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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 $O_2$ 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.
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% O₂)
- **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)
1.4 **STANDARD SPECIFICATIONS**

**Measurement:** % oxygen concentration  
**Measurement Method:** Zirconium Oxide  
**Measurement Range:** 0 to 100 vol% O₂  
**Output:** 0 to 5 vol% O₂, to 0 to 100 vol% O₂  
**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 10Ω 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.
II. STANDARD CONVERTER, DETECTOR AND CALIBRATION UNITS

2.1 ZA8C CONVERTER

•External Dimensions

![Diagram of ZA8C Converter]

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°F to 131°F (-20°C to 55°C)  
  **Storage Temperature:** -4°F to 140°F (-20°C 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% O₂  
  **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.)
Message Display:

**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% O₂
- 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% O₂. (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% O₂ 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)
**Digital Communication:**
Serial communication using RS-232C or RS-422A (driver not included)

**Communication Specifications (RS-232C or RS-422A):**
- **Transmission Items:** 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.
- **Communication:** Start-stop system, Half duplex
  - RS-232C two-wire system
  - RS-422A four-wire, multi-drop system
- **Communication Rate:** 9600, 4800, or 2400 bps may be selected
- **Transmission:** Transferable between No Procedure and Handshaking (No procedure is only for data transmission)
- **Data Length:** 8 bits
- **Parity:** No
- **Start Bit:** 1
- **Stop Bit:** 1
- **Comm. Code:** ASCII
- **Comm. Format:** (Refer to section 7.4)

**Analog Input Signal:**
- **Temperature input:** (1 point) 4-20 mADC (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:**
- **Input:** Two points, Isolated
  - 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.
**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**

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<th><strong>SINGLE POINT ANALYZER</strong></th>
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<td>-E</td>
<td>CSA &amp; CE Mark</td>
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<td>-3</td>
<td>220 VAC, 50/60 Hz</td>
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<td>240 VAC, 50/60 Hz</td>
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<td>-4</td>
<td>100 VAC, 50/60 Hz</td>
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<tr>
<td>-8</td>
<td>115 VAC, 50/60 Hz</td>
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<td>-N</td>
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<td>-A</td>
<td>RS-232C (ZA8C-S only)</td>
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<td>-B</td>
<td>RS-422A</td>
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<tr>
<td>-A</td>
<td>4-20 mA (ZA8C-S only)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>AUTO CALIBRATION</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-0</td>
<td>Not included</td>
</tr>
<tr>
<td>-1</td>
<td>Included</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>LANGUAGE</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-J</td>
<td>Japanese</td>
</tr>
<tr>
<td>-E</td>
<td>English</td>
</tr>
<tr>
<td>-G</td>
<td>German</td>
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<tr>
<td>-F</td>
<td>French</td>
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<table>
<thead>
<tr>
<th><strong>STYLE</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>*B</td>
<td>Style B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>AIR PURGE FITTING SIZE</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>/AP1</td>
<td>RCT/4 (F)</td>
</tr>
<tr>
<td>/AP2</td>
<td>1/4 NPT (F)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>WATER TIGHT CABLE GLANDS</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>/EGG</td>
<td>JIS A20 (7)</td>
</tr>
<tr>
<td>/PAT</td>
<td>Paper Tag</td>
</tr>
<tr>
<td>/SCT</td>
<td>Stainless Steel Tag</td>
</tr>
<tr>
<td></td>
<td>(attached with wire)</td>
</tr>
</tbody>
</table>
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

<table>
<thead>
<tr>
<th>SINGLE CHANNEL O₂ MANUAL CALIBRATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC1</td>
</tr>
<tr>
<td>TUBING/FITTINGS</td>
</tr>
<tr>
<td>-C</td>
</tr>
<tr>
<td>-S</td>
</tr>
<tr>
<td>REFERENCE AIR FLOWMETER</td>
</tr>
<tr>
<td>-R'U</td>
</tr>
</tbody>
</table>

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.
• **EXTERNAL DIMENSIONS**

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

<table>
<thead>
<tr>
<th>SINGLE CHANNEL O₂ AUTO CALIBRATION</th>
<th>MODEL NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC1</td>
<td></td>
</tr>
</tbody>
</table>

**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
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](image-url)
• 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):

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

Table 1: Approximate Weight of ZO21D detector w/4”, 150# ANSI flange
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 H₂O)
•Model and Code

## LOW TEMPERATURE DETECTOR

<table>
<thead>
<tr>
<th>INSERTION LENGTH ¹</th>
<th>ZO21D-L General Purpose</th>
<th>ZO21D-E CE Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>-040</td>
<td>0.40 m (1.3', 15.6&quot;)</td>
<td></td>
</tr>
<tr>
<td>-064</td>
<td>0.64 m (2.1', 25&quot;)</td>
<td></td>
</tr>
<tr>
<td>-076</td>
<td>0.76 m (2.5', 30&quot;)</td>
<td></td>
</tr>
<tr>
<td>-100</td>
<td>1.0 m (3.3')</td>
<td></td>
</tr>
<tr>
<td>-150</td>
<td>1.5 m (5.0')</td>
<td></td>
</tr>
<tr>
<td>-200</td>
<td>2.0 m (6.6')</td>
<td></td>
</tr>
<tr>
<td>-245</td>
<td>2.45 m (8.0')</td>
<td>ZO21D-L only</td>
</tr>
<tr>
<td>-300</td>
<td>3.0 m (10.0')</td>
<td>ZO21D-L only</td>
</tr>
<tr>
<td>-360</td>
<td>3.6 m (12.0')</td>
<td>ZO21D-L only</td>
</tr>
<tr>
<td>-420</td>
<td>4.2 m (14.0')</td>
<td>ZO21D-L only</td>
</tr>
<tr>
<td>-480</td>
<td>4.8 m (16.0')</td>
<td>ZO21D-L only</td>
</tr>
<tr>
<td>-540</td>
<td>5.4 m (18.0')</td>
<td>ZO21D-L only</td>
</tr>
</tbody>
</table>

### FLANGE MOUNTING ⁵, ⁶

<table>
<thead>
<tr>
<th></th>
<th>ZO21D-L only</th>
</tr>
</thead>
<tbody>
<tr>
<td>-A*U</td>
<td>ANSI 4&quot;, 150# FF flange ⁵</td>
</tr>
<tr>
<td>-B*U</td>
<td>ANSI 3&quot;, 150# FF flange ZO21D-L only</td>
</tr>
<tr>
<td>-C*U</td>
<td>ANSI 2&quot;, 150# FF flange ZO21D-L only</td>
</tr>
<tr>
<td>-J*U</td>
<td>JIS 5K, 65A FF flange</td>
</tr>
<tr>
<td>-T*U</td>
<td>2½&quot; Tri-clamp flange ZO21D-L only</td>
</tr>
<tr>
<td>-W*U</td>
<td>Westinghouse flange</td>
</tr>
</tbody>
</table>

### 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 w/ wire)     |
|/SCT     | Stainless Steel Tag (attached w/ wire) |
|/T       | Welded NPT Collar w/ out Flame arrester |

### NOTES:

1) For special Detector lengths and flanges contact Yokogawa Corporation of America.
2) The Filter Assemblies (E7042UQ and M100DA 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, Newnan, 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.
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**

![Diagram of the high temperature detector with dimensions](image)

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

<table>
<thead>
<tr>
<th>HIGH TEMPERATURE DETECTOR</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZO21D-H-015-K*U</td>
<td>High temperature detector includes a JIS5K32A flange</td>
</tr>
<tr>
<td>ZO21D-H-017-K*U</td>
<td>High temperature detector for flame arrester Includes a 3” ANSI flange ¹</td>
</tr>
<tr>
<td>ZO21D-F-015-K*U</td>
<td>CE Mark</td>
</tr>
</tbody>
</table>

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.
• External Dimensions

Figure 9: ZO21P-H
High Temperature Adapter Tee

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

NOTES:
1. MATERIAL IS 316 SST, EXCEPT FOR ANSI FLANGE WHICH IS 304 SST.
2. WEIGHT: 24.3 LBS(11 Kg)
**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°F to 3000°F (0°C to 1650°C) for Exalloy transport tube

  **Operation Pressure:**
  - ±0.7 psi (±500 mm H₂O) (Eductor is required for negative pressure)

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

Table 2: Material Reference Chart for Transport Tubes
## SPECIFICATIONS

- **Model and Code**

<table>
<thead>
<tr>
<th>HIGH TEMPERATURE PROBE ADAPTER</th>
<th>ZO21P</th>
<th>MODEL NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TEE CONFIGURATION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-H</td>
<td>Basic design (side eductor port)</td>
<td></td>
</tr>
<tr>
<td>-T</td>
<td>Basic design (bottom port)</td>
<td></td>
</tr>
<tr>
<td>-S</td>
<td>Split design (for blow back)</td>
<td></td>
</tr>
<tr>
<td>-F</td>
<td>Oversized design (for flame arrester, includes studs)</td>
<td></td>
</tr>
<tr>
<td>-C</td>
<td>All Hastelloy C (configured as -T only)</td>
<td></td>
</tr>
<tr>
<td><strong>TRANSPORT TUBE MATERIAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-A</td>
<td>Silicon Carbide (SiC) (Up to 2600ºF/1427ºC)</td>
<td></td>
</tr>
<tr>
<td>-B</td>
<td>310 Stainless Steel (Up to 1980ºF/1082ºC)</td>
<td></td>
</tr>
<tr>
<td>-C</td>
<td>Alumina Ceramic (Up to 3400ºF/1871ºC)</td>
<td></td>
</tr>
<tr>
<td>-H</td>
<td>HR160 Stainless Steel (Up to 2000ºF/1100ºC)</td>
<td></td>
</tr>
<tr>
<td>-X</td>
<td>Exalloy Ceramic (Up to 3000ºF/1650ºC)</td>
<td></td>
</tr>
<tr>
<td>-N</td>
<td>NO TRANSPORT TUBE</td>
<td></td>
</tr>
<tr>
<td><strong>INSERTION LENGTH</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-033</td>
<td>0.3 m (13&quot;)</td>
<td></td>
</tr>
<tr>
<td>-050</td>
<td>0.5 m (20&quot;)</td>
<td></td>
</tr>
<tr>
<td>-100</td>
<td>1.0 m (3.3&quot;)</td>
<td></td>
</tr>
<tr>
<td>-150</td>
<td>1.5 m (5.0&quot;)</td>
<td></td>
</tr>
<tr>
<td>-300</td>
<td>3.0 m (9.8&quot;) (not for -A or -C tubes)</td>
<td></td>
</tr>
<tr>
<td>-NNN</td>
<td>NO TRANSPORT TUBE</td>
<td></td>
</tr>
<tr>
<td><strong>FLANGE CONNECTION</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-A&quot;U</td>
<td>ANSI 4&quot;, 150# RF</td>
<td></td>
</tr>
<tr>
<td><strong>OPTIONS</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(may select one from each group)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Options Heater System</td>
<td>/HT</td>
<td>Aux heater system (to 600º F)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[includes controller and heaters]</td>
</tr>
<tr>
<td>Blowback Block Valve (for ZO21P-S)</td>
<td>/AV</td>
<td>Automatic valve</td>
</tr>
<tr>
<td></td>
<td>/MV</td>
<td>Manual valve</td>
</tr>
<tr>
<td>Eductor</td>
<td>/BE</td>
<td>Wrapped air eductor pre-attached with regulator and gauge (for ZO21P-H w/o /HT only)</td>
</tr>
<tr>
<td></td>
<td>/ER</td>
<td>Air ejector w/return exhaust pre-attached w/ regulator and gauge (for ZO21P-H or ZO21P-S only)</td>
</tr>
<tr>
<td></td>
<td>/SE</td>
<td>Separate air ejector, regulator and gauge (not preattached)</td>
</tr>
<tr>
<td></td>
<td>/WE</td>
<td>Self-cleaning water ejector (regulator and gauge not included)</td>
</tr>
<tr>
<td>/E4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>/SCT</td>
<td>Stainless Steel Tag (attached w/ wire)</td>
<td></td>
</tr>
<tr>
<td>/PAT</td>
<td>Paper Tag (attached w/ wire)</td>
<td></td>
</tr>
</tbody>
</table>

### NOTES:

1) The -H option is the standard tee. T-eductor port is mounted on the side - (180º 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 flame arrester.
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
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

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>25</td>
</tr>
<tr>
<td>20</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>2.50</td>
<td>5.63</td>
</tr>
</tbody>
</table>
| [63.5]   | [143.0]|}

![Figure 12: Auxiliary Ejector Assembly](image)

• 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 m³/hr) at 100 psig (700 kPa) supply - 20 psig (140 kPa) outlet.

Exhaust Capacity: 0.1 SCFM (0.17 m³/hr) - downstream pressure 5 psig (35 kPa) above setpoint.

Sensitivity: 1” H₂O (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 m³/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)
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**

![Diagram of ZO21DW Oxygen Detector](image)

**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 H₂O) (Not recommended for negative gas pressures)
  - **Reference Gas Flowrate:** 0.6 LPM (1.3 SCFH)
SPECIFICATIONS

Insertion Length and Weight:

<table>
<thead>
<tr>
<th>Length (L)</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3 ft (0.4 m)</td>
<td>14 lb (6.5 kg)</td>
</tr>
<tr>
<td>3.3 ft (1.0 m)</td>
<td>22 lb (10 kg)</td>
</tr>
<tr>
<td>5.0 ft (1.5 m)</td>
<td>29 lb (13 kg)</td>
</tr>
<tr>
<td>6.6 ft (2.0 m)</td>
<td>37 lb (17 kg)</td>
</tr>
<tr>
<td>10 ft (3.0 m)</td>
<td>44 lb (20 kg)</td>
</tr>
<tr>
<td>12 ft (3.6 m)</td>
<td>52 lb (23.5 kg)</td>
</tr>
</tbody>
</table>

Table 3: Probe lengths and weights for ZO21DW

Ambient Temperature: 14º to 176ºF (-10º to 80ºC)

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

<table>
<thead>
<tr>
<th>PRESSURE COMPENSATING (Low Temperature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZO21DW-L</td>
</tr>
<tr>
<td>INSERTION LENGTH¹</td>
</tr>
<tr>
<td>-040</td>
</tr>
<tr>
<td>-100</td>
</tr>
<tr>
<td>-150</td>
</tr>
<tr>
<td>-200</td>
</tr>
<tr>
<td>-300</td>
</tr>
<tr>
<td>-360</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLANGE CONNECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>-A*A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLANGE CONNECTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>-NPT</td>
</tr>
</tbody>
</table>

OPTIONS (can select more than one)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>/C</td>
<td>Check Valve (required)</td>
</tr>
<tr>
<td>/D</td>
<td>Derakane coating ¹</td>
</tr>
<tr>
<td>/F</td>
<td>Flame Arrestor</td>
</tr>
<tr>
<td>/SCT</td>
<td>Stainless Steel Tag (attached with wire)</td>
</tr>
<tr>
<td>/PAT</td>
<td>Paper Tag (attached with wire)</td>
</tr>
<tr>
<td>/T</td>
<td>Welded NPT Collar w ith out flame arrester</td>
</tr>
</tbody>
</table>

NOTES:

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

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

Table 4: Accessories
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

![Diagram of Probe Protector]

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

- **Model and Code**

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

<table>
<thead>
<tr>
<th>LOW TEMPERATURE PROBE PROTECTOR</th>
<th>MODEL NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSERTION LENGTH</td>
<td></td>
</tr>
<tr>
<td>040</td>
<td>0.40 m (1.3', 15.6&quot;)</td>
</tr>
<tr>
<td>046</td>
<td>0.46 m (1.5', 18&quot;)</td>
</tr>
<tr>
<td>064</td>
<td>0.64 m (2.1', 25&quot;)</td>
</tr>
<tr>
<td>076</td>
<td>0.76 m (2.5', 30&quot;)</td>
</tr>
<tr>
<td>100</td>
<td>1.0 m (3.3')</td>
</tr>
<tr>
<td>150</td>
<td>1.5 m (5.0')</td>
</tr>
<tr>
<td>200</td>
<td>2.0 m (6.6')</td>
</tr>
<tr>
<td>300</td>
<td>3.0 m (10.0')</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLANGE CONNECTION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-A*U</td>
<td>ANSI4&quot;, 150# FF flange</td>
</tr>
<tr>
<td>-B*U</td>
<td>ANSI3&quot;, 150# FF flange</td>
</tr>
<tr>
<td>-C*U</td>
<td>ANSI2&quot;, 150# FF flange</td>
</tr>
<tr>
<td>-J*U</td>
<td>JIS 5K, 65AFF Flange</td>
</tr>
<tr>
<td>-W*U</td>
<td>Westinghouse flange</td>
</tr>
</tbody>
</table>
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

![Diagram of ZO21V Probe Support]

-External Dimensions

-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

<table>
<thead>
<tr>
<th>LOW TEMPERATURE PROBE SUPPORT</th>
<th>MODEL NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZO21V</td>
<td></td>
</tr>
<tr>
<td>INSERTION LENGTH</td>
<td></td>
</tr>
<tr>
<td>-150</td>
<td>5.0 ft (1.5 m) [for use with 10 ft (3 m) probe]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLANGE CONNECTION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-A&quot;U</td>
<td>ANSI 4&quot;, 150# FF flange</td>
</tr>
<tr>
<td>-J&quot;U</td>
<td>JIS 5K, 65FF flange</td>
</tr>
<tr>
<td>-W&quot;U</td>
<td>Westinghouse flange</td>
</tr>
</tbody>
</table>
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

![Check Valve Diagram]

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).
• 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
• 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 (See Note)
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).
Table 6: Quick Disconnect Cable Specifications

- **External Dimensions**

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

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

Figure 20: ZO21D.../A
**Model and Code**

### ZO21D WIRING - SIGNAL CABLE

<table>
<thead>
<tr>
<th>CABLE TEMPERATURE RATING</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WZ-H</td>
<td>High temp cable (FEP jacket (up to 390°F (200°C))</td>
</tr>
<tr>
<td>WZ-L</td>
<td>Low temp cable (PVC jacket (up to 140°F (60°C))</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CABLE LENGTH (feet)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>-3H-0005</td>
<td>5' Heater Cable (3-Conductor)</td>
</tr>
<tr>
<td>-6S-0005</td>
<td>5' Signal Cable (6-Conductor)</td>
</tr>
<tr>
<td>-3H-0010</td>
<td>10' Heater Cable (3-Conductor)</td>
</tr>
<tr>
<td>-6S-0010</td>
<td>10' Signal Cable (6-Conductor)</td>
</tr>
<tr>
<td>-3H-0015</td>
<td>15' Heater Cable (3-Conductor)</td>
</tr>
<tr>
<td>-6S-0015</td>
<td>15' Signal Cable (6-Conductor)</td>
</tr>
<tr>
<td>-3H-0020</td>
<td>20' Heater Cable (3-Conductor)</td>
</tr>
<tr>
<td>-6S-0020</td>
<td>20' Signal Cable (6-Conductor)</td>
</tr>
<tr>
<td>-3H-0025</td>
<td>25' Heater Cable (3-Conductor)</td>
</tr>
<tr>
<td>-6S-0025</td>
<td>25' Signal Cable (6-Conductor)</td>
</tr>
<tr>
<td>-3H-0030</td>
<td>30' Heater Cable (3-Conductor)</td>
</tr>
<tr>
<td>-6S-0030</td>
<td>30' Signal Cable (6-Conductor)</td>
</tr>
<tr>
<td>-3H-0040</td>
<td>40' Heater Cable (3-Conductor)</td>
</tr>
<tr>
<td>-6S-0040</td>
<td>40' Signal Cable (6-Conductor)</td>
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<tr>
<td>-3H-0050</td>
<td>50' Heater Cable (3-Conductor)</td>
</tr>
<tr>
<td>-6S-0050</td>
<td>50' Signal Cable (6-Conductor)</td>
</tr>
<tr>
<td>-3H-0100</td>
<td>100' Heater Cable (3-Conductor)</td>
</tr>
<tr>
<td>-6S-0100</td>
<td>100' Signal Cable (6-Conductor)</td>
</tr>
<tr>
<td>-3H-0200</td>
<td>200' Heater Cable (3-Conductor)</td>
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<tr>
<td>-6S-0200</td>
<td>200' Signal Cable (6-Conductor)</td>
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<tr>
<td>-3H-0500</td>
<td>500' Heater Cable (3-Conductor)</td>
</tr>
<tr>
<td>-6S-0500</td>
<td>500' Signal Cable (6-Conductor)</td>
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</tbody>
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**CONNECTION**

<table>
<thead>
<tr>
<th>/QC</th>
<th>Quick disconnect w/cable clamp 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>/QF</td>
<td>Quick disconnect w/flex conduit adapter (1/2” NPTM) 2, 3</td>
</tr>
</tbody>
</table>

**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 converter.

**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.
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

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>0.5 inches</td>
</tr>
<tr>
<td>ID</td>
<td>0.622 min / 0.642 max</td>
</tr>
<tr>
<td>OD</td>
<td>0.820 min / 0.840 max</td>
</tr>
<tr>
<td>Inside Bend Radius</td>
<td>0.2 inch</td>
</tr>
<tr>
<td>Weight per 100 feet</td>
<td>27 pounds</td>
</tr>
</tbody>
</table>

-Model and Code

<table>
<thead>
<tr>
<th>PART NUMBER</th>
<th>OPTIONAL ITEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1132XP</td>
<td>1/2&quot; Flexible Conduit</td>
</tr>
<tr>
<td></td>
<td>(order quantity is conduit length in feet)</td>
</tr>
</tbody>
</table>
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 (80ºC).
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.

![Probe Insertion Hole Diagram]

Figure 21: Probe Insertion Hole
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 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.

<table>
<thead>
<tr>
<th>Flange Specification</th>
<th>Part Name</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANSI 4”, 150# FF</td>
<td>Gasket (same hole pattern as flange)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bolts (5/8 - 11 UNC x 2-1/2&quot;)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Nuts (5/8 - 11 UNC)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Washers (5/8&quot;)</td>
<td>16</td>
</tr>
<tr>
<td>ANSI 3”, 150# FF</td>
<td>Gasket (same hole pattern as flange)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bolts (5/8 - 11 UNC x 2-1/2&quot;)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Nuts (5/8 - 11 UNC)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Washers (5/8&quot;)</td>
<td>8</td>
</tr>
<tr>
<td>JS 5K - 65</td>
<td>Gasket (same hole pattern as flange)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bolts (M12 x 50) (1/2 - 13 UNC x 2&quot;)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Nuts (M10) (3/8 - 16 UNC)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Washers (12 mm) (5/8&quot;)</td>
<td>8</td>
</tr>
<tr>
<td>Westinghouse Flange</td>
<td>Gasket (same hole pattern as flange)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Bolts (M10 x 50) (3/8 - 16 x 2&quot;)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Nuts (M10) (3/8 - 16 UNC)</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Washers (10mm) (3/8&quot;)</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 7: Mounting parts required
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.

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.
   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.
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.

![Diagram of Fly Ash Filter Installation](image)

**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.
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.
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
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.

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.
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](image_url)

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

![Figure 30: Pipe Mounting Procedure](image)

**Wall Mounting**

1) Drill mounting holes as shown below.

![Figure 31: Drilling Mounting Holes](image)

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

![Figure 32: Mounting to the Wall](image)

**NOTE:** For wall mounting, the pipe bracket and bolts are not used.
• 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.
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.
IV. CALIBRATION AND PIPING

4.1 Piping

Figure 35: MC1 Piping Diagram
### Table 8: Piping

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

#### 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 ¼" tube through a pressure regulator. Normally, the venting joint does not require tubing.
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](image)

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.
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
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
Perfomring 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
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.
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.

![Figure 38: ZA8C Wiring](image)

### Table 9: Wiring Channels

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

![Power Wiring Diagram]

Power: 100, 110, 115 VAC, 50/60 Hz or, 220, 240 VAC, 50/60 Hz

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](image)

**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.

<table>
<thead>
<tr>
<th>Type Cable</th>
<th>AWG</th>
<th>No. Conductors</th>
<th>Insulation</th>
<th>Shield</th>
<th>Jacket (material, thickness)</th>
<th>Voltage/Temp</th>
<th>Weight/1,000 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Temp Signal</td>
<td>3</td>
<td>pair, twisted;</td>
<td>FEP</td>
<td>Aluminum Mylar;</td>
<td>FEP 0.010&quot; w all/ .066&quot; od</td>
<td>300 Volts/392º F</td>
<td>15.9 kg</td>
</tr>
<tr>
<td>WZ-H-6S</td>
<td></td>
<td>Black/White/Red/Green</td>
<td></td>
<td>AWG 18/7 TC Drain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Temp Signal</td>
<td>16</td>
<td>pair, twisted;</td>
<td>Polyethylene</td>
<td>Aluminum Polyester foil;</td>
<td>PVC 0.035&quot; w all/.475&quot; od</td>
<td>300 Volts/140º F</td>
<td>56.7 kg</td>
</tr>
<tr>
<td>WZ-L-6S</td>
<td></td>
<td>Black/White/Red/Green</td>
<td></td>
<td>Stranded tinned copper drain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Temp Heater</td>
<td>2</td>
<td>conductor</td>
<td>FEP</td>
<td>Aluminum Mylar;</td>
<td>FEP 0.010&quot; w all/.182&quot; od</td>
<td>300 Volts/392º F</td>
<td>15.9 kg</td>
</tr>
<tr>
<td>WZ-H-3H</td>
<td></td>
<td>Black/Red</td>
<td></td>
<td>AWG 16/19 TC Drain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Temp Heater</td>
<td>14</td>
<td>conductor</td>
<td>Polyethylene</td>
<td>Aluminum Polyester foil;</td>
<td>PVC 0.035&quot; w all/.350&quot; od</td>
<td>300 Volts/140º F</td>
<td>32.6 kg</td>
</tr>
<tr>
<td>WZ-L-3H</td>
<td></td>
<td>Black/Natural</td>
<td></td>
<td>Stranded tinned copper drain</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.**
**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.

![Diagram of ZO21D detector, Junction Box, and ZA8C Converter connections.](image)

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

![Diagram of ZO21D detector, Junction Box, and ZA8C Converter connections with heater cable.](image)

**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.
**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
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](image)

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.
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.

![Diagram of AC1 Auto Cal and ZA8C Converter with interconnect wiring](image)

**Figure 47: Interconnect Wiring for AC1 & ZA8C**
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.
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.

<table>
<thead>
<tr>
<th>Relay Operation</th>
<th>Type of relay contacts</th>
<th>Contact status</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>When contact signal</td>
<td>Normal condition</td>
</tr>
<tr>
<td>Normally Energized</td>
<td>Break contact (shortcircuiting jumpers 1 and 2)</td>
<td>[Closed]</td>
</tr>
<tr>
<td></td>
<td>Make contact (shortcircuiting jumpers 3 and 4)</td>
<td>[Open]</td>
</tr>
<tr>
<td>Normally Deenergized</td>
<td>Break contact (shortcircuiting jumpers 1 and 2)</td>
<td>[Open]</td>
</tr>
<tr>
<td></td>
<td>Make contact (shortcircuiting jumpers 3 and 4)</td>
<td>[Closed]</td>
</tr>
</tbody>
</table>

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.
5.5 CONTACT INPUT WIRING (OPTIONAL)

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:

<table>
<thead>
<tr>
<th>Description</th>
<th>ON electrical values</th>
<th>OFF electrical values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resistance (contact)</td>
<td>less than 200 ohms</td>
<td>greater than 100 k ohms</td>
</tr>
<tr>
<td>Voltage</td>
<td>-1 to 1 V DC</td>
<td>4.5 to 25 V DC</td>
</tr>
</tbody>
</table>

Table 12: Contact Input ON/OFF Electrical Parameters
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.

![Diagram of ZA8C (expanded) Converter and Temperature Transmitter](image)

Transmits 4 to 20 mA temperature signal only

*Figure 52: Measurement Gas Temperature Input*
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: _________ % 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
   LL: _________ % vol O₂
   H: _________ % 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.
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 F0 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.
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 (↑) 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 (↑→) to enter 21%. Remember to press the ENTER key.

**Step 3:** Press right arrow (→) key 1 time, then press up arrow key (↑) 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.
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 \( \text{O}_2 \).

Example: If you are controlling around 8% \( \text{O}_2 \) 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.
6.1.8 Procedure to set up alarm setpoints

**Step 1:** Using the arrow (↑→) 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.
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.
6.1.10 **Table of Diagnostic Values**

To provide an effective preventive maintenance record of your zirconia cell, it is recommended that the User keep a log of diagnostic values, which is updated after each two (2) point calibration is performed. Please note the following:

<table>
<thead>
<tr>
<th>Cell No.</th>
<th>Date of Calibration</th>
<th>B0 (Span Correction)</th>
<th>B1 (Zero Correction)</th>
<th>B3 (Resistance)</th>
<th>B4 (Cell Life)</th>
<th>A3 (EMF)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 13: Diagnostic Values*

The ZA8C converter is a microprocessor based oxygen converter capable of more than the standard 4 to 20 mA Analog output. The following provides a brief description of a few features that are standard to the ZA8C converter that the User may want to utilize.

The ZA8C converter allows the User to program two different ranges for the 4 to 20 mA signal. This gives the operator a **backup for an emergency situation where the unit has surpassed the 20 mA max**. Instead of having the display lockup at 20 mA, the unit will use an **alternate, predetermined Range** that is greater than the original setup. In addition, the unit will alert the user with an “Answer Back” contact output function, which forces the operator to acknowledge that the Range has changed. Additionally, the User has two low alarm values.
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.

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:
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.

<table>
<thead>
<tr>
<th>Key</th>
<th>Name</th>
<th>Functions/Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y E E</td>
<td>Interactive key (yes)</td>
<td>Used for replying &quot;yes&quot; to an inquiry (Y/N?)</td>
</tr>
<tr>
<td>N E</td>
<td>Interactive key (no)</td>
<td>Used for replying &quot;no&quot; to an inquiry (Y/N?)</td>
</tr>
<tr>
<td>₡ ₡ ₤</td>
<td>Sub-message display key Calibration start key</td>
<td>Used for displaying sub-messages. Used for suspending calibration.</td>
</tr>
<tr>
<td>₢ ₡ ₡ ₡</td>
<td>Calibration start key. Calibration data display key.</td>
<td>Used for starting calibration in one-touch or semi-automatic calibration.</td>
</tr>
<tr>
<td>₢ ₡ ₡ ₡</td>
<td>Measurement mode select key. Calibration data display key.</td>
<td>Used for returning the mode from the setting mode, etc. to an analog bar display (measurement mode). Used for monitoring various data during calibration.</td>
</tr>
<tr>
<td>₢ ₡ ₡ ₡</td>
<td>Entry key. Setting-mode select key.</td>
<td>Used for registering data in setting mode. Used for changing from the measurement mode to the setting mode.</td>
</tr>
<tr>
<td>₢ ₡ ₡ ₡</td>
<td>Cursor key. Message COS key</td>
<td>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.</td>
</tr>
<tr>
<td>₢ ₡ ₡ ₡</td>
<td>Number increase key. Number forward key.</td>
<td>Used for increasing a number on the cursor. Used for changing from one Function to the next.</td>
</tr>
<tr>
<td>₢ ₡ ₡ ₡</td>
<td>Number decrease key. Number backward key.</td>
<td>Used for decreasing a number on the cursor. Used for returning from one Function to the next.</td>
</tr>
</tbody>
</table>

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)
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)

Display of Function No. A-2

\[
\text{A2 AVERAGE (024 hour) = 011.52\% O2}
\]

Measurement mode: "MEAS" lights up on the display.
Setting mode: "MAINT" lights up on the display.

Inquiry display example

MAINTENANCE MODE ENTRY MODE <Y/N>?

Reply to the inquiry by pressing the interactive key (yes or no). (For more details, see the following example.)

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

Message display for changing to the setting mode

MAINTENANCE MODE ENTRY MODE <Y/N>?

YES

NO

Message display for entering the password

PASS WORD ??

Status, after the reply to the inquiry, differs according to the message details.

When password input message is displayed, enter "16". For the more detailed procedure, see (3).

Display of Function No. A-0 analog bar-graph

\[
\begin{array}{c|c|c|c|c}
0 & 1 & 2 & 3 & 4 \\
\hline
\end{array}
\]
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.
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.

Display of Function No., C-0

<table>
<thead>
<tr>
<th>No.</th>
<th>Function Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>CAL GAS CONC (% O2) SPAN</td>
<td>021.00</td>
</tr>
<tr>
<td>1</td>
<td>CAL GAS CONC (% O2) SPAN</td>
<td>021.00</td>
</tr>
<tr>
<td>2</td>
<td>CAL GAS CONC (% O2)</td>
<td>001.00</td>
</tr>
<tr>
<td>3</td>
<td>CALIBRATION MODE</td>
<td>0: AT 1:SEM1 2:TCH</td>
</tr>
<tr>
<td>4</td>
<td>CAL GAS CONC (% O2) SPAN</td>
<td>021.00</td>
</tr>
<tr>
<td>5</td>
<td>CAL GAS CONC (% O2)</td>
<td>001.00</td>
</tr>
</tbody>
</table>

Cursor moves over to the next number.

Number is changed from 0 to 1.

Data-entering status is effected.

The mode changes to the measurement mode and displays an analog bar-graph.
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).

Display of Function No. C-1

<table>
<thead>
<tr>
<th>C1</th>
<th>CAL GAS CONC (% O2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZERO = 00</td>
<td>00</td>
</tr>
</tbody>
</table>

The displayed data are registered and the cursor moves to the upper left.

Display of Function No. C-1

<table>
<thead>
<tr>
<th>D1</th>
<th>CAL GAS CONC (% O2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZERO = 001.00</td>
<td></td>
</tr>
</tbody>
</table>

The function group changes from Group C to D.

Display of Function No. D-0

<table>
<thead>
<tr>
<th>D2</th>
<th>OUTPUT RANGE 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>000 - 25</td>
<td>% O2</td>
</tr>
</tbody>
</table>

The cursor moves over to the No.

Press this key twice. The cursor moves over to "1".

Display of Function No. D-0

<table>
<thead>
<tr>
<th>D0</th>
<th>OUTPUT RANGE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>000 - 010</td>
<td>% O2</td>
</tr>
</tbody>
</table>

The displayed data are registered and the cursor moves to the upper left.

Press this key twice (D-1 comes up if you press this key only once.)

Display of Function No. D-0

<table>
<thead>
<tr>
<th>D0</th>
<th>OUTPUT RANGE 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>000 - 010</td>
<td>% O2</td>
</tr>
</tbody>
</table>

The cursor moves over to the No.

Press this key twice. The cursor moves over to "1".

Display of Function No. D-0

<table>
<thead>
<tr>
<th>D2</th>
<th>OUTPUT HOLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0:N 1: HLD 2:P - HLD</td>
</tr>
</tbody>
</table>

Registered.

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

Display of Function No. C-0

Enter O CAL GAS CONC (% O2) SPAN = 021.00

Press the key 4 times to move the cursor to the 1 from the C.

The 1 changed to 0 to come up with the figure 20.00

Display of Function No. C-0

Enter CO CAL GAS CONC (% O2) SPAN = 02 0.00

Display of Function No. C-0

Enter CO CAL GAS CONC (% O2) SPAN = 02 0.00

Display of Function No. C-0

Enter CO CAL GAS CONC (% O2) SPAN = 02 021.00

SET RANGE EXCEEDED

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

Display of Function No. D-0

D0 OUTPUT RANGE 1
000 -050 % O2

The mode is changed over to the measurement mode and the analog bar-graph is displayed.
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.

- **Display of Function No. A-0**
  - A7 EXCESS AIR RATIO = 01.40
  - B0 SPAN (0) = 099.7 %
  - 89/04/26 14:30 H

The display changes from Group A to Group B.

When there are 2 or more component screens, H shows in the lower, right position. The second (or next) screen can be displayed by pressing the HELP key.

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

- **Display of Function No. A-0**
  - SPAN CAL ON
  - ZERO CAL ON

The mode changes from the measurement mode to the calibration mode.

Upon pressing the key, the solenoid valve in the calibration gas line is closed. After the stability time as set in Function No. C-4 elapses, the mode changes back to the measurement mode.

If changing another display in the measurement mode to an analog bar-graph, press [DISP] key.
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 lights.

- **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.
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

```
UUUU
```

Alternately displayed

```
742
```

Current temperature of sensor in °C

- Example of measured oxygen concentration display

```
13.5
```

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

```
E - - 2
```

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
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.

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

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

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

**PLS READ INST MANUAL**
"TROUBLESHOOTING"

*Error Code "E---2"

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

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

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

**PLS READ INST MANUAL**
"TROUBLESHOOTING"
*Error Code "E---3"

Display when an error occurs (Example 3)

- TEMP TOO HI - CAUSE?
- INCOR or BRKN WRG

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

- BLWN FU or POOR CONT
- SHORT in TC

- PLS READ INST MANUAL
  "TROUBLESHOOTING"

*Error Code "E---4"

Display when an error occurs (Example 4)

- ANALOG CKT FAILURE
- AD CONV DEFECTIVE

- 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

- CAL GAS FLTR < IND ‘D
- POSSIBLE LEAK

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

- PLS READ INST MANUAL
  "TROUBLESHOOTING"

*Error Code "E---6"

Display when an error occurs (Example 6)

- CAL VAL ABNL - SPAN PT
- CAUSE? CELL DMGD

- CAL GAS FLTR < IND ‘D
- POSSIBLE LEAK

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

- PLS READ INST MANUAL
  "TROUBLESHOOTING"
A-1 Maximum or Minimum \( \text{O}_2 \) 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 \( \text{O}_2 \) concentrations**

| A1 | MAX = 19.32 %O2 | MIN = 15.48 %O2 |

A-2 Mean \( \text{O}_2 \) 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 \( \text{O}_2 \) concentration**

| A2 | AVERAGE (024 hour) 016.92 %O2 |
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.

\[ E = -50.74 \log \left( \frac{P_x}{P_a} \right) \text{ [mV]} \]

Where  \( P_x \): \( \text{O}_2 \) concentration in the measurement gas
\( P_a \): \( \text{O}_2 \) concentration in the comparison gas (21 vol\% \( \text{O}_2 \))

<table>
<thead>
<tr>
<th>% ( \text{O}_2 )</th>
<th>0.1</th>
<th>0.2</th>
<th>0.3</th>
<th>0.4</th>
<th>0.5</th>
<th>0.6</th>
<th>0.7</th>
<th>0.8</th>
<th>0.9</th>
</tr>
</thead>
<tbody>
<tr>
<td>mV</td>
<td>117.83</td>
<td>80.56</td>
<td>93.62</td>
<td>87.28</td>
<td>82.36</td>
<td>78.35</td>
<td>74.95</td>
<td>72.01</td>
<td>69.41</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% ( \text{O}_2 )</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>mV</td>
<td>67.09</td>
<td>51.82</td>
<td>42.88</td>
<td>36.54</td>
<td>31.62</td>
<td>27.61</td>
<td>24.21</td>
<td>21.27</td>
<td>18.67</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% ( \text{O}_2 )</th>
<th>10</th>
<th>21</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td>mV</td>
<td>16.35</td>
<td>0</td>
<td>-7.86</td>
<td>-14.2</td>
<td>-19.2</td>
<td>-23.1</td>
<td>-26.5</td>
<td>-29.5</td>
<td>-32.1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>% ( \text{O}_2 )</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>mV</td>
<td>-34.4</td>
</tr>
</tbody>
</table>

Figure 53: Oxygen Concentration, Vol\% \( \text{O}_2 \) vs Cell Voltage mV (Cell temperature 750° C)

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.
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 mA
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)
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 ($\text{CH}_4$, CO, H$_2$, etc.)

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

$$m = \frac{1}{21 - \text{Oxygen concentration}} \times 21$$

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
Zero point correction factor = (B/A) x 100 (%)  Correctable range: 100 ±30%
Span point correction factor = (C/A) x 100 (%)  Correctable range: 0 ±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 ±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.

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%.
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)
```

<table>
<thead>
<tr>
<th>B3</th>
<th>CELL RESISTANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>00175 OHM</td>
<td></td>
</tr>
</tbody>
</table>

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)
```

<table>
<thead>
<tr>
<th>B4</th>
<th>CELL ROBUSTNESS</th>
</tr>
</thead>
<tbody>
<tr>
<td>(5) LIFE &gt; 12 MONTH</td>
<td></td>
</tr>
</tbody>
</table>

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)
```

<table>
<thead>
<tr>
<th>B5</th>
<th>CJ TEMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>= 026°C</td>
<td></td>
</tr>
</tbody>
</table>

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%.
### B-7 Dry O\(_2\) 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 O\(_2\) concentration (vol\% O\(_2\)) and the moisture content (% H\(_2\)O) in the exhaust gas as follows:

\[
\begin{align*}
B7 & \text{ DRY O}_2 = 0.9751 \text{ %O}_2 \\
& \text{SET H}_2\text{O} = 0.0105 \text{ %H}_2\text{O}
\end{align*}
\]

### 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.

\[
\begin{align*}
B8 & \text{ GAS TEMP} = 0.450^\circ\text{C} \\
& \text{COMB EFF} = 0.760\%
\end{align*}
\]

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

The general procedures for starting up are as follows:

1. Inspect piping & wiring
2. Supply power to the converter
3. Warm up and configure data
4. Calibrate
5. Normal Operation

**NOTE:** Also check for normal operation of alarm output, etc. before starting up stationary operation.

6.4.1 **Supplying Power to Converter**

Check that the supplied voltage meets the specifications of your converter (see 2.1) and then turn on the power to the converter (on the left side of the external wire terminals.) At that time, the converter will begin to operate. Measurement will not take effect for approximately ten minutes or until the sensor reaches the specified temperature (750° C).

All of the set parameters will be in a default state.

The display will be as shown below immediately after the power is turned ON.

![Indication of warm-up temperature of sensor (°C)](image)

6.4.2 **During Warm-Up**

The warm-up period is about ten minutes. Since measuring operations are suspended during this time, you can take this opportunity to set the data as explained in the Quick Start-Up in section 6.1. The analog output signal during the warm-up period reads 0% \( \text{O}_2 \). After completion of the warm-up period, the data display indicates the measured oxygen concentration.
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% O\textsubscript{2} by entering “020.6”.

Message display (Example)

C0 CAL GAS CONC (%O\textsubscript{2})
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% O\textsubscript{2} enter “001.00”.

Message display (Example)

C1 CAL GAS CONC (%O\textsubscript{2})
ZERO = 001.00
# CONFIGURATION

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>Setting range or default details</th>
<th>Default</th>
<th>LCD display</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calibration</td>
<td>C-0</td>
<td>Span gas concentration: 4.5 to 100 vol% O₂</td>
<td>21.00% O₂</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Calibration</td>
<td>C-1</td>
<td>Zero gas concentration: 0.3 to 100 vol% O₂</td>
<td>1.00% O₂</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Calibration</td>
<td>C-2</td>
<td>Mode: One-touch(TCH)/Semi-Auto(SEMI)/Auto(AT)</td>
<td>TCH</td>
<td>2: TCH</td>
<td></td>
</tr>
<tr>
<td>Calibration</td>
<td>C-3</td>
<td>Stabilizing time: 0 to 10 minutes</td>
<td>3.0 min</td>
<td>3.0 minutes</td>
<td></td>
</tr>
<tr>
<td>Calibration</td>
<td>C-4</td>
<td>Calibration time: 0 to 10 minutes</td>
<td>3.0 min</td>
<td>3.0 minutes</td>
<td></td>
</tr>
<tr>
<td>Calibration</td>
<td>C-5</td>
<td>Calibration schedule: 0 to 255 day or 0 to 23 hours</td>
<td>1 day</td>
<td>1 day</td>
<td></td>
</tr>
<tr>
<td>Calibration</td>
<td>C-6</td>
<td>Calibration start time: Month, Day, Hour, Minute</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calibration</td>
<td>C-7</td>
<td>Skip: None(0), Span(1), Zero(2)</td>
<td>0: NONE</td>
<td>0: NONE</td>
<td></td>
</tr>
<tr>
<td>Analog Output</td>
<td>D-0</td>
<td>Range 1: (0 to 5) to (0 to 100) vol% O₂</td>
<td>0 to 10% O₂</td>
<td>000-010% O₂</td>
<td></td>
</tr>
<tr>
<td>Analog Output</td>
<td>D-1</td>
<td>Range 2: (0 to 5) to (0 to 100) vol% O₂</td>
<td>0 to 25% O₂</td>
<td>000-025% O₂</td>
<td></td>
</tr>
<tr>
<td>Analog Output</td>
<td>D-2</td>
<td>Hold: None(N), HLD, P-HLD</td>
<td>HOLD</td>
<td>1: HLD</td>
<td></td>
</tr>
<tr>
<td>Analog Output</td>
<td>D-3</td>
<td>Selection: 4 to 20 mA or 0 to 20 mA</td>
<td>4 to 20 mA DC</td>
<td>0: 4-20 mA</td>
<td></td>
</tr>
<tr>
<td>Analog Output</td>
<td>D-4</td>
<td>Output characteristic selection: Linear/Log</td>
<td>Linear</td>
<td>0: Linear</td>
<td></td>
</tr>
<tr>
<td>Analog Output</td>
<td>D-5</td>
<td>Smoothing constant: 0 to 255 sec.</td>
<td>0 sec</td>
<td>000 sec</td>
<td></td>
</tr>
<tr>
<td>Analog Output</td>
<td>D-6</td>
<td>Wet gas O₂/Dry gas O₂</td>
<td>Wet gas O₂</td>
<td>0: WET</td>
<td></td>
</tr>
<tr>
<td>Alarm</td>
<td>E-0</td>
<td>Extreme Upper limit/Upper limit: 0 to 100.0% O₂</td>
<td>Both 0 (none)</td>
<td>HH=0, HI=0</td>
<td></td>
</tr>
<tr>
<td>Alarm</td>
<td>E-1</td>
<td>Extreme Lower limit/Lower limit: 0 to 100.0% O₂</td>
<td>Both 0 (none)</td>
<td>LL=0, LO=0</td>
<td></td>
</tr>
<tr>
<td>Alarm</td>
<td>E-2</td>
<td>Contact delay: sec, Hysteresis: %O₂</td>
<td>3 sec, 0.1% O₂</td>
<td>3 sec, 0.1% O₂</td>
<td></td>
</tr>
<tr>
<td>Time matching, temperature unit assigning, etc.</td>
<td>F-0</td>
<td>Hour-meter setting: Day/Hour, Minute</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time matching, temperature unit assigning, etc.</td>
<td>F-1</td>
<td>O₂ concentration averaging time: 1 to 255 hour</td>
<td>1 hr</td>
<td>1 hr</td>
<td></td>
</tr>
<tr>
<td>Time matching, temperature unit assigning, etc.</td>
<td>F-2</td>
<td>Max/Mn O₂ averaging time: 1 to 255 hour</td>
<td>24 hr</td>
<td>24 hr</td>
<td></td>
</tr>
<tr>
<td>Time matching, temperature unit assigning, etc.</td>
<td>F-3</td>
<td>Temperature unit specification: °C, °F</td>
<td>°C</td>
<td>0°C</td>
<td></td>
</tr>
<tr>
<td>Time matching, temperature unit assigning, etc.</td>
<td>F-4</td>
<td>Input temperature range: 0 to 3000°C/°F</td>
<td>None (Note 1)</td>
<td>0°C</td>
<td></td>
</tr>
<tr>
<td>Contact Output</td>
<td>G-0</td>
<td>Contact output 1</td>
<td>NE/F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact Output</td>
<td>G-1</td>
<td>Contact output 2</td>
<td>NDE=E+C+W</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact Output</td>
<td>G-2</td>
<td>Contact output 3</td>
<td>NDE+HL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact Input</td>
<td>G-3</td>
<td>Contact input 1</td>
<td>R</td>
<td>1: R</td>
<td></td>
</tr>
<tr>
<td>Contact Input</td>
<td>G-4</td>
<td>Contact input 2</td>
<td>R</td>
<td>1: R</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>H-0</td>
<td>Communication mode: freewheel/handshake</td>
<td>handshake</td>
<td>handshake</td>
<td></td>
</tr>
<tr>
<td>Fuel calculation data</td>
<td>J-0</td>
<td>Types of fuels</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel calculation data</td>
<td>J-1</td>
<td>Moisture content in exhaust gas: 0 to 5 m³/kg(m³)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel calculation data</td>
<td>J-2</td>
<td>Theoretical air quantity: 1 to 20 m³/kg(m³)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel calculation data</td>
<td>J-3</td>
<td>Net calorific value: 0 to 15000 kcal/kg(m³)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel calculation data</td>
<td>J-4</td>
<td>X value (X=a+b*H1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel calculation data</td>
<td>J-5</td>
<td>Absolute humidity of atmosphere: 0 to 1 kg/kg</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel calculation data</td>
<td>J-6</td>
<td>Temperature of exhaust gas: 0 to 2000°C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel calculation data</td>
<td>J-7</td>
<td>Temperature of atmosphere: -50 to 60°C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 14: Configurable Items and Their Defaults
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)

<table>
<thead>
<tr>
<th>C2   CALIBRATION MODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2  0: AT 1: SEMI 2: TCH</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>C3 STABILIZING TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>03.5 minutes</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>C4    CALIBRATION TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>05.0 minutes</td>
</tr>
</tbody>
</table>
**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)

```
C5  CAL INTERVAL
  0: day   1: hr
[ When “0” is selected from
C5  CAL INTERVAL
  (0) 060 day
[ When “1” is selected from
C5  CAL INTERVAL
  (1) 12 hr
```

**C-6  CALIBRATION START TIME**

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

Message display (Example)

```
C6  CAL START TIME
  94/07/15  16:30
```

**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.
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.

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 mA DC or 0 to 20 mA DC). 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.

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. "Ø" will track, "1" will hold last value and "2" will prompt you for the value you want the reading to go to.
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)

```
D2    OUTPUT HOLD
2    0:N  1: HLD  2: P -  HLD
```

When “2” is assigned

```
D2    OUTPUT HOLD
(2 )   PRESET HOLD = 000%
```

**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)

```
D3     CURRENT OUTPUT
0        0" 4-20 mA  1: 0-20 mA
```

### 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)

```
D4    OUTPUT SCALE
0    0: Linear  1: Log
```
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% O\(_2\), 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
```
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)

<table>
<thead>
<tr>
<th>E1</th>
<th>ALARM SET PT (%O2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL</td>
<td>002.5</td>
</tr>
<tr>
<td>LO</td>
<td>004.9</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>E2</th>
<th>RL DELAY = 005SEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>RL HYS</td>
<td>= 2.0 %O₂</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>F0</th>
<th>CLOCK ENTRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>94/04/26 18:45</td>
<td></td>
</tr>
</tbody>
</table>
**F-1 MEAN \( \text{O}_2 \) 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 \( \text{O}_2 \)**

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: °C    1: °F
```
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°F 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°F 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 ºF
```

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°F (1100°C), set “0600” (°C). If no high-limit alarm is required, enter “000”.

Message display (Example)

```
F5   FLUE GAS TEMP HI
     ALM SET = 0600 ºC
```

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 I C O N T O U T P U T
1 0 0 0 0 0 0 0 0 0 1 0
```

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

Blowback start command (contact input)

ON

OFF

1 to 11 seconds (start timing)

Blowback signal (contact output)

ON

OFF

About ten seconds

By pressing the HELP key, the operation can be stopped in mid-stream.

Time interval set to function No. C-4
Readout on the message display (Example)

<table>
<thead>
<tr>
<th>G3</th>
<th>RY 1</th>
<th>CONT</th>
<th>INPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>0 : G</td>
<td>1 : R</td>
<td>2 : C</td>
</tr>
</tbody>
</table>

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)

<table>
<thead>
<tr>
<th>G4</th>
<th>RY 2</th>
<th>CONT</th>
<th>INPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0 : G</td>
<td>1 : R</td>
<td>2 : C</td>
</tr>
</tbody>
</table>

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 thorough 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)

<table>
<thead>
<tr>
<th>HO</th>
<th>COMM MODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0 : FREE</td>
</tr>
</tbody>
</table>

When “1” is assigned.

<table>
<thead>
<tr>
<th>HO COMM MODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) HAND SHAKE: CH3</td>
</tr>
</tbody>
</table>

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.
Readout on the message display (Example)

<table>
<thead>
<tr>
<th>H1</th>
<th>BAUD RATE (bps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>0:96 1:48 2:24</td>
</tr>
</tbody>
</table>

(Note) DISP Key

<table>
<thead>
<tr>
<th>H1</th>
<th>BAUD RATE (bps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2400 Bits/sec</td>
</tr>
</tbody>
</table>

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.

<table>
<thead>
<tr>
<th>J0</th>
<th>FUEL GRADE</th>
</tr>
</thead>
</table>

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 N m$^3$/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 N m$^3$/kg, for example enter "01.27".

<table>
<thead>
<tr>
<th>J1</th>
<th>H20 IN FUEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.27</td>
<td>m$^3$/kg (m$^3$)</td>
</tr>
</tbody>
</table>
**J-2 THEORETICAL AIR QUANTITY**
You can set the theoretical air quantity required for the fuel used in the measurement process to ignite (N m³/kg or m³/m³). 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 N m³/kg, enter "10.70".

---

**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/m³). 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 kcal/kg, enter "09860".

---

**J-4 X VALUE (X = A + B * H₁) **
The X value (N m³/kg or m³/m³) 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 (m³/kg), for instance, round off the value to the second decimal place and enter "00.77".

---

**J-5 ABSOLUTE HUMIDITY OF ATMOSPHERE**
You can set the absolute humidity of the atmosphere used in igniting (moisture: kg/dry air :kg). If the absolute humidity is 0.021 kg/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."
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".

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.

J7  AMB AIR TEMP
-001 ° C
### Liquid Fuels

<table>
<thead>
<tr>
<th>Type</th>
<th>Properties</th>
<th>Fuel Specific Chemical Components</th>
<th>Heat Value kcal/kg</th>
<th>Theoretical Combustion</th>
<th>Combustion gas qty N m³/kg</th>
<th>X-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerosene</td>
<td>0.73 0.33</td>
<td>C 0.77 0.19</td>
<td>0.0 0.0</td>
<td>12900 14500 11.6</td>
<td>1.06 1.05 0.00 3.56 12.97 0.95</td>
<td></td>
</tr>
<tr>
<td>Light oil</td>
<td>0.81 0.33</td>
<td>C 0.79 0.19</td>
<td>0.0 0.0</td>
<td>12900 14500 11.6</td>
<td>1.06 1.05 0.00 3.56 12.97 0.95</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0.83 0.33</td>
<td>C 0.79 0.19</td>
<td>0.0 0.0</td>
<td>12900 14500 11.6</td>
<td>1.06 1.05 0.00 3.56 12.97 0.95</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>0.85 0.33</td>
<td>C 0.79 0.19</td>
<td>0.0 0.0</td>
<td>12900 14500 11.6</td>
<td>1.06 1.05 0.00 3.56 12.97 0.95</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>0.83 0.33</td>
<td>C 0.79 0.19</td>
<td>0.0 0.0</td>
<td>12900 14500 11.6</td>
<td>1.06 1.05 0.00 3.56 12.97 0.95</td>
<td></td>
</tr>
</tbody>
</table>

### Gas Fuels

<table>
<thead>
<tr>
<th>Type</th>
<th>Properties</th>
<th>Fuel Specific Chemical Components</th>
<th>Heat Value kcal/kg</th>
<th>Theoretical Combustion</th>
<th>Combustion gas qty N m³/kg</th>
<th>X-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coke oven gas</td>
<td>0.55 0.50</td>
<td>C 0.80 0.15</td>
<td>0.0 0.0</td>
<td>12900 14500 11.6</td>
<td>1.06 1.05 0.00 3.56 12.97 0.95</td>
<td></td>
</tr>
<tr>
<td>Blast furnace gas</td>
<td>0.35 0.50</td>
<td>C 0.80 0.15</td>
<td>0.0 0.0</td>
<td>12900 14500 11.6</td>
<td>1.06 1.05 0.00 3.56 12.97 0.95</td>
<td></td>
</tr>
<tr>
<td>Natural gas</td>
<td>0.75 0.05</td>
<td>C 0.80 0.15</td>
<td>0.0 0.0</td>
<td>12900 14500 11.6</td>
<td>1.06 1.05 0.00 3.56 12.97 0.95</td>
<td></td>
</tr>
<tr>
<td>Propane</td>
<td>2.030 C 0.30</td>
<td>C 0.80 0.15</td>
<td>0.0 0.0</td>
<td>12900 14500 11.6</td>
<td>1.06 1.05 0.00 3.56 12.97 0.95</td>
<td></td>
</tr>
<tr>
<td>Butane</td>
<td>2.530 C 0.40</td>
<td>C 0.80 0.15</td>
<td>0.0 0.0</td>
<td>12900 14500 11.6</td>
<td>1.06 1.05 0.00 3.56 12.97 0.95</td>
<td></td>
</tr>
</tbody>
</table>

**Table 15: Various Values of Fuels**
<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**

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

Theoretical air quantity = \(\frac{12.38}{10000} \times H_1 - 1.36\) \([m^3/kg]\)

Net calorific value = \(H_1\)

\(X\) value = \(\frac{3.37}{10000} \times H_x - 2.55\) \([m^3/kg]\)

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**

Moisture content in exhaust gas = \(\frac{1}{100} \times \left( h_2 + \frac{1}{2} \sum y (C_x y) + w \right)\) \([m^3/m^3]\)

Theoretical air quantity = \(\frac{11.2}{10000} \times H_1\) \([m^3/m^3]\)

Net calorific value = \(H_1\)

\(X\) value = \(\frac{1.05}{10000} \times H_x\) \([m^3/m^3]\)

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**

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

Theoretical air quantity = \(\frac{1.01}{10000} \times H_1 / 1000 + 0.56\) \([m^3/kg]\)

Net calorific value = \(H_1 = H_h - 5.9 \times (9h + w)\) \([kcal/kg]\)

\(X\) value = \(\frac{1.11}{106/10000} \times H_x\) \([m^3/m^3]\)

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:

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

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 \(H_1\)
Figure 57: Absolute Humidity of Air
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

   (1) Check the set calibration data

   (2) Adjust opening in the valve for calibration gas
       (automatic or semi-automatic calibration)

   (3) Check calibration operation

   (4) Execute 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).
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.

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

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

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

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
(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.

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

Table 18: Setup Parameters for Calibration
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.

![Diagram of RS-232C Wiring](image)

**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.
<Specifications for Communication Cable and Maximum Length>
For RS-232C communication cable, use two twisted pair (24 AWG or thicker) shielded cables of Ø8 to Ø11 mm O.D. so that the cable impedance is 100Ω and cable capacitance is 50 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)
### 7.3 Specifications for ZA8C Converter Communications (RS-232C or RS-422A)

<table>
<thead>
<tr>
<th>Classifications</th>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Specifications</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signal Level</td>
<td></td>
<td>Conforming to EIA RS-232C or RS-422A standards I/O signal not isolated</td>
</tr>
<tr>
<td>Communication System</td>
<td></td>
<td>Start-Stop system, Half Duplex</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-RS-232C: Two-wire system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-RS-422A: Four-wire system, multi-drop connection - number of computer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>converters = 1 : N (N = 1 to 8)</td>
</tr>
<tr>
<td>Communication Distance</td>
<td></td>
<td>-RS-232C: Up to 15m</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-RS-422A: Up to 500m (between I/O isolated computer and ZA8C converter)</td>
</tr>
<tr>
<td>Communication Rate</td>
<td></td>
<td>2,400, 4,800, 9,600 bps switching</td>
</tr>
<tr>
<td>Transmission Procedure</td>
<td></td>
<td>No procedure, handshaking transfer. In the case of &quot;no procedure&quot; data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>transmission only (transmission period: 10 seconds)</td>
</tr>
<tr>
<td>Data Length</td>
<td></td>
<td>8 bits</td>
</tr>
<tr>
<td>Parity</td>
<td></td>
<td>None</td>
</tr>
<tr>
<td>Start Bit</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Stop Bit</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Communication Code</td>
<td>ASCII code</td>
<td></td>
</tr>
<tr>
<td><strong>Contents</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reception</td>
<td></td>
<td>(1) Zero and span calibration request, Calibration abort request</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) Analog output range selection signal</td>
</tr>
<tr>
<td>Transmission</td>
<td>Time, O2 concentration (wet and dry), cell emf, cell temperature, error</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>codes, alarm number, status number, calibration coefficient, cell</td>
</tr>
<tr>
<td></td>
<td></td>
<td>resistance, response time, cell life, exhaust gas temperature, O2 average</td>
</tr>
<tr>
<td></td>
<td></td>
<td>value, O2 averaging time, max. and min. O2</td>
</tr>
</tbody>
</table>

Table 19: Communication Specifications
### Command Interpretation

#### 1. RC (Request Calibration)

<table>
<thead>
<tr>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data structure</strong></td>
</tr>
<tr>
<td><strong>(1) Received data</strong></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
</tr>
<tr>
<td>R C 1 , 0 0</td>
</tr>
<tr>
<td>Delimiter</td>
</tr>
<tr>
<td>0: Calibration start, 1: Calibration stop</td>
</tr>
<tr>
<td>(Comma)</td>
</tr>
<tr>
<td>ZA8C converter channel number, No.1 to No.8</td>
</tr>
<tr>
<td>(Space)</td>
</tr>
<tr>
<td>Command</td>
</tr>
</tbody>
</table>

| **(2) Transmitted data** |
| 1 2 3 4 5 6 7 8 9 10 |
| R C 1 , 0 , 0 0 |
| (Same as received data) |
| 0: Calibratable, 1: Calibration abort, 4: Not calibratable |
| (Comma) |

#### 2. CR (Change Range)

<table>
<thead>
<tr>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data structure</strong></td>
</tr>
<tr>
<td><strong>(1) Received data</strong></td>
</tr>
<tr>
<td>1 2 3 4 5 6 7 8</td>
</tr>
<tr>
<td>C R 1 , 1 0</td>
</tr>
<tr>
<td>Delimiter</td>
</tr>
<tr>
<td>1: Output range 1, 2: Output range 2</td>
</tr>
<tr>
<td>(Comma)</td>
</tr>
<tr>
<td>ZA8C converter channel number, No.1 to No.8</td>
</tr>
<tr>
<td>(Space)</td>
</tr>
<tr>
<td>Command</td>
</tr>
</tbody>
</table>

| **(2) Transmitted data** |
| 1 2 3 4 5 6 7 8 |
| C R 1 , 1 0 |
| (Same as received data) |

"Analog output range selection" signal
(Note) The ZA8C converter contact input signal has priority.
(3) DT (Data Trigger)

<table>
<thead>
<tr>
<th>Function</th>
<th>Latest measured data and date and time are taken into the communication memory inside the Z8BC converter.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data structure</td>
<td>(1) Received data</td>
</tr>
<tr>
<td>Data Structure</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td></td>
<td>D T 1 c₉ l₉</td>
</tr>
<tr>
<td></td>
<td>Delimiter</td>
</tr>
<tr>
<td></td>
<td>Z8BC converter channel number, No.1 to No.8 (Note 1)</td>
</tr>
<tr>
<td></td>
<td>(Space)</td>
</tr>
<tr>
<td></td>
<td>Command</td>
</tr>
</tbody>
</table>

(Note 1) When channel No. is [0], all the converters take the measuring simultaneously.
(Note 2) Data retained with DT command is transmitted to the computer by DR command.
(Note 3) When a "DT 0 c₉ l₉" 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.

<table>
<thead>
<tr>
<th>Receiving format</th>
<th>In setting</th>
<th>DT 1 c₉ l₉</th>
</tr>
</thead>
<tbody>
<tr>
<td>In reading</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>

| Transmitting format | DT 1 c₉ l₉ |

(4) DR (Data Read)

<table>
<thead>
<tr>
<th>Function</th>
<th>This command can make Z8BC converter transmit date and time and measured data.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Structure</td>
<td>(1) Received data</td>
</tr>
<tr>
<td>Data Structure</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td></td>
<td>D R 1 c₉ l₉</td>
</tr>
<tr>
<td></td>
<td>Delimiter</td>
</tr>
<tr>
<td></td>
<td>Z8BC converter channel number, No.1 to No.8</td>
</tr>
<tr>
<td></td>
<td>(Space)</td>
</tr>
<tr>
<td></td>
<td>Command</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data Structure</th>
<th>(2) Transmitted data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 ... 226 227 228</td>
</tr>
<tr>
<td></td>
<td>D R 0 1 , Data c₉ l₉</td>
</tr>
<tr>
<td></td>
<td>Data (For format, see page 13 and later.)</td>
</tr>
<tr>
<td></td>
<td>(Comma)</td>
</tr>
<tr>
<td></td>
<td>Z8BC converter channel number, No.1 to No.8</td>
</tr>
<tr>
<td></td>
<td>(Space)</td>
</tr>
<tr>
<td></td>
<td>Command</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Receiving format</th>
<th>In setting</th>
<th>None</th>
</tr>
</thead>
<tbody>
<tr>
<td>In reading</td>
<td>DR 1 c₉ l₉</td>
<td></td>
</tr>
</tbody>
</table>

Note  Answer-back signals for commands other than the "DT 0 c₉ l₉" command may be sent by placing them after two undecided characters.
Data Part Format for DR Command Communication (Transmission) (1)

Transmission format (data part)

```
<table>
<thead>
<tr>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>'</td>
<td>9</td>
<td>0</td>
<td>/</td>
<td>0</td>
<td>7</td>
<td>/</td>
<td>1</td>
<td>5</td>
<td>,</td>
</tr>
</tbody>
</table>

(Apostrophe) (Slash) (Slash) (Comma)
```

Day
Month
Year (Christian Era)

```
<table>
<thead>
<tr>
<th>17</th>
<th>18</th>
<th>19</th>
<th>20</th>
<th>21</th>
<th>22</th>
<th>23</th>
<th>24</th>
<th>25</th>
<th>26</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
<td>:</td>
<td>5</td>
<td>6</td>
<td>,</td>
<td>S</td>
<td>:</td>
<td>1</td>
<td>,</td>
</tr>
</tbody>
</table>

(Colon) (Comma) (Comma)
```

Status code
S: 1 Measurements mode
S: 2 Maintenance mode

```
<table>
<thead>
<tr>
<th>27</th>
<th>28</th>
<th>29</th>
<th>30</th>
<th>31</th>
<th>32</th>
<th>33</th>
<th>34</th>
<th>35</th>
<th>36</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>:</td>
<td>0</td>
<td>0</td>
<td>/</td>
<td>A</td>
<td>:</td>
<td>0</td>
<td>0</td>
<td>,</td>
</tr>
</tbody>
</table>

(Slash) (Comma)
```

Alarm code
A: 00 No alarm
A: HH High-high alarm
A: H High alarm
A: L Low alarm
A: LL Low-low alarm
A: TH Input temperature alarm

Error code
E: 00 No error
E: 01 Cell failure
E: 02 Cell temperature error (low)
E: 03 Cell temperature error (high)
E: 04 A/D error
E: 05 Zero calibration error
E: 06 Span calibration error
E: 07 Stabilization time-over
E: 08 Memory failure
## Data Part Format for DR Command Communication (Transmission) (2)

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| 187 188 189 190 191 192 193 194 195 196 |
| R B 0 0 0 / 0 0 0 , |
| (Slash) (Comma) |
| Span side (0 to 100) |
| Zero side (0 to 100) |
| Range 2 |

| 197 198 199 200 201 202 203 204 205 206 |
| ′ 0 0 / 0 1 / 0 1 , |
| (Apostrophe) (Slash) (Slash) (Comma) |
| Day |
| Month |
| Year (Christian Era) |

| 207 208 209 210 211 212 213 214 215 216 |
| 1 0 : 0 0 , |
| (Colon) (Space) (Comma) |
| Minute |
| Hour |
| Span Calibration start time (Note) |

(Note) If omission of span calibration is set by C7, Zero calibration start time is displayed.

| 217 218 219 220 221 222 223 224 225 226 |
| B 0 0 1 0 , 0 % , |
| (Comma) (Space) (Comma) |
| Unit |
| Oxygen concentration |
| Value just before calibration start |
VIII. CALIBRATION

8.1 CALIBRATION PROCEEDURES

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:

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

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

\[
E = -\frac{RT}{nF} \ln \frac{P_X}{P_A} \quad \text{...(1)}
\]

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 750ºC, then the equation (1) becomes:

\[
E = -50.74 \log \frac{P_X}{P_A} \quad \text{...(2)}
\]

With this analyzer, the sensor (zirconia element) is heated up to 750ºC, 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.
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% $O_2$ with a balance of nitrogen gas ($N_2$). The span gas widely used is clean air (i.e., instrument air).
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 ration represented by $B/A \times 100(\%)$ on the basis of $A$, $B$, and $C$ shown in figure xa and the span point correction ration 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.

![Diagram of Figure 61: Calculation of a Calibration Curve and Correction Factor in a 2-point Calibration Using Zero and Span Gases](image)

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

**Span point correction factor** = $(C/A) \times 100 \%$  
Correctable range: $\pm 0.18\%$

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.
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.
8.1.6 Operation Flowchart of Semi-Automatic and Automatic Calibration

CAL

DISP

YES

The mode changes to a semi-automatic calibration.

Automatic calibration starts.

Also instructable through an external contact signal.

Setting of C-7 "1" (Skip Span)

Setting of C-7 "0" (Skip None)

Span gas solenoid valve "open"

On span cal

Span point calibration

Span gas solenoid valve "close"

Zero gas solenoid valve "open"

On zero cal

Zero point calibration

Zero gas solenoid valve "close"

Calibration over

Stabilizing time!

Displayed only during the time set in C-3

Ledger:

Skip Span Gas
Skip Zero Gas
Skip None

(Note 1) "WARM-UP ON" is displayed while warming up.

(Note 2)

(Note 3)

Setting of C-7 "2" (Skip Zero)

(Note 1)
8.1.7 Operation Flowchart of One-Touch Calibration

Please set C4

Span cal Y/N?

Zero cal Y/N?

Please confirm span gas = 20.90% O2

Introduce span gas

Flow rate = 600 ml/min

Span valve open Y?

Flow of span gas at 600 ml/min

On span cal

Did calibration time expire?

Is output stabilized?

Stability error

Try again Y/N?

Span point is calibrated.

Normally calibrated?

Span cal error

Try again Y/N?

Zero cal Y/N?

Stop span gas flow.

Mode changed to calibration.

(Note 1) If 00.0 min. is set in C-4, this message is displayed, prohibiting calibration. "WARM-UP ON" is displayed while warming up.

(Note 2) The following messages are displayed depending on the calibrated results.

"Span cal good Span valve close Y?"

"Span cal error Try again Y/N?"

"Stability error Try again Y/N?"

To 1 on the next page.

Displayed only 5 sec

To 2 on the next page.

Continued on next page.
Continued from the previous page

**Span cal good**
**Span valve close?**

- **NO** → HELP → **YES**

- **HELP** → NO → YES

**Please confirm zero gas = 01.00 % O2**

- **NO** → HELP → **YES**

**Introduce span gas**
**Flow rate = 600 ml/min**

- **Displayed only 5 sec**

**Zero valve open Y?**

- **HELP** → NO → To **③**

- **YES** → To **③**

**Flow of zero gas at 600 ml/min**

**On zero cal**

- **No** → **①**

- **YES** → **③**

- **Did calibration time expire?**

  - **YES** → **③**

  - **HELP** → **NO** → **YES** → **③**

- **Is output stabilized?**

  - **No** → **③**

- **Stability error Try again Y/N?**

  - **NO** → **YES** → **③**

- **Zero point calibration**

  - **Note 3** The following messages are displayed depending on the calibrated results.
    "Zero cal good Zero valve close Y?"
    "Zero cal error Try again Y/N?"
    "Stability error Try again Y/N?"

- **Normally calibrated?**

  - **No** → **③**

- **Zero cal error Try again Y/N?**

  - **NO** → **YES** → **③**

- **Span cal Y/N?**

  - **Note 3**

  - **Stop zero gas flow**

  - **DISPLAYED only during the time set in C-3**

- **Stabilizing time!**

  - **③**

- **Span cal Y/N?**

The one-touch calibration procedure above finishes. Select the function No. A-0 display by pressing the measurement mode select key.
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.
Tighten each bolt with a torque of about 60 kgf \cdot cm (52 in \cdot 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 ±30% or the range of the span point correction factor of 0 ±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
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 then 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.
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.

![Diagram of fuse locations and power switch](image)

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.
• 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.
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.

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Error Detail</th>
<th>Error Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>E—1</td>
<td>Sensor (cell) error</td>
<td>Goes into fail mode, automatically turning OFF the power supply to the detector heater.</td>
</tr>
<tr>
<td>E—2</td>
<td>Sensor temp &quot;LOW&quot;</td>
<td>Goes into fail mode, automatically turning OFF the power supply to the detector heater.</td>
</tr>
<tr>
<td>E—3</td>
<td>Sensor temp “HIGH”</td>
<td>Goes into fail mode, automatically turning OFF the power supply to the detector heater.</td>
</tr>
<tr>
<td>E—4</td>
<td>A/D (Analog circuit) error</td>
<td>Goes into fail mode, automatically turning OFF the power supply to the detector heater.</td>
</tr>
<tr>
<td>E—5</td>
<td>Calibration value “ZERO”</td>
<td>(Displayed during calibration) the present zero point calibration value is not affected.</td>
</tr>
<tr>
<td>E—6</td>
<td>Calibration value “SPAN”</td>
<td>(Displayed during calibration) the present zero point calibration value is not affected.</td>
</tr>
<tr>
<td>E—7</td>
<td>Start power stability time over</td>
<td>(Displayed during calibration) the present zero point calibration value is not affected.</td>
</tr>
<tr>
<td>E—8</td>
<td>ROM, RAM error</td>
<td>Goes into fail mode, automatically turning OFF the power supply to the detector heater.</td>
</tr>
<tr>
<td></td>
<td>Digital circuit error power failure</td>
<td>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.</td>
</tr>
</tbody>
</table>

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”.

---

This page is a part of the manual for the ZA8C converter, providing detailed information on troubleshooting. The sections cover various error codes and how to handle them, including manual and semi-automatic calibration errors. The table lists specific error codes along with their descriptions and the status they indicate in the device's display. The manual aims to assist users in diagnosing and fixing issues efficiently.
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.)

[Flowchart]

YES
 Replace the damaged parts.

NO

YES
 Replace the sensor assembly.

NO

YES
 Replace the wiring cables.

NO

YES
 Temporarily operate the analyzer by mounting the spare sensor assembly.

NO

End. Set temporary data.

YES
 The analyzer operates properly.

NO

Is there any place of disconnection or poor continuity in wiring between the converter and detector?

YES

Turn on the power switch to put the analyzer in operation.

NO

Is there any breakage or poor contact in wiring to the converter terminals?

YES

Examine the wiring connection to converter terminals 3 and 4. If the repeater terminal box is used, also check wiring connection there.

NO

Examine the wiring connection to converter terminals 1 and 2. Also check that terminals and cable conductors are not corroded.

NO

Examine the wiring connection to detector terminals 1 and 2. Also check that terminals and cable conductors are not corroded.

NO

Remove the sensor assembly from the detector and check for any corrosion that may cause poor contact between the electrode and contact. Sensor assemblies with no failure may be used again.

NO

Replace the wiring conductors from detector terminals 1 and 2 and short the conductors removed. Measure the resistance of this conductor on the converter side. Resistance value is normal if it indicates 10 ohms or less.

NO

Remove the sensor assembly from the detector and check for any corrosion that may cause poor contact between the electrode and contact. Sensor assemblies with no failure may be used again.

NO

Replace the sensor assembly.

NO

Replace the damaged parts.

NO

Replace the damaged parts.

NO

Replace the wiring cables.

NO

Replace the damaged parts.

NO

Replace the damaged parts.

NO

Replace the wiring cables.
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.

```
Turn off the power to the converter

Is there any breakage or poor contact in wiring to the converter terminals?
  YES
    Replace the damaged parts.
  NO

Is there any breakage or poor contact in wiring to the detector terminals?
  YES
    Replace the damaged parts.
  NO

Does the detector heater fail?
  YES
    As it cannot be restored, replace the detector.
  NO

Does the thermocouple in the detector fail?
  YES
    As it cannot be restored, replace the detector.
  NO

Does the cold junction compensating sensor fail?
  YES
    Replace the cold junction compensating sensor.
  NO

Is the error displayed?
  YES
    The electronic circuit in the converter may possibly be failed. Contact Yokogawa.
  NO

End. Set temporary data.
```
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.

Turn off the power to the converter

**Is there any breakage or poor contact in wiring to the converter terminals?**

YES

Replace the damaged parts.

**NO**

**Is there any breakage or poor contact in wiring to the detector terminals?**

YES

Replace the damaged parts.

**NO**

**Does the detector heater fail?**

YES

As it cannot be restored, replace the detector.

**NO**

**Does the thermocouple in the detector fail?**

YES

As it cannot be restored, replace the detector.

**NO**

**Does the cold junction compensating sensor fail?**

YES

Replace the cold junction compensating sensor.

**NO**

**Is the error displayed?**

YES

The electronic circuit in the converter may possibly be failed. Contact Yokogawa.

**NO**

End. Set temporary data.

*Examine fuses (F1 and F2) for the detector heater regardless of appearance. Check wiring connections in converter terminals 5, 6, 7, 8, 16 and 17. If the converter terminal box is used, also check the connections inside the box.

*Examine the wiring connection to detector terminals 3, 4, 5, 6, 7 and 8. Check if the terminals and cable conductors are not corroded. Also check that wiring is not short circuited between the converter and detector.

*Remove wiring to the converter terminals 16 and 17 and measure resistance between these leadwires. If it is 90 ohms or lower, it is normal. In addition, lead resistances between the converter and detector are normal if they are 10 ohms or less.

*Remove the wiring to converter terminals 5 and 6 and measure resistance between these leadwires. If it is 90 ohms or lower, it is normal. In addition, lead resistances between the converter and detector are normal if they are 10 ohms or less.

*Examine that the cold junction compensating sensor leadwires connected to wiring terminals 7 and 8 in the detector are not disconnected. If the cold junction compensating sensor is normal, the voltage across terminals 7 and 8 is about 0.4 to 0.7 V (varies with ambient temperatures).

*Temporarily operate the converter by turning its power switch.
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 ±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.
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 ±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 ±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 ±18%.
•Examine the sensor (cell) internal resistance displayed with function No. B-3. A new sensor shows the value of 200 ohms or less.
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 form 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.
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 $\Delta p$ (mm $H_2O$).

$$X = Y \left[1 + \left(\frac{\Delta p}{10336}\right)\right]$$

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)?
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 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.
# XI. SPARE PARTS

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

<table>
<thead>
<tr>
<th>Item</th>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E7042UD</td>
<td>*Cell Assembly kit</td>
</tr>
<tr>
<td>2</td>
<td>K9119EN</td>
<td>*Cell Parts (without cell) kit</td>
</tr>
<tr>
<td>A</td>
<td>Y9512RU</td>
<td>*Bolt (12 mm) (5)</td>
</tr>
<tr>
<td>B</td>
<td>Y9500SU</td>
<td>*Washer (5)</td>
</tr>
<tr>
<td>C</td>
<td>E7042BQ</td>
<td>*Pipe</td>
</tr>
<tr>
<td>D</td>
<td>E7042BR</td>
<td>Plate</td>
</tr>
<tr>
<td>E</td>
<td>E7042AY</td>
<td>Filter Assembly</td>
</tr>
<tr>
<td>F</td>
<td>G7048XL</td>
<td>Metal O-Ring</td>
</tr>
<tr>
<td>G</td>
<td>E7042BS</td>
<td>Contact</td>
</tr>
<tr>
<td>H</td>
<td>E7042AU</td>
<td>Cold Junction</td>
</tr>
<tr>
<td>I</td>
<td>M1132KN</td>
<td>Check Valve</td>
</tr>
<tr>
<td>J</td>
<td>E7042VG</td>
<td>Replacement filter for flame arrestor (Does not include flame arrestor).</td>
</tr>
<tr>
<td></td>
<td>E7042VP</td>
<td>Flame Arrestor Assembly</td>
</tr>
</tbody>
</table>

Note: * Denotes typical spare part.
11.2 MODEL ZO21P ADAPTER TEE SPARE PARTS

<table>
<thead>
<tr>
<th>Part Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>M1100HH</td>
<td>Adapter Tee (ZO21P-H)</td>
</tr>
<tr>
<td>M1132FH</td>
<td>Adapter Tee (ZO21P-F)</td>
</tr>
<tr>
<td>M1100HF</td>
<td>Plate</td>
</tr>
<tr>
<td>M1133FT</td>
<td>Gasket (JIS 5K32A) for ZO21P-H, T, S or C</td>
</tr>
<tr>
<td>M1132HP</td>
<td>Gasket (3&quot; ANSI) for ZO21P-F</td>
</tr>
<tr>
<td>Y9121BU</td>
<td>Nut</td>
</tr>
<tr>
<td>Y9120WU</td>
<td>Washer</td>
</tr>
<tr>
<td>M1132KY</td>
<td>Bolt</td>
</tr>
</tbody>
</table>

11.3 ZA8C SPARE PARTS

NOTES:
1. MATERIAL IS 316 SST, EXCEPT FOR ANSI FLANGE WHICH IS 304 SST.
2. WEIGHT: 24.3 LBS (11 Kg)
<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1132ZX</td>
<td>Dual stage regulator for zero gas cylinders, 316L stainless steel, CGA 580, and 3000 psi inlet.</td>
</tr>
<tr>
<td>M1133AR</td>
<td>Zero gas pressure switch, SPDT 1/8 NPTF.</td>
</tr>
<tr>
<td>M1132KD</td>
<td>Reference air regulator</td>
</tr>
<tr>
<td>M1132CG</td>
<td>Reference air gauge 0-30 psi</td>
</tr>
<tr>
<td>K9290UA</td>
<td>PCB2</td>
</tr>
<tr>
<td>K9290UH</td>
<td>LCD Assembly</td>
</tr>
<tr>
<td>K9290XC</td>
<td>Panel</td>
</tr>
<tr>
<td>K9290XL</td>
<td>CPU Assembly (extended version)</td>
</tr>
<tr>
<td>K9290XQ</td>
<td>CPU Assembly (basic version)</td>
</tr>
<tr>
<td>A1113EF</td>
<td>Fuse, 3A (in-line) (pkg. of 5)</td>
</tr>
<tr>
<td>L9021EF</td>
<td>Fuse, 0.5A (plug-in) (pkg. of 5)</td>
</tr>
<tr>
<td>L9811FP</td>
<td>Watertight glands (each)</td>
</tr>
</tbody>
</table>
## APPENDIX A

### FIGURES AND TABLES

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