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**User's  
Manual**

# **Model MG8G Paramagnetic Oxygen Analyzer**

IM 11P03A03-01E

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**vigilantplant.<sup>®</sup>**

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# INTRODUCTION

## ■ 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 symbols are used in the product and user's manual to indicate that there are precautions for safety:

## ■ 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.

## ■ 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 Hardware

### ● Appearance and Accessories

Check the following when you receive the product:

- Appearance
- Standard accessories

Contact our sales representative or your local distributor if the product's coating has come off, it has been damaged, or there is shortage of required accessories.

### ● Model and Suffix Codes

The name plate on the product contains the model and suffix codes. Compare them with those in the general specification to make sure the product is the correct one. If you have any questions, contact our sales representative or your local distributor.

Thank you for selecting our MG8G Paramagnetic Oxygen Analyzer.

In User's Manual, IM 11P03A03-01E, 4th Edition, supplied with the product, some revisions/additions have been made. Please replace the corresponding pages in your copy with attached, revised pages.

## Note

### Revisions

P.3-2	Section 3.1,	"Standard Specifications," Power Supply: Description changes. "Standard Specifications," : Addition of "KC Marking".
P.6-1	Section 6,	"PIPING," (2): Change the range of the pressure gauge. "PIPING," : Addition of setting pressure in figure 6.1.

**Calibration gas:**

Zero gas: N<sub>2</sub> gas

Note: Zero gas should not contain O<sub>2</sub> gas with a concentration equal to or greater than 0.1% of the upper range value.

Span gas: Dry air (instrument air O<sub>2</sub>: 20.95 vol%) or standard gas containing O<sub>2</sub> gas with a concentration of 80 to 100% of the span value (balance nitrogen).

**Auxiliary gas pressure:**

N<sub>2</sub>, 180kPa (Approx. 35ml/min)

Note: Auxiliary gas should not contain O<sub>2</sub> gas with a concentration equal to or greater than 0.1% of the upper range value.

**Measurement gas condition:**

Flow; 200ml/min $\pm$ 10%, The gas flow rate may be less than 200ml/min depending on the composition of the measurement gas.

Temperature; 0 to 50°C

Humidity; No moisture condensation in the flow path or the sensor.

**Warm-up time:**

Approx. 2.5 hours

**Installation condition:**

Ambient temperature; -5 to 55°C

Humidity; 10 to 95%RH (No condensing)

**Power supply:**

Power supply Voltage 100 to 115 V AC;

Rated voltage range: 100 to 115 V AC

Allowable voltage range: 90 to 127 V AC

Rated frequency: 50/60 Hz

Allowable frequency range: 48 to 63 Hz

Power supply Voltage 200 to 240 V AC;

Rated voltage range: 200 to 240 V AC

Allowable voltage range: 180 to 264 V AC

Rated frequency: 50/60 Hz

Allowable frequency range: 48 to 63 Hz

**Power consumption:**

100 to 115V AC; Max. 110VA, normally approx. 25V

200 to 240V AC; Max. 125VA, normally approx. 35V

**KC Marking:**

Korea Electromagnetic Conformity Standard

**Materials in contact with gas:**

SUS316 stainless steel, Fluorine-contained rubber

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**Line connection:**

Rc1/4

**Conduit connection port .**

Ø27 hole

**Installation:**

Indoor, panel or wall mounting

**Structure:**

Dustproof, General purpose

**Dimension:**

406 (W) x 288 (H) x 216 (D) mm

**Weight:**

Approx. 18kg

# 6. PIPING

- (1) Piping  
The standard line diagram is shown in figure 6.1. Use 6/4 mm diameter metal tubes for lines and connect the tubes in such a way that there are no leaks.
- (2) Installation of the pressure regulator and pressure gauge  
Install the pressure regulator and pressure gauge (0 to 0.4 MPa G) in the auxiliary line. Use the pressure regulator to set a specified pressure. For pressure settings, see Section 8.2, "Setting the Auxiliary Gas Pressure".
- (3) Caution on piping  
This oxygen analyzer uses calibration gases for zero and span calibrations. Install the lines so that the sample and calibration gases can be switched.
- (4) Purge lines  
If the atmosphere or sample gas contains corrosive or combustible gases or if the atmospheric temperature is likely to rise too high, purge the instrument with clean air. Connect a copper or stainless steel tube to the purge air inlet shown in Figure 6.2 to supply air at a pressure of about 50 kPa G.
- (5) Gas outlet (exhaust)  
Gas from the instrument should be vented to the atmosphere. The gas outlet should be designed so that the ingress of wind or rain is prevented.

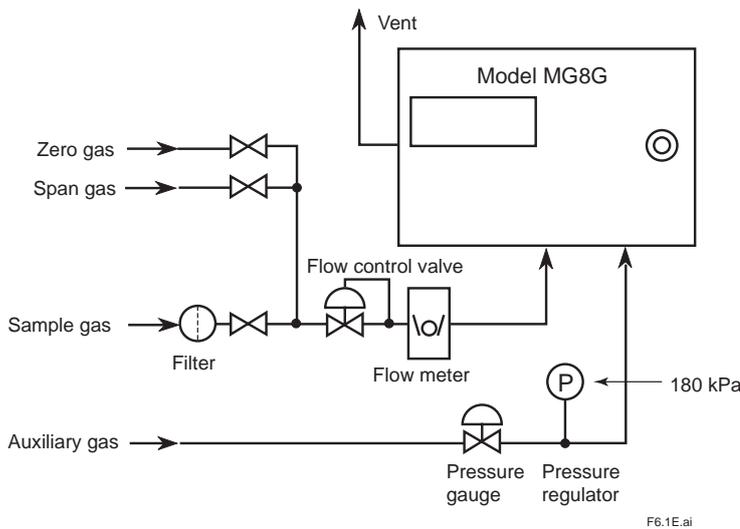
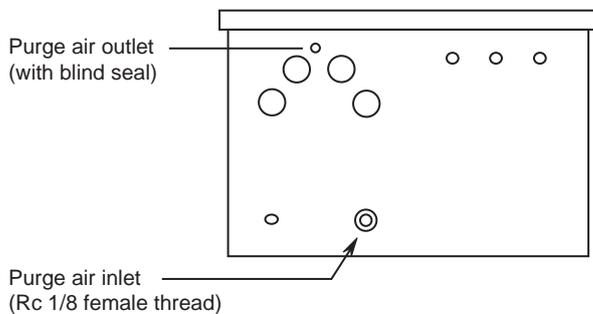


Figure 6.1 Line Diagram



(Note) Always remove the seal protecting the purge air outlet.

F6.2E.ai

Figure 6.2 Purge Air Connection

## ■ Symbol Marks

Throughout this user's manual, you will find several different types of symbols are used to identify different sections of text. This section describes these icons.



### **CAUTION**

Identifies instructions that must be observed in order to avoid physical injury and electric shock or death of the operator.



### **WARNING**

Identifies instructions that must be observed in order to prevent the software or hardware from being damaged or the system from becoming faulty.



### **IMPORTANT**

Identifies important information required to understand operations or functions.

### **TIP**

Identifies additional information.

### **SEE ALSO**

Identifies a source to be referred to.

Clicking a reference displayed in green can call up its source, while clicking a reference displayed in black cannot.

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## ◆ After-sales Warranty

- Do not modify the product.
  
- During the warranty period, for repair under warranty carry or send the product to the local sales representative or service office. Yokogawa will replace or repair any damaged parts and return the product to you. Before returning a product for repair under warranty, provide us with the model name and serial number and a description of the problem. Any diagrams or data explaining the problem would also be appreciated.
  - If we replace the product with a new one, we won't provide you with a repair report.
  - Yokogawa warrants the product for the period stated in the pre-purchase quotation Yokogawa shall conduct defined warranty service based on its standard. When the customer site is located outside of the service area, a fee for dispatching the maintenance engineer will be charged to the customer.
  
- In the following cases, customer will be charged repair fee regardless of warranty period.
  - Failure of components which are out of scope of warranty stated in instruction manual.
  - Failure caused by usage of software, hardware or auxiliary equipment, which Yokogawa Electric did not supply.
  - Failure due to improper or insufficient maintenance by user.
  - Failure due to modification, misuse or outside-of-specifications operation which Yokogawa does not authorize.
  - Failure due to power supply (voltage, frequency) being outside specifications or abnormal.
  - Failure caused by any usage out of scope of recommended usage.
  - Any damage from fire, earthquake, storms and floods, lightning, disturbances, riots, warfare, radiation and other natural changes.
  
- Yokogawa does not warrant conformance with the specific application at the user site. Yokogawa will not bear direct/indirect responsibility for damage due to a specific application.
  
- Yokogawa Electric will not bear responsibility when the user configures the product into systems or resells the product.
  
- Maintenance service and supplying repair parts will be covered for five years after the production ends. For repair for this product, please contact the nearest sales office described in this instruction manual.

# Model MG8G Paramagnetic Oxygen Analyzer

IM 11P03A03-01E 4th Edition

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# 1. NOTICE ON HANDLING

It is highly recommended that you read this instruction manual carefully before using this analyzer so that the analyzer can operate in the best condition. All installation conditions should be provided in compliance with these specifications.

## 1.1 Precaution in Unpacking

This analyzer is a precision instrument. Beware of the effect of shock on the analyzer, especially while unpacking, and avoid dropping it or letting it hit another object.

## 1.2 Check of Model Name and Specifications

The nameplate on the inside of the converter door shows the main items. Check to see if the specifications are as specified.



## 2. OVERVIEW

This oxygen analyzer integrates a detector and a converter into one unit to continuously measure the concentration of the oxygen in a sample gas.

The analyzing cell is almost free from the effects of co-existent gas, is highly sensitive, and has a superior response. The detector is constructed to withstand vibration and mechanical shock within the limits of current technology.

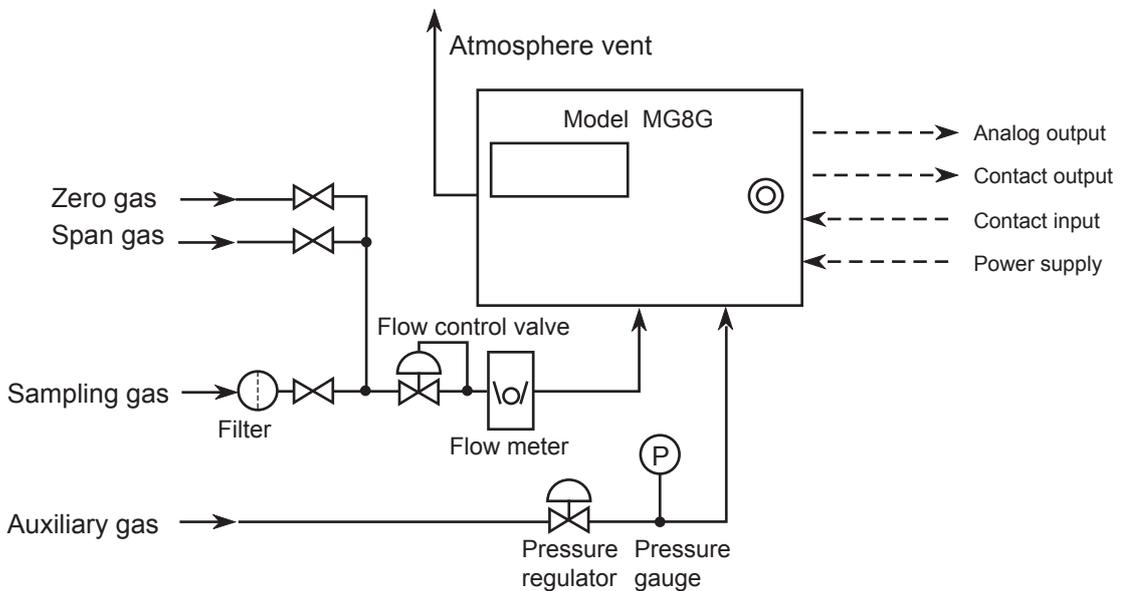
The converter has a large, easy-to-read digital display unit that displays oxygen concentration, cell output voltage, constant chamber-temperature, etc. Analog output is electrically isolated between the input and output sections.

Further, the instrument is provided with one-touch calibration and self-test functions to improve operability, maintainability and reliability.

### 2.1 Standard System Configuration

The standard system configuration of the MG8G paramagnetic oxygen analyzer is shown in

Figure 2.1. The system configuration that includes an automatic calibration option is shown in Figure 2.1.



F2.1E.ai

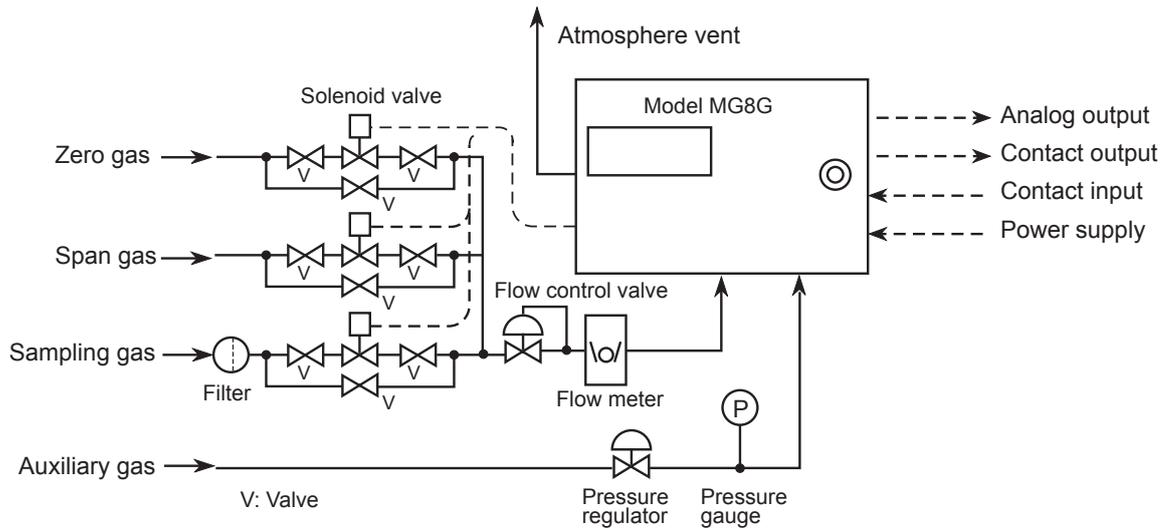
Figure 2.1 System Configuration Diagram



### CAUTION

Auxiliary gas (N<sub>2</sub> gas) is required in accordance with the measurement principle of the instrument. Before supplying power to the instrument, be sure to introduce the auxiliary gas.

## 2.2 System Configuration with Automatic Calibration



F2.2E.ai

Figure 2.2 System Configuration with automatic Calibration



### CAUTION

1. For sample gases, use a normally-open solenoid valve.  
For other gases, use a normally-closed solenoid valve.
2. Use the other values if the solenoid valves fail.

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## 3. SPECIFICATIONS

### 3.1 Standard Specifications

**Measurement Object:**

Oxygen concentration in gaseous mixture

**Measurement System:**

Paramagnetic system

**Measurement Range:**

0-5 to 0-25 vol%O<sub>2</sub>

3 ranges can be programmed arbitrarily within the above specified range.

**Self-diagnostic content:**

Sensor unit error, Constant temperature chamber error, Analog error, Memory error, Calibration coefficient error

**Analog output signal:**

4 to 20mA DC (load resistance: Maximum 550Ω)

**Contact output:**

Contact rating: 3A at 250 VAC or 30 VDC, dry contacts

Fail; 1 point, open or closed when error occurs, user configurable

Contact is activated when sensor unit error, constant temperature chamber error, analog error, memory error, or calibration coefficient error (when automatic or semiautomatic calibration is enabled) occurs

Maintenance status; 1 point, closed during maintenance

Range answerback or high/low alarm; 2 points, normally deenergized (open)

Range answerback or high/low alarm contact output, user selectable

**Operate solenoid valve:**

3 points, Switching between zero and span calibration gas and measured gas.

Maximum load; AC 1A

**Contact input:**

Input specification: Contact ON : 200Ω or less, Contact OFF : 100 kΩ or greater

Remote range switching: 2 points, Output ranges 1 to 3 can be switched by external contact signal.

Calibration start: 1 point, calibration start command by external contact signal.

**Calibration methods:**

- (1) Automatic calibration at set intervals by internal timer
- (2) Semiautomatic calibration started by external contact input
- (3) Manual calibration in the field

**Calibration gas:**

Zero gas: N<sub>2</sub> gas

Note: Zero gas should not contain O<sub>2</sub> gas with a concentration equal to or greater than 0.1% of the upper range value.

Span gas: Dry air (instrument air O<sub>2</sub>: 20.95 vol%) or standard gas containing O<sub>2</sub> gas with a concentration of 80 to 100% of the span value (balance nitrogen).

**Auxiliary gas pressure:**

N<sub>2</sub>, 180kPa (Approx. 35ml/min)

Note: Auxiliary gas should not contain O<sub>2</sub> gas with a concentration equal to or greater than 0.1% of the upper range value.

**Measurement gas condition:**

Flow; 200ml/min $\pm$ 10%, The gas flow rate may be less than 200ml/min depending on the composition of the measurement gas.

Temperature; 0 to 50°C

Humidity; No moisture condensation in the flow path or the sensor.

**Warm-up time:**

Approx. 2.5 hours

**Installation condition:**

Ambient temperature; -5 to 55°C

Humidity; 10 to 95%RH (No condensing)

**Power supply:**

100 - 115V AC 50/60Hz or 200 - 240V AC 50/60Hz

**Power consumption:**

100 to 115V AC; Max. 110VA, normally approx. 25V  
200 to 240V AC; Max. 125VA, normally approx. 35V

**Materials in contact with gas:**

SUS316 stainless steel, Fluorine-contained rubber

**Line connection:**

Rc1/4

**Conduit connection port .**

Ø27 hole

**Installation:**

Indoor, panel or wall mounting

**Structure:**

Dustproof, General purpose

**Dimension:**

406 (W) x 288 (H) x 216 (D) mm

**Weight:**

Approx. 18kg

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## 3.2 Characteristics

**Repeatability:**

±1% or less of F.S.

**Linearity:**

±1% or less of F.S.

**Response time :**

90% response within 3 sec. (from changing analog output at measured gas flow rate  
200 ml / min.)

**Zero drift:**

±1.5% or less of F.S. / Week

**Span drift:**

±2% or less of F.S. / Week

**Temperature drift:**

±1.5% or less of F.S. / 10 °C

**Effects of measured gas flow rate:**

±1% or less of F.S. for the rated flowrate ±10%

### 3.3 Model and Suffix Code

Model	Suffix Code	Option Code	Specification
MG8G	-----	-----	Paramagnetic oxygen analyzer
Measurement range	-M	-----	0 – 5 to 25 vol% O <sub>2</sub>
Wetted Material	A	-----	SUS316, Fluorine-contained rubber
Power supply	-2	-----	200 to 240V AC, 50 / 60Hz
	-5	-----	100 to 115V AC, 50 / 60Hz
Auxiliary gas	-W	-----	N <sub>2</sub> gas
Flow rate of auxiliary gas	L	-----	Standard (35ml / min)
Language	-J	-----	Japanese
	-E	-----	English
Auto calibration	C	-----	available
Style code	*C	-----	Style *C

Note: For measurement ranges of 0-5 vol% O<sub>2</sub> and less, the MG8E flameproof type paramagnetic oxygen analyzer may be used.

For applicability assessment, we will receive your request as a Customized Order.

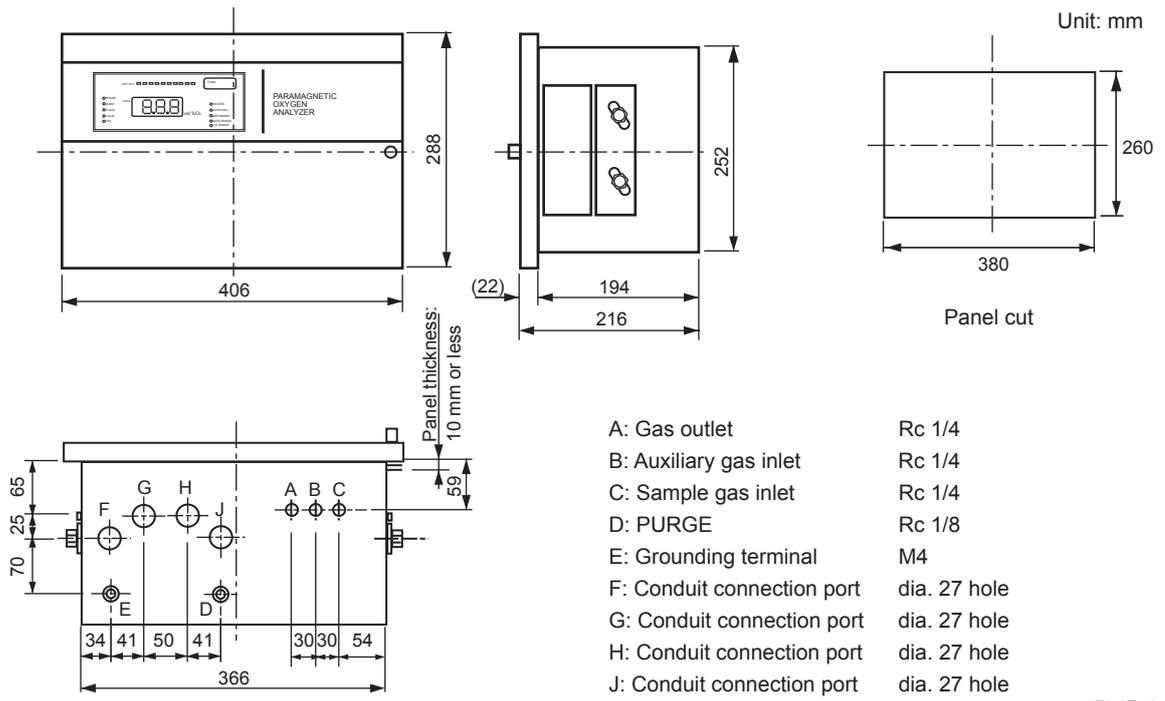
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#### STANDARD ACCESSORIES

Item	Parts No.	Qty	Description
Fuse	A1111EF	2	250V 2A
Spanner	G7050YZ	1	for adjustment of sensor angle
Regulator	G7033XF	1	for Auxiliary gas
Mirror	K9320CC	1	for adjustment of sensor angle
User's Manual	—	1	

T3.2E.ai

### 3.4 External Dimensions



F3.1E.ai



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## 4. INSTALLATION

This chapter describes how to install the analyzer and carry out wiring and line work.

### 4.1 Installation Location

Take the following requirements into account when choosing the place of installation.

- (1) Low vibration and mechanical shock levels.
- (2) Low atmospheric corrosive gas content. If corrosive gas content is too highly, atmospheric purge the case.
- (3) Diurnal temperature difference should be less than 15 degree C.
- (4) No exposure to direct sunlight
- (5) No direct exposure to high radiation heat, steam, hot air, temperatures, etc.
- (6) Low electromagnetic field effect.

Do not lay wiring parallel to power cables and wherever possible do not install the analyzer near motor, electromagnetic relays, pumps, etc..

- (7) Easy access for maintenance and inspection

## 4.2 Installation Procedure

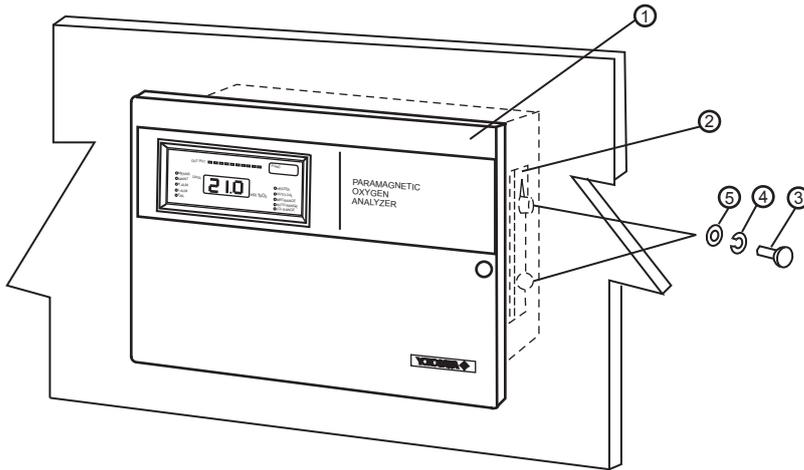
This oxygen analyzer can be panel or wall mounted.

### (1) Panel mounting

Remove the mounting brackets ② attached to the side of the mainframe ① and insert the mainframe into the panel through the panel cut-out. (See section 3.4 for panel cut-out size.)

Place the mounting brackets ② as indicated by the dotted lines in figure 6.2 and secure them to the mainframe with bolts ③ (M8× 10), spring washers ④, and plain washers ⑤.

Insert the mainframe into the panel until the mounting brackets touch the pane] and secure them to the panel.



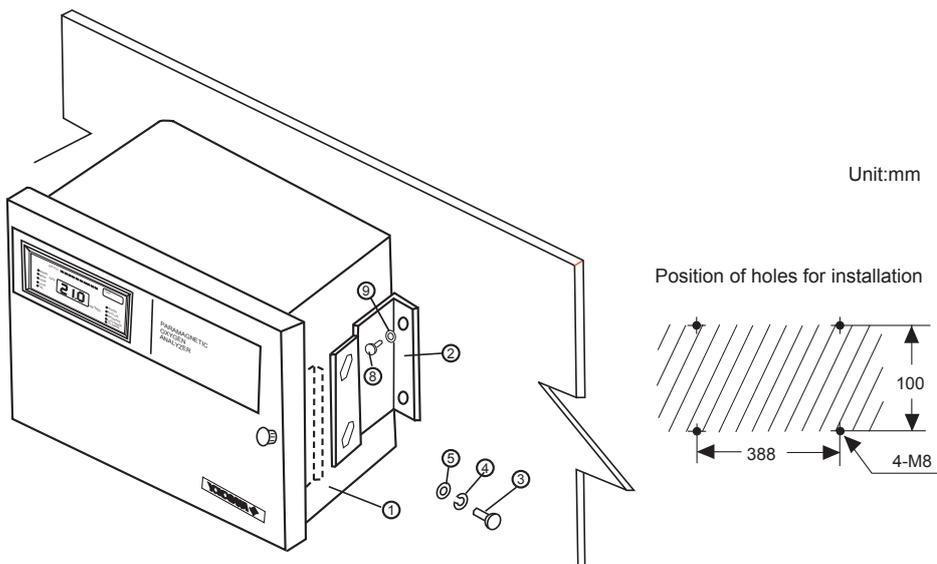
F4.1.ai

Figure 4.1 Paramagnetic Oxygen Analyzer installation (1)

### (2) Wall mounting

Locate the mounting brackets ② to the side of the mainframe ① as shown by the solid lines in Figure 6.2 and fasten them with bolts ③ (M8×10), spring washers ④, and plain washers <5> by tightening the bolts lightly.

Attach the mainframe to the wall with bolts ⑧ (M8 × 14) and washers ⑨ so that the back of the mainframe is in close contact with the wall; then, attach the mounting brackets to the mainframe.



Unit:mm

Position of holes for installation

100

388

4-M8

F4.2E.ai

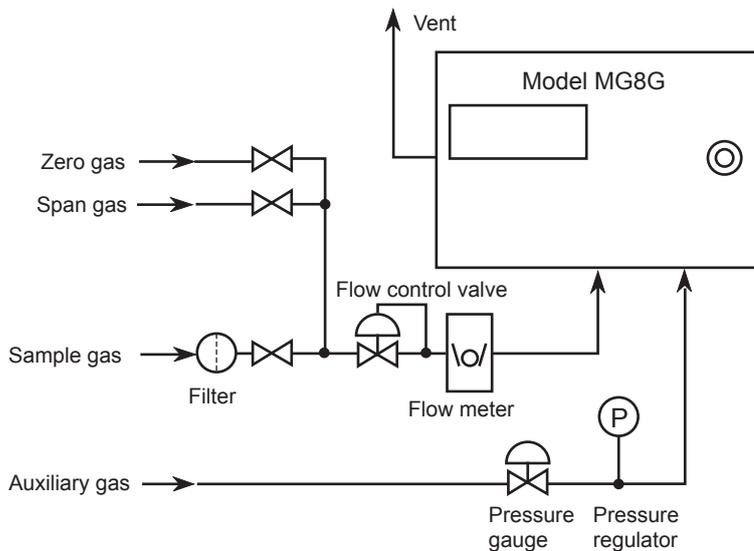
Figure 4.2 Paramagnetic Oxygen Analyzer installation (2)





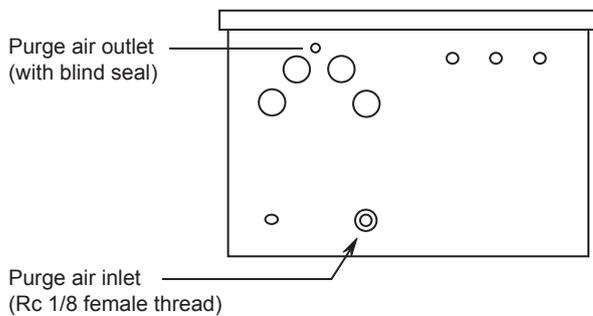
# 6. PIPING

- (1) Piping  
The standard line diagram is shown in figure 6.1. Use 6/4 mm diameter metal tubes for lines and connect the tubes in such a way that there are no leaks.
- (2) Installation of the pressure regulator and pressure gauge  
Install the pressure regulator and pressure gauge (0 to 2 kPa G) in the auxiliary line. Use the pressure regulator to set a specified pressure. For pressure settings, see Section 8.2, "Setting the Auxiliary Gas Pressure".
- (3) Caution on piping  
This oxygen analyzer uses calibration gases for zero and span calibrations. Install the lines so that the sample and calibration gases can be switched.
- (4) Purge lines  
If the atmosphere or sample gas contains corrosive or combustible gases or if the atmospheric temperature is likely to rise too high, purge the instrument with clean air. Connect a copper or stainless steel tube to the purge air inlet shown in Figure 6.2 to supply air at a pressure of about 50 kPa G.
- (5) Gas outlet (exhaust)  
Gas from the instrument should be vented to the atmosphere. The gas outlet should be designed so that the ingress of wind or rain is prevented.



F6.1E.ai

Figure 6.1 Line Diagram



(Note) Always remove the seal protecting the purge air outlet.

F6.2E.ai

Figure 6.2 Purge Air Connection

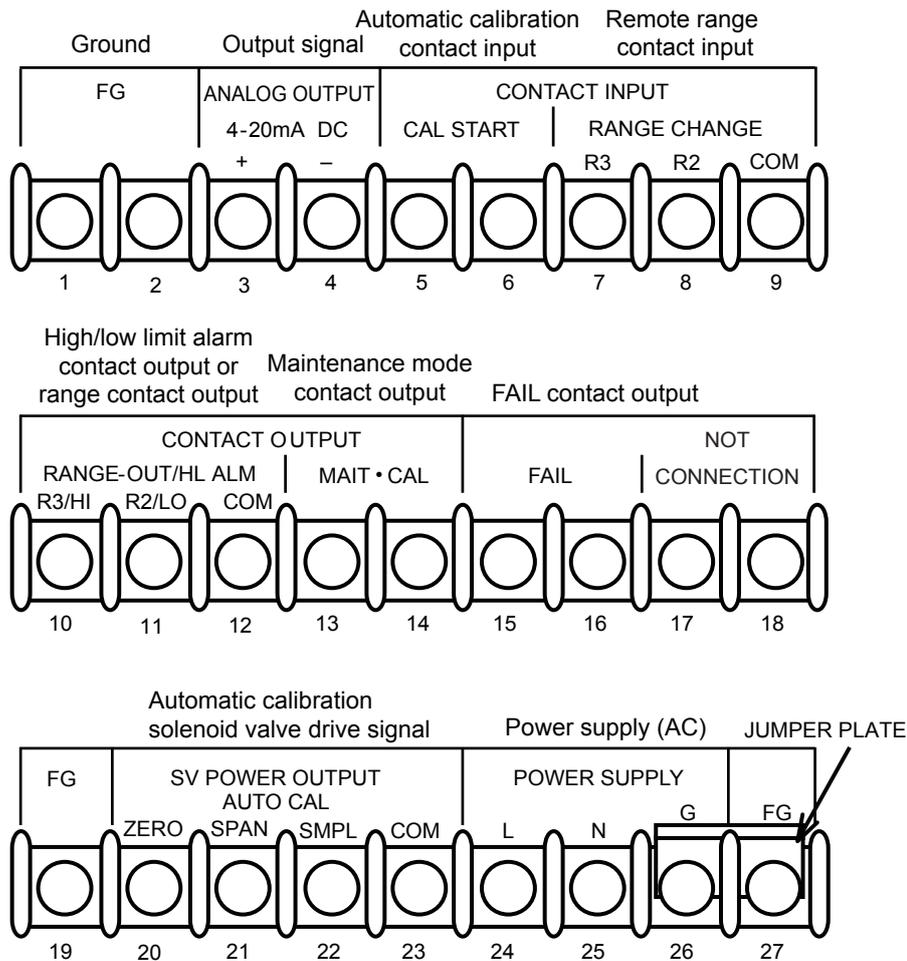


# 7. WIRING

## 7.1 External Connection Terminals

The external connection terminals are located inside the operation panel. To open the panel, loosen the two screws on the panel.

Figure 7.1 shows the diagram of the external connection terminals of the MG8G. The terminal numbers are indicated on the instrument. Be sure to make all connections correctly. The terminal screw thread is M4. Appropriate crimp terminals should be used. The FG terminals are connected to the case. Make sure that terminals G (26) and FG (27) should remain connected by a supplied jumper plate.



F7.1E.ai

Figure 7.1 External Connection Terminals

## 7.2 Wiring Precautions

- (1) Turn off all the power before wiring.
- (2) Do not route electrical wiring and wiring for large-capacity converters and motors or power wiring in the same wiring duct.
- (3) To prevent malfunction due to noise, do not route signal cables and power cables in the same cable hole.
- (4) When running cables in a place where ambient temperature is high or low, use cables suited for that condition.
- (5) When running cables in an atmosphere where hazardous gas or liquid, or oil or solvent is present, use cables made of materials that can withstand such aggressive conditions.
- (6) For wire termination use crimp terminals (M4 screws) with insulating sleeves.

## 7.3 Cable Specifications

- (1) For the wiring, use PVC insulated PVC sheathed control cables (CVV), PVC insulated PVC sheath shield control cables (CVVS), or other suitable cables.
- (2) When using multicore cables, use the ones with a finished outside diameter of 14 mm or less.
- (3) Analog output cables must have a shield wire, which should be connected to the FG terminal of the instrument.
- (4) For the grounding, use 600 V PVC insulated wires.

## 7.4 External Wiring

### 7.4.1 Power Wiring and Grounding

Connect a power line to terminals L (24) and N (25) of the instrument and a grounding wire to terminal FG (27) or the external grounding terminal at the bottom of the case. The ground resistance should be 100  $\Omega$  or less. The jumper plate between terminals G (26) and FG (27) must remain connected.

### 7.4.2 Analog Output Wiring

Connect an analog output cable to the ANALOG OUTPUT terminals, (3) and (4), and the shield wire to the FG terminal, (1) or (2), of the instrument. The load resistance including wiring resistance on the output should be 550 Ω or less.

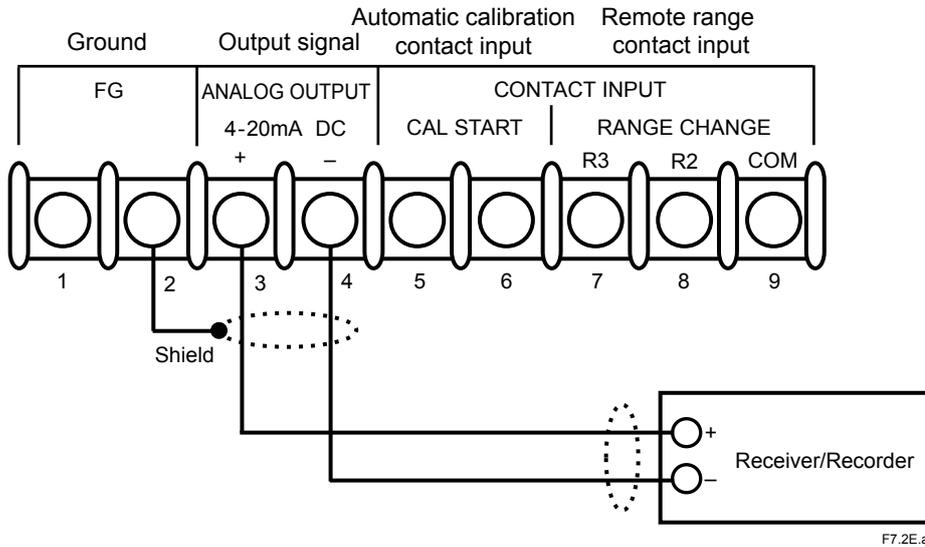


Figure 7.2 Analog Output Wiring

### 7.4.3 Wiring for Solenoid Valves for Automatic Calibration

This wiring is for the solenoid valves that switch zero, span, and sample gas lines in automatic or semiautomatic calibration. The power sources for solenoid valves are provided internally. Use solenoid valves that have the same power supply voltage and frequency specifications as the instrument. Use a normally open solenoid valve in sample gas line and normally closed solenoid valves for zero and span gas lines.

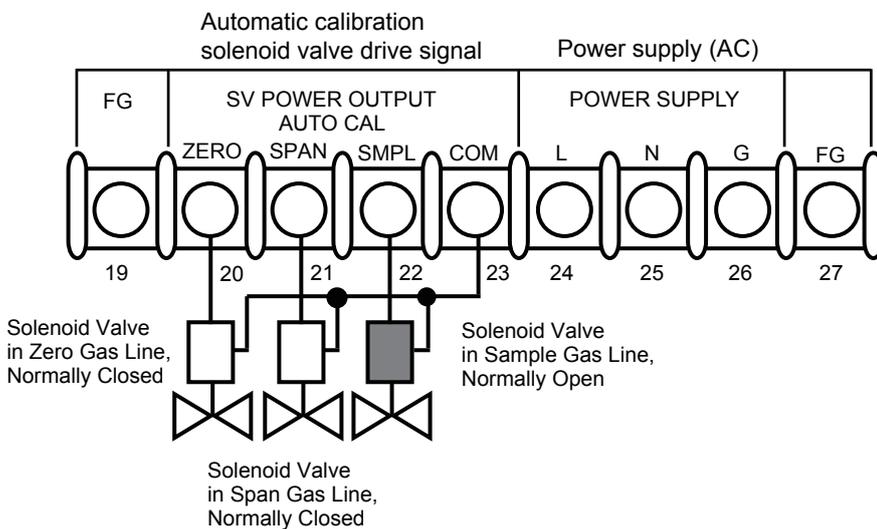


Figure 7.3 Solenoid Valve Wiring



## IMPORTANT

The power sources for solenoid valves are provided internally. Use solenoid valves that have the same power supply voltage and frequency specifications as the instrument.

### 7.4.4 Contact Output Wiring

All outputs are voltage-free, dry contacts (mechanical relay contacts) and rated 3A at 250 V AC or 30 V DC.

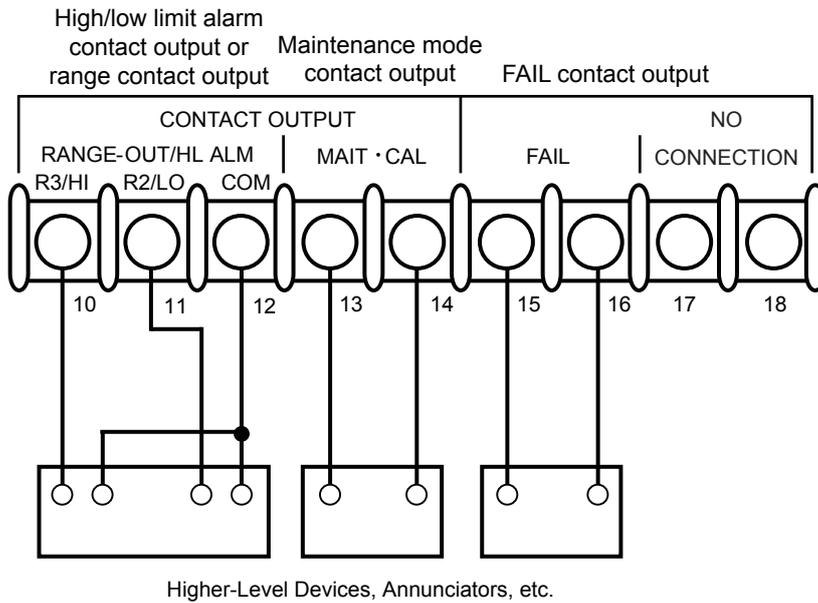


Figure 7.4 Contact Output Wiring

#### 7.4.4.1 Wiring for High/Low Alarm Contact Output/Range Answerback Contact Output

Either high/low alarm contact output or range answerback contact output can be selected. For their detailed functions and setting procedures, refer to Chapter 11, Parameter Settings. Terminal 12 is a common terminal and the contact between terminals 10 and 12 and the one between terminals 11 and 12 will open or close in response to the instrument status. For external connections to higher-level devices or other instruments, refer to Figure 7.4. Both contacts are open when the instrument is not powered.

Terminal No.	High/Low Alarm Contact Output		Range Answerback Contact Output		
	High Alarm	Low Alarm	Range 1	Range 2	Range 3
10-12	Closed		Open	Open	Closed
11-12		Closed	Open	Closed	Open

#### 7.4.4.2 Wiring for Maintenance Status Contact Output

The contact between terminals 13 and 14 is closed during maintenance. For its functions, refer to Chapter 11, Parameter Settings. The contact is open when the instrument is not powered.

#### 7.4.4.3 Wiring for Fail Contact Output

The contact between terminals 15 and 16 will be activated when an error occurs. The output contact is user configurable to be normally energized (the contact will open when an error occurs) or normally deenergized (the contact will close when an error occurs). For the setting and functions, refer to Chapter 11, Parameter Settings. The contact is open when the instrument is not powered.

### 7.4.5 Contact Input Wiring

The input is designed to accept a voltage free contact. The contact will open or close in response to the resistance detected on the input. Note that the resistance includes wiring resistance.

Contact closes at 200 Ω or less

Contact opens at 100 kΩ or more

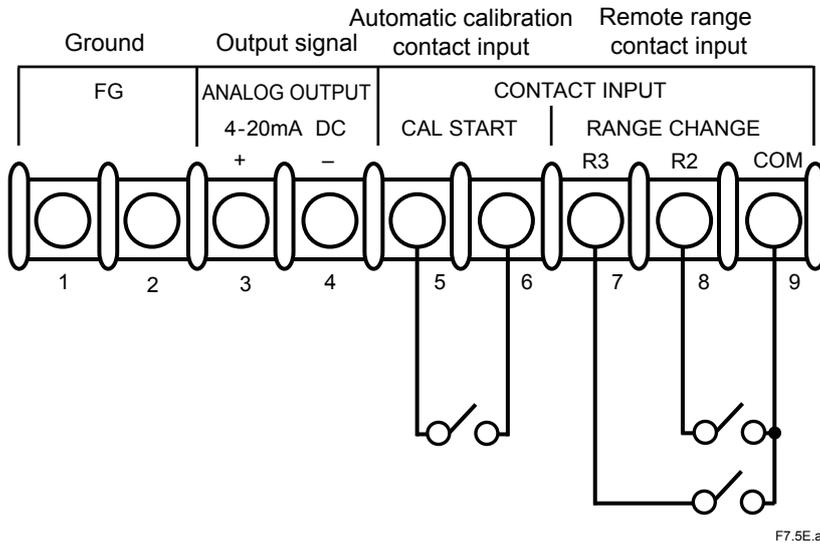


Figure 7.5 Contact Input Wiring

#### 7.4.5.1 Wiring for Calibration Start Contact Input

A calibration will start when the contact between terminals 5 and 6 closes. For the setting and functions, refer to Chapter 12, Calibration.

#### 7.4.5.2 Wiring for Remote Range Contact Input

The range will be switched externally by the state of the contacts between 7 and 9 and between 8 and 9. For the setting and functions, refer to Chapter 11, Parameter Settings.

Terminal No.	Remote Range Contact Input		
	Range 1	Range 2	Range 3
7-9	Open	Open	Closed
8-9	Open	Closed	Open



## 8. PREPARATIONS

### 8.1 Adjustment of the Level in the Sensor Unit

After the installation is complete, adjust the angle of the sensor unit.

- (1) Loosen the four screws (②, these screws cannot be removed), and remove the constant temperature chamber cover (①).
- (2) Remove the six screws (④, 3 each on top and bottom), and remove the heater assembly cover (③).
- (3) Loosen the four bolts (⑤) with the supplied wrench.
- (4) Place the supplied mirror (⑧) as shown in Figure 8.1 (b). Turn the adjustment screw (⑥) with a flat head screwdriver or other suitable tool until the air bubble in the level (⑦) comes in between the two red lines. Turning the adjustment screw counterclockwise brings the bubble position toward the front of the instrument.
- (5) Tighten the four bolts (⑤) with the wrench. Make sure that the bubble is in position.
- (6) Replace the heater assembly cover (③), and tighten the cover screws securely. Replace the constant temperature chamber cover (①), and tighten the cover screws securely. When replacing the covers, be sure that cables are not caught in the covers. Make sure that the covers are installed securely. Otherwise, the temperature in the constant temperature chamber may become unstable, causing measurement errors.

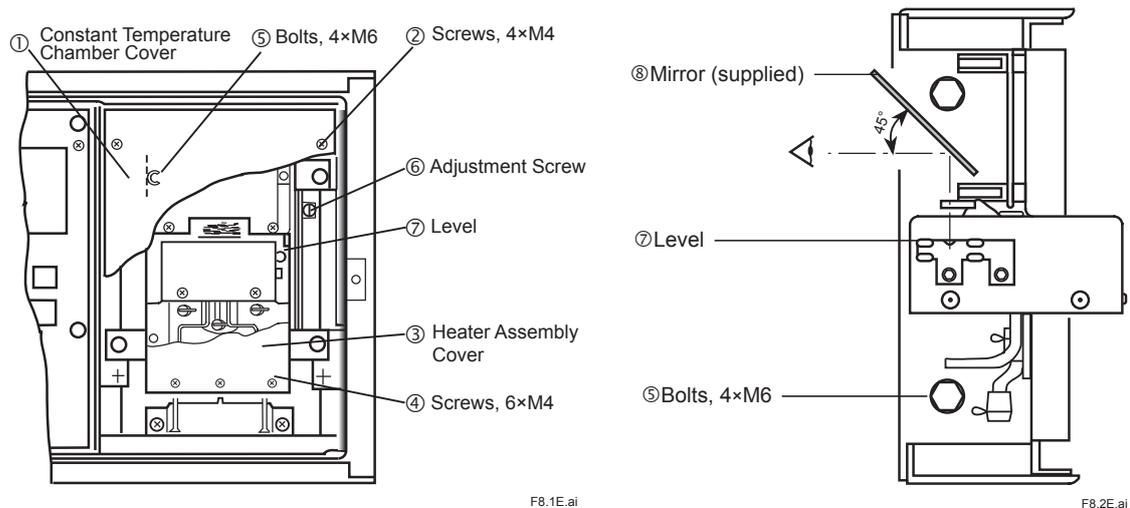


Figure 8.1 (a) Constant Temperature Chamber: Front View

(b) Constant Temperature Chamber: Side View

## 8.2 Setting the Auxiliary Gas Pressure

Set the pressure of the auxiliary gas to the specified pressure that is indicated on the name plate on the inside of the instrument door. Figure 8.2 shows an example of the name plate that indicates the specified pressure of the auxiliary gas.

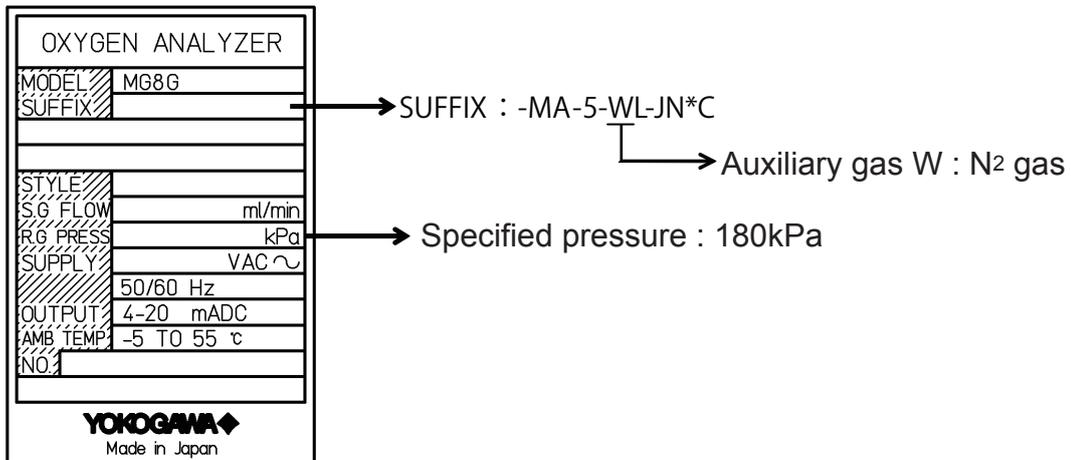


Figure 8.2 Name Plate

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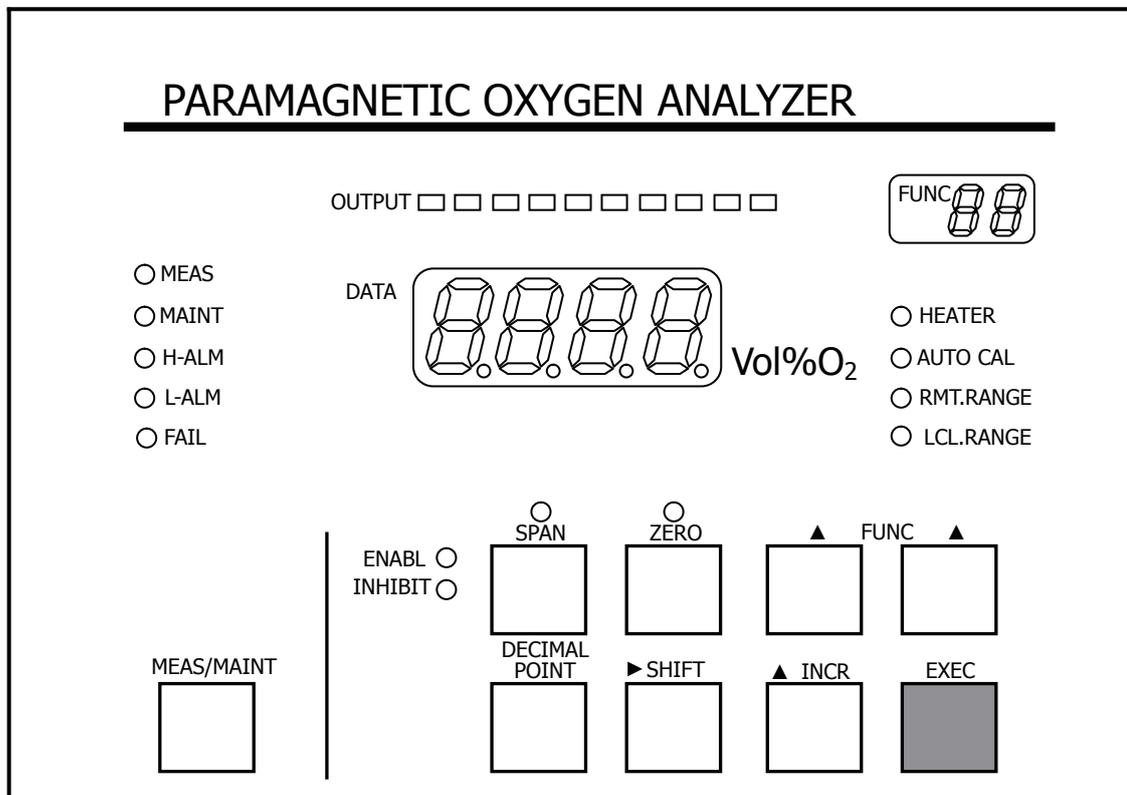
## 8.3 Checking Sample Gas

Do not allow sample gas to flow before the instrument is in steady state.

# 9. OPERATIONS

## 9.1 Operation Keys

The operation keys on the panel are shown in Figure 9.1 and their functions are summarized in Table 9.1.



F9.1E.ai

Figure 9.1 Operation Panel

Table 9.1 Operation Keys and Their Functions

Key	Function
MEAS/MAINT	Hold this key and press EXEC key to switch measurement (MEAS) mode and maintenance (MAINT) mode.
SPAN	Used to execute span calibration in calibration.Used to enter span gas concentration in setting.
ZERO	Used to execute zero calibration in calibration.Used to enter zero gas concentration in setting.
▲ FUNC ▲	Used to change the Function Number. Each press increases the number by one increment. Change the tens and ones digits independently.
DECIMAL POINT	Used to move the decimal point in setting. In this manual this key is referred to as the DP key.
► SHIFT	Used to blink digit on DATA display or to move blinking digit in setting.
▲ INCR	Each press increases the active value by one increment in setting.
EXEC	Used to confirm data entry or to execute function.

## 9.2 Displays and Indicators

The displays and indicators and their functions are summarized in Table 9.2. Also refer to Figure 9.1, Operation Panel.

**Table 9.2 Displays and Indicators**

Display/Indicator	Function
DATA (4-digit number)	Shows oxygen concentration in MEAS mode. Shows “-0.00” when measured concentration is below zero, regardless of value. Shows blinking value if auxiliary gas pressure falls below the setpoint when low auxiliary gas pressure alarm function is enabled. Shows setting parameters in MAINT mode.
FUNC (2-digit number)	Shows Function No. in MAINT mode. Blank in MEAS mode.
OUTPUT	Indicates analog output value in 10-level indicator bar. Indicator runs showing actual output value even while the analog output is being held.
FAIL	Lights when error occurs.
MEAS	Lights when instrument is in MEAS mode.
MAINT	Lights when instrument is in MAINT mode.
H-ALM	Lights when measured oxygen concentration exceeds high limit alarm value.
L-ALM	Lights when measured oxygen concentration falls below low limit alarm value.
ENABLE	Lights when password entered is effective in MAINT mode.
INHIBIT	Lights when password is not effective in MAINT mode.
SPAN	Lights when span calibration is selected in calibration. Lights when span gas is selected in calibration gas concentration setting. Blinks when span calibration is required.
ZERO	Lights when zero calibration is selected in calibration. Lights when zero gas is selected in calibration gas concentration setting.
HEATER	Turns on and off in response to power on/off status of heater for constant temperature chamber.
AUTO CAL	Lights when automatic calibration function is enabled.
RMT.RANGE	Lights when range switching function at contact input is enabled.
LCL.RANGE	Lights when range switching function at contact input is disabled.

## 9.3 Basic Operations

This section describes the basic operations of the MG8G paramagnetic oxygen analyzer.

In this section “☞ (pointer)” in the key operation fields indicates the key to be pressed and light gray characters in DATA fields indicate blinking characters on the display.

### 9.3.1 Switching from MEAS Mode to MAINT Mode

In MEAS mode the DATA display on the instrument shows oxygen concentrations in steady state and in MAINT mode operation parameters are set and confirmed or calibration is performed. When the instrument moves into steady state after a warm-up period, it is in MEAS mode. The instrument can be switched into MAINT mode from a warm-up period, stabilization period or steady state (MEAS mode).

Key Operation	FUNC	DATA	Procedure
			Press EXEC key while holding MEAS/MAINT key. MAINT and INHIBIT lamps turn on. Maintenance status contact is activated.

### 9.3.2 Entering the Password

A password is required when setting data or performing calibration in MAINT mode. A password for the instrument is “007” which cannot be changed. The following describes how to enter the password.

Key Operation	FUNC	DATA	Procedure
			Press FUNC keys to show “00” on FUNC display. DATA display shows “P000” where the password is entered.
			Press SHIFT key repeatedly to move the blinking digit to the rightmost digit.
			Press INCR key repeatedly until “7” is displayed.
			Press EXEC key to accept. The digit stops blinking. ENABLE lamp turns on, indicating that the password has become effective.

### 9.3.3 Changing the Function Number

Each function is assigned to the Function Numbers. Parameters can be viewed and set in the relevant Function Number. The Function Number can be changed using the FUNC keys when the instrument is in MAINT mode. The following describes how to change the Function Number.

Key Operation	FUNC	DATA	Procedure
			Switch to MAINT mode. Enter the password.
			Press the left FUNC key to increase the tens digit, and press the right FUNC key to increase the ones digit on FUNC display. When the Function Number is displayed, the assigned parameter is shown on DATA display.

- The Function Number can be changed even if the password is not effective in MAINT mode. However, in some functions parameters are not shown unless the password is effective. In this case, the DATA display shows “----.”. For details, refer to Table 9.3.
- In the Function Number to which no function is assigned, the DATA display shows “----.”

### 9.3.4 Returning to MEAS Mode from MAINT mode

The instrument can be returned to MEAS mode from anywhere in MAINT mode by pressing the EXEC key while holding the MEAS/MAINT key.

### 9.3.5 Entering Values

This section explains how to enter values. As an example, the procedure for changing oxygen concentration value in Function No. 02 is shown below. The concentration of span gas is changed from 20.95 to 9.80.

Key Operation	FUNC	DATA	Procedure
			Switch to MAINT mode. Enter the password.
	02	0.000	Press FUNC keys to show "02" on FUNC display. ZERO lamp turns on. DATA display shows "0.000."
	02	20.95	Press SPAN key. SPAN lamp turns on. DATA display shows "20.95," the default of span gas concentration. (The default is dependent on the specifications.)
	02	20.95	Press SHIFT key. The leftmost digit of "2" blinks, indicating that the digit can be changed.
	02	00.95	Press INCR key repeatedly until "9" is displayed.
	02	90.95	Press SHIFT key to move the blinking digit to the right.
	02	98.95	Press INCR key repeatedly until "8" is displayed.
	02	9.800	In the same manner, change the remaining digits. Press DP key to move the decimal point to the desired position.
	02	9.800	Press EXEC key to accept. The digit stops blinking, indicating that the change has been accepted.

### 9.3.6 Selecting Data

This section explains how to select and set one of parameters. As an example, selection of the range is shown below.

Key Operation	FUNC	DATA	Procedure
			Switch to MAINT mode. Enter the password.
			Press SHIFT key. "1" blinks, indicating that the digit can be changed.
			Press INCR key to change the digit to the desired range number. The digit cycles through only the available values (in this case 1 through 3).
			Press EXEC key. The digit stops blinking, indicating that the change has been accepted.

### 9.3.7 Functions Numbers

The functions assigned to the Function Numbers are listed in Table 9.3. In some functions parameters are not shown unless the password is effective in MAINT mode.

**Table 9.3 Function Numbers**

Func No.	Function	Setting and Range	Password	
			Not Effective	Effective
00	Entering password		⊙	⊙
01	Executing calibrations	ZERO key: executes zero calibration SPAN key: executes span calibration	----	⊙
02	Setting calibration gas concentrations	ZERO key: for zero gas concentration, 0 to 6 SPAN key: for span gas concentration, 0.5 to 25	○	⊙
03	Checking calibration coefficients	ZERO key: displays zero calibration coefficient SPAN key: displays span calibration coefficient	○	○
04	Setting output hold function during calibration	0: enabled 1: disabled	○	⊙
05	Initializing calibration coefficient			⊙
10	Setting remote range switching contact input	1: disabled 2: enabled	○	⊙
11	Selecting range	1: range 1 2: range 2 3: range 3	○	⊙
12	Setting span for range 1	5 to 25% O <sub>2</sub>	○	⊙
13	Setting span for range 2	5 to 25% O <sub>2</sub>	○	⊙
14	Setting span for range 3	5 to 25% O <sub>2</sub>	○	⊙
16	Fixed analog output	ZERO key: 4 mA SPAN key: 20 mA	----	○
20	Setting low limit alarm	0 to 25% O <sub>2</sub>	○	⊙
21	Setting high limit alarm	0 to 25% O <sub>2</sub>	○	⊙
22	Setting high/low limit alarm function	0: disabled 1: enabled	○	⊙
30	Checking temperature (°C) of constant temperature chamber		○	○
31	Checking sensor emf (mV)		○	○
40	Executing error check		----	⊙
41	Resetting sensor emf error status		----	⊙
42	Resetting calibration coefficient error status		----	⊙
43	Setting output hold function when error occurs	1: enabled – output is held at last measured value 2: disabled 3: enabled – output is held at preset value	○	⊙
44	Setting preset value	-10 to 110%	○	⊙
45	Setting contact output status when error occurs	0: contact closes when error occurs 1: contact opens when error occurs	○	⊙
50	Setting initial wait time for automatic calibration	0 day 0 hour to 99 days 24 hours	○	⊙
51	Setting interval for automatic calibration	0 day 1 hour to 99 days 24 hours	○	⊙
52	Setting zero calibration time	1 to 99 minutes	○	⊙
53	Setting span calibration time	1 to 99 minutes	○	⊙
54	Setting purge time	1 to 99 minutes	○	⊙
55	Executing span calibration	0: not execute span calibration 1: executes span calibration	○	⊙
56	Setting the number of times of skipping span calibrations	0 to 99 times	○	⊙
57	Starting automatic calibration function	0: OFF 1: ON	○	⊙
58	Manual operations of solenoid valves	ZERO key: opens solenoid valve in zero gas line SPAN key: opens solenoid valve in span gas line	----	⊙
67	Checking error status	For service	○	○
98	Checking firmware version		○	○
99	Initialization		----	⊙

○: Data can only be viewed.  
⊙: Data can be changed or functions can be executed.



# 10. START-UP

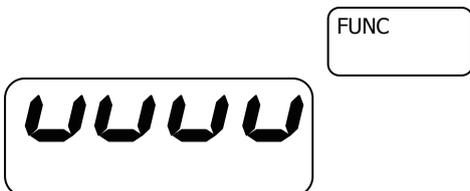
This chapter describes the procedures for supplying power, setting operation parameters, and manual calibration.

## 10.1 Supplying Power

Before supplying power to the instrument, make sure that:

- (1) the installation, piping and wiring have been done correctly;
- (2) the auxiliary gas is being supplied at the specified pressure;
- (3) the supply voltage meets the instrument specifications; and
- (4) no sample gas has been introduced.

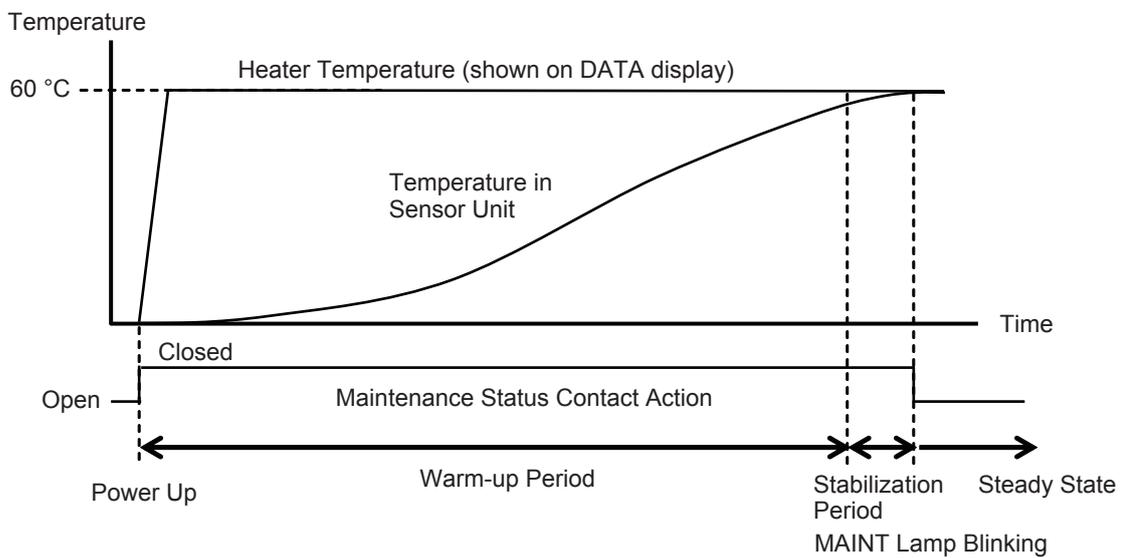
Then, turn on the power switch located next to the external connection terminals inside the operation panel. Upon power up, the instrument displays show as follows.

Display		Description
DATA		All segments on both DATA and FUNC displays turn on for about two seconds.
DATA		The firmware revision appears for about three seconds. (The number shown at left is an example.)
DATA		The instrument enters a warm-up period. As shown at left, the DATA display alternates between "uuuu" and the current heater temperature during the warm-up.
DATA		

## 10.2 Warm-up

After power up the instrument goes through a warm-up period and then reaches steady state where it is ready for measurement. This section describes how the instrument behaves during the warm-up period.

The instrument controls the temperature so that the temperature in the sensor unit is kept at 60 °C. It may take approximately three hours until the temperature in the sensor unit has stabilized at 60 °C. The required time varies depending on the temperature in the sensor unit at start-up or ambient temperature. When the temperature in the sensor unit approaches 60 °C, the DATA display shows oxygen concentrations and the MAINT lamp starts to blink. At the same time the instrument provides analog outputs corresponding to the output range. This period is called a stabilization period and in this period a temperature drift may occur since the temperature in the sensor unit has not completely stabilized. A calibration cannot be executed in this period. When the temperature in the sensor unit stabilized completely, the MAINT lamp stops blinking and the MEAS lamp turns on. This is steady state. During a warm-up period the analog output is fixed at 4 mA. During warm-up and stabilization periods the maintenance status contact is activated. Figure 9.2 shows the temperatures of the heater and in the sensor unit during warm-up and stabilization periods.



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**Figure 10.1** Temperatures of the Heater and in the Sensor Unit During Warm-up and Stabilization Periods

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## 10.3 Analog Output Loop Check

A loop check is for checking wiring between the analog output (terminals 3 and 4) of the instrument and the terminals of a higher-level device.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "16."
- (3) Press the ZERO key to provide 4mA output from the output terminals.
- (4) Press the SPAN key to provide 20 mA output from the output terminals.

## 10.4 Setting the Output Range

The three ranges should be preset to range 1, 2 and 3, respectively and one of the three ranges should be selected. The following describes how to set each range and how to select a range.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "12."
- (3) Set the upper range value for range 1 using the SHIFT and INCR keys. Press the EXEC key to accept.  
For example, for the range of 0 to 25% O<sub>2</sub>, enter "025." Now range 1 is set to 0 to 25%.
- (4) In the same manner, set the upper range values for ranges 2 and 3 in Function Numbers 13 and 14, respectively.
- (5) Change the Function Number to "11." Select the desired range – "1" for range 1, "2" for range 2, or "3" for range 3 – using the SHIFT and INCR keys. Press the EXEC key to accept.

---

## 10.5 Executing Calibrations

After start-up and switching to MEAS mode, zero and span calibrations must be executed. Always a zero calibration should be performed prior to a span calibration. Chapter 13, "Calibration" explains the calibration principle in detail. This section describes how to set the concentrations of calibration gases and how to perform zero and span calibrations manually.

### 10.5.1 Calibration Gas Requirements

As the zero gas, use nitrogen with a minimum purity of 99.99%. As the span gas, use a gas with an oxygen concentration of 80 to 100% of the upper range value of set range (e.g., for the range of 0 to 25%, the span gas should be 20 to 25% oxygen).

### 10.5.2 Setting Calibration Gas Concentrations

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "02."
- (3) Press the SPAN key.
- (4) Set the oxygen concentration of the span gas using the SHIFT, INCR, and DP keys. Press the EXEC key to accept. The setting range is 0.5 to 25% O<sub>2</sub>.

### 10.5.3 Manual Calibration

A zero calibration should be performed first, and then a span calibration. Zero and span calibrations must be conducted in the first calibration after start-up and after the initialization of the calibration coefficient.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "01." The DATA display shows the current oxygen concentration.
- (3) Press the ZERO key. Turn off the sample gas flow and apply the zero gas at the specified flow rate in the sample gas line. When solenoid valves for automatic calibration are installed, pressing the ZERO key closes the solenoid valve in sample gas line and opens the solenoid valve in zero gas line.
- (4) The oxygen concentration on the DATA display changes. When the reading has stabilized completely, press the EXEC key. The instrument is now calibrated to that value as the zero point.
- (5) Press the SPAN key. Turn off the zero gas flow and apply the span gas at the specified flow rate. When solenoid valves for automatic calibration are installed, pressing the SPAN key closes the solenoid valve in zero gas line and opens the solenoid valve in span gas line.
- (6) The oxygen concentration on the DATA display changes. When the reading has stabilized completely, press the EXEC key. The instrument is now calibrated to that value as the span point.
- (7) Turn off the span gas flow. Apply the sample gas and switch to MEAS mode.

# 11. PARAMETER SETTINGS

## 11.1 Output Hold

Analog output is held at a constant value when the instrument is in the following conditions.

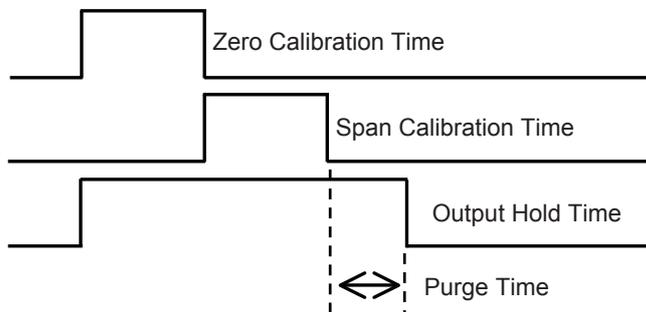
- During a warm-up period, analog output is held at 4 mA.
- During calibration, analog output is held at the last measured value or is not held (user selectable).
- When an error occurs, analog output is held at the last measured value or at a preset value, or is not held (user selectable).

If more than one condition above occurs simultaneously, the output hold are prioritized in the following order.

1. When an error occurs
2. During calibration
3. During a warm-up period

### 11.1.1 Setting the Output Hold Function During Calibration

The output hold function during calibration can be set to “enabled” or “disabled.” When the function is set to “enabled,” the analog output is held at the last measured value during calibration; when set to “disabled,” the instrument outputs measured values during calibration. The hold function deactivated after the purge time has elapsed in calibration. The purge time is the amount of time for sample gas to flow through the sensor unit to purge calibration gas in the unit after calibration and it is user configurable. For the setting of the purge time, refer to Chapter 12, Calibration.



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**Figure 11.1 Output Hold During Calibration**

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to “04.”
- (3) Set the output hold function during calibration using the SHIFT and INCR keys. To enable the function (i.e., the analog output is held at the last measured value), set to “0,” or to disable the function, set to “1.” Press the EXEC key to accept.

### 11.1.2 Setting the Output Hold Function When an Error Occurs

The output hold function when an error occurs can be set to “enabled” or “disabled.” When the function is set to “enabled,” the analog output is held at the last measured value or held at a preset value; when set to “disabled,” the instrument outputs measured values when an error occurs.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to “43.”
- (3) Set the output hold function when an error occurs using the SHIFT and INCR keys. To enable the function and hold the analog output at the last measured value, set to “1,” to enable the function and hold the analog output at a preset value, set to “3,” or to disable the function, set to “2.” Press the EXEC key to accept.
- (4) To set a preset value, change the Function Number to “44.”
- (5) Set the desired preset value using the SHIFT, INCR and DP keys. Press the EXEC key to accept.

A preset value should be represented as a percentage of the output, i.e., 4 mA = 0% and 20 mA = 100%. When setting a preset value to 4 mA, enter “0,” and to 20 mA, enter “100.” The setting range is from –10% (2.4 mA) to 110% (21.6 mA). The minus sign will appear in the leftmost digit by pressing the INCR key repeatedly to increase the blinking number: “0,” “1,” “2,” ... “9,” “–,” and returns to “0.”

---

## 11.2 Setting the Fail Contact

The Fail contact (terminals 15 and 16) is activated when an error occurs. The contact can be programmed to be normally energized (the contact will open when an error occurs) or normally deenergized (the contact will close when an error occurs). The contact is open when the instrument is not powered. For details about errors, refer to Chapter 15, Troubleshooting.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "45."
- (3) Set the Fail contact state using the SHIFT and INCR keys. To set the contact to be normally deenergized (the contact closes when an error occurs), enter "0," and to be normally energized (the contact opens when an error occurs), enter "1." Press the EXEC key to accept.

## 11.3 Action of the Maintenance Status Contact

The maintenance status contact (terminals 13 and 14) is closed during the following states and is otherwise open. The contact is open when the instrument is not powered.

- (1) Warm-up period
- (2) Stabilization period
- (3) MAINT mode  
The MAINT lamp is lit while the instrument is in MAINT mode. MAINT mode starts when pressing the EXEC key while holding the MEAS/MAINT key to enter the MAINT mode and ends when doing the same key operations to return to MEAS mode.
- (4) Semiautomatic or automatic calibration  
The maintenance status contact is closed during calibration including the purge time.

## 11.4 Setting the High/Low Limit Alarms

The contact is activated to give an alarm when the measured oxygen concentration is outside the limit. High and low alarm limit values can be set, respectively. When the measured value exceeds the high limit alarm value, the H-ALM lamp on the operation panel will turn on and the high limit alarm contact (terminals 10 and 12) will close. When the measured value falls below the low limit alarm value, the L-ALM lamp will turn on and low limit alarm contact (terminals 11 and 12) will close. The contacts are open when alarm is not generated and when the instrument is not powered. The following describes how to set the limit values.

- (1) Switch to MAINT mode and enter the password.
- (2) For the setting of the low limit alarm value, change the Function Number to "20," and for the setting of the high limit alarm value, change to "21."
- (3) Set the desired value using the SHIFT, INCR and DP keys. Press the EXEC key to accept. The setting range is 0 to 100% O<sub>2</sub>.
- (4) Change the Function Number to "22."
- (5) Set to "1" using the SHIFT and INCR keys and press the EXEC key to accept. Now the high/low limit alarm function is enabled.

When setting the high/low limit alarms, note that:

- The alarm contact is activated when the measured value is equal to or higher than the high alarm setpoint or when the measured value is equal to or less than the low alarm setpoint.
- The alarm contact does not operate if the high limit alarm value has been set equal to or lower than the low limit alarm value.



---

### CAUTION

Either the high/low limit alarm function or the range switching answerback function can be assigned to this contact. When the high/low limit alarm function is set to "enabled" in Function No. 22, the output range answerback function is disabled.

---

## 11.5 Setting the Remote Range

The remote range function enables the preprogrammed three ranges to be switched remotely by the range switching contact input (terminals 7, 8 and 9). When the remote range function is enabled, the RMT.RANGE lamp is lit, the range selected in Function No. 11 is invalid, and the range selected externally is used. The following describes how to set the remote range function.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "10."
- (3) Set to "2" using the SHIFT and INCR keys. Press the EXEC key to accept. Now the remote range function is enabled.

The remote range contact states and ranges are shown in Figure 11.1. When two contacts (terminals 7-9 and 8-9) are closed, the previously set range remains.

**Table 11.1 Remote Range Contact States and Ranges**

Terminal Number		Range Selected
7-9 (R3)	8-9 (R2)	
Open	Open	Range 1
Open	Closed	Range 2
Closed	Open	Range 3
Closed	Closed	Previous range

## 11.6 Setting the Range Switching Answerback Contact Output

The range switching answerback function enables the currently selected range to be output by the contact output (terminals 10, 11 and 12). Since either the range switching answerback function or the high/low limit alarm function can be assigned to this contact, the range switching answerback function cannot be used when the high/low limit alarm function is enabled.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "22."
- (3) Set to "0" to disable the high/low limit alarm function using the SHIFT and INCR keys. Press the EXEC key to accept. Now the range switching answerback function is enabled.

The range answerback contact states and ranges are shown in Figure 11.2.

**Table 11.2 Range Answerback Contact States and Ranges**

Terminal Number		Range Selected
10-12 (R3)	11-12 (R2)	
Open	Open	Range 1
Open	Closed	Range 2
Closed	Open	Range 3



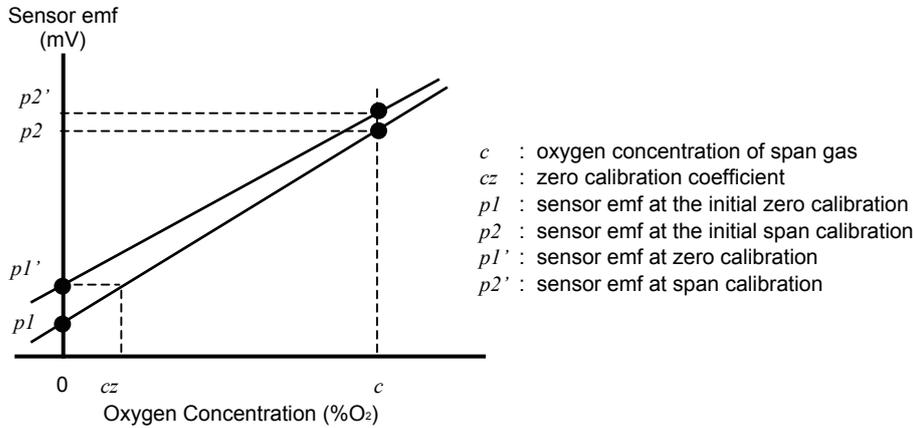
### CAUTION

When the range answerback function is enabled, the high/low limit alarm function is disabled.

# 12. CALIBRATION

## 12.1 Overview

The instrument should be calibrated at two points using zero gas (nitrogen gas with an oxygen concentration of 0%) and span gas with a known oxygen concentration. Figure 12.1 shows the relationship between the sensor emf and the oxygen concentration.



F12.1E.ai

**Figure 12.1 Sensor emf vs. Oxygen Concentration**

The ratio of the oxygen concentration to the sensor emf is calculated from the sensor emf values (*p1* and *p2*) obtained in calibration.

$$k = \frac{c}{p2 - p1}$$

Assuming that the sensor emf when sample gas is applied is *ps*, the concentration of the sample gas, *cs*, is obtained from the following equation.

$$cs = k \times (ps - p1)$$

Calibration is for obtaining *k*.

When only a zero calibration is performed, the instrument is calibrated to the zero gas's value and the ratio of the oxygen concentration to the sensor emf, *k*, that was obtained from the previous calibration, is used.

## 12.2 Calibration Coefficient

The calibration coefficient is a deviation from the initial calibration value.

### 12.2.1 Zero Calibration Coefficient

The zero calibration coefficient is the deviation between the sensor emf obtained when a zero calibration is performed and the initial calibration value, and is expressed as the one corrected for oxygen concentration. It is  $c_z$  (% O<sub>2</sub>) in Figure 12.1. When the zero calibration coefficient,  $c_z$ , is outside of  $\pm 1.25\%$  O<sub>2</sub>, a zero calibration coefficient error will occur.

### 12.2.2 Span Calibration Coefficient

The span calibration coefficient is the deviation between the ratio of the oxygen concentration to the sensor emf,  $k'$ , obtained when zero and span calibrations are performed and the initial calibration value, and is expressed as the ratio to the ratio obtained at the initial calibration,  $k$ .

$$\text{Span calibration coefficient} = \frac{k'}{k}$$

Where:

$k$ : the ratio of the oxygen concentration to the sensor emf obtained at the initial calibration

$k'$ : the ratio of the oxygen concentration to the sensor emf obtained in calibration

When the span calibration coefficient is outside the range of 0.9 to 1.09, a span calibration coefficient error will occur.

### 12.2.3 Checking the Calibration Coefficients

- (1) Switch to MAINT mode. There is no need to enter the password.
- (2) Change the Function Number to "03."
- (3) Press the ZERO key to check the zero calibration coefficient, and press the SPAN key to check the span calibration coefficient.

### 12.2.4 Initializing the Calibration Coefficients

By initializing the calibration coefficients, the zero calibration coefficient is reset to "0" and the span calibration coefficient to "1." Based on the sensor emf obtained in the next calibration after the initialization, the calibration coefficients will be calculated. The calibration after the initialization should be performed with special care.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "05." The DATA display shows "rES."
- (3) Press the EXEC key to initialize the calibration coefficients.



## CAUTION

- The calibration coefficients displayed in Function No. 03 are still the previous ones after the initialization.  
They will be updated only after zero and span calibrations after the initialization.
- When the concentration of the zero gas is changed in Function No. 02, the zero reference will be changed.  
Accordingly the calibration coefficients will be initialized: this is the same action as the initialization by the above procedure.

---

## 12.3 Executing Calibrations

Zero and span calibrations must be performed after the power is turned off and restarted. Without valid calibration oxygen concentration cannot be measured accurately. Before calibration, the following should be checked.

- (1) The auxiliary gas is being supplied at the specified pressure.
- (2) Auxiliary gas and zero gas with proper nitrogen purities are used.
- (3) The span gas concentration set in the instrument agrees with the actual gas concentration.
- (4) Calibration gases flow at the specified flow rate without fluctuation.

### 12.3.1 Manual Calibration

A zero calibration should be performed first, and then a span calibration. A span calibration cannot be executed before a zero calibration. It is allowed to perform only a zero calibration, but not allowed to perform only a span calibration.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "01." The DATA display shows the current oxygen concentration. The display may show the minus sign. The instrument determines the value even if the measured concentration is below zero. The measured concentration when zero gas is applied may be a negative value.
- (3) Press the ZERO key. Turn off the sample gas flow and apply the zero gas at the specified flow rate in the sample gas line. When solenoid valves for automatic calibration are installed, pressing the ZERO key closes the solenoid valve in sample gas line and opens the solenoid valve in zero gas line.
- (4) The oxygen concentration on the DATA display changes. When the reading has stabilized completely, press the EXEC key. The instrument is now calibrated to the value as the zero point.
- (5) Press the SPAN key. Turn off the zero gas flow and apply the span gas at the specified flow rate. When solenoid valves for automatic calibration are installed, pressing the SPAN key closes the solenoid valve in zero gas line and opens the solenoid valve in span gas line.
- (6) The oxygen concentration on the DATA display changes. When the reading has stabilized completely, press the EXEC key. The instrument is now calibrated to the value as the span point.
- (7) Turn off the span gas flow. Apply the sample gas and switch to MEAS mode.

### 12.3.2 Semiautomatic Calibration

In the semiautomatic calibration zero and span calibrations are carried out under the preprogrammed conditions using the calibration start contact input (terminals 5 and 6). The instrument will start calibration when the dry (voltage free) contact connected to the input is closed. For the semiautomatic calibration, the following should be set.

- (1) Zero calibration time (Function No. 52)  
The amount of time for zero gas to flow. The timer starts when the solenoid valve in zero gas line opens to allow the zero gas to flow through the sensor unit. Set the amount of time it takes for the reading to stabilize sufficiently. The setting range is from 1 to 99 minutes.
- (2) Span calibration time (Function No. 53)  
The amount of time for span gas to flow. The timer starts when the solenoid valve in zero gas line closes and the solenoid valve in span gas line opens to allow the span gas to flow through the sensor unit. Set the amount of time it takes for the span gas to purge the zero gas in the sensor and for the reading to stabilize sufficiently. The setting range is from 1 to 99 minutes.
- (3) Purge time (Function No. 54)  
The amount of time for sample gas to flow through the sensor unit to purge calibration gas after calibration. Set the amount of time it takes for the sample gas to purge the sensor unit completely. The setting range is from 0 to 99 minutes. When the output hold function during calibration is set to "enabled," the analog output will be held during the calibration including the purge time. Also, the maintenance status contact will be closed during the calibration including the purge time. The purge time is valid for manual calibration.

The zero calibration time, span calibration time and purge time can be set in Function Nos, 52, 53 and 54, respectively.

- 1) Switch to MAINT mode and enter the password.
- 2) Change the Function Number to "52."
- 3) Set the zero calibration time using the SHIFT and INCR keys. Press the EXEC key to accept.
- 4) In the same manner, set the span calibration time in Function No. 53 and the purge time in Function No. 54.



### CAUTION

- For semiautomatic calibration, wiring and piping for automatic calibration are required.
- If the calibration start contact remains closed after calibration, the instrument will not accept the next calibration start contact input. The contact should be opened once and then closed again for the next calibration.
- During MAINT mode, the calibration start contact input signal is not accepted.
- During manual calibration or automatic calibration, the calibration start contact input signal is not accepted.
- If the instrument is switched to MAINT mode by key operation while a semiautomatic calibration is being conducted, the calibration will be aborted.

### 12.3.3 Automatic Calibration

Calibration can be automatically executed for preprogrammed calibration times at preprogrammed intervals. For the automatic calibration, the following should be set.

- For the zero calibration time (Function No. 52), span calibration time (Function No. 53), and purge time (Function No. 54), refer to Section 12.3.2, Semiautomatic Calibration.
- Initial wait time (Function No. 50)  
The amount of time until the first calibration is executed after the automatic calibration function was started. The setting range is from 0 day 0 hour to 99 days 24 hours. When the time is set to "00 day 00 hour," the initial wait time is equal to the time set as the calibration interval (Function No. 51).
- Calibration interval (Function No. 51)  
Set the time interval for automatic calibration. The setting range is from 0 day 1 hour to 99 days 24 hours.
- Execution of span calibration (Function No. 55)  
Set whether or not to execute span calibration. To execute only zero calibration and not to execute span calibration, set to "0." To execute both zero and span calibrations, set to "1."
- The number of times of skipping span calibrations (Function No. 56)  
The number of times of skipping span calibrations can be set only when "1" is set in Function No. 55. Setting to "0" here means that span calibration is not skipped, i.e., both zero and span calibrations are executed each time. Setting to "1" or greater means that span calibration is skipped the set number of times after the first zero and span calibrations. The setting range is from 0 to 99 times.
- Starting automatic calibration function (Function No. 57)  
Set to "1" to start the automatic calibration function. After the set initial wait time has elapsed, the first calibration starts.

Figure 12.2 shows the timing diagram when the number of times of skipping span calibrations (Function No. 56) is set to "2."

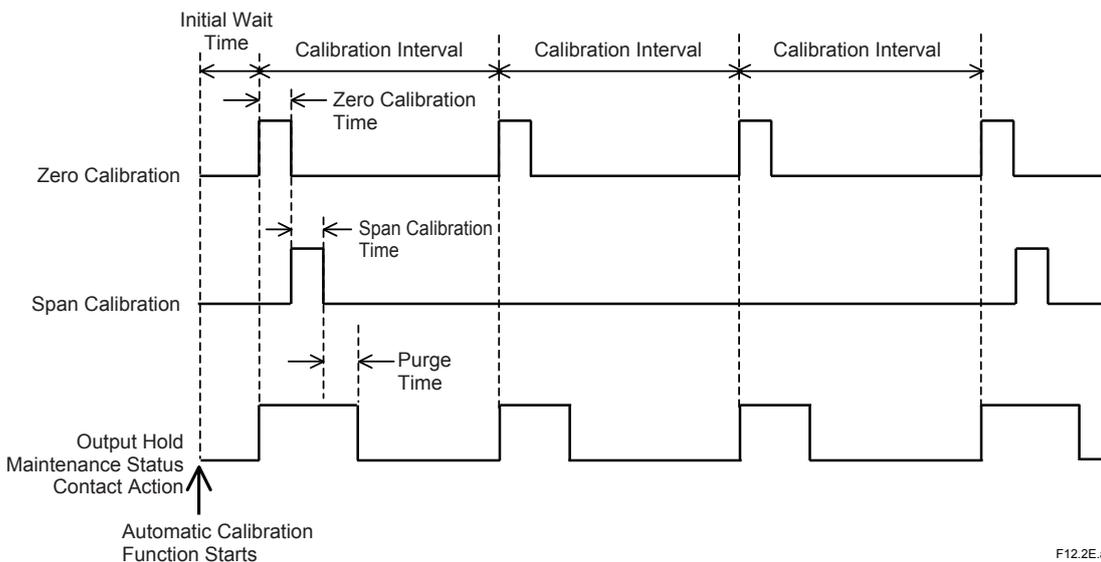


Figure 12.2 Timing Diagram for Automatic Calibration

The following describes how to set the automatic calibration. For the settings of the zero calibration time, span calibration time and purge time, refer to Section 12.3.2, Semiautomatic Calibration.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "50" to set the initial wait time. The DATA display shows "xx.xx." The two left digits represent days (00 to 99 days ) and the two right digits time (00 to 24 hours).
- (3) Set the desired day and time using the SHIFT and INCR keys. Press the EXEC key to accept.
- (4) Change the Function Number to "51" to set the calibration interval. The DATA display shows "xx.xx." The two left digits represent days (00 to 99 days) and the two right digits time (00 to 24 hours). Note that the minimum interval is one hour and "00.00" will be rejected.
- (5) Set the desired interval using the SHIFT and INCR keys. Press the EXEC key to accept.
- (6) Change the Function Number to "55" to set whether or not to execute span calibration. Set to "0" not to execute span calibration or set to "1" to execute span calibration, using the SHIFT and INCR keys. Press the EXEC key to accept.
- (7) When "1" is set in Function No. 55, the number of times of skipping span calibrations should be set in Function No. 56. Set the desired number of times of skipping span calibrations using the SHIFT and INCR keys. Press the EXEC key to accept. When "0" is set in Function No. 55, "—" appears on the display and the number of times of skipping span calibrations cannot be set.
- (8) Change the Function Number to "57." Set to "1" to start the automatic calibration function. Press the EXEC key. The timer starts counting and the AUTO CAL lamp turns on.



## CAUTION

- For automatic calibration, wiring and piping for automatic calibration are required.
- If the time to start a calibration is reached while the instrument is in MAINT mode, the automatic calibration will be canceled.
- Likewise, if the time to start a calibration is reached during manual calibration or semiautomatic calibration, including the purge time, the automatic calibration will be canceled.
- If the instrument is switched to MAINT mode by key operation while an automatic calibration is being conducted, the automatic calibration is aborted.
- If the sum of the zero calibration time, span calibration time and purge time is longer than the calibration interval, the next calibration will be canceled. The internal timer works even if the power supply to the instrument is interrupted while the automatic calibration function is enabled. After power is restored, calibrations will be executed on schedule; there is no delay due to the power interruption. Note that the internal timer does not work when the power supply is interrupted during the calibration time.
- Once the automatic calibration function is turned off by setting in Function No. 57, the timer will be reset.
- It is recommended that after the settings for the automatic calibration have been completed manual calibration should be conducted once to verify whether the calibration is conducted properly.

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## 13. OTHER FUNCTIONS

### 13.1 Checking the Temperature of the Constant Temperature Chamber (Function No. 30)

The temperature (°C) in the sensor unit can be checked in Function No. 30. It is stable at 60 °C after the instrument entered MEAS mode.

### 13.2 Checking the Sensor EMF (Function No. 31)

The sensor emf (mV) can be checked in Function No. 31. When the instrument is in a warm-up period, the DATA display will show “----.”

### 13.3 Manual Operation of the Solenoid Valves for Automatic Calibration (Function No. 58)

When wiring and piping for the solenoid valves for automatic calibration have been installed, each solenoid valve can be operated manually. The DATA display shows oxygen concentrations. This manual operation can be used for checking readings.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to “58.” The DATA display shows an oxygen concentration.
- (3) Press the ZERO key to open the solenoid valve in zero gas line and close the solenoid valve in sample gas line.
- (4) Press the SPAN key to open the solenoid valve in span gas line and close the solenoid valve in sample gas line.
- (5) Change the Function Number to the one other than “58” to close the solenoid valves for calibration gas lines and open the solenoid valve in sample gas line.

### 13.4 Checking the Firmware Version (Function No. 98)

The version of the firmware installed on the instrument can be checked in Function No. 98.

## 13.5 Initializing Parameters (Function No. 99)

The instrument can be initialized to the factory default settings which are summarized in Table xxxx.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "99." The DATA display shows "rES."
- (3) Press the EXEC key. This has not yet changed the settings.
- (4) Turn the power off and on again. Now the instrument has been initialized to the factory default settings.

**Table 13.1 Factory Default Settings**

Func No.	Function	Factory Default
00	Entering password	
01	Executing calibrations	
02	Setting calibration gas concentrations	ZERO key: 0.000, SPAN key: 20.95
03	Checking calibration coefficients	
04	Setting output hold function during calibration	0: enabled
05	Initializing calibration coefficient	
10	Setting remote range switching contact input	1: disabled
11	Selecting range	3: range 3
12	Setting span for range 1	005 (0 to 5% range)
13	Setting span for range 2	010 (0 to 10% range)
14	Setting span for range 3	025 (0 to 25% range)
16	Fixed analog output	
20	Setting low limit alarm	00.00
21	Setting high limit alarm	25.00
22	Setting high/low limit alarm function	0: disabled
30	Checking temperature (°C) of constant temperature chamber	
31	Checking sensor emf (mV)	
40	Executing error check	
41	Resetting sensor emf error status	
42	Resetting calibration coefficient error status	
43	Setting output hold function when error occurs	1: enabled – at last measured value
44	Setting preset value	00.00
45	Setting contact output status when error occurs	0: contact closes when error occurs
50	Setting initial wait time for automatic calibration	00.00 (0 day 0 hour)
51	Setting interval for automatic calibration	30.00 (30 days 0 hour)
52	Setting zero calibration time	10 (10 minutes)
53	Setting span calibration time	10 (10 minutes)
54	Setting purge time	10 (10 minutes)
55	Executing span calibration	1: executes span calibration
56	Setting the number of times of skipping span calibrations	00 (no skipping)
57	Starting automatic calibration function	0: OFF
58	Manual operations of solenoid valves	
67	Checking error status	
98	Checking firmware version	
99	Initialization	

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# 14. INSPECTION AND MAINTENANCE

This chapter describes the inspection and maintenance procedures to ensure optimum performance of the instrument and to keep it in good operating condition.

## 14.1 Checking the Auxiliary Gas

Check that the auxiliary gas is supplied at the specified pressure. When the gas is supplied from a gas cylinder, check the pressure gauge attached to the cylinder. If the pressure is low, replace the gas cylinder. The primary pressure of the supplied pressure regulator for supplying auxiliary gas must be at least 300 kPa. When the auxiliary gas pressure is readjusted, zero and span calibrations should be conducted.



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### CAUTION

After the gas cylinder is replaced, zero and span calibrations should be conducted. If air is trapped in the auxiliary gas line during replacement, the reading will fluctuate and it will take long time for the reading to stabilize. After the reading has stabilized completely, perform the calibrations.

---

## 14.2 Checking the Sample Gas

Check the flow rate of the sample gas on a timely basis.

## 14.3 Precautions When Stopping and Restarting the Operation

The most common failure or trouble occurs when stopping or restarting the operation. Extreme care should be taken.

- (1) When sample gas contains corrosive components, turn off the sample gas flow with the auxiliary gas being supplied. After turning off the sample gas flow, allow nitrogen gas or instrument air to flow to purge the sample gas line.
- (2) If possible, it is recommended that the auxiliary gas be allowed to flow while the operation is suspended..
- (3) Before restarting the operation, check the sample gas line for moisture due to condensation. If moisture is present, remove the sample gas line from the instrument and allow instrument air to flow to purge the pipe completely. Moisture in the sensor unit may result in a failure, and in the worst case, the instrument will need to be serviced at the factory.

## 14.4 Fuse Replacement

Two fuses are installed for live and neutral, respectively, in the power unit in the instrument. If the fuse blows, replace it using the following procedure.

- (1) Before replacement, turn off power to the instrument.
- (2) Open the instrument cover. Pull the fuse out from the fuse holder which is located near the power switch as shown in Figure 14.1. Turn the cap counterclockwise until it stops using a flat head screwdriver of the appropriate size. Pull out the cap together with the fuse.
- (3) Make sure that a new fuse is of the same rating. Attach the new fuse to the cap and insert it into the holder. Turn the cap clockwise while pushing it until it stops using the flat head screwdriver.

Fuse specifications:

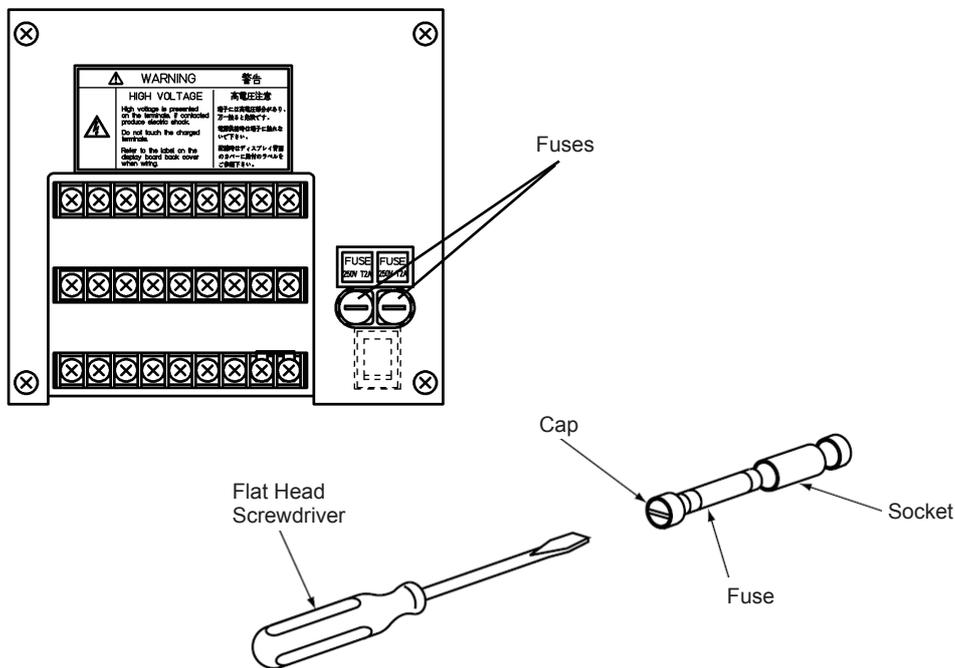
Maximum rated voltage:	250 V
Maximum rated current:	2.0 A
Type:	Time-lag
Standards compliance:	UL, CSA, VDE
Part number:	A1111EF

The fuse deteriorates with time. It is recommended that the fuses be replaced every two years even if the fuse has not blown.



### CAUTION

If the fuse blows again soon after replacement, there may be a malfunction in the circuit or in the external connections. Immediately turn off power to the instrument and investigate the cause.



F14.1E.ai

Figure 14.1 Fuse Removal

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## 14.5 Other Instructions

- (1) For inspection and maintenance of sampling systems, read corresponding user's manuals.
- (2) For the cleaning and overhaul of the sensor unit, consult Yokogawa.

## 14.6 Replacing the Limited Life Component

The following component has a limited life. It is recommended that it should be replaced approximately every five years. As for the replacement, ask Yokogawa.

- Power unit (located on the back of the terminal block and normally not visible)



# 15. TROUBLESHOOTING

This chapter describes errors detected by the self-diagnostic function and troubles during measurement, such as output fluctuations.

## 15.1 Errors and Remedies

### 15.1.1 Checking the Error Code

An error will occur if a failure is detected in the sensor, constant temperature chamber, or analyzer's internal circuit. When an error occurs, the FAIL lamp turns on and the Fail contact is activated. As for the calibration coefficient error, the FAIL lamp turns on and the Fail contact is activated only when semiautomatic or automatic calibration function is enabled. To check an error code, follow the procedure below.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "40." Press the EXEC key. The current error code will be displayed.
- (3) If no error is being generated, the DATA display shows "oooo."

The types of errors detected by the self-diagnostic function and remedies are summarized in Table 15.1.

**Table 15.1 Errors and Remedies**

Error Type	Code	Description	Action	Remedy
Sensor unit error	E-10	Sensor emf continues to exceed 400 mV for at least 10 seconds.		Remove the causes and reset the error status in Function No. 41.
	E-11	Sensor emf continues to fall below -50 mV for at least 10 seconds.		
Constant temperature chamber error	E-20	In stabilization period or steady state, heater temperature continues to fall below 55 °C for at least 10 seconds.	Turn off power to heater.	Remove the causes. Turn the power off and on again to restart. If error occurs again, contact Yokogawa Service.
	E-21	In stabilization period or steady state, heater temperature continues to exceed 65 °C for at least 10 seconds.		
	E-22	In warm-up period, heater temperature fails to rise.	Error code blinks on DATA display. Turn off power to heater.	
	E-23	In warm-up period, heater temperature continues to exceed 65 °C for at least 10 seconds.		
Analog error	E-30	Failure occurs in A/D converter on circuit.	Turn off power to heater.	Turn the power off and on again to restart. If error occurs again, contact Yokogawa Service.
	E-31	Voltage of sensor unit exceeds input range of A/D converter.		
	E-32 E-33			
Memory error	E-40	Failure occurs in memory device on circuit.	Turn off power to heater.	Turn the power off and on again to restart. If error occurs again, contact Yokogawa Service.
Calibration coefficient error	E-50	Zero calibration coefficient is outside of $\pm 1.25\%$ O <sub>2</sub> .	In manual calibration, error code appears on DATA display*. In semiautomatic or automatic calibration, Fail contact is activated and FAIL lamp turns on.	Remove the causes. Recalibrate the instrument or reset the error status in Function No. 42.
	E-51	Span calibration coefficient is below 0.9 or above 1.09.		

\* When a calibration coefficient error occurs during manual calibration, the Fail lamp will not turn on and the Fail contact is not activated.

## 15.1.2 Error Descriptions

### 15.1.2.1 Sensor Unit Errors (E-10, E-11)

A sensor unit error occurs when the sensor emf is outside the range of –50 mV to 400 mV. Possible causes are:

- (1) The pressure of the auxiliary gas dropped.  
Check the auxiliary gas pressure.
- (2) The flow rate of the sample gas was greater than the specified one.  
Check the sample gas flow rate.

Remove the causes and then reset the error status using the following procedure.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to “41.” The DATA display shows “rES.”
- (3) Press the EXEC key to reset the sensor emf error status.

### 15.1.2.2 Constant Temperature Chamber Errors (E-20, E-21)

The temperature of the constant temperature chamber of the MG8G is normally stable at 60 °C during a stabilization period and in steady state. When a constant temperature chamber error occurs, turn the power off and on again to restart, and after the instrument enters a stabilization period, check the temperature of the constant temperature chamber in Function No. 30. If the temperature fluctuates, possible causes are:

- (1) The power supply voltage fluctuates
- (2) The ambient temperature is outside the specification range: –5 to 55 °C

### 15.1.2.3 Constant Temperature Chamber Errors (E-22, E-23)

A constant temperature chamber error, E-22 or E-23, occurs while the instrument is in a warm-up period. Turn the power off and on again. After the constant temperature chamber has cooled down sufficiently, restart the instrument. If the same error occurs, there may be a failure in components for temperature control. Contact Yokogawa Service.

- (1) E-22: A possible cause is heater disconnection or action of the internal thermostat for over temperature protection.
- (2) E-23: A possible cause is a failure in parts for heater power control. When an E-23 error occurs, the internal thermostat may be activated at the same time. The internal thermostat is activated when the temperature reaches approximately 70 °C, but is not reset automatically when the temperature drops.

### 15.1.2.4 Analog Errors (E-30, E-31, E-32, E-33)

An analog error occurs when there is a failure in the analog circuit. Turn the power off and on again to restart the instrument. If the error occurs again, contact Yokogawa Service.

### 15.1.2.5 Memory Error (E-40)

A memory error occurs if there is a failure in reading or writing the memory device. Turn the power off and on again to restart the instrument. If the error occurs again, contact Yokogawa Service.

### 15.1.2.6 Calibration Coefficient Errors (E-50, E-51)

A calibration coefficient error occurs if the calibration coefficient obtained in zero or span calibrations is outside the normal range. A zero calibration coefficient error occurs if the zero calibration coefficient is outside of  $\pm 1.25\%$  O<sub>2</sub>. A span calibration coefficient error occurs if the span calibration coefficient is outside the range of 0.9 to 1.09. For details, refer to Chapter 12, Calibration.

When the error occurs, the FAIL lamp turns on and the FAIL contact is activated only when the semiautomatic or automatic calibration function is enabled. In the case of manual calibration, the DATA display shows "E-5." Possible causes are:

- The calibration gas concentration set in the instrument does not agree with the actual concentration of the calibration gas used.
- The pressure of the auxiliary gas was lower than the specified one.
- Zero or span gas was not being supplied.
- In manual calibration, a zero calibration was conducted with span gas flowing, or vice versa.

Remove the causes and reset the error status by performing zero and span calibration again. If the calibration coefficient is outside the specification range due to a sensor drift or characteristics change with time, initialize the calibration coefficients and perform zero and span calibration again.

When the error occurs during semiautomatic or automatic calibration, remove the causes and reset the error status using the following procedure.

- (1) Switch to MAINT mode and enter the password.
- (2) Change the Function Number to "42." The DATA display shows "rES."
- (3) Press the EXEC key to reset the calibration coefficient error status.

## 15.2 Faulty Readings During Measurement

This section describes faulty readings during measurement and possible causes.

### 15.2.1 Fluctuations in Readings

- Check that the flow rate of the sample gas is the specified one and is stable.
- Check the piping joints or connections in the line between the auxiliary gas cylinder and the analyzer for leaks.
- Check that the temperature of the constant temperature chamber is stable.
- Check the power supply voltage for fluctuations.
- Check that the analyzer is not exposed to direct sunlight or radiant heat from a heat source such as a furnace.

### 15.2.2 Drift in Readings

Check that the supply pressure of the auxiliary gas is appropriate. If the auxiliary gas pressure falls below the specified supply pressure, the output will drift as the pressure drops.

### 15.2.3 Short-Term Shift in Readings

Check that the flow rate of the sample gas is the specified one and is stable. If the flow of the sample gas containing oxygen is turned off, the reading will shift toward 0% O<sub>2</sub>.

## 15.3 When Calibration Cannot Be Executed

- Check that the password has been entered correctly and that the ENABLE lamp is lit.
- Check that the instrument is in steady state. If the MAINT lamp blinks in MEAS mode, the instrument is in a stabilization period and calibration cannot be executed.
- Check that the calibration gas concentrations are set properly.

## 15.4 In the Event of Power Failure

### 15.4.1 Instantaneous Power Failure

The instrument will not be affected and will continue to work if the duration of a power failure is 80 ms or shorter in the case of the instrument with a power supply of 100 to 115 V AC or if the duration of power failure is 350 ms or shorter in the case of the instrument with a power supply of 200 to 240 V AC. Even if the duration of a power failure is the above-mentioned time or less, the instrument may be restarted if the power failure occurs during the warm-up period because of the amount of time that the heater is turned on.

### 15.4.2 When the Power Returns

If the temperature of the constant temperature chamber remains at 50 °C or higher when the power returns from a relatively short-term (a few minutes) power failure, the instrument will return to MEAS mode in about 30 seconds. This applies only when the instrument was in steady state before the power failure.

# 16. MEASUREMENT PRINCIPLE

## 16.1 Measurement Principle

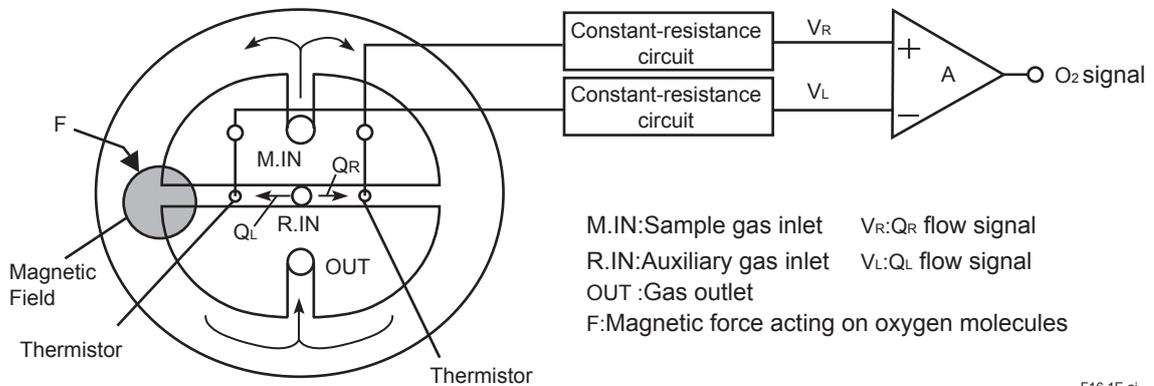
A diagram of the principle is shown in figure 16.1.

When the sample gas contains no oxygen molecules, the right and left flow rates of the auxiliary gas ( $N_2$ ),  $Q_L$  and  $Q_R$  are equal, or  $Q_R = Q_L$ .

If oxygen molecules are included in the gas, flow rate  $Q_L$  on the magnetic field-generating side is less than  $Q_R$  due to the force with which the magnetic field acts on the oxygen molecules, establishing  $Q_R > Q_L$ .

The difference in the flow rate,  $\Delta Q = Q_R - Q_L$  is proportional to the percentage of oxygen molecules in the measuring gas.

The thermistor sensor is operated in the constant-resistance circuit to convert the flow rates (velocity) into electric signals, the difference of which is obtained by amplifier A as an oxygen signal.



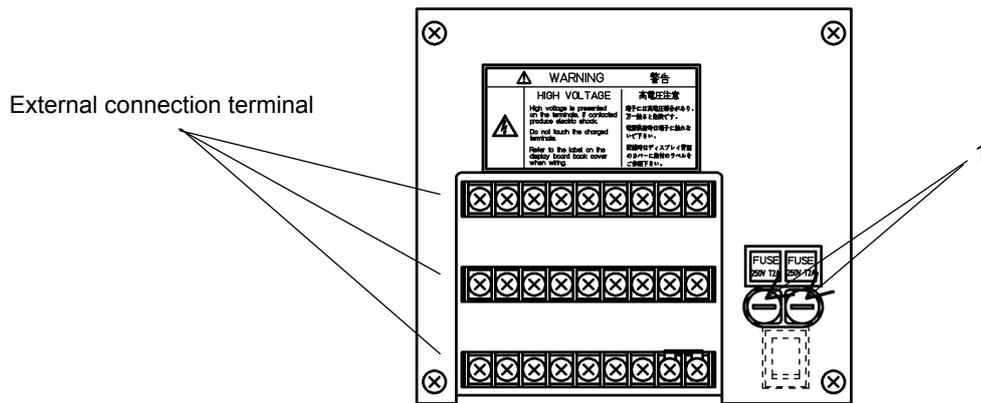
F16.1E.ai

Figure 16.1 Measurement Principle



Customer  
Maintenance  
Parts List

MG8G  
MG8E  
Paramagnetic Oxygen Analyzer



<u>Item</u>	<u>Parts No.</u>	<u>Qty</u>	<u>Description</u>
1	A1111EF	2	Fuse

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