

**INSTRUCTION MANUAL**

**SM425**

**ZIRCONIA OXYGEN ANALYZER**



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## INTRODUCTION

The SM425 Separate type Zirconia Oxygen Analyzer has been developed for combustion control in various industrial processes. This analyzer consists of a detector and a converter. You can select among several versions, based on 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 SM425. You may skip any section(s) on the equipment which is not included in your system.

Regarding the HART communication protocol, refer to M11M12A01-51E.

<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 SM425.>

Models and descriptions in this manual are as follows:

**Models and descriptions in this manual**

Model	Product Name	Description in this manual				
		Specificati on	Installatio n	Operatio n	Maintenanc e	CMPL
SM425P	General-use detector	○	○	○	○	○
SM425P	High-temperature detector (0.15m)	○	○	○	○	
SM425	Converter	○	○	○	○	○
ZO21R-L	Probe protector	○	○			
ZO21P-H	High-temperature probe adapter	○	○			○
ZA8F	Flow setting unit (for manual calibration use)	○	○	○		
SM425CAL	Automatic Calibration unit	○	○	○		○
-	Auxiliary ejector for high-temperature use (Part No. E7046EC,EN)	○	○			○
-	Calibration gas unit case (Part No. E744KF)	○	○			
-	Check valve (Part No. K9292DN, K929DS)	○	○			
-	Dust Filter for the detector (Part No. 96751017)	○	○			
-	Dust guard protector (Part No. K947UC)	○	○			
ZO21S	Standard gas unit	○		○	○	○

**CMPL:** Customer Maintenance Parts List

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

### Table of Contents

Section	Outline	Relates to		
		Installation	Operation	Maintenance
1. Overview	Equipment models and system configuration examples	○	▲	○
2. Specifications	Standard specification, model code (or part number), dimension drawing for each equipment.	■	○	○
3. Installation	Installation method for each equipment	■		▲
4. Piping	Examples of piping in three standard system configurations.	■		▲
5. Wiring	Wiring procedures such as "Power supply wiring", "output signal wiring", or others.	■		▲
6. Components	Major parts and their function are described in this manual.	▲	○	○
7. Startup	Basic procedure to start operation of SM425. Section 7 enables you to operate the equipment immediately.		■	▲
8. Detailed Data Setting	Details of key operation and displays		○	▲
9. Calibration	Describes the calibration procedure required in the course of operation.		○	▲
10. Other Functions	Other functions described		○	▲
11. Inspection and Maintenance	How to conduct maintenance of SM425 and procedures for replacement of deteriorated parts.		○	■
12. Troubleshooting	This section describes measures to be taken when an abnormal condition occurs.		▲	■
CMPL (parts list)	User replaceable parts list		▲	○

- : Read and completely understand before operating the equipment
- : Read before operating the equipment and refer to it whenever necessary
- ▲ : Recommended to read it at least once

## **For the safe use of this equipment**

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### 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 any 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 flowing the calibration gas to ensure there is no leakage.

Condensed moisture from a gas leak may damage the sensor.

---

### DANGER

The SM425 is very heavy. Handle it with care to avoid accidentally dropping it. Always handle safely to avoid personal injury and damage to the instrument.

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

Some process gases are 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 well ventilating the area.

---

#### **(1) About this manual**

- This manual should be passed on to the end user.
- The contents of this manual are subject to change without prior notice.
- The contents of the manual shall not be reproduced or copied, in part or in whole, without permission.
- This manual explains the operation and features of this product, but does not guarantee the instrument will suit the particular purposes of the user.
- Every effort has been made to ensure accuracy in the preparation of this manual; however, should any error or omissions come to the attention of the user, please contact Teledyne Monitor Labs Service Response Center at 1.800.846.6062.
- This manual will not be changed due to any change of specification, construction, and/or parts when the change does not affect the functions or performance of the product.
- If the product is used in a manner not specified in this manual, the safety of this product may be impaired.

**(2) Safety and Modification Precautions**

- Follow the safety precautions in this manual when using the product to ensure protection and safety of personnel, product, and system containing the product.

**(3) The following safety symbols are used on the product as well as in this manual.**

This symbol indicates the operator must follow the instructions in this manual in order to avoid the risk of personnel injury, electric shock, or fatalities. The manual describes what special care the operator must exercise to avoid such risks.



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



This symbol indicates information essential for understanding instrument operation and functions.



This symbol gives additional information to supplement the present topic.



This symbol identifies a reference source.



Protective Ground Terminal



Function Ground Terminal (Do not use the terminal as the protective ground terminal.)



Alternating Current

- Special descriptions in this manual

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

Operation keys, Enclosed in [], displays on the panel “ ”.

(Ex. [MODE] key)

(Ex. Message display → “BASE”)

(Ex. Data display “102” lit, “102” flashing)

- Drawing for flashing  
Indicated in light print. (flashing)

102 (lit)

102

## **NOTICE**

- Specification check.

When the instrument arrives, unpack with care. Verify the instrument has not been damaged during shipment. Verify the specification matched the order and required accessories are not missing. Specifications can be checked by the model code on the nameplate. Refer to Section 0 "Specifications: for the list of model codes.

- Details on operation parameters

When the SM425 Separate type Oxygen Analyzer arrives at the user site, it will operate based on the operation parameters (initial data) set at the factory.

Ensure this configuration is suitable for the application before any testing is performed. Set the instrument parameters for appropriate operation where necessary.

For details to set data, refer to sections 7 to 10.

Document all user changes to the operational configuration.

## **WARRANTY**

- The warranty statement for this product can be found at the Teledyne Monitor Labs web site: <http://www.teledyne-ml.com/>
- Customer shall notify TML of a defect within the warranty period and request a return authorization number and designated TML repair facility. Customer shall return the defective part or parts to the designated TML Customer Service Facility as set forth below, freight prepaid by the customer. TML will prepay the return freight.
- TML will notify the customer of TML's decision to repair or replace the defective part and the expected shipment date.
- At the customer's request, TML may elect to repair defective product(s) located in North America on site, in which case travel expenses, travel time, and related expenses incurred by TML personnel (excluding repair time) shall be paid by the customer.

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## LIST OF APPENDICES

### APPENDIX A: SM425 SPARE PARTS LIST

# USER NOTES

## 1.0 OVERVIEW

The SM425 Separate-type Zircon Oxygen Analyzer is used to monitor and control the oxygen concentration in combustion gases. Applications include boilers and industrial furnaces in industries which consume considerable energy such as steel, electric power, oil, petrochemical, ceramics, paper, pulp, food, textiles, incinerators, and any plant using medium/small boilers. It can help conserve energy in these industries. The SM425 also contributes to preservation of the earth's environment in preventing global warming and air pollution by controlling complete combustion to reduce CO<sub>2</sub>, SO<sub>x</sub>, and NO<sub>x</sub>.

The SM425P Separate-type Detector uses a high-reliability Zirconia sensor with a heater assembly that can be replaced on site. The detector can be mounted on the wall of a flue and measure the gases directly. The SM425P detector is used in applications where sample gas temperatures range from 0 to 700°C. The SM425 analyzer can be used in combustion gases at temperatures up to 1400°C if equipped with a general-use 0.15m long detector and a high-temperature probe adapter, ZO21P-H. Refer to Section 1.2.2 of this manual for detector descriptions and applications.

The converter is equipped with an LCD touch screen display which has various setting displays, calibration information, and oxygen trending. The converter is equipped with various standard functions such as measurement and calculation as well as maintenance functions that include self-test. Analyzer calibration can be fully automated with the SM425CAL, an automatic calibration unit, installed.

Some examples of typical system configurations are illustrated below:

### 1.1 SM425 System Configuration

The system configuration should be determined by the desired operating 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. No piping is required for the reference gas (air) which is fed in at the installation site. The portable ZO21S standard gas unit is used for calibration. Zero gas from this unit and span gas (air) is sent to the detector through piping connected during calibration.



#### CAUTION

- 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.
-

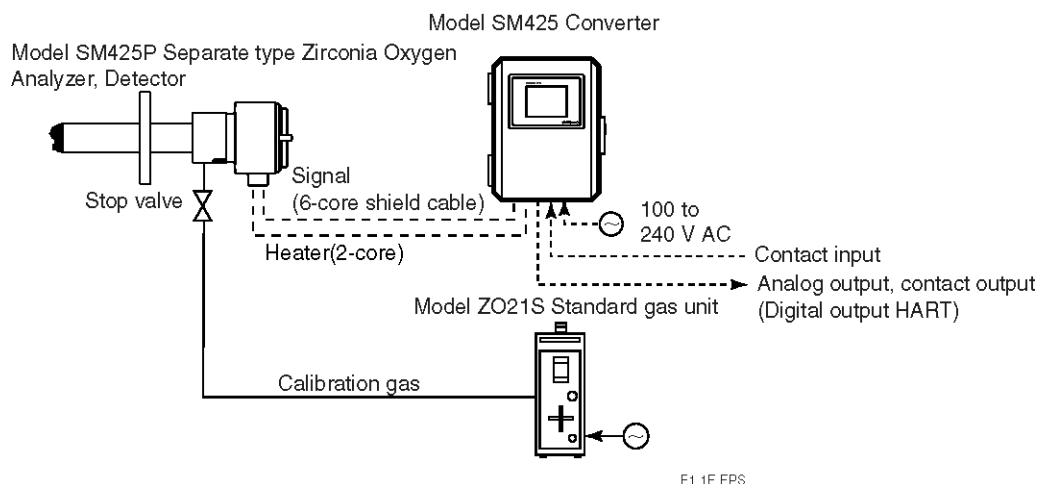


Figure 1-1 System 1

### 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% O<sub>2</sub>) is used as 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).

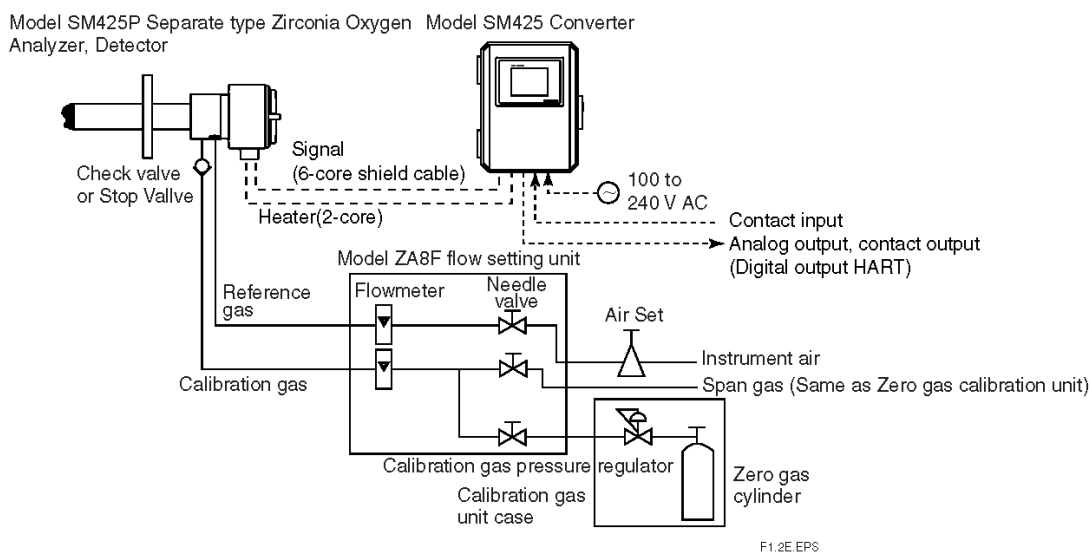
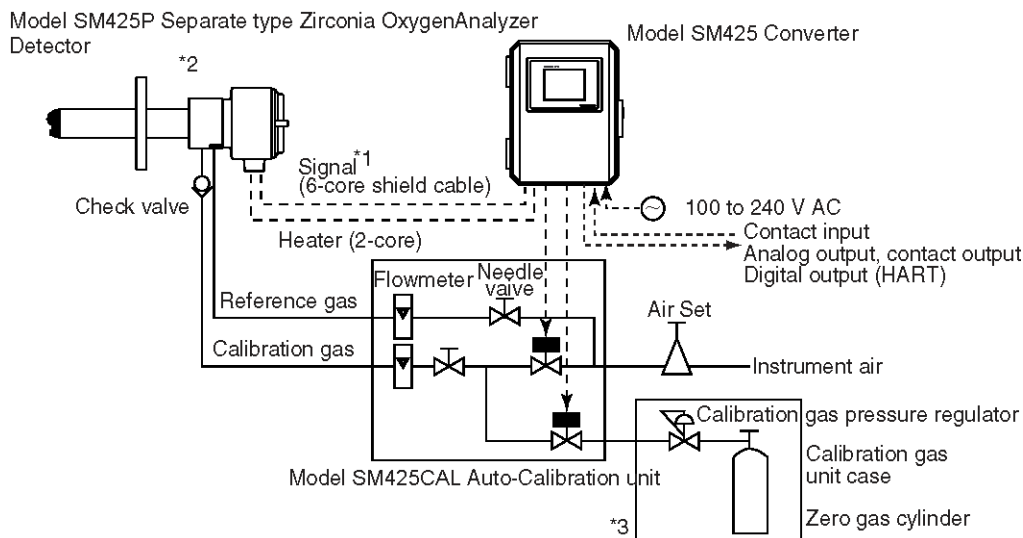


Figure 1-2 System 2

### 1.1.3 System 3

System 3 represents a typical analyzer configuration application for 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.

Figure 1-3 shows the SM425CAL autocalibration unit, with auto-switching of the calibration gas. An external "combustible gas detected" signal is connected to one of the converter input contacts to turn off power to the heater. A converter output contact is used to operate a purge gas valve to supply air to the sensor prior to warm-up.



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Figure 1-3 System 3

- \*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 in 1.2.2.
- \*3 When a zirconia oxygen analyzer is used, 100% N<sub>2</sub> gas cannot be used as the zero gas. Use approximately 1% of O<sub>2</sub> gas (N<sub>2</sub>-based).

## 1.2 SM425 System Components

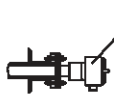
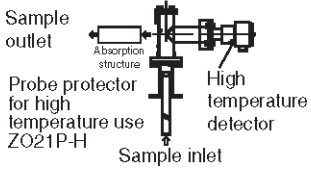
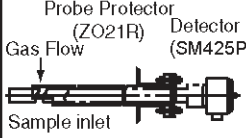

### 1.2.1 System Components

System Components	Sparate type		
	System config.		
	Ex.1	Ex.2	Ex.3
Model SM425P Separate type Zirconia Oxygen Analyzers ,Detector	●	●	●
Model SM425 Separate type Zirconia Oxygen Analyzer, Converter	●	●	●
Model ZO21P-H Adapter for High temperature Probe of separate type Zirconia Oxygen Analyzer	○	○	○
E7046EC, E7046EN Auxiliary Ejector for High temperature of separate type Oxygen Analyzer	○	○	○
Model ZO21R-L Probe Protector for Zirconia Oxygen Analyzers	○	○	○
K9471UA Filter for Oxygen Analyzer	○	○	○
K9471UC Dust Guard Protector	○	○	○
Model ZO21S Standard Gas Unit	●		
Model ZA8F Flow setting unit for manual calibration		●	
Model SM425CAL Automatic Calibration Unit for Separate type Analyzer			●
L9852CB, G7016XH Stop Valve for Calibration-gas line	●	(●)	
K9292DN,K9292DS Check Valve for Calibration-gas line		(●)	●
G7003XF/K9473XK, G7004XF/K9473XG Air Set		●	●
G7001ZC Zero-gas Cylinder		●	●
G7013XF, G7014XF Pressure Regulator for Gas Cylinder		●	●
E7044KF Case Assembly for Calibration-gas Cylinder		●	●
Model ZR22A, ZR202A Heater Assembly (Spare Parts for Model SM425P)	○	○	○

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

1.2.2 Detectors and Accessories

Process gas temperature 0 to 700°C			Process gas temperature 0 to 1400°C		
Mounting	Insertion length	General-use Probe	Application	High temperature detector	Application
Horizontal to vertical	0.4 to 2 m	 Detector (SM425P)	Boiler Heating furnace	 <p>Sample outlet</p> <p>Absorption structure</p> <p>Probe protector for high temperature use ZO21P-H</p> <p>High temperature detector</p> <p>Sample inlet</p>	Heating furnace
Vertical	2.5 m or more				
Horizontal to vertical	3 m or less	 <p>Probe Protector (ZO21R) Detector (SM425P)</p> <p>Gas Flow</p> <p>Sample inlet</p>	For pulverized coal boiler with gas flow velocity 10 m/s or more	<p>Temperature: Probe material SUS310S 800°C Probe material SiC 1400°C</p> <p>Mounting: Vertical downwards</p> <p>Insertion length: 1.0m, 1.5m</p> <p>When duct pressure is atmospheric or negative, attach air ejector. High temperature auxiliary ejector (E7046EC, E7046EN)</p>	
Horizontal to vertical	0.4 to 2 m	 <p>Filter (K9471UA) or Dust Guard Protector (K9471UC) Detector (SM425P)</p>	Black liquid recovery boiler Cement Kiln		
Vertical	2.5 m or more				

F1.4E.EPS



## 2.0 SPECIFICATIONS

This section describes the specifications for the following:

- SM425P General-use separate-type detector (See Section 1.4.1)
- ZO21R-L Probe protector (See Section 1.4.2)
- SM425P (0.15 m) High-temperature separate-type detector (See Section 1.5.1)
- ZO21P-H Adapter for High temperature probe (See Section 1.5.2)
- SM425 Separate type converter (See Section 1.6)
- ZA8F Flow setting unit (See Section 1.7.1)
- SM425CAL Automatic calibration unit (See Section 1.7.2)
- ZO21S Standard gas unit (See Section 1.8)

## 2.1 General Specifications

### 2.1.1 Standard Specifications

Measured Object:

Oxygen concentration in combustion process exhaust gas and mixed gases. If the process gas contains a corrosive gas such as ammonia or chlorine, the SM425 may not be suited to your application. In this case, contact Teledyne Monitor Labs.

Measurement System:

Zirconia system

Oxygen concentration:

0.01 to 100 vol% O<sub>2</sub>

Output Signal:

4 to 20 mA DC (maximum load resistance 550V)

Measurement Range:

Any setting in the range of 0 to 100 vol% O<sub>2</sub> (in 1 vol% O<sub>2</sub>).

Digital Communication (HART):

250 to 550V, 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:

0 to 100 vol% O<sub>2</sub>

Warm-up Time:

Approx. 20 min.

Repeatability:

(Excluding the case where the reference air is by natural convection)

± 0.5% Maximum value of range setting (range up to 0 to 25 vol% O<sub>2</sub>)

± 1% Maximum value of range setting (range from 0 to 25 vol% O<sub>2</sub> up to 0 to 100 vol% O<sub>2</sub>)

Linearity:

(Excluding standard gas tolerance and excluding the case where the reference air flow is natural convection.)

(Use oxygen of known concentration (in the measurement range) as the zero and span calibration gas.)

±1% Maximum value of range setting; from 0 to 5 vol% O<sub>2</sub> to 0 to 25 vol% O<sub>2</sub> range

(Sample gas pressure: within ±4.9 kPa)

±3% Maximum value of range setting; from 0 to 25 vol% O<sub>2</sub> to 0 to 50 vol% O<sub>2</sub> range

(Sample gas pressure: within ±0.49 kPa)

±5% Maximum value of range setting; from 0 to 50 vol% O<sub>2</sub> to 0 to 100 vol% O<sub>2</sub> range (Sample gas pressure: within ±0.49 kPa)

Drift:

(Excluding the first two weeks in use and excluding the case where the reference air flow is natural convection.)

Both zero and span ±2% Maximum value of range setting/month

Response Time:

Response of 90% within 5 seconds. (Measured from time when gas is introduced from calibration gas inlet to time when analog output starts changing in response.)

## 2.2 General-use Separate-type Detector and Related Equipment

General-use separate-type detector SM425P can be used in combination with the probe protector ZO21R-L (see Section 1.4.2).

### 2.2.1 SM425P 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 600°C or greater.

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

For high-temperature sample gas, apply 0.15 m length probe and High temperature Probe Adapter ZO21P-H.

Sample Gas Pressure:

-5 to +250 kPa (When the pressure in the furnace exceeds 3 kPa, it is recommended that you compensate for this pressure. When the pressure in the furnace exceeds 5 kPa, you must perform pressure compensation.)

For 0.15m probe, 0.5 to 5kPa.

No pressure fluctuation in the furnace should be allowed.

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 used with a check valve and a SM425CAL Autocalibration Unit, it is 200 kPa. If the pressure of your sample gas exceeds these limits, consult Teledyne Monitor Labs.

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

Probe Material:

SUS 316 (JIS)

Ambient Temperature:

-20 to +150°C

**Reference Air System:**

Natural Convection, Instrument Air, Pressure Compensation (other than 0.15 m probe length)

**Instrument Air System (excluding Natural Convection):**

Pressure; 200 kPa + the pressure inside the furnace (It is recommended to use air dehumidified with a dew point of -20°C or less, and free of dust and oil mist.)

Consumption; Approx. 1 NI/min

**Material in Contact with Gas:**

SUS 316 (JIS), Zirconia, SUS 304 (JIS) (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 1/4FNPT

**Wiring Connection:**

G1/2, Pg13.5, M20 by 1.5 mm, 1/2 NPT

**Installation:**

Flange mounting

**Probe Mounting Angle:**

Horizontal to vertically downward.

When the probe insertion length is 2 m or less, install at an angle from the horizontal to a vertically downward orientation.

When the probe insertion length is 2.5 m or more, mount vertically downward orientation (within  $\pm 5^\circ$ ). If using a probe protector, install at an angle between the horizontal and a vertically downward orientation (within  $\pm 5^\circ$ ).

**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)

Table 2-1 SM425P codes

Style: S2

Model	Suffix code	Option code	Description	
SM425P	-----	-----	Separate type Zirconia Oxygen/ High Temperature Humidity Analyzer, Detector	
Length	-015	-----	0.15 m (for high temperature use) (*1)	
	-040	-----	0.4 m	
	-070	-----	0.7 m	
	-100	-----	1.0 m	
	-150	-----	1.5 m	
	-200	-----	2.0 m	
	-250	-----	2.5 m (*2)	
	-300	-----	3.0 m (*2)	
	-360	-----	3.6 m (*2)	
	-420	-----	4.2 m (*2)	
	-480	-----	4.8 m (*2)	
	-540	-----	5.4 m (*2)	
Wetted material	-S	-----	SUS316	
	-C	-----	Stainless steel with Inconel calibration gas tube (*11)	
Flange (*3)	-A	-----	ANSI Class 150 2 RF SUS304	
	-B	-----	ANSI Class 150 3 RF SUS304	
	-C	-----	ANSI Class 150 4 RF SUS304	
	-E	-----	DIN PN10 DN50 A SUS304	
	-F	-----	DIN PN10 DN80 A SUS304	
	-G	-----	DIN PN10 DN100 A SUS304	
	-K	-----	JIS 5K 65 FF SUS304	
	-L	-----	JIS 10K 65 FF SUS304	
	-M	-----	JIS 10K 80 FF SUS304	
	-P	-----	JIS 10K 100 FF SUS304	
	-Q	-----	JIS 5K 32 FF SUS304 (for high temperature use) (*4)	
	-R	-----	JPI Class 150 4 RF SUS304	
-S	-----	JPI Class 150 3 RF SUS304		
-W	-----	Westinghouse		
Reference air	-C	-----	Natural convection	
	-E	-----	External connection (Instrument air) (*12)	
	-P	-----	Pressure compensated (*12)	
Gas Thread	-R	-----	Rc 1/4	
	-T	-----	1/4 FNPT	
Connection box thread	-P	-----	G1/2	
	-G	-----	Pg13.5	
	-M	-----	M20 x1.5 mm	
	-T	-----	1/2NPT	
	-Q	-----	Quick connect (*9)	
Instruction manual	-E	-----	English	
—	-A	-----	Always -A	
Options	/D	-----	DERAKANE coating (*10)	
	/C	-----	Inconel bolt (*5)	
	Valves	/CV	-----	Check valve (*6)
		/SV	-----	Stop valve (*6)
	Filter	/F1	-----	Dust Filter (*7)
		/F2	-----	Dust Guard Protector (*7)
	Tag plates	/SCT	-----	Stainless steel tag plate (*8)
		/PT	-----	Printed tag plate (*8)

\*1 Used with the ZO21P High Temperature Probe Adapter. Select flange (-Q).  
 \*2 When installing horizontally the probe whose insertion length is 2.5 meters or more, 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 air. 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 Available only in the U.S. DERAKANE is a registered trademark of the Dow Chemical Company.  
 \*11 Recommended if measured gas contains corrosive gas like chlorine.  
 \*12 Piping for reference air must be installed to supply reference air constantly at a specified flow rate.

T2.1 EPS

EXTERNAL DIMENSIONS

1. SM425P Separate type Zirconia Oxygen Analyzer, Detectors

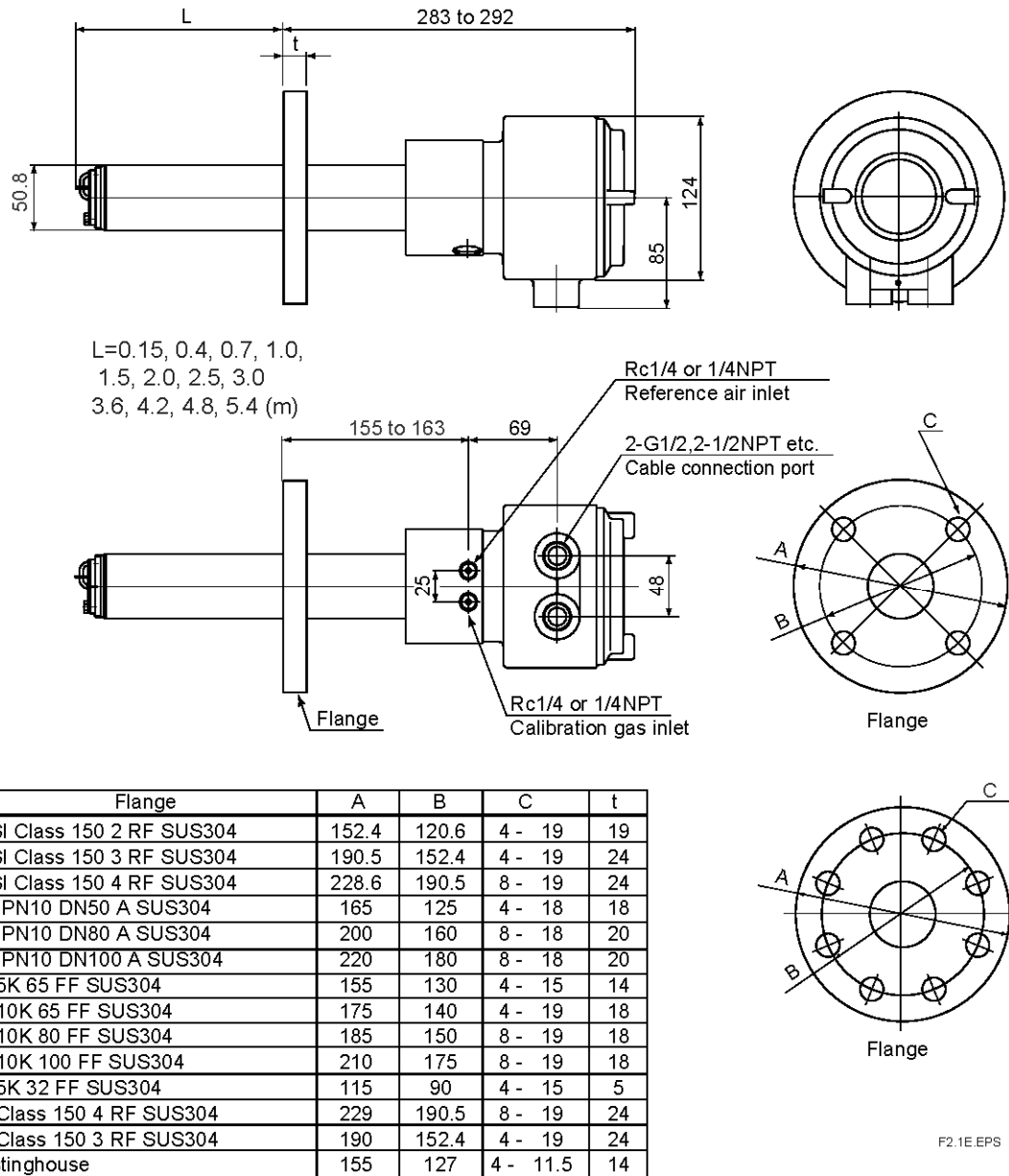


Figure 2-1 External dimensions of SM425P

SM425P...-P (with pressure compensation) Separate type Zirconia Oxygen Analyzer, Detectors

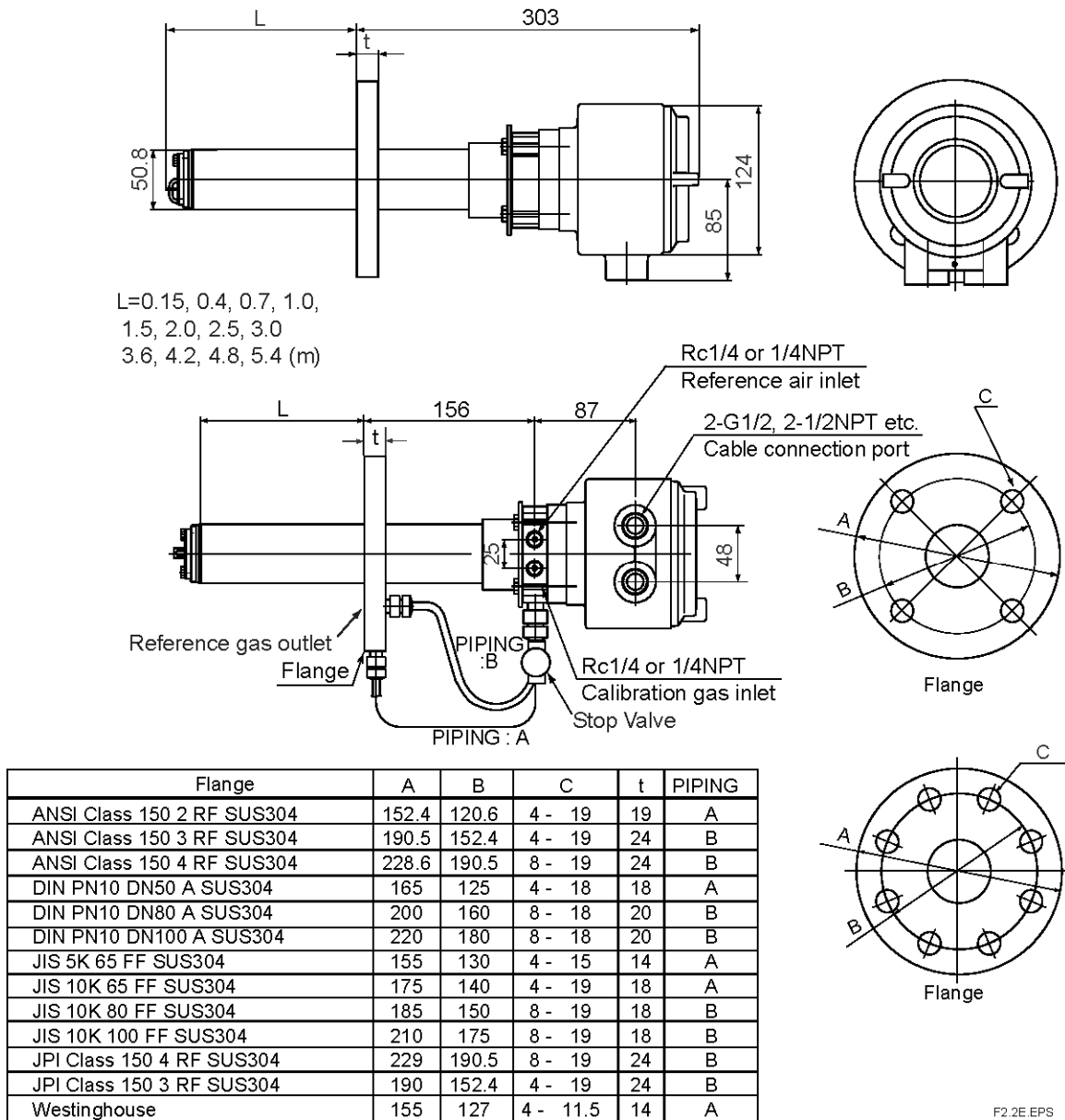


Figure 2-2 External dimensions of pressure compensated detector

### 2.2.2 ZO21R-L Probe Protector

This probe protector is required by the general-use detector in powdered coal boilers or in fluidized furnace applications to prevent particulate damage when gas flow exceeds 10 m/s.

Select the probe protector ZO21R-L- $\frac{1}{2}$ \*B appropriate for your application.

Insertion Length:

1.05 m, 1.55 m, 2.05 m.

Flange:

JIS 5K 65A FF SUS304 ANSI Class 150 4 FF (without serration). However, flange thickness is different.

Material:

SUS316 (JIS), SUS304 (JIS) (Flange)

Weight:

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

Installation:

Bolts, nuts, and washers are provided for detector, probe adapter and process-side flange.

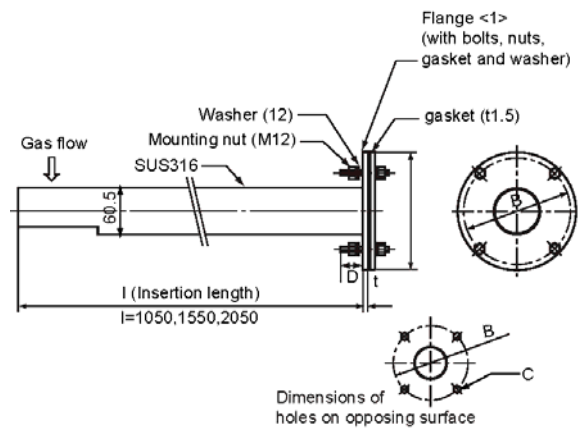
**Table 2-2 Probe protector codes**

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 SUS304
	-A - - - - -	- - - - -	ANSI Class 150 4 FF SUS304
Style code	*B - - - - -	- - - - -	Style B

\*1 Thickness of flange depends on dimensions of flange.

T2.2E.EPS

Unit mm



Flange<1>	A	B	C	t	D
JIS 5K 65 FF SUS304	155	130	4 - 15	5	40
ANSI Class 150 4 FF SUS304	228.6	190.5	8 - 19	12	50

F2.3E.EPS

**Figure 2-3 Probe protector hole pattern**

## 2.3 High-Temperature Separate-type Detector and Related Equipment

### 2.3.1 SM425P (0.15m) High-Temperature Separate-type Detector

Standard Specifications

Construction:

Water-resistant, non-explosion proof

Probe length:

0.15 m

Terminal box:

Aluminum alloy

Probe material:

Probe material in contact with gas: SUS 316 (JIS) (Probe), SUS 304 (JIS) (Flange), Zirconia (Sensor), Hastelloy B, (Inconel 600, 601)

Weight:

Approx. 3 kg

Installation:

Flange mounting (The use of high-temperature detector probe adapter ZO21P-H is necessary.)

Flange standard:

JIS 5 K 32 FF equivalent (thickness varies)

Mounting angle:

Any angle between the 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 3 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<sub>2</sub>, - 0.5 to + 0.5 kPa. (An auxiliary ejector is required for negative pressure application.)

Model and Code

Refer to "Model and Code" in



Table 2-1.

External Dimensions - refer to Figure 2-1.

### 2.3.2 ZO21P-H Adapter for High-Temperature Probe

The probe adapter is used to lower the sample gas temperature to below 700°C (below 300°C at probe adapter surface) before it is fed to the detector.

Insertion length:

1 m or 1.5 m

Material in Contact with Gas:

SUS 316 (JIS), Zirconia, SiC or SUS 310S, SUS 304(JIS) (flange)

Probe Material:

SiC, SUS 310S (JIS)

Installation:

Flange mounting (FF type or RF type)

Probe Mounting Angle:

Vertically downward within  $\pm 5^\circ$

Where the probe material is SUS 310S, horizontal mounting is available.

Construction:

Non explosion-proof. Rainproof construction

Weight:

Insertion length of 1.0 m: approx. 6.5 kg (JIS) / approx. 8.5 kg (ANSI)

Insertion length of 1.5 m: approx. 7.5 kg (JIS) / approx. 9.5 kg (ANSI)

Sample gas temperature:

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

Sample gas pressure:

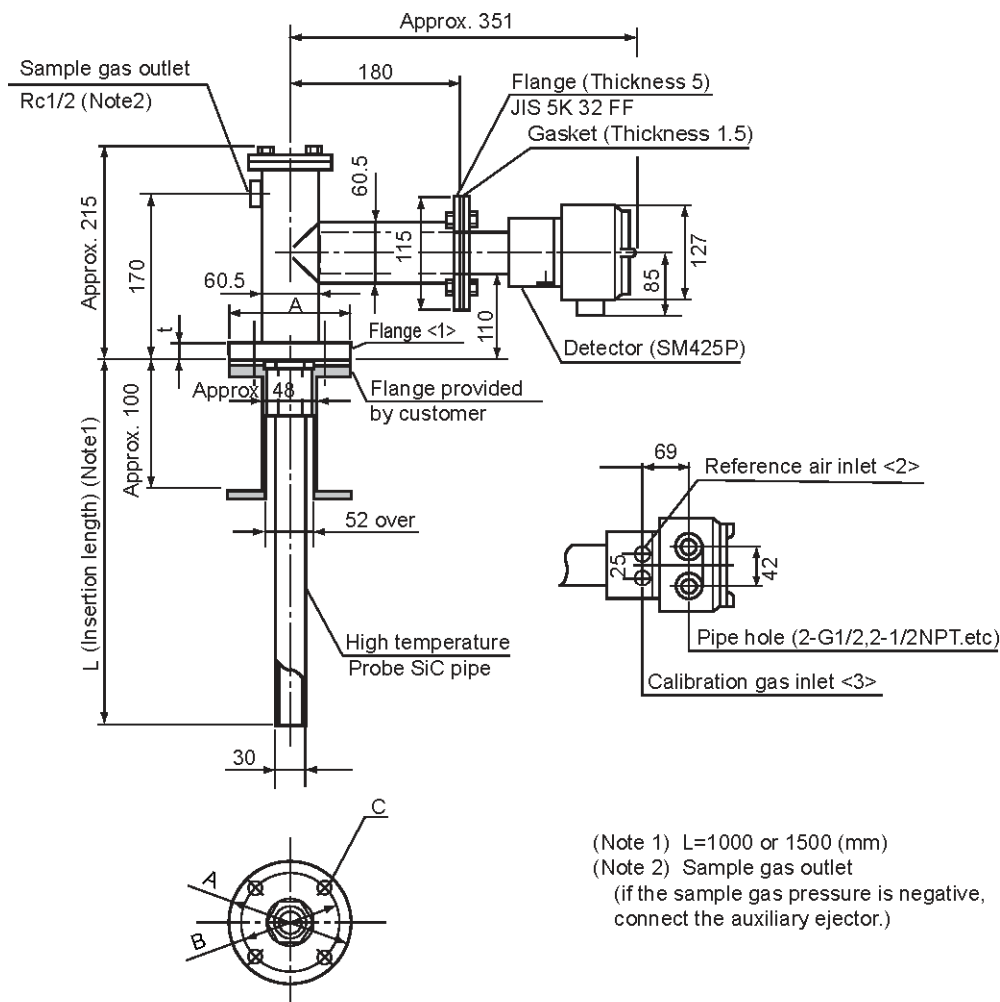
-0.5 to + 5 kPa. When using in the range of 0 to 25 vol% O<sub>2</sub> or more, the sample gas pressure should be in the range of - 0.5 to + 0.5 kPa. (Where the sample gas pressure for the high-temperature probe is negative, an auxiliary ejector is necessary.)

**Table 2-3 High temperature probe adapter codes**

Model	Suffix code	Option code	Description
ZO21P	-H .....	.....	High Temperature Probe Adapter
Material	-A .....	.....	SiC
	-B .....	.....	SUS 310S
Insertion Length	-100 .....	.....	1.0 m
	-150 .....	.....	1.5 m
Flange	-J .....	.....	JIS 5K 50 FF SUS304
	-N .....	.....	JIS 10K 65 FF SUS304
	-M .....	.....	JIS 10K 80 FF SUS304
	-L .....	.....	JIS 10K 100 FF SUS304
	-A .....	.....	ANSI Class 150 4 RF SUS304
	-R .....	.....	ANSI Class 150 2 1/2 RF SUS304
	-Q .....	.....	ANSI Class 150 3 RF SUS304
	-T .....	.....	JPI Class 150 3 RF SUS304
	-S .....	.....	JPI Class 150 4 RF SUS304
	-E .....	.....	DIN PN10 DN50 A SUS304
Style code	*A .....	.....	Style A

T2.3E.EPS

Unit: mm



(Note 1) L=1000 or 1500 (mm)  
 (Note 2) Sample gas outlet  
 (if the sample gas pressure is negative,  
 connect the auxiliary ejector.)

<1> Flange	<2>,<3> joint	A	B	C	t
JIS 5K 50 FF SUS304	Rc 1/4	130	105	4- 15	14
ANSI Class 150 4 RF SUS304	1/4 FNPT	228.6	190.5	8- 19	24

F2.4E.EPS

Figure 2-4 Dimensions of high temperature probe adapter

## 2.4 SM425 Separate-type Converter

### 2.4.1 Standard Specification

The SM425 Separate-type Converter can be controlled by LCD touch screen on the converter.

Display:

LCD display of size 320 by 240 dots with touch screen.

Output Signal:

4 to 20 mA DC, two points (maximum load resistance 550 ohms)

Contact Output Signal:

Four points (one is fail-safe, normally open)

Contact Input:

Two points

Auto-calibration Output:

Two points (for dedicated auto-calibration unit)

Ambient Temperature:

- 20 to + 55°C

Storage Temperature:

- 30 to + 70°C

Humidity Ambient:

0 to 95%RH (Non-condensing)

Installation Altitude:

2000 m or less

Category based on IEC 1010:

II (Note)

Pollution degree based on IEC 1010:

2 (Note)

Note: Installation category, or over-voltage category, specifies impulse withstanding 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.

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.

Safety and EMC conforming standards

Safety:

EN61010-1

CSA C22.2 No.61010-1

UL61010-1

EMC:

EN 61326 Class A  
EN 55011 Class A Group 1  
EN 61000-3-2  
AS/NZS CISPR 11

This instrument is a Class A product, and it is designed for use in an industrial environment.

Maximum Distance between Probe and Converter:

Conductor two-way resistance must be 10  $\Omega$  or less (when a 1.25 mm cable or equivalent is used, 300 m or less.)

Construction:

Outdoor installation, equivalent to NEMA 4X/IP66 (with conduit holes completely sealed with a cable gland)

Wiring Connection:

G 1/2, Pg13.5, M20 X 1.5 mm, 1/2 NPT, eight holes

Installation:

Panel, wall, or 2-inch 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

## 2.4.2 Functions

Display Functions:

Value Display; Displays values of the measured oxygen concentration.

Graph Display; Displays trends of measured oxygen concentration

Data Display; Displays maintenance data, such as cell temperature, reference junction temperature, or maximum/minimum oxygen concentration.

Status Message; Indicates an alarm or error condition with flashing of the corresponding icon. Indicates status such as warm-up or calibration by symbols.

Alarm, Error Display; Displays alarms such as "Abnormal oxygen concentration" or errors such as "Abnormal cell emf."

Calibration Functions:

Auto-Calibration; Requires an Auto-calibration unit. It calibrates automatically at specified intervals.

Semi-autocalibration; requires an Auto-calibration unit. Calibration is initiated either by the touch panel or an input control signal.

Manual Calibration; Calibration performed by manually opening/closing the calibration gas valve.

**Blowback Function:**

Output contacts can be programmed to indicate blowback status. Auto/semi-auto selectable.

**Maintenance Functions:**

Displays data parameters, calibration data parameters, blowback data parameters, current output loop check, and input/output contact check.

**Setup Functions:**

Displays equipment parameters, current output data parameters, alarm data parameters, contact data settings, other parameters.

**Self-diagnosis:**

Initiates diagnoses of the converter and probe. Indicates when any abnormal condition occurs.

**Password Functions:**

Password protection can be setup for analyzer operation.

**Display and Data Parameters:****Measuring-related items:**

Oxygen concentration (vol% O<sub>2</sub>), Output current value (mA), air ratio, and moisture quantity (in hot gases) (vol% H<sub>2</sub>O)

**Display Items:**

Cell temperature (°C), thermocouple reference junction temperature (°C), maximum/minimum/average oxygen concentration (vol% O<sub>2</sub>), cell emf. (mV), cell internal resistance (V), cell condition (in four grades), heater on-time rate (%), calibration record (ten times), and time (year/month/day, hour/minute)

**Calibration Parameters:**

Span gas concentration (vol% O<sub>2</sub>), zero-gas concentration (vol% O<sub>2</sub>), 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 period (day/hour), and 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 blowback)/abnormal, 4 mA/20 mA point oxygen concentration (vol% O<sub>2</sub>), and time constant.

**Alarm Related Items:**

Oxygen concentration high-alarm/high-high alarm limit values (vol% O<sub>2</sub>), Oxygen concentration low-alarm/low-low alarm limit values (vol% O<sub>2</sub>), Oxygen concentration alarm hysteresis (vol% O<sub>2</sub>), Oxygen concentration alarm detection, and alarm delay (seconds)

**Contact Related Items:**

Selection of contact input 1 and 2, and selection of contact output 1 to 3 (abnormal, high-high alarm, high-alarm, low-alarm, low-low alarm, maintenance, calibrating, range switching, warming-

up, calibration-gas pressure decrease, temperature high-alarm, blowback, flameout gas detection, calibration coefficient alarm, startup power stabilization timeout alarm)

#### Converter Output:

Two channels of mA analog output (4 to 20 mA DC (maximum load resistance of 550  $\Omega$ )) and one mA digital output point (HART) (minimum load resistance of 250  $\Omega$ ).

Range: any setting between 0 to 100 vol% O<sub>2</sub> in increments 1 vol% O<sub>2</sub>, or partial range is available

For the log output, the minimum range value is fixed at 0.1 vol% O<sub>2</sub>.

4 to 20 mA DC linear or log can be selected.

Input/output isolation provided.

Output damping: 0 to 255 seconds.

Can select hold or non-hold and set preset value for hold.

#### Contact Output:

Four channels, contact capacity 30 V DC 3 A, 250V AC 3 A (resistive load)

Three of the output channels are selectable to either normally energized or normally de-energized status.

Delayed functions (0 to 255 seconds) and hysteresis function (0 to 9.9 vol% O<sub>2</sub>) 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) Blowback start, (13) Flameout gas detection (answerback 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.

#### Contact Input:

Two input channels, dry voltage 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, and defective digital circuit

#### Calibration:

Method; zero/span calibration

Calibration mode; automatic, semi-automatic, or manual (All are operated interactively with an LCD touch panel). Either zero or span can be skipped.

Zero calibration-gas concentration setting range: 0.3 to 100 vol% O<sub>2</sub> (in increments of 0.01 vol% O<sub>2</sub> in smallest units).

Span calibration-gas concentration setting range: 4.5 to 100 vol% O<sub>2</sub> (in increments of 0.01 vol% O<sub>2</sub> in smallest units).

Use nitrogen-based gas mixture containing 10 vol% O<sub>2</sub>, and 80 to 100 vol% O<sub>2</sub> for standard zero-gas and standard span-gas respectively.

Calibration period; date/time setting: maximum 255 days

### Model and Codes

**Table 2-4 SM425 converter codes**

Model	Suffix code	Option code	Description
SM425	-----	-----	Separate type Zirconia Oxygen Analyzer, Converter
Converter thread	-P	-----	G1/2
	-G	-----	Pg13.5
	-M	-----	M20x1.5 mm
	-T	-----	1/2NPT
Display	-J	-----	Japanese
	-E	-----	English
	-G	-----	German
	-F	-----	French
	-C	-----	Chinese
Instruction manual	-E	-----	English
—	-A	-----	Always -A
Options		/HS	Set for Humidity Analyzer (*1)
		/H	Hood (*3)
	Tag plates	/SCT	Stainless steel tag plate (*2)
		/PT	Printed tag plate (*2)
	NAMUR NE43 compliant	/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.

T2.4E EPS

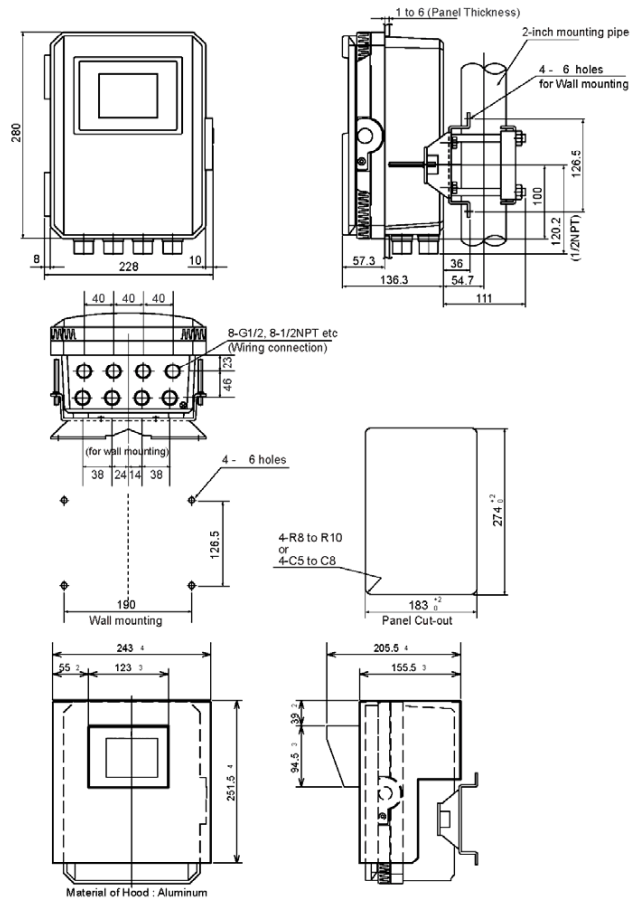
\*2 Specify either /SCT or /PT option code.

\*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 125V AC or greater, or in the EEC, the ZO21D cannot be used with the ZR402G.

External Dimensions



Accessories

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	

F2.5E EPG

Figure 2-5 SM425 converter dimensions



## 2.5 ZA8F Flow Setting Unit and SM425CAL 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).

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

#### Standard Specifications

Flowmeter:

Calibration gas; 0.1 to 1.0 l/min. Reference air; 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)

Pipe Connections:

Rc1/4 or 1/4FNPT

Reference Air pressure:

Clean air supply of measured gas pressure approx. 50 kPa G (or measured gas pressure plus approx. 150 kPa G when a check valve is used)

Pressure at inlet of the autocalibration unit. (Maximum 300 kPaG)

Air Consumption:

Approx. 1.5 l/min

Weight:

Approx. 2.3kg

Calibration gas (zero gas, span gas) flow 0.7 l/m (at calibration time only)



#### Note

Use instrument air for span calibration gas, if no instrument air is available, contact Teledyne Monitor Labs.

**Table 2-5 Flow setting unit codes**

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

T2.5E.EPS

External Dimensions

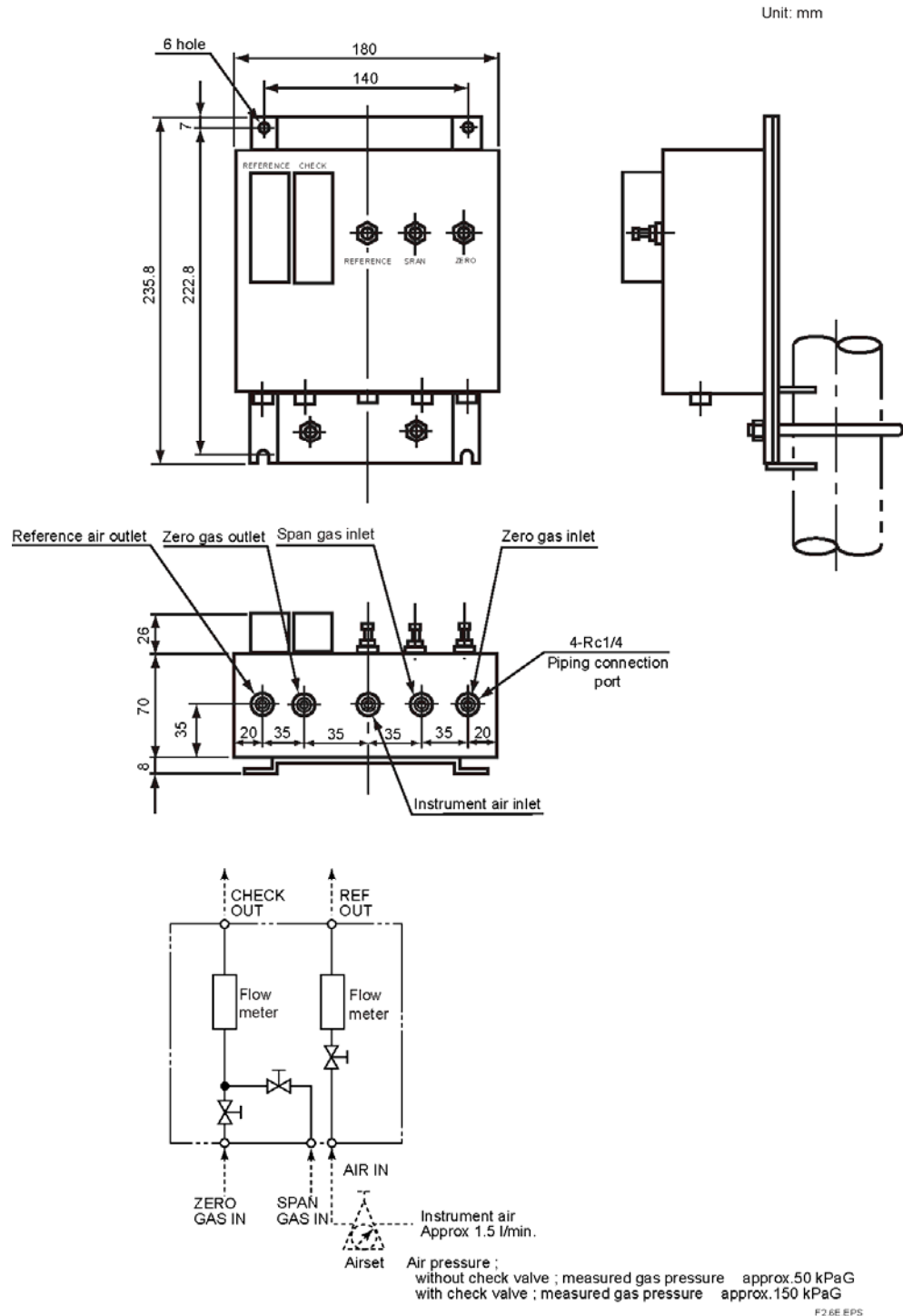


Figure 2-6 Flow setting unit dimensions

### 2.5.2 SM425CAL Automatic Calibration Unit

An automatic calibration unit supplies a specified flow of reference gas and calibration gas during automatic calibration of the detector.

#### Specifications

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

#### Construction:

Dust-proof and rainproof construction:

NEMA 4X/IP67 solenoid valve only (excluding flowmeter)

#### Mounting:

2-inch pipe or wall mounting, no vibration

#### Materials:

Body; Aluminum alloy, Piping; SUS316 (JIS), SUS304 (JIS), Flowmeter; MA (acrylic resin).  
Bracket; SUS304 (JIS)

#### Finish:

Polyurethane corrosion-resistance coating, mint green (Munsell 5.6BG3.3/2.9)

#### Piping Connection:

Refer to Model and Suffix Codes

#### Power Supply:

24V DC (from SM425), Power consumption; Approx. 1.3W

Reference Air Pressure: Sample gas pressure + Approx. 150 kPa (690 kPa max.), (Pressure at inlet of auto-calibration unit)

#### Air Consumption:

Approx. 1.5 l/min

#### Weight:

Approx. 3.5 kg

#### Ambient Temperature:

- 20 to + 55°C, no condensation or freezing

#### Ambient Humidity:

0 to 95% RH

#### Storage Temperature:

- 30 to + 65°C

**Model and Codes**

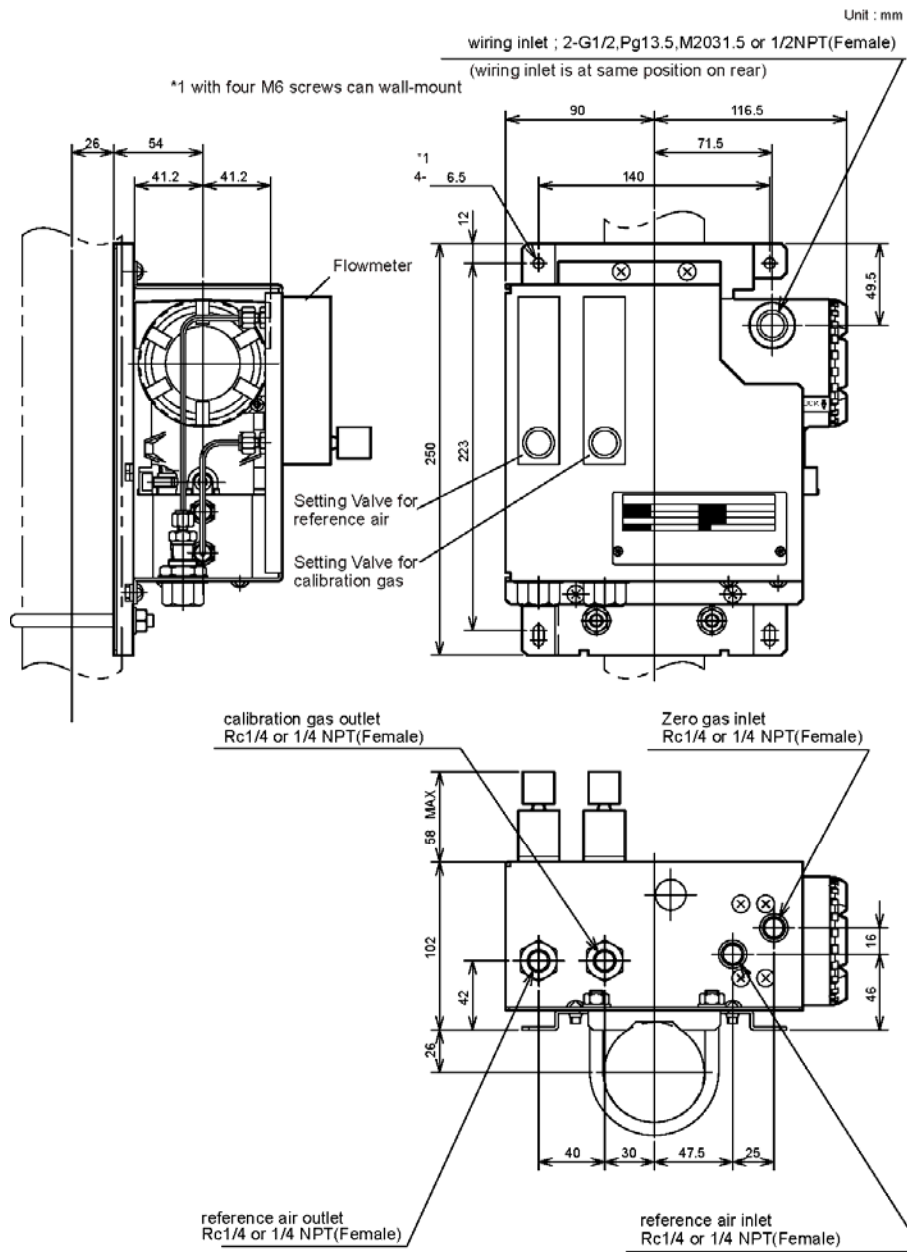
**Table 2-6 SM425CAL codes**

Model	Suffix code	Option code	Description
SM425CAL	.....	.....	Automatic calibration unit for SM425
Gas piping connection	-R	.....	Rc 1/4
	-T	.....	1/4" NPT
Wiring connection	-P	.....	Pipe connection (G1/2)
	-G	.....	Pg 13.5
	-M	.....	20 mm (M20 x 1.5)
	-T	.....	1/2 NPT
-		-A	Always -A

T2.5-1E.EPS

External Dimensions

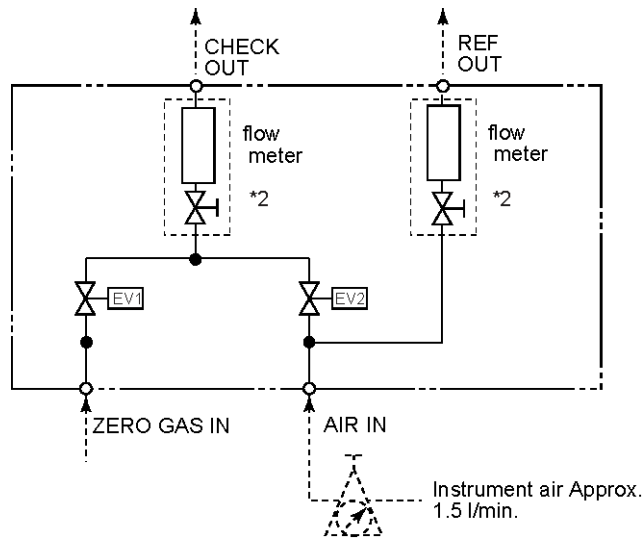
2B pipe mounting example



F2.6-2E EPS

Figure 2-7 SM425CAL external dimensions

**Piping Diagram**



F2.6-3E.EPS

\*2 Needle valve is supplied as accessory with flow meter.

**Figure 2-8 SM425CAL plumbing diagram**

## 2.6 ZO21S Standard Gas Unit

This is a zero gas and span gas source for a System 1 configuration. It is used in combination with the detector only during calibration.

### 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 kPa G (at 35°C)

Composition:

0.95 to 1.0 vol% O<sub>2</sub>+ N<sub>2</sub> based

Power Supply:

100, 110, 115, 200, 220, 240 VAC ± 10%, 50/60 Hz

Power Consumption:

Max. 5 VA

Case material:

SPCC (cold rolled steel sheet)

Print:

Epoxy resin, baked

Paint Color:

Mainframe; Munsell 2.0 GY3.1/0.5 equivalent

Cover; Munsell 2.8 GY6.4/0.9 equivalent

Piping:

Ø6x Ø4 mm flexible tube connection

Weight:

Approx. 3 kg

Span gas:

Internal pump draws in air from atmosphere and feeds to detector

\* Non CE Mark.

**Model and Codes**

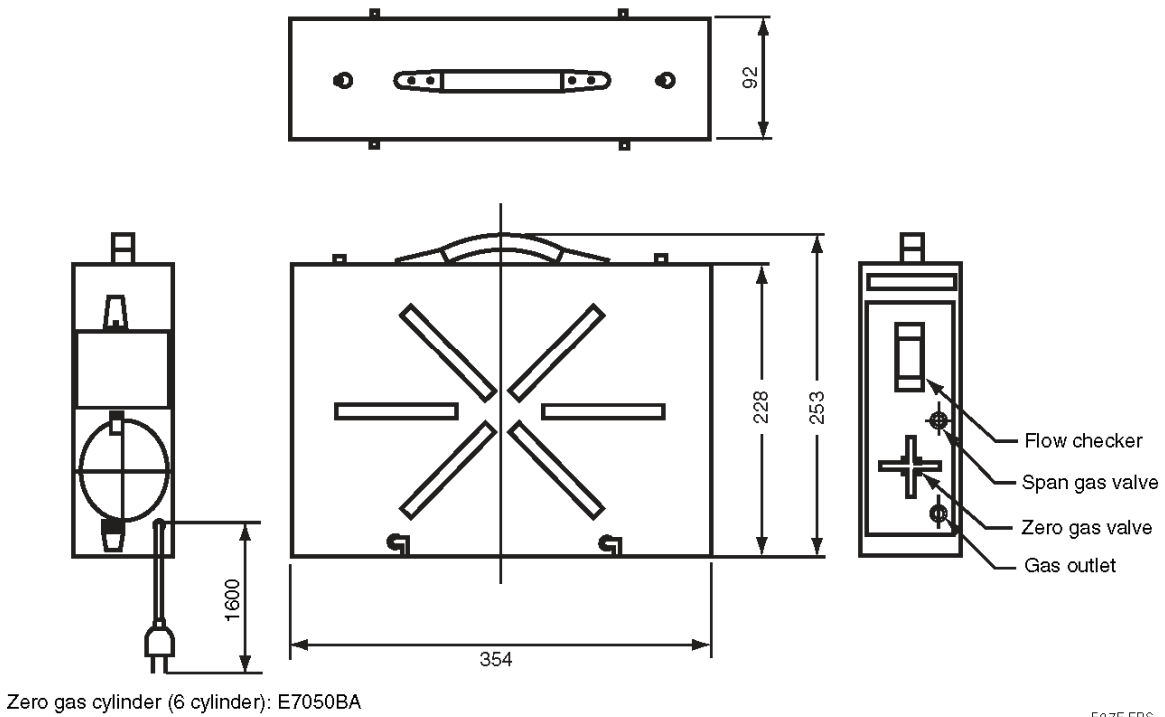
**Table 2-7 Standard gas unit codes**

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	-E .....	.....	English version
Style code	*A .....	.....	Style A

T2.6E.EPS

**External Dimensions**

Unit : mm



F27E.EPS

**Figure 2-9 Standard gas unit external dimensions**



## 2.7 Other Equipment

### 2.7.1 Dust Filter for the Detector (Part No.: 96751017)

This filter is used to protect the detector sensor in a high particulate application.

This filter requires a measurement gas flow of 1m/sec or faster for circulation of the gas.

#### Standard specification

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

Mesh: 30 microns

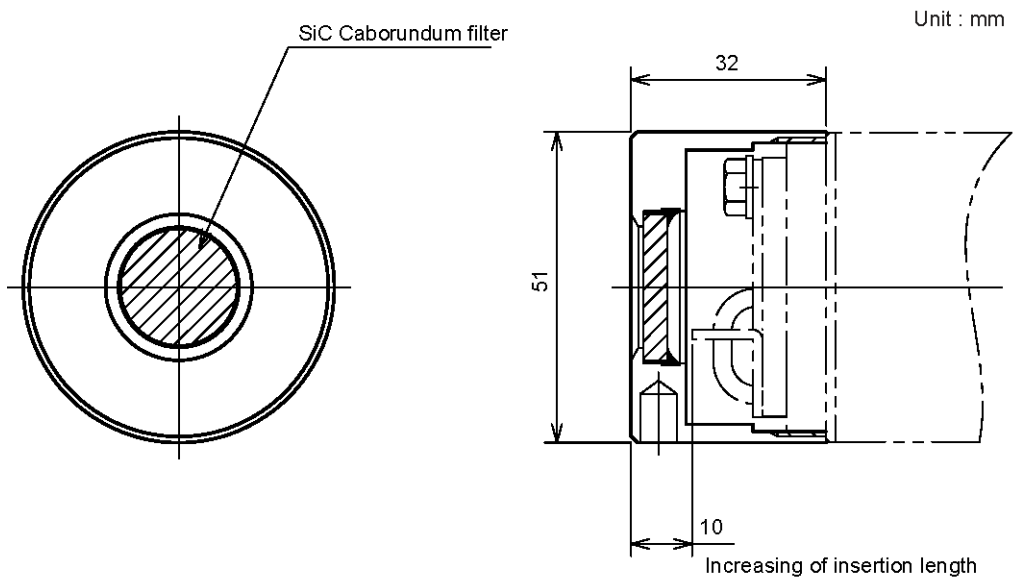
Material: Sic (Filter), SUS316 (JIS)

Weight: Approx. 0.2 kg

**Table 2-8 Filter part numbers**

Part No.	Description
K9471UA	Filter
K9471UX	Tool

T2.7E.EPS



F2.8E.EPS

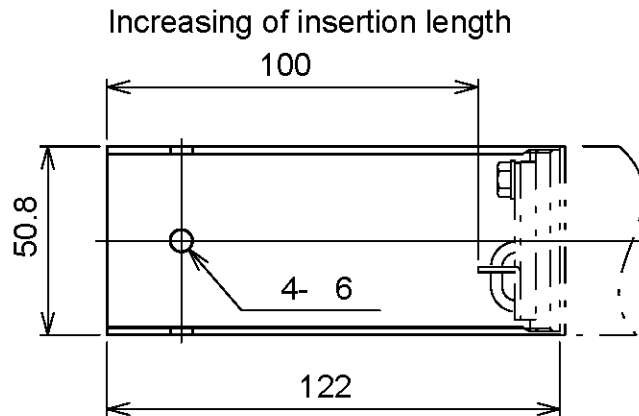
**Figure 2-10 Dust filter dimensions**

### 2.7.2 Dust Guard Protector (Part No.: K9471UC)

Recommended when process gas flows directly into the measurement cell, flammable particulate flows into the measurement cell, or water droplets may leak into the measurement cell during downtime.

Material: SUS316

Weight: Approx. 0.3 kg



F11-1.eps

Figure 2-11 Dust guard protector dimensions

### 2.7.3 Auxiliary Ejector for High Temperature (Part No. E7046EC or E7046EN)

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

#### Standard Specifications

##### Ejector Assembly

Ejector Inlet Air Pressure: 29 to 68 kPa G

Air Consumption: Approx. 30 to 40 l/min

Suction gas flow rate: 3 to 7 l/min

Connection to high-temperature probe adapter: R 1/2

Connection: Rc1/4 or 1/4 FNPT, SUS304 (JIS)

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

##### Pressure Gauge Assembly

Type: JIS B7505, A1.5U3/8 x75

Material in Contact with Gas: SUS316 (JIS)

Case Material: Aluminum alloy (Paint color; black)

Scale: 0 to 100 kPa G

Bushing (G3/8 x Rc1/4 or 1/4NPT, SUS304 (JIS))

##### Needle Valve

Connection: Rc1/4 or 1/4FNPT

Material: SUS316 (JIS)

**Table 2-9 Auxiliary ejector part numbers**

Part No.	Description
E7046EC	RC 1/4 06/04 mm TUBE joint: SUS304 (JIS)
E7046EN	1/4 NPT, 1/4 TUBE joint: SUS304 (JIS)

T2.8E.EPS

E7046EC : Piping connections, Rc1/4 or Rc1/4  
 E7046EN : Piping connections, 1/4NPT female or 1/4NPT male

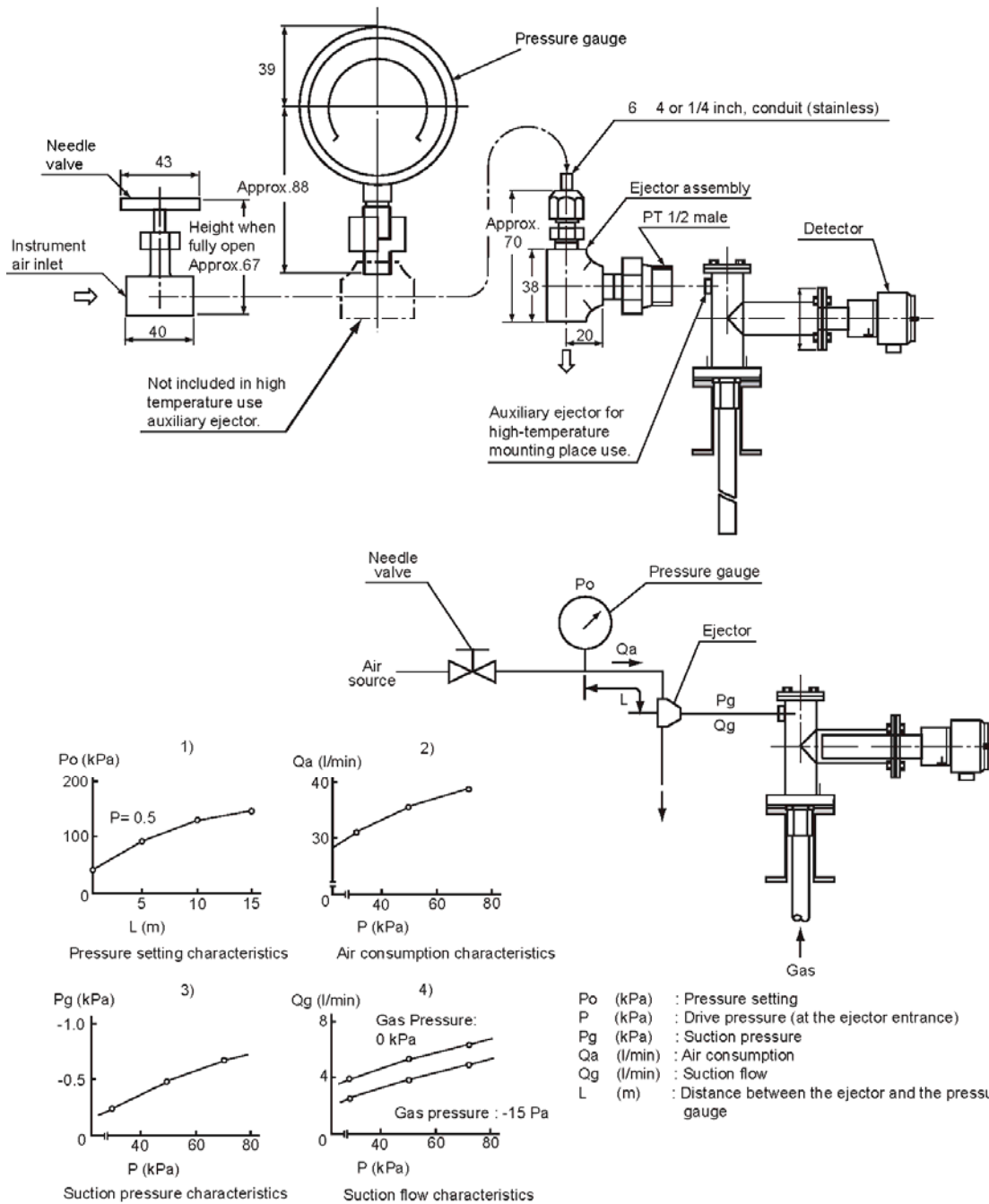


Figure 2-12 Auxiliary ejector for high temperature

(Note: Pipes and connectors are not included.)

**< Pressure setting for the auxiliary ejector for high-temperature use >**

Pressure supply for the auxiliary ejector should be set to a measured gas flow of approximately 5 l/min.

To set this, proceed as follows: (refer to Figure 2-12)

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.
2. Draw a line vertically down from the point of intersection to the axis to find the drive pressure,  $P$  (at the ejector entrance).
3. In Graph 1, determine  $P_o$  (pressure setting) from  $L$  (the distance between the ejector and the pressure gauge).
4. 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 1.11.2 and Section 1.18.4 for details.

---

**Graph explanation** (Figure 2-12)

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 measured 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.

### 2.7.4 Stop Valve (Part No. L9852CB or G7016XH)

This valve mounted on the calibration gas line in the system allows for one-touch calibration. This is applies to the system configuration shown for system 1 in section 0.

#### Standard Specifications

Connection: RC 1/4 or 1/4 FNPT

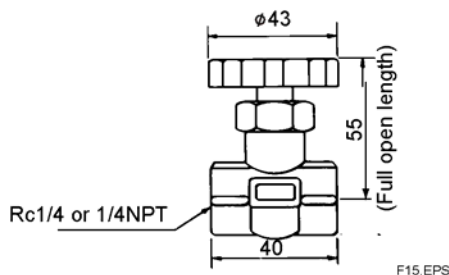
Material: SUS 316 (JIS)

Weight: Approx. 80 g

**Table 2-10 Stop valve part numbers**

Part No.	Description
L9852CB	Joint: RC 1/4, Material: SUS 316 (JIS)
G7016XH	Joint: 1/4 NPT, Material: SUS316 (JIS)

T2.9E.EPS



**Figure 2-13 Stop valve**

### 2.7.5 Check Valve (Part No. K9292DN or 96751016)

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 process gas from entering the calibration gas line.

#### Standard Specifications

Connection: Rc1/4 or 1/4FNPT

Material: SUS304 (JIS)

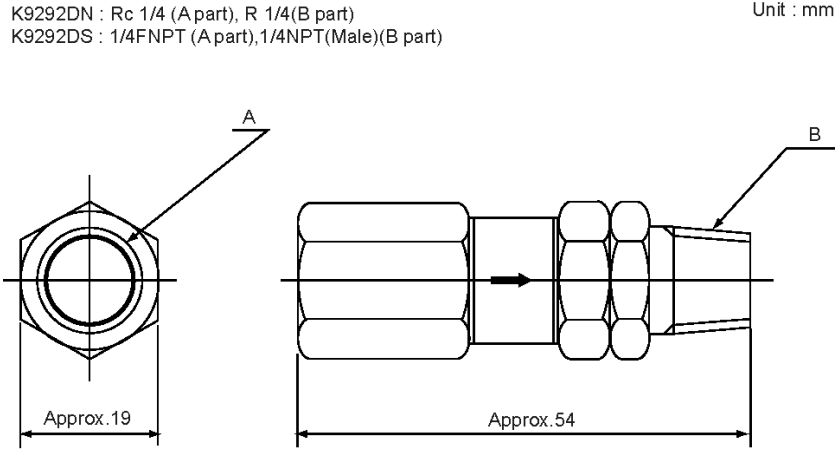
Pressure: 70 kPa G or more and 350 kPa G or less

Weight: Approx. 40 g

**Table 2-11 Check valve part numbers**

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

T2.10E.EPS



F2.11E.EPS

**Figure 2-14 Check Valve**

**2.7.6 Air Set**

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

**Part No. G7003XF or K9473XK**

**Standard Specifications**

Primary Pressure: Max. 1 MPa G

Secondary Pressure: 0.02 to 0.2 MPa G

Connection: Rc1/4 or 1/4FNPT (includes joint adapter)

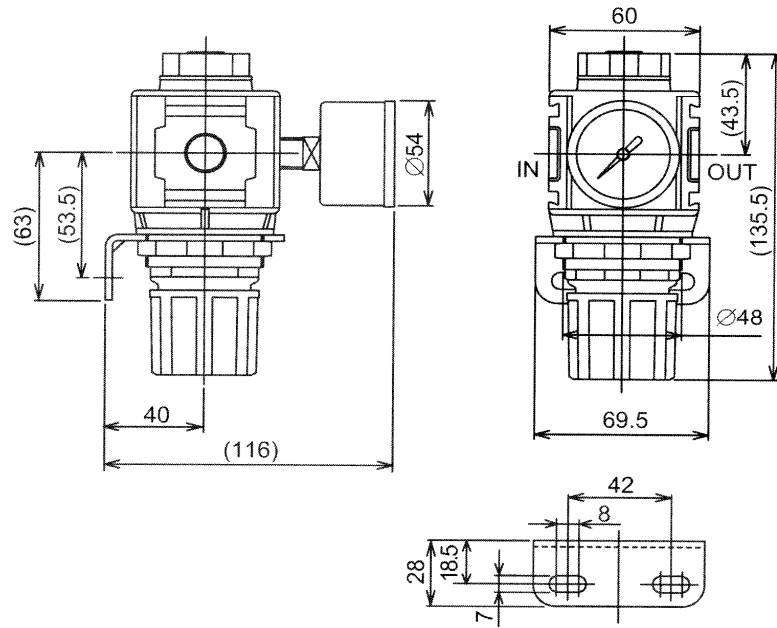
Weight: Approx.1 kg

**Table 2-12 Air set part numbers**

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

T2.11E.EPS

Unit: mm  
 Dimensions in parentheses are approximate.



Bracket Mounting Dimensions

K9473XH: Piping connection (IN: Primary side, OUT: Secondary side), Rc1/4  
 K9473XJ: Piping connection (IN: Primary side, OUT: Secondary side), 1/4NPT

**Figure 2-15 Air set G7003XF or K9473XK**



**Part No. G7004XF or K9473XG**

**Standard Specifications**

Primary Pressure: Max. 1 MPa G

Secondary Pressure: 0.02 to 0.5 MPa G

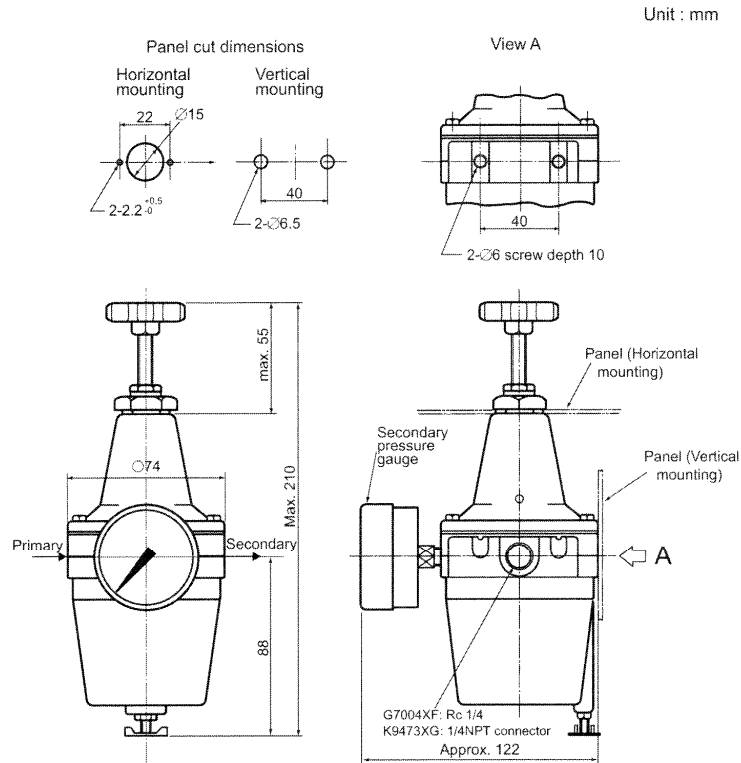
Connection: Rc1/4 or 1/4 FNPT with joint adapter

**Table 2-13 Air set (2) part numbers**

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

T2.13E.EPS

**External Dimensions**



**Figure 2-16 Air set G7004XF or K9473XG**

### 2.7.7 Zero Gas Cylinder (Part No. G7001ZC)

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

#### Standard Specifications

Capacity: 3.4 l

Filled pressure: 9.8 to 12 MPa G

Composition: 0.95 to 1.0 vol% O<sub>2</sub> in N<sub>2</sub>

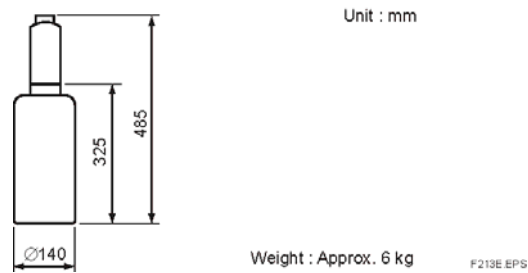


Figure 2-17 Zero gas cylinder

### 2.7.8 Cylinder Regulator Valve (Part No. G7013XF or G7014XF)

This regulator valve is used with the zero gas cylinders.

#### Standard Specifications

Primary Pressure: Max. 14.8 MPa G

Secondary Pressure: 0 to 0.4 MPa G

Connection:

Inlet W22 14 threads, right hand screw

Outlet Rc1/4 or 1/4FNPT

Material: Brass body

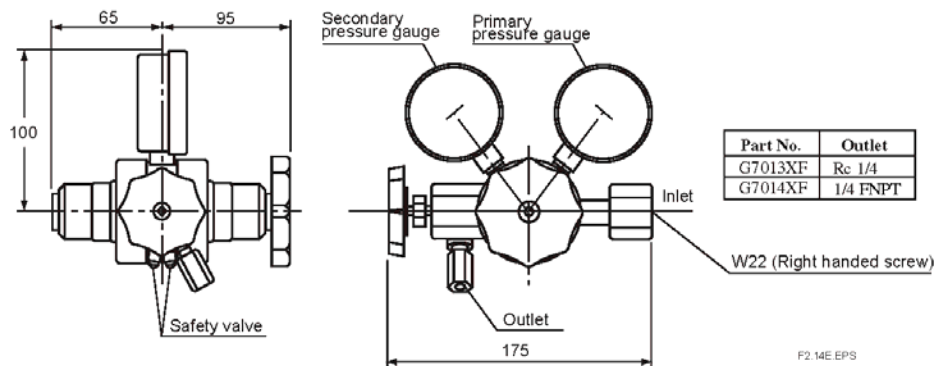


Figure 2-18 Cylinder regulator valve

**2.7.9 Calibration Gas Unit Case (Part No. E7044KF)**

This case is used to store the zero gas cylinders.

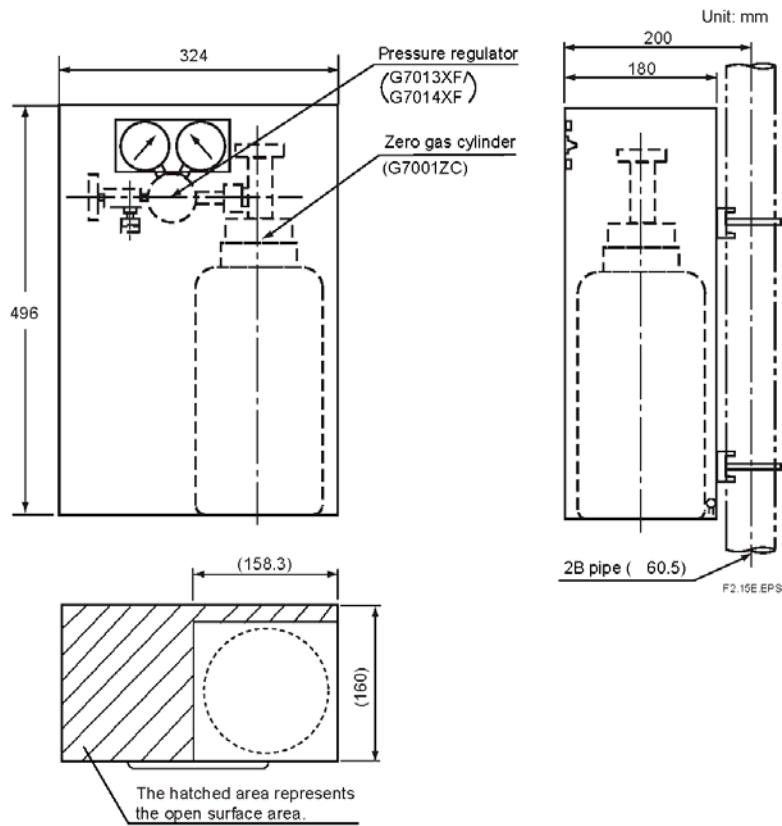
**Standard Specifications**

Case Paint: Baked epoxy resin, Jade green (Munsell 7.5 BG 4/1.5)

Installation: 2B pipe mounting

Material: SPCC (Cold rolled steel sheet)

Weight: 3.6 kg, Approx. 10 kg with gas cylinder



(Note) E7044KF (case assembly) has no zero gas cylinder and pressure regulator.

**Figure 2-19 Calibration gas unit case**

### 2.7.10 Model ZR22A Heater Assembly

**Table 2-14 Heater assembly codes**

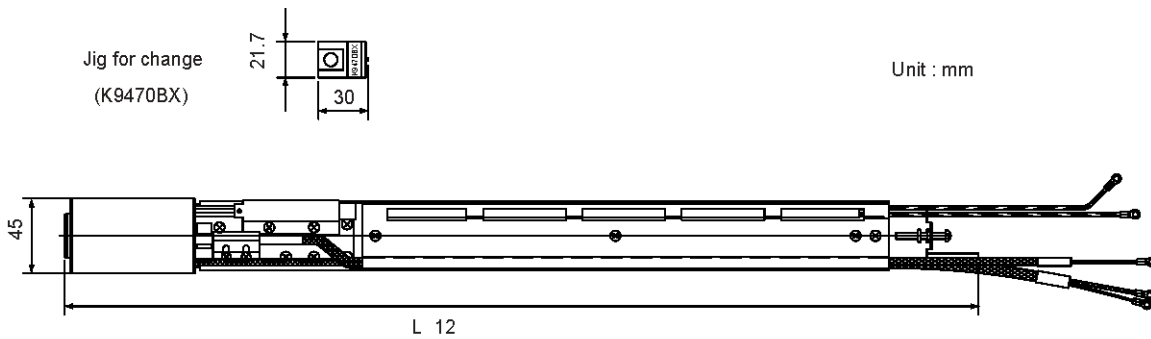
Style: S2

Model	Suffix code	Option code	Description
ZR22A			Heater Assembly for SM425P
Length ( 1)	-015		0.15 m
	-040		0.4 m
	-070		0.7 m
	-100		1 m
	-150		1.5 m
	-200		2 m
	-250		2.5 m
	-300		3 m
Jig for change	-A		with Jig (*2)
	-N		None
Reference air (*3)	-A		Reference air Natural convection
	-B		External connection (Instrument air)
	-C		Pressure compensated (for ZR22G S2)
			Pressure compensated (for ZR22G S1)

- 1 Suffix code of length should be selected as same as SM425P 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 air supply method and style.
- (Note) The heater is made of ceramic, do not drop or subject it to pressure stress.

T23.EPS

### External Dimensions



Unit : mm

L length

Model & Code	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

F2.16E.EPS

**Figure 2-20 Heater assembly**

## 3.0 INSTALLATION

This section describes installation of the following equipment:

- Section 1.10 Detector (except SM425P-015)
- Section 1.11 Detector (SM425P-015)
- Section 1.12 Converter
- Section 1.13 ZA8F Flow Setting Unit
- Section 1.14 SM425CAL Automatic Calibration Unit
- Section 1.15 Calibration Gas Unit Case (E7044KF)

### 3.1 Installation of the Detector

#### 3.1.1 Location

Use the following precautions when installing the detector:

1. Allow easy and safe access to the detector for testing and maintenance work.
2. Ambient temperature must never exceed 150°C. The terminal box should not be installed close to radiant heat.
3. A clean environment with no exposure to corrosive gases.



#### CAUTION

A natural convection type detector (SM425P-~~##~~C), which uses ambient air as reference gas, requires the ambient oxygen concentration be constant.

---

4. No vibration.
5. The measurement gas satisfies the specifications described in Section 0.
6. No measured gas-pressure fluctuations.

#### 3.1.2 Probe Insertion Port

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

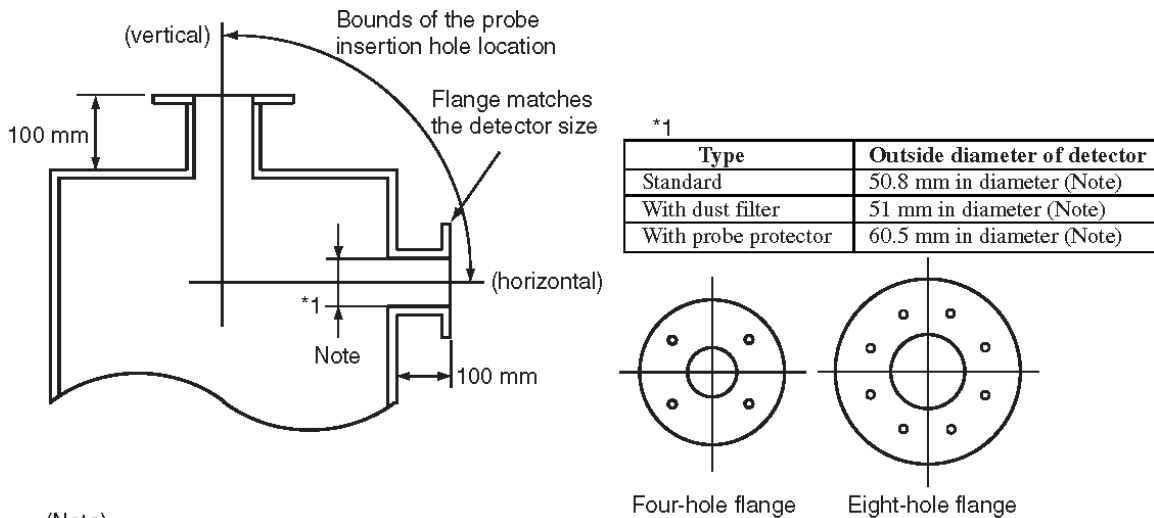
When preparing the probe insertion port, the following should be taken into consideration:

 **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 correct 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 the flange gasket does not block the reference air 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 1.17 before installation.
- The sensor (zirconia cell) must be kept dry and protected from water droplets.

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 measurement gas flow or the probe tip should point downstream.

Figure 3-1 illustrates an example of the probe insertion port.



(Note)  
 When using the detector with pressure compensation, ensure the flange gasket does not block the reference air 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 3.8 before installation.

F3.1E.EPS

**Figure 3-1 Example of forming probe insertion port**

### 3.1.3 Installation of the Detector

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#### CAUTION

- The cell (sensor) at the tip of the detector is 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 measured gas.
- 

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

#### <General-use detector>

1. Make sure that the cell mounting screws (four) at the probe tip are not loose.  
If a dust filter (see Section 1.9.1) is used, make sure it is properly attached to the detector. Refer to Section 1.10.4 for installation of the dust filter.
2. Where the detector is mounted horizontally, the calibration gas inlet and the reference gas inlet should face downward.

### 3.1.4 Installation of the Dust Filter ( Part No 96751017), etc

#### CAUTION

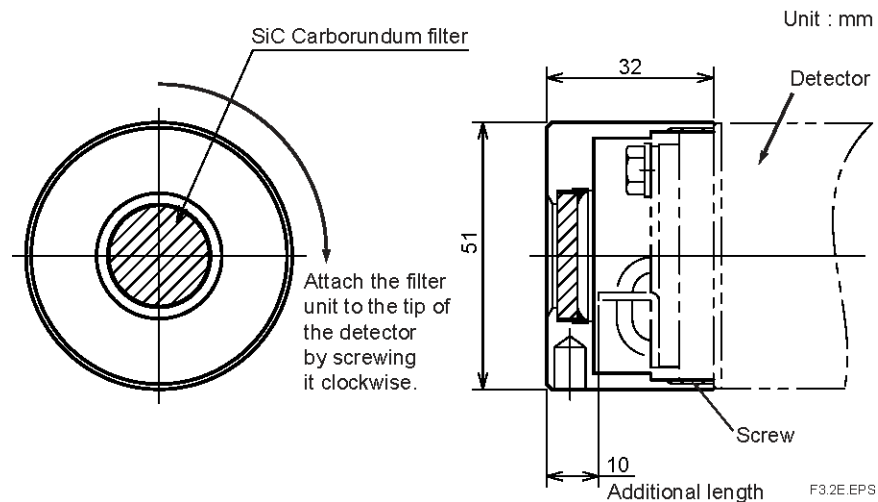
- The dust filter is used to protect the Zirconia sensor from corrosive dust or a high concentration of dust such as in utility boilers and concrete kilns. If a filter is used in combustion systems other than these, it may have adverse effects such as response delay. These combustion conditions should 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 (96751017).

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 Section 0 prior to filter mounting. It is necessary to be familiar with the detector's construction, especially the sensor assembly.

1. Mount the dust filter assembly by placing it on the end of the detector and screw the assembly clockwise. Use a hook pin wrench (K9471UX),  $\varnothing 52$  to 55 in diameter on the assembly to fasten or remove it.

Apply a heat-resistant coating to the threads during assembly or any subsequent reassembly (see Note below).

Note: The detector is heated to 700°C and requires heat-resistant coating on the threads to prevent seizing up. The recommended heat-resistant coating material is "NEVER SEIZE NICKEL SPECIAL".



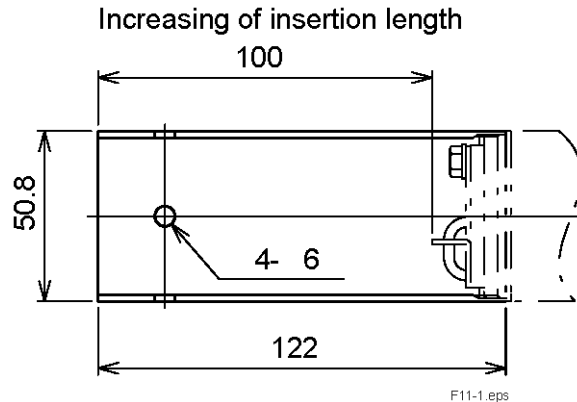
**Figure 3-2 Installation of the dust filter**

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

The SM425P detector is shipped with the dust guard protector when the option code "/F2" is specified. The protector is a particulate and moisture filter for the detector. The protector mounts on top of the detector. When attaching or detaching the protector, use a hook pin wrench for a  $\varnothing 52$ -55 hole (Pin



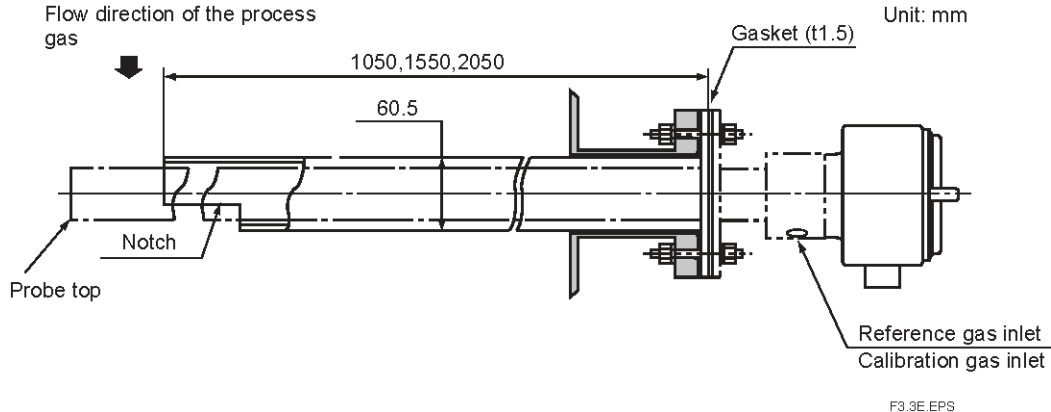
diameter 4.5 mm: P/N K9741UX) or insert a screwdriver through the holes. When attaching or re-attaching the protector, apply "Never Seize Nickel Special" to the threads.



#### <Detector with a probe protector (Model ZO21R-L-□□□-□\*B)>

The detector is used with a probe protector to support the probe (SM425P) when the probe length is 2.5m or more and it is mounted horizontally.

1. Install a gasket (not provided) between the flanges. Mount the probe protector in the probe insertion port.
2. Make sure the cell assembly mounting screws (four) at the probe tip are not loose.
3. Mount the detector so the reference gas and calibration gas inlet faces downward.



**Figure 3-3 Probe protector (supporting the mounting strength)**

#### <Detector with a probe protector (Model ZO21R-L-□□□-□\*B) for dust wear protection>

The detector is used with a probe protector to prevent particulate damage when gas flow exceeds 10m/s (fine-carbon boiler or fluid-bed furnace).

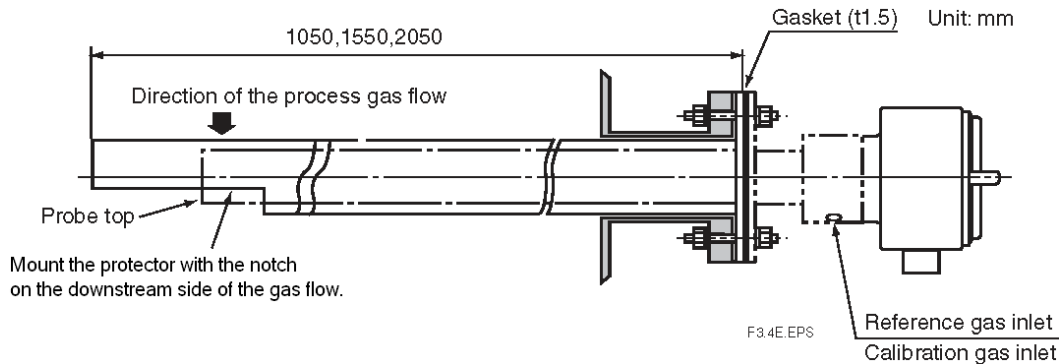
1. Install a gasket (not provided) between the flanges. Mount the probe protector in the probe insertion port. The probe protector should be installed with the notch downstream of the process gas flow.
2. Make sure the cell assembly mounting screws (four) at the probe tip are not loose.

- 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 Zirconia Oxygen Analyzer with pressure compensation (-P option), instrument air leaking from the probe protector may affect the measured value.



**Figure 3-4 Mounting of detector with a probe protector**

## 3.2 Installation of the Detector (SM425P-015)

### 3.2.1 Installation Location

This model detector is used with the High-temperature Probe Adapter (Model ZO21P-H) when the temperature of sample gas exceeds 700°C.

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

- Allow an easy and safe access to the detector for maintenance work.
- The ambient temperature should not exceed 150°C. The terminal box should not be exposed to radiant heat.
- The environment should be clean and without any corrosive gas exposure.
- Isolated from vibration.
- The process gas should satisfy the specifications described in Section 0.

### 3.2.2 Usage of the High-temperature Probe Adapter (Model ZO21P-H)

During normal operation, the surface temperature of the probe adapter should be between the dew point of the process gas and 300°C to prevent ejector clogging, gasket deterioration, or bolt scoring.

If the dew point of the measured gas is not known, keep the probe adapter surface temperature within the range of 200°C to 300°C.

The temperature is measured by the probe inside of the probe adapter and at the surface of the blind flange on the side opposite the mounting flange.

If the surface temperature is not within the above range, use the following procedures:

**<If the surface temperature exceeds 300°C>**

1. If the furnace pressure is negative, lower the pressure setting to reduce induction flow of the process gas.  
Refer to Section 1.9.3, Auxiliary Ejector for High Temperature, for the setting of induction flow.  
If you reduce induction flow, ensure the ejector inducts air when the furnace pressure fluctuates.
2. If the furnace pressure is positive, close the needle valve for the sample gas outlet to reduce the exhaust gas flow. Refer to Section 1.18.4, Piping to the High-temperature Probe Adapter.
3. If the probe adapter is surrounded by a heat insulator, remove the heat insulator.  
Ensure the temperature of the probe adapter does not fall below the dew point of the gas in winter.
4. To prevent temperature rise due to radiant heat, insert heat insulator between the wall of the furnace and the probe adapter.
5. To prevent temperature rise from thermal conduction, place the mounting flange as far as possible from the wall of the furnace.

**<If the surface temperature is less than 200°C or the dew point of the measurement gas>**

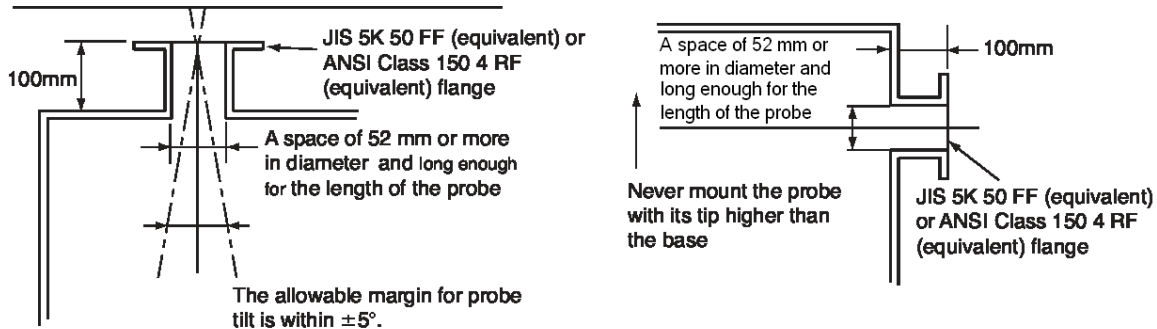
1. If the furnace pressure is negative, raise the analyzer pressure to increase induction flow of the process gas.  
Refer to Section 1.9.3, Auxiliary Ejector for High-temperature Use, for the setting of induction flow.  
If there is particulate in the gas, the ejector may become clogged as induction flow increases. Particulate filtering may be required.
2. When the furnace pressure is positive, open the needle valve for the sample gas outlet to increase the gas flow.  
Refer to Section 1.18.4, Piping to the High-temperature Probe Adapter.
3. Warm the probe adapter. Refer to Section 1.19.4, Piping to the High-temperature Probe Adapter. Ensure its temperature does not drop below freezing point in winter.
4. If the surface temperature is still less than 200°C or the dew point of the process gas, even if the previous measures have been taken, warm the probe adapter using a heat source such as steam.

### 3.2.3 Probe Insertion Port

A high-temperature detector consists of a SM425P-015 Detector and ZO21P High-temperature Probe Adapter. When forming the probe insertion port, the following should be taken into consideration:

1. If the probe is made of silicon carbide (SiC), the probe port should be formed so the probe can be mounted vertically (no more than a 5° tilt).
2. If the probe is made of stainless steel and the probe adapter is to be mounted horizontally, the probe port should be formed so the probe tip will not be higher than the probe base.

Figure 3-5 illustrates examples of the probe insertion port.



An SiC probe shall be mounted vertically.

Horizontal mounting is used with a SUS probe.

F3.5E.EPS

Figure 3-5 Examples of the probe insertion port

### 3.2.4 Mounting of the High-Temperature Detector



#### Note

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 process gas. It should be heatproof and corrosion-proof. The parts, which should be supplied by the user, are listed in Table 3-1.

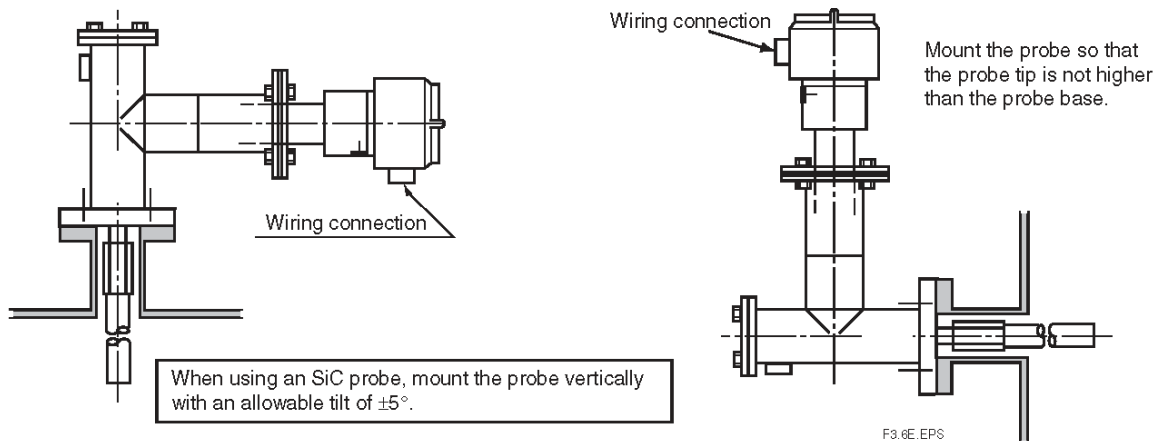
**Table 3-1 Accessories for mounting high-temperature probe adapter**

Mounting flange specification	Accessory name	Number	Note
JIS 5K 50 FF (equivalent)	Gasket	1	Heatproof and corrosionproof
	Bolt (M12 by 50)	4	
	Nut (M12)	4	
	Washer (for M12)	8	
ANSI Class 150 RF (equivalent)	Gasket	1	Heatproof and corrosionproof
	Bolt (M16 by 60)	8	
	Nut (M16)	8	
	Washer (for M16)	16	

T3.2E.EPS

A high-temperature detector should be mounted as follows:

1. It is recommended the detector be mounted vertically. If the detector must be mounted horizontally, ensure the probe tip be is mounted 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 there is no leakage of air into the furnace.
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 on the ejector.

**Figure 3-6 Mounting of the High-temperature Detector**

## 3.3 Installation of the Converter

### 3.3.1 Location

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 during normal operation and maintenance work.
3. An ambient temperature of not more than 55°C and stable to within 15°C a day.
4. The normal ambient humidity (recommended between 40 to 75% RH) and without any corrosive gases.
5. No vibration.
6. Close proximity to the detector.
7. A hood (/H) or other appropriate sunshade is required if installed outdoors. The converter must not be installed in direct sunlight.

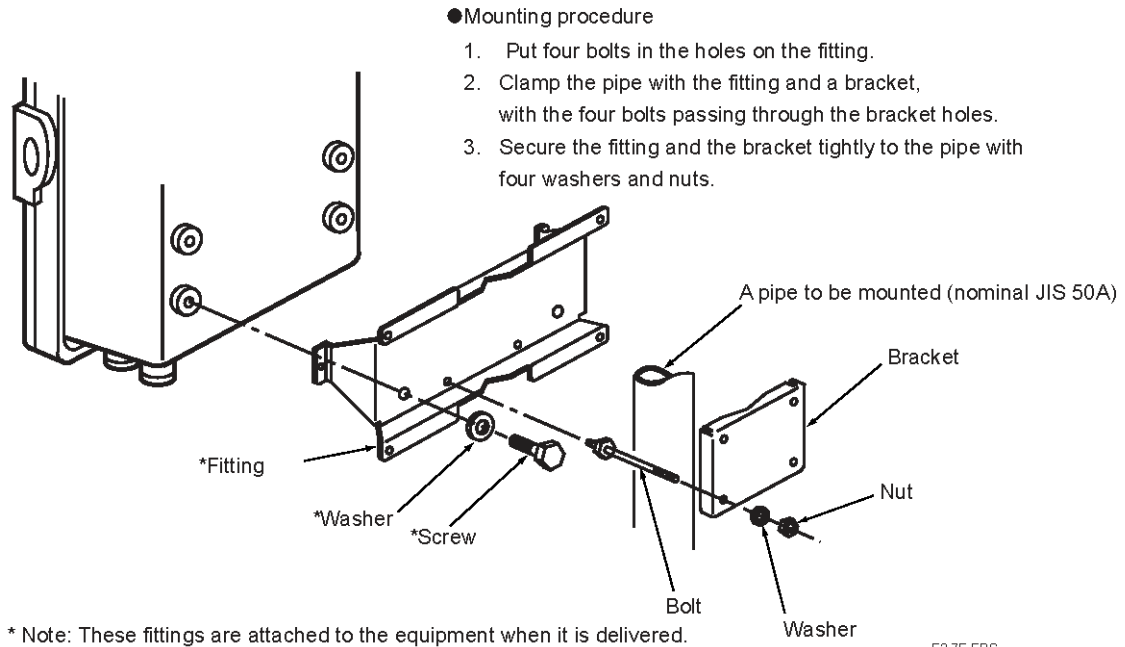
### 3.3.2 Mounting of the Converter

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>

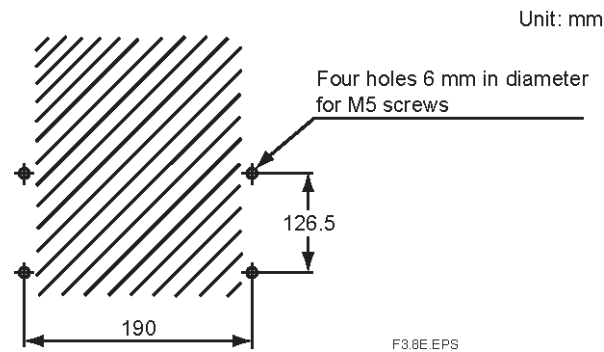
1. Use a vertical pipe of sufficient strength (nominal JIS 50A: O.D. 60.5 mm) for mounting the converter. (Converter weighs approximately 6 kg.)
2. Mount the converter on the pipe. Fix it firmly on the pipe in the procedure described in Figure 3-7.



**Figure 3-7 Pipe Mounting**

**<Wall Mounting>**

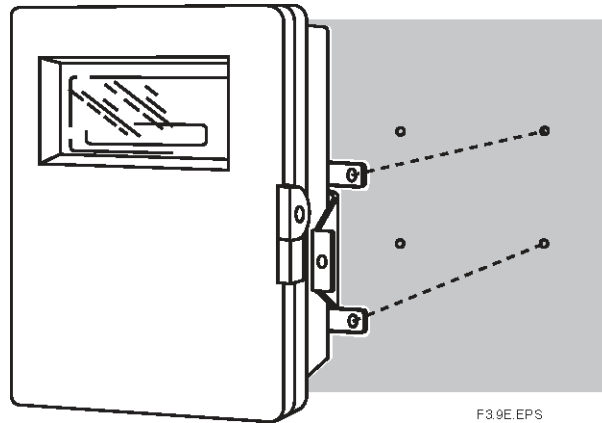
1. Drill mounting holes through the wall as shown in Figure 3-8.



**Figure 3-8 Mounting holes**

2. Mount the converter. Secure the converter on the wall using four screws.

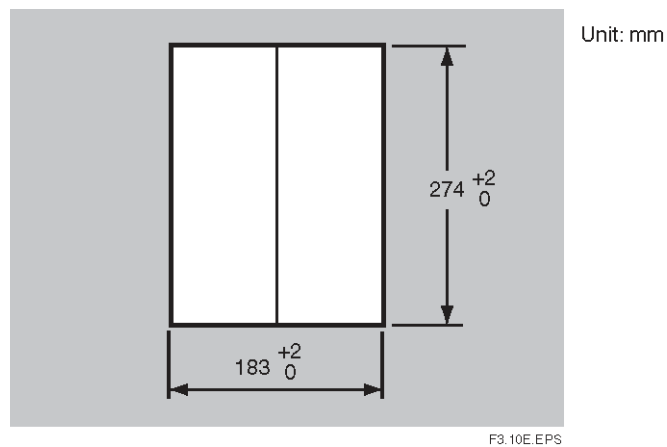
Note: For wall mounting, the bracket and bolts are not used.



**Figure 3-9 Wall Mounting**

### <Panel Mounting>

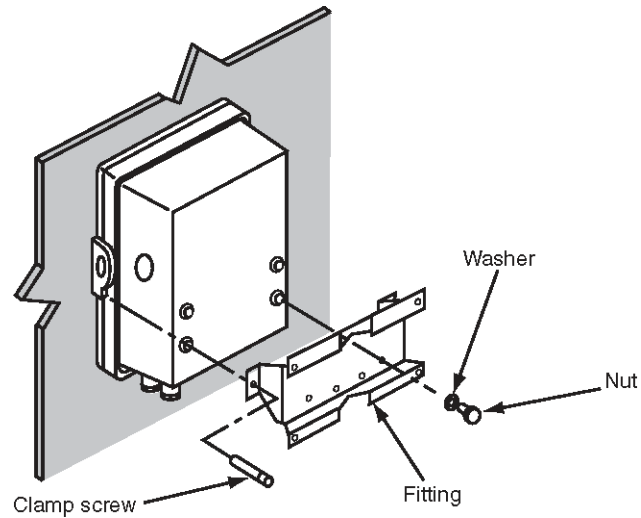
1. Cut out the panel according to Figure 3-10.



**Figure 3-10 Panel cutout sizes**

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. Re-attach the mounting fitting removed in step (2) to the converter.
5. Firmly fix the converter to the panel. Fully tighten the two clamp screws to hold the panel with the fitting.





**Figure 3-11 Panel mounting**

## 3.4 Installation of ZA8F Flow Setting Unit

### 3.4.1 Location

The following should be taken into consideration:

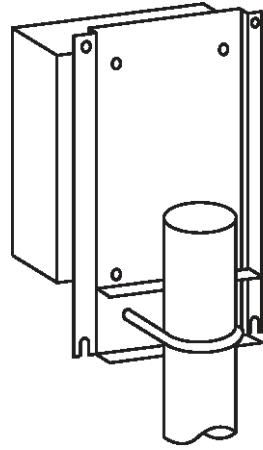
1. Easy access to the unit for during normal operation and maintenance work.
2. Near to the detector and the converter
3. No corrosive gas.
4. A stable ambient temperature of not more than 55°C.
5. Isolated from vibration.
6. Shielded from direct sunlight and rain.

### 3.4.2 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 mounted vertically for proper flowmeter operation.

#### <Pipe Mounting>

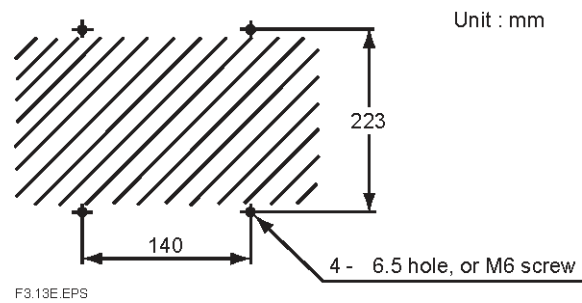
1. Use a vertical pipe of sufficient strength (nominal JIS 50A: O.D. 60.5 mm) for mounting the flow setting unit. (The unit weighs approximately 2 to 3.5 kg.)
2. Mount the flow setting unit on the pipe by tightening the U-bolt such that the metal fitting is firmly attached to the pipe.



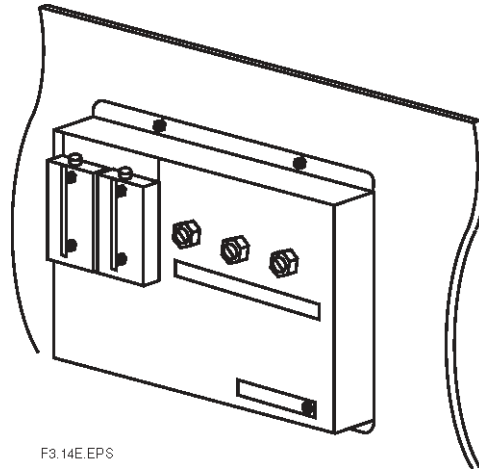
F3.12E.EPS

**Figure 3-12 Pipe Mounting****<Wall Mounting>**

1. Make a hole in the wall as illustrated in Figure 3-13.

**Figure 3-13 Mounting holes**

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



F3.14E.EPS

**Figure 3-14 Wall mounting**

## 3.5 Installation of SM425CAL Automatic Calibration Unit

### 3.5.1 Location

The following should be taken into consideration:

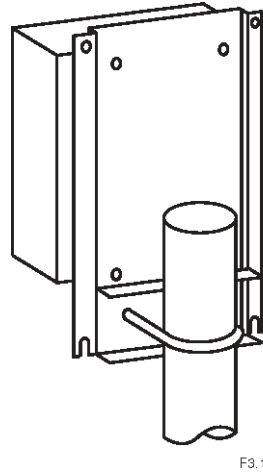
1. Easy access to the unit during normal operation and maintenance work.
2. Close proximity to the detector and the converter
3. No corrosive gas.
4. A stable ambient temperature of not more than 55°C.
5. Isolated from vibration.
6. Shielded from direct sunlight and rain.

### 3.5.2 Mounting of SM425CAL Automatic Calibration Unit

The Automatic Calibration Unit can be mounted either on a pipe (nominal JIS 50A) or on a wall. It should be mounted vertically for proper flowmeter operation.

#### <Pipe Mounting>

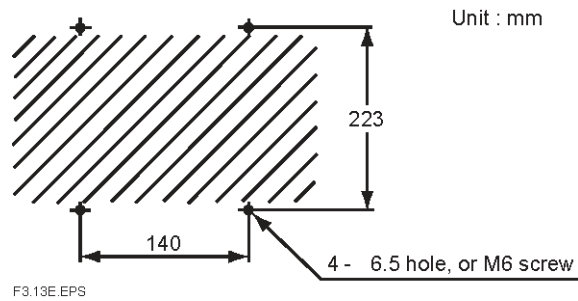
1. Use a vertical pipe of sufficient strength (nominal JIS 50A: O.D. 60.5 mm) for mounting of Automatic Calibration Unit. (The unit weights approximately 3.5 kg.)
2. Mount the Automatic Calibration Unit on the pipe by tightening the U-bolt such that the metal fitting is firmly attached to the pipe.



F3.12E.EPS

**Figure 3-15 Pipe Mounting****<Wall Mounting>**

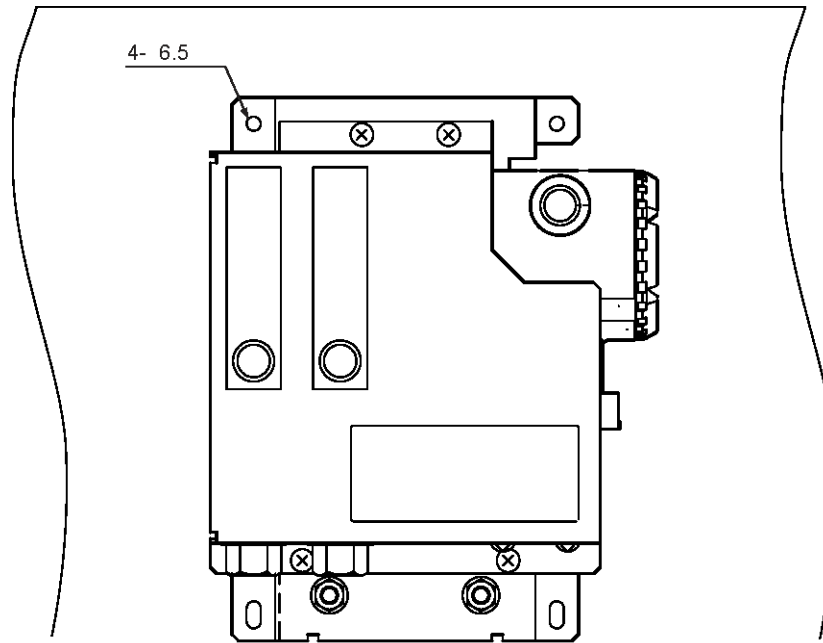
1. Make a hole in the wall as illustrated in Figure 3-16.



F3.13E.EPS

**Figure 3-16 Mounting holes**

2. Mount the Automatic Calibration Unit. Remove the pipe mounting parts from the mount fittings of the flow setting unit and attach the unit on the wall with four screws.  
If using M5 bolts, use washers.



F3.16-1E.EPS

**Figure 3-17 Wall Mounting**

## 3.6 Installation of the Calibration Gas Unit Case (E7044KF)

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

### 3.6.1 Location

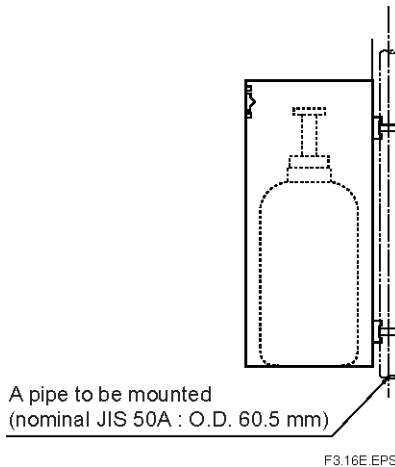
The following should be taken into consideration:

1. Easy access for cylinder replacement
2. Easy access for normal operation
3. Close proximity to the detector and converter as well as the flow setting unit.
4. The temperature of the case should not exceed 40°C from exposure to direct sunlight or radiated heat.
5. Isolated from vibration

### 3.6.2 Mounting

Mount the calibration gas unit case on a pipe (nominal JIS 50A) as follows:

1. Use a vertical pipe of sufficient strength (nominal JIS 50A: O.D. 60.5 mm) for mounting the flow setting unit. (The sum of the calibration gas unit case and the calibration gas cylinder weighs approximately 4.2 kg.)
2. Mount the unit case on the pipe by tightening the U-bolt such that the metal fitting is firmly attached to the pipe.



**Figure 3-18 Pipe Mounting**

### 3.7 Insulation Resistance Test

High voltage 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 the 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 kV resistance between the crossover wiring and ground, to discharge.
6. Testing between the heater terminal and ground, contact output terminal and ground, analog output/input terminal and 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.

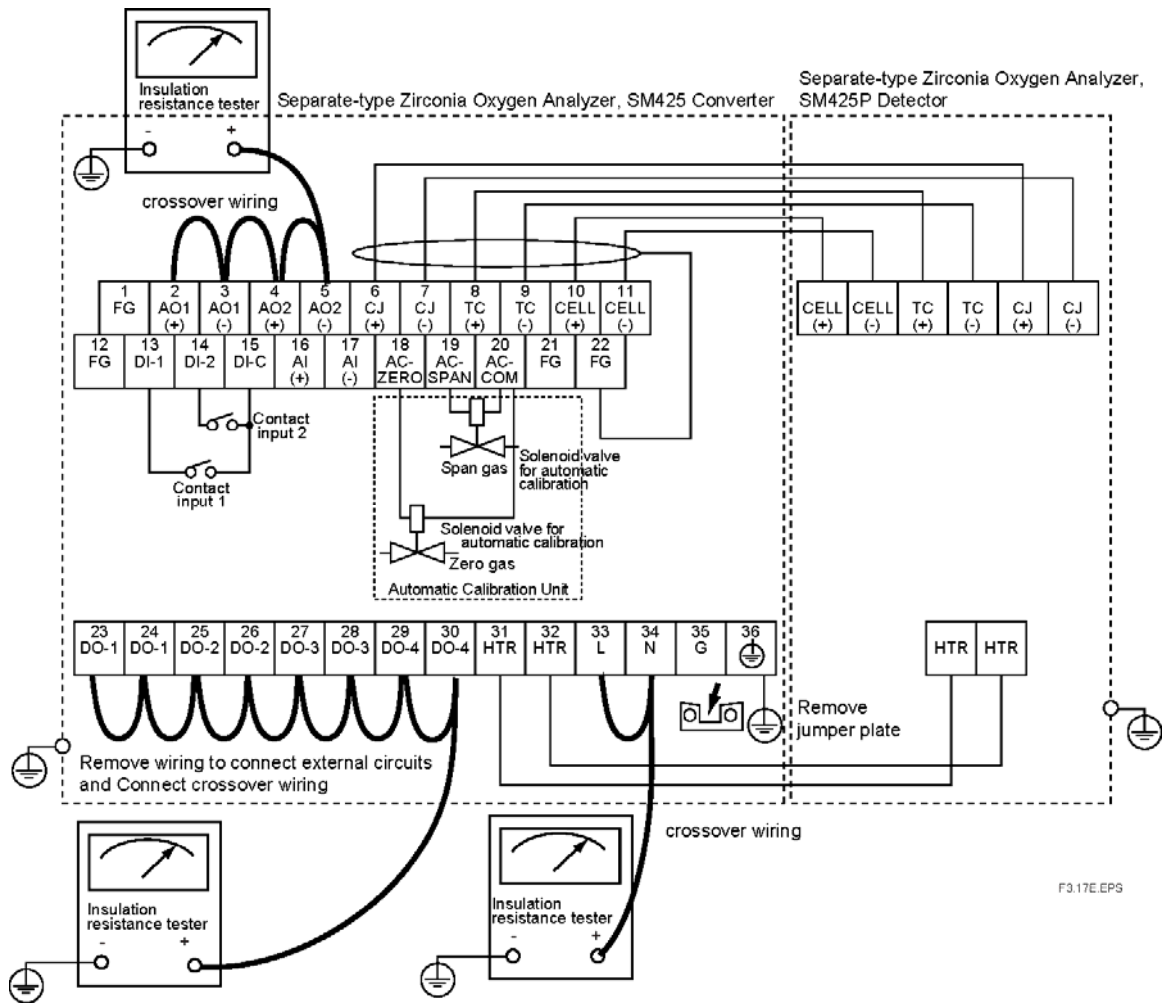
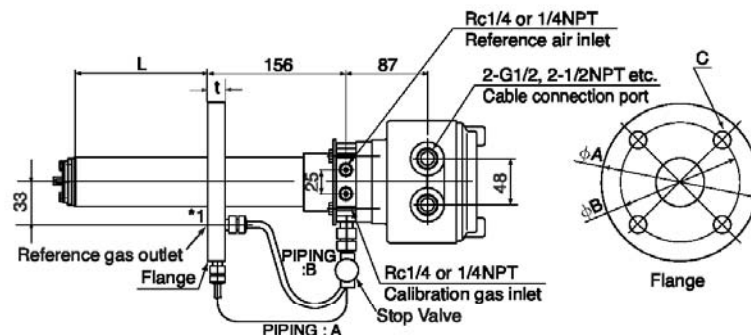


Figure 3-19 Measuring Insulation Resistance

### 3.8 External Dimensions of Detectors with Pressure Compensation

SM425P-□□□-□-A-P  
Flange ; ANSI Class 150 2 RF

Unit: mm

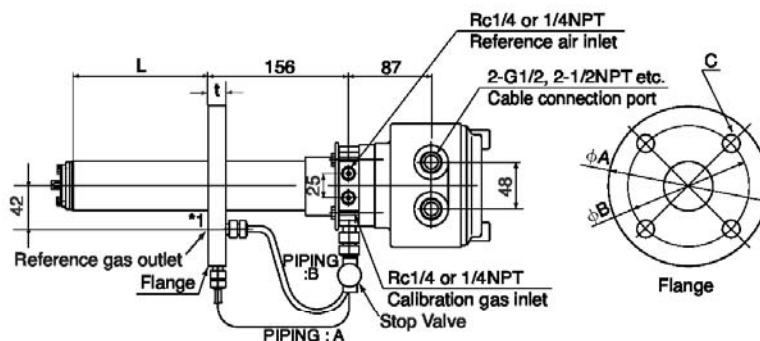


Model, Code	L	Flange				PIPING	Weight (kg)
		Specification	A	B	C		
SM425P-040-□-A	400	ANSI Class 150 2 RF SUS304	152.4	120.6	4-ϕ19	A	Approx. 6
SM425P-070-□-A	700						Approx. 7
SM425P-100-□-A	1000						Approx. 8
SM425P-150-□-A	1500						Approx. 10
SM425P-200-□-A	2000						Approx. 12
SM425P-250-□-A	2500						Approx. 14
SM425P-300-□-A	3000						Approx. 15
SM425P-360-□-A	3600						Approx. 17
SM425P-420-□-A	4200						Approx. 19
SM425P-480-□-A	4800						Approx. 21
SM425P-540-□-A	5400						Approx. 23

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● SM425P-□□□-□-B-P  
Flange ; ANSI Class 150 3 RF

Unit: mm

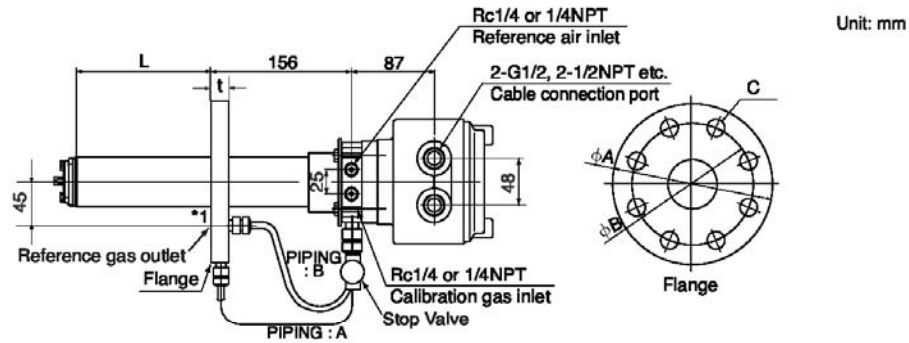


Model, Code	L	Flange				PIPING	Weight (kg)
		Specification	A	B	C		
SM425P-040-□-B	400	ANSI Class 150 3 RF SUS304	190.5	152.4	4-ϕ19	B	Approx. 9
SM425P-070-□-B	700						Approx. 10
SM425P-100-□-B	1000						Approx. 11
SM425P-150-□-B	1500						Approx. 13
SM425P-200-□-B	2000						Approx. 14
SM425P-250-□-B	2500						Approx. 16
SM425P-300-□-B	3000						Approx. 18
SM425P-360-□-B	3600						Approx. 20
SM425P-420-□-B	4200						Approx. 22
SM425P-480-□-B	4800						Approx. 24
SM425P-540-□-B	5400						Approx. 26

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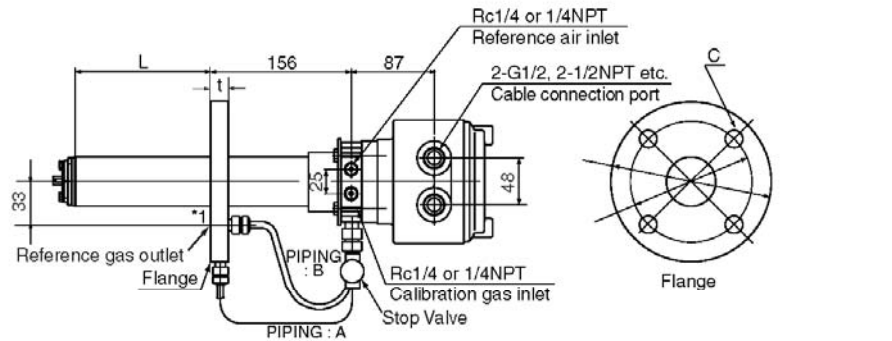
●SM425P-□□□□-C-P  
Flange ; ANSI Class 150 4 RF



Model, Code	L	Flange				PIPING	Weight (kg)
		Specification	A	B	C		
SM425P-040-□-C	400	ANSI Class 150 4 RF SUS304	228.6	190.5	8-φ19	B	Approx. 11
SM425P-070-□-C	700						Approx. 12
SM425P-100-□-C	1000						Approx. 13
SM425P-150-□-C	1500						Approx. 15
SM425P-200-□-C	2000						Approx. 17
SM425P-250-□-C	2500						Approx. 18
SM425P-300-□-C	3000						Approx. 20
SM425P-360-□-C	3600						Approx. 22
SM425P-420-□-C	4200						Approx. 24
SM425P-480-□-C	4800						Approx. 26
SM425P-540-□-C	5400						Approx. 28

12901-03E.EPS

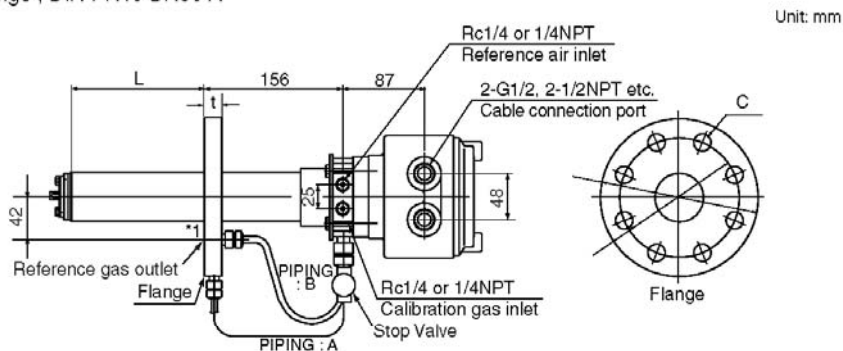
●SM425P-□□□□-E-P  
Flange ; DIN PN10 DN50 A



Model, Code	L	Flange				PIPING	Weight (kg)
		Specification	A	B	C		
SM425P-040-□-E	400	DIN PN10 DN50 A SUS304	165	125	4-φ18	A	Approx. 7
SM425P-070-□-E	700						Approx. 8
SM425P-100-□-E	1000						Approx. 9
SM425P-150-□-E	1500						Approx. 10
SM425P-200-□-E	2000						Approx. 12
SM425P-250-□-E	2500						Approx. 14
SM425P-300-□-E	3000						Approx. 16
SM425P-360-□-E	3600						Approx. 18
SM425P-420-□-E	4200						Approx. 20
SM425P-480-□-E	4800						Approx. 22
SM425P-540-□-E	5400						Approx. 24

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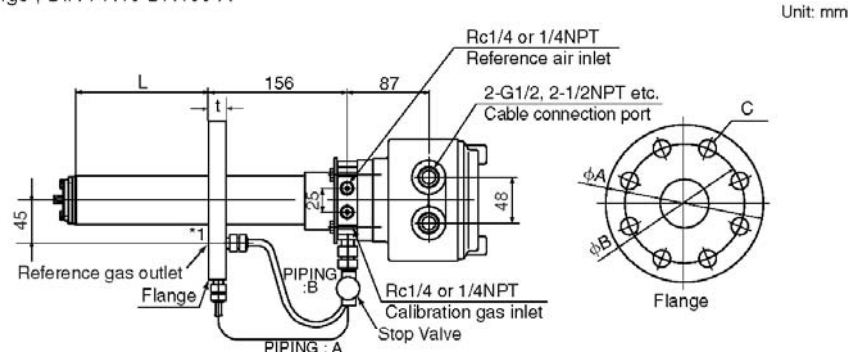
●SM425P-□□□□-□-F-P  
Flange ; DIN PN10 DN80 A



Model, Code	L	Flange					PIPING	Weight (kg)
		Specification	A	B	C	t		
SM425P-040-□-F	400	DIN PN10 DN80 A SUS304	200	160	8-φ18	20	B	Approx. 8
SM425P-070-□-F	700							Approx. 10
SM425P-100-□-F	1000							Approx. 11
SM425P-150-□-F	1500							Approx. 12
SM425P-200-□-F	2000							Approx. 14
SM425P-250-□-F	2500							Approx. 16
SM425P-300-□-F	3000							Approx. 18
SM425P-360-□-F	3600							Approx. 20
SM425P-420-□-F	4200							Approx. 22
SM425P-480-□-F	4800							Approx. 24
SM425P-540-□-F	5400							Approx. 26

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●SM425P-□□□□-□-G-P  
Flange ; DIN PN10 DN100 A

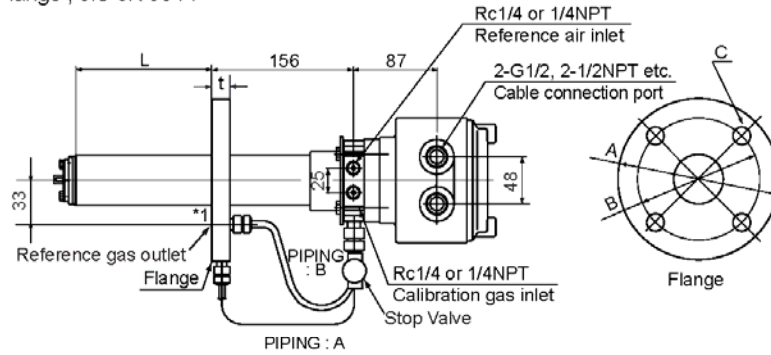


Model, Code	L	Flange					PIPING	Weight (kg)
		Specification	A	B	C	t		
SM425P-040-□-G	400	DIN PN10 DN100 A SUS304	220	180	8-φ18	20	B	Approx. 9
SM425P-070-□-G	700							Approx. 11
SM425P-100-□-G	1000							Approx. 12
SM425P-150-□-G	1500							Approx. 13
SM425P-200-□-G	2000							Approx. 15
SM425P-250-□-G	2500							Approx. 17
SM425P-300-□-G	3000							Approx. 19
SM425P-360-□-G	3600							Approx. 21
SM425P-420-□-G	4200							Approx. 23
SM425P-480-□-G	4800							Approx. 25
SM425P-540-□-G	5400							Approx. 27

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SM425P- -K-P  
Flange ; JIS 5K 65 FF

Unit: mm

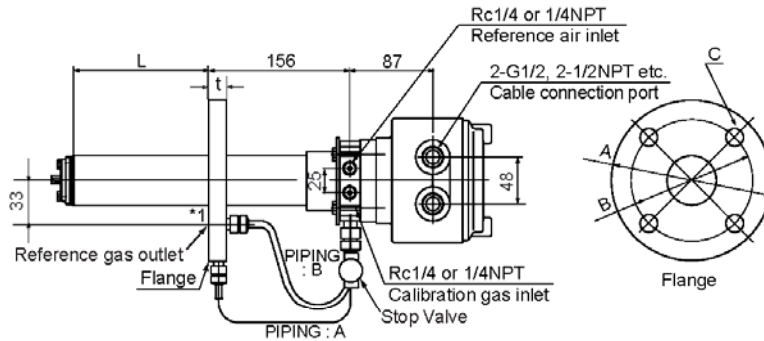


Model, Code	L	Flange					PIPING	Weight kg
		Specification	A	B	C	t		
SM425P-040- -K	400	JIS 5K 65 FF SUS304	155	130	4- 15	14	4	Approx. 6
SM425P-070- -K	700							Approx. 7
SM425P-100- -K	1000							Approx. 8
SM425P-150- -K	1500							Approx. 10
SM425P-200- -K	2000							Approx. 12
SM425P-250- -K	2500							Approx. 14
SM425P-300- -K	3000							Approx. 15
SM425P-360- -K	3600							Approx. 17
SM425P-420- -K	4200							Approx. 19
SM425P-480- -K	4800							Approx. 21
SM425P-540- -K	5400							Approx. 23

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SM425P- -L-P  
Flange ; JIS 10K 65 FF

Unit: mm

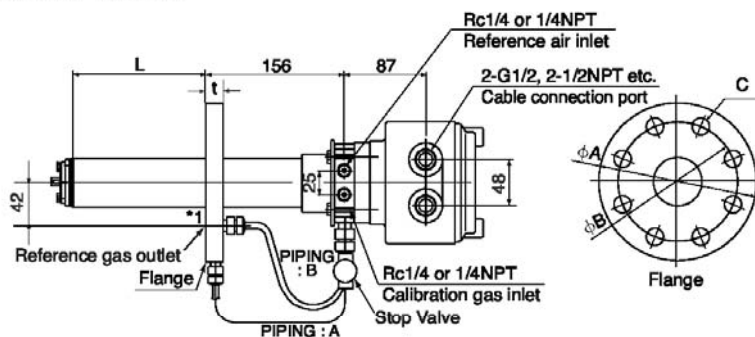


Model, Code	L	Flange					PIPING	Weight kg
		Specification	A	B	C	t		
SM425P-040- -L	400	JIS 10K 65 FF SUS304	175	140	4- 19	18	A	Approx. 7
SM425P-070- -L	700							Approx. 8
SM425P-100- -L	1000							Approx. 9
SM425P-150- -L	1500							Approx. 11
SM425P-200- -L	2000							Approx. 13
SM425P-250- -L	2500							Approx. 14
SM425P-300- -L	3000							Approx. 16
SM425P-360- -L	3600							Approx. 18
SM425P-420- -L	4200							Approx. 20
SM425P-480- -L	4800							Approx. 22
SM425P-540- -L	5400							Approx. 24

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● SM425P-□□□□-M-P  
Flange ; JIS 10K 80 FF

Unit: mm

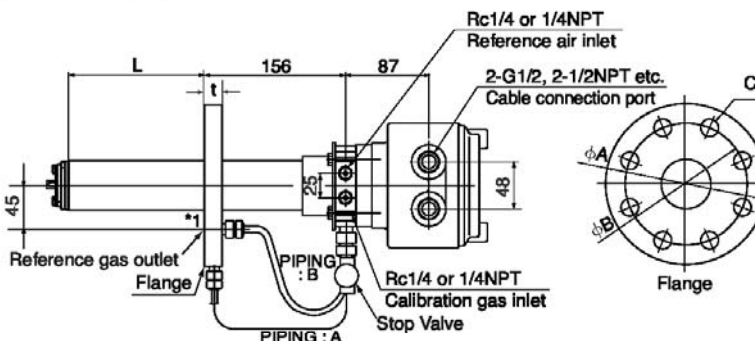


Model, Code	L	Flange					PIPING	Weight (kg)
		Specification	A	B	C	t		
SM425P-040-□-M	400	JIS 10K 80 FF SUS304	185	150	8-φ19	18	B	Approx. 7
SM425P-070-□-M	700							Approx. 8
SM425P-100-□-M	1000							Approx. 9
SM425P-150-□-M	1500							Approx. 11
SM425P-200-□-M	2000							Approx. 13
SM425P-250-□-M	2500							Approx. 15
SM425P-300-□-M	3000							Approx. 16
SM425P-360-□-M	3600							Approx. 18
SM425P-420-□-M	4200							Approx. 20
SM425P-480-□-M	4800							Approx. 22
SM425P-540-□-M	5400							Approx. 24

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● SM425P-□□□□-P-P  
Flange ; JIS 10K 100 FF

Unit: mm

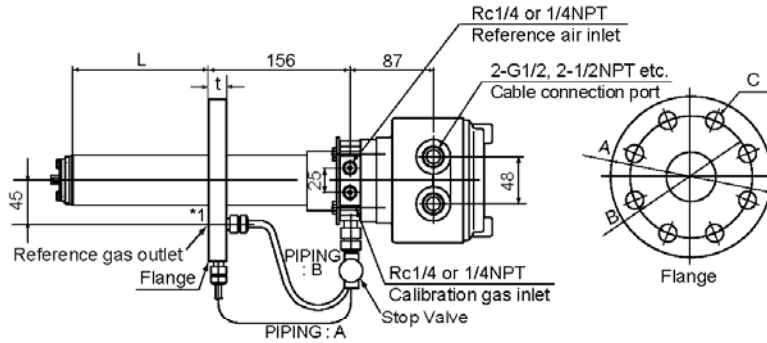


Model, Code	L	Flange					PIPING	Weight (kg)
		Specification	A	B	C	t		
SM425P-040-□-P	400	JIS 10K 100 FF SUS304	210	175	8-φ19	18	B	Approx. 8
SM425P-070-□-P	700							Approx. 10
SM425P-100-□-P	1000							Approx. 11
SM425P-150-□-P	1500							Approx. 12
SM425P-200-□-P	2000							Approx. 14
SM425P-250-□-P	2500							Approx. 16
SM425P-300-□-P	3000							Approx. 18
SM425P-360-□-P	3600							Approx. 20
SM425P-420-□-P	4200							Approx. 22
SM425P-480-□-P	4800							Approx. 24
SM425P-540-□-P	5400							Approx. 26

12901-10E.EPS

SM425P-□-R-P  
Flange ; JPI Class 150 4 RF

Unit: mm

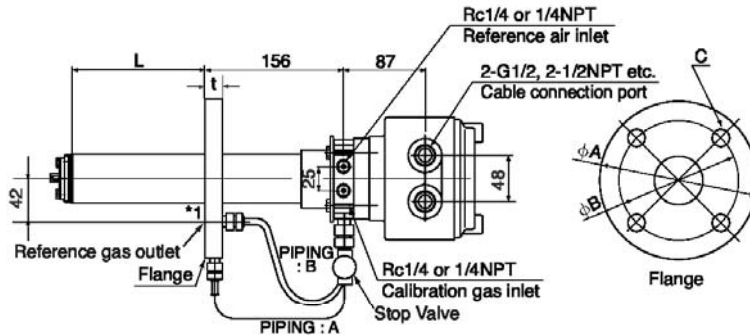


Model, Code	L	Flange					PIPING	Weight kg
		Specification	A	B	C	t		
SM425P-040-R	400	JPI Class 150 4 RF SUS304	229	190.5	8- 19	24	B	Approx. 11
SM425P-070-R	700							Approx. 12
SM425P-100-R	1000							Approx. 13
SM425P-150-R	1500							Approx. 15
SM425P-200-R	2000							Approx. 17
SM425P-250-R	2500							Approx. 19
SM425P-300-R	3000							Approx. 20
SM425P-360-R	3600							Approx. 22
SM425P-420-R	4200							Approx. 24
SM425P-480-R	4800							Approx. 26
SM425P-540-R	5400							Approx. 28

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●SM425P-□□□-□-S-P  
Flange ; JPI Class 150 3 RF

Unit: mm

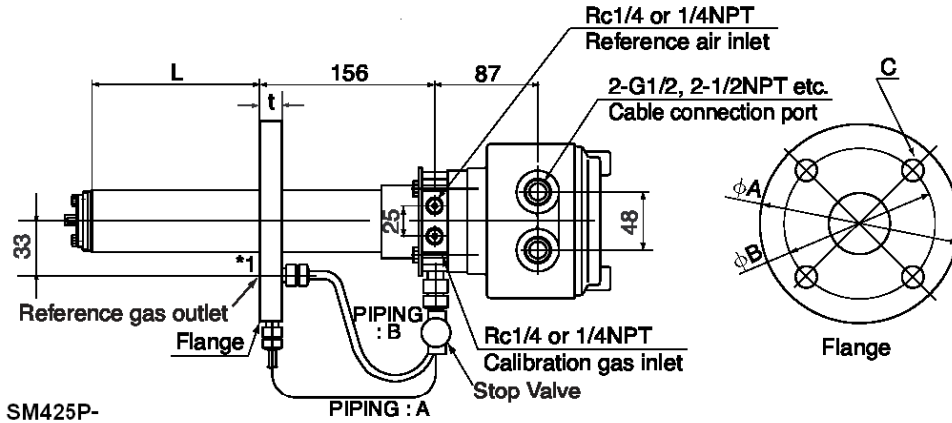


Model, Code	L	Flange					PIPING	Weight (kg)
		Specification	A	B	C	t		
SM425P-040-□-S	400	JPI Class 150 3 RF SUS304	190	152.4	4-φ19	24	B	Approx. 9
SM425P-070-□-S	700							Approx. 10
SM425P-100-□-S	1000							Approx. 11
SM425P-150-□-S	1500							Approx. 13
SM425P-200-□-S	2000							Approx. 14
SM425P-250-□-S	2500							Approx. 16
SM425P-300-□-S	3000							Approx. 18
SM425P-360-□-S	3600							Approx. 20
SM425P-420-□-S	4200							Approx. 22
SM425P-480-□-S	4800							Approx. 24
SM425P-540-□-S	5400							Approx. 26

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● SM425P-□□□-□-W-P  
Flange ; Westinghouse

Unit: mm



Model, Code	L	Flange				PIPING	Weight (kg)
		Specification	A	B	C		
SM425P-040-□-W	400	Westinghouse	155	127	4-φ11.5	A	Approx. 6
SM425P-070-□-W	700						Approx. 7
SM425P-100-□-W	1000						Approx. 8
SM425P-150-□-W	1500						Approx. 10
SM425P-200-□-W	2000						Approx. 12
SM425P-250-□-W	2500						Approx. 14
SM425P-300-□-W	3000						Approx. 15
SM425P-360-□-W	3600						Approx. 17
SM425P-420-□-W	4200						Approx. 19
SM425P-480-□-W	4800						Approx. 21
SM425P-540-□-W	5400	Approx. 23					

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## 4.0 PIPING

This section describes piping procedures based on three typical system configurations for SM425 Separate-type Zirconia Oxygen Analyzer.

- Verify each check valve, stop valve, and joint used for piping does not leak. Calibration gas leakage from pipes and joints may cause clogging of the pipes and inaccurate calibration.
- Test for leakage test after piping is installed.
- Verify instrument air is dehumidified to a dew point of  $-20^{\circ}\text{C}$  or lower and free of particulate and oil. Can also be used for the reference gas.
- Detectors using natural convection for the source of reference gas are affected by the ambient air conditions near the detector. Process gas measurement accuracy can be influenced by changes in the ambient air humidity, oxygen content, and pollutants. Consider using instrument air for reference gas to improve measurement accuracy.

### 4.1 Piping for System 1

The piping in System 1 is illustrated in Figure 4-1.

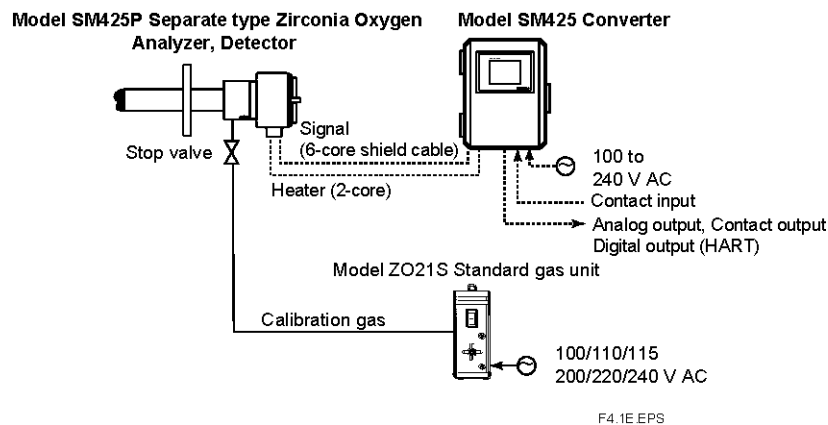


Figure 4-1 Piping in System 1

Piping in System 1 is as follows:

- Mount a stop valve at the calibration gas inlet of the detector using a nipple. Mount a joint for a 6 mm (O.D.) X 4 mm (I.D.) soft tube on the stop valve (see Section 1.18.2). Connect the calibration tube to this joint only during calibration.

**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. This may cause damage to the sensor by thermal shock when the calibration gas is introduced. The stop valve should be closed except during calibration.
  - Piping the reference gas is recommended if a high-temperature detector is used (the sample gas temperature is 700°C or higher). For other detectors, 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.
- 

- If a high-temperature detector is used and no piping can be installed for the reference gas, vent the exhaust of the high-temperature probe adapter away from the vicinity of the detector using an exhaust pipe (see Section 1.18.4, Figure 4-6 Exhaust pipe). Otherwise the requirements for reference gas may not be met.
- If a high-temperature detector is used and the process gas is under negative pressure, connect an auxiliary ejector to the sample gas exhaust port of the high-temperature probe adapter (see Section 1.18.4, Figure 4-3 Mounting the auxiliary ejector).
- If a high-temperature detector is used and the pressure of the process gas is 0.49 kPa or higher, it is recommended a needle valve (throttle) be used in the sample gas exhaust of the high-temperature probe adapter (see Section 1.18.4, Figure 4-4).

**CAUTION**

- The throttle valve is used to lower the sample gas temperature below 700°C. If the process is at high temperature and pressure, the sample gas temperature may not fall to below 700°C before it reaches the detector.

If the sample gas temperature is lowered too much, condensation may be produced in the high-temperature probe adapter. During wintertime it is recommended the probe adapter be protected with an insulating material to avoid condensation forming (see Section 1.18.4, Figure 4-5).

---

Refer to Section 1.11.2 for maintaining temperatures within the high-temperature probe adapter.

### 4.1.1 Parts Required for Piping in System 1

Verify the parts listed in Table 4-1 are ready.



**Table 4-1 System 1 required piping parts**

Detector	Piping location	Parts	Note	
General-use detector	Calibration gas inlet	Stop valve	of a quality specified by Teledyne Monitor Labs (L9852CB or G7016XH)	
		nipple *	Rc 1/4 or 1/4 NPT	general parts
		joint for tube connection	Rc 1/4 (1/4NPT) for a $\phi 6 \times \phi 4$ mm soft tube	general parts
	Reference gas inlet	(sealed up)	(when piping is required, refer to section 4.1.3)	
High-temperature detector	Calibration gas inlet	Stop valve	of a quality specified by Teledyne Monitor Labs (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 $\phi 6 \times \phi 4$ mm soft tube	
	Reference gas inlet	(sealed up)	(when piping is required, refer to section 4.1.3)	
	Sample gas outlet	Auxiliary ejector *	of a quality specified by Teledyne Monitor Labs (E7046EC or E7046EN)	
		T-shaped joint of the same diameter *	R1/4 or 1/4 NPT	general parts
Needle valve * nipple of other diameter *		Rc 1/4 or 1/4 NPT R1/2 to R1/4 or R1/2 to 1/4 NPT	general parts general parts	

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

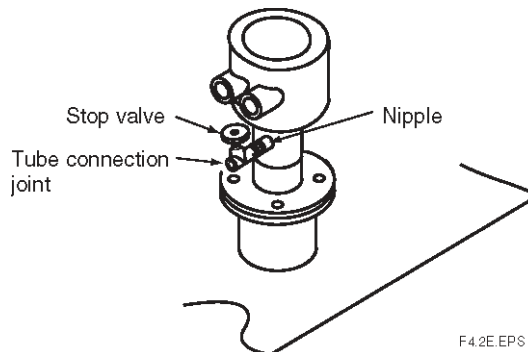
T4.1E.EPS

### 4.1.2 Connection to the Calibration Gas Inlet

Mount a stop valve (of a quality specified by Teledyne Monitor Labs) on a nipple (found on the open market) as illustrated in Figure 4-2 (A stop valve may have been mounted on the detector prior to shipping the detector.). Mount a joint (also found on the open market) at the stop valve tip.

Connect the piping (6(O.D.) ~4(I.D.) mm tube) from the standard gas unit to the calibration gas inlet of the detector when performing calibrations.

Note 1: Mount the stop valve close to the detector.



**Figure 4-2 Connection to the calibration gas inlet**

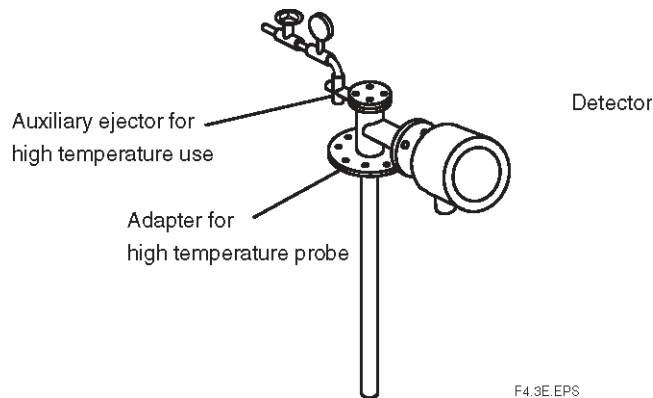
### 4.1.3 Connection to the Reference Gas Inlet

Normally, no piping is required for the reference gas inlet when the equipment uses natural convection for reference gas (models SM425P-###C). Leave the plug as it is. If the air around the detector is polluted and

the necessary oxygen concentration (21 vol% O<sub>2</sub>) cannot be obtained, install reference gas piping as described in Section 1.19, System 2.

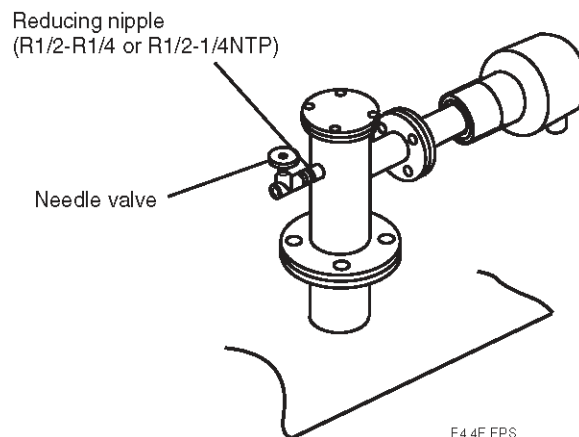
#### 4.1.4 Piping to the High-temperature Probe Adapter

- Refer to Section 1.11.2 for guidelines on using the high-temperature probe adapter.
- The sample gas should be at a temperature below 700°C before reaching the detector sensor. If the process gas is under negative pressure, it should be fed to the detector by an auxiliary ejector. Connect the auxiliary ejector (E7046EC/E7046EN) as illustrated in Figure 4-3. Mount the pressure gauge as close as possible to the auxiliary ejector. If ambient temperature is too high, mount the gauge in a location with a temperature below 40°C.



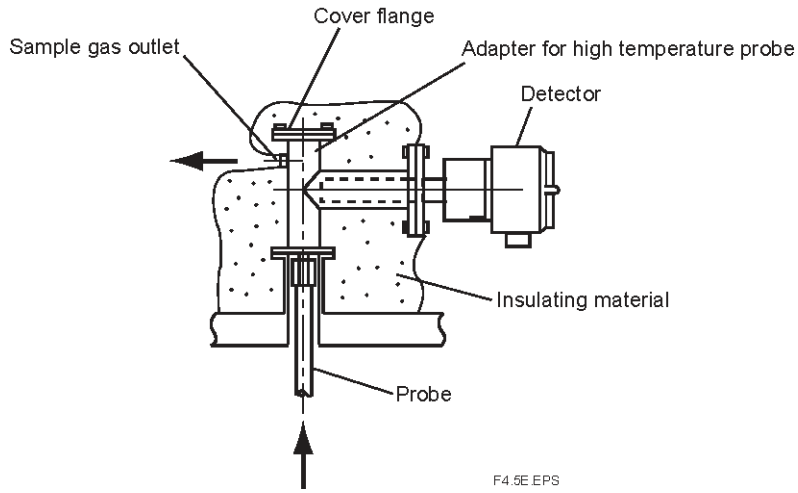
**Figure 4-3 Mounting the auxiliary ejector**

If the temperature of the process gas exceeds 700°C and its pressure exceeds 0.49k Pa, the sample gas temperature may exceed 700°C at the detector. In such a case, connect a needle valve (found on the open market) through a nipple (also found on the open market) to the probe adapter sample gas exhaust (Rc 1/2) to restrict the sample gas exhaust volume.



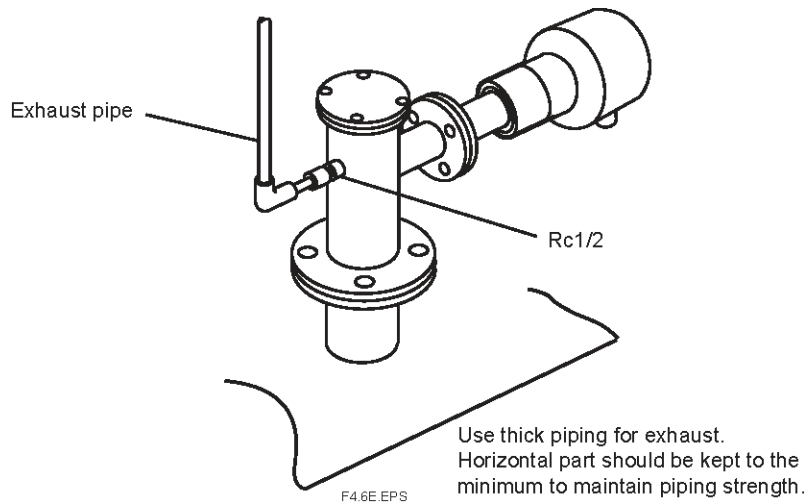
**Figure 4-4 Mounting the needle valve for restricting exhaust flow of the sample gas**

In cases where condensation is likely to occur in the probe adapter when the sample gas is cooled, protect the probe adapter with insulating material as illustrated in Figure 4-5.



**Figure 4-5 Preventing condensation**

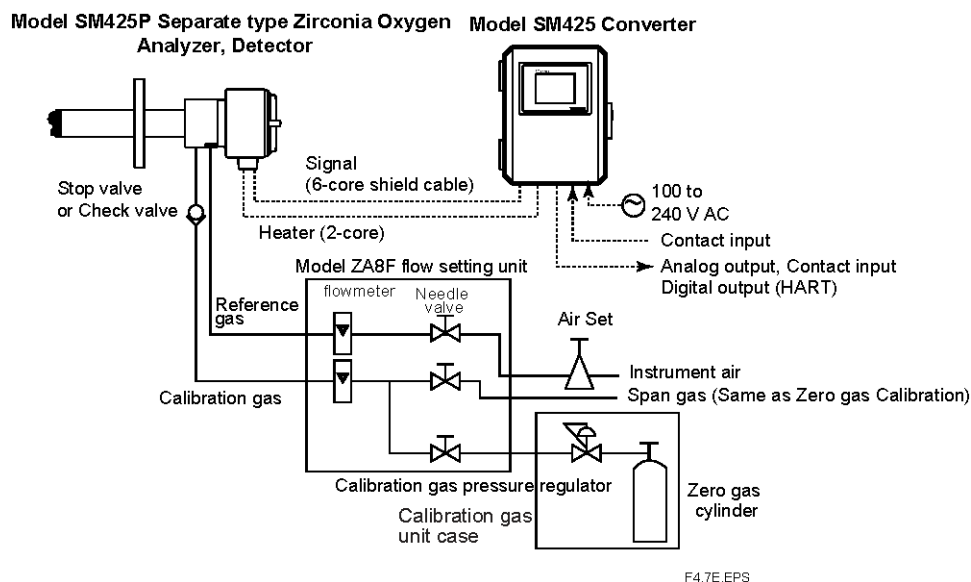
Sample exhaust should be vented away from detectors without reference gas piping. An exhaust pipe should be installed as shown in Figure 4-6 and kept warm to prevent condensation.



**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 to the nipple at the reference gas inlet of the detector.
- If a high-temperature detector is used and the sample gas is under negative pressure, connect an auxiliary ejector to the sample gas exhaust hole of the high-temperature probe adapter (see Section 1.18.4, Figure 4-3).
- If a high-temperature detector is used and the pressure of the measured gas is 0.5 kPa or higher, it is recommended a needle valve (throttle) be used in the sample gas exhaust of the high-temperature probe adapter (see Section 1.18.4, Figure 4-4).



### CAUTION

- A throttle valve is used to lower the sample gas temperature below 700°C. If the process is at high temperature and pressure, the sample gas temperature may not fall to below 700°C before it reaches the detector.

If the sample gas temperature is lowered too much, condensation may be produced in the high-temperature probe adapter. During wintertime it is recommended the probe adapter be protected with an insulating material to avoid condensation forming (see Section 1.18.4, Figure 4-5).

Refer to Section 1.11.2 for guidelines on using the high-temperature probe adapter.

- The air feed for blow-back should also be taken into consideration if blow-back is being used to reduce particulate clogging in the high-temperature probe adapter and detector.

**CAUTION**

- The probe is easily clogged if too much particulate is contained in the process gas such as in utility boilers or concrete kilns. To clear the particulate, compressed air is injected during blow back. Installation of blow back piping is shown in Section 1.20.1.

### 4.2.1 Piping Parts for System 2

Verify the parts listed in Table 4-2 are ready.

**Table 4-2 System 2 required piping parts**

Detector	Piping location	Parts	Note
General-use detector	Calibration gas inlet	Stop valve or check valve	Recommended by TML (L9852CB or G7016XH) Provided by TML (K9292DN or K9292DS)
		Nipple *	Rc1/4 or 1/4 NPT      general parts
		Zero gas cylinder	User's scope
		Gas pressure regulator	Recommended by TML (G7013XF or G7014XF)
		Joint for tube connection	Rc1/4 or 1/4 NPT      general parts
	Reference gas inlet	Air set	Recommended by TML (G7003XF/ K9473XK or G7004XF/K9473XG)
		Joint for tube connection	Rc1/4 or 1/4 NPT      general parts
	High-temperature Detector	Calibration gas inlet	Stop valve or check valve
Nipple *			Rc1/4 or 1/4 NPT      general parts
Zero gas cylinder			User's scope
Gas pressure regulator			Recommended by TML (G7013XF or G7014XF)
Joint for tube connection			Rc1/8 or 1/8 NPT
Reference gas inlet		Air set	Recommended by TML (G7003XF/ K9473XK or G7004XF/K9473XG)
		Joint for tube connection	Rc1/4 or 1/4 NPT      general parts
Sample gas outlet		Auxiliary ejector *	Recommended by TML (E7046EC or E7046EN)
		T-shaped joint of the same diameter *	R1/4 or 1/4 NPT      general parts
		Needle valve * Reducing nipple *	Rc1/4 or 1/4 NPT R1/2 to R1/4 or R1/2 to 1/4 NPT      general parts

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

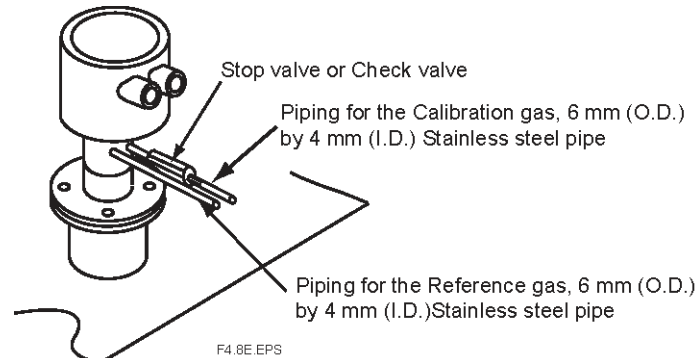
T4.2E.EPS

### 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. Also between the ZA8F flow setting unit and the SM425P detector.

The cylinder should be placed in an enclosure such as a calibration unit case to minimize the effects of sunlight and radiant heat and keep the cylinder temperature at 40°C or less. Mount a regulator valve (specified by Teledyne Monitor Labs) on the cylinder.

Mount a check valve or stop valve (specified by Teledyne Monitor Labs) on the nipple (found on the open 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.) ~ 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. Also between the flow setting unit and the detector.

Install an air-set (pressure regulator) in the piping between the air source and the flow setting unit. The air-set (pressure regulator) should be close to the flow setting unit.

Use a 6 mm (O.D.) ~ 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 1.18.4.

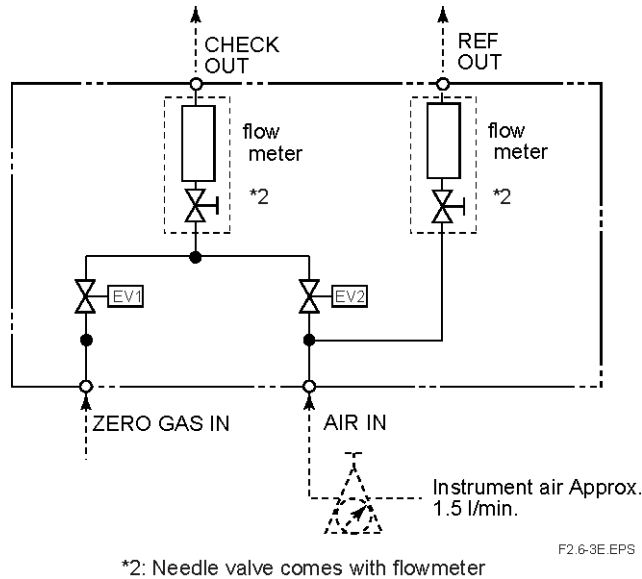
## 4.3 Piping for System 3

Piping in System 3 is illustrated in Figure 4-10. In System 3, calibration is automated. The piping is basically the same as that of System 2. Refer to Section 1.19.

Adjust secondary pressure of both the air-set (pressure regulator) and the zero-gas reducing valve such 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, verify 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 (pressure regulator) so span gas flow is within the permitted range.



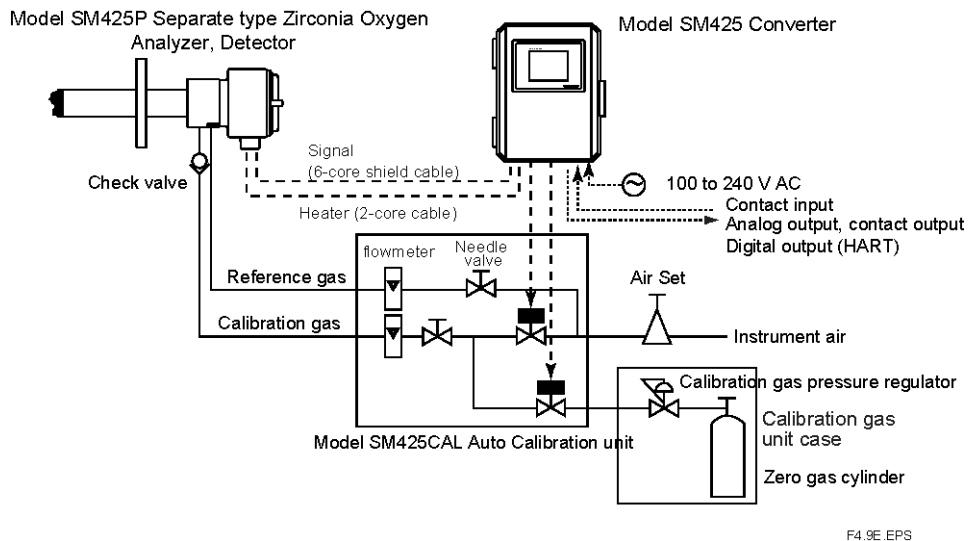
\*2: Needle valve comes with flowmeter  
**Figure 4-9 SM425CAL Autocalibration unit piping diagram**

If blow back is used, prepare blow back piping according to Section 1.20.1.



**Note**

Blow back is used to get rid of particulate on the detector by injecting compressed air in the high-temperature probe adapter.

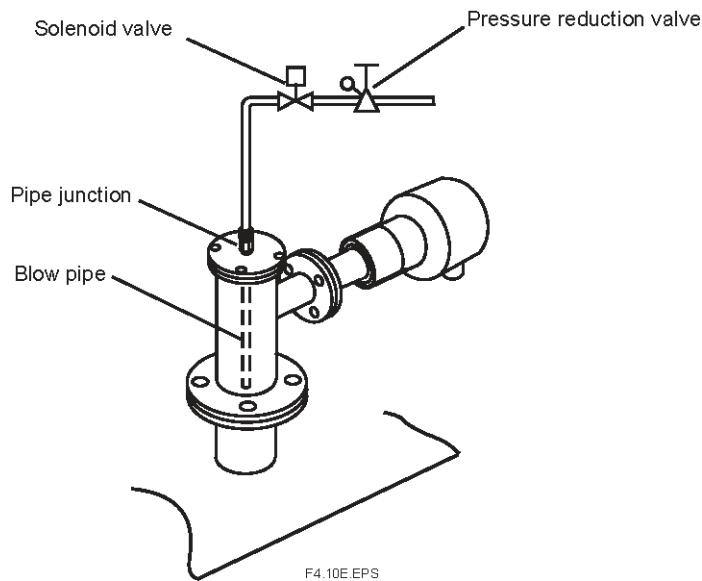


**Figure 4-10 Piping for System 3**

F4.9E.EPS

### 4.3.1 Blow Back Piping

This piping is required for blow back. The piping described below provides automatic blow back operation when the “blow back start” command is selected at the converter.



**Figure 4-11 Blowback Piping**

The following parts are required for blow back piping.

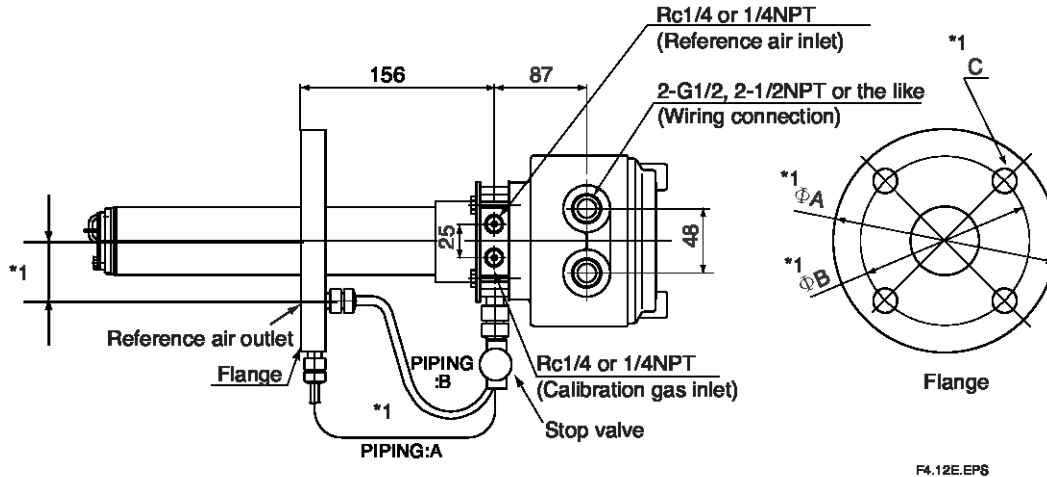
- Blow pipe (to be prepared as illustrated in Figure 4-12.)
- Two-way solenoid valve: “Open” when energized. (Found on the open market)
- Air set (recommended by Teledyne Monitor Labs, K9473XH / K9473XJ or G7004XF / K9473XG)

#### <Blow pipe manufacturing>

Manufacture the blow pipe as illustrated in Figure 4-12, and mount it on the high-temperature probe adapter.







\*1 Dimensions may vary depending on the detector type. Refer to Section 3.8  
 Ensure that the flange gasket does not block the reference air outlet.  
 Where necessary, make a notch on the flange

**Figure 4-13 Detector with Pressure Compensation**

Ensure that process gas does not flow into the probe.

#### Valve operation

1. For safety, shut down the process before installing the detector. It is especially dangerous if the process internal pressure is high.
2. Before starting instrument air flow, completely shut the stop valve in front of the reference gas outlet.
3. Check the reference gas outlet is not blocked.
4. Adjust the instrument air pressure to higher than process internal pressure.
5. Completely open the stop valve in front of the reference gas outlet and, after turning on instrument air flow, start up the process. As process internal pressure rises, verify instrument air continues to flow. Adjust the valve or increase supply pressure if necessary.
6. After process internal pressure stabilizes, adjust flow.
7. If the process is shut down, stop instrument air flow and completely shut the stop valve in front of the reference gas outlet. Reference gas may be left flowing.



#### CAUTION

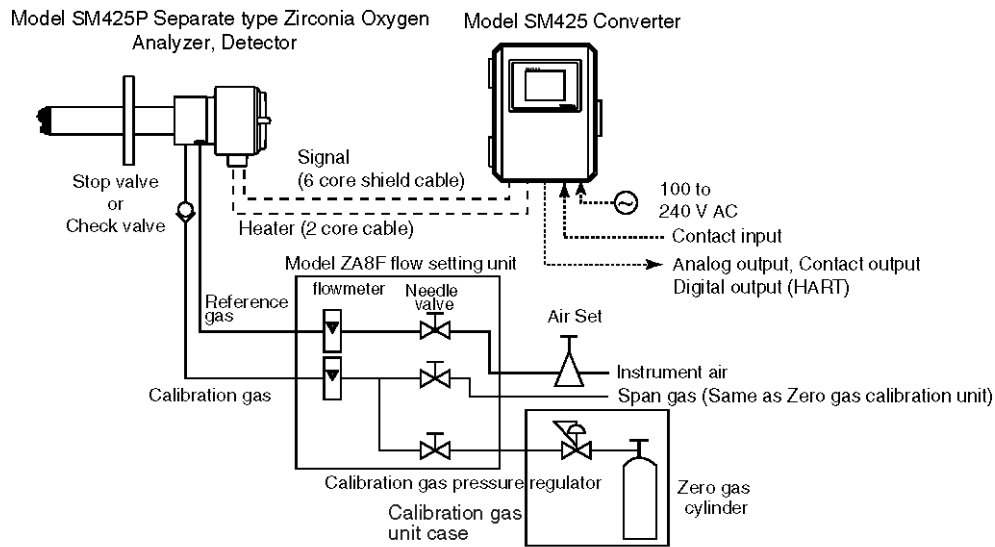
- If possible, to prevent process gas from entering the detector and damaging the zirconia cell, do not stop instrument air flow.
- Connect the calibration gas stop valve directly to the detector inlet. If there is piping between the detector and the valve, condensation may damage the sensor by thermal shock 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 process pressure. It is recommended using a flow gauge and an air-set (pressure regulator) that is suitable for the process pressure.

**CAUTION**

- When using the ZA8F Flow Setting Unit and SM425CAL Automatic Calibration Unit, note the supplying airflow (pressure) will vary depending on the process pressure.



F4.18E.EPS

**Figure 4-14 System 2**

**4.4.1 Piping Parts for a System using Detector with Pressure Compensation**

Verify the parts listed in Table 4.3 are ready.

**Table 4-3 Required parts for system with pressure comp. detector**

Detector	Piping location	Parts	Note
Detector with pressure compensation	Calibration gas inlet	Stop valve or check valve	Recommended by TML (L9852CB or G7016XH) Provided by TML (K9292DN or K9292DS)
		Nipple *	Rc1/4 or 1/4 NPT   general parts
		Zero gas cylinder	User's scope
		Gas pressure regulator	Recommended by TML (G7013XF or G7014XF)
		Joint for tube connection	Rc1/4 or 1/4 NPT   general parts
	Reference gas inlet	Air set	Recommended by TML (G7003XF / K9473XK or G7004XF / K9473XG)
		Joint for tube connection	Rc1/4 or 1/4 NPT   general parts

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

T4.3E.EPS

**4.4.2 Piping for the Calibration Gas**

Calibration gas piping is basically identical to that of System 2. See Section 1.19.2.

### **4.4.3 Piping for the Reference Gas**

Reference gas piping is basically identical to that of System 2. See Section 1.19.3.

## 5.0 WIRING

This section describes the wiring necessary for the SM425 Separate-type Zirconia Oxygen Analyzer.

### 5.1 General



#### CAUTION

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

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

1. Install an external switch or circuit breaker to the power supply of the converter.
  2. Use an external switch or circuit breaker rated 5A and conforming with IEC 947-1 or IEC 947-3.
  3. It is recommended that the external switch or circuit breaker be mounted in the same room as the converter.
  4. 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

1. Wiring should be performed according to the following procedure:
2. Be sure to connect the shield line to the "FG" terminal of the converter. The outer sheath of the signal line should be stripped to a length of 50 mm or less. The 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 conduit separate from 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	Cable type	Number of wires
CELL+, CELL- HTR TC+, HTR TC- CJ+, CJ-	Converter signal	Yes	CVVS	6
HEATER	Converter heater	No	CVV	2
L, N,	Power supply	No	CVV	2 or 3 *
AO-1+, AO-1-, AO-2+, AO-2-	Analog output	Yes	CVVS	2 or 4
DO-1, DO-2, DO-3, DO-4	Contact output	No	CVV	2 to 8
AC-Z, AC-S, AC-C	Automatic Calibration unit	No	CVV	3
DI-1, DI-2, DI-C	Contact input	No	CVV	3

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

T5.1E EPS



## 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 Requirement".

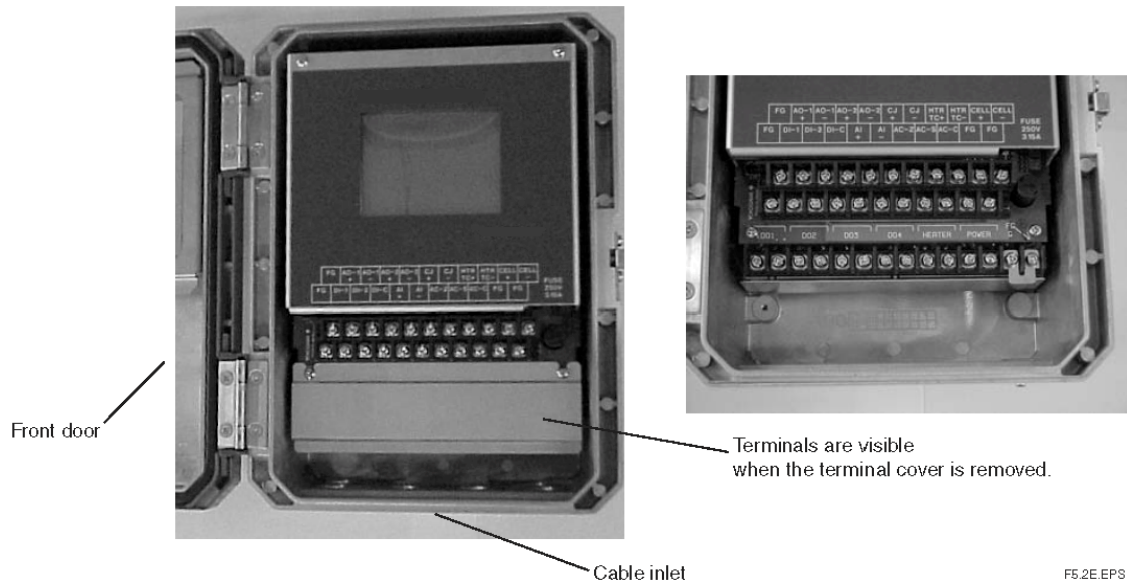
### 5.1.1 Terminals for the External Wiring in the Converter

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 secure the terminal covering plate with the two screws removed earlier.



**Figure 5-1 Terminals for external wiring in the converter**



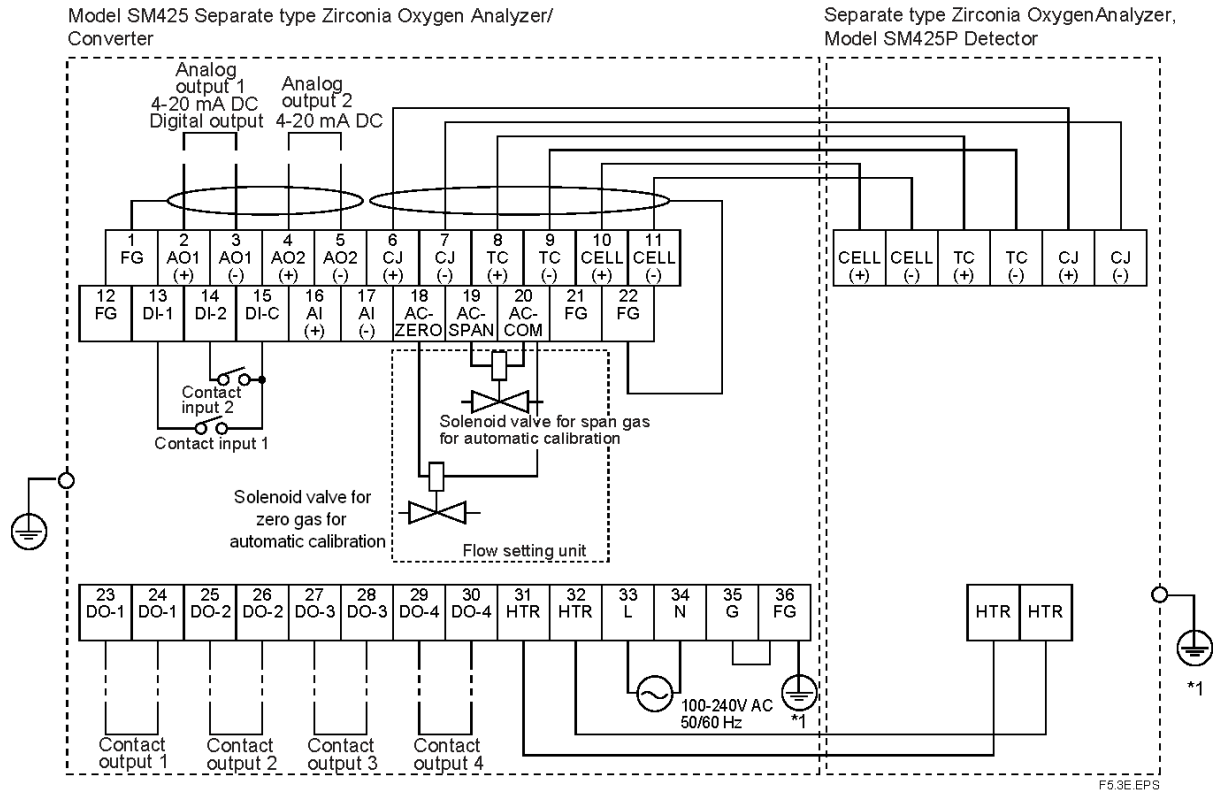
**Note**

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.

### 5.1.2 Wiring

Connect the following wiring to the converter. It requires a maximum of eight 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

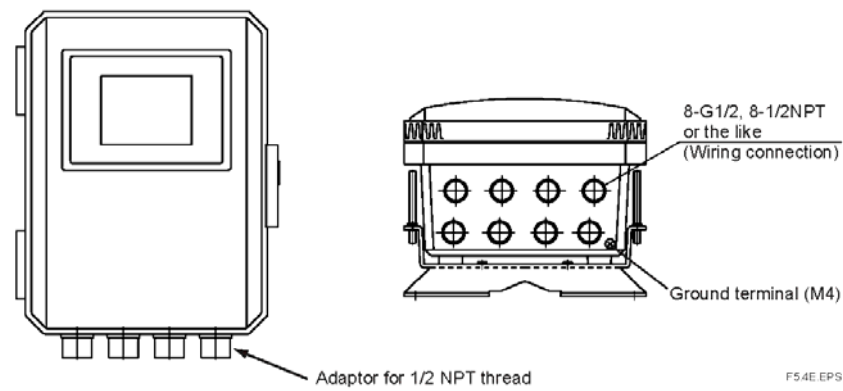


\*1 The protective grounding for the converter should be connected to either the protective ground terminal in the equipment or the ground terminal on the case.  
 Standard regarding grounding: Ground to earth, ground resistance: 100 Ω or less.

**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 hub that matches the thread size or install a cable gland.



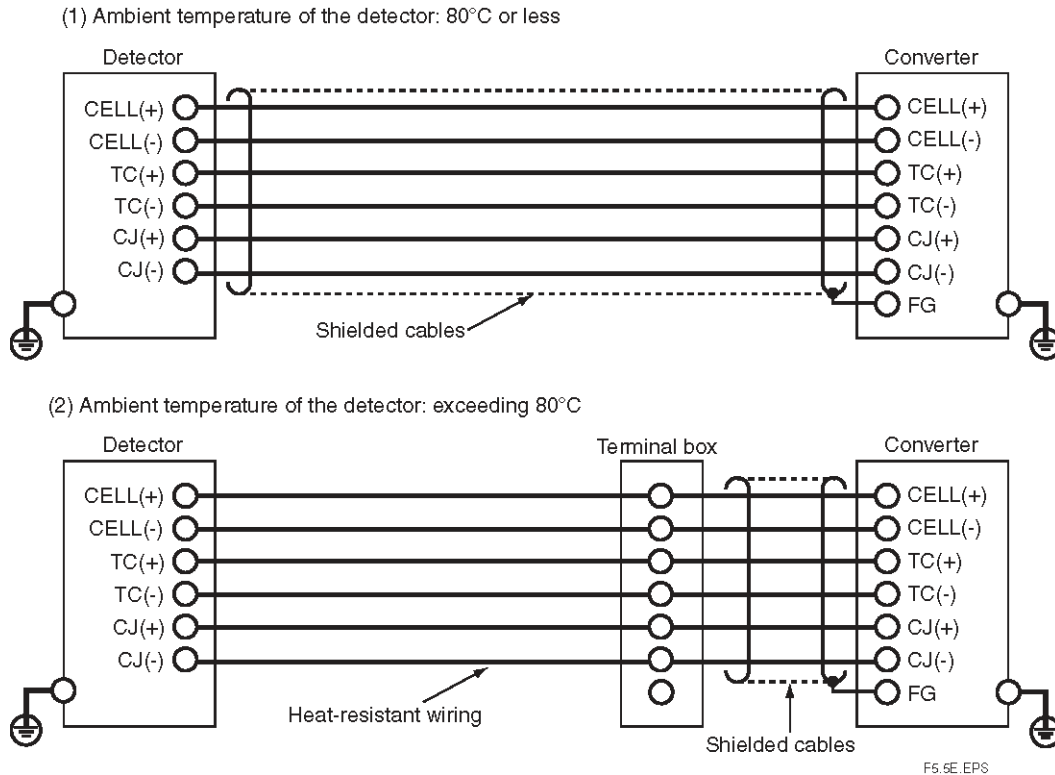
**Figure 5-3 Cable gland mounting**



## 5.2 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 with 10Ω of loop resistance or less. Keep detector wiring away from power wiring.

Separate signal and power wiring.



**Figure 5-4 Wiring for detector output**



### Note

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.

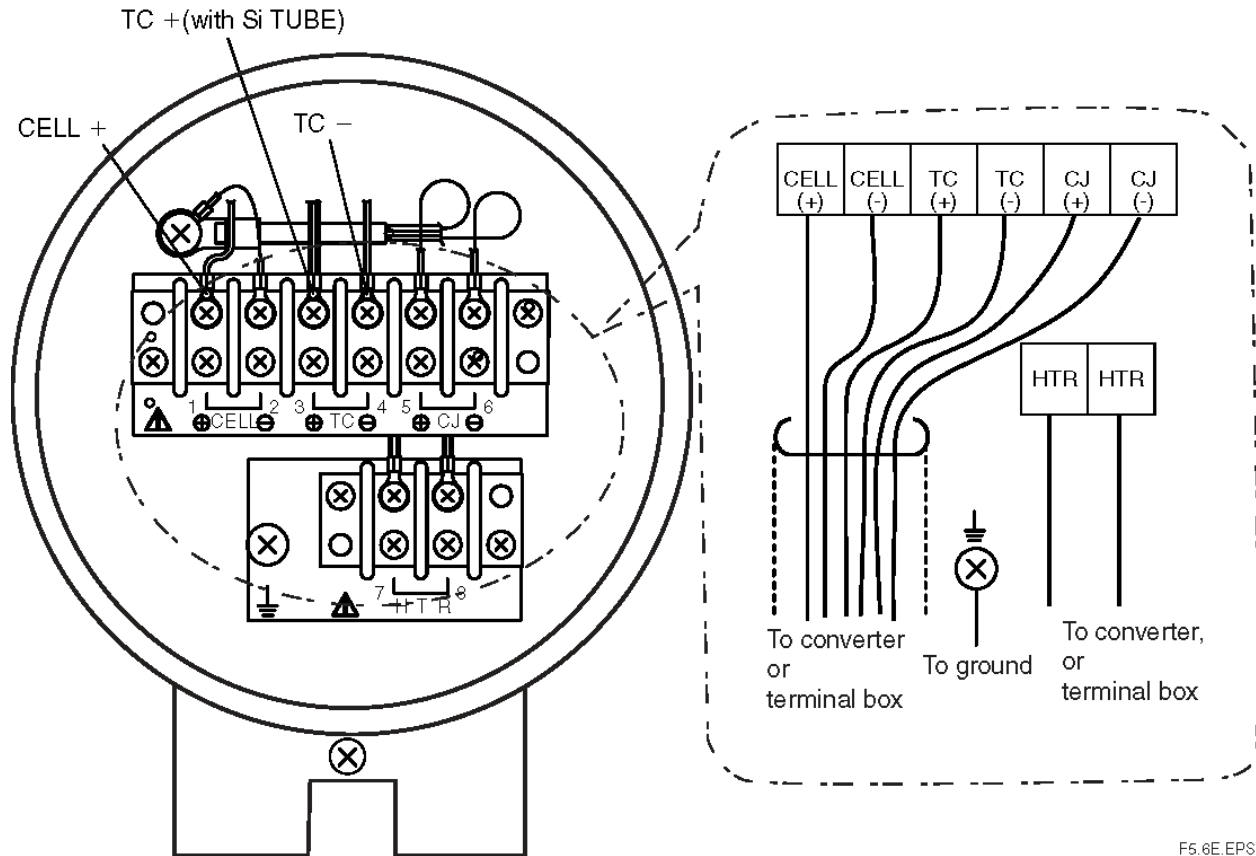
### 5.2.1 Cable Specifications

PVC sheathed PVC insulated cable (six core) is recommended for wiring the SM425. When the ambient temperature of the detector exceeds 80°C, install a terminal box. Connect the detector using six-piece 600-V silicon rubber insulated glass braided wire.

### 5.2.2 Connection to the Detector

To connect cables to the detector, proceed as follows:

1. Mount conduit hubs of the specified thread size or cable glands to the wiring connections of the detector. The detector may need to be removed in future for maintenance, so allow sufficient cable length.
2. If the ambient temperature at the location of wire installation is 80 to 150°C, use a flexible metallic wire conduit. If a non-shielded 600V silicon rubber insulated glass braided wire is used, keep the wire away from noise sources to avoid noise interference.
3. Figure 5-5 shows the layout of the detector terminals.
4. Except when “600V silicon rubber insulated glass braided wire” is used, connect the cable shield to the “FG” terminal of the converter.



**Figure 5-5 Detector terminals**

F5.6E.EPS

The sizes of the terminal screw threads are M3.5 except for the M4 on the grounding terminal. Each wire in the cable should be terminated in the corresponding size of crimp terminal (\*1) respectively.

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

### 5.2.3 Connection to the Converter

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

1. M4 screws are used for the terminals of the converter. Each wire in the cable should be terminated with the corresponding size crimp-on terminal.
2. If a rubber insulated glass braided wire is used to wire the detector, use a terminal box. For wiring between the terminal box and the converter, use PVC sheathed PVC insulated cable rather than individual wires.



#### Note

The above is to prevent moisture or corrosive gas from entering the converter and grounding the detector.

## 5.3 Wiring for Power to Detector Heater

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

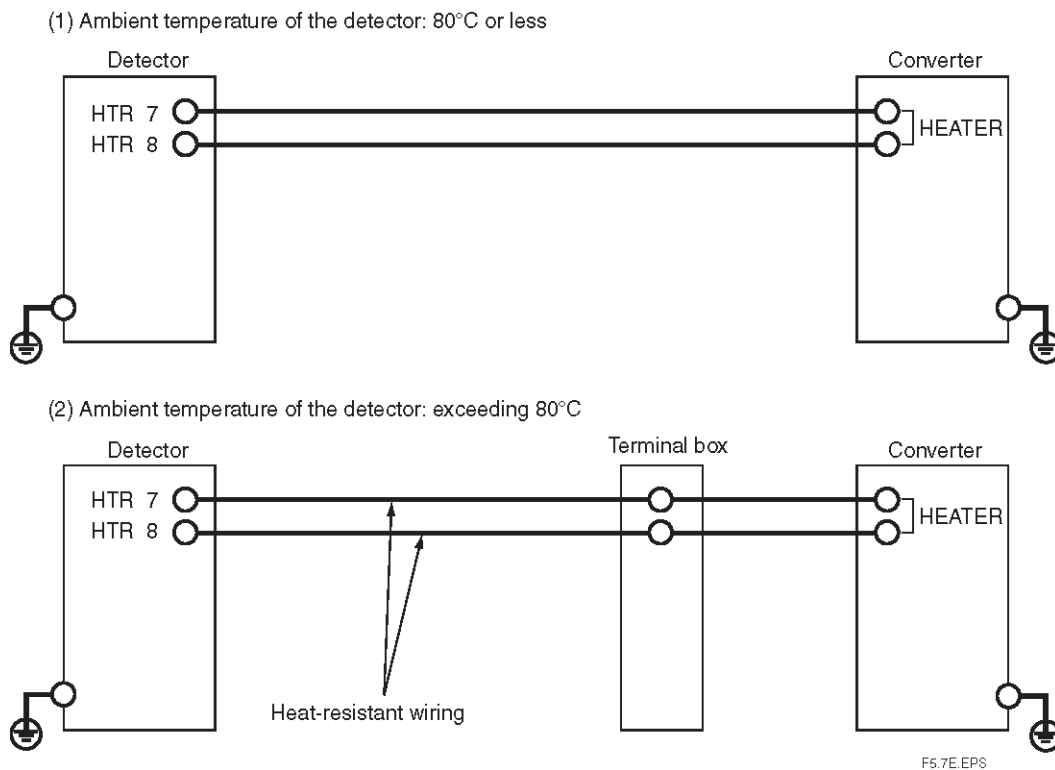


Figure 5-6 Wiring for power to the detector heater

### 5.3.1 Cable Specifications

PVC insulated PVC sheathed control cables (2 cores) are recommended for wiring the SM425. When the ambient temperature of the detector exceeds 80°C, install a terminal box and connect to the detector using six 600V silicon rubber insulated glass braided wires.

### 5.3.2 Connection to Detector

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

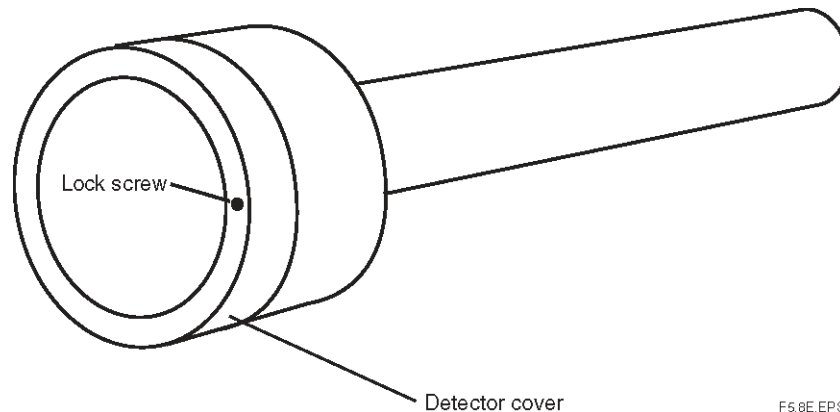
1. Mount cable glands or conduits of the specified thread size to the wiring connections of the detector. The detector may need to be removed in future for maintenance, allow sufficient cable length.
2. If the ambient temperature at the location of wire installation is 80 to 150°C, use a flexible metallic conduit for the wire. If a non-shielded “600V 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 with 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”.

---

 **CAUTION**

- 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 debris to avoid gouging the thread.
  - Use caution when closing the cover of the detector. After screwing the cover in the detector body, secure it with the lock screw.
- 



**Figure 5-7 Detector lock screw**

F5.8E.EPS

### 5.3.3 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 with the corresponding size crimp-on terminals.
2. If a rubber insulated glass braided wire is used to wire the detector, use a terminal box. For wiring between the terminal box and the converter, use PVC sheathed PVC insulated cable, rather than wire.

**Note**

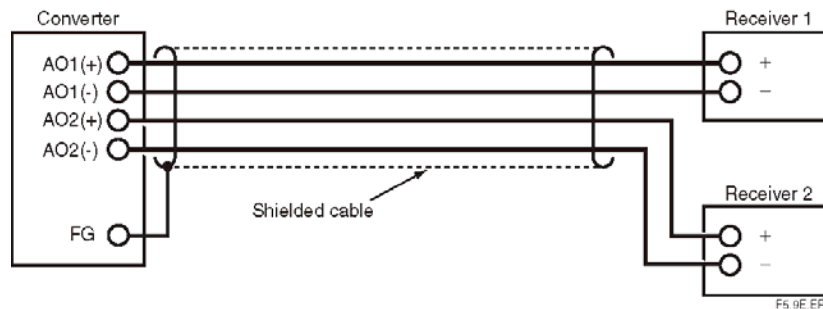
The preceding is recommended to prevent moisture or corrosive gas from entering the converter. Where the ambient environment of the detector and the converter is well-maintained, wiring from the detector directly to the converter without conduit is allowed.

**WARNING**

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

## 5.4 Wiring for Analog Output

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



**Figure 5-8 Wiring for analog output**

### 5.4.1 Cable Specifications

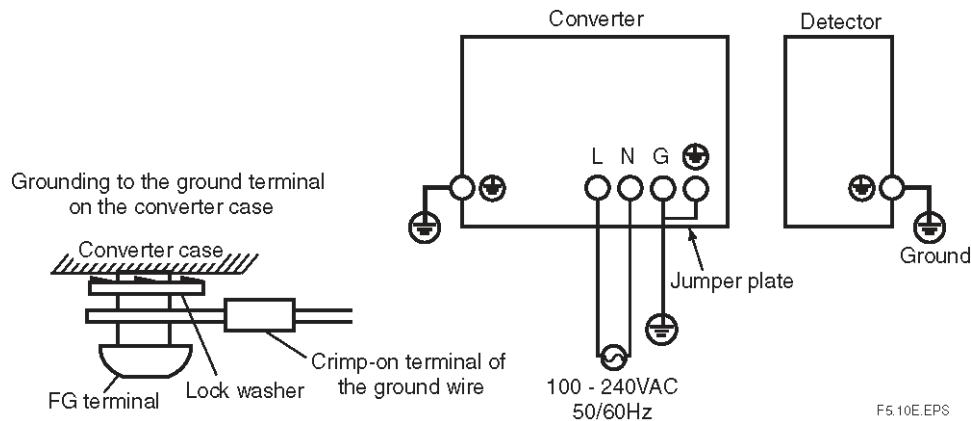
For this wiring, use a 2-core or a 4-core shielded cable.

### 5.4.2 Wiring Procedure

1. M4 screws are used for the terminal of the converter. Each wire of the cable should be terminated with the corresponding crimp-on terminal. Ensure the cable shield is connected to the 'FG' terminal of the converter.
2. "+" and "-" Polarities must be connected correctly.

## 5.5 Power and Grounding Wiring

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



**Figure 5-9 Power and Grounding wiring**

### 5.5.1 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 shielded cable.
2. The size of converter terminal screw threads is M4. Each cable should be terminated with the corresponding crimp-on terminal.

### 5.5.2 Grounding Wiring

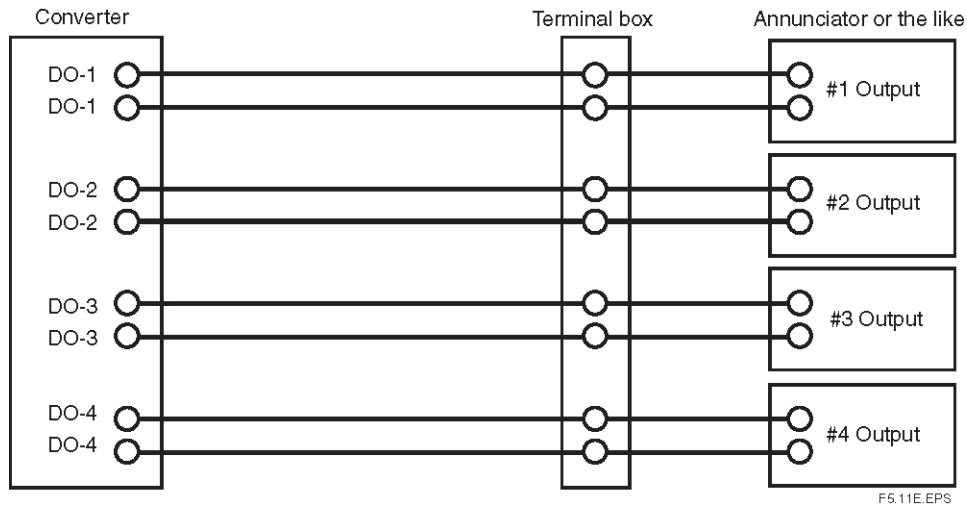
The ground wiring of the detector should be connected to the ground terminal of the detector case. The ground wiring of the converter should be connected to either the ground terminal of the converter case or the protective ground terminal in the equipment. The grounding terminals of the detector and the converter are of size M4. Proceed as follows:

1. Keep ground resistance to 100Ω or less.
2. If the ambient temperature of the wiring installation is 80 to 150°C for the detector wiring, use wiring material with sufficient heat resistance.
3. When connecting the ground wiring to the ground terminal of the converter case, be sure the lock washer is in contact with the case surface (see Figure 5-9.).
4. Ensure the jumper plate is connected between the "G" terminal and the protective ground terminal of the converter.

## 5.6 Contact Output Wiring

Contact outputs 1 to 3 can be user programmed to "low limit alarm", "high limit alarm", etc. The function of contact output 4 is fixed ("error output") and its action (contact closed during error condition) cannot be changed.

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



**Figure 5-10 Contact output wiring**

### 5.6.1 Cable Specifications

Number of wires in cable varies depending on the number of contact(s) used.

### 5.6.2 Wiring Procedure

1. M4 screws are used for the terminals of the converter. Each wire in the cable should be terminated with the corresponding crimp-on terminal.
2. The capacities of the contact output relay are 30 VDC 3 A, 250 VAC 3 A. Connect the load (e.g. pilot lamp and annunciator) with these operational limits.

## 5.7 Wiring for SM425CAL Automatic Calibration Unit

This wiring is for the solenoid valves controlling the zero gas and the span gas flows in the SM425CAL Automatic Calibration Unit (e.g. System configuration 3). Install this wiring as shown in Figure 5-11:

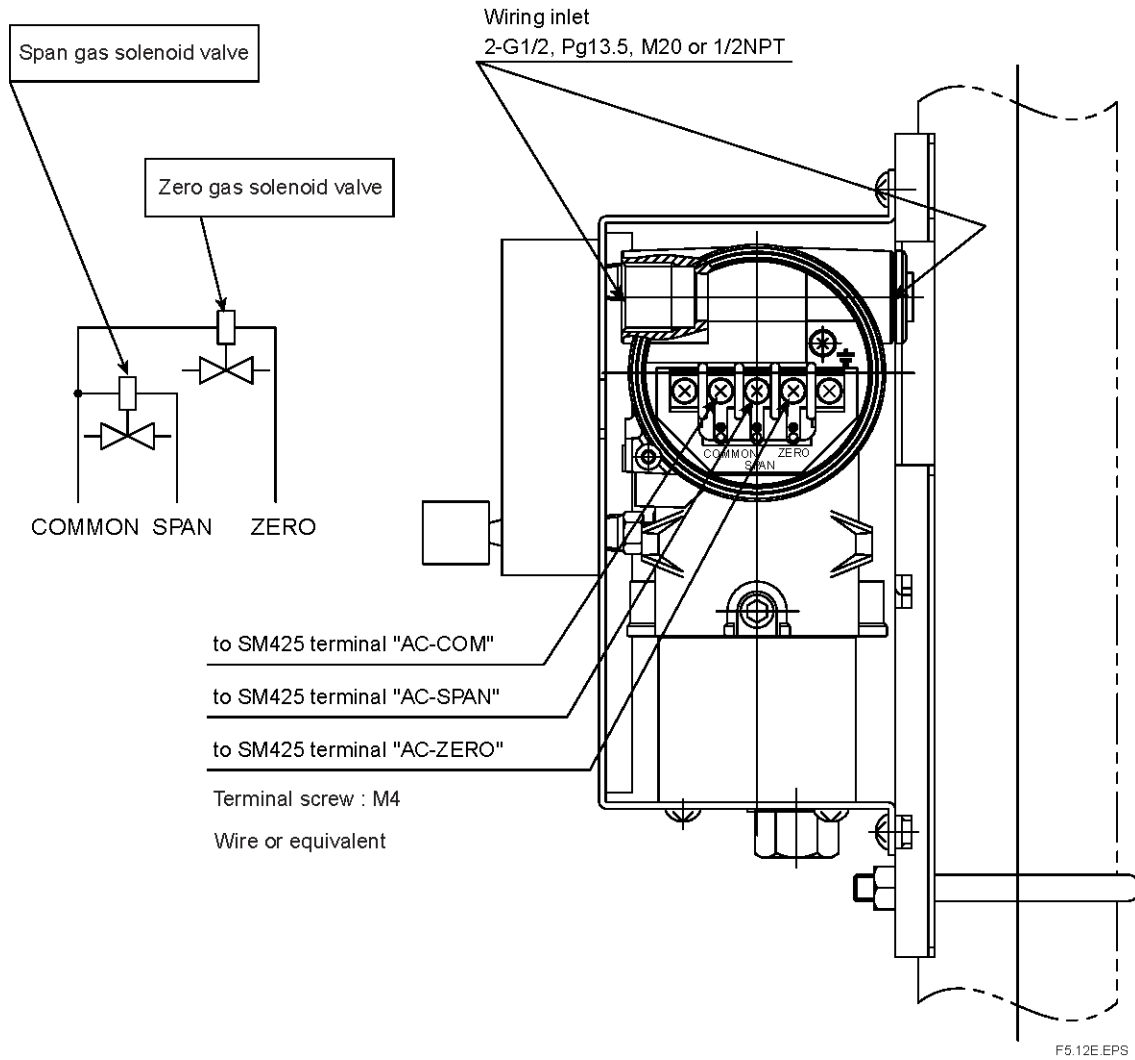


Figure 5-11 Automatic Calibration Unit

### 5.7.1 Cable Specifications

Use a three-core cable for this wiring.

### 5.7.2 Wiring Procedure

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



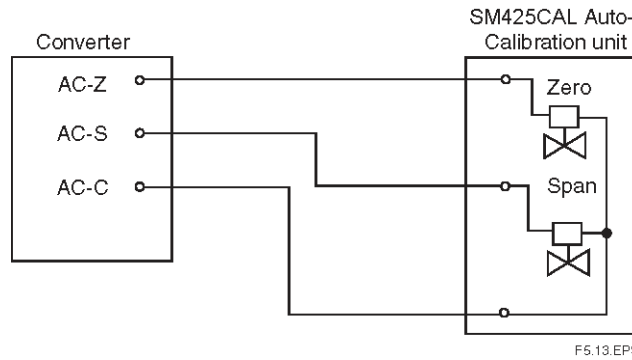


Figure 5-12 Wiring for Automatic Calibration Unit

### 5.8 Contact Input Wiring

The converter can initiate specified functions by external contact closure signals.

To use these contact signals, wire as follows:

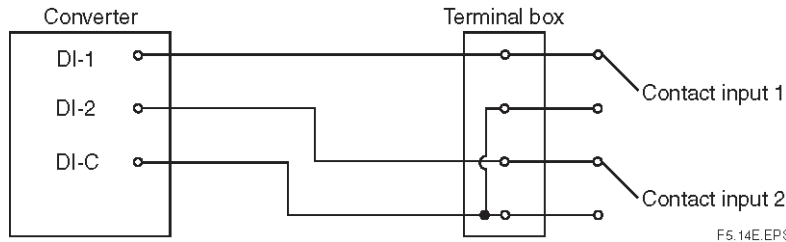


Figure 5-13 Contact Input Wiring

#### 5.8.1 Cable Specifications

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

#### 5.8.2 Wiring Procedure

1. M4 screws are used for the terminals of the converter. Each cable should be terminated with the corresponding crimp-on terminal.
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 kΩ or more

T5.2E.EPS

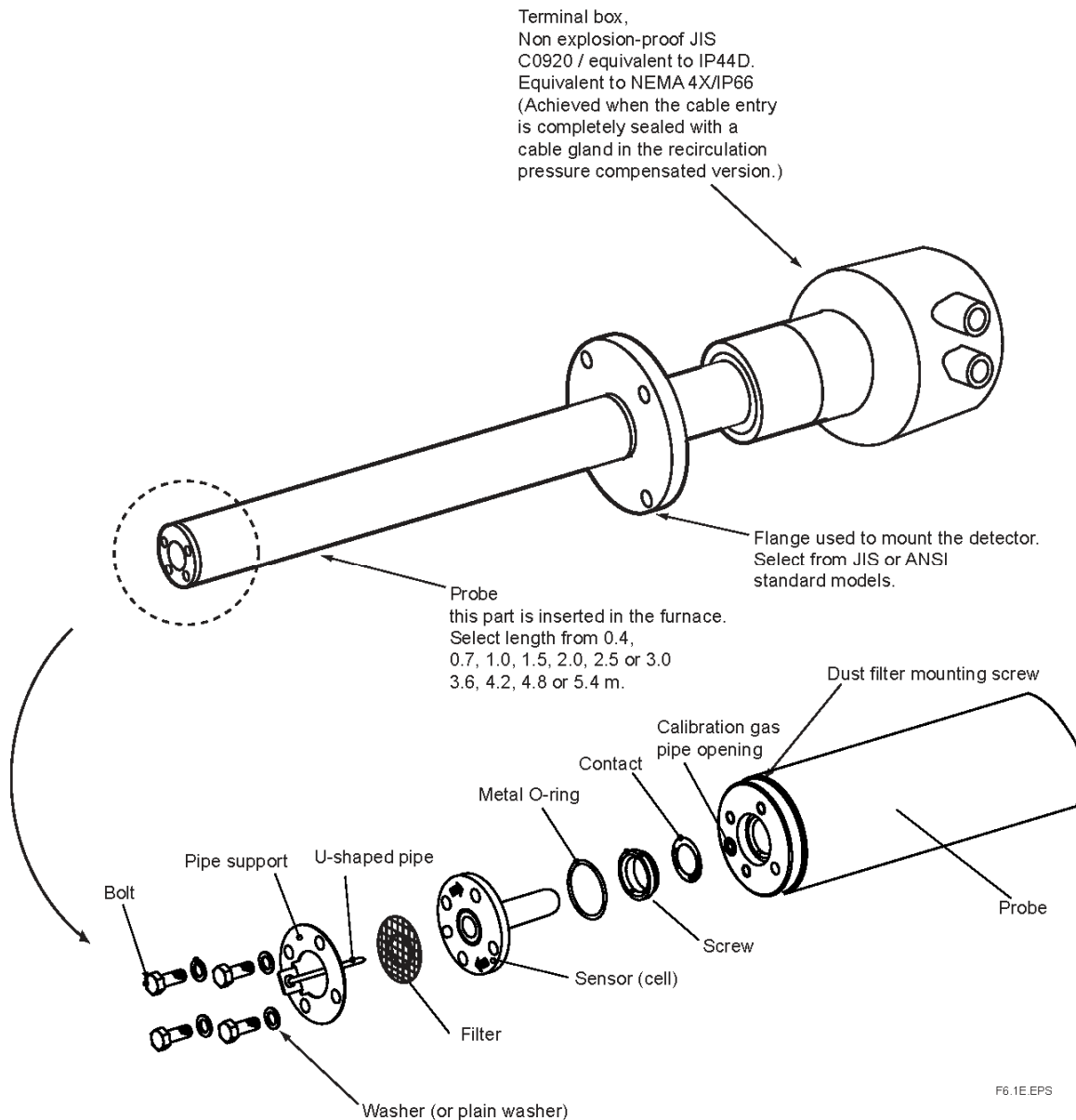
# USER NOTES

## 6.0 COMPONENTS

In this Section, the names and functions of components are described for the major equipment of the SM425 Separate-type Zirconia Oxygen Analyzer.

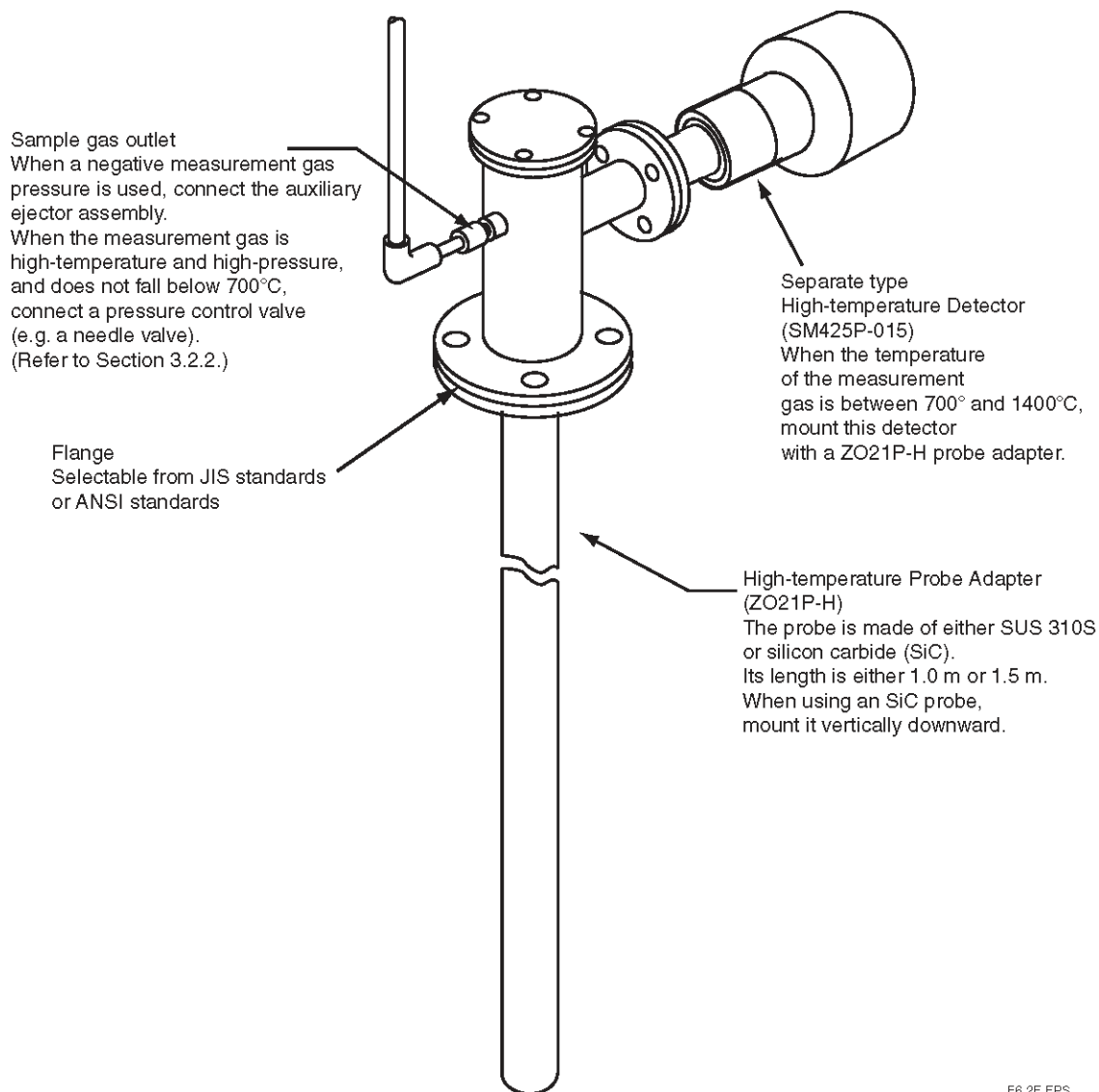
### 6.1 SM425P Detector

#### 6.1.1 General-purpose Detector (except for SM425P-015)



**Figure 6-1 General-use Detector (standard type)**

#### 6.1.2 High-Temperature Detector (SM425P-015)



**Figure 6-2 High-temperature Detector**

F6.2E.EPS

## 6.2 SM425 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 display allows viewing even in areas of low lighting

Error codes and details of errors are displayed, no need to refer to instruction manual

Password for security



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 factor
ALARM7	Abnormal span calibration factor
ALARM8	Stabilization time over

### Typical Converter Displays

**Example of basic display**

This data display provides for interactive operation.

**Example of trend display displays data changes**

During automatic calibration, you can check if oxygen content has stabilized, display data while viewing oxygen trend data, thus providing highly reliable calibration.

**Example of setting data display displays data changes**

### Commissioning

- ➔ Basic setup
- mA-output setup
- Alarms setup
- Contact setup
- Others

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

F1.5E.EPS  
F0.3E.EPS

Figure 6-3 Converter

## 6.3 ZA8F Flow Setting Unit, SM425CAL Automatic Calibration Unit

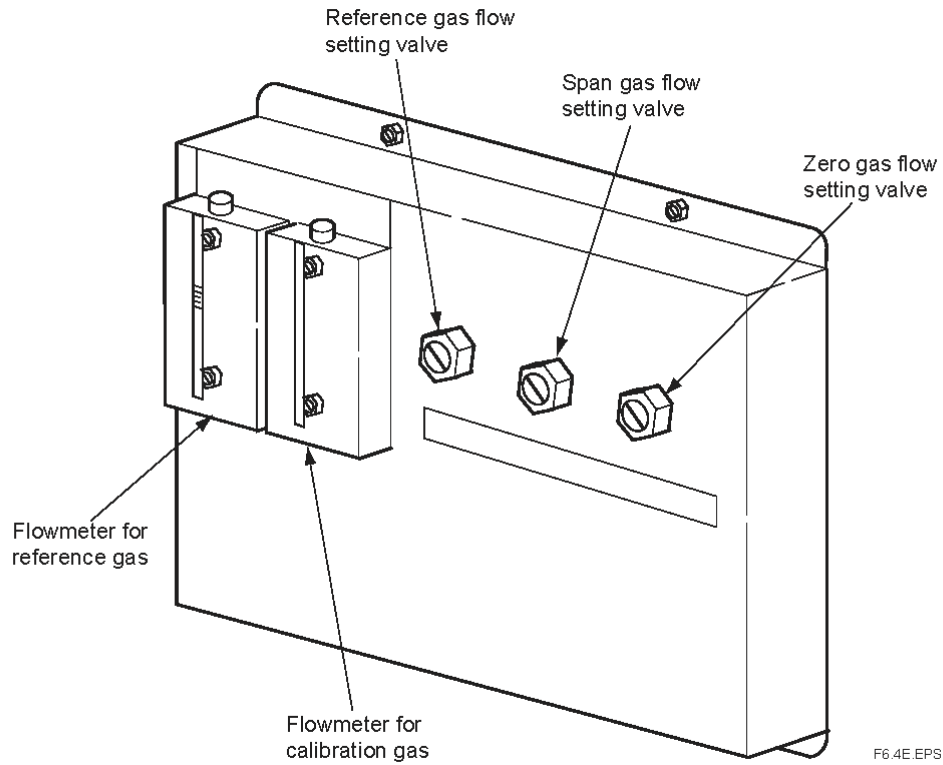


Figure 6-4 ZA8F Flow Setting Unit

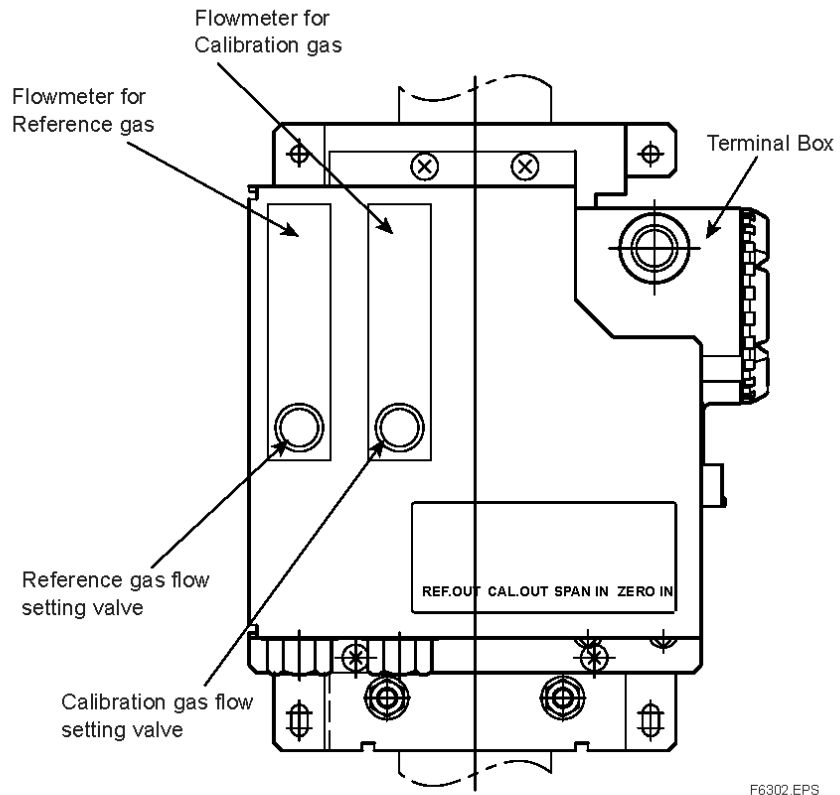


Figure 6-5 SM425CAL Automatic Calibration Unit

## USER NOTES



## 7.0 STARTUP

This section describes the minimum operating requirements for the SM425. Details include supplying power to the converter, analog output confirmation, and manual calibration.

For system tuning by the HART communicator, refer to IM11M12A01-51E "HART Communication Protocol".

### 7.1 Checking Piping and Wiring Connections

Verify the piping and wiring connections have been properly completed in accordance with Section 0, "Piping," and Section 0, "Wiring."

### 7.2 Checking Valve Setup

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

1. Fully close the stop valve in the detector's calibration gas inlet if it is used.
2. If instrument air is used as the reference gas, adjust the air-set secondary pressure for an air pressure equaling the process gas pressure plus approximately 50 kPa (150 kPa if check valve is used, maximum pressure rating is 300 kPa). 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. If the valve has a lock nut, loosen the lock nut before turning the valve shaft.) 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.

---

## 7.3 Supplying Power to the Converter



### CAUTION

To avoid temperature changes around the sensor, it is recommended power be continuously supplied to the Oxygen Analyzer even if it is only used periodically. The flowing of span gas (instrument air) beforehand is also recommended.

Supply power to the converter. A display indicating the detector sensor temperature then appears as shown in Figure 7-1. 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 measured 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 shown in Figure 7-2. This is called the basic panel display.

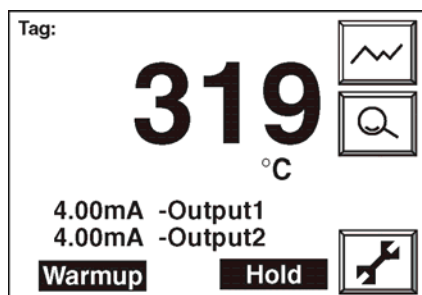


Figure 7-1 Sensor Display During Warmup

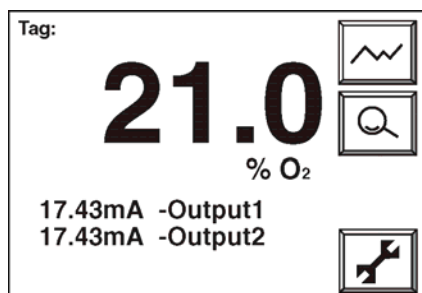


Figure 7-2 Measurement Mode Display

## 7.4 Touch panel Switch Operations

### 7.4.1 Basic Panel and Switch

The converter uses touch panel switches which can be operated by touching the panel display screen. Figure 7-3 shows the basic panel display screen. Various switches appear in the switch display area depending on the panel display selected. Table 7-1 shows the switch functions.

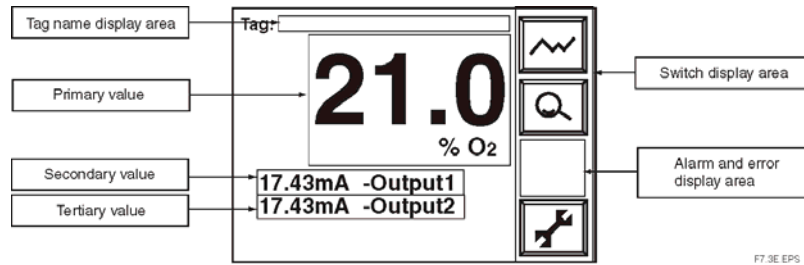


Figure 7-3 Basic Panel Display Screen

Tag name display area: Displays the set tag name (Refer to Section 1.53.4, “Entering Tag Name”).

Primary to tertiary display items: Displays the selected item. (Refer to Section 1.41, “Setting Display Item”.)

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

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

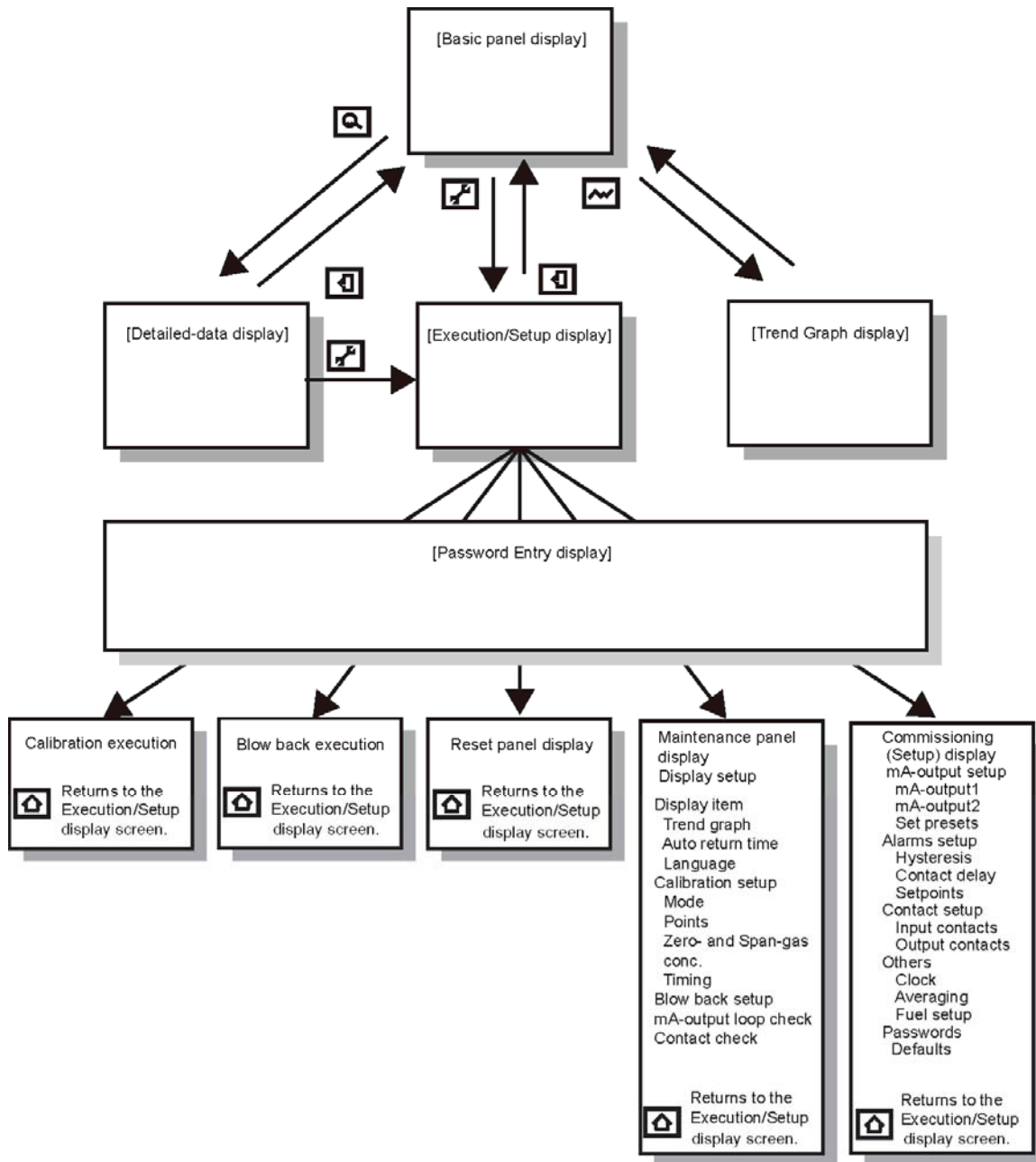
Table 7-1 Switches and Their Function

	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 is triggered.		Error: Displayed if an error occurs.

T7.1E.EPS

## 7.4.2 Display Configuration (for Oxygen Analyzer)

Figure 7-4 shows the display configuration tree. The Execution/Setup function display screens can be password protected. If protection has not been set, press the [Enter] key to proceed to the next panel display screen. The Home key returns you to the Execution/Setup display screen from other panel display screens.



F7.3.1E.EPS

Figure 7-4 Display Screen Configuration

### 7.4.3 Display Functions

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

1. Basic panel display: Displays the values measured in three selected items (see Section 1.41, "Setting Display Items").
2. Execution/Setup display screen: Selects calibration execution, blow back execution, reset panel display, maintenance, and setup display screens.
3. Detailed-data display screen: This allows you to view detailed data such as the cell electromotive force and cell temperature (see Section 1.53.1, "Detailed-data Display").
4. Trend Graph display screen: Displays a trend graph (see Section 1.53.2, "Trend Graphs").
5. Calibration execution screen: Executes zero and span calibrations (see Section 0, "Calibration" and the associated sections).
6. Blow-back execution screen: Executes a "blow back" (see Section 1.54, "Blow Back").
7. Reset panel display screen: If an error occurs, the equipment can be reset from this display (for more details, see Section 0, "Reset").
8. Maintenance panel display screen: Sets parameters for equipment operation and tests signal contacts and output current loops.
9. Commissioning (Setup) display screen: Sets up the operation data. (For details, see Section 0, "Detailed-data Settings" and the associated sections.)

### 7.4.4 Entering Numeric and Text Data

This section explains how to enter numeric and text data. If only numeric values are to be entered, a numeric-data entry display screen as shown in Figure 7-5 appears. Press the numeral keys to enter numeric values. Decimal points are not entered because their position is already fixed. "00098" was entered in the example shown in Figure 7-5 to obtain the "000.98" value.

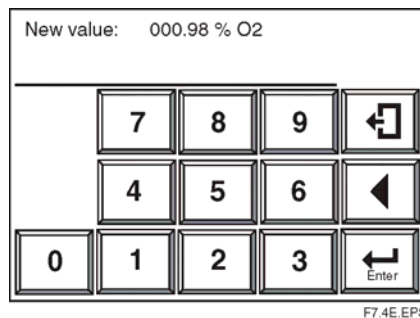


Figure 7-5 Numeric-data Entry Display

For text entries like a password that can contain a combination of alphabetic, numeric, and other characters, the alphabetic character entry screen appears first. The (0-9) key selects the numeric entry screen and the (other) key selects the screen for other characters. These screens have a (A-Z) key which navigates back to the alphabetic screen. Figure 7-6 shows the screens' relationships.

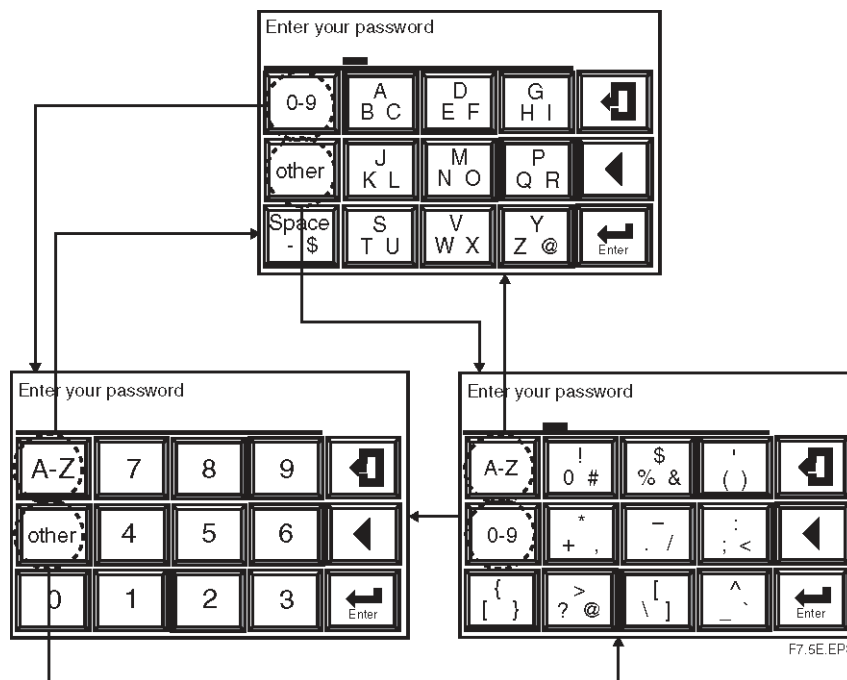


Figure 7-6 Text Entry Display

Three alphabetic characters and three “other” characters are assigned for each individual key. If the alphabetic character key is pressed and held, three characters appear in sequence. Release the key when the desired character appears to enter it. If an incorrect character is entered, move the cursor to that position and re-enter the character. Figure 7-7 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.

AB \_

Enter the character C in the same manner as above.

ABC \_

Press the [other] key.

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 \_

SIK7.4E

Figure 7-7 Text Entry Example

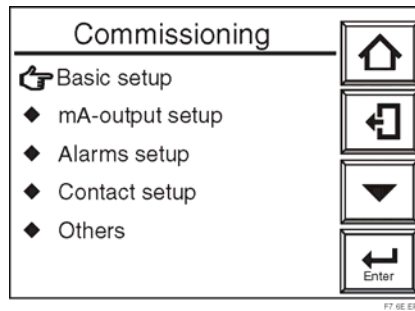
### 7.5 Confirmation of Converter Type Setting

This converter can be used for both the Oxygen Analyzer and the Humidity Analyzer. Confirm the converter is setup for Oxygen before commissioning the analyzer.

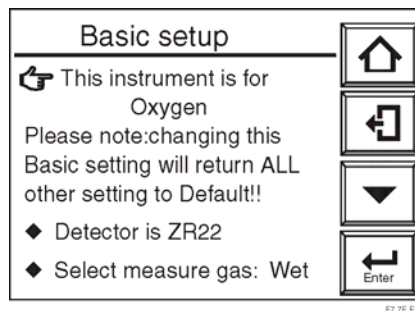
Note all settings will be reinitialized to default settings if the converter type selection is changed.

To confirm the converter type, follow these steps:

1. Press the setup key.
2. Use the ▼ key to select Setup and press the [Enter] key.
3. Press the [Enter] key on the password entry display screen if a password has not been set for commissioning. Otherwise enter the password for the Commissioning display screen. See Section 1.50.5, "Setting Passwords" for information on setting a new password.
4. Select "Basic setup" and press the [Enter] key on the Commissioning display screen as shown in Figure 7-8.
5. The Basic setup display screen shown in Figure 7-9 then appears. Confirm "This instrument is for Oxygen" is displayed.
6. If the converter type is to be changed, press the [Enter] key. The display screen shown in Figure 7-10 appears.
7. Use the ▼ key to select the type of equipment. Then press the [Enter] key to complete the converter selection.



**Figure 7-8 Setup Display**



**Figure 7-9 Basic Setup**

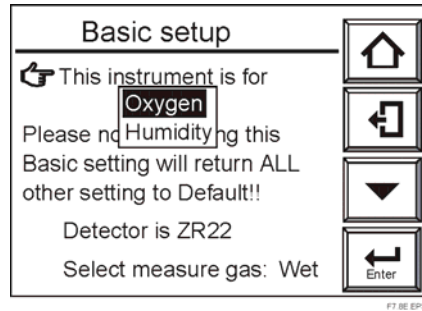


Figure 7-10 Equipment Setup

## 7.6 Confirmation of Detector Type Setting

Check the detector in Figure 7-9 is the correct type.

### WARNING

- If this converter is to be used with the ZO21D, the power requirements are limited to 125 V AC or less, 50 Hz or 60 Hz (it cannot be used with 125 VAC or greater, or in Europe).
- 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 Measurement Gas

Combustion gases contain moisture created by burning hydrogen in the fuel. If this moisture is removed, the oxygen concentration might increase. Specify whether the oxygen concentration in a wet gas is to be measured directly or compensated for its dry-gas value before use. Select “Select measure gas:” in Figure 7-9 to choose either wet or dry gas.

## 7.8 Output Range Setting

This paragraph shows how to set the analog output ranges. For more details, consult Section 1.45, “Current Output Settings”.

### 7.8.1 Configuring the 4-20 mA Outputs

To configure the 4-20 mA outputs, follow these steps:

1. Select “Setup” from the Execution/Setup display screen.
2. Select “mA-output setup” on the Commissioning (Setup) display screen.
3. Select “mA-output1” on the “mA-outputs” display screen shown in Figure 7-11. The “mA-output1 range” display is shown in Figure 7-12.
4. Select “Min. oxygen conc.” and press the [Enter] key to display the numeric-value entry display. Enter the oxygen concentration corresponding to the 4-mA output; for example enter [010] for a ten-percent concentration measurement.
5. Select “Max. oxygen conc.”. Enter the appropriate oxygen concentration corresponding to the 20-mA output in the same manner as in step 4 above.
6. Set “mA-output2” in the same manner as “mA-output1”.



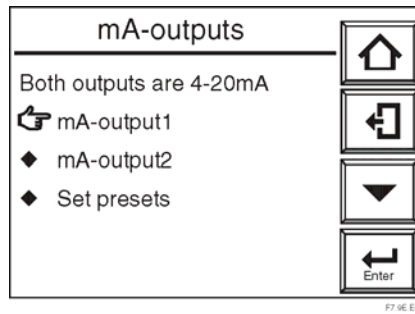


Figure 7-11 Selecting “mA-output1”

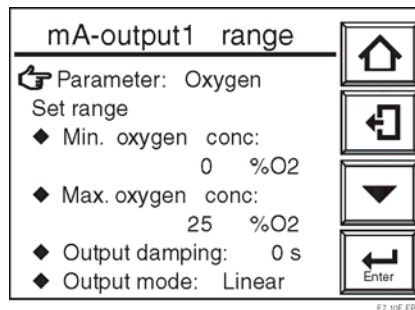


Figure 7-12 Setting “mA-output1 range”

## 7.9 Selecting Display Items

This paragraph briefly describes the selection of items to be displayed in the primary, secondary, and tertiary value areas of the basic panel display. See Figure 7-13, “Basic Panel Display”.

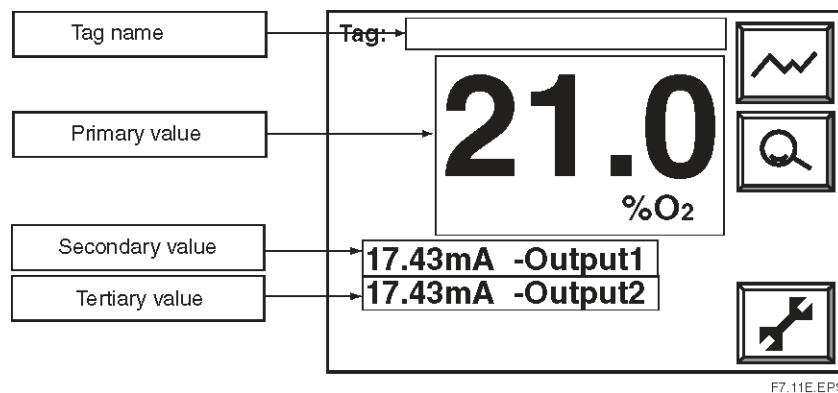


Figure 7-13 Basic Panel Display

1. Press the Setup key in the basic panel display screen to display the Execution/Setup display screen then select Maintenance.
2. Select Display setup from the Maintenance panel display screen (Figure 7-14).
3. Select the Display item in the Display setup screen (Figure 7-15). The Display item display (Figure 7-16) then appears. From this display screen, select Primary value and press the [Enter]

key to display the Display item selection display (Figure 7-17). Choose an item and press the [Enter] key.

4. Select the Secondary and Tertiary values in the same manner as the Primary value.
5. Consult Table 7-2, "Display Items" for items that can be selected for each of the display areas.

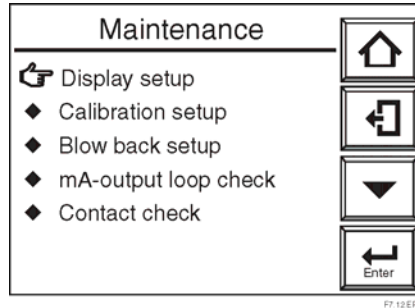


Figure 7-14 Maintenance Panel Display

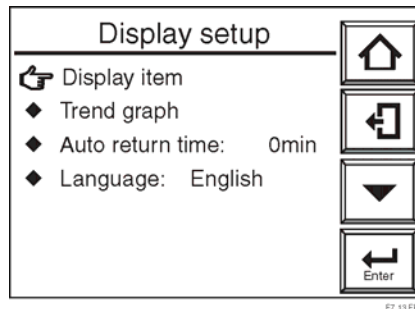


Figure 7-15 Display Setup

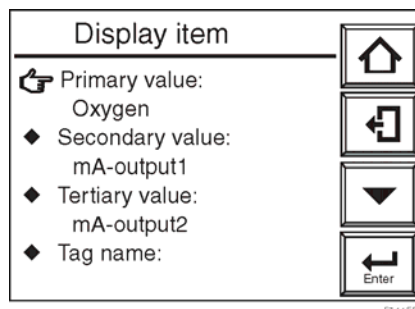


Figure 7-16 Display Item Display

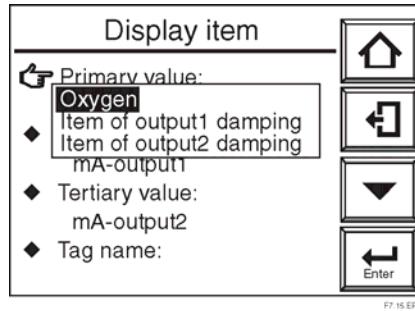


Figure 7-17 Display Item Selection

Table 7-2 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 <sub>2</sub> 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 2

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

T7.2E.EPS

### 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.

In the SM425, the air ratio is obtained by measuring the oxygen concentration in the exhaust gas. The air ratio may be expressed mathematically by:

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

If the air ratio is used to determine combustion efficiency, etc., verify that there are no air leaks or interference gases (CH<sub>4</sub>, CO, H<sub>2</sub>, etc.) present.

### About moisture quantity:

The moisture quantity in the exhaust gas is calculated based on the parameters of the fuel setting (refer to Section 1.50.3, “Fuel Settings”). 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

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

where,

Gw = water vapor content in exhaust gas, m<sup>3</sup>/kg (m<sup>3</sup>)

Z = Ambient absolute humidity, kg/kg

Ao = Ideal air amount, m<sup>3</sup>/kg (m<sup>3</sup>)

m = Air ratio

X = Fuel coefficient, Nm<sup>3</sup>/kg or m<sup>3</sup>/m<sup>3</sup>

For details on each parameter, refer to Section 1.50.3, "Fuel Settings."

## 7.10 Checking the Current Loops

A programmed test current is sent to the 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 screen.
2. Select "mA-output loop check" in the Maintenance panel display screen to display the "mA-output loop check" display. Select the desired analog output. See Figure 7-18.
3. A default value of 4 mA is generated when the numeric-data entry display appears. Enter a value to generate other currents, for example 20 mA.

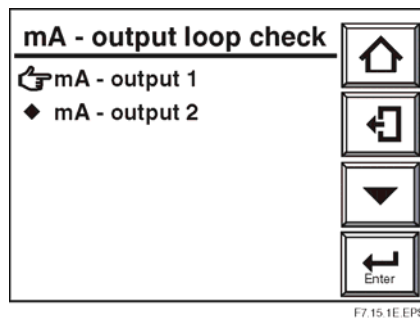


Figure 7-18 "mA-output loop check" Panel Display

## 7.11 Testing Contact I/O

### 7.11.1 Testing Output Contacts

To check an output contact, follow these steps:

1. Press the Setup key in the basic panel display screen to display the Execution/Setup display screen. Select Maintenance in that display screen.
2. Select "Contact check" in the Maintenance panel display screen then "contact output". The Output contacts display then appears (see Figure 7-19).
3. Select the desired output contact. A display appears for controlling the contact state. Use this display to conduct continuity checking.

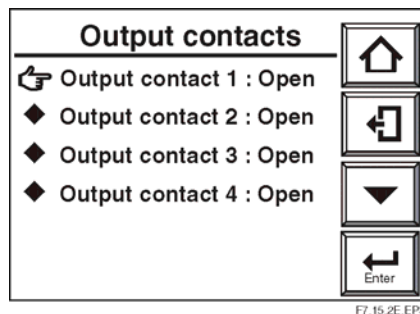


Figure 7-19 Output Contact Check Panel Display

## CAUTION

• Conducting an open-close check for contact output 4 generates an Error 1 or Error 2. 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. If these errors occur, reset the equipment or cycle power to restart (refer to Section 0, “Reset”).

### 7.11.2 Testing Calibration Output Contacts

The calibration contacts are used for solenoid valve drive signals for the SM425CAL Automatic Calibration Unit. When using the SM425CAL Automatic Calibration Unit, use the calibration contact output to check the wiring connections and solenoid valve operation of the Automatic Calibration Unit.

1. Select the “contact check” display. See Section 1.43.1.
2. Select “Calibration contacts”. The display shown in Figure 7-20 appears.
3. Cycle the zero-gas and the span-gas contacts. This will check the solenoid valve and wiring connections.

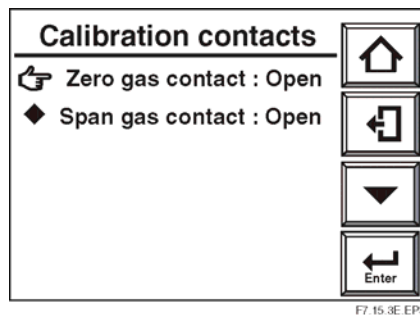


Figure 7-20 Calibration Contact Check Display

## Note

“Open” and “Closed” displayed on the Calibration contact display indicate actions of drive contacts. The valve is opened (gas flows) when the contact is in the closed state.

### 7.11.3 Testing Input Contacts

1. Select the “contact check” display screen. See Section 1.43.1.
2. Select “input contact”. The display screen shown in Figure 7-21 appears. This display screen indicates the state of the input contacts but does not control them. Cycle the input source(s) to check the wiring connections.

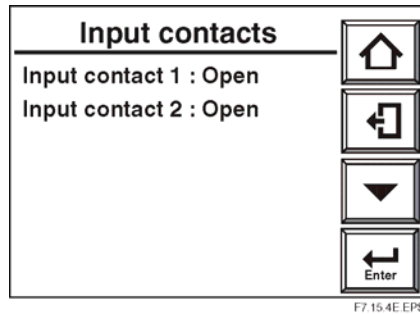


Figure 7-21 Input Contact Check Display

## 7.12 Manual Calibration

The SM425 analyzer is calibrated by comparing the measured zero and span gas values to reference zero and span gas values. There are three types of calibration procedures available:

1. Manual calibration.
2. Semi-automatic calibration which is initiated with the touch panel or a contact input signal. Semi-automatic calibration uses programmed calibration and stabilization times.
3. Automatic calibration which is initiated by an internal timer.

Manual calibration uses the ZA8F Flow Setting Unit to manually control the calibration gas supply. Semi-automatic and automatic calibrations use the SM425CAL Automatic Calibration Unit to automatically supply the calibration gases. The following paragraphs describe the manual calibration procedure. For details on semi-automatic and automatic calibrations, consult Section 0, "Calibration".

### 7.12.1 Setup for Manual Calibration

#### 7.12.1.1 Select a Calibration Mode

To select a calibration mode, use the following procedure:

Press the Setup key in the basic panel display screen to display the Execution/Setup display screen. Select Maintenance in the Execution/Setup screen then select Calibration setup to display the Calibration setup display screen as shown in Figure 7-22. Select Mode in this screen, and then select "Manual," "Semi-Auto" or "Auto." Any of these selections will add the manual calibration selection to the calibration execution display screen.

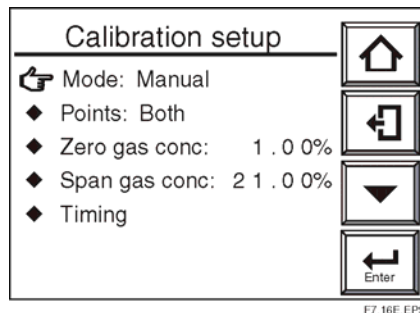


Figure 7-22 Calibration Setup

### 7.12.1.2 Select the Calibration Points

Select “Points” in the Calibration setup display screen. Select “Both” if performing the initial calibration for commissioning the analyzer.

### 7.12.1.3 Set the Calibration Gas Concentrations

1. Zero-gas concentration: Select “zero gas conc” and enter the value of zero calibration gas concentration using the Numeric-data Entry screen; if the oxygen concentration is 0.98 vol% O<sub>2</sub>, enter 00098.
2. Span-gas concentration: Select “span gas conc” and enter the value of span calibration gas concentration using the Numeric-data Entry screen; if instrument air is used, enter 02100 for a 21 vol% O<sub>2</sub> value. If using the ZO21S Standard Gas Unit and atmospheric air as the span gas, determine the actual oxygen concentration with a hand-held oxygen analyzer and enter it.



### CAUTION

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

## 7.12.2 Manual Calibration Procedure

### 7.12.2.1 Preliminary Checks

Before performing a manual calibration, verify the ZA8F Flow Setting Unit zero-gas flow valve is fully closed. Set the zero-gas cylinder pressure regulator to a secondary pressure equaling process gas pressure plus approx. 50 kPa (or process gas pressure plus approx. 150 kPa if a check valve is used). Maximum pressure rating is 300 kPa.

This applies even if the SM425CAL Autocalibration Unit is used.

### 7.12.2.2 Calibration Procedure

This procedure assumes instrument air is used as the reference for the span gas. Follow the steps below to conduct manual calibration:

1. Select the Setup key in the basic panel display screen to display the Execution/Setup display screen. Then select Calibration. The Calibration execution display screen shown in Figure 7-23 appears.

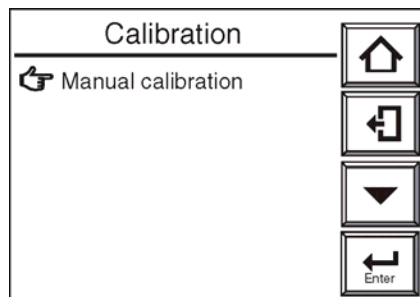


Figure 7-23 Calibration Display

- Select Manual calibration and press the [Enter] key. The Manual calibration display shown in Figure 7-24 then appears. Verify the concentration value displayed is the correct value for the reference span gas. If it is, select "Next".

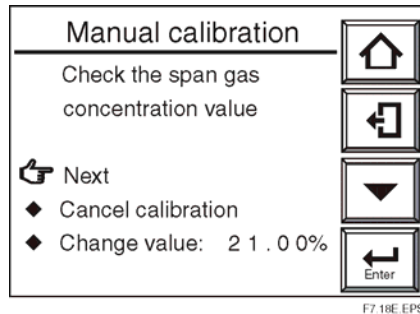


Figure 7-24 Manual Calibration

- Follow the prompt in Figure 7-25 to establish span gas flow. Open the span-gas flow valve of the Flow Setting Unit by loosening the valve lock-nut and slowly turning the valve shaft counterclockwise. Set the flow to  $600 \pm 60$  ml/min. as measured by the calibration gas flowmeter.

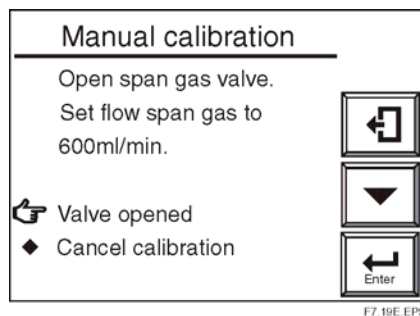


Figure 7-25 Span-gas Flow Display

- After the span gas flow has been established, select "Valve opened" as shown in Figure 7-25. An oxygen-concentration trend graph appears (see Figure 7-26). 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. The graph shows the concentration before calibration, so the value may not be correct at this point.

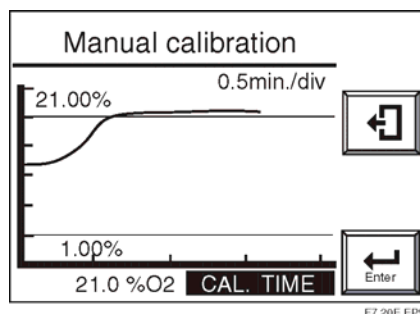


Figure 7-26 Manual Calibration Trend Graph



- After the measured value has stabilized, press the [Enter] key to display the “span-calibration complete” display screen shown in Figure 7-27. At this point, the measured value is corrected to the span-gas concentration setting. Close the span-gas flow valve. The valve lock-nut should be tightened completely to prevent the span gas from leaking.

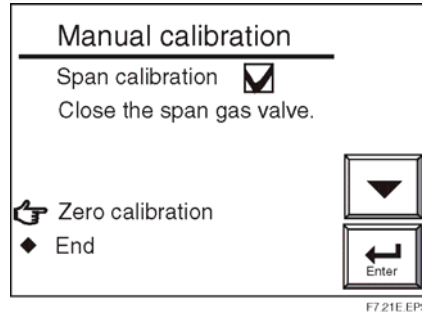


Figure 7-27 Span Calibration Complete

- Select Zero calibration as shown in Figure 7-27 to display the zero-gas concentration check display. Verify the concentration value displayed is the correct value for the reference zero gas. If it is, select “Next” as shown in Figure 7-28.

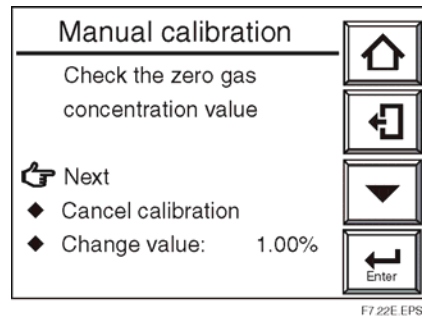


Figure 7-28 Zero-gas Concentration Check Display

- Follow the prompt in Figure 7-29 to establish the zero gas flow. Open the zero-gas flow valve of the Flow Setting Unit by loosening the valve lock-nut and slowly turning the valve shaft counterclockwise. Set the flow to  $600 \pm 60$  ml/min. as measured by the calibration gas flowmeter.

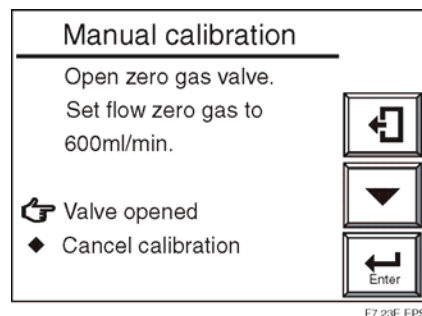


Figure 7-29 Zero-gas Flow Display

8. After the zero gas flow has been established, select “Valve opened” as shown in Figure 7-29. An oxygen-concentration trend graph screen appears (see Figure 7-30). 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. The graph shows the concentration before calibration, so the value may not be correct at this point.

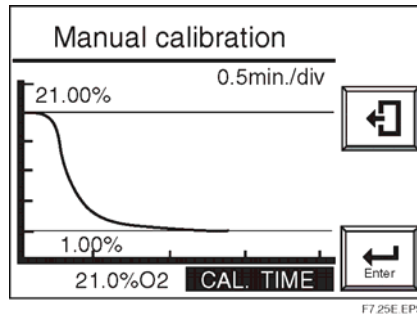


Figure 7-30 Manual Calibration Trend Graph

9. After the measured value has stabilized, press the [Enter] key to display the “zero-calibration complete” display screen shown in Figure 7-31. At this point, the measured value is corrected to the zero-gas concentration. Close the zero-gas flow valve. The valve lock-nut should be tightened completely to prevent the zero gas from leaking.

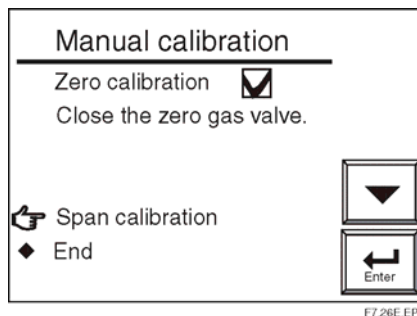


Figure 7-31 Zero Calibration Complete Display

10. Select End in the display screen as shown in Figure 7-31. An oxygen concentration trend graph screen appears and “HOLD TIME” flashes. This time is referred to as the output-stabilization time. If the HOLD TIME has been selected in the output-hold configuration, the analog output is held (refer to Section 1.46, “Setting Output Hold”). Manual calibration is completed when the preset output-stabilization time elapses. This output-stabilization time is set to 10 minutes at the factory before shipment. If the [Enter] or [Return] keys are selected during the output-stabilization time, manual calibration is completed and the analyzer returns to process monitoring.

## 8.0 DETAILED DATA SETTING

### 8.1 Configuring Analog Outputs

The following paragraph describes configuring the analog outputs.

#### 8.1.1 Setting Concentrations for Analog Outputs

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

1. Select Setup in the Execution/Setup display screen.
2. Select the mA-output setup in the Setup display screen.
3. Select mA-output1 in the mA-output display screen.
4. Select "Min. oxygen conc." in the mA-output1 range display screen 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% O<sub>2</sub>.
5. Select "Max. oxygen conc." in the mA-output1 range display screen and enter the oxygen concentration for the maximum current (20 mA) in the same manner as in step 4 above.
6. Configure mA-output2 concentrations in the same way as mA-output1.

#### 8.1.2 About Analog Concentration Ranges

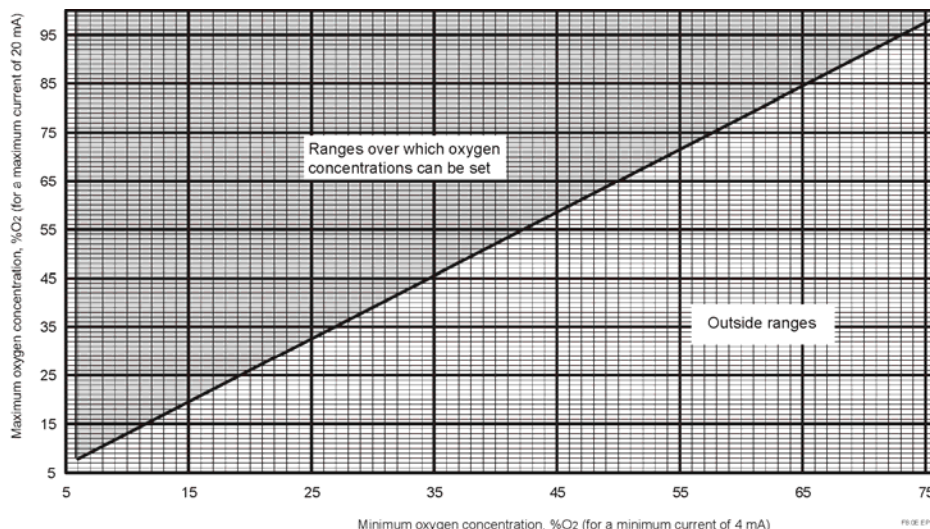
The minimum oxygen concentration for the minimum current (4 mA) is 0% O<sub>2</sub> or 6% to 76% O<sub>2</sub>. The maximum oxygen concentration for the maximum current (20 mA) ranges from 5% to 100% O<sub>2</sub>, and must be at least 1.3 times the concentration of the minimum current. The analyzer will not accept values that do not meet these requirements.

##### Setting example 1

If the concentration for 4 mA is 10% O<sub>2</sub>, the concentration for 20 mA must be 13% O<sub>2</sub> or greater.

##### Setting example 2

If the concentration for 4 mA is 75% O<sub>2</sub>, the oxygen for 20 mA must be greater than 98% O<sub>2</sub> (75 X 1.3). (Numbers after the decimal point are rounded up.)



### 8.1.3 Setting Output Damping Constants

If an analog output is used as a control signal, rapidly fluctuating oxygen concentrations will cause undesirable switching in the process or device being controlled. To avoid this, there is a damping constant which ranges from 0 to 255 seconds. Enter the appropriate output damping constant using the number-data entry display screen. For example, enter "030" to set the damping constant to 30 seconds.

### 8.1.4 Selection of Analog Output Mode

Either a linear or logarithmic output mode can be selected. The former provides a linear relationship between the analog output signal and oxygen concentration. The latter provides a logarithmic characteristic. Press the [Enter] key in the output mode display screen. A linear/logarithmic selection display then appears. Select the desired mode.



### CAUTION

- If the logarithmic mode is selected, the minimum output remains constant at 0.1% O<sub>2</sub>, and the minimum oxygen concentration value remains unchanged.

### 8.1.5 Default Output Current Values

Default output current settings are shown in Table 8-1.

**Table 8-1 Default Output Current Values**

Item	Default setting
Min. oxygen concentration	0% O <sub>2</sub>
Max. oxygen concentration	25% O <sub>2</sub>
Output damping constant	0 (seconds)
Output mode	Linear

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## 8.2 Configuring Output Hold

The “output hold” function retains an analog output signal at a predetermined value during certain equipment states. Outputs 1 and 2 can be set independently. Table 8-2 shows the output hold selections available for each of the states.

**Table 8-2 Output Hold Selections**

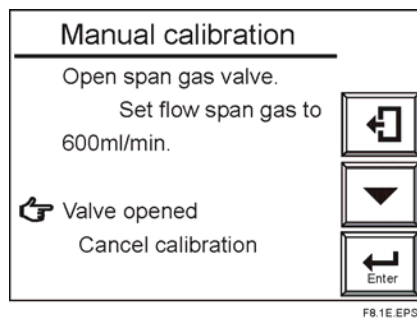
Equipment states	During warm-up	Under maintenance	Under calibration During blow back	On Error Occurrence (*1)
Output hold selections available				
4 mA	○			
20 mA	○			
No hold feature		○	○	○
Retains output from just before occurrence		○	○	○
Preset value (2.4 to 21.6 mA)	○	○	○	○

○: The output hold functions are available

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

### 8.2.1 Definition of Equipment States

1. During warm up: “During warm up” is the time required after applying power until the sensor temperature stabilizes at 750°C, and the equipment is in the measurement mode.
2. Under maintenance: “Under maintenance” is the time starting when the Setup key on the Basic Panel display screen is pressed until returning back to the Basic Panel display screen. The sub-screens under the Execution/Setup display screen are included. See Figure 7-4.
3. Under calibration (see Section 0, Calibration): For manual calibration “Under calibration” is the time starting from entering the Manual calibration display screen (shown in Figure 8-1) until the Calibration End key is pressed and the preset output stabilization time elapses.



**Figure 8-1 Manual calibration**

For semi-automatic calibration, “under calibration” is the time between initiating a calibration by input contact signal or from the touch panel screen and completion of output stabilization.

For automatic calibration, “under calibration” is the time between initiating a calibration by the timer settings and the completion of output stabilization.

4. During “Blow back” (see Section 1.54, “Blow back”):

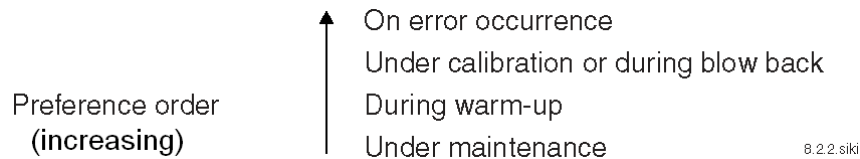
During semi-automatic blow back: “During blow back” is the time required after pressing the blow-back start key using the touch panel or entering a blow back start instruction by using a contact input, until the completion of blow back and output stabilization.

During automatic blow back: “During blow back” is the time required after reaching the blow-back start until the completion of blow-back and output stabilization.

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 preset for 4 mA for the maintenance operation and no output hold is selected for calibration, the output current will be held at 4 mA during maintenance until a calibration begins. The output hold will be released during the calibration cycle and will return to 4 mA at the completion of calibration and stabilization.

### 8.2.3 Configuring the Output Hold

Use the following procedure to set the output hold function:

1. Press the Setup key in the Basic Panel display screen to display the Execution/Setup display screen. Select Commissioning (Setup) then “mA-output setup”. Select “Set presets”. The mA-output preset display screen shown in Figure 8-2 appears.

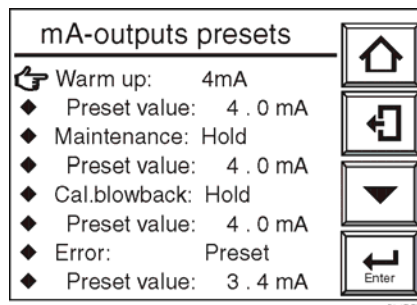
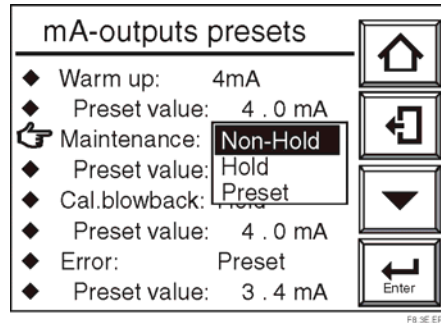


Figure 8-2 mA-output Preset Display



**Figure 8-3 mA-outputs preset Selection**

2. Select the desired equipment state. Figure 8-3 shows an example of selecting Maintenance. Select the desired output hold selection.
3. If a preset value is selected, set the corresponding output current. Select the preset value just below Maintenance on the screen; the numeric-data entry display screen appears. Enter the desired current value. To set 10 mA, type in 100 and press the [Enter] key to complete the setting. The setting range is from 2.4 to 21.6 mA.

NOTE: The "Error" selection on the "mA-outputs presets" display screen is not available for option codes "/C2" or "/C3" (NAMUR NE 43 compliant).

## 8.2.4 Default Output Hold Settings

Default output hold settings are shown in Table 8-3.

**Table 8-3 Output Hold Default Values**

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

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## 8.3 Configuring Oxygen Concentration Alarms

The SM423 has four programmable alarms based on oxygen concentration: high-high, high, low, and low-low. This paragraph explains the operation and programming of these alarms.

### 8.3.1 Alarm Values

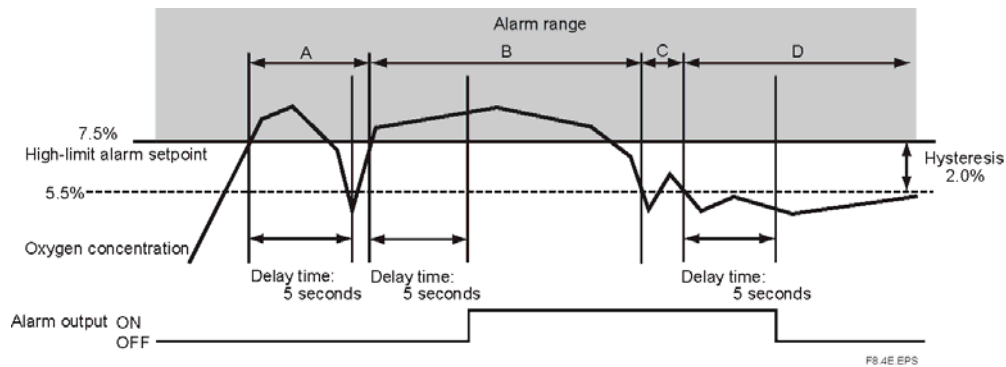
1. High-high and high alarm values: These alarms occur if oxygen levels exceed the alarm set points and the alarms are enabled (set to ON). The range for these set points is 0 to 100% O<sub>2</sub>.
2. Low and low-low alarm values: These alarms occur if oxygen levels fall below the alarm set points and the alarms are enabled (set to ON). The range for these set points is 0 to 100% O<sub>2</sub>.

### 8.3.2 Alarm Output Actions

The oxygen concentration alarms have two programmable parameters, delay and hysteresis, which can be used to minimize unwanted alarm action when the process oxygen level is near an alarm set point.

Delay is the time in seconds that the process must continuously be in an alarm state before the alarm is issued or continuously out of the alarm state before the alarm is cleared. Hysteresis is the concentration band on the “safe” side of an alarm set point, through which the process oxygen concentration must pass before the alarm will clear. Delay and hysteresis settings are common to all of the alarms. Delay and hysteresis can be deactivated by setting their values to zero.

Figure 8-4 illustrates the effects of delay and hysteresis.



**Figure 8-4 Alarm Output Action**

In the example in Figure 8-4, the high-limit alarm point is set to 7.5% O<sub>2</sub>, the delay time is set to five seconds, and hysteresis is set to 2% O<sub>2</sub>.

Alarm output actions in this figure are as follows:

1. In “A” Although oxygen concentration value exceeded the high-limit alarm set point, it falls lower than the high-limit alarm set point before the preset delay time of five seconds elapses. No alarm is issued.
2. In “B” Oxygen concentration value exceeds the high-limit alarm set point and the delay time elapses during that measurement. An alarm is activated.
3. In “C” Although oxygen concentration value falls lower than the hysteresis set value, the value rises again and exceeds the hysteresis set value before the preset delay time elapses. The alarm is not cleared.
4. In “D” Oxygen concentration value falls below the hysteresis set value and the preset delay time elapses, the alarm is cleared.



### 8.3.3 Alarm Configuration Procedure

To display the Alarm setup display, follow these steps:

1. Press the Setup key in the basic panel display screen to display the Execution/Setup display.
2. Select Setup in the Execution/Setup display screen. The “Commissioning” (Setup) display appears.
3. Select the Alarm setup in the “Commissioning” (Setup) display screen. The Alarms setup display shown in Figure 8-5 appears.

To set the hysteresis, proceed per the following steps.

4. Select Hysteresis in the Alarm setup display screen. The numeric-data entry display screen appears. Enter the desired hysteresis value as a percent of oxygen concentration. To set 2.5% O<sub>2</sub>, enter “0025.” The hysteresis setting can be in the range 0 to 9.9% O<sub>2</sub>.

To set the delay time, proceed per the following steps.

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

To set the alarm point, proceed per the following steps.

6. Select the Set points in the Alarms setup display screen. The Oxygen alarms display appears, as shown in Figure 8-6.
7. When “High alarm” is selected in the Oxygen alarms display screen, the “OFF/ON” selection display appears. Selecting “ON” enables the High alarm.
8. To set the High alarm value, select “Set value” just below the High alarm. The numeric-data entry display screen appears. Enter the alarm set value (percent of oxygen concentration). Enter “010” to set the alarm to 10% O<sub>2</sub>.
9. Set the other alarms in the same manner.

#### CAUTION

No alarm is issued when alarm is set to “OFF” (disabled). To enable alarm functions, set the alarms to “ON”.

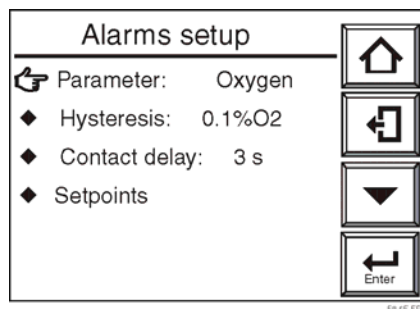


Figure 8-5 Alarms Setup Display

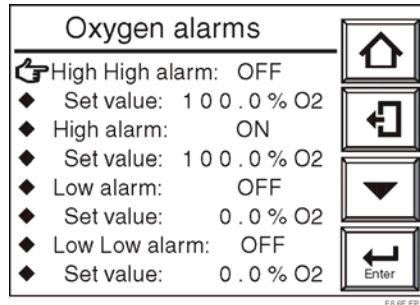


Figure 8-6 Oxygen Alarms Display

### 8.3.4 Default Alarm Settings

Default alarm settings are shown in Table 8-4.

**Table 8-4 Alarm Setting Default Values**

Item	Setting range	Default setting
Hysteresis	0 to 9.9 % O <sub>2</sub>	0.1% O <sub>2</sub>
Delay time	0 to 255 seconds	3 seconds
High-high limit alarm	—	Off
High-high-limit alarm setpoint	0 to 100% O <sub>2</sub>	100% O <sub>2</sub>
High-limit alarm	—	Off
High- and low-limit alarm setpoints	0 to 100% O <sub>2</sub>	100% O <sub>2</sub>
Low-limit alarm	—	Off
Low-limit alarm setpoint	0 to 100% O <sub>2</sub>	0% O <sub>2</sub>
Low-low-limit alarm	—	Off
Low-low-limit alarm setpoint	0 to 100% O <sub>2</sub>	0% O <sub>2</sub>

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## 8.4 Configuring Output Contacts

### 8.4.1 About Output Contacts

Mechanical relays provide the output contacts. Relay contact ratings are specified in Section 1.3, “General Specifications”. The operational states of the contacts are shown in Table 8-5. Contacts 1 to 3 can be programmed to either open or close when the relay is activated. The default is closed. Output contact 4 closes when activated. When power fails, output contacts 1 through 3 are open and contact 4 is closed.

**Table 8-5 Output contact states**

	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

T8.4E.EPS

### 8.4.2 Programming the Output Contacts

Only output contacts 1, 2, and 3 can be programmed. Each of these contacts can be activated by multiple alarms and “other conditions”. The alarm or condition is selected by turning it “ON”. In addition, the state of the active contact can be programmed to be open or closed.

To program the output contacts, follow these steps:

1. Press the Setup key in the basic panel display screen to display the Execution/Setup display screen.
2. Select Setup in the Execution/Setup display screen. The “Commissioning” (Setup) display screen appears.
3. Select the Contact setup in the “Commissioning” (Setup) display screen. The Contact setup display shown in Figure 8-7 appears.
4. Select the desired output contact. In this example contact output 1 has been selected (see Figure 8-8).
5. Table 8-6 lists the alarms, errors, and conditions that can be used to activate an output contact.
6. Select “Others” in the Output contact 1 display screen. The “Contact1” display shown in Figure 8-9 appears. Select Calibration in the Contact1 display screen.
7. The “ON/OFF” selection display appears. Select “ON”.
8. Press the Return key to go back to the previous display.
9. Select “During power-off the contact is open and in condition (when the contact is active) it is Open”. The “ON/OFF” display appears. If “OFF” is selected, the contact will be open in normal conditions and closed when the contact output is activated.



#### WARNING

- Contact output 4 can not be programmed.

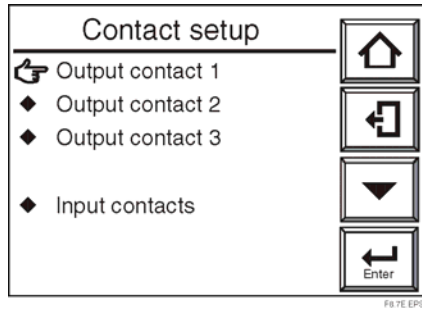


Figure 8-7 Contact Setup Display

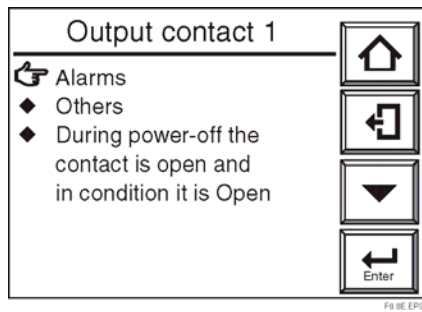


Figure 8-8 Output Contact 1 Display

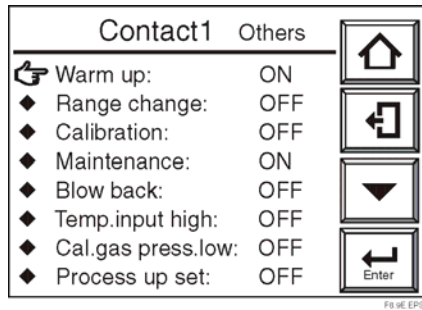


Figure 8-9 "Contact1 Others" Display

**Table 8-6 Output Contact Settings**

	Items to be selected	Brief description
Alarm and Error settings	High-high-limit alarm	If "high-high alarm ON" is selected, contact output occurs during a high-high-limit condition. In alarm setup the high-high alarm must be set ON (see Section 1.47).
	High-limit alarm	If "high alarm ON" is selected, contact output occurs during a high-limit alarm condition. In alarm setup the high-limit alarm must be set ON (see Section 1.47).
	Low-limit alarm	If "low alarm ON" is selected, contact output occurs during a low-limit alarm condition. In alarm setup the low-limit alarm must be set ON (see Section 1.47).
	Low-low-limit alarm	If "low-low alarm ON" is selected, contact output occurs during a low-low-limit alarm condition. In alarm setup the low-low alarm must be set ON (see Section 1.47).
	Calibration coefficient alarm	If calibration coefficient alarm is ON (enabled) when a zero-calibration coefficient alarm (alarm 6) or span calibration coefficient alarm (alarm 7) condition occurs, calibration coefficient alarm contact output occurs (see Section 1.62.1 Alarms).
	Startup power stabilization timeout alarm	If set ON then contact output occurs when startup power stabilization timeout alarm (alarm 8) occurs (see Section 1.63.1 Alarms).
	Error	If "Error ON" is selected, contact output occurs when an error results. (See Chapter 0, "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 1.46.1.
	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. In input contact setup the range change must be selected. For more on this, see Section 1.49.
	Calibration	If "Calibration ON" is selected, contact output occurs during calibration. For the definition of "During calibration," consult Section 1.46.1.
	Maintenance	If "Maintenance ON" is selected, contact output occurs during maintenance. For the definition of "During Maintenance," consult Section 1.46.1.
	Blow back	If "Blow back ON" is selected, contact output occurs during blow back. For the definition of "During blow back," consult Section 1.46.1.
	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. In input contact setup "Cal. gas press. low" must be selected. For more on this, see Section 1.49.
	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. In input contact setup "process upset" must be selected (see Section 1.49.)

Note: To provide an alarm with an output contact, make an alarm setting.

When using contact output as an answer-back signal for an input contact, make an input contact.

### 8.4.3 Default Output Contact Settings

Default output contact settings are shown in Table 8-7.

**Table 8-7 Output Contact Default Settings**

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

○: Present

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

## 8.5 Configuring Input Contacts

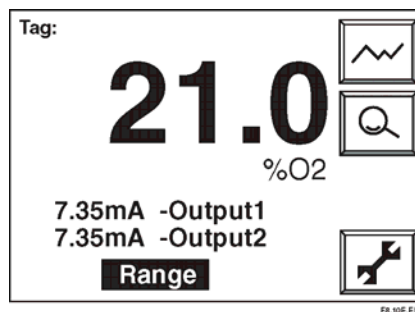
### 8.5.1 Input Contact Functions

The converter input contacts initiate selected functions by accepting a remote dry-contact ("voltage-free contact") signal. Table 8-8 shows the functions initiated by a remote contact signal.

**Table 8-8 Input Contact Functions**

Item	Function
Calibration-gas pressure drop	While the contact signal is on, neither semi-automatic nor automatic calibration is possible.
Measuring range change	While contact input is On, range of Analog Output 1 is switched to 0-25% O <sub>2</sub> and "Range" is displayed on the screen. See Figure 8.10.
Calibration start	If the contact signal is applied, semi-automatic calibration starts (only if the semi-automatic or automatic mode has been setup). Calibration is started with an applied one to 11 second time interval single-output contact signal. Even if a continuous contact signal is applied, a second calibration is not repeated. If you want to perform calibration, turn the contact signal off and then back on.
Process upset (Unburnt 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	If the contact signal is on, blow back starts. (A one to 11 second time interval single-output signal is available as a contact signal.) Even if a continuous contact signal is applied, a calibration is not repeated. If you want to make a second calibration, turn the contact signal off and then back on. (Refer to Section 10.2, "Blow back.")

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**Figure 8-10 Range Change Indicator**

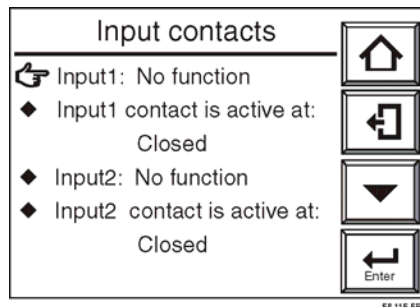
**Note**

1. Contact-initiated measurement range switching is available for analog output1 only.
2. Either semi-automatic or automatic mode must be selected in the Calibration Setup display screen to enable contact-initiated calibrations.
3. Either semi-automatic or automatic mode must be selected in the Blow Back Setup display screen to enable contact-initiated blow backs.
4. When the unburned gas detection signal is sent to an input contact, the converter will cut the power to the detector heater. As a result, the heater temperature decreases causing an Error 1 or Error 2 condition.

### 8.5.2 Configuration Procedure

The following example programs the “Input1” contact for semi-automatic calibration. In this case the calibration is initiated with an open contact signal:

1. Press the Setup key in the Basic Panel display screen to display the Execution/Setup display screen.
2. Select Setup in the Execution/Setup display screen to display the “Commissioning” (Setup) display screen.
3. Select “Contact setup” in the “Commissioning” (Setup) display screen.
4. Select “Input contacts” in the Contact setup display screen. The Input contacts display screen then appears, as shown in Figure 8-11.
5. Select Input1. The Input contacts display screen then appears, as shown in Figure 8-12.
6. Select Calibration start.
7. Select Input1 “closed.” An Open or Closed selection display screen then appears.
8. Choose Open.



**Figure 8-11 Input Contacts Display**



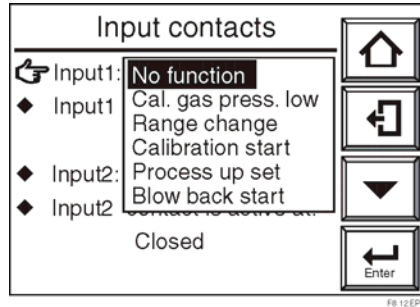


Figure 8-12 Input Contacts Display

### 8.5.3 Default Input Contact Setting

The default contact input setting is “No function” for both contacts.

## 8.6 Other Settings

### 8.6.1 Setting the Date and Time

Use the following procedure to set the current date and time. Time and date must be set for automatic calibrations and blowbacks to work:

1. Press the Setup key in the Basic Panel display screen.
2. Select “Setup” in the Execution/Setup display screen.
3. Select “Others” in the “Commissioning” (Setup) display screen. The “Others” display screen then appears, as shown in Figure 8-13.
4. Select Clock. The Clock display screen then appears, as shown in Figure 8-14.
5. Select Set date to display the numeric-data entry display screen. To set the date to June 21, 2000, enter 2106000 and press the [Enter] key. The display then returns to the Clock screen.
6. Select Set time. Enter the time in a 24-hour format. Type 1430 in the numeric-data entry display screen to set time to 2:30 pm. Press the [Enter] key. The seconds are reset to 00.

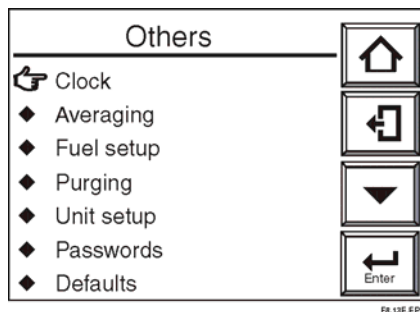


Figure 8-13 Other Settings

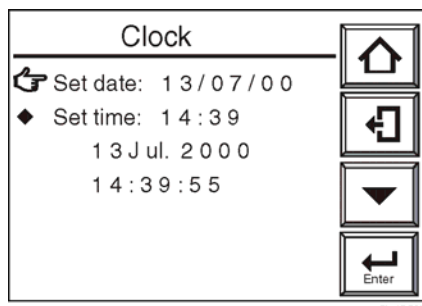


Figure 8-14 Clock Display

## 8.6.2 Setting Periods for Averaging and Maximum-Minimum Values

The SM425 monitors maximum, minimum, and average oxygen concentrations over intervals programmable from 1 to 255 hours. The average, maximum, and minimum values are displayed on the Detailed-Data display screen (see Section 1.53.1). Use the following procedure to program these intervals.

### 8.6.2.1 Procedure

1. Press the Setup key in the Basic Panel display screen.
2. Select "Setup" in the Execution/Setup display screen.
3. Select "Others" and then select "Averaging" in the "Others" display screen. The averaging display screen shown in Figure 8-15 appears.
4. Select "Set period over which average is calculated" and enter the desired numeric value from the numeric-data entry display screen. Type in 003 to enter three hours. The period over which average values can be calculated ranges from 1 to 255 hours.
5. Select "Set period over which maximum and minimum is stored" and enter the desired numeric value from the numeric-data entry display screen. To enter 48 hours, type in 048. The allowable input ranges from 1 to 255 hours.

### 8.6.2.2 Default Average, Maximum, and Minimum Period Settings

The default averaging period is 1 hour. The default period for storing maximum and minimum values is 24 hours.

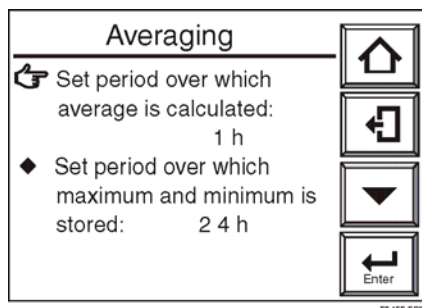


Figure 8-15 Setting Average, Maximum, and Minimum Periods

### 8.6.3 Setting Fuels

#### 8.6.3.1 Input Parameters

The SM425 calculates the moisture content contained in exhaust gases. The following explains the fuel parameters necessary for calculation and their entries. The moisture quantity may be mathematically expressed by:

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

$$= (Gw + Gw1)/G \times 100$$

$$= \frac{Gw + (1.61 \times Z \times m \times Ao)}{Go + Gw [(m - 1) Ao + (1.61 \times Z \times m \times Ao)]} \times 100 \dots \text{Equation 2}$$

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

where,

$\boxed{Ao}$ : Theoretical amount of air per unit quantity of fuel, m<sup>3</sup> /kg (or m<sup>3</sup> ) ... (2) in Table 8.9

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

$\boxed{Gw}$ : Water vapor contained in exhaust gas per unit quantity of fuel (by hydrogen and moisture content in fuel), m<sup>3</sup> /kg (or m<sup>3</sup> ) .....(1) in Table 8.9

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

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

m: Air ratio

$\boxed{X}$ : Constant determined depending on low calorific power of fuel ..... (3) in Table 8.9

$\boxed{Z}$ : Absolute humidity of the atmosphere ..... Figure 8.16

#### Figure 8-16 Moisture quantity calculation

Fill in the boxes with fuel parameters in Equation 2 above to calculate the moisture content. Use A0, 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 (Gw) =  $(1/100) \{1.24 (9h + w)\}$  [m<sup>3</sup>/kg]

Theoretical amount of air (Ao) =  $\{(12.38 / 10000) \times H1\} - 1.36$  [m<sup>3</sup>/kg]

Low calorific power = H1

X value =  $\{(3.37 / 10000) \times Hx\} - 2.55$  [m<sup>3</sup>/kg]

where, H1: low calorific power of fuel

h: Hydrogen in fuel (weight percentage)

w: Moisture content in fuel (weight percentage)

Hx: Same as numeric value of H1

- For gaseous fuel

Amount of water vapor in exhaust gas =  $(1/100) \{(h2) + 1/2 y (Cy hy) + w\}$  [m<sup>3</sup>/m<sup>3</sup>]

Theoretical amount of air =  $11.2 \times (H1/10000)$  [m<sup>3</sup>/m<sup>3</sup>]

Low calorific power = H1

X value =  $(1.05 / 10000) \times Hx$  [m<sup>3</sup>/m<sup>3</sup>]

where, H1: low calorific power of fuel

h: Hydrogen in fuel (weight percentage)

w: Moisture content in fuel (weight percentage)

Hx: Same as numeric value of H1

- For solid fuel

Amount of water vapor in exhaust gas (Gw) =  $(1/100) \{1.24 (9h + w)\}$  [m<sup>3</sup>/kg]

Theoretical amount of air =  $\{(1.01 \times (H1 / 1000))\} + 0.56$  [m<sup>3</sup>/kg]

Low calorific power = H1 = Hh - 25 (9h + w) [kJ/kg]

X value =  $1.11 - (0.106 / 1000) \times Hx$  [m<sup>3</sup>/m<sup>3</sup>]

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:

$$h = 5.7 \left[ \frac{100 - (w + a)}{100} \right] \times \frac{(100 - w)}{(100 - w1)}$$

where, a: Ash content [%]

w1: Moisture content [%], analyzed on a constant humidity basis

Hh: Higher calorific power of fuel [kJ/kg]

H1: Low calorific power of fuel [kJ/kg]

Hx: Same numeric value of H1

Figure 8-17 Calculation Formula

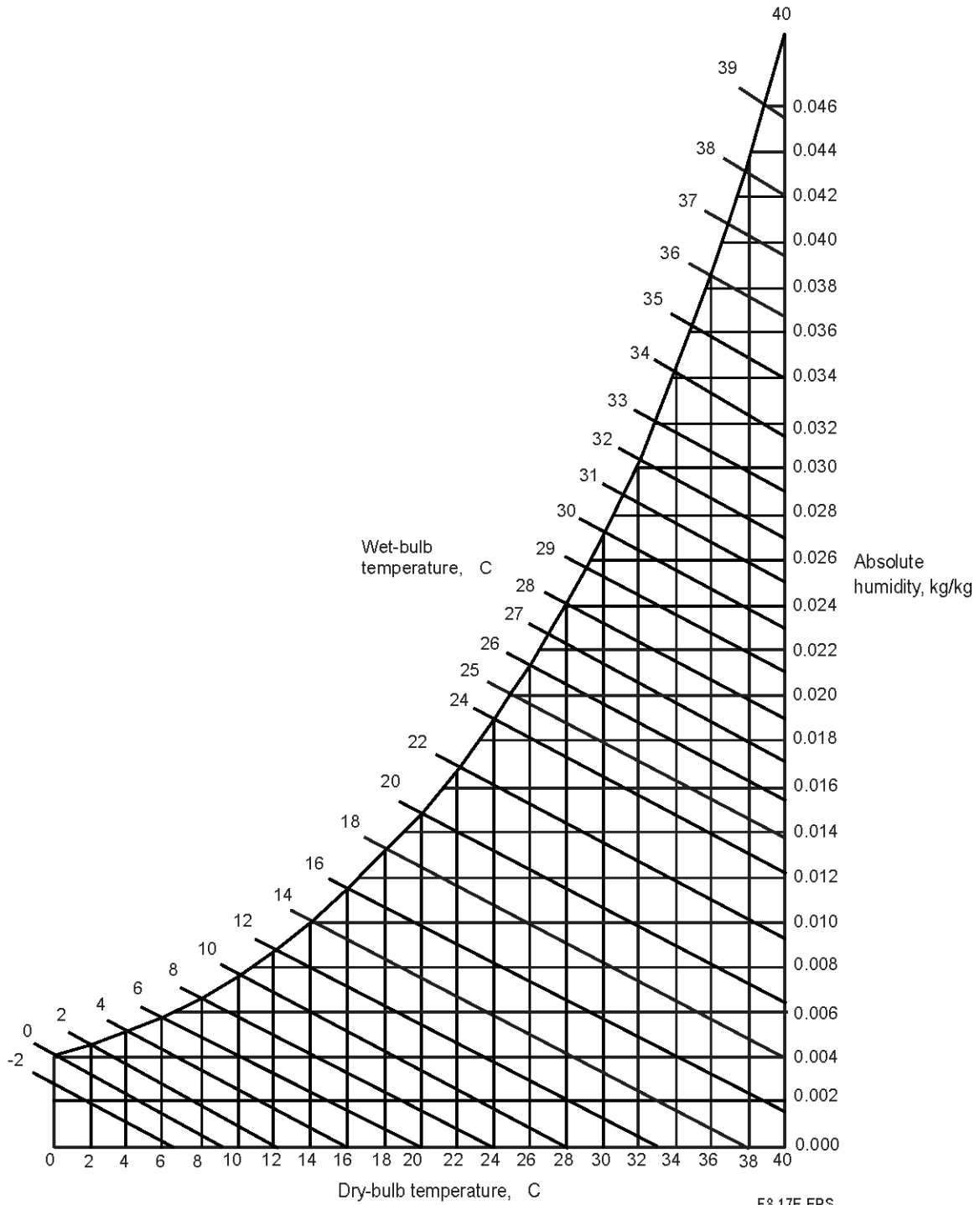


Figure 8-18 Absolute Humidity of Air

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 Nm <sup>3</sup> /kg	Amount of combustion gas Nm <sup>3</sup> /kg					X value	
				C	H	O	N	S	W	Ash content	Higher order		Lower order	CO <sub>2</sub>	H <sub>2</sub> O	SO <sub>2</sub>	N <sub>2</sub>		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 2	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
		No.4	0.94~0.97	83.0	10.5	0.5	0.4	3.5	2.0	0.1	43032	40604	10.3	1.55	1.18	0.02	8.18	10.93	0.72

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Gas fuel

Theoretical amount of air

Fuel properties Type			Specific weight kg/Nm <sup>3</sup>	Chemical component (weight percentage)						Calorific power kJ/Nm <sup>3</sup>		Theoretical amount of air for combustion Nm <sup>3</sup> /m <sup>3</sup>	Combustion product, Nm <sup>3</sup> /m <sup>3</sup>					X value	
				CO	H <sub>2</sub>	CO <sub>2</sub>	CH <sub>4</sub>	C <sub>m</sub> H <sub>n</sub>	O <sub>2</sub>	N <sub>2</sub>	Higher order		Lower order	CO <sub>2</sub>	H <sub>2</sub> O		N <sub>2</sub>		
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 <sub>3</sub> H <sub>8</sub> 90%, C <sub>4</sub> H <sub>10</sub> 10%						102055	93976	24.63	3.10	4.10		19.5	26.7	2.36	
Butane			2.530	C <sub>3</sub> H <sub>8</sub> 10%, C <sub>4</sub> H <sub>10</sub> 90%						125496	115868	30.37	3.90	4.90		24.0	32.8	2.91	
(Gases)				(Molecular Formula)															
Oxygen			1.43	O <sub>2</sub>						—	—	—	—	—		—	—	—	
Nitrogen			1.25	N <sub>2</sub>						—	—	—	—	—		—	—	—	
Hydrogen			0.09	H <sub>2</sub>						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 <sub>2</sub>						—	—	—	—	—		—	—	—	
Methane			0.72	CH <sub>4</sub>						39750	35820	9.570	1.0	2.0		7.57	10.6	0.90	
Ethane			1.34	C <sub>2</sub> H <sub>6</sub>						69638	63744	16.74	2.0	3.0		13.2	18.2	1.60	
Ethylene			1.25	C <sub>2</sub> H <sub>4</sub>						62991	59060	14.35	2.0	2.0		11.4	15.4	1.48	
Propane			1.97	C <sub>3</sub> H <sub>8</sub>						99070	91255	23.91	3.0	4.0		18.9	25.9	2.29	
Butane			2.59	C <sub>4</sub> H <sub>10</sub>						128452	118623	31.09	4.0	5.0		24.6	33.6	2.98	

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T8.0E.EPS

### 8.6.3.2 Procedure

Follow these steps to make a fuel setting:

1. Press the Setup key in the Basic Panel display screen.
2. Select Setup in the Execution/Setup display screen. The “Commissioning” (Setup) display screen then appears.
3. Select “Others” and then the Fuel setup as shown in Figure 8-19.
4. Select “Theoretical air quantity” and “Content of moisture in the exhaust gas” in turn. The numeric-data entry display screen then appears. Enter numeric data using the numeric keys.
5. Select “more” in the Fuel setup display screen. The Fuel setup screen shown in Figure 8-20 appears.
6. Enter the numeric data for “Value of the X coefficient” and “Absolute humidity of the atmosphere”.
7. Select “finished” to return to the display screen shown in Figure 8-9.

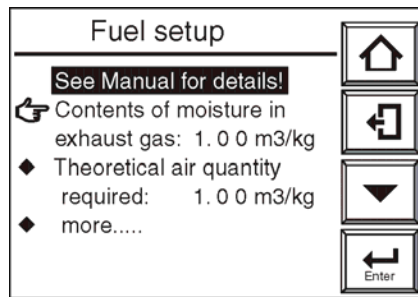
### 8.6.3.3 Default Fuel Settings

The default values for fuel values are shown in Table 8-10.

**Table 8-10 Default Settings for Fuel Values**

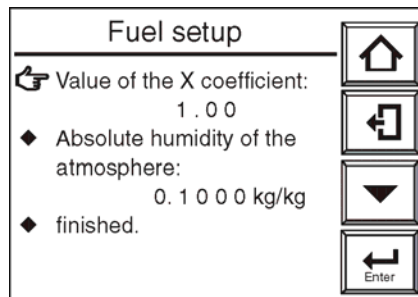
Item	Default setting
Amount of water vapor in exhaust gas	0.00 m <sup>3</sup> /kg (m <sup>3</sup> )
Theoretical amount of air	1.00 m <sup>3</sup> /kg (m <sup>3</sup> )
X value	1.00
Absolute humidity of the atmosphere	0.0 kg/kg

T8.9E.EPS



F8.19E.EPS

**Figure 8-19 Fuel Setup**



F8.19E.EPS

**Figure 8-20 Fuel Setup**

### 8.6.4 Setting Purging Time

Purging removes condensed water in the calibration gas pipe by supplying span calibration gas for a programmed length of time prior to detector warm-up. This prevents cell damage during calibration due to condensed water in the calibration gas pipe. The automatic calibration span gas solenoid opens during purging and closes after the purge time has elapsed to start the warm-up process.

Purging is initiated on power up when the cell temperature is 100°C or less and the purge time is set in the range of 1 to 60 minutes. A value of 0 minutes disables purging.

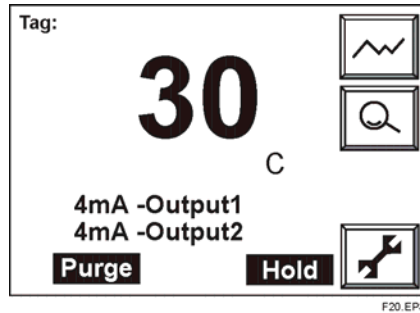


Figure 8-21 Display during Purging

#### 8.6.4.1 Procedure

Use the following procedure to set the purging time:

1. Press the Setup key in the Basic Panel display screen.
2. Select Setup in the Execution/Setup display screen. The “Commissioning” (Setup) display screen then appears.
3. Select “Others”. The “Others” display screen shown in Figure 8-22 then appears.
4. Select Purging. The purging time setting display screen appears, as shown in Figure 8-23
5. Point to the Purging time and press the [Enter] key. Then the display screen for setting purging time appears.
6. Enter the desired numeric value from the numeric-data entry display screen. The allowable input ranges from 0 to 60 minutes.

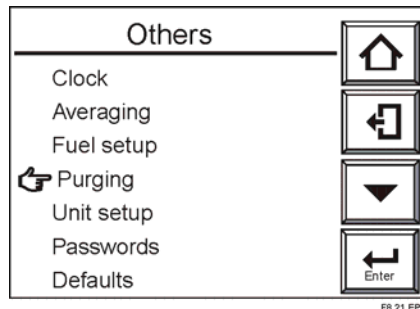


Figure 8-22 Other Settings



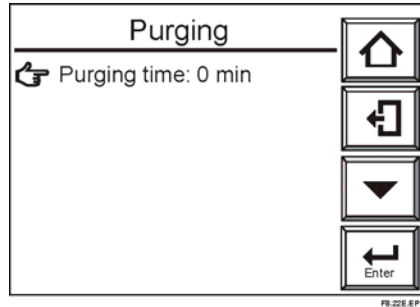


Figure 8-23 Purging Display

### 8.6.5 Setting Passwords

Passwords are used to prevent unauthorized access to display screens available in the Execution/Setup display screen menu. One password allows access to the Commissioning display screen and another password allows access to the Calibration execution, Blow back execution, and Maintenance display screens.

Proceed as follows:

1. Press the Setup key in the Basic Panel display screen.
2. Select Setup to display the “Commissioning” (Setup) display screen.
3. Select “Others” and then “Passwords”. The display screen should appear as shown in Figure 8-24.
4. Select “Calibration, Blow back and Maintenance” to set passwords for calibration, blow back, and maintenance.
5. The “text entry” display screens then appears. Enter up to eight alphanumeric characters as the password.
6. In the same manner, follow steps 1 through 5 above to set a password for Commissioning.
7. Record passwords and manage them appropriately.

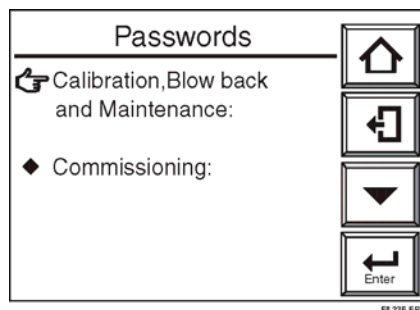


Figure 8-24 Passwords Display

If you forget a password, select Setup in the Execution/Setup display screen, and enter “MOON.” This allows access to the Setup display screen only. Select the Passwords display screen to verify the passwords.

# USER NOTES

## 9.0 CALIBRATION

### 9.1 Calibration Principles

#### 9.1.1 Measurement Principle

This section explains the principles of measurement and calibration for a zirconia oxygen analyzer.

The sensor cell is a zirconia element plated on both sides with platinum forming two electrodes. Zirconia, a solid electrolyte, becomes a conductor of oxygen ions at high temperatures resulting in a voltage being generated between the electrodes. This voltage is dependent on the difference between the partial pressures of oxygen in the reference and process gases. The electrode exposed to the higher partial pressure of oxygen becomes the negative electrode where the oxygen molecules are ionized by adding electrons. The ions pass through the zirconia element to the positive electrode and then release the extra electrons. This reaction is summarized as follows:



The electromotive force E (mV) or voltage between the two electrodes, generated by the reaction, is expressed by Nernst's equation:

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

where,

R: Gas constant

T: Absolute temperature

n: 4

F: Faraday's constant

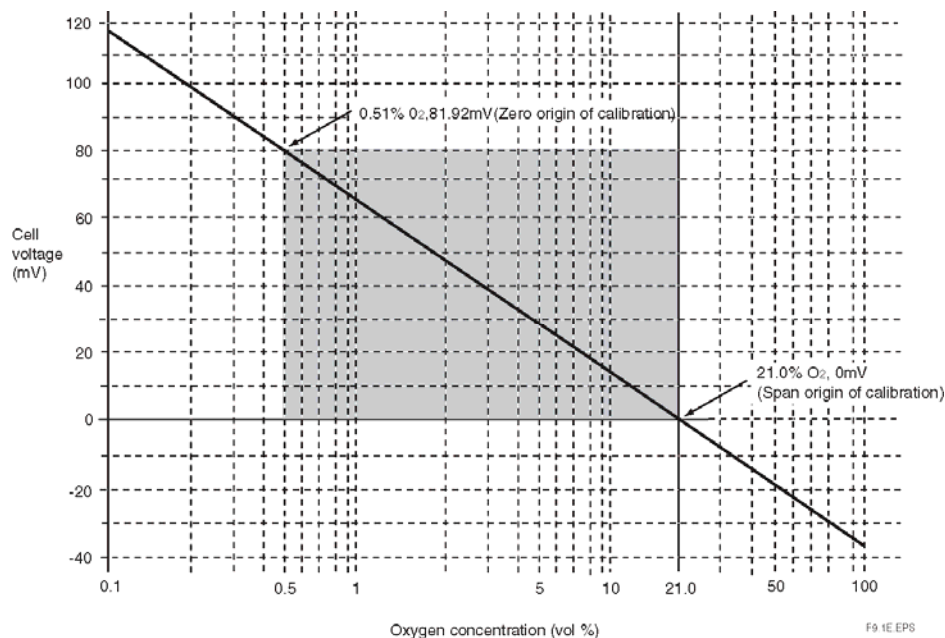
P<sub>x</sub>: Oxygen concentration in a gas in contact with the positive zirconia electrode (%)

P<sub>a</sub>: Oxygen concentration in a gas in contact with the negative zirconia electrode (%)

At 750°C (1023°K), the equation can be reduced to:

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

The sensor element of the SM425 is heated to 750 °C so Equation (2) can be used to calculate the cell's theoretical output voltage. Figure 9-1 plots the cell voltage generated by the ratio of the process gas concentration (positive electrode) to the reference gas concentration (negative electrode) where the reference gas is assumed to be 21.0%.



**Figure 9-1 Cell Voltage vs. Oxygen Concentration**

The measurement principles of a zirconia oxygen analyzer have been described above. However, this relationship between oxygen concentration and the electromotive force of a cell is only theoretical. In practice, a sensor shows a slight deviation from the theoretical value and calibration is necessary to obtain accurate measurements. Calibration generates a curve, which compensates for this deviation.

### 9.1.2 Calibration Gases

Gases with known oxygen concentrations are used for calibration. A two-point calibration is performed using two different gases: a zero gas of low oxygen concentration and a span gas of high oxygen concentration. It is recommended that a two-point calibration be conducted at least once even if the one-point calibration is normally used. A one-point calibration uses only one gas.

Zero gas normally has an oxygen concentration of 0.95 to 1.0 vol% O<sub>2</sub> with a balance of nitrogen gas (N<sub>2</sub>). Span gas can be instrument air (clean air with a dew-point temperature below -20°C and free of oil and particulate). For best accuracy, use a span gas with an oxygen concentration near the top of the measurement range mixed with nitrogen.

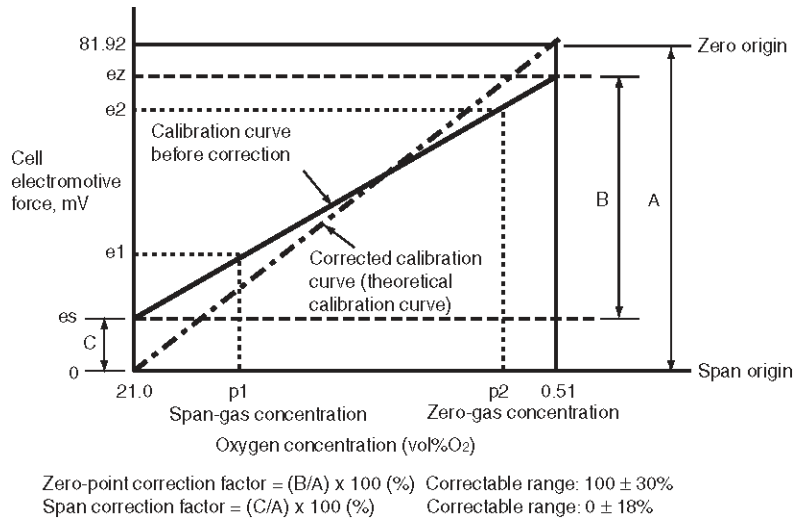
### 9.1.3 Calibration Curves

Calibration curves are generated either by the two-point method shown in Figure 9-2 or the one-point method shown in Figure 9-3.

Figure 9-2 shows a two-point calibration. Cell electromotive forces for a span gas with an oxygen concentration p<sub>1</sub> and a zero gas with an oxygen concentration p<sub>2</sub> are measured and determine the calibration curve passing through these two points. Subsequent process gas measurements are determined from this calibration curve.

The generated calibration curve is compared to a theoretical calibration curve to calculate the zero-point and span-point correction ratios. In Figure 9-2 the zero correction ratio is represented by  $B/A \times 100$  (%)

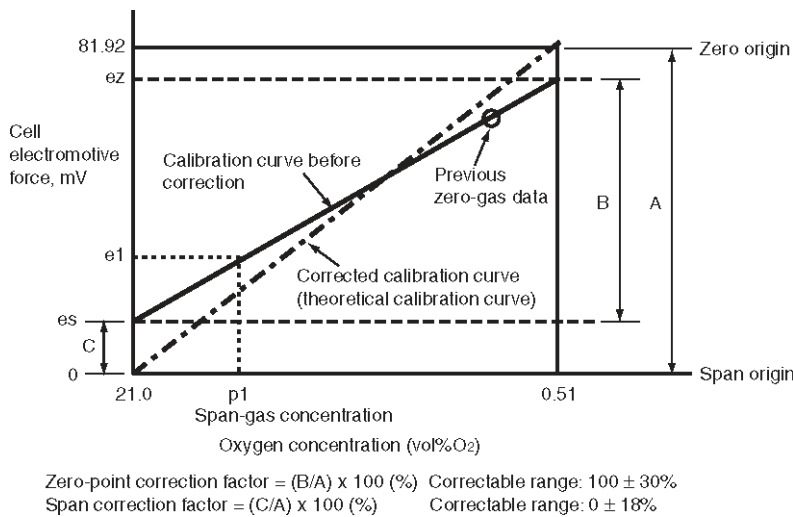
and the span-point correction ratio by  $C/A \times 100$  (%). If the zero correction ratio is not within the  $100 \pm 30$  % range or the span correction ratio is not in the  $0 \pm 18$  % range, the sensor can not be calibrated.



F9.2E.EPS

**Figure 9-2 Calculation of a Two-point Calibration Curve**

Figure 9-3 shows a one-point calibration using only 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 calibration. One-point calibrations using only zero gas can also be performed. The zero and span point correction factors are determined and the restrictions described above still apply.



F9.3E.EPS

**Figure 9-3 Calculation of a One-point Calibration**

### 9.1.4 Data Retained During Calibration

Calibration data and the sensor status data listed below are acquired during calibration. However, if the calibration fails (an error occurs during automatic or semi-automatic calibration), this data is not retained.

This data can be observed by selecting the detailed data display key from the basic panel display. For an explanation and the operating procedures of individual data, consult Section 1.53.1, "Detailed Display."

1. Record of span correction factor: Records the past ten span correction factors.
2. Record of zero correction factors: Records the past ten zero correction factors.
3. Response time: Response is calculated during two-point calibrations in semi-automatic or automatic calibration modes. It is not calculated for one-point calibrations or in manual calibration mode.
4. Cell's resistance: The cell's resistance is updated during calibrations other than span-only calibrations. This value includes the cell's internal resistance as well as other wiring resistances. The cell's internal resistance gradually increases as the cell ages but the degree of a cell's degraded performance cannot be determined from this value alone.
5. Robustness of a cell: The robustness of a cell is a number from one to four predicting the remaining life of a sensor.

## 9.2 Calibration

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### CAUTION

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

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### 9.2.1 Calibration Settings

The following paragraphs describe the calibration settings available on the "Calibration Setup Display". To select the "Calibration Setup Display" follow these steps:

1. Select the Setup key from the basic panel display screen. Then select Maintenance from the Execution/Setup display screen.
2. Select Calibration setup from the Maintenance display screen.

#### 9.2.1.1 Selecting Calibration Modes

There are three calibration modes available:

1. Manual calibrations are controlled by the touch pad. One-point and two-point calibrations can be performed.
2. Semi-automatic calibration is initiated by the touch panel or a contact input. A series of calibration operations following preset calibration periods and stabilization time are initiated.
3. Automatic calibration is initiated by the start time, start date and interval settings selected in the calibration timing display.

Calibrations are limited by the following mode selection:

- **When manual calibration is selected:**

Only manual calibrations can be executed. Semi-automatic and automatic calibrations are not available.

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

Either manual or semi-automatic calibrations can be executed. Automatic calibrations are not available.

- **When automatic calibration is selected:**

Manual, semi-automatic, or automatic calibrations can be executed.

Select Mode from the Calibration setup display screen(see Figure 9-4). Select manual, semi-automatic, or automatic calibration.

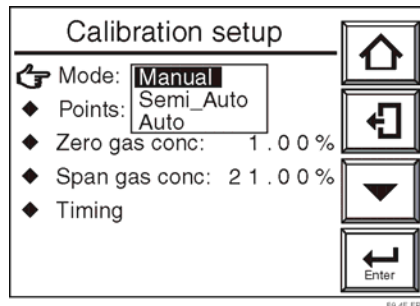


Figure 9-4 Calibration Mode Setup

### 9.2.1.2 Selecting Calibration Points

Two-point or one-point calibrations can be selected. “Both” selects a two-point calibration. One-point calibrations can be run with either the span or the zero point. “Both” is the preferred selection.

Select “Points” from the Calibration setup display screen and then select “Both,” “Span” or “Zero” (see Figure 9-5 below).

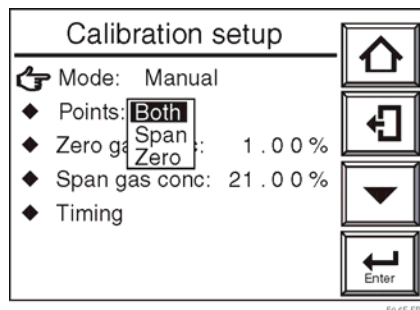


Figure 9-5 Calibration Points Setup

### 9.2.1.3 Setting Zero-gas Concentration Value

To enter the oxygen concentration of the zero-gas cylinder:

Select “Zero gas conc.” in the Calibration setup display screen. 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 % O<sub>2</sub>.)

Enter 00098 for an oxygen concentration of 0.98 vol% O<sub>2</sub>.

### 9.2.1.4 Setting Span-gas Concentration Value

To enter the oxygen concentration of the span-gas:

Select “Span gas conc.” in the Calibration setup display screen. Enter the desired span-gas oxygen concentration using the numeric-data entry display. If instrument air is used as the span gas, enter 21 % O<sub>2</sub>. (The span-gas set ranges from 4.5 to 100 % O<sub>2</sub>.)

Enter 02100 for an oxygen concentration of 21 vol% O<sub>2</sub>.

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.

If using the ZO21S Standard Gas Unit and atmospheric air as the span gas, determine the actual oxygen concentration with a hand-held oxygen analyzer.



## CAUTION

- When instrument air is used for the span calibration, remove the moisture from the instrument air to a dew-point temperature of -20°C and remove any oil and particulate from that air.
- Measurement accuracy is adversely affected if the air is not clean and sufficiently dehumidified.

### 9.2.1.5 Setting Calibration Timing

Calibration timing consists of five parameters: Hold time, Csl time, Interval, Start date, and Start time. These parameters are entered using the “Calibration Timing Display” which appears when “Timing” is selected on the “Calibration setup” display screen. Select the appropriate parameter and enter the desired value.

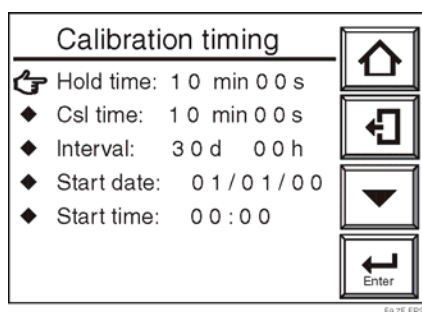


Figure 9-6 “Calibration Timing” Display

Hold time is the stabilization period following a calibration during which process gas diffuses back into the sensor. Normal measurements are resumed after completion of this stabilization period. See Figure 9-7. During this period, the analog output is held to the value obtained just prior to calibration. For more



details, consult Section 1.46, "Output Hold setting". Hold time can be set from 00 minutes, 00 seconds to 60 minutes, 59 seconds.

Csl Time (calibration time) is the time between the start of calibration-gas flow and calibration measurement reading. Csl time is applied to both zero and span gases. See Figure 9-7. Csl time can be set from 00 minutes, 00 seconds to 60 minutes, 59 seconds.

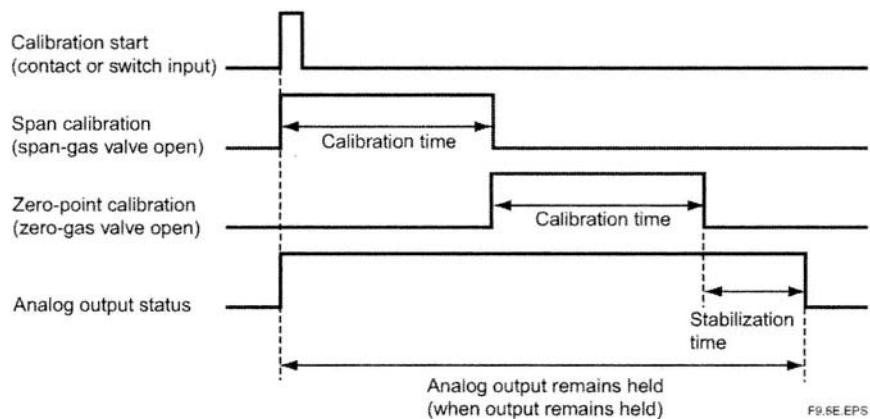
Interval applies to automatic calibration mode only. It is the timer between automatic calibration cycles and can be set from 000 days, 00 hours to 255 days, 23 hours.

Start date/Start time applies to automatic calibration mode only and is the starting time for the first calibration in the series. For example, to start the first calibration at 1:30 p.m. on March 25, 2001, enter 25/03/01 as the start date and 13 hours, 30 minutes as the start time

Table 9-1 summarizes the use of the timing parameters in the different calibration modes.

**Table 9-1 Calibration Modes and Timing Parameters**

	Manual	Semi-automatic	Automatic
Hold Time	X	X	X
Csl Time		X	X
Interval			X
Start Date			X
Start Time			X



**Figure 9-7 Calibration and Output-stabilization Time Settings**

Use the following guidelines to setting automatic calibration timing:

1. The calibration interval must not be shorter than the sum of the hold time and the Csl time (or twice the Csl time for a two-point calibration).
2. If the calibration start time occurs during a manual or semi-automatic calibration cycle, the automatic calibration will not start.
3. If the calibration time conflicts with maintenance service or blowback operations, calibration will start after completing the maintenance service or blowback operations (see Section 1.46.1, earlier in this manual).
4. If the calibration interval is set for 000 days and 00 hours, only one automatic calibration will occur.
5. Only present or future dates and times can start an automatic calibration.

## 9.2.2 Default Calibration Settings

The calibration settings shown in Table 9-2 are the default settings when the analyzer is delivered or data is reinitialized.

**Table 9-2 Default Settings for Calibration**

Item		Default Setting
<b>Manual Calibration</b>	Calibration mode	Manual
	Calibration procedure	Span - zero
	Zero-gas (oxygen) concentration	1.00%
	Span-gas (oxygen) concentration	21.00%
<b>Semi-automatic Calibration</b>	Output hold (stabilization) time	10 minutes, 00 seconds
	Calibration time	10 minutes, 00 seconds
<b>Automatic Calibration</b>	Calibration interval	30 days, 00 hours
	Start day	01 / 01 / 00
	Start time	00:00

T9.1E.EPS

## 9.2.3 Calibration Procedures

### 9.2.3.1 Manual Calibration

For manual calibration, see Section 1.44, "Calibration".



## CAUTION

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

### 9.2.3.2 Semi-automatic Calibration

To start a semi-automatic calibration from the touch panel, follow these steps:

1. Select the Setup key in the basic panel display screen. Then select Calibration from the Execution/Setup display screen. The Calibration display shown in Figure 9-8 appears.
2. Select Semi-autocalibration from the Calibration display screen as shown in Figure 9-9.
3. Select "Start calibration". The display shown in Figure 9-10 then appears.

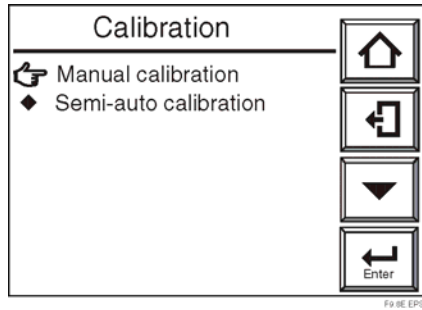


Figure 9-8 Calibration Display

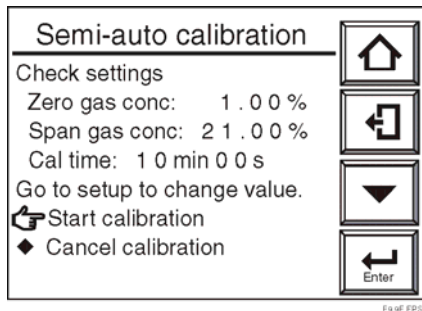


Figure 9-9 Semi-automatic Calibration Display

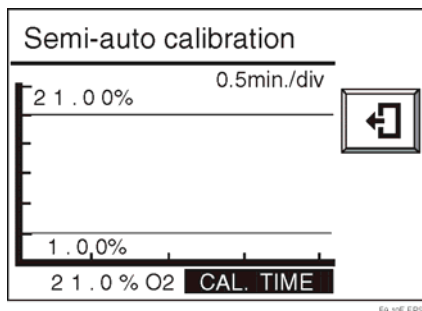


Figure 9-10 Semi-automatic Calibration Display

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

1. Select "Calibration start" as the function and the active state for the desired input contact (see Section 1.49).
2. Activate that input contact to start calibration.

**To stop calibration midway, follow these steps:**

1. Press the Return key once. The calibration will stop and the analyzer will begin the hold stabilization timeout.
2. Press the Return key again. The analyzer will return to normal measurement mode and the basic panel display.

**9.2.3.3 Automatic Calibrations**

Automatic calibrations are controlled by the settings in the calibration timing display. The initial calibration occurs at the programmed start time and start date. Subsequent calibrations are then executed at the selected interval.

## 10.0 OTHER FUNCTIONS

### 10.1 Display

#### 10.1.1 Detailed Display

Press the Detailed-data key on the basic panel display screen to display the detailed operation data as shown in Figure 10-1.

Scroll through the data screens using the ▲ or ▼ keys.

- Detailed-data display

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

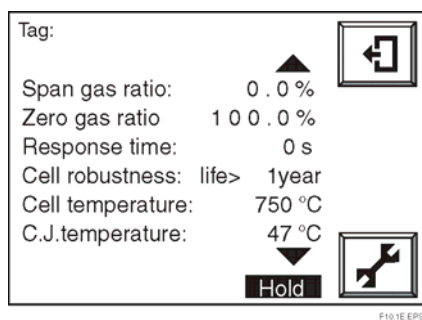
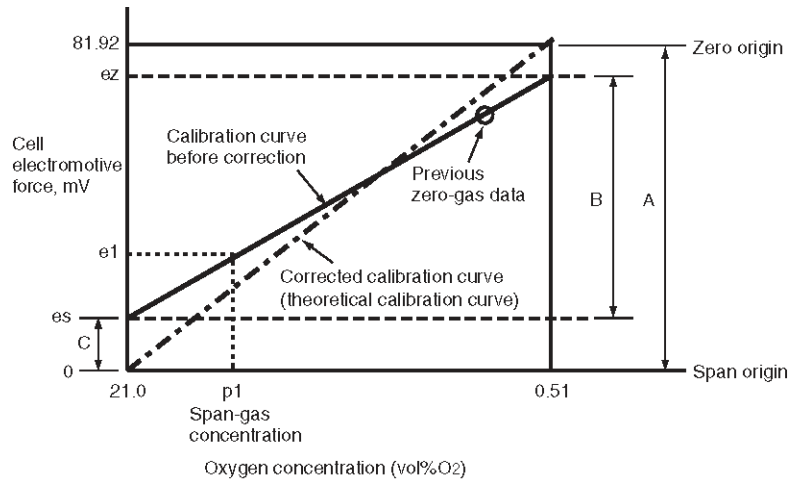


Figure 10-1 Detailed-data Display

##### 10.1.1.1 Span-gas and Zero-gas Correction Ratios

These are used to check the condition of the sensor (cell). If the correction ratio is outside of the limits shown in Figure 10-2, the sensor requires replacement.

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



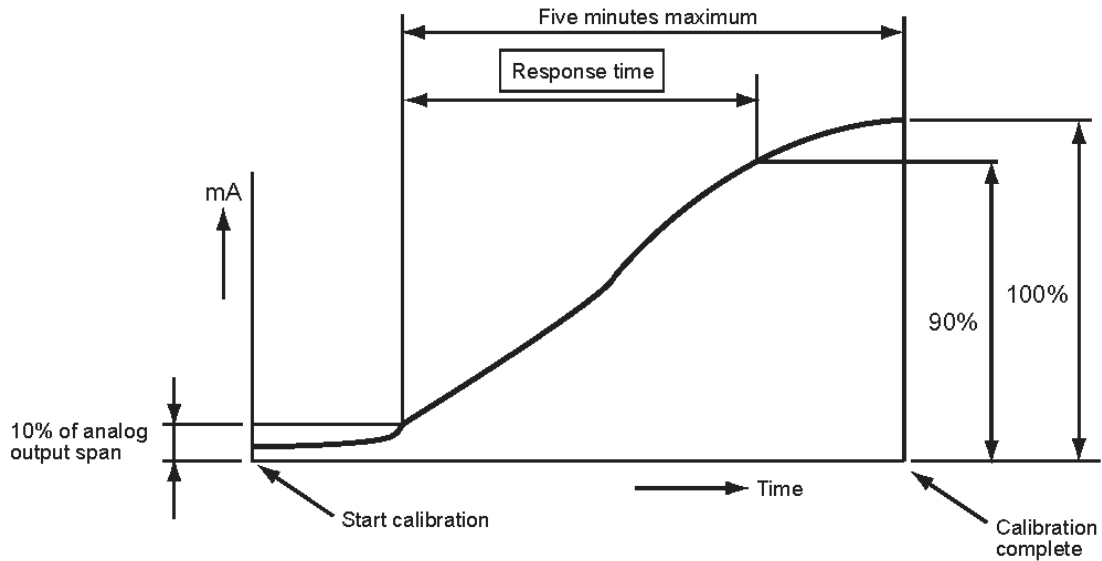
Zero-gas ratio =  $(B/A) \times 100$  (%) Correctable range:  $100 \pm 30\%$   
 Span-gas ratio =  $(C/A) \times 100$  (%) Correctable range:  $0 \pm 18\%$

F10.2E.EPS

**Figure 10-2 Corrected calibration curve**

**10.1.1.2 Response Time**

The cell's response time is defined in Figure 10-3. The zero-point and span-point must both be set during calibration for response time to be measured.



Response time is the time to rise from 10% to 90% of the calibrated range.

F10.3E.EPS

**Figure 10-3 Functional Drawing of Response Time**

### 10.1.1.3 Robustness of a Cell

The robustness of a cell is an indicator of the remaining life of a sensor. It is expressed as one of four time periods 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 for preventive maintenance only.

This cell's robustness is a function of the response time, the cell's internal resistance, and calibration factor. The robustness indicator requires the zero and span points to be set during calibration.

### 10.1.1.4 Cell Temperature

This indicates the cell (sensor) temperature, usually 750°C. Cell temperature is a function of the thermoelectromotive force and cold junction temperature described below.

### 10.1.1.5 C. J. Temperature

This indicates the detector terminal box temperature, which is the cold junction temperature of the thermocouple measuring the cell temperature. The maximum C. J. temperature allowed in the SM425 is 150°C. If the terminal box temperature exceeds this, move it away from the heat source.

### 10.1.1.6 Cell Voltage

The cell (sensor) voltage is an indicator of the condition of the sensor. The cell voltage indicates the oxygen concentration currently being measured. If the indicated voltage approximates the ideal value (corresponding to the measured oxygen concentration), the sensor is assumed to be normal.

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

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

where,  $P_x$ : Oxygen concentration in the measured gas

$P_a$ : Oxygen concentration in the reference gas, (21% O<sub>2</sub>)

Table 10-1 shows oxygen concentration versus cell voltage.

**Table 10-1 Oxygen Concentration vs. Cell Voltage, (cell temperature: 750°C)**

%O <sub>2</sub>	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 <sub>2</sub>	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 <sub>2</sub>	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 <sub>2</sub>	100								
mv	-34.4								

T10.1E.EPS

### **10.1.1.7 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.

### **10.1.1.8 Cold Junction Resistance (C.J. Voltage)**

The SM425P Detector measures the cold junction temperature using an RTD (Pt 1000). The RTD resistance is displayed as the cold junction resistance.

### **10.1.1.9 Cell's Internal Resistance**

A new cell (sensor) indicates an internal resistance of 200 $\Omega$  maximum. As the cell ages, the cell's internal resistance will increase.

### **10.1.1.10 Software Revision**

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

### **10.1.1.11 Maximum Oxygen Concentration**

The maximum oxygen concentration and the time of its occurrence during the period specified in the Averaging display are displayed. If the setup period elapses, the maximum oxygen concentration that has been displayed so far will be cleared and a new maximum oxygen concentration will be displayed. If the setup period of time is changed, the current maximum oxygen concentration will be displayed (for more details, see Section 1.50.2 earlier in this manual).

### **10.1.1.12 Minimum Oxygen Concentration**

The minimum oxygen concentration and the time of its occurrence during the period specified in the Averaging display are displayed. If the setup period elapses, the minimum oxygen concentration that has been displayed so far will be cleared and a new minimum oxygen concentration will be displayed. If the setup period of time is changed, the current minimum oxygen concentration will be displayed (for more details, see Section 1.50.2 earlier in this manual).

### **10.1.1.13 Average Oxygen Concentration**

The average oxygen concentration during the periods over which average values are calculated is displayed. If the setup period elapses, the average oxygen concentration that has been displayed so far will be cleared and a new average oxygen concentration will be displayed. If the setup period of time is changed, the current average oxygen concentration will be displayed (for more details, see Section 1.50.2 earlier in this manual).

### **10.1.1.14 Heater On-Time Ratio**

The probe sensor is heated to and maintained at 750°C. When the measured gas temperature is higher than 750°C, the heater ON-time will decrease.

### **10.1.1.15 Time**

The current date and time are displayed. These are backed up with built-in batteries. No adjustment is required after the power is switched off.



### 10.1.1.16 History of Calibration Time

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

### 10.1.1.17 Power Supply Voltage

For accurate temperature control of the detector heater, the power supply voltage and frequency must be set appropriately. Set the AC supply voltage to "Low" if supply is 140 Vac or less, or to "High" if it is 180 Vac or more.

### 10.1.1.18 Power Frequency

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

## 10.1.2 Trend Graph

Press the Graph Display key in the basic panel display screen to switch to the graph display screen. Touching anywhere on the graph display will return to the Basic Panel display screen. To set the Trend Graph display, follow the steps in Section 1.53.2.1.

### 10.1.2.1 Setting Display Items

1. Press the Setup key in the Basic Panel display screen to display the Execution/Setup display screen. Select Maintenance from the Execution/Setup display screen.
2. Select Display setup from the Maintenance display screen.
3. Select Trend Graph from the Display Setup display screen. The Trend graph display shown in Figure 10-4 appears.
4. Select "Parameter: Oxygen" from the Trend graph display screen. Then select the desired variable shown in Table 10-2.

Table 10-2 Trend Graph Display Items

<b>Selected item</b>	<b>Description</b>
<b>Oxygen Concentration</b>	<b>Time history graph of the process gas oxygen concentration.</b>
<b>Output 1</b>	<b>Time history graph of Output 1</b>
<b>Output 2</b>	<b>Time history graph of Output 2</b>

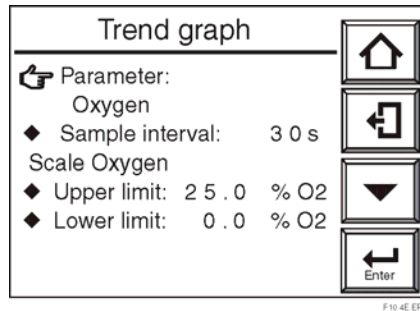


Figure 10-4 Trend Graph

### 10.1.2.2 Sampling Period

To plot a graph, set the sampling period for the measurement data.

This graph allows the plotting of 60 data points per graduation on the time axis. For example, a ten-second sampling period, graduation corresponds to 600 seconds (Figure 10-5). The sampling periods range from 1 to 30 seconds allowing time history ranging from 5 to 150 minutes.

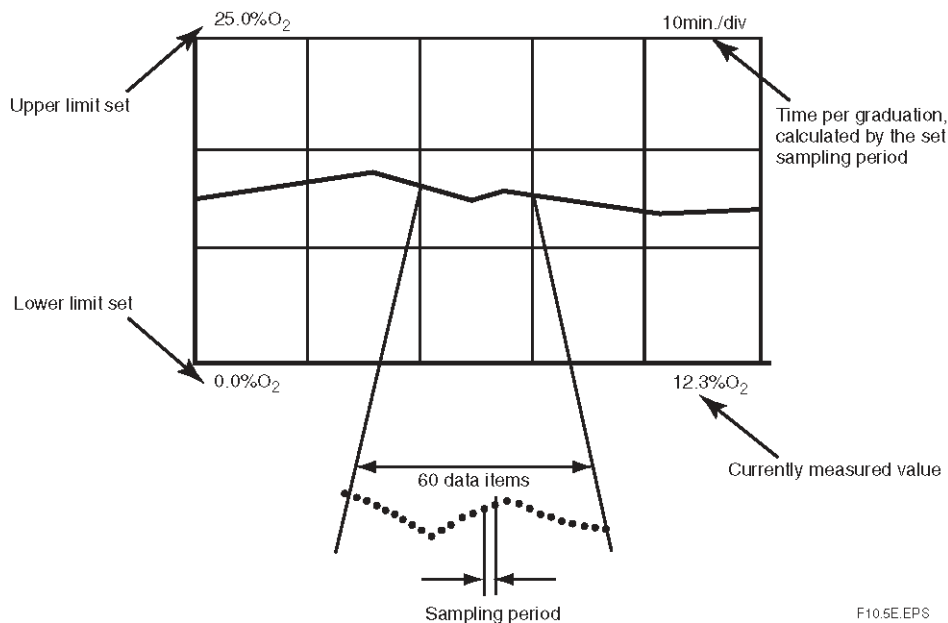


Figure 10-5 Plotting Graph for Sampling Period

### 10.1.2.3 Setting Upper and Lower Limit Values on Graph

Use the following procedure to set upper and lower limit values on the graph:

Press Upper limit in the Trend Graph display. The numeric-data entry key appears. Enter the upper limit value. 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 % O<sub>2</sub>.

### 10.1.2.4 Default Settings

Default graph setup values are shown in Table 10-3.

**Table 10-3 Default Values for Graph Setting**

Item Default	Value
Parameter	Oxygen concentration
Sampling period	30 seconds
Upper limit	25%O <sub>2</sub>
Lower limit	0%O <sub>2</sub>

T10.3E.EPS

**CAUTION**

If a rapid change in the measured value occurs during sampling, no sampled data are plotted on the graph. Adjust limits as needed.

**10.1.3 Auto(matic) Revert Time**

When the Execution/Setup display screen or any of its sub-screens (see Figure 7-4) are active with no user input for a certain time, the current display will automatically return to the Basic Panel display screen. This time-out is referred to as “auto return.”

The “auto return” time setting starts from the last key entry. The “auto return” time can be set from 0 to 255 minutes. If 0 is set, there will be no automatic return. By default, the “auto return” time is set to 0 (zero).

Use the following procedure to set the “auto return” time:

1. Select the Setup key from the Basic Panel display screen to display the Execution/Setup display screen. Then select Maintenance from the Execution/Setup display screen.
2. Select the Display setup from the Maintenance display screen.
3. Select Auto return time. The numeric-data entry display screen appears.
4. Enter your desired automatic return time. Time is set in minutes.

**10.1.4 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 screen to display the Execution/Setup display screen. Then select Maintenance from the Execution/Setup display screen.
2. Select the Display setup from the Maintenance display screen.
3. Select the Display item from the Display Setup display screen. 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.

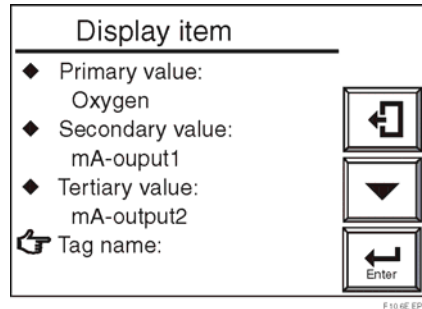


Figure 10-6 “Display Item” Display

### 10.1.5 Language Selection

You can select English, German, or French for the display. If you selected an English display (basic code: -E, for the display) at the time of purchase, “English” will be the default language.

To select the language you want, follow these steps:

1. Select the Setup key from the basic panel display screen to display the Execution/Setup display screen. Then select Maintenance from the Execution/Setup display screen.
2. Select the Display setup from the Maintenance display screen.
3. Select Language from the Display setup display screen. The language selection display screen as shown in Figure 10-7 appears.

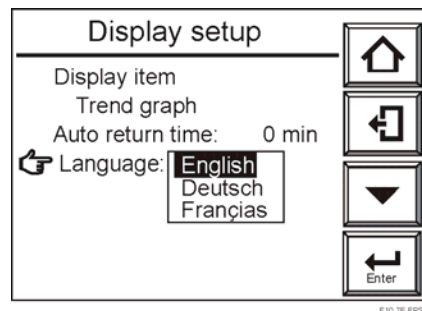


Figure 10-7 Display Setup Display Screen

## 10.2 Blow Back

### 10.2.1 Blow Back Setup

The following sections describe the blow back setup procedures required for carrying out blow back.

#### 10.2.1.1 Mode

There are three blow back modes available:

1. No function – blow back disabled.
2. Semi-automatic – in this mode, touch panel operations or contact input signals will start and perform blow back operations according to a preset time and output stabilization time.
3. Automatic – performs blow back operations automatically according to a preset interval.

These three modes each have the specific limitations described below:

- If “No Function” is selected: No blow back operations are executed.
- If “Semi-auto” is selected, semi-automatic blow back can be executed (but no calibration is made even when the automatic calibration startup time is reached.)
- If “Auto” is selected, automatic blow back can be executed in either the “Auto” or “Semi-auto” mode.

Use the following procedure to setup blow back operation:

1. Select the Setup key from the basic panel display screen to display the Execution/Setup display screen. Then select Maintenance from the Execution/Setup display screen.
2. Select the Blow back setup from the Maintenance display screen and select Mode. The mode selection display shown in Figure 10-8 appears.

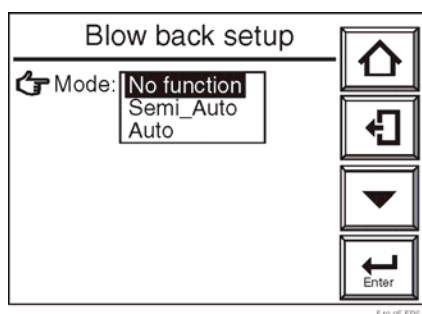


Figure 10-8 Blow Back Setup Screen

### 10.2.1.2 Operation of Blow Back

Figure 10-9 shows a timing chart for the operation of blow back. To initiate blow back from a contact input signal, use a contact input with an ON-time period of one to 11 seconds. Once blow back starts, a contact output opens and closes at ten-second intervals 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 1.46, earlier in this manual).

The hold (output stabilization) time is the time following the completion of blow back operations during which the process gas returns to the sensor and sensor output returns to normal operating conditions.

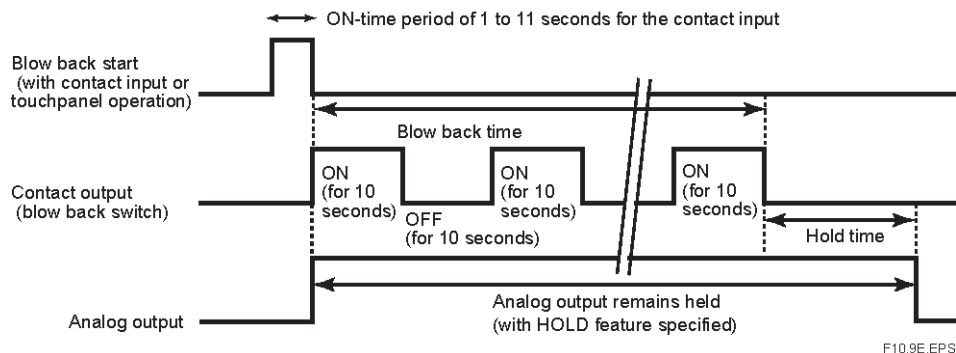


Figure 10-9 Operation of Blow Back

### 10.2.1.3 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 screen appears. The desired "Hold time" (output-stabilization time) can be set within the range of 00 minutes, 00 seconds to 60 minutes, 59 seconds.

When you select "Blow back time," the numeric-data entry display screen appears. Enter the desired "Blow back time" within the range of 00 minutes, 00 seconds to 60 minutes, 59 seconds.

### 10.2.1.4 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, 23 hours.

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

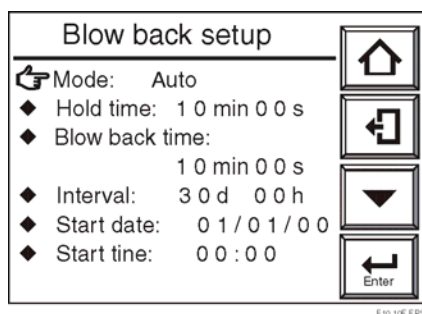


Figure 10-10 Blow back Setup Display

In the Blow Back setup display screen shown in Figure 10-10, if you choose "Mode: No function" or "Semi-auto blow back," the Interval, Start Date, and Start Time for these are not displayed.


**CAUTION**

- If the blow back is initiated with an input contact signal, it must be preset in the Input contacts setting (for more details, see Section 1.49).
- In Section 1.48, "Output Contact Setup", 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 operated by another 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 only 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 will be executed. No subsequent blow backs will be executed.
- If a past date is set for the Start time, no blow back will be executed.

### 10.2.1.5 Default Setting

Default blow back settings are 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	00:00

T10.4E.EPS

## 10.3 Operational Data Initialization

The initialization of the set data feature allows you to return to the default analyzer values. Default values are factory set. There are two types of initializations: an all set-data initialization and a function-by-function initialization. Table 10-5 lists the initialization items and default values.

To initialize the set data, follow these steps:

1. Press the Setup key in the Basic panel display screen to display the Execution/Setup display screen. Then choose Setup.
2. Select "Others" from the "Commissioning" (Setup) display screen.
3. Choose "Defaults." The "Defaults" display screen shown in Figure 10-11 appears.
4. Select the data to initialize from the "Defaults Display" screen shown in Figure 10-12.
5. Choose Defaults start. Data initialization then starts.

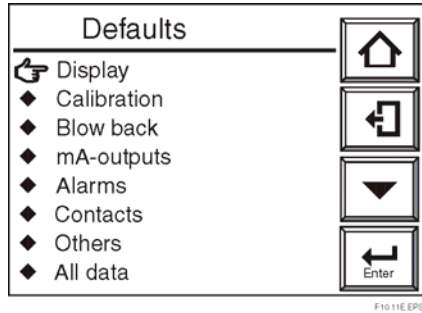


Figure 10-11 Defaults Display

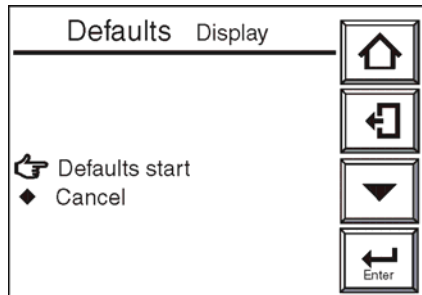


Figure 10-12 Initialization Start Display

---

 **WARNING**

- Initialization will not be completed if power is cycled during the set data initialization.
-



Table 10-5 Initialization Items and Default Values

Item	Data to be initialized		Default setting
Equipment selection	Type of equipment		Not initialized
	Detector		ZR22
	Measurement 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% O <sub>2</sub>
		Lower limit (graph)	0% O <sub>2</sub>
Automatic return time		0 min.	
Language		Not initialized	
Calibration data	Calibration setting	Mode	Manual
		Calibration procedure	Span - zero
		Zero-gas concentration	1.00% O <sub>2</sub>
		Span-gas concentration	21.00% O <sub>2</sub>
		Output hold time	10 min., 00 sec.
		Calibration time	10 min., 00 sec.
		Interval	30 days, 00 hr.
		Start date	01/01/00
Start time	00:00		
Blowback	Blowback setting	Mode	No function (invalid)
		(Output) hold time	10 min., 00 sec.
		Blowback time	10 min., 00 sec.
		Interval	30 days, 00 hr.
		Start date	01/01/00
		Start time	00:00
Current output data	mA-output 1 mA-output 2	Parameter	Oxygen concentration
		Min. oxygen concentration	0% O <sub>2</sub>
		Max. oxygen concentration	25% O <sub>2</sub>
		Output damping	0%
		Output mode	Linear
	Output hold setting	Warm-up	4 mA
		Set value	4 mA
		Maintenance	Previous value held
		Set value	4 mA
		Calibration, blowback	Previous value held
		Set value	4 mA
		Error	Preset value held
Set value	3.4 mA		

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Item	Data to be initialized		Default setting		
Alarm data	Alarm setting	Parameter	Oxygen concentration		
		Hysteresis	0.1% O <sub>2</sub>		
		Delayed action of alarm contact	3 seconds		
	Alarm set value	High-high alarm	None		
		Alarm value	100% O <sub>2</sub>		
		High-limit alarm	None		
		Alarm value	100% O <sub>2</sub>		
		Low-limit alarm	None		
		Alarm value	0% O <sub>2</sub>		
		Low-low alarm	None		
	Alarm value	0% O <sub>2</sub>			
Contacts	Output contact 1	Alarm	None		
		Other settings	Warm-up	On	
			Output range now being switched	None	
			Now calibrating	None	
			Now maintenance servicing	On	
			Blowback	None	
			High-limit temp. alarm	None	
			Calibration gas press. drop	None	
	Gas leak detection	None			
		Contact output action	Open		
	Other settings	Output contact 2	Alarm	None	
			Other settings	Warm-up	None
				Output range switching	None
				Now calibrating	On
				Now maintenance servicing	None
				Blowback	None
				High-limit temp. alarm	None
				Calibration gas press. drop	None
		Gas leak detection	None		
			Contact output action	Closed	
Output contact 3		Alarm	High-high alarm	None	
			High-limit alarm	On	
	Low-limit alarm		On		
	Low-low alarm		None		
	Calibration Coefficient Alarm		None		
	Startup power stabilization timeout		None		
	Error	None			
	Other settings	None			
	Contact output	Closed			
	Input contact 1	Function	None		
	Input contact 2	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 m <sup>3</sup> /kg (m <sup>3</sup> )		
		Theoretical amount of air	1.00 m <sup>3</sup> /kg (m <sup>3</sup> )		
		X value	1.00		
		Absolute humidity of atmosphere	0.0 kg/kg		
	Password	Deleted			

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## 10.4 Reset

Resetting is a restart of the analyzer. The equipment is reset by turning the power off and then back on. An analyzer processor restart can also be initiated without cycling power. Resetting is required if any of the following error conditions occur:

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 conditions, refer to Section 0, “Troubleshooting”.

If any of the above problems occur, 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 there is no problem with the detector or converter before cycling power.

If resetting does not clear the error condition, turn the power off and troubleshoot the problem according to the instructions in the Troubleshooting section (Section 0).

Reset the equipment using the following instructions:

1. Press the Setup key in the Basic panel display screen to display the Execution/Setup display screen.
2. Press the Reset key on the Execution/Setup display screen. The Reset display screen shown in Figure 10-13 appears.
3. Choose Start reset key and then press the [Enter] key to reset the equipment. The equipment will then be in its warm-up state.

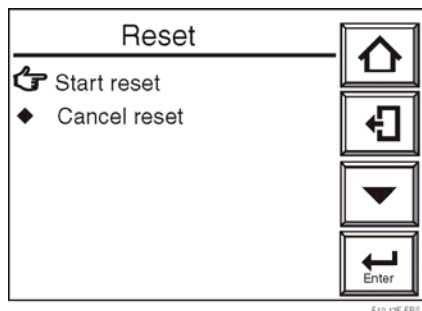
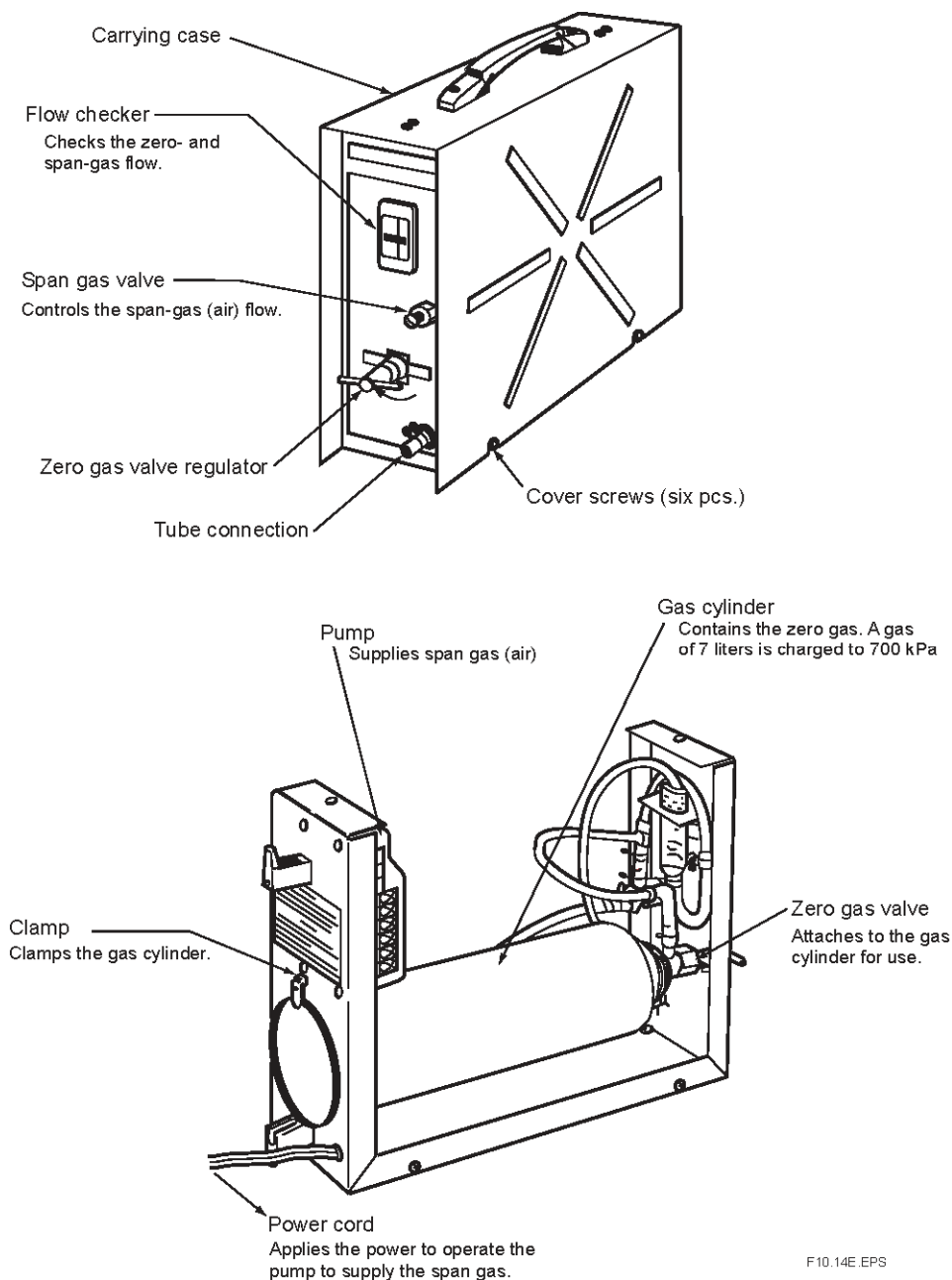


Figure 10-13 Reset Display

## 10.5 Handling of the ZO21S Standard Gas Unit

The following instructions describe how to flow zero and span gases using the ZO21S Standard Gas Unit. Use the ZO21S Standard Gas Unit, to calibrate a system classified as System 1, according to the following procedures.

### 10.5.1 Standard Gas Unit Component Identification



**Figure 10-14 Standard Gas Unit Component Identification**

### 10.5.2 Installing Gas Cylinders

Each ZO21S Standard Gas Unit comes with six zero-gas cylinders, including a spare. Each gas cylinder contains 7-liters of gas with a 0.95 to 1.0 vol % O<sub>2</sub> (concentration varies with each cylinder) and nitrogen, at a pressure of 700 kgPaG (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. Install the zero gas valves onto the gas cylinder. Before installing, turn the valve regulator of the zero-gas valve counterclockwise to completely retract the needle away at the top from the gasket surface. With the valve in this position, manually screw the valve mounting into the mouthpiece of the gas cylinder. Use a wrench to make final tightening adjustment.
2. Remove the carrying case from the standard gas unit. The case is attached to the unit with six screws.
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 as indicated on the gas cylinder. Replace the carrying case. Enter the oxygen concentration of the sealed gas into the analyzer using the instructions on the converter display. Also check that no piping is disconnected.

Follow the instructions in section 1.57.3 to flow gas from the Standard Gas Unit.

### 10.5.3 Calibration Gas Flow

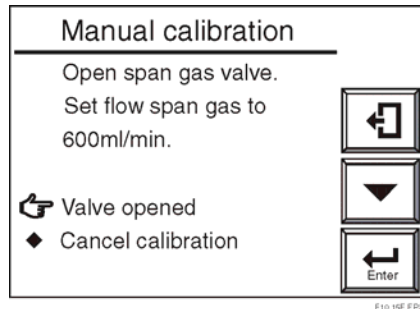
#### <Preparation before calibration>

1. To operate the standard gas unit, place it on a horizontal surface to allow the flow check to indicate an accurate flow rate. The unit requires ac power for driving the span gas (air) supply pump (the length of the power cord attached to the unit is 2 m).
2. Connect the tube connector port of the standard gas unit to the calibration gas inlet of the detector. Use a polyethylene resin tube with an outside diameter of 6 mm. Be careful to prevent gas leakage.
3. Fully open the needle 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 the oxygen concentration of the span gas is correctly set (21 vol% O<sub>2</sub> 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.

#### <Flow of span gas (air)>

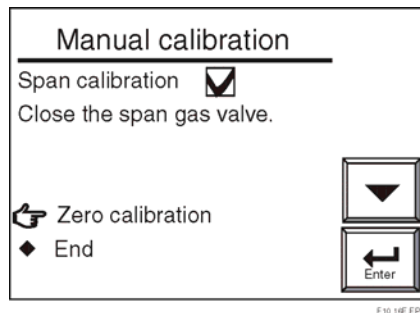
The standard gas unit is used only when manual calibration is employed. The timing for flowing span gas (air) is included in the manual calibration flowchart described in Section 1.57.2. For operation of the converter, see Section 1.44.

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



**Figure 10-15 Manual Calibration Display**

2. Next, adjust the flow rate to  $600 \pm 60$  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 screen shown in Figure 10-15. Check the Trend Graph display screen to verify the measured value has stabilized. Then press the [Enter] key. The Manual Calibration display screen will appear as shown in Figure 10-16. Disconnect the power cord to stop the pump.



**Figure 10-16 Manual Calibration Display**

#### <Flow of zero gas>

Initiate the zero-gas flow according to the Manual Calibration display screen shown in Figure 10-17 using the following procedure.

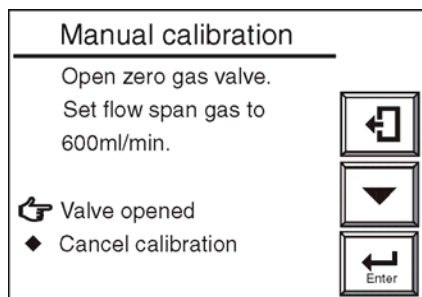


Figure 10-17 Manual Calibration Display

1. Turn the gas cylinder valve regulator fully clockwise by hand.
2. Adjust the flow rate to  $600 \pm 60$  ml/min (the flow indicating ball stops floating on the green line when the valve is slowly opened) by turning the regulator valve back slowly counterclockwise and monitoring the flow indicating ball.
3. Select Valve opened (to start calibration) from the Manual calibration display screen. Check the Trend Graph display screen to verify the measured value has stabilized. Then press the [Enter] key. The Manual calibration display screen should appear as shown in Figure 10-18. Immediately stop the zero-gas flow. Turn the zero-gas valve regulator fully clockwise.

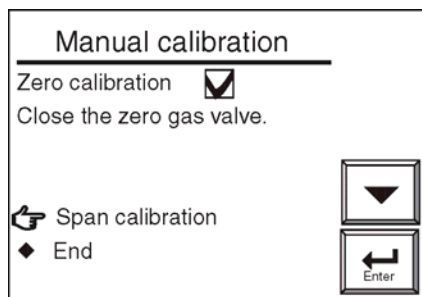


Figure 10-18 Zero-gas Calibration Complete (in Manual Calibration Display)



**Note**

With a calibration time of four minutes, each gas cylinder can be used for two zero-point calibrations.

**<Completion of calibration>**

1. Fully close the needle valve mounted on the calibration gas inlet of the detector.
2. Remove the tube connecting the detector to the standard gas unit.

**WARNING**

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

## 10.6 Methods of Operating Valves in the ZA8F Flow Setting Unit

The ZA8F Flow Setting Unit is used as a calibration device for analyzer conforming to System 2. Calibration of a System 2 is a manual operation. The Flow Setting valve must be adjusted each time a calibration is made (starting and stopping the calibration gas flow and adjusting the flow rate). This applies even if you are using the SM425CAL Autocalibration Unit. For operation of the converter, see Section 1.44.

### 10.6.1 Preparation Before Calibration

To operate the ZA8F Flow Setting Unit, initial calibration steps are as follows:

1. Verify the zero gas flow setting valve in the unit is completely closed. Open the regulator valve for the zero gas cylinder until the secondary pressure equals measured gas pressure + approx 50 kPa (or measured gas pressure plus approx. 150 kPa when a check valve is used, maximum pressure rating is 300 kPa).
2. Verify the oxygen concentration of the zero gas and span gas (instrument air 21 vol% O<sub>2</sub>) in the cylinder is set in the converter.

### 10.6.2 Span Gas Flow Valve Adjustment

The following description assumes that instrument air, the same as the reference gas, is used as the span gas.

1. When the display screen appears as shown in Figure 10-15 during calibration, open the span gas flow setting valve unit and adjust the flow rate to 600 ± 60 ml/min. Turn the valve slowly counterclockwise after loosening any lock nut. Check the flow rate using the calibration flowmeter. Adjust the measurement gas pressure to obtain pressures as listed in
2. Table 10-6 ± 10%.

**Table 10-6 Setting flow for high pressure (span)**

Measurement gas pressure (kPa)	50	100	150	200	250
Flowrate (ml/min)	500	430	380	250	320

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3. Adjust the flow rate and select Valve opened from the Manual Calibration display screen. Check the Trend graph display screen to verify the measured value has stabilized. Then press the [Enter] key. The Manual calibration display screen should appear as shown in Figure 10-16.
4. Close the span gas flow setting valve. Tighten any lock nut to prevent leakage of span gas into the sensor during process gas measurement.

### 10.6.3 Zero Gas Flow Valve Adjustment

Adjust the zero gas flow setting valve during zero-point calibration using the following procedure:

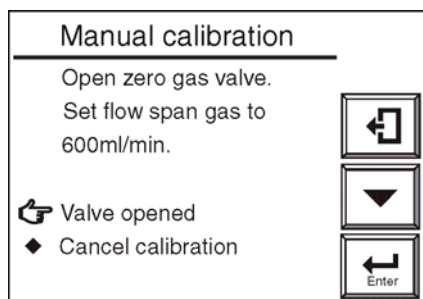


1. When the display screen as shown in Figure 10-19 during calibration, open the zero gas flow setting valve and adjust the flow rate to  $600 \pm 60$  ml/min. To rotate the valve shaft, loosen any lock nut and slowly turn it counterclockwise. Monitor the flow rate using the calibration gas flowmeter.
2. Adjust the measurement gas pressure to obtain pressures listed in Table 10-7  $\pm 10\%$ .

**Table 10-7 Setting flow for high pressure (zero)**

Measurement gas pressure (kPa)	50	100	150	200	250
Flowrate (ml/min)	500	430	380	250	320

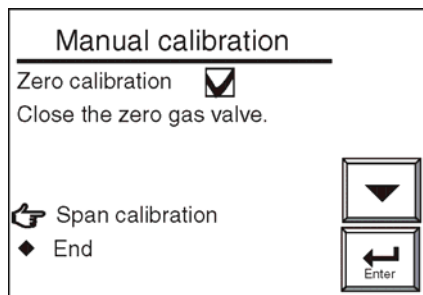
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**Figure 10-19 Manual Calibration Display**

3. Adjust the flow rate and select Valve opened from the Manual calibration display screen. Check the Trend Graph display screen to verify the measured value has stabilized. Then press the [Enter] key. The Manual calibration display screen should appear as shown in Figure 10-20.



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**Figure 10-20 Zero-point Calibration Complete (in Manual Calibration)**

4. Close the zero gas flow setting valve. Tighten any lock nut to prevent the leakage of the zero gas into the sensor during process gas measurement.

#### 10.6.4 Operation After Calibration

The analyzer does not require any special operation following calibration. It is recommended the pressure regulator for the zero gas cylinders be closed between calibrations.

## USER NOTES

## 11.0 INSPECTION and MAINTENANCE

This section describes the inspection and maintenance procedures for the SM425 Zirconia Oxygen Analyzer.

### CAUTION

Carefully observe the following when working on the detector:

- The sensor at the tip of the probe operates at temperatures approaching 750 °C. To avoid possible skin burns allow the sensor and probe to cool sufficiently before touching.
- Do not subject the probe to strong mechanical vibration, mechanical shock, or cool it rapidly. The sensor is made of ceramic (zirconia). If the detector is dropped or bumped, the sensor may be damaged.
- Do not reuse the metal O-ring between the sensor cell assembly and the probe. Process gas leakage may cause corrosive damage to the heater, thermocouple, or cell. Always replace the metal O-ring.
- Handle the probe with care. The dust-filter mounting screws on the tip of the probe may cause injury.
- Remove dust and other debris from the terminal box cover prior to opening or closing the terminal box.

## 11.1 Inspection and Maintenance of the Detector

### 11.1.1 Cleaning the Calibration Gas Tube

Calibration gas is supplied to the detector through tubing in the probe and ejected at the tip of the probe. Over time this tubing may become clogged by exposure to process gas and require a higher calibration gas pressure to achieve the specified flow rate. Clean the calibration gas tube if clogging is suspected.

To clean the tube, follow these steps:

1. Remove the detector from the mounting flange.
2. Remove the four bolts (and associated spring washers) that tighten the sensor assembly to the tip of the probe, the pipe support and the U-shaped pipe following Section 1.59.2
3. Use a rod 2 to 2.5 mm in diameter to clean the calibration gas tube inside the probe while keeping air flowing from the calibration gas inlet at about 600 ml/min. Insert the rod into the tube (3-mm inside diameter) no deeper than than 40 cm for a general-purpose detector or 15 cm for a high-temperature detector.
4. Clean the U-shaped pipe. The pipe can be rinsed with water. Dry thoroughly before reassembly.
5. Reassemble all components removed for cleaning following Section 1.59.2. Replace the O-ring(s) with new ones.

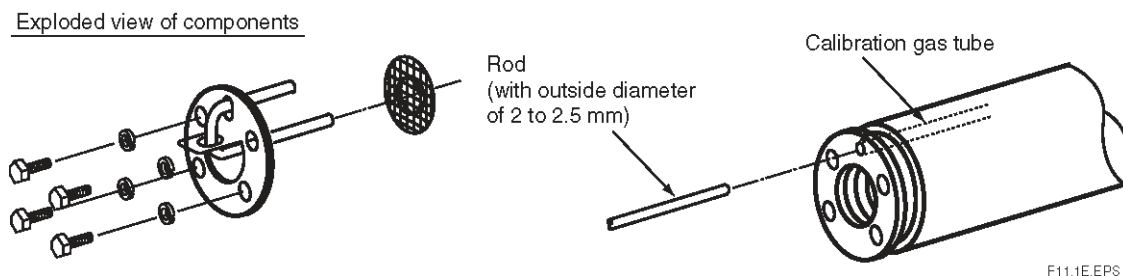


Figure 11-1 Cleaning the Calibration Gas Tube

### 11.1.2 Replacing the Sensor Assembly

The performance of the sensor (cell) deteriorates as its surface becomes contaminated during operation. The sensor must be replaced when it has reached its life expectancy. For example, when it can no longer detect a zero-gas ratio of  $100 \pm 30\%$  or a span-gas ratio of  $0 \pm 18\%$ . The sensor assembly must be replaced if it is damaged or becomes inoperable.

Determine the reason for the sensor malfunction and if possible initiate prevent action.



- To prevent burns, allow the detector to cool before replacing the sensor. Replace the metal O-ring and contact when replacing the sensor. A deformed contact should always be replaced.
  - Any corrosion or discoloring on the contact seating surface should be removed using sandpaper or a metal brush. A final polishing should be made with a high grade of sandpaper (e.g. 1500 grit) or an appropriate metal brush to eliminate any sharp protrusions on the surface. The contact's electrical resistance should be minimized.
  - Use sensor assemblies manufactured on or after Sept. 2000. The serial number on the side of the sensor assembly should be 0J000 or later (for example: OK123, 1AA01 etc).
- 

#### 11.1.2.1 Identifying Sensor Cell Parts to be Replaced

Identify the sensor parts that need to be replaced which typically are the sensor cell, metal O-ring, and contact. Replace the U-shaped pipe, bolts, filter and associated spring washers if necessary.

#### 11.1.2.2 Sensor Cell Removal Procedure

1. Remove the four bolts and associated washers from the tip of the detector probe.
2. Remove the U-shaped pipe support with the U-shaped pipe and the filter.
3. Pull the sensor assembly toward you while turning it clockwise. Remove the metal O-ring between the assembly and the probe. Be careful not to scratch or dent the metal O-ring contact surface on the tip of the probe. Use tweezers to pull the contact out of the groove in the tip of the probe.
4. Clean the sensor assembly and the metal O-ring contact surfaces on both the sensor and probe. Clean any parts that can be reused. The metal O-ring must be replaced to ensure a good seal.

#### 11.1.2.3 Sensor Cell Assembly procedure

1. Install the contact being careful not to deform it. Position it in the ringed groove so that it forms a solid contact with the probe.

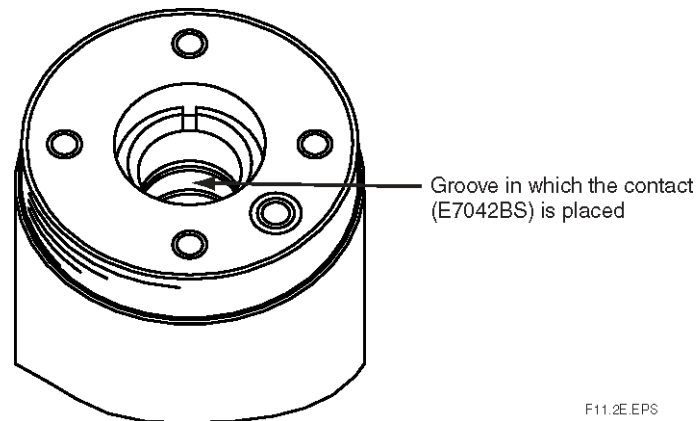


Figure 11-2 Installing the Contact

2. Make sure the O-ring groove on the flange surface of the sensor is clean. Install the metal O-ring in the O-ring groove and then insert the sensor in the probe while turning it clockwise. When the metal O-ring comes in contact with the probe's surface, align the bolt openings and the U-shaped-pipe insertion hole.
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 antiseize grease and install them with washers. Tighten the four bolts evenly by hand. Use a torque wrench to tighten the bolts 1/8 turn at a time to 5.9 Nm using a criss-cross pattern. If they are not uniformly tightened, the O-ring may not seal properly and the sensor or heater may be damaged.

Replacement of the sensor assembly is now complete. Install the detector probe and restart operation. Calibrate the instrument before making a measurement.

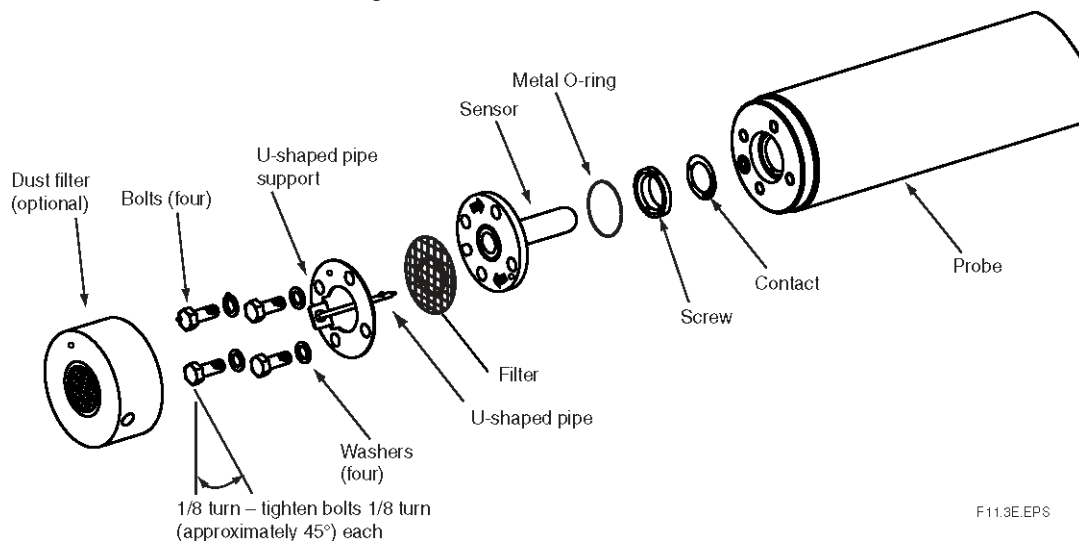


Figure 11-3 Exploded View of Sensor Assembly

**CAUTION**

Optional inconel bolts have a high coefficient of expansion. If excess torque is applied while the bolts are being tightened, abnormal strain or breakage may result. 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 and ceramic heater-furnace core are subject to fracturing. DO NOT subject them to strong mechanical vibrations or mechanical shock. The heater unit reaches high temperatures and contains high voltages. Remove power and allow heater unit temperature to cool to room temperature before performing any maintenance.

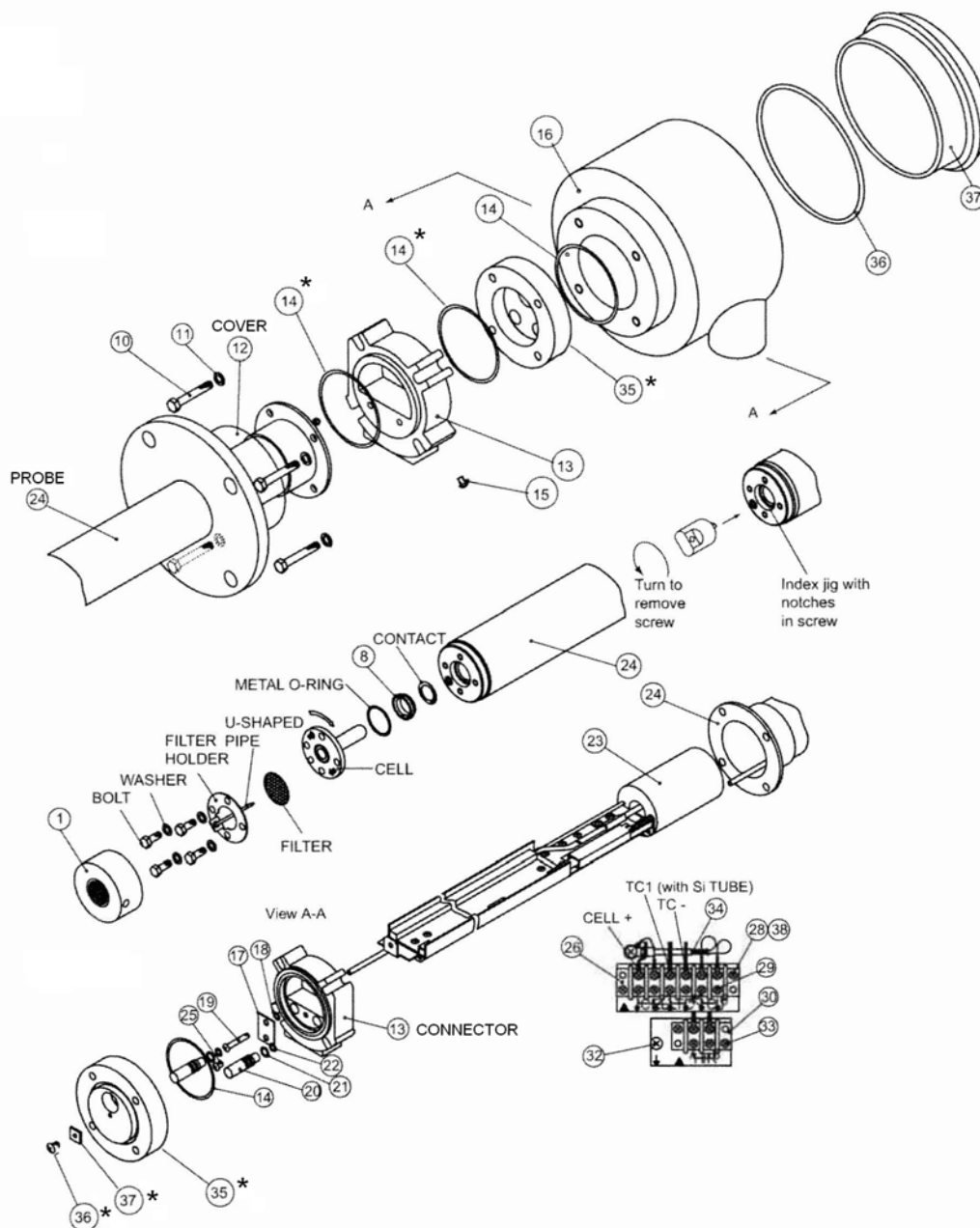
For details, refer to IM11M12A01-21E "Heater Assembly".

---

**Note**

If the heater strut assembly can not be removed because a screw has seized, contact one of our service representatives.

---



**Figure 11-4 Exploded View of Detector with Pressure Compensation**

Note: The parts marked by \* apply only to pressure compensated detectors.

### Replacement of heater strut assembly (SM425P Style S2 and after)

Refer to Figure 11-4 as an aid in the following discussion.

#### 11.1.3.1 Remove the Sensor Cell

Remove the Filter holder, the U-shaped Pipe, the Filter, and the Cell according to Section 1.59.2.2 "Sensor Cell Removal Procedure".

### 11.1.3.2 Remove the Terminal Box

1. Open the terminal box and remove the three terminal connections (CELL+, TC+, and TC-).
2. Remove terminal block SCREWS (28) before disconnecting the two HTR wires from the terminal block. The other terminal connections remain connected.
3. Remove the two SCREWS (15) that fasten the COVER (12) and slide the cover to the flange side.
4. Remove the four Bolts (10) and the terminal box (16) with care so the heater strut assembly wires will not get caught in the terminal box.
5. For pressure compensation type detectors, remove the SCREW (36) and PLATE (37) on the ADAPTER (35). Remove the adapter, drawing the wires of the heater strut assembly through it.

### 11.1.3.3 Replace Heater Strut assembly

1. Remove CONNECTOR (13) by loosening SCREW (19) until the connector can be removed from the heater strut assembly. There's no need to remove retaining O-ring (18).
2. Remove the SCREW (8) at the tip of the probe with a special tool (part no. 9470BX or equivalent) and then remove the HEATER STRUT ASSY (23) from the detector PROBE (24).
3. Insert the new HEATER STRUT ASSY (23) into the detector PROBE (24), while guiding the probe calibration pipe through the heater section and into the bracket hole of the heater strut assembly.
4. Coat SCREW (8) with grease (NEVER-SEEZ: G7067ZA); the replacement screw shipped with the heater strut assembly is already coated. Fasten the HEATER STRUT ASSY (23) to the PROBE (24) with SCREW (8) and tighten with special tool (part no. K9470BX or equivalent) to a torque of 12N.m  $\pm$ 10%.

### 11.1.3.4 Install the CONNECTOR

1. Remove remaining O-rings (22) from back of CONNECTOR (13) Install O-rings (22) over the calibration and reference pipes. Use new O-rings if they are damaged.
2. NOTE: If you attempt to insert the calibration-gas and reference-gas tubes into the connector without disassembling it, the O-rings may be damaged. Remove SCREW (25), PLATE (17), and the two CAPs (20) from CONNECTOR (13).
3. On pressure compensation type detectors, install O-ring (14) between connector and probe.
4. Pass the heater and thermocouple lead-wire through the CONNECTOR (13). Insert the calibration-gas and reference-gas tubes through the holes of the CONNECTOR (13).
5. Install O-rings (21) over the calibration-gas and reference-gas tube ends. Use new O-rings if they are damaged.
6. 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). Tighten the SCREW (19) until there is no movement between the CONNECTOR (13) and the HEATER STRUT ASSY (23).
7. For pressure compensation type detectors, insert O-ring (14) between the CONNECTOR (13) and ADAPTER (35). Pass the heater and thermocouple lead-wires through the holes in the adapter. Attach the adapter to the connector using PLATE (37) and SCREW (36).

### 11.1.3.5 Install the Terminal Box and Wiring

Install in reverse order of the above terminal box removal procedure. If there are no markers on the wiring from the heater strut assembly, identify the wires as follows; the two wires coming from the ceramic



insulator are heater wires and the single-core wire is CELL+. One of the two core-wires with semitransparent silicone tubing is TC+ and the other is TC-.

### 11.1.3.6 Install the Cell

Install the Filter holder, the U-shaped Pipe, the Filter, and the Cell according to Section 3.1.3 “Part assembly procedure of the sensor assembly”. The replacement heater strut assembly is shipped with a new CONTACT.

### 11.1.4 Replacement of Optional Dust Filter Assembly

Refer to Figure 11-4 Exploded View of Detector with Pressure Compensation”. Install the dust filter assembly (1) using a special pin spanner (with a pin 4.5 mm in diameter: part no. K9471UX or equivalent). Ensure threads of the dust filter assembly are coated with grease (NEVER-SEEZ: G7067ZA).

### 11.1.5 Replacement O-rings

Table 11-1 lists the part numbers for replacement O-rings. Refer to Figure 11-4 for locations of these parts in the detector. All detectors require one set of each part number. The pressure compensated type detector requires two additional (14) O-rings. The O-ring set (21) and (22) is used to seal the reference and calibration gas lines. These require periodic replacement.

**Table 11-1 O-ring part numbers**

	Part No.	Description
(7)	K9470BJ	Metal O-ring
(14)	K9470ZS	Metal 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 strong mechanical vibration or mechanical shock. This probe uses silicon carbide (SiC) which may become damaged if it is subjected to strong mechanical or thermal shock.

A probe adapter is used to direct process gas to the high-temperature detector. Sufficient gas flow through this adapter must be maintained to ensure accurate measurements. The adapter must be periodically inspected and cleaned if particulate buildup or clogging is found.

Remove particulate matter from probe with air or by cleaning with a metal rod. Remove the associated auxiliary ejector or needle valve from the high-temperature probe adapter and clean it with air or rinse in water.

### 11.1.7 Process Shutdown and Startup

#### <Process Shutdown>

Follow these precautions to prevent sensor damage during process shutdown.



Processes such as boiler and industrial furnace operations can entrain significant amounts of particulate and moisture in the gas stream that can be deposited on the zirconia cell during process shutdown and startup. Since the sensor is heated to 750°C, these deposits can become firmly fixed and degrade sensor performance. If there is a large amount of condensation, the sensor can be damaged and become unusable.

To prevent this from occurring, take the following actions when shutting down a process.

- (1) Either keep the converter powered up and reference air flowing to the sensor or remove the detector.
  - (2) If this is not possible, supply air to the calibration gas pipe at 600ml/min.
- 

#### <Process Startup>

During process startup, supply air to the calibration gas pipe at 600 ml/min for 5-10 minutes before supplying the power to converter.

## 11.2 Inspection and Maintenance of the Converter

### 11.2.1 Cleaning

The touch panel should be kept clean by wiping off with a soft dry cloth.

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

### 11.2.2 Adjusting LCD screen contrast

An LCD screen is built in the SM425 converter. The contrast of this LCD screen is affected by its ambient temperature. The converter is shipped with the contrast adjusted at a room temperature of 20-30°C. If the LCD display is hard to see under operating conditions, adjust the LCD screen contrast with the variable resistor shown in Figure 11-5.



Figure 11-5 LCD Contrast adjustment

### 11.2.3 Replacing Fuses

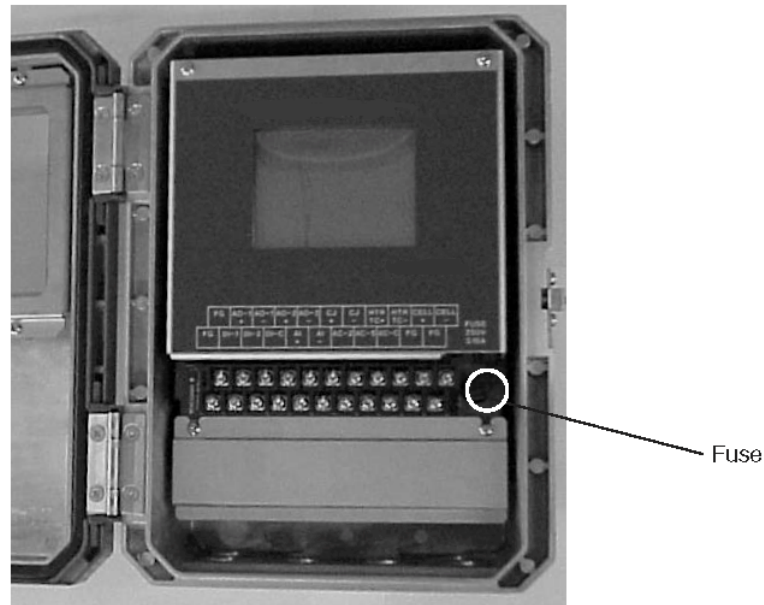
The location of the converter fuse is shown in Figure 11-6. If the fuse blows, replace it using the following procedure.



#### Note

If a replaced fuse blows out immediately, there may be a problem in the circuitry. Thoroughly go over the circuits to find out why the fuse has blown. This fuse protects the main power supply circuit and does not provide overcurrent protection for the heater temperature control circuit. For overcurrent protection circuitry, refer to Section 1.62.2.2, "Heater Temperature Failure."

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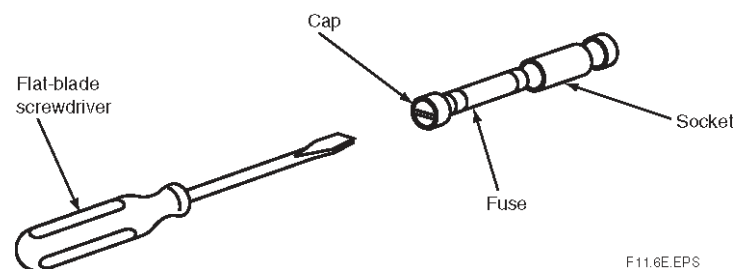


F11.5E.EPS

**Figure 11-6 Location of the Converter Fuse**

To replace the fuse, follow these steps:

1. Turn off the power to the converter.
2. Remove the fuse from its holder. With an appropriate flat-blade screwdriver that just fits the holder cap slot (Figure 11-7), turn the fuse holder cap 90° counterclockwise. Remove the fuse along with the cap.



F11.6E.EPS

**Figure 11-7 Removing the Fuse**

3. The specifications for a replacement fuse are:
  - Maximum rated voltage: 250 V
  - Maximum rated current: 3.15 A
  - Type: Time-lag fuse
  - Standards: UL-, CSA- or VDE-approved

Part number: 96751020

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

## 11.3 Replacing Flowmeter in SM425CAL Autocalibration Unit

NOTE: Mark original positioning of piping connections before disconnecting. Tighten an extra 5-10° when reconnecting and perform a liquid-leakage test. Refer to Figure 11-8 and Figure 11-9

1. Disconnect the external piping and wiring to the SM425CAL unit.
2. Remove four M6 bolts holding SM425CAL unit to mounting bracket.
3. Disconnect internal piping from flowmeter.
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. Reconnect internal piping and attach SM425CAL unit to mounting bracket using four M6 bolts.
6. Reconnect external piping and wiring to SM425CAL unit.

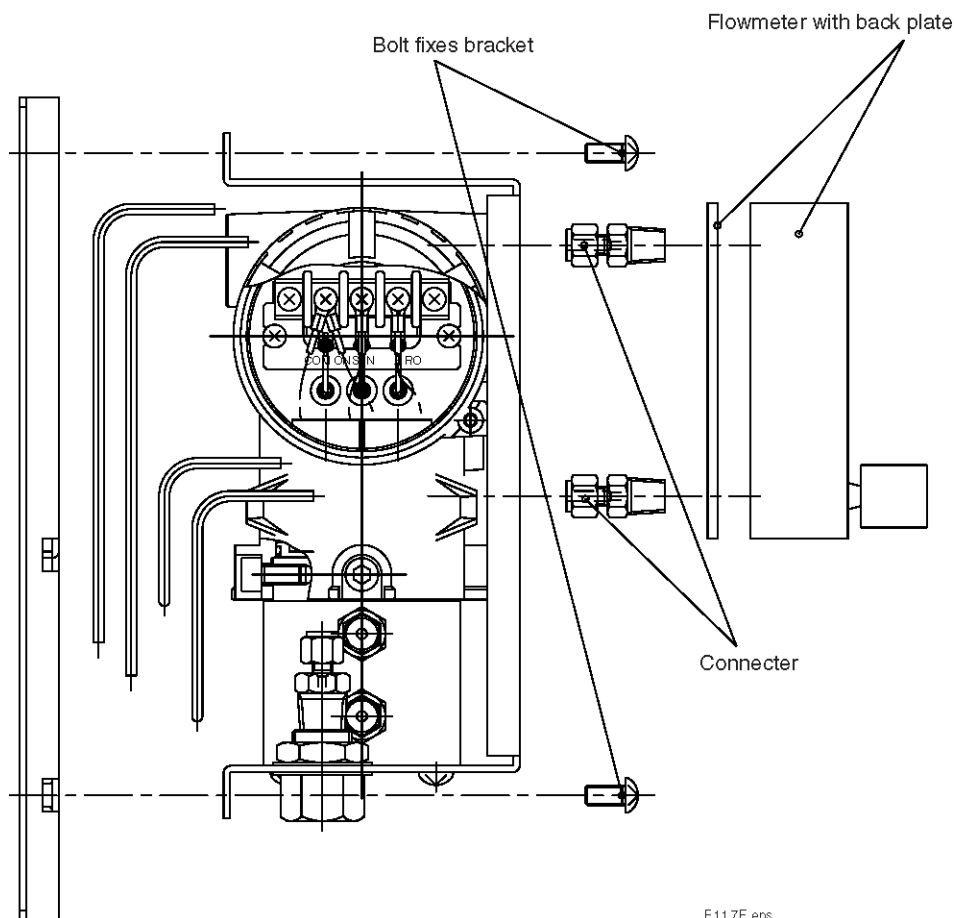


Figure 11-8 Flowmeter replacement

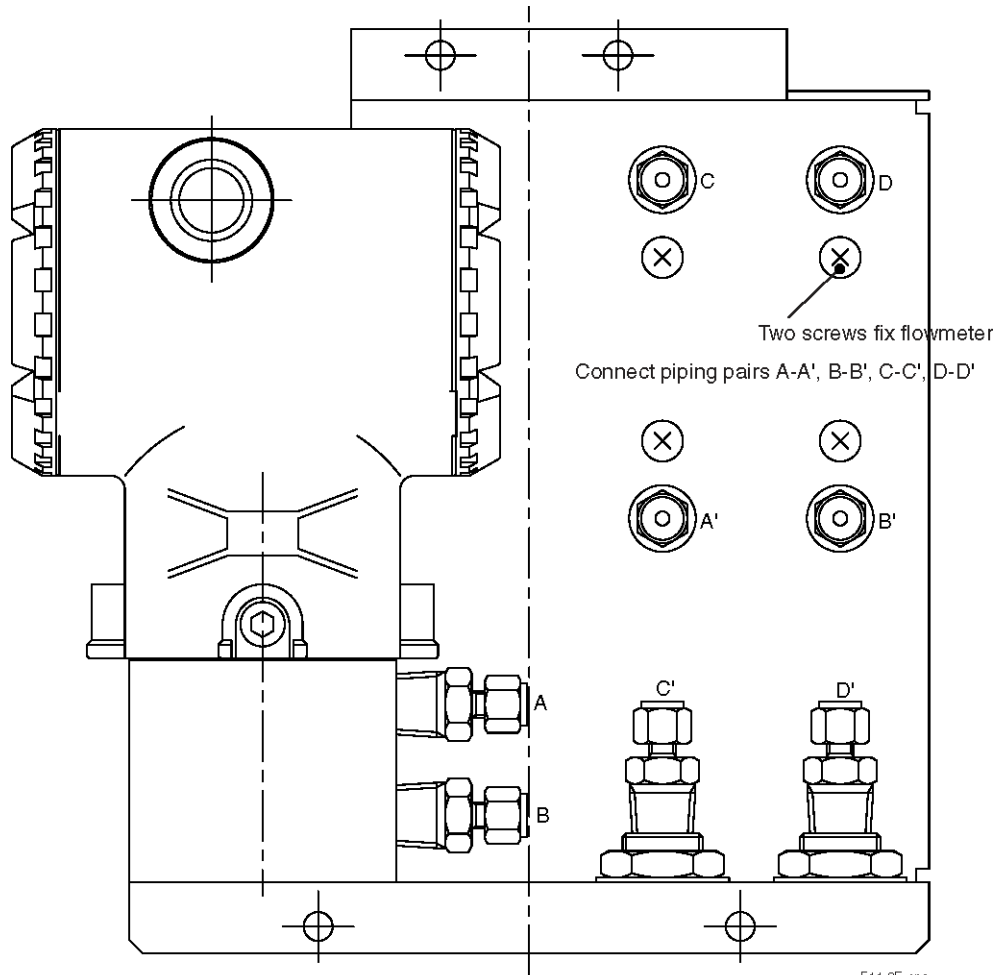


Figure 11-9 Flowmeter Attachment

## 12.0 TROUBLESHOOTING

This section describes errors and alarms detected by the self-diagnostic function of the converter. This section also describes the check and restoration methods to use when problems other than the above occur.

### 12.1 Errors: Displays and Corrective Actions

#### 12.1.1 What is an Error?

An error is caused by an abnormality in the detector or the converter, e.g., a malfunction in the cell (sensor) or heater in the detector, or a circuit failure in the converter. If an error occurs, the converter performs the following:

1. Turns off power to the heater in the detector to insure system safety.
2. Initiates a blinking error indication on the display (Figure 12-1).
3. Closes an output contact if the contact has been configured for an error condition (refer to Section 1.48, "Output Contact Setup").
4. Changes the analog output to the level configured in "Output hold setting" (refer to Section 1.46, "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 possible errors are listed in Table 12-1.

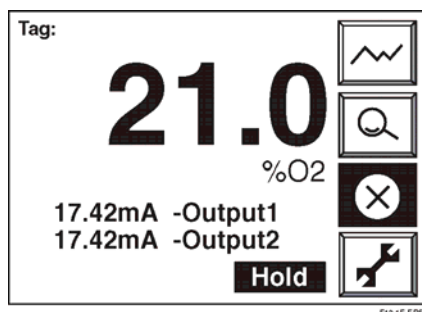


Figure 12-1 Error indication display

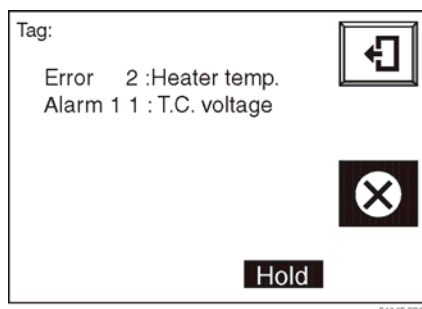


Figure 12-2 Error description display

**Table 12-1 Types of Errors and Causes**

<b>Error</b>	<b>Type of error</b>	<b>Cause</b>
Error-1	Cell voltage failure	The cell (sensor) voltage signal input to the converter falls below -50 mV
Error-2	Heater temperature failure	The heater temperature does not rise during warm-up, or it falls below 730 °C or exceeds 780 °C after warm-up is completed. Also occurs if the TC+ TC- thermocouple terminals are wired to converter with reverse (wrong) polarity.
Error-3	A/D converter failure	The A/D circuit in the converter has failed
Error-4	Memory failure	Data not correctly written to converter memory

## 12.1.2 Error Troubleshooting and Corrective Actions

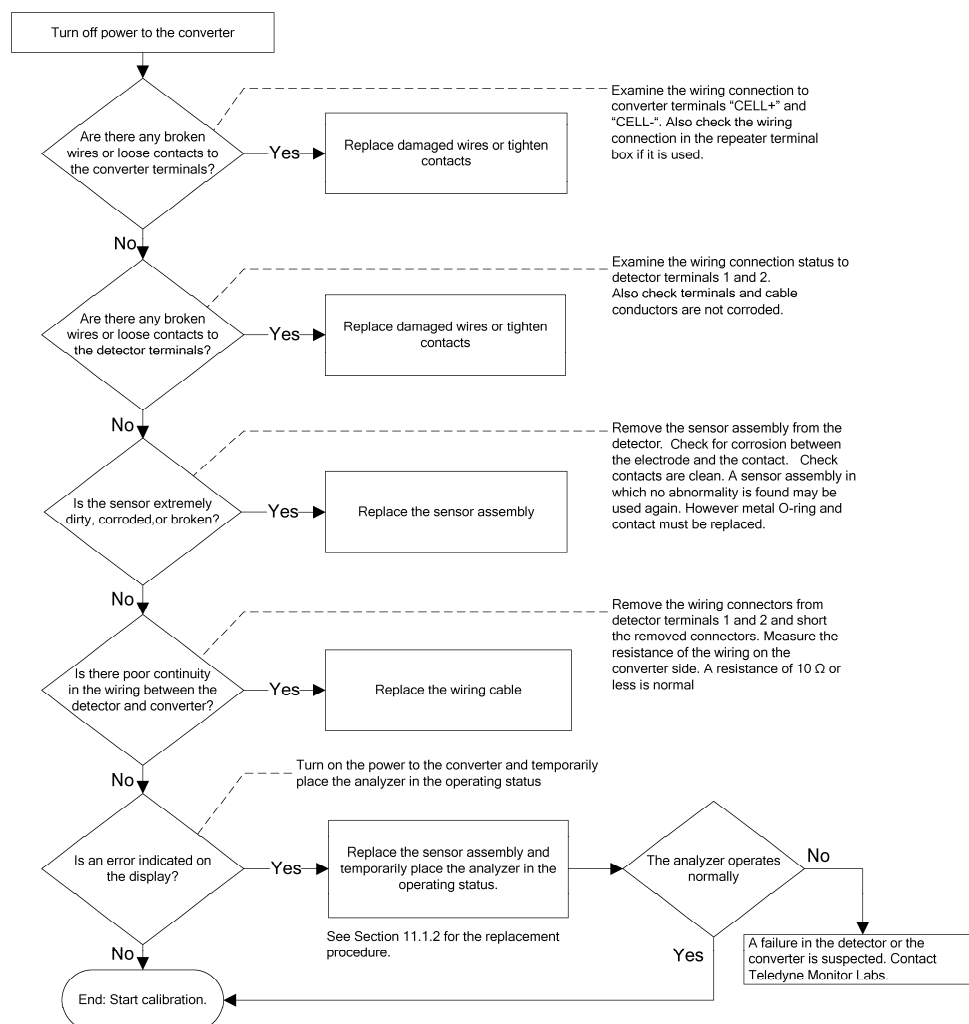
### 12.1.2.1 Error-1: Cell Voltage Failure

Error-1 occurs when the cell (sensor) voltage input to the converter falls below -50 mV (corresponding to about 200% O<sub>2</sub>). The following are possible causes for the cell voltage falling below -50 mV:

1. Poor contact in terminal connections between the converter and detector
2. Damaged wiring in the converter to detector cable
3. Damage or failure of the sensor assembly
4. No continuity between the sensor assembly electrode and the contact
5. Faulty detector wiring
6. Converter electronics failure



## &lt;Error Troubleshooting Flowchart&gt;

**12.1.2.2 Error-2: Heater Temperature Failure**

This error occurs if the detector heater temperature does not rise during warm-up or if the temperature falls below 730°C or exceeds 780°C after warm-up is completed. Alarm 10 (cold junction temperature alarm) or alarm 11 (thermocouple voltage alarm) may be generated during an Error-2 condition. Press the error indication to get a description of the error and confirm whether or not these alarms are being generated simultaneously.

If Alarm 10 is generated, a failure in the cold junction system is suspected. In this case, follow the procedure for troubleshooting alarm 10 in Section 1.63.2.5.

If Alarm 11 is generated, a failure in the thermocouple system located in the detector heater is suspected. In this case, follow the procedure for troubleshooting Alarm 11 in Section 1.63.2.6

If an Error-2 occurs immediately after power is supplied, the polarity of the thermo-couple input connection (TC+, TC-) in the converter may be reversed. Check detector connections.

Possible causes of an Error-2 condition 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 of the converter electronics
5. Heater temperature control overcurrent limiting triggered.
6. TC+ and 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, an internal fuse blows. The heater is then disconnected, resulting in an Error 2 (temperature failure) condition.

#### <Troubleshooting and Corrective Actions>

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 will be normal if the resistance is lower than about 90 $\Omega$ . If the resistance value is higher, failure of the heater unit is suspected. In this case, replace the heater unit (refer to Section 1.59.3, "Replacement of the Heater Unit"). In addition, check that the wiring resistance between the converter and detector is 10 $\Omega$  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 between these terminals. The thermocouple is considered normal if the resistance value is 5 $\Omega$  or less. If the value is higher than 5 $\Omega$ , damaged thermocouple wiring may be the cause. In this case, replace the heater unit (refer to Section 1.59.3, "Replacement of the Heater Unit"). Also, check the wiring resistance between the converter and detector is 10 $\Omega$  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:
  - Heater terminals are shorted together.
  - Heater terminal(s) are shorted to ground.
  - Heater terminals are shorted to power supply.

Do not attempt to replace an open internal fuse. Contact your Teledyne Monitor Labs service representative if this occurs.



#### CAUTION

• Measure the thermocouple resistance after the difference between the detector tip temperature and the ambient temperature decreases to 50°C or less. Accurate resistance measurements cannot be made at high temperatures.

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### 12.1.2.3 Error-3: A/D Converter Failure and Error-4: Writing-to-Memory Failure

- A/D Converter Failure  
The A/D converter circuit has failed.
- Writing-to memory Failure  
It is suspected that a failure has occurred in an operation writing to the memory (EEPROM) mounted in the electronic circuits inside the converter.

#### < Troubleshooting and Corrective Actions >

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 supply voltage (falling below 85 V, the least amount of voltage required to operate the converter) or a noise induced event. Check if there is a failure in the power supply system. Verify the converter and detector are securely grounded.

If the error occurs again after restarting, an electronic circuit failure has likely occurred. Consult the service personnel at Teledyne Monitor Labs.

## 12.2 Alarms: Displays and Corrective Actions

### 12.2.1 What is an Alarm?

The alarm indication blinks on the display to notify of an active alarm (Figure 12-3). Pressing the alarm indication displays a description of the alarm. Alarms include those shown in Table 12-2.

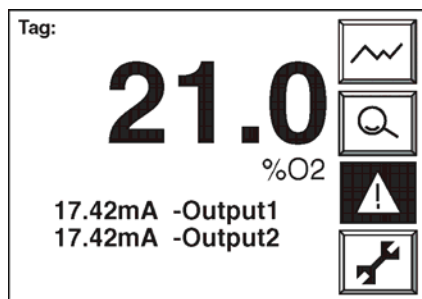


Figure 12-3 Alarm indication display

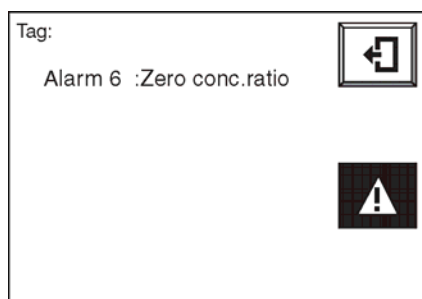


Figure 12-4 Alarm description display

**Table 12-2 Types of Alarms and Causes**

Alarm	Type of alarm	Cause
Alarm 1	Oxygen concentration alarm	Generated when measured oxygen concentration is outside of the user programmed range (refer to Section 8.3, "Setting Oxygen Concentration Alarms").
Alarm 6	Zero-point calibration coefficient alarm	Generated when the zero correction factor is out of the $100 \pm 30\%$ range in automatic and semiautomatic calibration (refer to Section 9.1.3, "Calibration Curves").
Alarm 7	Span-point calibration coefficient alarm	Generated when the span correction factor is out of the $0 \pm 18\%$ range in automatic and semiautomatic calibration (refer to Section 9.1.3, "Calibration Curves").
Alarm 8	EMF stabilization time-up	Generated when the cell (sensor) voltage did not stabilize during the calibration time in automatic and semiautomatic calibration.
Alarm 10	Cold junction temperature alarm	Generated when temperature of the cold junction located in the detector terminal box is out of the $-25\text{ }^{\circ}\text{C}$ to $155\text{ }^{\circ}\text{C}$ range.
Alarm 11	Thermocouple voltage alarm	Generated when thermocouple voltage is out of the $-5\text{ mV}$ to $42.1\text{ mV}$ range, (about $-170\text{ }^{\circ}\text{C}$ to $1020\text{ }^{\circ}\text{C}$ ).
Alarm 13	Battery low alarm	Internal battery needs replacement.

Normal operation of the analyzer can not resume until an alarm condition is corrected. An alarm is cleared only by a corrective action. An Alarm 10 and/or Alarm 11 may be generated at the same time as Error-2 (heater temperature error). The Error-2 corrective action has priority over the Alarm 10 and/or Alarm 11 corrective actions.

If the converter power is turned off after an alarm is generated and restarted before the cause of the alarm has been eliminated, the alarm will be generated again. However, Alarms 6, 7, and 8 (calibration alarms) are not generated unless calibration is executed.

## 12.2.2 Alarm Corrective Actions

### 12.2.2.1 Alarm 1: Oxygen Concentration Alarm

This alarm is generated when a measured value is outside of a user programmed range. For details on the oxygen concentration alarm, see Section 1.47, "Setting Oxygen Concentration Alarms," in the section on operation.

### 12.2.2.2 Alarm 6: Zero-point Calibration Coefficient Alarm

In automatic or semiautomatic calibration, this alarm is generated when the zero correction factor is out of the of  $100 \pm 30\%$  range (refer to Section 1.51.3, "Calibration Curves"). An Alarm 6 may be caused by any of the following:

1. The zero-gas oxygen concentration does not agree with the value set during "Calibration Setup."
2. The zero-gas flow is out of the specified flow ( $600 \pm 60\text{ mL/min}$ ).

3. The oxygen sensor assembly is damaged.

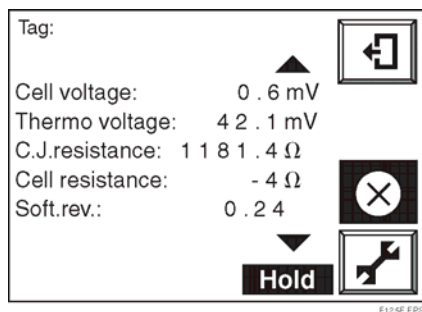
### < Troubleshooting and Corrective Actions >

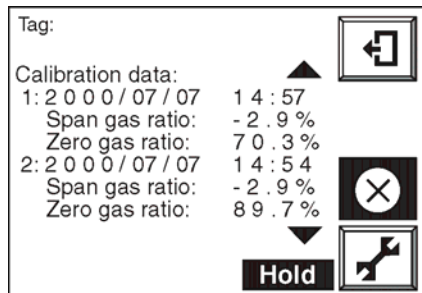
1. Confirm the following and correct as necessary. Then re-calibrate:
  - a. The “Zero gas conc.” programmed in “Calibration setup” menu agrees with the concentration of zero gas in use.
  - b. There are no leaks in the zero gas tubing.
2. No further action is required if the alarm clears following the re-calibration.
3. The sensor cell assembly requires replacement if re-calibration did not clear the alarm. Check the cell voltages when passing the zero gas and span gas before replacement by:
  - a. Select the detailed data display by pressing the detail display key in the basic panel display.
  - b. When the ▼ key is pressed once, the cell voltage should be indicated on the top line (Figure 12-5).
  - c. Verify the cell voltages are within  $\pm 10$  mV of the values in Table 12-3.

**Table 12-3 Oxygen Concentration and Cell Voltage**

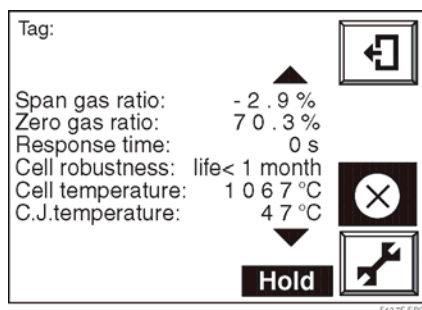
Oxygen Concentration (%O <sub>2</sub> )	Cell voltage (mV)
1%	67.1
21%	0

4. Verify sensor assembly damage using the following procedure:
  - a. Select the detailed data display.
  - b. Select “Calibration time history” by pressing the ▼ key (Figure 12-6). Since the ten previous span-correction factor and zero-correction factor values can be checked in this display, deterioration of the sensor is shown by large changes between factors.



**Figure 12-5 Detailed Data Display****Figure 12-6 Calibration History**

5. If deterioration of the sensor assembly has occurred abruptly, it may indicate the check valve, which prevents moisture in the process gas from getting into the calibration gas tubing, has failed. If process gas gets into the calibration gas tubing, it condenses and remains in the gas tubing. The condensate is blown into the sensor assembly by the calibration gas during calibration and causes the cell to cool quickly.
6. If the sensor assembly has been gradually deteriorating, check the sensor assembly status in the following procedure:
  - a. Select “Cell resistance” by pressing the ▼ key. A new cell will show a cell resistance value of 200Ω or less. A cell (sensor) that is approaching the end of its service life will show a resistance value of 3 to 10 kΩ.
  - b. Display “Cell robustness” by pressing the ▼ key. A good cell (sensor) will show “Life > 1 year” (Figure 12-7).

**Figure 12-7 Cell robustness display**

### 12.2.2.3 Alarm 7: Span-point Calibration Coefficient Alarm

In automatic or semiautomatic calibration, this alarm is generated when the span correction factor is out of the range of  $0 \pm 18\%$  (refer to Section 1.51.3, “Calibration Curves”). An Alarm 7 may be caused by any of the following:

1. The oxygen concentration of the gas does not agree with the value set for the span gas in “Calibration setup” menu.
2. The flow of the span gas is out of the specified flow ( $600 \pm 60$  mL/min) range.
3. The sensor assembly is damaged.

**< Troubleshooting and Corrective Actions >**

1. Confirm the following and correct as necessary. Then re-calibrate:
  - a. The "Span gas conc." programmed in "Calibration setup" menu agrees with the concentration of span gas in use.
  - b. There are no leaks in the span gas tubing.
2. No further action is required if the alarm clears following the re-calibration.
3. The sensor cell assembly requires replacement if re-calibration did not clear the alarm. Follow the procedure described in steps 3 to 6 of **< Troubleshooting and Corrective Actions >** in Section 1.63.2.2, "Alarm 6: Zero-point Calibration Coefficient Alarm."

**12.2.2.4 Alarm 8: EMF Stabilization Time Over**

This alarm is generated if the sensor (cell) voltage has not stabilized during the calibration time.

**<Cause of alarm>**

1. The flow of the calibration gas is less than the specified flow of  $600 \pm 60$  mL/min.
2. The length or thickness of the calibration gas tubing has been changed (lengthened or thickened).
3. The process gas is flowing towards the tip of the probe.
4. The sensor (cell) response is failing.

**< Troubleshooting and Corrective Actions >**

1. Re-calibrate using calibration gas at the specified flow ( $600 \pm 60$  mL/min) after verifying there are no leaks in the tubing.
2. If the alarm occurs again, verify dust or particulate is not accumulating on the tip of the calibration gas tube. If dust is found, clean the tube (see Section 1.59.1).  
In addition, the influence of process gas flow may be suspected. Do not let process gas flow towards the tip of the detector probe. The mounting of the detector may need to be changed.
3. If the alarm persists, replace the sensor assembly.

**12.2.2.5 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 is outside of the  $-25^{\circ}\text{C}$  to  $155^{\circ}\text{C}$  range. Select "C.J. Temperature" in the detailed data display then check the following:

If "C.J. Temperature" is  $200^{\circ}\text{C}$  or  $-50^{\circ}\text{C}$ , the following may be the problem:

1. Open cold junction signal wires between the converter and the detector or the cable is not securely connected to the 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” is out of the -20°C to 150°C range, the following may be problem:

1. The temperature of the detector terminal block is out of the operating temperature range (-20°C to 150°C).
2. A failure of the cold junction temperature sensor located at the detector terminal block occurred.
3. A failure of the electrical circuits inside the converter occurred.

### < Troubleshooting and Corrective Actions >

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, move the detector terminal block away from radiant heat.

For SM425P Detector:

1. Power off 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 k $\Omega$ , the cold junction temperature sensor is considered to be faulty. Replace that temperature sensor with a new one.
3. Check for broken or shorted wires. Verify the cable is securely connected to the terminals. Verify the resistance of the wiring between the converter and detector is 10  $\Omega$  or less.
4. If the wiring passes testing and inspection, an electronic failure has likely occurred. Contact the service personnel at Teledyne Monitor Labs.

For Model ZO21D Detector:

1. With converter power on, 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 range, the cold junction temperature sensor requires replacement.
2. If the voltage between the terminals is within the above range, check the cable for broken or shorted wires. Verify the cable is securely connected to the terminals. Verify the resistance of the wiring between the converter and detector is 10 $\Omega$  or less.
3. An electronic failure has likely occurred if the wiring passes testing and inspection. Contact the service personnel at Teledyne Monitor Labs.



**CAUTION**

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

---

**12.2.2.6 Alarm 11: Thermocouple Voltage Alarm**

This alarm is generated when the emf (voltage) of the thermocouple is not in the -5 mV to 42.1 mV (about -170°C to 1020°C) range. Whenever Alarm 11 is generated, Error-2 (heater temperature failure) also occurs. An Alarm 11 can be caused by any of the following:

1. The heater thermocouple signal wire between the converter and the detector is open, or the cable is not securely connected to the 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. The thermocouple at the detector heater assembly failed.
4. An electronic failure inside the converter occurred.

**< Troubleshooting and Corrective Actions >**

1. Power off the converter.
2. Disconnect the wiring from terminals 3 and 4 of the detector and measure the resistance between these wires. The resistance should be 5  $\Omega$  or less. A higher resistance indicates the thermocouple requires replacement (refer to Section 1.59.3, "Replacement of the Heater Unit").

**CAUTION**

• Measure the thermocouple resistance after the difference between the detector tip temperature and ambient temperature falls to 50°C or less. Accurate measurement cannot be made with a high thermocouple temperature.

---

3. If the thermocouple resistance is normal, check for open or shorted wires. Verify the wiring cable is securely connected to the terminals. Measure the resistance between the converter and the detector. It must be 10 $\Omega$  or less.
4. An electronic circuit failure is likely if the thermocouple and wiring testing passes. Contact the service personnel at Teledyne Monitor Labs.

**12.2.2.7 Alarm 13: Battery Low Alarm**

An internal battery is used as backup for the analyzer clock. After this alarm occurs, removing power from the instrument may cause the clock to stop. Stored parameters are not affected. The internal clock is

used for blowback scheduling. If you use this function check / correct the date and time every time you turn on the power until the alarm has been cleared.

#### <Corrective Action>

The battery can not be replaced by the user. Contact your Teledyne Monitor Labs service representative.



#### Note

Battery life varies with environmental conditions.

\* There is no battery draw if power is applied to the instrument continuously. Battery life is typically about ten years. However there will be battery draw during the time interval between shipment from the factory and site installation.

\* If power is not applied to the instrument, at ambient temperatures of 20 to 25°C the battery life is typically 5 years. In the range -30 to +70°C the battery life is typically 1 year.

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## 12.3 Corrective Actions for Measurement Errors

Measurement errors occur when:

1. The measured value is higher than the true value.
2. The measured value is lower than the true value.
3. The measured value shows abnormal or unexpected values.

### 12.3.1 Measured Value Higher Than Actual Value

#### <Causes and Corrective Actions>

1. An increase in process gas pressure from the process pressure at the time of calibration. The change in the oxygen concentration, X, is shown by the following expression:

$$X=Y [1+ (\Delta p/101.30)]$$

Where  $\Delta p$ , in kPa, is the change in the process gas pressure from the pressure at time of calibration and Y is the oxygen concentration measured at the calibration pressure (vol% O<sub>2</sub>).

In order to minimize fluctuations in oxygen concentration due to pressure:

- Maintain constant process pressure
  - Calibrate the analyzer at the average process pressure.
2. Significant increase in the moisture content of the calibration gases. A large change of moisture in reference air may cause an error in the measured oxygen concentration value (vol% O<sub>2</sub>). This may occur if ambient air is used as the reference gas. In order to minimize fluctuations in oxygen concentration due to moisture, use a reference gas whose moisture content is constant such as instrument air. Small fluctuations can also be caused by changes in the moisture content of the process gas.
  3. Calibration gas (span gas) is leaking into the detector through the calibration gas tubing. Verify the integrity of tubing joints and the needle. Check solenoid valves used in automatic calibration. Confirm that manual valves are fully closed.
  4. The reference gas and process gases are mixing. When the difference between oxygen partial pressures on the sensor anode and cathode sides decreases, the measured (process) value

increases. Visually inspect the sensor for cracks. If any crack is found, replace the sensor assembly. Cracks do not necessarily trigger an Error-1.

(Note) Data such as cell robustness displayed in the detailed data display should also be used for deciding sensor quality.

### 12.3.2 Measured Value Lower Than Actual Value

#### < Causes and Corrective Actions >

1. The process gas pressure decreases. Unacceptable fluctuations in measured process oxygen concentration due to pressure changes can be minimized by taking the steps referred to in subsection 12.3.1 (1).
2. Significant decrease in the moisture content of the calibration gases. A large change of moisture in reference air may cause an error in the measured oxygen concentration value (vol% O<sub>2</sub>). This may occur if ambient air is used as the reference gas. In order to minimize fluctuations in oxygen concentration due to moisture, use a reference gas whose moisture content is constant such as instrument air. Small fluctuations can also be caused by changes in the moisture content of the process gas.
3. Calibration gas (zero gas) is leaking into the detector through the calibration gas tubing. Verify the integrity of tubing joints and the needle. Check solenoid valves used in automatic calibration. Confirm that manual valves are fully closed.
4. Combustible particulate in the process gas are burning in the sensor reducing the oxygen content. Check there are no combustible particulate.
5. Temperature of the detector cell reaches 750°C or more.

### 12.3.3 Intermittent Abnormal Measurements

#### < Causes and Corrective Actions >

1. Electrical noise on the detector output wiring.
  - a. Verify the converter and detector are electrically grounded.
  - b. Check if the signal wiring is run with other power or signal wires.
2. The power supply is generating noise.
  - a. Check if the converter power is supplied from the same outlet, switch, or breaker as other equipment.
3. Poor wiring contact
  - a. Sensor voltage or thermocouple emf (voltage) may vary due to vibration or other factors if there is poor wiring contact.
  - b. Check for loose wiring connections or loose crimps on the crimp-on terminal lugs.
4. Combustible particulate in the process gas may be getting into the sensor.
  - a. Particulate filtering may be improved by using a dust-removing filter 96751017.
5. The sensor is cracked or the sensor-mounting is leaking.
  - a. Check for a crack in the sensor or if the sensor-flange metal O-ring needs replacement.
6. The calibration gas tubing may be leaking.
  - a. A negative process pressure magnifies this cause.

## **APPENDIX A – SM425 Spare Parts List**



**SM425 INSITU O2 ANALYZER SPARE PARTS LIST**

Part Number	Description
53000242	1.5M Probe Heater
96751016	Check Valve, 1/4 NPT
96751017	Probe Dust Cover
96751019	Electronics Board
96751020	Electronics Board Fuse