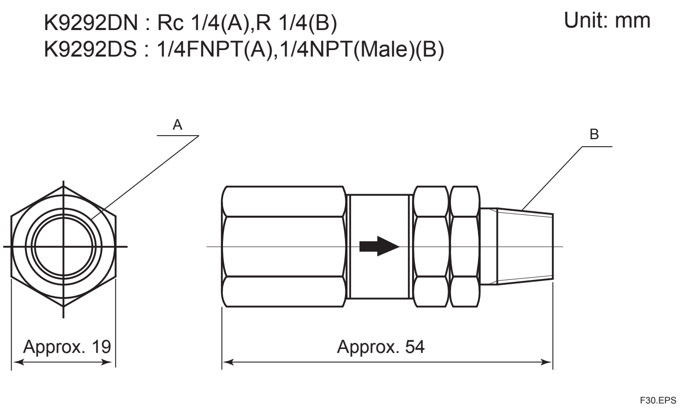
Connection: Rc1/4 or 1/4NPT (Female)

Material: SUS304 (JIS)

Pressure: Between 70 kPa G or more 350 kPa G or less

Weight: Approx. 90 g

Part No.	Description
K9292DN	Joint: Rc 1/4, Material: SUS304 (JIS)
K9292DS	Joint: 1/4 NPT (F), Material: SUS304 (JIS)



2.4.5 Air Set

This set is used to lower the pressure when instrument air is used as the reference and span gases.

- **Standard Specifications**

Part no. G7003XF or K9473XK

Primary Pressure: Max. 1 MPa G
Secondary Pressure: 0.02 to 0.2 MPa G
Connection: Rc1/4 or 1/4NPT (F) with joint adapter
Weight: Approx.1 kg

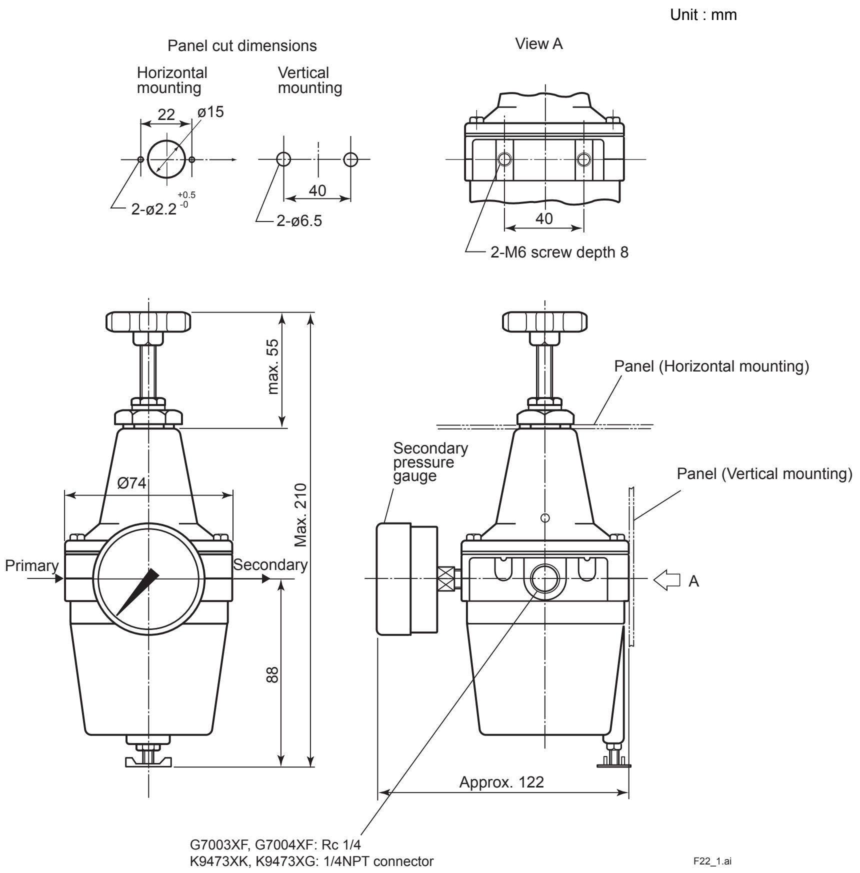
Part No.	Description
G7003XF	Joint: Rc1/4, Material: Zinc alloy
K9473XK	Joint: 1/4 NPT (F), Material: Zinc alloy with adapter

Part. no. G7004XF or K9473XG

Primary Pressure: Max. 1 MPa G
Secondary Pressure: 0.02 to 0.5 MPa G
Connection: Rc1/4 or 1/4NPT (F) with joint adapter
Weight: Approx. 1 kg

Part No.	Description
G7004XF	Joint: Rc1/4, Material: Zinc alloy
K9473XG	Joint: 1/4 NPT (F), Material: Zinc alloy with adapter

- **External Dimensions**



2.4.6 Zero Gas Cylinder (part no. G7001ZC)

The gas from this cylinder is used as the calibration zero gas and detector purge gas.

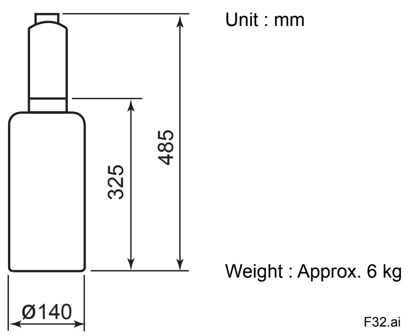
- **Standard Specifications**

Capacity: 3.4 l

Filled pressure: 9.8 to 12 MPa G

Composition: 0.95 to 1.0 vol%O_2 (N_2-balanced)

(Note) Export of such high pressure filled gas cylinder to most countries is prohibited or restricted.

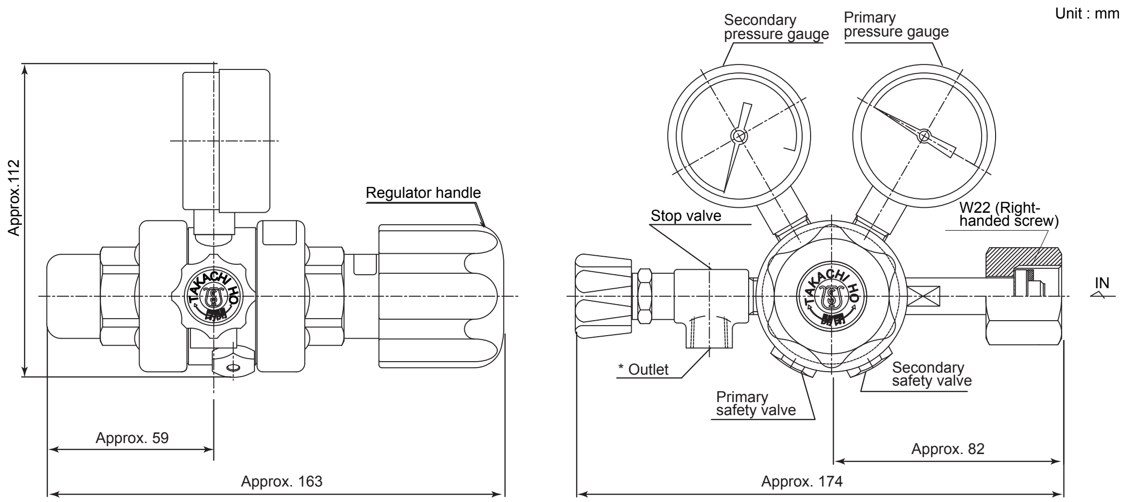


2.4.7 Pressure Regulator (G7013XF or G7014XF) for Gas Cylinder

This regulator valve is used with the zero gas cylinders.

● Standard Specifications

Primary Pressure: Max. 14.8 MPa G
Secondary Pressure: 0 to 0.4 MPa G
Connection: Inlet; W22 14 threads, right hand screw
Outlet; Rc1/4 or 1/4NPT (Female)
Material: Brass body



Part No.	* Outlet
G7013XF	Rc1/4
G7014XF	1/4 NPT female screw

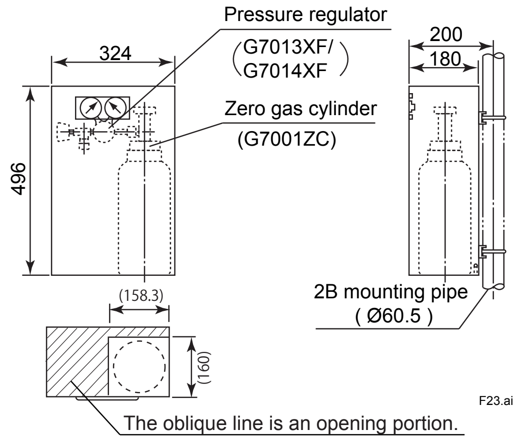
2.4.8 Case Assembly (E7044KF) for Calibration gas Cylinder

This case is used to store the zero gas cylinders.

● Standard Specifications

Installation: 2B pipe mounting
Material: SPCC (Cold rolled steel sheet)
Case Paint: Baked epoxy resin, Jade green (Munsell 7.5 BG 4/1.5)
Weight: Approx. 10 kg with gas cylinder

(Note) Export of such high pressure filled gas cylinders to most countries is prohibited or restricted.



(Note)The zero gas cylinder and the regulator valve are not included in the E7044KF (case assembly)

2.4.9 ZR202A Heater Assembly

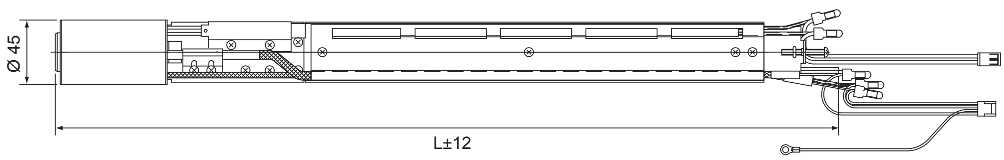
● Model and Codes

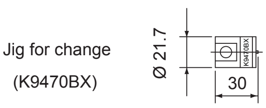
Model	Suffix code	Option code	Description
ZR202A	---------	-----------	Heater Assembly for ZR202G
Length (*1)	**-040**	-----------	0.4 m
	-070	-----------	0.7 m
	-100	-----------	1 m
	-150	-----------	1.5 m
	-200	-----------	2 m
	-250	-----------	2.5 m
	-300	-----------	3 m
Jig for change	**-A**	-----------	with Jig
	-N	-----------	None
—	**-A**	-----------	Always -A

*1 Suffix code of length should be selected as same as ZR202G installed.
(Note) The heater is made of ceramic, do not drop or subject it to pressure stress.

● External Dimensions

Unit : mm





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L: length

Model & Code	L	Weight (kg)
ZR202A-040	552	Approx. 0.8
ZR202A-070	852	Approx. 1.2
ZR202A-100	1152	Approx. 1.6
ZR202A-150	1652	Approx. 2.2
ZR202A-200	2152	Approx. 2.8
ZR202A-250	2652	Approx. 3.4
ZR202A-300	3152	Approx. 4.0

3. Installation

This chapter describes installation of the following equipment:

3.1 Installation of ZR202G Zirconia Oxygen/ Humidity Analyzer

The following should be taken into consideration when installing the probe:

(1) Easy and safe access to the probe for checking and maintenance work.

(2) Ambient temperature of not more than 55°C, and the terminal box should not be affected by radiant heat.

(3) A clean environment without any corrosive gases.

NOTE

A natural convection type analyzer (model ZR202G-□-□-□-□-C), which uses ambient air as reference gas, requires that the ambient oxygen concentration be constant. Automatic calibration cannot be used when natural convection is selected as reference gas.

(4) No vibration.

(5) The sample gas satisfies the specifications described in Chapter 2.

(6) No sample gas pressure fluctuations.

CAUTION

The ambient temperature of the ZR202G Integrated type Zirconia Oxygen/Humidity Analyzer should be between - 20°C and 55°C.

3.1.1 Probe Insertion Hole

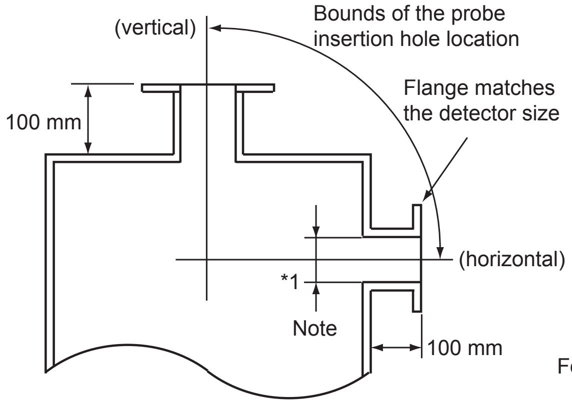
CAUTION

- The outside dimension of detector may vary depending on its options. Use a pipe that is large enough for the detector. Refer to Figure 3.1 for the dimensions.
  If the detector is mounted horizontally, the calibration gas inlet and reference gas inlet should face downwards.
- If the detector is mounted horizontally, the calibration gas inlet and reference gas inlet should face downwards.
- When using the detector with pressure compensation, ensure that the flange gasket does not block the reference gas outlet on the detector flange. If the flange gasket blocks the outlet, the detector cannot conduct pressure compensation. Where necessary, make a notch on the flange gasket.
- The sensor (zirconia cell) at the probe tip may deteriorate due to thermal shock if water drops are allowed to fall on it, as it is always at high temperature.

(1) Do not mount the probe with the tip higher than the probe base.

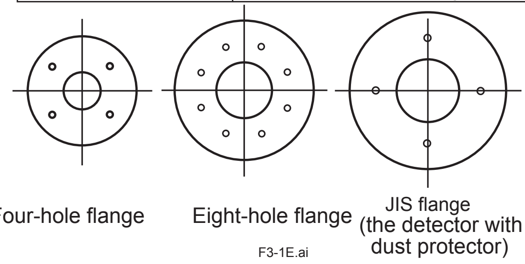
(2) If the probe length is 2.5 m or more, the detector should be mounted vertically (no more than a 5° tilt).

(3) The detector probe should be mounted at right angles to the sample gas flow or the probe tip should point downstream.



*1

Type	Outside diameter of detector
Standard	50.8 mm in diameter (Note)
With dust filter	51 mm in diameter (Note)
With probe protector	60.5 mm in diameter (Note)
With dust protector	80 mm in diameter or longer (Note)



(Note) When using the detector with pressure compensation, ensure that the flange gasket does not block the reference gas outlet on the detector flange. If the flange gasket blocks the outlet, the detector cannot perform pressure compensation.
Where necessary, make a notch in the flange gasket.
When using the detector with ZH21B dust protector the diameter of the hole should be 80mm or larger.

Figure 3.1 Illustrates an example of the probe insertion hole

3.1.2 Installation of the Probe

CAUTION

- The cell (sensor) at the tip of the detector is made of ceramic (zirconia). Do not drop the detector, as impact will damage it.
- A gasket should be used between the flanges to prevent gas leakage. The gasket material should be heatproof and corrosion-proof, suited to the characteristics of the sample gas.

The following should be taken into consideration when mounting the general-use detector:

<General-use detector>

(1) Make sure that the cell mounting screws (four bolts) at the probe tip are not loose.
If a dust filter (see Section 2.4.1) is used, make sure it is properly attached to the detector.
Refer to Section 3.1.3 for installation of the dust filter.

(2) Where the detector is mounted horizontally, the calibration gas inlet and the reference gas inlet should face downward.

3.1.3 Installation of the Dust Filter (K9471UA), Dust Guard Protector (K9471UC) Probe Protector (ZO21R)

<Procedures for installing the dust filter (K9471UA)>

CAUTION

- The dust filter is used to protect the Zirconia sensor from corrosive dust or a high concentration of dust such as in utility boilers and concrete kilns. If a filter is used in combustion systems other than these, it may have adverse effects such as response delay. The combustion conditions should be examined carefully before using a filter.
- The dust filter requires gas flow of 1 m/sec or faster at the front surface of the filter.

When you specify option code /F1, the detector is shipped with the dust filter mounted.

Follow this procedure when replacing the filter in the detector. It is recommended that you read Chapter 11 prior to filter mounting, for it is necessary to be familiar with the detector's construction, especially the sensor assembly.

(1) Mount the dust filter by putting it on the end of the detector and screw the dust filter clockwise. Put a hook pin wrench (K9471UX), Ø52 to 55 in diameter, into the hole on the dust filter to fasten or remove it.
Apply a heat-resistant coating (see Note 1) to the threads on the detector.
Where mounting dust filter after having once removed it from the detector, reapply the heat-resistant coating.

Note 1: As the detector is heated to 700°C, it is recommended to use the heat-resistant coating on the threads to prevent seizing up. Name of heat-resistant coating material: "Never-Seez Nickel Special".

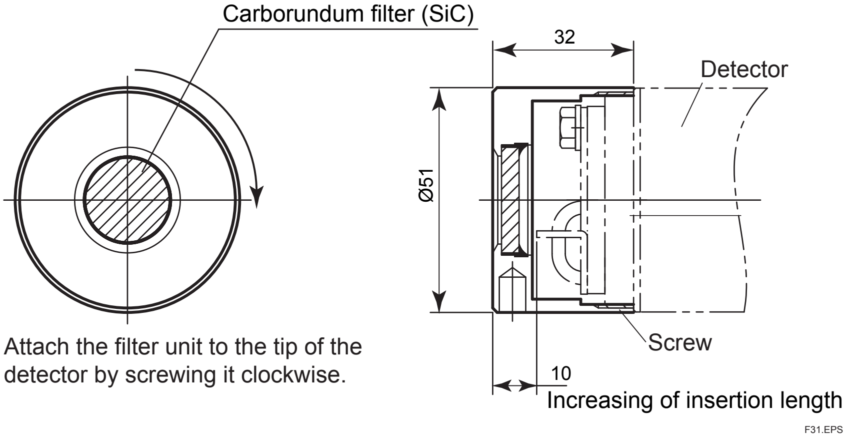


Figure 3.2 Installation of the dust filter

<Procedures for installing the dust guard protector (K9471UC)>

The ZR202G is shipped with the dust guard protector when the option code /F2 is specified in case of ordering the detector. The protector should be used when preventing dusts and water drops from lowering the detector performance is desired. Screw the protector on the top of the detector so as to cover the top. When attaching or detaching the protector, perform by hooking holes of its side with a hook pin wrench for Ø52-55 hole(Pin diameter 4.5 mm: P/N K9471UX or the like) or by pass a screwdriver through the holes. When re-attaching the protector after detaching it, apply the "Never-Seez Nickel Special" to it.

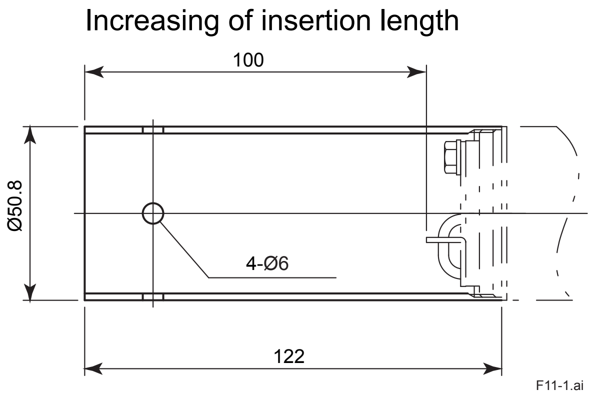


Figure 3.3 Installation of the dust guard protector

<Detector with a probe protector (Model ZO21R-L-200-☐ *B for enhance forth>

The detector is used with a probe protector to support the probe (ZR202G) when the probe length is 2.5m or more and mounted horizontally.

(1) Put a gasket (provided by the user) between the flanges and mount the probe protector in the probe insertion hole.

(2) Make sure that the sensor assembly mounting screws (four bolts) at the probe tip are not loose.

(3) Mount the detector so that the calibration/reference gas inlet faces downward.

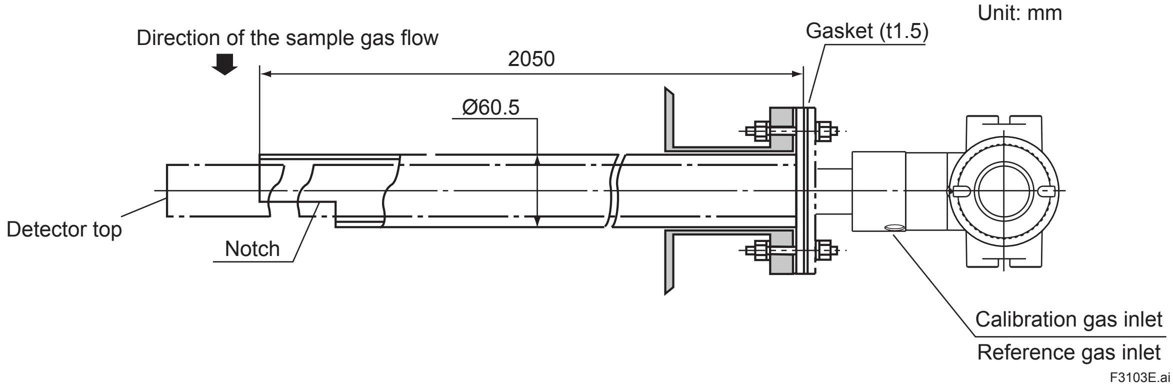


Figure 3.4 Probe protector (supporting the mounting strength)

<Detector with a probe protector (Model ZO21R-L-☐☐☐-☐ *B for dust wear protect>

The detector is used with a probe protector to prevent the sensor from being worn by dust particles when there is a high concentration of dust and gas flow exceeds 10 m/sec (fine-carbon boiler or fluid-bed furnace).

(1) Put the gasket that is provided by user between the flanges, and mount the probe protector in the probe insertion hole. The probe protector should be installed so that the notch comes to the downstream of the sample gas flow.

(2) Make sure that the sensor assembly mounting screws (four bolts) at the probe tip are not loose.

(3) Where the detector is mounted horizontally, the calibration/reference gas inlet should face downward.

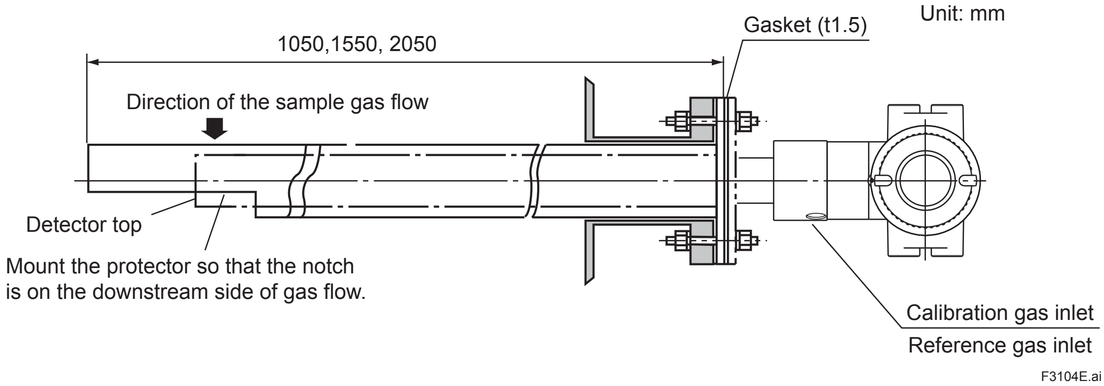


Figure 3.5 Mounting of detector with a probe protector (Dust wear protect)

CAUTION

When the probe protector is used in the ZR202G with pressure compensation (-P), instrument air leaking from the probe protector may affect the measured value.

3.1.4 Installation of ZH21B Dust Protector

(1) Put the gasket that is provided by the user between the flanges and mount the dust protector in the probe insertion hole.

(2) Make sure that the cell assembly mounting screws (four) at the probe tip are not loose.

(3) Mount the detector so that the calibration gas inlet and the reference gas inlet face downward.

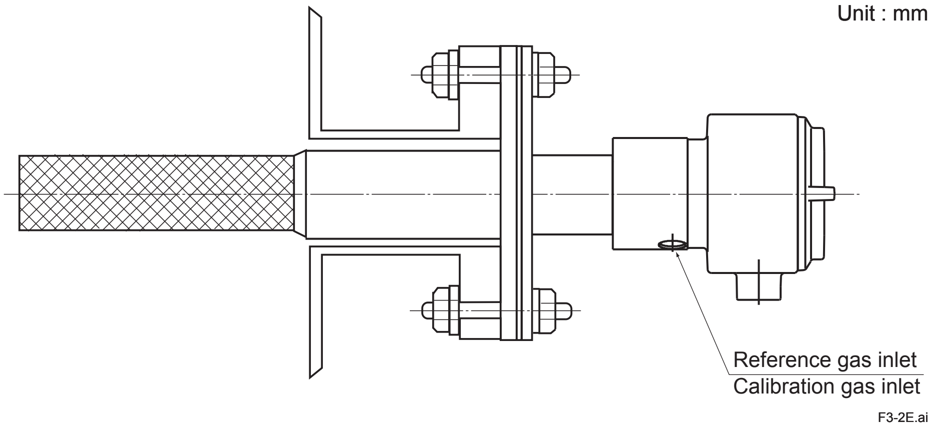


Figure 3.6 Installation of the dust filter

3.2 Installation of ZA8F Flow Setting Unit

The following should be taken into consideration:

(1) Easy access to the unit for checking and maintenance work.

(2) Near to the detector and the converter

(3) No corrosive gas.

(4) An ambient temperature of not more than 55°C and little changes of temperature.

(5) No vibration.

(6) Little exposure to rays of the sun or rain.

■ Mounting of ZA8F Flow Setting Unit

The flow setting unit can be mounted either on a pipe (nominal JIS 50 A) or on a wall. It should be positioned vertically so that the flowmeter works correctly.

<Pipe Mounting>

(1) Prepare a vertical pipe of sufficient strength (nominal JIS 50A: O.D. 60.5 mm) for mounting the flow setting unit. (The unit weighs approximately 2 to 3.5 kg.)

(2) Mount the flow setting unit on the pipe by tightening the nuts with the U-bolt so that the metal fitting is firmly attached to the pipe.

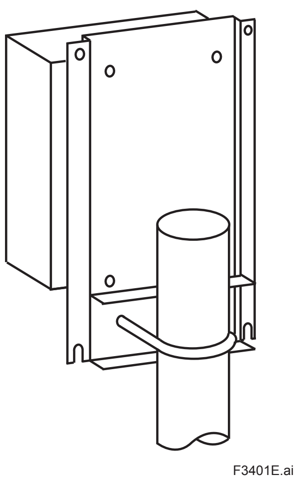


Figure 3.7 Pipe Mounting

<Wall Mounting>

(1) Make a hole in the wall as illustrated in Figure 3.8.

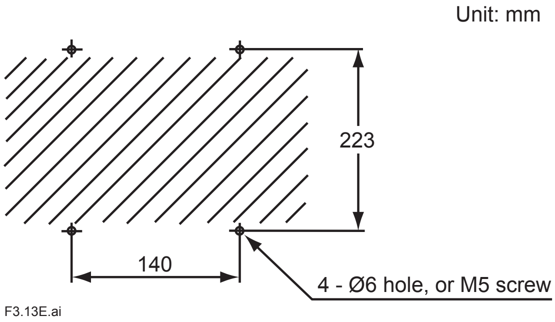


Figure 3.8 Mounting holes

(2) Mount the flow setting unit. Remove the pipe mounting parts from the mount fittings of the flow setting unit and attach the unit securely on the wall with four screws.

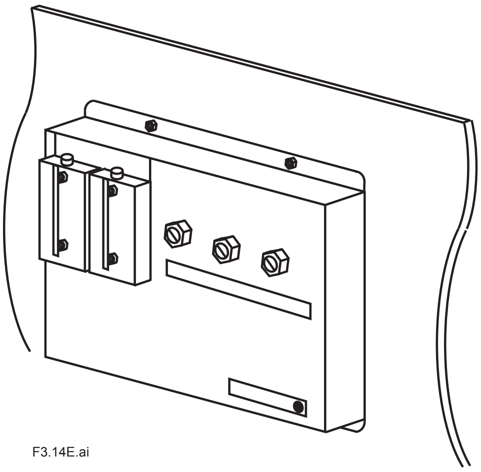


Figure 3.9 Wall mounting

3.3 Installation of ZR20H Automatic Calibration Unit

The following should be taken into consideration:

(1) Easy access to the unit for checking and maintenance work.

(2) Near to the detector and the converter

(3) No corrosive gas.

(4) An ambient temperature of not more than 55°C and little change of temperature.

(5) No vibration.

(6) Little exposure to rays of the sun or rain.

■ Mounting of ZR20H Automatic Calibration Unit

ZR202G - □ - □ - □ - □ - A or B is shipped with automatic calibration unit attached.

The automatic calibration unit includes flowmeters and solenoid valves, so as to ensure reliable and accurate operation – Flowmeter should be mounted vertically. The associated probe is designed for horizontal or vertical mounting.

If you buy the automatic calibration unit afterward, and need to install it or replace it, contact our service representative.

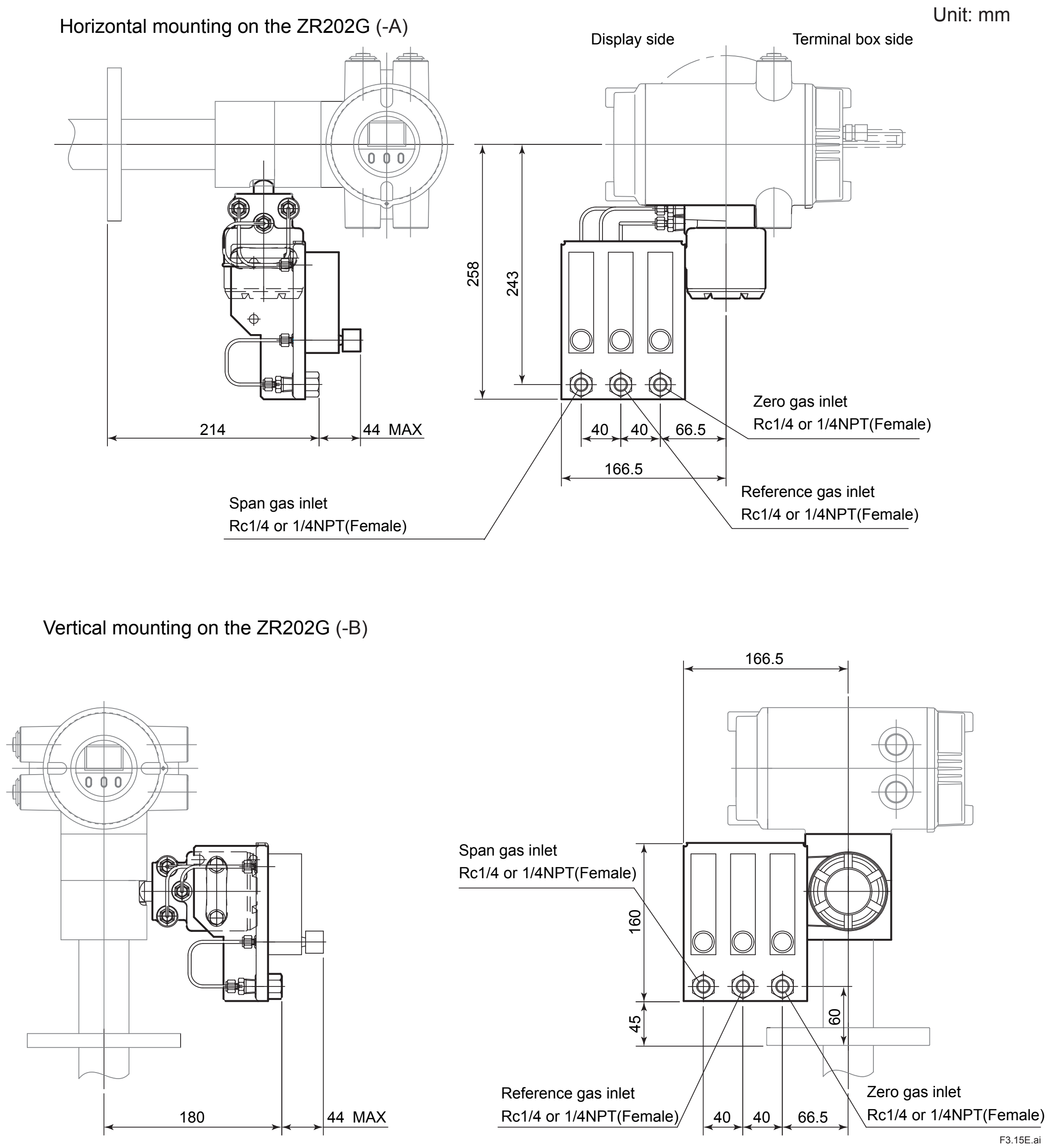


Figure 3.10 **Automatic Calibration Unit Mounting**

3.4 Installation of the Case Assembly (E7044KF) for Calibration Gas Cylinder

The case assembly is used to store the G7001ZC zero gas cylinders.

The following should be taken into consideration:

(1) Easy access for cylinder replacement
(2) Easy access for checking
(3) Near to the detector and converter as well as the flow setting unit.
(4) The temperature of the case should not exceed 40°C due to rays of the sun or radiated heat.
(5) No vibration

■ Mounting

Mount case assembly on a pipe (nominal JIS 50 A) as follows:

(1) Prepare a vertical pipe of sufficient strength (nominal JIS 50A: O.D. 60.5 mm) for mounting the case assembly. (The sum of the case assembly and the calibration gas cylinder weighs approximately 4.2 kg.)

(2) Mount the case assembly on the pipe by tightening the nuts with the U-bolt so that the metal fitting is firmly attached to the pipe.

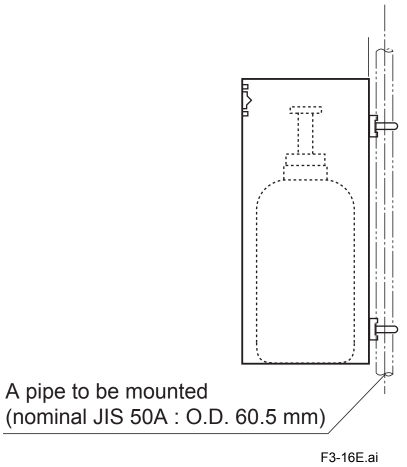


Figure 3.11 Pipe Mounting

3.5 Insulation Resistance Test

Even if the testing voltage is not so great that it causes dielectric breakdown, testing may cause deterioration in insulation and a possible safety hazard. Therefore, conduct this test only when it is necessary.

The applied voltage for this test shall be 500 V DC or less. The voltage shall be applied for as short a time as practicable to confirm that insulation resistance is 20 MΩ or more.

Remove wiring from the converter and the detector.

1. Remove the jumper plate located between terminal G and the protective grounding terminal.
2. Connect crossover wiring between L and N.
3. Connect an insulation resistance tester (with its power OFF). Connect (+) terminal to the crossover wiring, and (-) terminal to ground.
4. Turn the insulation resistance tester ON and measure the insulation resistance.
5. After testing, remove the tester and connect a 100 kΩ resistance between the crossover wiring and ground, to discharge.
6. Testing between the heater terminal and ground, contact output terminal and ground, analog output/input terminal and the ground can be conducted in the same manner.
7. Although contact input terminals are isolated, insulation resistance test cannot be conducted because the breakdown voltage of the surge-preventing arrester between the terminal and ground is low.
8. After conducting all the tests, replace the jumper plate as it was.

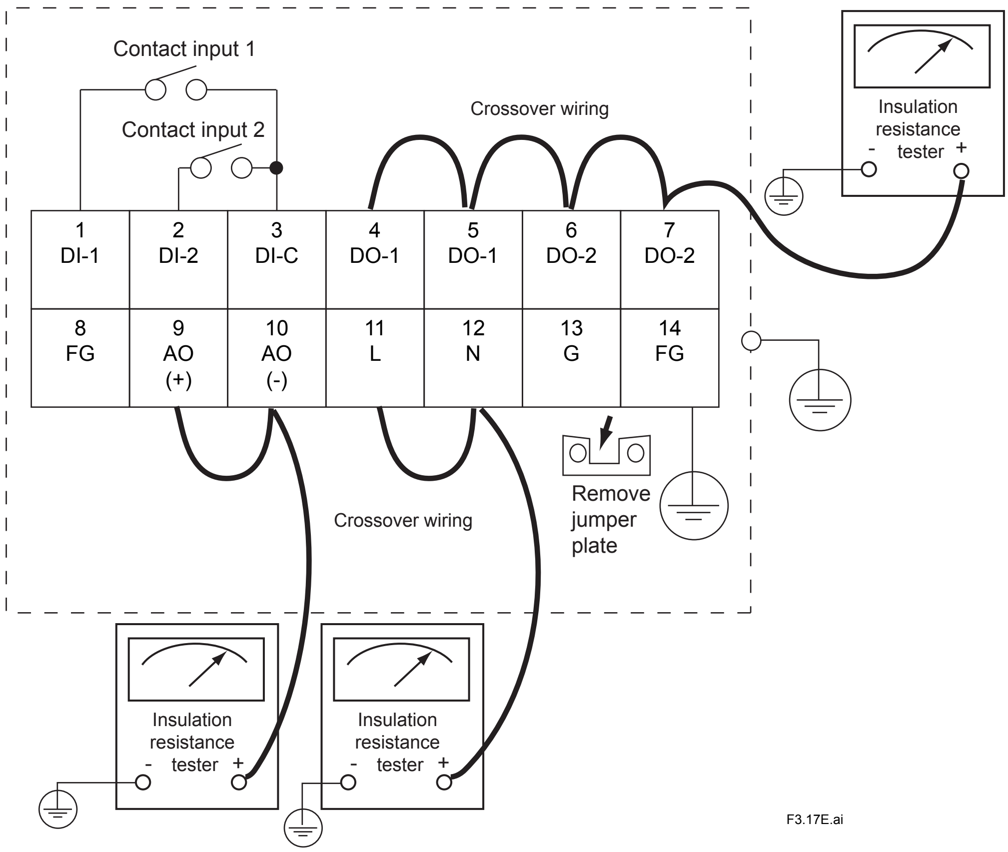

Contact input 1
Contact input 2
Crossover wiring
1 DI-1
2 DI-2
3 DI-C
4 DO-1
5 DO-1
6 DO-2
7 DO-2
8 FG
9 AO (+)
10 AO (-)
11 L
12 N
13 G
14 FG
Insulation resistance tester - +
Remove jumper plate
Crossover wiring
Insulation resistance tester - +
Insulation resistance tester - +
F3.17E.ai

Figure 3.12

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4. Piping

This chapter describes piping procedures in the three typical system configurations for EXAxt ZR Integrated type Zirconia Oxygen/Humidity Analyzer.

- Ensure that each check valve, stop valve and joints used for piping are not leaking. Especially, when there is any leakage at piping and joints for the calibration gas, it may cause clogging of the piping or incorrect calibration.
- Be sure to conduct leakage test after setting the piping.
- Basically, apply instrument air (dehumidified to the dew point -20°C or lower, removed any dust, oil mist and the like) for the reference gas when piping.
- When the instrument applies natural convection for reference gas (Model ZR202G-☐-☐-☐-☐-C), ambient air near the probe is used for reference gas; therefore the accuracy of analysis will be affected by ambient humidity changes or the like. If more accurate analysis is necessary, use instrument air (dehumidified to the dew point -20°C or lower, removed any dust, oil mist and the like) for reference gas.
  Stable analyzing can be conducted when using instrument air.

4.1 Piping for System 1

The piping in System 1 is illustrated in Figure 4.1

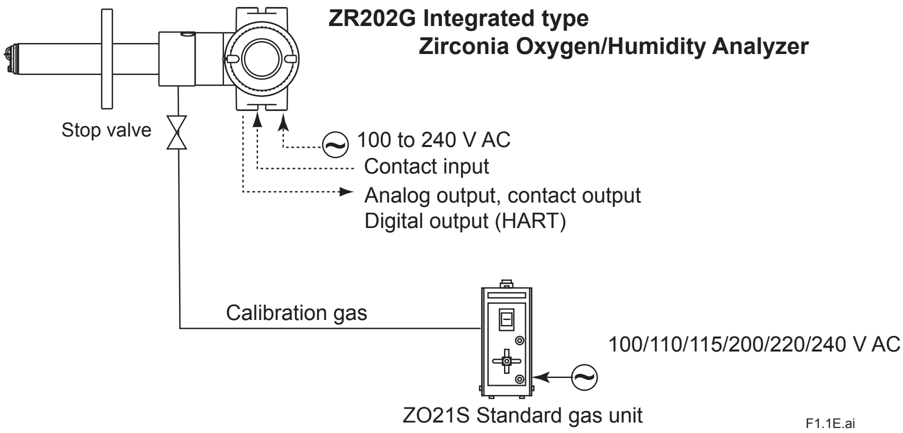


Figure 4.1 Piping for System 1

Piping in System 1 is as follows:

- Place a stop valve through the nipple at the calibration gas inlet of the equipment.
  Then mount a joint for a 6 mm (O.D.) x 4 mm (I.D.) soft tube at the stop valve connection hole of the inlet side (see Section 4.1.2). The tube is to be connected to this joint only during calibration.

CAUTION

- The stop valve should be connected directly to the equipment. If any piping is present between the analyzer and the stop valve, condensed water may be produced in the pipe, which may cause damage to the sensor by rapid cooling when the calibration gas is introduced.
- The reference gas should have an oxygen concentration identical to that of fresh air (21%).

4.1.1 Piping Parts for System 1

Check that the parts listed in Table 4.1 are provided.

Table 4.1 Piping Parts

Equipment	Piping location	Parts Name	Description	
Oxygen/ Humidity Analyzer	Calibration gas inlet	Stop valve	(L9852CB or G7016XH) recommended by YOKOGAWA	
		Nipple *	Rc1/4 or 1/4 NPT	General parts
		Joint for tube connection	Rc1/4 (1/4NPT) for a 6x4mm soft tube	General parts
	Reference gas inlet	(Sealed up)	(when piping is required, refer to Section 4.1.3)	

Note: Parts with marking * are used when required.
General parts can be found on the local market.

4.1.2 Piping for the Calibration Gas

When carrying out calibration, connect the piping (6(O.D) x 4(I.D.) mm tube) from the standard gas unit to the calibration gas inlet of the oxygen analyzer. Mount the stop valve (of a quality specified by YOKOGAWA) through a nipple (found on the local market) as illustrated in Figure 4.2, and mount a joint (also found on the local market) at the stop valve tip. (The stop valve may be mounted on the equipment when the oxygen analyzer is shipped.)

Note: Mount the stop valve in the vicinity of the equipment.

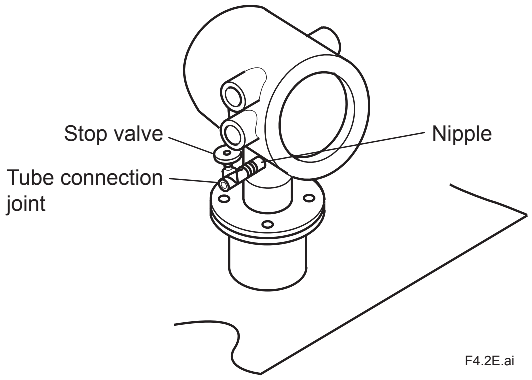


Figure 4.2 Piping for the Calibration Gas Inlet

4.1.3 Piping for the Reference Gas

- Normally, no piping is required for the reference gas inlet when the equipment applies natural convection for reference gas (models ZR202G-☐-☐-☐-☐-C). Leave the plug as it is. If the air around the probe is polluted and the necessary oxygen concentration (21 vol%O_2) cannot be obtained, make instrument air piping as in Section 4.2, System 2.
- When the equipment uses instrument air for the reference gas, piping is required as described in Section 4.2, System 2 (models ZR202G-☐-☐-☐-☐-E or P).

4.2 Piping for System 2

Piping in System 2 is illustrated in Figure 4.3.

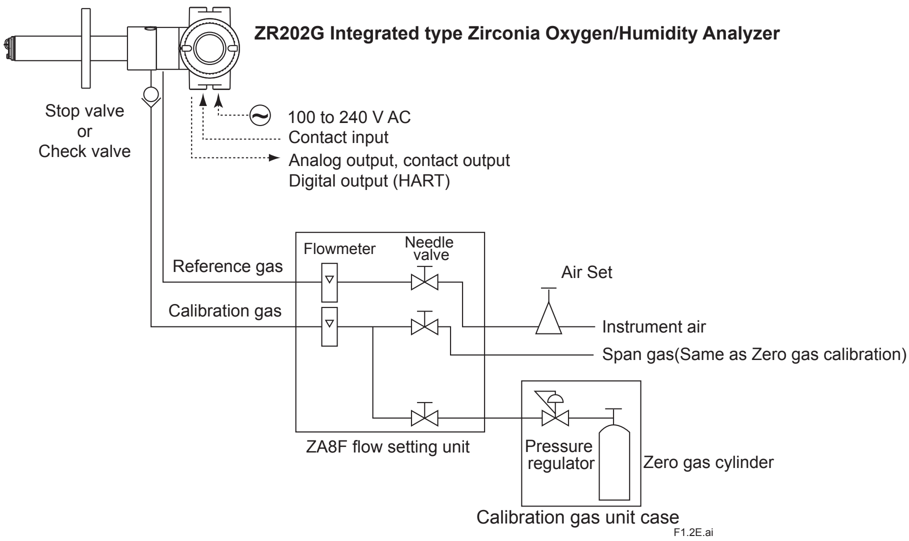


Figure 4.3 Piping for System 2

System 2 illustrated in Figure 4.3 requires piping as follows:

- Mount the check valve or the stop valve through a nipple to the calibration gas inlet of the equipment.

4.2.1 Piping Parts for System 2

Check that the parts listed in Table 4.2 are provided.

Table 4.2 Piping Parts

Equipment	Piping location	Parts Name	Description	
Oxygen/ Humidity Analyzer	Calibration gas inlet	Stop valve or check valve	Stop valve (L9852CB or G7016XH recommended by YOKOGAWA Check valve (K9292DN or K9292DS) provided by YOKOGAWA	
		Nipple *	Rc1/4 or 1/4 NPT	General parts
		Zero gas cylinder	User' s scope	
		Pressure Regulator	(G7013XF or G7014XF) recommended by YOKOGAWA	
		Joint for tube connection	Rc1/4 or 1/4 NPT	General parts
	Reference gas inlet	Air set	(G7003XF/K9473XK or G7004XF/ K9473XG) recommended by YOKOGAWA	
		Joint for tube connection	Rc1/4 or 1/4 NPT	General parts

Note: Parts with marking * are used when required.
General parts can be found on the local market.

4.2.2 Piping for the Calibration Gas

This piping is to be installed between the zero gas cylinder and the ZA8F flow setting unit, and between the ZA8F flow setting unit and the ZR202G analyzer.

The cylinder should be placed in a case assembly E7044KF or the like to avoid any direct sunlight or radiant heat so that the gas cylinder temperature may not exceed 40°C.

Mount the pressure regulator (recommended by YOKOGAWA) on the cylinder.

Mount the stop valve or the check valve (recommended by YOKOGAWA) through the nipple (found on the local market) at the calibration gas inlet of the equipment as illustrated in Figure 4.4. (The stop valve or the check valve may have been mounted on the equipment when shipped.) Connect the flow setting unit and the analyzer to a 6mm (O.D.) x 4mm (I.D.) (or nominal size 1/4 inches) or larger stainless steel pipe.

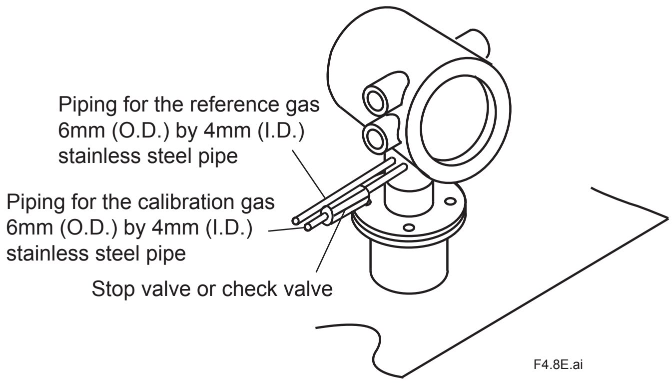


Figure 4.4 Piping for the Calibration Gas Inlet

4.2.3 Piping for the Reference Gas

Reference gas piping is required between the air source (instrument air) and the flow setting unit, and between the flow setting unit and the analyzer.

Insert the air set next to the flow setting unit in the piping between the air source and the flow setting unit.

Use a 6mm (O.D.) x 4mm (I.D.) (or nominal size 1/4 inches) stainless steel pipe between the flow setting unit and the analyzer.

4.3 Piping for System 3

Piping in System 3 is illustrated in Figure 4.5. In System 3, calibration is automated; however, the piping is basically the same as that of System 2. Refer to Section 4.2.

Adjust secondary pressure of both the air set and the zero gas regulator so that these two pressures are approximately the same. The flow rate of zero and span gases (normally instrument air) are set by a individual needle valve. After installation and wiring, check zero gas calibration contact output (see Sec. 7.10.2), and adjust zero gas regulator and calibration gas needle valve so that zero gas flow is within the permitted range. Next check span gas calibration contact output and adjust air set so that span gas flow is within the permitted range.

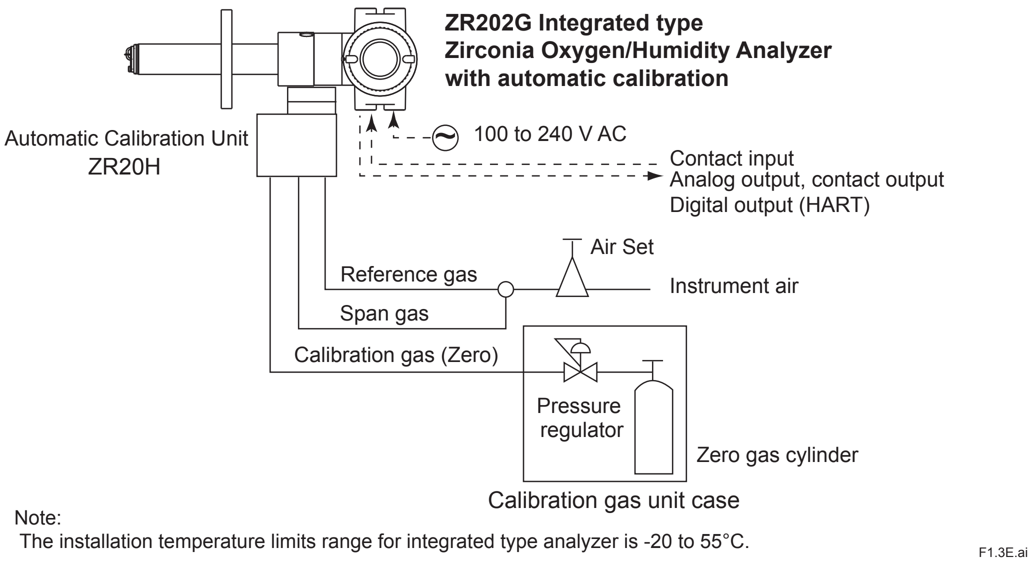
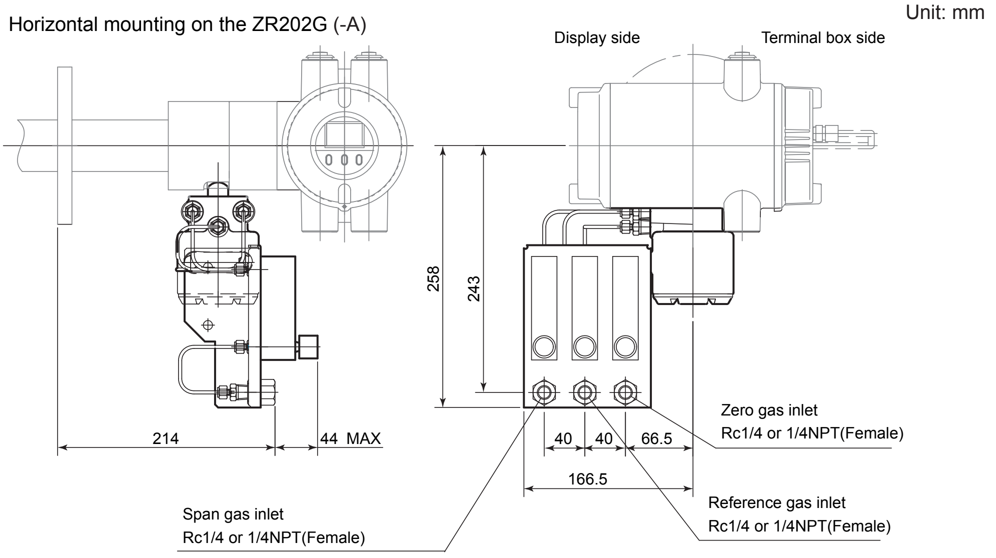


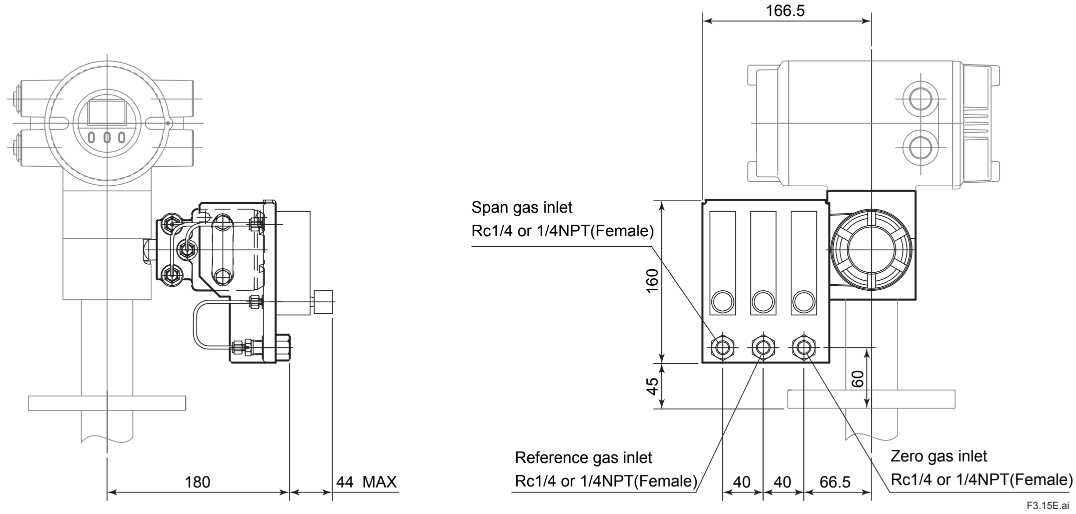
Figure 4.5 Piping for System 3

Installation of ZR20H Automatic Calibration Unit

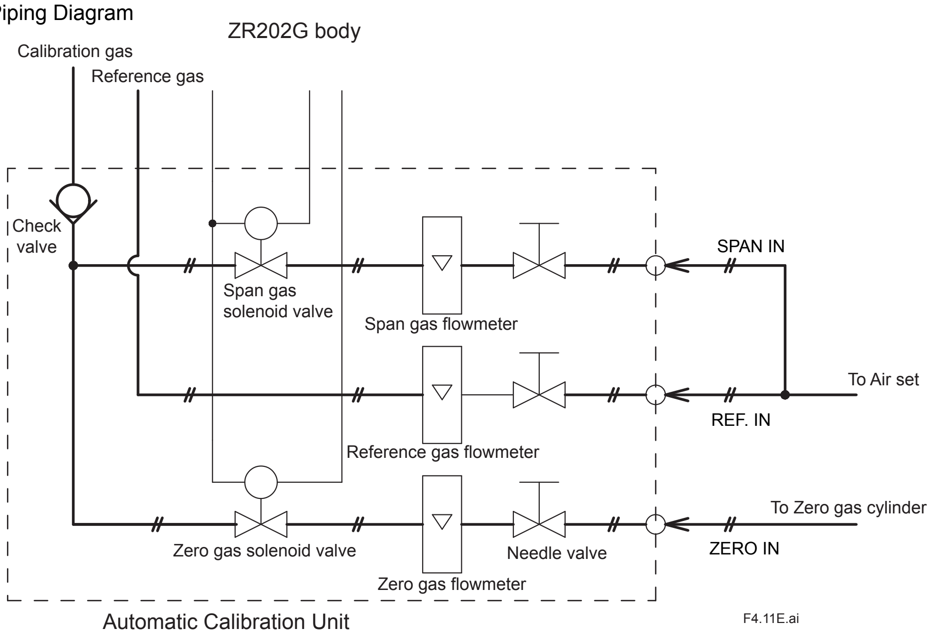
Horizontal mounting on the ZR202G (-A)



Vertical mounting on the ZR202G (-B)



Piping Diagram



4.4 Piping for the Oxygen Analyzer with Pressure Compensation

ZR202G-□-□-□-□-P Oxygen Analyzer with pressure compensation may be used in System 2 and System 3.

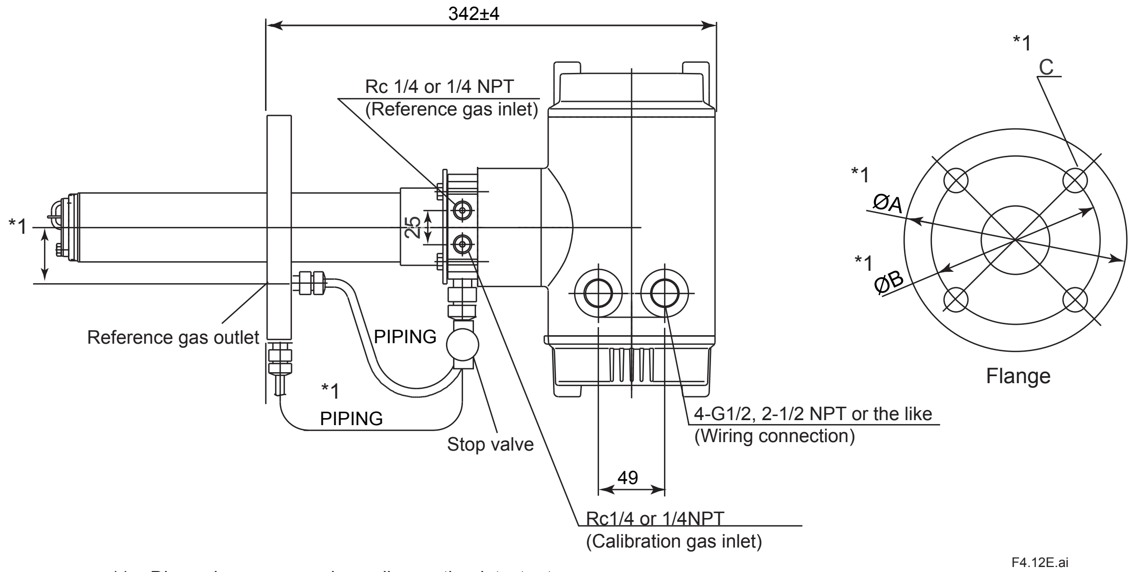
Use this style analyzer whenever the furnace pressure exceeds 5 kPa (see Note). Even if the furnace pressure is high, the detector can measure by adjusting pressure of the probe with the furnace pressure using instrument air. The inside pressure of the probe will be kept identical to the furnace pressure by feeding instrument air at higher pressure than that in the furnace.

NOTE

The process gas pressure should not be subjected to rapid changes.

The detector with pressure compensation is illustrated in Figure 4.6.

Unit: mm



*1: Dimension may vary depending on the detector type.
Ensure that the flange gasket does not block off the reference gas outlet.
Where necessary, make a notch on the flange

Figure 4.6 Oxygen Analyzer with Pressure Compensation

Ensure that the furnace gas does not flow into the probe.

Valve operation

1. For safety, stop the furnace that the detector is to be installed in. If furnace internal pressure is high, this is especially dangerous.
2. Before starting instrument air flow, completely shut the stop valve in front of the reference gas outlet.
3. Check that the reference gas outlet is not blocked by a flange gasket or the like.
4. Set the instrument air pressure higher than furnace internal pressure.
5. Completely open the stop valve in front of the reference gas outlet and, after turning on instrument air flow, start furnace operation. As furnace internal pressure rises, confirm that instrument air continues to flow and adjust the valve or increase supply pressure if necessary.
6. After furnace internal pressure stabilizes, adjust flow.
7. If furnace operation is stopped, stop instrument air flow and completely shut the stop valve in front of the reference gas outlet. You may leave reference gas flowing if you wish.

CAUTION

- Use suitable cable glands to completely seal the detector. As far as possible do not stop the instrument air flow, to prevent the sample gas from entering the detector and damaging the zirconia cell.
- Connect the stop valve, which is at the calibration gas inlet, directly to the equipment. If piping connections are made between the detector and the needle valve, condensation will result inside the piping and cause the sensor to be damaged when the calibration gas is introduced.

Figure 4.7 illustrates an example of System 2 using the analyzer with pressure compensation.

Supplying the air pressure (flow) may vary depending on the furnace pressure. It is recommended to use a flow gauge and an air set meeting the furnace pressure.

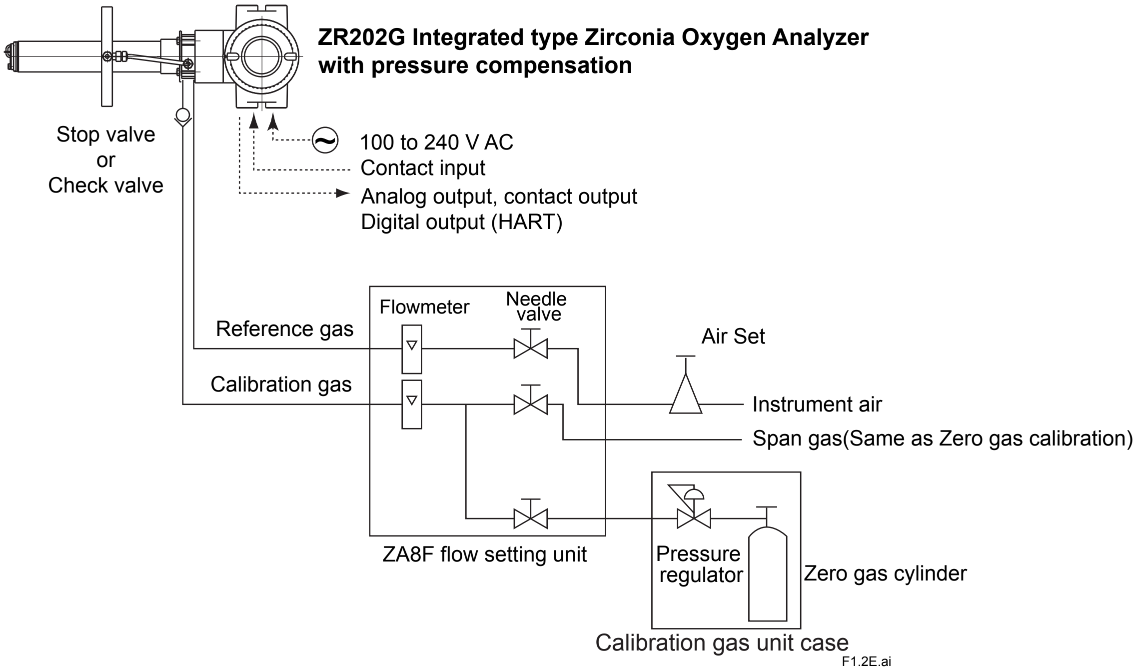


Figure 4.7 Illustrates an example of System 2 using the analyzer with pressure compensation.

NOTE

When using the ZA8F Flow Setting Unit and the ZR20H Automatic Calibration Unit, please note that the supplying airflow (pressure) will vary depending on the furnace pressure.

4.4.1 Piping Parts for Oxygen Analyzer with Pressure Compensation

Check that the parts listed in Table 4.3 are provided.

Table 4.3 Piping Parts

Equipment	Piping location	Parts Name	Description	
Oxygen Analyzer with pressure compensation	Calibration gas inlet	Check valve or stop valve	Stop valve (L9852CB or G7016XH) recommended by YOKOGAWA Check valve (K9292DN or K9292DS) provided by YOKOGAWA	
		Nipple *	Rc1/4 or 1/4 NPT	General parts
		Zero gas cylinder	User's scope	
		Pressure regulator	(G7013XF or G7014XF) recommended by YOKOGAWA	
		Joint for tube connection	Rc1/4 or 1/4 NPT	General parts
	Reference gas inlet	Air set	(G7003XF/ K9473XK or G7004XF / K9473XG) recommended by YOKOGAWA	
		Joint for tube connection	Rc1/4 or 1/4 NPT	General parts

Note: Use parts with marking * as required.
General parts can be found on the local market.

4.4.2 Piping for the Calibration Gas

Calibration gas piping is basically identical to that of System 2. See Section 4.2.2.

4.4.3 Piping for the Reference Gas

Reference gas piping is basically identical to that of for System 2. See Section 4.2.3.

5. Wiring

This chapter describes wiring procedures necessary for the EXAxt ZR Integrated type Zirconia Oxygen/Humidity Analyzer.

5.1 General

WARNING

NEVER supply current to the converter or any other device constituting a power circuit in combination with the converter, until all wiring is completed.

CAUTION

This product complies with CE marking.
Where compliance with CE marking is necessary, the following wiring procedure is necessary.

- Install an external switch or circuit breaker to the power supply of the converter.
- Use an external switch or circuit breaker rated 5 A and conforming with IEC 947-1 or IEC 947-3.
- It is recommended that the external switch or circuit breaker be mounted in the same room as the equipment.
- The external switch or circuit breaker should be installed within the reach of the operator, and marked as the power supply switch of this equipment.

Wiring procedure

Wiring should be made according to the following procedure:

1. Be sure to connect the shield of the shielded line to FG terminal of the analyzer.
2. The most outer sheath of the signal line and the power cable should be stripped off to the minimum necessary length.
3. Signal will be affected by noise emission when the signal lines, power cable and heater cable are located in the same conduit. When using a conduit, signal lines should be installed in the separate conduit from power and heater cables. Be sure to ground the metal conduit.
4. Mount the attached two blind plugs to unused cable connection gland(s) of the equipment.
5. The cables indicated in Table 5.1 are used for wiring.
6. After completing the wiring, screw the cover in the terminal box body and secure it with a lock screw.

Table 5.1 Cable Specifications

Terminal name of converter	Name	Need for shields	Number of wires
L, N, ⏚	Power supply		2 or 3 *
AO+, AO-	Analog output	O	2
DO-1, DO-2	Contact output		2 to 4
DI-1, DI-2, DI-C	Contact input		3

Note *: When the case is used for protective grounding, use a 2-wire cable.

WARNING

Cables that withstand temperatures of at least 80 °C should be used for wiring.

CAUTION

- Select suitable cable O.D. to match the cable gland size.
- Protective grounding should be connected in ways equivalent to JIS D style (Class 3) grounding (the grounding resistance is 100 Ω or less).
- Special consideration of cable length should be taken for the HART communication, For the detail, refer to Section 1.1.2 of the IM 11M12A01-51E “Communication Line Requirements”.

5.1.1 Terminals for the External Wiring

Remove the terminal cover on the opposite side of the display to gain access to the external wiring terminals.

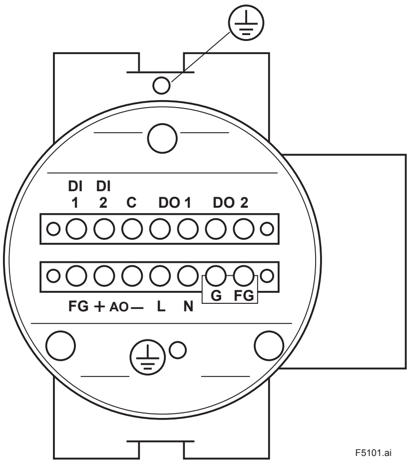
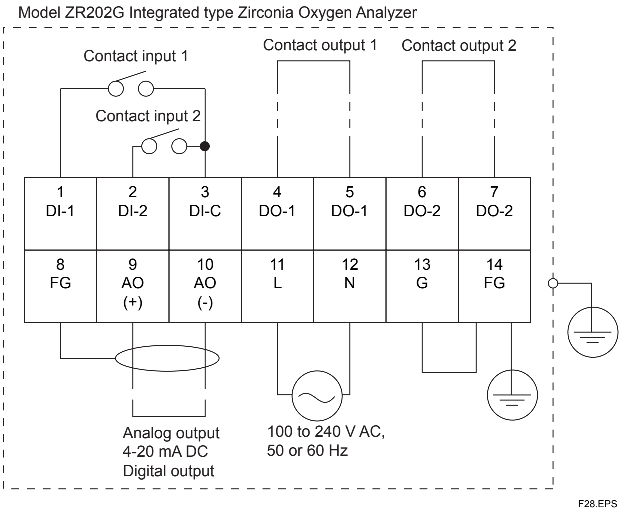


Figure 5.1 Terminals for External Wiring

5.1.2 Wiring

Make the following wiring for the equipment. It requires a maximum of four wiring connections as shown below.

(1) Analog output signal
(2) Power and ground
(3) Contact output
(4) Contact input



The protective grounding for the analyzer shall be connected either the protective ground terminal in the equipment or the ground terminal on the case.
Standard regarding grounding: Ground to earth, ground resistance: 100Ω or less.

Figure 5.2 Wiring Connection

5.1.3 Mounting of Cable Gland

For each wiring inlet connection of the equipment, mount the conduit appropriate for the screw size or a cable gland.

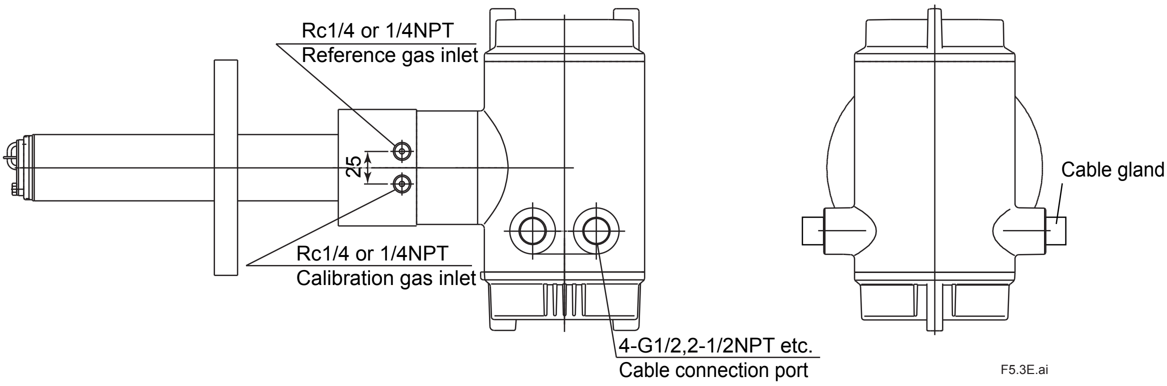


Figure 5.3 Cable Gland Mounting

5.2 Wiring for Analog Output

This wiring is for transmitting 4 to 20mA DC output signals to a device, e.g. recorder. Maintain the load resistance including the wiring resistance of 550Ω or less.

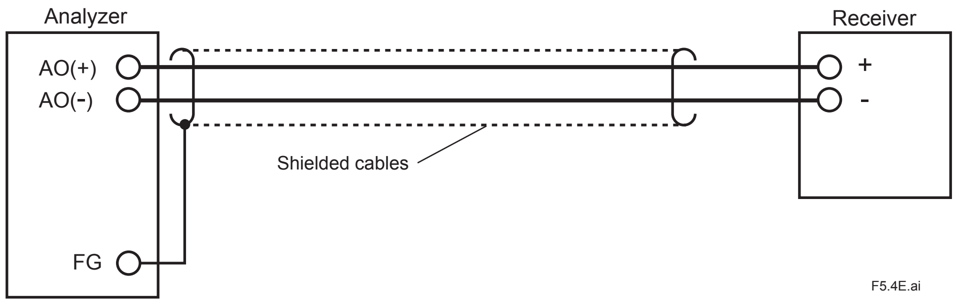


Figure 5.4 Wiring for Analog Output

5.2.1 Cable Specifications

Use a 2-core shielded cable for wiring.

5.2.2 Wiring Procedure

(1) M4 screws are used for the terminals. Use crimp-on terminals appropriate for M4 terminal screws for cable connections. Ensure that the cable shield is connected to the FG terminal of the equipment.

(2) Be sure to connect (+) and (-) polarities correctly.

CAUTION

- Before opening the cover, loosen the lock screw. If the screw is not loosened first, the cover will be improperly engaged to the body, and the terminal box will require replacement. When opening and closing the cover, remove any sand particles or dust to avoid gouging the thread.
- After screwing the cover on the equipment body, secure it with the lock screw.

5.3 Wiring Power and Ground Terminals

Wiring for supplying power to the analyzer and grounding the equipment.

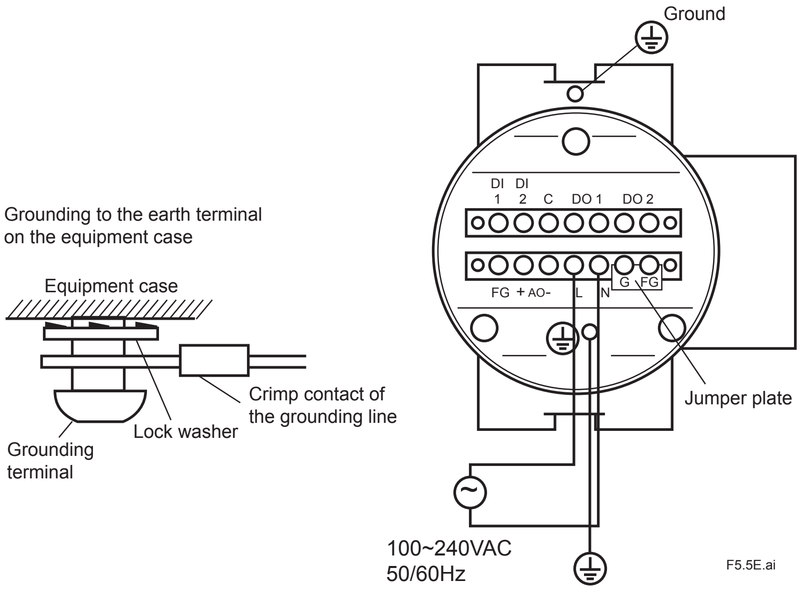


Figure 5.5 Power and Grounding Wiring

5.3.1 Wiring for Power Line

Connect the power wiring to the L and N terminals of the equipment. For a three-core cable, ground one core appropriately. Proceed as follows:

(1) Use a two-core or three-core cable.

(2) M4 screws are used for the terminals. Use crimp-on terminals appropriate for M4 terminal screws for cable connections.

5.3.2 Wiring for Ground Terminals

The ground wiring of the analyzer should be connected to either the ground terminal of the equipment case or the terminal inside of the equipment. Proceed as follows:

(1) Keep the ground resistance of 100Ω or less (JIS Class D grounding).

(2) When connecting the ground wiring to the ground terminal of the equipment case, be sure that the lock washer is in contact with the case surface (see Figure 5.5.).

(3) Ensure that the jumper plate is connected between the G terminal and the FG terminal of the equipment.

(4) The size of external ground screw thread is M4. Each cable should be terminated corresponding crimp-on terminals.

5.4 Wiring for Contact Output

The equipment can output a maximum of two contact signals. These contact outputs can be used for different applications such as a low alarm or high alarm.

Do the contact output wiring according to the following requirements.

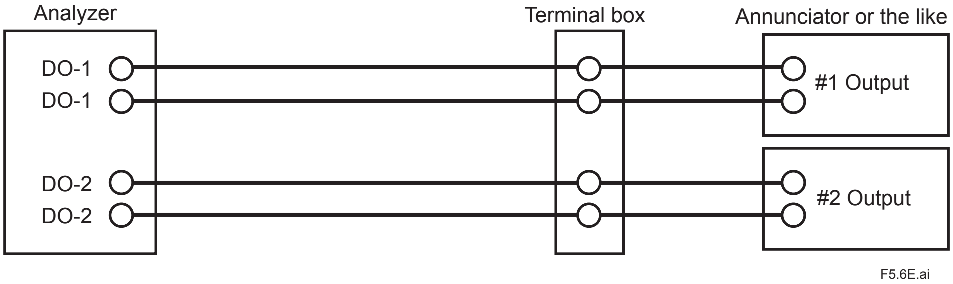


Figure 5.6 Contact Output Wiring

5.4.1 Cable Specifications

The number of cores varies depending on the number of contacts used.

5.4.2 Wiring Procedure

(1) M4 screws are used for the terminals. Use crimp-on terminals appropriate for M4 terminal screws for cable connections.

(2) The contact output relays are rated 30 V DC 3A, 250 V AC 3A. Connect a load (e.g. pilot lamp and annunciator) within these limits.

5.5 Wiring for Contact Input

The converter can execute specified function when receiving contact signals.

To use these contact signals, proceed wiring as follows:

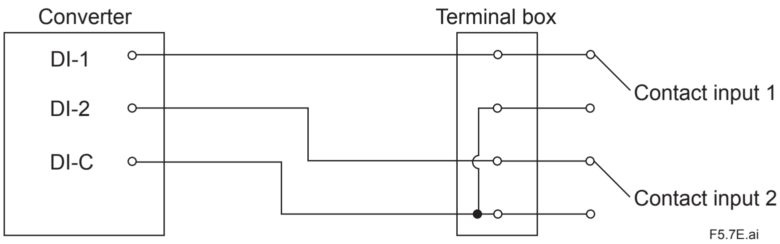


Figure 5.7 Contact Input Wiring

5.5.1 Cable Specifications

Use a 2-core or 3-core cable for this wiring. Depending on the number of input(s), determine which cable to use.

5.5.2 Wiring Procedure

(1) M4 screws are used for the terminal of the converter. Each cable should be equipped with the corresponding crimp contact.

(2) The ON/OFF level of this contact input is identified by the resistance. Connect a contact input that satisfies the descriptions in Table 5.2.

Table 5.2 Identification of Contact Input ON/OFF

	Closed	Open
Resistance	200 Ω or less	100 kΩ or more

6. Components

This chapter describes the names and functions of components for the major equipment of the EXAxt ZR Integrated type Zirconia Oxygen/Humidity Analyzer.

6.1 ZR202G Zirconia Oxygen/Humisity Analyzer

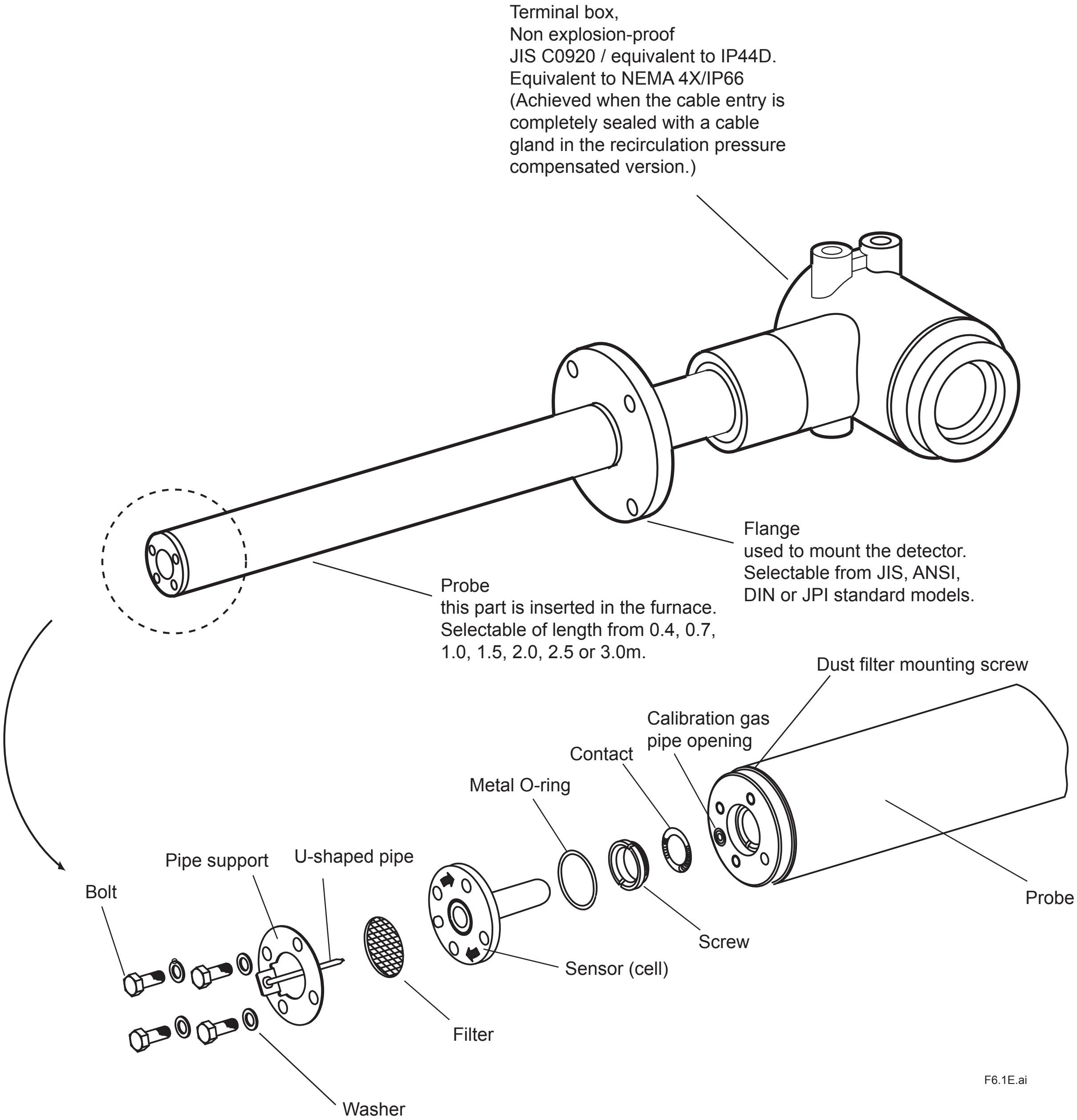


Figure 6.1 **Integrated type Zirconia Oxygen/Humidity Analyzer**

6.2 ZA8F Flow Setting Unit, ZR20H Automatic Calibration Unit

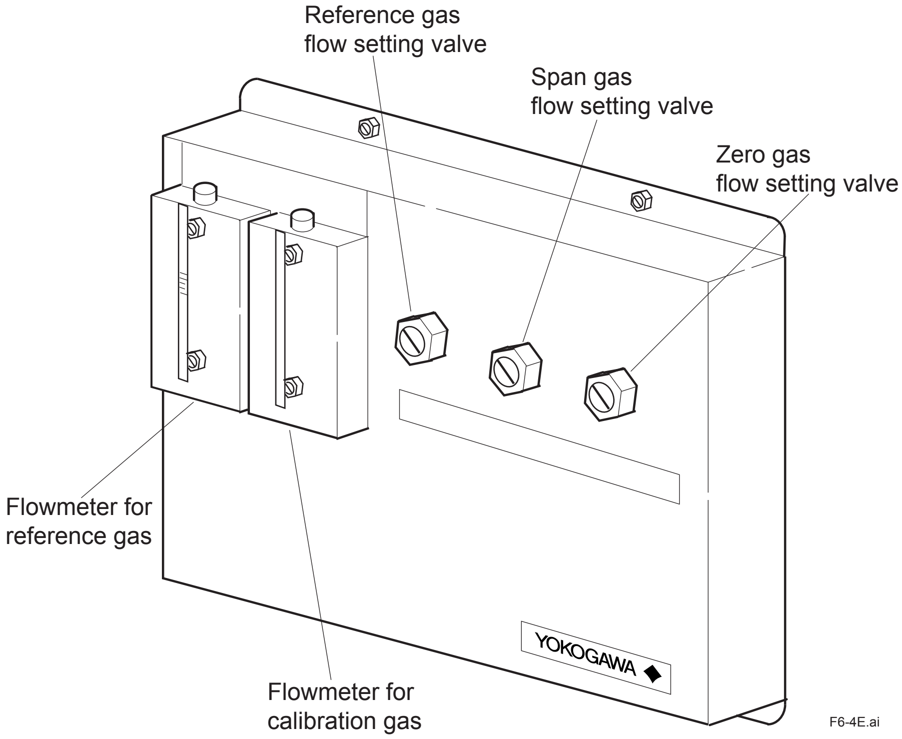


Figure 6.2 ZA8F Flow Setting Unit

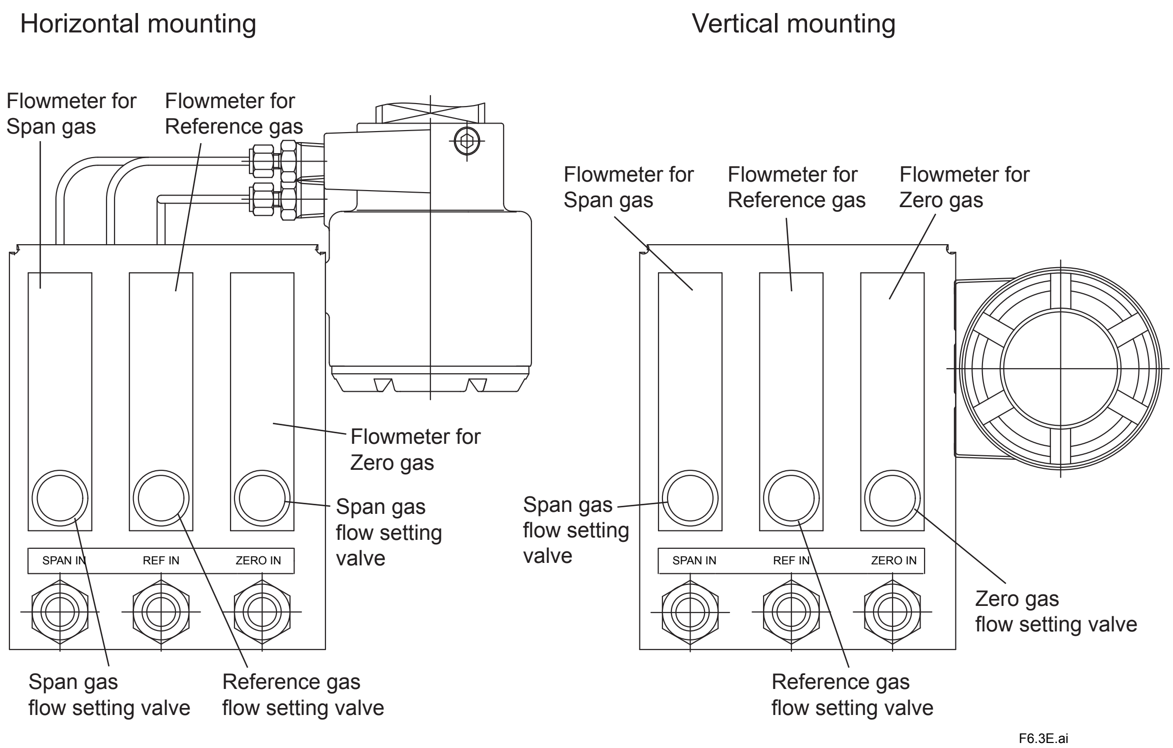


Figure 6.3 ZR20H Automatic Calibration Unit

7. Startup

The following describes the minimum operating requirements — from supplying power to the converter to analog output confirmation to manual calibration.

In the figure listed in this manual, the example of the oxygen analyzer is shown mainly.
In the case of the humidity analyzer, unit indication may be different. Please read it appropriately.

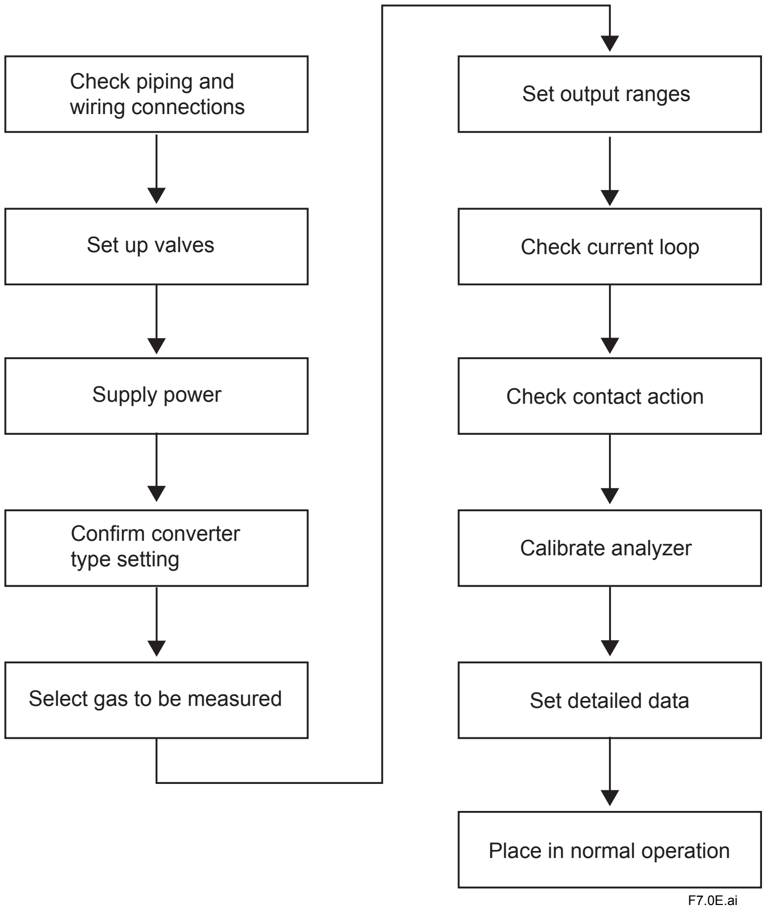


Figure 7.1 Startup Procedure

For system tuning by HART communication, refer to the IM 11M12A01-51E ''HART Communication Protocol''.

7.1 Checking Piping and Wiring Connections

Refer to Chapters 4 and 5, earlier in this manual, for piping and wiring confirmations.

7.2 Valve Setup

Set up valves and associated components used in the analyzer system in the following procedures:

(1) If a stop valve is used in the detector's calibration gas inlet, fully close this valve.

(2) If instrument air is used as the reference gas, adjust the Air set secondary pressure so that the air pressure of sample gas pressure plus approx. 50 kPa (plus approx. 150 kPa for with check valve) (300 kPa maximum for the ZA8F, 690 kPa maximum for the ZR20H) is obtained. Turn the reference gas flow setting valve in the flow setting unit to obtain the flow of 800 to 1000 ml/min. (Turning the valve shaft counterclockwise increases the rate of flow. When turning the valve shaft, if the valve has a lock nut, first loosen the lock nut.) After completing the valve setup, be sure to tighten the lock nut.

NOTE

The calibration gas flow setting will be described later. Fully close the needle valve in the flow setting unit.

7.3 Supplying Power to Converter

CAUTION

To avoid temperature changes around the sensor, it is recommended that the power be continuously supplied to the Oxygen Analyzer if it is used in an application where its operations and suspensions are periodically repeated.

It is also recommended to flow a span gas (instrument air) beforehand.

Supply power to the converter. A display as in Figure 7.2, which indicates the detector's sensor temperature, then appears. As the heat in the sensor increases, the temperature gradually rises to 750°C. This takes about 20 minutes after the power is turned on, depending somewhat on the ambient temperature and the sample gas temperature. After the sensor temperature has stabilized at 750°C, the converter is in the measurement mode. The display panel then displays the oxygen concentration as in Figure 7.3. This is called the basic panel display.

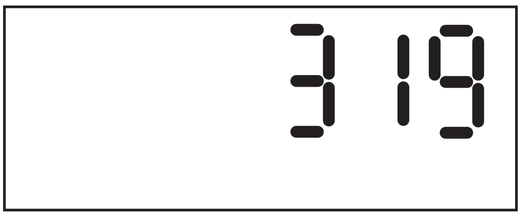


Figure 7.2 Display of Sensor Temperature While Warming Up

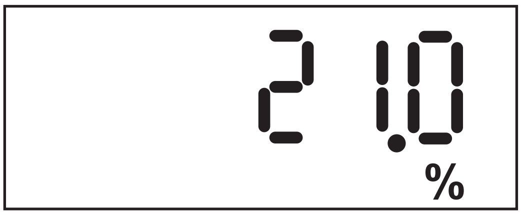


Figure 7.3 Measurement Mode Display

7.4 Operation of Infrared Switch

7.4.1 Display and Switches

This equipment uses an infrared switch that enables operation with the cover closed. Figure 7.4 shows the infrared switch and the display. Table 7.1 shows the three switch (keys) and functions.

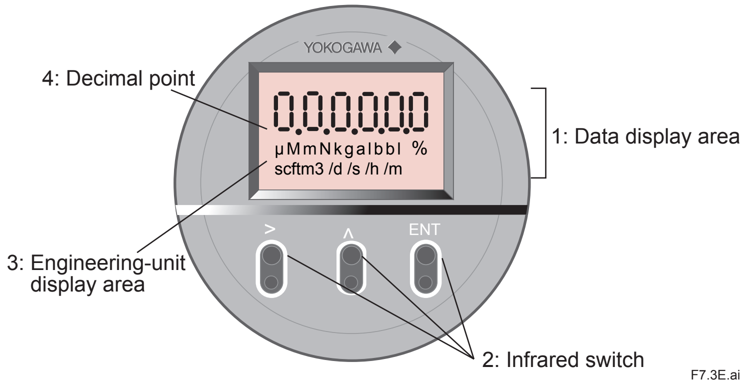


Figure 7.4 Infrared switch and the display

1. Data display area: Displays the oxygen concentration, humidity, set values, alarm numbers, and error numbers.
2. Infrared switch: Three switches perform data setting operations.
3. Engineering-unit display area: the percent sign appears when the oxygen concentration or humidity is displayed.
4. Decimal point: A decimal point is displayed.

Table 7.1 Switch and Function

Switch	Function
>	1. Moves the position of the digit to the right. If you continuously touch the key, the position of the digit will move continuously to the right, finally returning to the leftmost position after reaching the rightmost position of the digit. 2. Selects Yes or No. 3. When you touch this key together with the [ENT] key, the previous display then appears, or the operation will be cancelled.
^	Used to change values. If you continuously touch this key, the value of the digit will increase continuously, e.g., from 1 to 2 to 3 (for numeric data), or from A to B to C (for alphabetic characters), and finally return to its original value.
ENT	1. Used to change the basic panel display to the parameter selection display. 2. Used to enter data. 3. Advances the operation.

The three infrared switches are activated by completely touching the glass surface of the switch. To touch any of the keys continuously, first touch the surface and then completely remove your finger from the surface. Then touch it again.

Infrared switches consist of two elements: an infrared emitting element and an infrared acceptance element. Infrared light-waves from the element bounces on the operator's finger and are reflected back to the acceptance element, thereby causing the infrared switch to turn on and off, depending on the strength of the reflected light-waves. From this operating principles, carefully observe the following:

CAUTION

1. Be sure to put the equipment case cover back on. If this is not done, the infrared switch will not reflect the infrared light-waves, and a "dSPErr" error will be issued.
2. Before placing the equipment in operation, be sure to wipe off any moisture or dust on the glass surface if it is wet or dirty. Also make sure your fingers are clean and dry before touching the glass surface of the switch.
3. If the infrared switches are exposed to direct sunlight, they may not operate correctly. In such a case, change position of the display or install a sun cover.

7.4.2 Display Configuration

The parameter codes provided for the equipment are used to control the equipment display panels (see below). By selecting appropriate parameter codes, you can conduct calibration and set operation parameters. Figure 7.5 shows the configuration of display items. The parameter codes are listed in groups of seven; which are briefly described in Table 7.2.

To enter parameters, you first need to enter the password, refer to See 7.4.3.

Touch the [>] key and [ENT] key at same time to revert to the main screen.

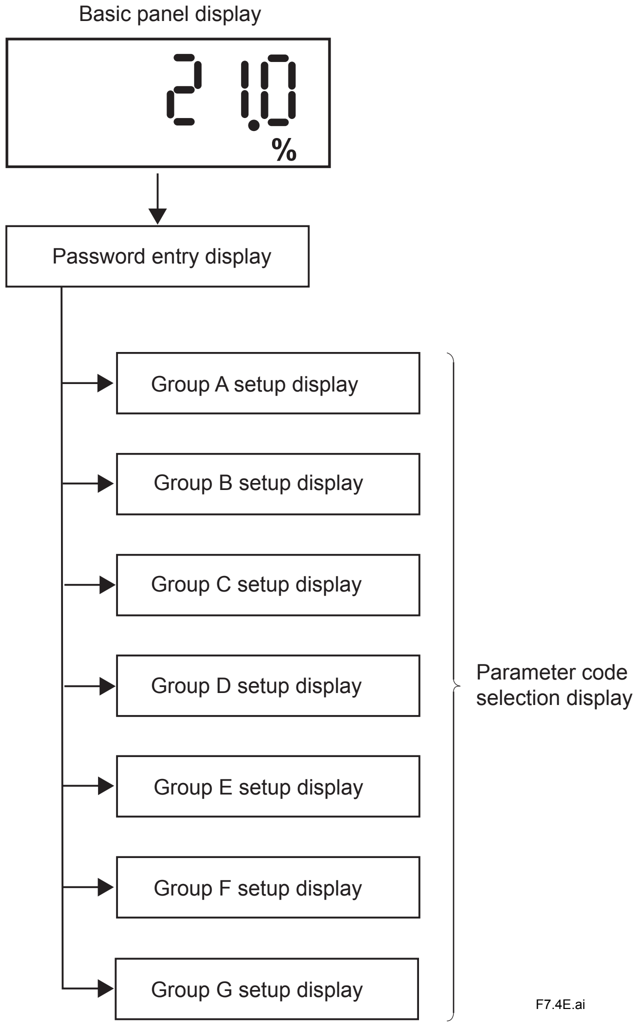


Figure 7.5 Display Configuration

Table 7.2 Display Functions

Display	Function and item to be set
Basic panel	Displays the oxygen concentration in normal operation, or displays the detector heater temperature while warming up. In case of humidity analyzer, displays the oxygen con. or moisture quantity, or mixture ratio in normal operation. If an error or alarm arises, the corresponding error or alarm number appears.
Password entry	Enters the password for the parameter code selection display.
Group A setup	Displays detailed data, such as the cell voltage or temperature.
Group B setup	Sets and performs calibration.
Group C setup	Sets analog output.
Group D setup	Sets an alarm.
Group E setup	Sets the input and output contacts.
Group F setup	Selects the type of equipment and sets the parameters for computation.
Group G setup	Performs the current-loop or contact checks.

7.4.3 Entering Parameter Code Selection Display

This section briefly describes the password entry procedure for entering the parameter code selection display. The password is 1102 - it cannot be changed to a different password.

Switch operation			Display	Description
>	^	ENT	21.0%	Warm-up is complete, and the basic panel is now displayed.
>	^	ENT	PASSno	Continuously touch the [ENT] key for at least three seconds to display "PASSno."
>	^	ENT	0000	Touch the [ENT] key again. This allows you to change the leftmost digit that is flashing.
>	^	ENT	1000	Set the password 1102. If you touch the [^] key, the digit that is flashing will be 1.
>	^	ENT	1000	Touch the [>] key to move the position of the digit that is flashing to the right one digit.
>	^	ENT	1100	Touch the [^] key to change the numeric value to 1.
>	^	ENT	1100	Touch the [>] key again to move the position of the digit that is flashing to the right one more digit. Continuously touch the [>] key, and the position of the digit that is flashing will move continuously to the right.
>	^	ENT	1102	Touch the [^] key to change the numeric value to 2. Continuously touch [^] key, and the numeric value increases continuously.
>	^	ENT	1102	If you touch the [ENT] key, all the digits flash.
>	^	ENT	A01	Touch the [ENT] key again to display A01 on the parameter code selection display.

The symbol [ ] indicates that the key is being touched. Light characters indicate that the digits are flashing.

CAUTION

- If no key is touched for at least 20 seconds during password entry, the current display will automatically switch to the basic panel display.
- If no key is touched for at least 10 minutes during parameter code selection, the current display will automatically switch to the basic panel display.

7.4.4 Selecting Parameter Codes

Switch operation			Display	Description
>	∧	ENT	A01	Password has been entered and the parameter code selection display has appeared. Character A is flashing, indicating that character A can be changed.
>	∧	ENT	A01	If you touch the [>] key once, the position of the digit that is flashing will move to the right. This allows you to change 0.
>	∧	ENT	A01	Touch the [>] key again to move the position of the digit that is flashing to the right one more digit. This enables you to change numeric character 1.
>	∧	ENT	A01	Touch the [>] key again to return the position of the digit that is flashing to A. Continuously touch the [>] key, and the position of the digit that is flashing will move continuously to the right.
>	∧	ENT	b01	If you touch the [∧] key once, character A will change to B.
>	∧	ENT	C01	Touch the [∧] key once to change to C.
>	∧	ENT	d01	Continuously touch the [∧] key, and the value of the digit that is flashing will increase continuously, from D to E to F to G to A. Numeric values will change from 0 to 1 to 2 to 3 … to 8 to 9 and back to 0. However, numbers that are not present in the parameter codes will be skipped. Each digit is changed independently. Even though a low-order digit changes from 9 to 0, a high-order digit will not be carried.
>	∧	ENT	Set Value	After you select the desired character, touch the [ENT] key. The set data will be displayed.

The symbol [ ] indicates that the key is being touched. Light characters indicates that the digits are flashing.

7.4.5 Changing Set Values

(1) Selecting numeric values from among preset values

Switch operation			Display	Description
>	∧	ENT	0	The set value is displayed after the parameter code selection. An example of how to select either 0, 1, or 2 as the set value is given below. (The currently set value is 0.)
>	∧	ENT	1	Touch the [∧] key once to change the current value from 0 to 1.
>	∧	ENT	2	Touch the [∧] key again to change to the numeric value 2.
>	∧	ENT	0	If you touch the [∧] key again, the numeric value will return to 0. Continuously touch the [∧] key, and the numeric values will change continuously.
>	∧	ENT	C01	Display the desired numeric value and touch the [ENT] key. The display will then return to the parameter code selection

(2) Entering numeric values such as oxygen concentration values and factors

Switch operation			Display	Description
>	^	ENT	00.0	The set value is displayed after the parameter code selection. An example of entering "9.8" is given below. (The currently set value is 0.0)
>	^	ENT	00.0	Touch the [>] key to move the position of the digit that is flashing to the digit to be changed. Continuously touch the [>] key, and the position of the digit that is flashing will move continuously to the right.
>	^	ENT	09.0	Touch the [^] key to set the numeric value 9. Continuously touch the [^] key, and the numeric value will change in sequence from 0 to 1 to 2 to 3 … to 8 to 9 and back to 0.
>	^	ENT	09.0	Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	09.8	Touch the [^] key to set the numeric value 8.
>	^	ENT	09.8	Where the correct numeric value is displayed, touch the [ENT] key.
>	^	ENT	09.8	If you touch the [ENT] key again, the flashing stops and the current set value will be in effect.
>	^	ENT	C11	Touch the [ENT] key once again to return to the parameter code selection display.

(3) If invalid numeric values are entered.

Switch operation			Display	Description
>	^	ENT	98.0	If an invalid numeric value (beyond the input range specified) is entered, "Err" will appear for two seconds after touching the [ENT] key.
>	^	ENT	Err	
>	^	ENT	00.0	"Err" appears for two seconds, and the display returns to the first set value. Re-enter the numeric value.

7.5 Confirmation of Equipment Type Setting

This equipment can be used for both the Oxygen Analyzer and the Humidity Analyzer. If you choose optional specification /HS at the time of purchase, the equipment is set for the Humidity Analyzer.

Before setting the operating data, be sure to check that the desired model has been set. Note that if the equipment type setting is changed after operating data are set, the operating data that have been set are then initialized and the default settings remain. Set the equipment type with parameter code「F01」. See Table 10.7 or Table 10.8, later in this manual.

CAUTION

Note that if the equipment type is changed, operation data that have already been set are initialized (reverting to the default setting).

Table 7.3 Converter Type Setting Procedure

Switch operation			Display	Description
>	∧	ENT	A01	Display after the password has been entered.
>	∧	ENT	F01	Touch the [∧] key to switch to Group F. If an unwanted alphabetic character after F has been entered, continuously touch the [∧] key to return to the original.
>	∧	ENT	0	Touch the [ENT] key for confirmation. If 0 (zero) is entered, the oxygen analyzer is already set. If 1 (one) is entered, the humidity analyzer has been set. Change the setting following the steps below.
>	∧	ENT	0	Continuously touch the [∧] key, and the position of the digit will change from 1 to 0 to 1 to 0. Release the [ENT] key when 0 is displayed.
>	∧	ENT	0	Touch the [ENT] key. The numeric value will flash.
>	∧	ENT	0	Touch the [ENT] key again to stop the numeric value from flashing.
>	∧	ENT	F01	Touch the [ENT] key once again, and the display will change to the parameter code.
>	∧	ENT	Basic panel display	Touch the [>] key together with the [ENT] key to return to the basic panel display. (This is not required if you proceed to make another setting.) (The displayed numeric characters indicate the measurement gas concentration.)

The symbol [ ] indicates that the key is being touched. Light characters indicates that the digits are flashing.

7.6 Selection of Measurement Gas

Combustion gases contain moisture created by burning hydrogen in the fuel. If this moisture is removed, the oxygen concentration might be higher than before. You can select whether the oxygen concentration in a wet gas is to be measured directly, or compensated for its dry-gas value before use. Use the parameter code "F02" to set the measurement gas. For details on the parameter code, see Table 10.7 or Table 10.8, later in this manual.

Table 7.4 Setting Measurement Gas

Switch operation			Display	Description
>	∧	ENT	A01	Display after the password has been entered.
>	∧	ENT	F01	Touch the [∧] key to switch to Group F. If an unwanted alphabetic character after F has been entered, continuously touch the [∧] key to return to the original.
>	∧	ENT	F01	Touch the [>] key to move the position of the digit that is flashing to the right.
>	∧	ENT	F02	Touch the [∧] key to change the numeric value to 2. If an unwanted numeric value has been entered, continuously touch the [∧] key to return to the original.
>	∧	ENT	0	Touch the [ENT] key for confirmation. If 0 (zero) is entered, the oxygen concentration in a wet gas is already set. If the oxygen concentration in a dry gas is to be entered, follow the steps below to set 1 (one).
>	∧	ENT	0	Continuously touch the [∧] key, and the position of the digit will change from 1 to 0 to 1 to 0. Release the [ENT] key when 1 (one) is displayed.
>	∧	ENT	0	Touch the [ENT] key. The numeric value will flash.
>	∧	ENT	0	Touch the [ENT] key again to stop the value from flashing.
>	∧	ENT	F03	Touch the [ENT] key once again, and the display will change to the parameter code selection panel.
>	∧	ENT	Basic panel display	Touch the [>] key together with the [ENT] key to return to the basic panel display. (This is not required if you proceed to make another setting.) (The displayed numeric characters indicate the measurement gas concentration.)

The symbol [ ] indicates that the key is being touched. Light characters indicates that the digits are flashing.

7.7 Output Range Setting

This section sets forth analog output range settings. For details, consult Section 8.1,"Current Output Settings," later in this manual.

7.7.1 Oxygen Analyzer -Minimum Current (4 mA) and Maximum Current (20 mA) Settings

Use the parameter codes "C11" to set the oxygen concentration at 4 mA and "C12" to set the oxygen concentration at 20 mA. The following shows where 10% O_2 is set at 4 mA and 20% O_2 at 20 mA.

Table 7.5 Minimum and Maximum Value Setting Procedure

Switch operation			Display	Description
>	^	ENT	A01	Display after the password has been entered.
>	^	ENT	C01	Set the oxygen concentration at 4 mA. Change the parameter code to C11. Touch the [^] key to switch to Group C.
>	^	ENT	C01	Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	C11	Touch the [^] key to enter the numeric value 1.
>	^	ENT	000	Touch the [ENT] key to display the current set value (0% O2 has been set).
>	^	ENT	000	Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	010	Touch the [^] key to change the numeric value to 1.
>	^	ENT	010	If you touch the [ENT] key, all the digits flash.
>	^	ENT	010	Touch the [ENT] key again to stop the flashing.
>	^	ENT	C11	Touch the [ENT] key once again, and the display will switch to the parameter code selection display.
>	^	ENT	C11	Set the oxygen concentration at 20 mA. Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	C12	Touch the [^] key to enter the numeric value 2.
>	^	ENT	025	Touch the [ENT] key to display the current set value.
>	^	ENT	025	Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	020	Touch the [^] key to change the numeric value to 0. The numeric value will change from 5 to 6 ... to 9 and back to 0.
>	^	ENT	020	If you touch the [ENT] key, all the digits flash.
>	^	ENT	020	Touch the [ENT] key again to stop the flashing.
>	^	ENT	C12	Touch the [ENT] key once again to switch to the parameter code selection display.
>	^	ENT	Basic panel display	Touch the [>] key together with the [ENT] key to return to the basic panel display. (This is not required if you proceed to make another setting.) (The displayed numeric characters indicate the measurement gas concentration.)

The symbol [ ] indicates that the key is being touched. Light characters indicates that the digits are flashing.

7.7.2 Output Range Setting

Select any one of the analog output settings — oxygen, humidity, and mixing ratio. If the /HS option was specified at the time of purchase, the equipment is a humidity analyzer. For other than this setting, the analyzer is an oxygen analyzer. If mixed measurement is required, change the existing output setting as follows. Use parameter code C01 for the setting. When the humidity analyzer is specified in the above setting for the type of detector, the analog output will be set to “humidity” if data initialization is performed.

7.7.3 Humidity Analyzer -Minimum Current (4 mA) and Maximum Current (20 mA) Settings

This section describes how to set the humidity readings corresponding to 4 mA and 20 mA to 30% H_2O and 80% H_2O respectively.

Table 7.6 Minimum and Maximum Value Setting Procedure

Switch operation			Display	Description
>	^	ENT	A01	Display after the password has been entered.
>	^	ENT	C01	Set the humidity reading at 4 mA. Change the parameter code to C13. Touch the [^] key to switch to Group C.
>	^	ENT	C01	Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	C11	Touch the [^] key to enter the numeric value 1.
>	^	ENT	C11	Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	C13	Touch the [^] key to enter the numeric value 13.
>	^	ENT	000	Touch the [ENT] key to display the current set value. The humidity 0% H_20 is now being displayed.
>	^	ENT	000	Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	030	Touch the [^] key to change the numeric value to 3.
>	^	ENT	030	If you touch the [ENT] key, all the digits flash.
>	^	ENT	030	Touch the [ENT] key again to stop the flashing.
>	^	ENT	C13	Touch the [ENT] key once again, and the display will switch to the parameter code selection display.
>	^	ENT	C13	Set the humidity reading at 20 mA. Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	C14	Touch the [^] key to change the number 3 in C13 to “4.”
>	^	ENT	025	Touch the [ENT] key to display the current set value.

Switch operation			Display	Description
>	^	ENT	025	Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	085	Touch the [^] key to change the number 2 in C25 to “8.”
>	^	ENT	085	Touch the [>] key to move the position of the digit that is flashing to the right.
>	^	ENT	080	Touch the [^] key to change the number 5 in C85 to “0.” The number changes from 5 to 6 . to 9 to 0.
>	^	ENT	080	If you touch the [ENT] key, all the digits flash.
>	^	ENT	080	Touch the [ENT] key again to stop the flashing.
>	^	ENT	C14	Touch the [ENT] key once again to switch to the parameter code selection display.
>	^	ENT	Basic panel display	Touch the [>] key together with the [ENT] key to return to the basic panel display. (This is not required if you proceed to make another setting.) (The displayed numeric characters indicate the measurement gas concentration.)

The symbol [ ] indicates that the key is being touched. Light characters indicates that the digits are flashing.

7.8 Setting Display Item

7.8.1 Oxygen Analyzer - Setting Display Item

Display items are defined as items displayed on the basic panel display.

Parameter code “A00” or “F08” is used to set the display items as shown in Table 7.7. The oxygen concentration is set at the factory before shipment. In addition, if the data initialization is performed, the oxygen concentration will be set.

Table 7.7 Display Item

Values set with A00 or F08	Items displayed on the basic panel display
0	Indicates the oxygen concentration.
1 or 2	For humidity analyzers only. (if 1 or 2 is set for the oxygen analyzer, "0.0" is only displayed on the basic panel display.)
3	Displays an item for the current output. If the output damping has been set for the current output, values involving the output damping are displayed.

CAUTION

If you set “3” in the parameter code “A00” or “F08”, be sure to select “Oxygen Concentration” in the following mA output setting (see Section 8.1, “Current Output Setting”).

7.8.2 Humidity Analyzer - Setting Display Item

Display items are those items that are displayed on the basic panel display. Parameter code A00 or F08 is used to set the display items as shown in the table below. If the humidity analyzer /HS option was specified at the time of purchase, the equipment is a humidity analyzer. For other than the above, the equipment is set to oxygen concentration at the factory before shipment. If mix ratio is to be measured, change the existing setting as follows.

Additionally, when humidity analyzer is selected in the Detector Type Setting in the previous section, the display item will be humidity if data initialization is performed.

Table 7.8 Display Item

Values set with A00 or F08	Items displayed on the basic panel display
0	Indicates the oxygen concentration.
1	Indicates the humidity.
2	Indicates the mix ratio.
3	Displays an item for the current output. If the output damping has been set for the current output, values involving the output damping are displayed.

7.9 Checking Current Loop

The set current can be output as an analog output. This enables the checking of wiring between the converter and the receiving instrument. Current loop checking is performed using parameter code “G01”.

Table 7.9 Checking Current Loop

Switch operation			Display	Description
>	^	ENT	A01	Display after the password has been entered.
>	^	ENT	G01	Touch the [^] key to switch to Group G.
>	^	ENT	00.0	Touch the [ENT] key. The output current remains preset with the output-hold feature (Section 2.3).
>	^	ENT	10.0	Touch the [^] key to set the numeric value 1 (to set a 10-mA output).
>	^	ENT	10.0	Touch the [ENT] key to have all the digits flash.
>	^	ENT	10.0	Touch the [ENT] key again to stop the flashing. A 10-mA output is then issued.
>	^	ENT	G01	Touch the [ENT] key once again to switch to the parameter code selection display. At that point, the output current returns to the normal value.
>	^	ENT	Basic panel display	Touch the [>] key together with the [ENT] key to return to the basic panel display.

The symbol [ ] indicates that the key is being touched. Light characters indicates that the digits are flashing.

7.10 Checking Contact I/O

Conduct a contact input and output check as well as an operation check of the solenoid valves for the optional automatic calibration unit.

Table 7.10 Parameter Codes for Checking Contact I/O

Check item	Parameter code	Set value and contact action	
Contact output 1	G11	0	Open
		1	Closed
Contact output 2	G12	0	Open
		1	Closed
Automatic calibration solenoid valve (zero gas)	G15	0	Off
		1	On
Automatic calibration solenoid valve (span gas)	G16	0	Off
		1	On
Contact input 1	G21	0	Open
		1	Closed
Contact input 2	G22	0	Open
		1	Closed

7.10.1 Contact Output Check

Follow Table 7.11 to check the contact output. The table uses an example with contact output 1.

Table 7.11 Checking Contact Output

Switch operation			Display	Description
>	^	ENT	A01	Display after the password has been entered.
>	^	ENT	G01	Touch the [^] key to switch to Group G.
>	^	ENT	G01	Touch the [>] key to move the position of the digit that is flashing to the right one digit.
>	^	ENT	G11	Touch the [^] key to enter 1.
>	^	ENT	0	Touch the [ENT] key to have 0 (zero) flash. The contact is then open.
>	^	ENT	1	Touch the [^] key to set 1 (one).
>	^	ENT	1	Touch the [ENT] key. The flashing continues.
>	^	ENT	1	Touch the [ENT] key again to stop the flashing, and the contact will be closed.
>	^	ENT	G11	Touch the [ENT] key once again to switch to the parameter code selection display. The contact then returns to the original state.
>	^	ENT	Basic panel display	Touch the [>] key together with the [ENT] key to return to the basic panel display. (This is not required if you proceed to make another setting.) (The displayed numeric characters indicate the measurement gas concentration.)

The symbol [ ] indicates that the key is being touched. Light characters indicates that the digits are flashing.

CAUTION

If you conduct an open-close check for the contact output 2, Error 1 (cell voltage failure) or Error 2 (heater temperature abnormal) will occur. This is because the built-in heater power of the detector, which is connected to contact output 2, is turned off during the above check. So, if the above error occurs, reset the equipment or turn the power off and then back on to restart (refer to Section 10.4, “Reset,” later in this manual).

7.10.2 Checking Calibration Contact Output

The calibration contacts are used for the solenoid valve drive signals for the Automatic Calibration Unit. This output signal enables you to check the equipment operation. Check the flowmeter gas flow for that operation.

Follow the steps in Table 7.12. The table uses an example with a zero gas solenoid valve.

Table 7.12 Checking Calibration Contact Output

Switch operation			Display	Description
>	∧	ENT	A01	Display after the password has been entered.
>	∧	ENT	G01	Touch the [∧] key to switch to Group G.
>	∧	ENT	G01	Touch the [>] key to move the position of the digit that is flashing to the right one digit.
>	∧	ENT	G11	Touch the [∧] key to enter 1.
>	∧	ENT	G11	Touch the [>] key to move the position of the digit that is flashing to the right one digit.
>	∧	ENT	G15	Touch the [∧] key to enter 5.
>	∧	ENT	0	Touch the [ENT] key to have 0 flash. The solenoid valve remains closed.
>	∧	ENT	1	Touch the [∧] key to enter 1.
>	∧	ENT	1	Touch the [ENT] key. The flashing continues.
>	∧	ENT	1	Touch the [ENT] key again to stop the flashing, and the solenoid valve will be open to let the calibration gas flow.
>	∧	ENT	G15	Touch the [ENT] key once again to switch to the parameter code selection display. The solenoid valve will then be closed.
>	∧	ENT	Basic panel display	Touch the [>] key together with the [ENT] key to return to the basic panel display. (This is not required if you proceed to make another setting.) (The displayed numeric characters indicate the measurement gas concentration.)

The symbol [ ] indicates that the key is being touched. Light characters indicates that the digits are flashing.

7.10.3 Checking Input Contacts

Follow Table 7.13 to check the input contacts. The table uses an example with input contact 1.

Table 7.13 Checking Input Contacts

Switch operation			Display	Description
>	^	ENT	A01	Display after the password has been entered.
>	^ 	ENT	G01	Touch the [^] key to switch to Group G.
> 	^	ENT	G01	Touch the [>] key to move the position of the digit that is flashing to the right one digit.
>	^ 	ENT	G21	Touch the [^] key to enter 2.
>	^	ENT 	0	Touch the [ENT] key. 0 is displayed with the contact open. If the contact is closed, the display will be 1 (one). This enables you to check whether or not the wiring connections have been properly made or not.
>	^	ENT 	G21	Touch the [ENT] key once again to switch to the parameter code selection display.
> 	^	ENT 	Basic panel display	Touch the [>] key together with the [ENT] key to return to the basic panel display.

The symbol [] indicates that the key is being touched. Light characters indicates that the digits are flashing.

7.11 Calibration

The converter is calibrated in such a way that the actual zero and span gases are measured and those measured values are used to agree with the oxygen concentrations in the respective gases.

There are three types of calibration procedures available:

(1) Manual calibration conducting zero and span calibrations, or either of these calibrations in turn.

(2) Semi-automatic calibration which uses the infrared switches or a contact input signal and conducts calibration operations based on a preset calibration time and stable time.

(3) Automatic calibration conducted at preset intervals.

Manual calibration needs the ZA8F Flow Setting Unit to allow manual supply of the calibration gases. Semi-automatic and automatic calibrations need ZR20H Automatic Calibration Unit to allow automatic supply of the calibration gases. The following sections set forth the manual calibration procedures. For details on semi-automatic and automatic calibrations, consult Chapter 9, “Calibration,” later in this manual

7.11.1 Calibration Setup

Set the following three items before carrying out a calibration. Parameter codes for these set items are listed in Table 7.14.

(1) Mode setting

There are three calibration modes: manual, semi-automatic, and automatic.

Select the desired mode. This section uses manual mode for calibration.

(2) Oxygen concentration in zero gas

Enter the zero gas oxygen concentration for calibration.

(3) Oxygen concentration in span gas

Enter the span gas oxygen concentration for calibration. If instrument air is used, enter 21 vol % O_2. When using the ZO21S Standard Gas Unit (for use of the atmospheric air as a span gas), use a hand-held oxygen analyzer to measure the actual oxygen concentration, and then enter it.

CAUTION

If instrument air is used for the span gas, dehumidify the air to a dew point of -20°C and remove any oil mist or dust.

Incomplete dehumidifying or unclean air will have an adverse effect on the measurement accuracy.

Table 7.14 Calibration Parameter Codes

Set item	Parameter code	Set value	
Calibration mode	B03	0	Manual calibration
		1	Semi-automatic calibration
		2	Automatic calibration
Zero gas oxygen concentration	B01	Enter oxygen concentration.	
Span gas oxygen concentration	B02	Enter oxygen concentration.	

Table 7.15 Calibration Setup Procedure

Switch operation			Display	Description
>	^	ENT	A01	Display after the password has been entered.
>	^	ENT	b01	Set the zero gas concentration. Switch the parameter code to B01. Here, set 0.98%.
>	^	ENT	001.00 %	Touch the [ENT] key to display the currently set value.
>	^	ENT	001.00 %	Touch the [>] key to move the position of the digit that is flashing to 1.
>	^	ENT	000.00 %	Touch the [^] key to change to 0.
>	^	ENT	000.00 %	Touch the [>] key to move the position of the digit that is flashing to the right one digit.
>	^	ENT	000.90 %	Touch the [^] key to change the numeric value to 9.
>	^	ENT	000.90 %	Touch the [>] key to move the position of the digit that is flashing to the right one digit.
>	^	ENT	000.98 %	Touch the [^] key to change the numeric value to 8.
>	^	ENT	000.98 %	Touch the [ENT] key to have all the digits flash.
>	^	ENT	000.98 %	Touch the [ENT] key again to stop the flashing.
>	^	ENT	b01	Touch the [ENT] key once again to switch to the parameter code selection display.
Set the span gas concentration by above procedure, set 21 %.				
>	^	ENT	b03	Next, set the calibration mode. Switch the parameter code to B03.
>	^	ENT	0	Touch the [ENT] key to display the currently set value. If it is 0, you can leave it as is. If it is other than 0, change it to 0 (zero).
>	^	ENT	0	Touch the [ENT] key. The numeric value will flash.
>	^	ENT	0	Touch the [ENT] key again to stop the flashing.
>	^	ENT	b03	Touch the [ENT] key once again to switch to the parameter code selection display.
>	^	ENT	Basic panel display	Touch the [>] key together with the [ENT] key to return to the basic panel display. (This is not required if you proceed to make another setting.) (The displayed numeric characters indicate the measurement gas concentration.)

The symbol [ ] indicates that the key is being touched. Light characters indicates that the digits are flashing.

7.11.2 Manual Calibration

The following describes how to conduct a calibration.

■ Preliminary

Before conducting a manual calibration, be sure that the ZA8F Flow Setting Unit zero gas flow valve is fully closed. Open the zero gas cylinder pressure regulator so that the secondary pressure will be a sample gas plus approx. 50 kPa (or sample gas pressure plus approx. 150 kPa when a check valve is used, maximum pressure rating is 300 kPa).

■ Calibration Implementation

This manual assumes that the instrument air is the same as the reference gas used for the span gas. Follow the steps below to conduct manual calibration. When using the ZO21S Standard Gas Unit (for use of the atmospheric air as a span gas), use a hand-held oxygen analyzer to measure the actual oxygen concentration, and then enter it.

Table 7.16 Conducting Calibration

Switch operation			Display	Description
>	∧	ENT	A01	Display after the password has been entered.
>	∧	ENT	b10	Switch the parameter code to B10. (The key operations for this procedure are omitted.)
>	∧	ENT	CAL	Touch the [ENT] key, and "CAL" will be displayed. To cancel the above, touch the [>] key and [ENT] key together to return to the B10 display.
>	∧	ENT	CAL	If you touch the [ENT] key again, "CAL" then flashes. To cancel the above, touch the [>] key and [ENT] key together, the display will return to the B10 display.
>	∧	ENT	SPAn Y	If you touch the [ENT] key again, "SPAn Y" appears (Y is flashing). If you omit the span calibration, touch the [>] key, and change "Y" to "N". If you touch the [ENT] key, the display then jumps to "ZEro Y."
>	∧	ENT	21.00 %	Touch the [ENT] key to display the calibration gas value, in other words, the span gas concentration set in Section 7.10.1, "Calibration Setup." To cancel the above, touch the [>] key and [ENT] key together, then the display returns to "SPAn Y."
>	∧	ENT	OPEn /20.84	If you touch the [ENT] key, "OPEn" and the currently measured value are displayed alternately. Open the Flow Setting Unit span gas flow valve and adjust the span gas flow to 600 ± 60 ml/min. To do this, loosen the valve lock nut and gently turn the valve control (shaft) counterclockwise. Check the calibration gas flowmeter for confirmation. If the automatic calibration unit is connected, open the span gas solenoid valve, and the measured value changes to the span gas value. When the display becomes stable, proceed to the next step. To cancel the above, touch the [>] key and [ENT] key together, then the display returns to "SPAn Y."
>	∧	ENT	20.84 %	If you touch the [ENT] key, all the digits flash. At that point, no calibration is conducted yet.
>	∧	ENT	ZEro Y	If you touch the [ENT] key again, the flashing stops and "ZEro Y" appears. Close the span gas flow valve. Secure the span gas lock nut for leakage. If the automatic calibration unit is connected, close the span gas solenoid valve. If zero gas calibration is omitted, touch the [>] key to change "Y" to "N". Next, if you touch the [ENT] key, the display jumps to "CALEnd."

Switch operation			Display	Description
>	∧	ENT	0.98 %	Touch the [ENT] key to display the calibration gas value. This value must be the zero gas concentration set in Section 7.10.1, "Calibration Setup," earlier in this manual. To cancel the above, touch the [>] key and [ENT] key together, then the display returns to "ZEro Y."
>	∧	ENT	OPEn /0.89	If you touch the [ENT] key, "OPEn" and the currently measured value are displayed alternately. Open the Flow Setting Unit zero gas flow valve and adjust the zero gas flow to 600 ± 60 ml/min. To do this, loosen the valve lock nut and gently turn the valve control (shaft) counterclockwise. Check the calibration gas flowmeter for confirmation. If the automatic calibration unit is connected, open the zero gas solenoid valve, and then the measured value changes to the zero gas value. When the display becomes stable, proceed to the next step. To cancel the above, touch the [>] key and [ENT] key together, then the display returns to "ZEro Y."
>	∧	ENT	0.89 %	If you touch the [ENT] key, all the digits flash. At that point, no calibration is conducted yet.
>	∧	ENT	CALEnd	Touch the [ENT] key again to get the measured value to agree with the zero gas concentration. Close the zero gas flow valve. Secure the valve lock nut for leakage during measurement. If the automatic calibration unit is connected, close the span gas solenoid valve. "CALEnd" flashes during the output hold time. If "output hold" is specified in the Output Hold setting," it remains as an analog output (see Section 8.2). When the preset output hold time is up, the calibration is complete.
>	∧	ENT	b10	The output hold time is set to 10 minutes at the factory. If you touch both the [>] key and [ENT] key at the same time during the preset Output Hold Time, the calibration is aborted and the parameter code selection display appears.
>	∧	ENT	Basic panel display	If you touch the [>] key and [ENT] key together, then the basic panel display appears.

The above "display" is a result of switch operations.

The symbol [ ] indicates the keys are being touched, and the light characters indicate "flashing."

"/" indicates that the characters are displayed alternately.

8. Detailed Data Setting

8.1 Current Output Setting

8.1.1 Oxygen Analyzer_Current Output Setting

This section describes setting of the analog output range. Table 8.1 shows parameter codes for the set items.

Table 8.1 Current Output Parameter Codes

Set item	Parameter code	Set value	
Analog output	C01	0	Oxygen concentration
		1	4 mA (fixed *1)
		2	4 mA (fixed *1)
Output mode	C03	0	Linear
		1	Logarithm
Min. oxygen concentration	C11	Oxygen concentration at 4 mA	
Max. oxygen concentration	C12	Oxygen concentration at 20 mA	
Output damping constant	C30	0 to 255 seconds	

*1: For the oxygen analyzer, set 0 (zero) only for parameter code C01. When it is set, the current output is 4-mA fixed regardless of the oxygen concentration.

8.1.2 Oxygen Analyzer_Analog Output Setting

This section describes how to set the analog output range.

(1) To provide an oxygen concentration, use parameter code C11 to set the minimum oxygen concentration at 4 mA, and use parameter code C12 to set the maximum oxygen concentration at 20 mA.

(2) To provide a humidity output, use parameter code C13 to set the minimum humidity at 4 mA, and use parameter code C14 to set the maximum humidity at 20 mA.

(3) To provide a mix ratio, use parameter code C15 to set the minimum mix ratio at 4 mA, and use parameter code C14 to set the maximum mixing ratio at 20 mA.

Refer to Table 8.2 for the parameter codes.

Table 8.2 Current Output Parameter Codes

Set item	Parameter code	Set value	
Analog output	C01	0	Oxygen concentration
		1	Humidity
		2	Mixing ratio
Output mode	C03	0	Linear
		1	Logarithm
Min. oxygen concentration	C11	Oxygen concentration reading corresponding to 4 mA	
Max. oxygen concentration	C12	Oxygen concentration reading corresponding to 20 mA	
Min. humidity	C13	Humidity reading corresponding to 4 mA	
Max. humidity	C14	Humidity reading corresponding to 20 mA	
Min. mixing ratio	C15	Mixing ratio at 4 mA	
Max. mixing ratio	C16	Mixing ratio at 20 mA	
Output damping constant	C30	0 to 255 seconds	

NOTE

When you select logarithmic mode in Section 8.1.3, “Output Mode,” later in this manual, the oxygen concentration, humidity reading, and mixing ratio remain constant at 0.1% O_2, 0.1% H_2O and 0.01 kg/kg respectively.

8.1.3 Setting Minimum Oxygen Concentration (at 4 mA) and Maximum Oxygen Concentration (at 20 mA)

Set the oxygen concentration values at 4 mA and 20 mA.

The minimum concentration of oxygen for the minimum current (4 mA) is 0% O_2 or 6% to 76% O_2.

The maximum concentration of oxygen for the maximum current (20 mA) ranges from 5% to 100% O_2, and must be greater than 1.3 times the concentration of oxygen set for the minimum. If it does not fall within this input range setting, the setting will be invalid, and the previous set values will remain.

Setting example 1

If the setting (for a 4 mA current) is 10% O_2, you must set the oxygen concentration for the maximum (20 mA) point at 13% O_2.

Setting example 2

If the setting (for a 4 mA current) is 75% O_2, you must set the oxygen concentration for the maximum (20 mA) point at 98% O_2 (75 × 1.3).

(Numbers after the decimal point are rounded up.)

CAUTION

When you select logarithmic mode, the minimum output remains constant at 0.1% O_2, and the parameter “C11” display remains unchanged.

8.1.4 Minimum and Maximum Settings Corresponding to 4 mA and 20 mA

Set the output items for oxygen concentration reading, humidity reading and mixing ratio corresponding to 4 mA and 20 mA. When the oxygen concentration was selected with parameter code C01, use parameter codes C11 and C12 for the minimum and maximum settings; when the humidity setting was selected with parameter code C01, use parameter codes C13 and C14 for those settings; and when the mix ratio setting was selected with parameter code C01, use parameter codes C15 and C16 for those settings.

8.1.5 Input Ranges

The range low and high values are restricted as follows:

● Oxygen Concentration setting range

The range min. O_2 concentration value (corresponding to 4 mA output) can be set to either 0 vol%O_2 or in the range of 6 to 76 vol%O_2.

The range max. O_2 concentration value (corresponding to 20 mA output) can be set to any value in the range of 5 to 100 vol%O_2, however the range max. setting must be at least 1.3 times the range min. setting.

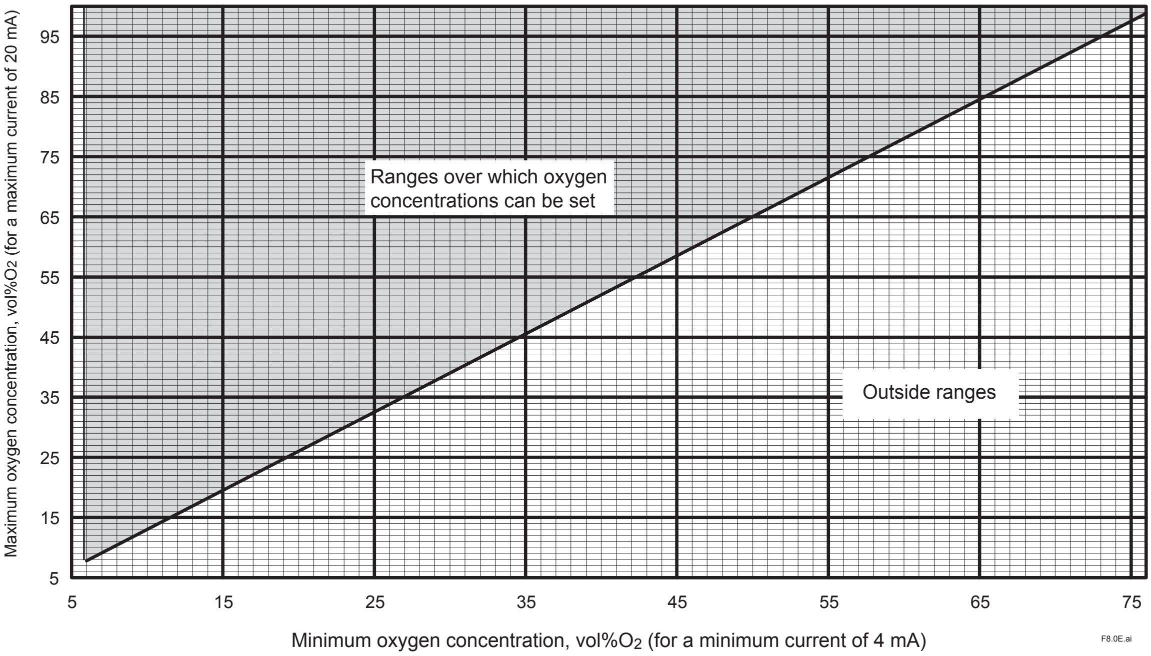
If you do not observe this restriction, the measurement will be invalid, and any previous valid value will be used. The gray area in figure represents the valid setting range.

Setting example 1

If the range minimum (corresponding to 4 mA output) is set to 10 vol%O_2 then range maximum (corresponding to 20 mA output) must be at least 13 vol%O_2.

Setting example 2

If the range minimum (corresponding to 4 mA output) is set to 75 vol%O_2 then range maximum (corresponding to 20 mA output) must be at least 75x1.3=98 vol%O_2 (rounding decimal part up).



Minimum-Maximum setting range of oxygen concentration

Figure A

● Humidity (amount-of-moisture-content) setting range

The minimum humidity is set to 0% H_2O or ranges from 26 to 100% H_2O. The maximum humidity ranges from 25% to 100% H_2O, and must be greater than 0.8 times plus 23 the humidity set for the minimum.

Setting example 1

If the setting (for a 4 mA current) is 0% H_2O, you must set the maximum (20 mA) point at more than 25% H_2O.

Setting example 2

If the setting (for a 4 mA current) is 26% H_2O, you must set the maximum (20 mA) point at more than 44% H_2O, (263 0.8 + 23% H_2O). (Numbers after the decimal point are rounded up.)

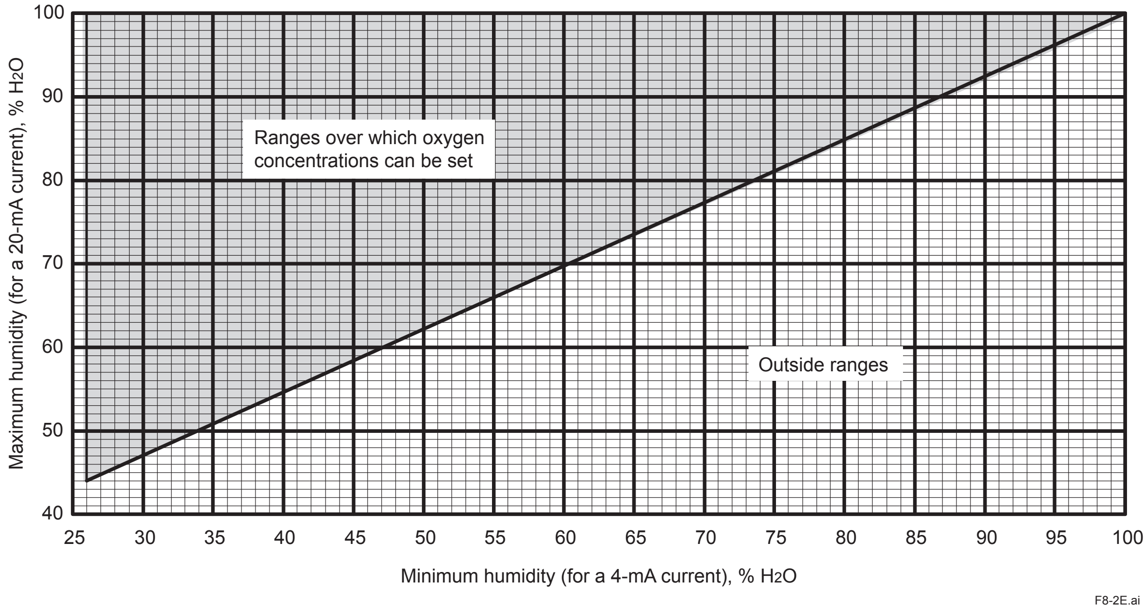


Figure B **Max. and Min. Humidity Set Ranges**

● "Mixing ratio" setting range

The minimum mixing ratio is set to 0 kg/kg or ranges from 0.201 to 0.625 kg/kg. The maximum "mixing ratio" setting ranges from 0.2 to 1.0 kg/kg, and must be greater than 1.3 times plus 0.187 the mixing ratio set for the minimum.

Setting example 1

If the setting (for a 4 mA current) is 0 kg/kg, you must set the maximum (20 mA) point at more than 0.2 kg/kg.

Setting example 2

If the setting (for a 4 mA current) is 0.201 kg/kg, you must set the maximum (20 mA) point at more than 0.449 kg/kg, (0.201 3 1.3 + 0.187 kg/kg). (Numbers after the decimal point are rounded up.)

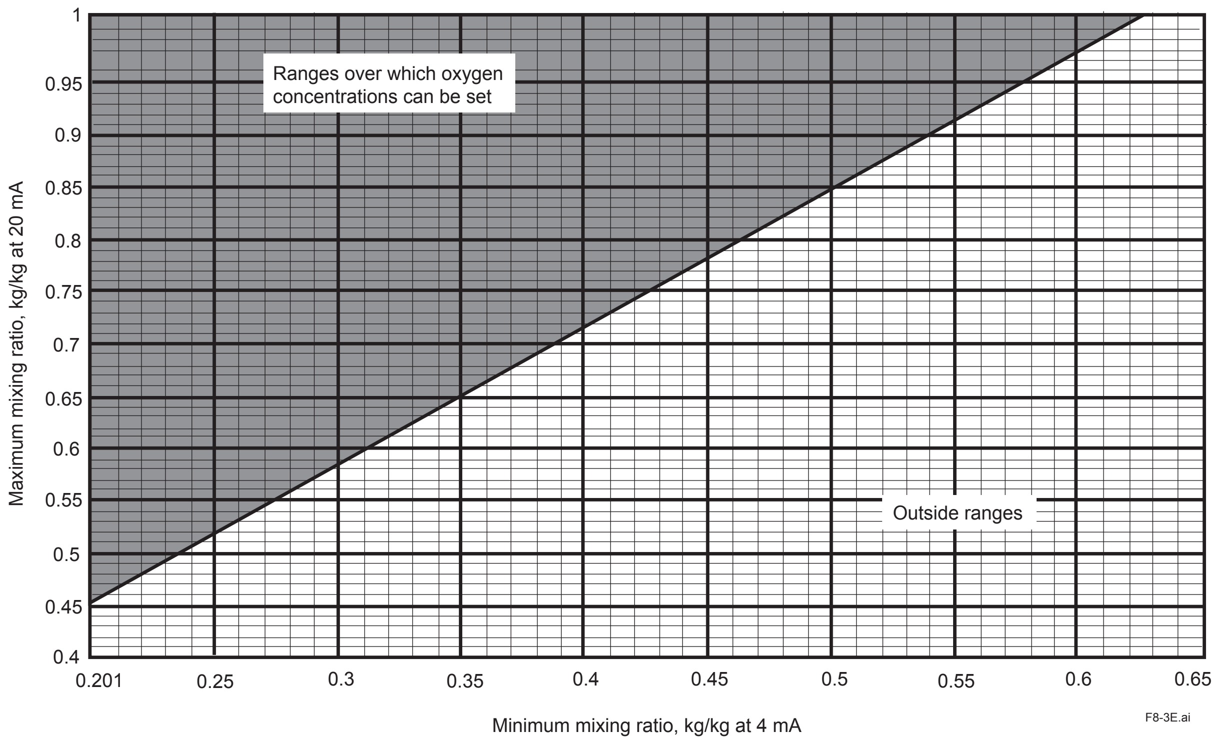


Figure C **Max. and Min. Mixing Ratio Set Ranges**

8.1.6 Entering Output Damping Constants

If a measured value adversely affected by a rapid change in the sample gas oxygen concentration is used for the control means, frequent on-off actions of the output will result. To avoid this, the converter allows the setting of output damping constants ranging from 0 to 255 seconds.

8.1.7 Selection of Output Mode

You can select a linear or logarithmic output mode. The former provides linear characteristics between the analog output signal and measured value.

NOTE

When you select logarithmic mode, the minimum output remains constant at 0.1% O_2, and the humidity remains set to 0.1% H_2O and mixing ratio is set to 0.01 kg/kg, regardless of the set values. Set value of C11 to C16 remains unchanged.

8.1.8 Default Values

When the analyzer is delivered or data are initialized, the output current settings are by default as shown in Table 8.3.

Table 8.3 Output Current Default Values

Item	Default setting
Min. oxygen concentration	0% O_2
Max. oxygen concentration	25% O_2
Minimum humidity	0% H_2O
Maximum humidity	25% H_2O
Minimum ratio setting	0 kg/kg
Maximum ratio setting	0.2 kg/kg
Output damping constant	0 (seconds)
Output mode	Linear

8.2 Output Hold Setting

The “output hold” functions retain an analog output signal at a preset value during the equipment’s warm-up time or calibration or if an error arises.

Table 8.4 shows the analog outputs that can be retained and the individual states.

Table 8.4 Analog Output Hold Setting

Equipment status / Output hold values available	During warm-up	During maintenance	During calibration	Error occurrence (*1)
4 mA	O			
20 mA	O			
Without hold feature		O	O	O
Retains output from just before occurrence		O	O	O
Set value (2.4 to 21.6 mA)	O	O	O	O

O: The output hold functions are available.
*1: The output hold functions on error occurrence are unavailable when option code “/C2” or “/C3” (NAMER NE 43 compliant) is specified.

8.2.1 Definition of Equipment Status

(1) During warm-up
"During warm-up" is the time required after applying power until the sensor temperature stabilizes at 750°C, and the equipment is in the measurement mode. This status is that the sensor temperature is displayed on the basic panel.

(2) During maintenance
"During maintenance" is the time from when a valid password is entered in the basic panel display to enable the parameter code selection display until the display goes back to the basic panel display

(3) During calibration (see Chapter 9, Calibration)
In the manual calibration, proceed with the calibration operation with the parameter code 「B10」 to display the span gas confirmation display for the first span calibration, thus starting the calibration time when the [ENT] key is touched. After a series of calibrations is complete and the preset output stabilization time has elapsed, the calibration time will be up. Figure 8.1 shows the definition of "during calibration" in the manual calibration.

Switch operation			Display
>	^	ENT	b10
>	^	ENT	CAL
>	^	ENT	CAL
>	^	ENT	SPAn Y
>	^	ENT	21.00 %
>	^	ENT	OPEn/20.84
>	^	ENT	20.84 %
>	^	ENT	ZEro Y
>	^	ENT	0.98 %
>	^	ENT	OPEn/0.89
>	^	ENT	0.89 %
>	^	ENT	CALEnd
>	^	ENT	b10
>	^	ENT	Measured-value display

Output hold time during calibration

Figure 8.1 **Definition of During Calibration**

In a semi-automatic calibration, “during calibration” is the time, starting when a calibration instruction is executed with an infrared switch or a contact input, to make a series of calibrations, until the preset output stabilization time elapses.

In an automatic calibration, “during calibration” is the time, starting when automatic calibration is carried out at the calibration start time, until the preset output stabilization time elapses.

(4) “Error” appears when Error 1 to Error 4 are being issued

8.2.2 Preference Order of Output Hold Value

The output hold value takes the following preference order:

Preference order (high) ↑
- During error occurrence
- During calibration
- During maintenance
- During warm-up

8.3.2E.siki

For example, if the output current is set to “4 mA” during maintenance, and “without hold” output during calibration is preset, the output is held at 4 mA in the maintenance display. However, the output hold is released at the time of starting the calibration, and the output will be held again at 4 mA after completing the calibration and when the output stabilization time elapses.

8.2.3 Output Hold Setting

Table 8.5 lists parameter codes with set values for individual set items.

Table 8.5 Parameter Codes for Output Holding

Set items	Parameter code	Set value	
During warm-up	C04	0	4 mA
		1	20 mA
		2	Holds Set value
During maintenance	C05	0	Without hold feature
		1	Last measured value.
		2	Holds set values.
During calibration	C06	0	Without hold feature
		1	Last measured value.
		2	Holds set values.
During error occurrence	C07	0	Without hold feature
		1	Last measured value.
		2	Holds set values.

Note: “C07” is not displayed when option code “/C2” or “/C3” (NAMUR NE 43 compliant) is specified.

8.2.4 Default Values

When the analyzer is delivered, or if data are initialized, output holding is by default as shown in Table 8.6.

Table 8.6 Output Hold Default Values

Status	Output hold (min. and max. values)	Preset value
During warm-up	4 mA	4 mA
Under maintenance	Holds output at value just before maintenance started.	4 mA
Under calibration or blow-back	Holds output at value just before starting calibration	4 mA
On Error occurrence	Holds output at a preset value.	3.4 mA

8.3 Setting Alarms

The analyzer enables the setting of four alarms high-high, high, low, and low-low alarms depending upon the oxygen concentration. The following section sets forth the alarm operations and setting procedures.

8.3.1 Alarm Values

(1) High-high and high alarm values
High-high alarms and high alarms are issued when they are set to be detected with parameter codes “D41” and “D42”, and if the measured values exceed the preset oxygen concentration values specified with “D01” and “D02”.

(2) Low and low-low alarm values
Low alarms and low-low alarms are issued when they are set to be detected with parameter codes “D43” and “D44”, and if the measured values are lower than the preset oxygen concentration values specified with “D03” and “D04”.

8.3.2 Alarm Output Actions

If the measured values of the oxygen concentration fluctuate between normal (steady-state) values and alarm setting, there may be a lot of alarm-output issuing and canceling. To avoid this, set the delay time and allow for hysteresis for alarm canceling under the alarm output conditions, as Figure 8.2 shows. When the delay time is set, an alarm will not be issued so quickly even if the measured value differs from the steady-state and enters the alarm setpoint range. If the measured value remains within the alarm setpoint range for a certain period of time (for the preset delay time), an alarm will result. On the other hand, there will be a similar delay each time the measured value returns to the steady state from the alarm setpoint range (canceling the alarm status). If hysteresis is set, alarms will be canceled when the measured value is less than or more than the preset hysteresis values. If both the delay time and hysteresis are set, an alarm will be issued if the measured value is in the alarm setpoint range and the delay time has elapsed. When the alarm is reset (canceled), it is required that the measured value be beyond the preset hysteresis value and that the preset delay time. Refer to Figure 8.2 for any further alarm output actions. The delay time and hysteresis settings are common to all alarm points.

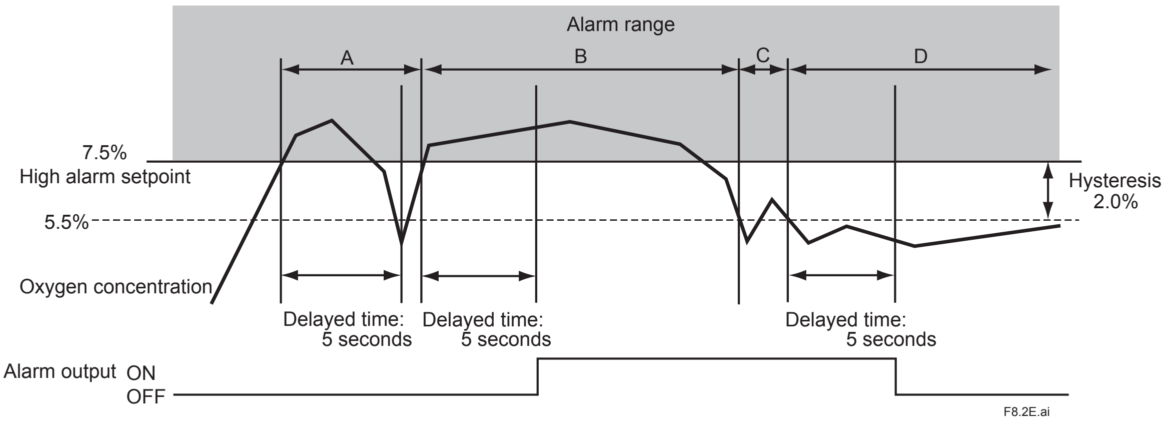


Figure 8.2 Alarm Output Action

In the example in Figure 8.2, the high alarm point is set to 7.5% O_2, the delayed time is set to five seconds, and hysteresis is set to 2% O_2.

Alarm output actions in this figure are expressed as follows:

(1) Although oxygen concentration measurement “A” has exceeded the high alarm setpoint, “A” falls lower than the high alarm setpoint before the preset delayed time of five seconds elapses. So, no alarm is issued.

(2) Oxygen concentration measurement “B” exceeds the high alarm setpoint and the delayed time has elapsed during that measurement. So, an alarm results.

(3) Although oxygen concentration measurement “C” has fallen lower than the hysteresis set value, that measurement exceeds the hysteresis set value before the preset delayed time has elapsed. So, the alarm is not canceled.

(4) Oxygen concentration measurement “D” has fallen below the hysteresis set value and the preset delayed time during measurement has elapsed, so the alarm is canceled.

8.3.3 Alarm Setting

Set the alarm setpoints following Table 8.7 listing parameter codes.

Table 8.7 Parameter Codes for Alarms

Set item	Parameter code	Set value	
Oxygen concentration high-high alarm setpoint	D01	0-100% O_2	
Oxygen concentration high alarm setpoint	D02	0-100% O_2	
Oxygen concentration low alarm setpoint	D03	0-100% O_2	
Oxygen concentration low-low alarm setpoint	D04	0-100% O_2	
Humidity high-high alarm setpoint	D05	0-100% H_2O	
Humidity high alarm setpoint	D06	0-100% H_2O	
Humidity low alarm setpoint	D07	0-100% H_2O	
Humidity low-low alarm setpoint	D08	0-100% H_2O	
Mixing ratio high-high alarm setpoint	D11	0-1 kg/kg	
Mixing ratio high alarm setpoint	D12	0-1 kg/kg	
Mixing ratio low alarm setpoint	D3	0-1 kg/kg	
Mixing ratio low-low alarm setpoint	D14	0-1 kg/kg	
Oxygen concentration alarm hysteresis	D30	0-9.9% O_2	
Humidity alarm hysteresis	D31	0-9.9% H_2O	
Mixing ratio alarm hysteresis	D32	0-0.1 kg/kg	
Delayed alarm action	D33	0-255 seconds	
Oxygen concentration high-high alarm detection	D41	0	Not detected
		1	Detected
Oxygen concentration high alarm detection	D42	0	Not detected
		1	Detected
Oxygen concentration low alarm detection	D43	0	Not detected
		1	Detected
Oxygen concentration low-low alarm detection	D44	0	Not detected
		1	Detected
Humidity high-high alarm detection	D45	0	Not detected
		1	Detected
Humidity high alarm detection	D46	0	Not detected
		1	Detected
Humidity low alarm detection	D47	0	Not detected
		1	Detected
Humidity low-low alarm detection	D48	0	Not detected
		1	Detected
Mixing ratio high-high alarm detection	D51	0	Not detected
		1	Detected
Mixing ratio high alarm detection	D52	0	Not detected
		1	Detected
Mixing ratio low alarm detection	D53	0	Not detected
		1	Detected
Mixing ratio low-low alarm detection	D54	0	Not detected
		1	Detected

CAUTION

Even with alarms set, if “Not detected” has been set in the above alarm detection, no alarm is issued. Be sure to set “Detected” in the above alarm detection if you use alarm features.

8.3.4 Default Values

When the analyzer is delivered, or if data are initialized, the default alarm set values are as shown in Table 8.8.

Table 8.8 Alarm Setting Default Values

Set item	Set value
Oxygen concentration high-high alarm setpoint	100% O_2
Oxygen concentration high alarm setpoint	100% O_2
Oxygen concentration low alarm setpoint	0% O_2
Oxygen concentration low-low alarm setpoint	0% O_2
Humidity high-high alarm setpoint	100% H_2O
Humidity high alarm setpoint	100% H_2O
Humidity low alarm setpoint	0% H_2O
Humidity low-low alarm setpoint	0% H_2O
Mixing ratio high-high alarm setpoint	1 kg/kg
Mixing ratio high alarm setpoint	1 kg/kg
Mixing ratio low alarm setpoint	0 kg/kg
Mixing ratio low-low alarm setpoint	0 kg/kg
Oxygen concentration alarm hysteresis	0.1% O_2
Humidity alarm hysteresis	0.1% H_2O
Mixing ratio alarm hysteresis	0.001 kg/kg
Delayed alarm action	3 seconds
High-high alarm detection	Not detected
High alarm detection	Not detected
Low alarm detection	Not detected
Low-low alarm detection	Not detected

8.4 Output Contact Setup

8.4.1 Output Contact

Mechanical relays provide contact outputs. Be sure to observe relay contact ratings. (For details, see Section 2.1, “General Specifications.”) The following sets forth the operation mode of each contact output. Output contact 1 you can select open or closed contact when the contact is “operated”. For output contact 2, contact is closed. The relay for output contact 1 is energized when its contacts are closed and vice versa. Accordingly, when no power is supplied to the equipment, those contacts remain open. In addition, the relay for output contact 2 is energized when the corresponding contact is open and de-energized when that contact is closed.

Table 8.9 Setting Output Contacts

	Operating state	When no power is applied to this equipment
Output contact 1	Open (de-energized) or closed (energized) selectable.	Open
Output contact 2	Closed (de-energized) only.	Closed

8.4.2 Setting Output Contact

Set the output contacts following Table 8.10.

Table 8.10 Parameter Codes for Output Contact Setting

Set item	Parameter code	Set value	
Output contact 1			
Operation	E10	0	Operated in closed status. (Normally de-energized)
		1	Operated when open. (Normally energized) (Note 1)
Error	E20	0	Not operated if an error occurs.
		1	Operated if an error occurs.
High-high alarm	E21	0	Not operated if a high-high alarm occurs.
		1	Operated if a high-high alarm occurs. (Note 2)
High alarm	E22	0	Not operated if a high alarm occurs.
		1	Operated if a high alarm occurs. (Note 2)
Low alarm	E23	0	Not operated if a low alarm occurs.
		1	Operated if a low alarm occurs. (Note 2)
Low-low alarm	E24	0	Not operated if a low-low alarm occurs.
		1	Operated if a low-low alarm occurs. (Note 2)
Maintenance	E25	0	Not operated during maintenance.
		1	Operated during maintenance (see Section 8.3.1).
Calibration	E26	0	Not operated during calibration.
		1	Operated during calibration (see Section 8.3.1).
Measurement range change	E27	0	Not operated when changing ranges.
		1	Operated when changing ranges. (Note 3)
Warm-up	E28	0	Not operated during warming up.
		1	Operated during warming up.
Calibration gas pressure decrease	E29	0	Not operated while a calibration gas pressure decrease contact is being closed.
		1	Operated while a calibration gas pressure decrease contact is being closed. (Note 4)
Unburnt gas detection	E32	0	Not operated while a unburnt gas detection contact is being closed.
		1	Operated while a unburnt gas detection contact is being closed. (Note 5)

Note 1: Output contact 2 remains closed.
Note 2: The oxygen concentration alarm must be preset (see Section 8.4).
Note 3: Range change answer-back signal. For this action, the range change must be preset during the setting of input contacts (see Section 8.6).
Note 4: Calibration gas pressure decrease answer-back signal. Calibration gas pressure decrease must be selected beforehand during the setting of input contacts.
Note 5: Non-combusted gas detection answer-back signals. “Non-combusted gas” detection must be selected during the setting of input contacts.

WARNING

Output contact 2 is linked to the detector’s heater power safety switch. As such, if output contact 2 is on, the heater power stops and an Error 1 (cell voltage abnormal) or Error 2 (heater temperature abnormal) occurs.

8.4.3 Default Values

When the analyzer is delivered, or if data are initialized, output contacts are by default as shown in Table 8.11.

Table 8.11 Output Contact Default Settings

Item	Output contact 1	Output contact 2
High-high alarm		
High alarm		
Low alarm		
Low-low alarm		
Error		O
Warm-up	O	
Output range change		
Calibration		
Maintenance	O	
High limit temperature alarm		
Calibration gas pressure decrease		
Unburnt gas detection		
Operating contact status	Open	Closed (fixed)

O: Present

NOTE

The above blank boxes indicate the items have been set off.

8.5 Input Contact Settings

8.5.1 Input Contact Functions

The converter input contacts execute set functions by accepting a remote (contact) signal. Table 8.12 shows the functions executed by a remote contact signal.

Table 8.12 Input Contact Functions

Set item	Function
Calibration gas pressure decrease	While a contact signal is on, neither semi-automatic nor automatic calibrations can be made.
Measuring range change	While contact input is on, the analog output range is switched to 0-25% O_2.
Calibration start	If a contact signal is applied, semi-automatic calibration starts (only if the semi-automatic or automatic mode has been setup). Contact signal must be applied for at least one second. Even though a continuous contact signal is applied, a second calibration cannot be made. If you want to make a second calibration, turn the contact signal off and then back on.
Unburnt gas detection	If a contact signal is on, the heater power will be switched off. (An one-to 11-second time interval single-output signal is available as a contact signal.) If this operation starts, the sensor temperature decreases and an error occurs. To restore it to normal, turn the power off and then back on, or reset the analyzer.

CAUTION

- Measurement range switching function by an external contact input is available for analog output 1 only and the range is fixed to 0-25%O_2.
- To conduct a semi-automatic calibration, be sure to set the Calibration setup mode to “Semi-automatic” or “Automatic”.

8.5.2 Setting Input Contact

To set the input contacts, follow the parameter codes given in Table 8.13.

Table 8.13 Parameter Codes for Input Contact Settings

Set item	Parameter code	Set value	
Input contact 1 (function)	E01	0	Invalid
		1	Calibration gas pressure decrease
		2	Measuring range change
		3	Calibration
		4	Unburnt gas detection
Input contact 2 (function)	E02	0	Invalid
		1	Calibration gas pressure decrease
		2	Measuring range change
		3	Calibration
		4	Unburnt gas detection
Input contact 1 (action)	E03	0	Operated when closed
		1	Operated when open
Input contact 2 (action)	E04	0	Operated when closed
		1	Operated when open

8.5.3 Default Values

When the analyzer is delivered, or if data are initialized, the input contacts are all open.

8.6 Other Settings

8.6.1 Setting the Date-and-Time

The following describe how to set the date-and-time. Automatic calibration works following this setting.

Use parameter code “F10” to set the date-and-time.

Table 8.14 Data-and-time Settings

Switch operation			Display	Description
>	∧	ENT	F10	Select the parameter code F10.
>	∧	ENT	00.01.01	If you touch the [ENT] key, the current date will be displayed. The display on the left indicates the date - January 1, 2000. To set June 21, 2000, follow the steps below:
>	∧	ENT	00.01.01	Touch the [>] key to move the position of the digit that is flashing to the right.
>	∧	ENT	00.06.01	Touch the [∧] key to change to 6.
>	∧	ENT	00.06.01	Touch the [>] key to move the position of the digit that is flashing to the right one digit.
>	∧	ENT	00.06.21	Touch the [∧] key to change to 2.
>	∧	ENT	00.06.21	Touch the [>] key to move the position of the digit that is flashing to the right one digit.
>	∧	ENT	07.18	Let the rightmost character flash, and touch the [>] key to display the time. Continuously touch the [>] key, then the date and time are alternately displayed. Displayed on the left is 7:18 a.m.
Omitted here.				
>	∧	ENT	14.30	Touch the [∧] key and enter the current time in same way as the date has been entered, on a 24-hour basis. 2:30 p.m. Displayed on the left means 2:40 p.m.
>	∧	ENT	14.30	If you touch the [ENT] key, all the digits flash.
>	∧	ENT	14.30	Touch the [ENT] key again to set the time.
>	∧	ENT	F10	If you touch the [>] and [ENT] keys together, the parameter code selection display appears.

The symbol ( ) indicates that the corresponding keys are being touched, and the light characters indicate flashing.

8.6.2 Setting Periods over which Average Values are Calculated and Periods over which Maximum and Minimum Values Are Monitored

The equipment enables the display of oxygen concentration average values and maximum and minimum values under measurement (see Section 10.1, later in this manual). The following section describes how to set the periods over which oxygen concentration average values are calculated and maximum and minimum values are monitored.

■ Procedure

Use the parameter-code table below to set the average, maximum and minimum oxygen concentration values. Periods over which average is calculated and periods over which maximum and minimum values are monitored can be set, ranging from 1 to 255 hours. If the set ranges are beyond the limits specified, an “Err” will be displayed.

Table 8.15 Parameter Codes for Average, Maximum and Minimum Values

Set item	Parameter code	Set range	Units
Periods over which average values are calculated	F11	1 to 255	Hours
Periods over which maximum and minimum values are monitored	F12	1 to 255	Hours

■ Default Value

When the analyzer is delivered, or if data are initialized, periods over which average values are calculated are set to one hour, and periods over which maximum and minimum values are monitored are set to 24 hours.

8.6.3 Setting Fuels

■ Input Parameters

The analyzer calculates the moisture content contained in exhaust gases. The following sets forth the fuel parameters necessary for calculation and their entries. The moisture quantity may be mathematically expressed by:

$$\text{Moisture quantity} = \frac{\overbrace{\text{(water vapor caused by combustion and water vapor contained in the exhaust gas)}}\text{ + (water vapor contained in air for combustion)}}{\text{actual exhaust gas(including water vapor) per fuel}} \times 100 \text{..... Equation 1}$$

$$= \frac{Gw + Gw_1}{G} \times 100$$

$$= \frac{Gw + (1.61 \times Z \times m \times Ao)}{Go + Gw + (m - 1)\,Ao + (1.61 \times Z \times m \times Ao)} \times 100 \qquad \text{........... Equation 2}$$

$$\fallingdotseq \frac{\boxed{Gw} + (1.61 \times \boxed{Z} \times m \times \boxed{Ao})}{\boxed{X} + \boxed{Ao} \times m} \times 100$$

where,

$\boxed{Ao}$: Theoretical amount of air per unit quantity of fuel, m^3/kg (or m^3/m^3) .... ② in Table 8.16

G: Actual amount of exhaust gas (including water vapor) per unit quantity of fuel, m^3/kg (or m^3/m^3)

$\boxed{Gw}$: Water vapor contained in exhaust gas per unit quantity of fuel (by hydrogen and moisture content in fuel), m^3/kg (or m^3/m^3) ....① in Table 8.16

Gw1: Water vapor contained in exhaust gas per unit quantity of fuel (moisture content in air), m^3/kg (or m^3/m^3)

Go: Theoretical amount of dry exhaust gas per unit quantity of fuel, m^3/kg (or m^3/m^3)

m: Air ratio

$\boxed{X}$: Fuel coefficient determined depending on low calorific power of fuel, m^3/kg (or m^3/m^3) ... ③ in Table 8.16

$\boxed{Z}$: Absolute humidity of the atmosphere, kg /kg .... Figure 8.4

Fill in the boxes with fuel parameters in Equation 2 above to calculate the moisture content. Use Ao, Gw and X shown in Table 8.16. If there are no appropriate fuel data in Table 8.16, use the following equations for calculation.

Find the value of “Z” in Equations 1 and 2 using Japanese Standard JIS B 8222. If a precise measurement is not required, obtain the value of “Z” using a graph for the absolute humidity indicated by a dry and wet bulb hygrometer.

- For liquid fuel

Amount of water vapor in exhaust gas (Gw) = (1/100) {1.24 (9h + w)} (m^3/kg)

Theoretical amount of air (Ao) = 12.38 x (Hl/10000) – 1.36 (m^3/kg)

Low calorific power = Hl

X value = (3.37 / 10000) x Hx – 2.55 (m^3/kg)

where, Hl: low calorific power of fuel

h: Hydrogen in fuel (weight percentage)

w: Moisture content in fuel (weight percentage)

Hx: Same as numeric value of Hl

- For gas fuel

Amount of water vapor in exhaust gas (Gw) = (1/100) {(h2) + 1/2 ∑y (Cx Hy) + wv} (m^3/m^3)

Theoretical amount of air (Ao) = 11.2 x (Hl/10000) (m^3/m^3)

Low calorific power = Hl

X value = (1.05 / 10000) x Hx (m^3/m^3)

where, Hl: low calorific power of fuel

CxHy: Each hydrocarbon in fuel (weight percentage)

h2: Hydrogen in fuel (weight percentage)

wv: Moisture content in fuel (weight percentage)

Hx: Same as numeric value of Hl

- For solid fuel

Amount of water vapor in exhaust gas (Gw) = (1/100) {1.24 (9h + w)} (m^3/kg)

Theoretical amount of air (Ao) = 1.01 x (Hl / 1000) + 0.56 (m^3/kg)

Low calorific power = Hl = Hh – 25 (9h + w) (kJ/kg)

X value = 1.11 - (0.106 / 1000) x Hx (m^3/m^3)

where, w: Total moisture content in use (weight percentage)

h: Hydrogen content (weight percentage)

The average hydrogen content of coal mined in Japan, which is a dry ash-free type, is 5.7 percent. Accordingly, "h" may be expressed mathematically by:

h = 5.7 [{100 – (w + a)} / 100] x (100 – w) / (100 – w1)

where, a: Ash content (%)

w1: Moisture content (%), analyzed on a constant humidity basis

Hh: Higher calorific power of fuel (kJ/kg)

Hl: Low calorific power of fuel (kJ/kg)

Hx: Same numeric value of Hl

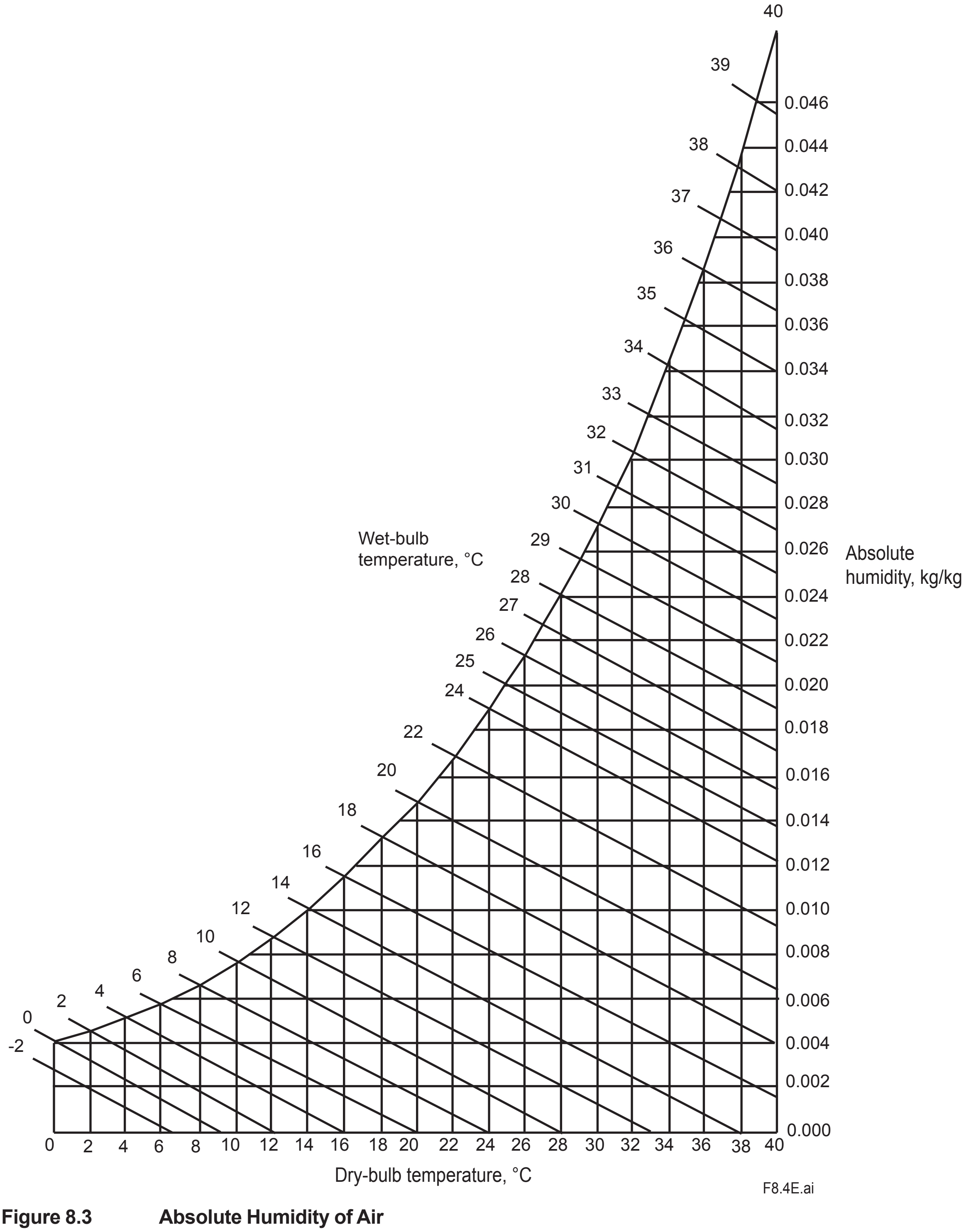


Figure 8.3 Absolute Humidity of Air

Table 8.16 Fuel Data

- **For liquid fuel**

Type \ Fuel properties	Specific weight kg/l	Chemical component (weight percentage) C	H	O	N	S	w	Ash content	Calorific power kJ/kg Higher order	Lower order	Theoretical amount of air for combustion Nm³/kg	Amount of combustion gas Nm³/kg CO_2	H_2O	SO_2	N_2	Total	X value
Kerosene	0.78~0.83	85.7	14.0	—	—	0.5	0.0	0.0	46465	43535	11.4	1.59	1.56	0.00	9.02	12.17	0.96
Light oil	0.81~0.84	85.6	13.2	—	—	1.2	0.0	0.0	45879	43032	11.2	1.59	1.47	0.00	8.87	11.93	0.91
A Heavy oil class 1 No.1	0.85~0.88	85.9	12.0	0.7	0.5	0.5	0.3	0.05	45544	42739	10.9	1.60	1.34	0.00	8.61	11.55	0.89
A Heavy oil class 1 No.2	0.83~0.89	84.6	11.8	0.7	0.5	2.0	0.4	0.05	45125	42320	10.8	1.58	1.32	0.01	8.53	11.44	0.86
B Heavy oil class 2	0.90~0.93	84.5	11.3	0.4	0.4	3.0	0.5	0.05	43827	41274	10.7	1.58	1.27	0.02	8.44	11.31	0.77
C Heavy oil class 3 No.1	0.93~0.95	86.1	10.9	0.5	0.4	1.5	0.5	0.1	43952	41441	10.7	1.61	1.22	0.01	8.43	11.27	0.79
C Heavy oil class 3 No.2	0.94~0.96	84.4	10.7	0.5	0.4	3.5	0.5	0.1	43116	40646	10.5	1.58	1.20	0.02	8.32	11.12	0.72
C Heavy oil class 3 No.3	0.92~1.00	86.1	10.9	0.5	0.4	1.5	0.6	0.1	43660	41190	10.7	1.61	1.22	0.01	8.43	11.27	0.77
C Heavy oil class 3 No.4	0.94~0.97	83.0	10.5	0.5	0.4	3.5	2.0	0.1	43032	40604	10.3	1.55	1.18	0.02	8.18	10.93	0.72
											②		①				③

- **For gas fuel**

Theoretical amount of air

Type \ Fuel properties	Specific weight kg/Nm³	Chemical component (weight percentage) CO	H_2	CO_2	CH_4	C_mH_n	O_2	N_2	Calorific power kJ/Nm³ Higher order	Lower order	Theoretical amount of air for combustion Nm³/m³	Combustion product, Nm³/ m³ CO_2	H_2O	N_2	Total	X value
Coke oven gas	0.544	9.0	50.5	2.6	25.9	3.9	0.1	8.0	20428	18209	4.455	0.45	1.10	3.60	5.15	0.46
Blast furnace gas	1.369	25.0	2.0	20.0	—	—	—	53.0	3391	3349	0.603	0.45	0.02	1.01	1.48	0.08
Natural gas	0.796	—	—	2.0	88.4	3.2	1.6	4.2	37883	34074	9.015	0.98	1.88	7.17	10.03	0.86
Propane	2.030	C_3H_8 90%, C_4H_{10} 10%							102055	93976	24.63	3.10	4.10	19.5	26.7	2.36
Butane	2.530	C_3H_8 10%, C_4H_{10} 90%							125496	115868	30.37	3.90	4.90	24.0	32.8	2.91
(Gases)		(Molecular Formula)														
Oxygen	1.43	O_2							—	—	—	—	—	—	—	—
Nitrogen	1.25	N_2							—	—	—	—	—	—	—	—
Hydrogen	0.09	H_2							12767	10758	2.390	—	1.0	1.89	2.89	0.27
Carbon monoxide	1.25	CO							12642	12642	2.390	1.0	—	1.89	2.89	0.32
Carbon dioxide	1.96	CO_2							—	—	—	—	—	—	—	—
Methane	0.72	CH_4							39750	35820	9.570	1.0	2.0	7.57	10.6	0.90
Ethane	1.34	C_2H_6							69638	63744	16.74	2.0	3.0	13.2	18.2	1.60
Ethylene	1.25	C_2H_4							62991	59060	14.35	2.0	2.0	11.4	15.4	1.48
Propane	1.97	C_3H_8							99070	91255	23.91	3.0	4.0	18.9	25.9	2.29
Butane	2.59	C_4H_{10}							128452	118623	31.09	4.0	5.0	24.6	33.6	2.98
											②		①			③

T8.8E.ai

■ Procedure

Use the parameter code table below to set fuel values.

Table 8.17 Setting Fuel Values

Set item	Parameter code	Set value	Engineering units
Amount of water vapor in exhaust gas	F20	0 to 5	m^3/kg (m^3)
Theoretical amount of air	F21	1 to 20	m^3/kg (m^3)
X value	F22	0 to 19.99	
Absolute humidity of the atmosphere	F23	O to 1	kg/kg

■ Default Values

When the analyzer is delivered, or if data are initialized, parameter settings are by default, as shown in Table 8.18.

Table 8.18 Default Settings of Fuel Values

Item	Default setting
Amount of water vapor in exhaust gas	1.00 m^3/kg (m^3)
Theoretical amount of air	1.00 m^3/kg (m^3)
X value	1.00
Absolute humidity of the atmosphere	0.1000 kg/kg

8.6.4 Setting Measurement Gas Temperature and Pressure

The analyzer calculates the moisture content contained in exhaust gases and saturated water vapors from the entered gas temperature and pressure to obtain the relative humidity and dew point. Enter the exhaust gas temperature and pressure (absolute pressure) necessary for the calculation (see Section 10.1 later in this manual).

NOTE

The critical temperature of the saturated water vapor pressure is 374°C. If a gas temperature exceeding 370°C is entered, no correct calculation will be obtained.

■ Procedure

To set the gas temperature and pressure, follow the parameter code table for fuel setting.

If you set a value exceeding the setting ranges, an error, ERR will result.

Table 8.19 Fuel Setting Default Value

Set item	Parameter code	Set value	Engineering units
Exhaust gas temperature	F13	0 to 3000	°C
Exhaust gas pressure	F14	0 to 300	kPa abs.

■ Default Values

When the analyzer is delivered or data are initialized, the parameters are by default as shown in Table 8.20.

Table 8.20 Parameter Codes for Exhaust Gas Temperature and Pressure Settings

Item	Default setting
Exhaust gas temperature	300°C
Exhaust gas pressure	101.33 kPa abs.

8.6.5 Setting Purging

Purging is to remove condensed water in the calibration gas pipe by supplying a span calibration gas for a given length of time before warm-up of the detector. This prevents cell breakage during calibration due to condensed water in the pipe.

Open the solenoid valve for the automatic calibration span gas during purging and after the purge time has elapsed, close the valve to start warm-up.

Purging is enabled when the cell temperature is 100°C or below upon power up and the purge time is set in the range of 1 to 60 minutes.

Displayed alternately

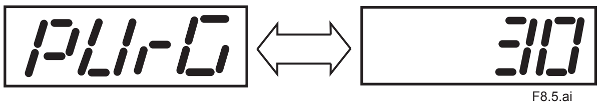


Figure 8.4 Display during Purging

■ Procedure

Use the parameter-code table below to set the purging time.

The allowable input ranges from 0 to 60 minutes.

Table 8.21 Purging Time

Set item	Parameter code	Set range	Units
Purging time	F15	0 to 60	minutes

■ Default Value

When the analyzer is delivered, or if data are initialized, purging time is set to 0 minutes.

9. Calibration

9.1 Calibration Briefs

9.1.1 Principle of Measurement with a zirconia oxygen analyzer

This section sets forth the principles of measurement with a zirconia oxygen analyzer before detailing calibration.

A solid electrolyte such as zirconia allows the conductivity of oxygen ions at high temperatures. Therefore, when a zirconia-plated element with platinum electrodes on both sides is heated up in contact with gases having different oxygen partial pressures on each side, the element shows the action of the concentration cell. In other words, the electrode in contact with a gas with a higher oxygen partial pressure acts as a negative electrode. As the gas comes in contact with the zirconia element in this negative electrode, oxygen molecules in the gas acquire electrons and become ions. Moving in the zirconia element, they eventually arrive at the positive electrode on the opposite side.
There, the electrons are released and the ions return to the oxygen molecules. This reaction is indicated as follows:

Negative electrode: $O_2 + 4e \rightarrow 2\,O^{2-}$

Positive electrode: $2\,O^{2-} \rightarrow O_2 + 4\,e$

The electromotive force E (mV) between the two electrodes, generated by the reaction, is governed by Nernst's equation as follows:

$E = -RT/nF \ln Px/Pa$...Equation (1)

where, R: Gas constant

T: Absolute temperature

n: 4

F: Faraday's constant

Px: Oxygen concentration in a gas in contact with the negative zirconia electrode (%)

Pa: Oxygen concentration in a gas in contact with the positive zirconia electrode (%)

Assuming the zirconia element is heated up to 750°C, then we obtain equation (2) below:

$E = -50.74 \log Px/Pa$...Equation (2)

With this analyzer, the sensor (zirconia element) is heated up to 750°C, so Equation (2) is valid. At that point, the relationship as in Figure 9.1 is effected between the oxygen concentration of the measurement gas in contact with the positive electrode and the electromotive force of the sensor (cell), where a comparison gas of air is used on the negative electrode side.

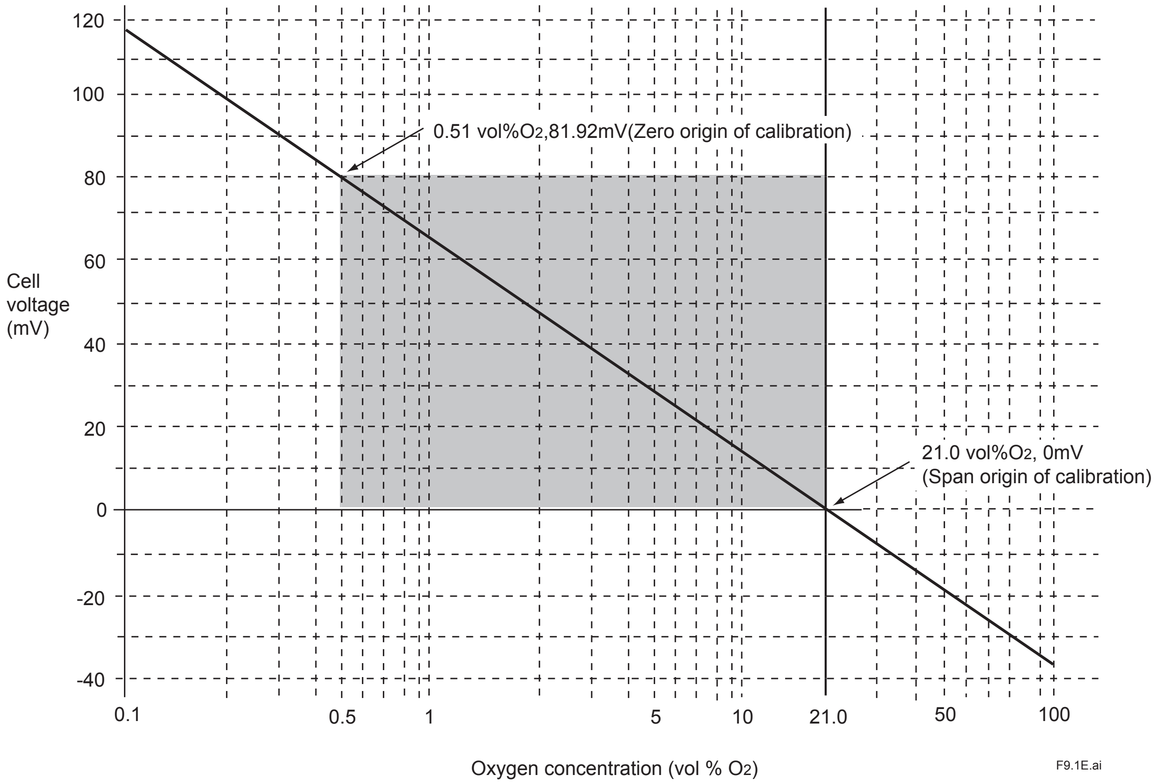


Figure 9.1 Oxygen Concentration in a Measurement Gas vs. Cell Voltage (21 vol%O_2 Equivalent)

The measurement principles of a zirconia oxygen analyzer have been described above. However, the relationship between oxygen concentration and the electromotive force of a cell is only theoretical. Usually, in practice, a sensor shows a slight deviation from the theoretical value. This is the reason why calibration is necessary. To meet this requirement, an analyzer calibration is conducted so that a calibration curve is obtained, which corrects the deviation from the theoretical cell electromotive force.

9.1.2 Measurement Principle of Zirconia Humidity Analyzer

A solid electrolyte such as zirconia allows the conduction of oxygen ions at high temperatures. Therefore, when a zirconia-plated element with platinum electrodes on both sides is heated up in contact with gases having different partial-oxygen pressures on each side, oxygen ions flow from a high partial-oxygen pressure to a low partial-oxygen pressure, causing a voltage. When a sample gas introduced into the zirconia-plated element with the measurement electrode, and air (21.0 vol % O2) is flowed through the reference electrode, an electromotive force (mV) is produced between the two electrodes, governed by Nernst's equation as follows:

E = - RT/nF log e y/a .... Equation (1)

where, R = Gas constant
T = Absolute temperature
n: 4
F = Faraday's constant
y = O2 vol % on the zirconia element measurement electrode
a = O2 vol % to 21.0 vol % O2 on the zirconia element reference electrode

The humidity analyzer uses a sample gas composed of water vapor and air.

(A) For the vol % H2O measurement

x:Assuming that H2O vol % in a mixed gas is measured:

y = (100 – x) 3 0.21 .... Equation (2)

From the above equations (1) and (2), we obtain:

E = -K log y/a = -Klog [(100 – x) 30.21] /21
= - K log (1 –0.01 x) ……………… Equation (3)

where, K = Constant

Using the above equation (3), we can calculate the water vapor in vol % from the electromotive force.

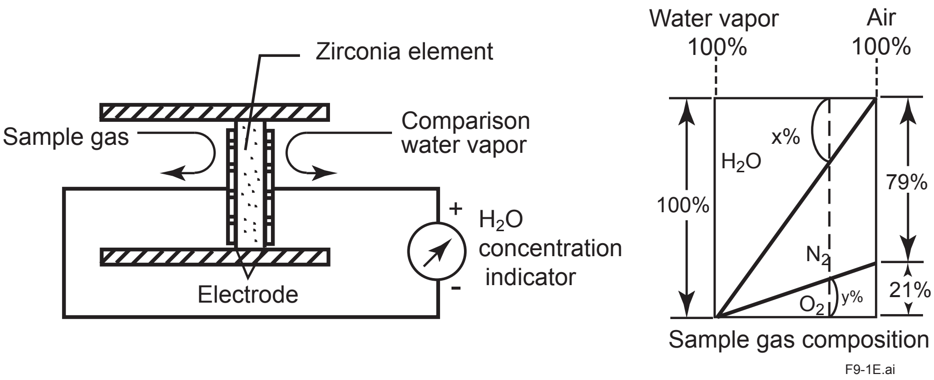


Figure 9.2 Schematic Diagram of Measurement Principle

(B) For the “mixing ratio” measurement

Assuming that the mixing ratio is rkg/kg, then “r” can be calculated from the value of H_2O vol % as follows:

r = 0.622 3 x/(100 – x) …………… Equation (4)

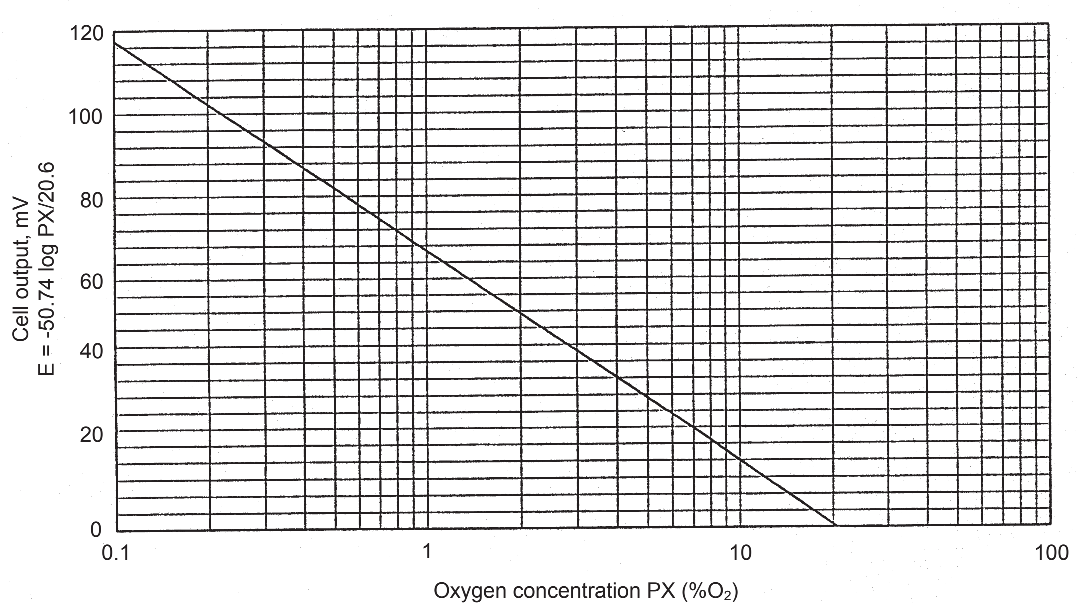
From the above equations (1), (2) and (4), we obtain:

E = -K log y/a = -K log 50.622 3 21/(0.622 + r)/216

= -K log 0.622/(0.622 + r) … …… Equation (5)

where, K = Constant

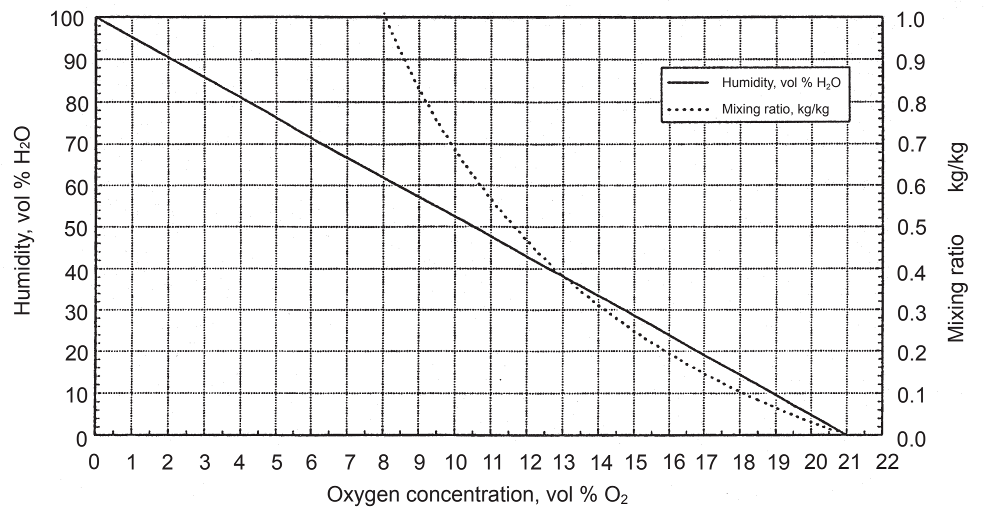
With Equation (5), we can obtain the mixing ratio rkg/kg from the electromotive force.



Oxygen concentration vs. cell output

F9-2E.ai

Figure 9.3



Oxygen concentration vs. Humidity, Mixing ratio

F9-3E.ai

Figure 9.4

9.1.3 Calibration Gas

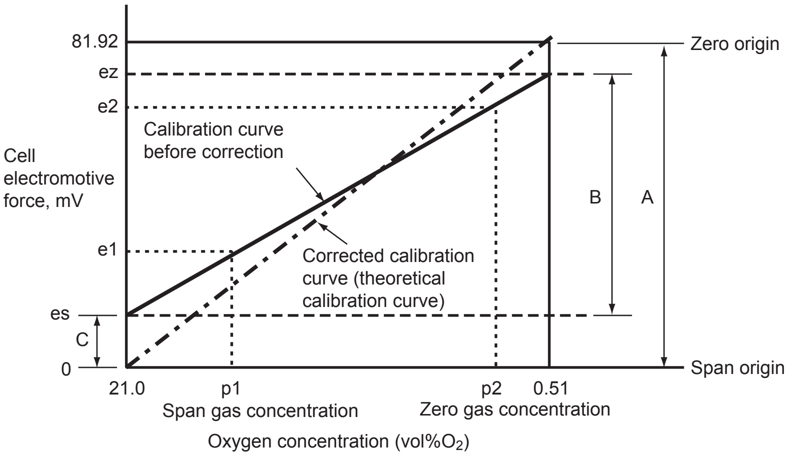
A gas with a known oxygen concentration is used for calibration. Normal calibration is performed using two different gases: a zero gas of low oxygen concentration and a span gas of high oxygen concentration. In some cases, only one of the gases needs to be used for calibration. However, even if only one of the gases is normally used, calibration using both gases should be done at least once.

The zero gas normally used has an oxygen concentration of 0.95 to 1.0 vol%O_2 with a balance of nitrogen gas (N_2). The span gas widely used is clean air (at a dew-point temperature below -20°C and free of oily mist or dust, as in instrument air).

9.1.4 Compensation

The deviation of a measured value from the theoretical cell electromotive force is checked by the method in Figure 9.5 or 9.6.

Figure 9.5 shows a two-point calibration using two gases: zero and span. Cell electromotive forces for a span gas with an oxygen concentration p1 and a zero gas with an oxygen concentration p2 are measured while determining the calibration curve passing between these two points. The oxygen concentration of the sample gas is determined from this calibration curve. In addition, the calibration curve corrected by calibration is compared with the theoretical calibration curve for determining the zero correction ratio represented by B/A x 100 (%) on the basis of A, B and C shown in Figure 9.5 and a span correction ratio of C/A x 100 (%). If the zero correction ratio exceeds the range of 100 ± 30% or the span correction ratio becomes larger than 0 ± 18%, calibration of the sensor becomes impossible.



Zero correction ratio = (B/A) x 100 (%) Correctable range: 100 ± 30%
Span correction ratio = (C/A) x 100 (%) Correctable range: 0 ± 18%

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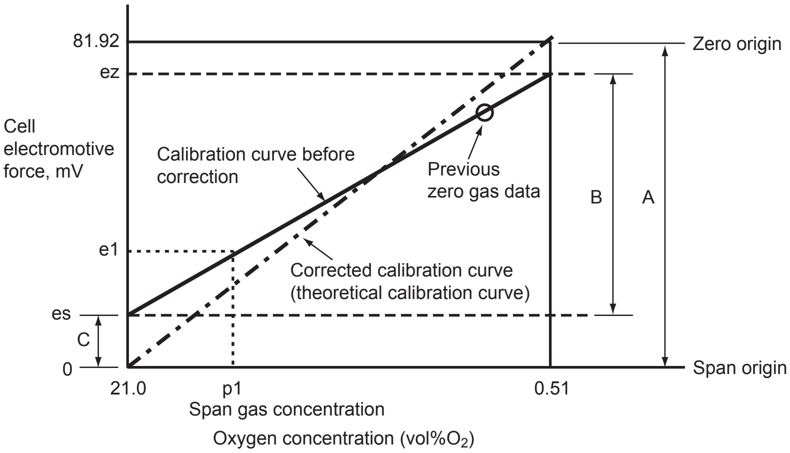
Figure 9.5 Calculation of a Two-point Calibration Curve and Correction Ratios Using Zero and Span Gases

Figure 9.6 shows a one-point calibration using only a span gas. In this case, only the cell electromotive force for a span gas with oxygen concentration p1 is measured. The cell electromotive force for the zero gas is carried over from a previous measurement to obtain the calibration curve. The principle of calibration using only a span gas also applies to the one-point calibration method using a zero gas only.



Zero correction ratio = (B/A) x 100 (%) Correctable range: 100 ± 30%
Span correction ratio = (C/A) x 100 (%) Correctable range: 0 ± 18%

F9.3E.ai

Figure 9.6 Calculation of a One-point Calibration Curve and Correction Ratios Using a Span Gas

9.1.5 Characteristic Data from a Sensor Measured During Calibration

During calibration, calibration data and sensor status data (listed below) are acquired. However, if the calibration is not properly conducted (an error occurs in automatic or semi-automatic calibration), these data are not collected in the current calibration.

These data can be observed using parameter codes “A20” to “A22”, and “A50” to “A79”. For an explanation and the operating procedures of individual data, consult Section 10.1, “Detailed Display.”

(1) Record of span correction ratio
Recorded the past ten span correction ratios.

(2) Record of zero correction ratio
Recorded the past ten zero correction ratios.

(3) Response time
You can monitor the response time provided that a two-point calibration has been done in semi-automatic or automatic calibration.

(4) Cell's internal resistance
The cell's internal resistance gradually increases as the cell (sensor) deteriorates. You can monitor the values measured during the latest calibration. However, these values include the cell's internal resistance and other wiring connection resistance. So, the cell's degrading cannot be estimated from these values only.
When only a span calibration has been made, these values will not be measured, and previously measured values will remain.

(5) Robustness of a cell
The robustness of a cell is an index for predicting the remaining life of a sensor and is expressed in a number on four levels.

9.2 Calibration Procedures

NOTE

Calibration should be made under normal operating conditions (if the probe is connected to a furnace, the analyzer will undergo calibration under the operating conditions of the furnace). To make a precise calibration, conduct both zero and span calibrations.

The following sets forth the required calibration settings:

9.2.1 Mode

There are three calibration modes available:

(1) Manual calibration which allows zero and span calibrations or either one manually in turn;

(2) Semi-automatic calibration which lets calibration start with the touch panel or a contact input, and undergoes a series of calibration operations following preset calibration periods and stabilization time.

(3) Automatic calibration which is carried out automatically following preset calibration periods.

Calibrations are limited by the following mode selection:

- **When Manual calibration is selected:**

  Manual calibration only can be conducted. (This mode does not allow semi-automatic calibration with a contact input nor automatic calibration even when its start-up time has reached.)

- **When Semi-automatic calibration is selected:**

  This mode enables manual and semi-automatic calibrations to be conducted.

  (The mode, however, does not allow automatic calibration even when its start-up time has reached.)

- **When Automatic calibration is selected:**

  This calibration can be conducted in any mode.

9.2.2 Calibration Procedure

Select both span and zero calibrations or span calibration only or zero calibration only. Usually select span and zero calibrations.

9.2.3 Zero gas Concentration

Set the oxygen concentration for zero calibration. Enter the oxygen concentration for the zero gas in the cylinder used.

9.2.4 Span gas Concentration

Set the oxygen concentration for span calibration. If instrument air is used as the span gas, enter 21 $\%O_2$.

When using the ZO21S Standard Gas Unit (for use of the atmospheric air as a span gas), use a hand-held oxygen analyzer to measure the actual oxygen concentration, and then enter it.

NOTE

- When instrument air is used for the span calibration, remove the moisture from the instrument air at a dew-point temperature of -20°C and also remove any oily mist and dust from that air.
- If dehumidifying is not enough, or if foul air is used, the measurement accuracy will be adversely affected.

9.2.5 Calibration Time

- When the calibration mode is in manual:
  First set the hold (output stabilization) time. This indicates the time required from the end of calibration to entering a measurement again. This time, after calibration, the measurement gas enters the sensor to set the time until the output returns to normal. The output remains held after completing the calibration operation until the hold (output stabilization) time elapses. The calibration time set ranges from 00 minutes, 00 seconds to 60 minutes, 59 seconds. For more details, consult Section 8.2,"Output Hold Setting." When the calibration mode is in semi-automatic, set the hold (output stabilization) time and calibration time. The calibration time is the time required from starting the flow of the calibration gas to reading out the measured value. The set calibration time is effective in conducting both zero and span calibrations. The calibration time set ranges from 00 minutes, 00 seconds to 60 minutes, 59 seconds. Figure 9.7 shows the relationship between the calibration time and hold (output stabilization) time.

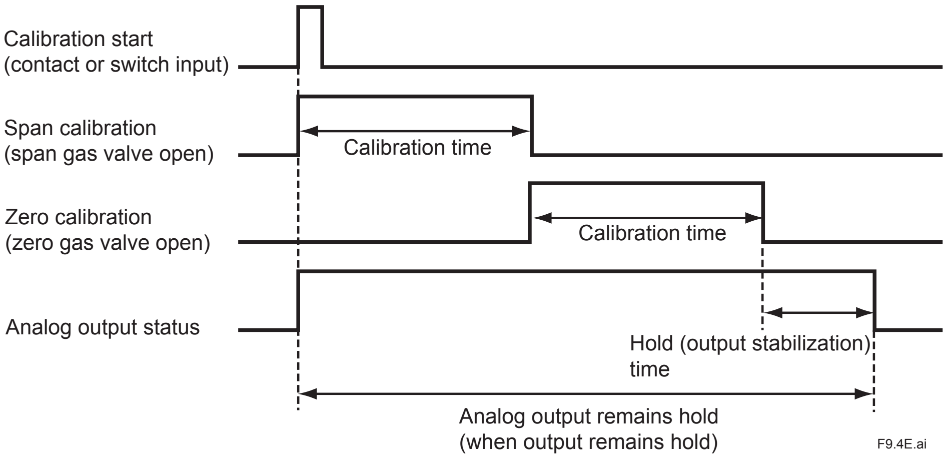


Figure 9.7 Calibration and Hold (Output stabilization) Time Settings

- When the calibration mode is in automatic:
  In addition to the above hold (output stabilization) time and calibration time, set the interval, start date, and start time.
  Interval means the calibration intervals ranging from 000 days, 00 hours to 255 days, 23 hours.
  Set the first calibration day and the start-calibration time to the start date and start time respectively. After the first calibration is carried out, the next calibration will be executed according to the preset calibration intervals.

■ Setting

When setting calibration timing requirements, bear the following precautions in mind:

NOTE

(1) If the calibration interval is shorter than the sum of hold (output stabilization) time plus calibration time, the second calibration start time will conflict with the first calibration. In such a case, the second calibration will not be conducted. (When both zero and span calibrations are to be performed, the calibration time is double that required for a single (zero or span) calibration.)

(2) For the same reason, if the calibration start time conflicts with manual calibration or semi-automatic calibration, the current calibration will not be conducted.

(3) If the calibration time conflicts with maintenance service operation, calibration will start after completing the maintenance service operation (see Section 8.2.1, earlier in this manual).

(4) If 000 days, 00 hours are set for the calibration intervals, only the first calibration will be conducted; a second or later calibration will not be conducted.

(5) If a past date is set to the calibration start day, no calibration will be conducted.

Table 9.1 Parameter Codes for Calibration Setting

<table>
<tr><th>Set Item</th><th>Parameter code</th><th colspan="2">Set value</th><th>Engineering unit</th></tr>
<tr><td>Zero gas concentration</td><td>B01</td><td colspan="2">Set Zero gas concentration</td><td>%O_2</td></tr>
<tr><td>Span gas concentration</td><td>B02</td><td colspan="2">Set Span gas concentration</td><td>%O_2</td></tr>
<tr><td rowspan="3">Calibration mode</td><td rowspan="3">B03</td><td>0</td><td>Manual calibration</td><td rowspan="3"></td></tr>
<tr><td>1</td><td>Semi-automatic and manual</td></tr>
<tr><td>2</td><td>Automatic, semi-automatic, and manual</td></tr>
<tr><td>Hold (Output stabilization) time</td><td>B04</td><td colspan="2">0 minutes 0 seconds to 60 minutes 59 seconds</td><td>MM.SS</td></tr>
<tr><td>Calibration time</td><td>B05</td><td colspan="2">0 minutes 0 seconds to 60 minutes 59 seconds</td><td>MM.SS</td></tr>
<tr><td>Calibration interval</td><td>B06</td><td colspan="2">0 days 0 hours to 255 days 23 hours</td><td>Date and time</td></tr>
<tr><td>Start date and time</td><td>B07</td><td colspan="2">Date and time of first calibration</td><td>YY.MM.
DD.HH.MM</td></tr>
<tr><td rowspan="3">Calibration procedure</td><td rowspan="3">B08</td><td>0</td><td>Zero and span</td><td rowspan="3"></td></tr>
<tr><td>1</td><td>Span only</td></tr>
<tr><td>2</td><td>Zero only</td></tr>
</table>

■ Default Values

When the analyzer is delivered, or if data are initialized, the calibration settings are by default, as shown in Table 9.2.

Table 9.2 Default Settings for Calibration

Item	Default Setting
Calibration mode	Manual
Calibration procedure	Span - zero
Zero gas (oxygen) concentration	1.00%
Span gas (oxygen) concentration	21.00%
Hold (Output stabilization) time	10 minutes, 00 seconds
Calibration time	10 minutes, 00 seconds
Calibration interval	30 days, 00 hours
Start date and time	00 (YY) 01 (MM) 01(DD) 00:00

9.3 Calibration

9.3.1 Manual Calibration

For manual calibration, consult Section 7.11, “Calibration,” earlier in this manual.

9.3.2 Semi-automatic Calibration

(1) Calibration startup using infrared switches

Table 9.3 Semi-automatic Calibration Procedure

Switch operation			Display	Description
>	∧	ENT	b11	Change the parameter code to b11. (Previous operations omitted)
>	∧	ENT	SA-CAL	Touch the [ENT] key to display "SA-CAL" (Semi Auto CAL).
>	∧	ENT	SPAn /20.84	Touch the [ENT] key again to open the span gas solenoid valve. The span gas then flows. "SPAn" and the currently measured value are alternately displayed. If the "output hold" is set, the output hold will start at this time.
>	∧	ENT	ZEro /0.89	If the set calibration time elapses, the span gas solenoid valve closes automatically, the zero gas solenoid valve opens and the zero gas flows. "ZEro" and the currently measured value are displayed alternately.
>	∧	ENT	CALEnd	End If the set calibration time elapses, the zero gas solenoid valve then closes automatically. The "CALEnd" flashes until the set output stabilization time elapses.
>	∧	ENT	Basic panel display	If the output stabilization time elapses, the basic panel display then appears. Output holding will be released.

When “CAL Err” appears, a calibration coefficient alarm (alarm 6 or 7) may have occurred.

Press [ENT] key to return to basic panel display. Check the alarm number. Refer to Subsection 12.2.2.2, Alarm 6, or Subsection 12.2.2.3, Alarm 7, remove the cause, and then recalibrate the instrument.

The symbol [ ] indicates that the corresponding keys are being touched, and the light characters indicate flashing.

“/” indicates that both are displayed alternately.

(2) To start calibration using an input contact, follow these steps:
- Make sure that Calibration start has been selected in the Input contacts display (see Section 8.5, earlier in this manual).
- Apply an input contact to start calibration.

(3) To stop calibration midway, follow these steps:
Touch the [>] key and [ENT] key together. The calibration will stop and the output stabilization time will be set up. Touch the [>] key once again to return to the basic panel display and the analyzer will be in normal measurement.

9.3.3 Automatic Calibration

No execution operations are required for automatic calibration. Automatic calibration starts in accordance with a preset start day and time. Calibration is then executed at preset intervals.

NOTE

Before conducting a semi-automatic or automatic calibration, run the automatic calibration unit beforehand to obtain a calibration flow of 600 ± 60 ml/min.

10. Other Functions

10.1 Detailed Display

Select the desired parameter code to display the detailed operation data (see Table 10.1, “Parameter Codes for Detailed Operation Data”.

NOTE

Refer to Section 7.8, “Setting Display Item”, for parameter code “A00”.

Table 10.1 Parameter Codes for Detailed Operation Data

Code	Item			Engineering unit	Code	Item	Engineering unit
A00	Selection of display items	0	Oxygen concentration		A50	Span correction ratio 0	%
		1	Oxygen analyzer (0.0)		A51	Span correction ratio 1	%
		2	Oxygen analyzer (0.0)		A52	Span correction ratio 2	%
		3	Analog output selected		A53	Span correction ratio 3	%
A01	Oxygen concentration			% O_2	A54	Span correction ratio 4	%
A02	Humidity			%H_2O	A55	Span correction ratio 5	%
A03	Mixing ratio			kg/kg	A56	Span correction ratio 6	%
A04	Relative humidity			%	A57	Span correction ratio 7	%
A05	Dew point			°C	A58	Span correction ratio 8	%
A06	Air ratio				A59	Span correction ratio 9	%
A07	Cell temperature			°C	A60	Zero correction ratio 0	%
A08	Cold junction temperature			°C	A61	Zero correction ratio 1	%
A09	Meas. gas temperature			°C	A62	Zero correction ratio 2	%
A10	Amount of water vapor in exhaust gas			%	A63	Zero correction ratio 3	%
A11	Cell voltage			mV	A64	Zero correction ratio 4	%
A12	TC voltage			mV	A65	Zero correction ratio 5	%
A15	Cold junction voltage			mV	A66	Zero correction ratio 6	%
A16	Output current			mA	A67	Zero correction ratio 7	%
A20	Cell response time			Seconds	A68	Zero correction ratio 8	%
A21	Cell internal resistance			Ω	A69	Zero correction ratio 9	%
A22	Cell robustness				A70	Calibration history 0	YY.MM.DD/ HH.MM
A23	Heater on-time ratio			%	A71	Calibration history 1	YY.MM.DD/ HH.MM
A24	Oxygen concentration (with time constant)			% O_2	A72	Calibration history 2	YY.MM.DD/ HH.MM
A25	Humidity (with time constant)			%H_2O	A73	Calibration history 3	YY.MM.DD/ HH.MM
A26	Mixing ratio (with time constant)			kg/kg	A74	Calibration history 4	YY.MM.DD/ HH.MM
A30	Max. oxygen concentration			% O_2	A75	Calibration history 5	YY.MM.DD/ HH.MM
A31	Occurrence of maximum oxygen concentration			YY.MM.DD/ HH.MM	A76	Calibration history 6	YY.MM.DD/ HH.MM

A32	Min. oxygen concentration	% O_2	A77	Calibration history 7	YY.MM.DD/ HH.MM
A33	Occurrence of minimum oxygen concentration	YY.MM.DD/ HH.MM	A78	Calibration history 8	YY.MM.DD/ HH.MM
A34	Average oxygen concentration	% O_2	A79	Calibration history 9	YY.MM.DD/ HH.MM
A35	Maximum humidity	%H_2O	A80	Time	YY.MM.DD/ HH.MM
A36	Occurrence of maximum humidity	YY.MM.DD/ HH.MM	A90	Software revision	
A37	Minimum humidity	%H_2O			
A38	Occurrence of minimum humidity	YY.MM.DD/ HH.MM			
A39	Average humidity	%H_2O			
A40	Maximum humidity	kg/kg			
A41	Occurrence of maximum humidity	YY.MM.DD/ HH.MM			
A42	Minimum humidity	kg/kg			
A43	Occurrence of minimum humidity	YY.MM.DD/ HH.MM			
A44	Average humidity	kg/kg			

10.1.1 Oxygen Concentration

The oxygen concentration in the process gas is displayed (consult Section 9.1.1, earlier in this manual).

10.1.2 Humidity

The moisture content contained in air is displayed where the process gas contains water vapors and air (refer to Section 9.1.1, earlier in this manual).

10.1.3 Mixing Ratio

Where the process gas contains water vapors and air, their mixing ratio is displayed (refer to Section 9.1.1, earlier in this manual).

10.1.4 Relative Humidity

The relative humidity "U" may be obtained using the following theoretical equation (JIS Z 8806).

$U = e/e_s \times 100$

where, e = Water vapor pressure of moist air

e_s = Saturated water vapor

Since the gas-pressure ratio is equal to the volume ratio, the above equation may be expressed mathematically by:

$U = P \times H/ e_s \times 100$

where, P = Gas pressure

H = Humidity (volume ratio)

The saturated water vapor pressure es is determined by a gas temperature, so the relative humidity can be obtained by entering the parameters. Use parameter F13 for temperature entry. Use parameter F14 for pressure entry.

10.1.5 Dew Point

The dew point is the temperature at which a water vapor pressure in the moist air is equal to the saturated water vapor pressure.

The water vapor pressure in the moist air can be obtained from the gas pressure and volume ratio (= pressure ratio), as given below.

$e = P \times H$

where, e = Water vapor pressure in moist air
P = Gas pressure
H = Humidity (volume ratio)

Use the above equation to find the water vapor in the moist air, and use the theoretical equation (JIS Z 8806) to obtain the temperature at which that water vapor is equal to the saturated water vapor pressure.

10.1.6 Air Ratio

"Air ratio" is defined as the ratio of (the amount of air theoretically required to completely burn all the fuel) to (the amount of air actually supplied).

For this equipment, the air ratio will be obtained in a simplified way by measuring the oxygen concentration in the exhaust gas. The air ratio may be expressed mathematically by:

$$m = \frac{1}{(21 - \text{oxygen concentration})} \times 21$$

If you use the air ratio data for estimating the combustion efficiency, etc., check that no air is leaking in beforehand and that the measured value has not been affected by any interference gas (CH_4, CO, H_2, etc.).

10.1.7 Cell Temperature

This indicates the cell (sensor) temperature, usually indicating 750°C., obtainable from the thermoelectromotive force and cold junction temperature described below.

10.1.8 Process Gas Temperature

A process gas temperature set with parameter code F13 is displayed.

10.1.9 C. J. Temperature

This is the internal (where the electronics is installed) temperature of equipment, which compensates for the cold junction temperature for a thermocouple measuring the cell temperature. If this temperature exceeds 85°C, the electronics may fail. When the ZR202G is used, the maximum C. J. temperature will be 150°C. If the internal temperature exceeds this, take measures to reduce the temperature such as by not exposing the equipment to radiation.

10.1.10 Amount of Water Vapor in Exhaust Gas

Calculate the water vapor in the combusted exhaust gas using parameters set in Section 8.6.3, "Setting Fuels." Use the following equation for calculation:

Moisture (water vapor) = (amount of water vapor per unit quantity of fuel) + (moisture in air) }/total amount of exhaust gas

$$= \frac{Gw + 1.61 \times Z \times Ao \times m}{X + Ao \times m}$$

where,

Gw = Amount of water vapor in exhaust gas, m^3/kg (or m^3/m^3)

Z = Atmospheric absolute humidity, kg/kg

Ao = Theoretical air amount, m^3/kg (or m^3/m^3)

m = Air ratio

X = Fuel coefficient, Nm^3/kg or m^3/m^3

For details on parameters, see Section 8.6.3, "Setting Fuels," earlier in this manual.

10.1.11 Cell Voltage

The cell (sensor) voltage will be an index to determine the amount of degradation of the sensor. The cell voltage corresponds to the oxygen concentration currently being measured. If the indicated voltage approximates the ideal value (corresponding to the measured oxygen concentration), the sensor will be assumed to be normal.

The ideal value of the cell voltage (E), when the oxygen concentration measurement temperature is controlled at 750°C., may be expressed mathematically by:

$E = -50.74 \log (Px/Pa)$ [mV]

where, Px: Oxygen concentration in the sample gas

Pa: Oxygen concentration in the reference gas, (21 vol%O_2)

Table 10.2 shows oxygen concentration versus cell voltage.

Table 10.2 Oxygen Concentration Vs. Cell Voltage, (cell temperature: 750°C)

%O_2	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
mv	117.83	102.56	93.62	87.28	82.36	78.35	74.95	72.01	69.41

%O_2	1	2	3	4	5	6	7	8	9
mv	67.09	51.82	42.88	36.54	31.62	27.61	24.21	21.27	18.67

%O_2	10	21.0	30	40	50	60	70	80	90
mv	16.35	0	-7.86	-14.2	-19.2	-23.1	-26.5	-29.5	-32.1

%O_2	100
mv	-34.4

T10.2E.ai

10.1.12 Thermocouple Voltage

The cell temperature is measured with a Type K (chromel-alumel) thermocouple. The thermocouple cold junction is located in the detector terminal box. The cell temperature and the thermocouple voltage (including the voltage corresponding to the cold junction temperature) are displayed.

10.1.13 Cold Junction Voltage

This equipment uses temperature-measurement ICs that measure the cold junction temperatures. The voltage measured by those ICs is displayed.

10.1.14 Current Output

The analog output current is displayed.

10.1.15 Response Time

The cell's response time is obtained in the procedure shown in Figure 10.1. If only either zero or span calibration has been carried out, the response time will not be measured just as it will not be measured in manual calibration.

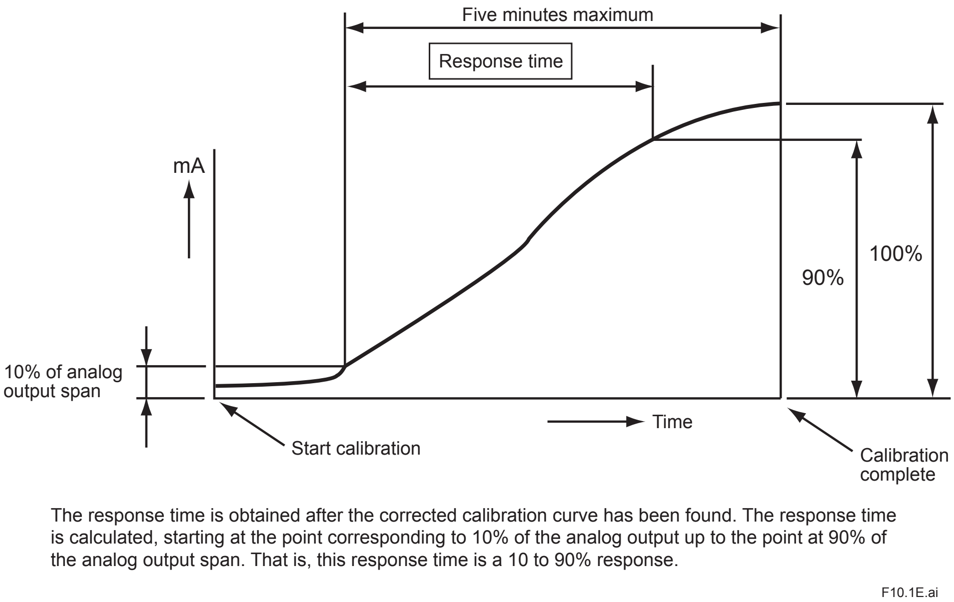


Figure 10.1 Typical Response Time characteristics

10.1.16 Cell's Internal Resistance

A new cell (sensor) indicates its internal resistance of 200 Ω maximum. As the cell degrades, so will the cell's internal resistance increase. The degradation of the cell cannot be found only by changes in cell's internal resistance, however. Those changes in the cell's internal resistance will be a hint to knowing the sensor is degrading. The updated values obtained during the calibration are displayed.

10.1.17 Robustness of a Cell

The robustness of a cell is an index for predicting the remaining life of a sensor and is expressed as one of four time periods during which the cell may still be used:

(1) more than a year

(2) more than six months

(3) more than three months

(4) less than one month

The above four time periods are tentative and only used for preventive maintenance, not for warranty of the performance.

This cell's robustness can be found by a total evaluation of data involving the response time, the cell's internal resistance, and calibration factor. However, if a zero or span calibration was not made, the response time cannot be measured. In such a case, the response time is not used as a factor in evaluating the cell's robustness.

Table 10.3 Cell Robustness and Service Life

Cell robustness	Cell s service life
5	One year min.
3	Six months min.
2	Three months min.
1	One month max.

10.1.18 Heater On-Time Ratio

The probe sensor is heated to and maintained at 750°C. When the sample gas temperature is high, the amount of heater ON-time decreases.

10.1.19 Oxygen Concentration (with time constant), Humidity (with time constant), and Mixing Ratio (with time constant)

When the output damping is specified in the mA-output range setting, the corresponding time constant is also displayed.

10.1.20 Maximum Oxygen Concentration, Humidity, and Mixing Ratio

The maximum oxygen concentration and the time of its occurrence during the period specified in the Averaging display are displayed. If the setup period elapses, the maximum oxygen concentration that has been displayed so far will be cleared and a new maximum oxygen concentration will be displayed. If the setup period of time is changed, the current maximum oxygen concentration will be displayed (for more details, see Section 8.6.2 earlier in this manual).

10.1.21 Minimum Oxygen Concentration, Humidity, and Mixing Ratio

The minimum oxygen concentration and the time of its occurrence during the period specified in the Averaging display are displayed. If the setup period elapses, the minimum oxygen concentration that has been displayed so far will be cleared and a new minimum oxygen concentration will be displayed. If the setup period of time is changed, the current minimum oxygen concentration will be displayed (for more details, see Section 8.6.2 earlier in this manual).

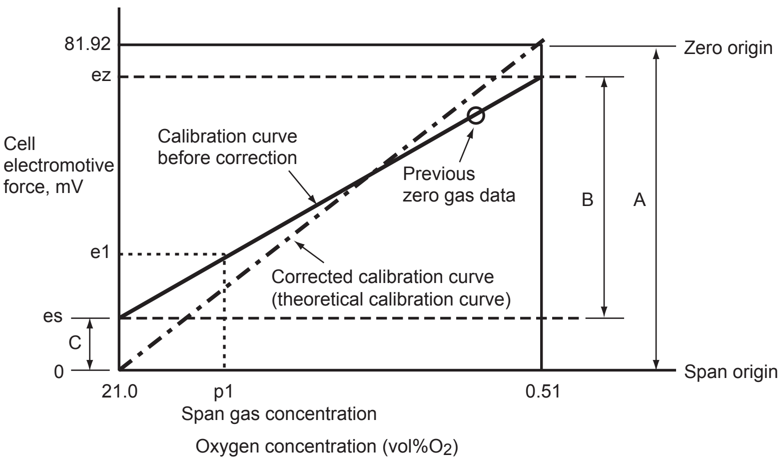
10.1.22 Average Oxygen Concentration, Humidity, and Mixing Ratio

The average oxygen concentration during the periods over which average values are calculated is displayed. If the setup period elapses, the average oxygen concentration that has been displayed so far will be cleared and a new average oxygen concentration will be displayed. If the setup period of time is changed, the current average oxygen concentration will be displayed (for more details, see Section 8.6.2 earlier in this manual).

10.1.23 Span and Zero Correction Ratios

Span and zero correction ratios for the past ten calibrations are recorded to enable you to check the degradation of the sensor (cell). If the correction ratio is beyond the limits as shown in Figure 10.2, the sensor should no longer be used.

These ratios can be found by calculating the data as shown below.



Zero correction ratio = (B/A) x 100 (%) Correctable range: 100 ± 30%
Span correction ratio = (C/A) x 100 (%) Correctable range: 0 ± 18%

F10.2E.ai

Figure 10.2

10.1.24 History of Calibration Time

The calibration-conducted dates and times for the past ten calibrations are stored in memory.

10.1.25 Time

The current date and time are displayed. These are backed up by built-in batteries, so no adjustment is required after the power is switched off. The following shows an example of displaying June 21, 2000, 3:06 p.m.

Displayed alternately

00.06.21 ↔ **15.06**

F10.3E.ai

Figure 10.3 Date-and-time Display

10.1.26 Software Revision

The revision (number) of the software installed is displayed.

10.2 Operational Data Initialization

Individual set data initialization enables you to return to the default values set at the time of delivery. There are two types of initializations: an all set-data initialization and a parameter-code-based initialization. Table 10.4 lists the initialization items by a parameter code, and default values.

Table 10.4 Parameter Codes for Initialization

Parameter code	Data to be initialized
F30	All data
F31	Data in Group A
F32	Data in Group B
F33	Data in Group C
F34	Data in Group D
F35	Data in Group E
F36	Data in Group F

CAUTION

When Data in Group F are initialized by the parameter code of “F36”, “F01” and “F02” and “F08” and “F10” cannot be initialized.

10.3 Initialization Procedure

Follow the table below to initialize parameters. The password for initialization is 1255.

Table 10.5 Initialization Procedure

Switch operation			Display	Description
>	^	ENT	F30	Enter the parameter code for the item to be initialized. The following show an example of entering "F30." (Previous needed operations are omitted.)
>	^	ENT	0000	Touch the [ENT] key to switch to the password entry display.
>	^	ENT	1000	Enter the password 1255 for initialization.
>	^	ENT	1000	
>	^	ENT	1200	
>	^	ENT	1200	
>	^	ENT	1250	
>	^	ENT	1250	
>	^	ENT	1255	
>	^	ENT	1255	After you enter the password and then touch the [ENT] key, all the digits flash.
>	^	ENT	USr Go	Touch the [ENT] key again to display "USr Go."
>	^	ENT	USr Go	Touch the [ENT] key once more. All the digits then flash for two to three seconds, and data initialization starts.
>	^	ENT	F30	The initialization is complete, and the parameter code selection display then appears.

The symbol ( ) indicates that the keys are being touched, the light characters indicates flashing.

⚠ WARNING

Do not attempt to turn off the equipment power during initialization (while “USr Go” is flashing).

10.4 Reset

Resetting enables the equipment to restart. If the equipment is reset, the power is turned off and then back on. In practical use, the power remains on, and the equipment is restarted under program control. Resetting will be possible in the following conditions:

(1) Error 1 if the cell voltage is defective
(2) Error 2 if a temperature alarm occurs
(3) Error 3 if the A/D converter is defective
(4) Error 4 if an EEPROM write error occurs

For details on error occurrence, consult Chapter 12, “Troubleshooting”, later in this manual.

If any of the above problems occurs, the equipment turns off the power to the detector heater. To cancel the error, reset the equipment following the steps below, or turn the power off and then back on.

CAUTION

- Make sure that before resetting or restarting the power that there is no problem with the equipment.
- If a problem arises again after the resetting, turn the power off and troubleshoot the problem by consulting the Troubleshooting chapter later in this manual. When there is no error, the Basic panel display will appear.

Table 10.6 Resetting

Switch operation			Display	Brief Description
>	^	ENT	Err-01 /------	If an error occurs, the error number and "------" are displayed alternately, as given on the left.
>	^	ENT	PASSno	Hold down the [ENT] key for at least three seconds.
>	^	ENT	0000	Touch the [ENT] key again to switch to the password entry display.
>	^	ENT	1000	Enter the password 1102.
			Intermediate switch operations omitted.	
>	^	ENT	1102	
>	^	ENT	A01	
>	^	ENT	G01	Change the parameter code to "G30".
>	^	ENT	G01	
>	^	ENT	G30	
>	^	ENT	All the digits light up.	Touch the [ENT] key to execute resetting.

The symbol [ ] indicates that the corresponding keys are being touched, and the light characters indicate “ flashing.”
“ / ” indicates that the characters are displayed alternately.

CAUTION

Parameters of blank item are not used for Oxygen Analyzer or Humidity Analyzer.

Table 10.7 Parameter Codes for Oxygen Analyzer

Display-related Items in Group A

Code	Item	Engineering unit	Code	Item	Engineering unit
A00	Selection of display items: 0 Oxygen concentration		A50	Span correction ratio 0	%
	1 Oxygen analyzer (0.0)		A51	Span correction ratio 1	%
	2 Oxygen analyzer (0.0)		A52	Span correction ratio 2	%
	3 Analog output selected		A53	Span correction ratio 3	%
A01	Oxygen concentration	% O_2	A54	Span correction ratio 0	%
A02			A55	Span correction ratio 3	%
A03			A56	Span correction ratio 2	%
A04			A57	Span correction ratio 1	%
A05			A58	Span correction ratio 2	%
A06	Air ratio		A59	Span correction ratio 1	%
A07	Cell temperature	°C	A60	Zero correction ratio 0	%
A08	Cold junction temperature	°C	A61	Zero correction ratio 1	%
A09	Meas. gas temperature	°C	A62	Zero correction ratio 2	%
A10	Amount of water vapor in % exhaust gas	%	A63	Zero correction ratio 3	%
A11	Cell voltage	mV	A64	Zero correction ratio 4	%
A12	TC voltage	mV	A65	Zero correction ratio 5	%
A15	Cold junction voltage	mV	A66	Zero correction ratio 6	%
A16	Output current	mA	A67	Zero correction ratio 7	%
A20	Cell response time	Seconds	A68	Zero correction ratio 8	%
A21	Cell internal resistance	Ω	A69	Zero correction ratio 9	%
A22	Cell robustness		A70	Calibration history 0	YY.MM.DD/ HH.MM
A23	Heater on-time ratio	%	A71	Calibration history 1	YY.MM.DD/ HH.MM
A24	Oxygen concentration (with time constant)	% O_2	A72	Calibration history 2	YY.MM.DD/ HH.MM
A25			A73	Calibration history 3	YY.MM.DD/ HH.MM
A26			A74	Calibration history 4	YY.MM.DD/ HH.MM
A30	Max. oxygen concentration	% O_2	A75	Calibration history 5	YY.MM.DD/ HH.MM
A31	Occurrence of maximum oxygen concentration	YY.MM.DD/ HH.MM	A76	Calibration history 6	YY.MM.DD/ HH.MM
A32	Min. oxygen concentration	% O_2	A77	Calibration history 7	YY.MM.DD/ HH.MM
A33	Occurrence of minimum oxygen concentration	YY.MM.DD/ HH.MM	A78	Calibration history 8	YY.MM.DD/ HH.MM
A34	Average oxygen concentration	% O_2	A79	Calibration history 9	YY.MM.DD/ HH.MM
A35			A80	Time	YY.MM.DD/ HH.MM
A36			A90	Software revision	

Note1: "/" indicates that both are displayed alternately.
Note2: Parameter codes with no items in the above table are not used in the oxygen analyzer.

Calibration-related Items in Group B

Code	Item	Tuning	Engineering unit	Default setting
B01	Zero gas concentration	0.3 to 100	% O_2	1% O_2
B02	Span gas concentration	4.5 to 100	% O_2	21% O_2
B03	Calibration mode	0 Manual calibration		Manual calibration
		1 Semi-automatic and manual calibration		
		2 Automatic, semi-automatic, and manual calibration		
B04	Hold (Output stabilization) time	0 minutes, 0 seconds to 60 minutes, 59 seconds	MM.SS	10 minutes, 0 seconds
B05	Calibration time	0 minutes, 0 seconds to 60 minutes, 59 seconds	MM.SS	10 minutes, 0 seconds
B06	Calibration interval	0 days 0 hours to 255 days 23 hours	DD.HH	30 days, 0 hours
B07	Calibration start date and time		YY.MM.DD/ HH.MM	00.01.01.00.00
B08	Calibration procedure	0 Zero and span		Zero and span
		1 Span only		
		2 Zero only		
B09	Calibration concentration measurement	Display only	% O_2	
B10	Manual calibration implementation			
B11	Semi-automatic calibration implementation			

Output-related Items in Group C

Code	Item	Tuning		Engineering unit	Default setting
C01	Analog output	0	Oxygen concentration		Oxygen concentration
		1	Amount of moisture content		
		2	Mixed ratio		
C03	Output mode	0	Linear		Linear
		1	Logarithm		
C04	Output during warm-up	0	Held at 4 mA		
		1	Held at 20 mA		
		2	Set value remains held.		Held at 4 mA.
C05	Output during maintenance	0	Not held		Held output just before maintenance service.
		1	Held output just before maintenance service.		
		2	Set value remains held.		
C06	Output during calibration	0	Not held		Held output just before calibration.
		1	Held output just before calibration.		
		2	Set value remains held.		
C07	Output during error occurrence	0	Not held		Held output at a preset value.
		1	Held output just before abnormal state occurs.		
		2	Set value remains held.		
C11	Min. oxygen concentration	See Section 8.1.		% O_2	0% O_2
C12	Max. oxygen concentration	See Section 8.1.		% O_2	25% O_2
C30	Output damping constant	0 to 255		Seconds	0 second
C31	Set value during warm-up	2.4 to 21.6		mA	4 mA
C32	Set value during maintenance	2.4 to 21.6		mA	4 mA
C33	Set value during calibration	2.4 to 21.6		mA	4 mA
C34	Set value in abnormal state	2.4 to 21.6		mA	3.4 mA

Note: "C07" and "C34" is not displayed when option code "/C2" or "/C3" (NAMUR NE 43 compliant) is specified.

Alarm-related Items in Group D

Code	Item	Tuning		Engineering unit	Default setting
D01	Oxygen concentration, high-high alarm setpoint	0 to 100		% O_2	100% O_2
D02	Oxygen concentration, high alarm setpoint	0 to 100		% O_2	100% O_2
D03	Oxygen concentration, low alarm setpoint	0 to 100		% O_2	0% O_2
D04	Oxygen concentration, low-low alarm setpoint	0 to 100		% O_2	0% O_2
D30	Oxygen concentration alarm hysteresis	0 to 9.9		% O_2	0.1% O_2
D33	Delayed alarm action	0 to 255		Seconds	3 seconds
D41	Oxygen concentration, high-high alarm detection	0	Not detected		Not detected
		1	Detection		
D42	Oxygen concentration, high alarm detection	0	Not detected		Not detected
		1	Detection		
D43	Oxygen concentration, low alarm detection	0	Not detected		Not detected
		1	Detection		
D44	Oxygen concentration, low-low alarm detection	0	Not detected		Not detected
		1	Detection		

Contact-related Items in Group E

Code	Item	Tuning		Engineering unit	Default setting
E01	Selection of input contact 1	0	Invalid		Invalid
		1	Calibration gas pressure decrease		
		2	Measurement range change		
		3	Calibration start		
		4	Detection of non-combusted gas		
E02	Selection of input contact 2	0	Invalid		Invalid
		1	Calibration gas pressure decrease		
		2	Measurement range change		
		3	Calibration start		
		4	Detection of non-combusted gas		
E03	Selecting action of input contact 1	0	Action with closed contact		Action with closed contact
		1	Action with open contact		
E04	Selecting action of input contact 2	0	Action with closed contact		Action with closed contact
		1	Action with open contact		
E10	Selecting action of output contact 1	0	Action with closed contact (normally energized)		Action with closed contact
		1	Action with open contact (normally de-energized)		
E20	Output contact 1 error	0	No action		No action
		1	Action		
E21	Output contact 1, high-high alarm	0	No action		No action
		1	Action		
E22	Output contact 1, high alarm	0	No action		No action
		1	Action		
E23	Output contact 1, low alarm	0	No action		No action
		1	Action		
E24	Output contact 1, low-low alarm	0	No action		No action
		1	Action		
E25	Output contact 1, during maintenance	0	No action		Action
		1	Action		
E26	Output contact 1, during calibration	0	No action		No action
		1	Action		
E27	Output contact 1, measurement range change	0	No action		No action
		1	Action		
E28	Output contact 1, during warm up	0	No action		Action
		1	Action		
E29	Output contact 1, calibration gas pressure decrease	0	No action		No action
		1	Action		
E32	Output contact 1, detection of non- combusted gas	0	No action		No action
		1	Action		

Equipment Setup and Others in Group F

Code	Item	Tuning		Engineering unit	Default setting
F01	Equipment setup	0	Oxygen analyzer		Oxygen analyzer
		1	Humidity analyzer		
F02	Selection of measurement gas	0	Wet		Wet
		1	Dry		
F04	Selection of temperature units	0	degree C		degree C
		1	degree F		
F05	Selection of pressure units	0	kPa		kPa
		1	psi		
F08	Selection of display items	0	Oxygen concentration		Oxygen concentration
		1	Amount of moisture quantity		
		2	Mixed ratio		
		3	Item selected with analog output		
F10	Date			YY.MM.DD/ HH.MM	
F11	Period over which average values are calculated	1 to 255 hours		Hours	One hour
F12	Period over which max. and min. values are monitored	1 to 255 hours		Hours	24 hours
F15	Purging time	0 to 60 minutes		Minutes	0 minute
F20	Amount of water vapor in exhaust gas	0 to 5		m^3/kg (m^3)	1.0 m^3/kg (m^3)
F21	Theoretical amount of air	0 to 20		m^3/kg (m^3)	1.0 m^3/kg (m^3)
F22	X value	0 to 19.99			1
F23	Absolute humidity of the atmosphere	0 to 1		kg/kg	0.1 kg/kg
F30	Initializing all data				
F31	Initializing data in group A				
F32	Initializing data in group B				
F33	Initializing data in group C				
F34	Initializing data in group D				
F35	Initializing data in group E				
F36	Initializing data in group F				

Inspection-related Items in Group G

Code	Item	Tuning		Engineering unit	Default setting
G01	mA-output loop	4 to 20		mA	4 mA
G11	Output contact 1	0	Open		Open
		1	Closed		
G12	Output contact 2	0	Open		Open
		1	Closed		
G15	Automatic calibration solenoid valve (zero)	0	Off		Off
		1	On		
G16	Automatic calibration solenoid valve (span)	0	Off		Off
		1	On		
G21	Input1 contact	0	Open		
		1	Closed		
G22	Input2 contact	0	Open		
		1	Closed		
G30	Reset				

Table 10.8 Parameter Codes for Humidity Analyzer

Display-related Items in Group A

Code	Item	Engineering unit	Code	Item	Engineering unit
A00	Selection of display items: 0 Oxygen concentration		A50	Span correction ratio 0	%
	1 Oxygen analyzer (0.0)		A51	Span correction ratio 1	%
	2 Oxygen analyzer (0.0)		A52	Span correction ratio 2	%
	3 Analog output selected		A53	Span correction ratio 3	%
A01	Oxygen concentration	% O_2	A54	Span correction ratio 0	%
A02	Humidity	%H_2O	A55	Span correction ratio 3	%
A03	Mixing ratio	kg/kg	A56	Span correction ratio 2	%
A04	Relative humidity	%	A57	Span correction ratio 1	%
A05	Dew point	°C	A58	Span correction ratio 2	%
A06			A59	Span correction ratio 1	%
A07	Cell temperature	°C	A60	Zero correction ratio 0	%
A08	Cold junction temperature	°C	A61	Zero correction ratio 1	%
A09	Meas. gas temperature	°C	A62	Zero correction ratio 2	%
A10			A63	Zero correction ratio 3	%
A11	Cell voltage	mV	A64	Zero correction ratio 4	%
A12	TC voltage	mV	A65	Zero correction ratio 5	%
A15	Cold junction voltage	mV	A66	Zero correction ratio 6	%
A16	Output current	mA	A67	Zero correction ratio 7	%
A20	Cell response time	Seconds	A68	Zero correction ratio 8	%
A21	Cell internal resistance	Ω	A69	Zero correction ratio 9	%
A22	Cell robustness	kg/kg	A70	Calibration history 0	YY.MM.DD/ HH.MM
A23	Heater on-time ratio	%	A71	Calibration history 1	YY.MM.DD/ HH.MM
A24	Oxygen concentration (with time constant)	% O_2	A72	Calibration history 2	YY.MM.DD/ HH.MM
A25	Humidity (with time /time constant)	%H_2O	A73	Calibration history 3	YY.MM.DD/ HH.MM
A26	Mixing ratio (with time /time constant)		A74	Calibration history 4	YY.MM.DD/ HH.MM
A30	Max. oxygen concentration	% O_2	A75	Calibration history 5	YY.MM.DD/ HH.MM
A31	Occurrence of maximum oxygen concentration	YY.MM.DD/ HH.MM	A76	Calibration history 6	YY.MM.DD/ HH.MM
A32	Min. oxygen concentration	% O_2	A77	Calibration history 7	YY.MM.DD/ HH.MM
A33	Occurrence of minimum oxygen concentration	YY.MM.DD/ HH.MM	A78	Calibration history 8	YY.MM.DD/ HH.MM
A34	Average oxygen concentration	% O_2	A79	Calibration history 9	YY.MM.DD/ HH.MM
A35	Maximum humidity	%H_2O	A80	Time	YY.MM.DD/ HH.MM
A36	Occurrence of max. humidity	YY.MM.DD/ HH.MM	A90	Software revision	
A37	Minimum humidity	%H_2O			
A38	Occurrence of min. humidity	YY.MM.DD/ HH.MM			
A39	Average humidity	%H_2O			

A40	Maximum mixing ratio	kg/kg
A41	Occurrence of max. mixing ratio	YY.MM.DD/ HH.MM
A42	Minimum mixing ratio	kg/kg
A43	Occurrence of min. mixing ratio	YY.MM.DD/ HH.MM
A44	Average mixing ratio	kg/kg

Note1: "/" indicates that both are displayed alternately.
Note2: Parameter codes with no items in the above table are not used in the oxygen analyzer.

Calibration-related Items in Group B

Code	Item	Tuning		Engineering unit	Default setting
B01	Zero gas concentration	0.3 to 100		% O_2	1% O_2
B02	Span gas concentration	4.5 to 100		% O_2	21% O_2
B03	Calibration mode	0	Manual calibration		Manual calibration
		1	Semi-automatic and manual calibration		
		2	Automatic, semi-automatic, and manual calibration		
B04	Hold (Output stabilization) time	0 minutes, 0 seconds to 60 minutes, 59 seconds		MM.SS	10 minutes, 0 seconds
B05	Calibration time	0 minutes, 0 seconds to 60 minutes, 59 seconds		MM.SS	10 minutes, 0 seconds
B06	Calibration interval	0 days 0 hours to 255 days 23 hours		DD.HH	30 days, 0 hours
B07	Calibration start date and time			YY.MM.DD/ HH.MM	00.01.01.00.00
B08	Calibration procedure	0	Zero and span		Zero and span
		1	Span only		
		2	Zero only		
B09	Calibration concentration measurement	Display only		% O_2	
B10	Manual calibration implementation				
B11	Semi-automatic calibration implementation				

Output-related Items in Group C

Code	Item	Tuning		Engineering unit	Default setting
C01	Analog output	0	Oxygen concentration		Humidity
		1	Amount of moisture content		
		2	Mixed ratio		
C03	Output mode	0	Linear		Linear
		1	Logarithm		
C04	Output during warm-up	0	Held at 4 mA		
		1	Held at 20 mA		
		2	Set value remains held.		Held at 4 mA.
C05	Output during maintenance	0	Not held		Held output just before maintenance service.
		1	Held output just before maintenance service.		
		2	Set value remains held.		
C06	Output during calibration	0	Not held		Held output just before calibration.
		1	Held output just before calibration.		
		2	Set value remains held.		
C07	Output during error occurrence	0	Not held		Held output at a preset value.
		1	Held output just before abnormal state occurs.		
		2	Set value remains held.		
C11	Min. oxygen concentration	See Section 8.1.		% O_2	0% O_2
C12	Max. oxygen concentration	See Section 8.1.		% O_2	25% O_2
C13	Minimum humidity	See Section 8.1.		%H_2O	0 %H_2O
C14	Maximum humidity	See Section 8.1.		%H_2O	25 %H_2O
C15	Minimum mixing ratio	See Section 8.1.		kg/kg	0 kg/kg
C16	Maximum mixing ratio	See Section 8.1.		kg/kg	0.2 kg/kg
C30	Output damping constant	0 to 255		Seconds	0 second
C31	Set value during warm-up	2.4 to 21.6		mA	4 mA
C32	Set value during maintenance	2.4 to 21.6		mA	4 mA
C33	Set value during calibration	2.4 to 21.6		mA	4 mA
C34	Set value in abnormal state	2.4 to 21.6		mA	3.4 mA

Note: “C07” and “C34” is not displayed when option code “/C2” or “/C3” (NAMUR NE 43 compliant) is specified.

Alarm-related Items in Group D

Code	Item	Tuning	Engineering unit	Default setting
D01	Oxygen concentration, high-high alarm setpoint	0 to 100	% O_2	100% O_2
D02	Oxygen concentration, high alarm setpoint	0 to 100	% O_2	100% O_2
D03	Oxygen concentration, low alarm setpoint	0 to 100	% O_2	0% O_2
D04	Oxygen concentration, low-low alarm setpoint	0 to 100	% O_2	0% O_2
D05	Humidity, high-high alarm setpoint	0 to 100	%H_2O	100 %H_2O
D06	Humidity, high alarm setpoint	0 to 100	%H_2O	100 %H_2O
D07	Humidity, low alarm setpoint	0 to 100	%H_2O	0 %H_2O
D08	Humidity, low-low alarm setpoint	0 to 100	%H_2O	0 %H_2O
D11	Mixing ratio, high-high alarm setpoint	0 to 1	kg/kg	1 kg/kg
D12	Mixing ratio, high alarm setpoint	0 to 1	kg/kg	1 kg/kg
D13	Mixing ratio, low alarm setpoint	0 to 1	kg/kg	0 kg/kg
D14	Mixing ratio, low-low alarm setpoint	0 to 1	kg/kg	0 kg/kg
D30	Oxygen concentration alarm hysteresis	0 to 9.9	% O_2	0.1% O_2
D31	Humidity alarm hysteresis	0 to 9.9	%H_2O	0.1 %H_2O
D32	Mixing ratio alarm hysteresis	0 to 0.1	kg/kg	0.001 kg/kg
D33	Delayed alarm action	0 to 255	Seconds	3 seconds
D41	Oxygen concentration, high-high alarm detection	0 Not detected 1 Detection		Not detected
D42	Oxygen concentration, high alarm detection	0 Not detected 1 Detection		Not detected
D43	Oxygen concentration, low alarm detection	0 Not detected 1 Detection		Not detected
D44	Oxygen concentration, low-low alarm detection	0 Not detected 1 Detection		Not detected
D45	Humidity, high-high alarm detection	0 Not detected 1 Detection		Not detected
D46	Humidity, high alarm detection	0 Not detected 1 Detection		Not detected
D47	Humidity, low alarm detection	0 Not detected 1 Detection		Not detected
D48	Humidity, low-low alarm detection	0 Not detected 1 Detection		Not detected
D51	Mix ratio, high-high alarm detection	0 Not detected 1 Detection		Not detected
D52	Mix ratio, high alarm detection	0 Not detected 1 Detection		Not detected
D53	Mix ratio, low alarm detection	0 Not detected 1 Detection		Not detected

D54	Mix ratio, low-low alarm detection	0	Not detected		Not detected
		1	Detection		

Contact-related Items in Group E

Code	Item	Tuning		Engineering unit	Default setting
E01	Selection of input contact 1	0	Invalid		Invalid
		1	Calibration gas pressure decrease		
		2	Measurement range change		
		3	Calibration start		
		4	Detection of non-combusted gas		
E02	Selection of input contact 2	0	Invalid		Invalid
		1	Calibration gas pressure decrease		
		2	Measurement range change		
		3	Calibration start		
		4	Detection of non-combusted gas		
E03	Selecting action of input contact 1	0	Action with closed contact		Action with closed contact
		1	Action with open contact		
E04	Selecting action of input contact 2	0	Action with closed contact		Action with closed contact
		1	Action with open contact		
E10	Selecting action of output contact 1	0	Action with closed contact (normally energized)		Action with closed contact
		1	Action with open contact (normally de-energized)		
E20	Output contact 1 error	0	No action		No action
		1	Action		
E21	Output contact 1, high-high alarm	0	No action		No action
		1	Action		
E22	Output contact 1, high alarm	0	No action		No action
		1	Action		
E23	Output contact 1, low alarm	0	No action		No action
		1	Action		
E24	Output contact 1, low-low alarm	0	No action		No action
		1	Action		
E25	Output contact 1, during maintenance	0	No action		Action
		1	Action		
E26	Output contact 1, during calibration	0	No action		No action
		1	Action		
E27	Output contact 1, measurement range change	0	No action		No action
		1	Action		
E28	Output contact 1, during warm up	0	No action		Action
		1	Action		
E29	Output contact 1, calibration gas pressure decrease	0	No action		No action
		1	Action		
E32	Output contact 1, detection of non- combusted gas	0	No action		No action
		1	Action		

Equipment Setup and Others in Group F

Code	Item	Tuning		Engineering unit	Default setting
F01	Equipment setup	0	Oxygen analyzer		Not initialized
		1	Humidity analyzer		
F02					
F04	Selection of temperature units	0	degree C		degree C
		1	degree F		
F05	Selection of pressure units	0	kPa		kPa
		1	psi		
F08	Selection of display items	0	Oxygen concentration		Humidity
		1	Amount of moisture quantity		
		2	Mixed ratio		
		3	Item selected with analog output		
F10	Date			YY.MM.DD/ HH.MM	
F11	Period over which average values are calculated	1 to 255 hours		Hours	One hour
F12	Period over which max. and min. values are monitored	1 to 255 hours		Hours	24 hours
F13	Process gas temperature	0 to 3000		°C	300°C
F14	Process gas pressure	0 to 300		kPa abs.	101.33 kPa abs.
F20					
F21					
F22					
F23					
F30	Initializing all data				
F31	Initializing data in group A				
F32	Initializing data in group B				
F33	Initializing data in group C				
F34	Initializing data in group D				
F35	Initializing data in group E				
F36	Initializing data in group F				

Inspection-related Items in Group G

Code	Item	Tuning		Engineering unit	Default setting
G01	mA-output loop	4 to 20		mA	4 mA
G11	Output contact 1	0	Open		Open
		1	Closed		
G12	Output contact 2	0	Open		Open
		1	Closed		
G15	Automatic calibration solenoid valve (zero)	0	Off		Off
		1	On		
G16	Automatic calibration solenoid valve (span)	0	Off		Off
		1	On		
G21	Input1 contact	0	Open		
		1	Closed		
G22	Input2 contact	0	Open		
		1	Closed		
G30	Reset				

10.5 Handling of the ZO21S Standard Gas Unit

The following describe how to flow zero and span gases using the ZO21S Standard Gas Unit. Operate the ZO21S Standard Gas Unit, for calibrating a system classified as System 1, according to the procedures that follow.

10.5.1 Standard Gas Unit Component Identification

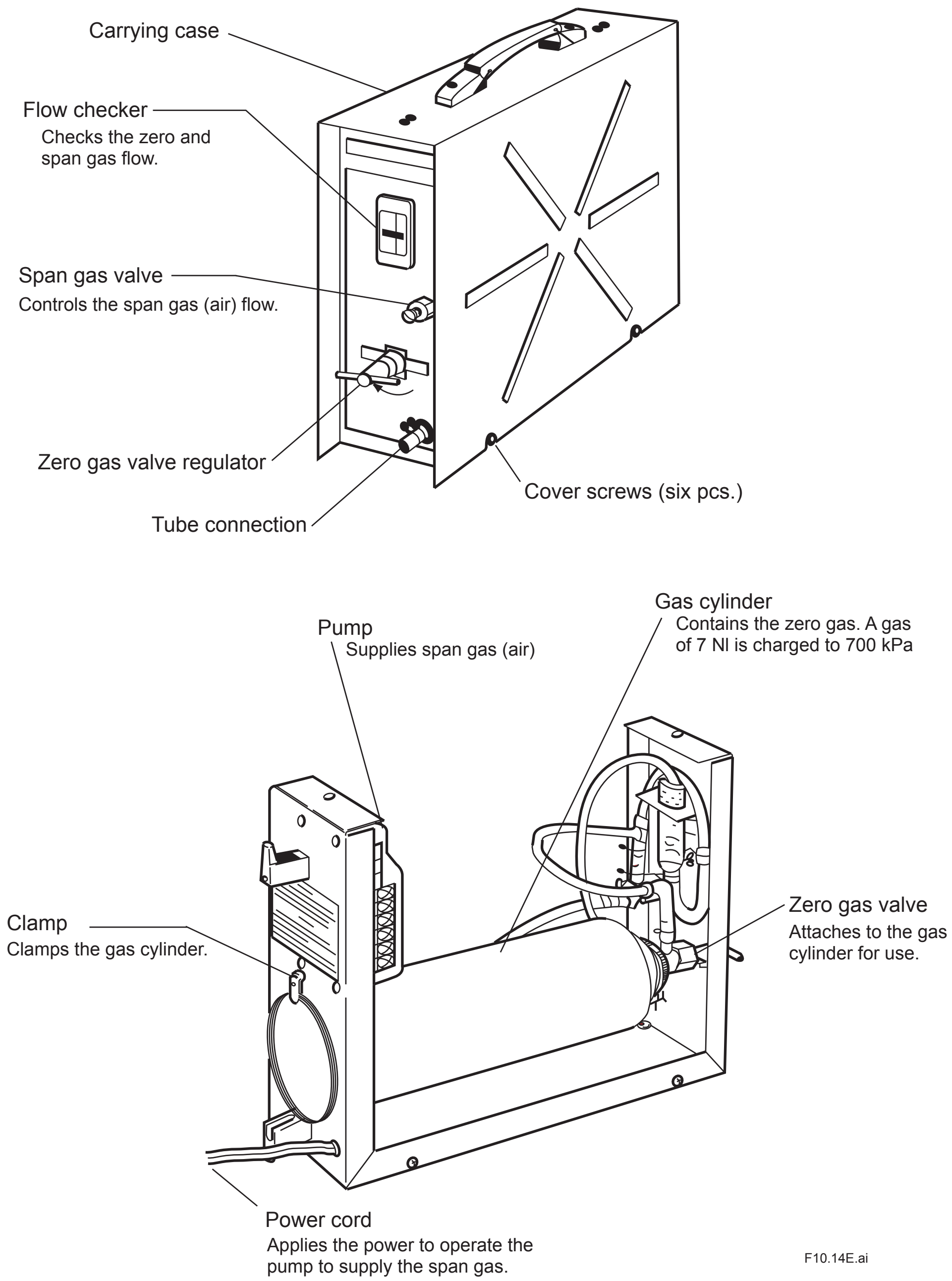


Figure 10.4 Standard Gas Unit Component Identification

10.5.2 Installing Gas Cylinders

Each ZO21S Standard Gas Unit comes with six zero gas cylinders including a spare. Each gas cylinder contains 7-liters of gas with a 0.95 to 1.0 vol% O_2 (concentration varies with each cylinder) and nitrogen, at a pressure of 700 kPaG (at 35°C).

The operating details and handling precautions are also printed on the product. Please read them beforehand.

To install the gas cylinder, follow these steps:

(1) Attach the zero gas valves onto the gas cylinder. First, turn the valve regulator of the zero gas valves counterclockwise to completely retract the needle at the top from the gasket surface. Maintaining the valve in this position, screw the valve mounting into the mouthpiece of the gas cylinder. (If screw connection is proper, you can turn the screw manually. Do not use any tool.) When the gasket comes in contact with the mouthpiece of the gas cylinder and you can no longer turn it manually, tighten the lock nut with a wrench.

(2) Remove the carrying case from the standard gas unit. The case is attached to the unit with six screws. So, loosen the screws and lift them off.

(3) Slide the gas cylinder through the hole in the back of the unit and connect the tube (the piping in the unit) to the valve connections. Insert each tube at least 10 mm to prevent leakage, and secure it using a tube clamp.

(4) Attach the gas cylinder to the case. Extend the valve regulator of the zero gas valves through the hole in the front panel of the unit and secure the bottom of the cylinder with the clamp.

(5) Take note of the oxygen concentration of the sealed gas indicated on the gas cylinder and replace the carrying case. Enter the oxygen concentration of the sealed gas using the parameter code B01 as a zero gas oxygen concentration. Also check that no piping is disconnected.

Thus, the work of installing a gas cylinder is completed. However, gases in the cylinders cannot immediately flow out after these procedures. To discharge the gases, it is necessary for the needle in the zero gas valves to puncture a hole in the gas cylinder (see Section 10.5.3).

10.5.3 Calibration Gas Flow

<Preparation before calibration>

(1) To operate the standard gas unit, place it on a nearly horizontal surface in order to allow the flow check to indicate the precise flow rate. In addition, a power supply for driving the span gas (air) supply pump is required near the unit (the length of the power cord attached to the unit is 2 m). Select a suitable location for the unit near the installation site of the converter.

(2) Connect the tube connector port of the standard gas unit to the calibration gas inlet of the detector, using a polyethylene resin tube with an outside diameter of 6 mm. Be careful to prevent gas leakage.

(3) Fully open the stop valve mounted on the calibration gas inlet of the detector.

(4) Enter the oxygen concentration of the sealed gas (noted from the cylinder) into the converter. Also check that the oxygen concentration of the span gas is correctly set (21 vol% O_2 for clean air). When using the ZO21S Standard Gas Unit (for use of the atmospheric air as a span gas), use a hand-held oxygen analyzer to measure the actual oxygen concentration, and then enter it.

<Flow of span gas (air)>

The standard gas unit is used only when manual calibration is employed.

Therefore, the timing for flowing span gas (air) is included in the manual calibration flowchart described in Section 7.11.2, earlier in this manual. For operation of the converter, see Section 7.11.2.

(1) When the “OPEn” and the “measured oxygen concentration” are alternately displayed during calibration, plug the power cord into the power supply socket to start the pump of the standard gas unit.

(2) Next, adjust the flow rate to 600 ± 60 ml/min using the span gas valve “AIR” (the flow check ball stops floating on the green line when the valve is slowly opened). To rotate the valve shaft, loosen the lock nut and turn it using a flat-blade screwdriver. Turning the valve shaft counterclockwise increases the flow rate.

(3) After adjusting the flow rate, tighten the valve lock nut.

(4) After the measured oxygen concentration is stabilized, touch the [ENT] key, then all the digits flash. Touch the [ENT] key again to display “ZEro Y”. Disconnect the power cord to stop the pump.

<Flow of zero gas>

Touch the [ENT] key to display a zero gas value set with the parameter code B01. Touch the [ENT] key again to flash “OPEn” and the “measured oxygen concentration” alternately. To cause the zero gas flow, follow these steps:

(1) Use the needle of the zero gas valve “CHECK GAS” to puncture a hole in the gas cylinder installed as described in Section 10.5.2. Fully clockwise turn the valve regulator by hand.

(2) Next, adjust the flow rate to 600 ± 60 ml/min (the flow check ball stops floating on the green line when the valve is slowly opened). Turn the regulator of the zero gas valve back slowly counterclockwise. At that time, the flow rate also decreases as the inner pressure of the gas cylinder decreases. Monitor the flow check and, when the ball’s position changes greatly, readjust the valve.

(3) Touch the [ENT] key after the measured oxygen concentration becomes stable. Then all the digits flash. Touch the [ENT] key again so that the “CALEnd” flashes.

NOTE

Be sure not to terminate the calibration in progress because of a shortage of gas in the cylinder. Each gas cylinder is operable for nine minutes or more provided the gas is discharged at the specified rate.

Therefore, if your calibration time is estimated at four minutes, you can operate the zero calibration twice.

(4) Stop the zero gas flow. Turn the zero gas valve regulator fully clockwise. If this valve regulator is not properly adjusted, the needle valve will not close completely and a cylinder gas may leak. When the output stabilization time elapses, the calibration is complete.

<Treatment after completion of calibration>

(1) Fully close the stop valve mounted on the calibration gas inlet of the detector.

(2) Remove the tube connecting the detector to the standard gas unit.

WARNING

Store the standard gas unit with the gas cylinder mounted where the ambient temperature does not exceed 40°C. Otherwise, the gas cylinder may explode. Store the spare gas cylinders under the same condition.

10.6 Methods of Operating Valves in the ZA8F Flow Setting Unit

The ZA8F Flow Setting Unit is used as the calibration equipment for a system conforming to System 2. Calibration in such a system is to be manually operated. So, you have to operate the valve of the Flow Setting Unit each time calibration is made (starting and stopping the calibration gas flow and adjusting the flow rate). For the operation of the converter, refer to Section 7.11.

10.6.1 Preparation Before Calibration

To operate the ZA8F Flow Setting Unit, prepare for calibration as follows:

(1) Check for a complete closing of the zero gas flow setting valve in the unit and open the regulator valve for the zero gas cylinder until the secondary pressure is sample gas pressure plus approx. 50 kPa (or sample gas pressure plus approx. 150 kPa when a check valve is used, maximum pressure rating is 300 kPa).

(2) Check that the oxygen concentration of the zero gas and span gas (instrument air 21 vol% O_2) in the cylinder is set for the converter.

10.6.2 Operating the Span Gas Flow Setting Valve

The following description is given assuming that instrument air, the same as the reference gas, is used as the span gas. For more details, see Section 7.11.2, "Manual Calibration," earlier in this manual.

(1) When "OPEn" and the "measured oxygen concentration" appear alternately during the span calibration, open the span gas flow setting valve of the flow setting unit and adjust the flow rate to 600 ± 60 ml/min.
Loosen the lock nut if the valve shaft has a lock nut, and turn the valve regulator slowly counterclockwise. To check the flow rate, use the calibration flowmeter. If the sample gas pressure is extremely high, adjust the sample gas pressure to obtain pressures (listed in Table 10.9) ± 10%.

Table 10.9

Sample gas pressure, (kPa)	50	100	150	200	250
Flow rate, (ml/min)	500	430	380	350	320

(2) Adjust the flow rate. After the measured oxygen concentration has stabilized, touch the [ENT] key, then all the digits will flash. Touch the [ENT] key again to display "ZEro Y."

(3) Close the span gas flow setting valve to stop the span gas (air) flow. If the valve shaft has a lock nut, be sure to tighten the lock nut to prevent any leakage of span gas into the sensor during measurement.

10.6.3 Operating the Zero Gas Flow Setting Valve

Operate the zero gas flow setting valve during zero calibration in the following procedures:

(1) When the "OPEn" and the "measured oxygen concentration" appear alternately during calibration, open the zero gas flow setting valve of the flow setting unit and adjust the flow rate to 600 ± 60 ml/min. To rotate the valve shaft, loosen the lock nut if the valve shaft has a lock nut and slowly turn it counterclockwise.

(2) To check the flow rate, use an appropriate calibration gas flowmeter. If the sample gas pressure is extremely high, adjust the sample gas pressure to obtain pressures (listed in Table 10.9) ± 10%.

(3) Adjust the flow rate. After the measured oxygen concentration is stabilized, touch the [ENT] key, then all the digits will flash. Touch the [ENT] key again to flash "CAL End."

(4) Close the zero gas flow setting valve to stop the zero gas flow. Be sure to tighten the lock nut if the valve shaft has a lock nut to prevent any leakage of zero gas into the sensor during measurement. When the stabilization time elapses, the zero calibration will be complete.

10.6.4 Treatment After Calibration

No special treatment of the instrument is needed after calibration. However, it is recommended that the pressure regulator for the zero gas cylinders be closed because calibration is not required so often.

11. Inspection and Maintenance

This chapter describes the inspection and maintenance procedures for the EXAxt ZR Zirconia Oxygen/Humidity Analyzer to maintain its measuring performance and normal operating conditions.

WARNING

Do NOT touch the probe if it has been in operation immediately just before being checked. (The sensor at the tip of the probe heats up to 750°C during operation. If you touch it, you will get burned.)

CAUTION

When checking the detector, carefully observe the following:

- Do not subject the probe to shock or cool it rapidly.
  The sensor is made of ceramic (zirconia). If the detector is dropped or bumped into something, the sensor may be damaged and no longer work.
- Do not reuse a metal O-ring to seal the cell assembly. If you replace the cell or remove it from the probe for checking, be sure to replace the metal O-ring. Otherwise, the furnace gas may leak, and then the leaking corrosive gas will cause the built-in heater or thermocouple to disconnect, or the detector may corrode.
- Handle the probe with care so that the dust filter mounted screws on the tip of the probe do not hurt your finger(s).
- Before opening or closing the terminal box, first remove dust, sand, or the like from the terminal box cover.

11.1 Inspection and Maintenance of the Detector

11.1.1 Cleaning the Calibration Gas Tube

The calibration gas, supplied through the calibration gas inlet of the terminal box into the detector, flows through the tube and comes out at the tip of the probe. The tube might become clogged with dust from the sample gas. If you become aware of clogging, such as when a higher pressure is required to achieve a specified flow rate, clean the calibration gas tube.

To clean the tube, follow these steps:

(1) Remove the detector from the installation assembly.

(2) Following Section 11.1.2, later in this manual, remove the four bolts (and associated spring washers) that tighten the sensor assembly, and the pipe support as well as the U-shaped pipe with filter .

(3) Use a rod 2 to 2.5 mm in diameter to clean the calibration gas tube inside the probe. In doing this, keep air flowing from the calibration gas inlet at about 600 ml/min and insert the rod into the tube (3-mm inside diameter).
However, be careful not to insert the rod deeper than 40 cm.

(4) Clean the U-shaped pipe. The pipe can be rinsed with water. However, it should be dried out thoroughly before reassembly.

(5) Restore all components you removed for cleaning. Follow Section 11.1.2 to restore all components in their original positions. Be sure to replace the O-ring(s) with new ones.

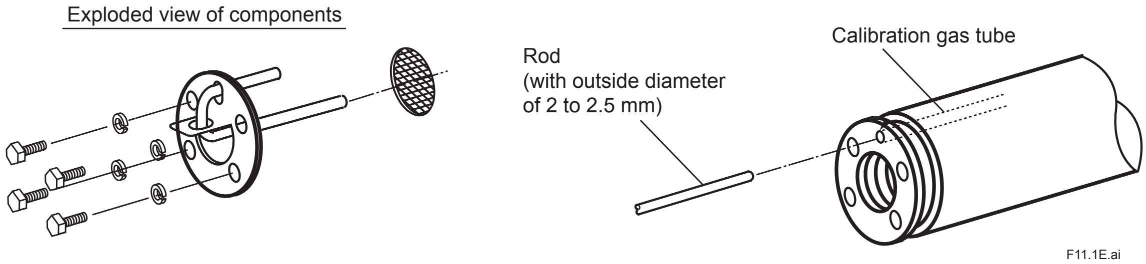


Figure 11.1 Cleaning the Calibration Gas Tube

11.1.2 Replacing the Sensor Assembly

The performance of the sensor (cell) deteriorates as its surface becomes soiled during operation. Therefore, you have to replace the sensor when its life expectancy expires, for example, when it can no longer satisfy a zero correction ratio of 100 ± 30% or a span correction ratio of 0 ± 18%. In addition, the sensor assembly is to be replaced if it becomes damaged and can no longer operate during measurement.

If the sensor becomes no longer operable (for example, due to breakage), investigate the cause and remedy the problem as much as possible to prevent recurrence.

CAUTION

- If the sensor assembly is to be replaced, allow enough time for the detector to cool down from its high temperature. Otherwise, you may get burned.
- If the cell assembly is to be replaced, be sure to replace the metal O-ring and the contact together. Additionally, even in a case where the cell is not replaced, if the contact becomes deformed and cannot make complete contact with the cell, replace the contact.
- If there is any corroded or discolored area in the metal O-ring groove in which the contact is embedded, sand the groove with sandpaper or use a metal brush, and then sand further with a higher grade of sandpaper (No. 1500 or so), or use an appropriate metal brush to eliminate any sharp protrusions on the groove. The contact's resistance should be minimized.
- Use cell assemblies manufactured in or after Sept. 2000: the serial number on the side of the cell assembly should be 0J000 or later (for example: 0K123, 1AA01 etc.)

1. Identifying parts to be replaced

In order not to lose or damage disassembled parts, identify the parts to be replaced from among all the parts in the sensor assembly. Normally, replace the sensor (cell), metal O-ring and contact together at the same time. If required, also replace the U-shaped pipe, bolts, filter and associated spring washers.

2. Removal procedures

(1) Remove the four bolts and associated washers from the tip of the detector probe.

(2) Remove the U-shaped pipe support together with the U-shaped pipe. Remove the filter also.

(3) Pull the sensor assembly toward you while turning it clockwise. Also, remove the metal O-ring between the assembly and the probe.
(When replacing the assembly, be careful not to allow any flaws on the tip of the probe with which the metal O-ring comes in contact (the surface with which the sensor flange also comes in contact. Otherwise, the sample gas will not be sealed.)

(4) Use tweezers to pull the contact out of the groove.

(5) Clean the sensor assembly, especially the metal O-ring contact surface to remove any contaminants adhering to that part. If you can use any of the parts from among those removed, also clean them up to remove any contaminants adhering to them.
(Once the metal O-ring has been tightened, it can no longer be used. So, be sure to replace it.)

3. Part assembly procedure

(1) First, install the contact. Being careful not to cause irregularities in the pitch of the coil spirals (i.e., not to bend the coil out of shape), place it in the ringed groove properly so that it forms a solid contact.

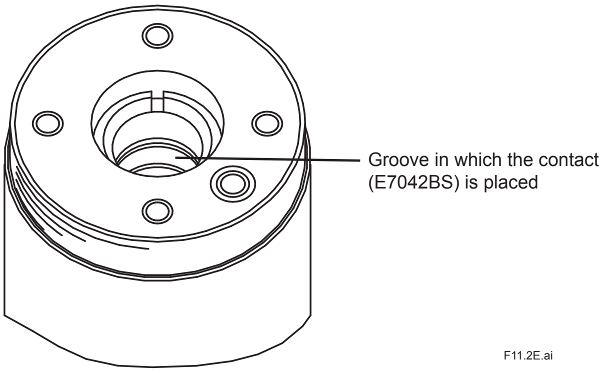


Figure 11.2 Installing the Contact

(2) Next, make sure that the O-ring groove on the flange surface of the sensor (cell) is clean. Install the metal O-ring in that O-ring groove, and then insert the sensor (cell) in the probe while turning it clockwise. After inserting it until the metal O-ring comes in contact with the probe’s O-ring contact surface, properly align the U-shaped-pipe insertion holes with the bolt openings.

(3) Attach the U-shaped pipe to its support, then fully insert the U-shaped pipe, filter and its support into the probe.

(4) Coat the threads of the four bolts with antiseize grease and then screw them in along with the washers. First, tighten the four bolts uniformly by hand, and then use a torque wrench to tighten all areas of the metal O-ring uniformly, that is, to make sure the sensor flange is perfectly horizontal to the O-ring’s working face in the probe. This is done by tightening first one bolt and then its opposing bolt each 1/8 turn, and then one of the other bolts followed by its opposing bolt, each also 1/8 turn.
This continues in rotating fashion until they are all fully tightened with the torque wrench preset to approximately 5.9 Nm. If they are not uniformly tightened, the sensor or heater may be damaged. Check with light that there is no gap between sensor flange and probe. Replacement of the sensor assembly is now complete. Install the detector and restart operation. Calibrate the instrument before making a measurement.

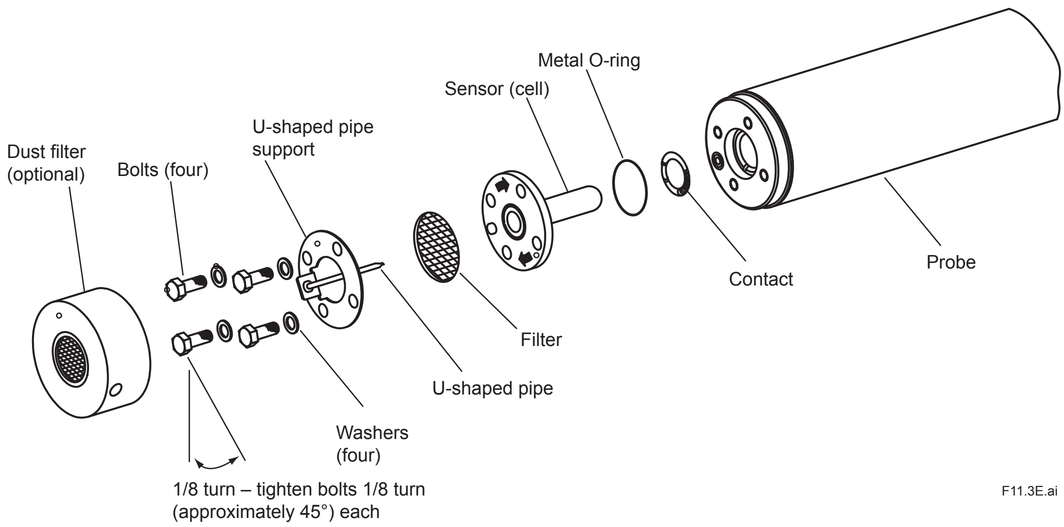


Figure 11.3 Exploded View of Sensor Assembly

NOTE

Optional Inconel bolts have a high coefficient of expansion. If excess torque is applied while the bolts are being tightened, abnormal strain or bolt breakage may result. So, tighten the bolts following the instructions given above.

11.1.3 Replacement of the Heater Assembly

This section describes the replacement procedure for the heater assembly.

The sensor or ceramic heater-furnace core internal structure is subject to fracturing, so do NOT subject it to strong vibrations or shock. Additionally, the heater assembly reaches high temperatures and is subjected to high voltages.

So, maintenance services should be performed after the power is off and the heater assembly temperature has returned to normal room temperature.

For details, refer to IM 11M12A01-21E “ Heater Assembly “.

NOTE

If the heater assembly can not be removed because a screw for the heater assembly fixation has fused to its thread, one of our service representatives can fix it.

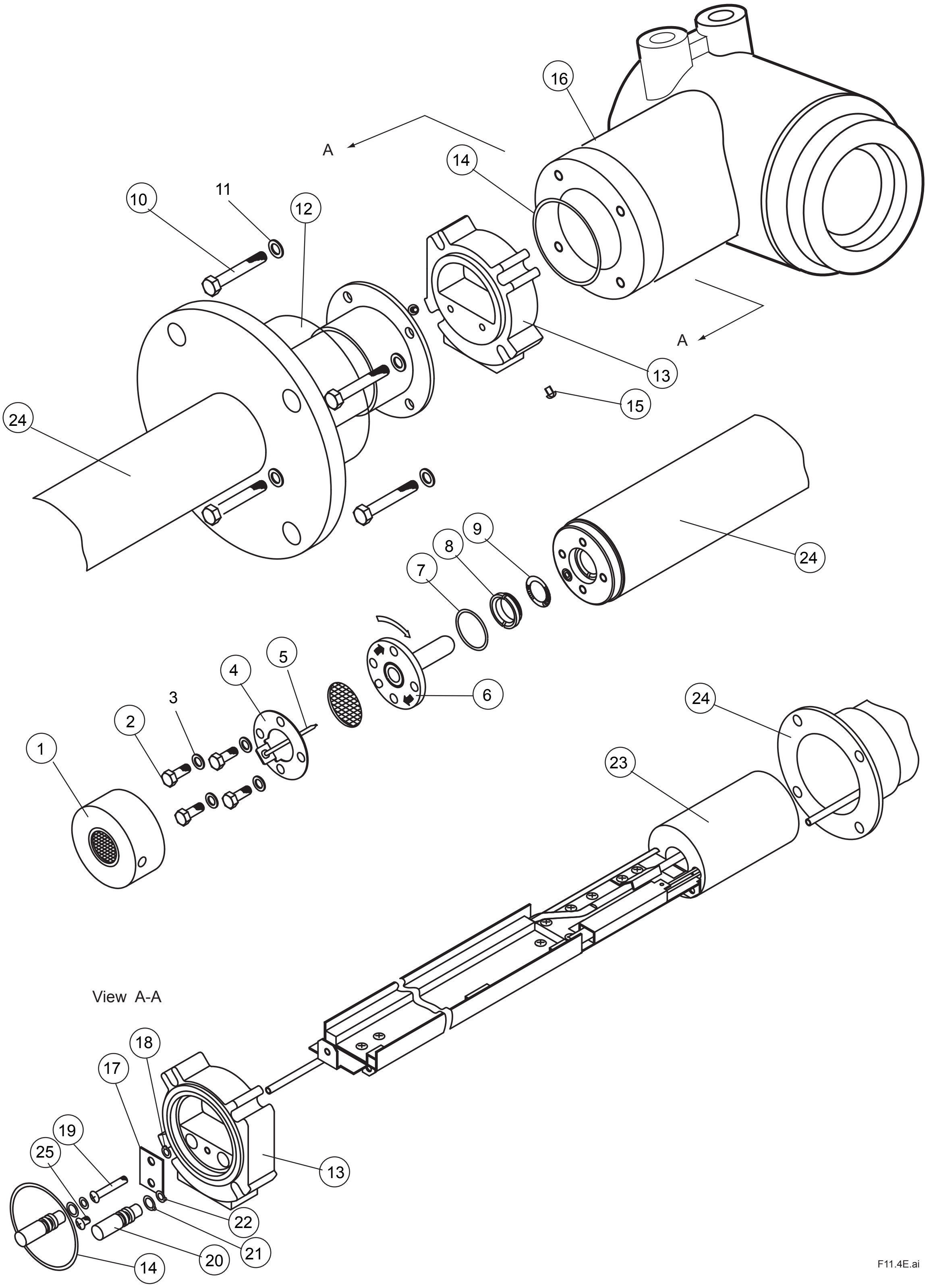


Figure 11.4 Exploded View of Detector

Replacement of heater assembly

Refer to Figure 11.4 as an aid in the following discussion.

Remove U-shaped pipe support ④, U-shaped pipe ⑤, Filter and the sensor (cell) ⑥, following Section 11.1.2, earlier in this manual.

Remove the two screws ⑮ that tighten the cover ⑫ and slide it to the flange side. Remove the four bolts ⑩ to remove the converter ⑯. Then remove the three connectors to which leadwire from the heater and thermocouple is connected.

Loosen screw ⑲ until heater assembly ㉓ plate can be removed. There's no need to remove O-ring ⑱ which prevents screw ⑲ from dropping out. Pull out connector ⑬. Loosen and remove the screw for the heater assembly fixation ⑧ with a special wrench (part no. K9470BX or equivalent) and then remove the heater assembly ㉓ from the detector ㉔.

To reassemble the heater assembly, reverse the above procedure:

Insert the heater assembly ㉓ into the detector ㉔, while inserting the calibration pipe in the detector ㉔ into the heater section in the heater assembly ㉓ as well as in the bracket hole. Coat the screw for the heater assembly fixation ⑧ with grease (Never-Seez: G7067ZA) and tighten the screw for the heater assembly fixation ⑧ with a special tool (part no. K9470BX or equivalent) with a tightening torque of 12N·m ± 10%.

Next, to install the O-rings ㉒ on the calibration-gas and reference-gas pipes, disassemble the connector ⑬ in the following procedure:

First, remove the screw ㉕ and then remove the plate ⑰ and two caps ⑳. If the O-ring ㉒ remains in the hole, pull them out from the back. Pass the heater and thermocouple leadwire through the connector ⑬. Also, pass the calibration gas and reference gas pipes through the opening of the connector ⑬. If the O-ring ㉒ fails, replace it with a new one.

Push the two caps ⑳ into the associated opening of the connector ⑬. Insert the plate ⑰, aligning it with the groove of the cap ⑳, and tighten it with the screw ㉕. If you attempt to insert the calibration gas and reference gas pipes into the connector ⑬ without disassembling the connector ⑬, the O-ring may be damaged. Tighten screw ⑲ in the heater assembly ㉓ until connector ⑬ can't move.

Reassemble in reverse order to the above disassembly procedure.

When installing the cell assembly ⑥, replace the metal O-ring ⑦ with a new one.

11.1.4 Replacement of Dust Filter

Set the dust filter ① in place using a special pin spanner (with a pin 4.5 mm in diameter: part no. K9471UX or equivalent). If a dust filter that has already been replaced once is used again, apply grease (Never-Seez: G7067ZA) to the threads of the dust filter.

11.1.5 Replacement of O-ring

The detector uses three different types of O-rings ⑭, ㉔, and ㉒. One O-ring alone ⑭, or two O-rings ㉑ and ㉒ are used. (For a pressure compensating model, two O-rings are used for individual uses. Two O-rings ㉑ and ㉒ are used for reference gas sealing and require periodic replacement.

	Part No.	Description
(7)	K9470BJ	Metal O-ring
(14)	K9470ZS	O-ring with grease
(21) (22)	K9470ZP	Two pairs of O-rings with grease

11.1.6 Stopping and Re-starting Operation

<Stopping Operation>

When operation is stopped, take care of the followings so that the sensor of the detector cannot become unused.

CAUTION

When operating an instrument such as boiler or industrial furnace is stopped with the zirconia oxygen analyzer operation, moisture can condensate on the sensor portion and dusts may stick to it.

If operation is restarted in this condition, the sensor which is heated up to 750°C firmly fixes the dusts on itself. Consequently, the dusts can make the sensor performance very lower. If a large amount of water is condensed, the sensor can be broken and never be used.

To prevent the above nonconformity, take the following action when stopping operation.

(1) If possible, keep on supplying the power to converter and flowing reference gas to the sensor.
If impossible to do the above, remove the detector.

(2) If unavoidably impossible to supply the power and removing the detector, keep on following air at 600 ml/min into the calibration gas pipe.

<Restarting Operation>

When restarting operation, be sure to flow air, for 5-10 minutes, at 600 ml/min into the calibration gas pipe before supplying the power to converter.

11.2 Inspection and Maintenance of the Converter

The converter does not require routine inspection and maintenance. If the converter does not work properly, in most cases it probably comes from problems or other causes.

■ Replacing Fuses

This equipment incorporates a fuse. If the fuse blows out, turn off the equipment power and replace it in the following procedure.

CAUTION

If a replaced fuse blows out immediately, there may be a problem in the circuit. Check the circuit carefully to find out why the fuse has blown.

Before removing the electronics, touch the grounded metal part to discharge any static electricity.

(1) Remove the display cover (Figure 11.5).

(2) Remove the three screws that are located toward you, among the four screws shown in Figure 11.6. Loosen the remaining one.

(3) Move the electronics up to remove it.

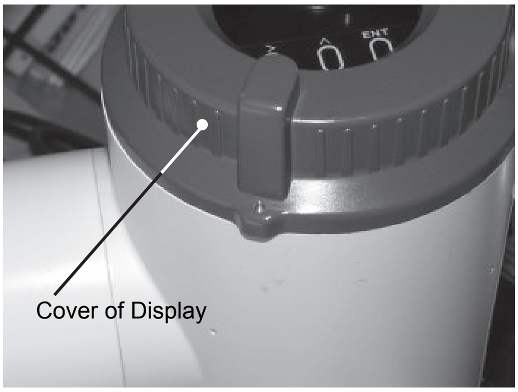


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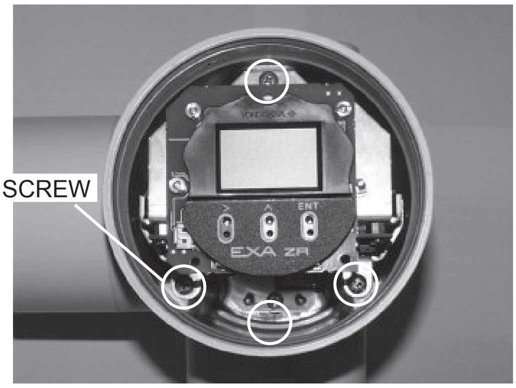
Figure 11.5 Cover of Display



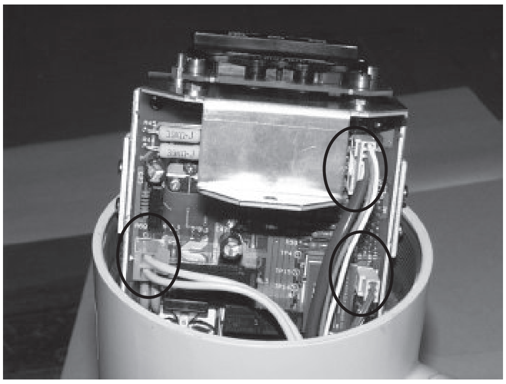
F11.6E.a

Figure 11.6 Location of Screw

(4) Disconnect the three connectors from the printed-circuit board, as shown in Figure 11.7, by holding the connector housing. Do not pull the leadwire out to remove the connectors, otherwise, disconnection may result.

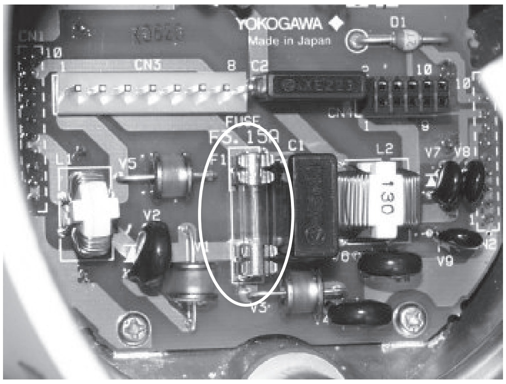
(5) Remove the electronics completely to gain access to the fuse on the bottom of the equipment case (Figure 11.8).

(6) Replace the fuse with a new one.



F11.7E.ai

Figure 11.7 Locations of Connectors



F11.8E.ai

Figure 11.8 Location of Fuse

(7) To restore the electronics, reverse the above removal procedures.
When restoring the electronics, do not get leadwire jammed in any part of the unit.

(8) Place the electronics and the printed-circuit board on which the fuse is installed properly; these are directly connected with connectors.

(9) Tighten the four screws in their positions.

(10) Replace and tighten the display cover properly. If the cover is not tightened sufficiently, the infrared switches will not operate correctly.

■ Fuse rating

Check the rating of the fuse and that it satisfies the following :

Maximum rated voltage : 250 V

Maximum rated current : 3.15 A

Type : Time-lag fuse

Standards : UL-, CSA- and VDE-approved

Part number : A1113EF

11.3 Replacement of Flowmeter for ZR20H Automatic Calibration Unit

(1) Remove pipe holding piping fitting

(2) Remove bolts holding flowmeter, and replace it. A white back plate (to make the float easy to see) is attached. The end of the pin holding down the back plate must be on the bracket side.

(3) Replace piping, and fix M6 bolts between brackets. *1

*1 : When disassembling and reassembling, mark original positions, and tighten an extra 5-10° when reassembling. After tightening, do a liquid leakage test.

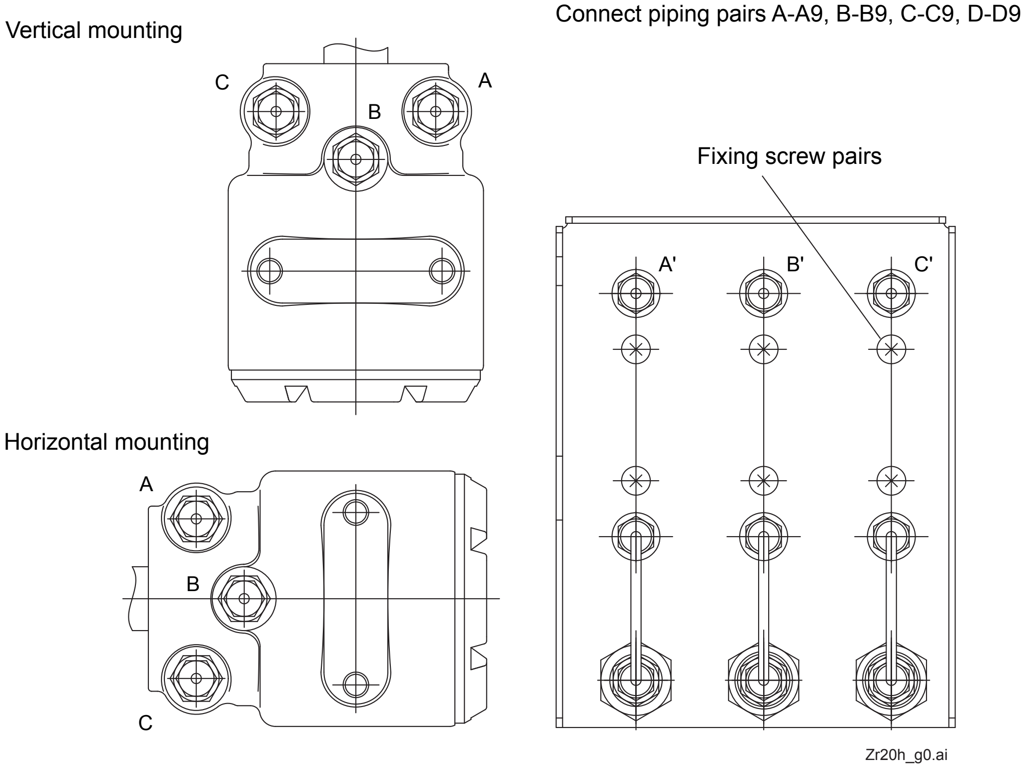


Figure 11.9 Fixing Flowmeter

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12. Troubleshooting

This chapter describes errors and alarms detected by the self-diagnostic function of the converter. This chapter also describes the check and restoration methods to use when problems other than the above occur.

12.1 Displays and Measures to Take When Errors Occur

12.1.1 What is an Error?

An error is detected if any abnormality is generated in the detector or the converter, e.g., in the cell (sensor) or heater in the detector, or the internal circuits in the converter. If an error occurs, the converter performs the following:

(1) Stops the supply of power to the heater in the detector to insure system safety.

(2) Causes an error indication in the display to start blinking to notify of an error generation (Figure 12.1).

(3) Sends an output contact if the error is set up for “Output contact setup” for that contact (refer to Section 8.4, “Output Contact Setup”).

(4) Changes the analog output status to the one set in “Output hold setting” (refer to Section 8.2, “Output Hold Setting”).
When the display shown in Figure 12.1 appears, pressing the error indication brings up a description of the error (Figure 12.2). The content of errors that are displayed include those shown in Table 12.1.

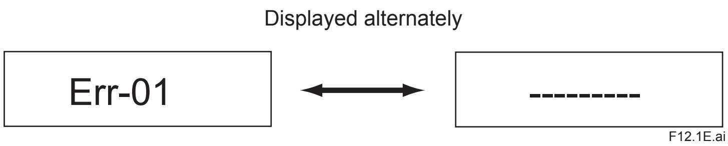


Figure 12.1

Table 12.1 Types of Errors and Reasons for Occurrence

Error	Type of error	Reason for Occurrence
Error-1	Cell voltage failure	The cell (sensor) voltage signal input to the converter falls below -50 mV.
Error-2	Heater temperature failure	The heater temperature does not rise during warm-up, or it falls below 730 °C or exceeds 780 °C after warm-up is completed.
Error-3	A/D converter failure	The A/D converter fails in the internal electrical circuit in the converter.
Error-4	Memory failure	Data properly are not written into memory in the internal electrical circuit in the converter.

12.1.2 Measures to Take When an Error Occurs

■ Error-1: Cell Voltage Failure

Error-1 occurs when the cell (sensor) voltage input to the converter falls below -50 mV (corresponding to about 200% O_2). The following are considered to be the causes for the cell voltage falling below -50 mV:

(1) Continuity failure between the cell assembly electrode and the contact

(2) Damage or deterioration of the cell assembly

(3) Improper connection between the sensor and the electronics.

(4) Wiring failure inside the detector

(5) Abnormality in the converter electronics

<Locating the failure and Take measures>

1) Turn off the power to the equipment.

2) Remove the cell assembly from the probe. Check for dirty or corroded sensor parts, including electrode and contact.

3) If the contact part is normal, the cell assembly may be damaged or deteriorated. Replace the cell assembly. In this case, be sure to replace the metal O-ring and contact.

4) If Error-1 still occurs, check that the sensor and the electronics are properly connected.

5) Remove the probe to gain access to the two connectors (four connectors for the optional automatic calibration unit), as indicated in Figure 12.2. Check these connectors are properly connected.

6) If Error-1 still occurs, the electronics may be defective. Contact your local Yokogawa service or sales representative.

■ Error-2: Heater Temperature Failure

This error occurs if the detector heater temperature does not rise during warm-up, or if the temperature falls below 730°C or exceeds 780°C after warm-up is completed.

Causes considered for cases where Error-2 occurs independently are shown below.

(1) Faulty heater in the probe (heater wire breakage)

(2) Faulty thermocouple in the probe

(3) Failure in the converter electronics

<Search for cause of failure and Take measures>

(1) Turn off the power to the analyzer.

(2) Remove the probe from the analyzer. Also remove all the connectors between the converter and probe. Measure the resistance of the heater wire (yellow wire) from the probe as indicated in Figure 12.2. The heater assembly is normal if the resistance is lower than about 90Ω. If the resistance is higher than that value, the heater assembly may be defective. In this case, replace the heater assembly (refer to Section 11.1.3, “Replacement of the Heater Assembly”).

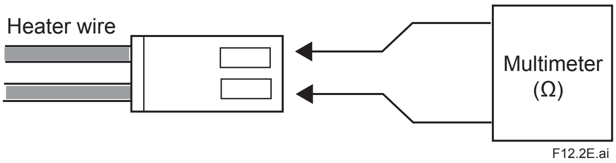


Figure 12.2

(3) Next, check the resistance of the thermocouple from the probe. Use a multimeter to measure the thermocouple resistance between terminal 3 (red cable connected) and terminal 4 (white cable connected) as indicated in Figure 12.3.

The thermocouple is normal if the resistance is 5Ω or less. If the value is higher than 5Ω, the thermocouple wire may be broken or about to break. In this case, replace the heater assembly (refer to Section 11.1.3, “Replacement of the Heater Assembly”).

CAUTION

Measure the thermocouple resistance value after the difference between the probe tip temperature and the ambient temperature decreases to 50°C or less. If the thermocouple voltage is large, accurate measurement cannot be achieved.

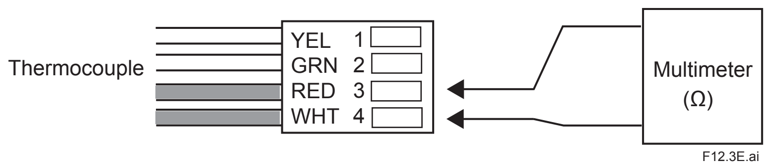


Figure 12.3

(4) If the inspection indicates that the thermocouple is normal, the electronics may be defective. Consult your local Yokogawa service or sales representative.

■ Error-3: A/D Converter Failure/Error-4: Writing-to-memory Failure

- **A/D Converter Failure**
  It is suspected that a failure has occurred in the A/D converter mounted in the converter electronics.
- **Writing-to-memory Failure**
  It is suspected that a failure has occurred in an operation writing to the memory (EEPROM) mounted in the converter electronics.

<Locating the failure and take measures>

Turn off the power to the converter once and then restart the converter. If the converter operates normally after restarting, an error might have occurred due to a temporary drop in the voltage (falling below 85 V, the least amount of voltage required to operate the converter) or a malfunction of the electronics affected by noise. Check whether or not there is a failure in the power supply system or whether the converter and detector are securely grounded.

If the error occurs again after restarting, a failure in the electronics is suspected. Consult the service personnel at Yokogawa Electric Corporation.

12.2 Displays and Measures to Take When Alarms are Generated

12.2.1 What is an Alarm?

When an alarm is generated, the alarm indication blinks in the display to notify of the alarm (Figure 12.3).

Pressing the alarm indication displays a description of the alarm. Alarms include those shown in Table 12.2.

Displayed alternately

AL-06 ⟷ 21.0%

F12.4E.ai

Figure 12.4

Table 12.2 Types of Alarms and Reasons for Occurrence

Alarm	Type of alarm	Reason for occurrence
Alarm 1 through 3	Oxygen concentration alarm concentration alarm humidity, and mixing ratio alarms	Occurs when a measured value exceed or falls below the set alarm value (refer to Section 8.3, "Setting Alarms").
Alarm 6	Zero calibration coefficient alarm	Generated when the zero correction ratio is out of the range of 100 ± 30% in automatic and semi-automatic calibration (refer to Section 9.1.4, Compensation).
Alarm 7	Span calibration coefficient alarm	Generated when the span correction ratio is out of the range of 0 ± 18% in automatic and semi-automatic calibration (refer to Section 9.1.4, "Compensation").
Alarm 8	EMF stabilization time-up	Generated when the cell (sensor) voltage is not stabilized even after the calibration time is up in automatic and semi-automatic calibration.
Alarm 10	Cold junction temperature alarm	Occurs when an equipment internal temperature exceeds 85°C.
Alarm 11	Thermocouple voltage alarm	Generated when thermocouple voltage exceeds 42.1 mV (about 1020°C) or falls below -5 mV (about -170°C).
Alarm 13	Battery low alarm	Internal battery needs replacement

If an alarm is generated, such measures as turning off the heater power are not carried out. The alarm is released when the cause for the alarm is eliminated.

However, Alarm 10 and/or Alarm 11 may be generated at the same time as Error-2 (heater temperature error).

In such a case, the measure taken for this error has priority.

If the converter power is turned off after an alarm is generated and restarted before the cause of the alarm has been eliminated, the alarm will be generated again.

However, Alarms 6, 7, and 8 (alarms related to calibration) are not generated unless calibration is executed.

12.2.2 Measures Taken When Alarms are Generated

● Alarm 1 through 3: Oxygen Concentration Alarm, Humidity, and Mixing Ratio Alarms

This alarm is generated when a measured value exceeds an alarm set point or falls below it. For details on the oxygen concentration alarm, see Section 8.3, “Setting Alarms,” in the chapter on operation.

● Alarm 6: Zero Calibration Coefficient Alarm

In calibration, this alarm is generated when the zero correction ratio is out of the range of 100 ± 30% (refer to Section 9.1.4, “Compensation”). The following can be considered the causes for this:

(1) The zero gas oxygen concentration does not agree with the value of the zero gas concentration set (refer to Section 9.2,“Calibration Procedures.)” Otherwise, the span gas is used as the zero gas.

(2) The zero gas flow is out of the specified flow (600 ± 60 ml/min).

(3) The sensor assembly is damaged and so cell voltage is not normal.

<Search for cause of failure and Take measures>

(1) Confirm the following and carry out calibration again: If the items are not within their proper states, correct them.
a. If the indication for “Zero gas conc.” is selected in “Calibration setup,” the set value should agree with the concentration of zero gas actually used.
b. The calibration gas tubing should be constructed so that the zero gas does not leak.

(2) If no alarm is generated as a result of carrying out re-calibration, it is suspected that improper calibration conditions were the cause of the alarm in the preceding calibration. In this case, no specific restoration is necessary.

(3) If an alarm is generated again as a result of carrying out re-calibration, deterioration of or damage to the cell (sensor) is suspected as the cause of the alarm. Replacement of the cell (sensor) with a new one is necessary. However, before replacement, carry out the following: Check the cell voltages when passing the zero gas and span gas.
a. Display the cell voltage with the parameter code A11.
b. Check whether or not the value of the displayed cell voltage is very different from the theoretical value at each oxygen concentration. Confirm the theoretical values of the cell voltage in Table 12.3. Although it cannot be generally specified as to what extent the difference from the theoretical value is allowed, consider it to be approximately ±10 mV.

Table 12.3 Oxygen Concentration and Cell Voltage Oxygen concentration

Oxygen concentration (% O_2)	Cell voltage (mV)
1%	67.1
21%	0

(4) Confirm whether deterioration of or damage to the sensor assembly that caused the alarm has occurred abruptly during the current calibration in the following procedure:
Check the history of the span gas correction ratio with the parameter codes A50 through A59, Check the history of the zero gas correction ratio with the parameter codes A60 through A69. The larger the parameter code number, the older the displayed data. Changes in deterioration of the sensor can be seen.

(5) If deterioration of the cell assembly has occurred abruptly, it may show that the check valve, which prevents moisture in the furnace from getting into the calibration gas tubing, has failed. If the gas in the furnace gets into the calibration gas tubing, it condenses and remains in the gas tubing. The cell assembly is considered to be broken for the reason that the condensation is blown into the cell assembly by the calibration gas during calibration and so the cell cools quickly.

(6) If the cell assembly has been gradually deteriorating, check the cell assembly status in the following procedure:
a. Display “Cell resistance” by specifying the parameter code A21. A new cell will show a cell resistance value of 200Ω or less. On the other hand, a cell (sensor) that is approaching the end of its service life will show a resistance value of 3 to 10 kΩ.

b. Display “Cell robustness” by specifying the parameter code A22. A good cell (sensor) will show “5,” “Life > 1 year” (refer to Section 10.1.17).

● Alarm 7: Span Calibration Coefficient Alarm

In calibration, this alarm is generated when the span gas correction ratio is out of the range of 0 ± 18% (refer to Section 9.1.4, “Compensation”).

The following are suspected as the cause:

(1) The oxygen concentration of the span gas does not agree with the value of the span gas set “Calibration setup.”

(2) The flow of the span gas is out of the specified flow value (600 ± 60 ml/min).

(3) The cell assembly is damaged and the cell voltage is abnormal.

<Search for cause of failure and Take measures>

(1) Confirm the following and carry out calibration again:
If the items are not within their proper states, correct them.
a. If the display “Span gas conc.” is selected in “Calibration setup,” the set value should agree
with the concentration of span gas actually used.
b. The calibration gas tubing should be constructed so that the span gas does not leak.

(2) If no alarm is generated as a result of carrying out re-calibration, it is suspected that improper calibration conditions were the cause of the alarm in the preceding calibration. In this case, no specific restoration is necessary.

(3) If an alarm is generated again as a result of carrying out re-calibration, deterioration of or damage to the cell (sensor) is suspected as the cause of the alarm. Replacement of the cell with a new one is necessary. However, before replacement, carry out the procedure described in step (3) and later of <Search for cause of failure and taking measure> in Section 12.2.2.2, “Alarm 6: Zero Calibration Coefficient Alarm.”

● Alarm 8: EMF Stabilization Time Over

This alarm is generated if the sensor (cell) voltage has not stabilized even after the calibration time is up for the reason that the calibration gas (zero gas or span gas) has not filled the sensor assembly of the detector.

<Cause of alarm>

(1) The flow of the calibration gas is less than normal (a specified flow of 600 ± 60 ml/min).

(2) The length or thickness of the calibration gas tubing has been changed (lengthened or thickened).

(3) The measuring gas flows toward the tip of the probe.

(4) The sensor (cell) response has deteriorated.

<Search for cause of failure and Take measures>

(1) Carry out calibration by passing the calibration gas at the specified flow (600 ± 60 ml/min) after checking that there is no leakage in the tubing.

(2) If calibration is carried out normally, perform a steady operation without changing the conditions. If the error occurs again, check whether or not the reason is applicable to the following and then replace the sensor assembly.

- A lot of dust and the like may be sticking to the tip of the sensor. If dust is found, clean and remove the dust (see Section 11.1.1).

In addition, if an error occurs in calibration even after the cell assembly is replaced, the influence of sample gas flow may be suspected. Do not let the sample gas flow toward the tip of the detector probe, for example, by changing the mounting position of the detector.

● Alarm 10: Cold Junction Temperature Alarm

The equipment incorporates a temperature sensor. An alarm is issued when the sensor temperature exceeds 85°C. If internal temperature of this equipment exceeds 85°C, the electronics may fail.

<Search for cause of failure and Take measures>

This equipment can be used at ambient temperatures up to 55°C. If the ambient temperatures may exceed the limits, take appropriate measures such as applying heat insulating material to the furnace walls, and adding a sun shield to keep out direct sunlight.

If this alarm occurs even when the ambient temperature is under 55°C, the electronics may be defective. Contact your local Yokogawa service or sales representative.

● Alarm 11: Thermocouple Voltage Alarm

This alarm is generated when the emf (voltage) of thermocouple falls below -5 mV (about -170°C) or exceeds 42.1 mV (about 1020°C).

(1) A failure of the thermocouple at the detector occurred.

(2) A failure of the electrical circuits occurred.

<Search for cause of failure and Take measures>

(1) Turn off the power to the analyzer.

(2) Remove the probe from the analyzer. Also remove all the connectors between the converter and probe. Measure the resistance of the heater wire (yellow wire) from the probe as indicated in Figure 12.5. The heater assembly is normal if the resistance is lower than about 90Ω. If the resistance is higher than that value, the heater assembly may be defective. In this case, replace the heater assembly (refer to Section 11.1.3, "Replacement of the Heater Assembly").

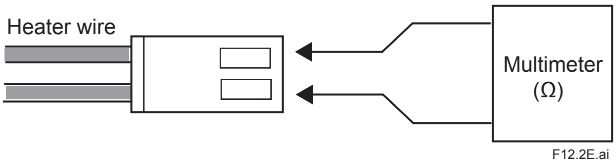


Figure 12.5

(3) Next, check the resistance of the thermocouple from the probe. Use a multimeter to measure the thermocouple resistance between terminal 3 (red cable connected) and terminal 4 (white cable connected) as indicated in Figure 12.6.

The thermocouple is normal if the resistance is 5Ω or less. If the value is higher than 5Ω, the thermocouple wire may be broken or about to break. In this case, replace the heater assembly (refer to Section 11.1.3, "Replacement of the Heater Assembly").

CAUTION

Measure the thermocouple resistance value after the difference between the probe tip temperature and the ambient temperature decreases to 50°C or less. If the thermocouple voltage is large, accurate measurement cannot be achieved.

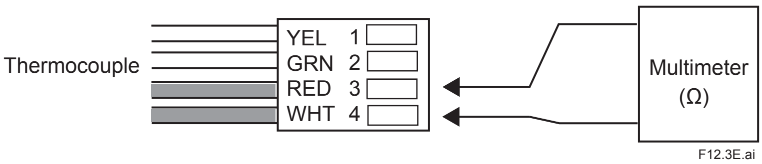


Figure 12.6

(4) If the inspection indicates that the thermocouple is normal, the electronics may be defective. Consult your local Yokogawa service or sales representative.

● Alarm 13: Battery Low Alarm

An internal battery is used as backup for the clock. After this alarm occurs, removing power from the instrument may cause the clock to stop but should not affect stored parameters. The internal clock is used for calibration and purge scheduling; if you use this then after a battery alarm occurs (until the battery is replaced) be sure to check / correct the date and time every time you turn on the power.

<Corrective action>

When the battery low alarm occurs, remember that the battery cannot be replaced by the user. Contact your Yokogawa service representative.

NOTE

Battery life varies with environmental conditions.

* If power is applied to the instrument continuously, then the battery should not run down, and life is typically about ten years. However the battery will be used during the time interval between shipment from the factory and installation.
* If power is not applied to the instrument, at normal room temperatures of 20 to 25°C then battery life is typically 5 years, and outside this range but within the range -30 to +70°C then battery life is typically 1 year.

12.3 Measures When Measured Value Shows an Error

The causes that the measured value shows an abnormal value is not always due to instrument failures. There are rather many cases where the causes are those that measuring gas itself is in abnormal state or external causes exist, which disturb the instrument operation. In this section, causes of and measures against the cases where measured values show the following phenomena will be described.

(1) The measured value is higher than the true value.

(2) The measured value is lower than the true value.

(3) The measured value sometimes shows abnormal values.

12.3.1 Measured Value Higher (Lower for Humidity Analyzer) Than True Value

<Causes and Measures>

(1) The measuring gas pressure becomes higher.
The measured oxygen concentration value X (vol% O_2) is expressed as shown below, when the measuring gas pressure is higher than that in calibration by Δp (kPa).

$$X = Y\,[\,1 + (\Delta p/101.30)\,]$$

where Y: Measured oxygen concentration value at the same pressure as in calibration (vol% O_2).

Where an increment of the measured value by pressure change cannot be neglected, measures must be taken.
Investigate the following points to perform improvement available in each process.
Is improvement in facility’s aspect available so that pressure change does not occur?
Is performing calibration available under the average measuring gas pressure (internal pressure of a furnace)?

(2) Moisture content in a reference gas changes (increases) greatly.
If air at the detector installation site is used for the reference gas, large change of moisture in the air may cause an error in measured oxygen concentration value (vol% O_2).
When this error is not ignored, use a gas in which moisture content is constant such as instrument air in almost dry condition as a reference gas.
In addition, change of moisture content in exhaust gas after combustion is also considered as a cause of error. However, normally this error is negligible.

(3) Calibration gas (span gas) is mixing into the sensor due to leakage.
If the span gas is mixing into the sensor due to leakage as a result of failure of the valve provided in the calibration gas tubing system, the measured value shows a value a little higher than normal.
Check valves (needle valves, check valves, solenoid valves for automatic calibration, etc.) in the calibration gas tubing system for leakage. For manual valves, check them after confirming that they are in fully closed states. In addition, check the tubing joints for leakage.

(4) The reference gas is mixing into the measuring gas and vice versa.
Since the difference between oxygen partial pressures on the sensor anode and cathode sides becomes smaller, the measured value shows a higher value.
An error which does not appear as the Error-1 may occur in the sensor. Sample gas and/or the reference gas may be leaking. Visually inspect the sensor. If any crack is found, replace the sensor assembly with a new one.

(Note) Data such as cell robustness displayed in the detailed data display should also be used for deciding sensor quality as references.

12.3.2 Measured Value Lower (Higher for Humidity Analyzer) Than True Value

<Causes and Measures>

(1) The measuring gas pressure becomes lower.
Where an increment of the measured value due to pressure change cannot be neglected, take measures referring to subsection 12.3.1 (1).

(2) Moisture content in a reference gas changes (decreases) greatly.
If air at the analyzer installation site is used for the reference gas, large change of moisture content in the air may cause an error in measured oxygen concentration value (vol% O_2).
When this error is not ignored, use a gas in which moisture content is constant such as instrument air in almost dry condition as a reference gas.
In addition, change of moisture content in exhaust gas after combustion is also considered as a cause of error. However, normally this error is negligible.

(3) Calibration gas (zero gas) is mixed into the sensor due to leakage.
If the zero gas is mixed into the detector due to leakage as a result of failure of the valve provided in the calibration gas tubing system, the measured value shows a value a little lower than normal.
Check valves (needle valves, check valves, solenoid valves for automatic calibration, etc.) in the calibration gas tubing system for leakage. For manual valves, check them after confirming that they are in fully closed states.

(4) Combustible components exist in the sample gas. If combustible components exist in the sample gas, they burn in the sensor and thus oxygen concentration decreases. Check that there are no combustible components.

(5) Temperature of the sensor cell reaches 750 °C or more.
If the sensor temperature is 750°C or higher, this may indicate that sample gas has leaks into the reference gas side, corrosion. Also check that the thermocouple resistance is no greater than 15Ω.

12.3.3 Measurements Sometimes Show Abnormal Values

<Cause and Measure>

(1) Noise may be mixing in with the converter from the detector output wiring.
Check whether the equipment is securely grounded.
Check whether or not the signal wiring is laid along other power cords.

(2) The converter may be affected by noise from the power supply.
Check whether or not the converter power is supplied from the same outlet, switch, or breaker as other power machines and equipment.

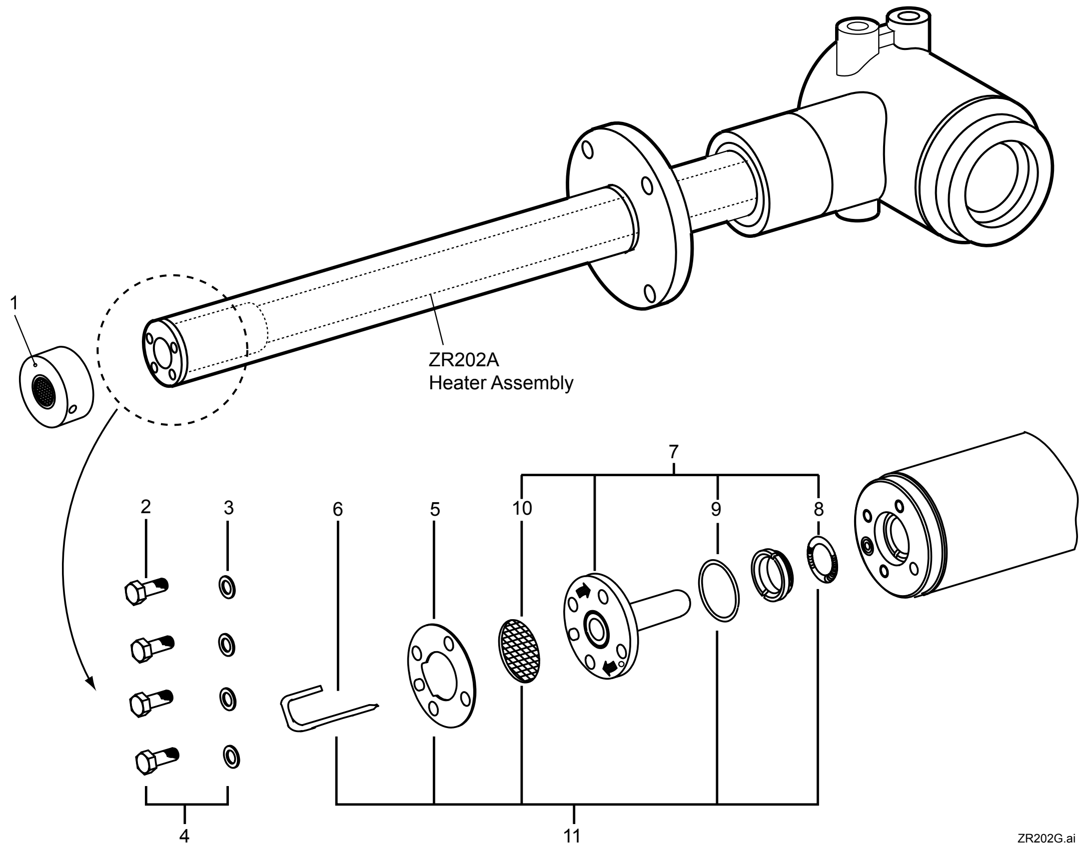
(3) Combustible components in the sample gas may be getting into the sensor.
If the combustible components show signs of dust, the abnormality may be improved by mounting a dust filter K9471UA.

(4) There may be a crack in the sensor or leakage at the sensor-mounting portion.
If the indication of concentration varies in synchronization with the pressure change in the furnace, check whether or not there is a crack in the sensor or whether the sensor flange is sticking tightly to the probe-attaching face with the metal O-ring squeezed.

(5) There may be leakage in the calibration gas tubing
In the case of a negative furnace inner pressure, if the indication of concentration varies with the pressure change in the furnace, check whether or not there is leakage in the calibration gas tubing.

Customer Maintenance Parts List

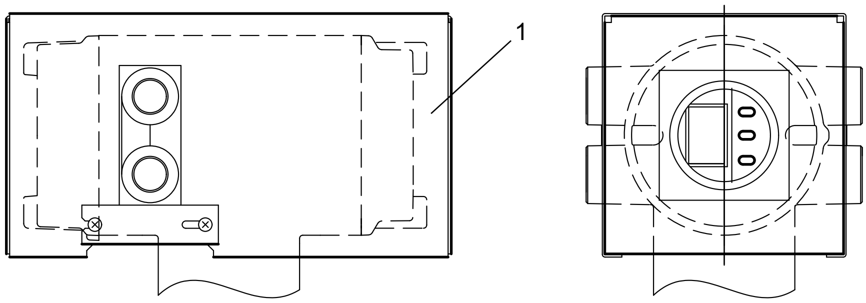
Model ZR202G
Zirconia Oxygen/Humidity Analyzer
(Integrated type)



Item	Part No.	Qty	Description
1	K9471UA	1	Dust Filter (Option)
2	---	4	Bolt
	G7109YC		(M5x12, SUS316 stainless steel)
	K9470BK		(M5x12, inconel) for Option code "/C"
3	E7042DW	4	Washer (SUS316 stainless steel)
4	---	1	Bolts and Washers
	K9470ZF		G7109YC x 4 + E7042DW x 4
	K9470ZG		K9470BK x 4 + E7042DW x 4 for Option code "/C"
5	E7042BR	1	Plate
6	K9470BM	1	Pipe
	K9473AN	1	Pipe for Option code "/C"
7	---	1	Cell Assembly
	ZR01A01-01		1 piece (E7042UD)
	ZR01A01-02		2 pieces
	ZR01A01-05		5 pieces
	ZR01A01-10		10 pieces
8	E7042BS	1	Contact
9	K9470BJ	1	Metal O-ring
10	E7042AY	1	Filter
11	---	1	Calibration Tube Assembly
	K9470ZK		Cal. Gas Tube Assembly
	K9470ZL		Cal. Gas Tube Assembly for Option code "/C"

CMPL 11M12A01-04E
1st Edition : Aug. 2000 (YK)
9th Edition : Feb. 2016 (YK)

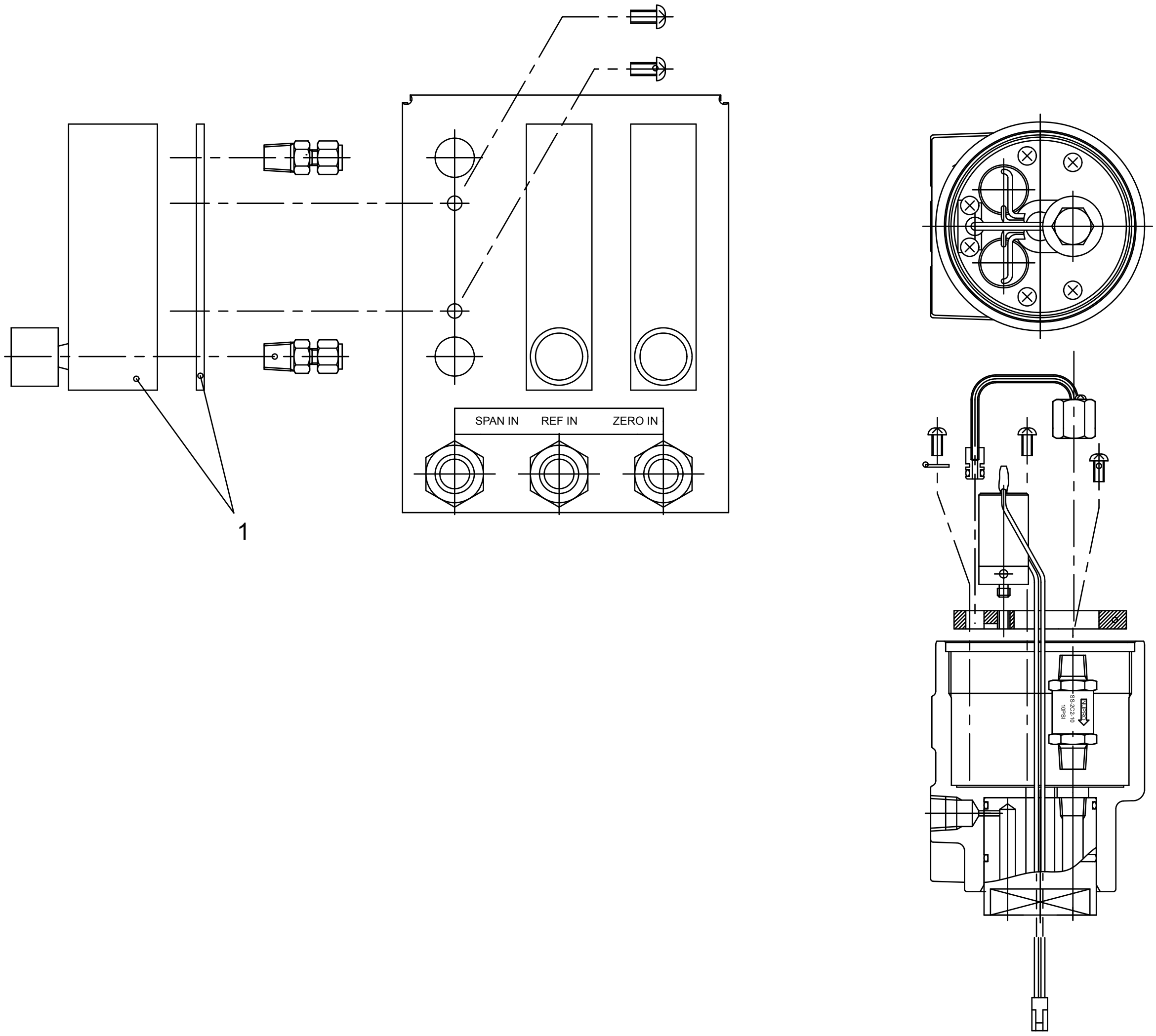
Hood for ZR202G



Item	Part No.	Qty	Description
1	K9472UF	1	Hood

Customer Maintenance Parts List

Model ZR20H
Automatic Calibration Unit
for Integrated type Zirconia Oxygen/Humidity Analyzer (ZR202G)

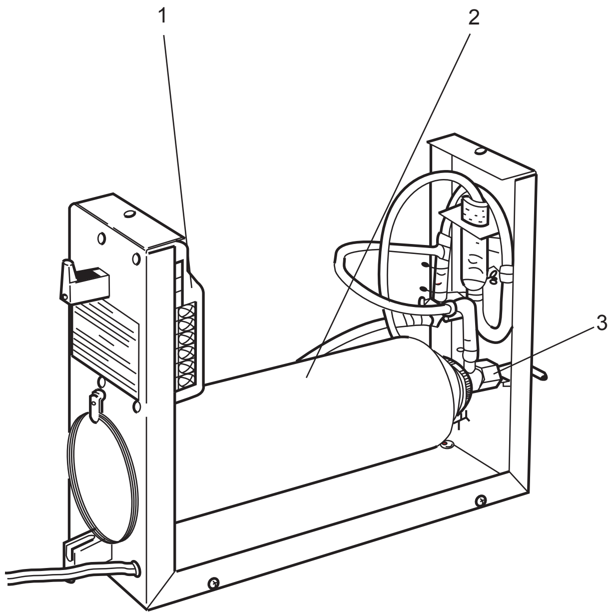


Item	Part No.	Qty	Description
1	K9473XC	1	Flowmeter

CMPL 11M12A01-12E
1st Edition : Feb. 2001 (YK)
4th Edition : Feb. 2016 (YK)

Customer Maintenance Parts List

Model ZO21S
Zirconia Oxygen Analyzer/ High Temperature Humidity Analyzer, Standard Gas Unit



Item	Part No.	Qty	Description
1	———	1	Pump (see Table 1)
2	E7050BA	1	Zero Gas Cylinder (x6 pcs)
3	E7050BJ	1	Needle Valve

Table 1

Power	Pump
AC 100 V 110 115	E7050AU
AC 200 V 220 240	E7050AV

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Yokogawa Electric Corporation

CMPL 11M3D1-01E
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Revision Information

- Manual Title : Model ZR202G Integrated type Oxygen/Humidity Analyzer
- Manual No. : IM 11M12A01-04E

Jul. 2017/11th Edition
Changed flange materials of ZR202G, ZO21R and ZH21B. (pages 2-3, 2-6 to 2-11)

May 2017/10th Edition
Addition RoHS etc. (pages i, v, vii, 2-2)

Feb. 2016/9th Edition
Bound up with IM 11M12A01-05E. IM 11M12A01-05E is obsoleted version.
Whole review.
CMPL 11M12A01-04E and CMPL 11M12A01-12E are updated.

Aug.2015/8th.Edition
Revised section
2.1.1 Some spell error corrections and addtion of specification description.
2.1.2 "ZR202G Integrated type Zirconia Oxygen Analyzer": Deleted the C-tick, Safety and EMC conforming standards.
2.4.3 "Stop Valve": Changed of the weight and dimensions.
2.4.4 "Check Valve": Changed of the weight.
5.1 "General" Table 5.1: Deleted cable type.
"General": Added "WARNING".
CMPL. "Customer Maintenance Parts List": CMPL 11M12A01-04E is updated to 8th edition.

Jan. 2012/7th Edition
Revised and Corrected over all

Sep. 2006/6th Edition
Revised section
2.4.5 "Air Set," Part No. K9473XH or K9473XJ, Standard Specification: Changed descriptions partly;
"Air Set,"Part No. G7004XF or K9473XG, Standard Specification: Changed descriptions partly;
2.4.7 "Cylinder Regulator Valve (Part No. G7013XF or G7014XF)", Standard Specifications; Changed descriptions partly and drawing;
5.3 "Wiring Power and Ground Terminals": Added description in Figure 5.5;
5.3.2 "Wiring for Ground Terminals": Added item (4);
7.4.5 "Changing Set Values": Changed description in table (1);
7.9.2 "Checking Calibration Contact Output": Changed description in table 7.10;
8.3.2 "Preference Order of Output Hold Value": Deleted "or blow-back";
8.3.3 "Output Hold Setting": Table 8.5, Parameter code C06, "maintenance" should read "calibration";
8.3.4 "Default Values": Table 8.6, Deleted "or blow-back";
8.5.1 "Output Contact": Made some corrections;
8.5.2 "Setting Output Contact":
Table 8.10, Changed descriptions;
WARNING: Deleted second warning;
9.2.2.2 "Semi-automatic Calibration": Table 9.3, Added note;
10.4 Table 10.6, Contact-related Items in Group E. Deleted some codes;
12.2.1 "What is an Alarm?": Table 12.2, Added Alarms 11 and 13;
12.2.2.2Alarm 6: Changed descriptions;
12.2.2.3Alarm 7: Changed descriptions;
• p. 12-7 and 12-8,
Added Sections 12.2.2.6 and 12.2.2.7;
• CMPL Changed part numbers of Items 4, 12 and 13;
2.1.2 "ZR202G Integrated type Oxygen Analyzer" Safety and EMC conforming standard: Added Caution.
2.1.2 "ZR202G Integrated type Oxygen Analyzer" Model and Codes: Added Note.
8.3 "Output Hold Setting," "Table 8.4 Analog Output Hold Setting": Added Note.
8.3.3 "Output Hold Setting," "Table 8.5 Parameter Codes for Output Holding": Added Note.
10.4 "Reset," "Table Output-related Items in Group C": Added Note.

Apr. 2005/5th Edition

Revised section

Introduction Added description regarding modification

1.2.1 " System Components" Changed part numbers of air set in table

2.1.2 Changed safety and EMC conforming standards and paint colors

2.2.2 Changed Finish color

2.3 Added description " Non CE Mark"

2.4.5 " Air Set" Changed part numbers and drawing of air set

4.2.1 " Piping Parts for System 2" Change part numbers of air set in Table 4.2

4.4.1 " Piping Parts for a System using Detector with Pressure Compensation" Changed part numbers of air set in Table 4.3

July 2003/4th Edition

Revised section

Notation of flange specification unified

Dust guard protector, G7004XF/K9473XG Air set added

CMPL 11M12A01-04E Cell assembly parts no. changed, revised to 5th edition.

Sep. 2001/3rd Edition

Revised section

1.2 Model ZR202A Heater Assembly added

2.2.1 ZA8F Flow Setting Unit error corrected

2.7.8 Model ZR202A Heater Assembly added

8.6 Table 8.12 Input Contact Functions changed

11.1.3 Reference document added to Replacement of the Heater Assembly

Heater Assembly added to CMPL 11M12A01-04E

CMPL 11M12A01-04E Model ZR20H changed

Mar. 2001/2nd Edition

Revised section

1.1.3 Explanation changed in "System 3" example

1.2.1 ZR20H added to list of Equipment Models

2.1.2 Some changes to ZR202G Integrated type in MS code table, and notes added

2.2 Reference gas pressure of ZA8F with check valve changed, detailed explanation added to ZR20H Automatic Calibration Unit

3.3 Added detail to 3.3 Installation of ZR20H Automatic Calibration Unit

3.5 Corrected errors in Insulation Resistance Test Wiring Diagram

4.3 Added explanation for piping to System 3 example

6.1 Added Filter to 6.1 ZR202G Detector

6.2 Added Names and Functions to 6.2 ZR20H Automatic Calibration Unit

7.1 Air-set secondary pressure with check valve changed

7.10.2 Reference gas pressure of ZA8F with check valve changed

10.6.1 Reference gas pressure of ZA8F with check valve changed

11.1 Added Filter to 11.1 Inspection and Maintenance of the ZR202G Detector

12.2.1 Corrected explanation of Alarm 10

Added Filter to CMPL 11M12A01-04E, and added ZR20H Automatic Calibration Unit to CMPL 11M12A01-12E

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