

**Model ZR22G, ZR402G
Separate type Zirconia
Oxygen/Humidity Analyzer**

IM 11M12A01-02E

◆ Introduction

Thank you for purchasing the ZR22G, ZR402G Separate type Zirconia Oxygen/Humidity Analyzer.

Please read the following respective documents before installing and using the ZR22G, ZR402G Separate type Zirconia 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 ZR22G, ZR402G Separate type Zirconia Oxygen/Humidity Analyzer	IM 11M12A01-02E	(This manual)
Model ZR22S, ZR402G Separate type Explosion-proof Zirconia Oxygen Analyzer	IM 11M13A01-02E	When you use the ZR22S Explosion-proof detector, read this manual.
Model ZR22A, ZR202A Heater Assembly	IM 11M12A01-21E	
Model EXAxt ZR Series HART Protocol	IM 11M12A01-51E	
Model AV550G Zirconia Oxygen Analyzer Averaging Converter	IM 11M12D01-01E	

* 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 Separate type Zirconia Oxygen/Humidity Analyzer is usually the Oxygen Analyzer which connected ZR402G converter and ZR22G detector together, but it is to the High Temperature Humidity Analyzer when the option code "/HS (Set for Humidity Analyzer)" of ZR402G is selected.

After that, in this manual, the Humidity Analyzer refers to the thing which ZR22G combined with ZR402G with "/HS".

In addition, 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 Separate type Zirconia Oxygen/Humidity Analyzer has been developed for combustion control in various industrial processes. This analyzer basically consists of a detector and a converter. You can select between several versions, based upon 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 refers to almost all of the equipment related to the EXAxt ZR. You may skip any section(s) on the 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".

The Integrated type (with sensor and analyzer integrated in one body) is described in IM 11M12A01-04E.

<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.>

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
ZR22G	General use detector	○	○	○	○	○
ZR22G	High temperature detector (0.15m)	○	○	○	○	
ZR402G	Converter	○	○	○	○	○
ZO21R	Probe protector	○	○			
ZO21P	High temperature probe adapter	○	○			○
ZH21B	Dust protector (only for Humidity analyzer)	○	○			
ZA8F	Flow setting unit (for manual calibration use)	○	○	○		
ZR40H	Automatic Calibration unit	○	○	○		○
-	Auxiliary ejector for high temperature use (Part No. E7046EC, E7046EN)	○	○			○
-	Calibration gas unit case (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	A
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	B
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

Handle it with care. 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 detector is made of ceramic (zirconia element). Do not drop the detector or subject it to pressure stress.

- Do NOT allow the sensor (probe tip) to make contact with anything when installing the detector.
- Avoid any water dropping directly on the probe (sensor) of the detector 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 detector (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.

◆ CE marking products / UKCA marking products

■ Authorized Representative in the EEA and the Importer into the EU/EEA Market

The Authorized Representative for this product in the EEA and the importer for this product into the EU/EEA market via Yokogawa sale channel is:

Yokogawa Europe B.V.
Euroweg 2, 3825 HD Amersfoort, The Netherlands

■ Importer for This Product into the Great Britain Market (ZR22G only)

In relation to UKCA marking, the importer for this product into the Great Britain market via the YOKOGAWA sales channel is :

Yokogawa United Kingdom Limited
Stuart Road Manor Park Runcorn, WA7 1TR, United Kingdom

■ 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 Batteries and Waste batteries:

(Only valid in the EU for EU Battery Directive/Regulation and in the UK for UK Battery Regulation)

Batteries are included in this product. This marking indicates they shall be sorted out and collected as ordained in the EU battery Directive/Regulation and UK battery Regulation.

When you need to replace batteries, contact your local Yokogawa office in the EEA and/or UK respectively.

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.

■ Information of the WEEE Directive

This product is purposely designed to be used in a large scale fixed installations only and, therefore, is out of scope of the WEEE Directive. The WEEE Directive does not apply. This product should be disposed in accordance with local and national legislation/regulations. The WEEE Directive is only valid in the EU and UK.

Model ZR22G, ZR402G

Separate type Zirconia

Oxygen/Humidity Analyzer

IM 11M12A01-02E 18th Edition

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1. Overview

The EXAxt ZR Separate type Zircon 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, paper and pulp, 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 CO₂, SO_x and NO_x.

The ZR22G Separate type Detector uses a high-reliability Zirconia sensor, and its heater assembly can be replaced on site. The detector is mounted, for example, on the wall of a flue and can measure the gases directly.

For use in combustion gases at temperatures up to 1400°C, choose the general use 0.15 m long detector, which is combined with the ZO21P, the high temperature probe protector.

The EXAxt ZR Separate-type Zirconia Humidity Analyzer is used to measure the humidity of hot gases continuously in driers which use hot gas or electricity as the heat source. It can also be used in a variety of manufacturing applications in humidifiers, as well as in driers, for humidity measurement and control. It can help improve productivity in these application fields.

The converter is equipped with an LCD touch screen which has various setting displays, a calibration display, oxygen concentration trend display, with easier operation and improvement of display functions. The converter is equipped with various standard functions such as measurement and calculation as well as maintenance functions including self-test. Analyzer calibration can also be fully automated — and the ZR40H, an automatic calibration unit, is available. Choose the detector version which best suits your needs so that an optimal combustion control system can be obtained.

Some examples of typical system configurations are illustrated below:

1.1 < EXAxt ZR > System Configuration

The system configuration should be determined by the conditions; e.g. whether 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 a detector and a converter. This system can be implemented for monitoring oxygen concentration in the combustion gases of a package 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 handy the ZO21S standard gas unit is used for calibration.

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

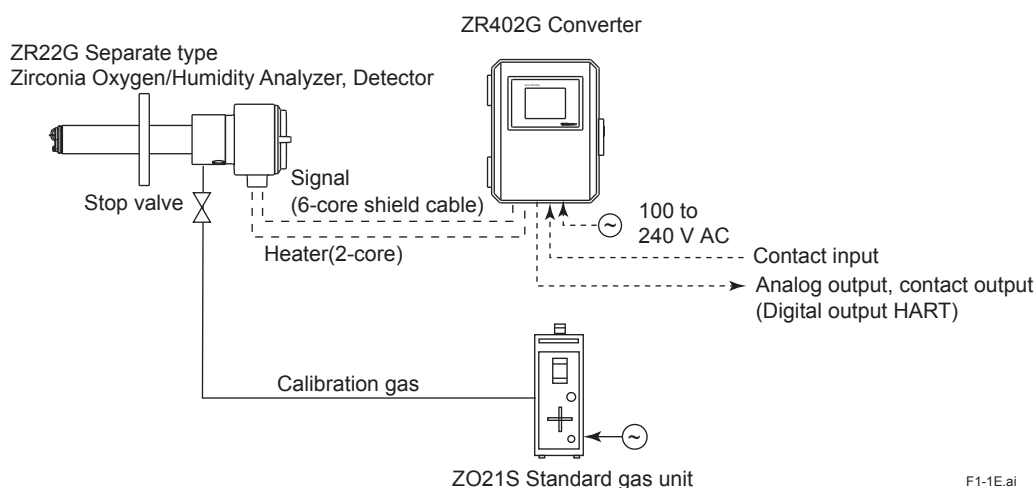


Figure 1.1

NOTE

- As this system uses ambient air for the reference gas, measuring accuracy will be affected by the installation location.
- A needle (stop) valve should be connected to the calibration gas inlet of the detector. 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. Clean (dry) air (21 vol%O₂) is used as the reference gas and the span gas for 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.

Zero gas is fed in from a cylinder during calibration. The gas flow is controlled by the ZA8F flow setting unit (for manual valve operation).

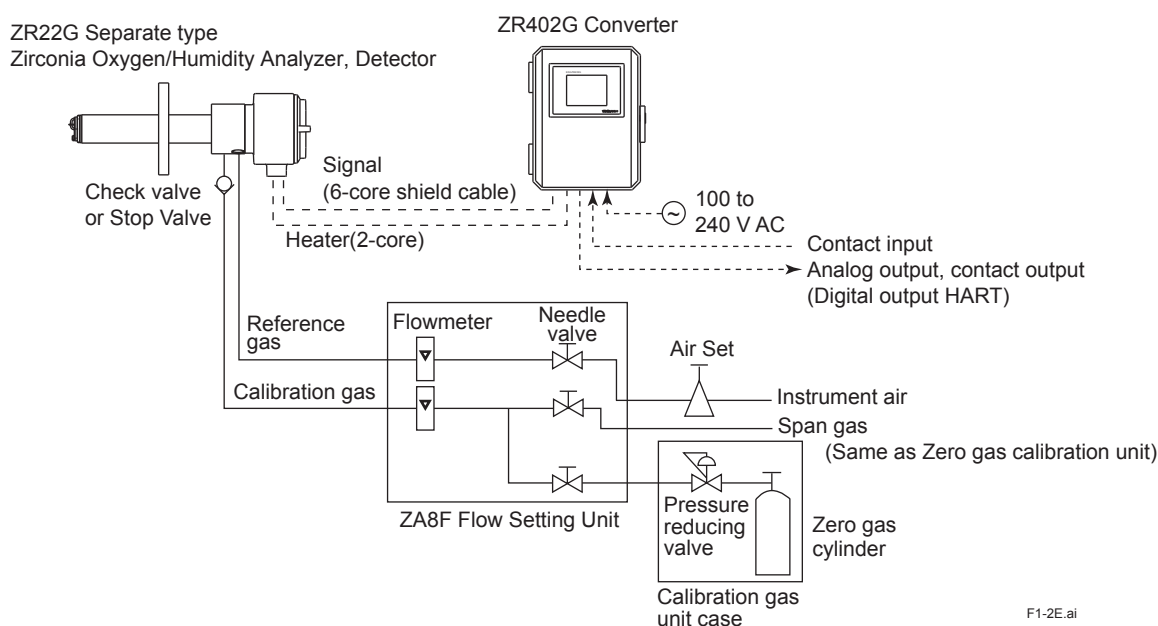
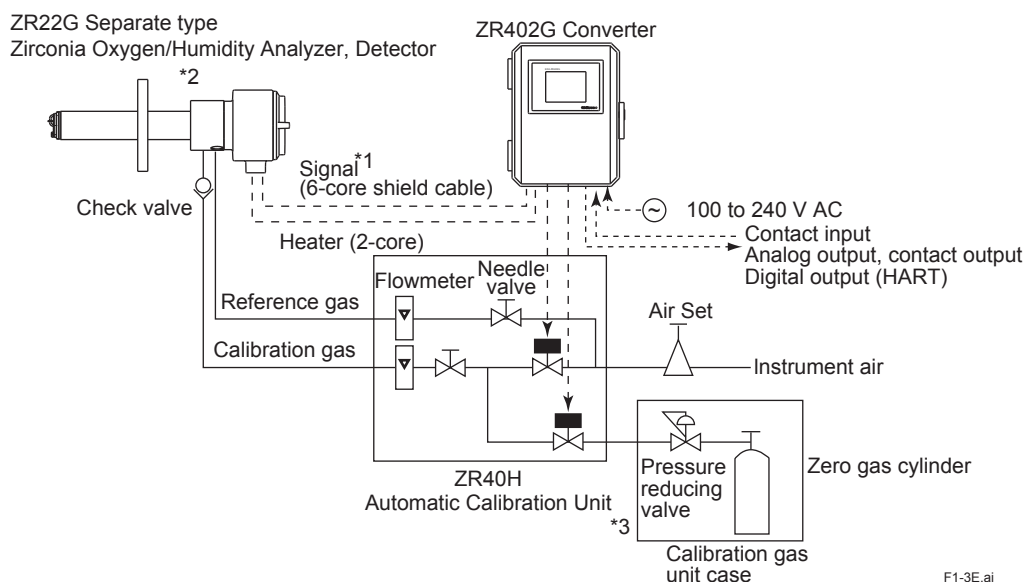


Figure1.2

1.1.3 System 3

This example, System 3, represents typical applications in large boilers and heating furnaces, where there 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 ZR40H 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.



*1 Shield cable ; Use shielded signal cables, and connect the shield 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% N₂ gas cannot be used as the zero gas. Use approximately 1% of O₂ gas (N₂-based).

Figure1.3

1.2 < EXAxt ZR > System Components

1.2.1 System Components

System Components	Separate type System config.			Oxygen Analyzer	Humidity Analyzer
	Ex.1	Ex.2	Ex.3		
Model ZR22G Separate type Zirconia Oxygen Analyzers ,Detector	A	A	A	A	A
Model ZR402G Separate type Zirconia Oxygen Analyzer, Converter	A	A	A	A	A
Model ZO21P Adapter for High Temperature Probe of separate type Zirconia Oxygen Analyzer	B	B	B	B	
E7046EC, E7046EN Ejector Assembly for High temperature of separate type Oxygen Analyzer	B	B	B	B	
Model ZO21R Probe Protector for Zirconia Oxygen Analyzers	B	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 ZR40H Automatic Calibration Unit for Separate type Oxygen 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)	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 ZR22A Heater Assembly (Spare Parts for Model ZR22G)	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 Detectors and Accessories

Sample gas temperature 0 to 700°C				Sample gas temperature 700 to 1400°C	
Mounting	Insertion length	General use Probe	Application	High temperature detector	Application
Horizontal to vertical	0.15 to 2 m	 Detector (ZR22G) Dust protector (ZH21B) Humidity analyzer use	Boiler Heating furnace	 Sample outlet Absorption structure Probe adapter for high temperature use ZO21P-H Sample inlet	Heating furnace
Vertical	2.5 m or more	 Detector (only ZR22G -040)			
Horizontal to vertical	3 m or less	 Probe Protector (ZO21R) Detector (ZR22G) Sample inlet	For pulverized coal boiler with gas flow velocity 10 m/sec or more	<p>Temperature: Probe material: SUS310S 800°C Probe material: SiC 1400°C Mounting: Vertical downwards Insertion length: 1.0 m, 1.5 m When duct pressure is atmospheric or negative, attach air ejector. High temperature auxiliary ejector assembly (E7046EC, E7046EN)</p>	
Horizontal to vertical	0.15 to 2 m	 Dust filter for Oxygen Analyzer (K9471UA) or Detector(ZR22G)	Black liquid recovery boiler Cement Kiln	 Pressure gauge Needle valve Inlet Ejector	
Vertical	2.5 m or more	 Dust guard protector (K9471UC)		 Blow	

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2. Specifications

This chapter describes the specifications for the following:

ZR22G	General use separate type detector (See Section 2.2.1)
ZO21R	Probe protector (See Section 2.2.2)
ZH21B	Dust protector (See Section 2.2.3)
ZR22G (0.15 m)	High temperature separate type detector (See Section 2.3.1)
ZO21P	Adapter for High temperature probe (See Section 2.3.2)
ZR402G	Separate type converter (See Section 2.4)
ZA8F	Flow setting unit (See Section 2.5.1)
ZR40H	Automatic calibration unit (See Section 2.5.2)
ZO21S	Standard gas unit (See Section 2.6)

2.1 General Specifications

■ 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) The sampling gases containing a corrosive gas such as ammonia or chlorine may be applicable to our oxygen gas analyzer. In this case, contact with YOKOGAWA and its agency. (In case of Humidity Analyzer, Water vapor (in vol%) in mixed gases (air and water vapor))
Measurement System:	Zirconia system
Measurement Range:	0.01 to 100 vol%O ₂ (In case of Humidity Analyzer, 0 to 100 vol% H ₂ O 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 ₂ O (in 1 vol% H ₂ O), 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 ₂ O, 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. (range from 0 to 5 vol%O ₂ or more and less than 0 to 25 vol%O ₂ range) ±1% Maximum value of set range. (range from 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% H ₂ O; (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 ; 0 to 5 vol%O ₂ or more and 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 ₂ O; (Sample gas pressure: within ± 0.49 kPa) ± 3 vol% H ₂ O; (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 ₂ O/month
Response Time :	Response of 90% within 5 seconds. (Measured after gas is introduced from calibration gas inlet and analog output start changing.)

Safety, EMC and RoHS conforming standards the ZR22G and ZR402G

Installation altitude based on IEC 61010: 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: 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 IEC 63000

2.2 General use Separate type Detector and Related Equipment

General use separate type detector ZR22G can be used in combination with the probe protector ZO21R (see Section 2.2.2).

In case of Humidity Analyzer, the "Detector with dust protector" consists of ZR22G general-use separate-type detector and ZH21B dust protector (refer to Section 2.2.3).

2.2.1 ZR22G General use Separate type Detector

Sample Gas Temperature: 0 to 700°C (Probe only)

It is necessary to mount the cell using Inconel cell-bolts when the temperature is greater than 600°C.

700 to 1400°C (with High Temperature Probe Adapter)

For high temperature sample gas (700 to 1400°C), apply 0.15 m long probe and High Temperature Probe Adapter ZO21P.

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.)
For 0.15 m probe, -0.5 to 5 kPa. No pressure fluctuation in the furnace should be allowed.

No pressure fluctuation in the process should be allowed.

In case of Humidity Analyzer, -5 to 2 kPa

Note: When the detector is used in conjunction with a check valve and a ZA8F Flow Setting Unit, the maximum pressure of sample gas is 150 kPa. When with a check valve and a ZR40H Automatic Calibration Unit, it is 200 kPa. If the pressure of your sample gas exceeds these limits, consult with Yokogawa.

Probe Length: 0.15, 0.4, 0.7, 1.0, 1.5, 2.0, 2.5, 3.0, 3.6, 4.2, 4.8, 5.4 m
In case of Humidity Analyzer, 0.15 m is excluded

Probe Material: SUS 316 (JIS)

Ambient Temperature: -20 to 150°C

Reference Gas System: Natural Convection, Instrument Air, or Pressure Compensation (other than for probe length 0.15 m)

Instrument Air System (excluding Natural Convection) :

Pressure; 200 kPa + the pressure inside the furnace (It is recommended to use air which has been dehumidified by cooling to dew point -20°C or less, and dust or oil mist removed.)

Consumption; Approx. 1 NI/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.)

Terminal Box Case: Material; Aluminum alloy

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

Cover; Mint green (Munsell 5.6BG3.3/2.9)

Finish: Polyurethane corrosion-resistant coating

Gas Connection: Rc1/4 or 1/4 FNPT

Wiring Connection: G1/2, Pg 13.5, M20 × 1.5, 1/2 NPT

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 exceeds 2.5 m, mount vertically downward (within $\pm 5^\circ$), and use a probe protector.
Weight:	Insertion length of 0.4 m: approx. 6 kg (JIS 5K 65) / approx. 11 kg (ANSI 150 4) Insertion length of 1.0 m: approx. 8 kg (JIS 5K 65) / approx. 13 kg (ANSI 150 4) Insertion length of 1.5 m: approx. 10 kg (JIS 5K 65) / approx. 15 kg (ANSI 150 4) Insertion length of 2.0 m: approx. 12 kg (JIS 5K 65) / approx. 17 kg (ANSI 150 4) Insertion length of 3.0 m: approx. 15 kg (JIS 5K 65) / approx. 20 kg (ANSI 150 4) Insertion length of 3.6 m: approx. 17 kg (JIS 5K 65) / approx. 22 kg (ANSI 150 4) Insertion length of 4.2 m: approx. 19 kg (JIS 5K 65) / approx. 24 kg (ANSI 150 4) Insertion length of 4.8 m: approx. 21 kg (JIS 5K 65) / approx. 26 kg (ANSI 150 4) Insertion length of 5.4 m: approx. 23 kg (JIS 5K 65) / approx. 28 kg (ANSI 150 4)

● Model and Codes

Style : S2

Model	Suffix code	Option code	Description
ZR22G	-----	-----	Separate type Zirconia Oxygen/Humidity Analyzer, Detector
Length	-015 -040 -070 -100 -150 -200 -250 -300 -360 -420 -480 -540	----- ----- ----- ----- ----- ----- ----- ----- ----- ----- ----- -----	0.15 m (for high temperature use) (*1) 0.4 m 0.7 m 1.0 m 1.5 m 2.0 m 2.5 m (*2) 3.0 m (*2) 3.6 m (*2) 4.2 m (*2) 4.8 m (*2) 5.4 m (*2)
Wetted material	-S -C	----- -----	Stainless steel Stainless steel with Inconel calibration gas tube (*10)
Flange (*3)	-A -B -C -E -F -G -K -L -M -P -Q -R -S -W	----- ----- ----- ----- ----- ----- ----- ----- ----- ----- ----- ----- ----- -----	ANSI Class 150 2 RF ANSI Class 150 3 RF ANSI Class 150 4 RF DIN PN10 DN50 A DIN PN10 DN80 A DIN PN10 DN100 A JIS 5K 65 FF JIS 10K 65 FF JIS 10K 80 FF JIS 10K 100 FF JIS 5K 32 FF (for high temperature use) (*4) JPI Class 150 4 RF JPI Class 150 3 RF Westinghouse
Reference gas	-C -E -P	----- ----- -----	Natural convection External connection (Instrument air) (*11) Pressure compensated (*11)
Gas Thread	-R -T	----- -----	Rc 1/4 1/4 NPT(Female)
Connection box thread	-P -G -M -T -Q	----- ----- ----- ----- -----	G1/2 Pg13.5 M20 x1.5 mm 1/2NPT Quick connect (*9)
Instruction manual	-J -E -C	----- ----- -----	Japanese English Chinese
—	-A	-----	Always -A
Options		/C	Inconel bolt (*5)
	Valves	/CV /SV	Check valve (*6) Stop valve (*6)
	Filter	/F1 /F2	Dust Filter (*7) Dust Guard Protector (*7)
	Tag plates	/SCT /PT	Stainless steel tag plate (*8) Printed tag plate (*8)

*1 Used with the ZO21P High Temperature Probe Adapter. Select flange (-Q). Only for Oxygen Analyzer.

*2 When installing horizontally the probe whose insertion length is 2.5 meters or 3.0 meters, use the Probe Protector. Be sure to specify ZO21R-L-200-□. Specify the flange suffix code either -C or -K.

*3 The thickness of the flange depends on its dimensions.

*4 Not used in conjunction with -P (pressure compensation) for reference gas. The flange thickness does not conform to JIS specification

*5 Inconel probe bolts and U shape pipe are used. Use this option for high temperature use (ranging from 600 to 700 °C).

*6 Specify either /CV or /SV option code.

*7 Not used with the high temperature humidity analyzer.

*8 Specify either /SCT or /PT option code.

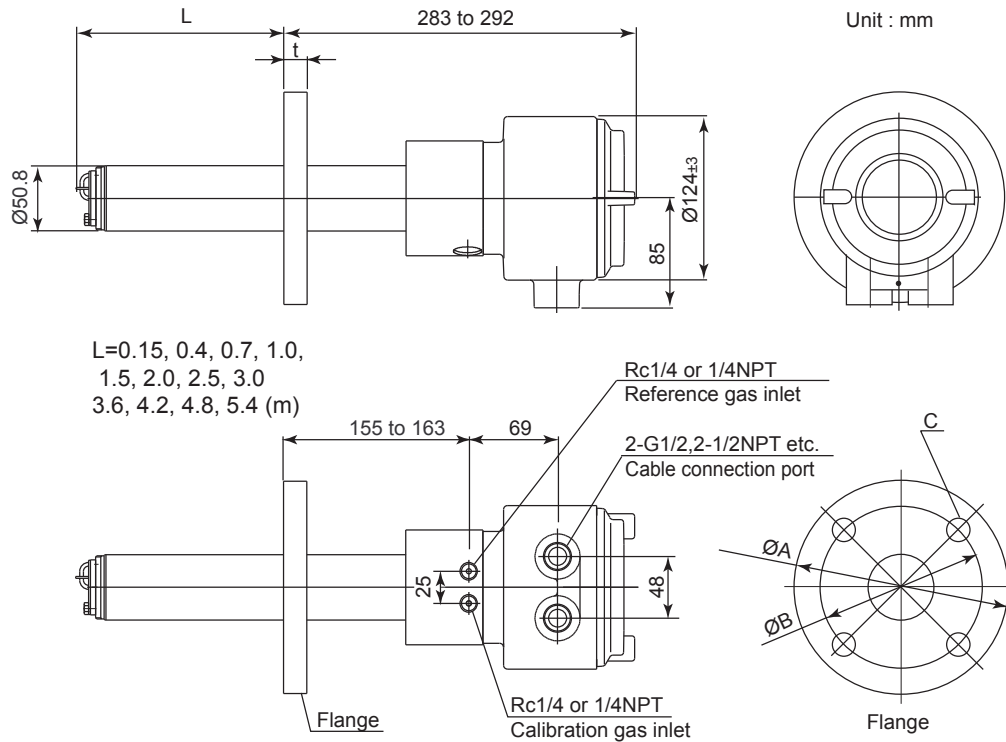
*9 Not waterproof, avoid rain. Operating maximum temperature is 80°C. Available only in the U.S.

*10 Recommended if sample gas contains corrosive gas like chlorine.

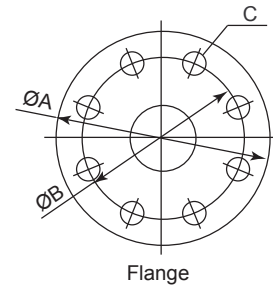
*11 Piping for reference gas must be installed to supply reference gas constantly at a specified flow rate.

● EXTERNAL DIMENSIONS

1. Model ZR22G Separate type Zirconia Oxygen/Humidity Analyzer, Detectors

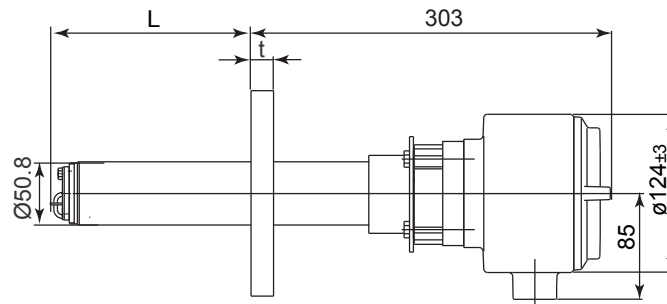


Flange	A	B	C	t
ANSI Class 150 2 RF	152.4	120.6	4 - Ø19	19
ANSI Class 150 3 RF	190.5	152.4	4 - Ø19	24
ANSI Class 150 4 RF	228.6	190.5	8 - Ø19	24
DIN PN10 DN50 A	165	125	4 - Ø18	18
DIN PN10 DN80 A	200	160	8 - Ø18	20
DIN PN10 DN100 A	220	180	8 - Ø18	20
JIS 5K 65 FF	155	130	4 - Ø15	14
JIS 10K 65 FF	175	140	4 - Ø19	18
JIS 10K 80 FF	185	150	8 - Ø19	18
JIS 10K 100 FF	210	175	8 - Ø19	18
JIS 5K 32 FF	115	90	4 - Ø15	5
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

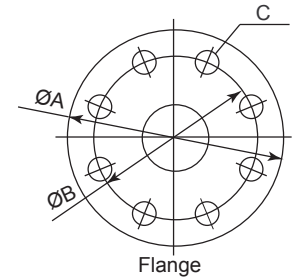
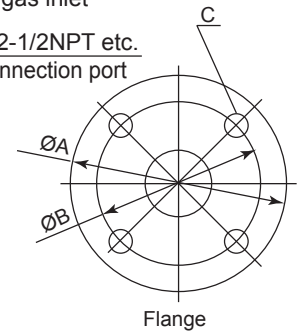
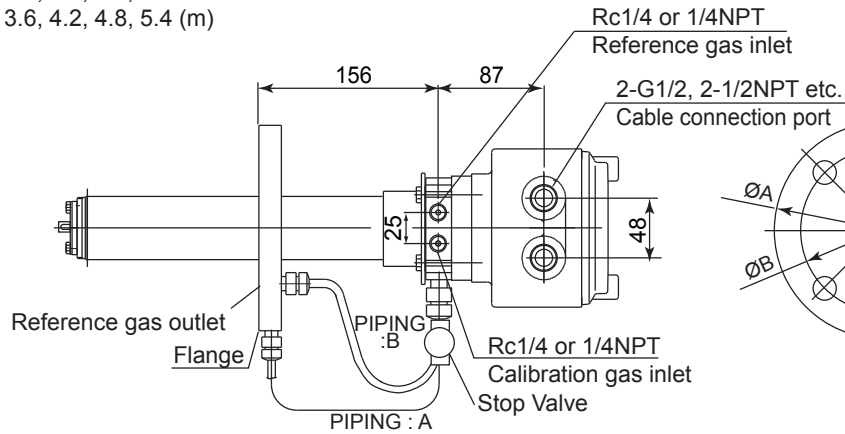


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2. Model ZR22G...-P (with pressure compensation) Separate type Zirconia Oxygen Analyzer, Detectors



L=0.15, 0.4, 0.7, 1.0,
1.5, 2.0, 2.5, 3.0
3.6, 4.2, 4.8, 5.4 (m)

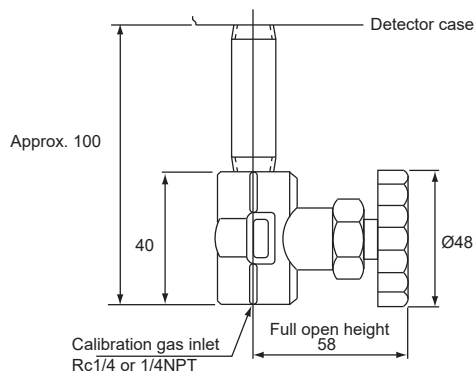


Flange	A	B	C	t	PIPING
ANSI Class 150 2 RF	152.4	120.6	4 - Ø19	19	A
ANSI Class 150 3 RF	190.5	152.4	4 - Ø19	24	B
ANSI Class 150 4 RF	228.6	190.5	8 - Ø19	24	B
DIN PN10 DN50 A	165	125	4 - Ø18	18	A
DIN PN10 DN80 A	200	160	8 - Ø18	20	B
DIN PN10 DN100 A	220	180	8 - Ø18	20	B
JIS 5K 65 FF	155	130	4 - Ø15	14	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

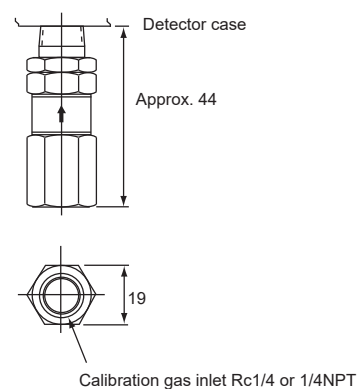
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● Check Valve (option code /CV), Stop valve (option code /SV) -specified Calibration gas inlet

Unit: mm



with Stop Valve (option: /SV)



with Check Valve (option: /CV)

2.2.2 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 or 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)

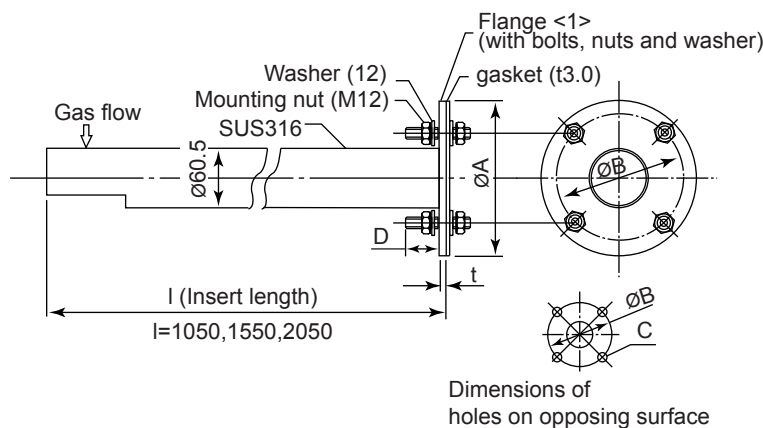
Weight: 1.05 m; Approx. 6/10/8.5 kg (JIS/ANSI),
1.55 m; Approx. 9/13/11.5 kg (JIS/ANSI),
2.05 m; Approx. 12/16/14.5 kg (JIS/ANSI)

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	-----	1.05 m (3.5 ft)
	-150	-----	1.55 m (5.1 ft)
	-200	-----	2.05 m (6.8 ft)
Flange (*1)	-J	-----	JIS 5K 65 FF
	-A	-----	ANSI Class 150 4 FF
Style code	*B	-----	Style B

*1 Thickness of flange depends on dimensions of flange.



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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

2.2.3 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.

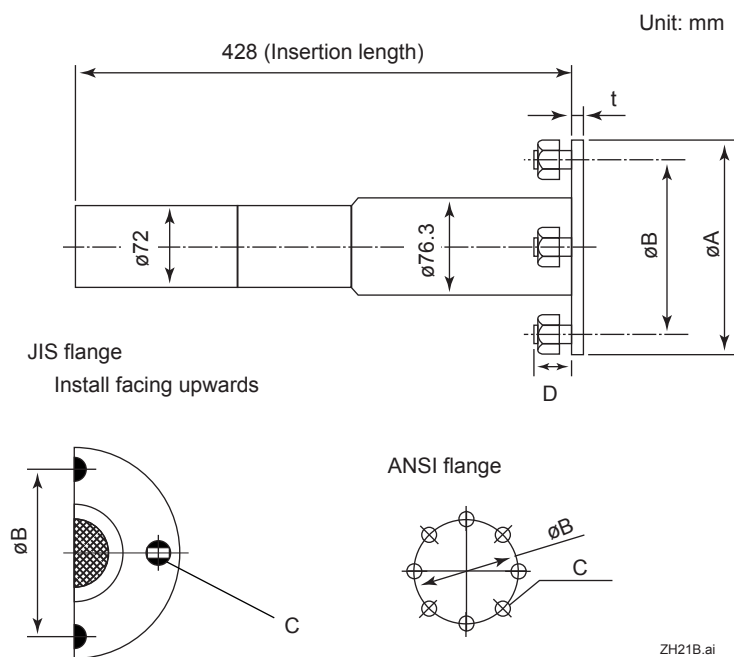
● Model and Codes

Model	Suffix code	Option code	Description
ZH21B	-----	-----	Dust Protector (0 to 600 °C)
Insertion length	-040	-----	0.428 m
Flange (*1)	-J	-----	JIS 5K 80 FF (*1)
	-A	-----	ANSI Class 150 4B FF (*2)
Style code	*B	-----	Style B

Note: The flange thickness varies.

*1: Specify the probe ZR22G-040-□-K

*2: Specify the probe ZR22G-040-□-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

2.3 Separate type Detector for High Temperature and Related Equipment

2.3.1 ZR22G (0.15m) Separate type Detector for High Temperature

Standard Specifications

Construction:	Water-resistant, non-explosionproof
Probe length:	0.15 m
Terminal box:	Aluminum alloy
Probe material:	Probe material in contact with gas: SUS 316 (JIS) (Probe), SUS304 (JIS) or ASTM grade 304 (Flange), Zirconia (Sensor), Hastelloy B, (Inconel 600, 601)
Weight:	Approx. 3 kg
Installation:	Flange mounting (The use of high temperature detector probe adapter ZO21P is necessary.)
Flange standard:	JIS 5 K 32 FF equivalent (thickness varies)
Mounting angle:	Any angle between horizontal and vertical (high temperature probe is fitted with an adapter)
Reference gas and calibration gas piping connection:	Rc 1/4 or 1/4 NPT female
Cable inlet:	G 1/2, Pg 13.5, M20 x 15, 1/2 NPT
Ambient temperature:	-20 to 150°C
Sample gas temperature:	0 to 700°C (temperature at the measuring point of the sampling gas. 0 to 750°C or 0 to 1400°C when the probe adapter for high temperature is used. Temperature of the probe adapter shall not exceed 300°C to protect the gasket and avoid the bolts seizing together.
Sample gas pressure:	-0.5 to 5 kPa: when used at the range of more than 0 to 25 vol%O ₂ , -0.5 to 0.5 kPa. (An ejector assembly is required for negative pressure application.)
Model and Code:	Refer to "Model and Codes" in page 2-5.
External Dimensions:	Refer to the Figure in page 2-6.

2.3.2 ZO21P High Temperature Probe Adapter

Measuring O₂ in the high temperature gases (exceeds 700°C) requires a general use probe ZR22G of 0.15 m length and a high temperature probe adapter.

Sample gas temperature: 0 to 1400°C (when using SiC probe)
0 to 800°C (when using SUS 310S probe adapter)

Sample gas pressure: -0.5 to 5 kPa. When using in the range of 0 to 25 vol%O₂ or more, the sample gas pressure should be in the range of -0.5 to 0.5 kPa. (Where the sample gas pressure for the high temperature probe is negative, an ejector assembly is necessary.)

Insertion length: 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 1.5 m

Material in Contact with Gas: SUS 316 (JIS), SiC or SUS 310S, SUS304 (JIS) or ASTM grade 304 (flange)

Probe Material: SiC, SUS 310S (JIS)

Installation: Flange mounting (FF type or RF type)

Probe Mounting Angle: Vertically downward within ± 5° Where the probe material is SUS 310S, horizontal mounting is available.

Construction: Non explosion-proof. Rainproof construction

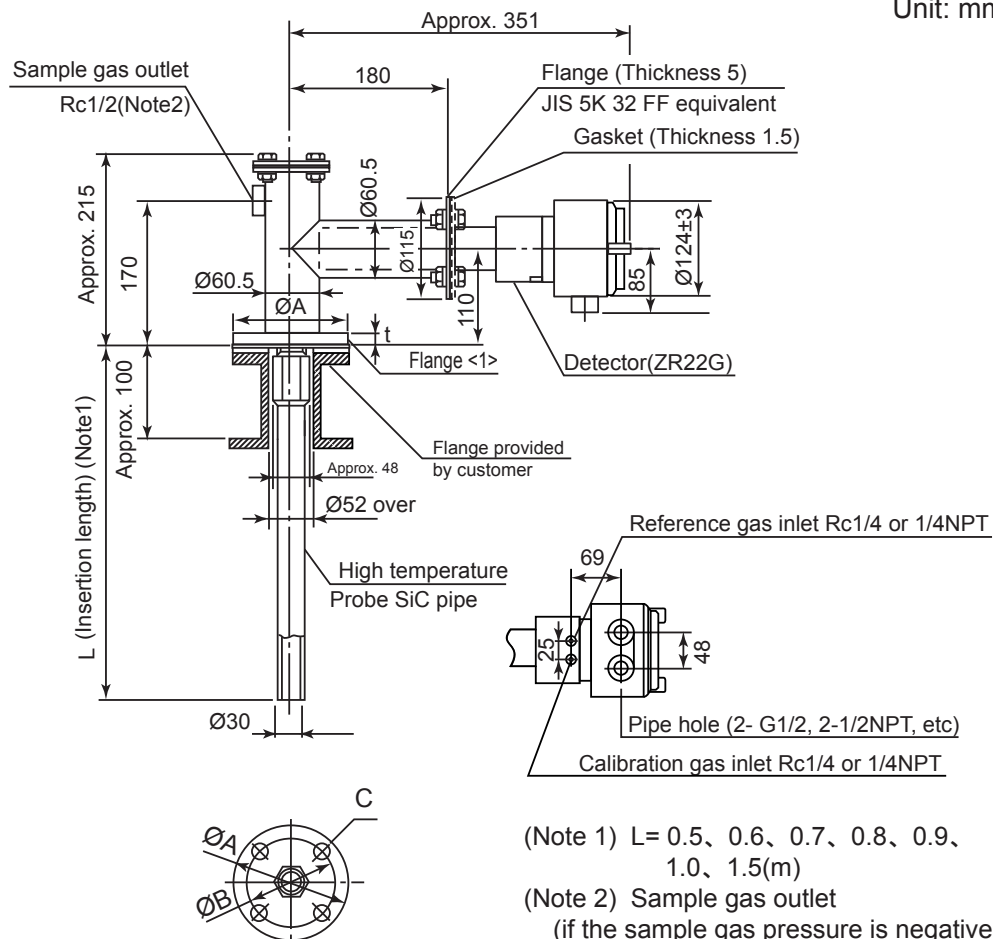
Weight(example): Insertion length of 1.0 m: approx. 5.3 kg (JIS) / approx. 11.3 kg (ANSI)
Insertion length of 1.5 m: approx. 5.8 kg (JIS) / approx. 11.8 kg (ANSI)

● Model and Codes

Model	Suffix code	Option code	Description
ZO21P	-H	-----	High Temperature Probe Adapter
Material	-A -B	----- -----	SiC SUS 310S (JIS)
Insertion length	-050 -060 -070 -080 -090 -100 -150	----- ----- ----- ----- ----- ----- -----	0.5 m 0.6 m 0.7 m 0.8 m 0.9 m 1.0 m 1.5 m
Flange	-J -N -M -L -A -R -Q -T -S -E	----- ----- ----- ----- ----- ----- ----- ----- ----- -----	JIS 5K 50 FF JIS 10K 65 FF JIS 10K 80 FF JIS 10K 100 FF ANSI Class 150 4 RF ANSI Class 150 2 1/2 RF ANSI Class 150 3 RF JPI Class 150 3 RF JPI Class 150 4 RF DIN PN10 DN50 A
Style code	*B	-----	Style B
Option	Ejector Tag plate	/EJ1 /EJ2 /SCT	Ejector Assy with E7046EC Ejector Assy with E7046EN Stainless steel tag plate

Note: For this high-temperature use probe adapter, be sure to specify the ZR22G probe of its insertion length 0.15 meters.

Unit: mm



Flange<1>	A	B	C	t
JIS 5K 50 FF	130	105	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
ANSI Class 150 4 RF	228.6	190.5	8 - Ø19	24
ANSI Class 150 3 RF	190.5	152.4	4 - Ø19	24
ANSI Class 150 2 RF	177.8	120.6	4 - Ø19	19
JPI Class 150 4 RF	229	190.5	8 - Ø19	24
JPI Class 150 3 RF	190	152.4	4 - Ø19	24
DIN PN10 DN50A	165	125	4 - Ø18	18

2.4 ZR402G Separate type Converter

● Standard Specification

The ZR402G Separate type Converter can be controlled by LCD touchscreen on the converter.

Display:	LCD display of size 320 by 240 dot with touchscreen.
Output Signal:	4 to 20 mA DC, two points (maximum load resistance 550 Ω)
Contact Output Signal:	Four points (one is fail-safe, normally open)
Contact Input:	Two points
Analog Input:	One point (thermal input 4-20 mA)
Automatic Calibration Output:	Two points (for dedicated automatic calibration unit)
Ambient Temperature:	-20 to 55°C
Storage Temperature:	-30 to 70°C
Ambient Humidity:	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.
Maximum Distance between Detector and Converter:	Conductor two-way resistance must be 10 Ω or less (when a 1.25 mm ² cable or equivalent is used, 300 m or less.)
Construction:	Equivalent to NEMA 4X/IP66 (with conduit holes completely sealed with a cable gland)
Wiring Connection:	G1/2, Pg13.5, M20 x 1.5 mm, 1/2 NPT (with plug), eight holes
Installation:	Panel, wall or pipe mounting
Case:	Aluminum alloy
Paint Color:	Door: Silver gray (Munsell 3.2PB7.4/1.2) Case: Silver gray (Munsell 3.2PB7.4/1.2)
Finish:	Polyurethane corrosion-resistance coating
Weight:	Approx. 6 kg

● Functions

Display Functions: (includes Humidity Analyzer)

- Value Display; Displays values of the measured oxygen concentration, moisture quantity, mixture ratio, etc
- Graph Display; Displays trends of measured oxygen concentration, moisture quantity, mixture ratio, etc.
- Data Display; Displays various useful data for maintenance, such as cell temperature, reference junction temperature, maximum/minimum oxygen concentration, maximum/minimum moisture quantity or the like
- Status Message; Indicates an alarm or error occurrence by flashing of the corresponding icon. Indicates status such as warming-up, calibrating, or the like by icons.
- Alarm, Error Display; Displays alarms such as "Abnormal oxygen concentration", "Abnormal moisture quantity" or errors such as "Abnormal cell e.m.f." when any such status occurs.

Calibration Functions:

- Automatic calibration; Requires the ZR40H Automatic Calibration Unit. It calibrates automatically at specified intervals.

Semi-auto Calibration; Requires the ZR40H Automatic Calibration Unit. Input calibration direction on the touchscreen or contact, then it calibrates automatically afterwards.

Manual Calibration; Calibration with opening/closing the valve of calibration gas in operation interactively with an LCD touchscreen.

Blow back Function:

Output through the contact in the set period and time. Auto/Semi_Auto selectable.

Maintenance Functions:

Can operate updated data settings in daily operation and checking. Display data settings, calibration data settings, blow back data settings, current output loop check, input/output contact check.

Setup Functions:

Initial settings suit for the plant conditions when installing the converter.
Equipment settings, current output data settings, alarm data settings, contact data settings, other settings.

Self-diagnosis:

This function diagnoses conditions of the converter or the detector and indicates when any abnormal condition occurs.

Password Functions:

Enter your password to operate the analyzer excepting data display.
Individual passwords can be set for maintenance and setup.

Display and setting content: (includes Humidity Analyzer)

Measuring related items: Oxygen concentration (vol%O₂), output current value (mA), air ratio, moisture quantity (in hot gases) (vol%H₂O), mixture ratio (kg/kg), relative humidity (%RH) and dew point (°C)

Display Items: Cell temperature (°C), thermocouple reference junction temperature (°C), maximum/minimum/average oxygen concentration (vol%O₂), maximum/minimum/average moisture quantity (vol% H₂O), 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)

Calibration Setting Items: Span gas concentration (vol%O₂), zero gas concentration (vol%O₂), 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)

Equipment Related Items: Measuring gas selection

Output Related Items: Analog output/output mode selection, output conditions when warming-up/maintenance/calibrating (during blow back)/abnormal, oxygen concentration at 4 mA/20 mA (vol% O₂), moisture quantity at 4 mA/20 mA (vol% H₂O), mixture ratio at 4 mA/20 mA (kg/ kg), time constant.

Alarm Related Items: Oxygen concentration high alarm/high-high alarm limit values (vol%O₂), oxygen concentration low alarm/low-low alarm limit values (vol%O₂), moisture quantity high alarm/high-high alarm limit values (vol% H₂O), moisture quantity lowalarm/ low-low alarm limit values (vol% H₂O), mixture ratio high alarm/high-high alarm limit value (kg/ kg), mixture ratio low alarm/low-low alarm limit values (kg/ kg), oxygen concentration alarm hysteresis (vol%O₂), 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 to 4 (abnormal, high-high alarm, high alarm, low alarm, low-low alarm, maintenance, calibrating, range switching, warming-up, calibration gas pressure decrease, temperature high alarm, blow back, flameout gas detection, calibration coefficient alarm, stabilization timeout)
Converter Output:	Two points mA analog output (4 to 20 mA DC (maximum load resistance of 550 Ω)) and one mA digital output point (HART) (minimum load resistance of 250 Ω).
Oxygen analyzer;	Range: Any setting between 0 to 5 through 0 to 100 vol%O ₂ in 1 vol%O ₂ , or 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 provided.
Humidity analyzer;	Range: any setting between 0 to 5 through 0 to 100 vol% O ₂ , 0 to 25 through 0 to 100 vol% H ₂ O, 0 to 0.200 through 0 to 1.000 kg/ kg or partial range is available. For the log output, the minimum range values are fixed at 0.1 vol% O ₂ for the oxygen concentration, 0.1 vol% H ₂ O for the moisture quantity, and 0.01 kg/kg for the mixture ratio. 4 to 20 mA DC linear or log can be selected. Input/output isolation provided.
Output damping:	0 to 255 seconds. Hold / non-hold selection, preset value setting possible with hold.
Contact Output:	Four points, contact capacity 30 V DC 3 A, 250 V AC 3 A (resistive load) Three of the output points can be selected to either normally energized or normally de-energized status. Delayed functions (0 to 255 seconds) and hysteresis function (0 to 9.9 vol%O ₂ , 0 to 9.9 vol%H ₂ O, 0.000 to 0.010 kg/kg) 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) Temperature high alarm, (12) Blow back start, (13) Flameout gas detection (answer-back of contact input), (14) Calibration coefficient alarm, (15) Startup power stabilization timeout alarm Contact output 4 is set to normally operated, and fixed error status.
Converter Input:	Thermal input one point (4 to 20 mA DC)
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), (5) Blow back start
Contact capacity:	Off-state leakage current: 3 mA or less
Self-diagnosis:	Abnormal cell, abnormal cell temperature (low/high), abnormal calibration, defective A/D converter, defective digital circuit
Calibration:	
Method;	zero/span calibration
Calibration mode;	automatic, semi-automatic and manual (All are operated interactively with an LCD touchscreen). Either zero or span can be skipped.
Zero calibration gas concentration setting range:	0.3 to 100 vol%O ₂ (in increments of 0.01 vol%O ₂ in smallest units).

Span calibration gas concentration setting range:

4.5 to 100 vol%O₂ (in increments of 0.01 vol%O₂ in smallest units).

Use nitrogen-balanced mixed gas containing 0 to 10 vol%O₂ scale of oxygen, and 80 to 100 vol%O₂ scale of oxygen for standard zero gas and standard span gas respectively.

Calibration interval; date/time setting: maximum 255 days

● Model and Codes

Model	Suffix code		Option code	Description
ZR402G	-----		-----	Separate type Zirconia Oxygen/Humidity Analyzer, Converter
Converter thread	-P -G -M -T		----- ----- ----- -----	G1/2 Pg13.5 M20x1.5 mm 1/2NPT
Display		-J -E -G -F -C -P	----- ----- ----- ----- ----- -----	Japanese English German French Chinese Portuguese
Instruction manual		-J -E -C	----- ----- -----	Japanese English Chinese
—			-A	----- Always -A
Options Tag plates NAMUR NE43compliant			/HS	Set for Humidity Analyzer (*1)
			/H	Hood (*3)
			/SCT /PT	Stainless steel tag plate (*2) Printed tag plate (*2)
			/C2	Failure alarm down-scale: Output status at CPU failure and hardware error is 3.6 mA or less (*4)
			/C3	Failure alarm up-scale: Output status at CPU failure and hardware error is 21.0 mA or more (*4)

*1 For humidity measurements, be sure to specify /HS options.

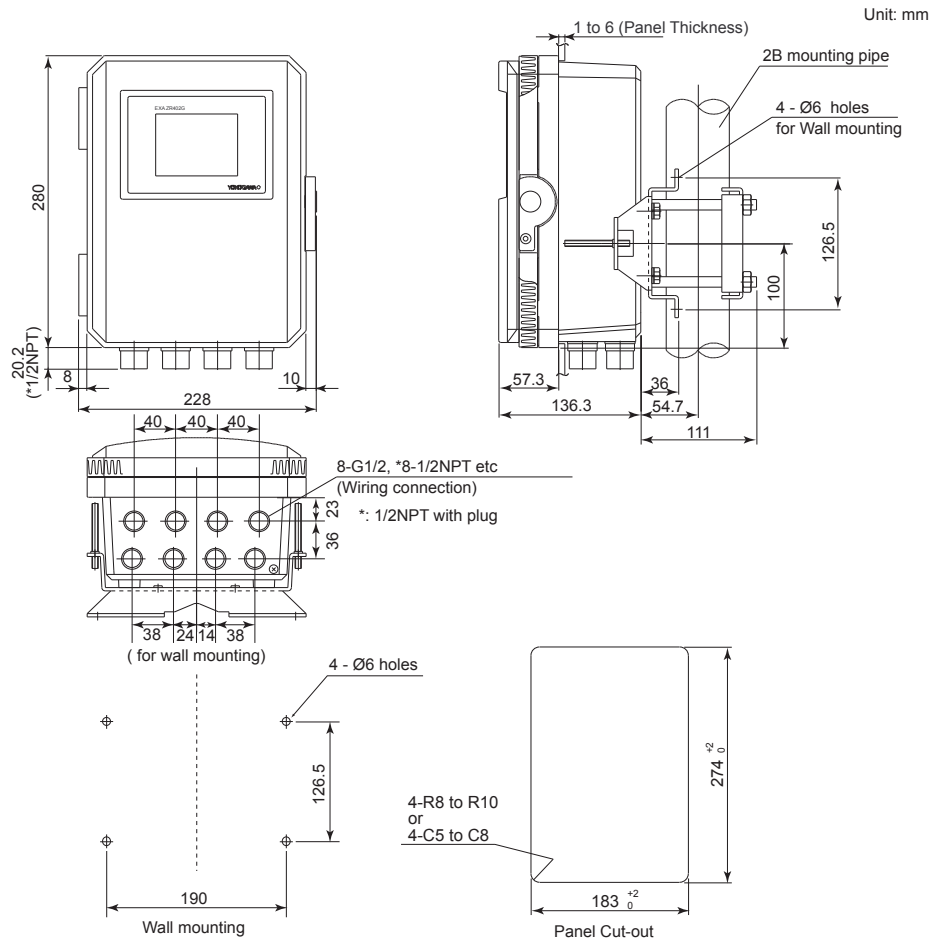
*2 Specify either /SCT or /PT option code.

*3 Sun shield hood is still effective even if scratched.

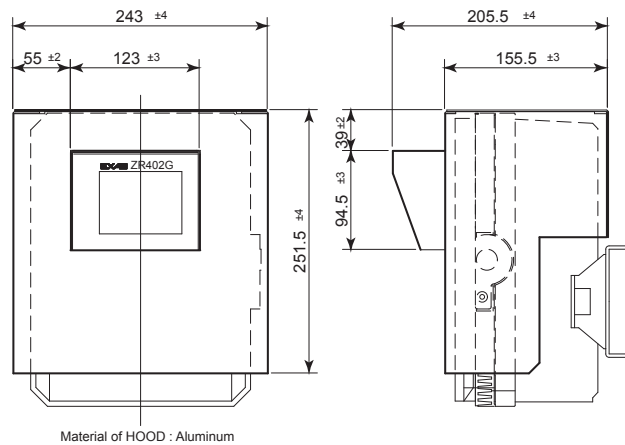
*4 Output signal limits: 3.8 to 20.5 mA. Specify either /C2 or /C3 option code.

(Note) If AC line voltage is 125 V AC or greater, or in the EEC, the ZO21D cannot be used with the ZR402G.

● External Dimensions



● With sun shield hood (option code /H)



● Accessories

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Item	Pat.No.	Qty	Description
Fuse	A1113EF	1	3.15A
Bracket for mounting	F9554AL	1	For pipe mounting, panel mounting or wall mounting
Screw for Bracket	F9123GF	1	

2.5 ZA8F Flow Setting Unit and ZR40H Automatic Calibration Unit

2.5.1 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 rates 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 1/4FNPT
Reference Gas pressure:	Clean air supply of sample gas pressure plus approx. 50 kPaG (or sample gas pressure plus approx. 150 kPa G when a check valve is used). Pressure at inlet of the Flow Setting Unit.(Maximum 300 kPaG)
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)

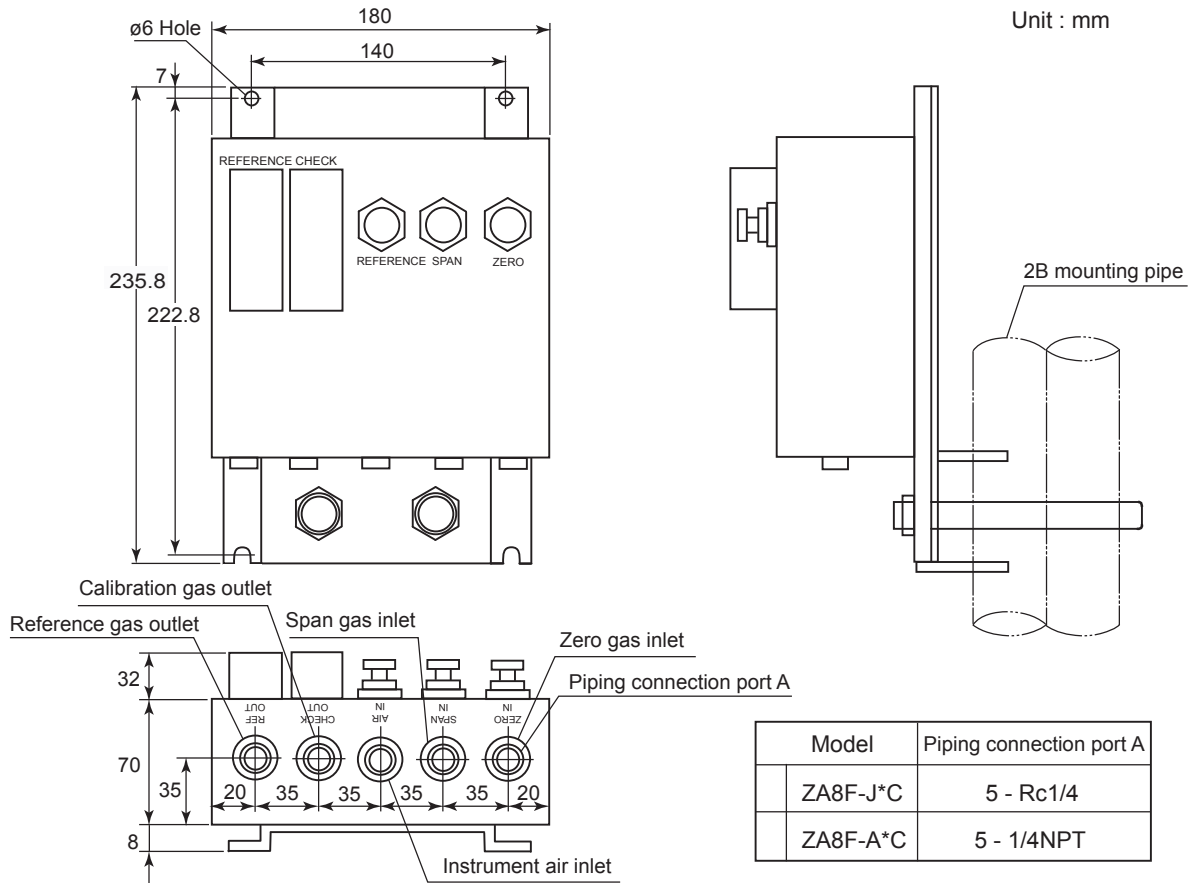
NOTE

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

● Model and Codes

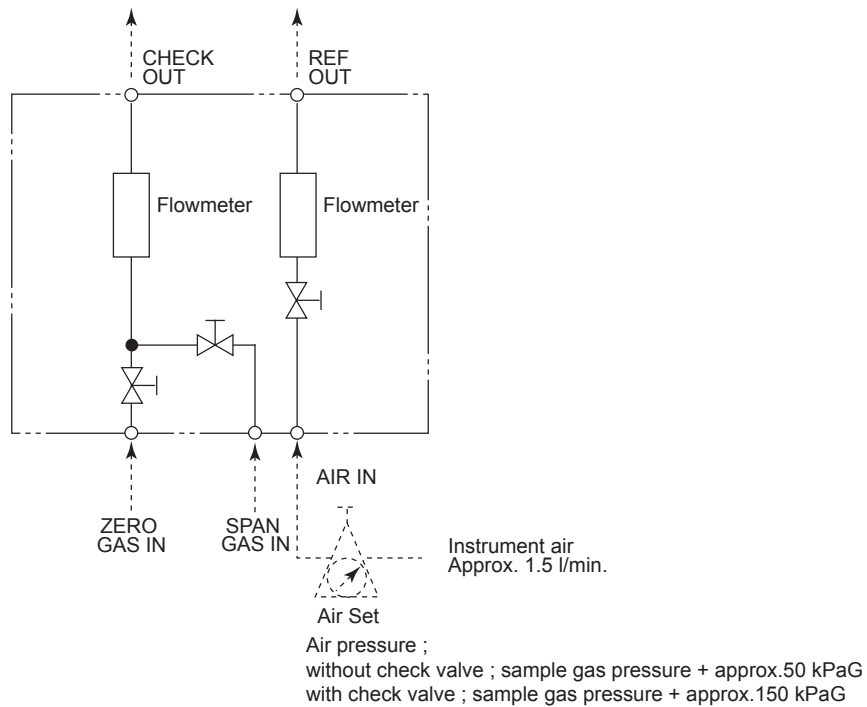
Model	Suffix code	Option code	Description
ZA8F	-----	-----	Flow setting unit
Joint	-J -A	----- -----	Rc 1/4 With 1/4 NPT adapter
Style code	*C	-----	Style C

● External Dimensions



PIPING INSIDE THE FLOW SETTING UNIT

Weight : Approx. 2.3 kg



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2.5.2 ZR40H 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

Used when auto calibration is required for the separate type and instrument air is provided. The solenoid valves are provided as standard.

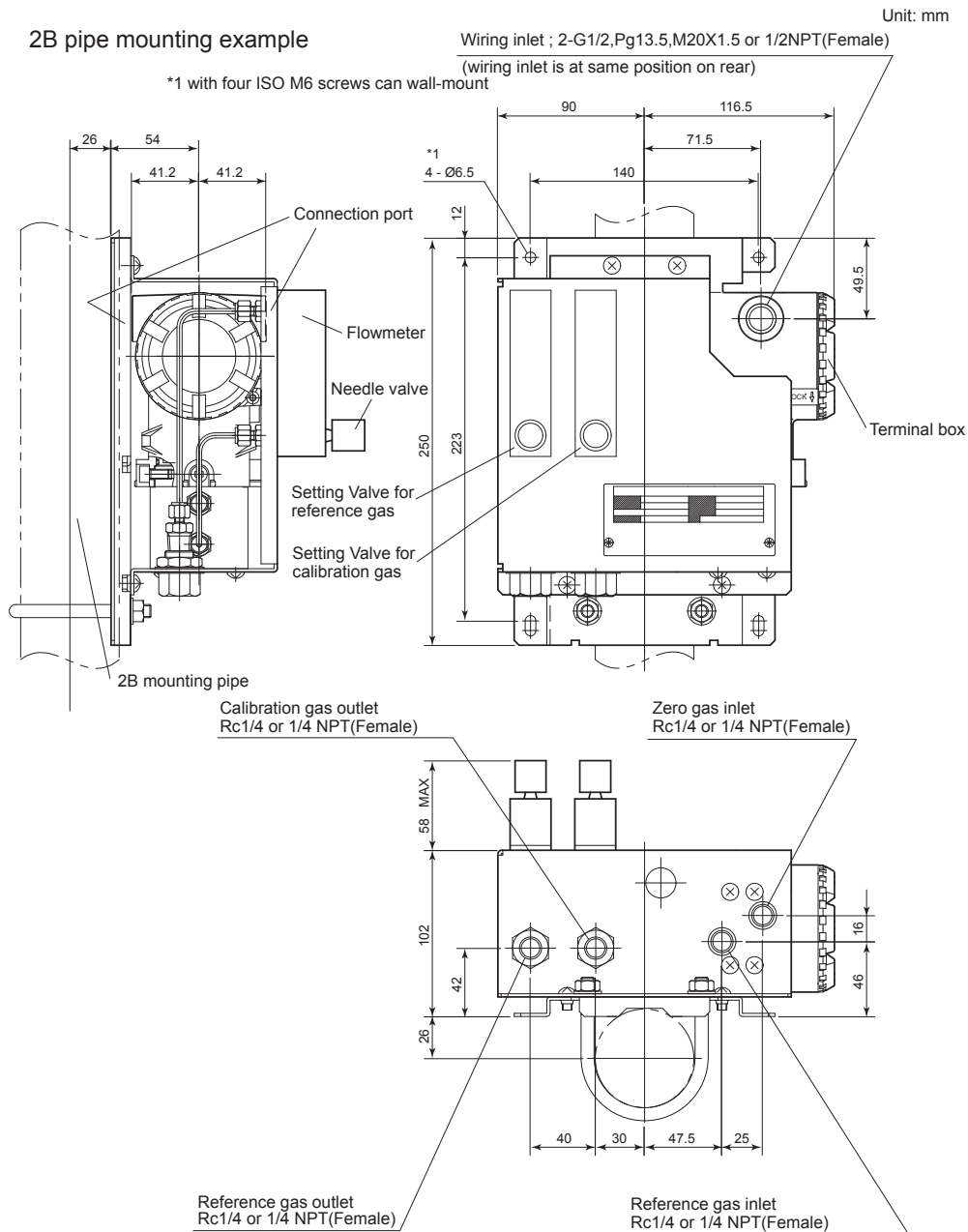
Construction:	Dust-proof and rainproof construction: NEMA4X/IP67-only for case coating solenoid valve, not flowmeter (excluding flowmeter)
Mounting:	2-inch pipe or wall mounting, no vibration
Materials:	Body; Aluminum alloy, Piping; SUS316 (JIS), SUS304 (JIS), Flowmeter; MA (Metha acrylate resin). Bracket; SUS304 (JIS)
Finish:	Polyurethane corrosion-resistance coating, mint green (Munsell 5.6BG3.3/2.9)
Piping Connection:	Refer to Model and Codes
Power Supply:	24 V DC (from ZR402G), Power consumption; Approx.1.3W
Reference Gas Pressure:	Sample gas pressure plus approx. 150 kPa (690 kPa max.), (Pressure at inlet of the Automatic Calibration Unit)
Air Consumption:	Approx. 1.5 l/min
Weight:	Approx. 3.5 kg
Ambient Temperature:	-20 to +5°C, no condensation or freezing
Ambient Humidity:	0 to 95%RH
Storage Temperature:	-30 to 65°C

● Model and Codes

Model	Suffix code	Option code	Description
ZR40H	-----	-----	Automatic calibration unit for ZR402G
Gas piping connection	-R -T	----- -----	Rc 1/4 1/4 NPT
Wiring connection	-P -G -M -T	----- ----- ----- -----	Pipe connection (G1/2) Pg 13.5 M20 x 1.5 mm 1/2 NPT
—	-A	-----	Always -A

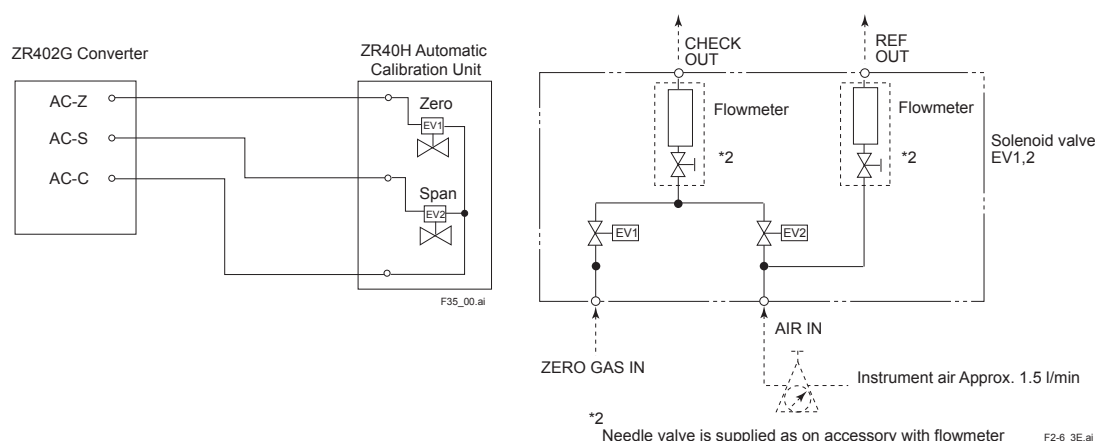
● External Dimensions

2B pipe mounting example



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● Piping Diagram



2.6 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 provided): E7050BA

Capacity: 1 L

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

Composition: 0.95 to 1.0 vol%O₂ + N₂ balance

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

Power Consumption: Max. 5 VA

Case material: SPCC (cold rolled steel sheet)

Paint Color: Mainframe; Munsell 2.0 GY3.1/0.5 equivalent

Cover; Munsell 2.8 GY6.4/0.9 equivalent

Piping: Ø6 x Ø4 mm flexible tube connection

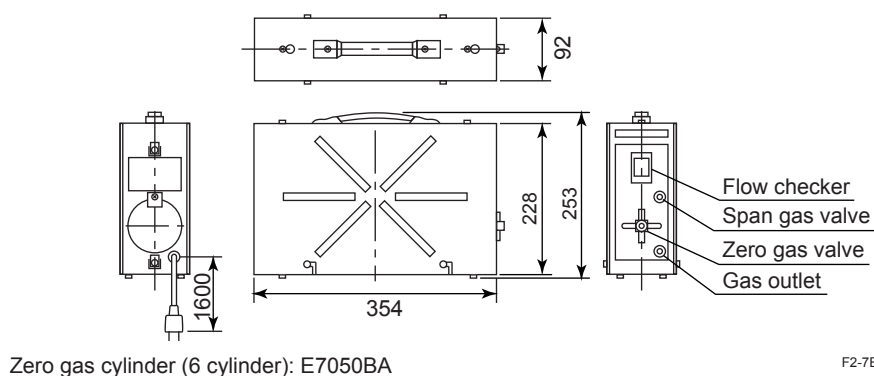
Weight: Approx. 3 kg

● 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

Unit: mm



2.7 Other Equipments

2.7.1 Dust Filter for the Detector (K9471UA)

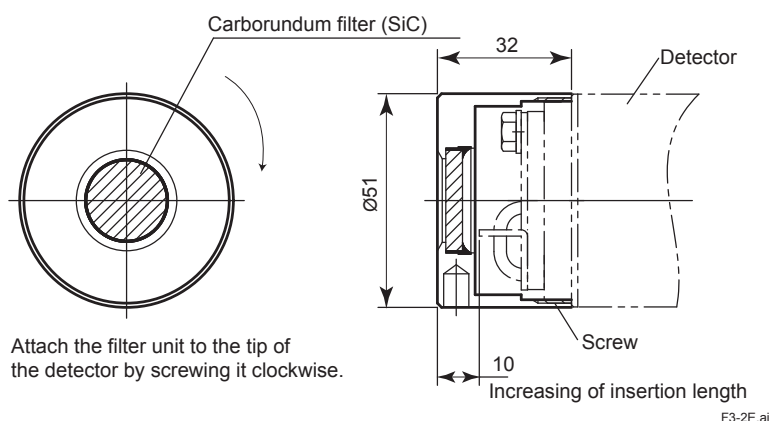
This filter is used to protect the detector sensor from a corrosive dust components or high velocity dust in recovery boilers and cement kilns.

Sample gas flow rate is needed to be 1 m/sec or more 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:	Carborundum (Filter), SUS316 (JIS)
Weight:	Approx. 0.2 kg

Part No.	Description
K9471UA	Filter
K9471UX	Tool

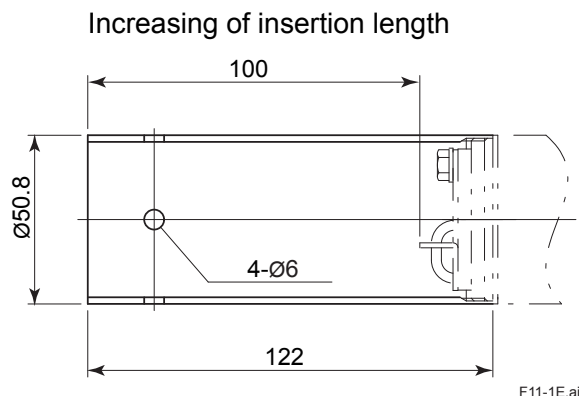


2.7.2 Dust Guard Protector (K9471UC)

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



2.7.3 Ejector Assembly for High Temperature (E7046EC, E7046EN)

This ejector assembly is used where pressure of sample gas for high temperature detector is negative. This ejector assembly consists of an ejector, a pressure gauge assembly and a needle valve.

● Standard Specifications

Ejector

Ejector Inlet Air Pressure: 29 to 69 kPa G

Air Consumption: Approx. 30 to 40 l/min

Suction gas flow rate: 3 to 7 l/min

Connection: Rc1/4, SUS304 (JIS)

Tube Connection: Ø6 / Ø4 mm or 1/4 inch copper tube (stainless tube)

Pressure Gauge Assembly

Material in Contact with Gas: SUS316 (JIS)

Case Material: Aluminum alloy (Paint color; black)

Scale: 0 to 100 kPaG

Connection: R1/4 or 1/4NPT, SUS304 (JIS) (with Bushing G3/8 x R1/4 or 1/4NTP)

Needle Valve

Connection: Rc1/4 or 1/4FNPT

Material: SUS316 (JIS)

(Note) Pipe and connections are not provided.

Part No.	Description
E7046EC	Ejector; Ø6 / Ø4 TUBE joint, Pressure gauge; R1/4, Needle valve; Rc1/4: SUS304 (JIS)
E7046EN	Ejector; 1/4 TUBE joint, Pressure gauge; 1/4NPT(M), Needle valve; 1/4FNPT : SUS304 (JIS)

< Pressure setting for the ejector assembly for high temperature use >

Pressure supply for the ejector assembly should be set so that the suction flow of the sample gas becomes approximately 5 l/min.

To set this, proceed as follows:

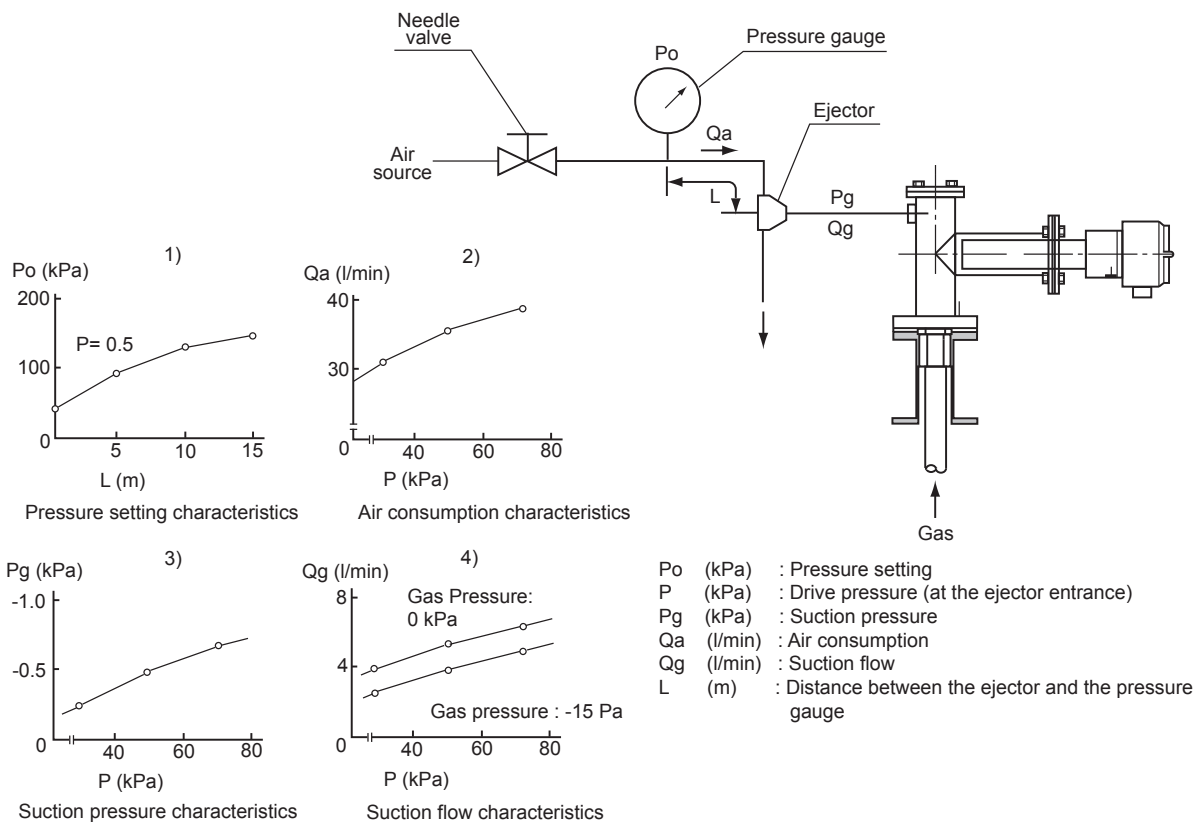
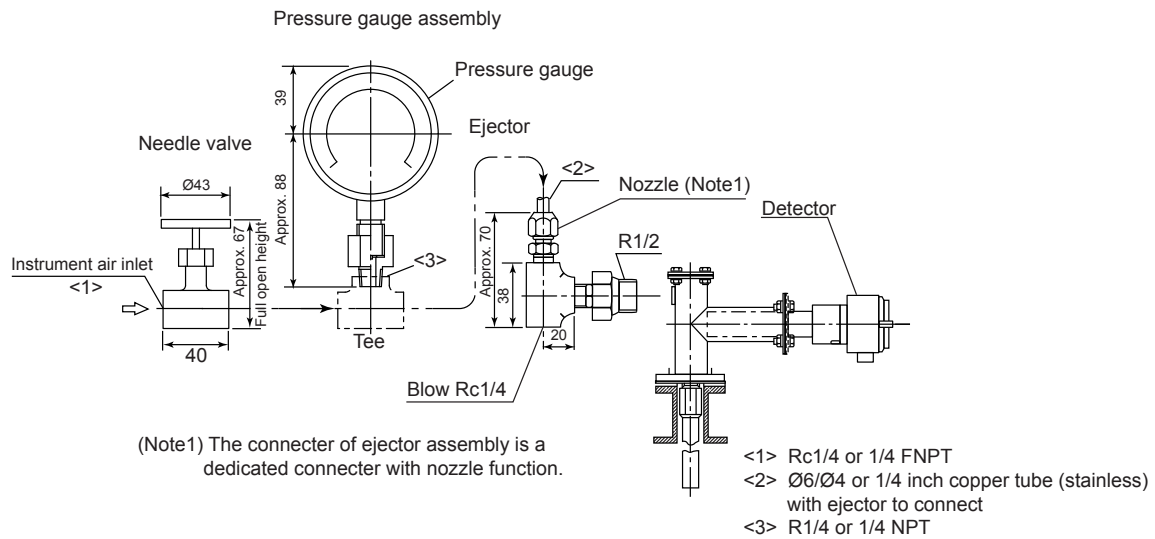
- (1) In Graph 4, draw a horizontal line from the 5 l/min point. on the vertical axis (Suction flow: Q_g) toward the gas pressure line to be used, to find the point of intersection. Draw a line vertically down from the point of intersection to the axis to find the drive pressure, P (at the ejector entrance).
- (2) In Graph 1, determine P_o (pressure setting) from L (the distance between the ejector and the pressure gauge).
- (3) Open the needle valve to supply air for the ejector to the pressure gauge until it indicates the pressure setting, P_o .

NOTE

Q_g (the suction flow) may require change according to the conditions of use. Refer to Section 3.2.1 and Section 4.1.4 for details.

Graph explanation

- (1) Graph 1 is to compensate for pressure loss in piping between the ejector and the pressure gauge, and find P_o (pressure setting).
- (2) Graph 2 shows correlation between P (drive pressure) and Q_a (air consumption).
- (3) Graph 3 shows correlation between P (drive pressure) and P_g (suction pressure; when the sample gas inlet of the ejector is closed).
- (4) Graph 4 shows correlation between P (drive pressure) and Q_g (suction flow) for each gas pressure.



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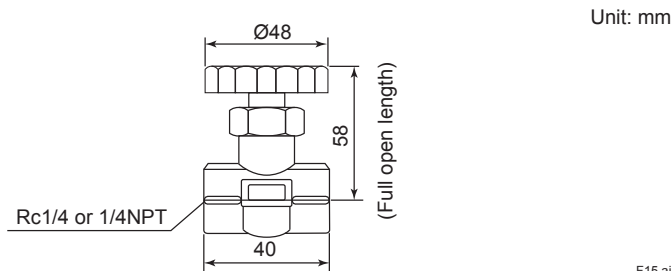
2.7.4 Stop Valve (L9852CB, G7016XH)

This valve mounted on the calibration gas line in the system to allow for manual calibration. This applies to the system configuration shown for system 1 in section 1.

Standard Specifications

Connection: Rc 1/4 or 1/4 NPT(F)
 Material: SUS 316 (JIS)
 Weight: Approx. 150 g

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



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2.7.5 Check Valve (K9292DN, 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 2 and 3) system configuration.

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

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

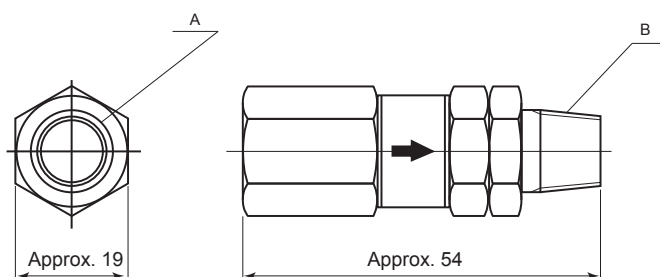
● Standard Specifications

Connection: Rc1/4 or 1/4NPT(F)
 Material: SUS304 (JIS)
 Pressure: 70 kPa G or more and 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, Material: SUS304 (JIS)

K9292DN : Rc 1/4(A), R 1/4(B)
 K9292DS : 1/4FNPT(A), 1/4NPT(Male)(B)

Unit: mm



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2.7.6 Air Set

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

● Standard Specifications

G7003XF, 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: Rc 1/4, Material: Zinc alloy
K9473XK	Joint: 1/4 NPT(F) with adapter, Material: Zinc alloy, Adapter: SUS 316

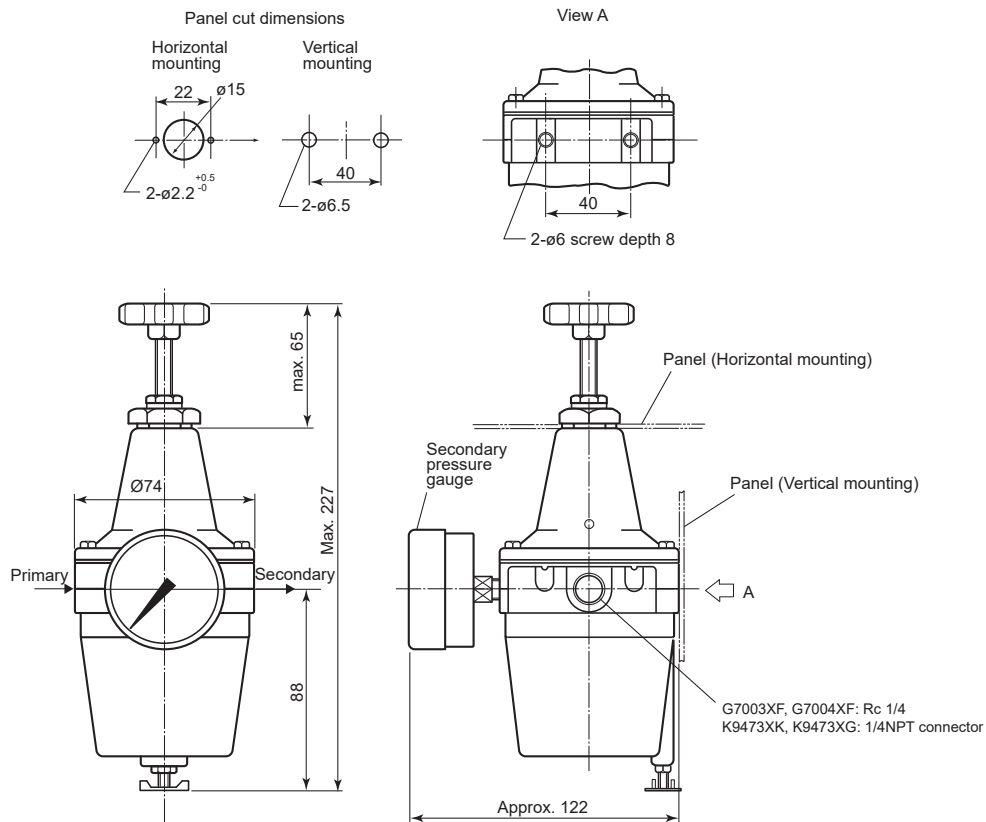
G7004XF, K9473XG

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: Rc 1/4, Material: Zinc alloy
K9473XG	Joint: 1/4 NPT(F) with adapter, Material: Zinc alloy, Adapter: SUS 316

● External Dimensions

Unit : mm



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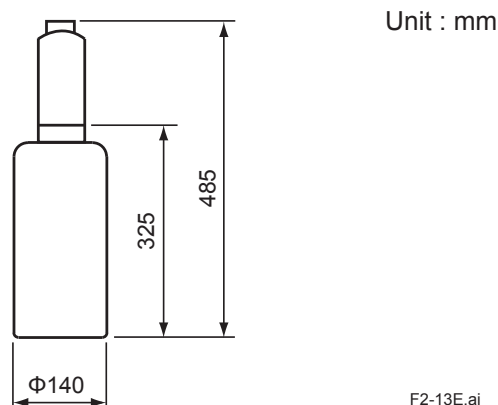
2.7.7 Zero Gas Cylinder (G7001ZC)

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%O₂ in N₂
 Weight: Approx. 6 kg

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

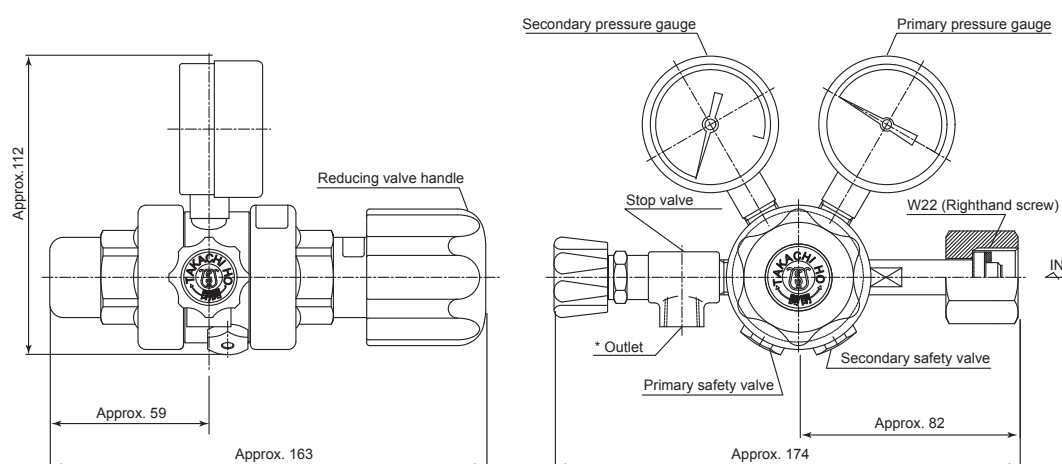


2.7.8 Cylinder Pressure Reducing Valve (G7013XF, G7014XF)

This pressure reducing 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(F)
 Material: Brass body



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

2.7.9 Case Assembly for Calibration Gas Cylinder (E7044KF)

This case assembly is used to store the zero gas cylinders.

● Standard Specifications

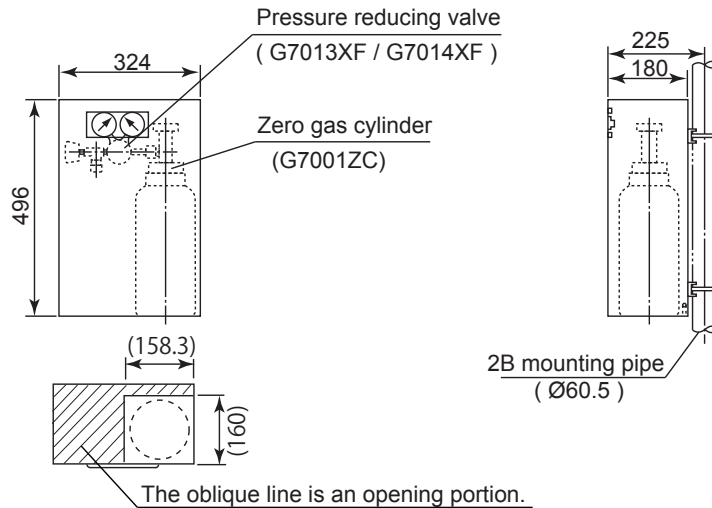
Installation: 2B pipe mounting

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 cylinder to most countries is prohibited or restricted.



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

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2.7.10 ZR22A Heater Assembly

● Model and Codes

Style: S2

Model	Suffix code	Option code	Description
ZR22A	-----	-----	Heater Assembly for ZR22G
Length (*1)	-015 -040 -070 -100 -150 -200 -250 -300	----- ----- ----- ----- ----- ----- ----- -----	0.15 m 0.4 m 0.7 m 1 m 1.5 m 2 m 2.5 m 3 m
Jig for change	-A -N	----- -----	with Jig (*2) None
Reference gas (*3)	-A -B -C	----- ----- -----	Natural convention, External connection (Instrument air) Pressure compensated (for ZR22G S2) Pressure compensated (for ZR22G S1)

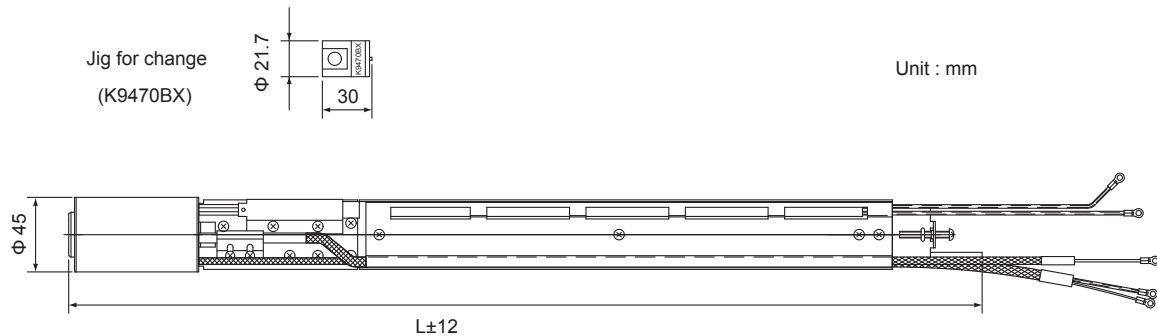
*1 Suffix code of length should be selected as same as ZR22G installed.

*2 Jig part no. is K9470BX to order as a parts after purchase.

*3 Select appropriately among "-A", "-B", "-C" according to the reference gas supply method and style.

(Note) The heater is made of ceramic, do not drop or subject it to pressure stress.

● External Dimensions



Model & Codes	L	Weight (kg)
ZR22A-015	302	Approx. 0.5
ZR22A-040	552	Approx. 0.8
ZR22A-070	852	Approx. 1.2
ZR22A-100	1152	Approx. 1.6
ZR22A-150	1652	Approx. 2.2
ZR22A-200	2152	Approx. 2.8
ZR22A-250	2652	Approx. 3.4
ZR22A-300	3152	Approx. 4.0

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3. Installation

This chapter describes installation of the following equipment:

Section 3.1	General-purpose Detector (except ZR22G-015)
Section 3.2	High Temperature Detector (ZR22G-015)
Section 3.3	Converter
Section 3.4	ZA8F Flow Setting Unit
Section 3.5	ZR40H Automatic Calibration Unit
Section 3.6	Case Assembly (E7044KF)

3.1 Installation of General-purpose Detector

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

- (1) Easy and safe access to the detector for checking and maintenance work.
- (2) An ambient temperature of not more than 150°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 detector (model ZR22G-□-□-□-C), which uses ambient air as reference gas, requires that the ambient oxygen concentration be constant.

- (4) No vibration.
- (5) The sample gas satisfies the specifications described in Chapter 2.
- (6) No sample gas pressure fluctuations.

3.1.1 Probe Insertion Hole

Includes those analyzers equipped with a probe supporter and probe protector.

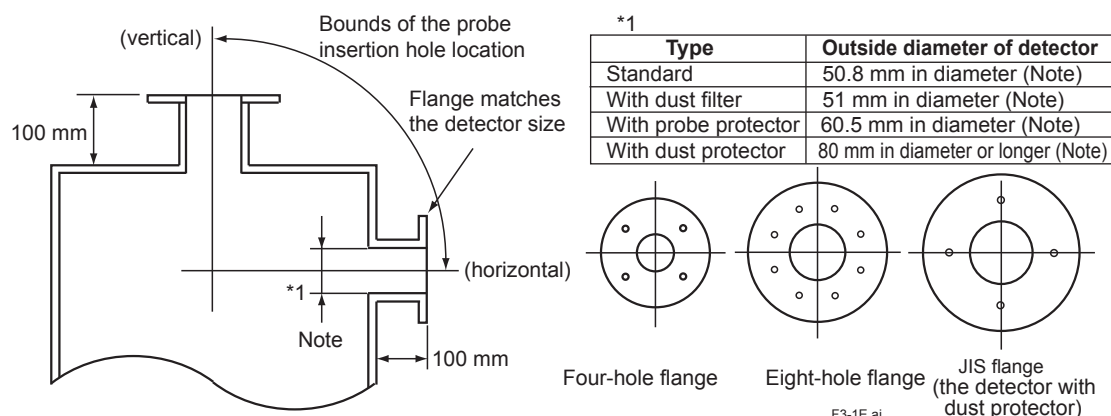
When preparing the probe insertion hole, the following should be taken into consideration:

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.
- 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 in the flange gasket. Confirm the external dimensions of the detector in Section 2.2 before installation.
- The sensor (zirconia cell) at the tip of the detector 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 meters 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.



(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. Confirm the outside dimensions of the detector in Section 2.2 before installation.

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 Detector

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>

- Make sure that the cell mounting screws (four bolts) at the tip of the detector are not loose. If a dust filter (see Section 2.7.1) is used, make sure it is properly attached to the detector. Refer to Section 3.1.3 for installation of the dust filter.
- 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

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 cement kilns. If a filter is used in combustion systems other than these, it may have adverse effects such as response delay. These 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 replace the filter on 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 assembly by putting it on the end of the detector and screw the assembly clockwise. Put a hook pin wrench (K9471UX), $\varnothing 52$ to $\varnothing 55$ in diameter, into the hole on the assembly to fasten or remove it.
Apply a heat-resistant coating (see Note 1) to the threads on the detector.
When remounting filter assembly 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 heat-resistant coating on the threads to prevent seizing up.
Name of the heat-resistant coating material: NEVER SEEZ Nickel Special™.

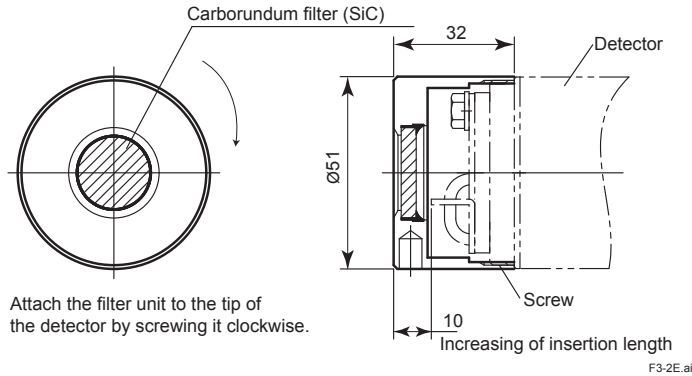


Figure 3.2 Installation of the dust filter

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

The ZR22G detector 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 $\varnothing 52$ to $\varnothing 55$ hole (Pin diameter 4.5 mm: P/N K9741UX 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.

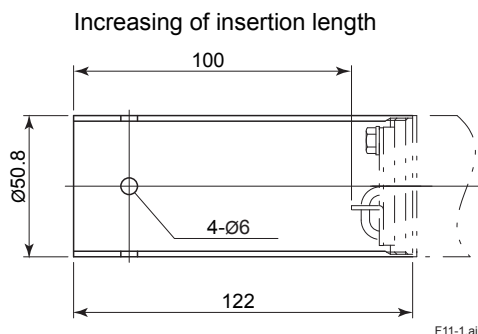


Figure 3.3

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

The detector is used with a probe protector to support the probe (ZR22G) when the probe length is 2.5 m or more and it is 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 tip of the detector are not loose.
- (3) Mount the detector so that the reference gas and calibration gas inlet faces downward.

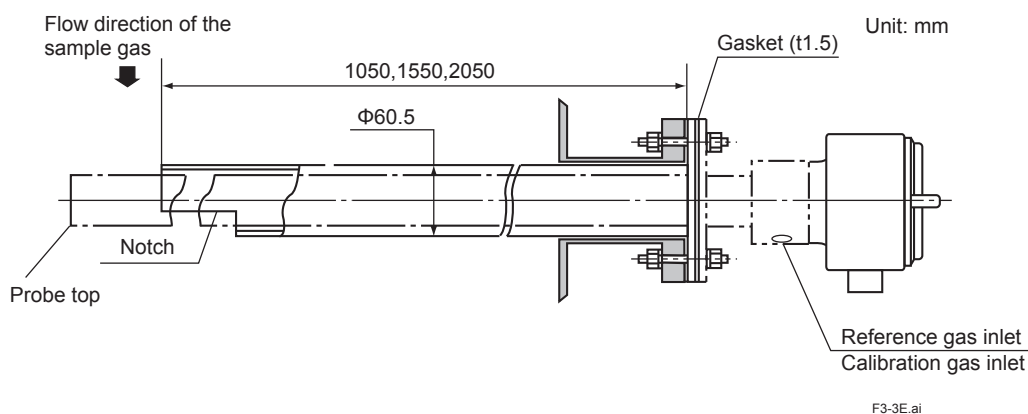


Figure 3.4 Probe protector (supporting the mounting strength)

<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 (pulverized coal boiler or fluidized-bed furnace).

- (1) Put a gasket (provided by the user) between the flanges, and mount the probe protector in the probe insertion hole. The probe protector should be installed so that the notch is 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 reference gas and calibration gas inlet should face downward.

CAUTION

When the probe protector is used in the ZR22G with pressure compensation (-P), instrument air leaking from the probe protector may affect the measured value.

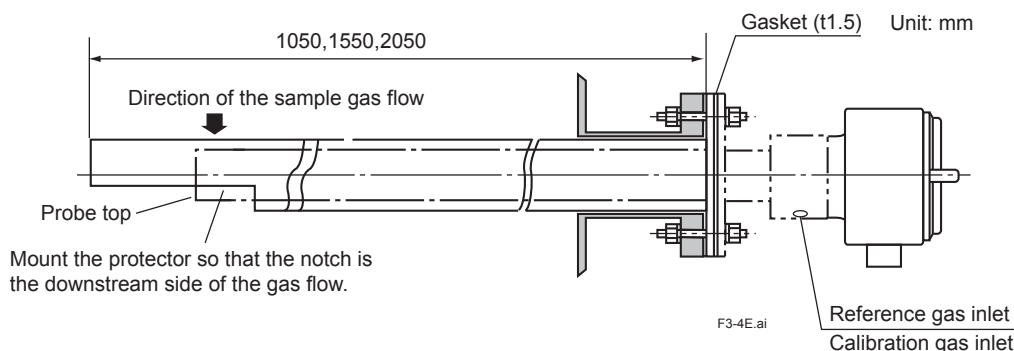


Figure 3.5 Mounting of detector with a probe protector

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.

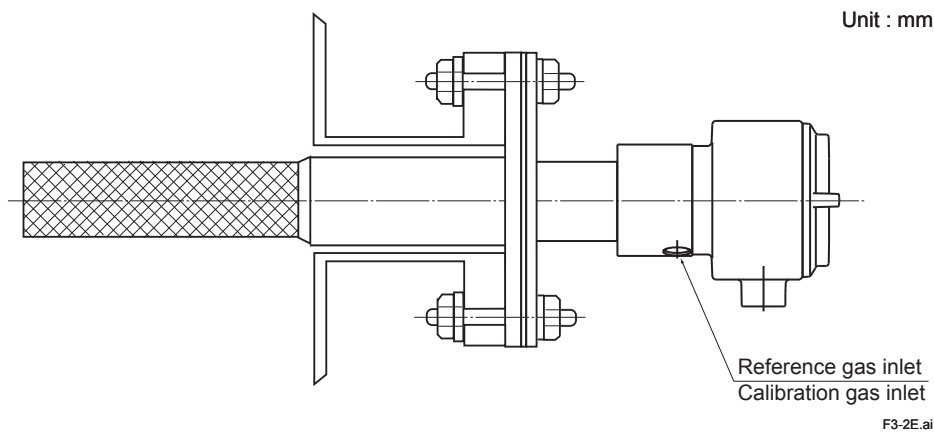


Figure 3.6 Installation of the dust filter

3.2 Installation of High Temperature Detector (ZR22G-015)

This detector is used with the High Temperature Probe Adapter (Model ZO21P-H) when the temperature of sample gas exceeds 700°C, or when it is required due to maintenance spaces.

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

- (1) Easy and safe access to the detector for checking and maintenance work.
- (2) Ambient temperature of not more than 150°C and the terminal box should not be exposed to radiant heat.
- (3) A clean environment without any corrosive gases.
- (4) No vibration.
- (5) The sample gas should satisfy the specifications described in Chapter 2.

3.2.1 Usage of the High Temperature Probe Adapter (ZO21P-H)

During analysis, the surface temperature of the probe adapter should be within the range from more than the dew point of the sample gas and 300°C or less to prevent ejector clogging, gasket deterioration or bolt scoring.

Where the dew point of the sample gas is not known, keep within the range of more than 200°C to less than 300°C.

The temperature shall be measured at the probe in the probe adapter and the surface of the blind flange at the opposite side.

When the surface temperature is not within the above range, the following measures can be taken to change the temperature.

<When the surface temperature exceeds 300°C>

- (1) When the furnace pressure is negative, lower the pressure setting to reduce induction flow of the sample gas.
Refer to Section 2.7.3, Ejector Assembly for High Temperature, for the setting of induction flow. When you reduce induction flow, ensure that the ejector inducts air when the furnace pressure fluctuates.
- (2) When the furnace pressure is positive, close the needle valve for the sample gas outlet to reduce the exhaust gas flow. Refer to Section 4.1.4, Piping to the High Temperature Probe Adapter.

- (3) When the probe adapter is surrounded by a heat insulator, remove the heat insulator. Ensure that the temperature of the probe adapter does not fall below the dew point of the gas in winter.
- (4) To prevent temperature rises due to radiant heat, insert heat insulator between the wall of the furnace and the probe adapter.
- (5) To prevent temperature rises from thermal conduction, place the mounting flange as far from the wall of the furnace as possible.

<When the surface temperature is less than 200°C or below the dew point of the sample gas>

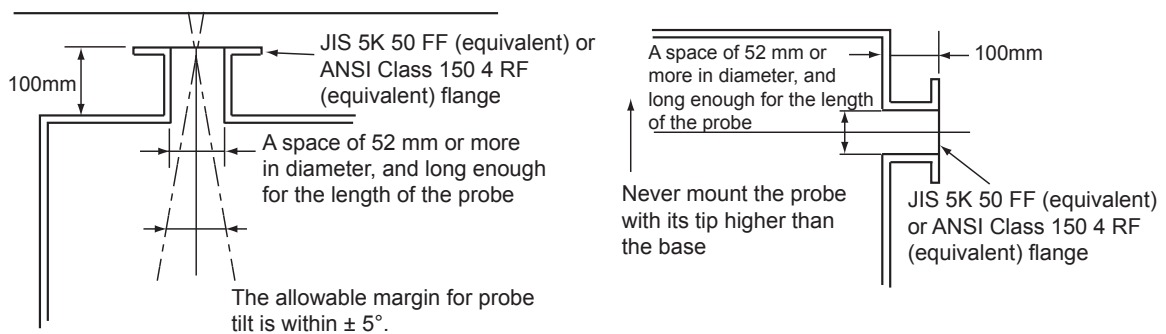
- (1) When the furnace pressure is negative, raise the pressure setting to increase induction flow of the sample gas.
Refer to Section 2.7.3, Ejector Assembly for High Temperature, for the setting of induction flow. If there is much dust in the gas, the ejector may become clogged as induction flow increases.
- (2) When the furnace pressure is positive, open the needle valve of the sample gas outlet to increase the gas flow.
Refer to Section 4.1.4, Piping to the High Temperature Probe Adapter.
- (3) Warm the probe adapter. Refer to Section 4.1.4, Piping to the High Temperature Probe Adapter.
- (4) When the surface temperature is still less than 200°C or below the dew point of the sample gas, even if the above measures have been taken, warm the probe adapter using a heat source such as steam.

3.2.2 Probe Insertion Hole

A high temperature detector consists of a ZR22G-015 Detector and ZO21P High Temperature Probe Adapter. When forming the probe insertion hole, the following should be taken into consideration:

- (1) If the probe is made of silicon carbide (SiC), the probe hole should be formed so that the probe is mounted vertically (within $\pm 5^\circ$ tilt).
- (2) In the case where the probe is made of stainless steel and the probe adapter (ZO21P-H-B) is to be mounted horizontally, the probe hole should be formed so that the probe tip is not higher than the probe base.

Figure 3.7 illustrates examples of the probe insertion hole.



An SiC probe shall be mounted vertically.

Horizontal mounting is used with a SUS probe.

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Figure 3.7 Examples of the probe insertion hole

3.2.3 Mounting of the High Temperature Detector

CAUTION

- Ceramic (zirconia) is used in the sensor (cell) portion on the detector probe tip. Care should be taken not to drop the detector during installation.
- The same applies to a probe made of silicon carbide (SiC).
- A gasket should be used on the flange surface to prevent gas leakage. The gasket material should be selected depending on the characteristics of the sample gas. It should be heatproof and corrosion-proof. The parts, which should be supplied by the user, are listed in Table 3.1.

Table 3.1 Accessories for mounting high temperature probe adapter

Mounting flange specification	Parts name	Q'ty	Note
JIS 5K 50 FF (equivalent)	Gasket	1	Heatproof and corrosion-proof
	Bolt (M12 by 50)	4	
	Nut (M12)	4	
	Washer (for M12)	8	
ANSI Class 150 4RF (equivalent)	Gasket	1	Heatproof and corrosion-proof
	Bolt (M16 by 60)	8	
	Nut (M16)	8	
	Washer (for M16)	16	

A high temperature detector should be mounted as follows:

- (1) It is recommended to mount the detector vertically. When it is impossible due to the physical arrangements and the detector is mounted horizontally, ensure that the probe tip be placed no higher than the probe base.
- (2) When mounting a high temperature probe adapter, be sure to insert a gasket between the flanges to prevent gas leakage. When the furnace pressure is negative, ensure that there is no leakage of air into the detector.
- (3) When mounting the detector in a position other than vertical, the cable inlet should face downward.
- (4) When installing the detector in a low-temperature location such as in the open air, cover the probe adapter including the ejector with a heat insulator (e.g. ceramic wool) to keep it warm and to prevent condensation of drain on the ejector.

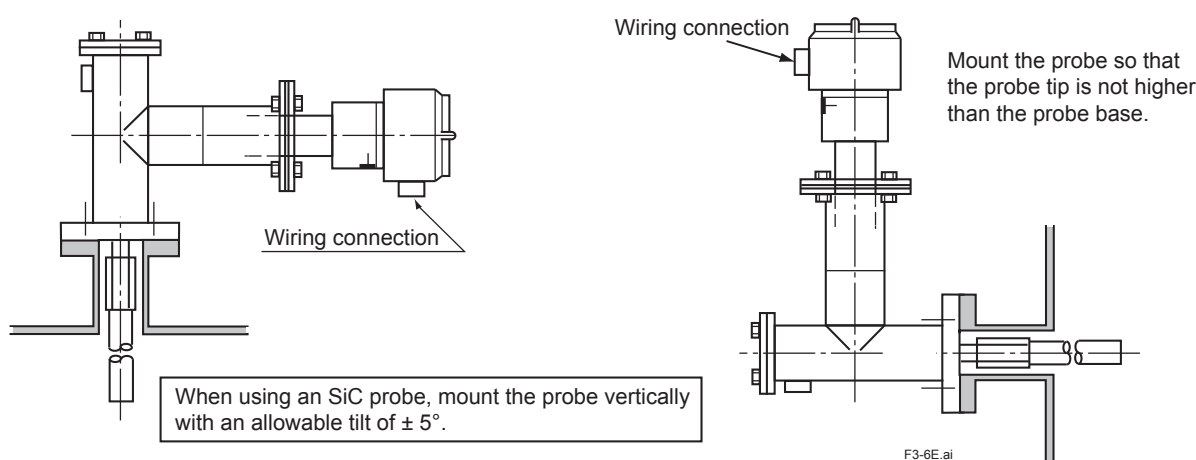


Figure 3.8 Mounting of the High Temperature Detector

3.3 Installation of the ZR402G Converter

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

- (1) Readability of the indicated values of oxygen concentration or messages on the converter display. Easy and safe access to the converter for operating keys on the panel.
- (2) Easy and safe access to the converter for checking and maintenance work.
- (3) An ambient temperature of not more than 55°C and little change in temperature (recommended within 15°C in a day).
- (4) The normal ambient humidity (recommended between 40 to 75%RH) and without any corrosive gases.
- (5) No vibration.
- (6) Near to the detector.
- (7) Not in direct rays of the sun. If the sun shines on the converter, prepare the hood (/H) or other appropriate sunshade.

■ Mounting of the Converter

The converter can be mounted on a pipe (nominal JIS 50A: O.D. 60.5 mm), a wall or a panel. The converter can be mounted at an angle to the vertical, however, it is recommended to mount it on a vertical plane.

Mount the converter as follows.

<Pipe Mounting>

- (1) Prepare a vertical pipe of sufficient strength (nominal JIS 50A: O.D. 60.5 mm) for mounting the converter. (Converter weighs approximately 6 kg.)
- (2) Mount the converter on the pipe. Fix it firmly on the pipe in the procedure described in Figure 3.9.

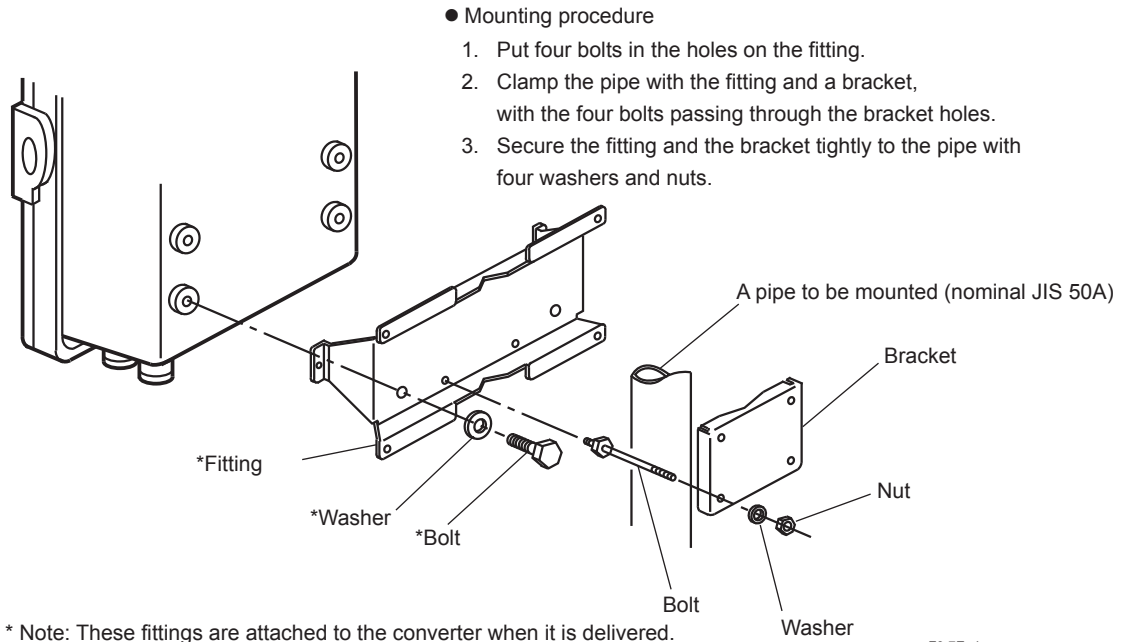


Figure 3.9 Pipe Mounting

<Wall Mounting>

- (1) Drill mounting holes through the wall as shown in Figure 3.10.

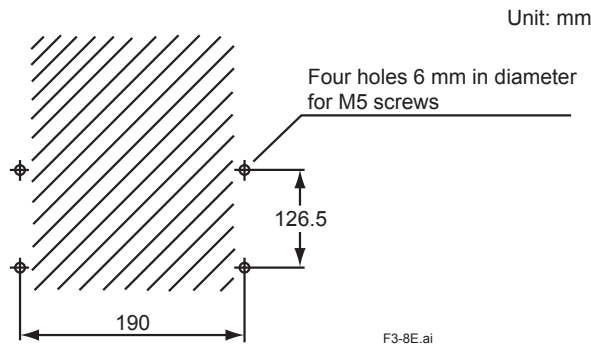


Figure 3.10 Mounting holes

- (2) Mount the converter. Secure the converter on the wall using four screws.

Note: For wall mounting, the bracket and bolts are not used.

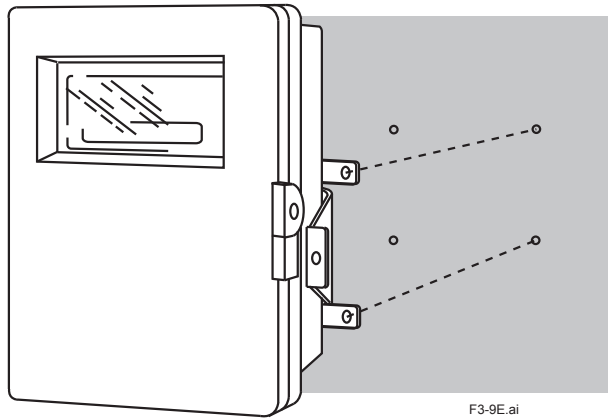


Figure 3.11 Wall Mounting

<Panel Mounting>

- (1) Cut out the panel according to Figure 3.12.

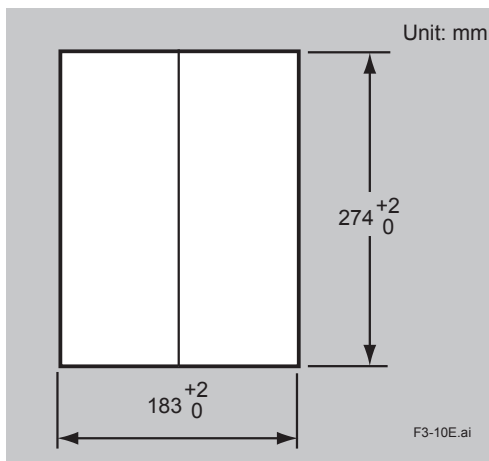


Figure 3.12 Panel cutout sizes

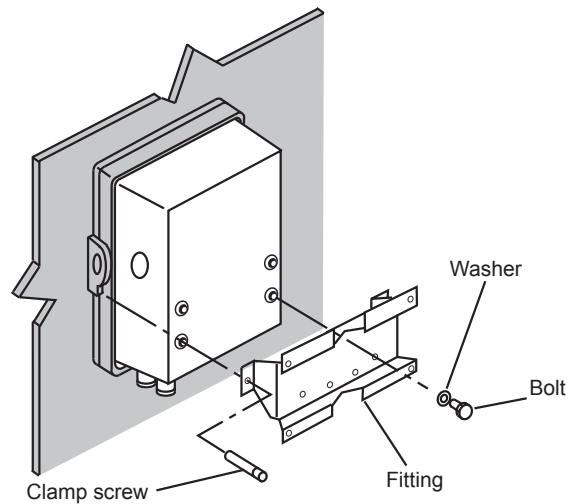


Figure 3.13 Panel mounting

- (2) Remove the fitting from the converter by loosening the four screws.
- (3) Insert the converter case into the cutout hole of the panel.
- (4) Attach the mounting fitting which is once removed in step (2) again to the converter.
- (5) Firmly fix the converter to the panel. Fully tighten the two clamp screws to hold the panel with the fitting.

3.4 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 or 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 50A) 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.

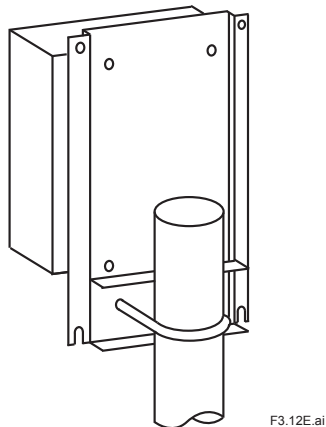


Figure 3.14 Pipe Mounting

<Wall Mounting>

- (1) Make a hole in the wall as illustrated in Figure 3.15.
- (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.

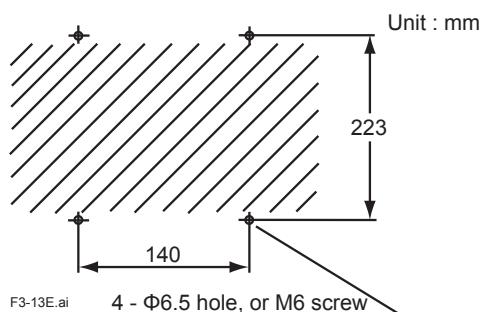


Figure 3.15 Mounting holes

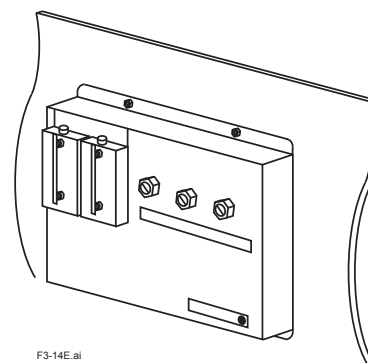


Figure 3.16 Wall mounting

3.5 Installation of ZR40H 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 or 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 ZR40H Automatic Calibration Unit

The automatic calibration unit can be mounted either on a pipe (nominal JIS 50A) 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 of automatic calibration unit. (The unit weights approximately 3.5 kg.)
- (2) Mount the automatic calibration unit on the pipe by tightening the nuts with the U-bolt so that the metal fitting is firmly attached to the pipe.

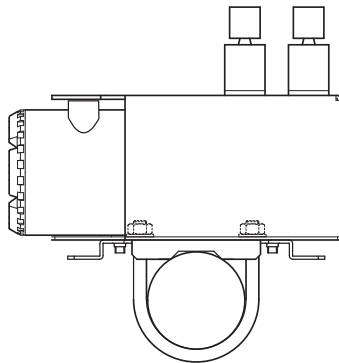


Figure 3.17 Pipe Mounting

<Wall Mounting>

- (1) Make a hole in the wall as illustrated in Figure 3.18.

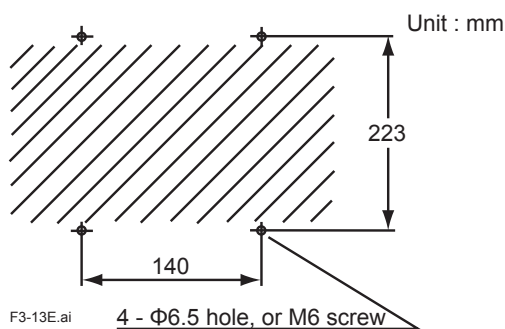


Figure 3.18 Mounting holes

- (2) Mount the automatic calibration unit. Remove the U-bolt from the automatic calibration unit and attach the unit on the wall with four screws. When setting it with M5 bolts, use washers.

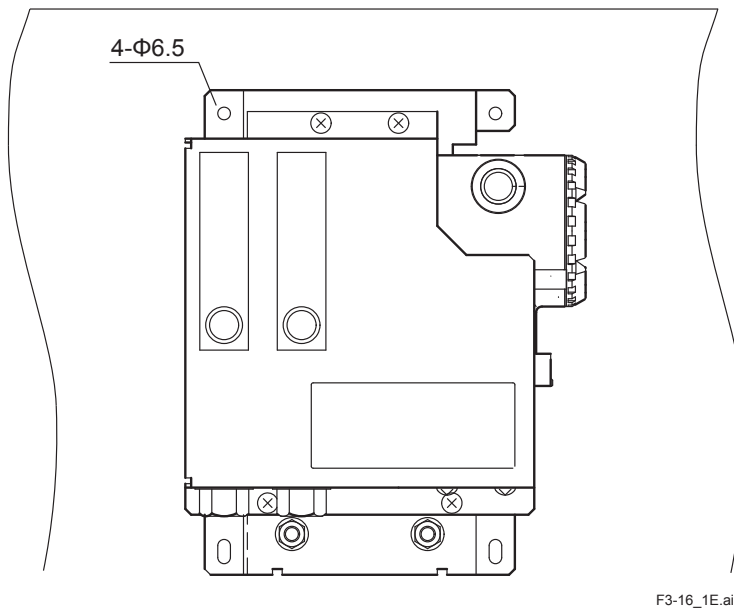


Figure 3.19 Wall Mounting

3.6 Installation of the Case Assembly (E7044KF)

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 or 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 50A) 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.

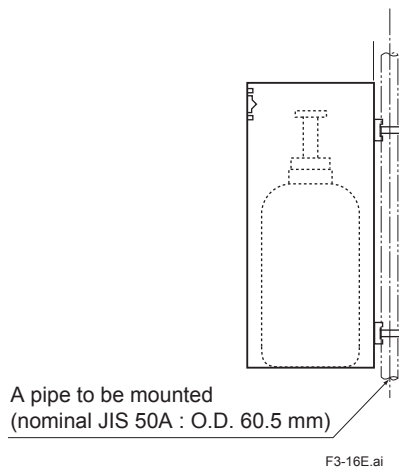


Figure 3.20 **Pipe Mounting**

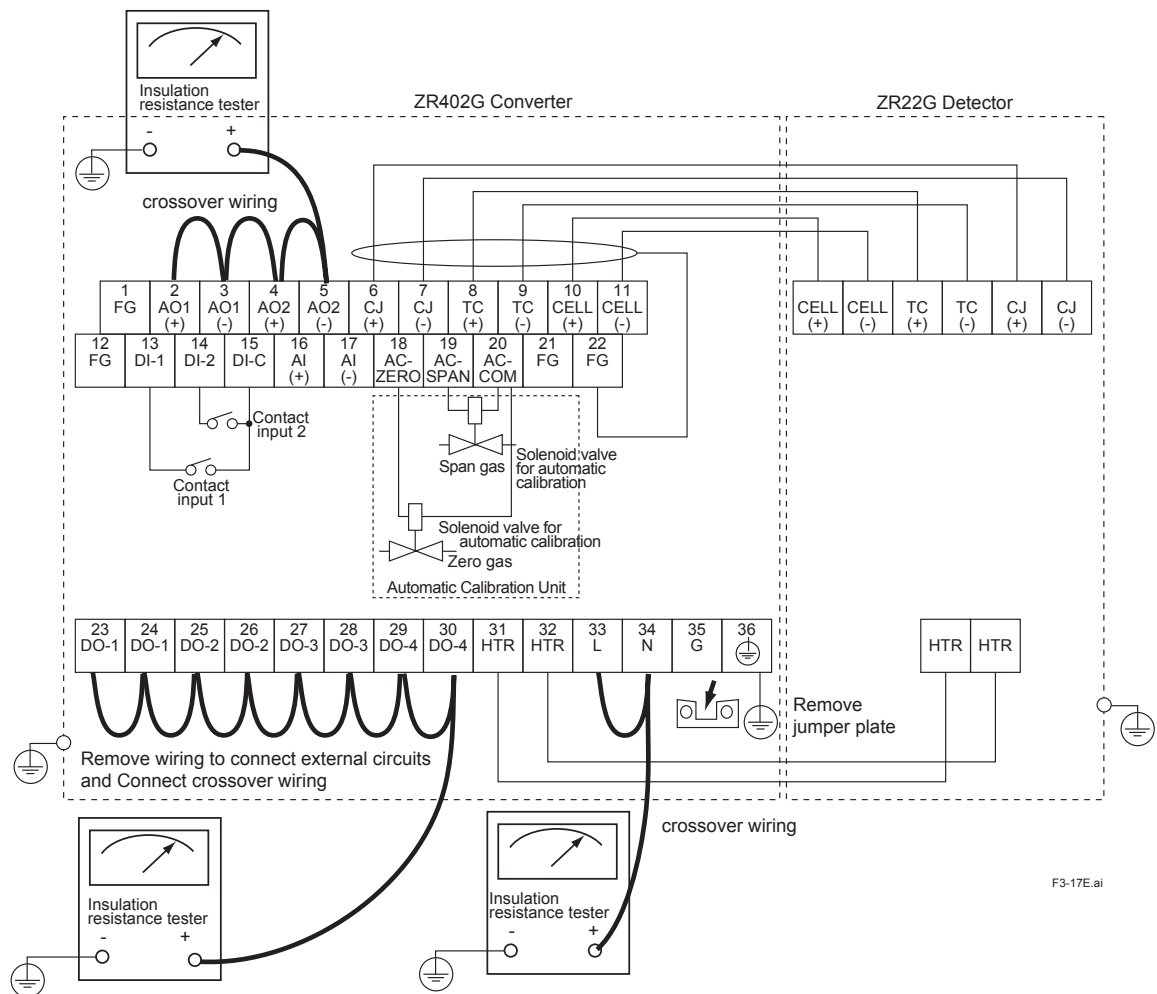
3.7 Insulation Resistance Test

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 for over 1 min. During discharge, do not touch the terminal.
- (6) Testing between the heater terminal and ground, contact output terminal and ground, analog output/input terminal and 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.



F3-17E.ai

Figure 3.21

4. Piping

This chapter describes piping procedures based on three typical system configurations for EXAxt ZR Separate type Zirconia Oxygen/Humidity Analyzer.

- Ensure that each check valve, stop valve and joint used for piping do not allow leakage. Especially, if there is any leakage of the calibration gas from pipes and joints, it may cause clogging of the pipes or incorrect calibration.
- Be sure to conduct leakage test after piping.
- Basically, apply instrument air (dehumidified by cooling to the dew point -20°C or lower, and removing any dust, oil mist and the like) for the reference gas.
- When the instrument uses natural convection for reference gas, ambient air near the detector 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, and removing 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.

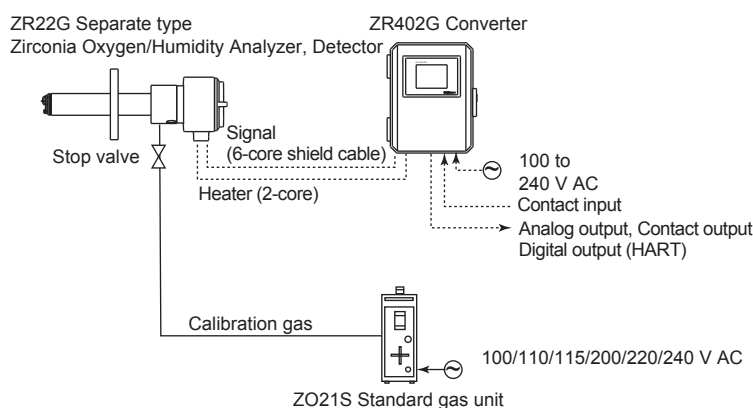


Figure 4.1 Piping in System 1

CAUTION

- The stop valve should be connected directly to the detector. If any piping is present between the detector and the stop valve, water may condense in the pipe, which may cause damage to the sensor by rapid cooling when the calibration gas is introduced.
The stop valve should be closed except while the calibration gas is being introduced.
- If a high temperature detector is used (the sample gas temperature is 700°C or higher), piping for the reference gas is required. In other cases, piping is required if the air around the detector is not clean.
- The reference gas should have an oxygen concentration identical to that of fresh air (21%).
- When a high temperature detector is used, the sample gas is vented into the surrounding air.
Therefore, the oxygen concentration required may not be obtained unless an exhaust pipe is installed.

Piping in System 1 is as follows:

- Connect a stop valve to the nipple at the calibration gas inlet of the detector. 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.

- It is recommended to use ZH21B dust protector to protect the probe output from dust agitation (i.e., to prevent combustible materials from entering the probe cell) where humidity measurements are made under dusty or combustible, such as paper dust, environment.
- If a high temperature detector is used and no piping can be installed for the reference gas, place piping in the exhaust hole for the sample gas on the high temperature probe adapter so that the sample gas is carried away from the vicinity of the detector (see Section 4.1.4, Figure 4.6).
- If a high temperature detector is used and the sample gas pressure is negative, connect an ejector assembly to the sample gas exhaust hole of the high temperature probe adapter (see Section 4.1.4, Figure 4.3).
- If a high temperature detector is used and the pressure of the sample gas is 0.49 kPa or higher, it is recommended that a needle valve (throttle) be used in the sample gas exhaust of the high temperature probe adapter (see Section 4.1.4, Figure 4.4).

CAUTION

This is for lowering the sample gas temperature below 700°C. If the gas temperature is high and the pressure is also significantly high, the sample gas temperature may not fall to below 700°C before it reaches the detector.

On the other hand, if the sample gas temperature is lowered too much, condensation may be produced in the High Temperature Probe Adapter. During wintertime, it is recommended that the High Temperature Probe Adapter be protected with an insulating material to avoid condensation forming (see Section 4.1.4, Figure 4.5).

For the usage of the High Temperature Probe Adapter, refer to Section 3.2.1.

4.1.1 Parts Required for Piping in System 1

Check that the parts listed in Table 4.1 are ready.

Table 4.1

Detector	Piping location	Parts Name	Note	
General use detector	Calibration gas inlet	Stop valve	Recommended by YOKOGAWA (L9852CB or G7016XH)	
		Nipple *	Rc 1/4 or 1/4 NPT	General parts
		Joint for tube connection	Rc 1/4 (1/4 NPT) for a Ø6 x Ø4 mm soft tube	General parts
	Reference gas inlet	(sealed up)	(when piping is required, refer to section 4.1.3)	
High temperature detector (0.15 m)	Calibration gas inlet	Stop valve	Recommended by YOKOGAWA (L9852CB or G7016XH)	
		Nipple *	Rc 1/4 or 1/4 NPT	General parts
		Joint for tube connection	Rc 1/4 (1/4 NPT) for a Ø6 x Ø4 mm soft tube	
	Reference gas inlet	(sealed up)	(when piping is required, refer to section 4.1.3)	
	Sample gas outlet	Ejector assembly *	Recommended by YOKOGAWA (E7046EC or E7046EN)	
		T-shaped joint of the same diameter *	R1/4 or 1/4 NPT	General parts
		Needle valve *	Rc1/4 or 1/4 NPT	General parts
		Nipple of other diameter *	R 1/2 to R 1/4 or R 1/2 to 1/4 NPT	General parts

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

4.1.2 Connection to the Calibration Gas Inlet

When carrying out calibration, connect the piping (6(O.D.) ~4(I.D.) mm tube) from the standard gas unit to the calibration gas inlet of the detector. First, mount a stop valve (of a quality specified by YOKOGAWA) on 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 detector prior to shipping the detector.)

Note: Mount the stop valve close to the detector.

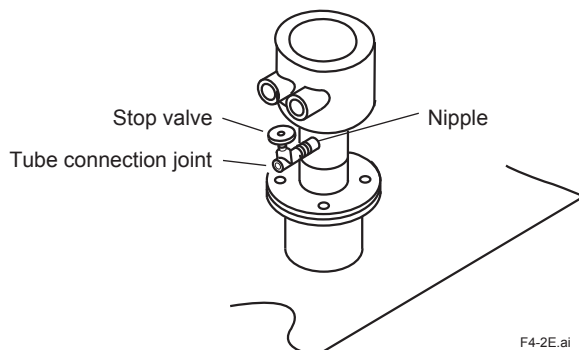


Figure 4.2 Connection to the calibration gas inlet

4.1.3 Connection to the Reference Gas Inlet

- Normally, no piping is required for the reference gas inlet when the equipment uses natural convection for the reference gas (models ZR22G-□-□-□-C). Leave the plug as it is. If the air around the detector is polluted and the necessary oxygen concentration (21 vol%O₂) cannot be obtained, prepare piping the same as which described 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 ZR22G-□-□-□-E or P).

4.1.4 Piping to the High Temperature Probe Adapter

- The sample gas should be at a temperature below 700°C before reaching the detector sensor. If the gas is under negative pressure, it should be fed to the detector by suction.
- For usage of the probe adapter when using high temperature detector, refer to Section 3.2.1.
- If the sample gas is under negative pressure, connect the ejector assembly (E7046EC/ E7046EN) as illustrated in Figure 4.3. Mount the pressure gauge as close as possible to the ejector assembly. However, if the ambient temperature is too high, mount the gauge in a location with a temperature below 40°C.

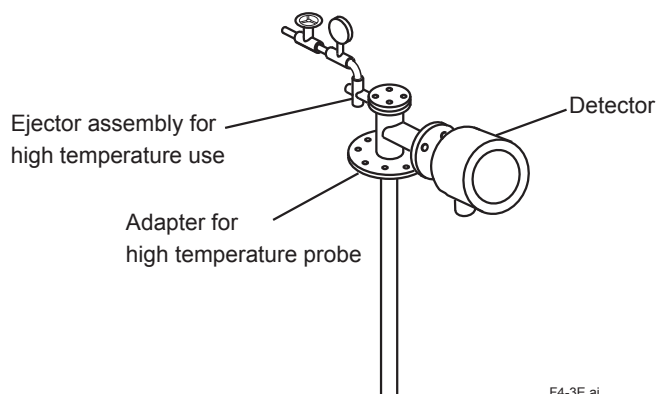


Figure 4.3 Mounting the ejector assembly

If the temperature of the sample gas exceeds the specified value and its pressure exceeds 0.49 kPa, the sample gas temperature may not be below 700°C at the detector.

In such a case, connect a needle valve (found on the local market) through a nipple (also found on the local market) to the probe adapter sample gas exhaust (Rc 1/2) so that the sample gas exhaust volume is restricted.

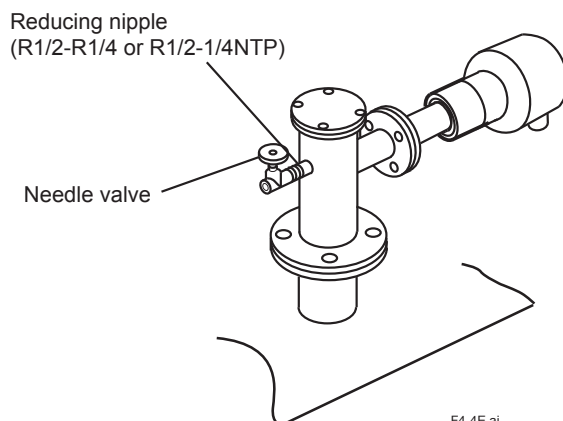


Figure 4.4 Mounting the needle valve for restricting exhaust flow of the sample gas

In cases where condensation is likely to occur in the probe adapter when the sample gas is cooled, protect the probe adapter with an insulating material as illustrated in Figure 4.5.

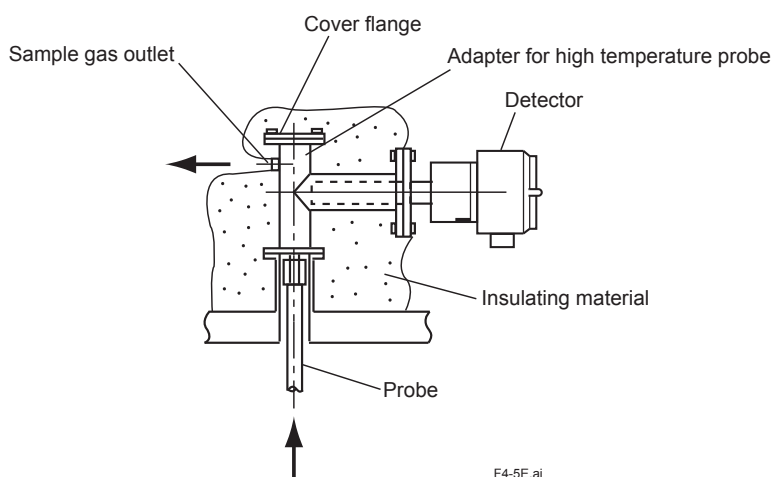


Figure 4.5 Preventing to condensation

If the sample gas is to be vented at a distance from the detector because no reference gas piping can be provided, an exhaust pipe should be installed as illustrated in Figure 4.6. In addition, the exhaust pipe shall be kept warm to protect against condensation.

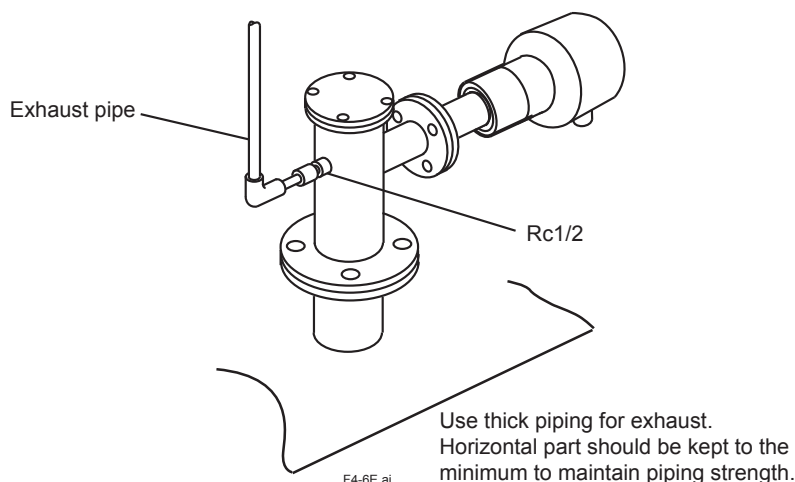


Figure 4.6 Exhaust pipe

4.2 Piping for System 2

Piping in System 2 is illustrated in Figure 4.7.

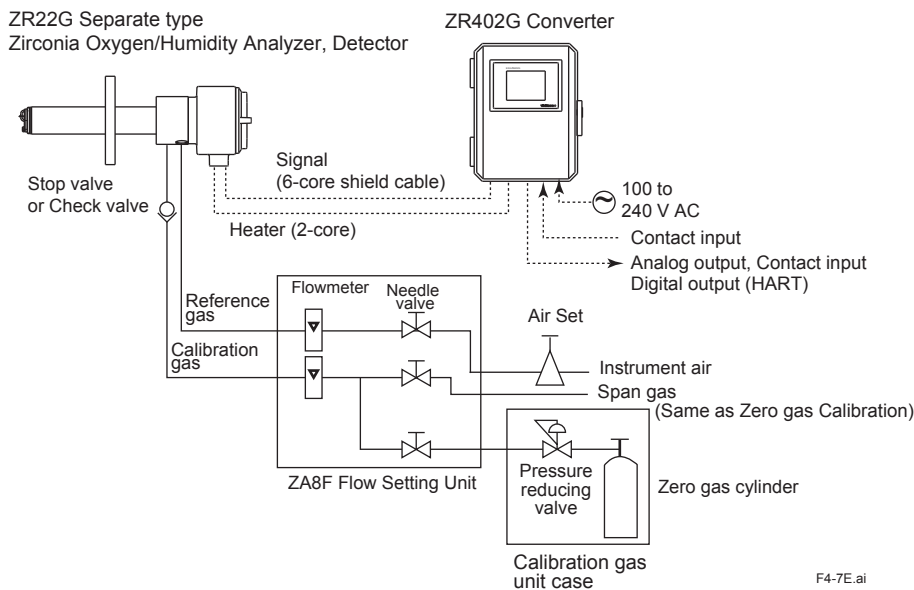


Figure 4.7 Piping for System 2

System 2 illustrated in Figure 4.7 requires piping as follows:

- Connect a stop valve or check valve the nipple at the calibration gas inlet of the detector.
- It is recommended to use ZH21B dust protector to protect the probe output from dust agitation (i.e., to prevent combustible materials from entering the probe cell) where humidity measurements are made under dusty or combustible environment.
- If a high temperature detector is used and the sample gas pressure is negative, connect an ejector assembly to the sample gas exhaust hole of the high temperature probe adapter (see Section 4.1.4, Figure 4.3).
- If a high temperature detector is used and the pressure of the sample gas is 0.49 kPa or higher, it is recommended that a needle valve (throttle) be used in the sample gas exhaust of the high temperature probe adapter (see Section 4.1.4, Figure 4.4).

CAUTION

This is for lowering the sample gas temperature below 700°C. If the gas temperature is high and the pressure is also significantly high, the sampled gas temperature may not reduced below 700°C when reaching the detector.

On the other hand, if the sample gas temperature is lowered too much, condensation may be produced in the high temperature probe adapter. During wintertime, it is recommended that the high temperature probe adapter be protected with an insulating material to prevent condensation (see Section 4.1.4, Figure 4.5).

For the usage of the high temperature probe adapter, refer to Section 3.2.1.

- If the dust sticking to the interior of the high temperature probe adapter is to be eliminated by blow back while using the high temperature detector, the air feed for blow back should also be taken into consideration.

CAUTION

The probe is easily clogged if too much dust is contained in the sample gas such as in a utility boiler or cement kiln. To get rid of the dust with compressed air, the piping from the air source is connected only during cleaning. Blow back piping can be installed for dust cleaning as illustrated in Section 4.3.1.

4.2.1 Piping Parts for System 2

Check that the parts listed in Table 4.2 are ready.

Table 4.2 Piping Parts

Detector	Piping location	Parts Name	Note	
General use detector	Calibration gas inlet	Stop valve or check valve	Recommended by YOKOGAWA (L9852CB or G7016XH) Provided by YOKOGAWA (K9292DN or K9292DS)	
		Nipple *	Rc 1/4 or 1/4 NPT	General parts
		Zero gas cylinder	User's scope	
		Pressure reducing valve	Recommended by YOKOGAWA (G7013XF or G7014XF)	
		Joint for tube connection	Rc 1/4 or 1/4 NPT	General parts
	Reference gas inlet	Air set	Recommended by YOKOGAWA (G7003XF/K9473XK or G7004XF/K9473XG)	
		Joint for tube connection	Rc 1/4 or 1/4 NPT	General parts
High temperature Detector (0.15 m)	Calibration gas inlet	Stop valve or check valve	Recommended by YOKOGAWA (L9852CB or G7016XH) Provided by YOKOGAWA (K9292DN or K9292DS)	
		Nipple *	Rc 1/4 or 1/4 NPT	General parts
		Zero gas cylinder	User's scope	
		Pressure reducing valve	Recommended by YOKOGAWA (G7013XF or G7014XF)	
		Joint for tube connection	Rc 1/8 or 1/8 NPT	
	Reference gas inlet	Air set	Recommended by YOKOGAWA (G7003XF/K9473XK or G7004XF/K9473XG)	
		Joint for tube connection	Rc 1/4 or 1/4 NPT	General parts
	Sample gas outlet	Ejector assembly *	Recommended by YOKOGAWA (E7046EC or E7046EN)	
		T-shaped joint of the same diameter *	R 1/4 or 1/4 NPT	General parts
		Needle valve *	Rc 1/4 or 1/4 NPT	General parts
		Nipple of other diameter *	R 1/2 to R 1/4 or R 1/2 to 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 ZR22G detector.

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

Mount a reducing valve (specified by YOKOGAWA) on the cylinder.

Mount a check valve or stop valve (specified by YOKOGAWA) on the nipple (found on the local market) at the calibration gas inlet of the detector as illustrated in Figure 4.8.

(The check valve or the stop valve may have been mounted on the detector when shipped.)

Connect the flow setting unit and the detector to a stainless steel pipe 6 mm (O.D.) x 4 mm or larger (I.D.) (or nominal size 1/4 inch).

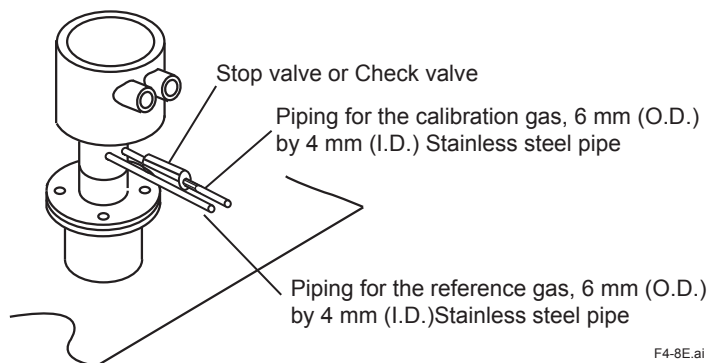


Figure 4.8 Piping for the Calibration Gas Inlet

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 detector.

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

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

4.2.4 Piping to the High Temperature Probe Adapter

Refer to Section 4.1.4 for the piping.

4.3 Piping for System 3

Piping in System 3 is illustrated in Figure 4.10. 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 reducing valve so that these two pressures are approximately the same. The flow rate of zero and span gases (normally instrument air) are set by a single needle valve.

After installation and wiring, check the calibration contact output (see Sec. 7.11.2), and adjust zero gas reducing valve 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.

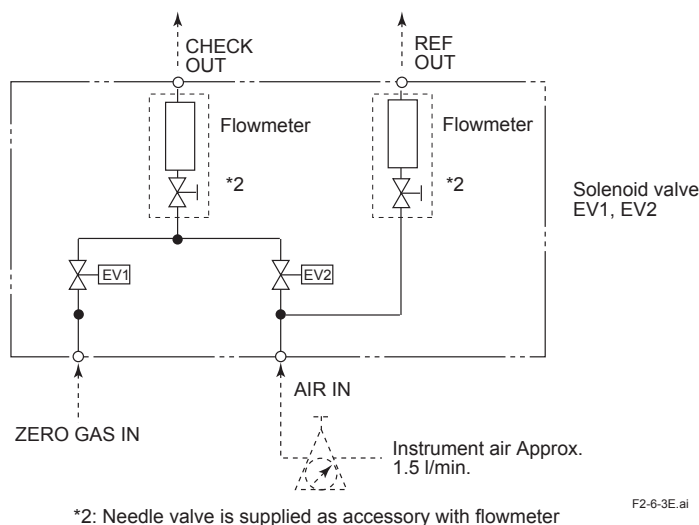


Figure 4.9 Piping inside in System 3

When blow back function is used by contact input to the ZR402G converter, install blow back piping as illustrated in Section 4.3.1.

Note: Blow back function means the function to get rid of dust inside a probe in a high temperature probe adapter by using compressed air, when a high temperature detector is used.

It is recommended to use ZH21B dust protector to protect the probe output from dust agitation (i.e., to prevent combustible materials from entering the probe cell) where humidity measurements are made under dusty or combustible environment.

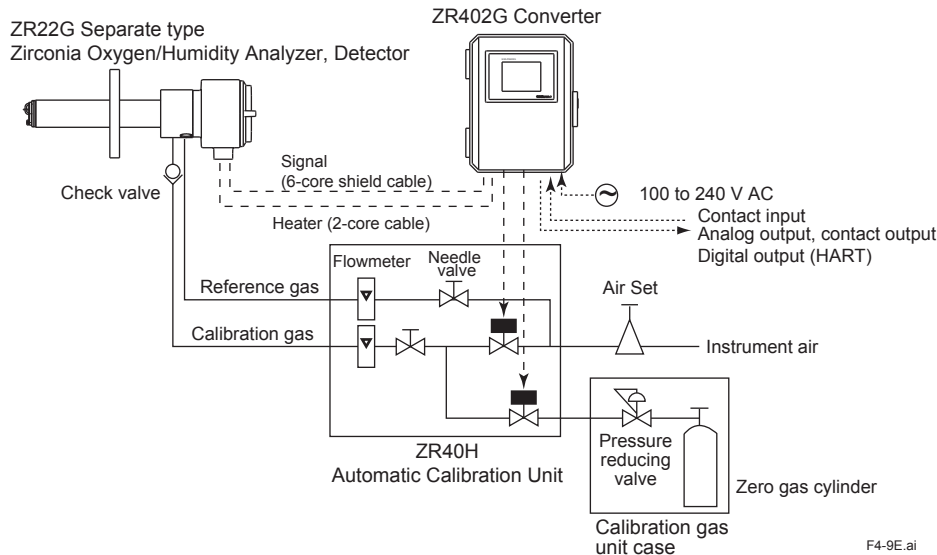


Figure 4.10 Piping for System 3

■ Blow Back Piping

This piping is required when the blow back function is carried out. The piping described below provides automatic blow back operation when the “Blow back start” command is entered to the converter.

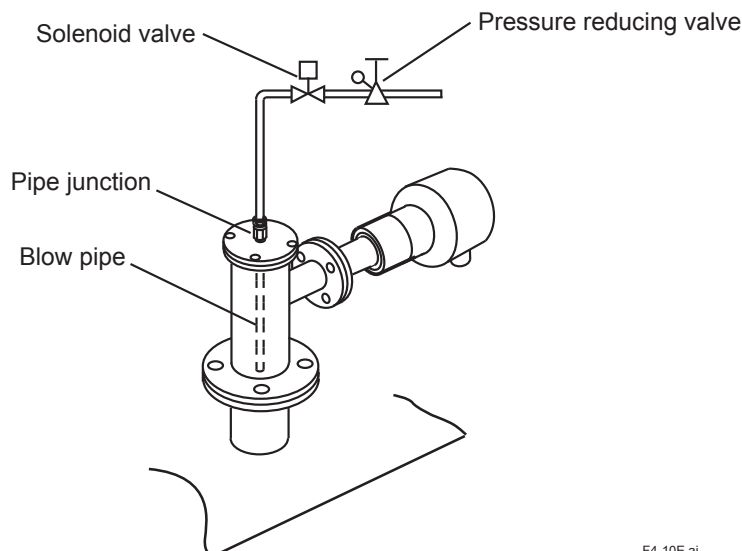
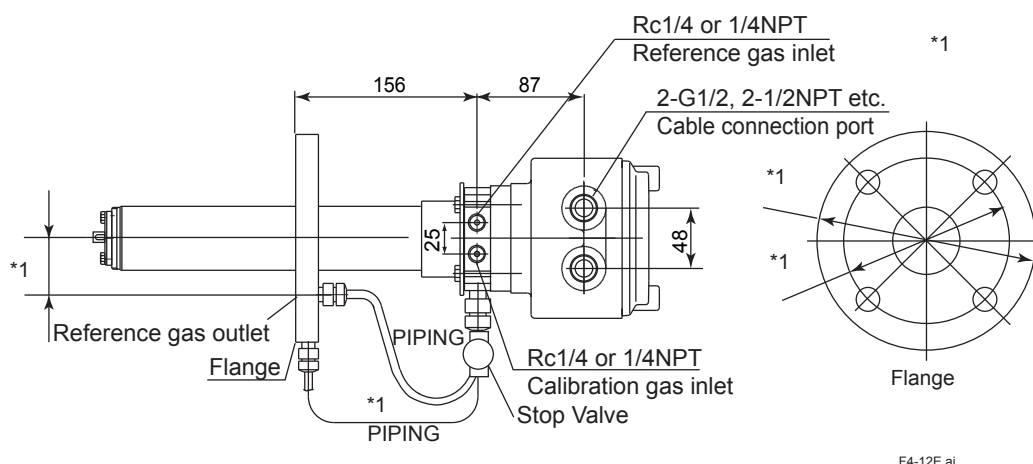


Figure 4.11 Blow back Piping

The following parts are required for blow back piping.

- Flange (to be prepared as illustrated in Figure 4.12.)
- Blow pipe (to be prepared as illustrated in Figure 4.12.)
- Two-way solenoid valve: “Open” when electric current is on. (Found on the local market).
- Air set (recommended by YOKOGAWA, G7003XF / K9473XK or G7004XF / K9473XG)



*1 Dimensions may vary depending on the detector type. Refer to Section 2.2
Ensure that the flange gasket does not block the reference gas outlet.
Where necessary, make a notch on the flange

Figure 4.13 Detector with Pressure Compensation

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

- 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 detector. If there is piping between the detector and the valve, condensation may damage the sensor by rapid cooling when calibration gas is introduced.

Figure 4.14 illustrates an example of System 2 using a detector with pressure compensation. Supply air pressure (flow) may vary depending on the furnace pressure. It is recommended to use a flowmeter and an air set that is suitable for the furnace pressure.

NOTE

When using the ZA8F Flow Setting Unit and ZR40H Automatic Calibration Unit, please note that the supplying airflow (pressure) will vary depending on the furnace pressure.

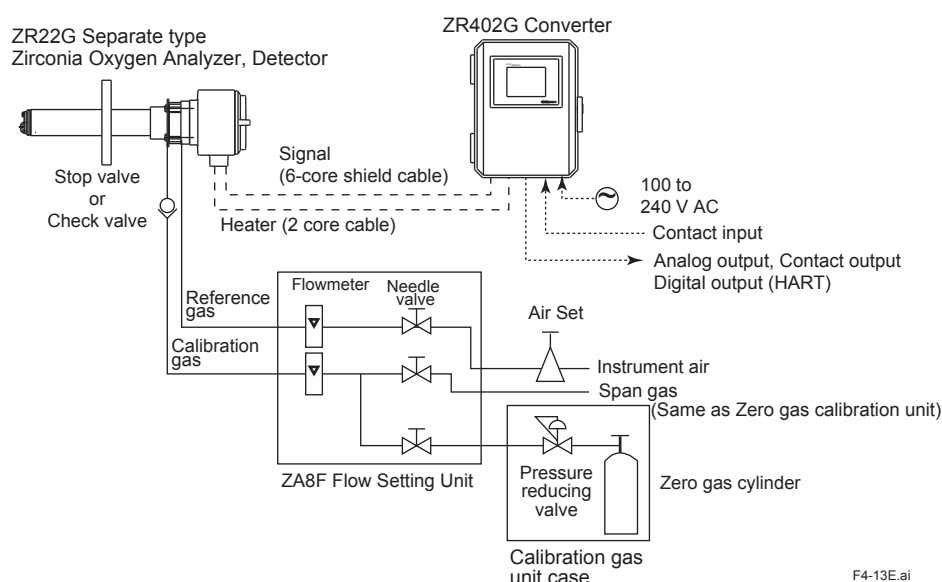


Figure 4.14 System 2 using a detector with pressure compensation

4.4.1 Piping Parts for a System using Detector with Pressure Compensation

Check that the parts listed in Table 4.3 are ready.

Table 4.3 Piping Parts

Detector	Piping location	Parts Name	Note	
Detector with pressure compensation	Calibration gas inlet	Stop valve or check valve	Recommended by YOKOGAWA (L9852CB or G7016XH) Provided by YOKOGAWA (K9292DN or K9292DS)	
		Nipple *	Rc 1/4 or 1/4 NPT	General parts
		Zero gas cylinder	User's scope	
		Pressure reducing valve	Recommended by YOKOGAWA (G7013XF or G7014XF)	
		Joint for tube connection	Rc 1/4 or 1/4 NPT	General parts
	Reference gas inlet	Air set	Recommended by YOKOGAWA (G7003XF/K9473XK or G7004XF/K9473XG)	
		Joint for tube connection	Rc 1/4 or 1/4 NPT	General parts

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

4.4.2 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

In this Chapter, the wiring necessary for connection to the EXAxt ZR Separate type Zirconia Oxygen/Humidity Analyzer is described.

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 performed according to the following procedure:

1. Be sure to connect the shield line to FG terminal of the converter.
2. The outer sheath of the signal line should be stripped to a length of 50 mm or less.
The most outer sheath of the power cable should be stripped to a length of 20 mm or less.
3. Signals may be affected by noise if signal lines, power cable and heater cable are located in the same conduit. When using conduit, signal lines should be installed in a separate conduit than power and heater cables.
4. Install metal blind plug(s) in unused cable connection gland(s) of the converter.
5. Metal conduit should be grounded.
6. The following cables are used for wiring:

Table 5.1 Cable specifications

Terminal name of converter	Name	Need for shields	Number of cores
CELL+, CELL- HTR TC+, HTR TC- CJ+, CJ-	Detector signal	O	6
HEATER	Detector heater		2
L, N	Power supply		2 or 3 *
AO-1+, AO-1-, AO-2+, AO-2-	Analog output	O	2 or 4
DO-1, DO-2, DO-3, DO-4	Contact output		2 to 8
AC-Z, AC-S, AC-C	Automatic Calibration unit		3
DI-1, DI-2, DI-C	Contact input		3
AI+, AI-	Temperature input	O	2

Note *: When the case is used for protective grounding, use a 2-core 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 in the Converter

Open the front door and remove the terminal covering plate to gain access to the converter external wiring terminals (see Figure 5.1).



CAUTION

After wiring necessary cable to the converter terminals, be sure to fix the terminal covering plate with two screws again.

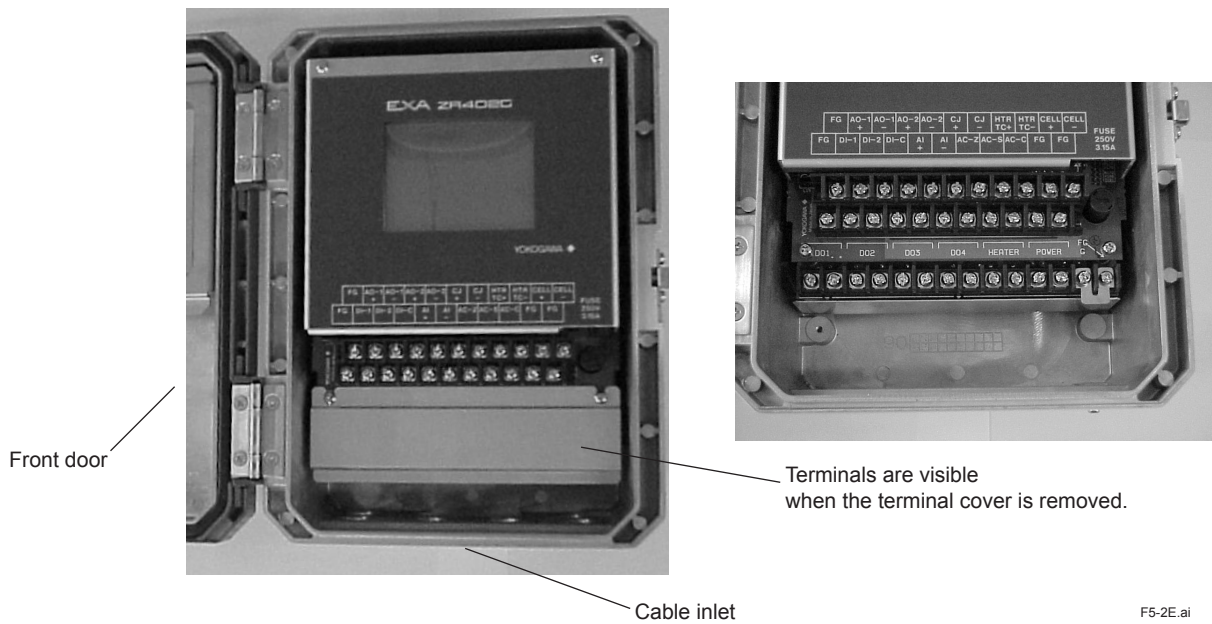


Figure 5.1 Terminals for external wiring in the converter

5.1.2 Wiring

Connect the following wiring to the converter. It requires a maximum of seven wiring connections as shown below.

- (1) Detector output (connects the converter with the detector.)
- (2) Detector heater power (connects the converter with the detector.)
- (3) Analog output signal
- (4) Power and ground
- (5) Contact output
- (6) Operation of the solenoid valve of automatic calibration unit
- (7) Contact input
- (8) Temperature input

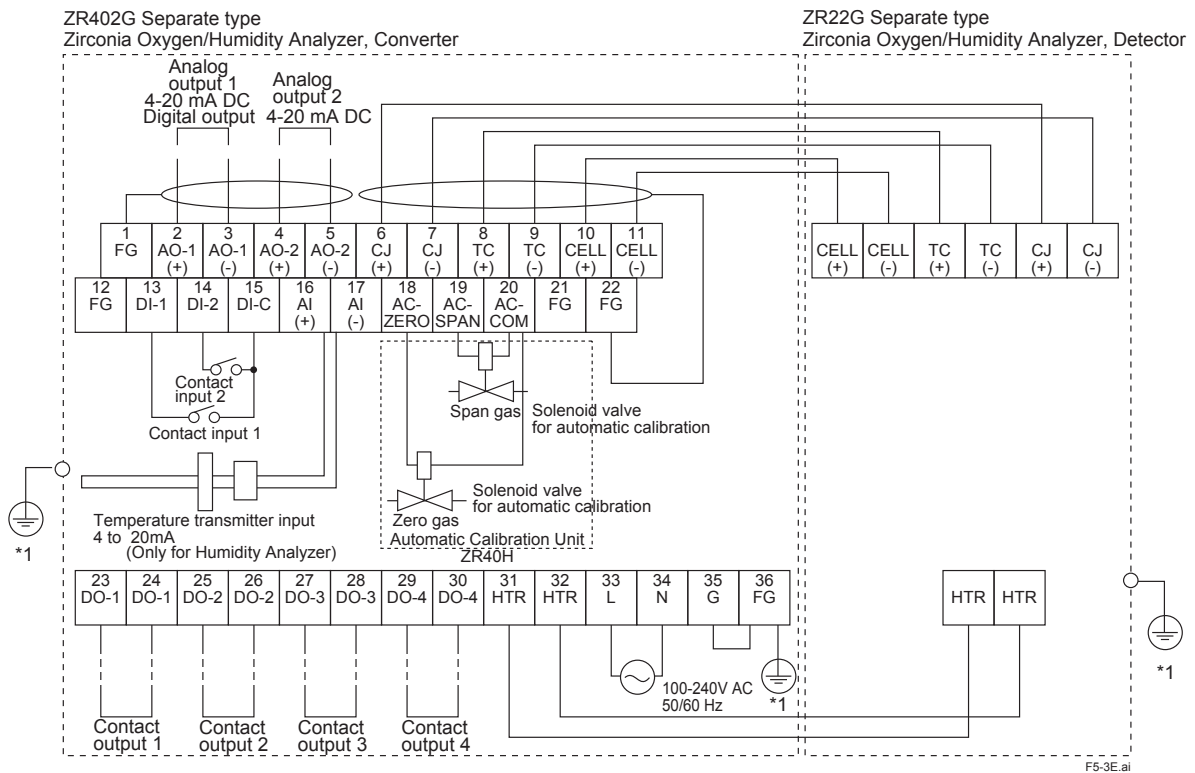


Figure 5.2 Wiring connection to the converter

5.1.3 Mounting of Cable Gland

For each cable connection opening of the converter, mount a conduit that matches the thread size, or a cable gland.

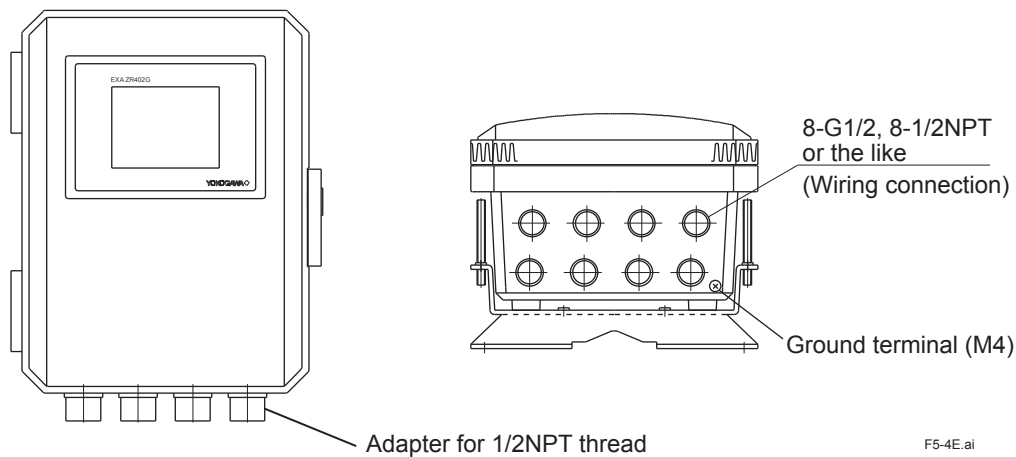


Figure 5.3 Cable gland mounting

5.2 Wiring

5.2.1 Connection to Converter

To connect the wiring to the converter, proceed as follows:

- (1) M4 screws are used for the terminals of the converter. Each cable should be terminated in the corresponding size crimp-on terminals.
- (2) When a rubber insulated glass braided wire is used for wiring to the detector, use a terminal box. For wiring between the terminal box and the converter, basically use a cable that withstand temperatures of at least 80°C.

NOTE

The above is to prevent moisture or corrosive gas from entering the converter. Where the ambient environment of the detector and the converter is well-maintained, it is permissible to connect the wiring from the detector directly to the converter with protection by conduits.



WARNING

This wiring is to carry power for the heater. Be careful to wire the correct terminals, and be careful not to ground or short circuit terminals when wiring, as otherwise the instrument may be damaged.

5.2.2 Connection to Detector

When connecting the cable to the detector, proceed as follows:

- (1) Mount cable glands or conduits of the specified thread size to the wiring connections of the detector.
The detector may need to be removed in future for maintenance, so be sure to allow sufficient cable length.
- (2) If the ambient temperature at the location of wire installation is 75 to 150°C, be sure to use a flexible metallic conduit for the wire. If a non-shielded “600 V silicon rubber insulated glass braided wire” is used, keep the wire away from noise sources to avoid noise interference.
- (3) The size of the terminal screw threads is M3.5. Each cable should be terminated in the corresponding size crimp-on terminals contact (*1) respectively.

*1 If the ambient temperature at the detector installation site exceeds 60°C, use a “bare crimp-on terminal”.

● Notice when closing the cover of the detector

NOTE

- Before opening the detector cover, loosen the lock screw. If the screw is not loosened first, the screw will damage the cover, 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 in the detector body, secure it with the lock screw.

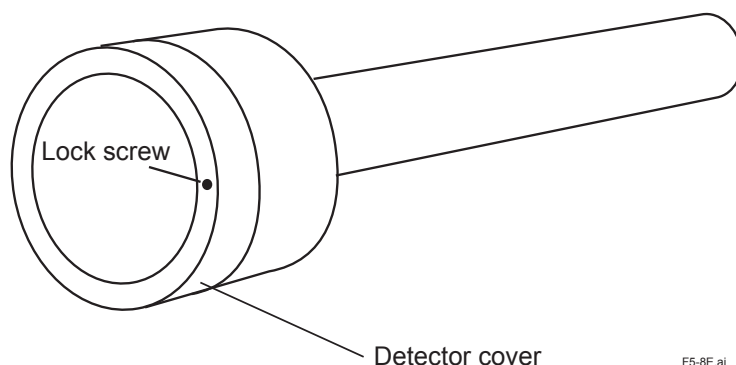


Figure 5.4

5.2.3 Power and Grounding Wiring

This wiring supplies power to the converter and grounds the converter/detector.

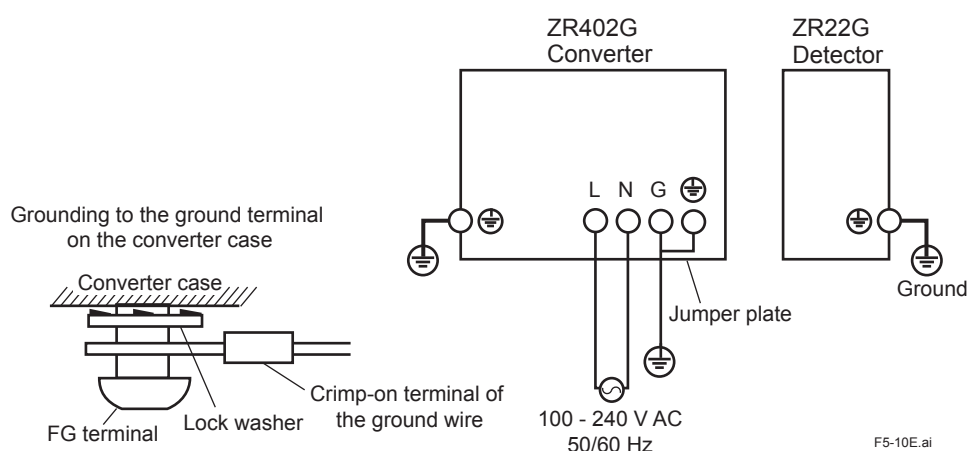


Figure 5.5 Power and Grounding wiring

Power Wiring

Connect the power wiring to the L and N terminals of the converter. Proceed as follows:

- (1) Use a 2-core or a 3-core cable.
- (2) The size of converter terminal screw threads is M4. Each cable should be terminated corresponding to crimp-on terminals.

Grounding Wiring

The ground wiring of the detector should be connected to the ground terminal of the detector case. The ground wiring of the converter should be connected to either the ground terminal of the converter case or the protective ground terminal in the equipment.

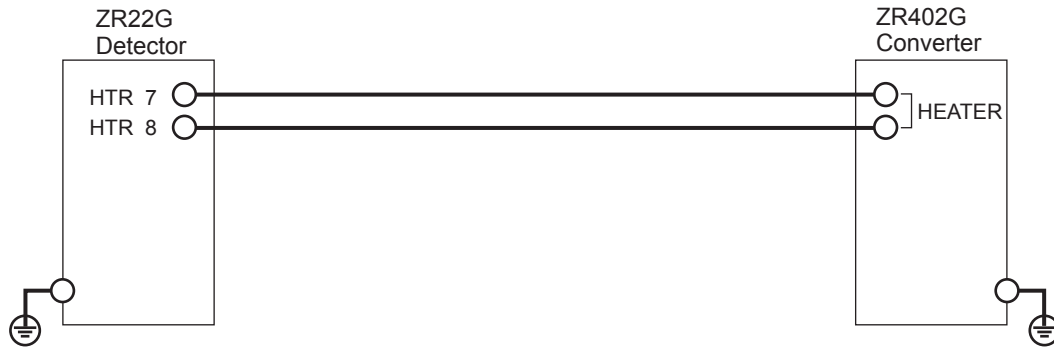
The grounding terminals of the detector and the converter are of size M4. Proceed as follows:

- (1) Keep ground resistance to 100 Ω or less (equivalent JIS D style (Class 3)).
- (2) When the ambient temperature of the wiring installation is 75 to 150°C for the wiring of the detector, use wiring material with sufficient heat resistance.
- (3) When connecting the ground wiring to the ground terminal of the converter case, be sure that the lock washer is in contact with the case surface (see Figure 5.5.).
- (4) Ensure that the jumper plate is connected between the G terminal and the protective ground terminal of the converter.

5.2.4 Wiring for Power to Detector Heater

This wiring provides electric power from the converter to the heater for heating the sensor in the detector.

(1) Ambient temperature of the detector: 75°C or less



(2) Ambient temperature of the detector: exceeding 75°C

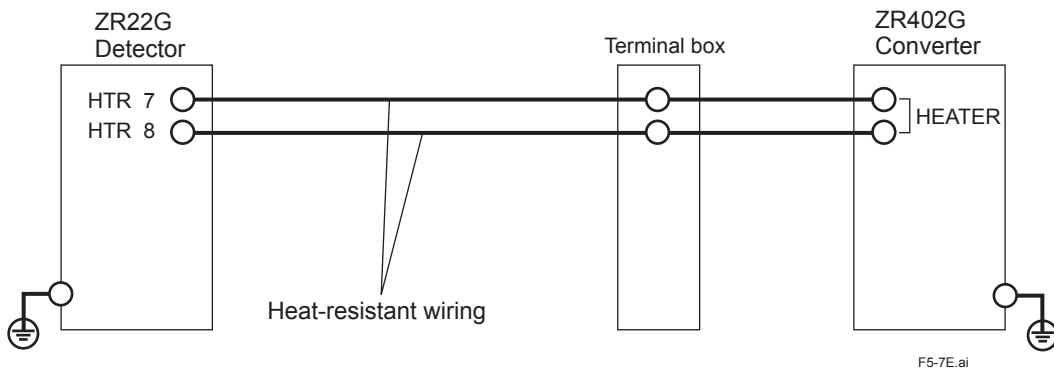


Figure 5.6 Wiring for power to detector heater

Cable Specifications

Basically, cables (2 cores) that withstand temperatures of at least 80°C are used for this wiring. When the ambient temperature of the detector exceeds 75°C, install a terminal box, and connect to the detector using six-piece 600 V silicon rubber insulated glass braided wires.

5.2.5 Wiring for Detector Output

This wiring enables the converter to receive cell output from the detector, output from a thermocouple and a reference junction compensation signal. Install wires that allow for 10 Ω of loop resistance or less. Keep detector wiring away from power wiring.

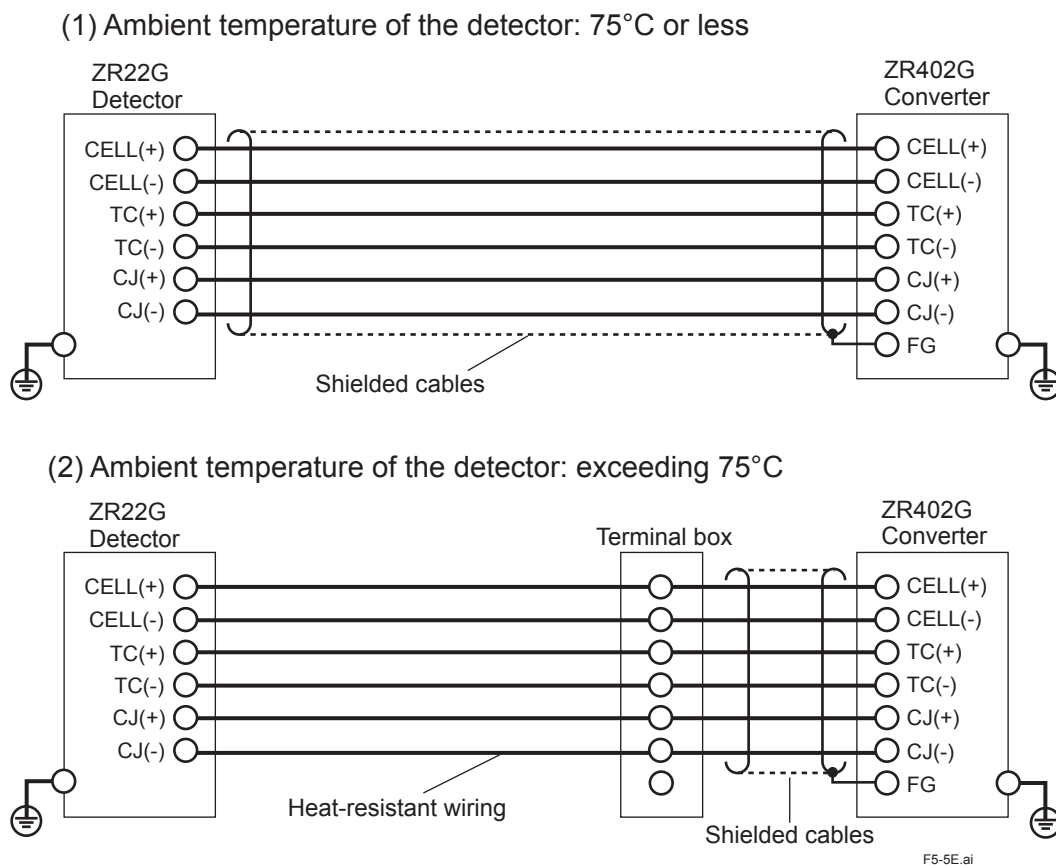


Figure 5.7 **Wiring for detector output**



CAUTION

If shielded cables cannot be used between the detector and the terminal box, for example, when heat-resistant wiring is used, locate the detector and the terminal box as close together as possible.

Cable Specifications

Basically, a cable (6-core) that withstand temperatures of at least 80°C is used for this wiring. When the ambient temperature of the detector exceeds 75°C, install a terminal box, and connect with the detector using six-piece 600 V silicon rubber insulated glass braided wires.

5.2.6 Wiring for Analog Output

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

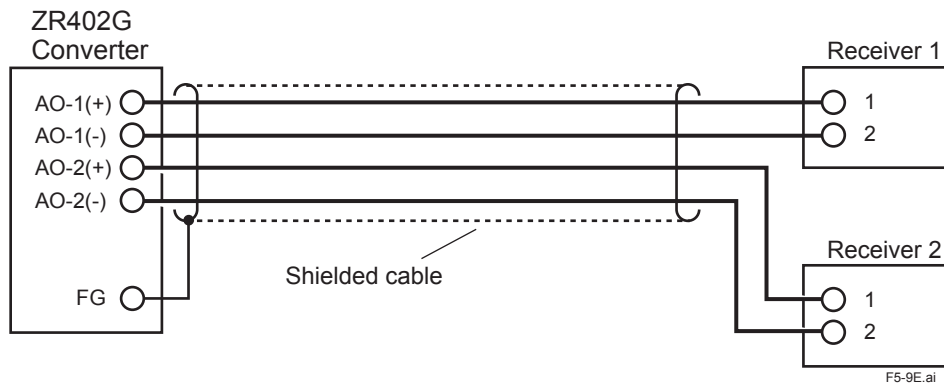


Figure 5.8 Wiring for analog output

Cable Specifications

For this wiring, use a 2-core or a 4-core shielded cable.

Wiring Procedure

- (1) M4 screws are used for the terminals of the converter. Each wire in the cable should be terminated corresponding to crimp-on terminals. Ensure that the cable shield is connected to the FG terminal of the converter.
- (2) Be sure to connect “+” and “-” polarities correctly.

5.2.7 Contact Output Wiring

Contact outputs 1 to 3 can be freely assigned to “low limit alarm”, “high limit alarm”, etc. user selectable, but the assignment of contact output 4 is fixed (“error output”). And the action (contact closed on error output) also cannot be changed.

When using these contact outputs, install the wiring as follows:

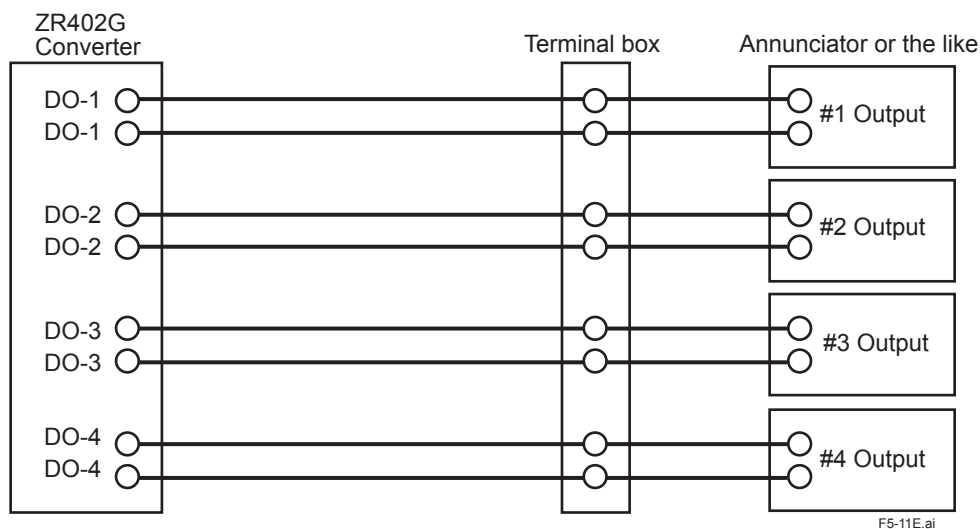


Figure 5.9 Contact output wiring

Cable Specifications

Number of wire in cable varies depending on the number of contact used.

Wiring Procedure

- (1) M4 screws are used for the terminals of the converter. Each cable should be terminated corresponding to crimp-on terminals.
- (2) The capacities of the contact output relay are 30 V DC 3 A, 250 V AC 3 A. Connect a load (e.g. pilot lamp and annunciator) within these limits.

5.2.8 Contact Input Wiring

The converter can execute specified function when receiving contact signals. To use these contact signals, wire as follows:

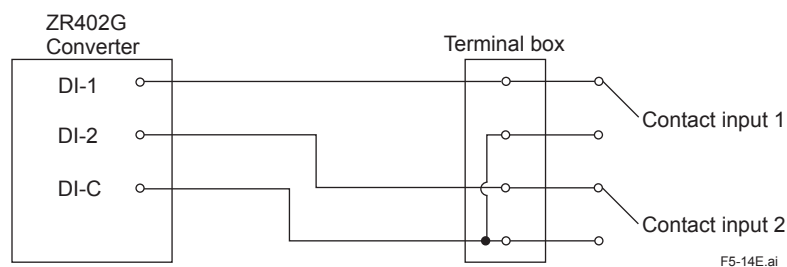


Figure 5.10 Contact Input Wiring

Cable Specifications

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

Wiring Procedure

- (1) M4 screws are used for the terminals of the converter. Each cable should be terminated corresponding to crimp-on terminals.
- (2) The ON/OFF level of this contact input is identified by the resistance. Connect a contact input that satisfies the specifications in Table 5.2.

Table 5.2 Identification of Contact Input ON/OFF

	Closed	Open
Resistance	200 Ω or less	100 k Ω or more

5.2.9 Wiring for ZR40H Automatic Calibration Unit

This wiring is for operating the solenoid valve for the zero gas and the span gas in the ZR40H Automatic Calibration Unit, in a system where the calibration gas flow rate is automatically controlled (e.g. System configuration 3). When installing this wiring, proceed as follows:

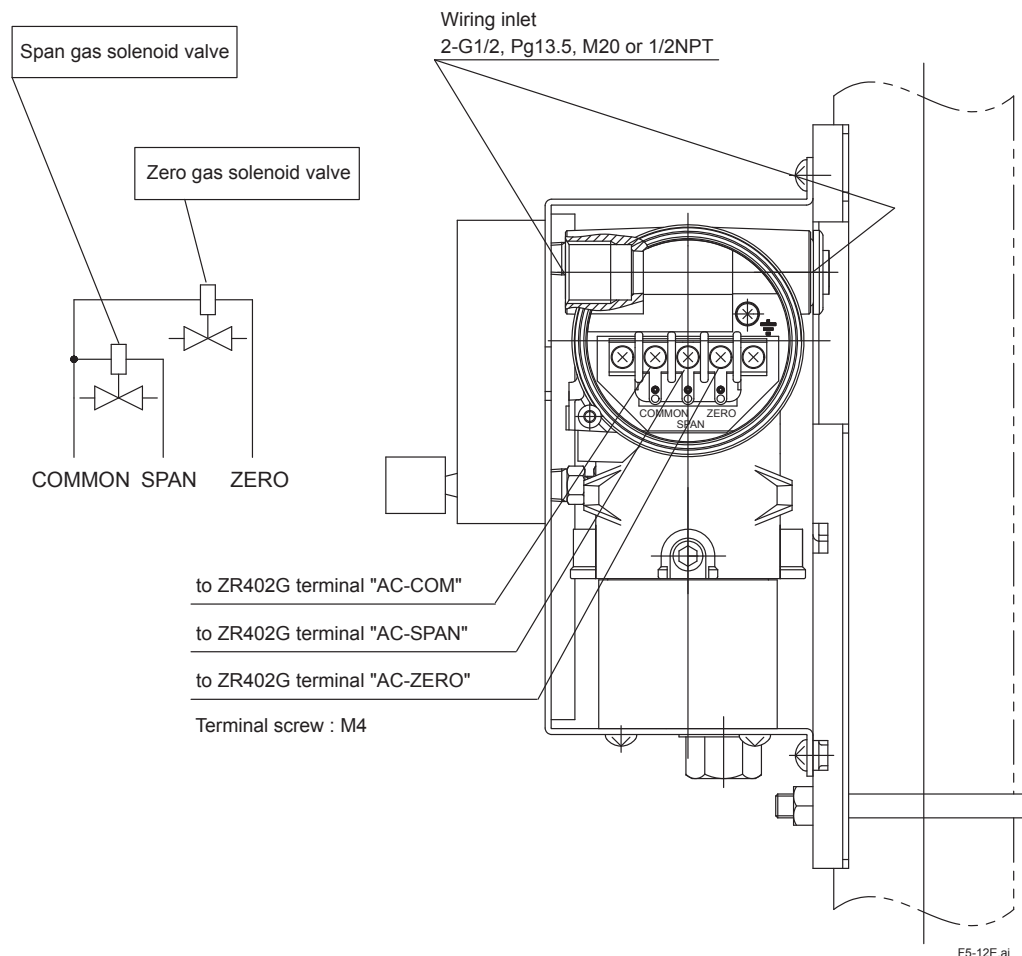


Figure 5.11 Automatic Calibration Unit

Cable Specifications

Use a 3-core cable for the above wiring.

Wiring Procedure

M4 screws are used for the terminals of the converter. Each cable should be terminated corresponding to crimp-on terminals. M4 screws are used for the terminals of the solenoid valve as well.

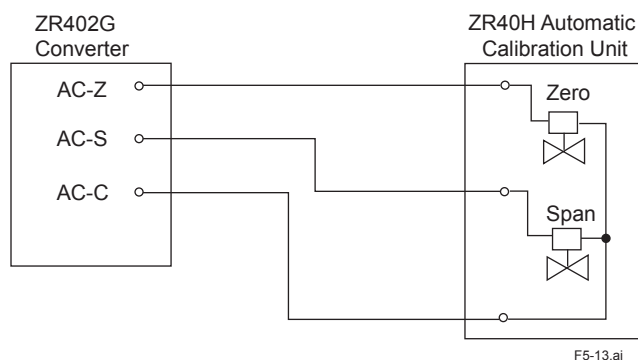


Figure 5.12 Wiring for Automatic Calibration Unit

5.2.10 Temperature Input Wiring

(Only for Humidity Analyzer)

When inputting the measurement gas temperature from external of the equipment, connect a two-wire temperature transmitter. The relative humidity and dew point are acquired based on the temperature signal from the connected transmitter, in the case where the setting is "Temperature input selected" and "external input". As for the wiring of the temperature transmitter and thermocouples, refer to appropriate temperature transmitter instruction manual.

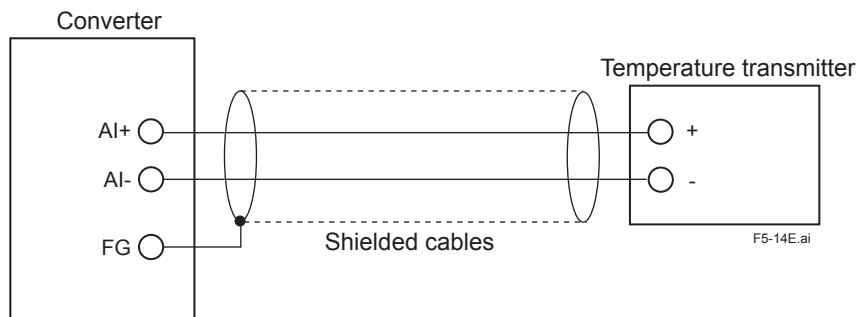


Figure 5.13

● Applicable Temperature Transmitter

Apply a temperature transmitter that is suit for the following interfaces:

Output signal: 4 to 20 mA DC, two-wire system

Maximum supply voltage from the analyzer: 24 V DC

Input resistance of the analyzer: Maximum 250 Ω (The load resistance of the transmitter is the total of wiring resistance and input resistance.)

Temperature Transmitter Burnout

When outputting a burnout signal of the temperature transmitter with a contact output of the analyzer, use "high-limit temperature alarm". (Refer to Section 8.4, "Contact Output Setting.") In this case, set the burnout signal of the temperature transmitter to exceed the high limit (20 mA or more).

Cable Specifications

Use a two-core shielded cable for wiring.

Wiring Procedure

- (1) M4 screws are used for the converter terminals. Cables should be equipped with appropriate crimp contacts. Ensure that the cable shield be connected to the FG terminal of the converter.
- (2) Be sure to connect "+" and "-" polarities correctly.

6. Components

In this Chapter, the names and functions of components are described for the major equipment of the EXAxt ZR Separate type Zirconia Oxygen/Humidity Analyzer.

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.

6.1 ZR22G Detector

6.1.1 General-purpose Detector (except for ZR22G-015)

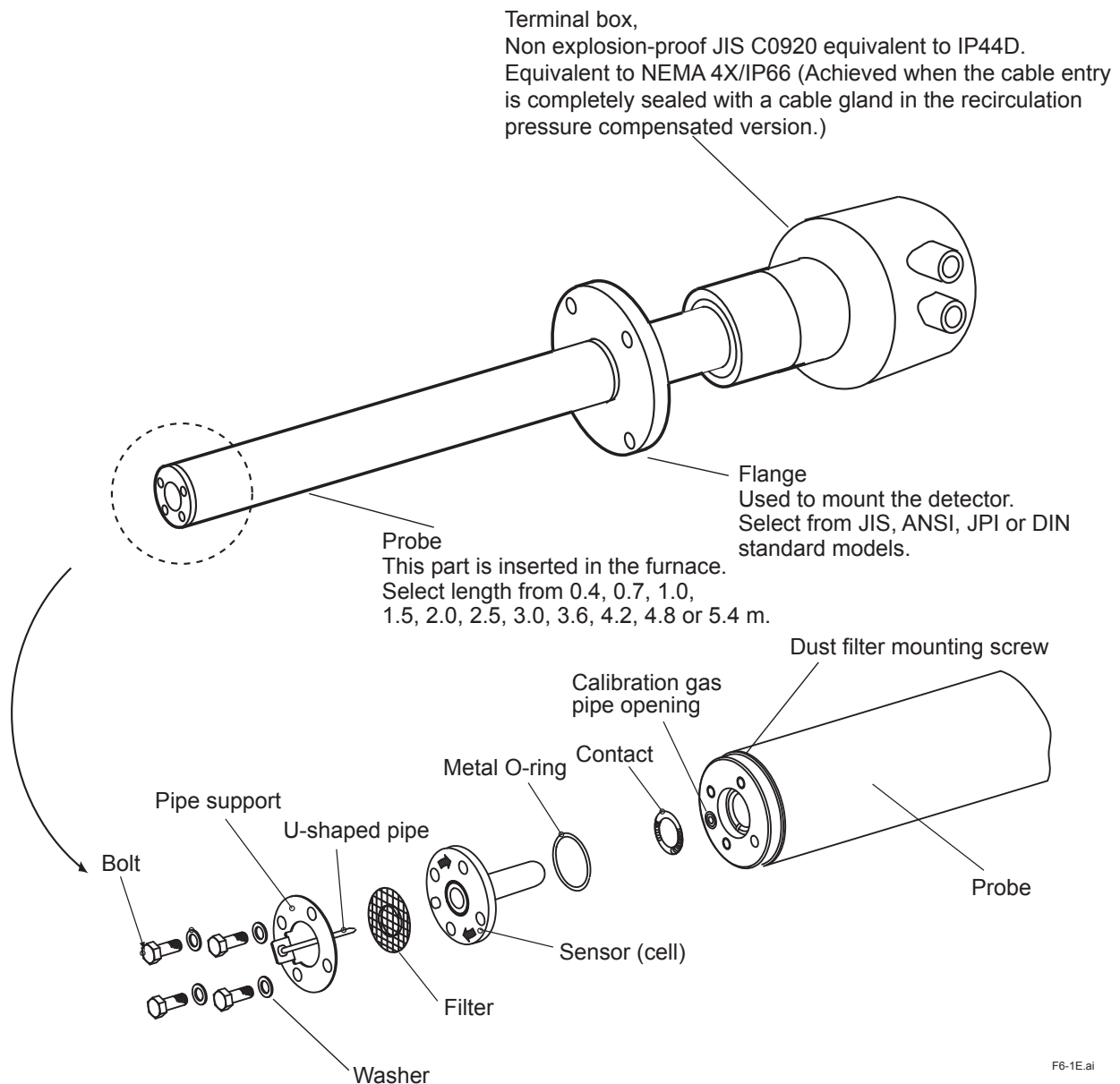


Figure 6.1 General-purpose Detector

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6.1.2 High Temperature Detector (ZR22G-015)

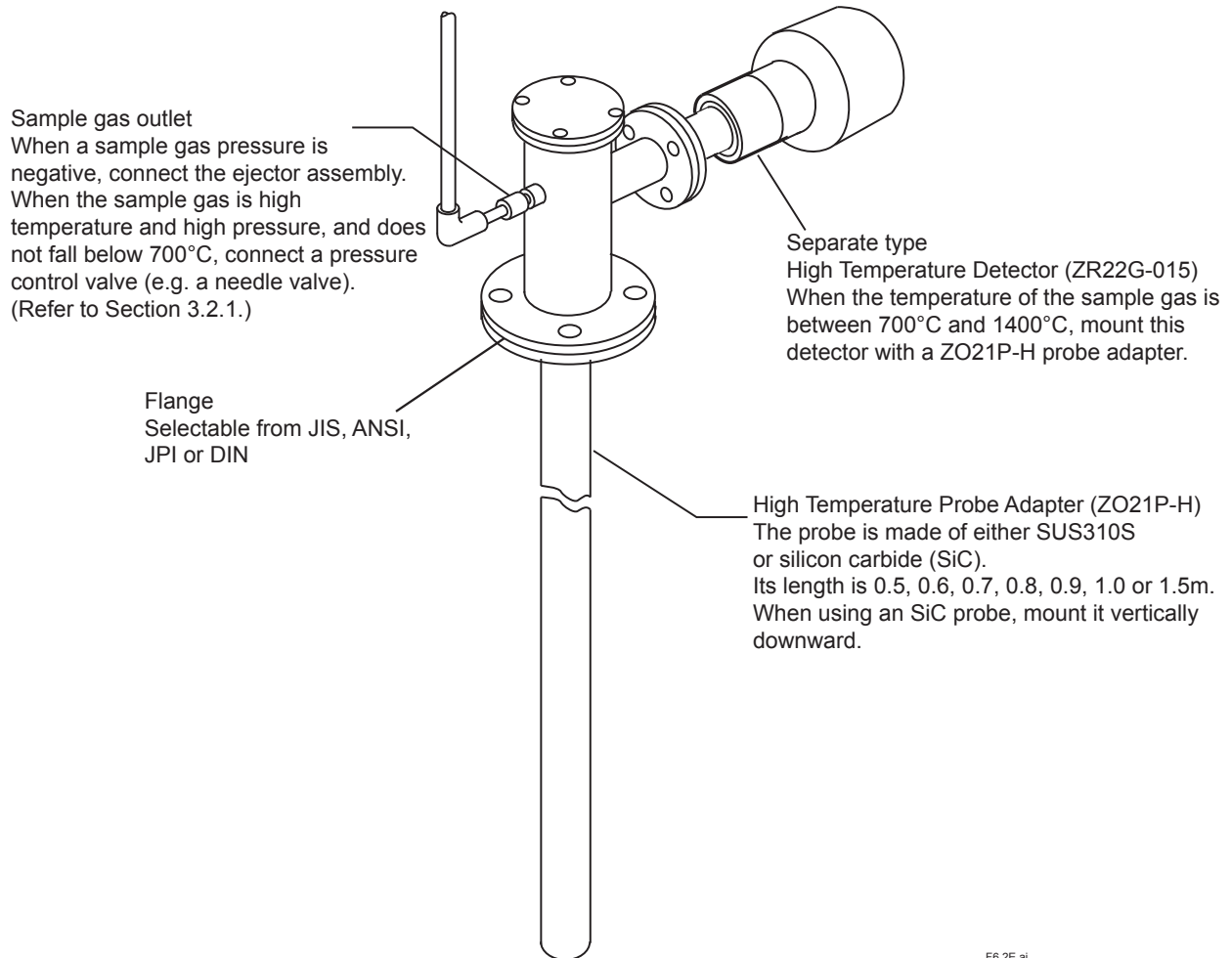


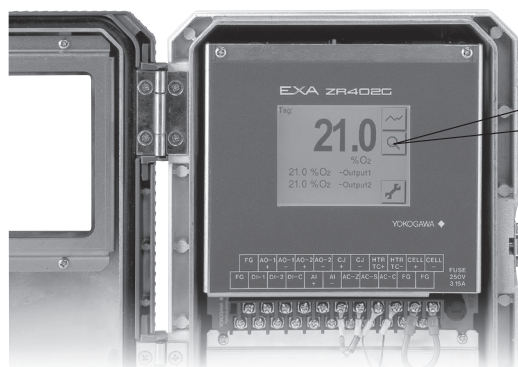
Figure 6.2 High Temperature Detector

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6.2 ZR402G Converter

Complete Operation Display

- Interactive operations along with operation display.
- A variety of display modes - enabling you to select the operation mode freely.
- Back-lit LCD allows viewing even in the darkness.
- Error codes and details of errors can be checked in the field without the need to refer to appropriate instruction manual.



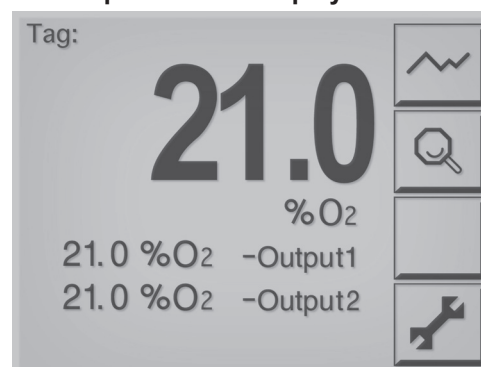
Self-testing suggests countermeasures for problems

If a problem occurs, the liquid-crystal display will provide an error code and description of the problem. This enables prompt and appropriate corrective action to be taken.

Error code	Reason for error
E--1	Cell failure
E--2	Abnormal heater temperature
E--3	Defective A/D converter
E--4	Faulty EEPROM
ALARM1	Abnormal oxygen concentration
ALARM2	Abnormal moisture
ALARM3	Abnormal mixing ratio
ALARM6	Abnormal zero calibration ratio
ALARM7	Abnormal span calibration ratio
ALARM8	Stabilization time over

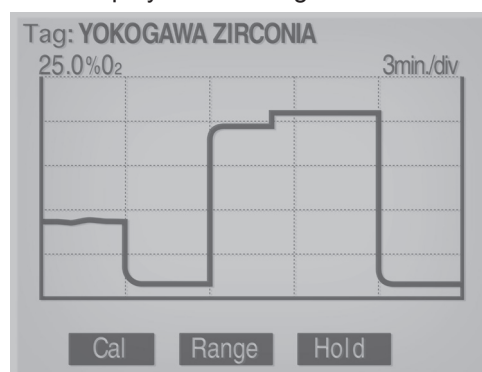
Typical Converter Displays

● Example of basic display



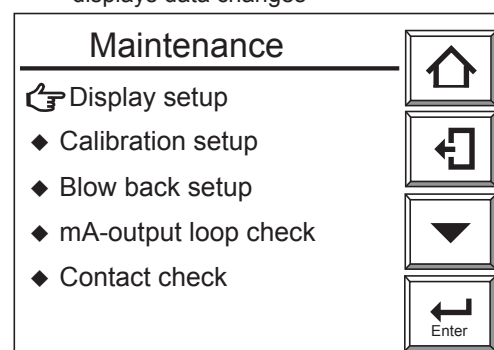
This display enables you to operate the analyzer while checking data on the display.

● Example of trend display — displays data changes



During calibration, you can check the stabilized, display data while viewing oxygen trend data, thus providing highly reliable calibration.

● Example of setting data display — displays data changes



- One-touch interactive display operation
- User-friendly design providing easy operation without having to use the instruction manual

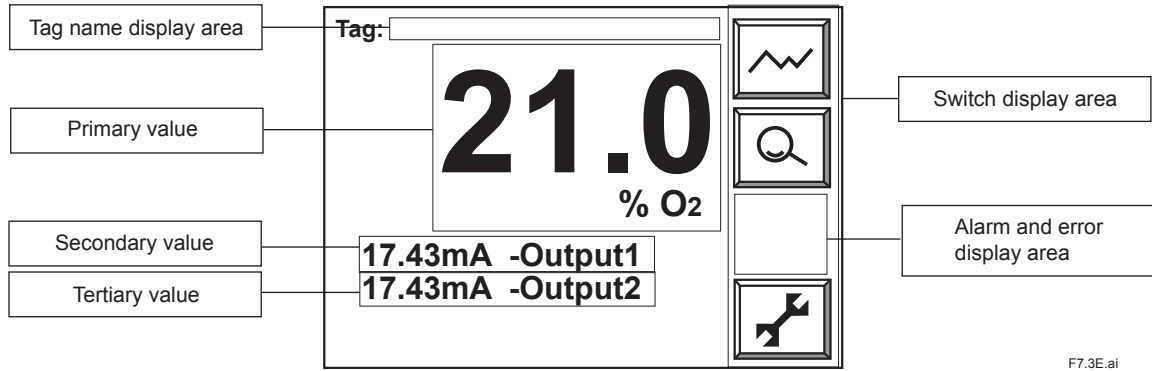
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Figure 6.3 Converter

6.3 Touchpanel Switch Operations

6.3.1 Basic Panel and Switch

The converter uses a touchpanel switch which can be operated by just touching the panel display. Figure 6.4 shows the Basic panel display. The switches that appear in the switch display area vary depending on the panel display, allowing all switch operations. Table 6.1 shows the switch functions.



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Figure 6.4 Basic Panel Display

Tag name display area: Displays the set tag name (Refer to Section 10.3.2, Entering Tag Name).

Primary to tertiary value display items: Displays the selected item. (Refer to Section 7.9, Setting Display Item.)

Switch display area: Displays switches and functions selected according to the panel display.

Alarm and error display area: Displays an error if an alarm or error occurs. If you touch this area, the details of the error or alarm are then displayed.

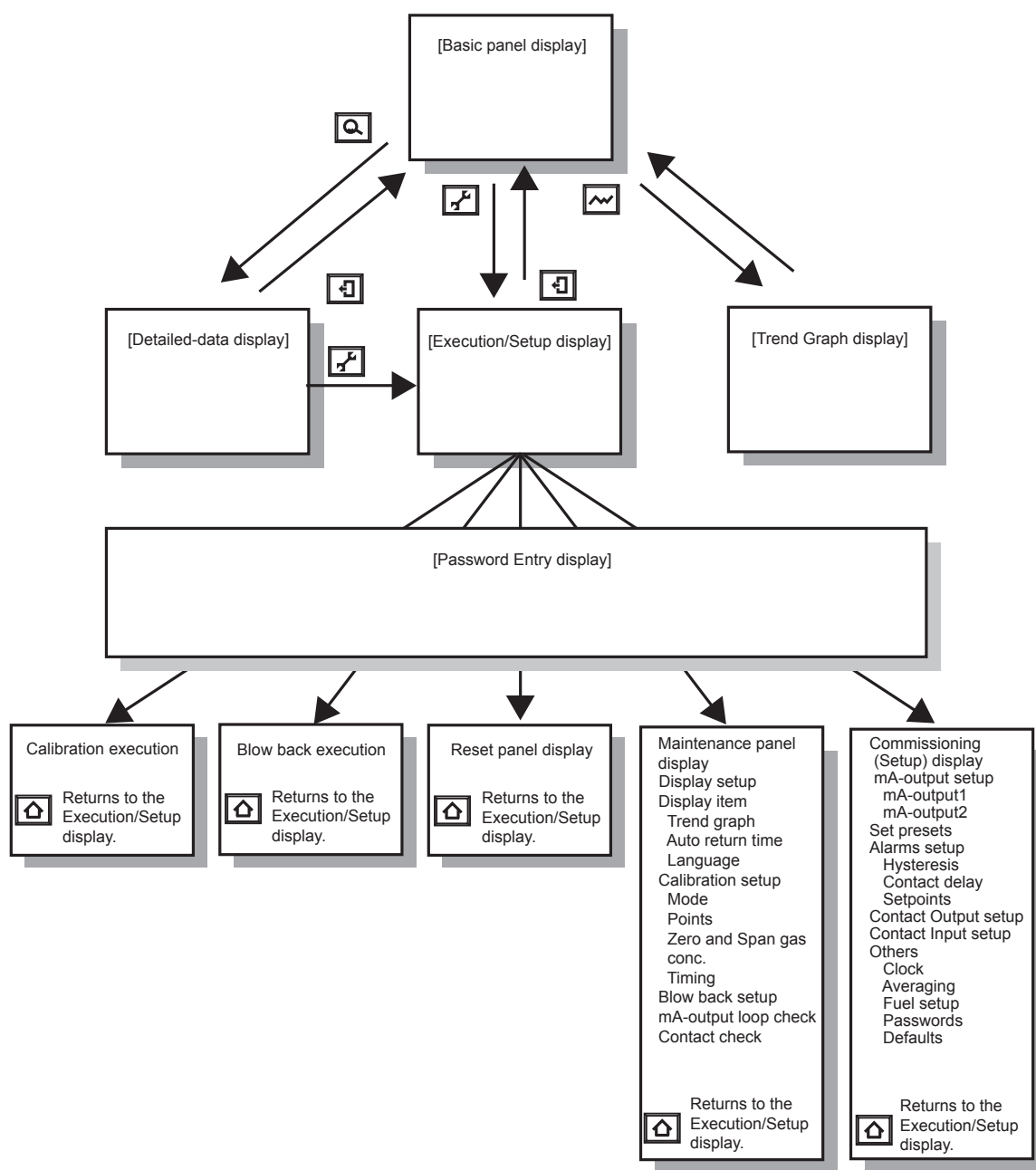
Table 6.1 Switches and Their Functions

	Home key: Returns to the Execution/Setup display.		Enter key: Enters the input value and sets up the selected item.
	Reject key: Moves back to the previous display.		Setup key: Used to enter the Execution/Setup display.
	Cursor key: Moves the cursor down.		Detailed-data key: Displays the analog input value.
	Graph display key: Displays a trend graph.		Cursor: Points the cursor at the currently selected item.
	Alarm: Displayed if an alarm arises.		Error: Displayed if an error occurs.

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6.3.2 Display Configuration

Figure 6.5 shows the configuration. A password the displays positioned below enables display “Execution/Setup” to be protected. If a password has not been set, press the [Enter] key to proceed to the next panel display. The [Home] key enables you to return to “Execution/Setup display” from any panel display.



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Figure 6.5 **Display Configuration**

6.3.3 Display Functions

Individual panel displays in the display configuration provide the following functions:

- (1) Basic panel display: Displays the values measured in three selected items (see Section 7.9, Setting Display Item).
- (2) Execution/Setup display: Selects the calibration, maintenance and setup items.
- (3) Detailed-data display: This allows you to view such detailed data as the cell electromotive force and cell temperature (see Section 10.1, Detailed-data Display, later in this manual).
- (4) Trend Graph display: Displays a trend graph (see Section 10.2, Trend Graph, later in this manual).
- (5) Calibration execution: Makes zero and span calibrations (see Chapter 9, Calibration, and the associated sections later in this manual).

- (6) Blow back execution: Executes a “Blow back setup” (see Section 10.4, Blow Back, later in this manual).
- (7) Reset panel display: If an error arises, you can restart the equipment from this display (for more details, see Section 10.6, Reset, later in this manual).
- (8) Maintenance panel display: Sets the data for equipment maintenance or makes a loop check.
- (9) Commissioning (Setup) display: Sets up the operation data. (For details, see Chapter 8, Detailed Data Settings, and the associated sections later in this manual.)

6.3.4 Entering Numeric and Text Data

This section sets out how to enter numeric and text data. If only numeric values are entered, a numeric-data entry display as in Figure 6.6 then appears. Press the numeral keys to enter numeric values. If those values include a decimal point as in Figure 6.6, the decimal point need not be entered because the decimal point position is already fixed, so just enter 00098.

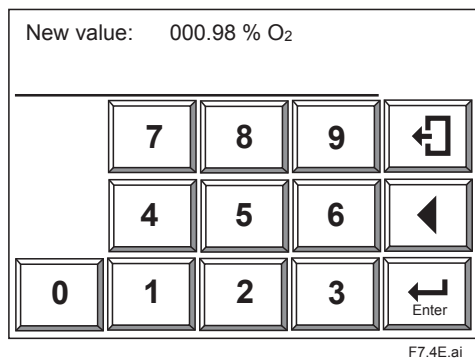


Figure 6.6 **Numeric-data Entry Display**

To enter a password (in combination with text data, numeric values and codes), the alphabetic character entry panel display first appears. If you press any numeral key [0 - 9], the current display then changes to the numeric-value entry panel display, enabling you to enter numeric values. If you press the [other] key, the current display then changes to the code-entry display, enabling you to enter codes. These displays alternate between the three. Figure 6.7 shows the relationship between these three displays. Three alphabetic characters and three codes are assigned for each individual switch. If the alphabetic character key is pressed and held, three characters appear in turn. Move the cursor to the desired character and release the key to enter it. If an incorrect character is entered, move the cursor to re-enter the characters. The following shows an example of entering “abc%123.”

Operation
Press the [ABC] key once.
Press and hold the [ABC] key.

Display
A_
A A
B → C

Release the [ABC] key when the character B appears in the cursor position.
Enter the character C in the same manner as above.
Press the [other] key.

AB_
ABC_

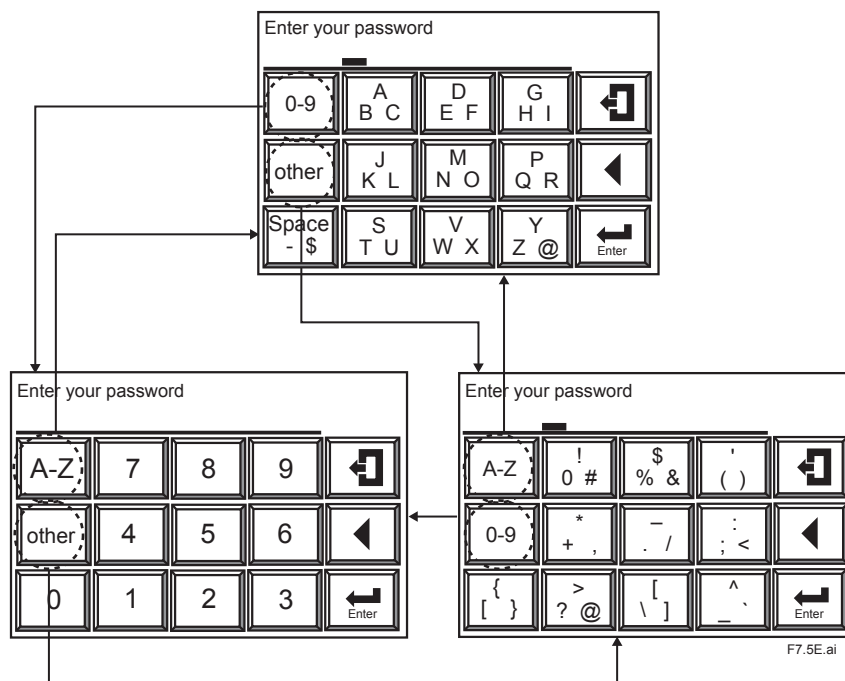
Press and hold the [\$%&] key and enter “%.”
Then press the [0-9] key.

ABC%_

Enter the numeric characters 1, 2 and 3 in turn.
Press the [Enter] key to complete the entry.

ABC%123_

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Figure 6.7 Text Entry Display

6.4 ZA8F Flow Setting Unit, ZR40H Automatic Calibration Unit

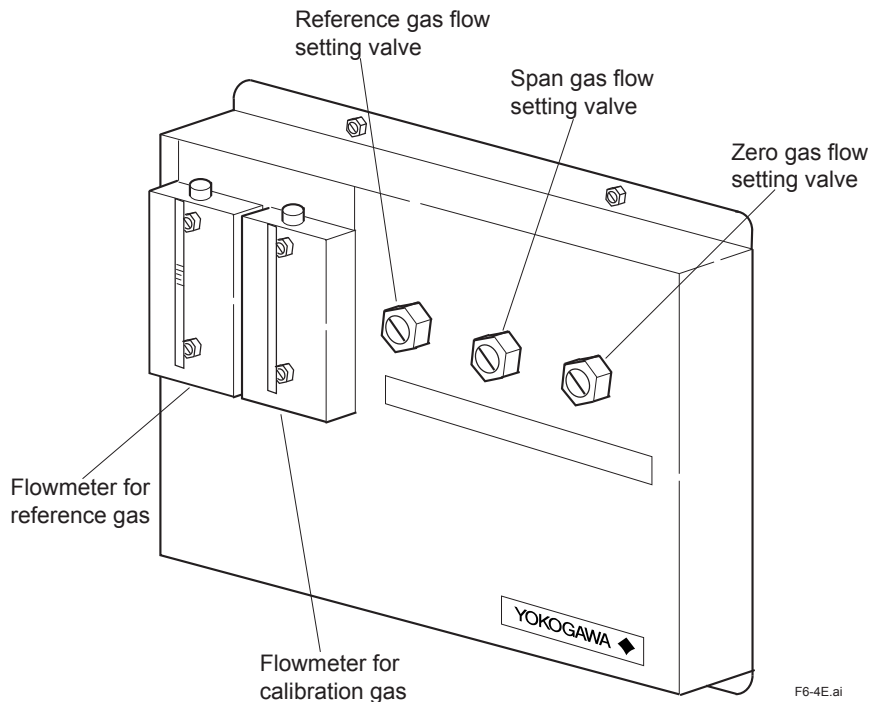


Figure 6.8 ZA8F Flow Setting Unit

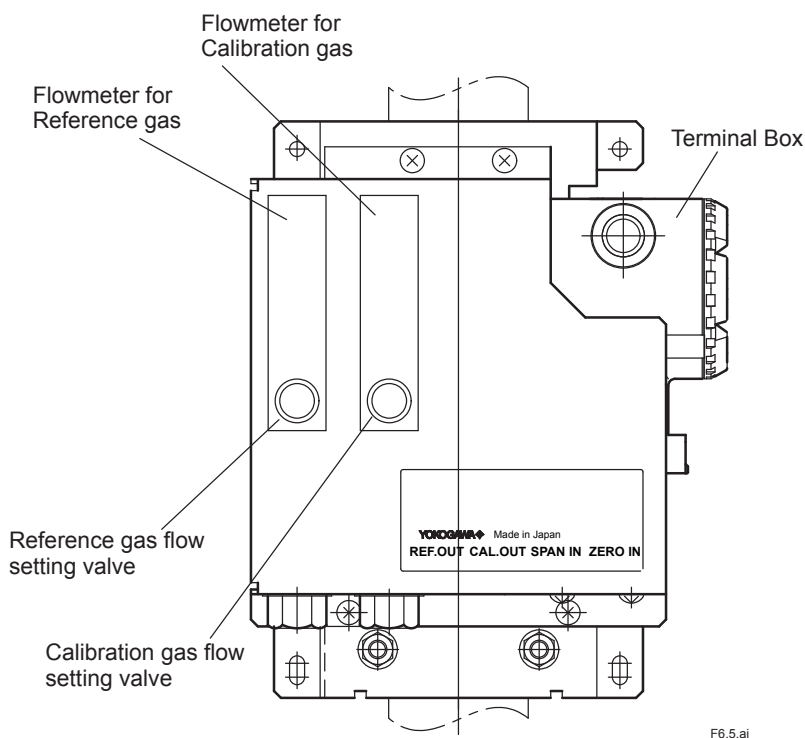


Figure 6.9 ZR40H Automatic Calibration Unit

7. Startup

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

System tuning by the HART communicator, refer to IM11M12A01-51E “HART Communication Protocol”.

In the figure listed in this manual, the example of the oxygen analyzer is shown mainly.

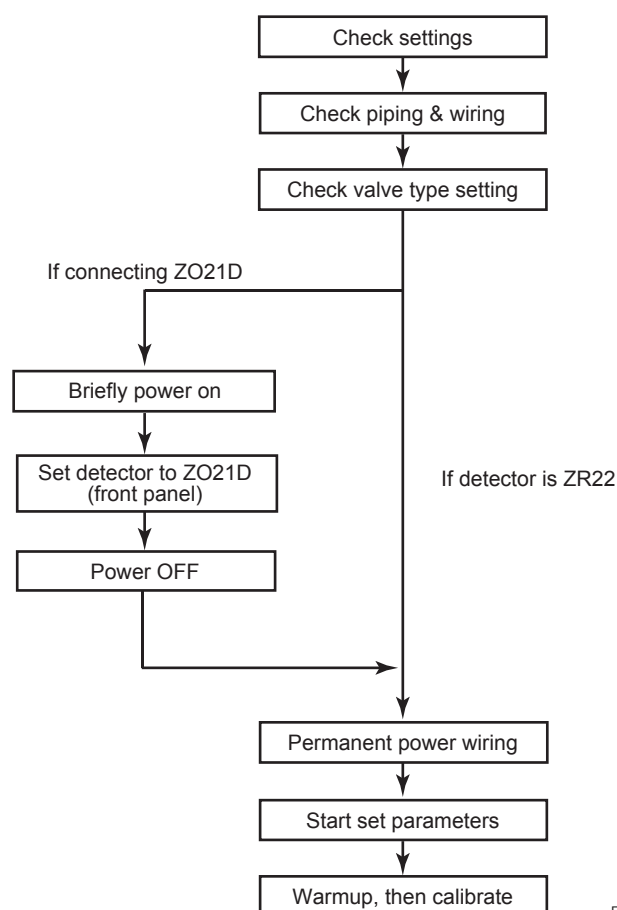
In the case of the humidity analyzer, unit indication may be different. Please read it appropriately.

7.1 Startup Procedure

The startup procedure is as follows:

CAUTION

If you connect Model ZO21D* detectors, then you need to change the detector parameters. Before connecting power, refer to: Section 7.6 Confirmation of Detector Type Setting.



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Figure 7.1 Startup Procedure

7.2 Checking Piping and Wiring Connections

Check that the piping and wiring connections have been properly completed in accordance with Chapter 4, "Piping," and Chapter 5, "Wiring."

7.3 Checking Valve Setup

Set up valves and associated components used in the analyzer system as follows:

- (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 an air pressure equals 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) is obtained. Turn the reference gas flow setting valve in the flow setting unit to obtain a flow of 800 to 1000 ml/min. (Turning the valve shaft counterclockwise increases the rate of flow. Before 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 is described later. Fully close the needle valve in the flow setting unit.

7.4 Supplying Power to the Converter

CAUTION

To avoid temperature changes around the sensor, it is recommended that (rather than turning it on and off) power be continuously supplied to the Oxygen Analyzer if it is used in an application where it is used periodically.

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 measurement mode. The display panel then displays the oxygen concentration as in Figure 7.3. This is called the Basic panel display.

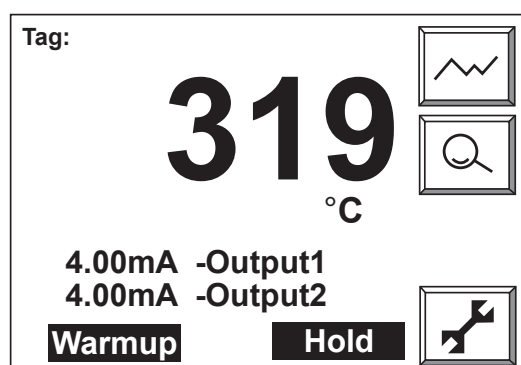


Figure 7.2 Display During Warm-up

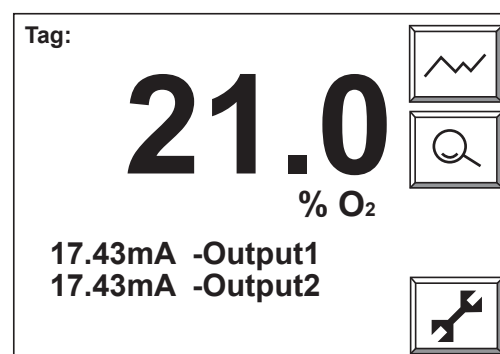


Figure 7.3 Measurement Mode Display

7.5 Confirmation of Converter Type Setting

This converter can be used for both the Oxygen Analyzer and the Humidity Analyzer. Before setting the operating data, be sure to check that the desired converter model has been set.

Note that if the converter type setting is changed, the operating data that have been set are then initialized and the default settings remain. To set the desired operating data, follow these steps:

- (1) Press the [Setup] key.
- (2) Use the [▼] key to select “Commissioning” and press the [Enter] key.
- (3) In the password display, enter the [Enter] key. If the password is to be set again, enter the new password (for details, see Section 8.6.6, Setting Passwords, later in this manual).
- (4) The Commissioning display shown in Figure 7.4 appears. Select “Basic setup” and press the [Enter] key.
- (5) The Basic setup display shown in Figure 7.5 then appears. Confirm the currently set converter type. If the Humidity Analyzer option /HS was selected at the time of purchase, the converter was set for high temperature humidity use before shipment.
- (6) If the converter type is to be changed, press the [Enter] key. The display shown in Figure 7.6 then appears.
- (7) Use the [▼] key to select the type of equipment. Then press the [Enter] key to complete the converter selection.
- (8) If the type of converter is changed after setting the operating data, those data are then initialized and the default settings remain. Reset the operating data to meet the new type of equipment.

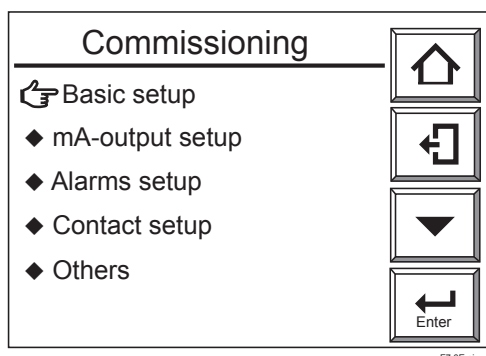


Figure 7.4 Commissioning Display

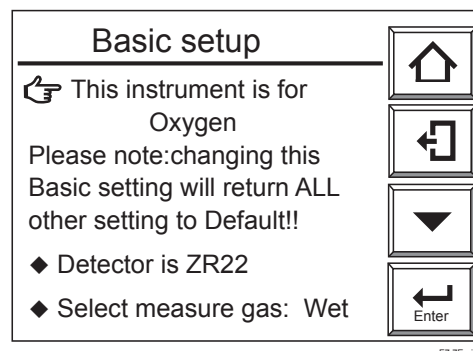


Figure 7.5 Basic Setup

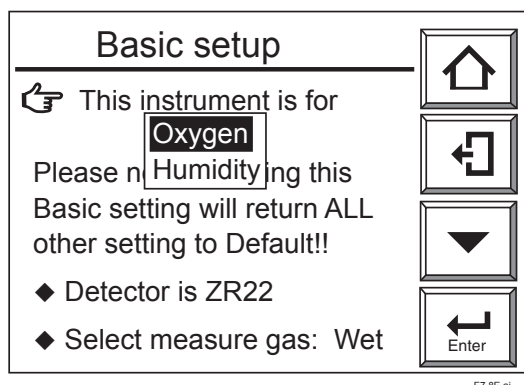


Figure 7.6 Equipment Setup

7.6 Confirmation of Detector Type Setting

Check that the detector in Figure 7.5 is the one for this equipment.

CAUTION

- If this converter is to be used in conjunction with the ZO21D, the power requirements are limited to 125 V AC or less, 50 or 60 Hz (it cannot be used with a 125 V or greater, or in the EEC).
- If detector settings are to be changed, first disconnect the wiring connections between the detector and the converter. Then change detector settings appropriately.

7.7 Selection of Sample 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. Select the "Select measure gas: Wet" in Figure 7.6 to select either wet or dry gas.

7.8 Output Range Setting

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

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

To set the minimum and maximum current settings, follow these steps:

- (1) Select the "Commissioning" from the Execution/Setup display.
- (2) From the Commissioning (Setup) display, select "mA-output setup"; the display shown in Figure 7.7 then appears.
- (3) Select "mA-output1" from the mA-outputs display. The "mA-output1 range" display shown in Figure 7.8 then appears.
- (4) In the display shown in Figure 7.8, select "Min. oxygen conc" and press the [Enter] key to display the numeric-data entry display. Enter the oxygen concentration at a 4-mA output; enter [010] for a ten-percent oxygen concentration measurement.
- (5) Also in Figure 7.8, select "Max. oxygen conc" at a 20-mA output. Enter the appropriate maximum oxygen concentration (at the 20-mA output) in the same manner as in step 4 above.
- (6) Set "mA-output2" in the same manner as in the appropriate steps above.

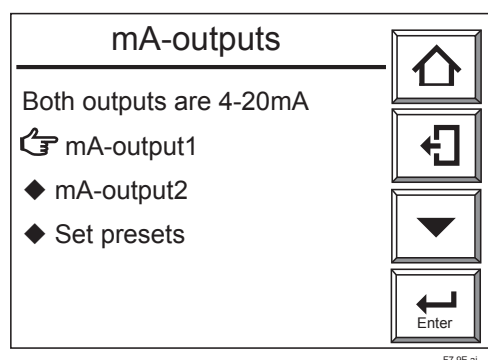


Figure 7.7 Setting "mA-outputs"

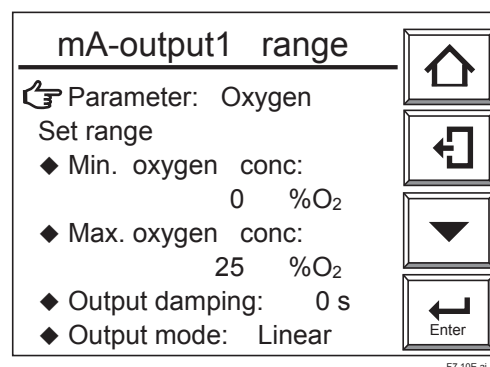


Figure 7.8 Setting "mA-output1 range"

7.8.2 Humidity Analyzer - Analog Output Setting

Select any one of the analog output settings — Oxygen, Humidity, and Mixing from the mA-output range display. If the /HS option is specified at the time of purchase, the equipment is a humidity analyzer. For other than this setting, the analyzer is an oxygen analyzer. If a mixed measurement is required, change the current output setting as given below. If the humidity analyzer is specified in the above detector type setting, the analog output is set to “humidity” when the data initialization is attempted.

- (1) Select the Setup from the Execution/Setup display.
- (2) From the Commissioning (Setup) display, select “mA-output setup”; the display shown in Figure 7.9 then appears.
- (3) Select “mA-output1” from the “mA-outputs” display. The “mA-output1 range” display shown in Figure 7.10 then appears.
- (4) Select the Parameter, then the Oxygen, Humidity, and Mixing appear in the mAoutput1 range display (Figure 7.11). Select “Mixing” and press the [Enter] key.
- (5) The “Mixing” in Figure 7.12 appears.
- (6) Perform the same setting in mA-output2 if necessary.

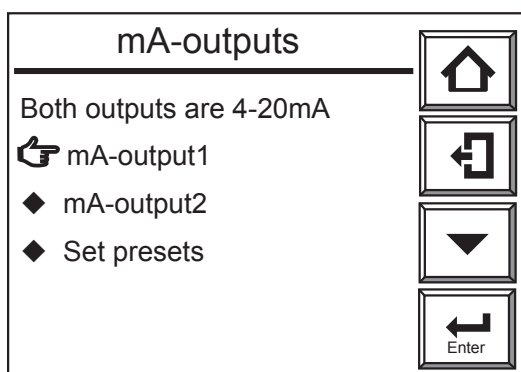


Figure 7.9 mA-outputs Setting Display

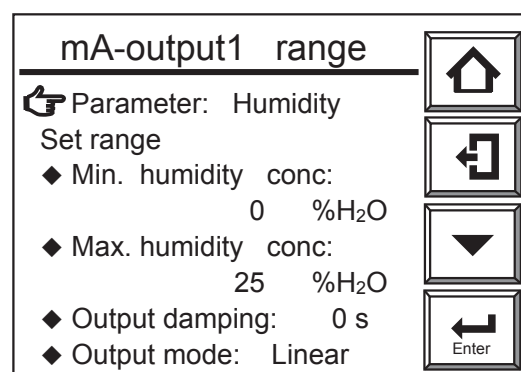


Figure 7.10 mA-output1 Range Display

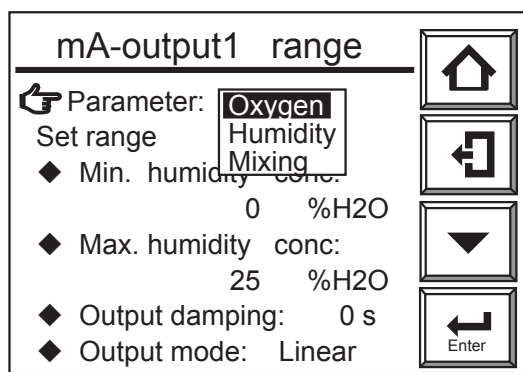


Figure 7.11 mA-output1 Range Display

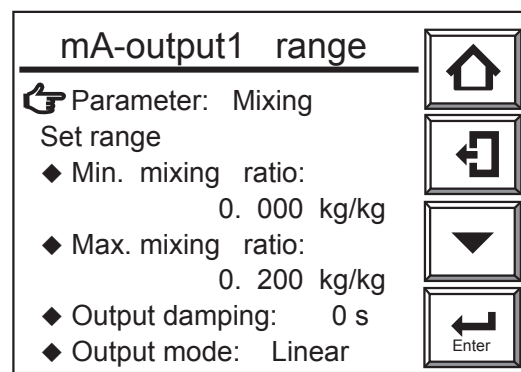


Figure 7.12 Mixing Ratio Display

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

To set the analog output range, follow these steps:

- (1) Select the Setup from the Execution/Setup display.
- (2) From the Commissioning (Setup) display, select the “mA-output setup.” Select “mAoutput1” from the “mA-outputs” display. The “mA-output1 range” that displays “Parameter: Humidity,” as shown in Figure 7.10 then appears.

- (3) To set the minimum humidity at 4 mA, choose the Min. humidity conc. To set the maximum humidity at 20 mA, choose the Max. humidity conc.
- (4) To set 50% H₂O, type in 050 and press the [Enter] key.
- (5) Set "mA-output2" in the same manner as in the appropriate steps above.

NOTE

Analog output range settings should be limited. For more details, consult Section 8.1, "Current Output setting," later in this manual.

7.9 Setting Display Item

7.9.1 Oxygen Analyzer - Setting Display Item

This section briefly describes the display item settings shown in Figure 7.13, "Basic Panel Display."

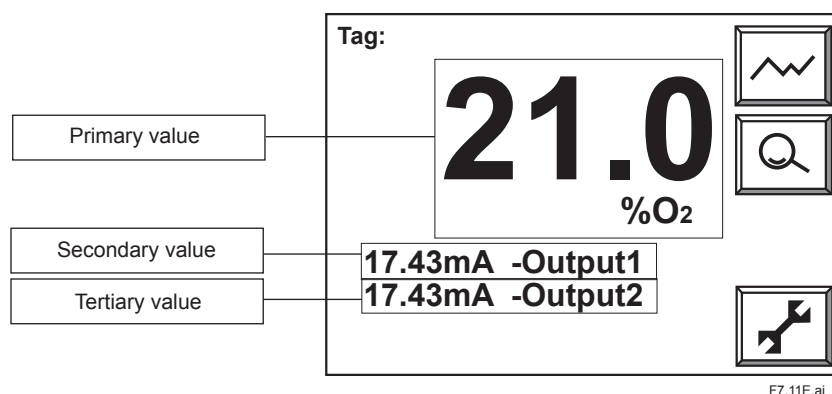


Figure 7.13 Basic Panel Display

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display. Then select "Maintenance" in the Execution/Setup display.
- (2) Select the "Display setup" from the Maintenance panel display (Figure 7.14). The Display setup display (Figure 7.15) then appears.
- (3) In the above Display setup display, select the "Display item". The Display item display (Figure 7.16) then appears. From this display, select the "Primary value" and press the [Enter] key to display the "Display item" selection display (Figure 7.17).
- (4) Select the Secondary and Tertiary values in the same manner as in the steps above.
- (5) Consult Table 7.1, Display Items, enabling the selection of display items in individual display areas.

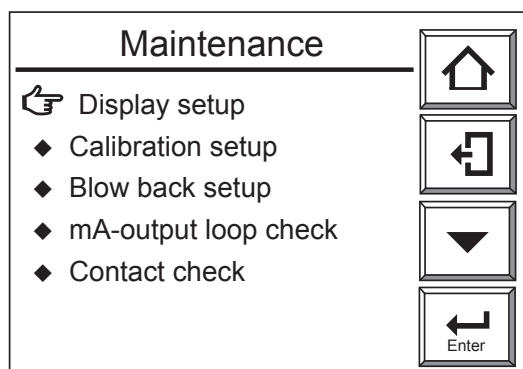


Figure 7.14 Maintenance Panel Display

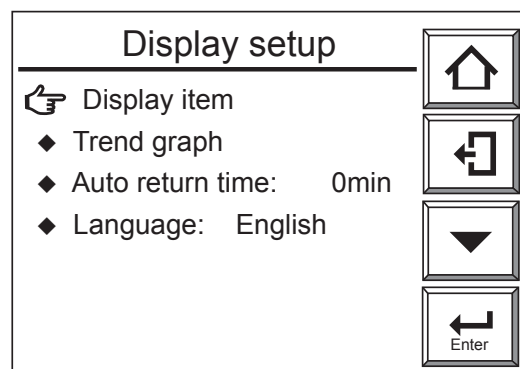


Figure 7.15 Display Setup

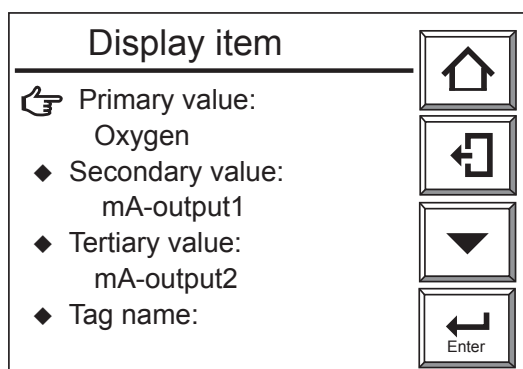


Figure 7.16 Display Item Display

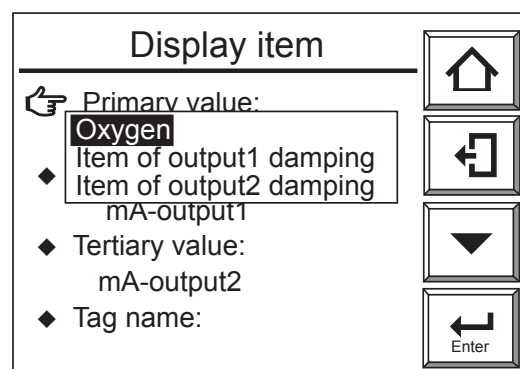


Figure 7.17 Display Item Selection

Table 7.1 Display Items

Item	Primary value	Secondary and tertiary values	Display
Oxygen concentration	<input type="radio"/>	<input type="radio"/>	Oxygen concentration during measurement
Air ratio		<input type="radio"/>	Current computed air ratio
Moisture quantity		<input type="radio"/>	Moisture quantity (%H ₂ O) in the exhaust gas
Output 1 item	<input type="radio"/>	<input type="radio"/>	Oxygen concentration with the equipment set for oxygen analyzer (See *1 below.)
Output 2 item	<input type="radio"/>	<input type="radio"/>	Oxygen concentration with the equipment set for oxygen analyzer (See *1 below.)
Current output 1		<input type="radio"/>	Current value output from analog output 1
Current output 2		<input type="radio"/>	Current value output from analog output

*1: If an analog output damping constant is set, the oxygen concentration display then includes these settings.

● About the 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:

$$m = \{ 1 / (21 - \text{Oxygen concentration}) \} \times 21$$

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 (CH₄, CO, H₂, etc.).

● About moisture quantity:

The moisture quantity in the exhaust gas is calculated based on the parameters of the fuel setting (refer to Section 8.6.3, Setting Fuels, later in this manual). The moisture content may be expressed mathematically by:

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

$$= \{ Gw + (1.61 \times Z \times Ao \times m) \} / \{ X + (Ao \times m) \}$$

where,

Gw = water vapor content in exhaust gas, m³/kg (m³/m³)

Z = Ambient absolute humidity, kg/kg

Ao = Ideal air amount, m³/kg (m³/m³)

m = Air ratio

X = Fuel coefficient

For details on each parameter, refer to Section 8.6.3, Setting Fuels.

7.9.2 Humidity Analyzer - Setting Display Item

This section briefly describes the display item settings shown in Figure 7.18, “Basic Panel Display.” If the humidity analyzer /HS option was specified at the time of purchase, the primary value has set “Humidity.” If a mixing ratio is to be measured, change the current primary value following the steps below.

Additionally, if the “humidity” has been selected in the Detector Type Setting in Section 7.6, earlier in this manual, the primary value is set to the humidity and the secondary and tertiary values are current outputs 1 and 2, respectively when data initialization is performed.

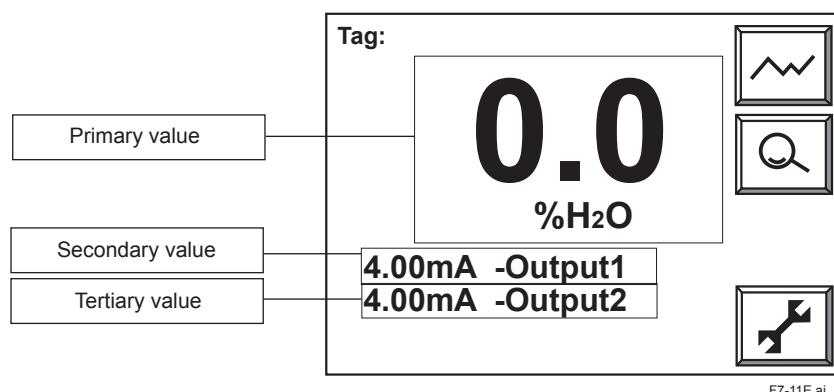
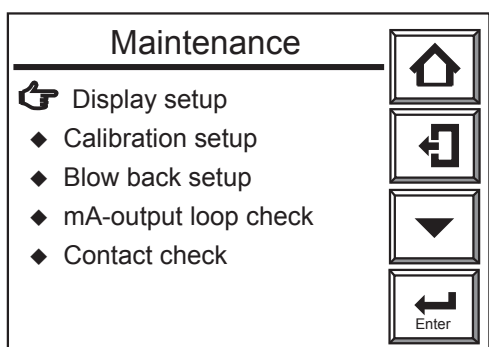


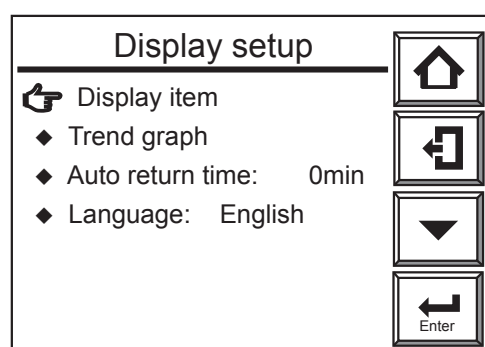
Figure 7.18 Basic Panel Display

- (1) Press the Setup key in the basic panel display to display the Execution/Setup display. Then select Maintenance in the Execution/Setup display.
- (2) Select the Display setup from the Maintenance panel display (Figure 7.19). The Display setup display (Figure 7.20) then appears.
- (3) In the above Display setup display, select the Display item. The Display item display (Figure 7.21) then appears. From this display, select the Primary value and press the [Enter] key to display the Display item selection display (Figure 7.22).
- (4) Select the Secondary and Tertiary values in the same manner as in the steps above.
- (5) Consult Table 7.2, “Display Items,” enabling the selection of display items in individual display areas.



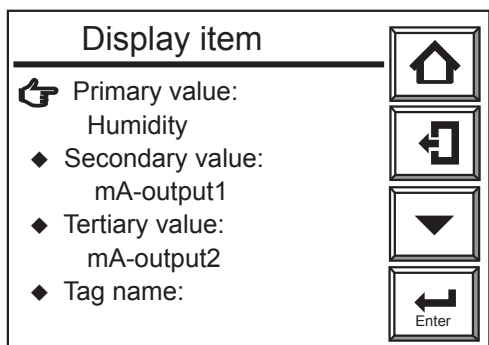
F7-12.ai

Figure 7.19 Maintenance Panel Display



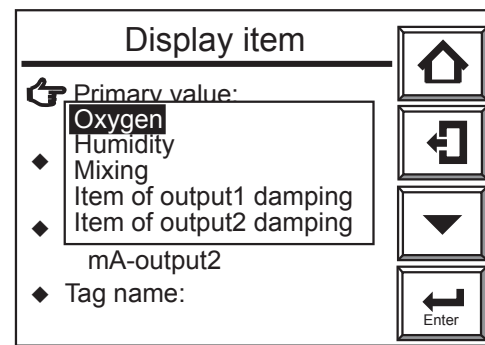
F7-13.ai

Figure 7.20 Display Setup



F7-14.ai

Figure 7.21 Display Item Display



F7-15.ai

Figure 7.22 Display Item Selection

Table 7.2 Display Items

Item	Primary value	Secondary and tertiary values	Display
Oxygen concentration	○	○	Oxygen concentration during measurement
Humidity	○	○	Humidity (%H ₂ O) in the exhaust gas
Mixing ratio	○	○	Mixing ratio during measurement
Relative humidity		○	Relative humidity calculated from the measured value
Dew point		○	Dew point calculated from the measured value
Output 1 item	○	○	Oxygen concentration with the equipment set for oxygen analyzer (See *1 below.)
Output 2 item	○	○	Oxygen concentration with the equipment set for oxygen analyzer (See *1 below.)
Current output 1		○	Current value output from analog output 1
Current output 2		○	Current value output from analog output

*1: If an analog output damping constant is set, the oxygen concentration display then includes these settings.

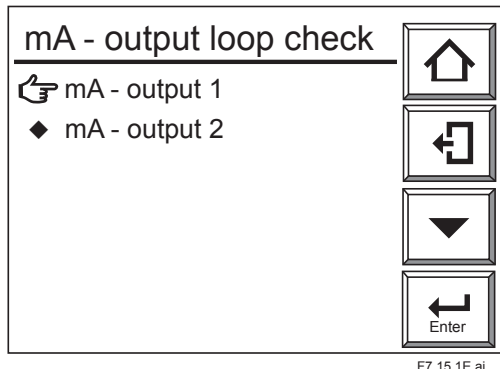
NOTE

For the relative humidity and dew-point calculations, appropriate operation parameters should be entered. For details on the parameters, consult Section 8.6.3, "Setting Measurement Gas Temperature and Pressure," later in this manual.

7.10 Checking Current Loop

The set current can be output as an analog output.

- (1) Press the [Setup] key on the Basic panel display to display the Execution/Setup display. Then select "Maintenance" in the Execution/Setup display.
- (2) Select "mA-output loop check" in the Maintenance panel display to display the mA - output loop check display, enabling you to check "mA-output1" and "mA-output2". Select the desired output terminal for current-loop checking (see Figure 7.23).
- (3) At the time of entering the numeric-data entry display, the output current will change to 4 mA (default value). If the desired current is entered, the corresponding output will be provided.



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Figure 7.23 "mA - output loop check" Panel Display

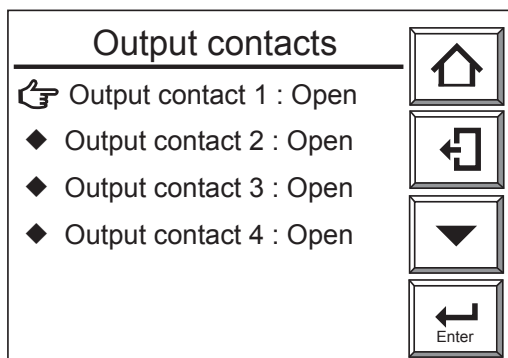
7.11 Checking Contact I/O

Conduct the contact input and output checking as well as operational checking of the solenoid valves for automatic calibration.

7.11.1 Checking Contact Output

To check the contact output, follow these steps:

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display. Select "Maintenance" in that display.
- (2) Select "Contact check" then "Output contacts" in the Maintenance panel display to display the Output contacts display (see Figure 7.24).
- (3) In this display, select the desired output contact for checking. The display, which enables the closing and opening of contacts, then appears. Use the display to conduct continuity checking.



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Figure 7.24 Output Contact Check Panel Display

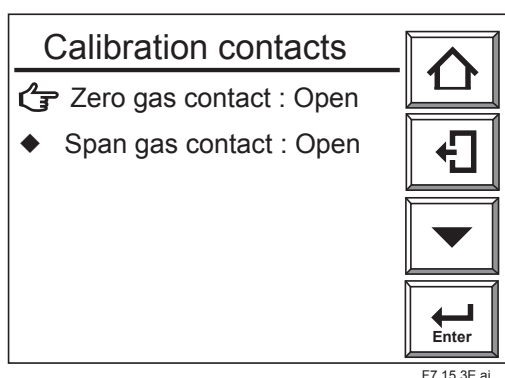
NOTE

If you conduct an open-close check for contact output 4, Error 1 or Error 2 will occur. This is because the built-in heater power of the detector, which is connected to contact output 4, 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 10.6, Reset, later in this manual).

7.11.2 Checking Calibration Contact Output

The calibration contacts are used for solenoid valve drive signals for the ZR40H Automatic Calibration Unit. When using the ZR40H Automatic Calibration Unit, use the calibration contact output to check that the wiring connections have been properly completed and check equipment operation.

- (1) Referring to Section 7.11.1, display the contact check display.
- (2) Select the “Calibration contacts” to display the panel display as Figure 7.25 shows.
- (3) Open the “Zero gas contact” and the “Span gas contact”. This will help check the automatic calibration unit and wiring connections.



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Figure 7.25 Calibration Contact Check Display

NOTE

“Open” and “Closed” displayed on the Calibration contacts display indicate actions of drive contacts and are opposite to the valve open and close actions. If “Open” is displayed on the Calibration contacts display, no calibration gas flows. If “Closed” is displayed on that display, calibration gas flows.

7.11.3 Checking Input Contacts

- (1) Referring to Section 7.11.1, display the contact check display.
- (2) Display the “Input contacts” check display as Figure 7.26 shows. The “Open” or “Closed” input contact in the display shows the current contact input terminal status and the display changes according to the contact status. Using this enables you to check that the wiring connections have been properly completed.

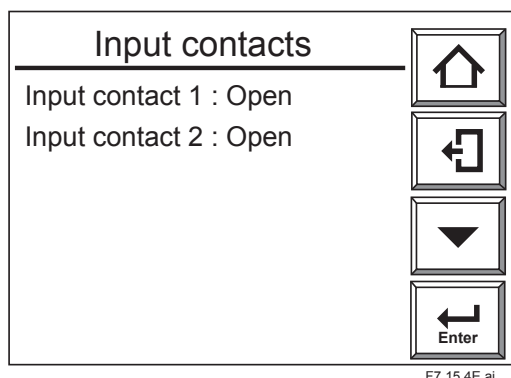


Figure 7.26 Input Contact Check Display

7.12 Calibration

To calibrate this instrument, the procedure is to measure zero gas and span gas and set the instrument to read the known concentrations. The procedure for both zero and span calibration, or for either zero or span calibration, can be performed manually from the touch display, or can be performed semi-automatically using contact signal inputs to start calibration, (allowing preset calibration and stabilization times), or it can be performed automatically at preset intervals.

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 touchpanel 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 the ZR40H 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.

7.12.1 Calibration Setup

■ Mode Setting

For the mode setting, do the following:

Press the [Setup] key in the Basic panel display to display the Execution/Setup display. Select "Maintenance" in the Execution/Setup display to display the Maintenance panel display. Then select "Calibration setup" to display the Calibration setup display as Figure 7.27 shows. Select Mode in this panel, and then select "Manual", "Semi_Auto" or "Auto".

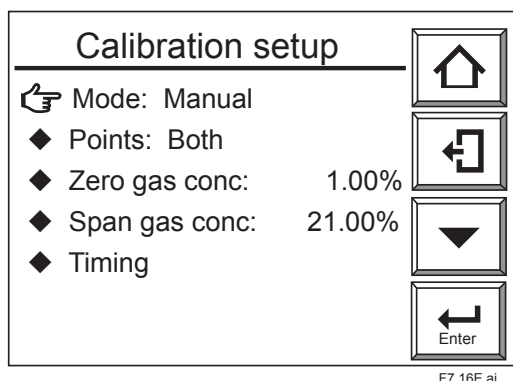


Figure 7.27 Calibration Setup Display

■ Calibration Setting Procedures

Select “Points” (calibration procedure) in the Calibration setup display to display the “Both, Span, Zero” selection display. In this display, select “Both.”

■ Calibration Gas Concentration Setting

- (1) Zero gas concentration
If “Zero gas conc” is selected in the Calibration setup display, the numeric-data entry display then appears.
Use this display to enter an oxygen concentration value for the zero gas calibration; if the oxygen concentration is 0.98 vol%O₂, enter 00098.
- (2) Span gas concentration
With “Span gas conc” selected in the Calibration setup display, display the Numeric - data Entry display and enter an oxygen concentration value for the span gas calibration; If instrument air is used, enter 02100 for a 21 vol%O₂ value. When using the ZO21S Standard Gas Unit (for use of the atmospheric air as a span gas), use a portable oxygen analyzer to measure the actual oxygen concentration, and then enter it.

NOTE

- If instrument air is used for the span gas, dehumidify the air by cooling to a dew point of - 20 °C and remove any oil mist or dust.
- If dehumidification is insufficient, or polluted air is used, a measurement accuracy may be adversely affected.

7.12.2 Manual Calibration

■ Preliminary

Before performing manual calibration, be sure that the ZA8F Flow Setting Unit zero gas flow setting valve is fully closed. Open the zero gas cylinder pressure reducing valve so that the secondary pressure equals 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).

This applies even if you are using the ZR40H Automatic Calibration Unit.

■ Calibration Procedures

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:

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display. Then select "Calibration" in the Execution/Setup display.

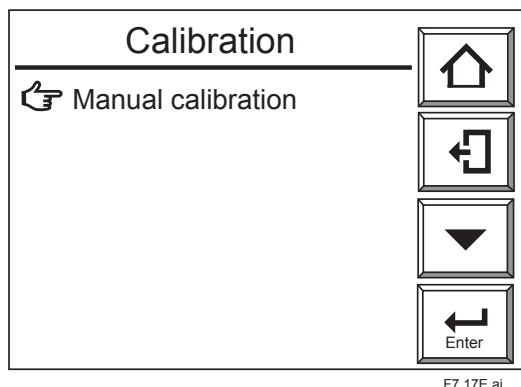


Figure 7.28 Calibration Display

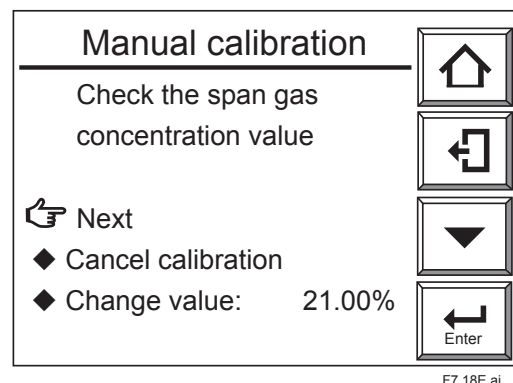


Figure 7.29 Manual Calibration

- (2) Press the [Enter] key to select "Span calibration". The Manual calibration display shown in Figure 7.29 then appears. Check that the oxygen concentration for the span gas in this display coincides with the oxygen concentration in the calibration gas actually used. If the check results are assumed to be OK, select "Next" in the Manual calibration display.
- (3) Follow the display message in Figure 7.30 to turn on span gas flow. Open the span gas flow valve for the Flow Setting Unit by loosening the valve lock nut and slowly turning the valve shaft counterclockwise to flow the span gas at 600 ± 60 ml/min. Use the calibration gas flowmeter to check the flow.

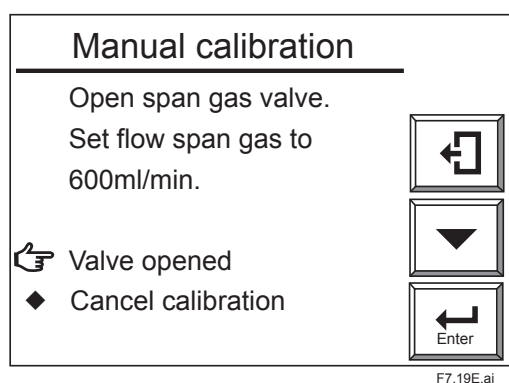


Figure 7.30 Span gas Flow Display

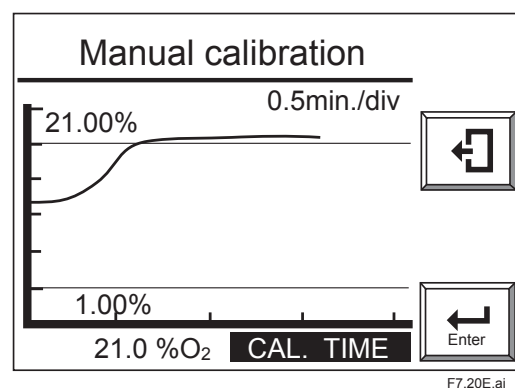


Figure 7.31 Span gas Trend Graph (for Manual Calibration)

- (4) If "Valve opened" is selected as in Figure 7.30, an oxygen concentration trend graph (with the oxygen concentration being measured) appears (see Figure 7.31). The CAL.TIME in the bottom area of the panel flashes. Observe the trend graph and wait until the measured value stabilizes in the vicinity of 21% on the graph. At this point, calibration has not yet been executed yet, so even if the measured value is above or below 21%, no problem occurs.
- (5) After the measured value has stabilized, press the [Enter] key to display the "Span calibration complete" display shown in Figure 7.32. At this point, the measured value is corrected to equal the span gas concentration setting. Close the span gas flow valve. The valve lock nut should be tightened completely so that the span gas does not leak.

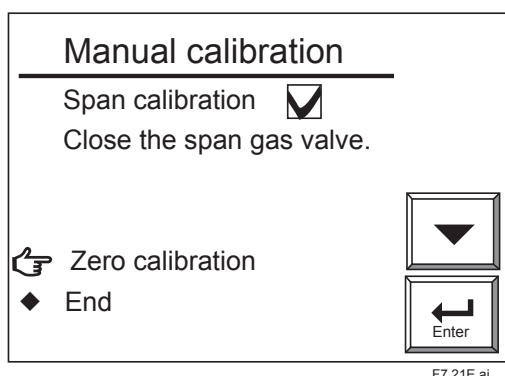


Figure 7.32 Span Calibration Complete
Zero Calibration
Start Display

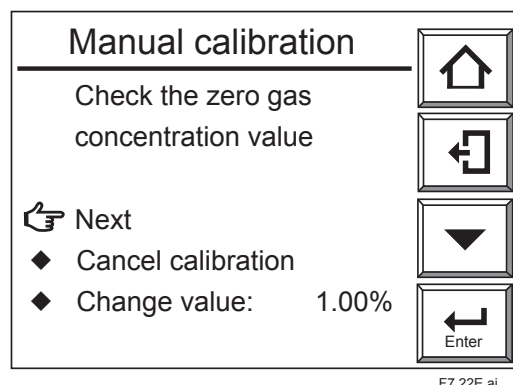


Figure 7.33 Zero Gas Concentration
Check Display
(in Manual Calibration)

- (6) Select "Zero calibration" as in Figure 7.32 to display the zero gas concentration check display (Manual calibration). Check that the zero gas oxygen concentration value and the calibration gas oxygen concentration value agree. Then select "Next" as in Figure 7.33.
- (7) Follow the instructions in the display as in Figure 7.34 to turn on the zero gas flow. To do this, open the zero gas flow valve for the Flow Setting Unit and adjust that valve to obtain a flow of 600 ± 60 ml/min. The valve should be adjusted by loosening its lock nut and slowly turning the valve shaft counterclockwise. Use the calibration gas flowmeter to check the flow.

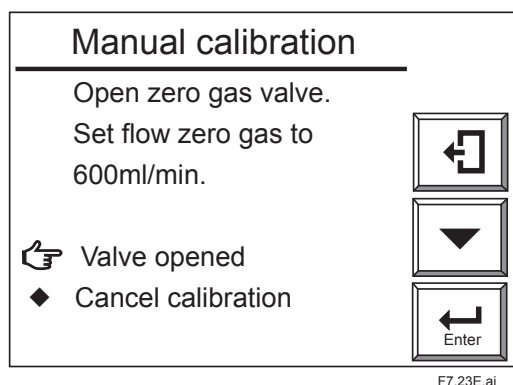


Figure 7.34 Zero Gas Flow Display
(for Manual calibration)

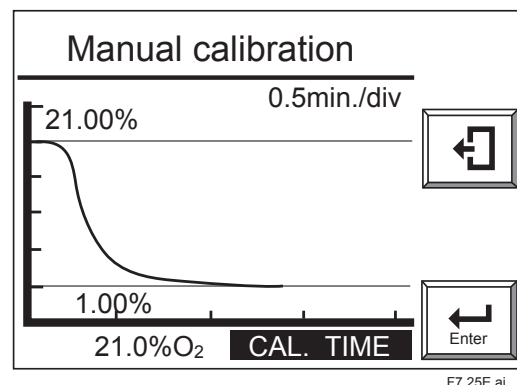


Figure 7.35 Zero Gas, Trend Graph

- (8) If "Valve opened" is selected as in Figure 7.34, an oxygen concentration trend graph (with the oxygen concentration being measured) appears (see Figure 7.35). The CAL.TIME in the bottom area of the panel flashes. Observe the trend graph and wait until the measured value stabilizes in the vicinity of the zero gas concentration on the graph. At this point, no calibration has been executed yet, so even if the measured value is above or below the zero gas concentration value, no problem occurs.
- (9) After the measured value has stabilized, press the [Enter] key to display the "Zero calibration complete" display shown in Figure 7.36. At this point, the measured value is corrected to equal the zero gas concentration setting. Close the zero gas flow valve. The valve lock nut should be tightened completely so that the zero gas does not leak.

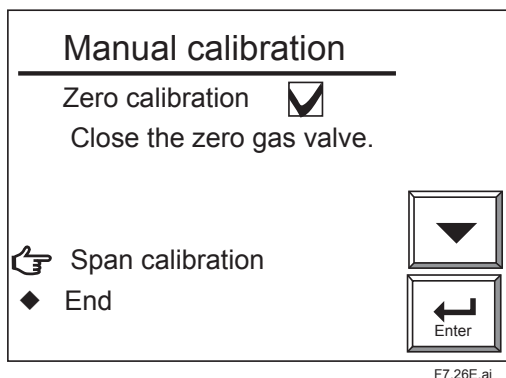


Figure 7.36 Zero Calibration Complete Display

- (10) Select “End” in the display as shown in Figure 7.36. An oxygen concentration trend graph (with the oxygen concentration being measured) appears and HOLD TIME then flashes. This time is referred to as the output-stabilization time. If the HOLD TIME has been set with the output hold setting, the analog output remains held (refer to Section 8.2, Output Hold Setting, later in this manual). Manual calibration is completed when the preset hold (output stabilization) time elapses. This hold (output stabilization) time is set to 10 minutes at the factory before shipment. If you press the [Enter] or [Reject] key within the hold (output stabilization) time, manual calibration is then completed.

8. Detailed Data Setting

8.1 Current Output Setting

This section describes setting of the analog output range.

8.1.1 Oxygen Analyzer - Setting Minimum Current (4 mA) and Maximum Current (20 mA)

To set the minimum and maximum currents, proceed as follows:

- (1) Select [Commissioning] in the Execution/Setup display.
- (2) Select the “mA-output setup” in the Commissioning display.
- (3) Select “mA-output1” in the mA-outputs display.
- (4) Select “Min. oxygen conc” in the mA-output1 range display and press the [Enter] key. The numeric-data entry display then appears. Enter the oxygen concentration for the minimum current (4 mA); for example, enter “010” for 10 vol%O₂.
- (5) Select “Max. oxygen conc” in the mA-output1 range display and enter the oxygen concentration for the maximum current (20 mA) in the same manner as in step 4 above.
- (6) Set mA-output2 in the same way as the setting procedure for mA-output1 given above.

8.1.2 Humidity Analyzer - Setting Minimum Current (4 mA) and Maximum Current (20 mA)

To set the minimum humidity to 50% H₂O and the maximum humidity to 100% H₂O, follow these steps:

- (1) Select Setup in the Execution/Setup display.
- (2) Select the mA-output setup in the “Commissioning” (Setup) display.
- (3) Select mA-output1 in the mA-outputs display.
- (4) Select the Max. humidity conc. in the mA-output1 range display and press the [Enter] key. The numeric-data entry display then appears. Enter the humidity value for the maximum current (20 mA); for example, enter “100” for 100% H₂O.

NOTE

For the humidity measurement, 0% H₂O is a default setting for the minimum humidity and 25% H₂O is the default for the maximum humidity. If you first attempt to set 50% H₂O for the minimum humidity, you cannot set it because that value is outside the set range. In such a case, set the maximum humidity first.

- (5) Select the Min. humidity conc. and enter a minimum humidity value, e.g., 050 for 50% H₂O.
- (6) Follow the above steps to set the mA-output2, if necessary.

8.1.3 Input Ranges

The range low and high values are restricted as follows:

● Oxygen Concentration setting range

The range min. O₂ concentration value (corresponding to 4 mA output) can be set to either 0 vol%O₂ or in the range of 6 to 76 vol%O₂.

The range max. O₂ concentration value (corresponding to 20 mA output) can be set to any value in the range of 5 to 100 vol%O₂, 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%O₂ then range maximum (corresponding to 20 mA output) must be at least 13 vol%O₂.

Setting example 2

If the range minimum (corresponding to 4 mA output) is set to 75 vol%O₂ then range maximum (corresponding to 20 mA output) must be at least $75 \times 1.3 = 98$ vol%O₂ (rounding decimal part up).

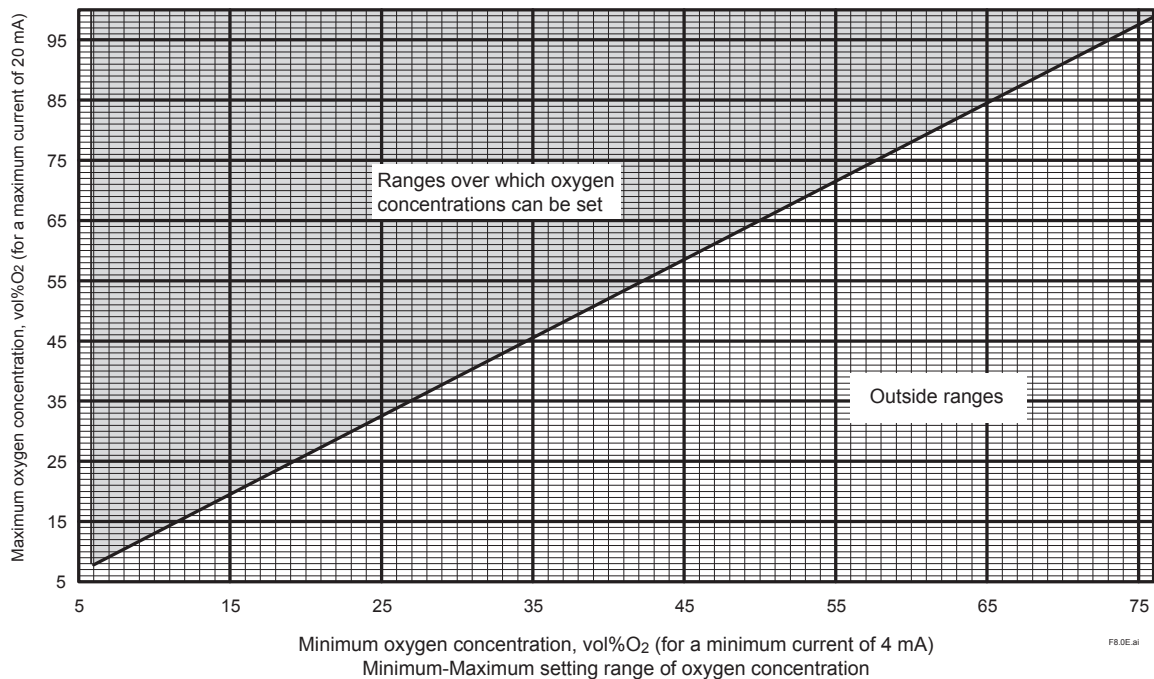


Figure A

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

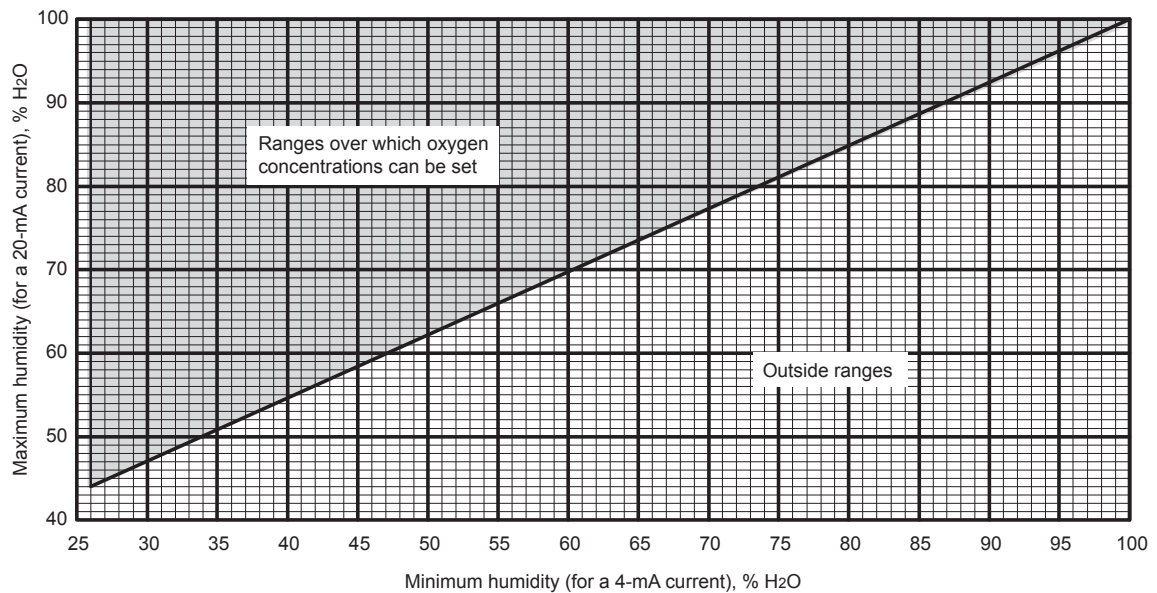
The minimum humidity is set to 0% H₂O or ranges from 26 to 100% H₂O. The maximum humidity ranges from 25% to 100% H₂O, and must be greater than 0.8 times plus 23 the humidity set for the minimum.

Setting example 1

If the setting (for a 4 mA current) is 0% H₂O, you must set the maximum (20 mA) point at more than 25% H₂O.

Setting example 2

If the setting (for a 4 mA current) is 26% H₂O, you must set the maximum (20 mA) point at more than 44% H₂O, ($26 \times 0.8 + 23\%$ H₂O). (Numbers after the decimal point are rounded up.)



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Figure B Max. and Min. Humidity Set Ranges

● “Mixing ratio” setting range

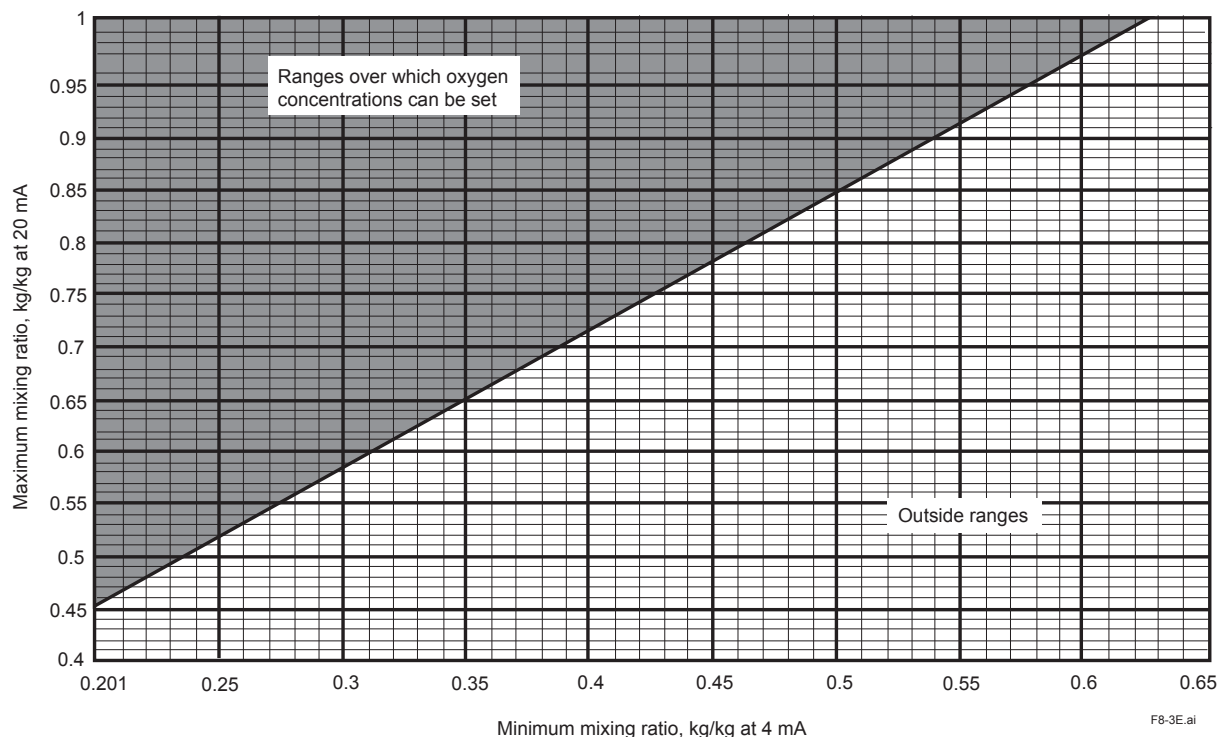
The minimum mixing ratio is set to 0 kg/kg or ranges from 0.201 to 0.625 kg/kg. The maximum “mixing ratio” setting ranges from 0.2 to 1.0 kg/kg, and must be greater than 1.3 times plus 0.187 the mixing ratio set for the minimum.

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, $(0.201 \times 1.3 + 0.187 \text{ kg/kg})$. (Numbers after the decimal point are rounded up.)



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Figure C Max. and Min. Mixing Ratio Set Ranges

8.1.4 Setting Output Smoothing Coefficient

When the oxygen concentration in the sample gas fluctuates rapidly, if the measured value is used for control this can lead to problems with undesirable frequent ON/OFF switching. You can set a smoothing time constant of between 0 and 255 seconds to reduce the effect. Select the appropriate output damping constant from the numeric-data entry display. To set 30 seconds, enter 030.

8.1.5 Selection of Output Mode

You can select whether the relationship between the sample oxygen concentration and the analog output signal be linear or logarithmic. Press the [Enter] key in the output mode display. A linear/ logarithmic selection display then appears. Select the desired mode.

NOTE

If you select an output mode of “logarithmic” then regardless of range setting the minimum output value becomes 0.1 vol%O₂ (humidity; 0.1% H₂O, mixing ratio; 0.01 kg/kg) fixed.

8.1.6 Default Values

When the analyzer is delivered or reset to defaults, the output current default settings by as shown in Table 8.1.

Table 8.1 Output Current Default Values

Item	Default setting
Min. oxygen concentration	0 vol%O ₂
Max. oxygen concentration	25 vol%O ₂
Minimum humidity conc.	0 % H ₂ O
Maximum humidity conc.	25 % H ₂ O
Minimum mixing ratio	0.000 kg/kg
Maximum mixing ratio	0.200 kg/kg
Output damping constant	0 (seconds)
Output mode	Linear

8.2 Output Hold Setting

The “output hold” functions hold an analog output signal at a preset value during the equipment’s warm-up time or calibration or if an error arises. Outputs 1 and 2 can not be set individually. Table 8.2 shows the analog outputs that can be retained and the individual states.

Table 8.2

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

○ : 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 sensor temperature stabilizes at 750°C and the instrument is in the measurement mode.

(2) Under Maintenance

“Under maintenance” is the time that starts when you move to the Execution/Setup display by touching the [Setup] key on the Basic panel display and ends when you return to the Basic panel display. It includes when you operates keys on lower level menu displays of the Execution/Setup display.

(3) Under Calibration (see Chapter 9, Calibration, later in this manual)

For manual Calibration, “Under calibration” is the time that starts when you move to the Manual calibration display (Figure 7.30) from the Calibration display, lasts while you are operating keys for performing calibration manually, and ends when you press the End key and after a preset hold time has elapsed.

For semi-automatic calibration, “Under calibration” is the time required from entering calibration instructions to perform a, either by using the touchpanel or by a contact input, calibration until the hold (output stabilization) time elapses.

For automatic calibration, “Under calibration” is the time required, after performing an appropriate calibration until the hold (output stabilization) time elapses.

(4) During Blow back (see Section 10.4, Blow Back, later in this manual)

During semi-automatic blow back:

“During semi-automatic blow back” is the time required after pressing the [Blow back start] key, by using the touchpanel or entering a blow back start instruction by using a contact input, until the blow back time and hold (output stabilization) time elapse.

During automatic blow back:

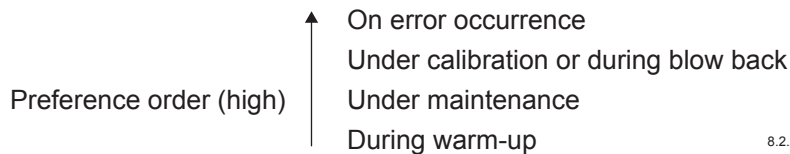
“During automatic blow back” is the time required after reaching the blow back start time until the blow back time and hold (output stabilization) time elapse.

(5) On Error occurrence

This is the time at which any of Errors 1 to 4 occurs.

8.2.2 Preference Order of Output Hold Value

The output hold value takes the following preference order:



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For example, if the output current is set to 4 mA during maintenance, and no output-hold output for during calibration is preset, the output is held at 4 mA during the maintenance display. However, the output hold is released at the time of starting the calibration, and the output will be again held at 4 mA after completing the calibration and when the hold (output stabilization) time elapses.

8.2.3 Output Hold Setting

To set the output hold, follow these steps:

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display. Then select “Commissioning” in the Execution/Setup display. Next, select the “mA-output setup” and then the “mA-outputs presets” display as shown in Figure 8.2.

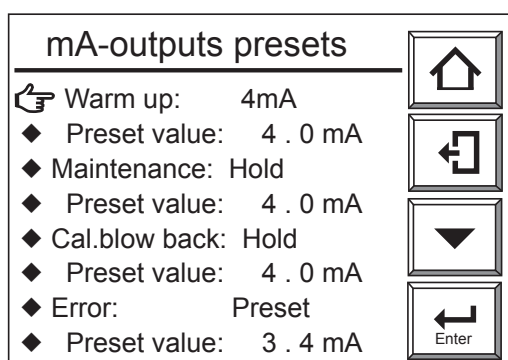


Figure 8.1 mA-outputs presets Display

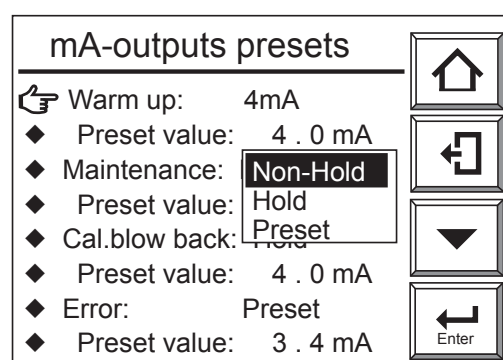


Figure 8.2 Selecting Maintenance

- (2) From this display (Fig. 8.2), select the desired display. Figure 8.3 shows an example of selecting “Maintenance”. Select the desired output status.
- (3) If a preset value is selected, set the corresponding output current. If you select a preset value just below Maintenance on the screen, the numeric-data entry display will appear. Enter the current value you want. To set 10 mA, type in 010 and press the [Enter] key to complete the setting. The setting range is from 2.4 to 21.6 mA.

NOTE

“Error” of mA-outputs presets 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 hold is the default as shown in Table 8.3.

Table 8.3 Output Hold Default Values

Status	Output hold setting	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 or blow back.	4 mA
On Error occurrence	Holds output at a preset value.	3.4 mA

8.3 Alarms Setting

The analyzer enables the setting of four alarms — high-high, high, low, and low-low alarms — depending upon the measurement conditions. The following section sets out the alarm operations and setting procedures.

8.3.1 Setting the Alarm Values

(1) High-high and high alarm values

If high-high and high alarm values are set to ON, then alarms occur if measured values exceed the alarm set values.

(2) Low and low-low alarm values

If low-low and low alarm values are set, then alarms occur if measured values fall below the alarm set values.

8.3.2 Alarm Output Actions

If the measured values of the oxygen concentration fluctuate between normal (steady state) values and the alarm setting, alarm outputs may be frequently issued and canceled.

To avoid this, set the alarm delay and hysteresis for alarm canceling under the alarm output conditions, as Figure 8.3 shows.

When a 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 be issued. 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 greater 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.

For the alarm to be reset (canceled), the measured value must be beyond the preset hysteresis value and the preset delay time must have elapsed.

Refer to Figure 8.3 for any further alarm output actions. The delayed time and hysteresis settings are common to all alarm points.

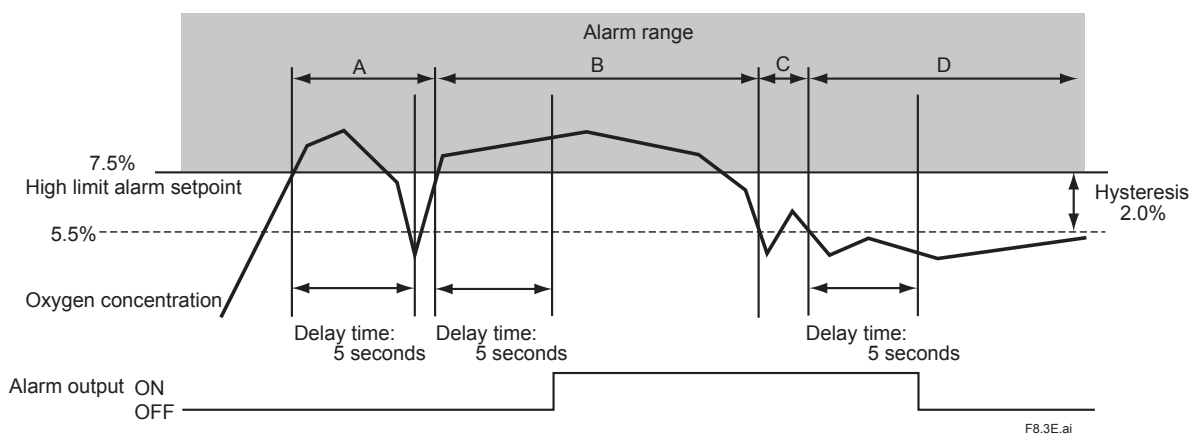


Figure 8.3 Alarm Output Action

In the example in Figure 8.3, the high limit alarm point is set to 7.5 vol%O₂, the delay time is set to five seconds, and hysteresis is set to 2 vol%O₂.

Alarm output actions in each section in this figure are as follows:

- Although the oxygen concentration value exceeds the high limit alarm setpoint, it falls below the high limit alarm setpoint before the preset delay time of five seconds elapses. So, no alarm is issued.
- The oxygen concentration value exceeds the high limit alarm setpoint and the delay time elapses during that measurement. So, an alarm is issued.
- Although the oxygen concentration value falls below the hysteresis set value, the value rises again and exceeds the hysteresis set value before the preset delay time elapses. So, the alarm is not canceled.
- The oxygen concentration value falls below the hysteresis set value and the preset delay time elapses, so the alarm is canceled.

8.3.3 Alarm Setting Procedure

To set the alarm setpoints, follow these steps:

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display.
- (2) Select "Commissioning" in the Execution/Setup display. The Commissioning (Setup) display then appears.
- (3) Select the "Alarms setup" in the Commissioning (Setup) display. The Alarms setup display shown in Figure 8.4 then appears.

• **To set the hysteresis, proceed to the following steps.**

- (4) Select "Hysteresis" in the Alarms setup display. The numeric-data entry display then appears. Enter the desired hysteresis value as a percent of oxygen concentration. To set 2.5 vol%O₂, enter "0025." The hysteresis setting can be in the range of 0 to 9.9 vol%O₂.

• **To set the delay time, proceed as per the following steps.**

- (5) Select the "Contact delay" in the Alarms setup display. The numeric-data entry display then appears. Enter the desired delay time, in seconds. To set three seconds, enter "003." The delay time setting can be in the range of 0 to 255 seconds.

• **To set the alarm point, proceed to the following steps.**

- (6) Select the "Setpoints" in the Alarms setup display. The Oxygen alarms display then appears, as shown in Figure 8.5.
- (7) When you select "High alarm" in the Oxygen alarms display, the "OFF" or "ON" selection display then appears. If you select "ON," the High alarm will then be enabled (enable/disable).
- (8) To set the High alarm values select "Set value" just below the High alarm. The numeric-data entry display then appears. Enter the alarm set value (percent of oxygen concentration). If you want to set the alarm value to 10 vol%O₂, enter "010."
- (9) Set the other alarm settings in the same manner as in the steps above.

NOTE

No alarm is issued when alarm is set to "OFF" (disabled). To use the alarm functions, be sure to set the alarms "ON".

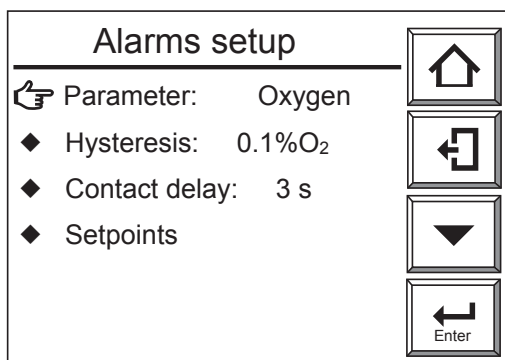


Figure 8.4 Alarms Setup Display

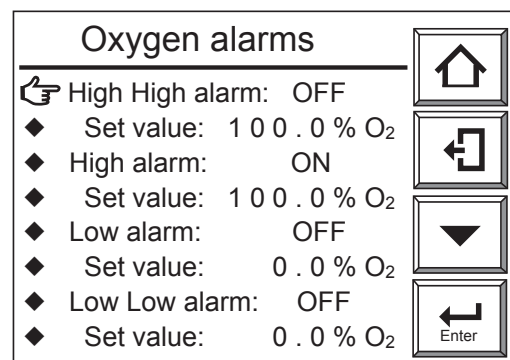


Figure 8.5 Oxygen Alarms Display

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 8.4.

Table 8.4 Alarm Setting Default Values

Set item	Oxygen concentration		Humidity (amount of moisture content)		Mixing ratio	
	Setting range	Default setting	Setting range	Default setting	Setting range	Default setting
Hysteresis	0 to 9.9 vol%O ₂	0.1 vol%O ₂	0 to 9.9 %H ₂ O	0.1 %H ₂ O	0 to 0.1 kg/kg	0.001 kg/kg
Delay time	0 to 255 seconds	3 seconds	0 to 255 seconds	3 seconds	0 to 255 seconds	3 seconds
High-high limit alarm	—	OFF	—	OFF	—	OFF
High-high limit alarm setpoint	0 to 100 vol%O ₂	100 vol%O ₂	0 to 100 %H ₂ O	100.0 %H ₂ O	0 to 1 kg/kg	1 kg/kg
High limit alarm	—	OFF	—	OFF	—	OFF
High limit alarm setpoints	0 to 100 vol%O ₂	100 vol%O ₂	0 to 100 %H ₂ O	100.0 %H ₂ O	0 to 1 kg/kg	1 kg/kg
Low limit alarm	—	OFF	—	OFF	—	OFF
Low limit alarm setpoint	0 to 100 vol%O ₂	0 vol%O ₂	0 to 100 %H ₂ O	0.0 %H ₂ O	0 to 1 kg/kg	0 kg/kg
Low-low limit alarm	—	OFF	—	OFF	—	OFF
Low-low limit alarm setpoint	0 to 100 vol%O ₂	0 vol%O ₂	0 to 100 %H ₂ O	0.0 %H ₂ O	0 to 1 kg/kg	0 kg/kg

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 operation modes of each contact output are as follows. For output contacts 1 to 3 you can select open or closed contact when the contact is “operated”. Default is closed. For output contact 4, contact is closed. When power fails, contact outputs 1 to 3 are open, and 4 is closed.

Table 8.5

	State when contact “ operated ”	When no power is applied to this equipment
Output contact 1	Open (deenergized) or closed (energized) selectable.	Open
Output contact 2	Open (deenergized) or closed (energized) selectable.	Open
Output contact 3	Open (deenergized) or closed (energized) selectable.	Open
Output contact 4	Closed (deenergized) only	Closed

8.4.2 Setting Procedure

To set the output contact, follow these steps.

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display.
- (2) Select “Commissioning” in the Execution/Setup display. The Commissioning (Setup) display then appears.
- (3) Select the “Contact setup” in the Commissioning (Setup) display. The Contact setup display shown in Figure 8.6 then appears.
- (4) Select the desired output contact. This section shows an example where “Output contact1” is selected (see Figure 8.7).
- (5) Each set item and the selected items are briefly described in Table 8.6. The following describes an example of setting where Output contact 1 is closed during calibration.
- (6) Select “Others” in the Output contact 1 display. The “Contact1 Others” display shown in Figure 8.8 then appears. Select “Calibration” in the Contact1 Others display.
- (7) The ON or OFF selection display then appears. Select “ON” herein.
- (8) Press the [Reject] key to go back to the previous display.
- (9) Move the pointer to “During power-off the contact is open and in condition it is Open” and press the [Enter] key. The “OFF” or “ON” selection display then appears. If you select “OFF,” this means “Open” in normal conditions and “Closed” when the contact output is on.



CAUTION

The contact output 4 is fixed as “close in power ON”, which cannot be changed by setting.

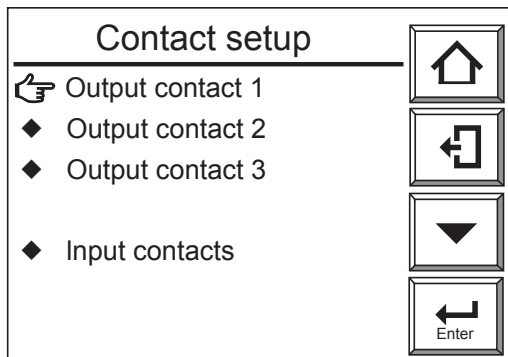


Figure 8.6 Contact Setup Display

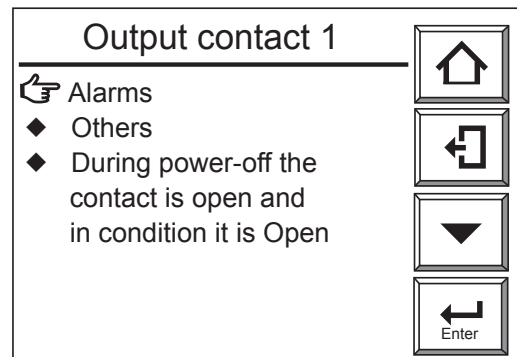


Figure 8.7 Output Contact 1 Display

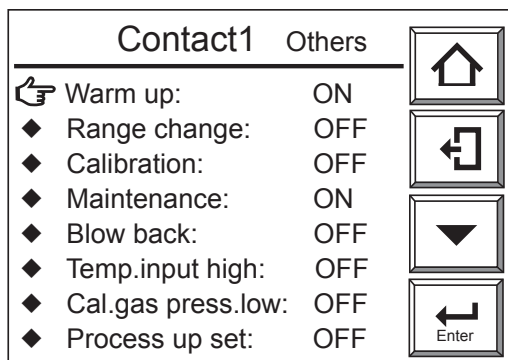


Figure 8.8 “Contact1 Others” Display

Table 8.6 Output Contact Settings

	Item to be selected	Brief description
Alarm and Error settings	High-high limit alarm	If “High-High alarm ON” is selected, contact output occurs when the high-high limit is issued. To do this, it is required, in Alarms setup, that the high-high alarm be set on beforehand (see Section 8.3).
	High limit alarm	If “High alarm ON” is selected, contact output occurs when the high limit alarm is provided. To do this, it is required, in Alarms setup, that the high limit alarm be set on beforehand (see Section 8.3).
	Low limit alarm	If “Low alarm ON” is selected, contact output occurs when the low limit alarm is provided. To do this, it is required, in Alarms setup, that the low limit alarm be set on beforehand (see Section 8.3).
	Low-low limit alarm	If “Low-Low alarm ON” is selected, contact output occurs when the low-low limit alarm is issued. To do this, it is required, in Alarms setup, that the low-low alarm be set on beforehand (see Section 8.3).
	Calibration coefficient alarm	If Calibration coefficient alarm is ON (enabled), then when a zero calibration coefficient alarm (Alarm 6) or span calibration coefficient alarm (Alarm 7) occurs then calibration coefficient alarm contact output occurs (see Sec. 12.2.1)
	Startup power stabilization timeout alarm	If set ON then contact output occurs when startup power stabilization timeout alarm (Alarm 8) occurs (see Sec.12.2.1)
	Error	If “Error ON” is selected, contact output occurs when an error is issued. (See Chapter 12, Troubleshooting).
Other settings	Warm-up	If “Warm-up ON” is selected, contact output occurs during warm-up. For the definition of Warm-up (see Section 8.2.1).
	Output range change	If “Range change ON” is selected, contact output occurs (“answer-back signal to a range change signal”) while a range change signal is applied to a contact input. To do this, it is required, in Input contacts setup, that the range change be selected beforehand. For more on this (see Section 8.5).
	Calibration	If “Calibration ON” is selected, contact output occurs during calibration. For the definition of Under calibration (see Section 8.2.1).
	Maintenance	If “Maintenance ON” is selected, contact output occurs during maintenance. For the definition of Under maintenance (see Section 8.2.1).
	Blow back	If “Blow back ON” is selected, contact output occurs during blow back. For the definition of During blow back (see Section 8.2.1).
	High limit temperature alarm	Not supported by the oxygen analyzer.
	Calibration gas press. low	If “Cal. gas press. low ON” is selected, contact output occurs (“answer-back signal to a calibration gas low pressure signal”)when a calibration gas low pressure signal is applied to the contact input. To do this, it is required, in Input contacts setup, that “Cal. gas press. low” be selected beforehand. For more on this (see Section 8.5).
	Process upset	If “Process upset” is selected, contact output occurs (“answer-back signal to a process upset signal) when the process upset signal is applied to the contact input. To do this, it is required, in Input contacts setup, that “Process upset” be selected beforehand (see Section 8.5).

Note: To provide an alarm with an output contact, be sure to make an alarm setting.
When using contact output as an answer-back signal for an input contact, be sure to make an input contact setting.

8.4.3 Default Values

When the analyzer is delivered, or if data are initialized, alarm and other setting defaults are as shown in Table 8.7.

Table 8.7 Output Contact Default Settings

	Item to be selected	Output contact 1	Output contact 2	Output contact 3	Output contact 4
Alarm settings	High-high limit alarm				—
	High limit alarm			ON	—
	Low limit alarm			ON	—
	Low-low limit alarm				—
	Calibration coefficient alarm				—
	Startup power stabilization timeout alarm				—
	Error				ON
Other settings	Warm-up	ON			—
	Output range change				—
	Calibration		ON		—
	Maintenance	ON			—
	Blow back				—
	High limit temperature alarm				—
	Calibration gas press. low	(default)	(default)	(default)	—
	Process upset				—
	Operating contact status	Open	Closed	Closed	Closed (fixed)

Note: Blank boxes in the above table indicate that the default is “disabled”.

8.5 Input Contact Settings

8.5.1 Input Contact Functions

The converter input contacts execute set functions by accepting a remote dry-contact (“voltage-free contact”) signal. Table 8.8 shows the functions executed by a remote contact signal.

Table 8.8 Input Contact Functions

tem	Function
Calibration gas pressure low	Contact input disables Semi-automatic or Automatic Calibration.
Measuring range change	While contact input is On, range of Analog Output 1 is switched as follows: When analog output 1 range is set to “Oxygen”, then range is switched to 0 to 25% O ₂ . When analog output 1 range is set to “Humidity”, then output range is switched to 0 to 100% H ₂ O. When analog output 1 range is set to “Mixing ratio”, then output range is switched to 0 to 1 kg/kg. While range is switched by the contact input, [Range] is displayed on the screen. See Figure 8.9.
Calibration start	Contact input starts Semi-Automatic Calibration. Calibration Mode setting must be [Semi_Auto] or [Auto]. Contact signal must be applied for at least 1 sec. Even if input signal continues to be applied, calibration is not repeated unless contact input is released then reapplied.
Process upset (Combustible gas detection)	If the Contact signal is ON, heater power will be switched off. (A 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.
Blow back start	Contact input starts Blow back. Contact signal must be applied for at least 1 sec. Even if input signal continues to be applied, Blow back is not repeated unless contact input is released then reapplied. (Refer to Section 10.4, Blow Back.)

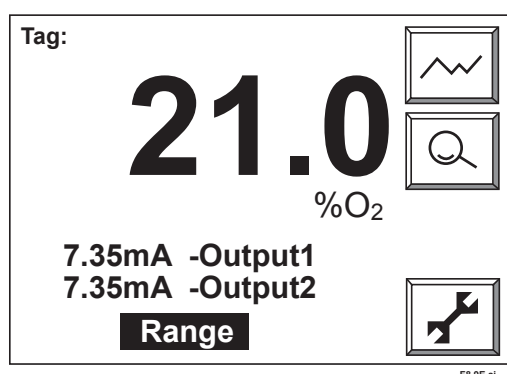


Figure 8.9 Changing Measuring Range with Input Contact

CAUTION

- Measurement range switching function by an external contact input is available for analog output1 only.
- When making a semi-automatic calibration, be sure to set the semi-automatic or automatic mode using the Calibration setup display.
- When carrying out “Blow back,” be sure to set “Blow back” in the output contact setup.
- When the combustible gas detection signal is sent to the contact input, the converter will cut the power supply to the heater of the detector. As a result, the heater temperature becomes low and Error 1 or Error 2 happens.

8.5.2 Setting Procedure

This setting example shows how to set “When contact input 1 Opens, Start Semi_Auto Calibration”.

- (1) From the Basic panel display touch [Setup] key, and the [Execution/Setup] display appears.
- (2) Select “Commissioning” and the Commissioning display appears.
- (3) Select “Contact Setup” then “Input contacts”.
- (4) Select “Input 1”. Function Selection window (Fig 8.11) appears.
- (5) Select “Calibration start”.
- (6) For Input contact 1 select (operate if) “Closed”. (You can select “Open” or “Closed”).
- (7) Change Closed to Open.

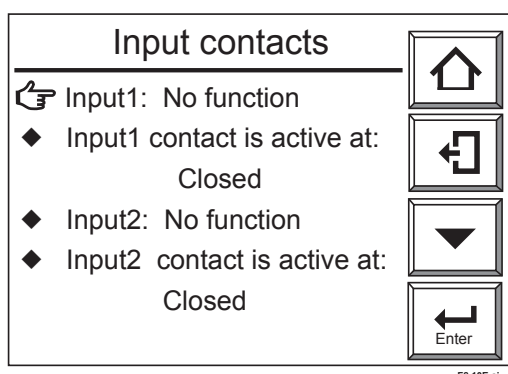


Figure 8.10 Input Contacts Display

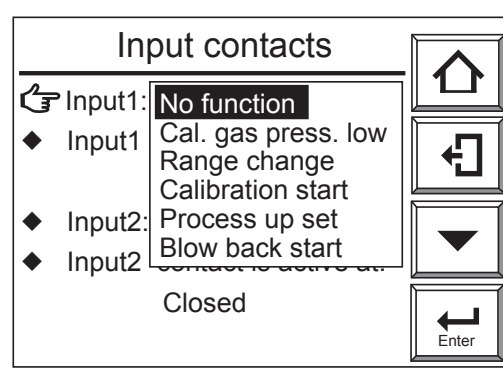


Figure 8.11 Input Contacts Display

8.5.3 Default Values

All contact inputs are set to “No function”(disabled) prior factory shipment or after data initialization..

8.6 Other Settings

8.6.1 Setting the Date-and-Time

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

Proceed as follows:

- (1) From the Basic panel display if you touch the [Setup] key, the Execution/Setup display appears.
- (2) Select “Commissioning” and the Commissioning display appears.
- (3) Select “Others” and the display of Fig 8.12 appears.
- (4) Select “Clock” and the display of Fig 8.13 appears.
- (5) Select “Set date” and the numerical entry display appears. To enter June 21, 2004 , enter 210604. Touch the [Enter] key and you revert to the display of Fig 8.13.
- (6) Select “Set time”. Enter the time in 24-hour format. To set 2:30 pm, enter 1430 on the numerical display and touch enter. Touch the [Enter] key. The clock starts from 00 seconds..

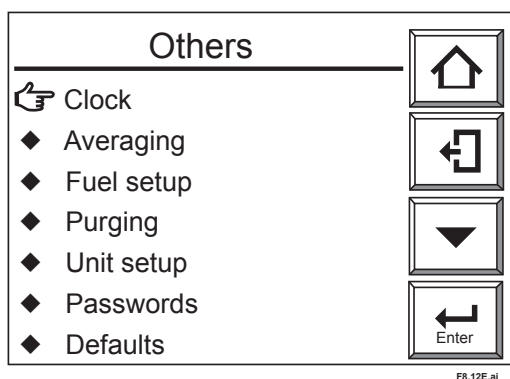


Figure 8.12 Other Settings

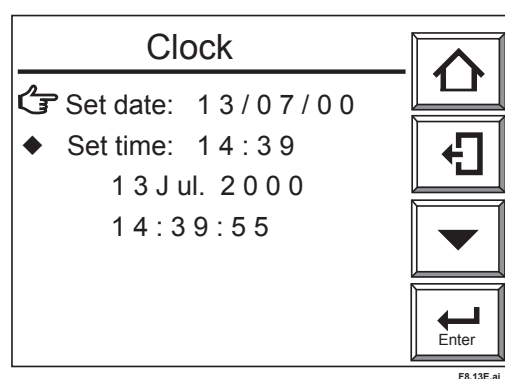


Figure 8.13 Clock Display

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

- (1) From the Basic panel display touch [Setup] key, and the Execution/Setup display appears.
- (2) Select “Commissioning” and the Commissioning display appears.
- (3) Select “Others” then Averaging. The display of Fig. 8.14 appears.
- (4) Select “Set period over which average is calculated” and numerical entry display appears. To set 3 hours, enter 003. Entry range is 1 to 255 hours.

- (5) Select “Set period over which maximum and minimum is stored” and numerical entry display appears. To set 48 hours, enter 048. Entry range is 1 to 255 hours.

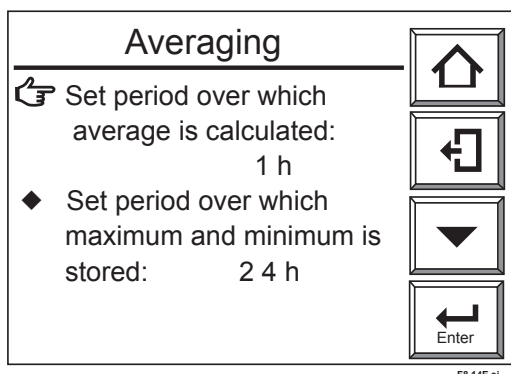


Figure 8.14 Setting Average-Value Calculation Periods and Maximum- and Minimum-Value Monitoring Periods

■ Default Values

“Set period over which average is calculated” is set to 1hr, and “Set period over which maximum and minimum is stored” is set to 24 hrs prior factory shipment or after data initialization..

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:

$$\begin{aligned} \text{Moisture quantity} &= \frac{\text{(water vapor caused by combustion and water vapor contained in the exhaust gas)} + \text{(water vapor contained in air for combustion)}}{\text{actual exhaust gas (including water vapor) per fuel}} \times 100 \dots \text{Equation 1} \\ &= (Gw + Gw1)/G \times 100 \\ &= \frac{Gw + (1.61 \times Z \times m \times Ao)}{Go + Gw + [(m - 1) Ao + (1.61 \times Z \times m \times Ao)]} \times 100 \dots \text{Equation 2} \\ &= \frac{\boxed{Gw} + (1.61 \times \boxed{Z} \times m \times \boxed{Ao})}{\boxed{X} + \boxed{Ao} \times m} \times 100 \end{aligned}$$

where,

\boxed{Ao} : Theoretical amount of air per unit quantity of fuel, m³/kg (or m³/m³) ... ② in Table 8.8

G: Actual amount of exhaust gas (including water vapor) per unit quantity of fuel, m³/kg (or m³/m³)

\boxed{Gw} : Water vapor contained in exhaust gas per unit quantity of fuel (by hydrogen and moisture content in fuel), m³/kg (or m³/m³) ① in Table 8.8

Gw1: Water vapor contained in exhaust gas per unit quantity of fuel (moisture content in air), m³/kg (or m³/m³)

Go: Theoretical amount of dry exhaust gas per unit quantity of fuel, m³/kg (or m³/m³)

m: Air ratio

\boxed{X} : Fuel coefficient determined depending on low calorific power of fuel, m³/kg (or m³/m³) ③ in Table 8.8

\boxed{Z} : Absolute humidity of the atmosphere, kg/kg Figure 8.16

Fill in the boxes with fuel parameters in Equation 2 above to calculate the moisture content. Use Ao, Gw and X shown in Table 8.9. If there are no appropriate fuel data in Table 8.9, 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 (G_w) = $(1/100) \{1.24 (9h + w)\}$ (m^3/kg)

Theoretical amount of air (A_o) = $12.38 \times (H/10000) - 1.36$ (m^3/kg)

Low calorific power = H

X value = $(3.37 / 10000) \times H_x - 2.55$ (m^3/kg)

where, H : low calorific power of fuel

h : Hydrogen in fuel (weight percentage)

w : Moisture content in fuel (weight percentage)

H_x : Same as numeric value of H

- For gas fuel

Amount of water vapor in exhaust gas (G_w) = $(1/100) \{h_2 + 1/2 \sum y (C_x H_y) + w_v\}$ (m^3/m^3)

Theoretical amount of air (A_o) = $11.2 \times (H/10000)$ (m^3/m^3)

Low calorific power = H

X value = $(1.05 / 10000) \times H_x$ (m^3/m^3)

where, H : low calorific power of fuel

$C_x H_y$: Each hydrocarbon in fuel (weight percentage)

h_2 : Hydrogen in fuel (weight percentage)

w_v : Moisture content in fuel (weight percentage)

H_x : Same as numeric value of H

- For solid fuel

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

Theoretical amount of air (A_o) = $1.01 \times (H / 1000) + 0.56$ (m^3/kg)

Low calorific power = $H = H_h - 25 (9h + w)$ (kJ/kg)

X value = $1.11 - (0.106 / 1000) \times H_x$ (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:

$$h = 5.7 \{ [100 - (w + a)] / 100 \} \times (100 - w) / (100 - w_1)$$

where, a : Ash content (%)

w_1 : Moisture content (%), analyzed on a constant humidity basis

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

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

H_x : Same numeric value of H

Figure 8.15 Calculation Formula

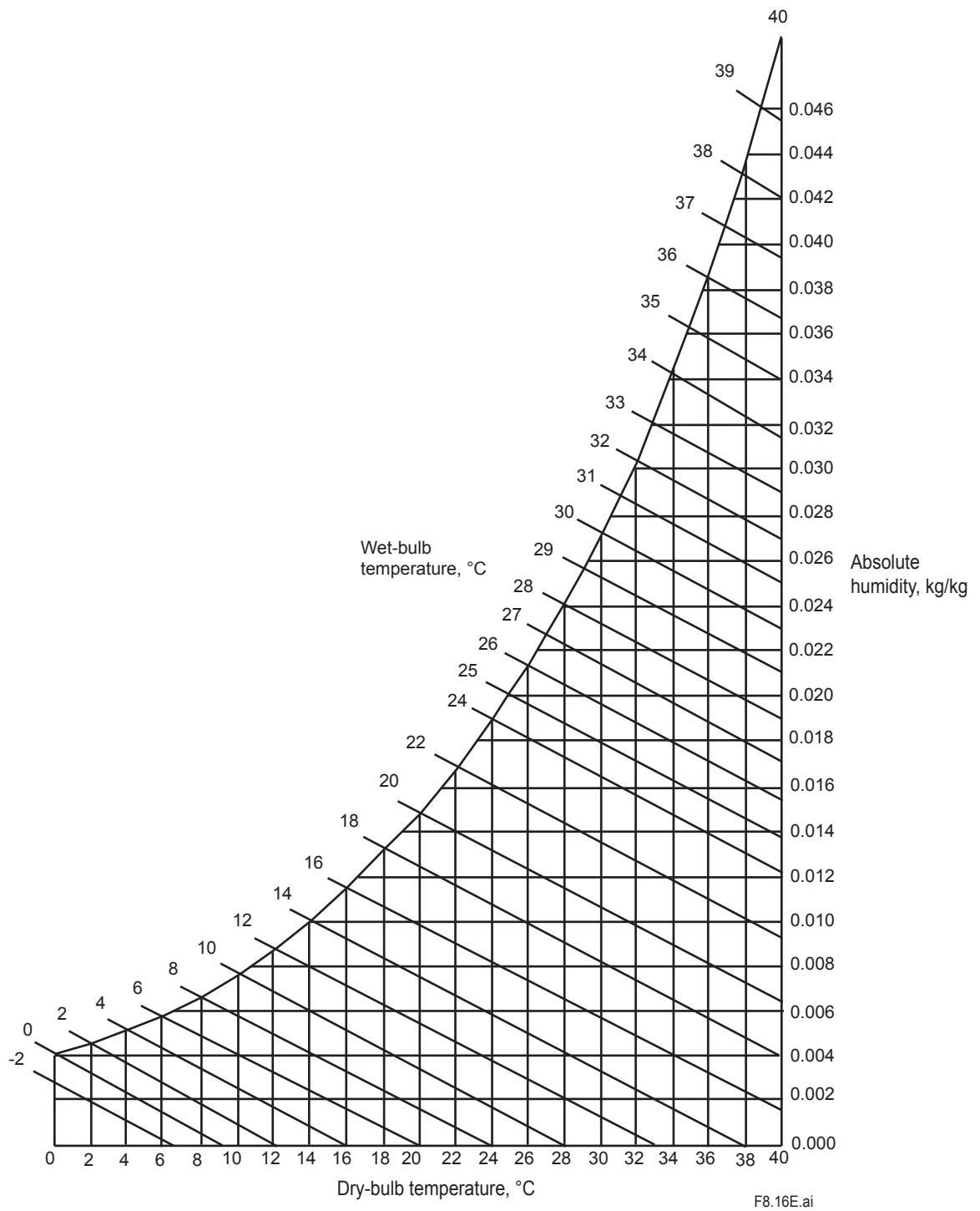


Figure 8.16 Absolute Humidity of Air

Table 8.9 Fuel Data

● For liquid fuel

Fuel properties Type			Specific weight kg/l	Chemical component (weight percentage)							Calorific power kJ/kg		Theoretical amount of air for combustion Nm³/kg	Amount of combustion gas Nm³/kg					X value
				C	H	O	N	S	w	Ash content	Higher order	Lower order		CO₂	H₂O	SO₂	N₂	Total	
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
		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
		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
		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

②

①

③

● For gas fuel

Theoretical amount of air

Type	Fuel properties	Specific weight kg/Nm ³	Chemical component (weight percentage)							Calorific power kJ/Nm ³		Theoretical amount of air for combustion Nm ³ /m ³	Combustion product, Nm ³ / m ³				X value
			CO	H ₂	CO ₂	CH ₄	C _m H _n	O ₂	N ₂	Higher order	Lower order		CO ₂	H ₂ O	N ₂	Total	
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 ₃ H ₈ 90%, C ₄ H ₁₀ 10%							102055	93976	24.63	3.10	4.10	19.5	26.7	2.36
Butane		2.530	C ₃ H ₈ 10%, C ₄ H 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 ₂ H ₆							69638	63744	16.74	2.0	3.0	13.2	18.2	1.60
Ethylene		1.25	C ₂ H ₄							62991	59060	14.35	2.0	2.0	11.4	15.4	1.48
Propane		1.97	C ₃ H ₈							99070	91255	23.91	3.0	4.0	18.9	25.9	2.29
Butane		2.59	C ₄ H ₁₀							128452	118623	31.09	4.0	5.0	24.6	33.6	2.98

②

①

③

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■ Procedure

To make a fuel setting, follow these steps:

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display.
- (2) Select "Commissioning" in the Execution/Setup display. The Commissioning (Setup) display then appears.
- (3) Select "Others" in that display and then the Fuel setup shown in Figure 8.17.
- (4) Choose the "Theoretical air quantity required" and the "Contents of moisture in exhaust gas" in turn. The numeric-data entry display then appears. Enter numeric data using the numeric keys.
- (5) Choose "more" in the Fuel setup display. The Fuel setup shown in Figure 8.18 then appears.
- (6) Set the numeric data to the "Value of the X coefficient" and then to the "Absolute humidity of the atmosphere".
- (7) Choose "finished" to return to the display shown in Figure 8.17.

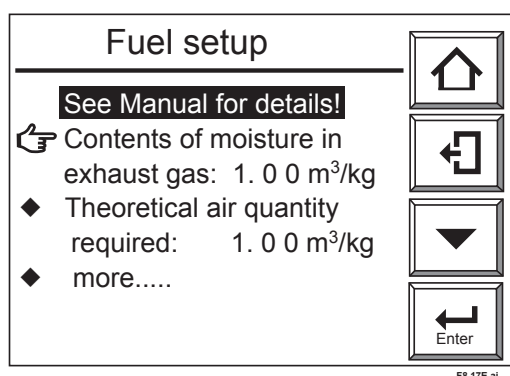


Figure 8.17 Fuel Setup

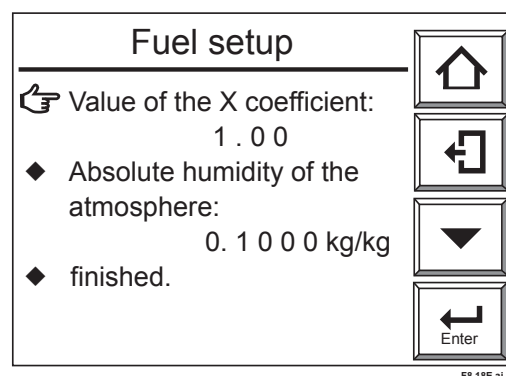


Figure 8.18 Fuel Setup

■ Default Values

When the analyzer is delivered, or if data are initialized, default, parameter settings are as shown in Table 8.10.

Table 8.10 Default Settings for Fuel Values

Item	Default setting
Amount of water vapor in exhaust gas	0.00 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	0.0 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. The relative humidity may be obtained using the following theoretical equation (JIS Z 8806).

To obtain the relative humidity:

The relative humidity U that is obtained from JIS Z 8806 is:

$$U = e/es \times 100$$

where, e = water vapor pressure of moist air
 es = 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 = moisture content (volume ratio)

The saturated water vapor pressure e_s is determined by a gas temperature, so the relative humidity can be obtained by entering the above parameters.

To obtain the 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 (moisture content) (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.

● Setting Measurement Gas Temperature

There are two ways of entering measurement gas temperatures: one is to measure actual gas temperature using a two-wire temperature transmitter and the other is to enter the preset value manually.

Set the measurement gas temperature as follows:

- (1) Press the Setup key in the basic panel display to display the Execution/Setup display.
- (2) Select Setup in the Execution/Setup display. The "Commissioning" (Setup) display then appears.
- (3) Select Others in that display and then the Exhaust gas setup shown in Figure 8.19.
- (4) Point to the Temperature input mode and press the [Enter] key. Then the display for selecting either "Preset" or "mA input," appears. Choose the desired one for your system requirements.
- (5) If you choose the "Preset," a display for entering numeric data then appears. Enter the measurement gas temperature (see CAUTION).
- (6) If you choose "mA-input," the Exhaust gas setup display shown in Figure 8.20 appears. Enter temperatures at 4- and 20-mA outputs of the temperature transmitter from the numeric data entry display (See CAUTION).
- (7) If you use measurement gas temperature alarms, choose the "Alarm value of temperature" and enter an alarm temperature from the numeric data entry display.

NOTE

- The critical temperature of the saturated water vapor pressure is 374.8 C. If a gas temperature exceeding 370.8 C is entered, no correct calculation will be obtained.
- If an invalid value is set, no correct calculation will be obtained. Be sure to check allowable temperature ranges of the temperature transmitter you use, and then enter the value correctly.

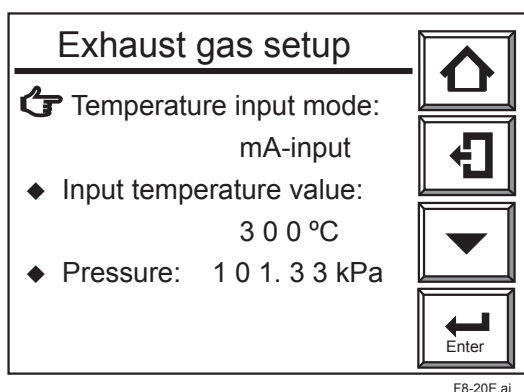


Figure 8.19 Exhaust Gas Setup Display (Preset Entry)

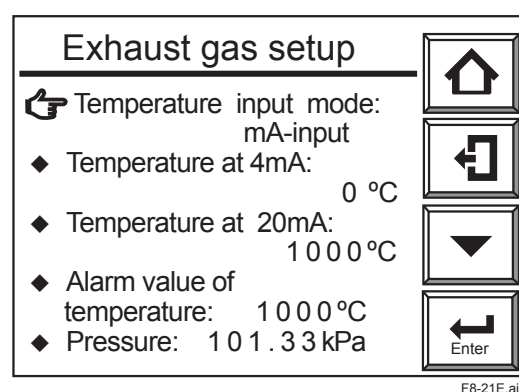


Figure 8.20 Exhaust Gas Setup Display (Entering mA-input)

● Setting Measurement Gas Pressure

To set the measurement gas pressure, follow these steps:

- (1) Call up the Exhaust gas setup display and choose Pressure.
- (2) Enter the measurement gas pressure (absolute pressure) from the numeric data entry display.

● Default Values

When the analyzer is delivered, or if data are initialized, measurement gas temperature and pressure set ranges and their default settings are as shown in Table 8.11.

Table 8.11 Measurement Gas Temperature and Pressure Set Ranges and Default Settings

Set Item	Set range	Default setting
Temperature input selection		Preset value
Measurement gas temperature	0 to 3000°C	300°C
Temperature at 4 mA	0 to 3000°C	0°C
Temperature at 20 mA	0 to 3000°C	1000°C
Absolute humidity of the atmosphere	0 to 689.47 kPa abs	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.

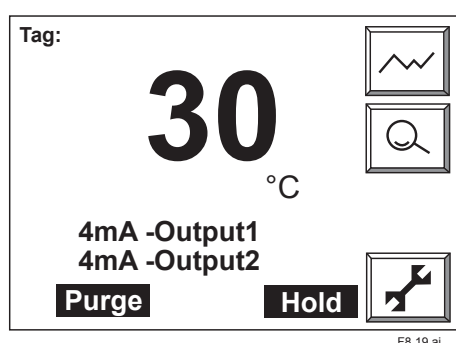


Figure 8.21 Display during Purging

■ Procedure

Set the purging time as follows:

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display.
- (2) Select "Commissioning" in the Execution/Setup display. The Commissioning (Setup) display then appears.
- (3) Select "Others" in that display and the Others display then appears, as shown in Figure 8.22.
- (4) Select "Purging". The purging time setting display appears, as shown in Figure 8.23.
- (5) Point to the "Purging time" and press the [Enter] key. Then the display for selecting purging time appears.
- (6) Enter the desired numeric value from the numeric-data entry display.
The allowable input ranges from 0 to 60 minutes.

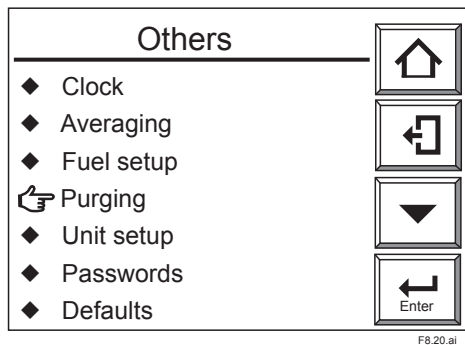


Figure 8.22 Other Settings

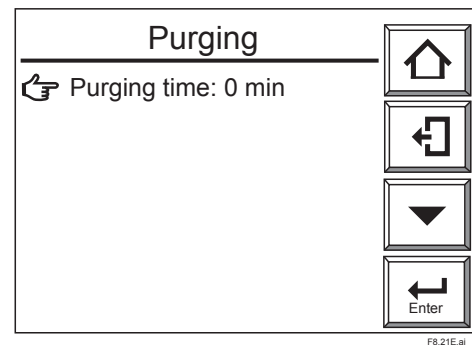


Figure 8.23 Purging Display

8.6.6 Setting Passwords

Unauthorized access to lower level menu displays from the Execution/Setup display can be protected by passwords. You can set separate passwords for Calibration, Blow back, and Maintenance and for Commissioning

Proceed as follows:

- (1) From the Basic panel display touch the [Setup] key, and the Execution/Setup display appears.
- (2) Select "Commissioning", and the Commissioning display appears.
- (3) Select "Others" then "Passwords". The display shown in Fig. 8.22 appears.
First set the password for Calibration, Indication Check, Blow back, and Maintenance:
- (4) Select "Calibration, Blow back, and Maintenance".
- (5) A text entry display appears. Enter password as up to 8 alphanumeric characters.
- (6) You can enter a password for Commissioning by the same procedure.
- (7) Record the passwords and look after them carefully.

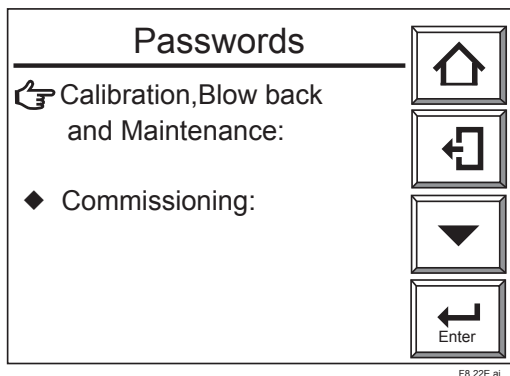


Figure 8.24 Passwords Display

<Default setting>

The passwords are not set as shipped from factory. If you reset initialize the parameters, and password settings are deleted.

If you forget a password, select “Commissioning” in the Execution/Setup display, and enter “MOON.” By doing so, you can enter the Commissioning display only. Then display the Passwords and verify the set passwords.

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: $\text{O}_2 + 4\text{e} \rightarrow 2 \text{O}^{2-}$

Positive electrode: $2 \text{O}^{2-} \rightarrow \text{O}_2 + 4 \text{e}$

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

$$E = -RT/nF \ln P_x/P_a \text{.....Equation (1)}$$

where,

R: Gas constant

T: Absolute temperature

n: 4

F: Faraday's constant

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

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

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

$$E = -50.74 \log \frac{P_x}{P_a} \text{.....Equation (2)}$$

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 sample 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.

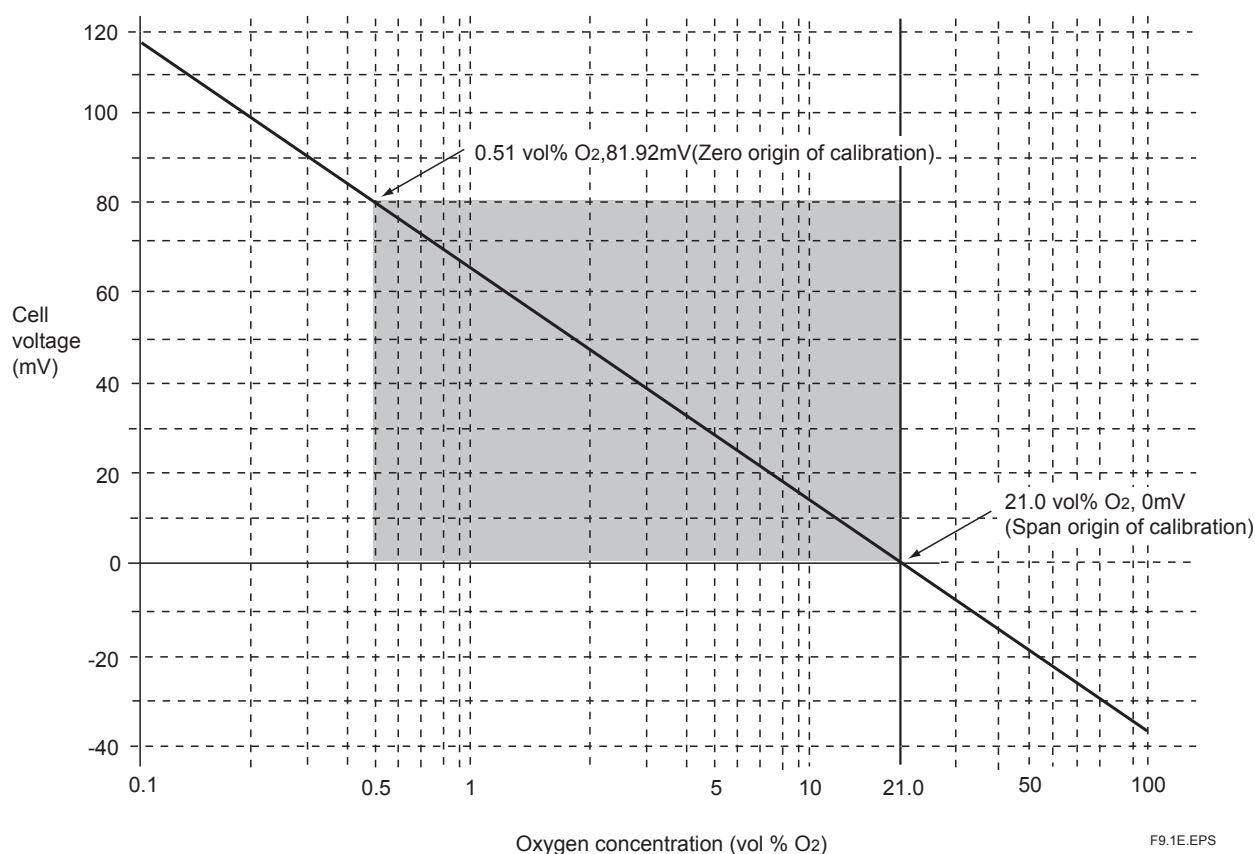


Figure 9.1 Oxygen concentration in a Sample Gas vs Cell Voltage (21 vol% O₂ Equivalent)

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:

$$E = -RT/nF \log_e y/a \quad \text{Equation (1)}$$

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:

$$y = (100 - x) \div 3 \div 0.21 \quad \text{Equation (2)}$$

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

$$E = -K \log y/a = -K \log [(100 - x) 30.21] / 21$$

$$= -K \log (1 - 0.01 x) \dots \dots \dots \text{Equation (3)}$$

where, $K = \text{Constant}$

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

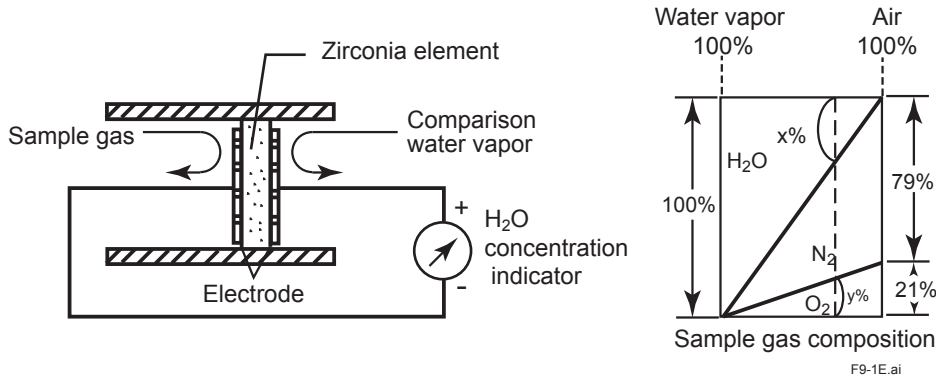


Figure 9.2 Schematic Diagram of Measurement Principle

(B) For the “mixing ratio” measurement

Assuming that the mixing ratio is $r \text{ kg/kg}$, then “ r ” can be calculated from the value of $\text{H}_2\text{O vol \%}$ as follows:

$$r = 0.622 \, x / (100 - x) \dots \dots \dots \text{Equation (4)}$$

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

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

$$= -K \log 0.622 / (0.622 + r) \dots \dots \dots \text{Equation (5)}$$

where, $K = \text{Constant}$

With Equation (5), we can obtain the mixing ratio $r \text{ kg/kg}$ from the electromotive force.

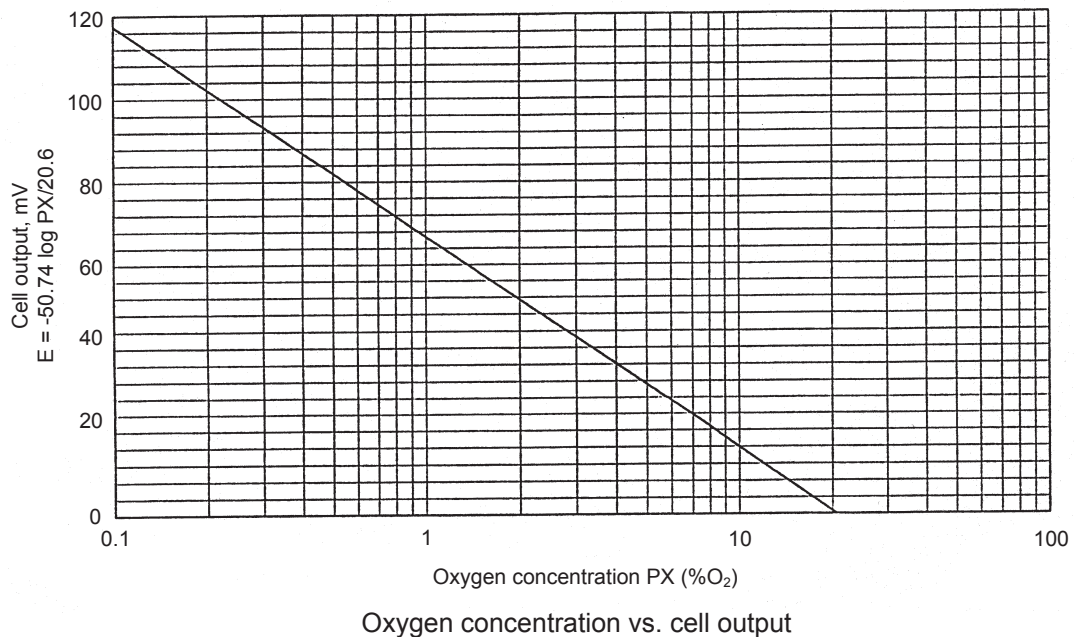
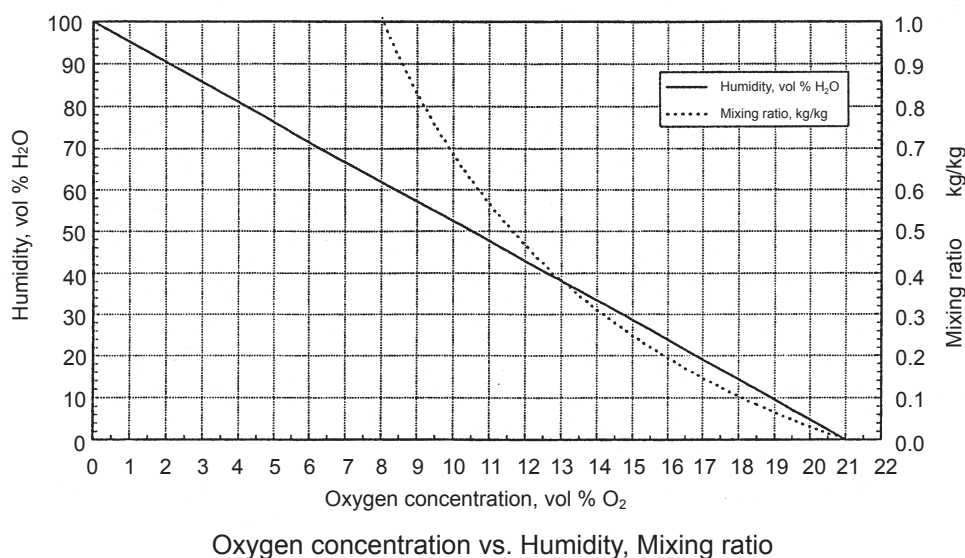


Figure 9.3



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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.

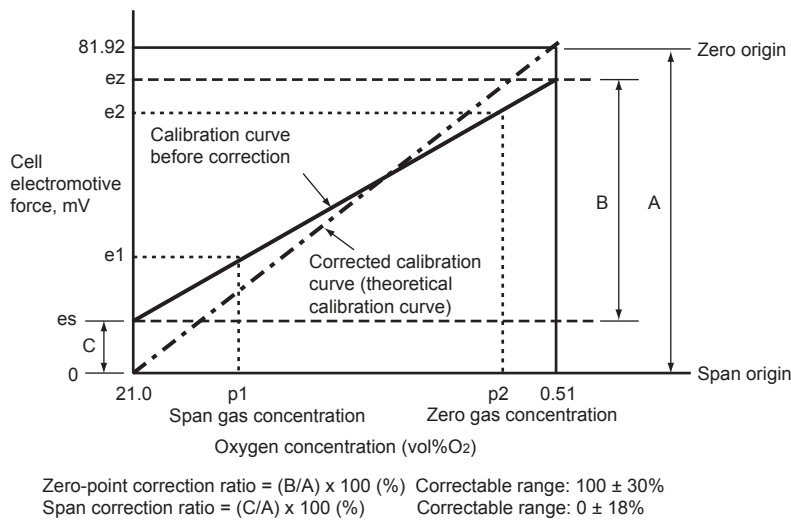
The zero gas normally used has an oxygen concentration of 0.95 to 1.0 vol%O₂ with a balance of nitrogen gas (N₂). The span gas widely used is clean air (at a dew-point temperature below -20°C and free of oily mist or dust, as in instrument air).

For best accuracy, as the span gas use oxygen whose concentration is near the top of the measurement range, in a nitrogen mixture.

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 Figure 9.6.

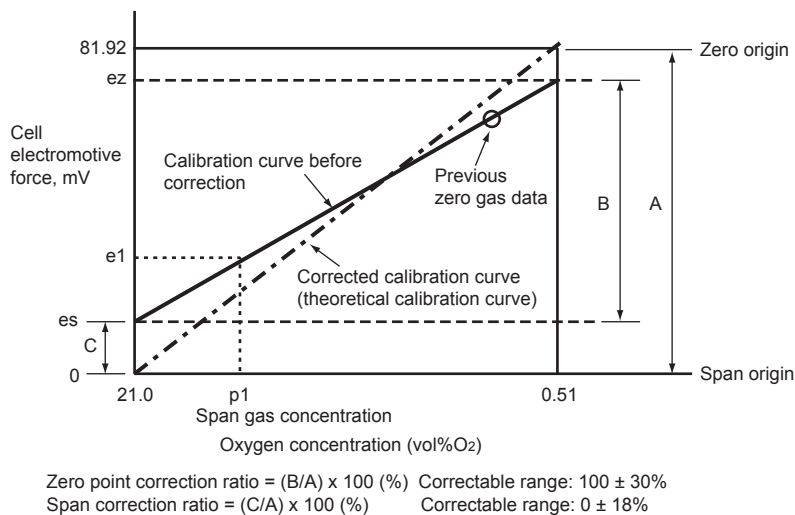
Figure 9.5 shows a two-point calibration using two gases: zero and span. Cell electromotive forces for a span gas with an oxygen concentration p_1 and a zero gas with an oxygen concentration p_2 are measured while determining the calibration curve passing between these two points. The oxygen concentration 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-point correction ratio represented by $B/A \times 100$ (%) on the basis of A, B and C shown in Figure 9.5 and a span correction ratio of $C/A \times 100$ (%). If the zero-point correction ratio exceeds the range of $100 \pm 30\%$ or the span correction ratio becomes larger than $0 \pm 18\%$, calibration of the sensor becomes impossible.



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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 p_1 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.



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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 by selecting the [Detailed-data] key from the Basic panel display. For an explanation and the operating procedures of individual data, consult Section 10.1, Detailed-data 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 touchpanel or a contact input, and undergoes a series of calibration operations following preset calibration interval and stabilization time.
- (3) Automatic calibration which is carried out automatically following preset calibration interval.

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.

To execute this calibration, follow these steps:

- (1) Select the [Setup] key from the Basic panel display to display the Execution/Setup display. Then select "Maintenance" from the Execution/Setup display.

- (2) Select "Calibration setup" from the Maintenance display. Then select "Mode" from the Calibration setup display (see Figure 9.7).
Now you can select "Manual", "Semi_Auto", or "Auto" calibration.

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.

Select "Points" from the Calibration setup display and then you can select "Both," "Span" or "Zero" (see Figure 9.8).

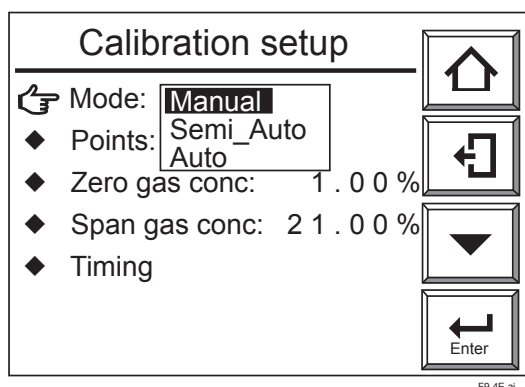


Figure 9.7 Calibration Setup display

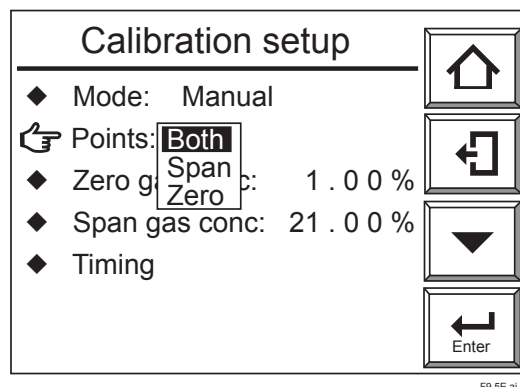


Figure 9.8 Calibration Setup display

9.2.3 Zero gas Concentration

Set the oxygen concentration for zero-point calibration. Enter the oxygen concentration for the zero gas in the cylinder used in the following procedures:

Select "Zero gas conc" from the Calibration setup display. The numeric-data entry display then appears. Enter the desired oxygen concentration for the zero-point calibration. (The zero gas set ranges from 0.3 to 100 vol%O₂.)

Enter 00098 for an oxygen concentration of 0.98 vol%O₂.

9.2.4 Span gas Concentration

Set the oxygen concentration for span calibration. If instrument air is used as the span gas, enter 21% O₂.

Select "Span gas conc" from the Calibration setup display. Enter the desired span gas oxygen concentration from the numeric-data entry display.

(The span gas set ranges from 4.5 to 100 vol%O₂.)

Enter 02100 for an oxygen concentration of 21 vol%O₂.

Instrument air is here defined as dry air with a dew-point temperature of no higher than -20°C. If the dew-point temperature is higher than -20°C, use a hand-held oxygen analyzer to measure the actual oxygen concentration.

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 the instrument air supply is to be used as span gas, cool it to -20°C below dew point to remove moisture, oil mist and dust from the air.
- If you do not do this to purify the air, then the accuracy of the calibration may be affected.

9.2.5 Setting Calibration Time

• When the calibration mode is in manual:

First set the “Hold time” (output stabilization time). This indicates the time required from the end of calibration to entering a measurement again. This time, after calibration, the sample 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 9.9 shows the relationship between the calibration time and hold (output stabilization) time.

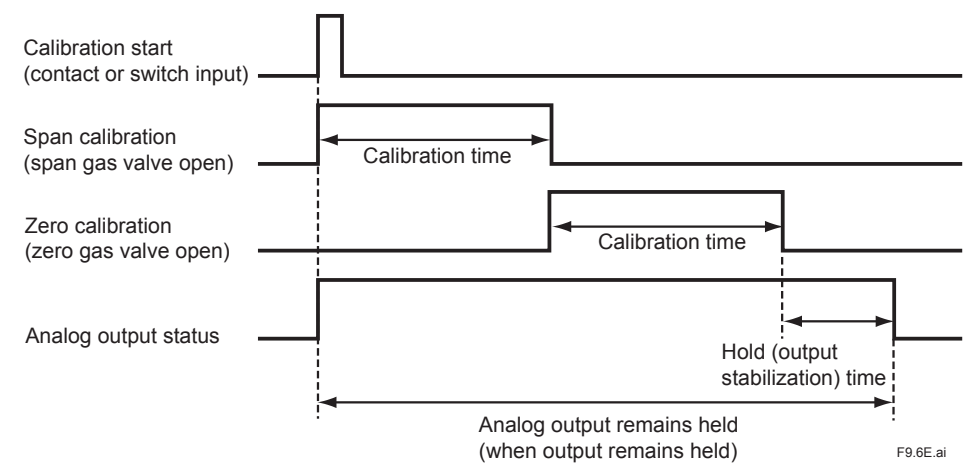


Figure9.9 Calibration and Hold Time Settings

• 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. For example, to start the first calibration at 1:30 p.m. on March 25, 2001, enter 25/03/01 to the start date and 13 hours, 30 minutes to the start time, following the steps below:

- (1) Select the “Calibration timing” display. A panel display as shown in Figure 9.10 appears.
- (2) Select each item for the calibration to display the numeric-data entry display. Enter the desired numeric values for the calibration.

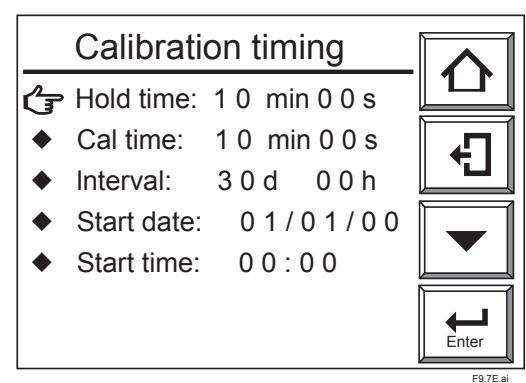


Figure 9.10 Calibration Timing Display

NOTE

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

- (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 or blow back operations, calibration will start after completing the maintenance service or blow back operations (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.

Default Values

When the analyzer is delivered, or if data are initialized, the calibration settings are by default, as shown in Table 9.1.

Table 9.1 **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	01 / 01 / 00
Start time	0:00

9.3 Calibration

NOTE

- (1) Perform calibration under normal working conditions (e.g. continuous operation with sensor mounted on furnace).
- (2) Perform both Span and Zero calibration for best resultant accuracy.
- (3) 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.
- (4) If dehumidifying is not enough, or if foul air is used, the measurement accuracy will be adversely affected.

9.3.1 Manual Calibration

For manual calibration, consult Section 7.12, Calibration, earlier in this manual.

9.3.2 Semi-automatic Calibration

To start calibration, follow these steps:

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display. Then select "Calibration" from the Execution/Setup display. The Calibration display shown in Figure 9.11 appears.
- (2) Select "Semi-auto calibration" to display the Semi-auto calibration display shown in Figure 9.12.
- (3) Select "Start calibration". The display shown in Figure 9.13 appears, and then start calibration.

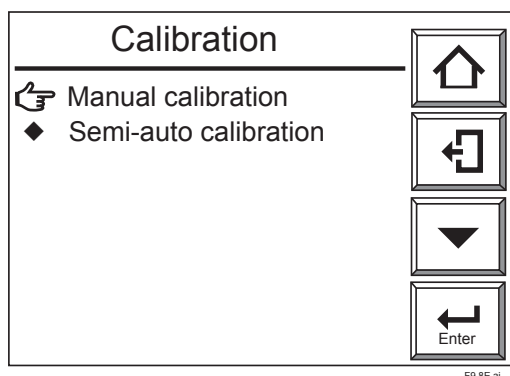


Figure 9.11 Calibration Display

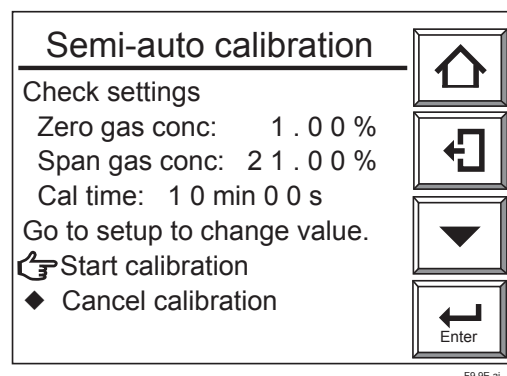


Figure 9.12 Semi-auto Calibration Display

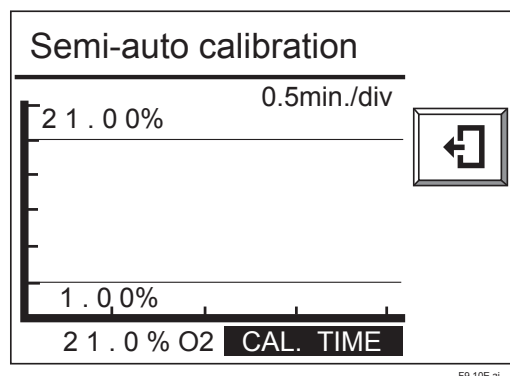


Figure 9.13 Semi-auto Calibration Display

To start calibration using an input contact, follow these steps:

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

To stop calibration midway, follow these steps:

- (1) Press the [Reject] key. If this key is pressed midway during calibration, the calibration will stop and the hold (output stabilization) time will be set up.
- (2) Press the [Reject] 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 starting Semi-automatic calibration or Automatic calibration, operate the calibration gas solenoid valves and adjust calibration gas flow to 600 ± 60 ml/min.

10. Other Functions

10.1 Detailed-data Display

Press the [Detailed-data] key on the Basic panel display to view the detailed operation data as shown in Figure 10.1.

Pressing the [▼] or [▲] key, you can advance the page or go back to your desired page.

- Detailed-data display

There are ten panel displays for viewing detailed data. The following briefly describe the operational data displayed on the Detailed-data display.

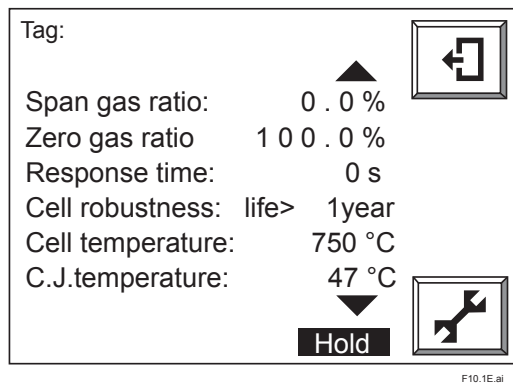
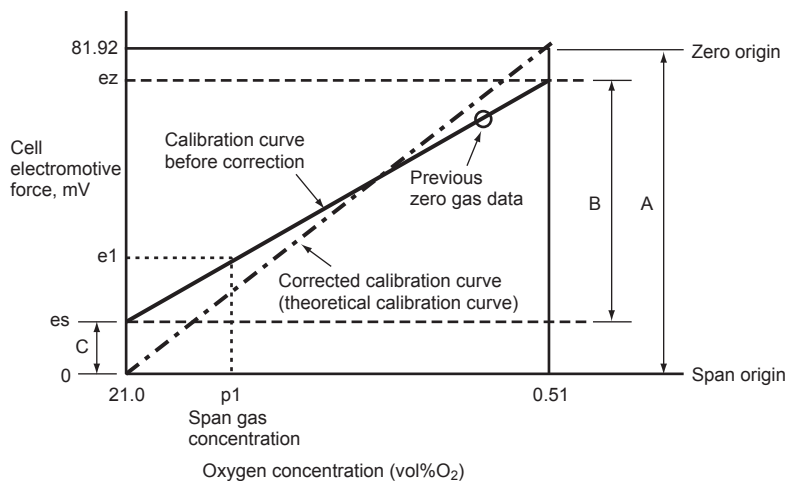


Figure 10.1 Detailed-data Display

10.1.1 Span gas and Zero gas Correction Ratios

These are used to check for 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.



$$\text{Zero gas correction ratio} = (B/A) \times 100 (\%) \quad \text{Correctable range: } 100 \pm 30\%$$

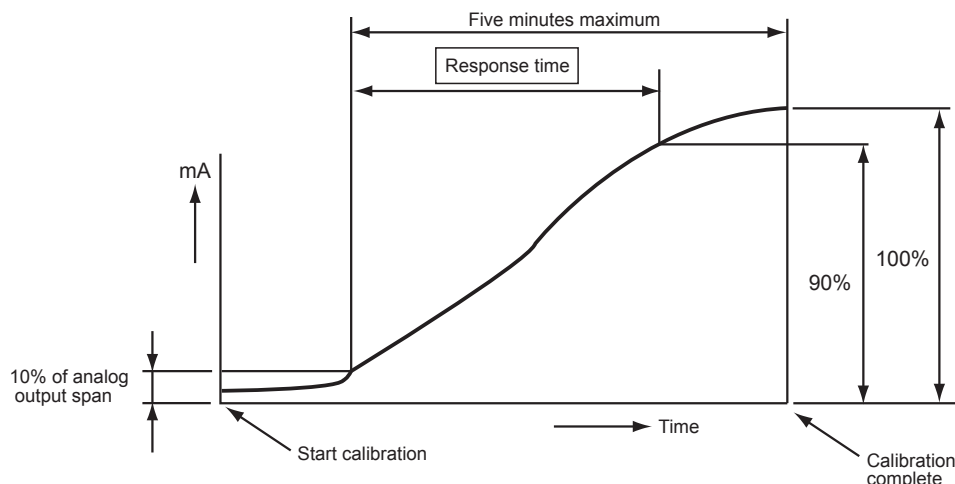
$$\text{Span gas correction ratio} = (C/A) \times 100 (\%) \quad \text{Correctable range: } 0 \pm 18\%$$

F10.2E.ai

Figure 10.2

10.1.2 Cell Response Time

The cell's response time is obtained in the procedure shown in Figure 10.3. If only either a zero-point or span calibration has been carried out, the response time will not be measured just as it will not be measured in manual calibration.



The response time is obtained after the corrected calibration curve has been found. The response time is calculated, starting at the point corresponding to 10% of the analog output up to the point at 90% of the analog output span. That is, this response time is a 10 to 90% response.

F10.3E.ai

Figure 10.3 Typical Response Time characteristic

10.1.3 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.

10.1.4 Cell Temperature

This displays the cell (sensor) temperature, which is determined from the thermocouple emf and cold junction temperature. Normally it is 750°C.

10.1.5 C. J. Temperature

This indicates the detector terminal box temperature, which compensates for the cold junction temperature for a thermocouple measuring the cell temperature. When the ZR22 Detector is used, the maximum C. J. temperature will be 150°C. If the terminal box temperature exceeds this, take measures to shield the terminal box from heat radiation.

The maximum C. J. temperature varies depending on the type of detector.

10.1.6 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:

$$E = -50.74 \log (P_x/P_a) \text{ [mV]}$$

where, P_x : Oxygen concentration in the sample gas

P_a : Oxygen concentration in the reference gas, (21 vol%O₂)

Table 10.1 shows oxygen concentration versus cell voltage.

Table 10.1 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								

T10.1E.ai

10.1.7 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.

10.1.8 Cold Junction Resistance (C.J. Voltage)

The ZR22 Detector measures the cold junction temperature using an RTD (Pt 1000). (The earlier model of ZO21D uses transistors to measure the cold junction temperature.)

If detector is "ZR22" is selected in the Basic setup display, the RTD resistance values will be displayed. If the ZO21D is selected, the transistor voltage will be displayed.

10.1.9 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 evaluated just by changes in cell's internal resistance, however. Those changes in the cell's internal resistance are just a guide to the extent the cell is degrading. The updated values obtained during the calibration are displayed.

10.1.10 Software Revision

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

10.1.11 Maximum Oxygen Concentration, Humidity and Mixing Ratio

The maximum oxygen concentration, humidity and mixing ratio and the time of its occurrence during the period specified in the Averaging display are displayed. After the present monitoring interval has elapsed, 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).

10.1.12 Minimum Oxygen Concentration, Humidity and Mixing Ratio

The minimum oxygen concentration, humidity and mixing ratio 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).

10.1.13 Average Oxygen Concentration, Humidity and Mixing Ratio

The average oxygen concentration, humidity and mixing ratio 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).

10.1.14 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.

10.1.15 Time

The current date and time are displayed. These are backed up with built-in batteries, so the clock continue the run even if the power is switched off.

10.1.16 History of Calibration Time

The calibration-conducted dates and times, and span gas and zero gas ratios for the past ten calibrations are stored in memory.

10.1.17 Power Supply Voltage

For the temperature control for the heater of the detector to work best, you should set the power supply voltage and frequency appropriately, as the control parameters are based on this. Set the AC supply voltage to "Low" if supply is 140 V AC or less, and to "High" if it is 180 V or more.

10.1.18 Power Frequency

Set the AC supply frequency setting appropriately --"Low" for 50 Hz, and "High" for 60 Hz.

10.2 Trend Graph

Press the [Graph display] key in the Basic panel display to switch to the graph display.

This will help grasp the measured-value trend. Touching anywhere on the graph display will return to the Basic panel display. To set the Trend graph display, follow the steps.

10.2.1 Setting Display Items

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display. Select “Maintenance” from the Execution/Setup display.
- (2) Select “Display setup” from the Maintenance display.
- (3) Select “Trend graph” from the Display setup display. The Trend graph display shown in Figure 10.4 appears.
- (4) Select “Parameter: Oxygen” from the Trend graph display. Then select the desired display item shown in Table 10.2.

Table 10.2 Trend Graph Display Items

Selected item	Description
Oxygen concentration	Oxygen concentration graph under measurement
Humidity	Humidity graph under measurement
Mixing ratio	Mixing-ratio graph under measurement
Output 1	Output 1-selected item graph If this equipment is for the oxygen analyzer, the trend graph will be an oxygen concentration graph.
Output 2	Output 2-selected item graph If this equipment is for the oxygen analyzer, the trend graph will be an oxygen concentration graph.

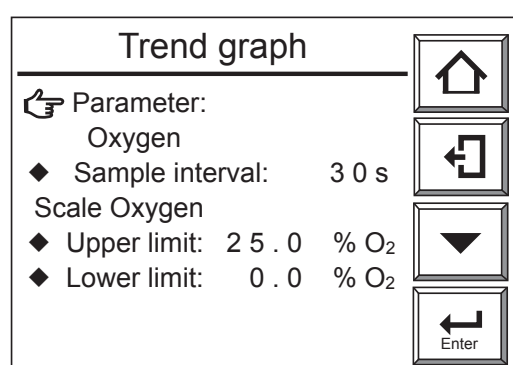


Figure 10.4 Trend Graph Display

10.2.2 Sampling Interval

To plot a graph, set the “Sampling interval” for the measurement data.

This graph allows the plotting of 60 data items on one division on the time axis. So, if you set a ten-second sampling interval, one division corresponds to 600 seconds (Figure 10.5). The allowable sampling intervals range from 1 to 30 seconds. If you set a one-second sampling interval, the axis of the abscissas then corresponds to five minutes.

If you set it to 30 seconds, the axis of the abscissas then corresponds to 150 minutes.

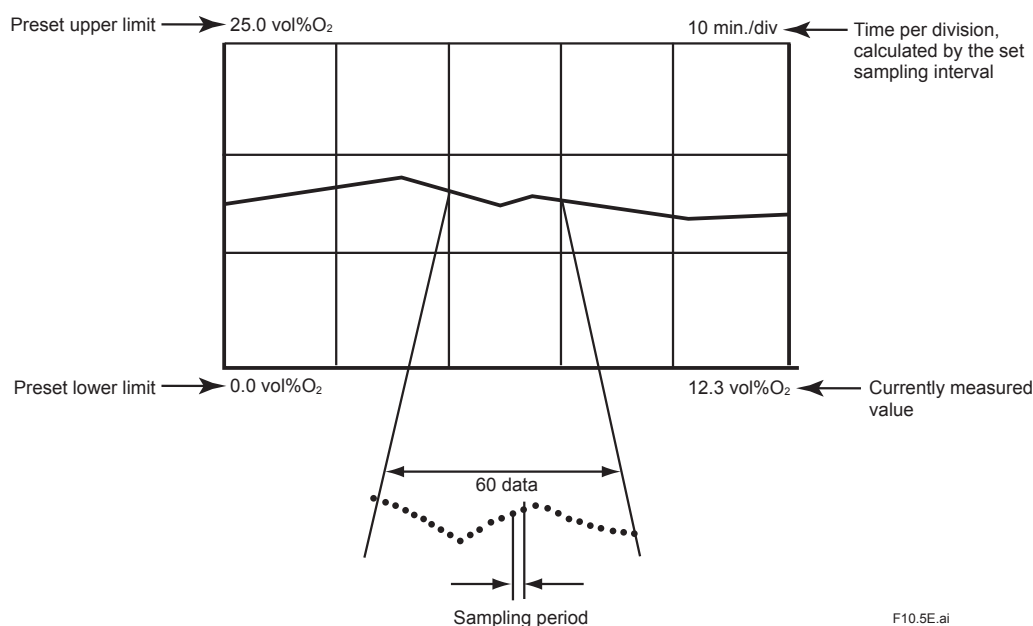


Figure 10.5 Plotting Graph for Sampling Interval

10.2.3 Setting Upper and Lower Limit Values on Graph

Set upper- and lower-limit values on the graph in the following procedure:

Press "Upper limit" in the Trend graph display. The numeric-data entry key appears. Enter the upper-limit value. Also enter the lower-limit value in the same way. The allowable settings for both upper-limit and lower-limit values range from 0 to 100 vol%O₂ (0 to 100 %H₂O for humidity, 0 to 1 kg/kg for mixing ratio.)

10.2.4 Default Setting

When the analyzer is delivered, or if data are initialized, the set data are by default, as shown in Table 10.3.

Table 10.3 Default Values for Graph Setting

Item Default	Value
Parameter	Oxygen concentration
Sampling interval	30 seconds
Upper limit (oxygen concentration)	25 vol%O ₂
Lower limit (oxygen concentration)	0 vol%O ₂
Upper limit (humidity)	25 % H ₂ O
Lower limit (humidity)	0 % H ₂ O
Upper limit (mixing ratio)	0.2 kg/kg
Lower limit (mixing ratio)	0 kg/kg

NOTE

If a rapid change in the measured value occurs during sampling, no sampled data are plotted on the graph. Use the graph indication tentatively. Check the output current for accurate data.

10.3 Other Display-related Functions

10.3.1 Auto-Return Time

On the Execution/Setup display or lower level menu displays, if no keys are touched for a preset time, the Auto return time, then the display will automatically revert to the Basic panel display. The "Auto return time" can be set in the range 0 to 255 minutes. If it is set to 0, then the display does not automatically revert. By default, the "Auto return time" is set to 0 (zero).

<Setting procedure>

- (1) On the Basic panel display, touch the [Setup] key to display the Execution/Setup display, then select "Maintenance". Select "Display setup" then "Auto return time".
- (2) The numerical entry display appears for you to enter the desired Auto return time.
To set an Auto return time of one hour, enter 060.
- (3) If you set 0, then the Auto return function does not operate.

<Default setting>

The Auto return time is set to 0 prior factory shipment or after data initialization.

10.3.2 Entering Tag Name

You can attach a desired tag name to the equipment. To attach it, follow these steps:

- (1) Select the [Setup] key from the Basic panel display to display the Execution/Setup display. Then select "Maintenance" from the Execution/Setup display.
- (2) Select the "Display setup" from the Maintenance display.
- (3) Select the "Display item" from the Display setup display. The display shown in Figure 10.6 then appears.
- (4) Select the "Tag name" from the Display item. The text-data entry display then appears.
- (5) Enter up to 12 alphanumeric characters including codes for the desired tag name.

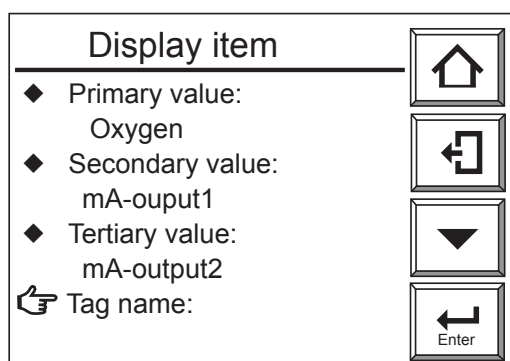


Figure 10.6 Display Item Display

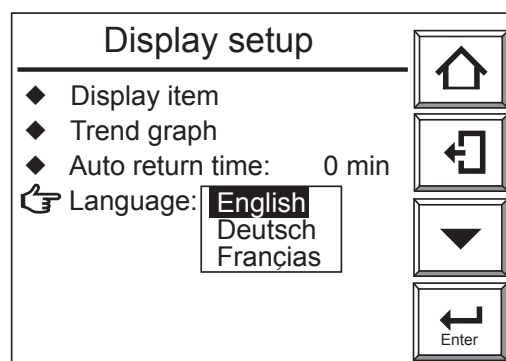


Figure 10.7 Selecting the Display Language

10.3.3 Language Selection

You can select a display language from among English, Japanese, German and French. The display language is set to the one specified in the purchase order when the analyzer is shipped from the factory.

To select the language you want, follow these steps:

<Setting procedure>

- (1) On the Basic panel display, touch the [Setup] key to display the Execution/Setup display.
- (2) Select "Maintenance", then "Display setup".
- (3) Select "Language" and the dropdown selection (Figure 10.7) allows you to select the desired language.

10.4 Blow Back

This section explains the parameter settings for performing blow back.

10.4.1 Mode

There are three modes of blow back operation: no function, semi-automatic, and automatic. Blow back is not performed when the mode is set to “No function”. In “Semi_Auto” mode, blow back can be started by key operation on the display or by a contact input signal, and then sequentially performed at a preset blow back time and hold time. In “Auto” mode, blow back is automatically performed at preset intervals. For “Semi_Auto” or “Auto” modes, blow back is performed. The following restrictions apply:

When “No function” is selected:

Blow back is not performed

When “Semi_Auto” is selected:

Semi-auto blow back can be performed. (Blow back does not start at Auto blow back start time.)

When “Auto” is selected:

Blow back can be performed in either “Auto” or “Semi_Auto” mode.

<Setting Procedure>

- (1) From the Basic panel display, touch [Setup] key; on the Execution/Setup display which appears, select “Maintenance”.
- (2) On the Maintenance display, select “Blow back setup” and the Mode selection pull down allows you to select between “No function”, “Semi_Auto” and “Auto” (see Fig.10.8).

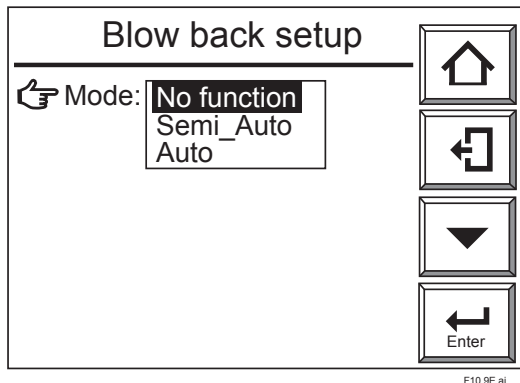


Figure 10.8 Blow back setup Display

10.4.2 Operation of Blow back

Figure 10.9 shows a timing chart for the operation of blow back. To execute blow back with a contact input, use a contact input with an ON-time period of one to 11 seconds. Once blow back starts, a contact output repeatedly opens and closes at an interval of approximately 10 seconds during the preset blow back time. After the blow back time elapses, the analog output remains held at the preset status until the hold time elapses (refer to Section 8.2, earlier in this manual).

As the hold (output stabilization) time, set the time until the sample gas is returned to the sensor and output returns to the normal operating conditions, after completing blow back operations.

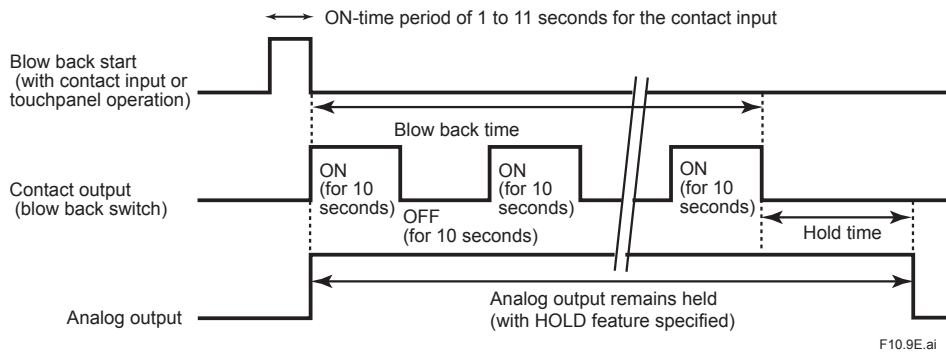


Figure 10.9 Operation of Blow back

10.4.3 Setting Output Hold Time and Blow back Time

If the blow back mode is in “No function”, the output “Hold time” and “Blow back time” are not displayed. If you select “Hold time”, the numeric-data entry display appears. Enter the desired “Hold time” (output stabilization time) from 00 minutes, 00 seconds to 60 minutes, 59 seconds.

When you select “Blow back time”, the numeric-data entry display appears. Enter the desired “Blow back time” from 00 minutes, 00 seconds to 60 minutes, 59 seconds.

10.4.4 Setting Interval, Start Date, and Start Time

The “Interval” is the time to execute blow back. Display the numeric-data entry panel display to set the desired interval from 000 days, 00 hours to 255 days, 59 hours.

For the “Start date” and “Start time”, set the date when the blow back is first executed and the time when to start the blow back, respectively. If you want to execute the first blow back, for example, at 4:00 p.m. on March 25, 2001, enter 25/ 03/ 01 for the Start date and 16:00 for the Start time.

Figure 10.10 Blow back Setup Display

In the Blow back setup display shown in Figure 10.10, if you choose “Mode: No function” or “Semi_Auto”, the Interval, Start date, and Start time for these are not displayed.

NOTE

- If the blow back is executed with an input contact, it must be preset in the Input contact settings (for more details, see Section 8.5, earlier in this manual).
- In Section 8.4, Output Contact Setup, earlier in this manual, set the contact used as the blow back switch beforehand.
- Do not set any other function for the contact used as the blow back switch. Otherwise, blow back may be activated when the contact is closed by any other function.

- No blow back is executed during calibration or maintenance service. If automatic blow back reaches the preset start time during calibration or maintenance service, blow back will be executed after completing the calibration or maintenance service and after the equipment returns to the measurement mode.
- If automatic blow back reaches the preset start time during semi-automatic blow back, the current automatic blow back will not be executed.
- If you set the blow back interval at 000 days, 00 hours, only the first blow back is then executed. No subsequent blow backs will be executed.
- If a past date is set for the Start time, no blow back will be executed.

10.4.5 Default Setting

When the analyzer is delivered, or if data are initialized, the blow back settings are by default, as shown in Table 10.4.

Table 10.4 Blow back Default Setting

Item	Default setting
Mode	No function ("invalid")
Hold time	10 minutes, 00 seconds
Blow back time	10 minutes, 00 seconds
Interval	30 days, 00 hours
Start date	01/ 01/00
Start time	0:00

10.5 Parameter Initialization

Parameter settings can be initialized to the factory default settings. Initialization can be done for all parameters or for individual parameters. The parameters that can be initialized and their defaults are listed in Table 10.5.

<Initialization procedure>

- (1) On the Basic panel display, touch the [Setup] key to display the Execution/Setup display.
- (2) Select "Commissioning", next "Others" then "Defaults". A display like Figure 10.11. appears.
- (3) Select the desired item to be initialized then a display like Figure 10.12 appears.
Select "Defaults start" then initialization starts.

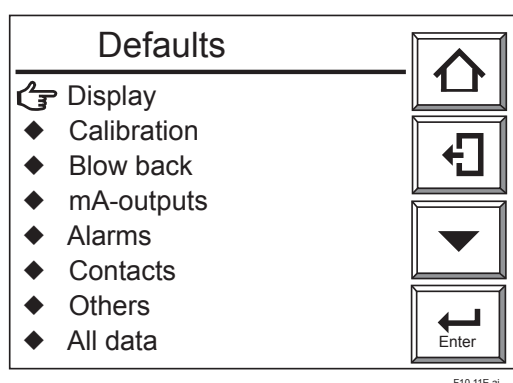


Figure 10.11 Defaults Display

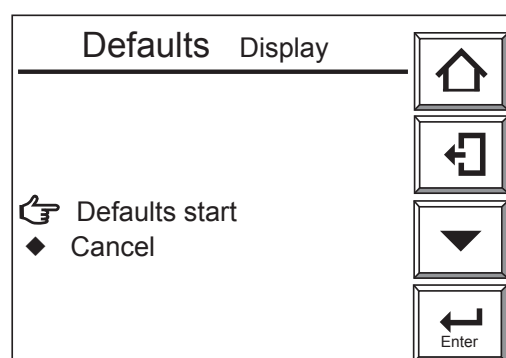


Figure 10.12 Initialization Start Display



WARNING

Do not turn off the power during initialization. Otherwise, initialization will not be performed properly.

Table 10.5 Initialization Items and Default Values (Oxygen Analyzer)

Item	Initialization Parameter		Default setting
Equipment selection	Type of equipment		Not initialized
	Detector		ZR22
	Sample gas		Wet gas
Displayed data	Display item	1st display item	Oxygen concentration
		2nd display item	Current output 1
		3rd display item	Current output 2
		Tag name	Deleted
	Trend graph	Parameter	Oxygen concentration
		Sampling interval	30 seconds
		Upper limit (graph)	25 vol%O ₂
		Lower limit (graph)	0 vol%O ₂
	Automatic return time		0 min.
	Language		Not initialized
Calibration data	Calibration setting	Mode	Manual
		Calibration procedure	Span - zero
		Zero gas concentration	1.00 vol%O ₂
		Span gas concentration	21.00 vol%O ₂
		Output hold time	10 min., 00 sec. (Semi_Auto)
		Calibration time	10 min., 00 sec. (Semi_Auto)
		Interval	30 days, 00 hr. (Auto)
		Start date	01/01/00 (Auto)
		Start time	0:00 (Auto)
Blow back	Blow back setting	Mode	No function (invalid)
		(Output) hold time	10 min., 00 sec.
		Blow back time	10 min., 00 sec.
		Interval	30 days, 00 hr.
		Start date	01/01/00
		Start time	0:00

Item	Initialization Parameter		Default setting
Current output data	mA-output 1 mA-output 2	Parameter	Oxygen concentration
		Min. oxygen concentration	0 vol%O ₂
		Max. oxygen concentration	25 vol%O ₂
		Output damping constant	0 sec.
		Output mode	Linear
	Output hold setting	Warm-up	4 mA
		Set value of Warm-up	4 mA
		Maintenance	Previous value held
		Set value of Maintenance	4 mA
		Calibration, blow back	Previous value held
		Set value of Calibration, blow back	4 mA
		Error	Preset value held
		Set value of Error	3.4 mA
Alarm data	Alarm setting	Parameter	Oxygen concentration
		Hysteresis	0.1 vol%O ₂
		Delayed action of alarm contact	3 seconds
	Alarm set value	High-high alarm	OFF
		Alarm value of High-high alarm	100 vol%O ₂
		High limit alarm	OFF
		Alarm value of High limit alarm	100 vol%O ₂
		Low limit alarm	OFF
		Alarm value of Low limit alarm	0 vol%O ₂
		Low-low alarm	OFF
		Alarm value of Low-low alarm	0 vol%O ₂

Item	Initialization Parameter			Default setting	
Contacts	Output contact 1	Alarm		OFF	
		Other settings	Warm-up	ON	
			Output range now being switched	OFF	
			Now calibrating	OFF	
			Now maintenance servicing	ON	
			Blow back	OFF	
			High limit temp. alarm	OFF	
			Calibration gas press. drop	OFF	
			Gas leak detection	OFF	
		Contact output action			Open
	Output contact 2	Alarm		OFF	
		Other settings	Warm-up	OFF	
			Output range switching	OFF	
			Now calibrating	ON	
			Now maintenance servicing	OFF	
			Blow back	OFF	
			High limit temp. alarm	OFF	
			Calibration gas press. drop	OFF	
			Gas leak detection	OFF	
		Contact output action			Closed
	Output contact 3	Alarm	High-high alarm	OFF	
			High limit alarm	ON	
			Low limit alarm	ON	
			Low-low alarm	OFF	
			Calibration Coefficient Alarm	OFF	
			Startup power stabilization timeout	OFF	
			Error	OFF	
		Other settings		OFF	
		Contact output			Closed
	Output contact 4	Alarm	Error	ON	
		Other settings		OFF	
		Contact output			Closed (Fixed)
	Input contact 1 Input contact 2	Function			OFF
		Action			Closed
Other data	Average value/Maximum and minimum values	Average-value calculation		One hour	
		Intervals over which max. and min. values are monitored		24 hours	
	Fuel set value	Amount of water vapor in exhaust gas		0.00 m³/kg (m³)	
		Theoretical amount of air		1.00 m³/kg (m³)	
		X value		1.00	
		Absolute humidity of atmosphere		0.0 kg/kg	
	Password			Deleted	

Table 10.6 Initialization Items and Default Values (Humidity Analyzer)

Item	Initialization Parameter		Default setting
Equipment selection	Type of equipment		Not initialized
	Detector		ZR22
	Sample gas		Wet gas
Displayed data	Display item	1st display item	Humidity
		2nd display item	Current output 1
		3rd display item	Current output 2
		Tag name	Deleted
	Trend graph	Parameter	Humidity
		Sampling interval	30 seconds
		Upper limit (graph)	25 vol%O ₂
		Lower limit (graph)	0 vol%O ₂
	Automatic return time		0 min.
	Language		Not initialized
Calibration data	Calibration setting	Mode	Manual
		Calibration procedure	Span - zero
		Zero gas concentration	1.00 vol%O ₂
		Span gas concentration	21.00 vol%O ₂
		Output hold time	10 min., 00 sec. (Semi_Auto)
		Calibration time	10 min., 00 sec. (Semi_Auto)
		Interval	30 days, 00 hr. (Auto)
		Start date	01/01/00 (Auto)
		Start time	0:00 (Auto)
Blow back	Blow back setting	Mode	No function (invalid)
		(Output) hold time	10 min., 00 sec.
		Blow back time	10 min., 00 sec.
		Interval	30 days, 00 hr.
		Start date	01/01/00
		Start time	0:00
Current output data	mA-output 1 mA-output 2	Parameter	Humidity
		Min. oxygen concentration	0 vol%O ₂
		Max. oxygen concentration	25 vol%O ₂
		Output damping constant	0 sec.
		Output mode	Linear
	Output hold setting	Warm-up	4 mA
		Set value of Warm-up	4 mA
		Maintenance	Previous value held
		Set value of Maintenance	4 mA
		Calibration, blow back	Previous value held
		Set value of Calibration, blow back	4 mA
		Error	Preset value held
		Set value of Error	3.4 mA

Item	Initialization Parameter		Default setting
Alarm data	Alarm setting	Parameter	Oxygen concentration
		Hysteresis	0.1 vol%O ₂
		Delayed action of alarm contact	3 seconds
	Alarm set value	High-high alarm	OFF
		Alarm value of High-high alarm	100 vol%O ₂
		High limit alarm	OFF
		Alarm value of High limit alarm	100 vol%O ₂
		Low limit alarm	OFF
		Alarm value of Low limit alarm	0 vol%O ₂
		Low-low alarm	OFF
		Alarm value of Low-low alarm	0 vol%O ₂
	Humidity alarm setting	Hysteresis	0.1 % H ₂ O
		Contact delay	3 seconds
	Humidity alarm set value	High-high alarm	OFF
		Alarm value of High-high alarm	100 % H ₂ O
		High limit alarm	OFF
		Alarm value of High limit alarm	100 % H ₂ O
		Low limit alarm	OFF
		Alarm value of Low limit alarm	0 % H ₂ O
		Low-low alarm	OFF
		Alarm value of Low-low alarm	0 % H ₂ O
	Mixing-ratio alarm setting	Hysteresis	0 % kg/kg
		Contact delay	3 seconds
	Mixing-ratio alarm set value	High-high alarm	OFF
		Alarm value of High-high alarm	1 kg/kg
		High limit alarm	OFF
		Alarm value of High limit alarm	1 kg/kg
		Low limit alarm	OFF
		Alarm value of Low limit alarm	0 kg/kg
		Low-low alarm	OFF
		Alarm value of Low-low alarm	0 kg/kg

Item	Initialization Parameter			Default setting
Contacts	Output contact 1	Alarm		OFF
		Other settings	Warm-up	ON
			Output range now being switched	OFF
			Now calibrating	OFF
			Now maintenance servicing	ON
			Blow back	OFF
			High limit temp. alarm	OFF
			Calibration gas press. drop	OFF
		Gas leak detection	OFF	
		Contact output action		Open
	Output contact 2	Alarm		OFF
		Other settings	Warm-up	OFF
			Output range switching	OFF
			Now calibrating	ON
			Now maintenance servicing	OFF
			Blow back	OFF
			High limit temp. alarm	OFF
			Calibration gas press. drop	OFF
		Gas leak detection	OFF	
		Contact output action		Closed
	Output contact 3	Alarm	High-high alarm	OFF
			High limit alarm	ON
			Low limit alarm	ON
			Low-low alarm	OFF
			Calibration Coefficient Alarm	OFF
			Startup power stabilization timeout	OFF
			Error	OFF
		Other settings		OFF
		Contact output		Closed
	Input contact 1 Input contact 2	Function		OFF
		Action		Closed
Other data	Average value/Maximum and minimum values		Average-value calculation	One hour
			Intervals over which max. and min. values are monitored	24 hours
	Measurement gas temperature		Temperature input mode	Preset
			Measurement gas temperature	300°C
			Temperature at 4 mA	0°C
			Temperature at 20 mA	1000°C
			Measurement gas pressure	101.33 kPa abs.
	Password			Deleted

10.6 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.

NOTE

Make sure that before resetting or restarting the power that there is no problem with the detector or converter.

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.

To reset the equipment, follow these steps:

- (1) Press the [Setup] key in the Basic panel display to display the Execution/Setup display.
- (2) Choose “Reset”. The Reset display shown in Figure 10.13 appears.
- (3) Choose “Start reset” and then press the [Enter] key to reset the equipment and the equipment will then be in its warm-up state.

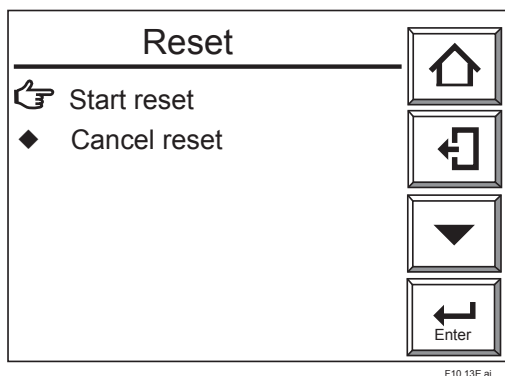


Figure 10.13 Reset Display

10.7 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.

10.7.1 Standard Gas Unit Component Identification

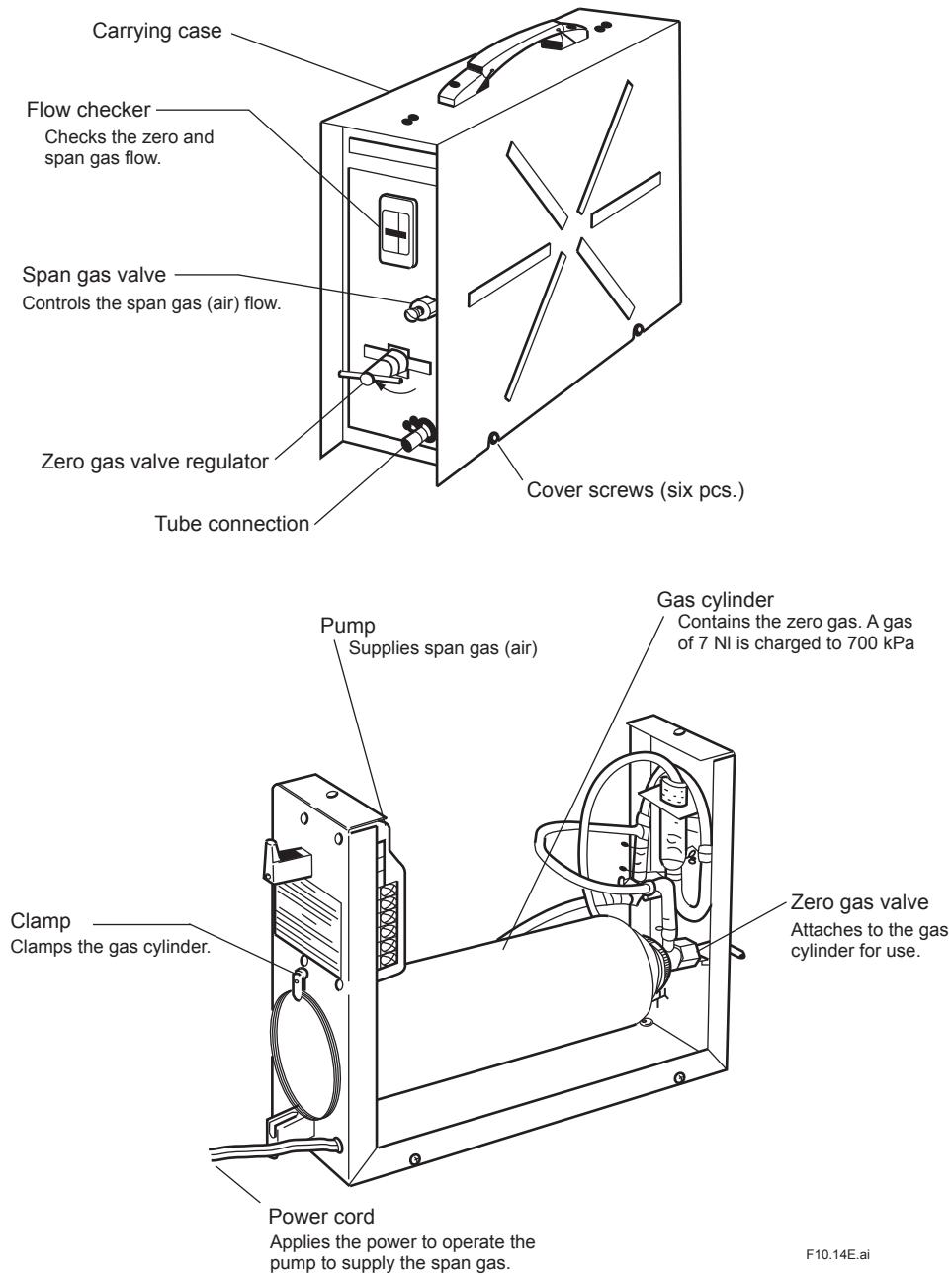


Figure 10.14 Standard Gas Unit Component Identification

10.7.2 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%O₂ (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, following instructions on the converter display. 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 10.7.3).

10.7.3 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%O₂ 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 10.7.2. For operation of the converter, see Section 7.12, earlier in this manual.

- (1) When the message "Open span gas valve" is displayed on the converter display during calibration, plug the power cord into the power supply socket to start the pump of the standard gas unit.

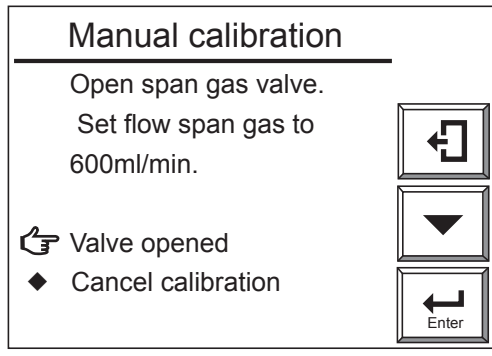


Figure 10.15 Manual Calibration Display

- (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) Select "Valve opened" (to start calibration) from the Manual calibration display shown in Figure 10.15. Check the Trend graph display to see that the measured value is stabilized. Then press the [Enter] key. The Manual calibration display shown in Figure 10.16 appears. Disconnect the power cord to stop the pump.

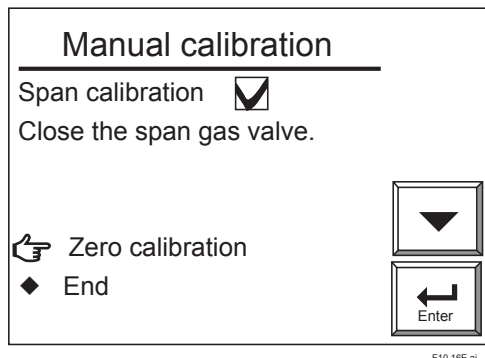


Figure 10.16 Manual Calibration Display

<Flow of zero gas>

Cause a zero gas to flow according to the Manual calibration display shown in Figure 10.17.

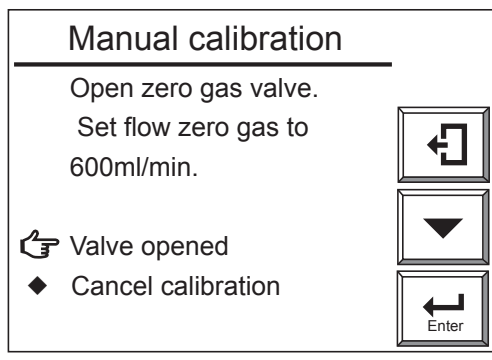


Figure 10.17 Manual Calibration Display

- (1) Use the needle of the zero gas valve "CHECK GAS" to puncture a hole in the gas cylinder installed as described in Section 10.7.2. 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 valves back slowly counterclockwise. At that time, the flow rate also decreases as the inner pressure of the gas cylinder decreases. Therefore, monitor the flow check and, when the ball's position changes greatly, readjust the valve.
- (3) Select "Valve opened" (to start calibration) from the Manual calibration display. Check the Trend graph display to see that the measured value is stabilized. Then press the [Enter] key. The Manual calibration display shown in Figure 10.18 appears. Then stop the zero gas flow immediately. 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.

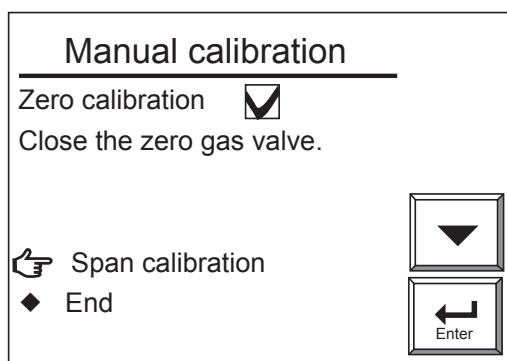


Figure 10.18 Zero gas Calibration Complete (in Manual Calibration Display)

NOTE

Be sure not to terminate a 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-point calibration twice.

<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.

10.8 Methods of Operating Valves in the ZA8F Flow Setting Unit

The ZA8F Flow Setting Unit is used as a calibration device 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 each time calibration is made (starting and stopping the calibration gas flow and adjusting the flow rate). This applies even if you are using the ZR40H Automatic Calibration Unit. For operation of the converter, see Section 7.12, earlier in this manual.

10.8.1 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 equals 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%O₂) in the cylinder is set in the converter.

10.8.2 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.

- (1) When the display shown in Figure 10.15 appears during calibration, open the span gas flow setting valve of the flow setting unit and adjust the flow rate to 600 ± 60 ml/min. Turn the valve slowly counterclockwise after loosening the lock nut if the valve has a lock nut. 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 10.7) $\pm 10\%$.

Table 10.7

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

- (2) Adjust the flow rate and select "Valve opened" from the Manual calibration display. Check the Trend graph display to see that the measured value is stabilized. Then press the [Enter] key. The Manual calibration display shown in Figure 10.16 appears.
- (3) Close the span gas flow setting valve to stop the span gas (air) flow. If the valve has a lock nut, be sure to tighten the lock nut to prevent any leakage of span gas into the sensor during measurement.

10.8.3 Operating the Zero Gas Flow Setting Valve

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

- (1) When the display shown in Figure 10.19 appears 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, if the valve has a lock nut loosen the lock nut and slowly turn it counterclockwise. To check the flow rate, monitor the calibration gas flowmeter. If the sample gas pressure is extremely high, adjust the sample gas pressure to obtain pressures (listed in Table 10.7) $\pm 10\%$.

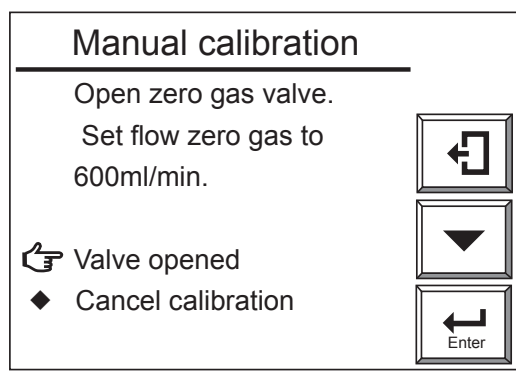


Figure 10.19 Manual Calibration Display

- (2) Adjust the flow rate and select "Valve opened" from the Manual calibration display. Check the Trend graph display to see that the measured value is stabilized. Then press the [Enter] key. The Manual calibration display shown in Figure 10.20 appears.

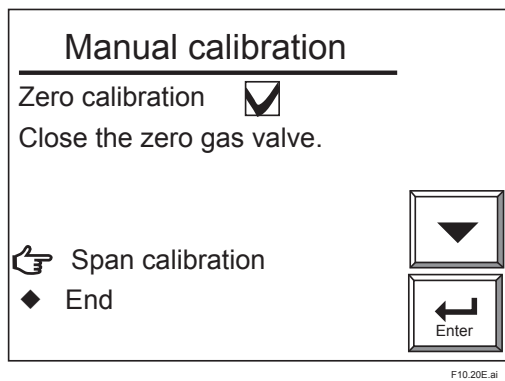


Figure 10.20 Zero-point Calibration Complete (in Manual Calibration)

- (3) Close the zero gas flow setting valve to stop the zero gas flow. If the valve has a lock nut, be sure to tighten the lock nut to prevent the any leakage of the zero gas into the sensor because the valve may become loose during measurement.

10.8.4 Operation After Calibration

No special operation of the instrument is needed after calibration. However, it is recommended that the pressure reducing valve 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 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 go open circuit, 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 (600 ± 60 ml/min), 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 washers) that tighten the sensor assembly, and the pipe support as well as the U-shaped pipe.
- (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 for a general-purpose detector, or 15 cm for high temperature detector.
- (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.

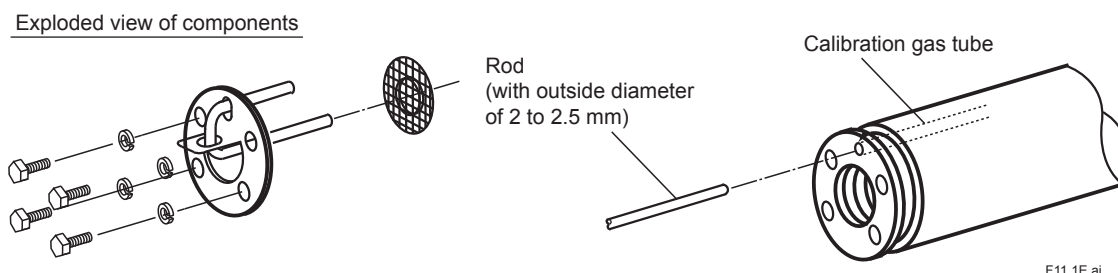


Figure 11.1 Cleaning the Calibration Gas Tube

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 gas ratio of $100 \pm 30\%$ or a span gas ratio of $0 \pm 18\%$. 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 sensor assemblies manufactured in or after Sept. 2000: the serial number on the side of the sensor 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, metal O-ring and contact together at the same time. If required, also replace the U-shaped pipe, bolts, filter and associated spring washers.

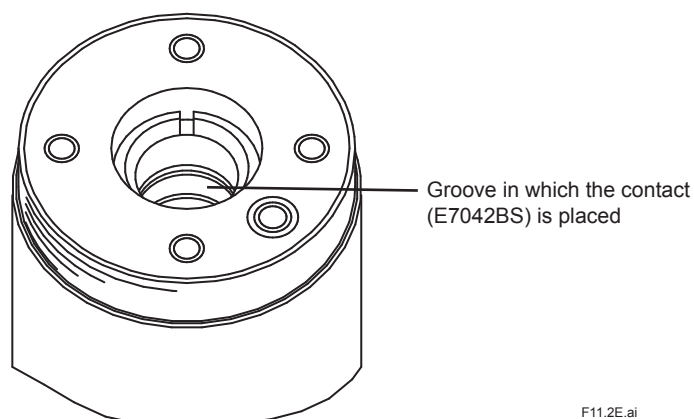
2. Removal procedures

- (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 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. Remove filter also.
(When replacing the assembly, be careful not to scratch or dent 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 in the tip of the probe.

- (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 used, it can not be reused. 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.



F11.2E.ai

Figure 11.2 **Installing the Contact**

- (2) Next, make sure that the O-ring groove on the flange surface of the sensor is clean. Install the metal O-ring in that O-ring groove, and then insert the sensor 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 with filter, then fully insert the U-shaped pipe and its support into the probe.
- (4) Coat the threads of the four bolts with anti-seize 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 N • m. If they are not uniformly tightened, the sensor or heater may be damaged.
Replacement of the sensor assembly is now complete. Install the detector and restart operation. Calibrate the instrument before making a measurement.

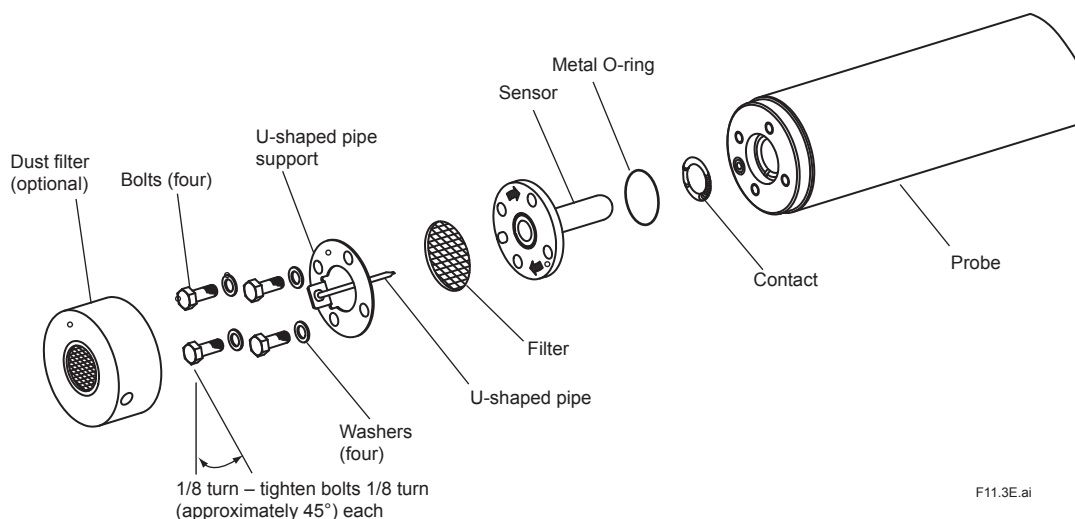


Figure 11.3 **Exploded View of Sensor Assembly**

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 Unit

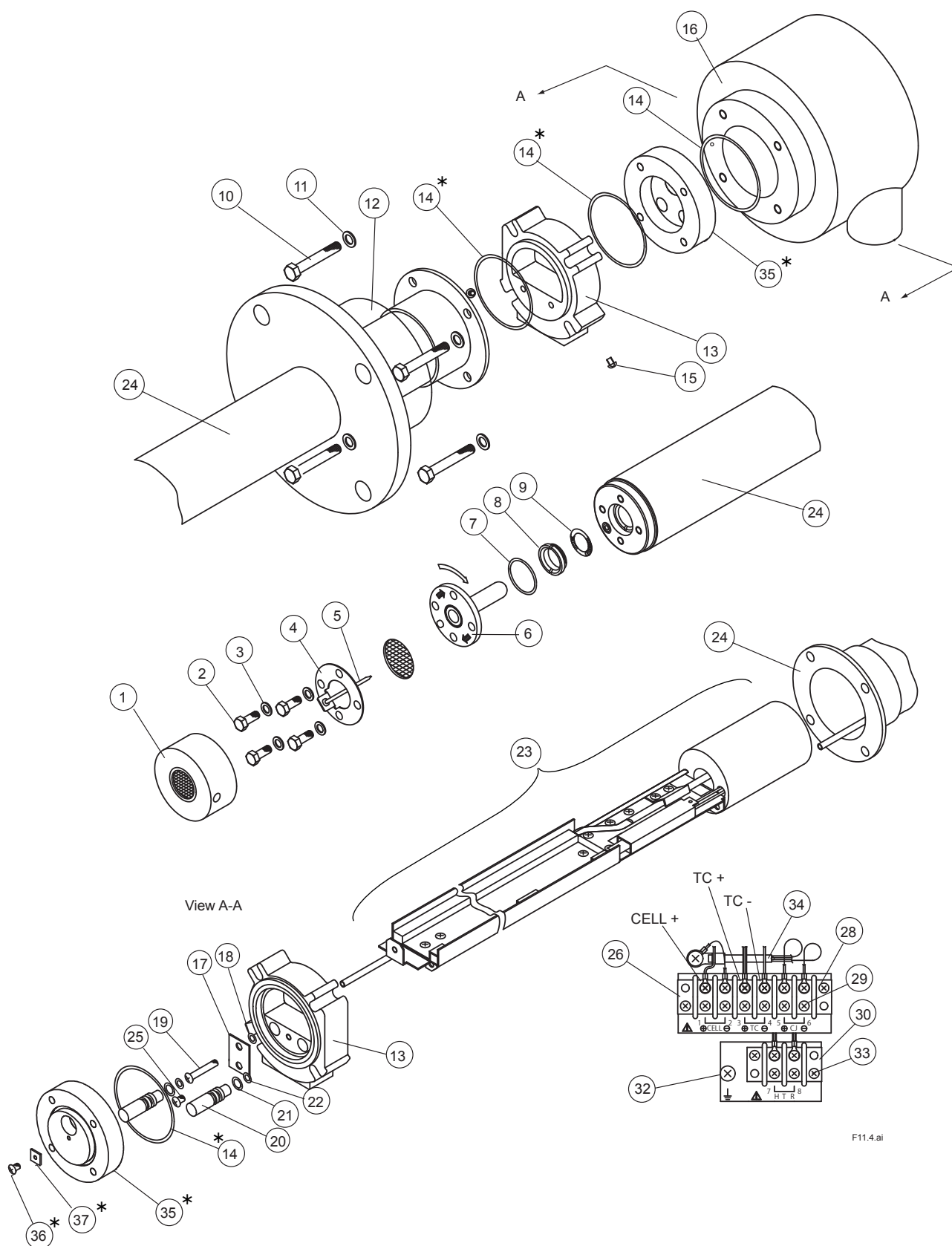
This section describes the replacement procedure for the heater unit.

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 unit reaches high temperatures and is subjected to high voltages. So, maintenance services should be performed after the power is off and the heater unit temperature has returned to normal room temperature.

For details, refer to IM11M12A01-21E “Heater Assembly”.

NOTE

If the heater strut assembly can not be removed because a screw has fused to its thread, one of our service representatives can fix it.



F11.4.ai

Figure 11.4 Exploded View of Detector (When pressure compensation specified)

Note: The parts marked by * is not equipped with the types except the pressure compensation type.

Replacement of heater strut assembly (ZR22G : Style S2 and after)

Refer to Figure 11.4 as an aid in the following discussion.

Remove the cell assembly (6), following Section 11.1.2, earlier in this manual. Open the terminal box (16) and remove the three terminal connections – CELL +, TC + and TC -. Before disconnect the HTR terminals, remove the terminal block screw (28). Keeping the other terminal remaining to be connected. Disconnect the two HTR connections. (These terminals have no polarity.)

Remove the two screws (15) that fasten the cover (12) and slide it to the flange side.

Remove the four bolts (10) and terminal box (16) with care so that the already disconnected wire will not get caught in the terminal box.

In case of the pressure compensation type detector, remove the screw (36) and the plate (37) on the adapter (35). Remove the adapter (35), drawing out the wires of the heater strut assembly (23) from it.

Loosen screw (19) until heater strut assembly (23) plate can be removed.

There's no need to remove O-ring (18) which prevents screw (19) from coming 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 strut assembly (23) from the detector (24).

To reassemble the heater strut assembly, reverse the above procedure:

Insert the heater strut assembly (23) into the detector (24), while inserting the calibration pipe in the detector (24) into the heater section in the heater strut 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 $12\text{N} \cdot \text{m} \pm 10\%$.

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-rings (22) remains in the hole, pull them out from the back. Pass the heater and thermocouple lead wire 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 the screw (19) in heater strut assembly (23) until connector (13) can't move.

Reassemble in reverse order to the above disassembly procedure.

The two wires with ceramic insulators from the heater strut assembly are heater wires, and the single-core shielded wire is the cell signal + terminal; for the two-core shielded cable, the semi-translucent rubber-sheathed wire is the thermocouple + terminal, and the other wire is the – terminal. (If the wires are marked, match the markings with those on the terminal board).

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), (21), 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 and calibration 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 Cleaning the High Temperature Probe Adapter



CAUTION

Do not subject the probe of the High Temperature Probe Adapter (ZO21P-H-A) to shock. This probe uses silicon carbide (SiC) which may become damaged if it is subjected to a strong shock or thermal shock.

The high temperature detector is structured so that the gas to be measured is directed toward the detector with the high temperature probe adapter. Therefore, if the probe or the sample gas outlet clogs, a precise measurement is no longer possible because of no gas flow. If you use the high temperature detector, you have to inspect it periodically and, if any part of it is significantly clogged with dust, clean it.

Dust found sticking to the probe should be blown off. If any dust still remains after the blowing, clean it with a metal rod, etc., inserted. In addition, if dust is found on the auxiliary ejector or needle valve (choke) at the sample gas outlet, remove these parts from the high temperature probe adapter and then clean them. To remove dust, blow air on them or rinse them with water.

11.1.7 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 much lower. If a large amount of water is condensed, the sensor can be broken and will 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 this is impossible to do the above, remove the detector.
- (2) If unavoidably impossible to supply the power and removing the detector, keep on the 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 power to the 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.

A dirty touchpanel should be wiped off with a soft dry cloth.

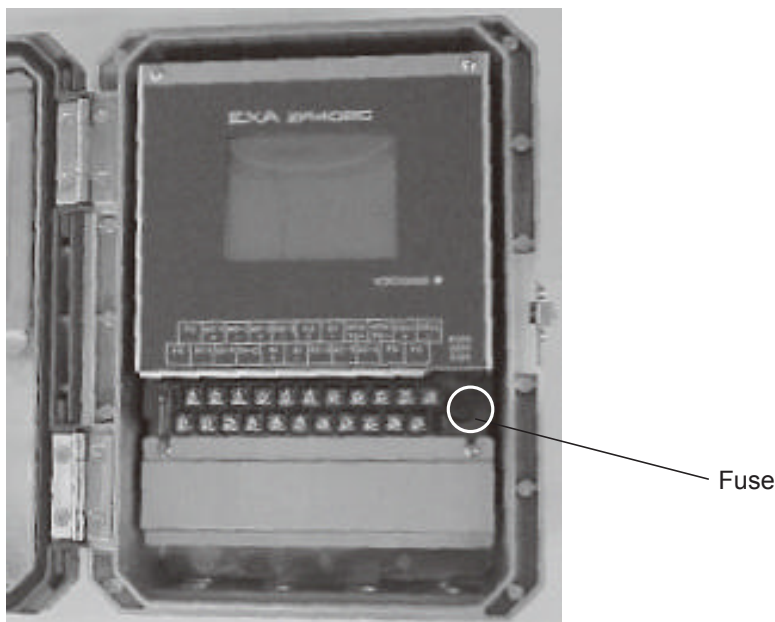
11.2.1 Replacing Fuses

The converter incorporates a fuse, as indicated in Figure 11.5. If the fuse blows out, replace it in the following procedure.



CAUTION

- If a replaced fuse blows out immediately, there may be a problem in the circuit. Go over the circuit completely to find out why the fuse has blown.
- This fuse is for protecting the main power supply circuit and does not provide overcurrent protection for the heater temperature control circuit. For overcurrent protection circuitry, refer to Section 12.1.2.2, Heater Temperature Failure.



F11.5E.ai

Figure 11.5 Location of Fuse in the Converter

To replace the fuse, follow these steps:

- (1) Turn off the power to the converter for safe replacement.
- (2) Remove the fuse from its holder. With the appropriate flat-blade screwdriver that just fits the holder cap slot (Figure 11.6), turn the fuse holder cap 90° counterclockwise. By doing so, you can remove the fuse together with the cap.

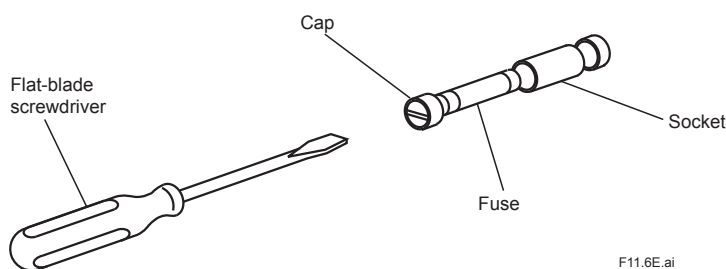


Figure 11.6 Removing the Fuse

- (3) 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- or VDE-approved

Part number: A1113EF

Place a new, properly rated fuse in the holder together with the cap, and push and turn the cap clockwise 90° with the screwdriver to complete installation of the fuse.

11.2.2 Cleaning

Use a soft dry cloth to clean any part of the converter during inspection and maintenance.

11.2.3 Adjust LCD screen contrast

An LCD is built in the ZR402G converter. The contrast of this LCD is affected by its ambient temperature. For this reason, the LCD is shipped, after adjusting the contrast so as to become the most suitable in a room temperature (20-30°C). However, when display on the LCD is hard to see, adjust the LCD contrast by change the resistance of the variable resistor; its position is shown in Fig. 11.7



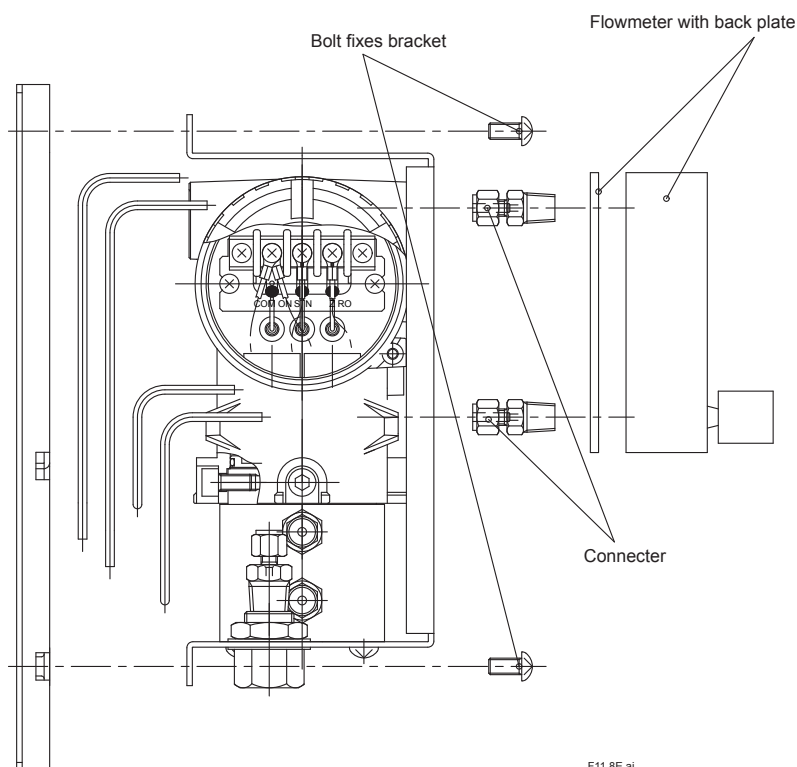
Figure 11.7

11.3 Replacing Flowmeter in ZR40H Automatic Calibration Unit

- (1) Remove piping and wiring, and remove the ZR40H from the 2B pipe or wall mounting.
- (2) Remove four M6 bolts between brackets.
- (3) Remove piping extension

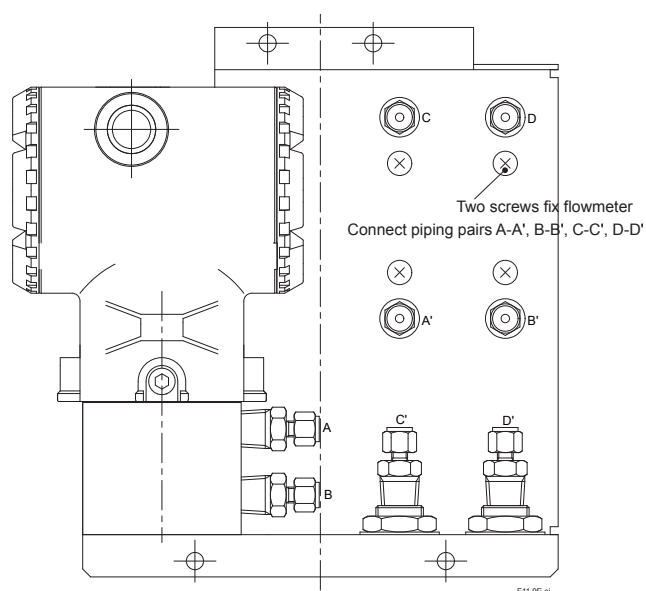
- (4) Remove bolts holding flowmeter, and replace it. A white back plate (to make the float easy to see) is attached. The end of the pin holding down the back plate must be on the bracket side.
- (5) Replace piping, and fix M6 bolts between brackets. *1

*1 : When disassembling and reassembling, mark original positions, and tighten an extra 5-10° when reassembling.
After tightening, do a liquid leakage test.



F11.8E.ai

Figure 11.8 Flowmeter replacement



F11.9E.ai

Figure 11.9 Fixing Flowmeter

12. Troubleshooting

This chapter describes errors and alarms detected by the self-diagnostic function of the converter. It also explains inspections and remedies when other problems occur.

12.1 Displays and Remedies When Errors Occur

12.1.1 Error Types

An error occurs when an abnormality is detected in the detector or the converter, e.g., in the cell (sensor), detector heater, or internal circuits of the 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.

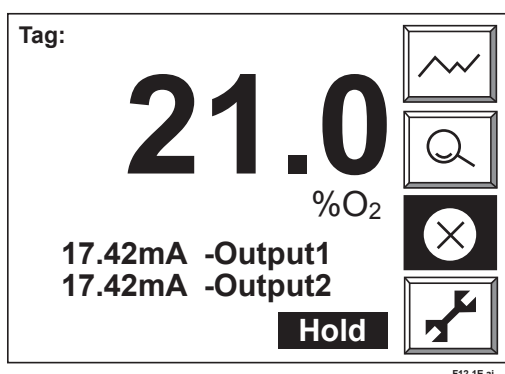


Figure 12.1

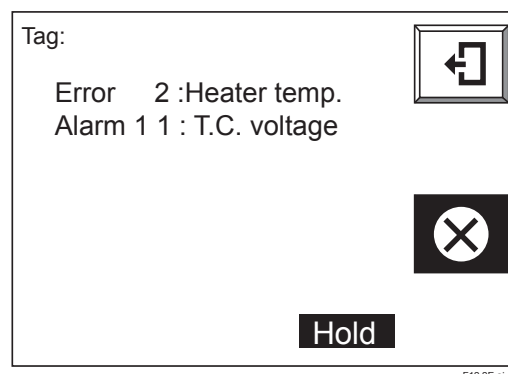


Figure 12.2

Table 12.1 Types of Errors and Reasons for Occurrence

Error Code	Error Type	Occurrence Conditions
Error1	Cell voltage failure	The cell (sensor) voltage signal input to the converter falls below -50 mV.
Error2	Heater temperature failure	The heater temperature does not rise during failure warm-up, or it falls below 730°C or exceeds 780°C after warm-up is completed. Or this occurs if the TC+, TC- thermocouple terminals are wired to converter with reverse (wrong) polarity.
Error3	A/D converter failure	The A/D converter fails in the internal electrical circuit in the converter.
Error4	Memory failure	Data properly are not written into memory in the internal electrical circuit in the converter.

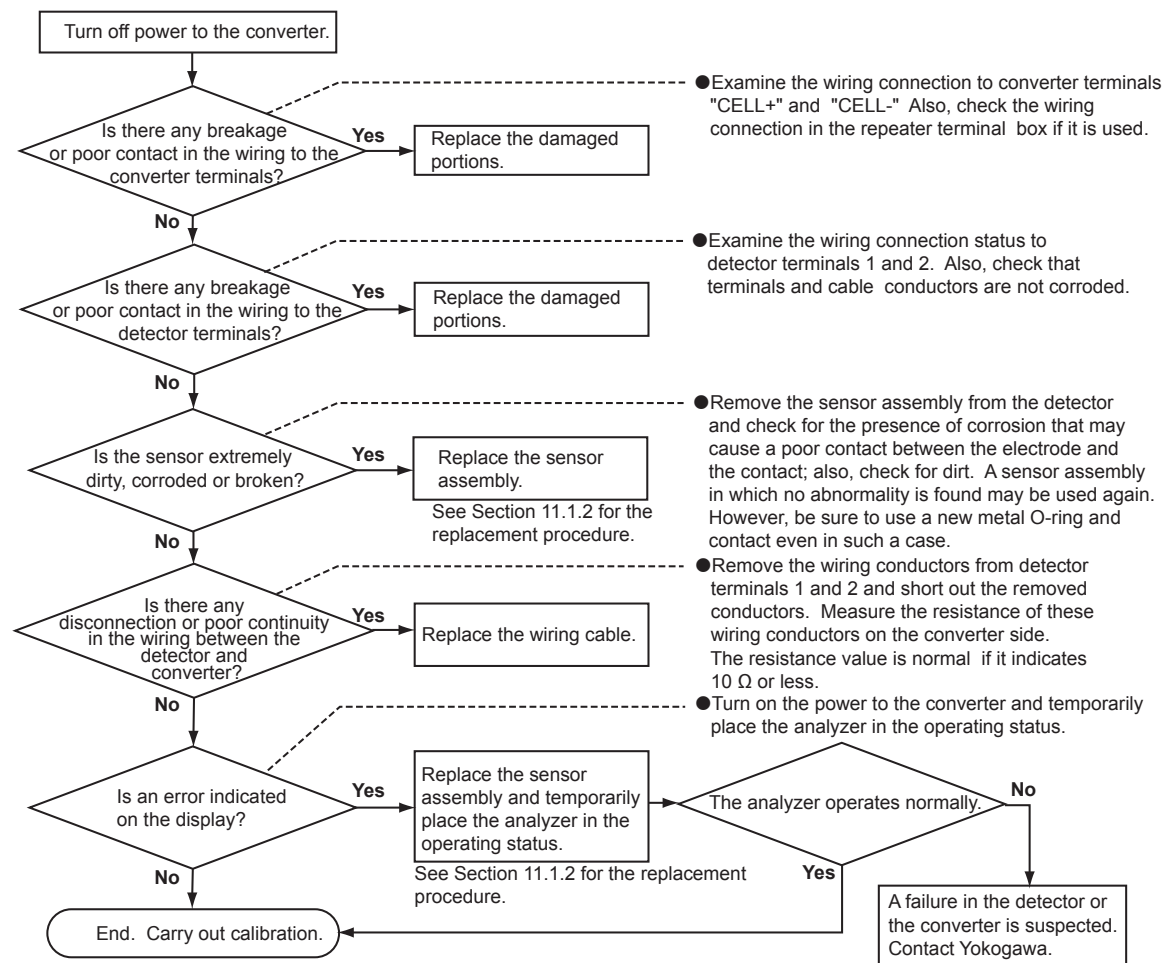
12.1.2 Remedies When an Error Occurs

■ Error1: Cell Voltage Failure

Error1 occurs when the cell (sensor) voltage input to the converter falls below -50 mV (corresponding to about 200 vol% O₂). The following are considered to be the causes for the cell voltage falling below -50 mV:

- (1) Poor contact in terminal connections between the converter and detector
- (2) Breakage in wiring cable between the converter and the detector
- (3) Damage or deterioration of the sensor assembly
- (4) Continuity failure between the sensor assembly electrode and the contact
- (5) Wiring failure inside the detector
- (6) Abnormality in electrical circuits in the converter

<Locating the failure and countermeasures>



F12.1.2E.ai

■ Error2: Heater Temperature Failure

This error occurs if the detector heater temperature does not rise during warm-up, falls below 730 °C after warm-up, or exceeds 780 °C. When Error2 occurs, Alarm 10 (cold junction temperature alarm) or Alarm 11 (thermocouple voltage alarm) may be generated at the same time. Be sure to press the error indication to get the error description and confirm whether or not these alarms are being generated simultaneously.

If Alarm 10 is generated simultaneously, a failure in the cold junction system on the detector terminal block is suspected. In this case, follow the procedure according to troubleshooting for Alarm 10 in 12.2.2.5.

If Alarm 11 is generated simultaneously, a failure in the thermocouple system located in the detector heater is suspected. In this case, follow the procedure according to troubleshooting for Alarm 11 in 12.2.2.6.

If this failure occurs immediately after the power is supplied, the polarity at thermocouple input connection (TC+, TC-) on the converter may be reversed. Check the connection from the detector.

Causes considered for cases where Error2 occurs independently are shown below.

- (1) Faulty heater in the detector (heater wire breakage)
- (2) Faulty thermocouple in the detector
- (3) Faulty cold junction sensor located at the detector terminal block.
- (4) Failure in electrical circuits inside the converter
- (5) Heater temperature control overcurrent limiting triggered.
- (6) TC+ ,TC- thermocouple terminals wired to detector with reverse (wrong) polarity.

Overcurrent protection is triggered if there are problems in the heater wiring. When the protective circuit is triggered, the internal fuse blows and the heater is disconnected, resulting in Error 2 (temperature failure).

<Locating cause of failure, and countermeasures>

- (1) Turn off power to the converter.
- (2) Remove the cable from terminals 7 and 8 of the detector and measure the resistance value between these terminals. The heater unit is normal if the resistance is lower than about 90 Ω . If the resistance value is higher, failure of the heater unit is suspected. In this case, replace the heater unit (refer to Section 11.1.3, Replacement of the Heater Unit). In addition, check that the wiring resistance between the converter and detector is 10 Ω or less.
- (3) Ensure that TC+ terminal (terminal 3 in detector) is connected to converter TC+ terminal, and TC- terminal (terminal 4) is connected to converter TC- terminal.
- (4) Remove the wiring from terminals 3 and 4 of the detector and measure the resistance value between these terminals. The thermocouple is considered normal if the resistance value is 5 Ω or less. If the value is higher than 5 Ω , it may indicate that the thermocouple wire has broken or is about to break. In this case, replace the heater unit (refer to Section 11.1.3, Replacement of the Heater Unit). Also, check that the wiring resistance between the converter and detector is 10 Ω or less.
- (5) Even if items (2) to (4) are normal, the heater overcurrent protection fuse may have blown. Check for wiring problems such as the following:
 - (a) Heater terminals shorted.
 - (b) Heater terminal(s) shorted to ground.
 - (c) Heater terminals shorted to power supply.

If the internal fuse blows, this cannot be replaced by the user. Contact your Yokogawa service representative.

NOTE

Measure the thermocouple resistance value after the temperature difference between the detector tip and the ambient atmosphere has decreased to 50°C or less. If the thermocouple voltage is large, accurate measurement cannot be achieved.

■ Error3: A/D Converter Failure/Error4: Writing-to-memory Failure

- A/D Converter Failure

It is suspected that a failure has occurred in the A/D converter mounted in the electrical circuits inside the converter.

- Writing-to-memory Failure

It is suspected that a failure has occurred in an operation writing to the memory (EEPROM) mounted in the electrical circuits inside the converter.

<Locating the failure, and countermeasures>

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 electrical circuits 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 electrical circuits is suspected. Consult the service personnel at Yokogawa.

12.2 Displays and Remedies When Alarms are Generated

12.2.1 Alarm Types

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.

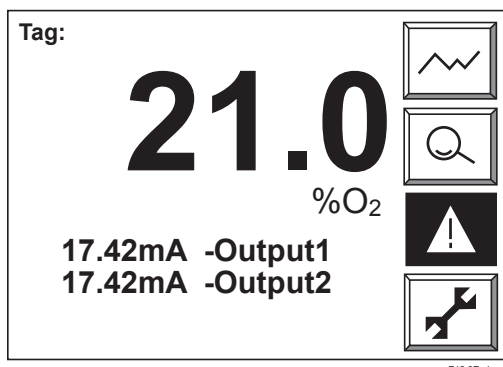


Figure 12.3

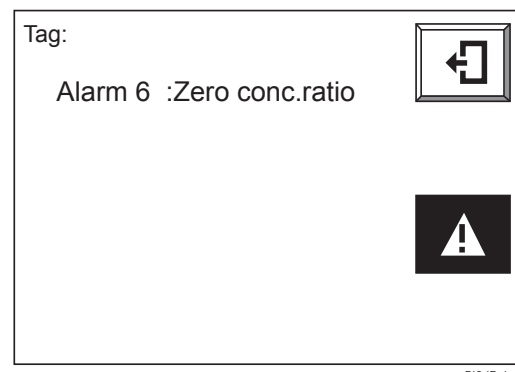


Figure 12.4

Table 12.2 Types of Alarms and Reasons for Occurrence

Alarm Code	Alarm Type	Occurrence Conditions
Alarm 1	Oxygen concentration alarm	Measured oxygen concentration value exceeds or falls below the preset alarm limits. (refer to Section 8.3, Setting Alarms).
Alarm 2	Humidity alarm	Occurs when the humidity to be measured exceeds or falls below the set alarm points (refer to Section 8.3, "Alarm Setting").
Alarm 3	Mixing-ratio alarm	Occurs when the mixing ratio to be measured exceeds or falls below the set alarm points (refer to Section 8.3, "Alarm Setting").
Alarm 6	Zero-point calibration coefficient alarm	In automatic or semi-automatic calibration, zero correction ratio is outside the range of $100 \pm 30\%$. (refer to Section 9.1.4, Compensation).
Alarm 7	Span-point calibration coefficient alarm	Span correction ratio is outside the range of $0 \pm 18\%$ (refer to Section 9.1.4, Compensation).
Alarm 8	EMF stabilization time-up alarm	In automatic or semi-automatic calibration, cell voltage does not stabilize after calibration time is up.
Alarm 9	Exhaust gas temperature alarm	When "mA-input" is selected in the Exhaust gas setup display, this alarm occurs if the exhaust gas temperature exceeds the set alarm values (refer to Section 8.6.4, "Setting Measurement Gas Temperature and Pressure").
Alarm 10	Cold junction temperature alarm	Temperature of the cold junction placed in the detector terminal box falls below -25°C or exceeds 155°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 12	Input current alarm	When "mA-input" is selected in the Exhaust gas setup display, this alarm occurs if the input current from the temperature transmitter is outside from 3.2 to 21.6 mA .
Alarm 13	Battery low alarm	Internal battery needs replacement.

If an alarm is generated, actions such as turning off the heater power are not carried out. The alarm is cancelled when the cause of the alarm is removed. However, Alarm 10 and/or Alarm 11 may be generated concurrently with Error2 (heater temperature error). In this case, the operation when the error occurs has priority.

If the power to the converter is turned off after an alarm is generated and the converter is restarted before the cause of the alarm has been removed, 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 Remedies When Alarms are Generated

■ Alarm 1, Alarm 2, and Alarm 3: Oxygen Concentration Alarm, Humidity Alarm and Mixing Ratio Alarm

This alarm is generated when a measured value exceeds an alarm set point or falls below it. For details on these alarms, see Section 8.3, Setting Alarms, in the chapter on operation.

■ Alarm 6: Zero-point Calibration Coefficient Alarm

In automatic or semi-automatic calibration, this alarm is generated when the zero correction ratio is out of the range of $100 \pm 30\%$ (refer to Section 9.1.4, Compensation).

The following are possible causes of this alarm.

- (1) The zero-gas oxygen concentration does not agree with the value of the zero-gas concentration set in Calibration setup. Otherwise, the span gas is used as the zero gas.
- (2) The flow rate of zero gas is out of the specified flow ($600 \pm 60 \text{ ml/min}$).
- (3) The sensor assembly is damaged and so cell voltage is not normal.

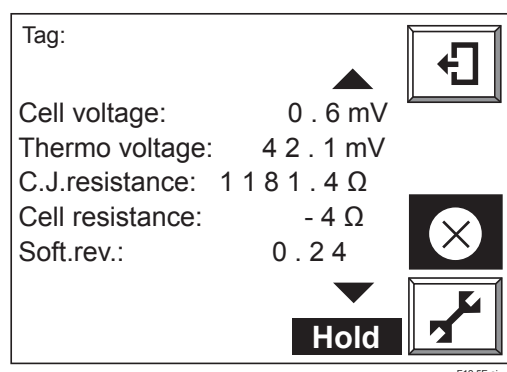
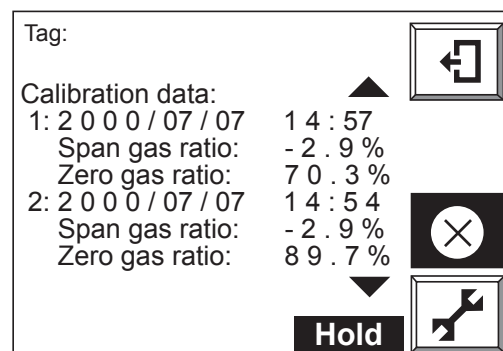
<Locating cause of failure, and countermeasures>

- (1) Check that the following have been set up correctly. If not, correct them. Then, recalibrate.
 - a. Check the preset zero gas concentration on the Calibration setup display. The displayed concentration value has agreed with the concentration of the zero gas actually used.
 - b. The piping for calibration gases has been constructed so that the zero gas does not leak.
- (2) If the alarm is not generated during the recalibration, improper calibration conditions are considered as the cause of the alarm generated in the previous calibration. In this case, no particular restoration is necessary.
- (3) If the alarm is generated again during the recalibration, deterioration of or damage to the sensor assembly is considered as the cause of the alarm. It is necessary to replace the cell with a new one. Before replacement, carry out the following.
Check the cell voltages when the zero gas and span gas are introduced.
 - a. From the Basic panel display, move to the Detailed-data display of the channel where the alarm is being generated.
 - b. When the [▼] key is pressed once, the cell voltage should be indicated on the top line (Figure 12.5).
 - c. Check whether or not the displayed cell voltage is very different from the theoretical value at the oxygen concentration of the relevant gas. See Table 12.3 for the theoretical cell voltages. Although the tolerance to the theoretical value cannot be generally specified, a reasonable one may be approximately ± 10 mV.

Table 12.3 Oxygen Concentration and Cell Voltage

Oxygen concentration (vol%O ₂)	Cell voltage (mV)
1%	67.1
21%	0

- (4) Check whether the deterioration of or damage to the sensor assembly that caused the alarm has occurred suddenly during the current calibration in the following procedure:
 - a. Call up the Detailed-data Display.
 - b. Use the [Page Scroll] key to check Calibration Data (Figure 12.6). The span and zero correction ratios of the last ten calibration can be checked here. By checking these data, whether the sensor deterioration has occurred suddenly or gradually can be determined.

**Figure 12.5 Detailed Data Display****Figure 12.6 Calibration History**

- (5) If the sensor assembly has deteriorated suddenly, the check valve that prevents moisture in the furnace from entering into the calibration pipes may have malfunctioned. If the furnace gas flows into calibration lines, the gas is cooled and thus condensation develops and accumulates in the pipe. During calibration the condensate is carried with the calibration gas and blow onto the sensor assembly, whereby the cell is cooled quickly. This results in the failed sensor assembly.

- (6) If the sensor assembly has deteriorated gradually, check the condition of the sensor assembly following the procedure below.
 - a. Use the [Page Scroll] key to check Cell Resistance. It should be 200 V or less if the cell (sensor) is new. On the other hand, if the cell (sensor) is approaching the end of its service life, it will be 3 to 10 kV.
 - b. Use the [Page Scroll] key to check Cell Robustness. It should say "Life > 1 year" if the cell (sensor) is in good condition.

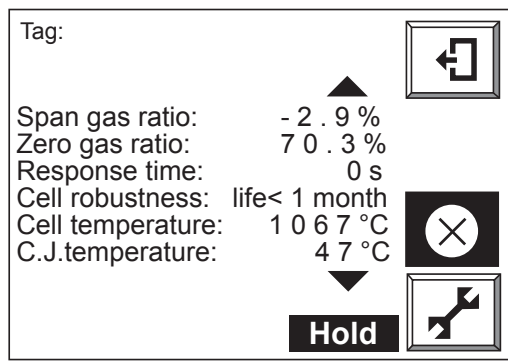


Figure 12.7

■ Alarm 7: Span-point Calibration Coefficient Alarm

In automatic or semi-automatic calibration, this alarm is generated when the span correction ratio is out of the range of $0 \pm 18\%$ (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 in Calibration setup.
- (2) The flow of the span gas is out of the specified flow value (600 ± 60 ml/min).
- (3) The sensor assembly is damaged and the cell voltage is abnormal.

<Locating cause of failure, and countermeasures>

- (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 point 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-point Calibration Coefficient Alarm.

■ Alarm 8: EMF Stabilization Time-up Alarm

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.

<Locating cause of failure, and countermeasures>

- (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 detector probe. If dust is found, clean the probe (see Section 11.1.1).
 In addition, if an error occurs in calibration even after the sensor 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 9: Exhaust Gas Temperature Alarm

When "mA-input" is selected in the Exhaust gas setup display, this alarm occurs if the exhaust gas temperature exceeds the set alarm values.

The following are probable causes:

- (1) The temperature transmitter output range does not meet the analyzer Exhaust gas setup (if this alarm occurs when the equipment starts up).
- (2) Thermocouple(s) connected to the temperature transmitter may be defective (disconnected).
- (3) Temperature transmitter may be defective.
- (4) Exhaust gas temperature may exceed the set alarm value.

<Locating cause of failure, and countermeasures>

- (1) Check that the temperature transmitter output temperatures at 4 and 20 mA meet the temperatures at 4 mA and 20 mA set with this equipment.
- (2) Check that an actual exhaust gas is normal.

Press the detailed data display key to display and check that the exhaust gas temperature in the displayed detailed data is normal. If this value is outside the temperature transmitter's normal output, the thermocouple(s) connected to the temperature transmitter may be damaged (disconnected). See the applicable temperature transmitter instruction manual for solving problems.

■ Alarm 10: Cold Junction Temperature Alarm

This alarm is generated when the temperature of the cold junction located at the terminal block of the detector falls below -25°C or exceeds 155°C . Check the following:

Display "C.J.temperature" in the Detailed-data display. If "C.J.temperature" is indicated as 200°C or -50°C , the following can be considered.

- (1) Breakage of the cold junction signal wires between the converter and the detector, or the cable is not securely connected to the connecting terminals.
- (2) The positive and negative poles of the cold junction signal wiring are shorted out in the wiring extension or at the connection terminals.
- (3) A failure of the cold junction temperature sensor located at the detector terminal block occurred.
- (4) A failure of the electrical circuits inside the converter occurred.
If "C.J.temperature" exceeds 150°C or falls below -20°C, the following can be considered.
 - The temperature of the detector terminal block is out of the operating temperature range (-20°C to 150°C).
 - A failure of the cold junction temperature sensor located at the detector terminal block occurred.
 - A failure of the electrical circuits inside the converter occurred.

<Locating cause of failure and countermeasures>

Before proceeding to the following troubleshooting procedure, examine whether or not the temperature of the detector terminal block is out of the operating temperature range.

The operating temperature range varies with the type of detector. If the detector terminal block is out of its operating temperature range, take the measure to lower the temperature, such as situating it so that it is not subjected to radiant heat.

The case where the Model ZR22 Detector is used:

- (1) Stop the power to the converter.
- (2) Remove the wiring from terminals 5 and 6 of the detector and measure the resistance between these terminals. If the resistance value is out of the range of 1 to 1.6 kΩ, the cold junction temperature sensor is considered to be faulty. Replace that temperature sensor with a new one.
- (3) If the resistance value is within the above range, the cold junction temperature sensor seems to be normal. Check whether or not the cable is broken or shorted out, and whether the cable is securely connected to the terminals. Also, check that the resistance of the wiring between the converter and detector is 10 Ω or less.
- (4) If there is no failure in the wiring, the electrical circuits inside the converter may possibly fail. Contact the service personnel at Yokogawa.

The case where the Model ZO21D Detector is used:

- (1) Without stopping the power to the converter, remove the wiring from terminals 5 and 6 of the detector and measure the voltage between these terminals. If the voltage between the terminals is out of the range of 0.4 to 0.7 V, the cold junction temperature sensor seems to be faulty. Replace the cold junction temperature sensor.
- (2) If the voltage between the terminals is within the above range, the cold junction temperature sensor seems to be normal. Check whether or not the cable is broken or shorted out, and whether the cable is securely connected to the terminals. Also, check that the resistance of the wiring between the converter and detector is 10 Ω or less.
- (3) If there is no failure in the wiring, the electrical circuits inside the converter may possibly fail. Contact the service personnel at Yokogawa.



CAUTION

The operating temperature range of the Model ZO21D Detector is -10°C to 80°C (except for the high temperature detector ZO21D-H). Since a cold junction temperature alarm for this analyzer is not generated until the temperature exceeds 155°C, if the Model ZO21D Detector is used, be careful in controlling the ambient temperature of the terminal block.

■ Alarm 11: Thermocouple Voltage Alarm

This alarm is generated when the emf (voltage) of the thermocouple falls below -5 mV (about -170°C) or exceeds 42.1 mV (about 1020°C). Whenever Alarm 11 is generated, Error2 (heater temperature failure) occurs.

- (1) Breakage of the heater thermocouple signal wire between the converter and the detector occurred, or the cable is not securely connected to the connecting terminals.
- (2) The positive and negative poles of the heater thermocouple signal wiring are shorted out in the wiring extension or at the connection terminals.
- (3) A failure of the thermocouple at the detector heater assembly occurred.
- (4) A failure of the electrical circuits inside the converter occurred.

<Locating cause of failure, and countermeasures>

- (1) Stop the power to the converter.
- (2) Remove the wiring from terminals 3 and 4 of the detector and measure the resistance between these terminals. If the resistance value is 5 Ω or less, the thermocouple seems to be normal. If it is higher than 5 Ω, it may indicate the possibility that the thermocouple has broken or is about to break. In this case, replace the heater unit (refer to Section 11.1.3, Replacement of the Heater Unit).



CAUTION

Measure the thermocouple resistance value after the difference between the detector tip temperature and ambient temperature falls to 50°C or less. If the thermocouple voltage is large, accurate measurement cannot be achieved.

- (3) If the thermocouple is normal, check whether or not the wiring cable is broken or shorted out, and also whether the wiring cable is securely connected to the terminals. Also check that the wiring resistance between the converter and the detector is 10 Ω or less.
- (4) If there is no failure in the wiring, the electrical circuits inside the converter may possibly fail. Contact the service personnel at Yokogawa.

■ Alarm 12: Input Current Alarm

When “mA-input” is selected in the Exhaust gas setup display, this alarm occurs if the current input from the temperature transmitter goes outside the range from 3.2 to 21.6 mA.

If this alarm occurs simultaneously with Alarm 9: Exhaust Gas Temperature Alarm, first solve the problem for Alarm 9. If Alarm 12 occurs independently, the cable connection between this equipment and the temperature transmitter may be improper (disconnected).

<Locating cause of failure, and countermeasures>

- (1) Check that cable connections (including connecting lugs) are proper.
- (2) If the cable connections are correct, display the exhaust gas temperature and check that it matches the temperature transmitter's temperature signals. If mismatched, check whether the transmitter output range meets the Exhaust gas setup of this equipment.
- (3) If the range setting is correct, the analyzer electronics may be defective. In such a case, contact 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 blow back 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 Countermeasures When Measured Value Shows 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 Countermeasures>

- (1) The measuring gas pressure becomes higher.

The measured oxygen concentration value X (vol%O₂) 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%O₂).

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%O₂).

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 detector due to leakage.
If the span gas is mixing 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 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 Error1 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.
Referring to Section 11.1.3, check if there is a problem with the sensor mounting. If things are abnormal but there is no error indication, then maybe the sensor assembly isn't properly secured, the O-ring seal is dirty, the measurement gas and ratio gas are leaking into each other (if measurement gas pressure is high, then it may leak into ratio gas, and vice versa); as oxygen partial pressure difference between ratio gas and measurement gas is small, the oxygen concentration in measured gas will read high and the humidity value will read low. Replace the sensor assembly as shown in 11.1.3, and be sure to replace the metal O-ring with a new one.
If the sensor is cracked, the symptoms will be the same – low humidity measured value. Perform a visual inspection, and – if a crack is found – replace the sensor assembly as described in 11.1.3.

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 Countermeasures>

- (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 detector 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%O₂) or humidity value (vol% H₂O or kg/kg).
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 detector 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 a fully closed situation.
- (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 detector cell reaches 750°C or more.

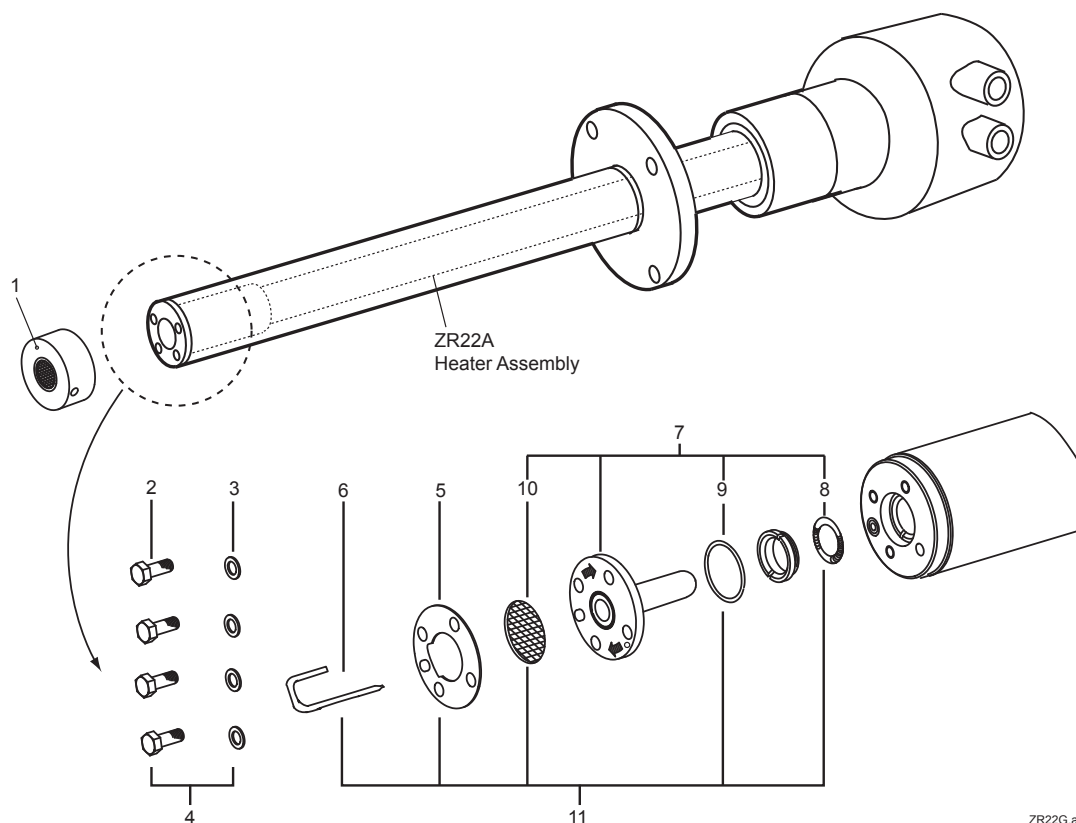
12.3.3 Measurements Sometimes Show Abnormal Values

<Cause and Countermeasures>

- (1) Noise may be mixing in with the converter from the detector output wiring.
Check whether the converter and detector are 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) Poor wiring contact
If there is poor contact in the wiring, the sensor voltage or thermocouple emf (voltage) may vary due to vibration or other factors.
Check whether or not there are loose points in the wiring connections or loose crimping (caulking) at the crimp-on terminal lugs.
- (4) 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-removing filter K9471UA.
- (5) 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.
- (6) 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 ZR22G
Zirconia Oxygen/Humidity Analyzer, Detector
(Separate type)

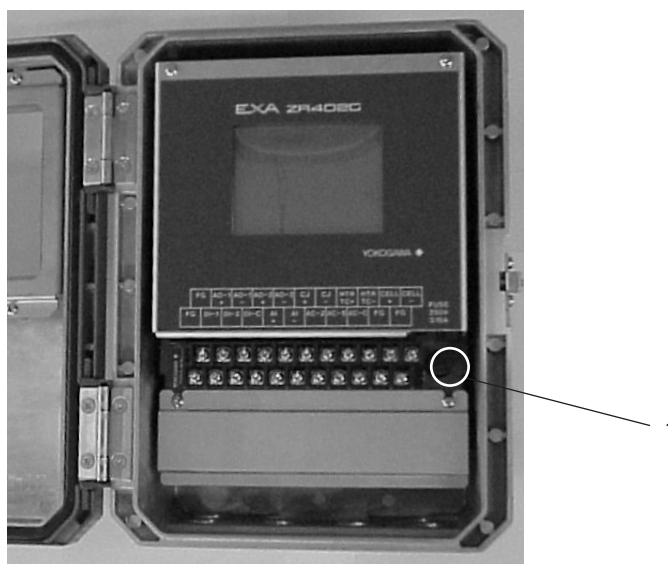


ZR22G.ai

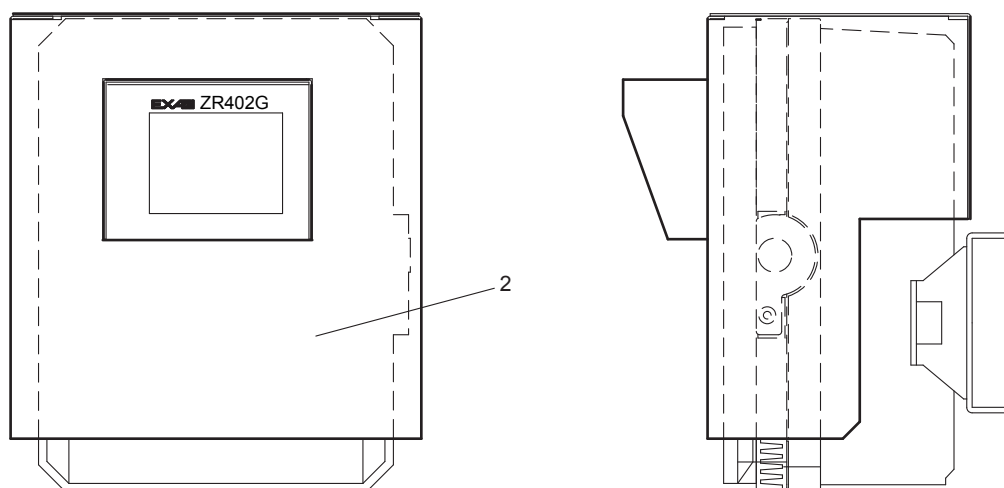
Item	Part No.	Qty	Description
1	K9471UA	1	Dust Filter (Option)
2	---	4	Bolt
	G7109YC		(M5x12, SUS316 stainless steel)
	K9470BK		(M5x12, inconel) for Option code "/C"
3	E7042DW	4	Washer (SUS316 stainless steel)
4	---	1	Bolts and Washers
	K9470ZF		G7109YC x 4 + E7042DW x 4
	K9470ZG		K9470BK x 4 + E7042DW 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
	E7042UD		only for Japan
	ZR01A01		for other than Japan
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"

Customer Maintenance Parts List

Model ZR402G
Zirconia Oxygen Analyzer/High Temperature
Humidity Analyzer, Converter



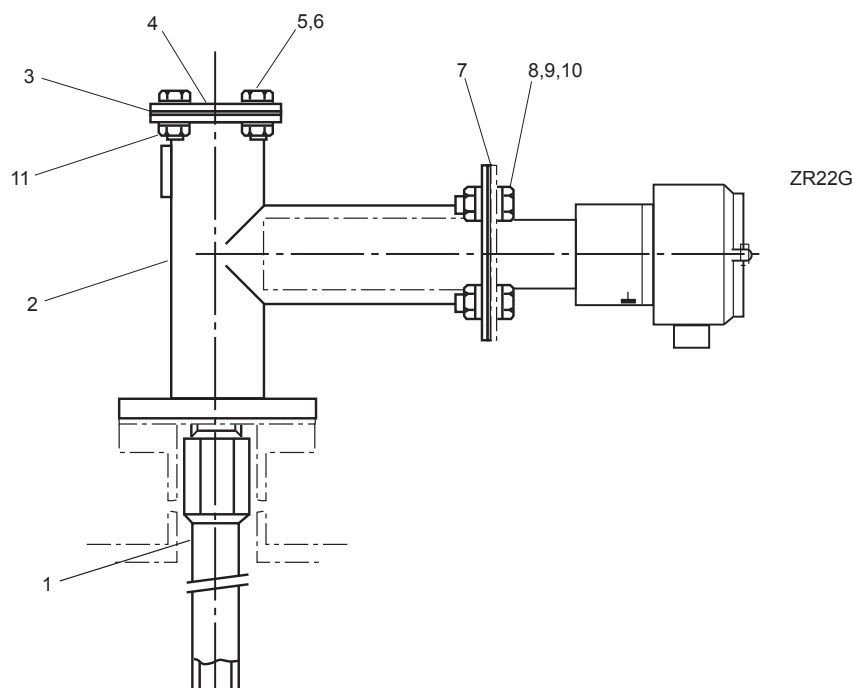
Hood for ZR402G



Item	Part No.	Qty	Description
1	A1113EF	1	Fuse (3.15A)
2	K9471UF	1	Hood

Customer Maintenance Parts List

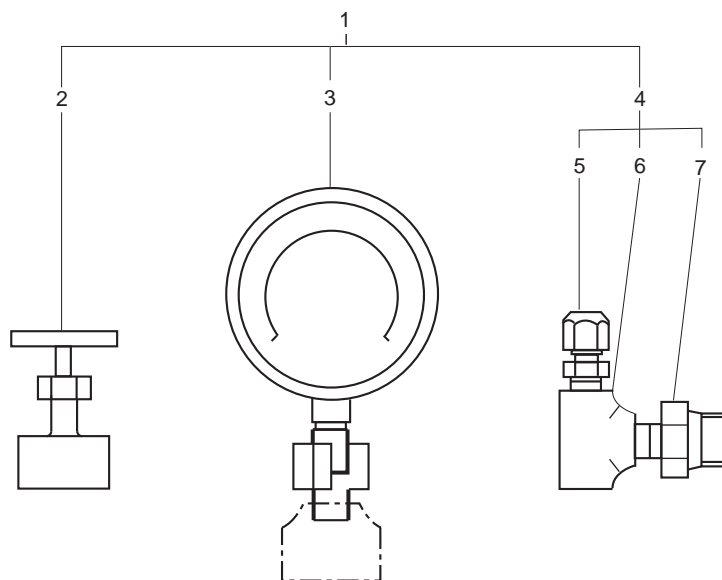
Model ZO21P Zirconia Oxygen Analyzer High Temperature Probe Adaptor



Item	Part No.	Qty	Description	Item	Part No.	Qty	Description
1	K9292TP	1	Probe (SiC, L=0.5 m)	2	E7046FA	1	Probe Adaptor (for JIS 5K-50-FF)
	E7046CF	1	Probe (SiC, L=0.6 m)		E7046FE	1	Probe Adaptor (for ANSI CLASS150-4-RF)
	K9292TQ	1	Probe (SiC, L=0.7 m)		E7046FK	1	Probe Adaptor (for DIN PN10-DN50-A)
	E7046CG	1	Probe (SiC, L=0.8 m)		E7046FD	1	Probe Adaptor (for JIS 10K-100-FF)
	E7046CH	1	Probe (SiC, L=0.9 m)		E7046FC	1	Probe Adaptor (for JIS 10K-80-FF)
	E7046AL	1	Probe (SiC, L=1.0 m)	E7046FB	1	Probe Adaptor (for JIS 10K-65-FF)	
	E7046BB	1	Probe (SiC, L=1.5 m)	E7046FG	1	Probe Adaptor (for ANSI CLASS150-3-RF)	
	K9292TV	1	Probe (SUS, L=0.5 m)	E7046FF	1	Probe Adaptor (for ANSI CLASS150-2 1/2-RF)	
	E7046CR	1	Probe (SUS, L=0.6 m)	E7046FJ	1	Probe Adaptor (for JPI CLASS150-4-RF)	
	K9292TW	1	Probe (SUS, L=0.7 m)	E7046FH	1	Probe Adaptor (for JPI CLASS150-3-RF)	
	E7046CS	1	Probe (SUS, L=0.8 m)	3	E7046FQ	1	Gasket
	E7046CT	1	Probe (SUS, L=0.9 m)	4	E7046FN	1	Plate
	E7046AP	1	Probe (SUS, L=1.0 m)	5	Y9825NU	4	Bolt
	E7046AQ	1	Probe (SUS, L=1.5 m)	6	Y9800WU	8	Washer
			7	G7073XL	1	Gasket	
			8	Y9630RU	4	Bolt	
			9	Y9121BU	4	Nut	
			10	Y9120WU	4	Washer	
			11	Y9801BU	4	Nut	

Customer Maintenance Parts List

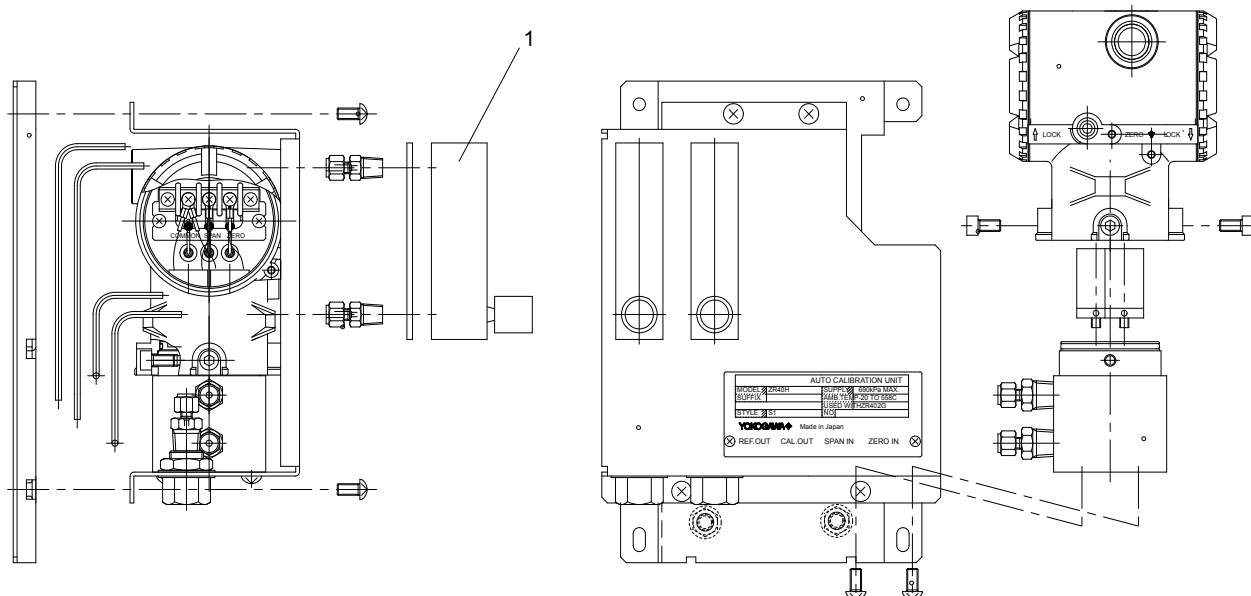
E7046EC/E7046EN
Zirconia Oxygen Analyzer
Auxiliary Ejector Assembly (for Model ZO21P-H)



Item	Part No.	Qty	Description
1	E7046EC	1	Auxiliary Ejector Assembly, Connection Rc1/4
	E7046EN	1	Auxiliary Ejector Assembly, Connection 1/4 NPT
2	L9852CB	1	Needle Valve, Connection Rc1/4
	G7016XH	1	Needle Valve, Connection 1/4NPT
3	E7046EK	1	Pressure Gauge, Connection Rc1/4
	E7046EV	1	Pressure Gauge, Connection 1/4NPT
4	E7046ED	1	Ejector, Connection Rc1/4
	E7046EP	1	Ejector, Connection 1/4NPT
5	E7046EF	1	Nozzle Assembly, Tube Connection Ø6xØ4 tube
	E7046ER	1	Nozzle Assembly, Tube Connection 1/4 inch tube
6	G7031XA	1	Tee, Connection Rc1/4
7	E7046EJ	1	Reducing nipple, Connection R1/4

Customer Maintenance Parts List

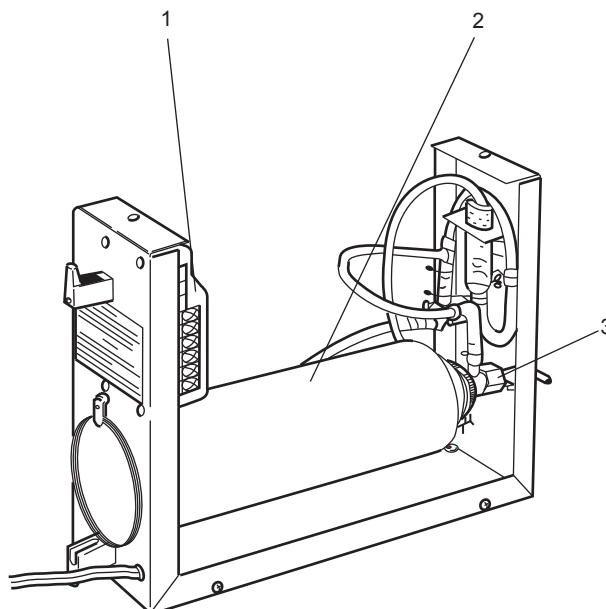
Model ZR40H
Automatic Calibration Unit
for Separate type Zirconia Oxygen/Humidity
Analyzer (ZR22G + ZR402G)



Item	Part No.	Qty	Description
6	K9473XC	1	Flowmeter

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

Revision Information

- Manual Title : Model ZR22G, ZR402G Separate type Zirconia Oxygen/Humidity Analyzer
- Manual No. : IM 11M12A01-02E

Dec. 2022/18th Edition

Change "CE marking products" (page vi)

June 2021/17th Edition

Revised RoHS conformity standards. (page 2-2)

Corrected (page vi)

Mar. 2020/16th Edition

Added a suffix code (-P for Portuguese) on Model and Code (page 2-16)

Oct. 2019/15th Edition

Corrected (page 2-7, 2-13)

Added a dimension figure. (page 2-7)

Revised CMPL 11M12A01-02E to 10th edition.

Feb. 2018/14th Edition

Corrected flange size of blow pipe. (page 4-9)

Jul. 2017/13th Edition

Changed flange materials of ZR22G, ZO21R, ZH21B and ZO21P. (pages 2-3, 2-5 to 2-11)

Apr. 2017/12th Edition

Addition RoHS etc.(pages i, vi, 2-2)

Feb. 2016/11th Edition

Bound up with IM 11M12A01-03E. IM 11M12A01-03E is obsoleted version.

Whole review.

CMPL 11M12A01-02E revised to 9th edition.

Aug.2015/10th.Edition

Revised section

2.1 "General Specifications": Added to "Standard Specifications"

2-24 "Stop Valve": Changed of the weight and dimensions.

2-24 "Check Valve": Changed of the weight.

Nov. 2014/9th Edition

Revised section

2.1.1 "Standard Specifications": Added the C-tick, Safety and EMC conforming standards.

2.2.1 "ZR22G General use Separate type Detector" Sample gas pressure: Correction of erroneous description. (0.5 to 5 kpa → -0.5 to 5 kPa)

2.2.2 "ZO21R Probe Protector": Deleted the flange of the DIN standard and changed the dimension of the insertion length.

2.3.2 "ZO21P High Temperature Probe Adapter" Model and Codes: Added of the option code.

2.3.2 "ZO21P High Temperature Probe Adapter" Table: Changed the some numerical value.

2.4.1 "Standard Specification": Deleted the C-tick, Safety and EMC conforming standards.

5.1 "General" Table 5.1: Deleted cable type.

5.1 "General" : Added "WARNING".

5.2, "Wiring for Detector Output" Ambient temperature of the detector : Changed temperature.

5.2.1 "Cable Specifications": Changed description.

5.2.2 "Connection to the Detector" (2):Changed range of the ambient temperature at the location of the wire installation.

5.2.3 "Connection to the Converter"(2):Changed description.

5.3 "Wiring for Power to Detector Heater" Ambient temperature of the detector: Changed temperature.

5.3.1 "Cable Specifications": Changed description.

5.3.2 "Connection to Detector" (2):Changed range of the ambient temperature at the location of the wire installation.

5.3.3 "Connection to Converter" (2): Changed description.

5.5.2, "Grounding Wiring" (2):Changed range of the ambient temperature at the location of the wire installation.

CMPL 11M03B01-10E revised to 8th edition.

CMPL 11M03B01-05E revised to 8th edition.

CMPL 11M12A01-02E revised to 8th edition.

CMPL 11M12A01-11E revised to 4th edition.

Jan. 2012/8th Edition

Revised and Corrected over all

- 5.1 Table 5.1 "Cable specifications": Deleted cable type.
Added "WARNING"
- 5.2 Added the heat resistant request of the cable.
Changed range of the ambient temperature at the location of the wire installation.

Sep. 2006/7th Edition

Revised section

- 2.7.6 "Air Set," Part No. K9473XH or K9473XJ, Standard Specification:
Changed descriptions partly; "Air Set," Part No. G7004XF or K9473XG,
Standard Specification: Changed descriptions partly;
 - 2.7.8 "Cylinder Regulator Valve (Part No. G7013XF or G7014XF), Standard Specification":
Changed descriptions partly and drawing.
 - 8.2.3 "Output Hold Setting": Changed value in Figures 8.2 and 8.3.
 - 8.2.4 "Default Values": Changed value and description in Table 8.3.
 - 8.6.1 "Setting the Date-and-Time": Added Item in Figure 8.15.
 - 8.6.4 "Setting Purging": Added Item.
 - 8.6.5 "Setting Passwords": Changed section number.
 - 10.3 "Operational Data Initialization": Changed value in Table 10.5.
- Revised section
- 2.3.2 "ZO21P-H Adapter for High Temperature Probe": Changed the thickness of the gasket in the drawing.
 - 2.4.1 "Standard Specification," Safety and EMC conforming standards: The following CAUTION description should be added.
"Standard Specification," Construction: "NEMA 4 " should read "NEMA 4X/IP66."
 - 2.4.2 "• Model and Codes,": Added Note and Suffix Codes.
 - 8.2 "Output Hold Setting," Table 8.1.2 : Added Note.
 - 8.2.3 "Output Hold Setting" To set the output hold, follow these setps: The following Note description should be added.
- Revised and Corrected over all

Apr. 2005/6th Edition

Revised section

Introduction Added description in DANGER, Added description regarding modification

- 1.2.1 " System Components" Changed part numbers of air set in table
- 2.2.1 Changed terminal box paint colors
- 2.4.1 Changed safety and EMC conforming standards and paint colors
- 2.5.2 Changed Finish color
- 2.6 Added description Non CE Mark
- 2.7.6 " 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
- 4.3.1 " Blow Back Piping" Changed part numbers of air set
- 4.4.1 " Piping Parts for a System using Detector with Pressure Compensation" Changed part numbers of air set in Table 4.3
- 5.3.3 Added WARNING
- 11.2.1 Added instruction in Note
- 12.1.1 Added description in Error-2 of Table 12.1, Type of Errors and Reasons for Occurrence
- 12.1.2.1 Changed reference information
- 12.1.2.2 Added descriptions
- 12.2.1 Added Alarm 13 in Table 12.2, Types of Alarms and Reasons for Occurrence
- 12.2.2.7 Added Section 12.2.2.7, "Alarm 13: Battery Low Alarm"

Dec. 2003/5th Edition

Changes of related by ROM and Main Board Assembly changed.

July 2003/4th Edition

Style of model ZR22G and ZR22A changed to S2

Notation of flange specification unified

Dust guard protector, Airset added

CMPL 11M12A01-02E Cell some parts no. changed, revised to 5th edition.

CMPL 11M03B01-05E some parts no. changed, revised to 6th edition.

Sep. 2001/3rd Edition

Revised section

- 1.2 Model ZR22A Heater Assembly added

- 2.5.1 ZA8F Flow Setting Unit error corrected
- 2.7.9 Model ZR22A Heater Assembly added
- 8.5.1 Table 8.7 Input Contact Functions changed
- 10.1.5 "French" added to Language Selection
- 11.1.3 Reference document added to Replacement of the Heater Unit
- Heater Assembly added to CMPL 11M12A01-02E
- CMPL11M03B01-05E revised to 6th Edition, some part No. changed.
- CMPL11M03B01-10E revised to 5th Edition, some part deleted.

Mar. 2001/2nd Edition

Revised section

- 1.1.3 "System 3" explanation changed
- 2.2 In "General use Separate type Detector", some MS codes changed
- 2.4 Corrected errors in ZR402G External Dimensions figure, changed MS Code table
- 2.5.1 Changed reference gas pressure where check valves is used, style changed of ZA8F
- 2.5.2 Added detail about ZR40H Automatic Calibration Unit
- 2.7.3 Added items to figure of Auxiliary Ejector for High Temperature
- 3.2.2 Corrected Figure 3.6 Panel Cutout, Figure 3.13 Mounting Holes
- 3.5 Added to 3.5 Installation of ZR40H Automatic Calibration Unit
- 6.1 Added Filter to 6.1 ZR22G Detector
- 6.3 Added Names and Functions to 6.3 ZR40H Automatic Calibration Unit
- 7.2 Changed reference gas pressure where check valve is used
- 7.12.2.1 Changed reference gas pressure where check valve is used
- 10.1.1.6 Corrected Table 10.1
- 10.6.1 Changed reference gas pressure where check valve is used
- 11.1 Added Filter to 11.1 Inspection and Maintenance of the Detector Added Filter to CMPL11M12A01-02E, and added ZR40H Automatic Calibration Unit to CMPL11M12A01-11E

Oct. 2000/1st Edition

Newly published

