
**Instruction
Manual**

ZA8 Zirconia Oxygen Analyzer

**IM 11M6A2-YIA
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INTRODUCTION

I. INTRODUCTION

1.1 GENERAL

The ZA8C In-Situ Zirconia Oxygen Analyzer has been designed to measure excess oxygen in a wide variety of combustion processes. It is an outstanding unit for monitoring oxygen concentrations in combustion gas of large or small boilers, industrial furnaces and combustion processes or for the control of low percent oxygen combustion.

The analyzer consists of a detector, converter and calibration unit. Optional accessories may be selected to enhance installation, add system care, minimize maintenance and automate calibration. An optimal control system can be realized if the appropriate supplemental equipment is selected.

The ZA8C converter utilizes a high performance microprocessor-based electronics unit incorporating the latest technology. When combined with the proven, reliable output of the ZO21D zirconia oxide detector, the user receives an accurate, dependable oxygen concentration measurement needed for control and monitoring capabilities.

Featuring a single chip microprocessor, the ZA8C incorporates the industry's latest technological advances. Reliable and simple one-chip operating is achieved through interactive operation with the microcomputer. A backlit, 40-dot matrix, liquid crystal display provides excellent readability of data while reduced components create an easy to handle, lightweight design.

1.2 OVERVIEW

The ZA8C In-Situ Type Zirconia Oxygen Analyzer is used to monitor and control the excess oxygen concentration in combustion gases of boilers, incinerators and other industrial furnaces.

Two types of detectors are available for the ZA8C: A low temperature detector (model ZO21D-L) sampling gases up to 1200°F (700°C) and a high temperature detector (model ZO21D-H) to sample gases up to 3400°F (1871°C). The flue gas temperature determines which detector will give the best oxygen measurement for combustion control, as the detector is inserted into the flue via flange and spool piece attached to the flue wall.

The ZA8C is equipped with user friendly displays, featuring measurement information, cell diagnostics and help functions. Because of an easily accessible pre-configured display menu, values such as display menu, min/max values of O₂ concentration, averaging values, air ratio and more are displayed on the LCD with the push of a button. The ZA8C lets the user select the calibration method: Automatic (with an AC1 unit) or Manual (with a MC1 unit). The converter is equipped with various functions which perform such tasks as measurement and calculation as well as maintenance functions, including self-diagnostics.

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1.3 SYSTEM CONFIGURATION

The basic system consists of a detector, converter and calibration unit.

1.3.1 Detectors and Accessories

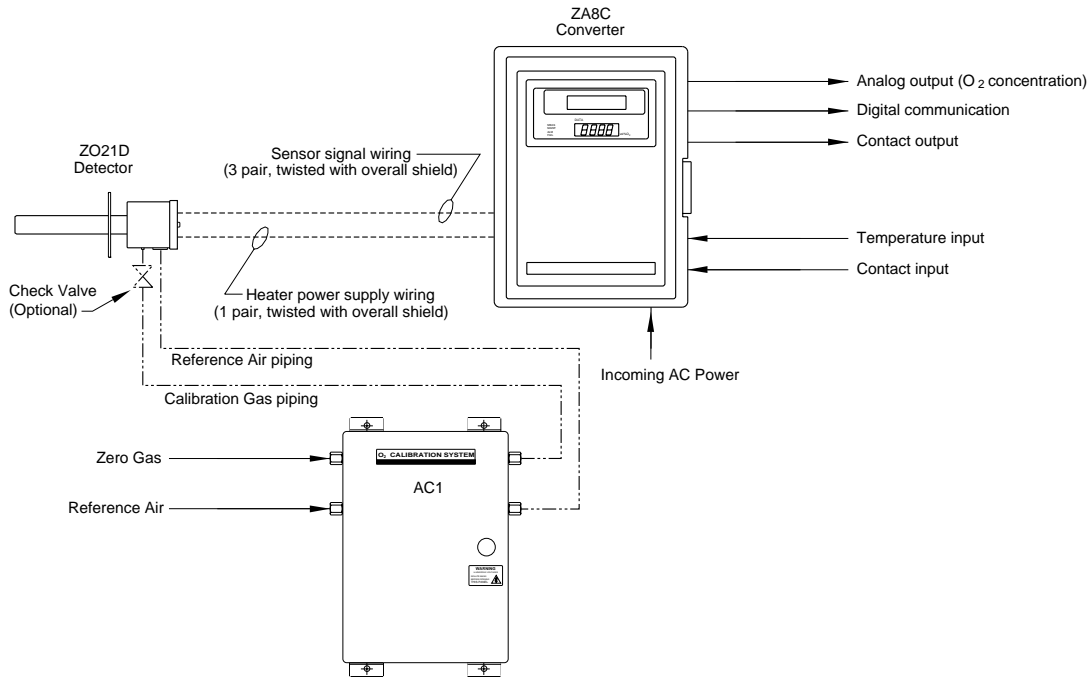


Figure 1: Typical System Configuration

1.3.2 Features

Repeatability:	±0.5% full scale
Linearity:	±1% full scale (for a maximum range of 0 to 25 vol% O ₂)
Drift:	Span -0.8% of full scale/month; Zero 0.7% of full scale/month
Response:	90% response within five seconds (measured from the time gas is switched on at the detector calibration gas inlet until the analog output signal starts to vary)

INTRODUCTION

1.4 STANDARD SPECIFICATIONS

Measurement:	% oxygen concentration
Measurement Method:	Zirconium Oxide
Measurement Range:	0 to 100 vol% O ₂
Output:	0 to 5 vol% O ₂ to 0 to 100 vol% O ₂
Warm up time:	10 minutes (4 hours for stability)

Wiring between the detector and converter:

1. Separate conduits are required for the signal cable and heater cable.
2. Probe signal cable should be three pair twisted, with overall shield.
3. Probe heater cable should be one pair twisted, with overall shield.
4. The maximum distance between the detector and converter is 1500 feet using 16# AWG shielded wire; however, the electrical resistance of cable is less than 10 Ω of loop resistance.

Power Requirements: 110 (standard), 115, 220, 240 VAC (-15%, +10%) 50/60 Hz.

Power Consumption:

1. Approximately 80 VA during normal operation.
2. During start-up, maximum 270 VA are required.

SPECIFICATIONS

II. STANDARD CONVERTER, DETECTOR AND CALIBRATION UNITS

2.1 ZA8C CONVERTER

•External Dimensions

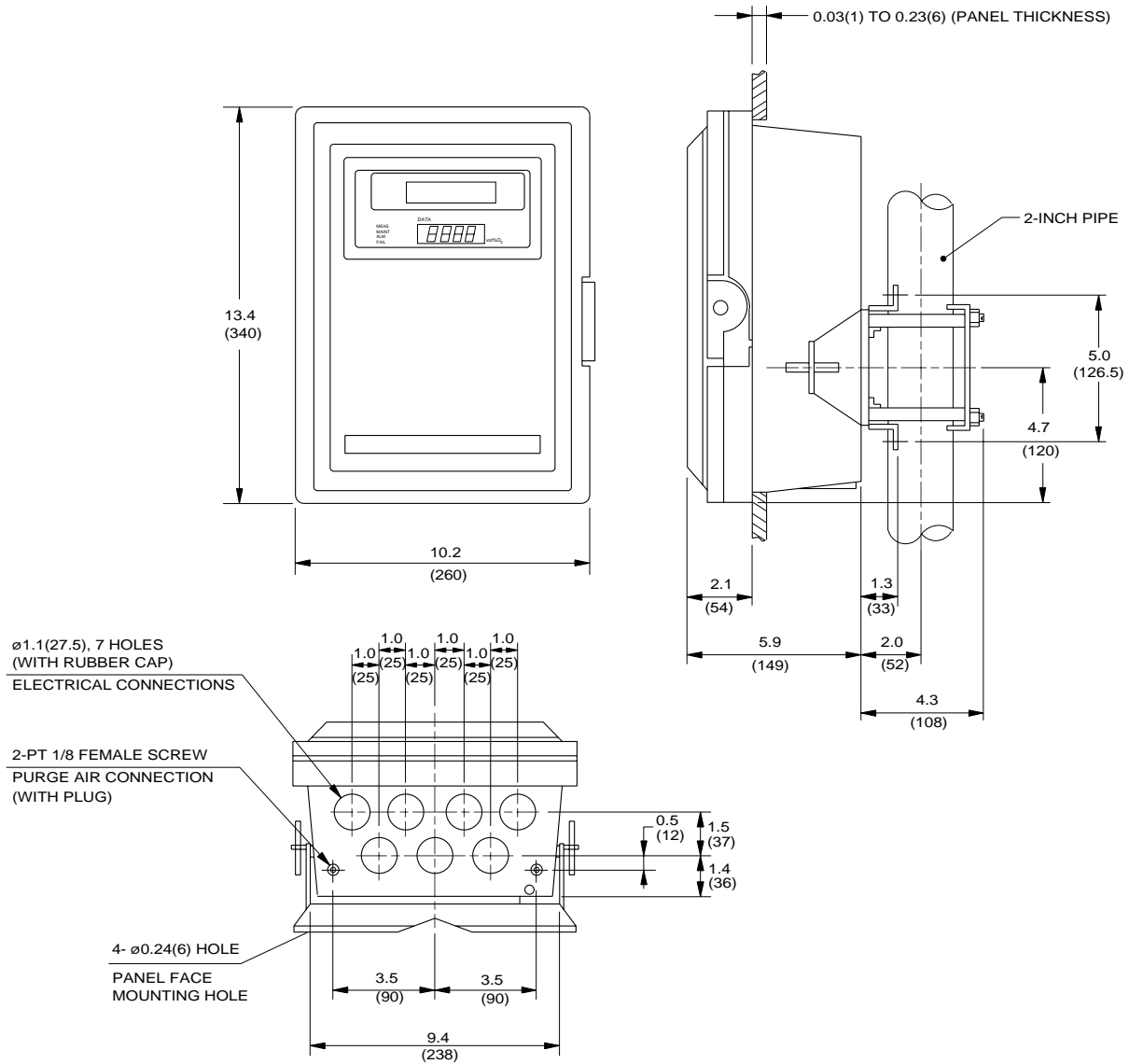


Figure 2: ZA8C

SPECIFICATIONS

•Standard Specifications

Construction:	Dust-proof, watertight (by sealing the wiring port) NEMA 4
Case Material:	Aluminum alloy
Coating:	Epoxy resin, baked finish
Color:	Mansell 2.5GY5.01/1.0 equivalent
Installation:	Attached to 2" pipe, wall or panel
Weight:	26 lbs
Ambient Temperature:	-4° to 131°F (-20° to 55°C)
Storage Temperature:	-4° to 140°F (-20° to 60°C)
Power Source:	110, 115, 220, or 240 VAC (-15%, +10%), 50/60 Hz
Display:	Dual Display - LCD and LED
Data display:	40 Dot Matrix LCD; 4 digit LED
Oxygen concentration:	0.0 to 100.0 vol% O ₂

Error Codes:

E--1	Cell failure
E--2	Cell temperature low
E--3	Cell temperature high
E--4	A/D failure
E--5	Calibration failure of the zero gas
E--6	Calibration failure of the span gas
E--7	Stabilizing time too short
E--8	ROM, RAM failure (No display) Digital circuit failure, or power disconnected

Status Display: The operational status is identified by backlit indicators as follows:

Operation Mode: GREEN pilot lamp is ON
MEAS (Measurement mode)
MAINT (Maintenance, data-setting mode)

Error Mode: RED pilot lamp is ON
ALM (Contact signal of upper or lower limit alarm is output.)
FAIL (An error was detected during the self-test.)

SPECIFICATIONS

Message Display:	Dot matrix LCD, 40 characters
Group A (1st level)	
A-0	Analog bar-graph, output range, preset alarm output value
A-1	Maximum and Minimum oxygen concentration within a specified time interval
A-2	Average oxygen concentration within a specified time interval
A-3	Cell emf in mV
A-4	Cell temperature in °F/°C, Thermocouple emf in mV
A-5	Output current in mA, Output range in vol% O ₂
A-6	Year, month, date, hour, minute
A-7	Air ratio
Group B (2nd level)	
B-0	History of the span calibration
B-1	History of the zero calibration
B-2	Cell response time in seconds
B-3	Cell internal resistance in ohms
B-4	Cell health status
B-5	Thermocouple cold junction temperature in °F/°C
B-6	Cell heater ON time
B-7	Dry oxygen concentration/Wet oxygen concentration
B-8	Exhaust gas temperature, combustion efficiency

NOTE: For Groups C through J, refer to Table 14 “Configurable Items and their Defaults”.

Analog Output:	1 output point
Range:	Two ranges can be specified, each within 0 to 5, 100 vol% O ₂ . (Range switching may be local or remote by contact input.)
Output:	4 to 20 mA or 0 to 20 mADC; Maximum load resistance: 550Ω; Input/Output isolated
Characteristic:	Linear or Log (0.1 to 5, 0.1 to 10, 0.1 to 25, or 0.1 to 100 vol% O ₂ range)
Contact Output:	Three output points
Contact capacity:	30 VDC 2A, 250 VAC 2A; Resistance load
Relay status:	Normally energized or normally de-energized can be programmed. (The contact status is selected with a jumper pin).

Application:

The following functions can be configured for contact outputs #1 to #3:

- Errors
- Entry in progress; Range switching instruction answer back; Warm-up in progress; Calibration in progress; Blow back initiated; Calibration gas pressure low; Abnormal process gas temperature
- O₂ Alarm Low-Low; Low; High-High; High

Relay output status (factory default configuration)

- Contact Output #1 - NC (Relay coil is normally energized)
- Contact Output #2 - NO (Relay coil is normally non-energized)
- Contact Output #3 - NO (Relay coil is normally non-energized)

SPECIFICATIONS

Digital Communication:

Serial communication using RS-232C or RS-422A (driver not included)

Communication Specifications (RS-232C or RS-422A):

<i>Transmission Items:</i>	Time, O ₂ concentration (wet and dry), cell emf, cell temperature, fail code, alarm code, status number, calibration coefficient, cell resistance, response time, cell life, measuring gas temperature, average oxygen concentration, average computing time, maximum and minimum oxygen concentration, output current and calibration start day/time.
<i>Communication:</i>	Start-stop system, Half duplex RS-232C two-wire system RS-422A four-wire, multi-drop system
<i>Communication Rate:</i>	9600, 4800, or 2400 bps may be selected
<i>Transmission:</i>	Transferable between No Procedure and Handshaking (No procedure is only for data transmission)
<i>Data Length:</i>	8 bits
<i>Parity:</i>	No
<i>Start Bit:</i>	1
<i>Stop Bit:</i>	1
<i>Comm. Code:</i>	ASCII
<i>Comm. Format:</i>	(Refer to section 7.4)

Analog Input Signal:

Temperature input: (1 point) 4-20 mA DC (Measurement range 0 to 3000 °F/°C)

NOTE: This input can be used for the boiler efficiency calculation as well as controlling an alarm output.

Contact Input:

Two points, Isolated

Input: Contact (Resistor) input or Voltage input

- 1) Contact (resistor) input
ON (maximum 220 W)
OFF (minimum 100 kW)
- 2) Voltage input
ON -1 to 1 VDC
OFF 4.5 to 25 VDC

Application:

One of the following can be specified:

- Calibration gas pressure low
- Range switching
- Calibration start command
- Process gas failure alarm (See Note)
- Blow back start command

NOTE: When process gas failure is specified, the alarm contact will cut off heater power.

SPECIFICATIONS

Self-Test

- Cell temperature low
- Cell temperature high
- A/D analog circuit failed
- Calibration value was incorrect
- ROM or RAM failed
- Digital circuit failed
- Power supply was switched OFF

Calibration:

Operation: One-touch calibration, Automatic, Semi-automatic

- 1) Automatic - All calibration procedures are executed according to the sequence specified.
- 2) Semi-automatic - Pressing the "Cal" key initiates the automatic calibration sequence.
- 3) One-touch calibration - Calibration gas flow and key operation are executed manually according to the message displayed.

Oxygen concentration of the calibration gas: 0.3 to 21 vol% O₂

Contact signal for the auto calibration unit:

One each NO contact for zero gas and span gas
Normally de-energized

Air purge:

Possible (Optional)

Piping connection:

1/8" NPT by 1/4" NPT

Air qualification:

Instrument air

Air consumption:

Approximately 2 SCFH at 5 psig

SPECIFICATIONS

•Model and Code for ZA8C Converter

SINGLE POINT ANALYZER	
ZA8C-S	MODEL NUMBER
APPROVAL	
-S	Standard - No approval
-E	CSA & CE Mark
POWER SUPPLY	
-3	220 VAC, 50/60 Hz
-4	240 VAC, 50/60 Hz
-4	100 VAC, 50/60 Hz
-8	115 VAC, 50/60 Hz
DIGITAL COMMUNICATIONS	
-N	Not required
-A	RS-232C (ZA8C-S only)
-B	RS-422A
DIGITAL INPUT	
-0	Not included
-1	Included
PROCESS TEMPERATURE INPUT	
-N	None
-A	4-20 mA (ZA8C-S only)
AUTO CALIBRATION	
0	Not included
-1	Included
LANGUAGE	
-J	Japanese
-E	English
-G	German
-F	French
STYLE	
*B	Style B
AIR PURGE FITTING SIZE	
/AP1	RC1/4 (F)
/AP2	1/4 NPT (F)
WATER TIGHT CABLE GLANDS	
/ECG	JIS A20 (7)
/PAT	Paper Tag
/SCT	Stainless Steel Tag (attached with wire)

SPECIFICATIONS

2.2 MC1 MANUAL CALIBRATION PLATE

The MC1 is the manual calibration unit for a single oxygen probe. It provides flowrate regulation of the reference air and cal gas, allowing the operator to easily interface with ZA8C commands during calibration. Separate flowmeters are used to set cal gas and reference air flowrates.

•External Dimensions

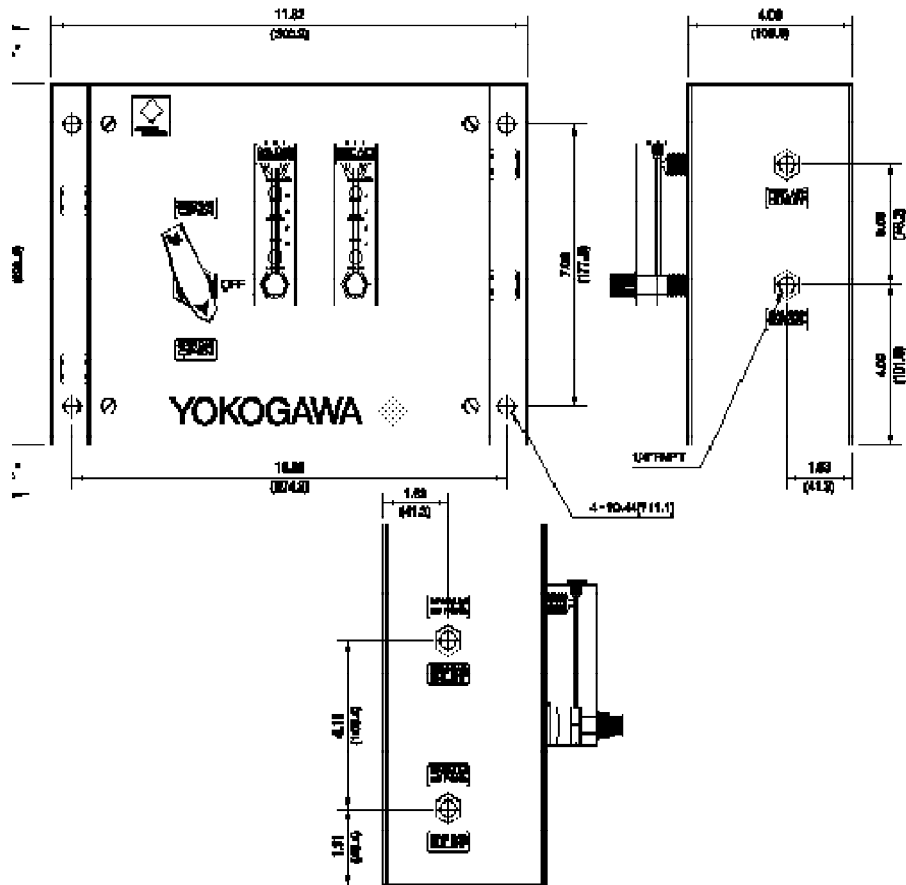


Figure 3: Manual Calibration Unit

SPECIFICATIONS

•Standard Specifications

Flowrates: Cal gas - 0.6 LPM (1.3 SCFH); Reference air - 0.8 LPM (1.7 SCFH)

NOTE: Exceeding recommended flowrates may damage the detector cell.

Maximum pressure: 35 psig

Cal plate: Stainless steel

Connection: 1/4" FNPT

Cal tubing: 1/4" copper (standard); 1/4" stainless steel (optional)

Weight: Approximately 4.4 lb (2 kg)

Ambient Temperature: 176°F (80°C) maximum

•Model and Code for MC1 Cal Unit

SINGLE CHANNEL O ₂ MANUAL CALIBRATION	
MC1	MODEL NUMBER
TUBING/FITTINGS	
-C	1/4" copper tubing and brass fittings
-S	1/4" stainless steel tubing and fittings
REFERENCE AIR FLOWMETER	
-R*U	Reference air flow meter

2.3 AC1 SINGLE POINT AUTOMATIC CALIBRATION

The AC1 Automatic Calibration System is designed to work with the ZA8C Oxygen Converter to provide accurate, automatic or semi-automatic calibration of the ZO21D oxygen detector. The solenoids of the AC1 are sequentially activated by internal contacts at the ZA8C converter. Calibration is achieved using instrument air and a compressed gas composed of oxygen balanced in Nitrogen (typically 1%). The AC1 unit controls the flow of calibration gases and reference air.

To simplify operation of your O₂ monitoring system, the AC1 comes fully assembled with plumbing, flow control hardware, and solenoid wiring for calibrating the oxygen probe. All the User need provide is plumbing to the ZO21D probe and plumbing of the gases to the AC1, along with regulators and interconnecting wiring between the AC1 and ZA8C. The AC1 requires 120 VAC.

The AC1 calibration unit is available with a choice of stainless steel fittings and tubing or brass fittings and copper tubing. Reference air flow control is a standard feature of the AC1, with separate flow indicators for cal gas and reference air. A clean, dry air source such as instrument air is used as both span gas and reference air. The AC1 enclosure is available in NEMA 4 or 4X rating.

Initial setup of the auto calibration unit is simplified by the use of manual overrides for all solenoids. The overrides allow for a quick balancing of the calibration gas, without the use of power.

SPECIFICATIONS

•EXTERNAL DIMENSIONS

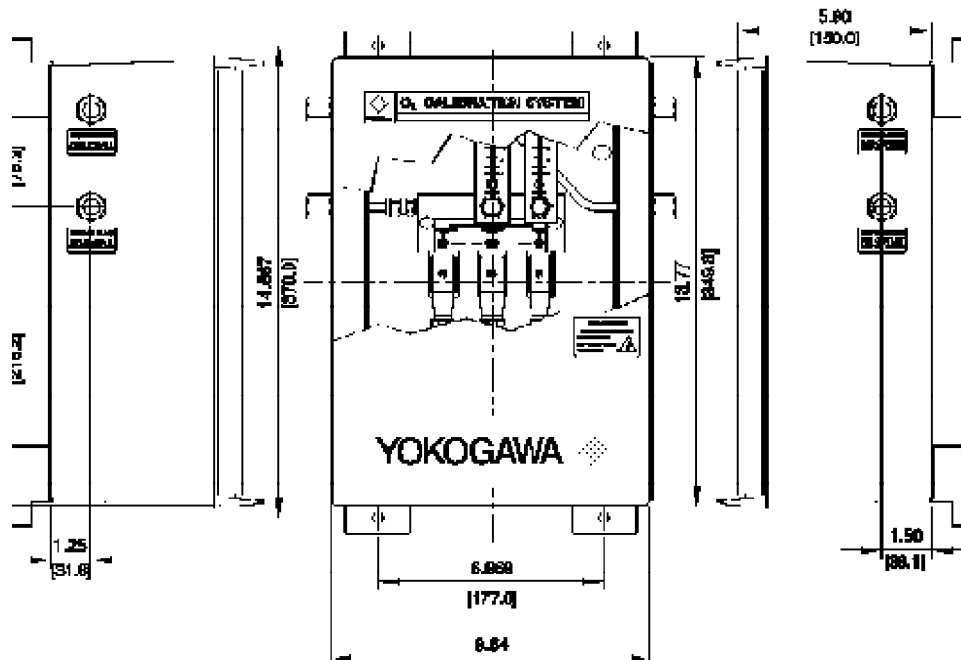


Figure 4: Auto Calibration Unit

Figure 4 shows the mounting dimensions for the unit. It should be located in an accessible spot as close to the oxygen probe as possible. Even though the enclosure is rated for NEMA 4 or 4X, it is advisable to keep the unit out of direct rain. All external tubing should be 1/4" stainless steel or copper. Connections to the unit are 1/4" FNPT.

•Standard Specifications

Operating pressure:	up to 35 PSI
Maximum pressure:	50 PSI
Flowmeter range:	0.15 to 1 LPM (separate flowmeter for cal gas and reference air)
Flowrate:	Cal Gas - 0.6 LPM; Reference Air - 0.8 LPM
Cal tubing:	1/4" copper (standard); 1/4" stainless steel (optional)
Gas connection:	1/4" FNPT
Voltage:	110 VAC, 50/60 Hz (standard)
Ambient Temperature:	176°F (80°C) maximum

SPECIFICATIONS

•Model and Code for AC1 Auto-Cal Unit

SINGLE CHANNEL O ₂ AUTO CALIBRATION	
AC1	MODEL NUMBER
ENCLOSURE	
-4	NEMA 4, metal enclosure
-5	NEMA 4X, fiberglass enclosure
TUBING/FITTINGS	
-C	1/4" copper tubing and brass fittings
-S	1/4" stainless steel tubing and fittings
REFERENCE AIR FLOWMETER	
-R*U	Reference air flow meter

SPECIFICATIONS

2.4 ZO21D-L STANDARD DETECTOR

The ZO21D-L general purpose low temperature detector is a direct insertion (in-situ) type oxygen detector used to continuously monitor the oxygen concentration of combustion gas. A zirconia cell maintained by an internal heater at 1382°F (750°C) is the measuring sensor. Detector options include a check valve, flame arrester (for FM approval), derakane coating and quick disconnect cabling.

•External Dimensions

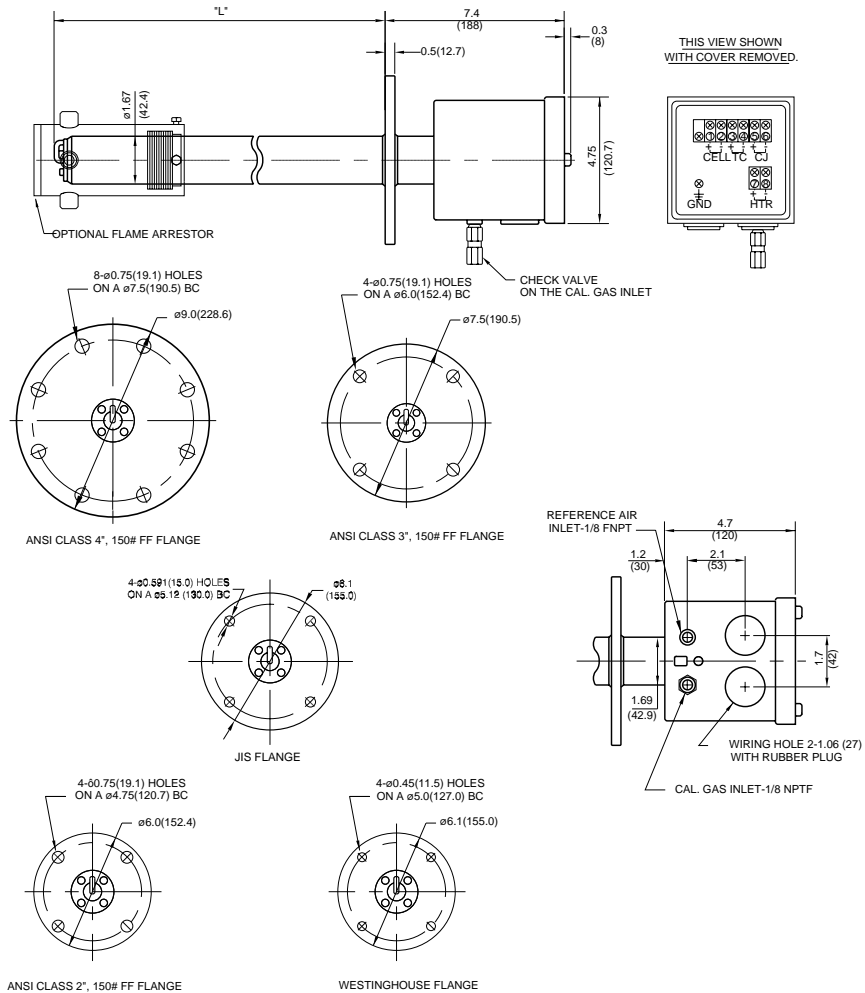
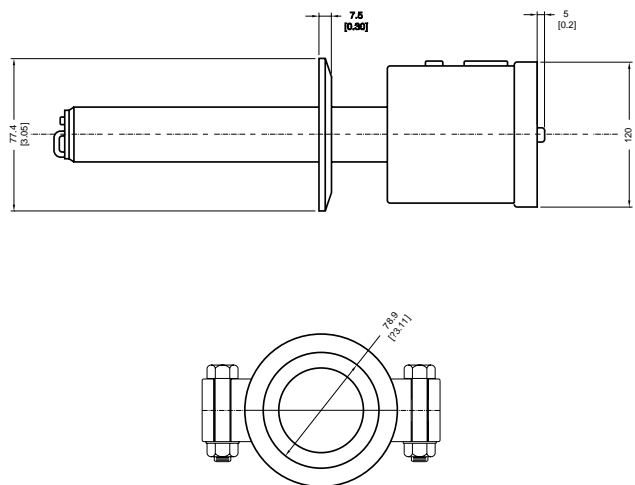


Figure 5: Standard Detector

SPECIFICATIONS



ZO21D WITH TRI-CLAMP FITTING

Figure 6: ZO21D Detector w/Tri-Clamp

•Standard Specifications

Type:

General Purpose, direct insertion, water resistant

Lengths:

(1.3, 1.5, 2.1, 2.5, 3.3, 5.0, 6.6, 8.0, 10.0, 12.0, 14.0, 16.0 and 18.0 feet). Custom lengths are also available from the factory.

Weight (shipping):

Insertion Length (L)	Approx. Weight
1.3 ft (0.4 m)	7.7 lb (3.5 kg)
1.5 ft (0.46 m)	8.0 lb (3.8 kg)
2.1 ft (0.6 m)	9.2 lb (4.2 kg)
2.5 ft (0.8 m)	10.0 lb (4.6 kg)
3.3 ft (1.0 m)	15.0 lb (7.0 kg)
5.0 ft (1.5 m)	22.0 lb (10.0 kg)
6.6 ft (2.0 m)	29.0 lb (13.0 kg)
10.0 ft (3.0 m)	35.0 lb (16.0 kg)
12.0 ft (3.6 m)	48.0 lb (22.0 kg)
14.0 ft (4.2 m)	56.0 lb (25.5 kg)
16.0 ft (4.8 m)	64.0 lb (29.0 kg)
18.0 ft (5.4 m)	72.0 lb (33.0 kg)

Table 1: Approximate Weight of ZO21D detector w/4", 150# ANSI flange

SPECIFICATIONS

Material:	Terminal Box - 304SS Probe - 316SS Probe Flange - 304SS Zirconium Oxide Sensor
Installation:	Flange Mounting Flange specs: 4" ANSI, Class 150# FF reduced bulk 3" ANSI, Class 150# FF reduced bulk 2" ANSI, Class 150# FF reduced bulk 2½" Tri-Clover Westinghouse flange
NOTE: Custom flanges are available upon request.	
Mounting angle:	The probe may be mounted vertically with cell end down or any angle to horizontal. A probe support (or protector) is required for all probes longer than two meters.
Reference air and Calibration gas inlets:	1/8" NPT female
Cable inlet:	27 mm (2 locations)
Ambient temperature:	14° to 176°F (-10° to 80°C)
Sample temperature:	0° to 1230°F (0° to 700°C)
Sample gas pressure:	±0.7 psig (±500 mm H ₂ O)

SPECIFICATIONS

•Model and Code

LOW TEMPERATURE DETECTOR		
ZO21D-L	General Purpose	
ZO21D-E	CE Mark	
INSERTION LENGTH ¹		
-040	0.40 m (1.3', 15.6")	
-046	0.46 m (1.5', 18")	ZO21D-L only
-064	0.64 m (2.1', 25")	ZO21D-L only
-076	0.76 m (2.5', 30")	ZO21D-L only
-100	1.0 m (3.3')	
-150	1.5 m (5.0')	
-200	2.0 m (6.6')	
-245	2.45 m (8.0')	ZO21D-L only
-300	3.0 m (10.0')	
-360	3.6 m (12.0')	<i>These detector lengths</i> ZO21D-L only
-420	4.2 m (14.0')	<i>These detector lengths</i> ZO21D-L only
-480	4.8 m (16.0')	<i>These detector lengths</i> ZO21D-L only
-540	5.4 m (18.0')	ZO21D-L only
FLANGE MOUNTING ^{3, 6}		
-A*U	ANSI 4", 150# FF flange ⁵	
-B*U	ANSI 3", 150# FF flange	ZO21D-L only
-C*U	ANSI 2", 150# FF flange	ZO21D-L only
-J*U	JIS 5K, 65A FF flange	
-T*U	2½" Tri-clamp flange	ZO21D-L only
-W*U	Westinghouse flange	ZO21D-L only
OPTIONS (can select more than one)		
/A	Quick disconnects (male portion)	
/C	Check Valve (M1132KN)	
/D	Derakane coating ⁴	
/F	Flame arrester 2	
/PAT	Paper Tag (attached with wire)	
/SCT	Stainless Steel Tag (attached with wire)	
/T	Welded NPT Collar without Flame arrester	

NOTES:

- 1) For special Detector lengths and flanges contact Yokogawa Corporation of America.
- 2) The Filter Assemblies (E7042UQ and M1100DA or DA-2) are not compatible with, nor required when the flame arrester option is selected. The flame arrester includes its own filter. Replacement part number for flame arrester filter is E7042VG. Filter assemblies and/or flame arrester option will not fit through a 2", ANSI mounting flange (-C*U) or 2½" Tri-clamp (-T*U).
- 3) The (*U) portion of the part number indicates that the detector is made in the United States at Yokogawa Corporation of America, Norman, Georgia.
- 4) Derakane coating is recommended for any application up to 390° F (200° C) where elements corrosive to the detector may be present, such as those found in chemical incinerators.
- 5) The 4" ANSI Flange (-A*U) is suggested for probe lengths 2 m or greater.
- 6) Detector lengths greater than 10.0 ft (3.0 m) use a RF flange instead of a FF flange.
- 7) Only available with -040 and -100 lengths.

SPECIFICATIONS

2.5 ZO21D-H HIGH TEMPERATURE DETECTOR WITH ZO21P-H ADAPTER

The high temperature detector is a general purpose probe utilized in conjunction with a high temperature adapter tee (ZO21P) in applications with temperatures ranging between 1200°F and 3400°F . The detector is mounted to an adapter reducing the heat of the process gas through conduction. Probe options include derakane coating, flame arrester (for FM approval), and quick disconnect wiring.

•External Dimensions

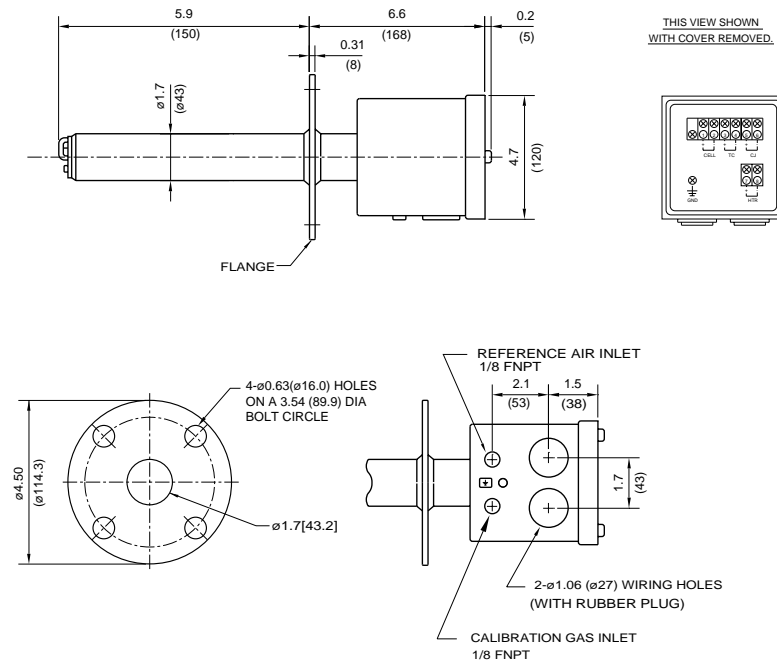
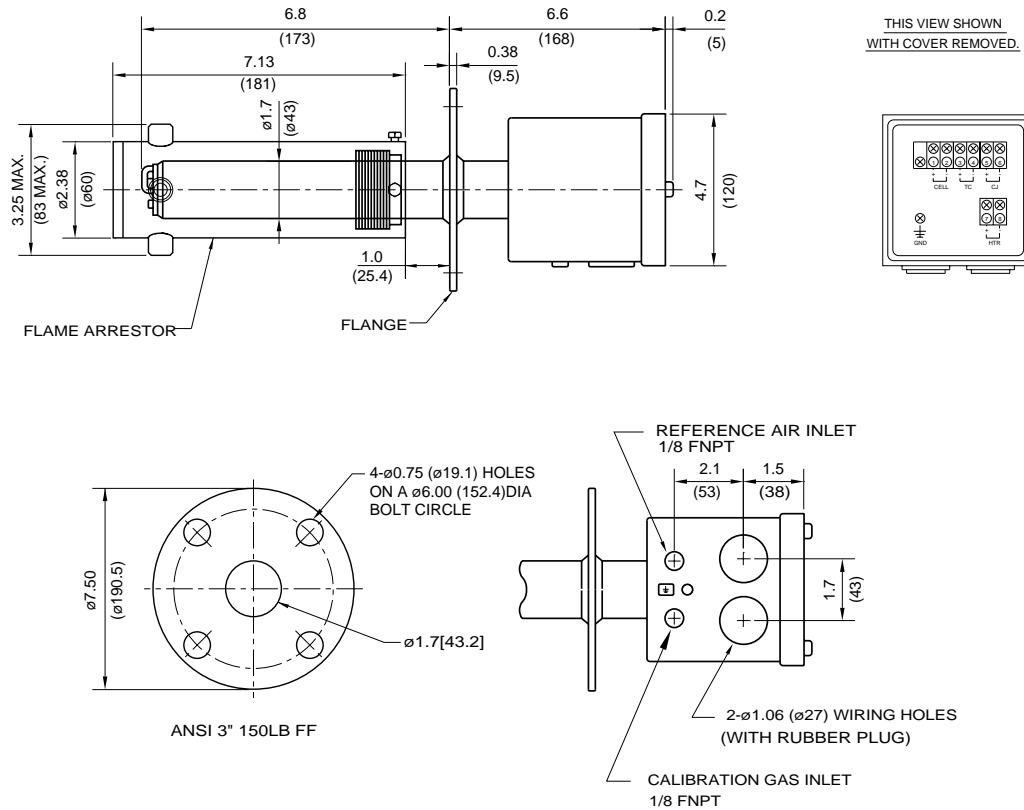


Figure 7: ZO21D-H-015-K-U
High Temperature detector with 150# JIS flange and junction box

SPECIFICATIONS



**Figure 8: ZO21D-H-017-L*U/F
High Temperature Detector with Junction Box and flange**

•Standard Specifications

Type: General Purpose, Water-vapor Resistant

Material: Terminal Box- 304SS
Probe - 316SS
Flange - 304SS
Zirconium Oxide Sensor

Weight: 7 lbs (3.2 kgs); /F option - add 8 lbs (3.6 kgs)

Installation: Flange mounting with the high temperature probe adapter any angle from vertical to horizontal.

Reference air and Calibration gas inlet: 1/8" NPT female fittings

Cable inlet: Two holes of 27 mm

SPECIFICATIONS

- Ambient Temperature:** 14° to 302°F (-10° to 150°C)
- Sample Gas Temp:** 32° to 1230°F (0° to 700°C) when no adapter is used and 32° to 3600°F (0° to 1400°C) when probe adapter is used.
- Sample Gas Pressure:** ±0.7 psi (±500 mm H₂O)
- Optional Quick Disconnects:** (Refer to sections 2.7.6 and 2.7.7)

•**Model and Code**

HIGH TEMPERATURE DETECTOR	
MODEL NUMBER	DESCRIPTION
ZO21D-H-015-K*U	High temperature detector includes a JIS5K32A flange
ZO21D-H-017-K*U	High temperature detector for flame arrester Includes a 3" ANSI flange ¹
ZO21D-F-015-K*U	CE Mark
OPTIONS (can select more than one)	
/A	Quick disconnects (male portion) (not available on ZO21D-F)
/C	Check Valve (M1132KF)
/D	Derakane coating ²
/F	Flame arrester (ZO21D-H-017 only) ¹
/SCT	Stainless Steel Tag (attached with wire)
/PAT	Paper Tag (attached with wire)
/T	Welded NPT Collar without Flame Arrester ¹

NOTES:

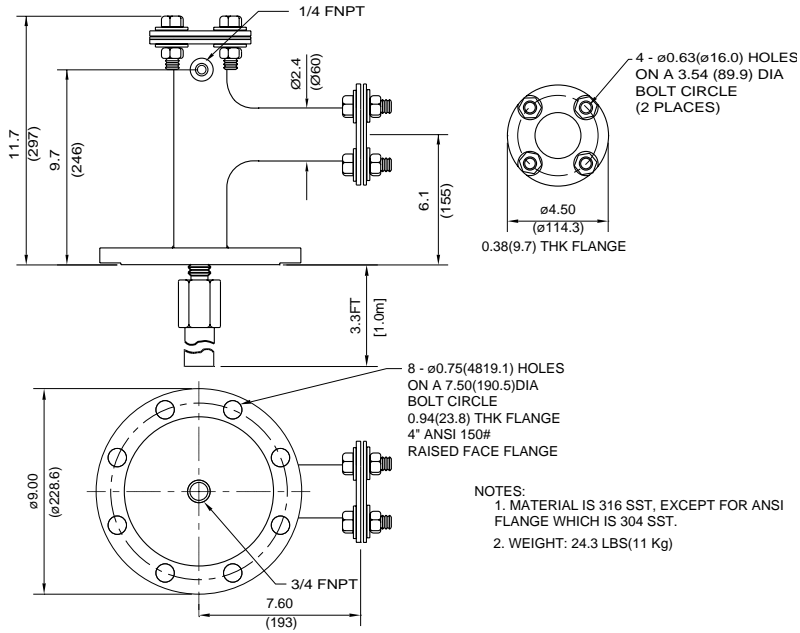
- 1) /F VERSION - Order ZO21D-H-017-L*U/F for probe with preattached flame arrester. Probe adapter ZO21P-F is used with flame arrester option. /T on a probe includes the mounting threads without the flame arrester. DO NOT SPECIFY /T/F.
- 2) **/D DERAKANE COATING** - Used for corrosive applications. Cannot be used if the tee temperature is maintained above 390° F (200° C).

2.5.1 ZO21P Adapter for the High Temperature Probe

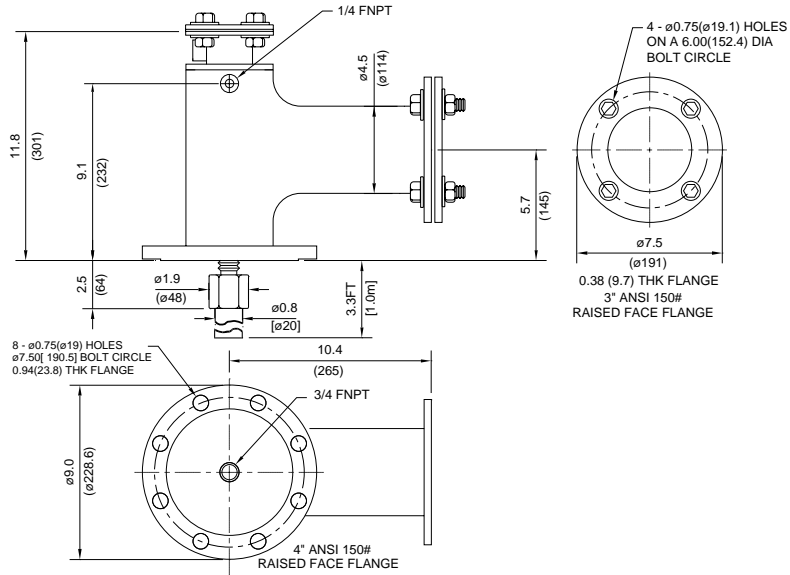
The probe adapter is used to reduce the sample gas temperature below 1230°F (700°C) before it is measured by the detector. The adapter tee cools the process gas through conduction, preventing overheating of the cell. A transport tube and eductor assembly provide the extraction of the process gas in negative pressure applications. A heated eductor option helps prevent condensation from forming in the ejector assembly. See Table 2 for the transport tube material and insertion lengths. In applications prone to blockage, an optional manual "Blow Back" system is used. Instrument air is blown through the transport tube, removing possible obstructions. Refer to IM 11M6Z2-YIA for details regarding the "Blow Back" system.

SPECIFICATIONS

•External Dimensions



**Figure 9: ZO21P-H
High Temperature Adapter Tee**



**Figure 10: ZO21P-F
High Temperature Adapter for the Flame Arrester**

SPECIFICATIONS

•Standard Specifications

Insertion length:	Refer to Table 1, "Material reference chart for transport tube"
Materials:	Adapter = 316 Stainless Steel Flange = 304 Stainless Steel Transport Tube = See Table 1
Weight:	24 lbs; /F option - add 5 lbs; /BE option - add 5 lbs; /BH option - add 5 lbs; /B option - add 2 lbs
Installation:	Flange mounting
Flange specifications:	4" ANSI CLASS 150# RF flange
Mounting Angle:	Vertical (can also be attached horizontally if the probe material is 310SS)
Sample Gas Exhaust:	NPT 1/4" female
Process Temperature:	32° to 3000°F (0° to 1650°C) for Exalloy transport tube
Operation Pressure:	±0.7 psi (±500 mm H ₂ O) (Eductor is required for negative pressure)

Material	Length (L)	Part Number	Max. Temperature	Weight	Tube Diameter O.D.
Silicon Carbide	0.3 m (1.0 ft)	E7046AL-J01	2600°F (1427°C)	2 lb (0.9 kg)	1.3 in.
Silicon Carbide	0.5 m (1.5 ft)	E7046AL-J02	2600°F (1427°C)	2.4 lb (1.0 kg)	1.3 in.
Silicon Carbide	1.0 m (3.3 ft)	E7046AL-J03	2600°F (1427°C)	5 lb (2.3 kg)	1.3 in.
Silicon Carbide	1.5 m (5.0 ft)	E7046AL-J04	2600°F (1427°C)	7 lb (3.2 kg)	1.3 in.
310 S Stainless Steel	0.3 m (1.0 ft)	E7046AP-J01	1980°F (1082°C)	1.5 lb (0.7 kg)	1.1 in.
310 S Stainless Steel	0.5 m (1.5 ft)	E7046AP-J02	1980°F (1082°C)	2.2 lb (1.0 kg)	1.1 in.
310 S Stainless Steel	1.0 m (3.3 ft)	E7046AP-J03	1980°F (1082°C)	6 lb (2.7 kg)	1.1 in.
310 S Stainless Steel	1.5 m (5.0 ft)	E7046AP-J04	1980°F (1082°C)	8 lb (3.6 kg)	1.1 in.
310 S Stainless Steel	3.0 m (9.8 ft)	E7046AP-J05	1980°F (1082°C)	12.6 lb (5.7 kg)	1.1 in.
Alumina	0.3 m (1.0 ft)	M1132ZA-01	3400°F (1871°C)	1.2 lb (0.5 kg)	0.8 in.
Alumina	0.5 m (1.5 ft)	M1132ZA-02	3400°F (1871°C)	2 lb (0.9 kg)	0.8 in.
Alumina	1.0 m (3.3 ft)	M1132ZA-03	3400°F (1871°C)	5 lb (2.3 kg)	0.8 in.
Alumina	1.5 m (5.0 ft)	M1132ZA-04	3400°F (1871°C)	7 lb (3.2 kg)	0.8 in.
HR160	0.3 m (1.0 ft)	M1132XA-01	2000°F (1100°C)	1.6 lb (0.7 kg)	1.1 in.
HR160	0.5 m (1.5 ft)	M1132XA-02	2000°F (1100°C)	2.2 lb (1.0 kg)	1.1 in.
HR160	1.0 m (3.3 ft)	M1132XA-03	2000°F (1100°C)	6 lb (2.7 kg)	1.1 in.
HR160	1.5 m (5.0 ft)	M1132XA-04	2000°F (1100°C)	8 lb (3.6 kg)	1.1 in.
HR160	3.0 m (9.8 ft)	M1132XA-05	2000°F (1100°C)	12.6 lb (5.7 kg)	1.1 in.
Exalloy Ceramic	0.3 m (1.0 ft)	M1233KA-01	3000°F (1650°C)	1.5 lb (0.7 kg)	1.3 in.
Exalloy Ceramic	0.5 m (1.5 ft)	M1233KA-02	3000°F (1650°C)	1.9 lb (0.8 kg)	1.3 in.
Exalloy Ceramic	1.0 m (3.3 ft)	M1233KA-03	3000°F (1650°C)	3 lb (1.4 kg)	1.3 in.
Exalloy Ceramic	1.5 m (5.0 ft)	M1233KA-04	3000°F (1650°C)	4.4 lb (2.0 kg)	1.3 in.
Exalloy Ceramic	3.0 m (9.8 ft)	M1233KA-05	3000°F (1650°C)	7.8 lb (3.5 kg)	1.3 in.

Table 2: Material Reference Chart for Transport Tubes

SPECIFICATIONS

•Model and Code

HIGH TEMPERATURE PROBE ADAPTER	
ZO21P	MODEL NUMBER
TEE CONFIGURATION¹	
-H	Basic design (side eductor port)
-T	Basic design (bottom port)
-S	Split design (for blow back)
-F	Oversized design (for flame arrester, includes studs)
-C	All Hastelloy C (configured as -T only)
TRANSPORT TUBE MATERIAL	
-A	Silicon Carbide (SiC) (Up to 2600°F/1427°C)
-B	310 Stainless Steel (Up to 1980°F/1082°C)
-C	Alumina Ceramic (Up to 3400°F/1871°C)
-H	HR160 Stainless Steel (Up to 2000°F/1100°C)
-X	Exalloy Ceramic (Up to 3000°F/1650°C)
-N	NO TRANSPORT TUBE
INSERTION LENGTH	
-033	0.3 m (13")
-050	0.5 m (20")
-100	1.0 m (3.3')
-150	1.5 m (5.0')
-300	3.0 m (9.8') (not for -A or -C tubes)
-NNN	NO TRANSPORT TUBE
FLANGE CONNECTION	
-A*U	ANSI 4", 150# RF
OPTIONS (may select one from each group)	
Options Heater System	
/HT	Aux heater system (to 600° F) [includes controller and heaters]
Blowback Block Valve (for ZO21P-S)	
/AV	Automatic valve
/MV	Manual valve
Eductor	
/BE	Wrapped air eductor pre-attached w ith regulator and gauge (for ZO21P-H w ithout /HT only)
/ER	Air ejector w /return exhaust pre-attached w ith regulator and gauge (for ZO21P-H or ZO21P-S only)
/SE	Separate air ejector, regulator and gauge (not preattached)
/WE	Self-cleaning w ater ejector (regulator and gauge not included)
Tag	
/SCT	Stainless Steel Tag (attached w ith w ire)
/PAT	Paper Tag (attached w ith w ire)

NOTES:

1) The -H option is the standard tee. T-educator port is mounted on the side - (180° from the probe.) -S is designed for applications that require blow back to keep the transport tube clean. It must have a valve installed (1" NPT, full port, high temp). Customer must specify option /MV or /AV. -F is an oversized tee for applications requiring a flamer arrester.

SPECIFICATIONS

2.5.2 Temperature Controller (/HT)

Controller is installed in NEMA 4X enclosure, and is preconfigured with a setpoint value of 600°F with 700°F alarm.

•Standard Specifications

Supply Voltage:	85 to 264 VAC; 50/60 Hz; Rating: 100 to 240 VAC
Thermocouple:	Type J included, preset @ 600°F (316°C) setpoint
Power Consumption:	Less than 17 VA for standard AC type.
Operating environment:	30° to 122°F (0° to 50°C); 45 to 85% RH
Control:	Preset for PD control.
Alarm:	Heater break alarm preset at 700°F (371°F)
Net Weight:	6 oz (0.17 kg)
Certification:	UL recognized; CSA listing.

2.5.3 Water Eductor (option /WE)

Used as the pumping mechanism for obtaining a sample from the process, water is used to create a vacuum, thereby directing the sample through the adapter tee.

•Standard Specifications

Water Pressure:	20 PSI minimum
Water Consumption:	2.5 GPM
Water Vacuum Flow:	.56 GPM
Air Vacuum Flow:	.08 SCFM
Vacuum Force:	29" Hg
Material:	Anodized Aluminum
Weight:	6 oz

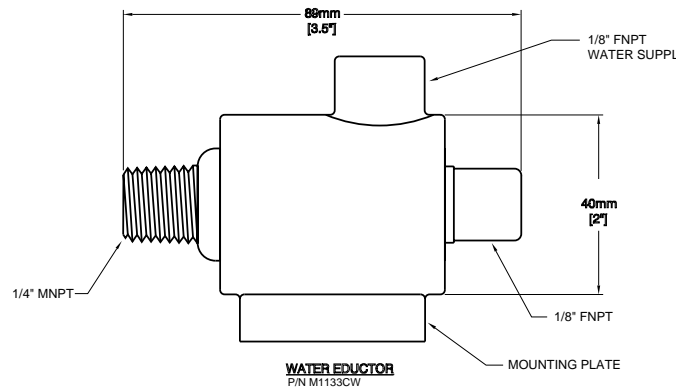


Figure 11: Water Eductor Ejector Assembly

SPECIFICATIONS

2.5.4 Auxiliary Ejector Assembly for High Temperature Use (M1132KE)

High temperature applications require the use of the auxiliary ejector assembly in negative pressure installations. Using instrument air, the auxiliary ejector draws a sample through the adapter tee without mechanical assistance. The assembly includes an ejector, regulator and pressure gauge and is included in the heated eductor (/BE option) for the ZO21P high temperature adapter tee.

•External Dimensions

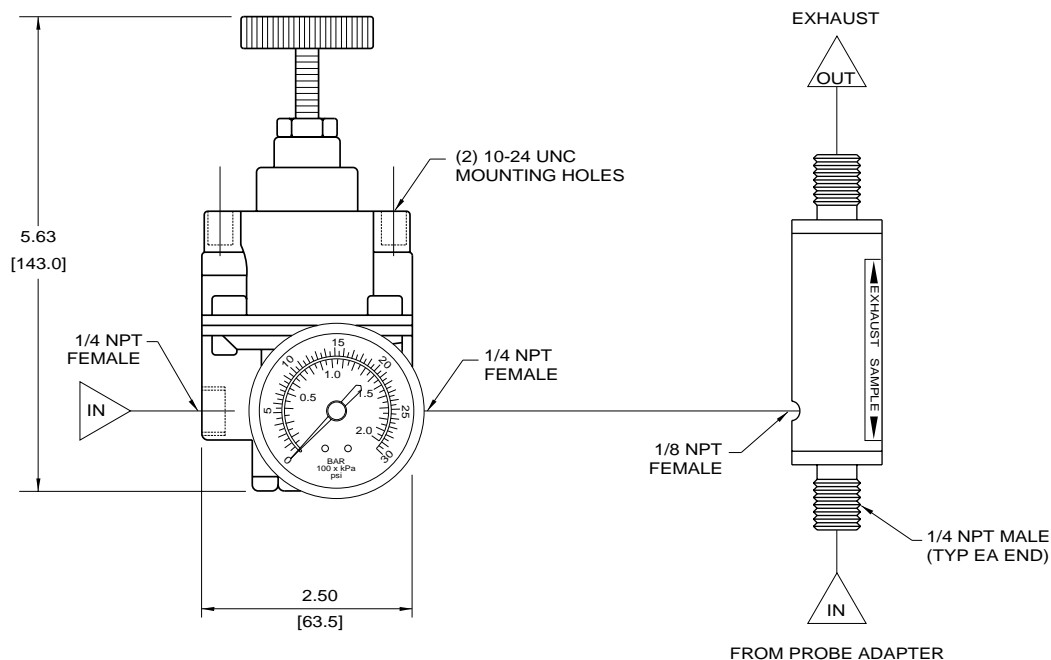


Figure 12: Auxiliary Ejector Assembly

•Standard Specifications

Ejector (M1132KA):

Material:	316SS
Air Supply:	1/8" NPT female
Air Consumption:	1.7 SCFM
Exhaust:	1/4" NPT male straight
Vacuum Force:	7.6" Hg
Vacuum Flow:	2.4 SCFM
Air Consumption:	1.7 SCFM
Weight:	6 oz. (170 kg)

SPECIFICATIONS

Vacuum:	1/4" NPT male
Connection to high-temp probe adapter:	1/4" NPT
Piping Connection:	1/4" NPT female
Connection tube:	1/4" stainless pipe

Pressure Gauge (M1132CG):

Indicates the pressure of instrument air flowing into the eductor.

Gauge Size:	2"
Measuring Range:	0 to 60 psi
Piping Connection:	1/4" NPT male
Scaling:	0 to 30 psig (0 to 2 bar)
Ambient Temperature:	140°F (40°C) at maximum

Pressure Regulator (M1132KD):

This general purpose regulator is used to adjust the flow of instrument air entering the ejector. Made of durable materials and corrosion resistant construction, it provides reliable operation in harsh industrial environments.

Flow Capacity:	20 SCFM (33.6 m ³ /hr) at 100 psig (700 kPa) supply - 20 psig (140 kPa) outlet.
Exhaust Capacity:	0.1 SCFM (0.17 m ³ /hr) - downstream pressure 5 psig (35 kPa) above setpoint.
Sensitivity:	1" H ₂ O (25.4 mm)
Effect of Supply Pressure variation:	Less than 0.2 psig (1.4 kPa) for 25 psi (170 kPa) change
Maximum Supply Pressure:	250 psig (1700 kPa)
Air Consumption:	Less than 6 SCFH (0.17 m ³ /hr)
Output Range:	0 to 60 psi (0-400 kPa)
Port Size:	1/4" NPT
Materials:	Body - Die cast aluminum alloy; Diaphragm - Nitrile elastomer and nylon fabric; Trim - Brass, zinc plated steel, acetal.
Weight:	4.0 lbs (1.8 kgs)

SPECIFICATIONS

2.6 ZO21DW PRESSURE COMPENSATING OXYGEN DETECTOR

The ZO21DW is a pressure compensating type oxygen detector used in applications with positive pressures exceeding 0.7 PSIG (500 mm H₂O). Because the zirconia cell measures the ratio of the oxygen partial pressures between the measuring and reference sides of the zirconia cell, uncompensated positive pressure differences exceeding 0.7 PSIG (500 mm H₂O) may create errors with the standard oxygen detectors (ZO21D-L and ZO21D-H). Compensation is accomplished via a specially designed reference system using dry instrument air (see Note below). Options include flame arrester, check valve, and derakane coating.

Note: User must supply a pressure compensated reference air system with any ZO21DW detector. **The ZO21DW is not used in NEGATIVE Pressure Applications.**

•External Dimensions

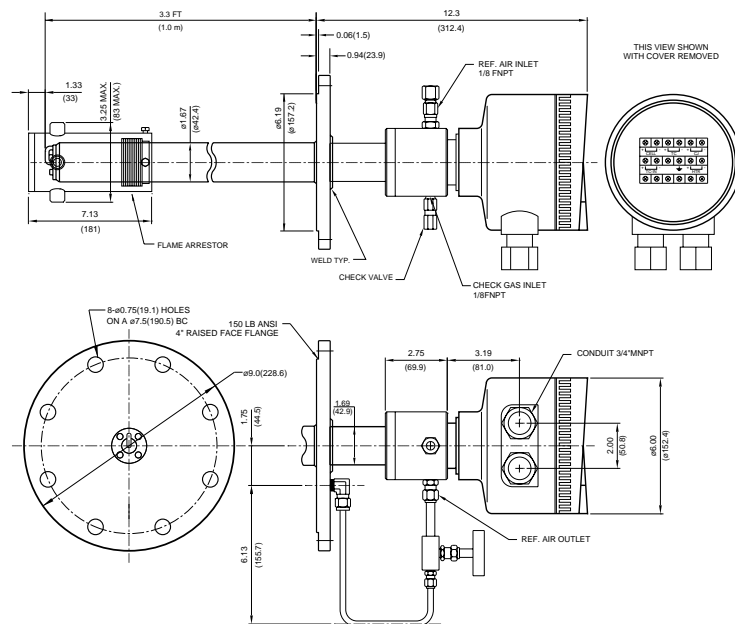


Figure 13: Pressure Compensating Oxygen Detector

•Standard Specifications

Sample Gas Temperature:	32° to 1112°F (0° to 600°C)
Sample Gas Pressure:	Maximum duct pressure, 35 PSIG (24,607 mm H ₂ O) (Not recommended for negative gas pressures)
Reference Gas Flowrate:	0.6 LPM (1.3 SCFH)

SPECIFICATIONS

Insertion Length and Weight:

Length (L)	Weight
1.3 ft (0.4 m)	14 lb (6.5 kg)
3.3 ft (1.0 m)	22 lb (10 kg)
5.0 ft (1.5 m)	29 lb (13 kg)
6.6 ft (2.0 m)	37 lb (17 kg)
10 ft (3.0 m)	44 lb (20 kg)
12 ft (3.6 m)	52 lb (23.5 kg)

Table 3: Probe lengths and weights for ZO21DW

- Ambient Temperature:** 14° to 176°F (-10° to 80°C)
- Material in Contact with Gas:** Terminal box: Aluminum casting; probe: 316SS; flange: 304SS; sensor: Zirconia
- Construction:** Water-resistant, direct insertion
- Installation:** Flange Mounted, ANSI Class 4", 150# RF Flange
- Flange Connection:** 1/8" FNPT Fitting with NPSM 3/4" Conduit Fitting.
- Probe Mounting Angle:** Vertically with cell end down or horizontally, or at an angle in between. When probe length is greater than 2.0 m, use a probe support or probe protector (see Accessories).
- Wiring:** For description, refer to Accessories.

•Model and Code

PRESSURE COMPENSATING (Low Temperature)	
ZO21DW-L	MODEL NUMBER
INSERTION LENGTH ¹	
-040	0.40 m (1.3', 15.6")
-100	1.0 m (3.3')
-150	1.5 m (5.0')
-200	2.0 m (6.6')
-300	3.0 m (10.0')
-360	3.6 m (12.0')
FLANGE CONNECTION	
-A*A	ANSI 4", 150# RF flange
FLANGE CONNECTION	
-NPT	1/8" FNPT fitting w ith NPSM 3/4" conduit fitting
OPTIONS (can select more than one)	
/C	Check Valve (required)
/D	Derakane coating ¹
/F	Flame Arrestor
/SCT	Stainless Steel Tag (attached w ith w ire)
/PAT	Paper Tag (attached w ith w ire)
/T	Welded NPT Collar w ithout flame arrester

NOTES:

1) Derakane coating is recommended for applications up to 390° F (200° C) where elements corrosive to the detector may be present. Such as those found in chemical incinerators.

SPECIFICATIONS

2.6.1 ZO21DW Reference Air System, Model ZA8R

The model ZA8R is a dual calibration unit that in addition to performing automatic calibration, also provides pressure compensation for the model ZO21DW pressure compensating detector. Optionally, instrument air may be used to provide Safety Blowback. Consult factory for more detailed information.

•Standard Specifications

Calibration Air:	Clean dry instrument grade air
Flowmeter Range:	0.15 to 1 LPM
Flowrate:	Cal Gas - 0.6 LPM (1.3 SCFH) Reference Air - 0.8 LMP (1.7 SCFH)
Operating Pressure:	Pressure setting for Cal Gas and Reference Air is approximately 14 PSIG above wind box pressure.
Maximum pressure:	35 PSIG
Operating pressure:	0.7 to 35 PSIG
Gas connection:	1/4" FNPT
Voltage:	110 VAC, 50/60 Hz (standard) 220 VAC, 50/60 Hz (optional)
Ambient Temperature:	14° to 176°F (-10° to 80°C)

2.7 ACCESSORIES

Accessory	Description	ZO21D-L	ZO21D-H
Probe Protector	ZO21R	X	
Probe Support	ZO21V	X	
Low Temp Sintered SS Filter	M1100DA (to 500°F)	X	
Hastelloy X Filter	M1100DA-2 (to 1250°F)	X	
Ceramic Filter & Dust Guard	E7042UQ (UU)	X	X
Check Valve	M1132KN (/C option on probe)	X	X
Flame Arrestor	E7042VP (/F option on probe)	X	X
Derakane Coating	(/D option on probe)	X	X
Zirconia Cell Assembly	E7042UD	X	X

Table 4: Accessories

SPECIFICATIONS

2.7.1 ZO21R Probe Protector

A probe protector is required for most coal fired boilers, lime kilns, cement kilns and incinerators where the abrasive particles in the flue gas may erode the wall of the oxygen detector. Probe protectors may only be used in conjunction with the ZO21D-L.

•External Dimensions

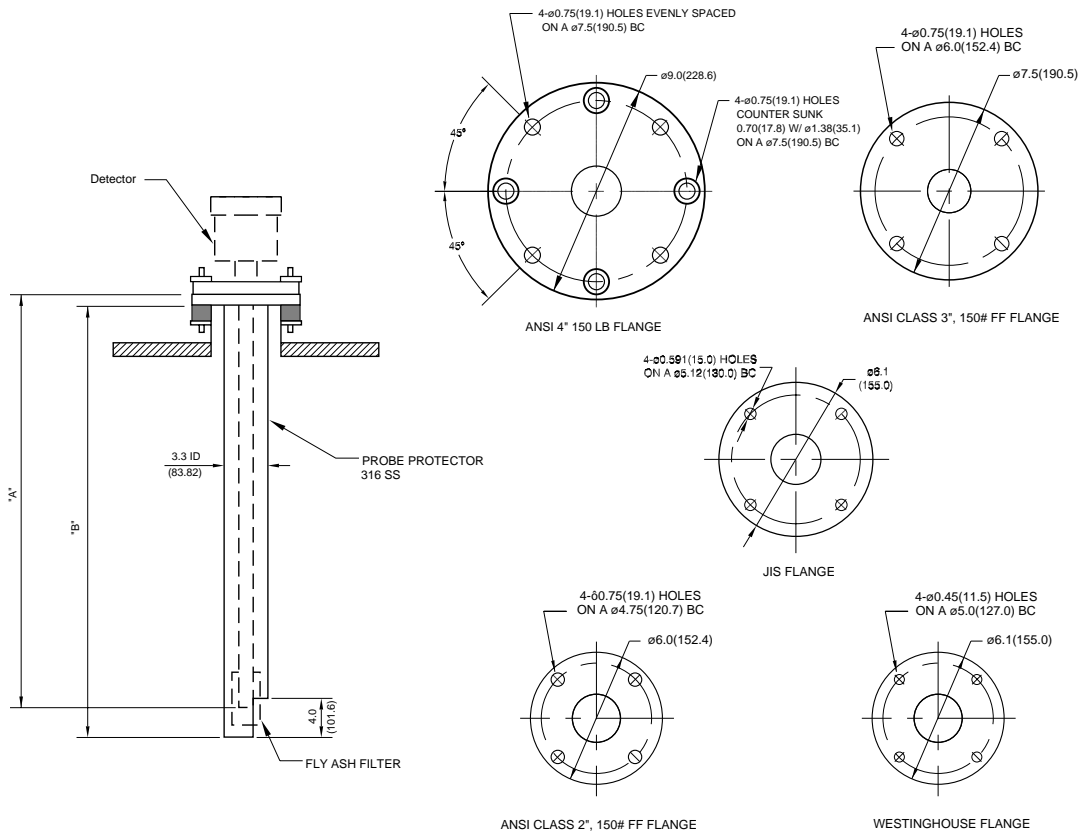


Figure 14: Probe Protector

NOTE: When probe is longer than 10 feet, clamps are used to center the probe.

•Standard Specifications

Material: 316SS Pipe
304SS, ANSI 4" 150# flange

Installation: Flange Mount (FF type)

Length/Weight:

For custom lengths, please contact your local Yokogawa Industrial Automation representative.

SPECIFICATIONS

Insertion Length (L)	Approx. Weight
1.3 ft (0.4 m)	15 lb (7 kg)
1.5 ft (0.46 m)	18 lb (8.2 kg)
2.1 ft (0.64 m)	20 lb (9.1 kg)
2.5 ft (0.76 m)	21 lb (9.5 kg)
3.3 ft (1.0 m)	22 lb (10 kg)
5.0 ft (1.5 m)	29 lb (13 kg)
6.6 ft (2.0 m)	35 lb (16 kg)
10.0 ft (3.0 m)	48.5 lb (22 kg)

Table 5: Approximate Length and Weight of ZO21R-L probe protector w/4", 150# ANSI flange

•Model and Code

LOW TEMPERATURE PROBE PROTECTOR	
ZO21R-L	MODEL NUMBER
INSERTION LENGTH	
-040	0.40 m (1.3', 15.6")
-046	0.46 m (1.5', 18")
-064	0.64 m (2.1', 25")
-076	0.76 m (2.5', 30")
-100	1.0 m (3.3')
-150	1.5 m (5.0')
-200	2.0 m (6.6')
-300	3.0 m (10.0')
FLANGE CONNECTION	
-A*U	ANSI 4", 150# FF flange
-B*U	ANSI 3", 150# FF flange
-C*U	ANSI 2", 150# FF flange
-J*U	JIS 5K, 65AFF Flange
-W*U	Westinghouse flange

SPECIFICATIONS

2.7.2 ZO21V Probe Support

A probe support is required for detector lengths of 10 feet (3 meters) or greater. Probe supports may only be used in conjunction with the ZO21D-L low temperature detector.

•External Dimensions

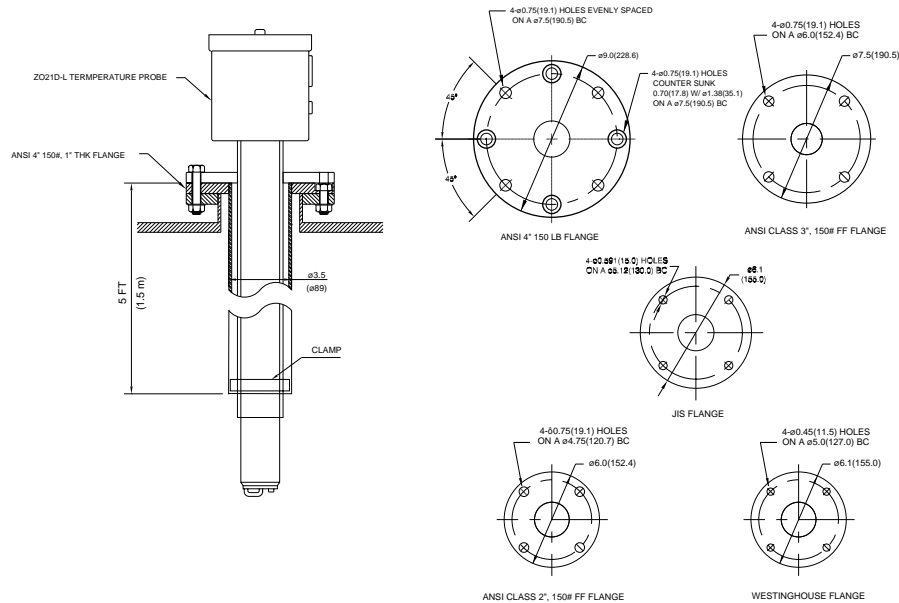


Figure 15: Probe Support

•Standard Specifications

- Material:** SUS316 (Support)
SUS304 (Flange)
- Supporter Length:** 5 ft (1.5 m) for use with a 10 ft (3.0 m) probe
- Weight:** Approx. 22 lbs (10 kgs) when JIS flange is used.
Approx. 28 lbs (12.7 kgs) when ANSI flange is used.
- Installation:** Flange mounting (FF type) with an internal spacer to position detector.

•Model and Code

LOW TEMPERATURE PROBE SUPPORT	
ZO21V	MODEL NUMBER
INSERTION LENGTH	
-150	5.0 ft (1.5 m) [for use with 10 ft (3 m) probe]
FLANGE CONNECTION	
-A*U	ANSI 4", 150# FF flange
-J*U	JIS 5K, 65FF flange
-W*U	Westinghouse flange

SPECIFICATIONS

2.7.3 Check Valve, M1132KN

The check valve prevents water vapor in the process from diffusing down the calibration line where it may condense and cause the cell to crack. A check valve should be used on all natural gas and positive pressure applications as well as any time with long periods (>3 months) of time between calibrations.

•External Dimensions

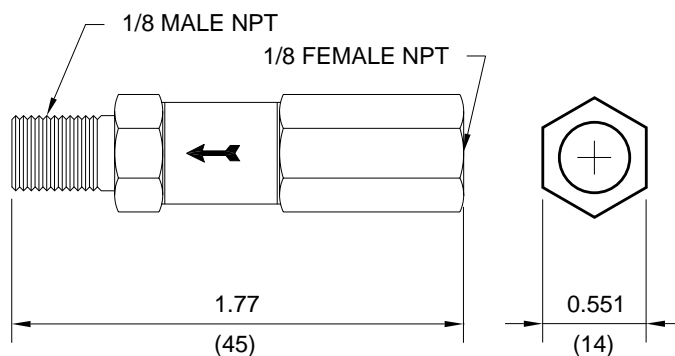


Figure 16: Check Valve

•Standard Specifications

Connection: 1/8" FNPT inlet; 1/8" MNPT outlet

Material: 304SS

Cracking Pressure: 1 psi

Weight: Approximately 0.1 lb (50 g)

NOTE: The check valve is not a substitution for an in-line filter for removing moisture from instrument air source.

2.7.4 SILICON CARBIDE FILTER & DUST GUARD, E7042UQ AND E7042UU

This assembly protects the zirconia cell from fine particulate components in the flue gas which may poison or reduce the life of the cell (not used with the flame arrester).

SPECIFICATIONS

•External Dimensions

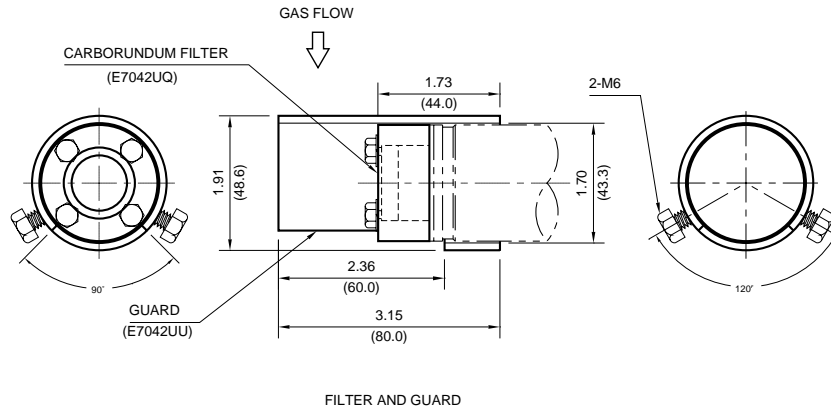


Figure 17: Filter and Dust Guard

•Standard Specifications

Mesh:	70 micron (Filter)
Material:	Carborundum (Filter), 316SS
Max. Temperature Rating:	932°F (500°C)
Connection:	Stainless steel bolts
Weight:	Approximately 1.6 lbs

2.7.5 Fly Ash Filter, M1100DA

The fly ash filter is for high dust applications such as coal fired boilers, kilns and bark boilers.

•External Dimensions

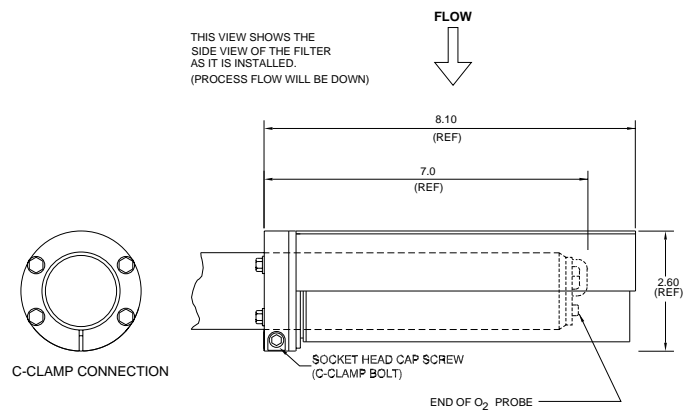


Figure 18: Fly Ash Filter

SPECIFICATIONS

•Standard Specifications

Mesh:	10 Micron (Filter)
Material:	316 Sintered stainless steel
Max. Temperature Rating:	572°F (300°C)
Connection:	Stainless steel C-clamp with bolt
Weight:	Approximately 1.5 lbs

2.7.6 HASTELLOY X SINTERED FILTER ASSEMBLY, M1100DA-2

Designed for use in applications above 572°F (300°C), this filter addresses blockage and coating problems experienced by tough applications.

•External Dimensions

Refer to Figure 17

•Standard Specifications

Mesh:	10 Micron (Filter)
Material:	Hastelloy x (<i>See Note</i>)
Max. Temperature Rating:	1292°F (700°C)
Connection:	Stainless steel C-clamp with bolts
Weight:	Approximately 1.8 lbs

NOTE: M1100DA-2 is not suitable for Recovery Boiler Applications.

2.7.7 Quick Disconnect Cable (/A option on probe)

Quick disconnect connectors are used on the detector's heater and signal cables for easy wire installations and maintenance. See model ZO21D detectors for pre-attached male connectors in Section 1 (/A options shown). Field connectors must be ordered separately (WZ... options shown).

SPECIFICATIONS

Type Cable	AWG	No. Conductors	Insulation	Shield	Jacket (material, thickness)	Voltage/Temp	Weight/1,000 ft
High Temp Signal WZ-H-6S	16	3 pair, tw isted; Black/White/Red/Green	FEP	Aluminum Mylar; AWG 18/7 TC Drain	FEP.010" w all/ .268" od	300 Volts/ 392° F (200°C)	35 lb (15.9 kg)
Low Temp Signal WZ-L-6S		3 pair, tw isted; Black/White/Red/Green	Polyethylene	Aluminum Polyester foil; Stranded tinned copper drain	PVC.035" w all/ .475" od	300 Volts/ -4° to 140° F/ (-20° to 60° C)	125 lb (56.7 kg)
High Temp Heater WZ-H-3H	14	2 conductor Black/Red	FEP	Aluminum Mylar; AWG 16/19 TC Drain	FEP.010" w all/ .182" od	300 Volts/ 392° F (200°C)	35 lb (15.9 kg)
Low Temp Heater WZ-L-3H		2 conductor Black/Natural	Polyethylene	Aluminum Polyester foil; Stranded tinned copper drain.	PVC.035" w all/ .350" od	300 Volts/ -4° to 140° F/ (-20° to 60° C)	72 lb (32.6 kg)

Table 6: Quick Disconnect Cable Specifications

•External Dimensions

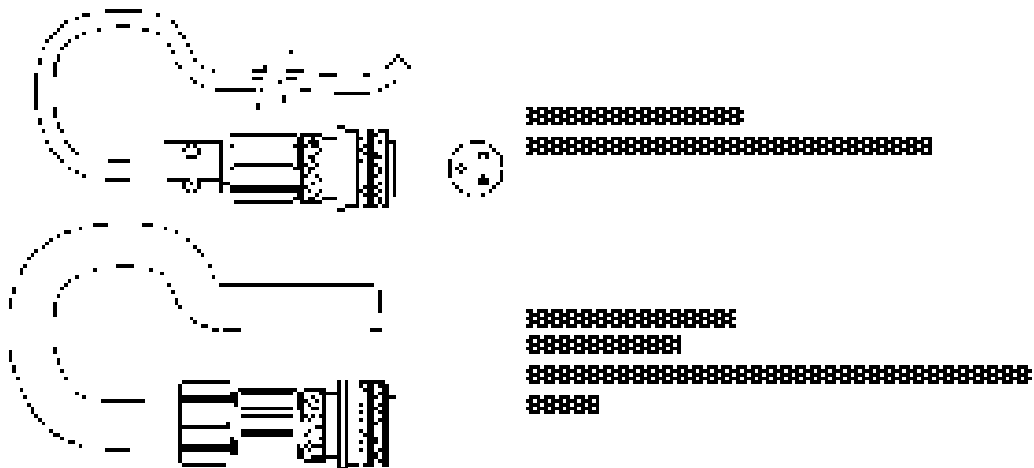


Figure 19: WZ.../QC or /QF

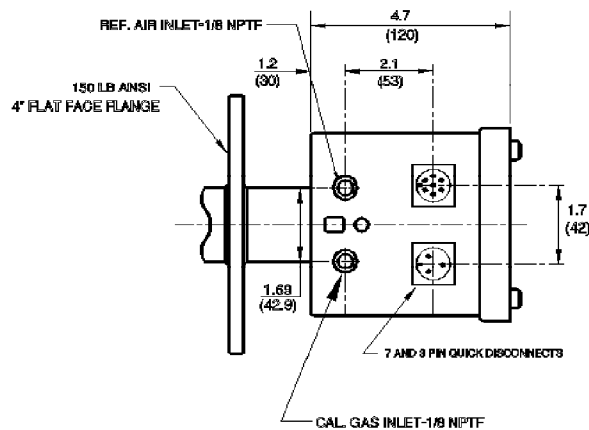


Figure 20: ZO21D.../A

SPECIFICATIONS

•Model and Code

ZO21D WIRING - SIGNAL CABLE	
CABLE TEMPERATURE RATING	
WZ-H	High temp cable (FEP jacket (up to 390°F) (200°C))
WZ-L	Low temp cable (PVC jacket (up to 140°F) (60°C))
CABLE LENGTH (feet)	
-3H-0005	5' Heater Cable (3-Conductor)
-6S-0005	5' Signal Cable (6-Conductor)
-3H-0010	10' Heater Cable (3-Conductor)
-6S-0010	10' Signal Cable (6-Conductor)
-3H-0015	15' Heater Cable (3-Conductor)
-6S-0015	15' Signal Cable (6-Conductor)
-3H-0020	20' Heater Cable (3-Conductor)
-6S-0020	20' Signal Cable (6-Conductor)
-3H-0025	25' Heater Cable (3-Conductor)
-6S-0025	25' Signal Cable (6-Conductor)
-3H-0030	30' Heater Cable (3-Conductor)
-6S-0030	30' Signal Cable (6-Conductor)
-3H-0040	40' Heater Cable (3-Conductor)
-6S-0040	40' Signal Cable (6-Conductor)
-3H-0050	50' Heater Cable (3-Conductor)
-6S-0050	50' Signal Cable (6-Conductor)
-3H-0100	100' Heater Cable (3-Conductor)
-6S-0100	100' Signal Cable (6-Conductor)
-3H-0200	200' Heater Cable (3-Conductor)
-6S-0200	200' Signal Cable (6-Conductor)
-3H-0500	500' Heater Cable (3-Conductor)
-6S-0500	500' Signal Cable (6-Conductor)
CONNECTION ¹	
/QC	Quick disconnect w/cable clamp ¹
	Quick disconnect w/flex conduit adapter (1/2" NPTM)
/QF	^{2, 3}

CAUTION: WZ-H-6S-0500/QF will add a soldered quick disconnect fitting to the end of the 500 foot low temperature cable, with 2 separate Flex Conduit adapter fittings (1/2" NPT). The customer will probably use a junction box close to the probe, and run the remainder several hundred feet from the junction box to the convert

NOTES:

- 1) Must select /A option for the ZO21D probe quick disconnects.
- 2) The quick disconnect with cable clamp (/QC option) can only be used with the Low Temperature (WZ-L...) cable.
- 3) The quick disconnect with flex conduit adapter (/QF) fittings can only be used with the High Temperature (WZ-H...) cable.
- 4) The 1/2" flex conduit must be ordered separately. See WZ-FC information.

SPECIFICATIONS

2.7.8 Flexible Metallic Conduit, WZ-FC

This jacketed, liquid-tight, flexible metallic conduit provides complete protection from liquids and vapors. It has an absorbing motion and withstands severe vibration and tight bending. The conduit jacket is a special thermoplastic rubber compound. Its applicable temperature range is from -76° to 302°F (-60° to 150°C), with intermittent excursions to 329°F (165°C).

•Standard Specifications

Size:	0.5 inches
ID:	0.622 min / 0.642 max
OD:	0.820 min / 0.840 max
Inside Bend Radius:	0.2 inch
Weight per 100 feet:	27 pounds

•Model and Code

PART NUMBER	OPTIONAL ITEMS
M1132XP	1/2" Flexible Conduit (order quantity is conduit length in feet)

INSTALLATION

III. INSTALLATION

3.1 INSTALLATION OF THE ZO21D-L DETECTOR

3.1.1 Installation Site

Note the following when installing the detector:

- 1) Easy access to the detector for maintenance work.
- 2) Ambient temperature does not exceed 176°F (80°C).
- 3) A clean environment free of corrosive gases.
- 4) Minimum vibration.

3.1.2 Probe Insertion Hole

Includes those analyzers equipped with a probe supporter and probe protector. When preparing the probe insertion hole, the following should be taken into consideration:

- 1) The detector probe tip should not be mounted above the horizontal.
- 2) If the probe length is greater than 2 meters (10 feet), the detector requires a probe support or protector.
- 3) The probe should be situated so that the sensor is at a right angle to the gas flow

NOTE: To prevent the sensor from deterioration due to condensation, DO NOT mount the probe above the horizontal.

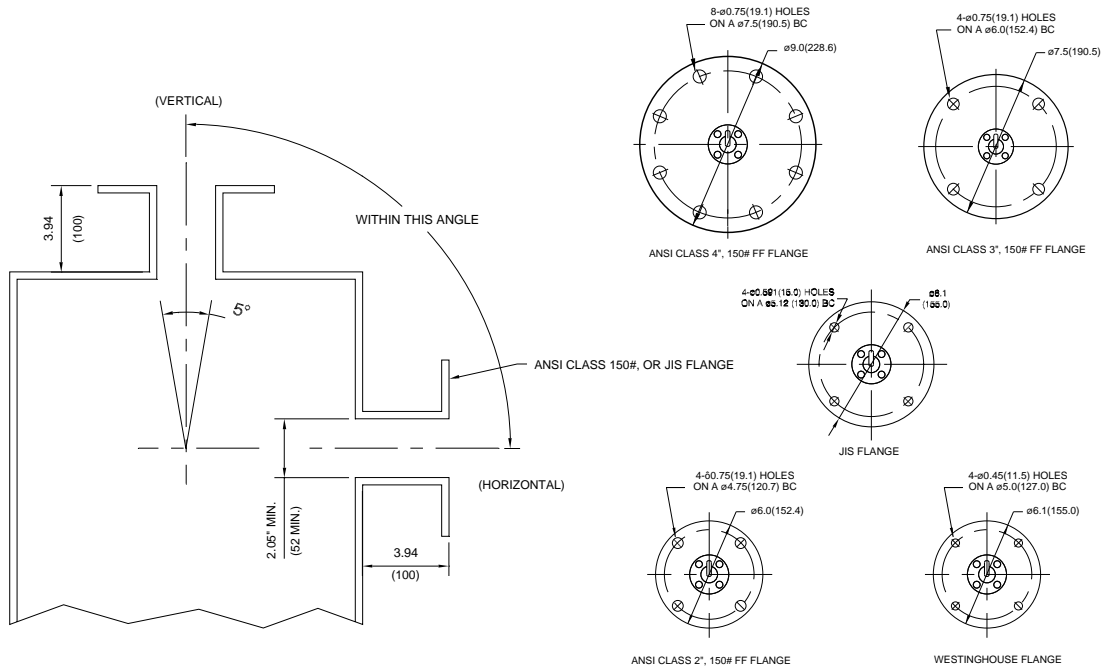


Figure 21: Probe Insertion Hole

INSTALLATION

3.1.3 ZO21D-L Detector Installation

The cell (sensor) at the tip of the detector is made of ceramic (zirconia). The heater is made of a quartz type material; therefore, care should be taken to avoid any mechanical shock or jarring to the probe such as dropping. Use a suitable gasket on the flange surface to prevent gas leakage. The gasket material should be heatproof and corrosion-proof. If corrosion is a prevalent problem at the flange, request derakane coating when ordering probes. See accessories.

The following should be taken into consideration when mounting the detector.

- 1) The zirconia cell is packaged inside of the ZO21D detector box, in a styrofoam cup. Remove the cell, and using a 5/16" wrench, secure the cell as shown in Figure 22. The bolts are tightened according to the sequence shown. Use approximately 52 lb•in (60 kg•cm) of torque. Please note that bolts are pre-attached to the ZO21D detector, and are not inside of the styrofoam cup with the zirconia cell.
- 2) Accessories (optional)
Attach filter to detector, if purchased, according to instructions found in Section 3.1.5. Install probe protector, or support, according to instructions found in Section 3.1.8.
- 3) Place gasket between probe and process flange connection. The gasket is used to prevent leaks. If a protector or support is used, also place gasket between all flange surfaces to prevent leaks.
- 4) Carefully insert the probe into the process, and secure the bolts and washers of the flange using a wrench. If a filter or probe protector is used, note the probe positioning as described in Section 3.1.5 for the filter, and Section 3.1.8 for the probe protector.
- 5) In a case where the detector is mounted horizontally, the cable lead-in hole on the junction box of the detector should face downward.

Flange Specification	Part Name	Quantity
ANSI 4", 150# FF	Gasket (same hole pattern as flange)	1
	Bolts (5/8 - 11 UNC x 2-1/2")	8
	Nuts (5/8 - 11 UNC)	8
	Washers (5/8")	16
ANSI 3", 150# FF	Gasket (same hole pattern as flange)	1
	Bolts (5/8 - 11 UNC x 2-1/2")	4
	Nuts (5/8 - 11 UNC)	4
	Washers (5/8")	8
JIS 5K - 65	Gasket (same hole pattern as flange)	1
	Bolts (M12 x 50) (1/2 - 13 UNC x 2")	4
	Nuts (M10) (3/8 - 16 UNC)	4
	Washers (12 mm) (5/8")	8
Westinghouse Flange	Gasket (same hole pattern as flange)	1
	Bolts (M10 x 50) (3/8 - 16 x 2")	4
	Nuts (M10) (3/8 - 16 UNC)	4
	Washers (10mm) (3/8")	8

Table 7: Mounting parts required

INSTALLATION

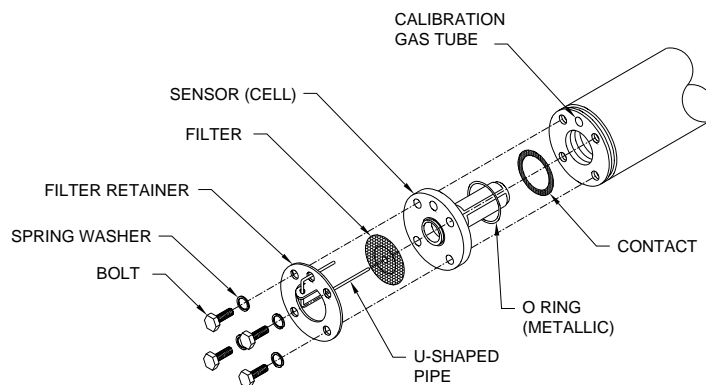


Figure 22: Parts in Sensor Assembly

3.1.4 Installation of ZO21D-L Accessories

In order to extend the useful life of the probe, accessories are used. The following is a list of accessories for the low temperature detector, model ZO21D-L, along with installation instructions. All instructions assume that the zirconia cell has been previously installed, as described above in Section 3.1.3.

3.1.5 Silicon Carbide Filter (E7042UQ) and Dust Guard (E7042UU) Installation

The dust filter (E7042UQ) is used to protect the sensor from low concentrations of dust. Install the filter as follows:

- 1) Remove the sensor bolts (4) and washers .
These bolts are not used with filter mounting. The filter assembly includes bolts. It is recommended that you keep the original bolts since operation without a filter may be required in the future.

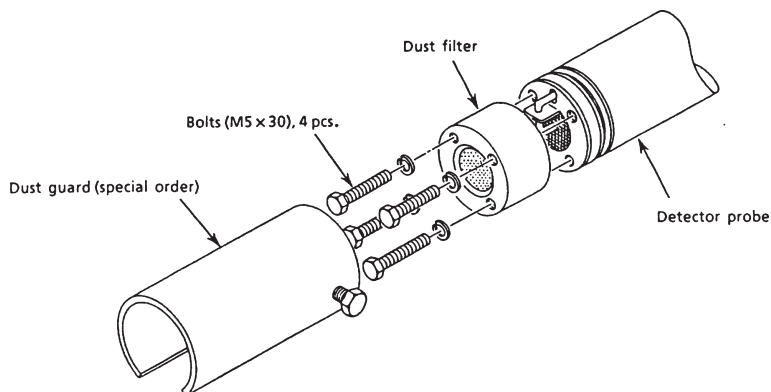


Figure 23: Dust Filter and Guard

- 2) Mount the dust filter as follows:
Attach the filter with the supplied bolts and washers. Tighten each bolt to 52 lb•in (60 kg•cm) torque.
- 3) If dust concentration is high and gas flow exceeds 10 m/sec, a dust guard (E7042UU) is recommended. Attach the dust guard with the open side away from the flow mount to the detector probe with two screws. Tighten the screws, matching them with the probe grooves.
- 4) Position the probe's dust guard upstream and perpendicular to the gas flow.

INSTALLATION

3.1.6 Fly Ash Filter Installation (M1100DA or M1100DA-2)

- 1) Carefully note direction of flow and place filter over end of probe. Locate the C-clamp approximately 7.0 in (17.78 cm) from the probe tip.
- 2) After filter is located over the probe, tighten the socket head bolt until the filter will not move. Do not overtighten.
- 3) Put the hexhead cap screws (2) through the washers into the filter holes and securely tighten each bolt.
- 4) Mark the flange to show the position of the filter shield. Position the probe so that the shield portion of the filter upstream and perpendicular to the gas flow.

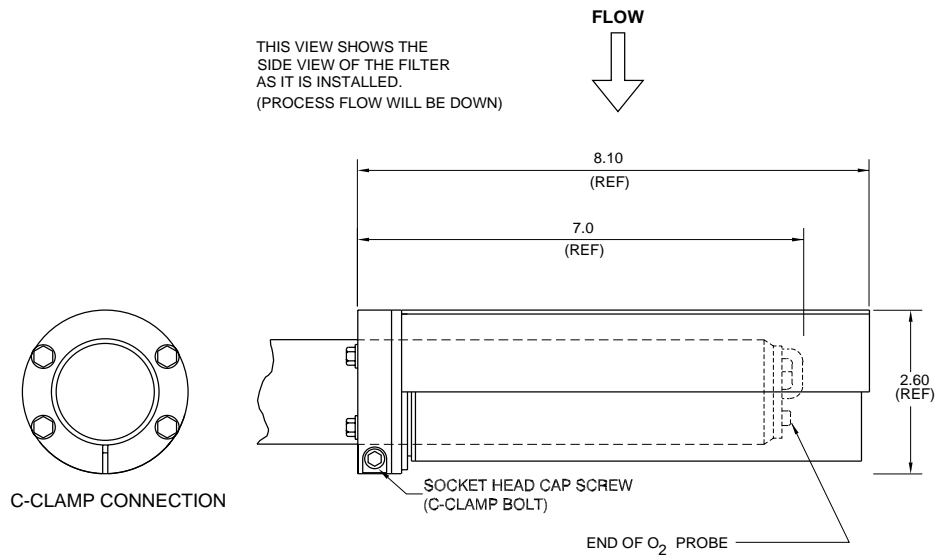


Figure 24: Fly Ash Filter

3.1.7 Flame Arrester (/F option)

If a flame arrester is used with the probe, a filter is not required. The flame arrester extinguishes flames generated by the zirconia cell (maintained at 1382°F (750°C)) and cools the hot gases before they escape, thereby preventing the detector from causing an explosion or fire in the duct.

- 1) Thread the flame arrester to the ZO21D probe near the tip.
- 2) Thread the 2 bolts to the flame arrester in the holes provided in order to prevent any movement of the flame arrester.

3.1.8 Detector with probe support or protector

- 1) Attach the guide ring of the probe support to the detector 1.5 m from the probe flange, and affix it with two screws. Tighten the screws firmly.
- 2) Insert the gasket supplied by the user between the flange surfaces and mount the probe support. Mount the probe protector so that the opening at the tip is located on the downstream side of the gas to be analyzed.
- 3) Make sure the 4 bolts used to attach the zirconia cell to the probe are tightly secured.
- 4) For probe supports, install the support collar 57 inches (1447 mm) from the face of the flange. Tighten screws to a 52 lb•in (60 kg•cm) torque. If a probe protector is used instead of a support, install the support collar 9 inches (228 mm) from the probe tip.

NOTE: Clamps are used to prevent damage to the probe and to allow easy removal of the probe.

INSTALLATION

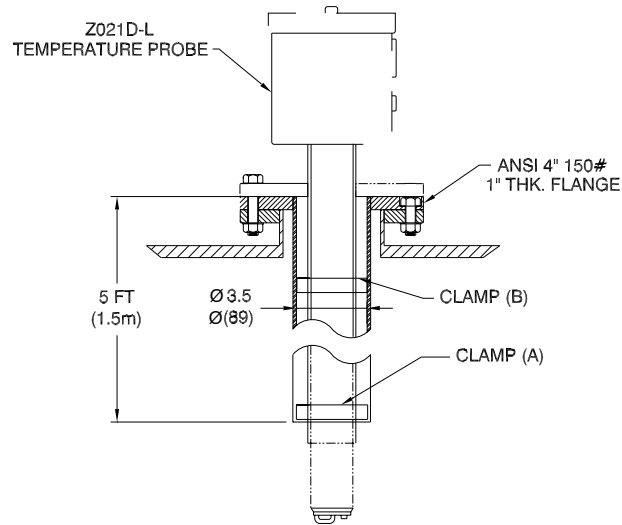


Figure 25: ZO21D with probe support (ZO21V)

- 5) Install a gasket between all flange surfaces in order to prevent leaks.
- 6) If the detector is mounted horizontally, position it so that the cable lead-in hole (gland) is located at the bottom.
- 7) Mount probe support perpendicular to gas flow. If probe protector is used instead of support, take care to position the notched edge of protector upstream from the gas flow, as shown in figure 24.
- 8) The 4", 150# ANSI flange has 4 of the 8 bolt holes recessed. The recessed bolt holes should be attached to the process flange connection. The remaining holes should be attached to the probe. Secure all bolts tightly.

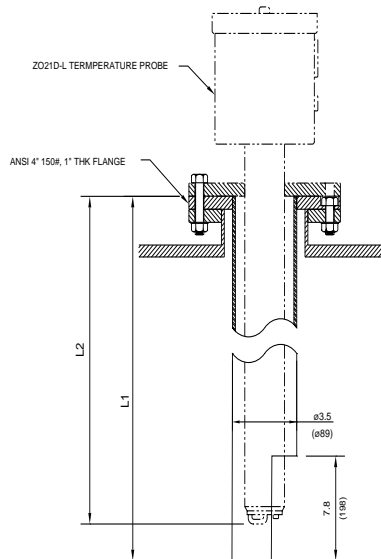


Figure 26: ZO21D with probe protector (ZO21R)

INSTALLATION

3.2 INSTALLATION OF THE HIGH-TEMPERATURE DETECTOR

3.2.1 Installation Site

The following should be taken into consideration.

- 1) Easy access to the detector for inspection and maintenance work.
- 2) The ambient temperature should not be too high (below 300°F (150°C)) nor should the terminal box be subjected to radiant heat.
- 3) No corrosive gas present in surrounding atmosphere.
- 4) No vibration should be allowed.
- 5) The gas should satisfy the conditions as described in the specifications chapter.

3.2.2 Probe Insertion Hole

A high-temperature detector consists of a detector ZO21D-H and high temperature probe adapter (ZO21P) and the auxiliary ejector.

The probe insertion hole should be prepared as follows:

- 1) If the transport tube is made of silicon carbide (SiC), the probe hole should be prepared so that the tube is placed vertically (no more than a 5° tilt.)
- 2) If the transport tube is made of stainless steel and the probe adapter positioned horizontally, it is important that the probe tip remains below the probe base.

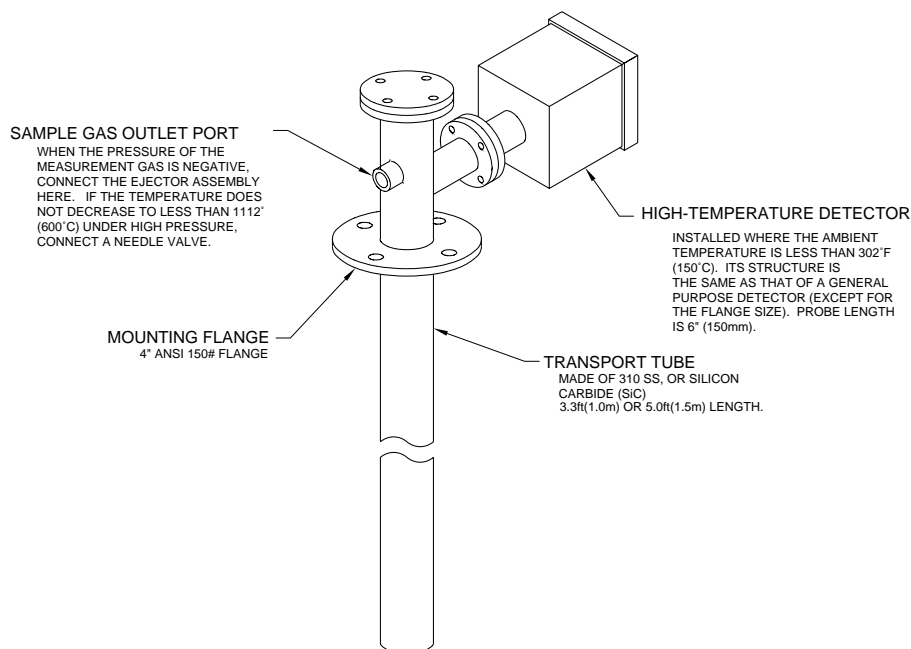


Figure 27: ZO21PH High Temperature Tee Adapter

INSTALLATION

3.2.3 Mounting the ZO21D-H detector and ZO21P adapter tee

Ceramic (zirconia) used in the sensor (cell) portion on the detector probe tip and heater is made of a quartz crystal. Care should be taken not to drop the detector during installation. The same applies to a transport tube made of silicon carbide (SiC) or alumina ceramic.

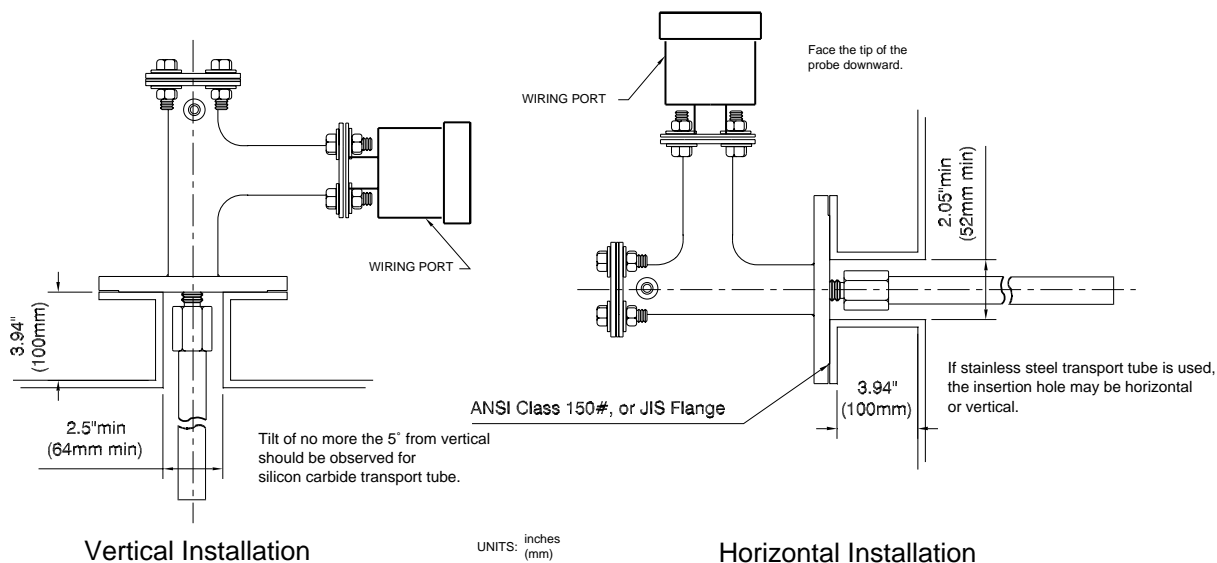


Figure 28: Installation into probe insertion hole

A gasket should be used at the flange surface to prevent gas leakage. The gasket material should be selected depending on the characteristics of the sample. The gasket must be heatproof and corrosion-proof.

- 1) Zirconia cell is packaged inside of detector box, in a Styrofoam cup. Remove cell and using 5/16" wrench, secure cell according to instructions included with the cell. Use approximately 30 to 40 in/lb of torque. Please note that bolts are pre-attached to probe and are not in the Styrofoam cup with cell. If a flame arrester is used with the probe, thread the flame arrester to the ZO21D-H-017-L*U/F probe. Thread the 2 bolts to the flame arrester in the 2 holes provided in order to prevent any movement of the flame arrester.
- 2) The ZO21D-H is flange mounted to the ZO21P adapter tee, placing a gasket between the probe's flange and ZO21P adapter. Cable glands on the probe's junction box should face downward if the probe is mounted horizontally.
- 3) Attach the transport tube to the ZO21P adapter. The probe hole should be prepared so that the probe tip is not higher than the probe base.

NOTE: It is important that the probe tip (where zirconia cell is attached) is not higher than probe base (where terminals are enclosed in junction box). Condensation will form inside the cell, if the tip is mounted higher than the base.

- 4) Place gasket between ZO21P and process flange connection. The gasket is used to prevent leaks.

INSTALLATION

- 5) If transport tube is mounted horizontally, and extends longer than 1 meter, a support tube must be used (3" O.D. minimum).
- 6) Carefully insert the transport tube into the process, and secure the bolts and washers of the ZO21P flange using a wrench.
- 7) Insulate ZO21P and all metal surfaces.
- 8) If the process duct pressure is negative, attach an eductor to the ZO21P adapter as shown in figure 29.

However, if the pressure exceeds 2 inH₂O (50 mmH₂O), connect a needle valve at the 1/4" FNPT fitting for the eductor port so that the sample gas exhaust volume can be controlled.

3.2.4 Installation of ZO21D-H High Temperature System:

When the sample exceeds 1200 °F (650 °C), a probe adapter tee is used to cool the sample via natural convection before reaching the probe.

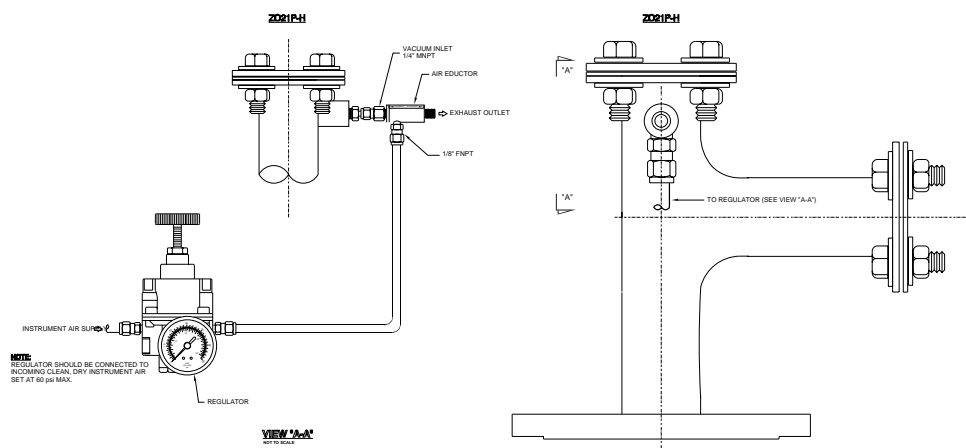


Figure 29: ZO21P High Temperature Adapter Tee

3.2.5 Auxiliary Ejector Assembly, M1132KE

Ejector Installation

When the process pressure is negative or equal to that of atmosphere, an ejector is used to create a positive force that draws a sample through the high temperature assembly. There is a choice of either an air or water ejector. Water is self-cleaning, and is used when the sample contains a large volume of particulates that would cause the exhaust of the eductor to plug if air were used. The ejector is attached to the high temperature adapter's eductor port fitting, which is a 1/4" FNPT connection. When the eductor return option (/ER) is selected, an air eductor is pre-attached to the ZO21P adapter, and the exhaust is returned to the process via 316 stainless steel tubing. However, for all other options, the User must provide the exhaust plumbing to atmosphere, drain, etc. Note the following procedure for installing an eductor (refer to figure 29):

INSTALLATION

- 1) Attach the eductor to the adapter tee's 1/4" FNPT port. Use teflon tape or a suitable alternate on the threads in order to prevent leaks. Also, install all compression fittings correctly. Take care to attach the inlet of the eductor to the adapter, and not the exhaust!
- 2) Use 316 stainless steel tubing to attach the supply (either water or air as determined by eductor selection) to the eductor. A regulator is used between the supply and eductor in order to adjust the pressure of the supply (air or water). For air, a 0 to 60 PSI regulator is sufficient. For water, a 0 to 50 GPM regulator is recommended. DO NOT start the eductor supply until the exhaust has been piped appropriately for the application.
- 3) Use 316 SS tubing to pipe the sample that exits the exhaust of the eductor to drain, atmosphere, or others as determined by the safety procedures dictated by the application. Use a teflon tape or suitable alternate on the threads in order to prevent leaks.

Determining the Eductor Flowrate/Pressure

In order to determine the flowrate or pressure of the supply (either water or air), the ZA8C analyzer must be completely wired to the probe. It is recommended that all parts are wired and plumbed appropriately, which includes the ZA8C analyzer, ZO21D probe, and calibration unit (either MC1 or AC1). If the installation of all components is completed, turn on the ZA8C analyzer. After the analyzer is no longer in the "warm up" mode and the LED begins to display the O₂ value (typically 20.6 vol % O₂), turn on the supply to the eductor, starting with a low setting and gradually increase the regulator setting until the O₂ reading displayed on the LED of the ZA8C begins to drop. Do not increase the flow or pressure past this value. Wait until the reading begins to stabilize. If the reading does not stabilize after a few minutes, reduce the flow or pressure slowly until the reading stabilizes. Once the reading has stabilized, this is the setpoint for the supply to the eductor.

IMPORTANT NOTE: The supply to the eductor must remain at this setting in order for the sample to continuously flow from the process.

3.3 INSTALLATION OF THE ZA8C CONVERTER

3.3.1 Location

Install the converter to meet the following:

- 1) Easy access to displays and keyboard entry.
- 2) Maintenance and inspection are easily carried out.
- 3) Ambient temperature does not exceed 131°F (55°C) and temperature variations are minimal.
- 4) Humidity is moderate (40 to 75% RH) and no corrosive gases are present.
- 5) Where vibration is limited.
- 6) The detector is installed within 1,500 feet maximum.

NOTE: If the ambient atmosphere contains corrosive gases, install air purging.

3.3.2 Mounting

The converter may be pipe, wall or panel mounted.

•Pipe Mounting

Mount the converter as described below:

- 1) Use a vertical pipe (O.D. approximately 2") of sufficient strength for mounting the converter.
- 2) Attach firmly to the pipe in the procedure shown in Figure 30 using the enclosed mounting hardware.
 - a. Screw four bolts into the mounting bracket.
 - b. Hold the pipe between the bracket and mounting fitting, passing bolts through the bracket holes.

INSTALLATION

- c. Clamp the mounting fitting to the pipe. Set washers onto the bolts and fully fasten the nuts.

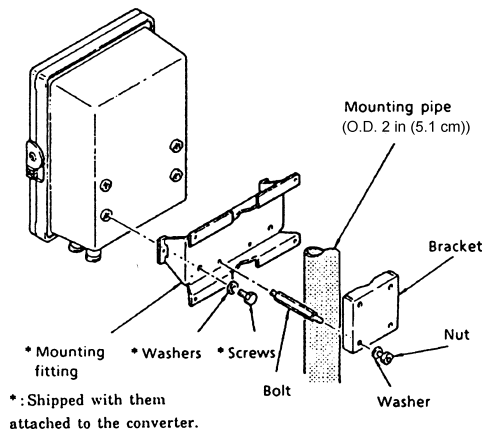


Figure 30: Pipe Mounting Procedure

•Wall Mounting

- 1) Drill mounting holes as shown below.

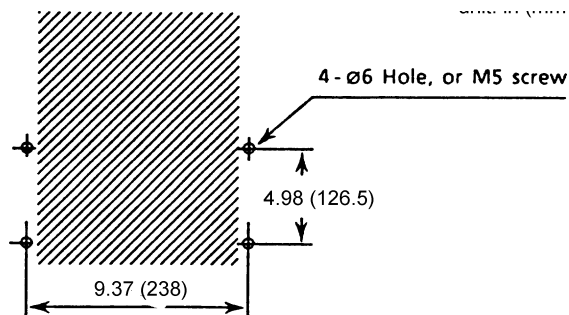


Figure 31: Drilling Mounting Holes

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

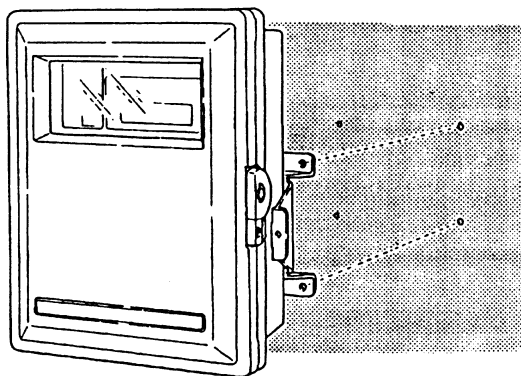


Figure 32: Mounting to the Wall

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

INSTALLATION

•Panel Mounting

- 1) Cut out the panel according to the figure below.

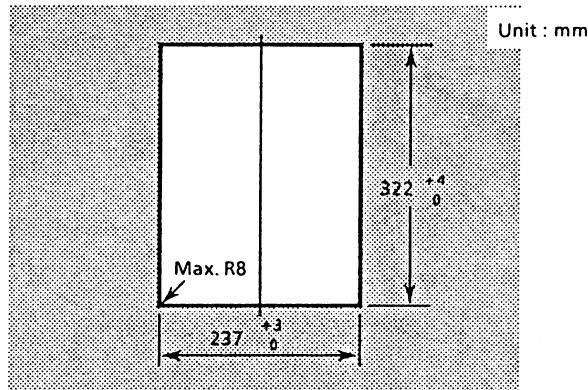


Figure 33: Panel Cut Dimensions

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

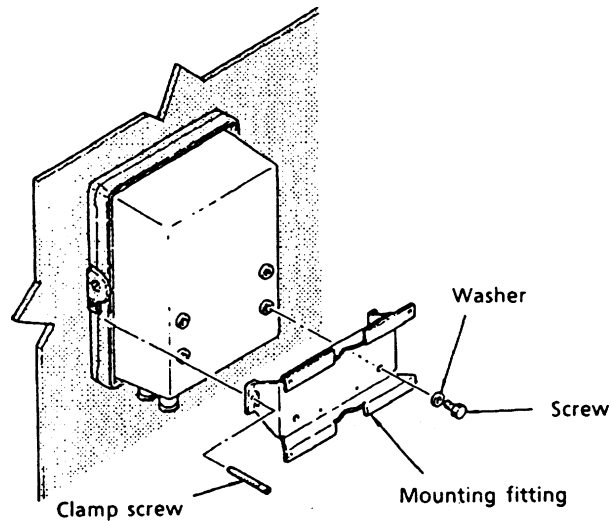


Figure 34: Mounting to the Panel

3.4 MOUNTING OF THE CALIBRATION SYSTEM (AC1 OR MC1)

There are two types of calibration systems. The Auto Calibration unit, model AC1, uses solenoids that automate the calibration system. The solenoids are wired to the ZA8C, and during the calibration mode, the solenoids are activated by the ZA8C, and the gas flows to the ZO21D detector, without the user opening the valve or adjusting flowrates. The Manual Calibration unit, model MC1, is not electrically activated by the ZA8C. During the calibration mode, the user opens the valve and adjusts the flowrate of the gas, as instructed by the ZA8C. Both the MC1 and AC1 calibration units provide one point of control for the calibration system.

INSTALLATION

3.4.1 Location

The following guidelines should be used when selecting a location for the calibration unit.

- 1) Easily accessible for maintenance and inspections.
- 2) As close to the ZO21D probes as practical, which will minimize the amount of tubing required for plumbing. The MC1 is mounted near the ZA8C converter.
- 3) Ambient temperature does not exceed 131°F (55°C).
- 4) Humidity is moderate and no corrosive gases are present.

NOTE: Use air purge for the AC1 enclosure if corrosive gas or high dust present.

- 5) Minimal vibration area.
- 6) Instrument Air is available.

3.4.2 Mounting (AC1)

The AC1 unit is designed for wall mounting by securing the four standoffs with bolts.

Allow sufficient room to connect the cal gas and reference air tubing. Input gases (zero gas and instrument air) are connected to the LEFT side, while all probe connections (cal lines and reference air) are on the side. Mount the unit so that the terminal strip is easily visible for wiring purposes. The AC1 unit is available with Nema 4 or Nema 4X enclosures and is provided with a key.

IMPORTANT NOTE: Unit must be mounted level, to ensure the accuracy of flowrates.

3.4.3 Mounting (MC1)

The MC1 unit should be mounted as close as practical to the ZA8C oxygen converter, since the ZA8C displays calibration instructions for opening valves during a calibration. The MC1 unit is designed for wall mounting by securing the four standoffs with bolts. Allow sufficient room to connect cal gas and reference air tubing. Input gases (zero gas and instrument air) are connected to the RIGHT side, while all probe connections (cal lines and reference air) are on the LEFT side.

IMPORTANT NOTE: Unit must be mounted level, to ensure the accuracy of flowrates.

PIPING

IV. CALIBRATION AND PIPING

4.1 PIPING

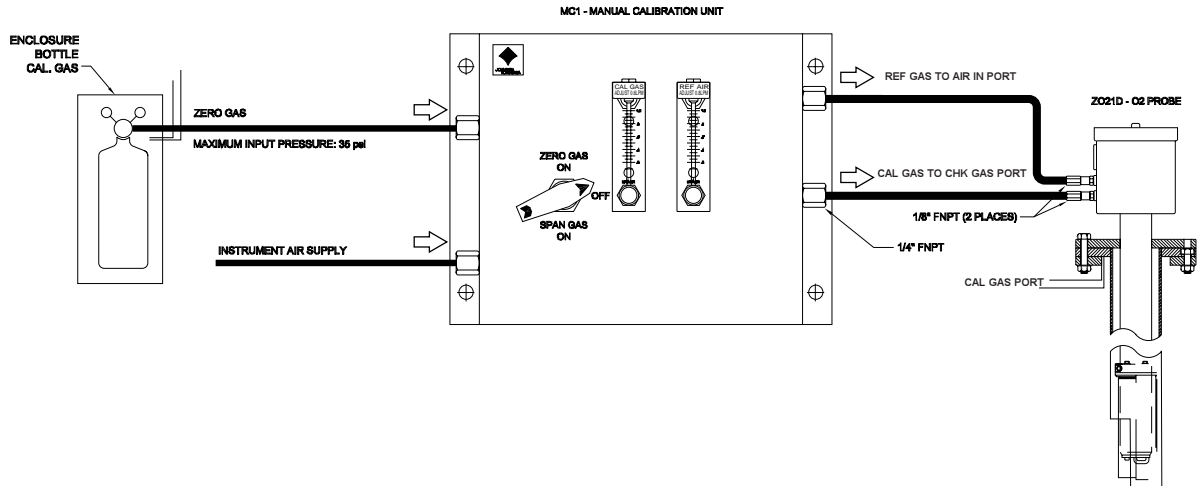


Figure 35: MC1 Piping Diagram

PIPING

Detector	Piping	Parts Required	Description
Low Temp Detector	Calibration gas	Check valve	Recommended by YIA (M1132KF)
		Nipple	1/8" NPT (On open market)
		Zero Gas Cylinder	1% oxygen in Nitrogen (On open market.)
		Cylinder 2 stage regulator	By YIA (M1132ZX w/ CGA 580) or on open market.
		Piping connection	1/4" NPT (On open market)
	At the reference gas inlet	Instrument Air	Supplied by customer
		Piping connection	1/8" NPT (On open market)
High temp Detector	Calibration gas	Check valve	Recommended by YIA (M1132KF)
		Nipple	1/8" NPT (On open market)
		Zero Gas Cylinder	1% oxygen in Nitrogen (on open market.)
		Cylinder 2 stage regulator	By YIA (M1132ZX w/ CGA 580) or on open market.
		Piping connection	1/4" NPT on (On open market)
	At the reference gas inlet and purge gas	Instrument Air	Supplied by customer
		Piping connection	1/8" NPT (On open market)
		(Air) Ejector Assembly Water Eductor	Recommended by YIA M1132KE (air) M1132CW (water)
	Eductor supply and exhaust	Supply piping connection	1/8" NPT(On open market)
		Exhaust piping connection	1/4" NPT(On open market)
Calibration Unit	Tubing	316 Stainless Steel, 1/4" O.D. (On open market)	
	Teflon Tape	Sealant for all NPT connections.(On open market)	

Table 8: Piping

4.2 AIR PURGE FITTING IN THE CONVERTER

It is recommended that air purging is used when the converter is to be installed in a place where the atmospheric gas is corrosive. The converter is shipped with air purge joints (each one with air supply and venting ports.) Attach the purge fittings and connect tubing as described below.

- 1) The air supply joint has a different diameter for air hole from that of the air venting joint. Be sure to use the joint having the 0.5mm diameter hole for the air supply port.
- 2) Use clean, dry air source, such as instrument air. Air consumption is approximately 5 LPM when the supply air pressure is 0.5 kgf/cm².
- 3) Remove each tapered plug with hexagon socket attached to two air purge joint connections at the bottom of the converter case, and connect the attached joints. Connect air supply to the air purge supply port with a nominal size 1/4" tube through a pressure regulator. Normally, the venting joint does not require tubing.

PIPING

4.3 CALIBRATION GAS

4.3.1 Zero Gas

Never use pure Nitrogen. Typically, 1% oxygen balanced in Nitrogen is used, however, an oxygen mixture between 0.4 % and 8% is acceptable. A compressed gas cylinder containing certified gas mixtures fitted with a dual stage regulator should be used. The maximum working pressure of the calibration box is 35 PSI. (See figure 35)

NOTE: Compressed Gas Cylinder must have the same CGA connection fitting as the dual stage regulator (see Accessories).

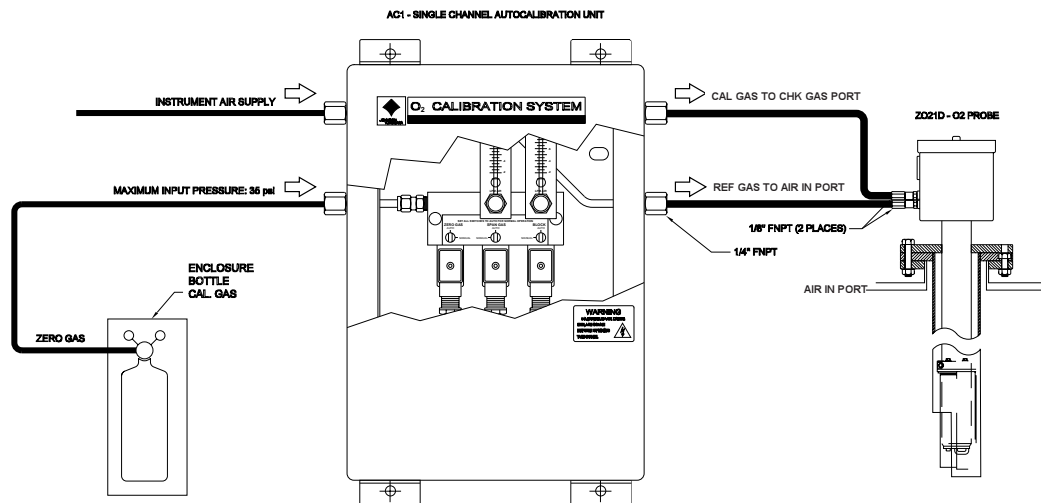


Figure 36: AC1 Piping Diagram

4.3.2 Span Gas

A clean, dry air source is recommended, such as instrument air. Install an in-line filter before the calibration unit to remove any moisture or dirt. A regulator must be attached to the instrument air source to provide the appropriate working pressure for the calibration unit. The maximum pressure is 35 PSI.

4.3.3 Reference Gas

Reference air is from the same source as the span gas, which is clean, dry instrument air. The reference air flows to the back side of the zirconia cell, and is used at all times. The calibration unit is plumbed to provide a continuous flow rate of the reference air, as well as, calibration gas flow during calibration

4.3.4 Piping of Gases to Cal Unit

Plumbing is required from the instrument air line and zero gas cylinder to the calibration unit. Standard 1/4" O.D. is recommended, stainless steel is preferred. Separate tubing for both the instrument air and zero gas are connected to the 1/4" FNPT fittings on the *LEFT side* of the calibration unit.

PIPING

4.4 PIPING TO ZO21D PROBE

Tubing to the ZO21D probe is from the RIGHT side of the calibration unit. Run ¼" tubing from the auto cal unit to the 1/8" FNPT fitting on the ZO21D probe. The Reference Air tubing is connected to the **AIR IN** port at the probe, and the Cal Gas tubing is connected to the **CHK GAS** port on the probe. The AIR IN and CHK GAS ports are located on the bottom of the probe junction box near the cable gland holes. These ports require a 1/8" NPT fitting. Any unused ports must have a Teflon taped plug. All probes have independent plumbing from other probes and are not to be teed at any point. Teflon tape or a suitable substitute is required to make an air tight seal.

IMPORTANT NOTE: To prevent leakage, all threaded fittings should have Teflon tape (or suitable alternate) and all compression fittings should be installed per manufacturer's recommendations. In addition, a check valve is usually installed on the cal gas inlet of the probe to protect the cal tubing from moisture contamination.

4.5 INITIAL FLOW RATE SETUP (AC1)

Ensure that the cal gas and reference air are properly plumbed to the left side of the AC1 auto cal unit. The zero gas and instrument air should be set at approximately 20 + 2 PSIG. Power is not needed to set the flow rates.

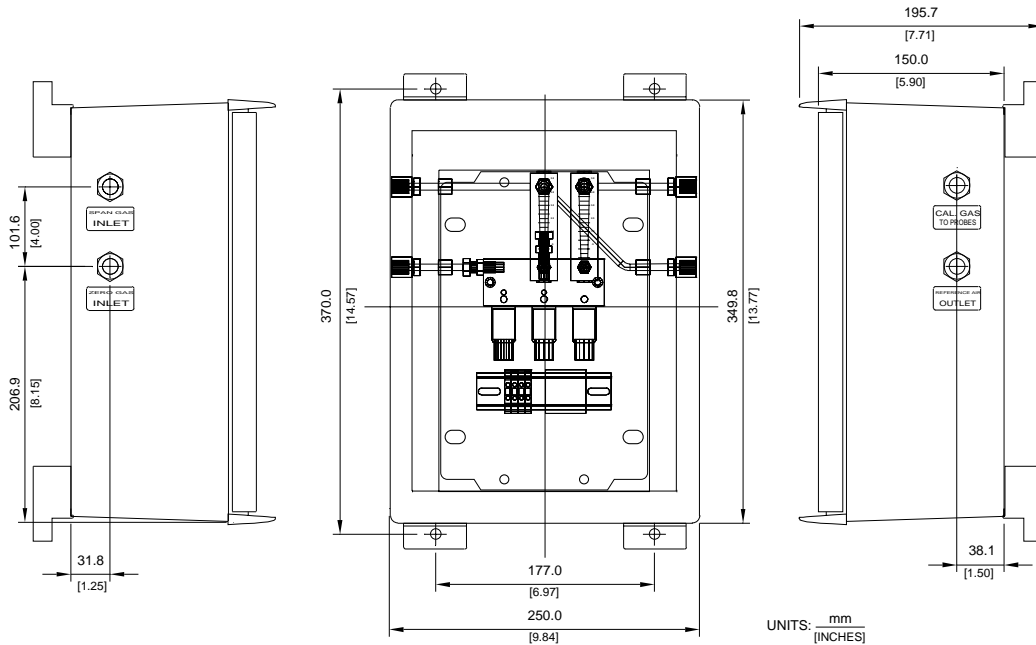


Figure 37: AC1 Piping

PIPING

4.5.1 Setting the Reference Air Flow Rate

Locate the reference air flowmeters. Adjust the flow adjustment knob on the REFERENCE AIR FLOWMETER to 0.8 LPM or 800 ml/min.

4.5.2 Balancing Pressure drops in the cal lines

For accurate calibrations, the auto cal system must provide a fixed flow of Zero gas and Span gas (0.6 LPM or 600 ml/min). To balance the pressure drops, perform the following steps:

These adjustments can be made with a flat tip screwdriver.

1. Locate the BLOCK and SPAN GAS SOLENOID. Using a screwdriver, turn the override screw to the manual position.
2. Use the flow regulator knob on the CAL GAS FLOWMETER to adjust the flow to 1.0 LPM.
3. Switch the override screw of the SPAN GAS solenoid to AUTO.
Turn the override screw for the ZERO GAS solenoid to Manual.
4. Adjust the pressure regulator on the zero gas cylinder for a flow of 1.0 LPM on the Calibration Gas flowmeter.

IMPORTANT: DO NOT USE THE flow regulator knob of the flowmeter to achieve this flow rate!

5. Adjust the flow regulator knob on the Calibration Gas flowmeter until the flowmeter reads 0.6 LPM.
6. Verify that all the manual overrides are set back to AUTO.

Standard operation

- The Reference Air flowmeter indicates 0.8 LPM during normal operation and calibration.
- All manual overrides are set to the AUTO position.
- The Calibration Gas flowmeter will show a flow of 0.6 LPM during Calibration only.

Before considering your calibration unit automated, it is a good practice to check for leaks along the full distance of the cal line tubing in addition to doing a CAL CHECK to confirm that the gases are plumbed correctly to each probe.

4.6 CHECKING FOR LEAKS

- 1) Locate the BLOCK SOLENOID. Turn the override screw on the BLOCK SOLENOID and SPAN SOLENOID to the manual position.
- 2) Use leak detection spray on all compression fittings and bends of the cal and reference line tubing.
- 3) Inspect the full length of the cal line to determine if there is a leak. Repair any leaks.
- 4) After repairing the leaks, if any, return all solenoids to the auto position.

NOTE: For ZA8C programming values, see section 6.3.

4.7 MC1 FLOW RATE SETUP

Performing a Calibration

For accurate calibrations, the manual cal system must provide a fixed flow of zero gas and span gas (0.6 LPM or 600 cc/min) during calibration. There are two flowmeters and one hand valve adjuster for the MC1. The hand valve is used only during calibration to flow either span gas or zero gas to the probe, using the Cal Gas flowmeter to indicate the flowrate. The Reference Air flowmeter is used to

PIPING

flow the reference air for the ZO21D probe, and remains flowing at all times with a flowrate of 0.8 LPM. The ZA8C display will prompt the User to perform the following steps, when programmed for One Touch (TCH) calibration as follows (refer to figure 35):

- 1) Position the valve knob to Span Gas On. This will start the flow of Span Gas (or Air) to the probe.
- 2) Adjust the Cal Gas flowmeter to show 0.6 LPM as the flowrate. Also, if necessary, adjust the reference flowmeter to show 0.8 LPM
- 3) To stop the flow of Span gas, position the valve knob to the OFF position.
- 4) To start the flow of zero gas to the probe, position the valve knob to Zero Gas On.
- 5) Adjust the Cal Gas flowmeter to show 0.6 LPM as a flowrate. Also, if necessary, adjust the reference flowmeter to show 0.8 LPM.
- 6) To stop the flow of Zero gas, position the valve knob to the OFF position.

WARNING: If reference air is used during calibration, the reference air must be left on after calibration!!

Checking for Leaks for MC1

- 1) Position the valve to Span.
- 2) Apply a leak detection spray on all compression fittings and bends of the cal line tubing for the probe, the cal unit inlet, cal unit outlet, probe inlet for Cal Gas and reference air. Spray both the reference air and Cal Gas line.
- 3) Inspect the full length of the cal line to determine if there is a leak. Repair any leaks.
- 4) After repairing the leaks, if any, return the valve to the OFF position. Set reference air flowmeter to 0.8 LPM.

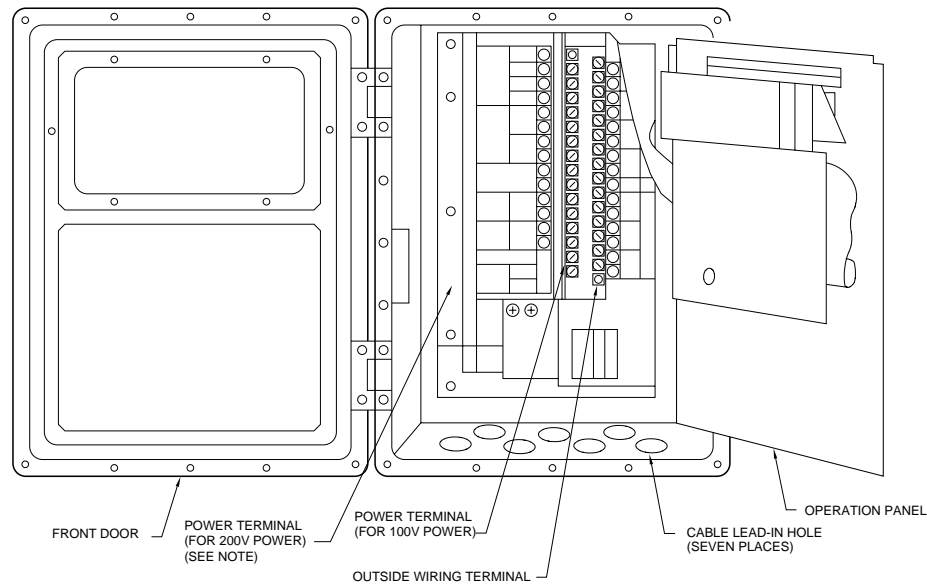
NOTE: For ZA8C programming values, see section 6.3.

WIRING

V. WIRING

5.1 OVERVIEW OF TYPES OF WIRES

Your new ZA8C converter is capable of expanding to fit your future needs. This section provides detailed information on wiring the ZA8C converter to any type of system configuration. Each channel is labeled on the ZA8C's terminal board.



NOTE:
IN CASE OF CONVERTERS FOR 220 V OR 240 V AC POWER, AN EXCLUSIVE TERMINAL IS PREPARED IN THE LEFT INSIDE CORNER.

Figure 38: ZA8C

Wiring Channel	Description of Wiring	Required Cable	Optional Cable	Purpose
1	Detector Signal	X		Connects the converter with detector's cell, cold junction, and thermocouple signals
2	Detector Heater	X		Connects the converter with detector's heater
3	Analog Output		X	Provides analog output to auxiliary equipment
4	Power & Ground	X		Power & Ground Wiring for the converter only
5	Serial Communication (optional)		X	Digital Communication
6	Contact Output (optional)		X	Dry Contact Outputs (3)
7	Contact Input (optional)		X	Contact Input (2)
8	Solenoid Valve (optional)	X	X	Calibration via Solenoid valves. Not used with Manual Calibration Unit
9	Temperature Input (optional)		X	Gas temperature input from external temperature source

Table 9: Wiring Channels

WIRING

There are 7 cable wiring ports (i.e. rubber glands) on the bottom of the ZA8C converter. Keep the detector signal cable separate at all times from the power and heater cables. The AC voltage cables must be kept separate from DC voltage cables at all times in order to prevent electrical noise problems.

5.1.1 Initial Preparations

The oxygen converter, detector, and auto calibration units are supplied with rubber plugs already installed in the cable ports. If corrosive gas is present, it may be necessary to purge the enclosures of the converter and calibration units. In such an instance, a watertight gland is used instead of the rubber plug. The ZA8C converter is shipped with purge connection pre-attached. The AC1 calibration unit does not have a purge connection.

When using wire conduit, the gland is removed, and a standard 3/4" (19 mm) conduit fitting is used. Note the following procedure for using the plastic watertight cable gland.

1. Remove the rubber plug.
2. Remove the nut from the cable gland and set the nut in the keyway inside of the cable bushing.
3. Thread the gland over the cable, in the correct sequence.
4. Screw the gland onto the nut from the outside, using a gasket to seal completely the space between the ZA8C case hole and the gland.

The ZO21D detector is supplied with 2 rubber plugs installed in the cable ports. The diameter of the cable bushing hole in the detector is 1.06 in (27 mm). If necessary, protect the cable by using a flexible wire conduit of nominal diameter 3/4" (19 mm). The detector may need to be removed in the future for maintenance, so be sure to allow a sufficient cable length.

5.1.2 Safety Precaution During Wiring

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

5.1.3 Power and Ground Wiring

This wiring provides the converter with AC power and ground the converter. The detector and auto calibration units are powered from the ZA8C converter.

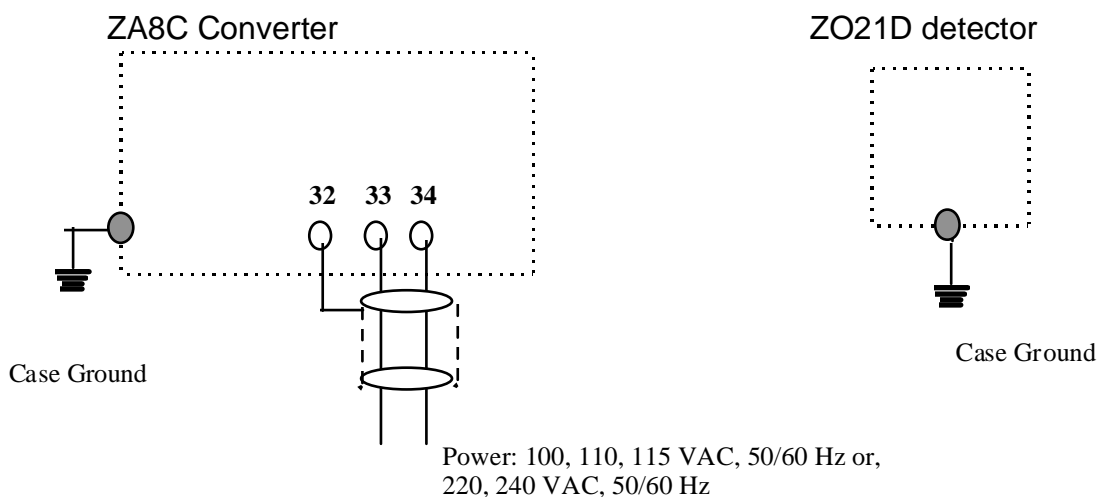


Figure 39: Power Wiring

WIRING

Power Wiring

Connect the power wiring at the appropriate terminals of the converter, as shown in Figure 38. Note the following when installing the wiring:

1. Use 14 AWG, 2 conductor, shielded cable. The size of the converter terminal screw threads is M4.

Ground Wiring

Case Ground Wiring

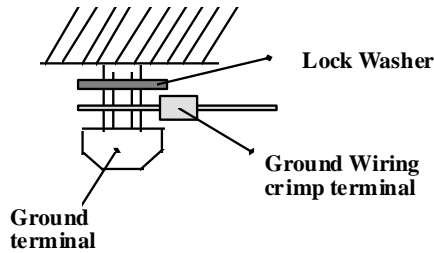


Figure 40: Case Ground Wiring

For the ground wiring, it is a general rule that wires should be installed from the ground terminal of the detector case or the converter case. Be careful of the following when wiring:

1. Keep the ground resistance less than 100 ohms.
2. Connect the cable to the converter case ground terminal so that the lock washer makes contact with the case as shown in Figure 40.

5.1.4 Wiring for the Detector

The wiring of the detector requires two cables: a Signal Cable and a Heater cable, as specified in the following table.

Type Cable	AWG	No. Conductors	Insulation	Shield	Jacket (material, thickness)	Voltage/Temp	Weight/1,000 ft
High Temp Signal WZ-H-6S	16	3 pair, tw isted; Black/White/Red/Green	FEP	Aluminum Mylar; AWG 18/7 TC Drain	FEP.010" w all/ .268" od	300 Volts/ 392° F (200° C)	35 lb (15.9 kg)
Low Temp Signal WZ-L-6S		3 pair, tw isted; Black/White/Red/Green	Polyethylene	Aluminum Polyester foil; Stranded tinned copper drain	PVC.035" w all/ .475" od	300 Volts/ -4° to 140° F/ (-20° to 60° C)	125 lb (56.7 kg)
High Temp Heater WZ-H-3H	14	2 conductor Black/Red	FEP	Aluminum Mylar; AWG 16/19 TC Drain	FEP.010" w all/ .182" od	300 Volts/ 392° F (200° C)	35 lb (15.9 kg)
Low Temp Heater WZ-L-3H		2 conductor Black/Natural	Polyethylene	Aluminum Polyester foil; Stranded tinned copper drain.	PVC.035" w all/ .350" od	300 Volts/ -4° to 140° F/ (-20° to 60° C)	72 lb (32.6 kg)

Table 10: Specifications of Signal and Heater Cables

Signal Cable

This wiring is used to transmit the mV DC outputs from the detector: the cell output, Type K thermocouple cell temperature, and the compensating cold junction. Typically a 16 AWG, 3 twisted pair cable with drain is used as signal cable. Install wires that allow for no greater than 10 ohms of loop resistance. It is important to install these wires separate from the power and heater wiring.

Connect the shield (or drain) for the signal cable at the ZO21D detector's ground terminal, and not at the converter's ground terminal as shown in Figures 41 and 42. Note that the ambient temperature at the detector determines the wire configuration. **No thermocouple cable is used between the detector and converter due to the use of a cold junction compensator at the detector's junction box.**

WIRING

NOTE: Thermocouple cable is not required. However, if Type K cable is already available and installed, remove the cold junction compensator thermistor from the probe junction box and attach to the corresponding terminals at the ZA8C converter.

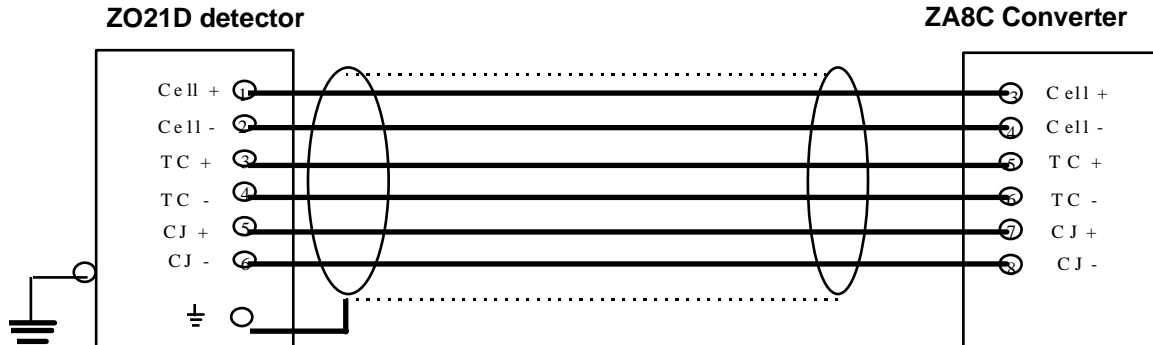


Figure 41: Detector Signal Output -112°F (-80°C) or less ambient

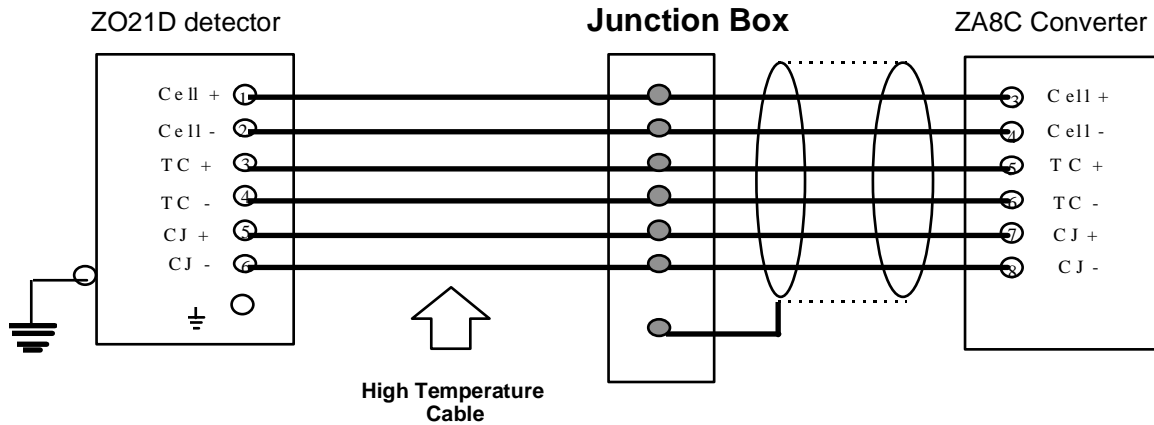
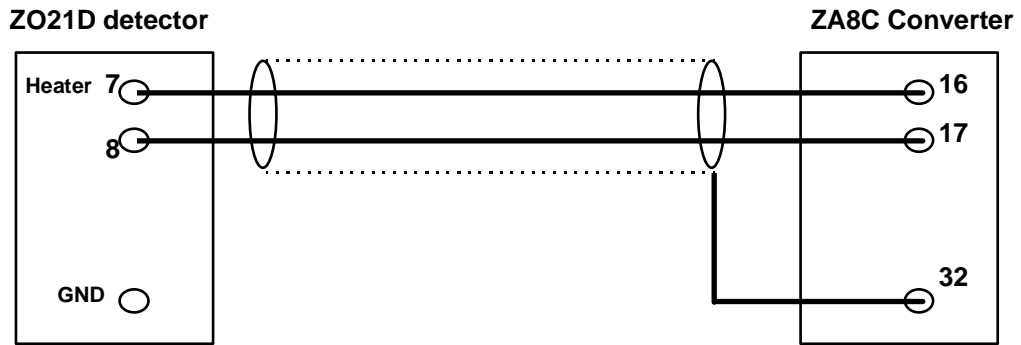


Figure 42: Detector Signal Output - Between 176° and 302°F (80° and 150°C) at the detector

Heater Cable

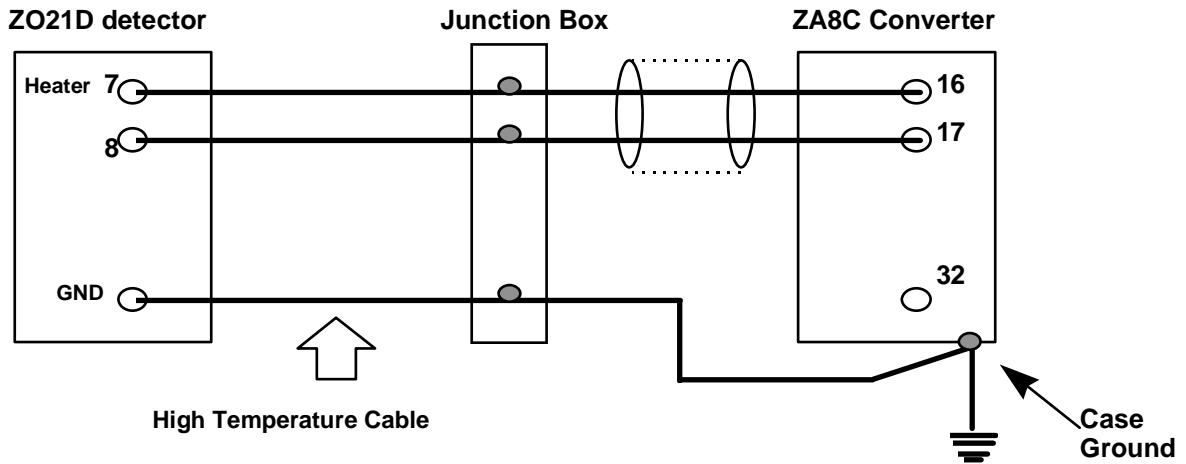
This wiring is used to transmit the 110 VAC output from the convert to the detector's heater. The power consumption of the heater is 80 VA normal, and 270 VA maximum. Typically a 14 AWG, 1 twisted pair cable with drain is used for the heater. Connect the heater cable's shield (or drain) at the ground terminal of the converter, and not the detector as shown in Figures 43 and 44. Note that the ambient temperature at the detector determines the wire configuration. Again, the heater cable must remain separate from the Signal cable.

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Heater Cable: 14 AWG, 1 twisted pair w/separate shield

Figure 43: Detector Heater Output - Maximum 112°F (80°C) ambient



Heater Cable: 14 AWG, 1 twisted pair w/separate shield

Figure 44: Detector Heater Output - Between 176° and 302°F (80° and 150°C) at the detector

WIRING

5.1.5 Quick Disconnect Wiring (Optional)

Yokogawa Industrial Automation offers “quick disconnect” wiring for the detector heater and signal cables. The cable is pre-attached to connectors so that all the User need perform is match the connectors for the heater (a 3 pin connector) and signal (a 7 pin connector) male and female connectors. During maintenance, detaching the cable at the detector is quick and easy.

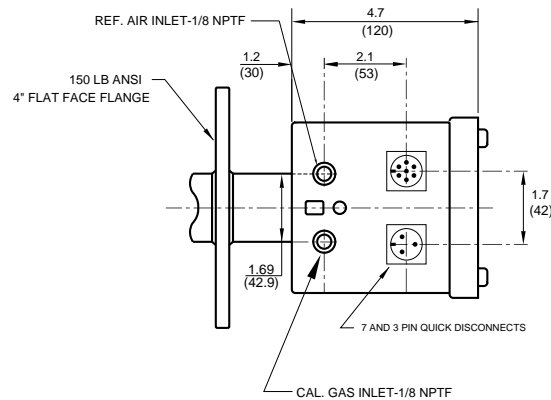


Figure 45: Quick Disconnect

5.2 ANALOG OUTPUT WIRING

This wiring is used to transmit the 4 to 20 mA DC or 0 to 20 mA DC output signal to a peripheral device, such as a recorder. A 16 AWG cable, 2 conductor with shield is recommended. Maximum load resistance is 550 ohms.

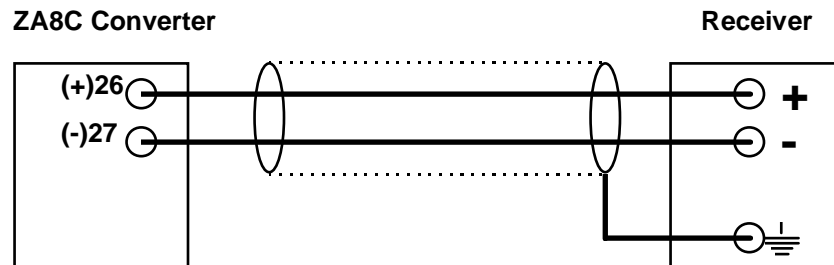


Figure 46: Wiring for Analog Output

The terminal screw thread is M4 at the ZA8C converter. Connect the shield of the cable generally on the side of the device receiving the analog signal, i.e. the recorder as shown in Figure 45. It is important to connect the polarities correctly.

WIRING

5.3 SOLENOID WIRING FOR CALIBRATION UNIT (AC1)

The AC1 is the automated calibration unit for the ZA8C which uses solenoids to control the flowrate of the calibration gas and reference air. The solenoids are powered from the ZA8C unit. All adjustments of flowrates for calibration gases can be performed without AC power. 14 AWG, 4 conductor is recommended, run in conduit separate from detector cables. If conduit is not used, wiring should have a suitable jacket to meet environmental and regulatory codes. The “Jumper” shown in the drawing is used to wire all solenoids at the ZA8C common (120 VAC). Note the manual calibration unit, model MC1, does not use solenoids, and therefore does not require cable.

NOTE: To prevent noise from solenoids from interfering with surrounding electrical lines, we recommend the use of metal conduit or shielded cable grounded at the auto cal unit.

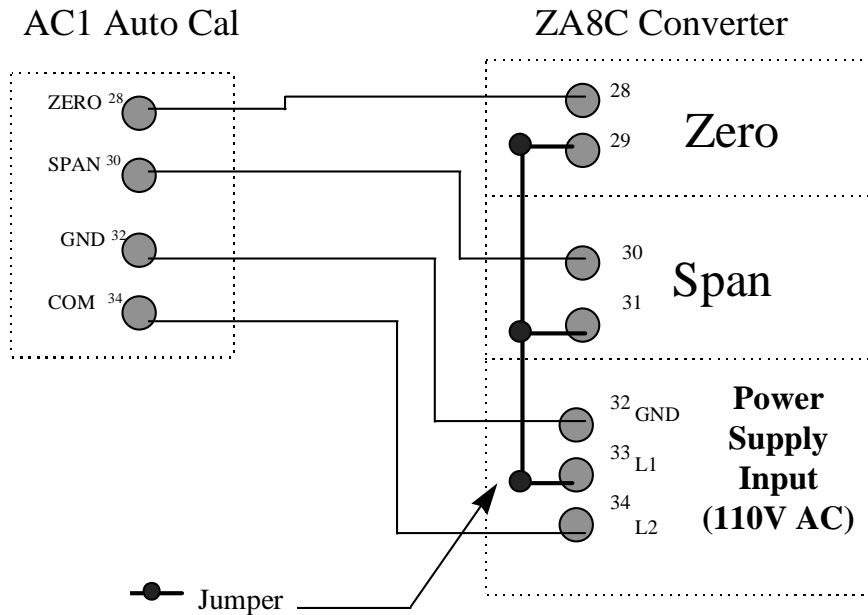


Figure 47: Interconnect Wiring for AC1 & ZA8C

WIRING

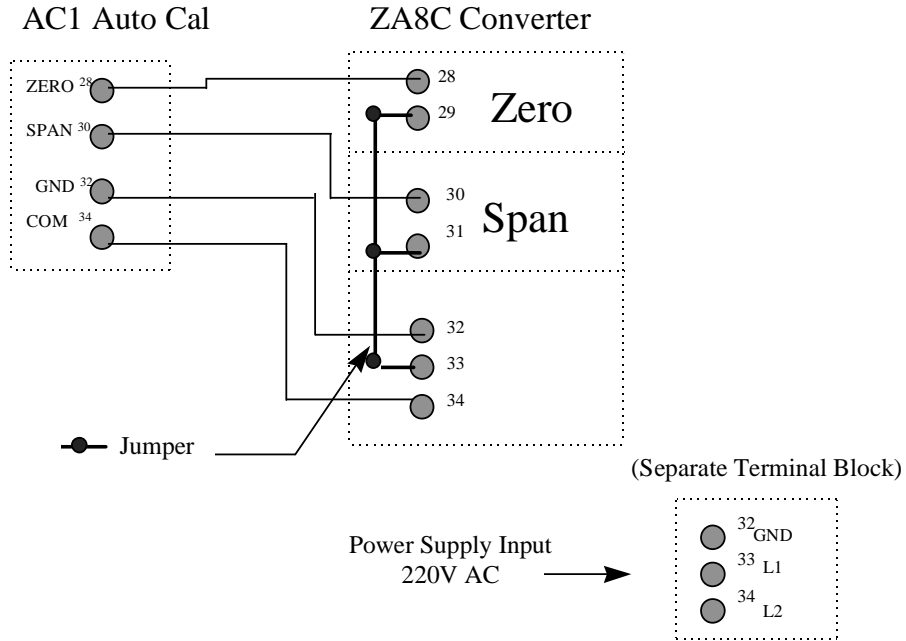


Figure 48: Interconnect Wiring for 220 V AC ZA8C & AC1

5.4 CONTACT OUTPUT WIRING (OPTIONAL)

The converter can output a maximum of 3 contact signals. The function of the output signals is determined from a menu of 13 parameters, as described in the G0 through G3 menu (i.e. “low limit alarm” or “high limit alarm”). See Figure 49 for wiring details. Use a cable suitable to safely transmit the signal based on the following: 30 VDC 2A and 250 VAC 2A. Grouping the conductors into 1 cable jacket is recommended when using multiple contacts, using either a 2, 4, or 8 conductor cable and dividing the signal after the junction box, as shown in Figure 49.

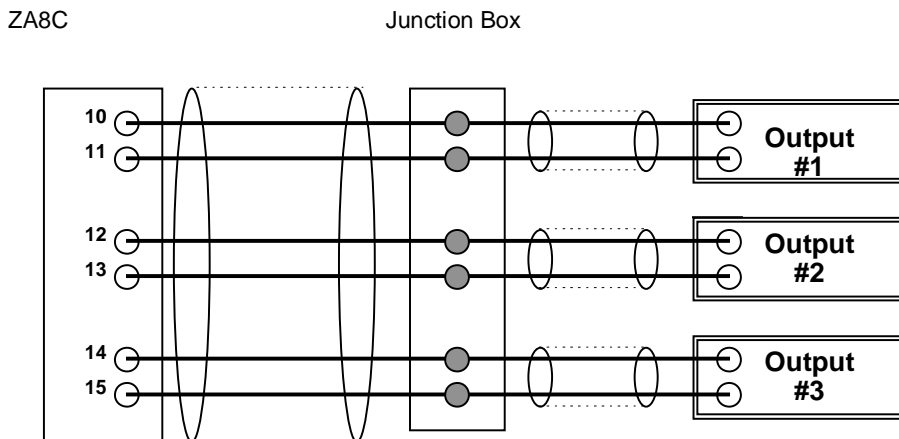


Figure 49: Contact Output Wiring

WIRING

5.4.1 Changing Relay Contact for Contact Output

Contact status (Normally Open or Normally Closed) of the contact outputs selecting applications with function No. G-0, G-1, or G-2 is determined by the selected relay operation (normally energized or de-energized) and types of relay contact (“make” contact or “break” contact).

NOTE: NO of the contact status means the contact operating status where the contact is “closed” when a contact signal is output (NC is its inversion). “Make” contact in the types of relay contact means the contact which is closed when the relay coil is energized.

Relay Operation	Type of relay contacts	Contact status		
		When contact signal	Normal condition	Power OFF
Normally Energized	Break contact (shortcircuiting jumpers 1 and 2)	[Closed]	[Open]	[Closed]
	Make contact (shortcircuiting jumpers 3 and 4)	[Open]	[Closed]	[Open]
Normally Deenergized	Break contact (shortcircuiting jumpers 1 and 2)	[Open]	[Closed]	[Closed]
	Make contact (shortcircuiting jumpers 3 and 4)	[Closed]	[Open]	[Open]

Table 11: Contact States Classified with Relay Operation and Types of Contact

On shipment, the relays are set as shown below.

- Function No. G-0 (Contact output #1, Contact status NO): Normally energized, Break contact
- Function No. G-1 (Contact output #2, Contact status NO): Normally de-energized, Make contact
- Function No. G-2 (Contact output #3, Contact status NO): Normally de-energized, Make contact

If the type of contact is necessary to be changed, do it in the following procedure. The relay operation can be set to function No. G-0, No. G-1, or No. G-2 with key operation.

- (1) Turn off the power switch in the converter.
- (2) Open the operating panel and remove the PCB cover. Remove screw 1 in Figure 50, and also loosen screws 2 and 3.
- (3) Set the corresponding jumper connector position again and change the type of contact. For obtaining a make contact, set the jumper connector to pins 2 and 3, while for obtaining a break contact, set the jumper connector to pins 1 and 2. When the set work has been done, reinstall the PCB cover and turn on the power switch.

WIRING

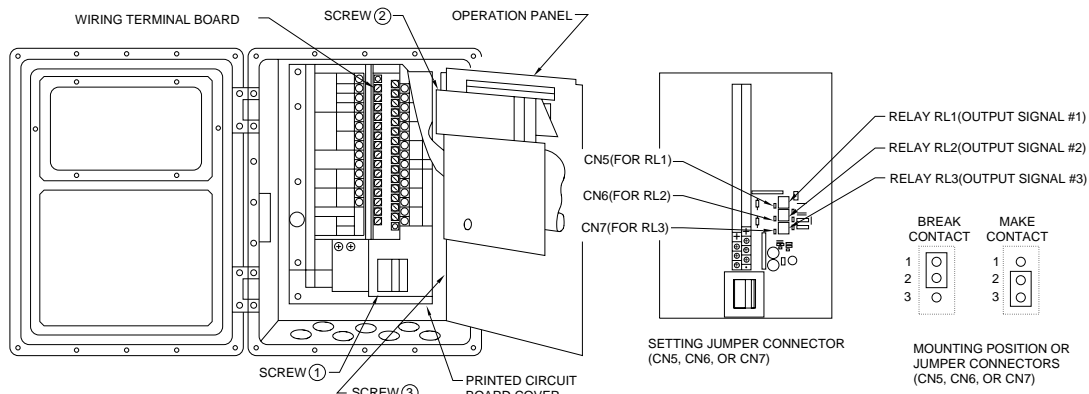


Figure 50: ZA8C Relational Diagram

5.5 CONTACT INPUT WIRING (OPTIONAL)

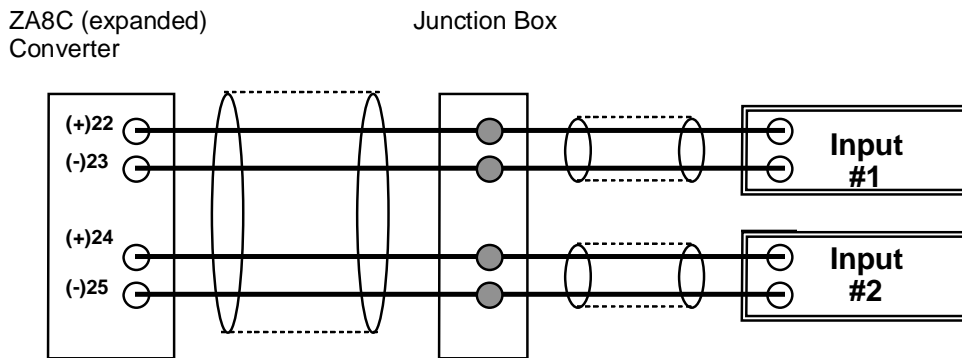


Figure 51: Contact Input Wiring

The wiring for the contact inputs is either a 2 conductor cable for use of 1 contact or a 4 conductor cable, for 2 contact inputs. Use a cable suitable to transmit the parameters shown in the table below:

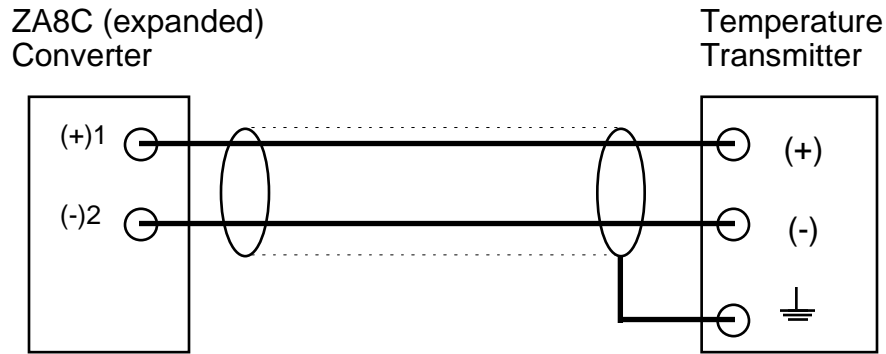
Description	ON electrical values	OFF electrical values
Resistance (contact)	less than 200 ohms	greater than 100 k ohms
Voltage	-1 to 1 V DC	4.5 to 25 V DC

Table 12: Contact Input ON/OFF Electrical Parameters

WIRING

5.6 TEMPERATURE INPUT SIGNAL WIRING (OPTIONAL)

The ZA8C converter can accept a 4 to 20 mA DC temperature input corresponding to the temperature range of a thermocouple. This temperature input is used by the ZA8C to calculate the boiler efficiency or to trigger an alarm whenever the process gas exceeds the setpoint. 2 conductor shielded cable is recommended that conforms to electrical standards. Ground the cable shield at the device that transmits the temperature signal to the converter.



Transmits 4 to 20 mA temperature signal only

Figure 52: Measurement Gas Temperature Input

CONFIGURATION

VI. PROGRAMMING

In this chapter, the basic operation methods for the ZA8C In-Situ Type Zirconia Oxygen Analyzer are described.

6.1 QUICK START-UP PROGRAMMING FOR ZA8C SINGLE POINT O₂ SYSTEM

6.1.1 CONFIGURING THE ZA8C CONVERTER

This is the final stage of the installation of your new Single Point Oxygen measuring system. At this stage you should have completed the following:

- Detector Installation
- Converter Installation
- Calibration Unit Installation
- Wiring/Tubing
- Setting Flow Rates for Calibration Unit.

If you have not completed any of the above, please do so before proceeding.

Please confirm the following:

- 1) There is a wire connected to all the terminals labeled in white (excluding shields) on the ZA8C. Open the front panel to perform this quick check. If there is a wire missing on any one of these “white terminals” then your ZA8C will not function properly (excluding analog output).
- 2) Verify that the zirconia cell was removed from its foam package and installed in the ZO21D detector.
- 3) Please record the mix of the calibration gases that you are using as follows:
Zero Gas: _____ % vol O₂
Span Gas: 21 % vol O₂

NOTE: The span is usually instrument air, which is between 19.0% and 21% vol O₂. Also, record the high and low set point values below.

HH: _____ % vol O₂ H: _____ % vol O₂
LL: _____ % vol O₂ L: _____ % vol O₂

Record the range of normal operation, and an alternate range:

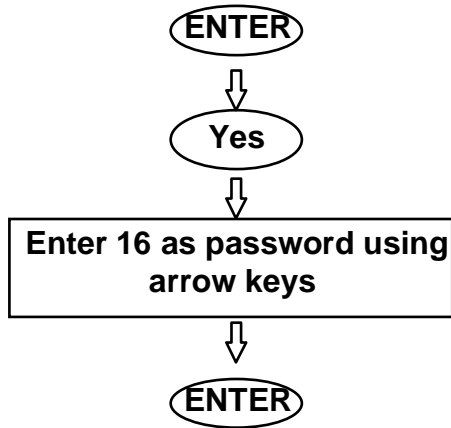
(Normal 4 to 20 mA range) Range 1: _____ % vol O₂ to _____ % vol O₂
Range 2: _____ % vol O₂ to _____ % vol O₂

6.1.2 POWER UP ZA8C

- 1) Open the front panel of the ZA8C and turn on the power. This button is located in the lower left hand corner.
- 2) Close the front panel. Your LED display will flash UUUUU and numbers. The number is the temperature of the O₂ cell in degrees Celsius. The LCD will display “Warming Up.” Now is the time to begin configuring the ZA8C.

CONFIGURATION

6.1.3 Procedure to Enter Maintenance Mode



Step 1: Press ENTER

LCD will display “Maintenance Mode/Entry Model <Y/N>” Note the green light to the left of the LCD.

Step 2: Press Yes

LCD will display “Password?”

Step 3: Use arrow (↑→) keys to Enter your 2 digit password number which is on the inside door on the ZA8C. Your number is probably 16.

Step 4: Press ENTER

This will Enter your password number. If your password is correct, the display will show the C0 menu. If the password is not accepted, the unit will Return to Step 1 above.

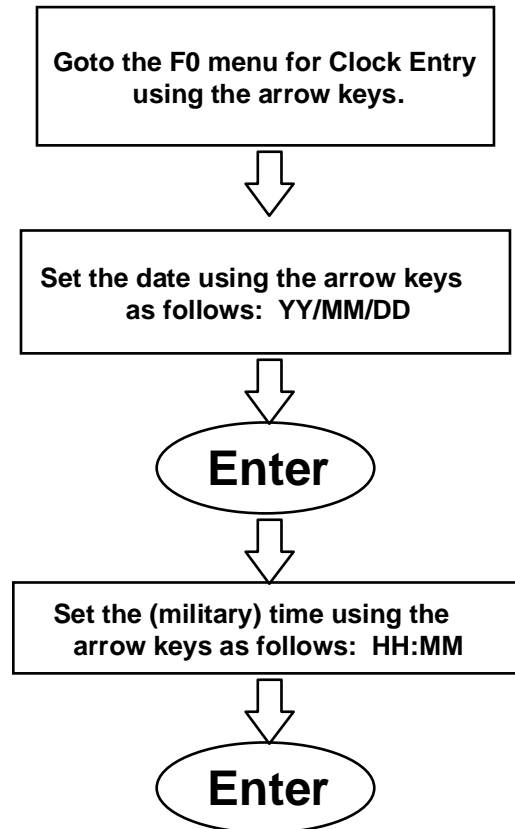
6.1.4 Procedure to set internal date and time

Step 1: Press the up arrow (↑) key 3 times for the FO Clock Entry menu.

Step 2: Use the arrow keys (↑→) to set the date as yy/mm/dd by placing the flashing indicator on the digit you wish to change.

Step 3: Press Enter.

Step 4: Also, Enter the (military) time as HH:MM. Remember to press the ENTER key.



CONFIGURATION

6.1.5 Procedure to enter calibration gas values

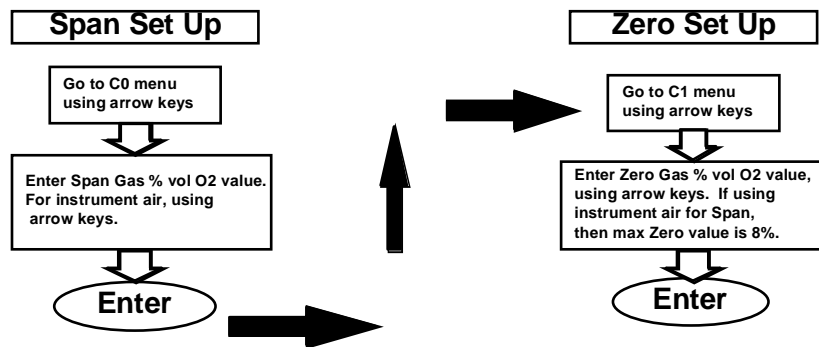
Begin entering the calibration gas and reference air values from the data that was recorded earlier in section 6.1.1.

Step 1: The flashing cursor must highlight the character you wish to change. To change press up arrow key (\uparrow) until the display shows C0, Span Value menu.

Step 2: Normally, if instrument air is used the Span value is between 19% and 21%. Use arrow keys ($\uparrow\rightarrow$) to enter 21%. Remember to press the ENTER key.

Step 3: Press right arrow (\rightarrow) key 1 time, then press up arrow key (\uparrow) 1 time for the C1, Zero Value menu.

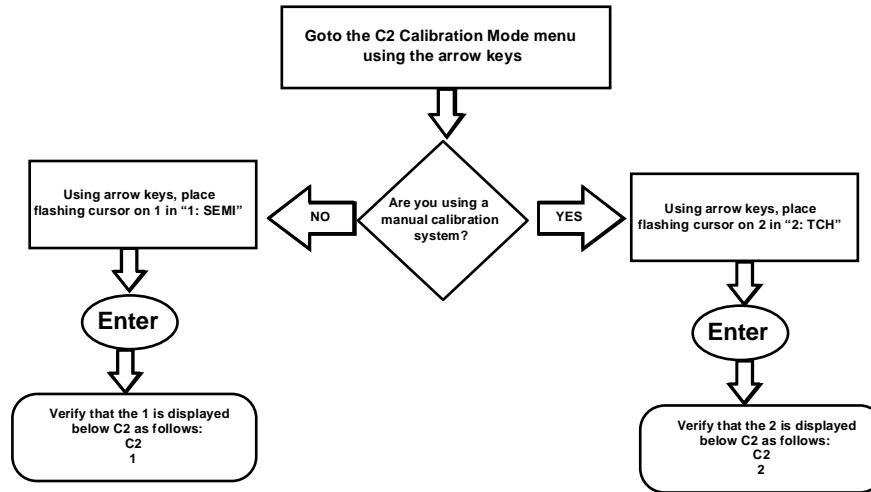
Step 4: Use the arrow keys to enter your vol% O₂ value for your zero gas cylinder. Remember to press the ENTER key.



The following is a list of values that must be programmed in order for the calibration system to work properly at the ZA8C.

CONFIGURATION

6.1.6 Procedure to set up calibration mode for manual or auto calibration systems

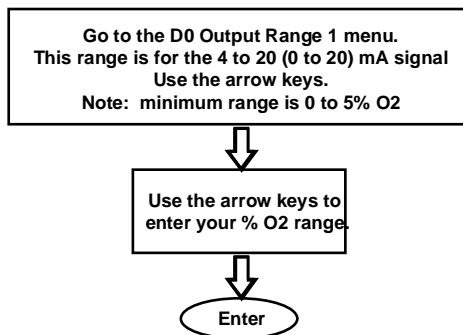


Step 1: Press right arrow key (→) 1 time, then press up arrow key 1 time for C2 menu, where we indicate the type of calibration system in use.

Step 2: If you are using a manual calibration system (i.e. no solenoids) enter Touch. Use the arrow keys to put the flashing indicator on the number 2, then press ENTER. The very left position should show the number 2.

Step 3: If you are using autocal, for now enter Semi-Auto, which will allow us to calibrate at the push of a button. Use the arrow keys to put the flashing indicator on the number 1, then press ENTER. The very left position should show the number 1.

6.1.7 Procedure to configure (0 to 100%)



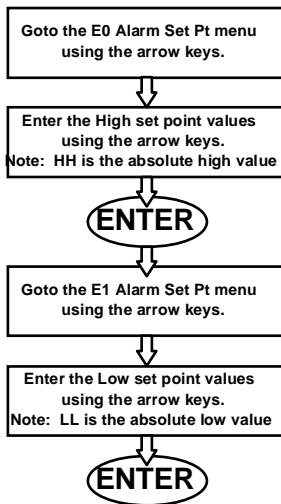
Step 1: Press the up arrow key 1 time for the D0 menu. Enter the normal Range for your O₂.

Example: If you are controlling around 8% O₂ and never get above 10%, set a range of 0 to 15%. This is your 4 to 20 mA (or 0 to 20 mA) signal.

Step 2: Use the arrow keys to enter your range. Remember to press the ENTER key.

CONFIGURATION

6.1.8 Procedure to set up alarm setpoints



Step 1: Using the arrow (\uparrow \rightarrow) keys, Go to the E0 Alarm Set Points menu.

Step 2: Enter the high set point values using the arrow keys. Don't forget to press ENTER.

Step 3: Using the arrow keys, go to the E1 Alarm Set Points menu.

Step 4: Enter the low set point values using the arrow keys. Don't forget to press ENTER.

6.1.9 Procedure to perform a manual calibration and record diagnostic parameters

Step 1: Exit the Maintenance mode by pressing the DISP (display) key. This returns the unit to the measurement mode.

Step 2: To begin a calibration, press the CAL key. The display will ask if you want to begin a span calibration, "SPAN CAL Y/N?"

Step 3: Press the YES key.

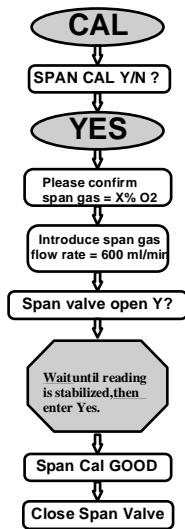
Step 4: If you are using a manual calibration system, begin the flow of span gas.

Step 5: Wait until the O₂ reading has stabilized.

Step 6: Press the YES key.

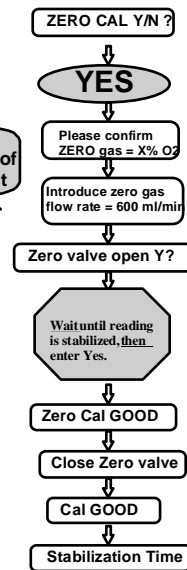
CONFIGURATION

SPAN Display Flowchart



Manual Cal Users should begin the flow of Span Gas at this point

ZERO Display Flowchart



Manual Cal Users should begin the flow of Zero Gas at this point

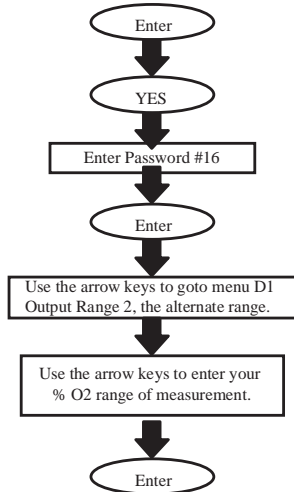
NOTE: At this point the unit will read the span gas and then prompt the manual calibration user to close the span valve. To complete the calibration, you must do a zero cal.

- Step 7:** The unit will ask if you want to do a Zero Cal, “ZERO CAL Y/N?”
- Step 8:** Press the YES key.
- Step 9:** If you are using a manual calibration system, begin the flow of zero gas.
- Step 10:** Wait until the O₂ reading has stabilized.
- Step 11:** Press the YES key.

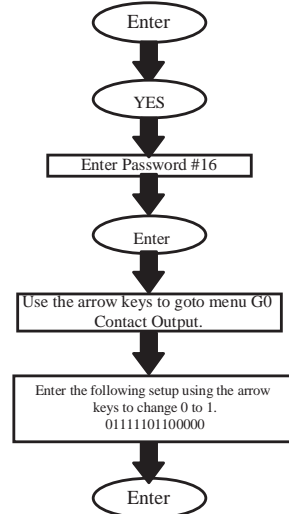
NOTE: At this point the unit will read the zero gas and then prompt the manual calibration user to close the zero valve. When the display asks if you want to do a span cal, press the NO key until the bar graph is displayed.

CONFIGURATION

SetUp Optional Range 2

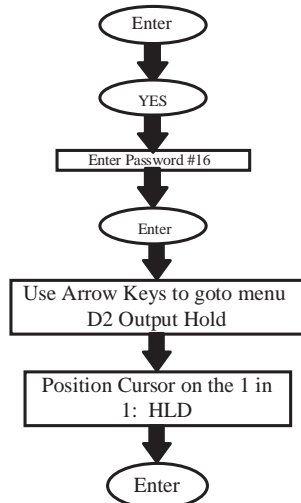


Program Range Answerback Contact Output

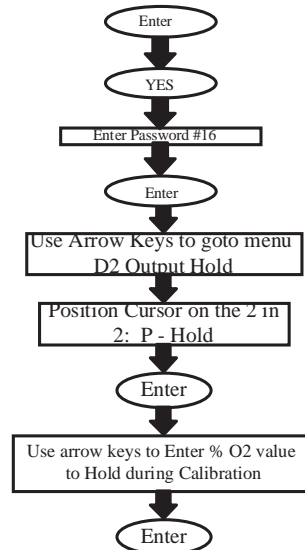


When a calibration is initiated, you can hold the output value prior to the calibration, or set a preset value until the calibration is completed. Should an error occur during calibration, the unit will remain in hold until the cause of the error is eliminated.

Hold Last Measured Value



Hold Pre-Determined Value



The ZA8C has a total of 4 contact outputs, which the User can choose to represent up to 14 different situations. We recommend that the User use at least the following conditions for LED alarm contacts:










CONFIGURATION

- 1) Error
- 2) High and Low Setpoints
- 3) Range selection Answerback
- 4) Calibration
- 5) Cal Gas Pressure (see Contact Output Section)

6.2 OPERATING KEYS

6.2.1 Types and Functions of Operating Keys

There are nine set keys on the operation panel of the converter. You can select an operation mode (measurement or maintenance), register temporary data, display various measurements or calculated data using these nine keys. To operate the keys, press the center of each key.

Key	Name	Functions/Applications
	Interactive key (yes)	Used for replying "yes" to an inquiry (Y/N?)
	Interactive key (no)	Used for replying "no" to an inquiry (Y/N?)
	Sub-message display key Calibration start key	Used for displaying sub-messages. Used for suspending calibration.
	Calibration start key.	Used for starting calibration in one-touch or semi-automatic calibration.
	Measurement mode select key. Calibration data display key.	Used for returning the mode from the setting mode, etc. to an analog bar display (measurement mode). Used for monitoring various data during calibration.
	Entry key. Setting-mode select key.	Used for registering data in setting mode. Used for changing from the measurement mode to the setting mode.
	Cursor key. Message COS key	Used for moving the cursor to the number or letter to be changed or registered. Used for the display continuation of a message on 2 or more screens.
	Number increase key. Number forward key.	Used for increasing a number on the cursor. Used for changing from one Function to the next.
	Number decrease key. Number backward key.	Used for decreasing a number on the cursor. Used for returning from one Function to the next.

6.2.2 Examples of Applications of the Operating Keys

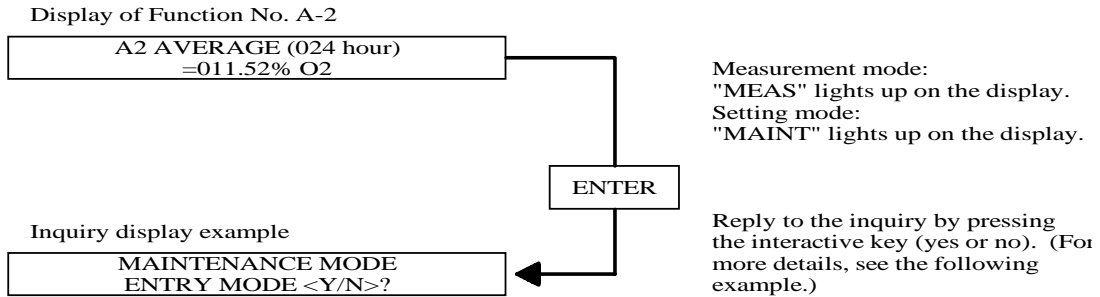
This section describes how to operate the keys with the following examples of operations. For displays, see chapter 7.

- 1) Change over from the measurement mode to the setting mode
- 2) Reply to inquiry
- 3) Entering the password
- 4) Selection of Function No. (Selection of number)
- 5) Selection of Function No. (Selection of group symbol)

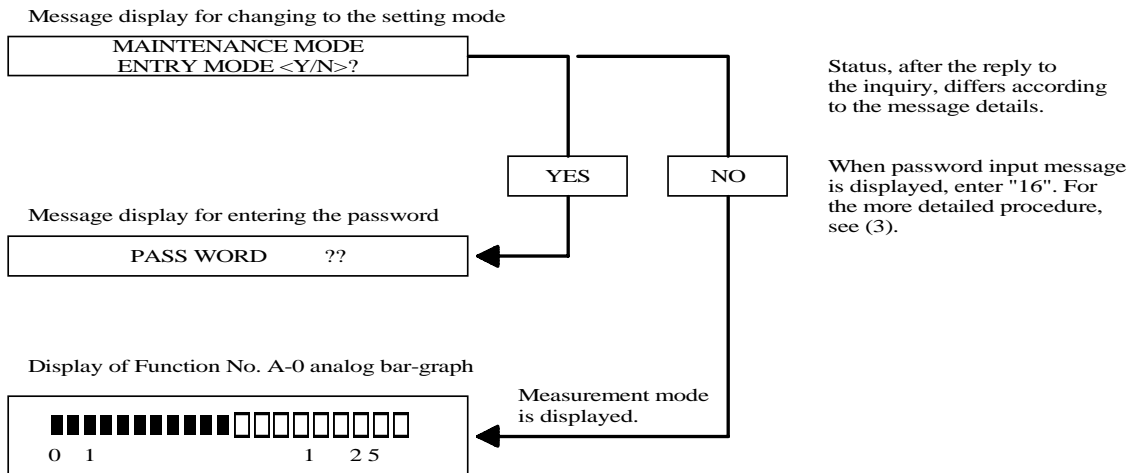
CONFIGURATION

- 6) Entering the setting data (Selection of setting details)
- 7) Entering the setting data (Input of data values)
- 8) Change over from the setting mode to the measurement mode
- 9) Changing displayed data
- 10) Calibration start or suspension instructions
- 11) Displaying the data values in the calibration mode

- 1) Change over from the measurement mode to the setting mode
Used as the setting mode selection key (entry key)



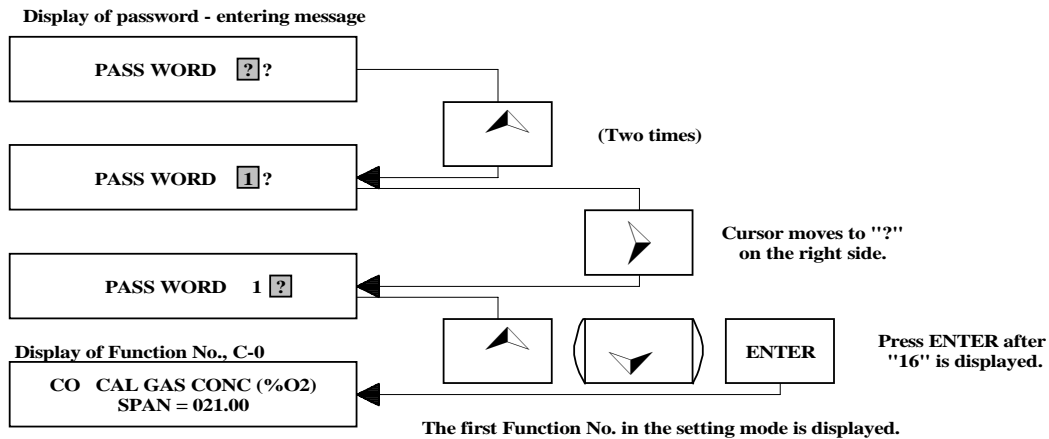
- 2) Reply to inquiry
Use an interactive key ("YES" or "NO" key).



CONFIGURATION

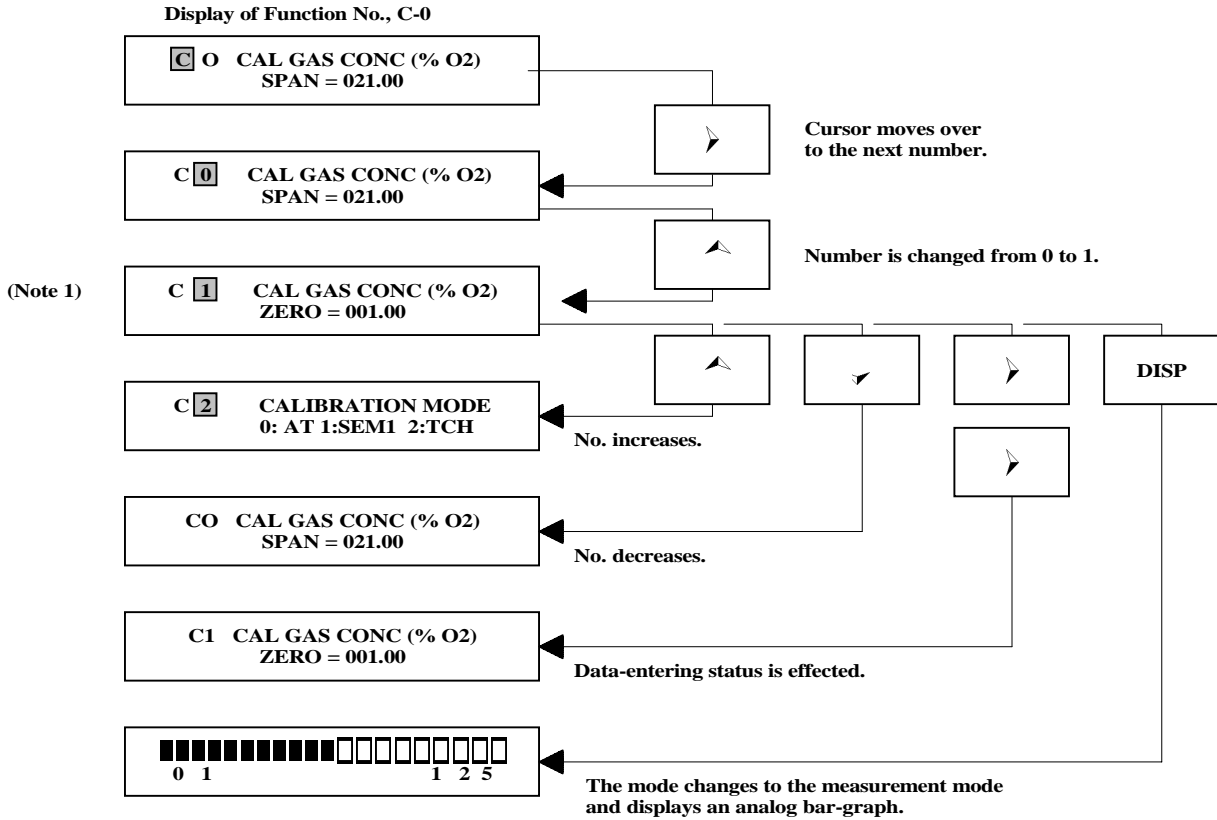
3) Entering the password (16)

To assign a function in the setting mode, enter the password. The password is "16", as shown on the label attached to the inside door of the ZA8C. To do so, use the number increase/decrease key, cursor movement key, and the entry key. The flashing indicator is positioned on the item that can be changed with the arrow keys.



CONFIGURATION

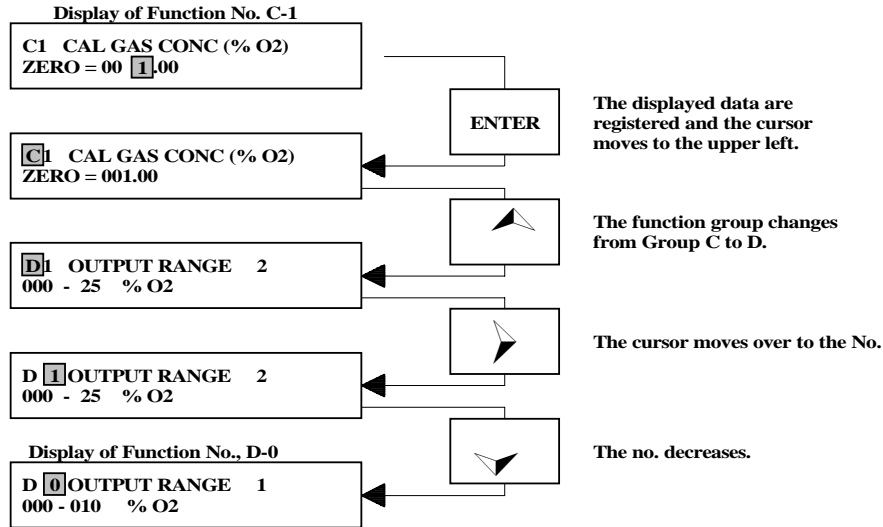
- 4) Selection of the Function No. (selection of number)
 The number increase key, number decrease key and the cursor key are used. The commonly used functions are silk-screened on the front of the ZA8C converter for easy operation without an instruction manual. However, the programming of the contact inputs and outputs, along with the efficiency parameters are only found in this manual.



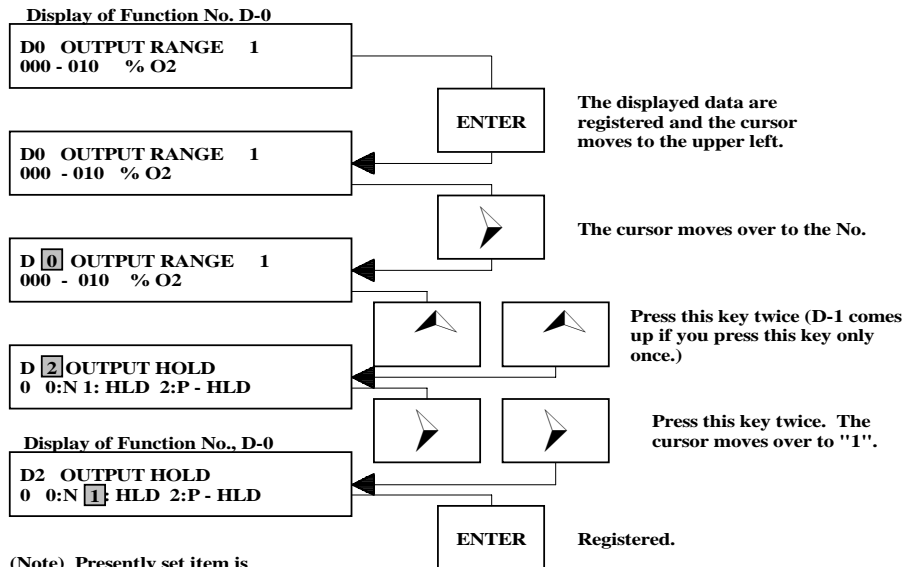
(Note 1) If the entry key "ENTER" is pressed when the cursor resides in a function No. position, note that "0:AT (automatic calibration)" is automatically set as the calibration mode.

CONFIGURATION

- 5) Selection of Function No. (selection of group symbol)
 Use the number increase key, number decrease key, entry key, etc. to select a group symbol. The type of key you select is dependent on the current operating state in which you are working (i.e., the operation mode and the position of the cursor).



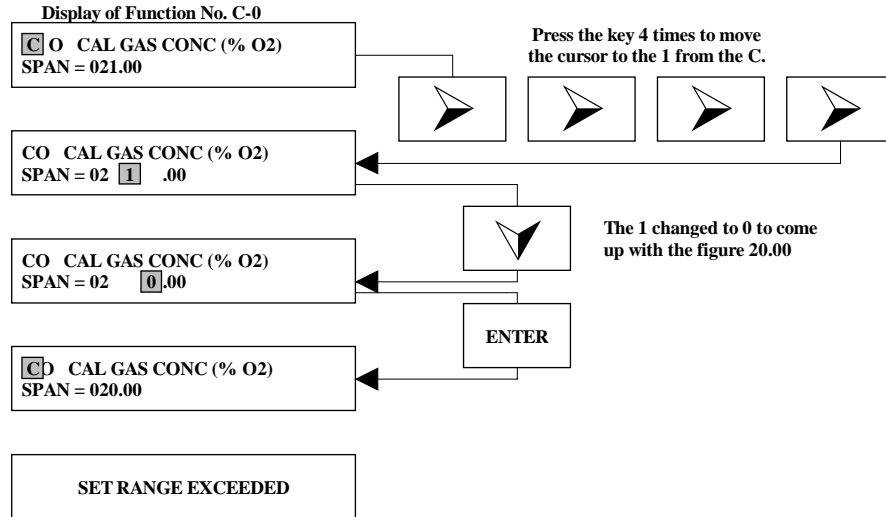
- 6) Entering the setting data (Selection of setting details)
 Use the number increase key, number decrease key, entry key, etc. for setting details. The type of key you select is dependent on the current operating state in which you are working (i.e., the operation mode and the position of the cursor).



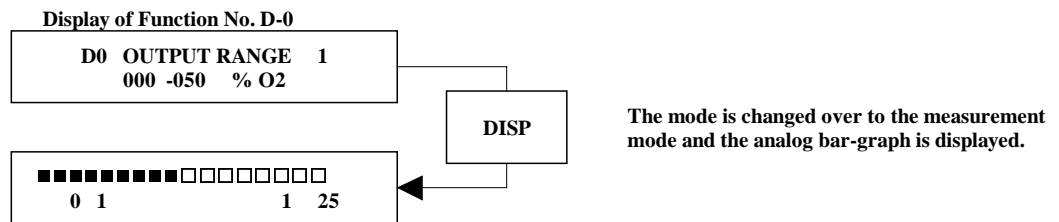
(Note) Presently set item is displayed by the number of left side in the lower line.

CONFIGURATION

- 7) Entering the setting data (Input of data values)
 Use the number increase key, number decrease key, cursor key, entry key, etc. Which keys you use depend on the present state you are in (i.e., the operation mode and the position of the cursor).

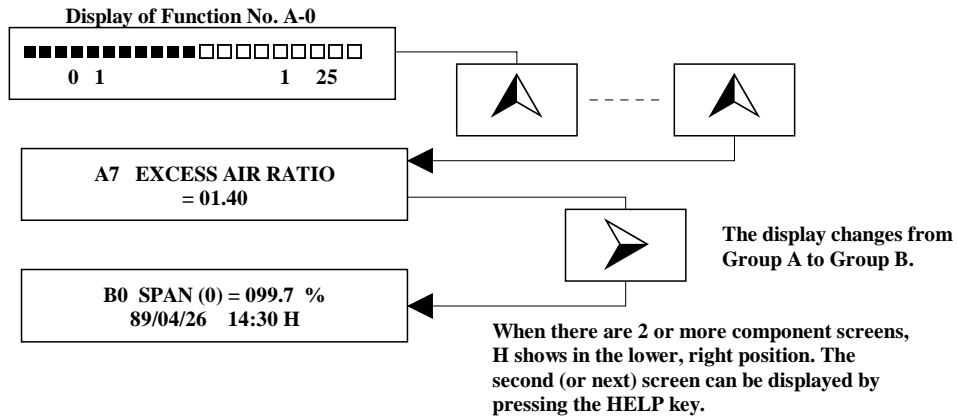


- 8) Change over from the setting mode to the measurement mode
 Use the measurement mode select key.

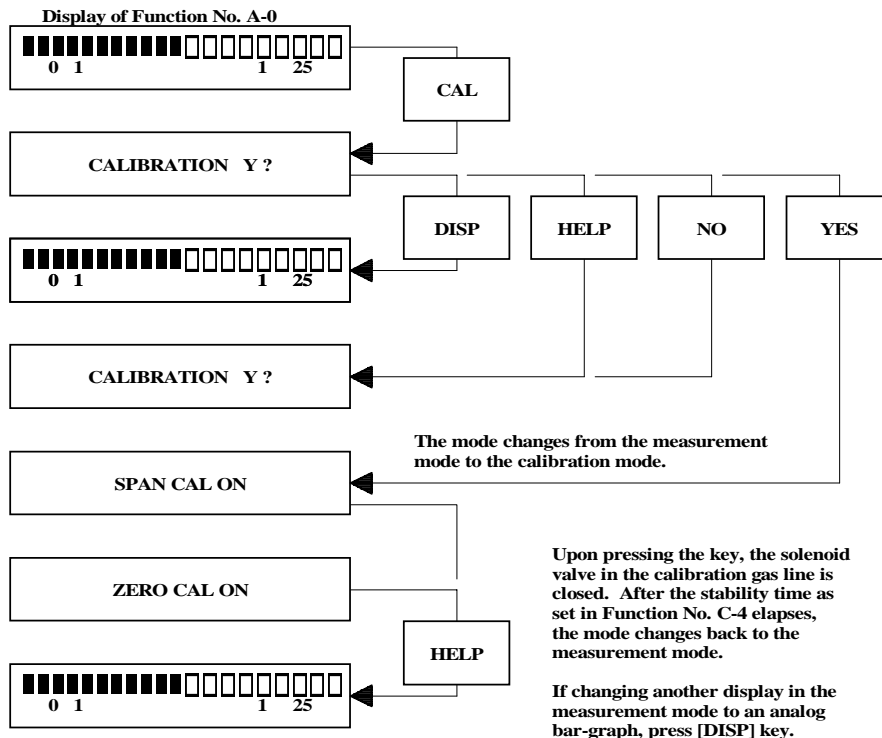


CONFIGURATION

- 9) Changing displayed data
 Use the number increase key to change the function number. Use the cursor key to change to another function group or to move to the next screen.



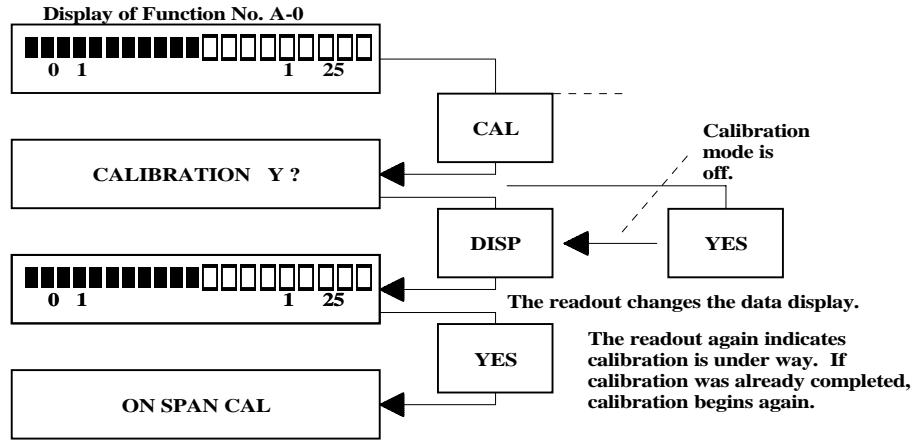
- 10) Calibration start or suspension instructions
 Use the calibration start or suspension key. For more details on the calibration keys, see chapter IX.



CONFIGURATION

11) Displaying the data values in the calibration mode

You can display the readout from Function No. A-0. You can also display the set data in Function No. C-0 and subsequent functions. However, no data is settable.

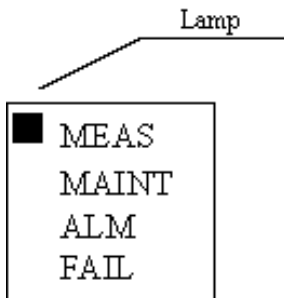


6.3 READOUT DISPLAYS

There are three kinds of readouts: a status display, data display and message display on the operation panel of the converter. In the status readout, the operation mode and the error alarm (if any) are displayed. In the data readout, the measured oxygen concentration and the details of any error which has occurred are displayed. In the message readout, various measured data, set data and messages are displayed.

6.3.1 Status Display

The related operation mode and the occurrence of an alarm, etc. are indicated by illuminated lamps.



MEAS: Lights up in the measurement mode.

MAINT: Lights up in the calibration mode or setting mode. This light also glows when an error occurs with the instrument stopping measurement operations.

ALM: Lights up when an alarm is issued according to the details set in Function Nos. G-0 to G-2. The operation mode changes from the measurement mode to the maintenance mode depending on the type of alarm.

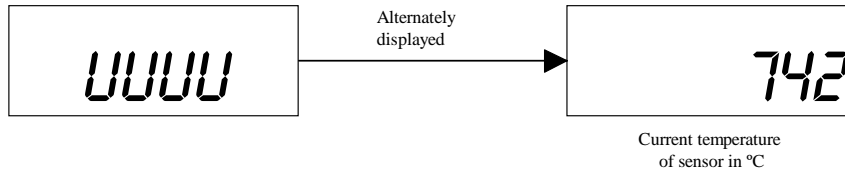
FAIL: Lights up when an error occurs while stopping the measurement operations of the instrument.

CONFIGURATION

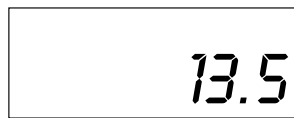
6.3.2 Data Display

This display incorporates a large 4-digit LED. Items displayed here are the warm-up state (warm-up symbol ON and the current temperature of the sensor), measured oxygen concentration (vol% O₂) and the error code. Normally, just the measured oxygen concentration is displayed.

- Example of warm-up state display

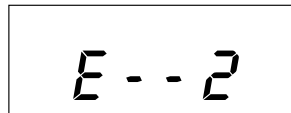


- Example of measured oxygen concentration display



NOTE: Measured value is displayed. Thus, even if "1" (oxygen concentration in dry gas) is selected in function No. D-6, indication in the data display is the oxygen concentration in wet gas.

- Example of error occurrence display



NOTE: An error display "E--5", "E--6" or "E--7" generated in calibration is indicated alternately with the oxygen concentration display.

6.3.3 Message Display

The message display incorporates the dot matrix LCD of 40 characters (20 characters x two lines). This readout displays the following messages:

To display the message of a value-setting group, you have to enter the specified password. The password is the 2-digit number "16".

- 1) Measurement value group A (Function No. A-0 - A-7)
- 2) Measurement value group B (Function No. B-0 - B-8)
- 3) Value-setting group C (Function No. C-0 - C-7)
- 4) Value-setting group D (Function No. D-0 - D-6)
- 5) Value-setting group E (Function No. E-0 - E-2)
- 6) Value-setting group F (Function No. F-0 - F-5)
- 7) Value-setting group G (Function No. G-0 - G-4)
- 8) Value-setting group H (Function No. H-0 - H-1)
- 9) Value-setting group J (Function No. J-0 - J-7)
- 10) Status message group
- 11) Interactive message group
- 12) Sub-message group

CONFIGURATION

Among other message groups, the value-setting group has already been described in 7.1.5. For the status, interactive and sub-message groups to be displayed automatically, the relevant descriptions will be given when required (e.g., “Calibration” in chapter 9). Therefore, the following description describes only the messages in the measurement value groups (1) and (2):

{Displaying measurement value group messages}

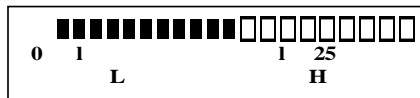
A-0 Display of an Analog Bar-graph

When you press the measurement mode select key, an analog bar-graph is first displayed. On the top line is displayed the analog bar-graph showing the oxygen concentration of the measurement span. On the bottom line are displayed the minimum and maximum values of the measurement range and arrows indicating the lower limit alarm set value (Lo) and the upper limit alarm set value (Hi).

When an error occurs, a message is also displayed. If there are multiple messages, “H” is displayed at the bottom right part of the display. Thus, in this case, display auxiliary messages using [HELP] key to confirm the contents.

- 1) The minimum unit on the analog bar-graph corresponds to 2.5% created by dividing the 100% of measurement span by 40. There is one displayed value after being smoothed.
- 2) Displayable alarm set values (indexes) are those only for the lower and upper limits. The extreme upper and extreme lower limits, if any, are not displayed. In addition, if the lower or upper alarm set value is set in excess of the measurement range, it is not displayed either.
- 3) If the alarm set value indication (index) overlaps the display unit of the minimum of maximum value in the measurement range, it is not displayed.
- 4) If the analog bar-graph indicates the hold value (preset or preceding value), “HOLD” is displayed in the lower line.

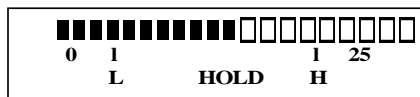
Display of analog bar-graph (Example 1)



(Note 1) The value corresponding to the output current is shown in the analog bar-graph. Therefore, when "1" is selected with function No. D-4, logarithmic indication of the current is displayed. When "1" is selected with function No. D-6, oxygen concentration in dry gas is displayed.

(Note 2) If a HOLD value is displayed, "HOLD" is also displayed.

(Example 2):
In HOLD state



CONFIGURATION

Display when an error occurs (Example 1)

**CELL FAILURE - CAUSE?
INCOR WRG (CONV > DET) H**

When more than one error occurs, "H" is displayed. Sequentially transfer the display using the auxiliary message display key.

**POOR or NC in OUTLNE
CELL BRKN or DMGD H**

**PLS READ INST MANUAL
"TROUBLESHOOTING"**

*Error Code "E---2"

Display when an error occurs (Example 2)

**TEMP TOO LO - CAUSE?
INCOR or BRKN WRG H**

**CLDJCT CKT, e + c - ABNL
HTR or TC LNE BRKN H**

**BLWN FU or POOR CONT
SHORT in TC H**

**PLS READ INST MANUAL
"TROUBLESHOOTING"**

CONFIGURATION

*Error Code "E---3"

Display when an error occurs (Example 3)

TEMP TOO HI - CAUSE?
INCOR or BRKN WRG H

CLDJCT CKT, e + c - ABNL
HTR or TC LNE BRKN H

BLWN FU or POOR CONT
SHORT in TC H

PLS READ INST MANUAL
"TROUBLESHOOTING"

*Error Code "E---4"

Display when an error occurs (Example 4)

ANALOG CKT FAILURE
AD CONV DEFECTIVE H

CUST RPR IMPOSSIBLE
CONT .YIA SVCE DEPT

*Error Code "E---5"

Display when an error occurs (Example 5)

CAL VAL ABNL (0 PT)
CAUSE? CELL DMGD H

CAL GAS FLTR < IND ' D
POSSIBLE LEAK H

WRNG GAS - CHNG SPAN --> 0
DIFF CONC & MEM VAL H

PLS READ INST MANUAL
"TROUBLESHOOTING"

*Error Code "E---6"

Display when an error occurs (Example 6)

CAL VAL ABNL - SPAN PT
CAUSE ? CELL DMGD H

CAL GAS FLTR < IND ' D
POSSIBLE LEAK H

WRNG GAS - CHNG 0 --> SPAN
DIFF CONC & MEM VAL H

PLS READ INST MANUAL
"TROUBLESHOOTING"

CONFIGURATION

*Error Code "E---7"

Display when an error occurs (Example 7)

STAB T FNSHD -- CAUSE?
T OV B F R OUT STBLN H

CAL GAS FLRT < IND 'D
POS LKG / CELL DMGD H

PLS READ INST MANUAL
"TROUBLESHOOTING"

*Error Code "E---8"

Display when an error occurs (Example 8)

MEMORY FAILURE in
ROM/RAM H

CUST RPR IMPOSSIBLE
CONT YIA SVCE DEPT

A-1 Maximum or Minimum O₂ Concentration

The maximum and minimum values of measured oxygen concentrations are stored and updated according to the time intervals set in function No. F-2. In function No. A-1, the latest values are displayed. By subsequently pressing "HELP", the auxiliary message display key, generated data and time of those values are displayed.

Display of maximum and minimum O₂ concentrations (example)

A1 MAX = 19.32 %O₂
MIN = 15.48 %O₂ H

A-2 Mean O₂ Concentration

The mean value of the measured oxygen concentration is stored and updated according to the time intervals set in function No. F-1. In function No. A-2, the latest value is displayed.

Display of mean O₂ concentration (example)

A2 AVERAGE (024 hour)
016.92 %O₂

CONFIGURATION

A-3 Cell Voltage

Cell (sensor) voltage is an index for noting the deterioration of the sensor. In function No. A-3, the cell voltage at the oxygen concentration presently measured is displayed. The sensor is judged to be normal if the measured value agrees with the theoretical value at the same oxygen concentration.

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

Where P_x : O_2 concentration in the measurement gas

P_a : O_2 concentration in the comparison gas (21 vol% O_2)

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

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

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

% O_2	100
mV	-34.4

Figure 53: Oxygen Concentration, Vol% O_2 vs Cell Voltage mV (Cell temperature 750° C)

Display of cell
voltage (example)

A3 CELL EMF = 018.3 mV

A-4 Cell Temperature/Thermocouple Voltage

Cell temperature is measured using a type K (chromel-alumel) thermocouple. The cold junction of this thermocouple is located at the terminal end of the detector. The temperature at this cold junction is measured with a transistor. In function No. A-4, displayed is a voltage affected by the temperature at the cold junction terminal.

If the cell temperature is higher than 780° C (1436° F), error “E—3” is effected, while error “E—2” is displayed at 730° C (1346° F) or less.

NOTE: When the cell temperature is to be determined based on the displayed voltage, compensate for voltage error due to the temperature at the cold junction.

Display of
cell temperature/
thermocouple voltage
(example)

A4 CELL TEMP = 0750°C
TC (K) EMF = 030.4 mV

CONFIGURATION

A-5 Output Current/Output (Measurement) Range

The current output value (mA) of the output signal and the measurement range (vol% O₂) are displayed.

Display of
output current/
measurement range
(example)

A5 OUTPUT = 10.4 mADC
RANGE = 000 - 025% O₂

NOTE: The relationship between the output values of the current (mADC) and the oxygen concentration (vol% O₂) is as shown below:

- (1) For a linear output signal of 0 to 20 mADC:
Output current (mA) = 20 x (Px/Range H)
 - (2) For a linear output signal of 4-20 mADC:
Output current (mA) = 16 x (Px/Range H) + 4
 - (3) For a logarithmic output signal of 0 to 20 mADC:
Output current (mA) = 20 x {(1/log(Range H/0.1))} {log(Px/0.1)}
 - (4) For a logarithmic output signal of 4-20 mADC:
Output current (mA) = 16 x {(1/log(Range H/0.1))} {log(Px/0.1)} + 4
- Where, Px: Oxygen concentration (vol% O₂)
Range H: Maximum value of measurement range (vol% O₂)

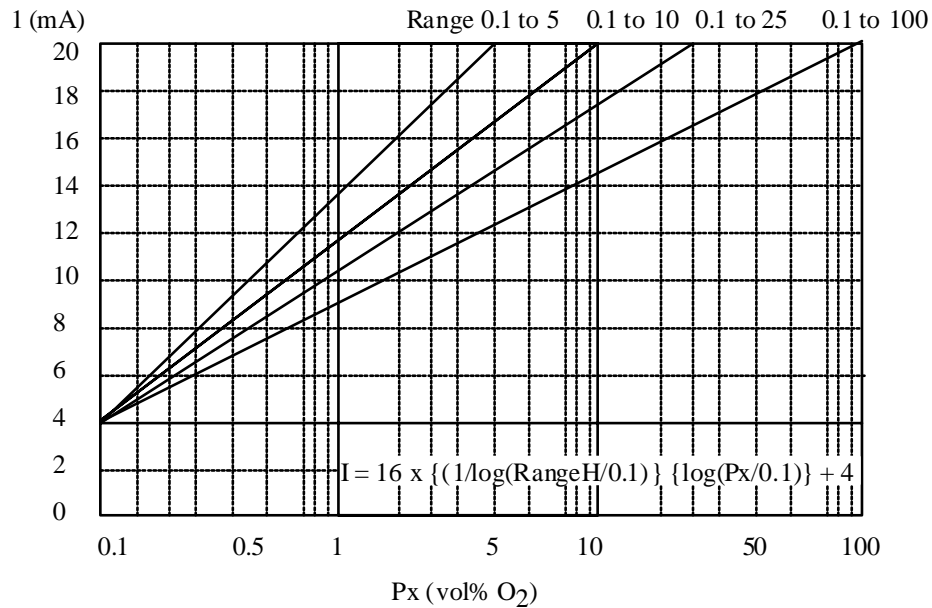


Figure 54: Relationship between each range and the logarithmic output signal (4-20 mADC)

CONFIGURATION

A-6 Time

The time is displayed by the clock function of the converter (Year, Month, Day, Hour, Minute). If correction of this time is required, enter the correct time in Function No. F-0.

Display of time
(example)

A6 PRESENT TIME
90/05/26 13:00

NOTE: Clock function must be reset when power is removed from the analyzer.

A-7 Air Ratio

The current air ratio, obtained by calculation, is displayed. If you use this air ratio data for estimating the combustion efficiency, etc., check that there is no air leaking in beforehand and that the measured value has not been affected by any interference gas (CH₄, CO, H₂, etc.)

Air ratio *m* is calculated by the following formula:

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

Display of air ratio
(example)

A7 EXCESS AIR RATIO
03.59

NOTE: A-7 is the last message in the measured value group A. If you want to display messages in measured value group B, press the cursor { > } key.

B-0 Span Point Correction Ratio Record

The span point correction ratio, obtained every time the span point is calibrated, is displayed. You can determine the degree of deterioration in the cell (sensor) from this value. You can display the data record for the previous ten times including the latest data. To display each datum on the screen, call up the next screen by pressing the message "HELP" key. You can have the span point correction ratio as follows: Color the correctable range of the span point is 0 ±18% (corresponding to a voltage at a span point of about ±15 mV).

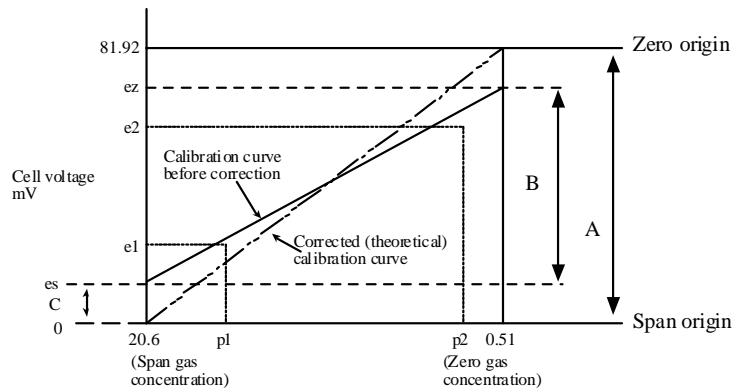


Figure 55: Span Point Correction Ratio

CONFIGURATION

Zero point correction factor = $(B/A) \times 100$ (%) Correctable range: $100 \pm 30\%$

Span point correction factor = $(C/A) \times 100$ (%) Correctable range: $0 \pm 18\%$

Display of the span
point correction ratio
record (1) (example)

B0 SPAN (0) = 001.5%
89/04/30 09:30 H

B-1 Zero Point Correction Ratio Record

The zero point correction ratio, obtained every time the zero point is calibrated, is displayed. You can determine the degree of cell (sensor) deterioration from this value. You can display the data record for the previous ten times including the latest data. To display each data display screen, call up the next screen by pressing the message “HELP” key. You can get the zero point correction ratio by the method in Figure 54. The correctable range for the zero point is $100 \pm 30\%$.

Display of the zero
point correction ratio
record (1) (example)

B1 ZERO (0 = 098.7%
89/04/30 09:30 H

B-2 Response Time

Response time, displayed in function No. B-2, can be obtained during calibration by the method in Figure 55.

NOTE: If the zero point or the span point is skipped, it is not executed as in the one-touch calibration mode.

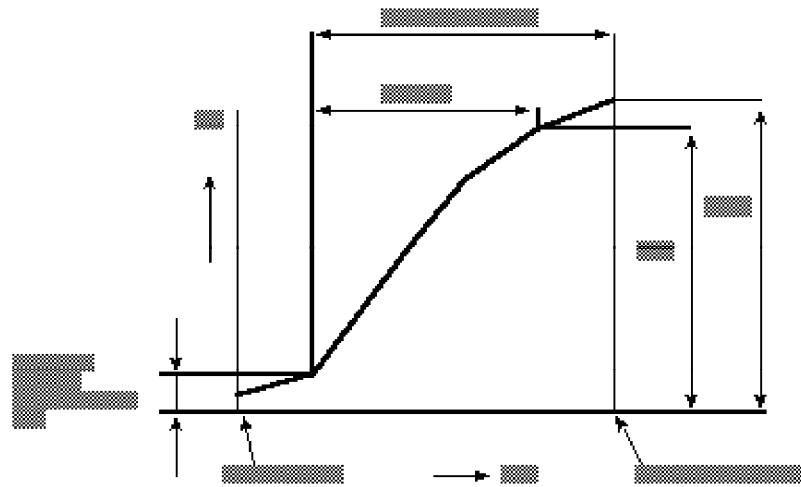


Figure 56: Calculation of response time

Response time is calculated after the corrected calibration curve is obtained. With a starting point where a voltage corresponding to 10% of the corrected calibration curve span is found, the time that it takes for the voltage to reach the 90% mark of a 100% voltage corresponding to the oxygen concentration of a calibration gas (zero gas) set in the converter is calculated. In other words, the response time for the above is in the range from 10 to 90%.

CONFIGURATION

Display of response
time (example)

B2 CELL RESPONISE
(10 - 90%) = 003 SEC

B-3 Resistance in the Cell

A new cell (sensor) has an internal resistance of less than 200Ω. The resistance increases as the cell deteriorates. Therefore, the internal resistance of a cell is an index for indicating the degree of the sensor deterioration. In function No. B-3, the value obtained at the most recent calibration is displayed.

Display of inner
resistance of cell
(example)

B3 CELL RESISTANCE
00175 OHM

B-4 Robustness of the Cell

The robustness of the cell, an index for estimating the remaining life of the cell (sensor) is classified by a number from five (good) to one (poor). This robustness is determined after comprehensively evaluating various data monitored during calibration (e.g., the response time, the internal resistance of the cell, and the calibration coefficient.). However, when the zero point or span is skipped, no response time is measurable. Thus, cell robustness is obtained from the other evaluation items.

Display of
cell robustness
(example)

B4 SELL ROBUSTNESS (5)
LIFE > 12 MONTH

B-5 Temperature at the Cold Junction on a Thermocouple

The temperature at the cold junction terminal, measured with a transistor, is displayed. The highest permissible temperature of the terminal is 80° C (176° F). If this temperature is exceeded, it must be lowered by shielding the detector terminal box from radiation heat, etc.

Display of the
temperature at the cold
junction on a
thermocouple (example)

B5 CJ TEMP = 026°C

B-6 Heater ON Time Ratio

The sensor in the detector is heated up to and maintained at a temperature of 750° C (1382° F) by the heater. The higher the temperature of the measurement gas, the less the ON time of the heater becomes. However, if this time becomes too short, the temperature of the measurement gas might exceed the limit temperature of 600° C (1100° F), which is not recommended for the detector. The heater ON time ratio is an index for monitoring an abnormal temperature rise in the measurement gas. However, its critical temperature rise varies depending on the conditions in individual processes. Therefore, no definite specifications are given herein; however, a general guideline is about 20 to 30%.

CONFIGURATION

Display of the heater
ON time ratio
(example)

B6 CELL HEATER DUTY
037.5%

B-7 Dry O₂ Concentration/Moisture Content

When data corresponding to Function No. J-0 to J-7 are set, the captioned values are calculated based on the data while displaying the dry O₂ concentration (vol% O₂) and the moisture content (% H₂O) in the exhaust gas as follows:

Display of the dry O₂
concentration/moisture
content (example)

B7 DRY O2 = 097.51 %O2
SET H20 = 0010.5 %H20

B-8 Combustion Efficiency

The combustion efficiency is an effective operation control item even with a small boiler such as, a package boiler. When the data related to function No. J-0 to J-7 are set, an approximate combustion efficiency is calculated based on the data and is displayed by function No. B-8.

When 0° C (° F) is assigned in function F-4, “range input temperature”, the value J6 is displayed directly as the temperature of the exhaust gas.

Display of combustion
efficiency (example)

B8 GAS TEMP = 0450°C
COMB EFF = 076.0%

NOTE: The readouts of all the messages in measured value group B have been described on the preceding pages.

CONFIGURATION

6.4.3 Data Setting Configuration

The ZA8C In-Situ Type Zirconia Oxygen Analyzer allows custom configuration functions for your individual application.

Basic data, e.g., parameters required for operation, are stored in EEPROM in the converter. Temporary data, as set forth individually, are stored in the RAM. The temporary data, read in the RAM, are preserved through the backup of an electric double-layer capacitor for a short time even if the main power supply fails. After that, however, the data in the RAM is lost while the stored data in the converter changes to a default state.

Upon shipment, the data loaded into the converter are in the default state. When operation begins, set the data to match each operation. The following table shows the default values.

Menu groups A & B are display functions which are discussed later in this chapter. The following menus are set up parameters required for accurate operation of your oxygen analyzer system.

GROUP C (0 THROUGH 7)

C-0 SPAN GAS CONCENTRATION

Set the oxygen concentration for the span gas used in calibration. If, for example, instrument air is used as a span gas, set the value at 20.6 vol% O₂ by entering “020.6”.

Message display (Example)

C0 CAL GAS CONC (%O2)
SPAN = 020.60

C-1 ZERO GAS CONCENTRATION

Set the oxygen concentration for the zero gas used for calibration. Set it for the certified gas value in the cylinder you are using at present. If, for example, the concentration is 1 vol% O₂ enter “001.00”.

Message display (Example)

C1 CAL GAS CONC (%O2)
ZERO = 001.00

CONFIGURATION

Group	No.	Setting range or default details	Default	LCD display	Setting
Calibration	C-0	Span gas concentration: 4.5 to 100 vol% O ₂	21.00% O ₂	21	
	C-1	Zero gas concentration: 0.3 to 100 vol% O ₂	1.00% O ₂	1	
	C-2	Mode: One-touch(TCH)/Semi-Auto(SEMI)/Auto(AT)	TCH	2: TCH	
	C-3	Stabilizing time: 0 to 10 minutes	3.0 min	3.0 minutes	
	C-4	Calibration time: 0 to 10 minutes	3.0 min	3.0 minutes	
	C-5	Calibration schedule: 0 to 255 day or 0 to 23 hours	1 day	1 day	
	C-6	Calibration start time: Month, Day, Hour, Minute			
Analog Output	D-0	Range 1: (0 to 5) to (0 to 100) vol% O ₂	0 to 10% O ₂	000-010% O ₂	
	D-1	Range 2: (0 to 5) to (0 to 100) vol% O ₂	0 to 25% O ₂	000-025% O ₂	
	D-2	Hold: None(N), HLD, P-HLD	HOLD	1: HLD	
	D-3	Selection: 4 to 20 mA or 0 to 20 mA	4 to 20 mA DC	0: 4-20 mA	
	D-4	Output characteristic selection: Linear/Log	Linear	0: Linear	
	D-5	Smoothing constant: 0 to 255 sec.	0 sec	000 sec	
	D-6	Wet gas O ₂ /Dry gas O ₂	Wet gas O ₂	0: WET	
Alarm	E-0	Extreme Upper limit/Upper limit: 0 to 100.0% O ₂	Both 0 (none)	HH=0, HI=0	
	E-1	Extreme Lower limit/Lower limit: 0 to 100.0% O ₂	Both 0 (none)	LL=0, LO=0	
	E-2	Contact delay: sec, Hysteresis: %O ₂	3 sec, 0.1% O ₂	3 sec, 0.1% O ₂	
Time matching, temperature unit assigning, etc.	F-0	Hour-meter setting: Day/Hour, Minute			
	F-1	O ₂ concentration averaging time: 1 to 255 hour	1 hr	1 hr	
	F-2	Max/Min O ₂ averaging time: 1 to 255 hour	24 hr	24 hr	
	F-3	Temperature unit specification: °C, °F	°C	0: °C	
	F-4	Input temperature range: 0 to 3000°C/°F	None (Note 1)		
Contact Output	G-0	Contact output 1	NE/F		
	G-1	Contact output 2	NDE/E+C+W		
	G-2	Contact output 3	NDE/H+L		
Contact Input	G-3	Contact input 1	R	1: R	
	G-4	Contact input 2	R	1:R	
Communication	H-0	Communication mode: freewheel/handshake	handshake	handshake	
	H-1	Baud rate: 9600 b/s, 4800 b/s, 2400 b/s	4800 bps	1:48	
Fuel calculation data	J-0	Types of fuels			
	J-1	Moisture content in exhaust gas: 0 to 5 m ³ /kg(m ³)			
	J-2	Theoretical air quantity: 1 to 20 m ³ /kg(m ³)			
	J-3	Net calorific value: 0 to 15000 kcal/kg(m ³)			
	J-4	X value (X=a+b*H1)			
	J-5	Absolute humidity of atmosphere: 0 to 1 kg/kg			
	J-6	Temperature of exhaust gas: 0 to 2000°C			
J-7	Temperature of atmosphere: -50 to 60°C				

Table 14: Configurable Items and Their Defaults

CONFIGURATION

C-2 CALIBRATION MODE

Select mode from AUTO (AT), SEMI-AUTO (SEMI) and ONE-TOUCH (TCH). Set the cursor to the corresponding number. The calibration mode presently set is expressed with the member displayed under the function number.

Message display (Example)

```
C2 CALIBRATION MODE
2  0: AT  1: SEMI  2: TCH
```

Number of mode presently set.

C-3 STABILIZING TIME

Set a waiting period from the completion of the calibration to the beginning of measurements again, in minutes. Set an interval for the time between stopping the flow of the calibration gas and completing the replacement of the calibration gas with measurement gas. If, for example, it is 3 minutes 30 seconds enter "03.5".

The operation mode, switched to the maintenance mode (MAINT) during calibration operations, will return to the measurement mode (MEAS) after the stabilizing time has passed.

Message display (Example)

```
C3 STABILIZING TIME
03.5 minutes
```

C-4 CALIBRATION TIME

Set a time after which the converter reads the oxygen concentration of a calibration gas (span gas or zero gas). In automatic or semiautomatic calibration mode, set a time (in minutes) from which the converter turns on the appropriate solenoid valve causing the calibration gas to flow to the probe. In one-touch calibration, set a permissible maximum interval (in minutes) for the time between when you enter a positive answer (by pressing the "YES" key) in reply to the message "Span (or Zero) valve open Y?" shown in the message display, and when the calibration value is completely read. If, for example, for five minutes enter "05.0".

Upon the completion of the calibration time interval, you will see the message, "Span (or Zero) cal good".

Message display (Example)

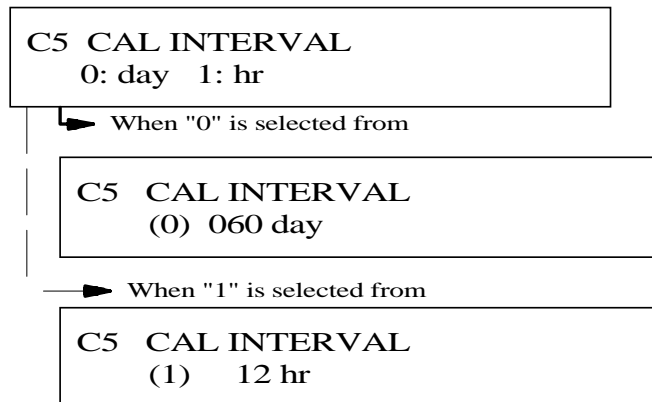
```
C4 CALIBRATION TIME
05.0 minutes
```

CONFIGURATION

C-5 CALIBRATION FREQUENCY

In automatic calibration, you can set the interval from the time of starting a calibration to the time of starting the next calibration. Set in days or hours, according to the calibration frequency of your process conditions. It is normally recommended that intervals of one to three months (30 to 90 days) be used. If a calibration interval of 60 days is to be set, select "0" from the settable-item selection messages thereby displaying the day-setting message and set 60 days by entering "060". If you want to set 12 hours select "1" from the settable-item selection messages and enter 12 hours with "12".

Message display (Example)



C-6 CALIBRATION START TIME

Set the date and time at which the first automatic calibration is to start. If it is 4:30 p.m., July 15, 1994 set the date by entering "94/07/15 16:30".

Message display (Example)



NOTE: If you change any parameters in C-0 through C-5 and are operating in the auto-cal mode, you must enter a cal start time in C-6 later than present time and date.

C-7 SKIP

Calibration is normally performed for both zero and span points. However, either of them may be skipped (but both zero and span points should be calibrated once). If you do not want to skip either, select "0". For skipping span or zero point, select "1" or "2", respectively.

These assignments are effective for semiautomatic and automatic calibrations. You cannot omit them in one-touch calibration.

CONFIGURATION

Message display (Example)

C7	SKIP
0	0: NONE 1: SPN 2: ZR

GROUP D

D-0 OUTPUT RANGE 1

Set the range of oxygen concentration to correspond to the analog output signal (4-20 mA or 0 to 20 mADC). You can set a free range from 0 to 5 vol% O₂ to 0 to 100 vol% O₂. Also, a partial range is selectable provided the minimum operating span is 5 vol% O₂ under the condition that the ratio of “maximum/minimum” is “1.3:1” or greater.

NOTE: If the output mode is set to “Logarithm” in function No. D-4, the minimum value of the output range is always “0.1” regardless of this setting.

Message display (Example)

D0	OUTPUT RANGE	1
	000 - 010	%O2

D-1 OUTPUT RANGE 2

Output Range 2 can be output only when the converter has the functions of “contact input” or “digital communication” by the “range change command”. Similar to output range 1, set the oxygen concentration range correspondent to the analog output signal (4-20 mADC or 0 to 20 mADC). Any range from 0 to 5 vol% O₂ up to 0 to 100 vol% O₂ can be set.

In addition, if the “range selection command” is to be made with a contact input, select Change in measurement range in function No. G-3 or G-4. However, if the command is made via digital communications, do not select Change in measurement range. If selected, a command via digital communications cannot be received.

Message display (Example)

D1	OUTPUT RANGE	2
	010 - 025	%O2

D-2 OUTPUT SIGNAL HOLD

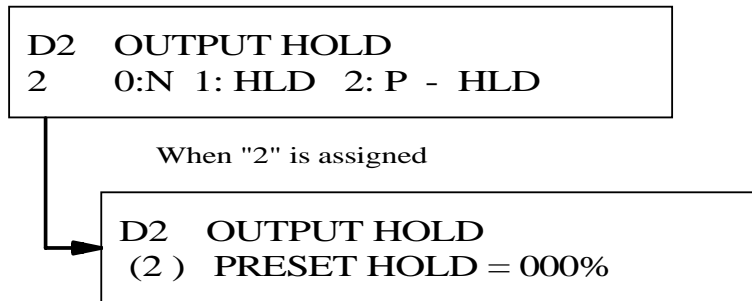
You can select what the 4-20 mA output will do when the analyzer is not in the "MEAS" mode. You can have the output track the O₂ level, hold at last reading or go to a predetermined level. "0" will track, "1" will hold last value and "2" will prompt you for the value you want the reading to go to.

CONFIGURATION

When “2” is selected, a message for setting a preset value is then displayed, enter the value from the keypad. Preset values are in vol% O₂ units. If you want 5% (corresponding to 12 mADC on a 0-10% range), select “005”.

NOTE: The output signal in a state other than normal operation, such as in data setting mode or during warm up, shows the value either for holding the preceding value for preset holding (where “2” is set), even if “0” is set. If the preset value is not set in the preset hold mode, the preceding value holds.

Message display (Example)

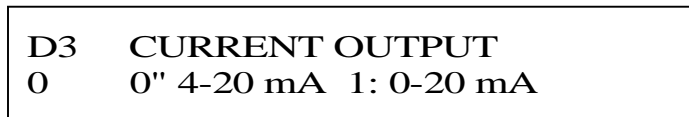


NOTE: This option only affects the 4-20 mA signal. The Red LED on the analyzer will always display actual O₂ levels (wet basis).

D-3 TYPES OF OUTPUT SIGNALS

Assign the analog output signals to match your DCS or recorder's specifications. Enter “0” or “1” for 4-20 mADC or 0 to 20 mADC, respectively.

Message display (Example)



D-4 OUTPUT SIGNAL CHARACTERISTICS

The relationship between the 4-20 mADC or 0 to 20 mADC analog output signal and oxygen concentration is normally linear. However, you can modify it to logarithmic.

For a linear or logarithmic relationship, assign “0” or “1”, respectively.

NOTE: For the “relationship between the output current and oxygen concentration” when selecting “log” see the description of function No. A-5.

Message display (Example)



CONFIGURATION

D-5 OUTPUT SMOOTHING CONSTANT

If the oxygen concentration of the measured gas changes suddenly, and you use these measured values directly to control operations, problems (e.g., frequent turning ON/OFF of operations) might occur. To avoid such situations, you can introduce a time constant in order to smooth out the signal variations. You can set a time constant of up to 255 seconds, enter a suitable value from the keypad. If it is 30 seconds, enter "030".

Message display (Example)

```
D5  SIGNAL DAMPING
    030  sec
```

D-6 MOISTURE BASE IN MEASUREMENT GAS

Combustion gases contain moisture created by burning hydrogen in the fuel. If this moisture is removed, the oxygen concentration will be higher than before. You can select whether the oxygen concentration is wet or dry value before use. For wet or dry conditions, assign "0" or "1", respectively.

Set the moisture content required for the calculation according to function No. J-1 through J-7.

Message display (Example)

```
D6  WET/DRY 02 SELECT
0   0:WET  1:DRY
```

GROUP E

E-0 SETTING OF HIGH HIGH-LIMIT/HIGH-LIMIT ALARMS

Set the level(s) for contact output signals for the high high-limit (HH) and/or high-limit (HL) alarms. If, for instance, you want to have an alarm set at an oxygen high-limit of 7.5 vol% O₂ but deactivate the high high-limit alarm, enter "000.0" for the high high-limit alarm (HH=) and "007.5" for the high-limit alarm (HI=).

For an alarm contact output, refer to function No. G-0 through G-2.

NOTE: The Analog Bargraph (Function A-0) will display the limit alarms under the bargraph.

Message display (Example)

```
E0  ALARM SET PT (%O2)
    HH = 000.0 HI = 007.5
```

CONFIGURATION

E-1 SETTING OF LOW LOW-LIMIT/LOW-LIMIT ALARMS

Set the level(s) of contact output signals for the low low-limit (LL) and/or low-limit (LO) alarms. If you want to have an alarm set at an oxygen extreme low limit of 2.5% and activate a low-limit alarm of 4.9%, enter "002.5" for the low low-limit alarm (LL=) and "004.9" for the low-limit alarm (LO=).

For an alarm contact output, refer to function No. G-0 through G-2.

NOTE: The Analog Bargraph (Function A-0) will display the limit alarms under the bargraph.

Message display (Example)

<p>E1 ALARM SET PT (%O₂) LL = 002.5 LO = 004.9</p>

E-2 CONTACT OPERATION OF ALARM OUTPUT

When measured values return to a stationary range after leaving the alarm range, it is sometimes desirable for existing alarm output to be reset conditionally instead of being reset immediately. You can set such conditions, i.e., operation delay and hysteresis. The operation delay, once set here, is effective even after measured values shift from the stationary range to the alarm range. Set the operation delay (in "seconds") and the hysteresis in the oxygen concentration (vol% O₂), respectively.

To set an operation delay of five seconds and a hysteresis in the oxygen concentration of 2.0 vol% O₂, enter "005" and "2.0" on the keypad.

NOTE: The operation delay set here is applied to all contact signals selected with function numbers G-0 to G-2.

Message display (Example)

<p>E2 RL DELAY = 005SEC RL HYS = 2.0 %O₂</p>

GROUP F

F-0 SETTING OF DATE AND TIME

Set the clock to the present date and time. If the present date/time is April 26, 1994/6:45 p.m., enter "94/04/26 18:45" and press the "ENTER" key to activate the date and time.

Message display (Example)

<p>F0 CLOCK ENTRY 94/04/26 18:45</p>
--

CONFIGURATION

F-1 MEAN O₂ CONCENTRATION CALCULATION TIME

Set the time for collecting data in order to calculate the mean oxygen concentration (indicated when you access function No. A-2). Measured data are collected and summarized in 60 second intervals, while averages are calculated every time a datum is collected. After the set time expires, the calculated mean value is reset and the operation of calculating a new mean value begins all over again. If you want to update accumulated data every 24 hours, set this function at “024”. Accumulation of data begins from the time you press the entry key.

NOTE: The calculation of the mean value is activated every time a datum is collected. So, the longer the calculation time is extended, the more data which are used in averaging are collected. If you use a mean data periodically, you should take notice of this.

Message display (Example)

F1 AVERAGE INTERVAL 024 hr

F-2 TIME INTERVAL FOR MONITORING MAXIMUM/MINIMUM O₂

The converter stores the maximum and minimum values of measured oxygen concentrations within a set time period. These values are displayed by accessing function No. A-1.

You can set the time period for storing these maximum and minimum values. If you want to store them for a week, enter “168” (hr). The storage of data begins when you press the entry key. Stored maximum and minimum values are updated by comparing them with the new data periodically. When the set time expires, the stored values are reset and new maximum and minimum value storage begins all over again.

Message display (Example)

F2 MAX, MIN INTERVAL 168 hr

F-3 SELECTING INPUT TEMPERATURE SCALE (° F/° C)

Set the temperature scale to be ° F or ° C. If ° F is selected you must enter a value of 32° F in function F5, otherwise, the alarm lamp will remain in effect.

Message display (Example)

F3 TEMPERATURE UNIT 1 0: °C 1: °F

CONFIGURATION

F-4 INPUT TEMPERATURE RANGE

You assign the temperature range of the process gas, corresponding to the analog input signal of 4-20 mA. If your range is 0° to 1000° F (537° C), enter “1000”. At that time, check the temperature scale readout on the message display (the scale as assigned in function No. F-3 will be indicated). The maximum setting value is 3000° regardless of the temperature scale.

NOTE: The minimum input temperature is 32° F (0° C). Therefore, when a temperature decreases below 32° F, ALM lamp is lit. Similarly, if the input signal decreases to 4 mA or less for some reasons, ALM lamp is also lit. If no temperature input is used, value must be set to 32° F.

Message display (Example)

F4 FLUE GAS TEMP SPN
1000 °F

F-5 HIGH ALARM INPUT TEMPERATURE

Set the high-limit temperature of the process gas. Set a desired temperature within the measurement range. If the alarm value is 600° C (1100° F), set “0600” (° C). If no high-limit alarm is required, enter “000”.

Message display (Example)

F5 FLUE GAS TEMP HI
ALM SET = 0600 °C

This alarm output is available as a contact output when you select the “process gas temperature high-limit alarm setting” in function No. G-0, G-1, or G-2.

NOTE: If no temperature input is used, value must be set to 0° C or 32° F.

G-0, G-1, G-2 CONTACT OUTPUTS, 1,2,3

Output any contact signal selected out of 13 specified types. You select this together with the assignment of the relay contact operation (normally energized or de-energized) in function No. G-0, G-1 and G-2.

Message display (Example) -- See Note 1

G	O		R	Y	1		C	O	N	T		O	U	T	P	U	T		
				1	0	0	0	0	0	0	0	0	0	0	0	1	0		
			:	1	2	3	4	5	6	7	8	9	10	11	12	13	14		

Digit No. 1: Relay Operation

Digit No. 2 to 14: Section of contact signal to be used (to use =1, Don't use =0)

Digit No. 1)

Relay Operation: Relay operation is selected whether it is normally energized or de-energized.

0: Normally energized (NE)

1: Normally de-energized (NDE)

CONFIGURATION

Digit No. 2)	Error Occurrence: Relays operate when an error (code “E—1” through “E—8”) occurs.
Digit No. 3)	High-high alarm (HH): Relay operates when the high-high limit set-point set with function No. E-0 is reached. (Note 2)
Digit No. 4)	High Alarm (H): Relay operates when the high limit set-point set with function No. E-0 is reached . (Note 2)
Digit No. 5)	Low Alarm (L): Relay operates when the low limit set-point set with function No. E-1 is reached. (Note 2)
Digit No. 6)	Low-low Alarm (LL): Relay operates when the low-low limit set-point set with function No. E-1 is reached. (Note 2)
Digit No. 7)	Entry (E): Relay operates when the maintenance mode is set.
Digit No. 8)	In Calibration (C): Relay operates when calibration action is selected.
Digit No. 9)	Range selection Answerback (R): Relay operates when the selection command is input in a state where the range selection command (R) is set in function No. G-3 or No. 14.
Digit No. 10)	In Warm-up (W): Relay operates when the detector is warmed up.
Digit No. 11)	LO - Calibration Gas pressure (G): Relay operates when the optional pressure switch input is set in function G-3 or G-4 and switch closes.
Digit No. 12)	Process Gas Temperature High Alarm (T): Relay operates when process gas rises above the input temperature high limit alarm set-point set with function No. F-5.
Digit No. 13)	Solenoid Valve Assembly Drive (P): Relay operates when the process gas failure alarm is input in the state where the process gas failure alarm input (P) is set with function No. G-3 (Note 3) and the input closes.
Digit No. 14)	Blowback (B): Relay operates when blowback state command input is set with function G-3.

NOTE 1: When a function is to be used, it is specified by setting the corresponding digit to 1.

The default status is those shown below:

G-0: (0) 1 0 0 0 0 0 0 0 0 0 0 0 0

G-1: (1) 0 0 0 0 0 1 1 0 1 0 0 0 0

G-2: (1) 0 0 1 1 0 0 0 0 0 0 0 0 0

NOTE 2: The relay is energized corresponding to the operation delay and hysteresis valve set in function No. E-2.

NOTE 3: “Solenoid valve assembly drive” is a function for driving a solenoid valve which supplies purge gas to the detector when gases not yet burned are mixed into the measuring gas. This function can also be applied to the cases where a sensor breakage accident due to condensed water should be prevented by purging the calibration gas tubing at the restart of operation.

NOTE 4: On shipment, relay contacts for contact output relays are set as shown below.
Function No. G-0 (Contact output #1) relay contacts: “Break contact” (closed when de-energized)
Function No. G-1 (Contact output #2) relay contacts: “Make contact”
Function No. G-2 (Contact output #3) relay contacts: “Make contact”

CONFIGURATION

The contact type can be changed by resetting the jumper connector positions on the PCB. If “Break contact” (open when energized) is necessary, change it referring to subsection 6.1.6.

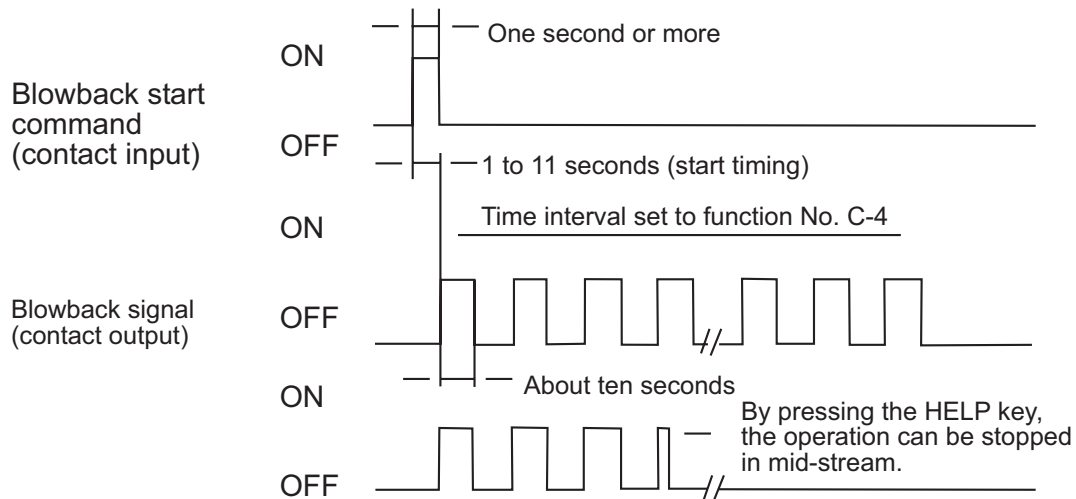
G-3 CONTACT INPUT 1

The instrument can accept a total of two contact inputs assigned in functions No. G-3 and G-4. You select them from the following five types in function G-3:

- 0: Calibration gas under pressure alarm (G)
- 1: Instructions for change in measurement range (R)
- 2: Instructions for start of calibration (C)
- 3: Process gas error alarm (P) (G-3 only)
- 4: Instructions for start of blow-back (B) (G-3 only)

NOTE: The Blowback start command is valid when blowback is specified for function No. G-0 (or G-1 or G-2). The blowback start command contact input must be made for more than one second. When the converter receives the blowback start command, it outputs a contact signal which turns ON and OFF about every ten seconds for an interval the same as the “calibration time” set for function No. C-4, starting at 1 to 11 seconds after receiving the command.

- 1) Blowback can be stopped with the HELP key.
- 2) Blowback is not started during calibration because the calibration-start commands (AUTO, SEMI-AUTO, ONE TOUCH) and calibrating action have priority.
- 3) The “blowback signal” time does not include the stabilizing time set for function No. C-3.
- 4) The analog output at the blowback operation becomes the mode specified for function No. D-2 (Non-Hold, Hold, or Preset Hold).



CONFIGURATION

Readout on the message display (Example)

```
G3  RY 1  CONT INPUT
3  0 : G  1 : R  2 : C  3 : P  4 : B
```

G-4 CONTACT INPUT 2

In function No. G-4, select the contact input signal from the following three types:

- 0: Calibration gas under pressure alarm (G)
- 1: Instructions for change in measurement range (R)
- 2: Instructions for start of calibration (C)

If the measurement range change instruction is assigned, move the cursor with the keys to “2”.

Readout on the message display (Example)

```
G4  RY 2  CONT INPUT
2   0 : G  1 : R  2 : C
```

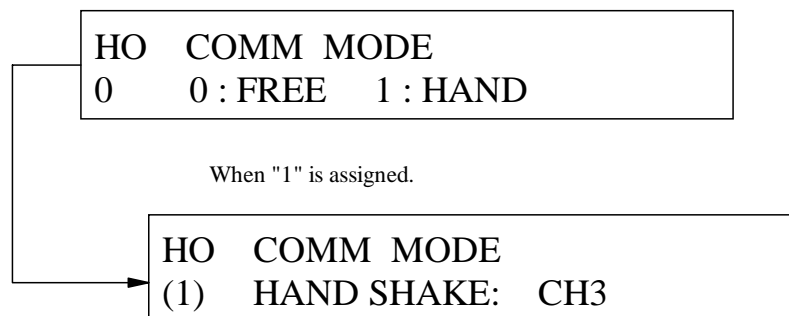
GROUP H

H-0 COMMUNICATION MODE

The communication mode should be specified only when digital communications are achieved. When “1” is specified, “Set ZA8C converter channel number (CH=)” appears. Enter channel numbers 1 through 8 for the individual converters.

NOTE: When an RS-422A communication interface is used, up to eight converters can be connected to one computer. Channel numbers are used to identify the converters, so set channel numbers which are different for each converter.

Readout on the message display (Example)



H-1 BAUD RATE (DATA COMMUNICATION RATE) ASSIGNMENT

Assign operating digital communications. For a data communication rate of 9600 bps or 4800 bps, enter “0” or “1”, respectively. For 2400 bps, select “2” from the keypad.

CONFIGURATION

Readout on the message display (Example)

```
H1 BAUD RATE (bps)
2 0:96 1:48 2:24
```

(Note) DISP Key

```
H1 BAUD RATE (bps)
(2) 2400 Bits/sec
```

GROUP J

J-0 TYPES OF FUELS

You can select a type of fuel for obtaining combustion efficiency, etc. Select and assign in Function No. J-0 what fuel you are using from the following five types:

- 0: Heavy oil A (A)
- 1: Heavy oil B (B)
- 2: Heavy oil C (C)
- 3: Gas (G)
- 4: Coal (X)

If your oil in use is heavy oil (C), move the cursor to "2" with the keys.

Readout on the message display (Ex.)

```
J0 FUEL GRADE
2 0:A 1:B 2:C 3:G 4:X
```

J-1 MOISTURE CONTENT IN EXHAUST GAS

You can set the amount of moisture contained in the combustion exhaust gas of the fuel used in the measurement process (in terms of $\text{N m}^3/\text{kg}$ or m^3/m^3 in proportion to the unit volume of the fuel.) Look up the setting value from Table 15. If there are no relevant descriptions for your fuel, calculate the value using the formula shown on page 119.

If the moisture content is $1.27 \text{ N m}^3/\text{kg}$, for example enter "01.27".

Readout on the message display (Ex.)

```
J1 H2O IN FUEL
01 . 27 m3 / kg (m3)
```

CONFIGURATION

J-2 THEORETICAL AIR QUANTITY

You can set the theoretical air quantity required for the fuel used in the measurement process to ignite ($\text{N m}^3/\text{kg}$ or m^3/m^3). Look up the setting value from Table 15. If there are no relevant descriptions for your fuel, calculate the value using the formula shown on page 119.

If the theoretical quantity is $10.7 \text{ N m}^3/\text{kg}$, enter "10.70".

Readout on the message
display (Ex.)

J2 THEORITICAL AIR 10 . 70 m3 / kg (m3)
--

J-3 NET CALORIFIC VALUE

You can set the net calorific value of the fuel used in the measurement process to ignite (kcal/kg or kcal/m^3). Look up the setting value from Table 15. If there are no relevant descriptions for your fuel, calculate the value using the formula shown on page 119.

If the net calorific value is $9860 \text{ kcal}/\text{kg}$, enter "09860".

Readout on the message
display (Ex.)

J3 NET CALORIFIC VAL 09860 kcal / kg (m3)
--

J-4 X VALUE ($X = A + B * H_1$)

The X value ($\text{N m}^3/\text{kg}$ or m^3/m^3) is the coefficient provided with each fuel. Look up the x value of the fuel used from Table 15. If there are no relevant descriptions for your fuel, calculate the value using the formula shown on page 119.

If the x value is $0.773 \text{ (m}^3/\text{kg)}$, for instance, round off the value to the second decimal place and enter "00.77".

Readout on the message
display (Ex.)

J4 VALUE OF X 00 . 77 m3 / kg (m3)

J-5 ABSOLUTE HUMIDITY OF ATMOSPHERE

You can set the absolute humidity of the atmosphere used in igniting (moisture: $\text{kg}/\text{dry air :kg}$). If the absolute humidity is $0.021 \text{ kg}/\text{kg}$, enter "0.021".

For your reference, a graph for determining absolute humidity by the temperature indications of a psychrometer is shown in Figure 57. It is a little inferior in accuracy. If the exact humidity is required, determine the value by referring to References such as JIS B8222, "Heat Balancing of Boilers for Land Use."

CONFIGURATION

Readout on the message
display (Ex.)

J5 ABS HMD OF AIR
0 . 0210 kg / kg

J-6 TEMPERATURE OF EXHAUST GAS

You can set the temperature of the exhaust gas in the actual combustion process (° C).

If the temperature of the exhaust gas is 450° C, enter "0450".

Readout on the message
display (Ex.)

J6 FUEL GAS TEMP
0450 ° C

J-7 TEMPERATURE OF ATMOSPHERE

You can set the temperature of the atmosphere taken in for igniting (° C). Measure the temperature of the atmosphere at a place as close to the air intake port as possible.

If the temperature is minus 1° C, for instance, enter "-001". You can alternately display plus and minus signs by pressing the increase key.

Readout on the message
display (Ex.)

J7 AMB AIR TEMP
- 001 ° C

CONFIGURATION

J-2: THEORETICAL AIR FLOW J-5: X VALUE

•Liquid fuels

Fuel Properties Type		Specific weight kg/l	Chemical components (% by weight)							Heat value kcal/kg		Theoretical combustion Nm ³ /kg	Combustion gas qty Nm ³ /kg					X value	
			C	H	O	N	S	W	Ash	High	Low		CO ₂	H ₂ O	SO ₂	N ₂	Total		
Kerosene		0.78 0.83	85.7	14.0	-	-	0.5	0.0	0.0	11100	10400	11.4	1.59	1.56	0.00	9.02	12.17	0.93	
Light oil		0.81 0.84	85.3	13.2	-	-	1.2	0.0	0.0	10930	10230	11.2	1.59	1.47	0.00	8.27	11.93	0.91	
A	Heavy oil class 1	HO.1	0.85 0.88	85.9	12.0	0.7	0.5	0.5	0.5	0.05	10330	10210	10.9	1.60	1.34	0.00	8.31	11.55	0.89
		HO.2	0.85 0.89	84.6	11.5	0.7	0.5	2.0	0.5	0.05	0.730	10110	10.5	1.53	1.22	0.01	8.53	11.44	0.85
B	Heavy oil class 2	0.90 0.93	84.5	11.3	0.4	0.4	2.0	0.4	0.05	0.470	9930	10.7	1.53	1.27	0.02	8.44	11.31	0.77	
C	Heavy oil class 2	HO.1	0.93 0.95	83.1	10.9	0.5	0.4	1.5	0.5	0.1	0.300	9900	10.7	1.61	1.22	0.01	8.43	11.27	0.79
		HO.2	0.94 0.96	84.4	10.7	0.5	0.4	2.5	0.5	0.1	0.300	9710	10.5	1.53	1.20	0.02	8.22	11.12	0.72
		HO.3	0.92 1.00	83.1	10.9	0.5	0.4	1.5	0.5	0.1	0.420	9340	10.7	1.61	1.22	0.01	8.43	11.27	0.77
		HO.4	0.94 0.97	83.0	10.5	0.5	0.4	2.5	2.0	0.1	0.230	9700	10.5	1.53	1.13	0.02	8.13	10.93	0.72

J-2: H STANDARD VALUE OF FUEL IN USE

J-1: H OBTAIN CONTENT IN EXHAUST GAS

J-2: THEORETICAL AIR FLOW J-5: X VALUE

•Gas fuels

Fuel Properties Type		Specific weight kg/l	Chemical components (% by weight)								Heat value kcal/kg		Theoretical combustion Nm ³ /m ³	Combustion gas qty Nm ³ /m ³					X value
			C	H ₂	CO ₂	CH ₄	C _m H _n	O ₂	N ₂	High	Low	CO ₂		H ₂ O		N ₂	Total		
Coke oven gas		0.544	9.0	50.5	2.3	23.9	2.9	0.1	2.0	4330	4250	4.455	0.45	1.10		3.30	5.15	0.53	
Blast furnace gas		0.369	25.0	2.0	20.0	-	-	-	22.0	310	300	0.302	0.45	0.02		1.01	1.53	0.02	
Natural gas		0.796	-	-	2.0	33.4	2.2	1.3	4.2	9050	8150	9.015	0.93	1.33		7.17	10.03	0.33	
Propane		2.020	C ₃ H ₈ 90%, C ₃ H ₁₀ 10%							24330	22450	24.22	3.10	4.10		19.5	23.7	2.23	
Butane		2.530	C ₄ H ₁₀ 30%, C ₄ H ₁₂ 70%							29330	27330	29.27	3.90	4.90		24.0	29.3	2.91	
(Gases)			(M OBTAIN FROM UR)																
Oxygen		1.43	O ₂								-	-	-	-	-	-	-	-	-
Nitrogen		1.25	N ₂								-	-	-	-	-	-	-	-	-
Hydrogen		0.09	H ₂								3050	2570	2.330	-	1.0		1.33	2.33	0.27
Carbon Monoxide		1.25	CO								3020	3020	2.330	1.0	-		1.33	2.33	0.22
Carbon Dioxide		1.93	CO ₂								-	-	-	-	-	-	-	-	-
Methane		0.72	CH ₄								3493	3257	3.570	1.0	2.0		7.57	10.5	0.90
Ethane		1.34	C ₂ H ₆								13333	12233	12.74	2.0	3.0		13.2	19.2	1.60
Ethylene		1.25	C ₂ H ₄								15053	14109	14.25	2.0	2.0		11.4	15.4	1.43
Propane		1.97	C ₃ H ₈								23337	21300	23.31	3.0	4.0		13.3	23.3	2.29
Butane		2.59	C ₄ H ₁₀								29333	28333	31.09	4.0	5.0		24.3	33.3	2.93

J-2: H STANDARD VALUE OF FUEL IN USE

J-1: H OBTAIN CONTENT IN EXHAUST GAS

Table 15: Various Values of Fuels

CONFIGURATION

<Calculation Formulae>

If you use a fuel not described in Table 15, calculate the set values for Function Nos. J-1 to J-4 using the following formula:

•Liquid fuels

$$\text{Moisture content in exhaust gas} = 1/100 \{1.24 (9h + w)\} \quad [\text{m}^3/\text{kg}]$$

$$\text{Theoretical air quantity} = 12.38/10000 \times H_1 - 1.36 \quad [\text{m}^3/\text{kg}]$$

$$\text{Net calorific value} = H_1$$

$$\text{X value} = 3.37/10000 \times H_x - 2.55 \quad [\text{m}^3/\text{kg}]$$

Where, H_1 : Net calorific value of fuel
 h : Hydrogen in fuel (% by weight)
 w : Moisture content in fuel (% by weight)
 H_x : Same as H_1

•Gas fuels

$$\text{Moisture content in exhaust gas} = 1/100 \{(h_2) + 1/2 \sum y (C_x h_y) + w\} \quad [\text{m}^3/\text{m}^3]$$

$$\text{Theoretical air quantity} = 11.2 \times H_1/10000 \quad [\text{m}^3/\text{m}^3]$$

$$\text{Net calorific value} = H_1$$

$$\text{X value} = 1.05/10000 \times H_x \quad [\text{m}^3/\text{m}^3]$$

Where, H_1 : Net calorific value of fuel
 h : Hydrogen in fuel (% by weight)
 w : Moisture content in fuel (% by weight)
 H_x : Same as H_1

•Solid fuels

$$\text{Moisture content in exhaust gas} = 1/100 \{1.24 (9h + w)\} \quad [\text{m}^3/\text{kg}]$$

$$\text{Theoretical air quantity} = 1.01 \times H_1/1000 + 0.56 \quad [\text{m}^3/\text{kg}]$$

$$\text{Net calorific value} = H_1 = H_h - 5.9 (9h + w) \quad [\text{kcal}/\text{kg}]$$

$$\text{X value} = 1.11 - (0.106/1000) \times H_x \quad [\text{m}^3/\text{m}^3]$$

Where, w : Total moisture content during use (% by weight)
 h : Hydrogen content (% by weight)

Mean hydrogen content of domestic coal (moisture - /ash-free) is 5.7%.

Therefore, h is approximated by the following formula:

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

Where, a : Ash content [%]

w_1 : Moisture content based on industrial analysis (constant - humidity base) [%]

H_h : High heat value of fuel [kcal/kg]

H_l : Low heat value of fuel [kcal/kg]

H_x : Same as H_1

CONFIGURATION

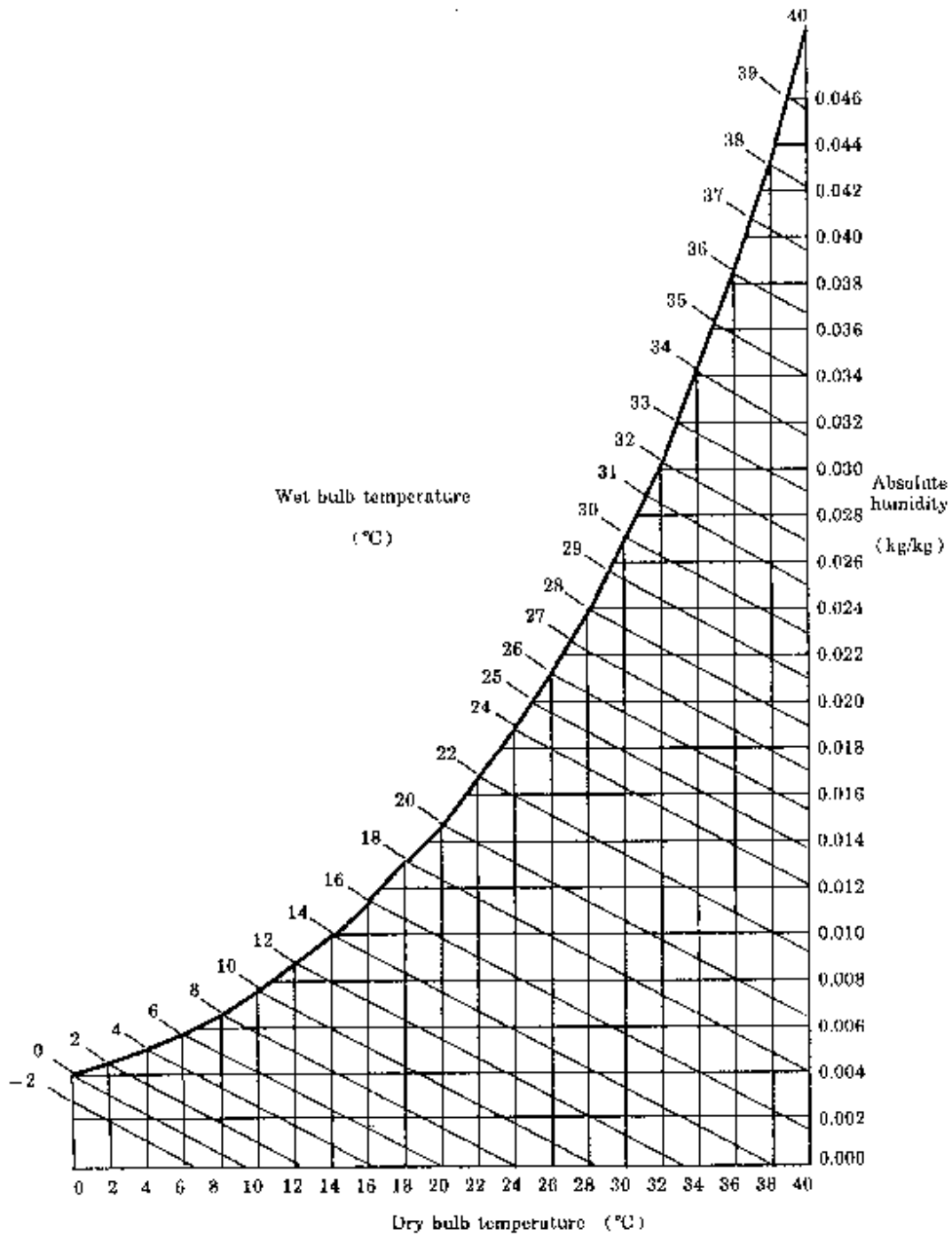


Figure 57: Absolute Humidity of Air

CONFIGURATION

6.4.4 Calibration

The calibration of this instrument is carried out by comparing either the oxygen concentration of the zero gas or of the span gas with the measured value of the relevant calibration gas. The reference oxygen concentration (set in C-0 and C-1) is already read into the memory of the converter. The converter detects the deviation of the measured result from this value and automatically corrects it.

The following three methods of calibration are available; further calibrations can be carried out periodically or occasionally, and the calibration gas for these later calibrations can be automatically or manually introduced. You can select any of these methods by registering it in the converter.

1) Automatic Calibration

A calibration operation begins when you set the calibration start time and the calibration frequency, and then press the key (or enter an external contact signal) to begin. All operations related to calibration (e.g., calibration time, opening/closing of the solenoid valve and sequence) are automatically activated based on the data set in the converter.

NOTE: If you manually start a calibration from the keypad, digital input or serial communication, the automatic sequence is aborted. A new start time must be entered in C-6.

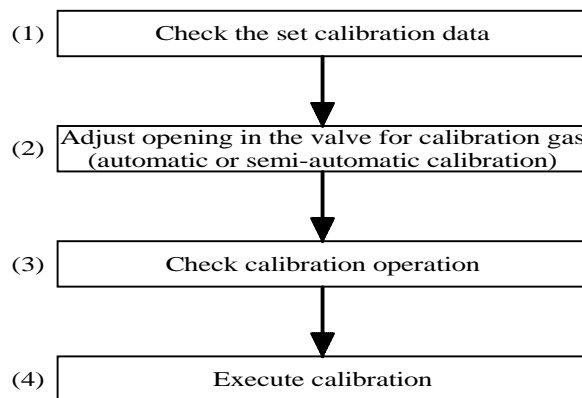
2) Semiautomatic calibration

In this mode, calibration begins only when the converter is operated with the keys or receives starting instructions from a contact signal through an external circuit. The other details are the same as those for “automatic calibration”.

3) One-touch calibration

In this mode, operate keys to send the calibration gas or for other procedures depending on the readout on the message display on the converter after you have given the calibration start instructions (in the same way as for semiautomatic calibration). Other calibration operations are automatically processed by the converter.

•Preparation for calibration



•Checking the set calibration data

Sequentially display the data from Codes C-0 to C-7 on the message display of the converter and check for errors in the set data (e.g., the selected calibration method and the concentration of the calibration gas).

CONFIGURATION

6.5 STATIONARY OPERATION

6.5.1 Collection of Control Data

You can display “Maximum/Minimum O₂ concentration” of function No. A-1 or “Mean O₂ concentration” of A-2 on the message display.

6.5.2 Troubleshooting

If an error occurs:

- 1) A “FAIL” LED on the converter status display lights up;
- 2) An error code appears in the data display area;
- 3) Error messages appear in the message display area. If the error messages do not appear, push the "DISP" key.

Every time an error occurs, immediately correct it according to the instructions in chapter 11. The following error codes are operable.

Error Code	Error Detail	Error Status
E-1	Sensor (cell) error	Goes into fail mode, automatically turning OFF the power supply to the detector heater.
E-2	Sensor temp "LOW"	Goes into fail mode, automatically turning OFF the power supply to the detector heater.
E-3	Sensor temp "HIGH"	Goes into fail mode, automatically turning OFF the power supply to the detector heater.
E-4	A/D (Analog circuit) error	Goes into fail mode, automatically turning OFF the power supply to the detector heater.
E-5	Calibration value "ZERO"	(Displayed during calibration) the present zero point calibration value is not affected.
E-6	Calibration value "SPAN"	(Displayed during calibration) the present zero point calibration value is not affected.
E-7	Start power stability time over	(Displayed during calibration) the present zero point calibration value is not affected.
E-8	ROM, RAM error	Goes into fail mode, automatically turning OFF the power supply to the detector heater.
□□□ (Display erased)	Digital circuit error power failure	Goes into fail mode, automatically turning OFF the power supply to the detector heater. (Displayed upon restart after remedying the power failure). Data values default.

Table 16: Error Codes, Details and Status

NOTE: E-5, E-6 or E-7 is displayed alternately with the O₂ concentration.

6.5.3 Checking Operating Conditions

In order to maintain normal operating conditions, determine which items are to be inspected periodically, and check them regularly for errors.

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Items recommended for periodic inspections are listed below for your reference. For maintaining or recovering performance, see chapter 10.

Inspection item	Purpose & detail of inspection	Inspection interval
Complete closing of calibration gas inlet	To prevent condensation which may break sensor. Check for a complete closing of needle valve.	1 to 7 days
Set flow rate of flow setting unit	Check that flow is about 600 ml/min. for both the reference & calibration gases, for correctly measured and calibrated values.	1 to 7 days
Cell voltage (Function No. A-3)	To know the extent of deterioration of the sensor (cell). Compare the displayed value with theoretical one.	1 to 2 weeks
Pressure in the calibration gas cylinder	To determine the intervals between replacement of calibration gas (zero) cylinders. Specify min. pressure and check for higher pressure.	1 to 2 weeks
Set value of oxygen concentration for calibration gas (zero)	To obtain a correct calibrated value. Check for complete setting of oxygen conc in the calibration gas (zero) in use.	Upon replacement
Digital circuit error power failure	To determine the intervals between replacement of purge gas cylinders. Determine min. pressure and check for higher pressure.	1 to 2 weeks

Table 17: Example of Items for Periodic Inspection

6.5.4 Frequent Stopping and Restarting Operations

If you stop the operation of the zirconia oxygen analyzer at the same time as the boiler, furnace, etc., condensation forms in the sensor and dust may adhere to it. If you restart operations with the sensor in this state, as it heats up to 750° C (1382° F), it causes dust to accumulate which significantly deteriorates its performance. In an extreme case with a lot of condensation, the analyzer may break, or the zirconia cell may crack due to thermal shock.

To prevent such an occurrence, take the following steps to stop the equipment.

- 1) Keep the power supply to the analyzer ON as long as possible. If this is impossible, remove the detector.
- 2) If both of the above are impossible, keep air flowing into the calibration gas piping at a rate of about 600 ml/min.

•Operation restart

If none of the above precautions for stopping operations can be done, supply air into the calibration gas piping for five to ten minutes at a rate of about 600 ml/min.

After stopping operations for a long period of time, set the necessary data again.

6.6 CALIBRATION FROM THE ZA8C CONVERTER

6.6.1 Set-Up Menus for Calibration

In order to fully employ the use of an auto calibration system, the appropriate parameters must be entered into your ZA8C converter. Entering this information will give an accurate calibration, thereby providing correct diagnostics values for span correction, zero correction, etc. Every time a 2 point

CONFIGURATION

(span and zero) calibration is performed. The timing sequence of the AC1 auto calibration unit is controlled by the ZA8C converter. You must configure the ZA8C parameters, as described in this section. Refer to section 6.1 for detailed information.

ZA8C Menu	Description	Default Setting	Typical Setting
F-3	Date/Time	YY/MM/DD hh:mm	
C0	Span Gas Concentration	21.00%	20.60%
C1	Zero Gas Concentration	1.00%	Between 0.5 and 5 %
C2	Calibration Mode 0- Automatic 1- Semi-automatic 2- One Touch	2-One Touch	0-Automatic (for AC1) or 2-one touch (for MC1)
C3	Stabilization Time	3 minutes	3 to 5 minutes
C4	Calibration Time		3 to 5 minutes
C5	Calibration Frequency	1 day	1/month
C6	Calibration Start Time	YY/MM/DD hh:mm	

Table 18: Setup Parameters for Calibration

SERIAL COMMUNICATION

VII. SERIAL COMMUNICATION

To allow for RS-232C or RS-422A communications, you must connect the converter to a PC.

7.1 WIRING WITH RS-232C COMMUNICATIONS CABLE

Figure x shows terminal connections of RS-232C communication cable. RS-232C communications are carried out by connecting only one converter to one computer.

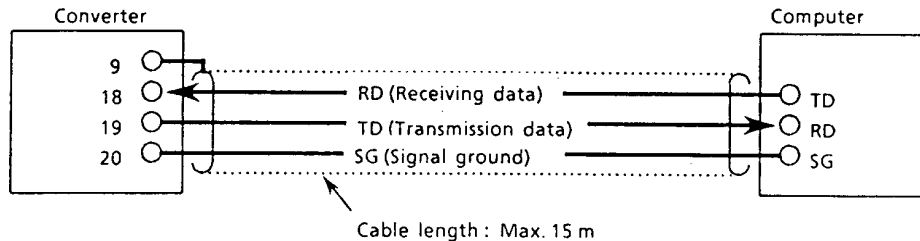


Figure 58: Wiring of RS-232C Communications Cable

<Specifications for Communication Cable and Maximum Length>

Use a three-conductor - (nominal cross section: 0.2 mm²) or two twisted pair (24 AWG or thicker) - shielded cable for RS-232C communications wiring. In addition, the cable length is limited up to 15 m.

In end-treating the cable, attach crimping type solderless terminal lugs matching M4 (4 mm) screws to the cable end to be connected to the converter terminals.

7.2 WIRING WITH RS-422A COMMUNICATIONS CABLE

RS-422A communication can be carried out by connecting up to eight converters to one computer. In the ZA8C converter, communication I/O signals are not isolated. If the computer is distant (communication cable length is 15 m or more as a guideline) from the converter and thus their ground potentials cannot be equalized, use a computer having I/O signal isolating type interface.

Figure 51 shows terminal connections of RS-422A communication cable.

<Notices in Making Wiring>

- 1) Communication cables away from power cables which may become noise sources. In addition, cables so that adjacent cables are not in parallel with each other.
- 2) If more than one converter is to be connected to a computer, ground wiring should be such that the ground potentials of each converter are equal.

SERIAL COMMUNICATION

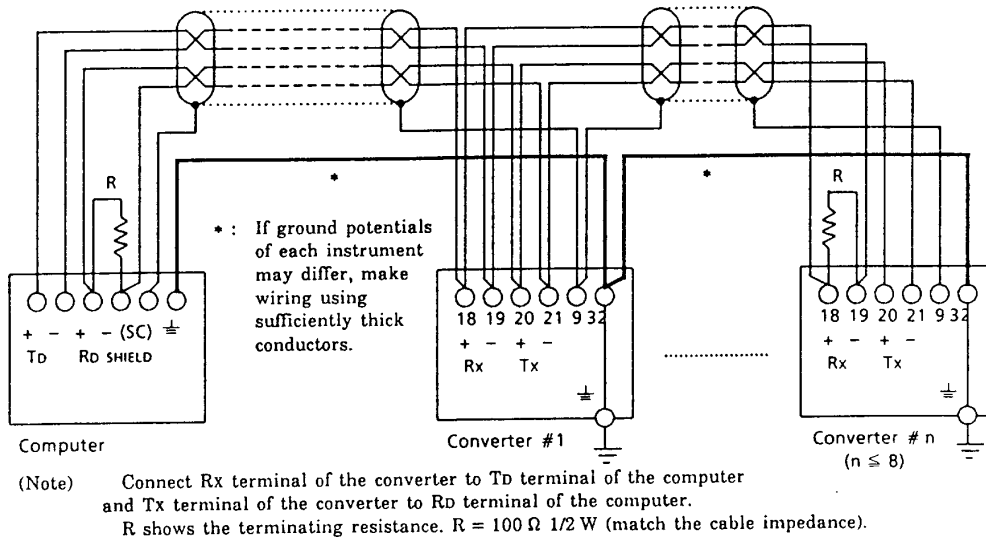


Figure 59: Connections for RS-422A Communications

<Specifications for Communication Cable and Maximum Length>

For RS-232C communication cable, use two twisted pair (24 AWG or thicker) shielded cables of $\varnothing 8$ to $\varnothing 11$ mm O.D. so that the cable impedance is $100\ \Omega$ and cable capacitance is $50\ \text{pF/m}$ or less. It is recommended that the cable length be within 15 m to balance ground potentials. However, if a computer having I/O signal isolating interface is used, the cable length may be extended up to 500 m. In this case, the ground system wiring should be made in a procedure shown in figure 59.

As end treatment of the cable, attach the crimping type solderless terminal lugs matching M4 (4 mm) screws to the end of the cable to be connected to the converter terminals. Expose the conductors from the cable shield as short as possible.

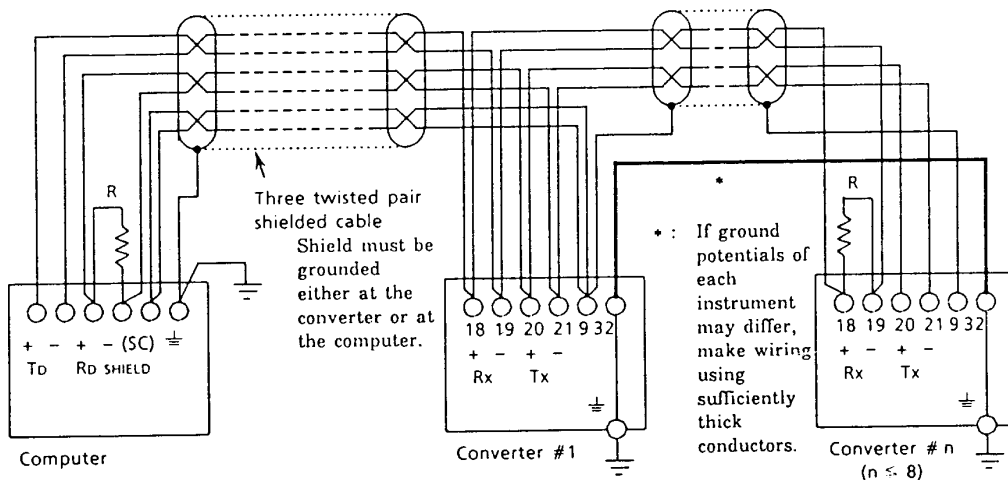


Figure 60: Connections for RS-422A Communications (when using an I/O isolating computer)

SERIAL COMMUNICATION

7.3 SPECIFICATIONS FOR ZA8C CONVERTER COMMUNICATIONS (RS-232C OR RS-422A)

Classifications	Item	Description
Specifications	Signal Level	Conforming to EIA RS-232C or RS-422A standards I/O signal not isolated
	Communication System	Start-Stop system, Half Duplex •RS-232C: Two-wire system •RS-422A: Four-wire system, multi-drop connection - number of computer converters = 1: N (N = 1 to 8)
	Communication Distance	•RS-232C: Up to 15m •RS-422A: Up to 500m (between I/O isolated computer and ZA8C converter)
	Communication Rate	2,400, 4,800, 9,600 bps switching
	Transmission Procedure	No procedure, handshaking transfer. In the case of "no procedure" data transmission only (transmission period: 10 seconds)
	Data Length	8 bits
	Parity	None
	Start Bit	1
	Stop Bit	1
Contents	Reception	(1) Zero and span calibration request, Calibration abort request (2) Analog output range selection signal
	Transmission	Time, O ₂ concentration (wet and dry), cell emf, cell temperature, error codes, alarm number, status number, calibration coefficient, cell resistance, response time, cell life, exhaust gas temperature, O ₂ average value, O ₂ averaging time, max. and min. O ₂

Table 19: Communication Specifications

SERIAL COMMUNICATION

● Command Interpretation

(1) RC (Request Calibration)

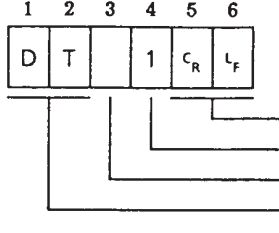
Function	"Zero, span calibration start request" signal or "Calibration abort" signal (Note) Set the ZA8C converter calibration mode to "Auto" or "Semi-auto".																																				
Data structure	<p>(1) Received data</p> <table border="1" style="margin-left: 20px;"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td> </tr> <tr> <td>R</td><td>C</td><td></td><td>1</td><td>,</td><td>0</td><td>C_R</td><td>L_F</td> </tr> </table> <p style="margin-left: 20px;"> Delimiter 0: Calibration start, 1: Calibration stop (Comma) ZA8C converter channel number, No.1 to No.8 (Space) Command </p> <p>(2) Transmitted data</p> <table border="1" style="margin-left: 20px;"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td> </tr> <tr> <td>R</td><td>C</td><td></td><td>1</td><td>,</td><td>0</td><td>,</td><td>0</td><td>C_R</td><td>L_F</td> </tr> </table> <p style="margin-left: 20px;"> (Same as received data) 0: Calibratable, 1: Calibration abort, 4: Not calibratable (Comma) </p>	1	2	3	4	5	6	7	8	R	C		1	,	0	C _R	L _F	1	2	3	4	5	6	7	8	9	10	R	C		1	,	0	,	0	C _R	L _F
1	2	3	4	5	6	7	8																														
R	C		1	,	0	C _R	L _F																														
1	2	3	4	5	6	7	8	9	10																												
R	C		1	,	0	,	0	C _R	L _F																												

(2) CR (Change Range)

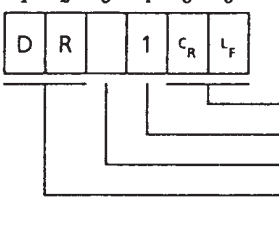
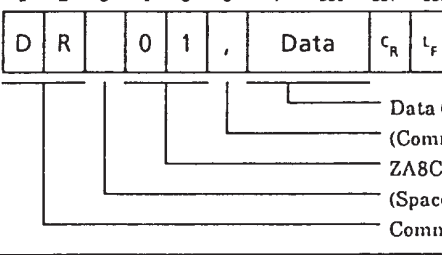
Function	"Analog output range selection" signal (Note) The ZA8C converter contact input signal has priority.																																
Data structure	<p>(1) Received data</p> <table border="1" style="margin-left: 20px;"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td> </tr> <tr> <td>C</td><td>R</td><td></td><td>1</td><td>,</td><td>1</td><td>C_R</td><td>L_F</td> </tr> </table> <p style="margin-left: 20px;"> Delimiter 1: Output range 1, 2: Output range 2 (Comma) ZA8C converter channel number, No.1 to No.8 (Space) Command </p> <p>(2) Transmitted data</p> <table border="1" style="margin-left: 20px;"> <tr> <td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td> </tr> <tr> <td>C</td><td>R</td><td></td><td>1</td><td>,</td><td>1</td><td>C_R</td><td>L_F</td> </tr> </table> <p style="margin-left: 20px;">(Same as received data)</p>	1	2	3	4	5	6	7	8	C	R		1	,	1	C _R	L _F	1	2	3	4	5	6	7	8	C	R		1	,	1	C _R	L _F
1	2	3	4	5	6	7	8																										
C	R		1	,	1	C _R	L _F																										
1	2	3	4	5	6	7	8																										
C	R		1	,	1	C _R	L _F																										

SERIAL COMMUNICATION

(3) DT (Data Trigger)

Function	Latest measured data and date and time are taken into the communication memory inside the ZA8C converter.	
Data structure	<p>(1) Received data</p>  <p>(Note 1) When channel No. is [0], all the converters take the measuring simultaneously.</p> <p>(Note 2) Data retained with DT command is transmitted to the computer by DR command.</p> <p>(Note 3) When a "DT 0 C_R L_F" command is sent from the computer to the converter, allow a one-second interval or longer until the next command (as for example, a DR command) is sent.</p>	
Receiving format	In setting	DT 1 C _R L _F
	In reading	None
Transmitting format	DT 1 C _R L _F	

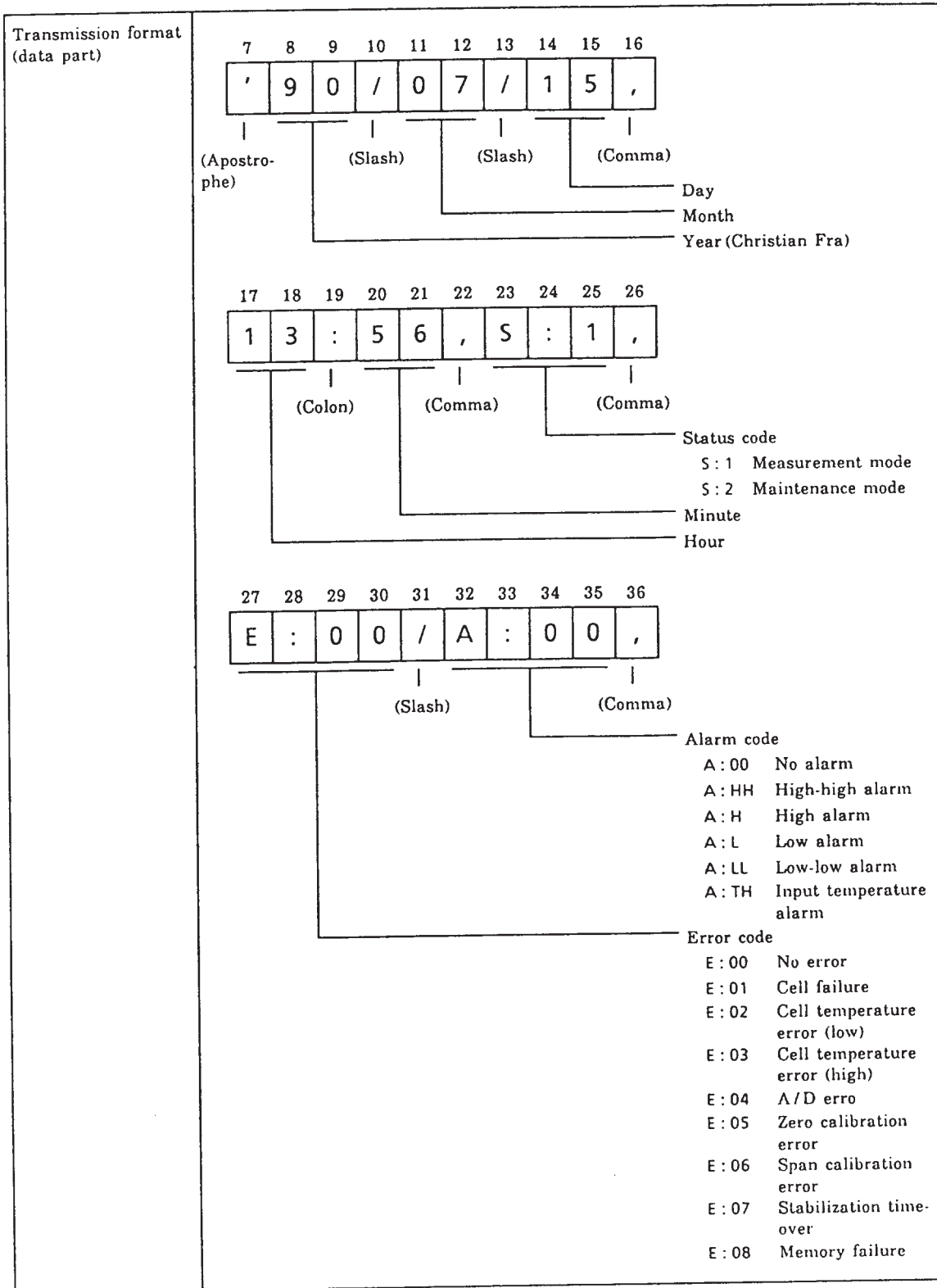
(4) DR (Data Read)

Function	This command can make ZA8C converter transmit date and time and measured data.	
Data Structure	<p>(1) Received data</p>  <p>(2) Transmitted data</p> 	
Receiving format	In setting	None
	In reading	DR 1 C _R L _F

Note Answer-back signals for commands other than the "DT 0 C_R L_F" command may be sent by placing them after two undecided characters.

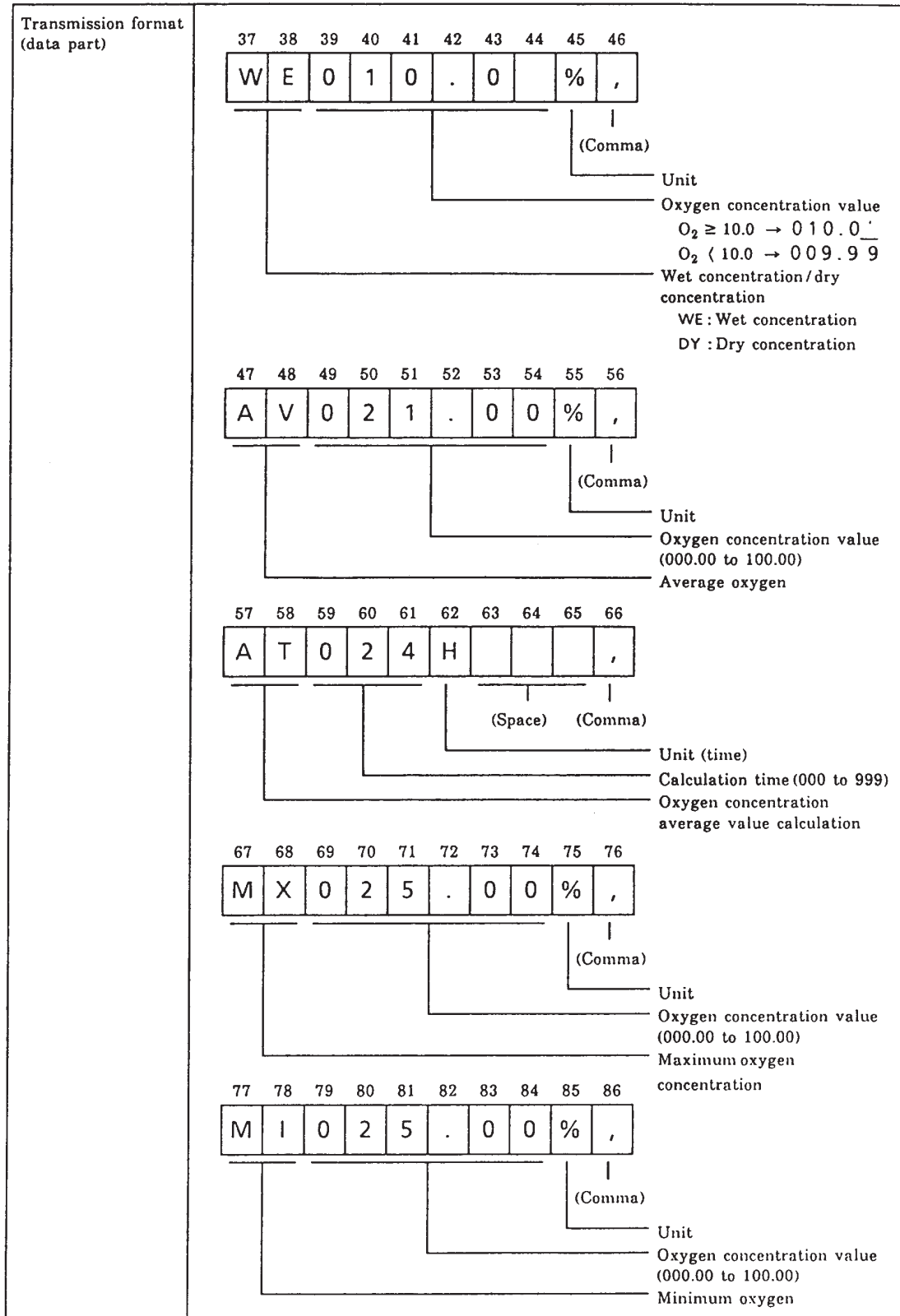
SERIAL COMMUNICATION

Data Part Format for DR Command Communication (Transmission) (1)



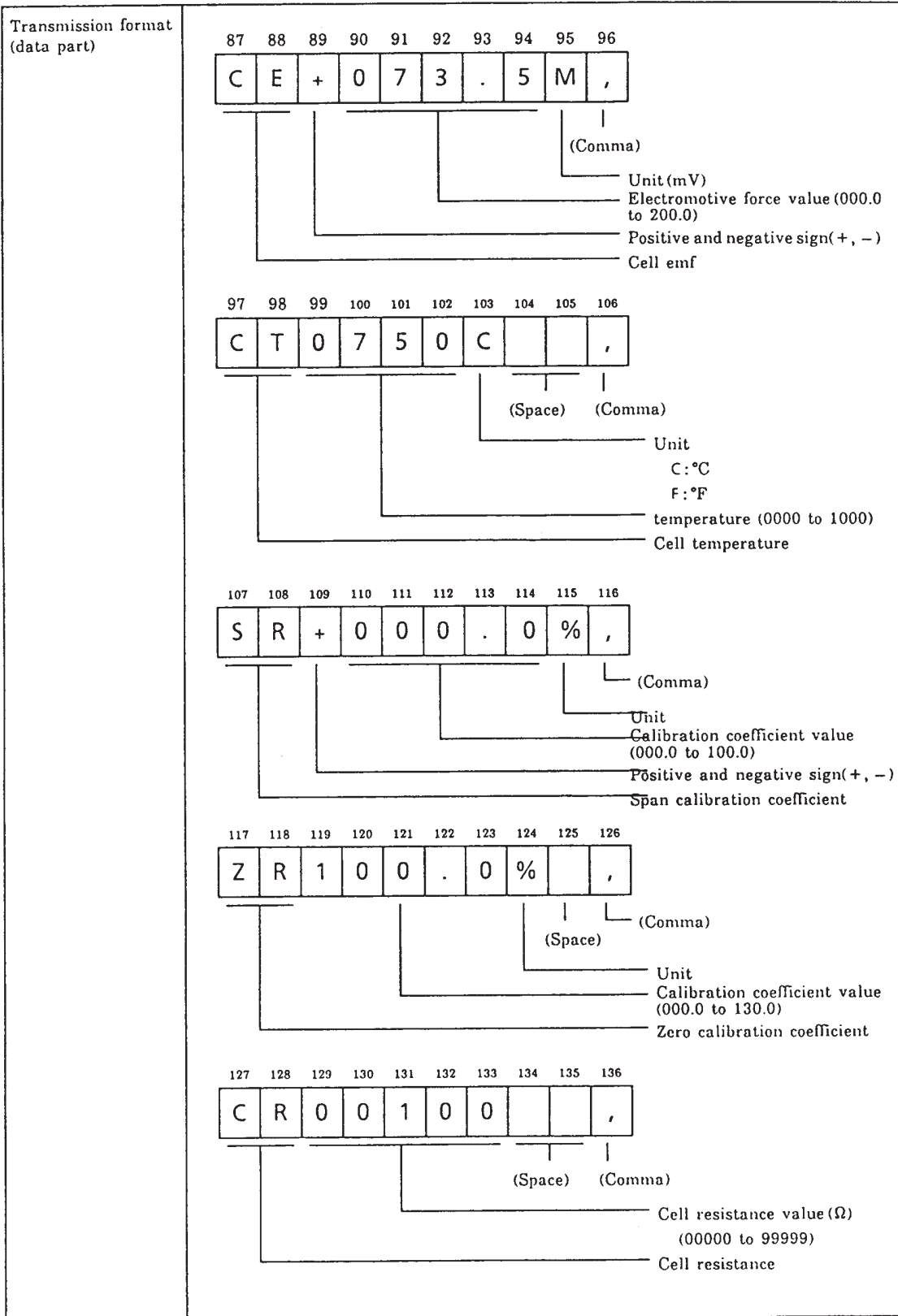
SERIAL COMMUNICATION

Data Part Format for DR Command Communication (Transmission) (2)



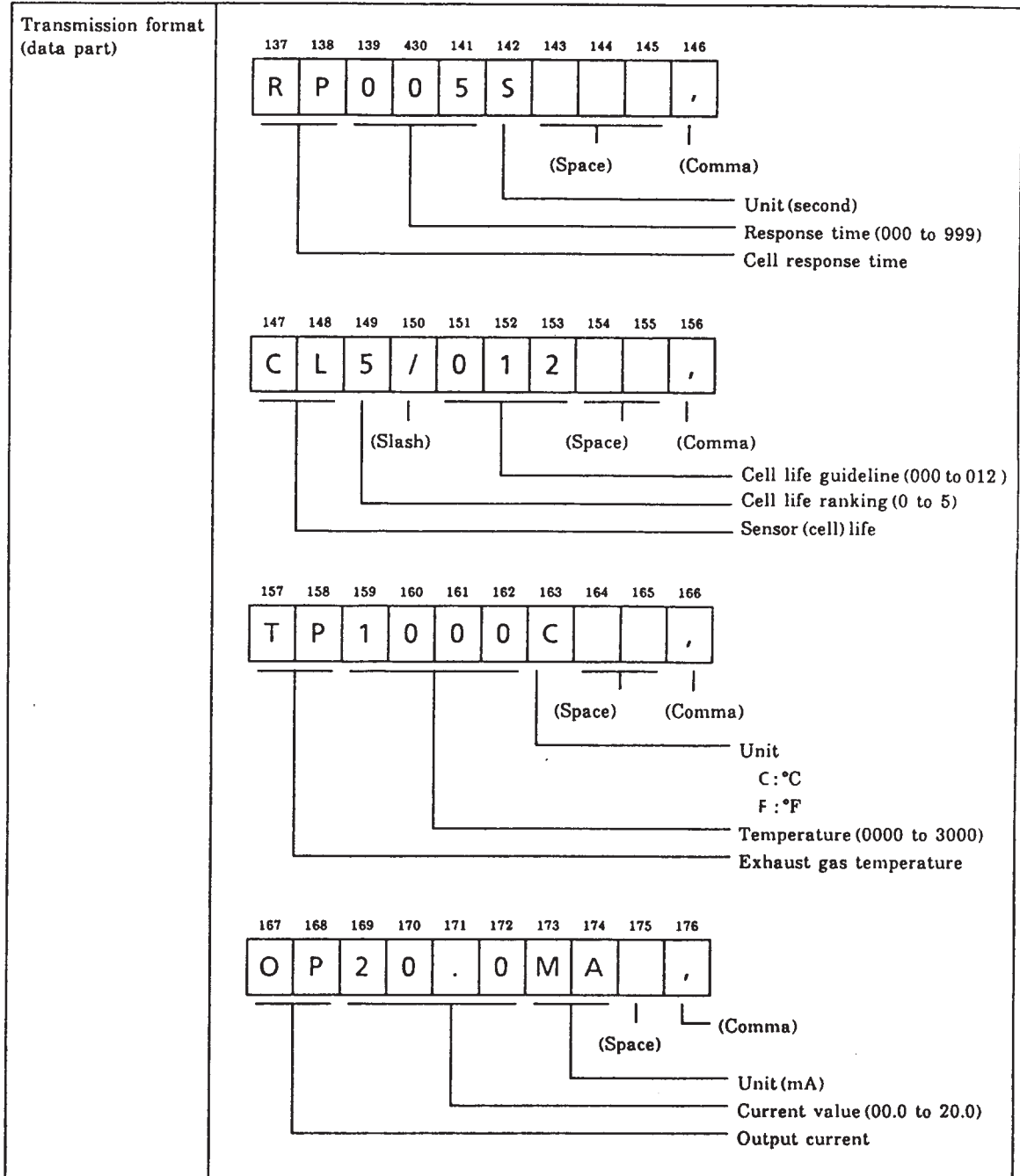
SERIAL COMMUNICATION

Data Part Format for DR Command Communication (Transmission) (3)



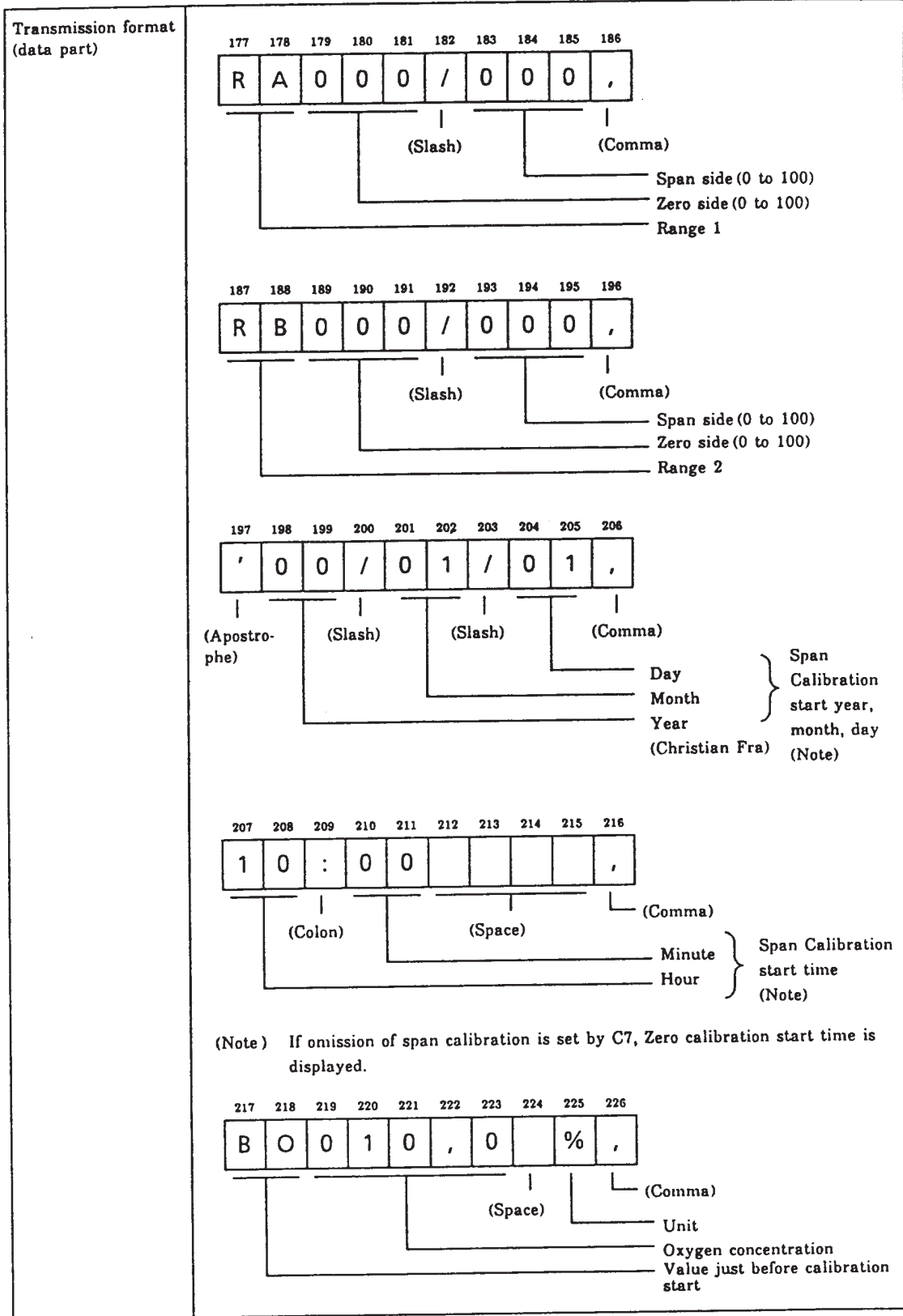
SERIAL COMMUNICATION

Data Part Format for DR Command Communication (Transmission) (4)



SERIAL COMMUNICATION

Data Part Format for DR Command Communication (Transmission) (5)



CALIBRATION

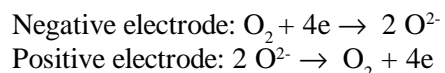
VIII. CALIBRATION

8.1 CALIBRATION PROCEDURES

8.1.1 Principles of the Zirconia Oxygen Analyzer

Before detailing calibration, the principles of measuring with a zirconia oxygen analyzer will be described.

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



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

$$E = - \frac{RT}{nF} \ln \frac{P_x}{P_A} \dots\dots\dots(1)$$

Where:

R: Gas constant

T : Absolute temperature

n : 4

F : the Faraday constant

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

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

Assuming the zirconia element is heated up to 750°C, then the equation (1) becomes:

$$E = -50.74 \log \frac{P_x}{P_A} \dots\dots\dots(2)$$

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

CALIBRATION

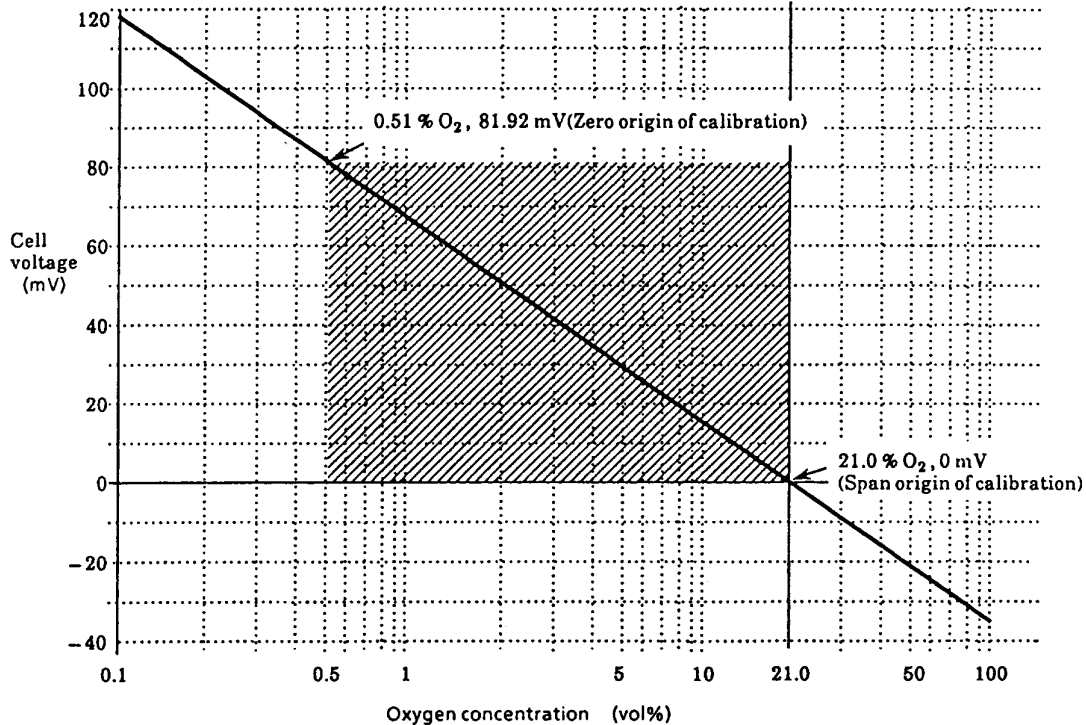


Figure 61: Oxygen Concentration in Measurement Gas vs Cell Voltage (21.0% O₂ Equivalent)

Measurement principles of a zirconia oxygen analyzer have been described above. However, the relationship between oxygen concentration and the electromotive force of a cell is only a theoretical one. Usually, a practical sensor shows a slight deviation from the theoretical value. This is the reason why calibration is required. It's performed to obtain a calibration curve for correcting a deviation from a theoretical cell electromotive force.

8.1.2 Calibration Gas

A gas with a known oxygen concentration is used for calibration. Normal calibration is performed using 2 different gases: a zero gas of low oxygen concentration and a span gas of high oxygen concentration. In some cases, only one or the other gas may be used for calibration. However, even if only one of the gases is normally used, calibration using both gases should be done at least once.

The zero gas normally used has an oxygen concentration of 0.95 to 1.0 vol% O₂ with a balance of nitrogen gas (N₂). The span gas widely used is clean air (i.e., instrument air).

CALIBRATION

8.1.3 Compensation

The deviation of a measured value from the theoretical cell electromotive force is checked by the method in figures 61 or 62.

Figure 61 shows a 2-point calibration using 2 gases: zero and span. Cell electromotive forces for a span gas with an oxygen concentration p_1 and a zero gas with an oxygen concentration p_2 are measured while determining a calibration curve passing between these 2 points. The oxygen concentration of the measurement gas is determined from this calibration curve. In addition, the calibration curve corrected by calibration is compared with the theoretical calibration curve for determining the zero point correction ratio represented by $B/A \times 100(\%)$ on the basis of A, B and C shown in figure xa and the span point correction ratio of $C/A \times 100(\%)$. If the zero point correction ratio exceeds a range of $100 \pm 30\%$ or the span point correction ratio becomes larger than $\pm 0.18\%$, calibration of the sensor become impossible.

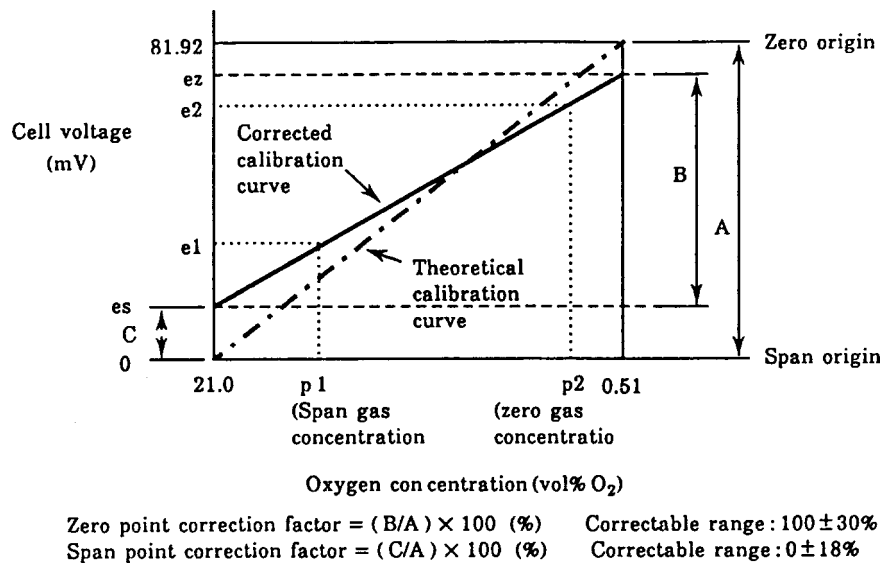
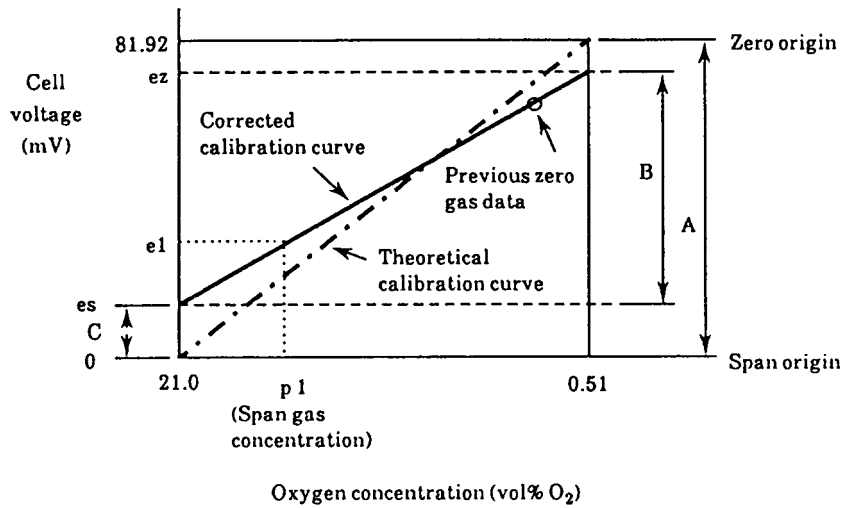


Figure 62: Calculation of a Calibration Curve and Correction Factor in a 2-point Calibration Using Zero and Span Gases

Figure 62 shows a 1-point calibration using only a span gas. In this case, only the cell electromotive force for a span gas with an oxygen concentration p_1 is measured. The cell electromotive force for the zero gas is carried over from a previous measurement to obtain the calibration curve. The principles of calibration using only a span gas also applies to the 1-point calibration method using a zero gas only.

CALIBRATION



$$\begin{aligned} \text{Zero point correction factor} &= (B/A) \times 100 (\%) & \text{Correctable range} &: 100 \pm 30\% \\ \text{Span point correction factor} &= (C/A) \times 100 (\%) & \text{Correctable range} &: 0 \pm 18\% \end{aligned}$$

Figure 63: Calculation of a Calibration Curve and Correction Factor in a 1-point Calibration Using a Span Gas

8.1.4 Diagnostic Data from a Sensor Measured During Calibration

During calibration, the following data for monitoring the conditions of the sensor are collected, as well as calibration data. However, if calibration is not properly executed (errors may occur in automatic or semi-automatic calibration), these data are not collected in the current calibration. Also, if one of the calibration gases is skipped, the data is not collected.

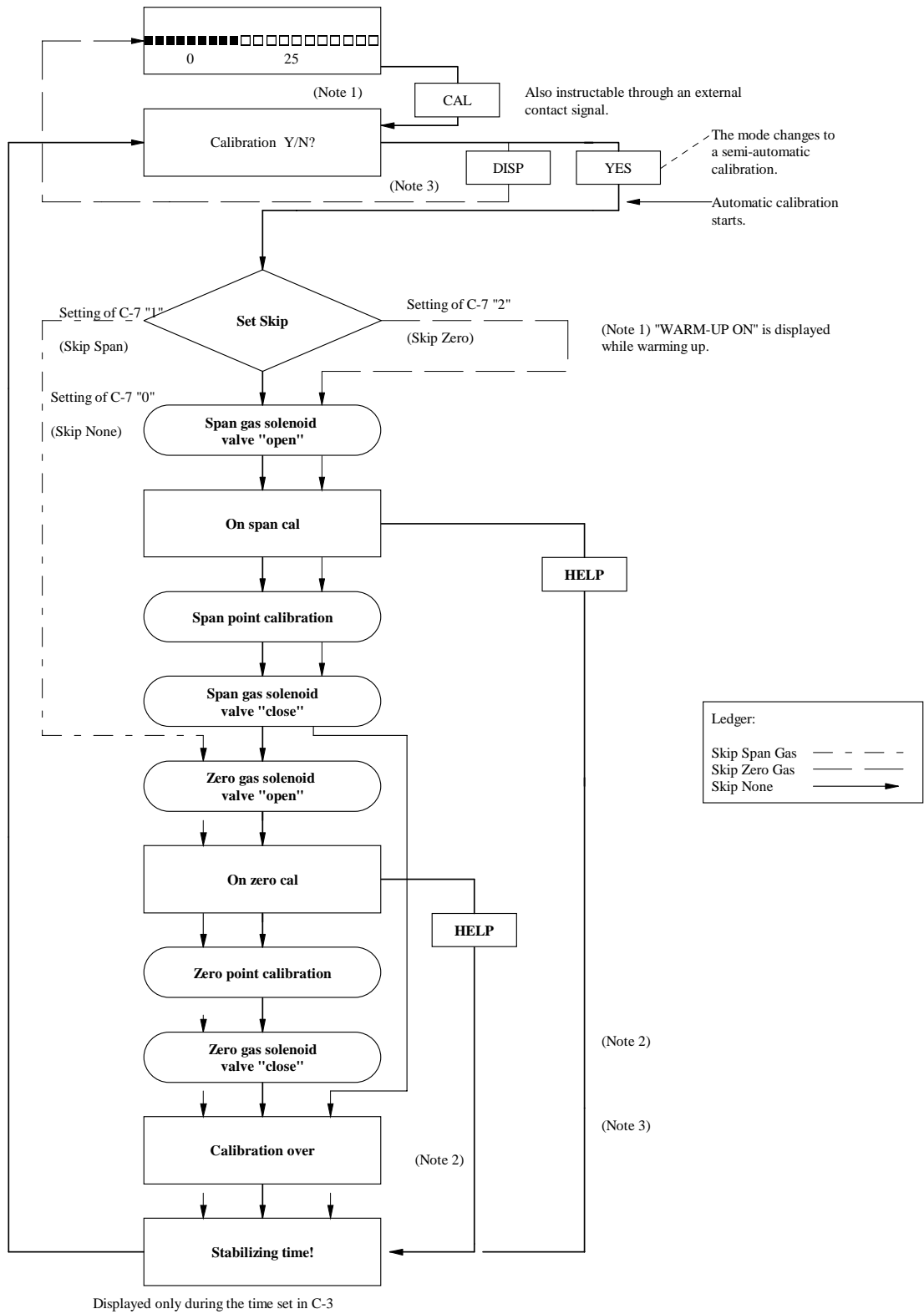
Record of span correction factor	You can monitor values acquired from the past 10 calibrations using Function No. B-0.
Record of zero correction factor	You can monitor values acquired from the past 10 calibrations using Function No. B-1.
Response time	You can monitor the response time provided that a 2-point calibration has performed. These values can be monitored using Function No. B-2.
Internal resistance of a cell	Internal resistance gradually increases as the cell (sensor) deteriorates. You can monitor the value measured during the latest calibration using Function No. B-3.
Robustness of a cell	The robustness of a cell is an index for predicting the remaining life of a sensor and is expressed in a number on 5 levels. You can monitor cell robustness using Function No. B-4.

8.1.5 Operation Flowchart of Semi-Automatic and Automatic Calibrations

In this section, the procedures for operating semi-automatic, automatic and one-touch calibrations are described using flowcharts.

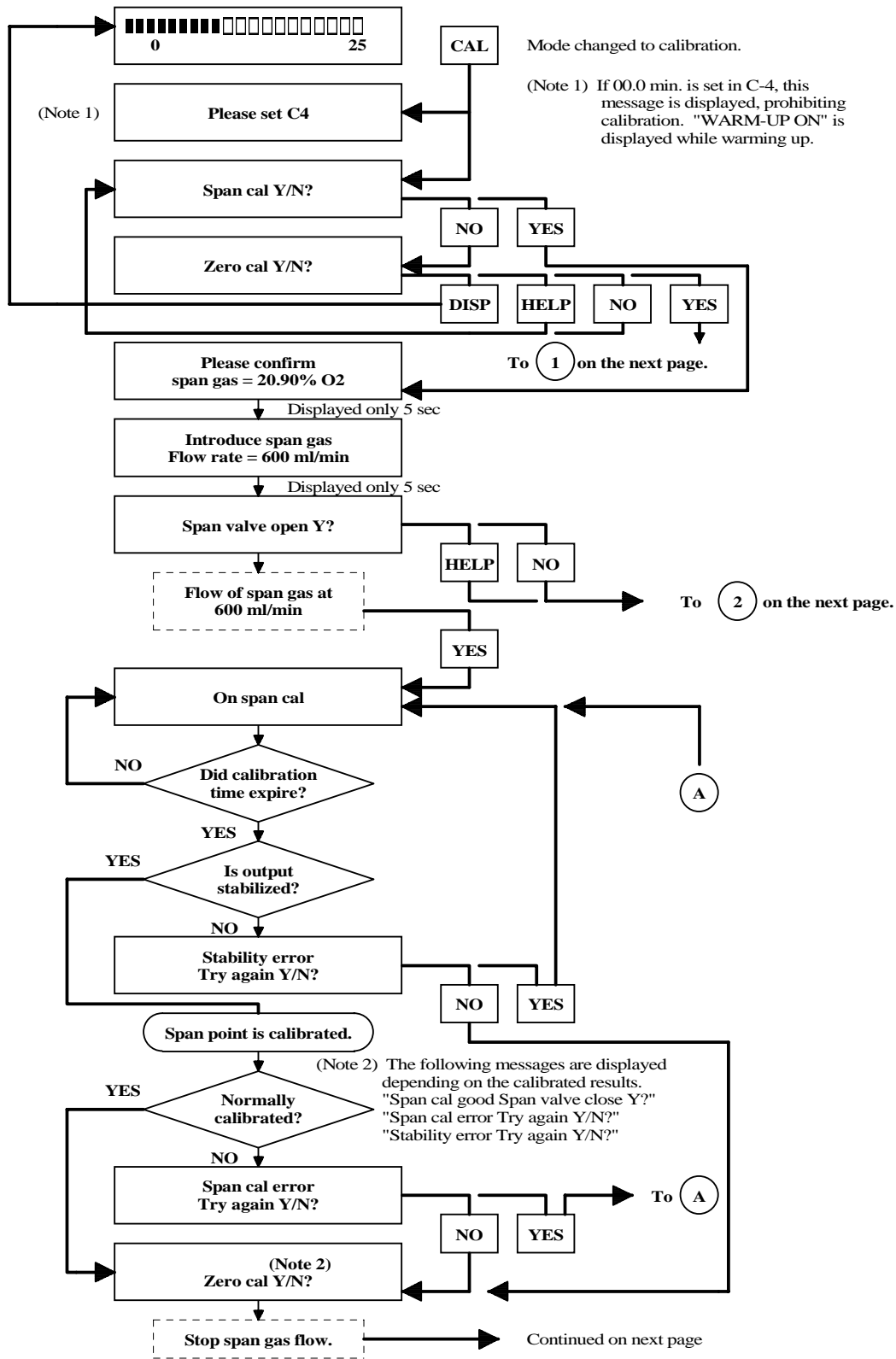
CALIBRATION

8.1.6 Operation Flowchart of Semi-Automatic and Automatic Calibration

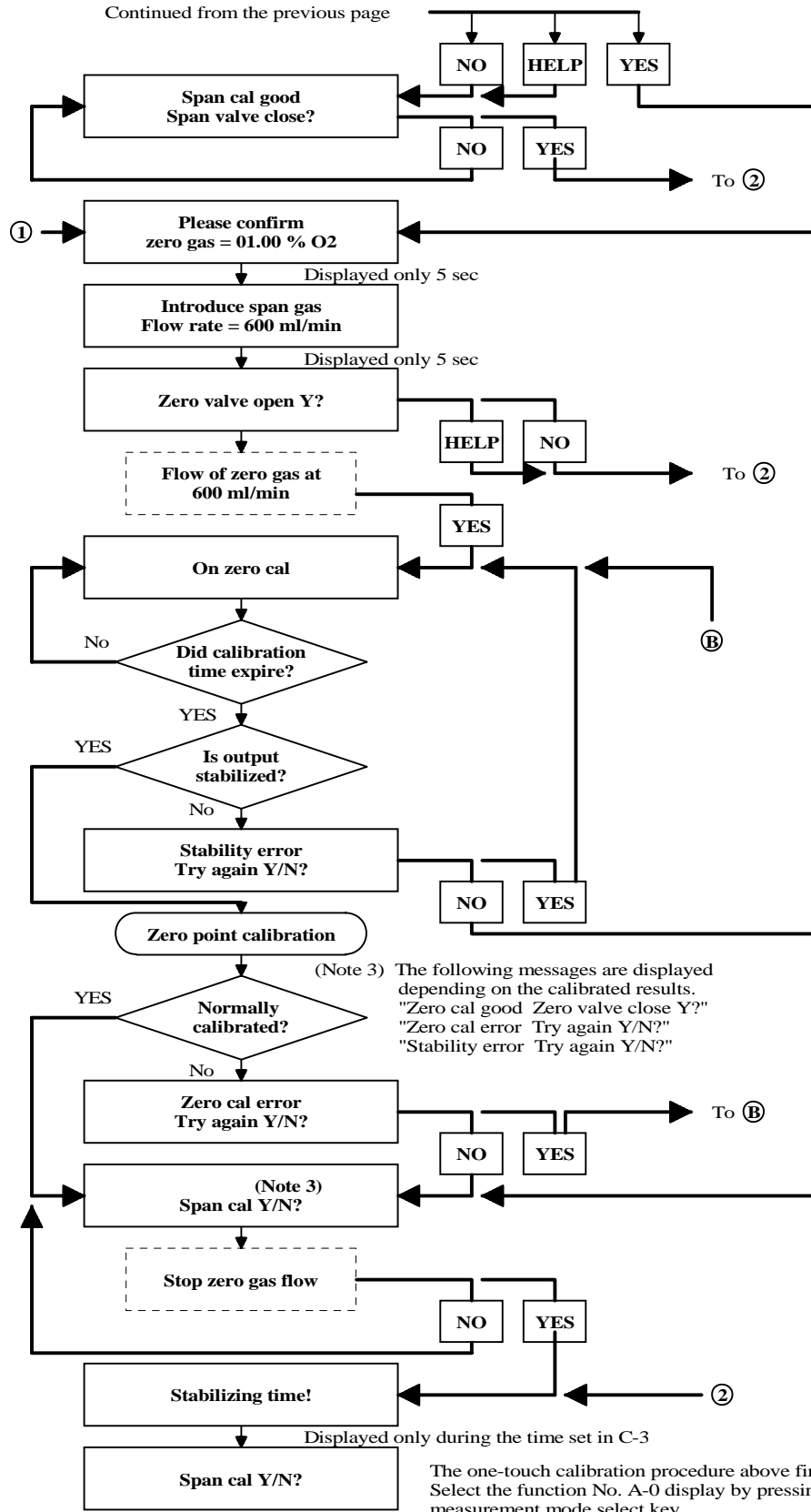


CALIBRATION

8.1.7 Operation Flowchart of One-Touch Calibration



CALIBRATION



INSPECTION AND MAINTENANCE

IX. INSPECTION AND MAINTENANCE

In this chapter, inspection and maintenance for keeping or recovering the measuring performances of the ZA8C In-Situ Type Zirconia Oxygen Analyzer is described:

9.1 INSPECTION AND MAINTENANCE OF THE DETECTOR

9.1.1 Precautions for Inspecting the Detector

- 1) Be careful not to touch any hot parts.
The sensor at the tip of the detector probe is heated up to 750°C (1382°F) during operation. If an operation is carried out immediately before inspection, be careful not to touch the probe with your finger tips.
- 2) Do not drop, bump or cause any great impact on the sensor assembly.
The sensor is made of ceramic (zirconia). If the detector is dropped or hit with something, the sensor will be damaged and no longer work.

9.1.2 Cleaning the Filter in the Sensor Assembly

If the filter at the back of the detector probe becomes clogged with dust, measurement problems occur. If dust blocks the flow of gas, wipe off the dust with a brush.

9.1.3 Cleaning the Calibration Gas Tube

Calibration gas, supplied from the calibration gas inlet of the terminal box into the detector, flows through the tube and comes out at the tip of the probe. The tube might become clogged with dust from the measurement gas. If you become aware of clogging, such as when a higher pressure is required to achieve a specified flow rate, clean the calibration gas tube.

Clean the calibration gas tube in the following manner:

- 1) Remove the detector.
- 2) Remove the four bolts (and the spring washers) attaching the sensor assembly from the top of the detector probe.
- 3) Remove the filter. Remove the filter hold plate assembly together with the U-shaped pipe.
- 4) Clean the calibration gas tube equipped in the probe, using a rod of 2 to 2.5 mm in diameter (see Figure 56). Keep air flowing from the calibration gas inlet at about 600 ml/min and insert the rod into the tube (3 mm in inside diameter). However, be careful not to insert the rod deeper than 40 cm for the general-purpose detector, or 15 cm for the high-temperature detector.
- 5) Clean the filter and the U-shaped pipe, as removed in (3). The U-shaped pipe can be rinsed with water. However, it should be dried out before reassembly.
- 6) Reassemble the parts removed for cleaning. Replace the filter with the fine-meshed ring element side facing the sensor. Coat the screw threads of the bolts with a heat-resistant agent (such as never seize) and then screw them in.

INSPECTION AND MAINTENANCE

Tighten each bolt with a torque of about 60 kgf • cm (52 in • 16) uniformly.

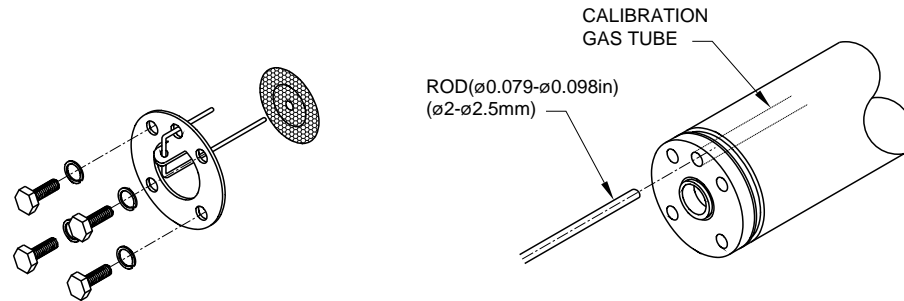


Figure 64: Cleaning of Calibration Gas Tube

9.1.4 Replacing the Sensor Assembly

The performance of the sensor (cell) deteriorates as the surface becomes soiled during operation. Therefore, you have to replace the sensor when its life expectancy expires, namely when it can no longer satisfy the range of the zero point correction factor of $100 \pm 30\%$ or the range of the span point correction factor of $0 \pm 15\%$, and so on. In addition, the sensor assembly is to be replaced also when it is damaged and can no longer work normally in measuring.

When the sensor is no longer operable (for example, due to breakage), investigate the cause and remedy the problem as far as possible to prevent its reoccurrence.

Replace the sensor assembly as follows:

- 1) In order not to lose or damage disassembled parts, identify the parts to be replaced from among all the parts in the sensor assembly. Normally, replace the sensor, filter, metal O-ring and the contact together at the same time. If required, also replace the U-shaped filter hold plate, bolts and the spring washers.

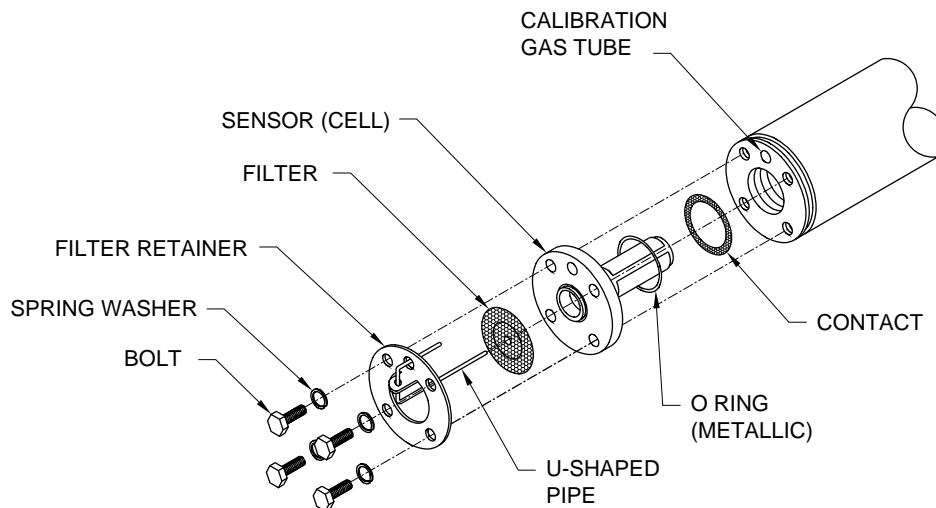


Figure 65: Parts in a Sensor Assembly

INSPECTION AND MAINTENANCE

- 2) Remove the bolts from the back of the detector probe, together with the washers.
- 3) Remove the filter hold plate with the U-shaped pipe. At this point, the filter can also be separated from the detector probe.
- 4) Remove the sensor and the metal O-ring (embedded in a groove on the flange surface of the sensor). Pull the sensor out by twisting it slightly.
- 5) Remove the contact using tweezers to pull it out of the groove.
- 6) If you can use any of the parts from among those removed, clean them with solvent to remove any contaminants adhering to them. Also, clean the parts used for mounting the detector probe, as they may also be soiled with the measurement gas.
- 7) The parts are to be assembled sequentially. First, replace the contact. Being careful not to cause irregularities in the pitch of the coil spirals (i.e., not to bend the coil out of shape), place it in the ringed groove so that it forms a solid contact.
- 8) Next, set the metal O-ring in the O-ring groove on the flange surface of the sensor and then mount the sensor. To insert the sensor, turn it clockwise. After inserting it all the way to its base, adjust its position so that the U-shaped pipe insertion holes of the sensor and of the probe are properly aligned.
- 9) Replace the filter, the filter hold plate and the U-shaped pipe. To mount the U-shaped pipe, attach the pipe to the filter hold plate and then insert the assembly into the U-shaped pipe insertion hole. In addition, mount the filter with the fine-meshed ring-shaped element side facing and forming a contact with the sensor.
- 10) Attach the reassembled parts with the four bolts. Coat the threads of the bolts with a heat-resistant agent (such as never seize) and then screw them in along with the washers. Tighten all four bolts with a torque of about 60 kgf • cm (52 in • lb).

The work of replacing the sensor assembly is now complete. Mount the detector and restart the operation. However, be sure to calibrate the instrument before beginning a measurement.

9.1.5 Cleaning the High Temperature Probe Adapter

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

Dust sticking to the probe should be blown off. If any dust still remains after blowing, clean it with a metal rod. In addition, if dust is found on the auxiliary ejector at the sample gas outlet, remove these parts from the high-temperature probe adapter and then clean them. To remove dust, blow them with air or rinse them with water. If the ejector is plugged, replace it with a new ejector. If the transport tube is clogged, remove particulates with a metal rod.

9.2 INSPECTION AND MAINTENANCE OF THE CONVERTER

You need not inspect or perform maintenance work on the converter daily or periodically. If the converter fails to work properly, check for the correct input voltage or a brown fuse.

INSPECTION AND MAINTENANCE

9.2.1 Replacing Fuses

The converter incorporates a total of four fuses: two for the detector heater and two for the electric circuit in the converter. If any fuse burns out, replace it in the following manner. However, it is recommended that the fuses for the detector heater (F1, F2) be replaced every two years even if they are not burned out.

NOTE: If a replaced fuse blows out immediately, a problem may exist in the circuit. Completely go over the circuit to find out why the fuse blew.

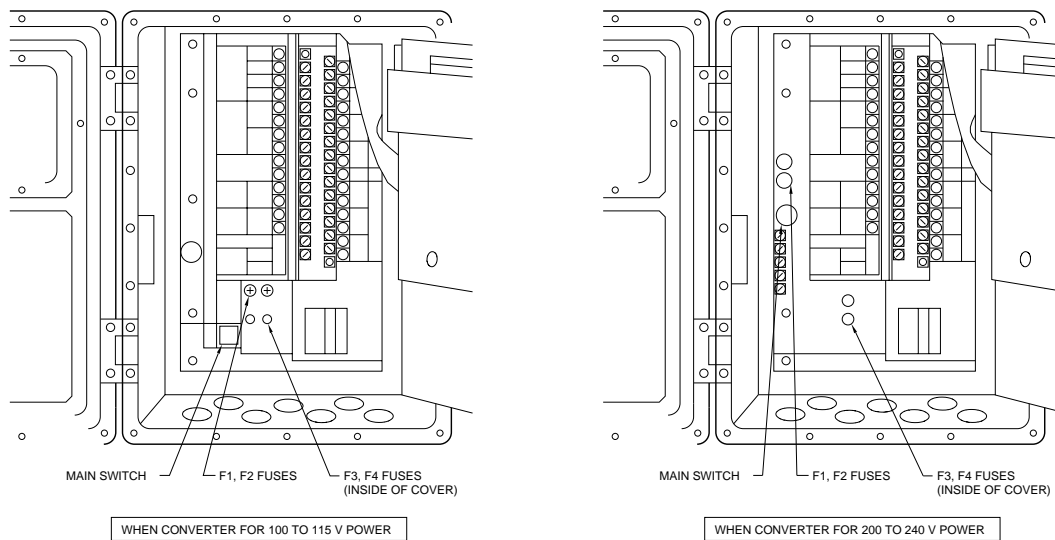


Figure 66: Positions for Installing fuses in a Converter

•Replacement of Detector Heater Fuses (F1, F2)

The location of the fuse and power switch is different in converters for a 115 V series power supply than for a 220 V series power supply. Replace the fuses for the detector heater in the following manner:

- 1) Turn OFF the power to the converter for safe replacement work.
- 2) Remove the fuses from the fuse holders. For 115 V series power converters, turn the fuse holder cap 90° counterclockwise using a flat blade screwdriver that just fits the holder cap slot. In this state, the fuse can be pulled out together with the cap. For 220 V series power converters, the use of a tool is not necessary.
- 3) After checking that the new fuse has the specified rating (3 A), place this new fuse (cartridge glass-tube fuse) in the holder. In 100 V series power converters, insert the fuse into the cap and then both into the holder. Turn the cap 90° clockwise while pushing it at the same time with a flat blade screwdriver.

INSPECTION AND MAINTENANCE

•Replacing the fuse (F3, F4) to protect the electric circuit in a converter

- 1) Turn OFF the main switch of the converter to maintain safety while replacing the fuse.
- 2) Remove the fuse. Fuses F3, F4 are cartridge socket types in which two prongs of the fuse are inserted into the socket on the printed circuit board. If you cannot remove fuses F3, F4 easily with your hand, use a tool such as a long nose or needle nose pliers.
- 3) Check the new fuse for the specified rating (0.2 A) before installing it. Hold the body of the fuse gently with a pair of pliers and fully insert the two prongs into the socket on the printed circuit board. Be careful not to bend the prongs during installation (otherwise, the fuse may be damaged).

9.2.2 Replacing the Message Display Unit

The dot matrix LCD, incorporated in the message display unit, should provide long term operation. However, over time, the performance deteriorates gradually and unavoidably (i.e., giving ambiguous readouts, etc.). If the readout on the display becomes unreadable, replace the LCD assembly.

TROUBLESHOOTING

X. TROUBLESHOOTING

This chapter describes the checking and restoring methods when the ZA8C converter self-diagnosis function detected errors or other troubles occur.

10.1 ERROR CODE DESCRIPTIONS

10.1.1 Types of Error Codes

There are nine types of error that can be detected with the self-diagnostics function of the ZA8C converter. When these errors occur (except for digital circuit failures), the corresponding error codes are displayed in the data display. In the LCD display, error messages are also displayed. In addition, if more than one error occurs simultaneously, the letter “H” is also displayed in the lower right corner of the LCD display. In this case, by selecting the displayed message using the auxiliary message display key “HELP”, suggested causes of the error are displayed.

Error Code	Error Detail	Error Status
E--1	Sensor (cell) error	Goes into fail mode, automatically turning OFF the power supply to the detector heater.
E--2	Sensor temp "LOW"	Goes into fail mode, automatically turning OFF the power supply to the detector heater.
E--3	Sensor temp "HIGH"	Goes into fail mode, automatically turning OFF the power supply to the detector heater.
E--4	A/D (Analog circuit) error	Goes into fail mode, automatically turning OFF the power supply to the detector heater.
E--5	Calibration value "ZERO"	(Displayed during calibration) the present zero point calibration value is not affected.
E--6	Calibration value "SPAN"	(Displayed during calibration) the present zero point calibration value is not affected.
E--7	Start power stability time over	(Displayed during calibration) the present zero point calibration value is not affected.
E--8	ROM, RAM error	Goes into fail mode, automatically turning OFF the power supply to the detector heater.
□□□ (Display erased)	Digital circuit error power failure	Goes into fail mode, automatically turning OFF the power supply to the detector heater. (Displayed upon restart after remedying the power failure). Data values default.

Table 20: Error Codes, Their Contents and Status When Each Error Occurs

Errors displayed with error code “E—5”, “E—6”, or “E—7” are those generated in carrying out automatic or semi-automatic calibration. If these errors occur, that error code and oxygen concentration valve are alternately displayed in the data display. The error is released when the analyzer returns to the measurement mode and, at the same time, the error code display disappears. The error message display is cleared by pressing the measurement mode select key “DISP”.

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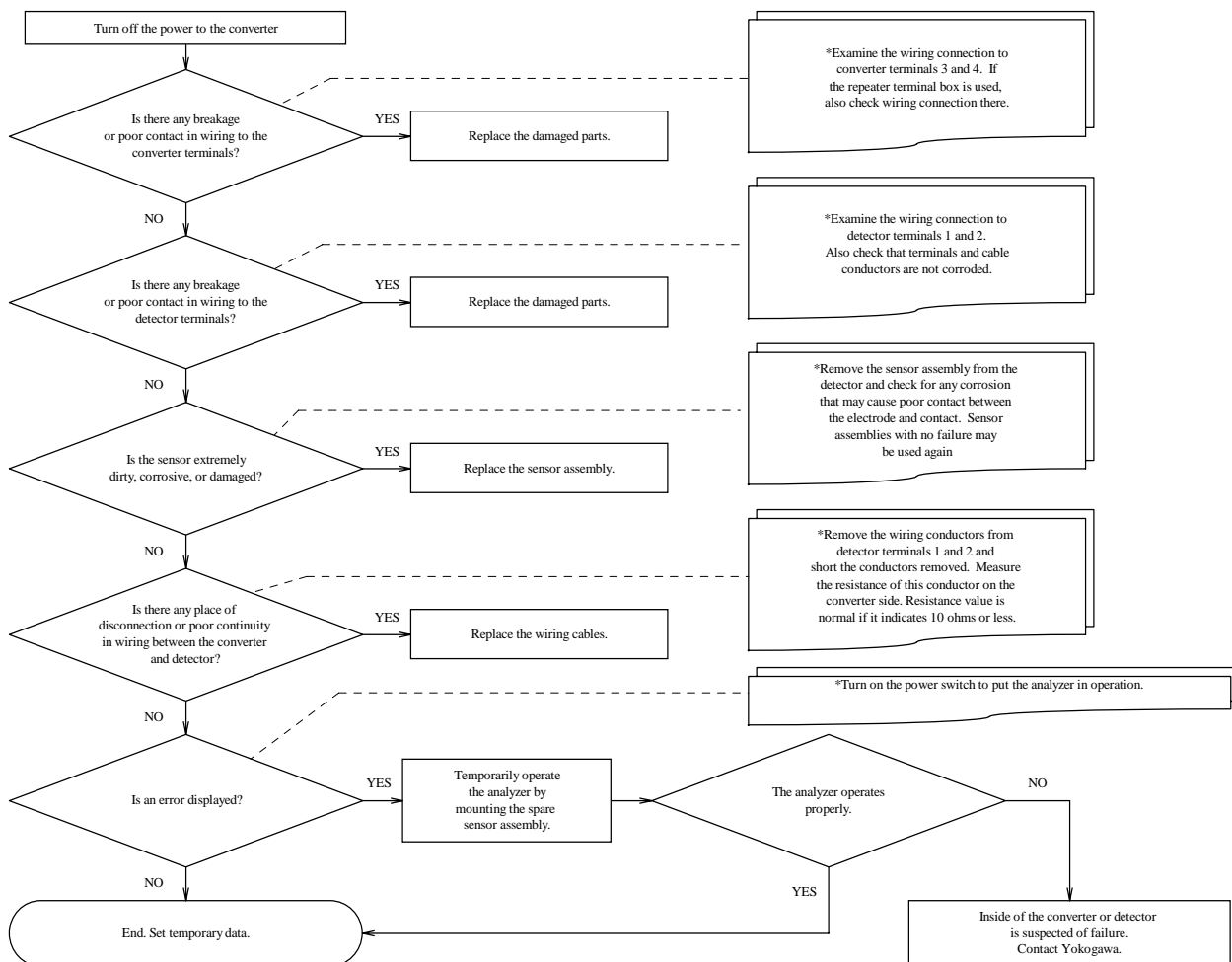
NOTE: Re-calibration after an error occurred should be performed after examining that set points and piping conditions are not improper.

Errors displayed with error code “E—1”, “E—2”, “E—3”, “E—4”, or “E—8” including digital circuit failure are caused by equipment failures. If these errors occur, the converter stops the supply of power to the detector heater and holds the output signal at the value immediately before the error occurrence (preset value if “2” is set with function No. D-2). When these errors occur, turn off the converter power and begin restoration. The error code display is released after the equipment is restored and operates normally.

10.1.2 Causes of “E—1 Sensor (Cell) Failure” and Procedure for Restoration

•Causes

- 1) Failure in wiring between the converter and the detector (poor contact of terminal connections, disconnection, etc.)
- 2) Sensor (cell) assembly failure (damage, deterioration)
- 3) Failure in the sensor (cell) assembly mounting part (poor continuity between the sensor electrode and the contact, etc.)
- 4) Wiring system failure inside the detector (disconnection, etc.)



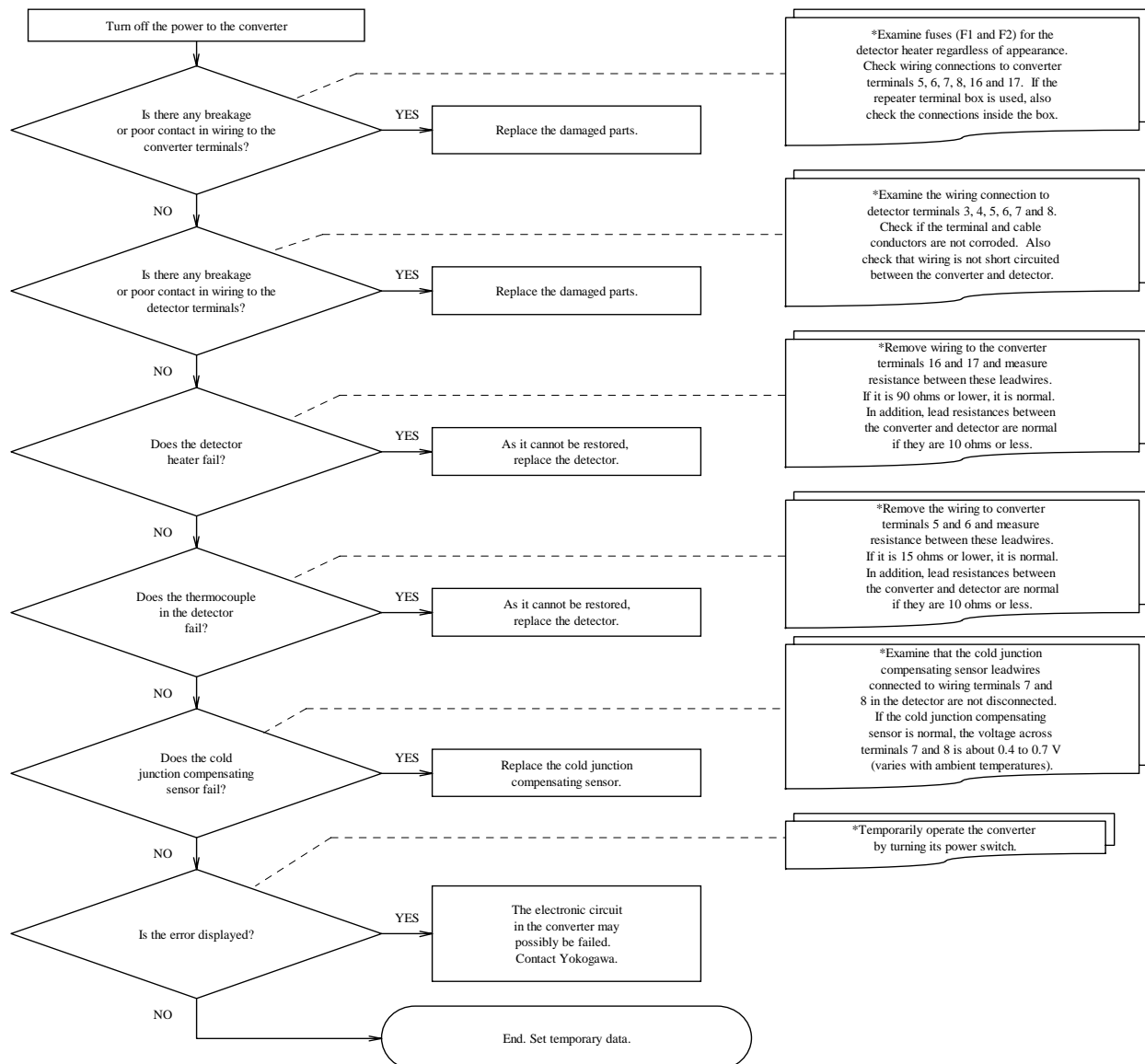
TROUBLESHOOTING

10.1.3 Causes of “E—2 Sensor Temperature Error (Low)” and Procedure for Restoration

This error occurs when the sensor temperature after warm-up (in steady state operation) is lower than 730°C (1346°F).

•Causes

- 1) Fuse (F1 and/or F2) for the detector heater in the converter is blown.
- 2) Failure in wiring between the converter and the detector (poor contact of terminal connections, disconnection, short circuiting, etc.).
- 3) Failure of Sensor for cold junction compensation at the detector terminal board (poor contact in terminal connections, or failure).
- 4) Failure of thermocouple in the detector (disconnection, short circuiting in wiring inside the detector).
- 5) Failure of the heater inside the detector (disconnection, etc.).
- 6) Electronic circuit failure inside the converter.



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10.1.4 Causes of “E—3 Sensor Temperature Error (High)” and Procedure for Restoration

This error occurs when the converter detects that the sensor temperature is higher than 780°C (1486°F). It also occurs if the converter detects failure of the heater circuit and temperature measuring and controlling circuit during warm-up.

•Causes

If the error code is displayed in steady state operation, the following are considered as the possible causes:

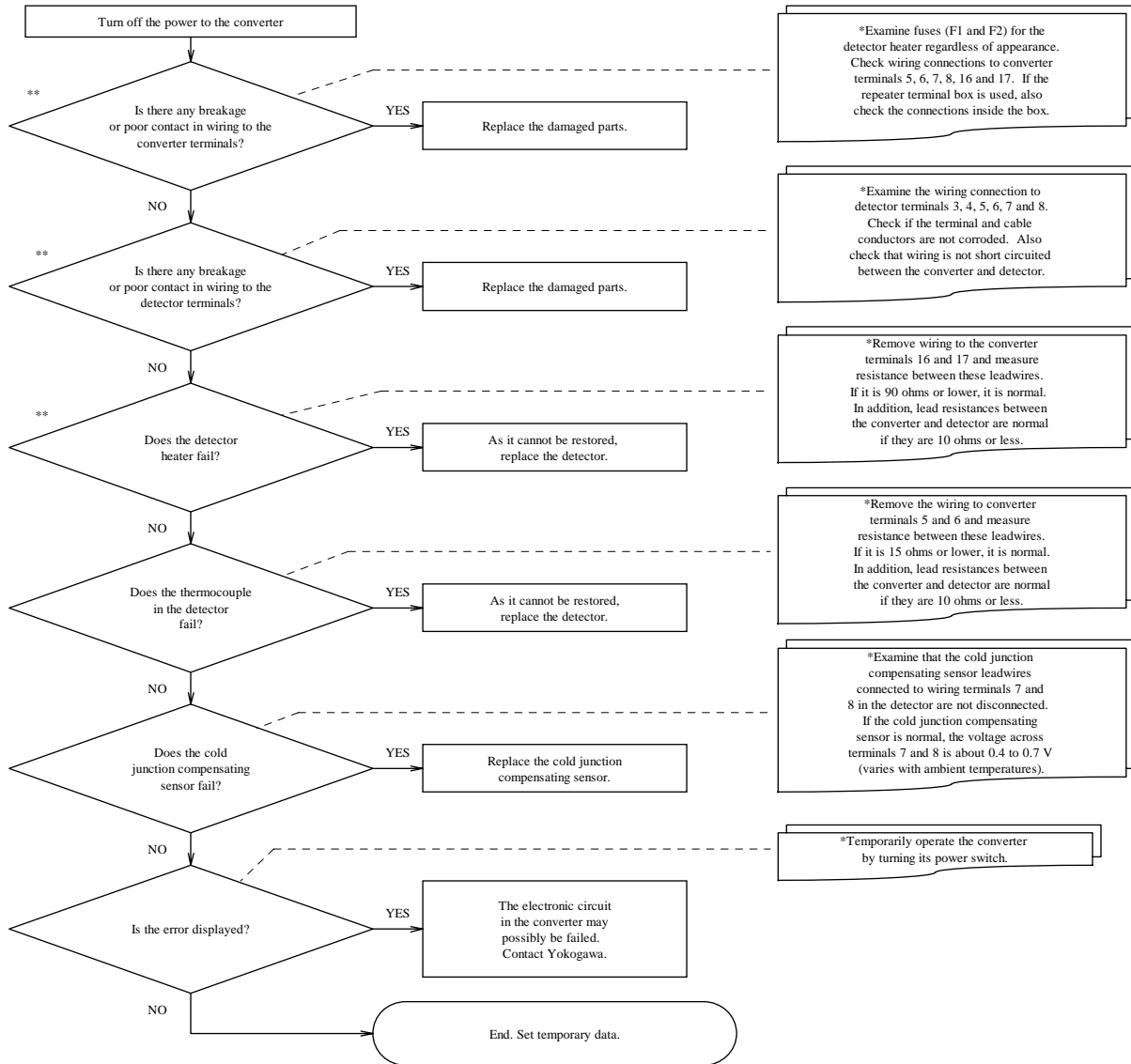
- 1) Cold junction compensating sensor failure at the detector terminal board.
- 2) Failure of thermocouple in the detector.
- 3) Failure of electronic circuits in the converter.

Next, if the error code is displayed during warm-up, the following are considered as the possible causes:

- 1) Fuses (F1 and/or F2) in the converter for the detector heater are blown.
- 2) Wiring failure between the converter and the detector (poor contact at the terminal connections, disconnection, short circuiting, etc.).
- 3) Failure of the heater in the detector (disconnection, etc.).

TROUBLESHOOTING

Note: Items marked with ** should be checked when the error occurs during warm-up.



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10.1.5 Causes of “E—4 A/D (Analog Circuit) Failure” and Procedure for Restoration

This error occurs when the electric circuit of the converter does not operate normally.

•Causes

- 1) The analog circuits of the converter contains a failure.
- 2) The supply voltage significantly drops (15% or more of the rating).

•Locating the Failures and Measures

Turn the converter power switch off and back on again. Next, check to see if operation is normal.

If operation is normal, the error is considered to be caused by temporary failure of the power system, such as voltage drop or influence of noise. If the cause is clear, take suitable measures to prevent reoccurrence of the same problem.

If the error occurs again, it may be caused by the converter’s electric circuits, such as a CPU card. In this case, it is not as easy to locate and restore the failed part. If the error occurs again, contact YOKOGAWA INDUSTRIAL AUTOMATION. However, first confirm by checking the power supply that the power system is not at fault.

10.1.6 Causes of “E—5 Calibration Value Error (Zero)” and Procedure for Restoration

This error occurs when the zero point correction factor exceeds the range $100 \pm 30\%$ in the automatic and semi-automatic calibrations.

•Causes

- 1) The oxygen concentration of zero gas and the value set with function No. C-1 do not agree or the span gas is accidentally used as the zero gas.
- 2) The zero gas does not flow by the specified quantity (about 600 ml/min).
- 3) The sensor (cell) is damaged and the cell emf contains an error.

•Locating the Cause of Failure and Taking Measures

- 1) To make sure, carry out the calibration once more. Before calibration, examine the following. If they are not in normal state, correct them.
 - Does the value set in the function No. C-1 agree with the zero gas oxygen concentration?
 - Does the calibration gas tubing have measures to no zero gas leakage?
- 2) If the error does not occur in re-calibration, it is considered as the cause of the error in the first calibration that the calibrating conditions were not proper. In this case, no particular restoration is necessary. Restart the steady state operation. If the error also occurs in re-calibration, it is considered as the cause of error occurrence that the sensor is deteriorated or is damaged. Confirm that the error corresponds to one or more of the following phenomena and replace it with a new sensor (see 10.1.4).
 - When zero gas is passed, the sensor (cell) emf indicated with function No. A-3 greatly differs from the theoretical value in that oxygen concentration.
 - When three kinds of gas (zero gas, span gas, and the gas having approximately middle oxygen concentration between the above two) are measured, correlation cannot be found in these measured data for oxygen concentration.

TROUBLESHOOTING

In addition, check the sensor deterioration for damage which caused the error occurrence whether or not it abruptly occurs by the following phenomena. If abrupt occurrence may be suspected, check the check valve located at the inlet of detector calibration gases whether or not the valve has failed. Check valve failure causes condensed water in the calibration gas tubing, which is the cause of sensor breakage.

- Examine historical data of the zero point correction factor displayed with function No. B-1. Permissible range of the zero point correction factor is $100 \pm 30\%$.
- Examine the sensor (cell) internal resistance displayed with function No. B-3. A new sensor shows the value of 200 ohms or less. While the dissipated sensor approaching to the end of the life indicates the value of 3 to 10 k ohms.
- Examine the sensor integrity data (five grade evaluation of five to one) displayed with function No. B-4. A sensor in good state shows "5".

10.1.7 Causes of "E—6 Calibration Value Error (Span)" and Procedure for Restoration

This error occurs when the span point correction factor exceeds the range $0 \pm 18\%$ in the automatic and semi-automatic calibrations.

•Causes

- 1) The oxygen concentration of span gas and the value set with function No. C-0 do not agree or the zero gas is accidentally used as the span gas.
- 2) The span gas does not flow by the specified quantity (about 600 ml/min).
- 3) The sensor (cell) is damaged and the cell emf contains an error.

•Locating the Cause of Failure and Taking Measures

- 1) To make sure, carry out the calibration once more. Before calibration, examine the following. If they are not in normal state, correct them.
 - Does the value set in the function No. C-0 agree with the span gas oxygen concentration?
 - Is there a leak in the span gas tubing or connections?
- 2) If the error does not occur in re-calibration, it is considered as the cause of the error in the first calibration that the calibration conditions were not proper. In this case, no particular restoration is necessary. Restart the steady state operation.

If the error also occurs in re-calibration, it is considered as the cause of error occurrence that the sensor has deteriorated or is damaged. Confirm that the error corresponds to one or more of the following phenomena and replace it with a new sensor (see section 10.1.4).

- 1) When span gas is passed, the sensor (cell) emf indicated with function No. A-3 greatly differs from the theoretical value in that oxygen concentration.
- 2) When three kinds of gas (zero gas, span gas, and the gas having approximately middle oxygen concentration between the above two) are measured, correlation cannot be found in these measured data for oxygen concentration. In addition, check the sensor deterioration or damage which caused the error occurrence may be suspected, check the check valve located at the inlet of the detector calibration gases whether or not the valve has failed. Check valve failure causes condensed water in the calibration gas tubing, which is the cause of sensor breakage.
 - Examine historical data of the span point correction factor displayed with function No. B-0. Permissible range of the span point correction factor is $0 \pm 18\%$.
 - Examine the sensor (cell) internal resistance displayed with function No. B-3. A new sensor shows the value of 200 ohms or less.

TROUBLESHOOTING

- 3) While the displayed sensor approaching to the end of the life indicates the value of 3 to 10 k ohms.
 - Examine the sensor integrity data (five grade evaluation five to one) displayed with function No. B-4. A sensor in good state shows “5”.

10.1.8 Causes of “E—7 EMF Stabilization Time Over” and Procedure for Restoration

This error occurs when the sensor (cell) emf is not stabilized even if the calibration time is over because the sensor part of the detector is not filled with calibration gas (zero and span gases) at the one-touch calibration.

•Causes

- 1) Flow of the calibration gas is small (specified flow: about 600 ml/min).
- 2) Measuring gas flows toward the tip of the detector probe.
- 3) Sensor (cell) response is deteriorated.

•Locating the Cause of Failure and Taking Measures

- 1) Examine the setting time with function No. C-4 whether or not it is suitable. If not suitable, modify the setpoint and perform re-calibration again. Carry out re-calibration after confirming that the tubing does not leak and flowing calibration gas by the specified rate (about 600 ml/min).
- 2) When calibration is normally carried out, continue the steady state operation. If the error occurs again, replace the sensor assembly after checking that whether or not the error corresponds to the following.
 - Dust significantly sticks to the detector probe tip. If dust sticks, clean it (see Chapter 10).If the error occurs in calibration even after the sensor assembly is replaced, influence of measuring gas flow is considered as the cause. If this occurs, stop the measuring gas from flowing toward the detector probe tip by changing the mounting position of the detector.

10.1.9 Causes of “E—8 ROM and RAM Failure” and Procedure for Restoration

This error occurs when ROM contents reading and/or writing memory to RAM are not possible.

•Causes

- 1) ROM and RAM pins are not fully inserted into the socket.
- 2) High supply voltages exceeding the specifications are applied or the effect of noise is given to ROM and RAM.
- 3) ROM and/or RAM failed.
- 4) Failure occurred in digital circuits on the CPU board and others.

•Locating the Cause of Failure and Taking Measures

Turn off the converter power switch. After confirming that the supply voltage satisfies the specification, turn on the power switch again to operate the converter.

If the error repeats, repair is necessary. Contact Yokogawa Industrial Automation.

10.1.10 Causes of Display Disappearance (Data Display) and Procedure for Restoration

Operation of the converter digital circuits is being self-checked with the watchdog timer (WDT) or clock monitor.

TROUBLESHOOTING

This error occurs when power is turned on again after power supply to the converter electrical circuit is interrupted due to power failure, when the electrical circuit is interrupted due to power failure, or when the converter digital circuits fail, such as time-up of the watchdog timer normally reset in a fixed period. In any case, if the error occurs, on-screen information in the data display disappears.

Next, measures when the error occurs due to the digital circuit operation failure will be described.

•Causes

- 1) Low supply voltages exceeding the specifications are applied or the effect of noise is given to digital circuits.
- 2) Digital circuit failure.

•Locating the Cause of the Failure and Taking Measures

Once the converter is turned off, the likelihood of explosion is eliminated. Make sure the supply voltage satisfies the specification and then turn on the power switch on to begin operation of the converter.

If the error occurs again, repair is necessary. Contact Yokogawa Industrial Automation.

10.2 Measures When Measured Value Shows an Error

When measured values are abnormal, the cause is not always due to instrument failure. There are many cases when the measuring gas itself is in an abnormal state or external causes, which disturb the instrument operation, exist. In this section, we present cases where measured values show the following phenomena:

- 1) The measured value is higher than the true value.
- 2) The measured value is lower than the true value.
- 3) The measured value sometimes show abnormal values.

10.2.1 Measured Value Higher Than True Value

•Causes and Measures

- 1) The measuring gas pressure becomes higher.
The measured oxygen concentration value X (vol% O_2) is expressed as shown below, when the measuring gas pressure is higher than that in calibration by Δp (mm H_2O).
$$X=Y [1 + (\Delta p/10336)]$$

where Y : Measured oxygen concentration value at the same pressure as in calibration (vol% O_2).

When an increment of the measured value by pressure change cannot be neglected, measures must be taken.

Investigate the following points to perform improvement available in each process.

- Is improvement in facility's aspect available so that pressure change does not occur?
- Is performing calibration available under the averaging measuring gas pressure (internal pressure of a furnace)?

TROUBLESHOOTING

- 2) Moisture content in a reference gas changes (increase) greatly.
When this error is not ignored, use a gas in which moisture content is constant such as instrument air in almost dry condition as a reference gas.
In addition, change of moisture content in exhaust gas after combustion is also considered as a cause of error. However, normally this error is negligible.
- 3) Calibration gas (span gas) is mixing into the detector due to leakage.
If the span gas is mixing into the detector due to leakage for the reason of failure of the valve provided in the calibration gas tubing system, the measured value shows a value a little higher than normal.
Check valves in the calibration gas tubing system for leakage. For manual valves, check them after confirming that they are in a fully closed state.
- 4) The reference gas is mixing into the measuring gas and vice versa.
Since the difference between oxygen partial pressures on the sensor anode and cathode sides becomes smaller, the measured value shows a higher value.
An error which does not appear as the error “E—1” may occur in the sensor. Visually inspect the sensor. If any crack is recognized, replace it with a new sensor assembly.
- 5) The fly ash filter is clogged with ash, and requires replacement.

NOTE: Data such as cell integrity displayed with function No. B-4 should also be used for deciding sensor quality.

10.2.2 Measured Value Lower Than True Value

•Causes and Measures

- 1) The measuring gas pressure becomes lower.
Where an increment of the measured value by pressure change cannot be neglected, follow the steps as described in subsection 10.1.1 (1).
- 2) Moisture content in a reference gas changes (decreases) greatly.
If air at the detector installation site is used for the reference gas, a large change of moisture in the air may cause an error in measured oxygen concentration value (vol% O₂). To correct this error, use a gas with little or no moisture content. Another cause of error may be the sudden change in moisture content of the exhaust gas after combustion. However, normally this error is negligible.
- 3) Calibration gas (zero gas) is mixed into the detector due to leakage.
If zero gas leakage into the detector is the cause of failure, the measured value will show a value a lower than normal. Check the valves in the calibration gas tubing system for leakage. For manual valves, check them after confirming that they are in fully closed state.

10.2.3 Measured Value Sometimes Show Abnormal Values

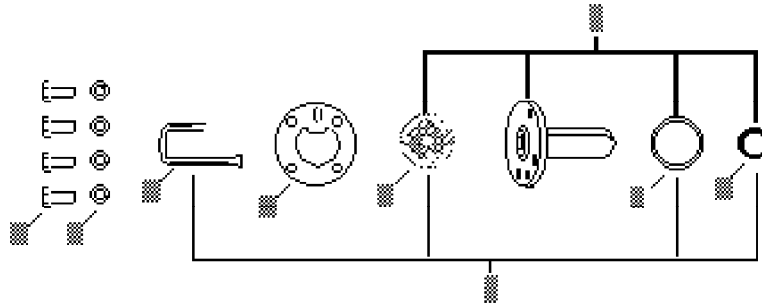
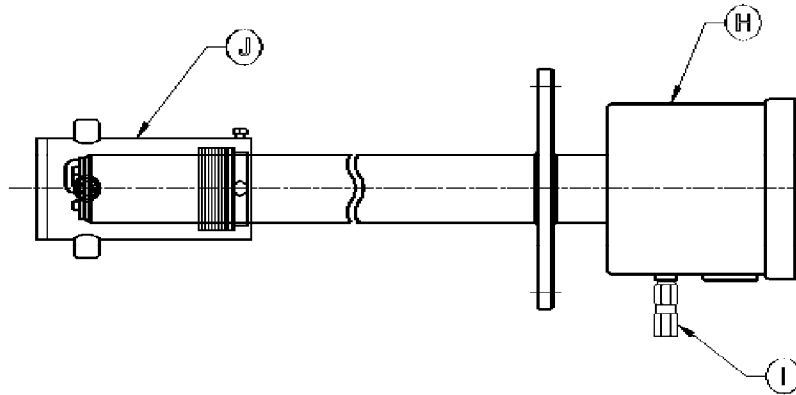
•Causes and Measures

- 1) Noise is mixed into the converter from the detector output wiring.
Shield the wiring to eliminate noise mixing into the converter.
- 2) The converter is affected with noises from the power supply.
Insert the line filter in the power line.
- 3) The cell leads are incorrectly wired on the signal cable.
- 4) The calibration gas for zero gas may not correspond to the certified value listed on the cylinder. Reprogram menu C-1 and calibrate the sensor.

SPARE PARTS

XI. SPARE PARTS

11.1 MODEL ZO21D-L LOW TEMPERATURE DETECTOR WITH FLAME ARRESTOR, CHECK VALVE AND FLANGES



Item	Part No.	Description
1	E7042UD	*Cell Assembly kit
2	K9119EN	*Cell Parts (w ithout cell) kit
A	Y9512RU	*Bolt (12 mm) (5)
B	Y9500SU	*Washer (5)
C	E7042BQ	*Pipe
D	E7042BR	Plate
E	E7042AY	Filter Assembly
F	G7048XL	Metal O-Ring
G	E7042BS	Contact
H	E7042AU	Cold Junction
I	M1132KN	Check Valve
J	E7042VG	Replacement filter for flame arrestor (Does not include flame arrestor).
	E7042VP	Flame Arrestor Assembly

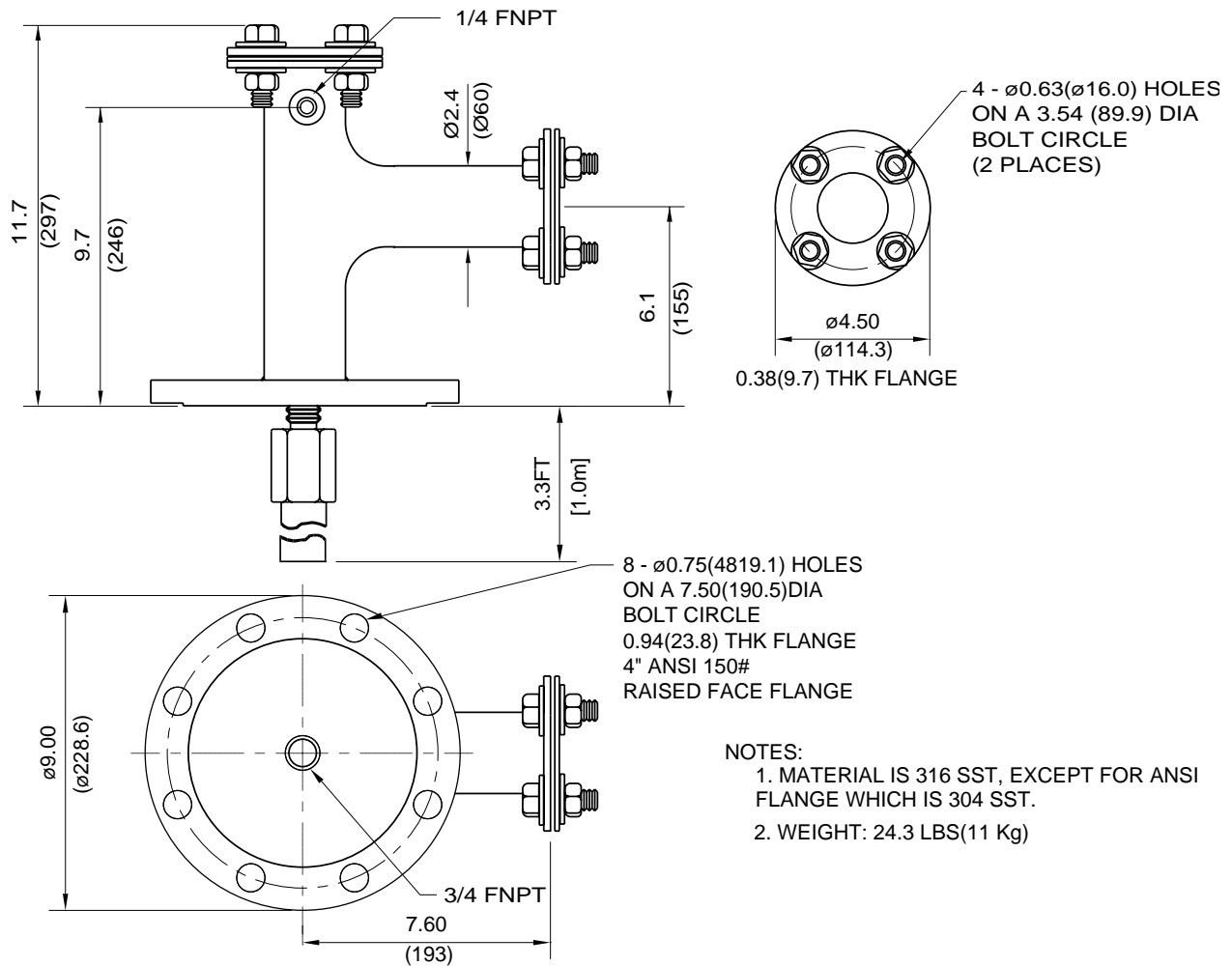
Note: *Denotes typical spare part.

SPARE PARTS

11.2 MODEL ZO21P ADAPTER TEE SPARE PARTS

Part Number	Description
M1100HH	Adapter Tee (ZO21P-H)
M1132FH	Adapter Tee (ZO21P-F)
M1100HF	Plate
M1133FT	Gasket (JIS 5K32A) for ZO21P-H, T, S or C
M1132HP	Gasket (3" ANSI) for ZO21P-F
Y9121BU	Nut
Y9120WU	Washer
M1132KY	Bolt

11.3 ZA8C SPARE PARTS



SPARE PARTS

Part No.	Description
M1132ZX	Dual stage regulator for zero gas cylinders, 316L stainless steel, CGA 580, and 3000 psi inlet.
M1133AR	Zero gas pressure switch, SPDT 1/8 NPTF.
M1132KD	Reference air regulator
M1132CG	Reference air gauge 0 -30 psi
K9290UA	PCB2
K9290UH	LCD Assembly
K9290XC	Panel
K9290XL	CPU Assembly (extended version)
K9290XQ	CPU Assembly (basic version)
A1113EF	Fuse, 3A (in-line) (pkg. of 5)
L9021EF	Fuse, 0.5A (plug-in) (pkg. of 5)
L9811FP	Watertight glands (each)

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APPENDIX A. FIGURES AND TABLES

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