Model AV8G
Averaging Converter
Model ZO21D
Direct Insertion Type
Zirconia Oxygen Detector

IM 11M3D1-01E
1st Edition

CONTENTS

FD No. 1019K (CID: 5778A)

1. HANDLING PRECAUTIONS

The Model AV8G Direct Insertion Type Zirconia Oxygen Analyzer accurately measures oxygen gas concentration. To maintain this instrument in good oeprating condition please read this instruction manual carefully.

1.1 Unpacking the Carton

Prior to unpacking the shipping cartons, inspect them for any exterior damage. If any damage is noted save the carton to establish a claim for damages with the shipping agent. YOKOGAWA is not liable for any damages incurred during shipment.

Take care in removing the analyzer from the cartons. The probes (detectors) will be in separate cartons from the electronics (hereafter referred to as the converter). The detectors have a ceramic sensor which can be broken if the detector is bumped against a hard object.

1.2 Removing the Shipping Locks

The inner door of the converter is secured with locks for protection during shipment. Turn each of these locks a quarter of a turn with your fingers to unlock them. These locks should only be unlocked during electrical hookup or maintenance operations. Do not use excessive force in turning these locks, as they might be broken.

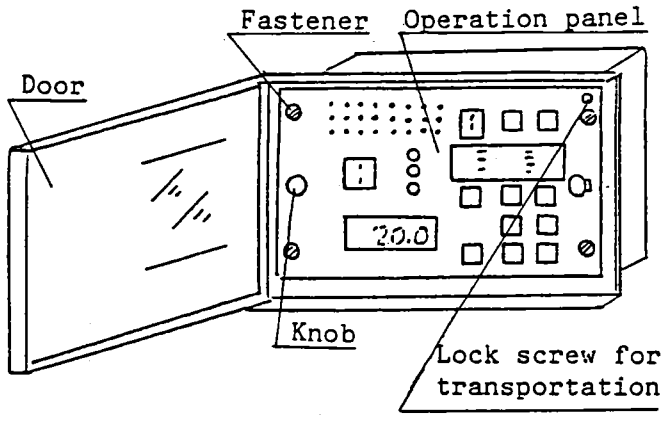


Figure 1.1 Location of Lock Screw for Transportation

1.3 Confirming the Model and Suffix Code

Each shipping carton is labeled with a number. The box labeled 1 of X (where X is the total number of cartons) contains the packing list. Get the packing list and verify that the model and serial number of each device (converter and detectors) match the identification plate.

The identification plate of the converter is located on the inside of the outer door. The identification plate of the detectors is located on the inside of the terminal cover.

If the model code and serial numbers do not match the packing list please contact your local YOKOGAWA representative or the customer service department of YOKOGAWA.

2. OUTLINE

The oxygen concentration analyzer consists of a direct insertion type detector and digital display converter which can continuously measure stabilized oxygen gas concentration contained in a combustion exhaust gas. Since this analyzer requires no sampling system it quickly responds to changes in oxygen gas concentration and reduces troublesome maintenance.

The converter can be connected up a maximum of eight detectors (if the proper power supply is installed). The internal construction of the converter is very modular. All of the circuit boards are on card slides that plug into a motherboard. The minimum configuration of a converter (Model AV8G) contains a power supply, a CPU card, an A/D card, an I/O card, and two channel cards.

Each channel card has an individual 4 to 20 mA output, which represents the oxygen concentration of that particular probe. The I/O card has a 4 to 20 mA output which represents the average oxygen concentration of a user defined group of probes. The convertor can also display individual cell output (mV), individual cell temperature (degrees centigrade), oxygen concentration of individual detectors, oxygen concentration of a defined group, as well as many diagnostic messages and all calibration parameters.

The digital circuit design of the converter simplifies operation and calibration while increasing the overall reliability. The above mentioned features make this analyzer suitable for many applications such as power boilers, recovery boilers, bark boilers, lime kilns, and process heaters.

3. STANDARD SPECIFICATIONS

Measurement ranges:

Display: 0 to 25% Oxygen

Output: Dual ranges are selectable from the following combinations:

0 to 5, 0 to 10% 0 to 5%, 0 to 25%

0 to 10, 0 to 25%

Switching between the two ranges can be done by internal switch by remote contact. These range settings are common to all outputs. A range change will simultaneously change the output of each channel.

Scanning speed: Less than 0.25 seconds per channel

Ambient temperature:

Detector: 14 to 176 Deg. F (-10 to 80 Deg. C)

Converter: 23 to 122 Deg. F (-5 to 50 Deg. C)

Warm-up time: Approximately 25 minutes

Maximum distance between detector and averaging converter:

1500 feet using 14 AWG.

980 feet using 16 AWG.

Conductor two way resistance must be 10 Ohms or less

Number of detector probes: 1 to 8

Low and/or high temperature models are used depending on the sample gas conditions.

For additional information on the detectors please refer to GS 11M3 A1-E.

Power supply:

100/110/115 VAC +/- 10%, 50/60 Hz (field selectable)

Power consumption:

30 VA + 50 VA per channel.

50 VA per channel becomes 200 VA per channel during warm-up period.

Performance characteristics:

Repeatability: +/- 0.5% F.S.

Linearity: +/- 1.0% F.S.

Drift: +/- 2.0% F.S. per week

Response time: Within 5 seconds for 90% response when calibration gas is introduced through the check gas inlet of the detector.

Averaging Converter

Number of channels:

Selectable from 1 to 8 detectors.

Channels can be added to the AV8G by simply inserting an additional channel card for each new detector. Please note which power supply is resident in the AV8G (it can be either a 4 channel or an 8 channel power supply.)

Digital display: 4 digit LED

Display contents:
Oxygen concentration can be displayed on a per channel basis or a group average basis.
Cell mV output.
Cell temperature (Deg. C)
Correction rate (the rate which the cell output deviates from a theoretical ideal.)
Fail check (AV8G will display the condition of the CPU.)
User entered parameters (calibration gas values, calibration interval, calibration duration, calibration stabilization time output range, channels to be included in averaged output, and high or low alarm set points.)

Averaged analog output(s): One 4 to 20 mA output is std, a second 4 to 20 mA output is optional. Each output is linear and isolated. The user can select which channels are included in each output. Failed detectors or detectors in calibration are automatically removed from the averaged output.

Individual analog outputs: Each detector has one 4 to 20 mA output that is linear and isolated. The range can be set for 0 to 5% or 0 to 10% or 0 to 25% 02. These settings are common to all channels. When the range is changed it changes all channel outputs simultaneously. The user can select whether the output will be held or not held during calibration.

Status output:
Unit alarm: 1 Normally closed, normally energized
Failure alarm: 8 Normally closed, normally energized
Maintenance: 1 Normally open, normally de-energized
Hi/lo alarm: 2 Normally open, normally de-energized
Warm up: 1 Normally open
Answer back for remote range switching: 1
Contact rating: 125 VDC, 0.1 amp

User entered parameters:
Measurement point: Which channels will be monitored
Oxygen Hi/Lo alarm: A common hi and lo alarm set point.
Groups for averaging: The user can define which detectors will be included in the average. As an option, a second group can be defined and have its own output.
Calibration gas value: Reference oxygen can be set betwen 4.0 and 21.0%. Zero gas can be set between 0.5 and 10.0%.
Stabilization time: The user can define the amount of time after a calibration is performed before the output of that particular channel is included in the averaged output.

Security: User settable parameters are password and switch protected.
Self diagnostics: The AV8G can identify and indicates the following problems--cell failure, abnormal cell temperature, abnormal calibration value, analog, and digital circuit failure.

Calibration: A manual calibration can be simply performed by entering the gas concentration values for zero and span gas, introducing the calibration gas to the detector, and pressing keys on the AV8G to perform the calibration. Setting potentiometers for this calibration is not necessary.

4. SYSTEM CONFIGURATION

Figure 4.1 shows the standard configuration of the Yokogawa Model AV8G Oxygen Analyzer. Basically, this configuration consists of the detector and the converter while the flow setting unit, Model AV8F is required for automatic zero and span calibration adjustments. The insertion lengths of the standard detectors are 0.4 meters (16 inches). Lengths of 1 meter (3.3 feet), 1.5 meters (5.0 feet), 2.0 meters (6.6 feet), and 3.0 meters (9.9) are available. Special lengths are available upon request.

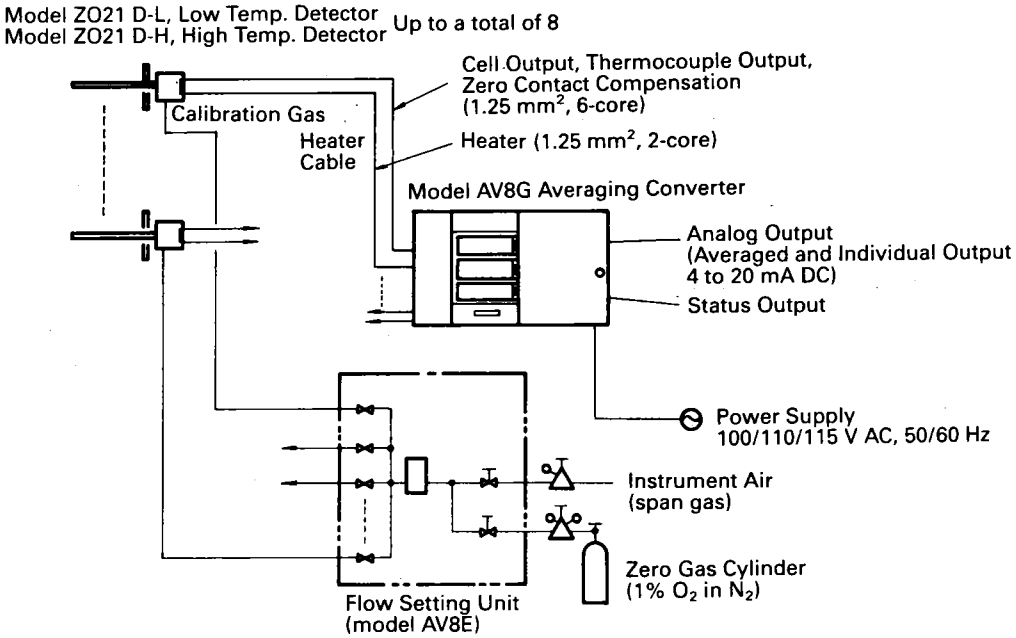


Figure 4.1 Standard System Configuration

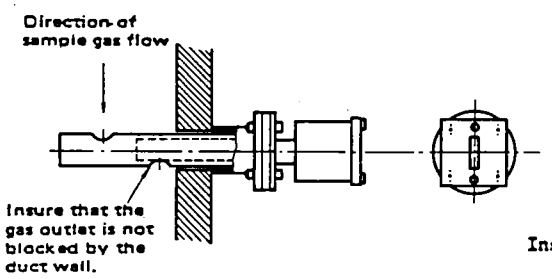


Figure 4.2 Installing the Probe Adaptor

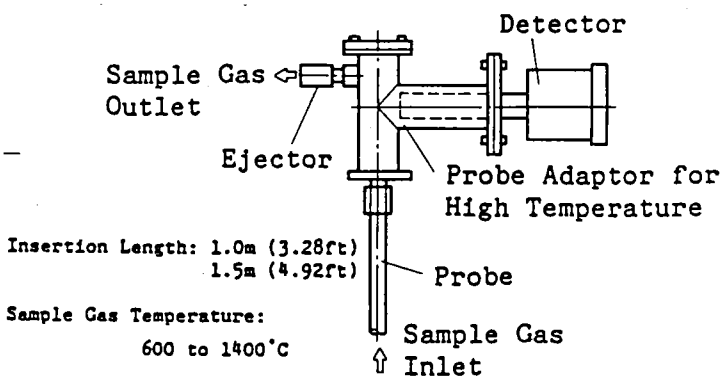


Figure 4.3 High Temperature Detector

5. INSTALLATION

This section describes the wiring and piping procedures for the oxygen analyzer.

5.1 Selecting an Installation Site and Installation Method

5.1.1 Considerations for Selecting an Installation Site

(1) Detector.

- Site should be relatively free of mechanical vibration (20 mils or less).
- Sample gas temperature should be lower than 1112 Deg. F (600 Deg. C) for a low temperature detector or lower than 2552 Deg. F (1400 Deg. C) for a high temperature detector.
- Sample gas pressure should not exceed +/- 0.7 PSIG (+/- 500 mm H20.)
- Ambient temperature should be between 14 and 176 Deg. F (-5 and 50 Deg. C.)
- Site should be free of corrosive gases.
- Site should allow sufficient space for maintenance.
  Site should not be near a source of radiant heat or steam.

(2) Converter.

- Site should be relatively free of mechanical vibration (20 mils or less).
- Site should be free of corrosive gases. If corrosive gases are present the converter case should be air purged.
- Ambient temperature should remain between 23 and 122 Deg. F.
- The convertor should not be mounted in direct sunlight or near sources of radiant heat, steam, strong magnetic fields, power lines, motors, magnetic relays, or pumps.

5.1.2 Installation

(1) Installing the detector and probe adaptor.

a. Install the detector so that the probe faces perpendicular to the direction of the measurement gas flow---see Figure 5.1.

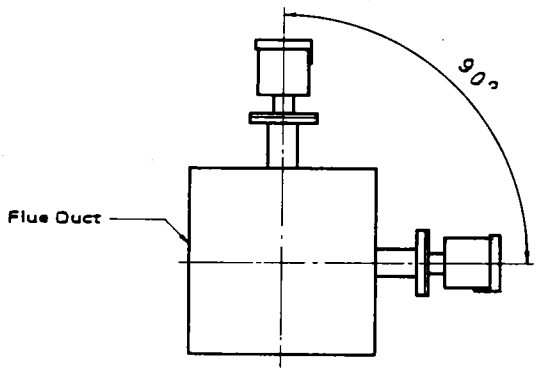


Figure 5.1 Installing the Detector

All probes with a length of 2 meters or less can be installed in any position between vertical down and horizontal. It is recommended that probes longer than 2 meters be installed in a vertical down position. Probes longer than 2 meters that have to mounted in a position other than vertical down are recommended to have probe supports.

b. Install the probe adaptor so it faces perpendicular to the direction of the measurement gas flow. It can be installed in any position between vertical down and horizontal---see Figure 5.2.

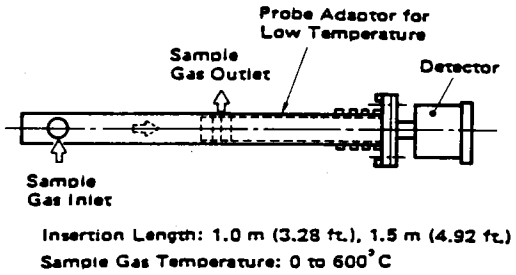


Figure 5.2 Blow Adaptor (low temperature type)

(2) Installing the high temperature detector.

a. The high temperature detector consists of 3 parts: the detector itself (P/N ZO21D-H-015-K*A), the high temperature probe adaptor with SiC pipe or SS310S pipe, and the ejector assembly (P/N K9119FW). The high temperature detector must be installed vertically. Do not incline it in excess of 5 degrees from vertical-otherwise damage to the probe could result. If the high temperature detector needs to be inclined more than 5 degrees contact your local YOKOGAWA representative.

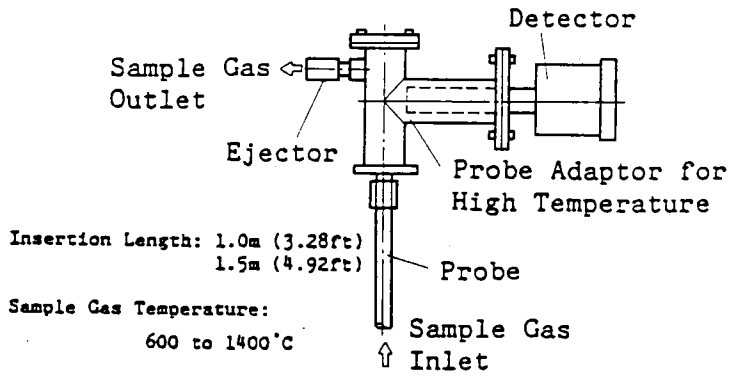


Figure 5.3 High Temperature Detector

b. If the sample gas temperature around the sample gas outlet is less than 356 Deg. F (180 Deg. C) then the detector housing needs to be covered with ceramic fiber insulation to prevent sample gas condensation inside the detector housing---see Figure 5.4.

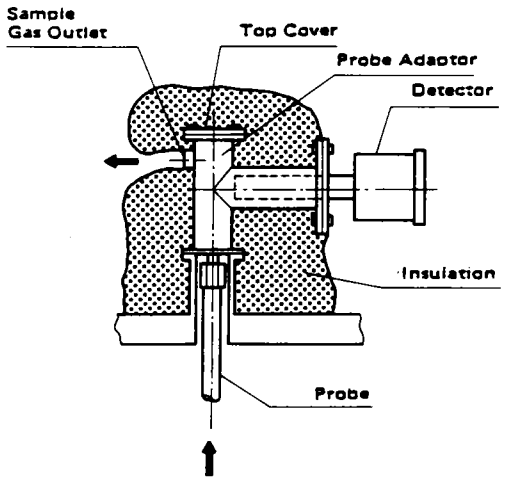


Figure 5.4 Installing the High Temperature Detector

Condensation can potentially damage the ceramic zirconia sensor. If the insulation is not adequate to keep the gas temperature above the gas dew point, then steam or electric tracing may be required to prevent condensation of corrosive gases such as sulfuric acid.

c. If the detector housing temperature is higher than 302 Deg. F (150 Deg. C) due to radiant heat, it is recommended that a thermal barrier be provided.

5.1.3 Installing the Converter

The converter can be flush mounted, surface mounted, or mounted on a pipe.

(1) Pipe mounting---see Figure 5.5.

a. Fix the bracket to the center of the bottom of the converter by four bolts.
b. Fix the channel inside the bracket by two bolts.
c. Mount the converter on top of the pipe.
d. Place the V-shaped notch of the channel to the side face of the pipe.
e. Firmly bolt the saddle together with the pipe to the channel using two bolts.

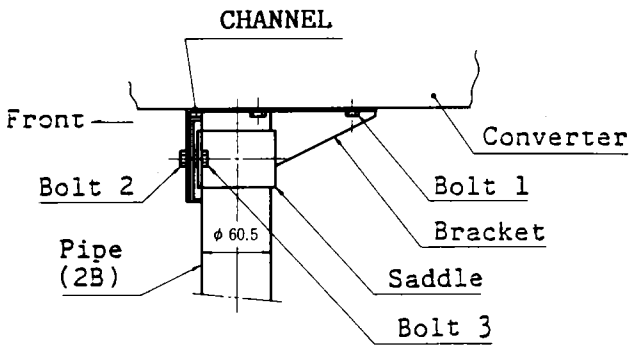


Figure 5.5 Mounting on the Pipe

(2) Panel mounting.
   a. Remove the side brackets and insert the converter into the panel cutout---see Figure 5.6.
   b. Firmly remount the side brackets to the converter while ensuring that the front edge is flush with the back of the panel.
   c. Due to the weight of the converter it is necessary to provide a rear support member.

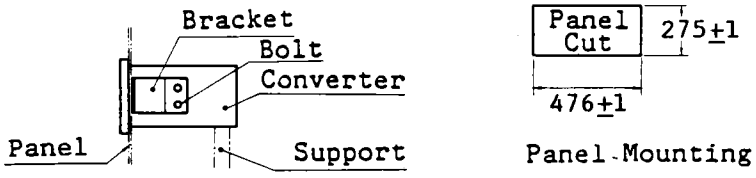


Figure 5.6 Mounting the Converter

(3) Wall mounting---See Figure 5.7.
Fix a strong bracket to the wall using angled steel suports as shown in Figure 5.7. Note the location of the air purge inlet fitting when constructing the wall mounting bracket. The air purge fitting can be removed if it is not going to be used.

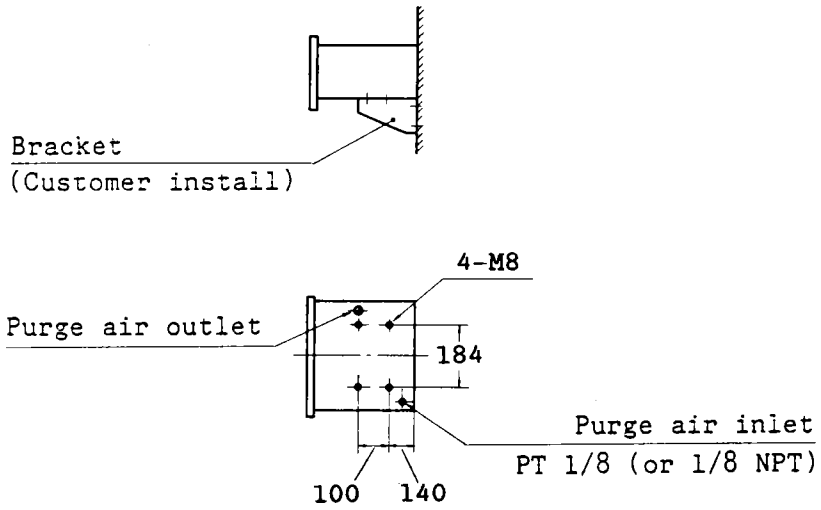


Figure 5.7 Wall Mounting

5.2 Wiring and Piping

5.2.1 Wiring

(1) To locate the wiring terminal strips inside the converter, open the outer door and pull out the operation panel---see Figure 5.8. The operation panel is held by four fasteners located in the corners. Turn these fasteners 3--4 times counterclockwise to loosen them. Be careful not to force them with a screwdriver if they are in a bind as they might break. Once the fasteners are loose, grasp the knobs on the operation panel and pull it out approximately side as the outer door, pivot the operation panel to the left to gain access to the wiring terminal strips.

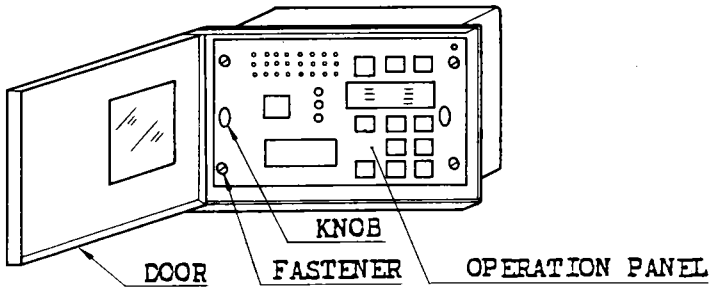


Figure 5.8 Open the Operation Panel

See Figure 5.9 for the location of each circuit board. Remove the switch cover on the power supply board and make sure all switches are turned off. Verify that the MX/CH boards start immediately to the right of the I/O board and that there are no empty slots between the first (leftmost) and last (rightmost) MX/CH boards.
If your particular converter is set up for 8 channel operation, pull out the MX/CH board for channel 8 (the rightmost board) about three inches for better access to the wiring terminal.

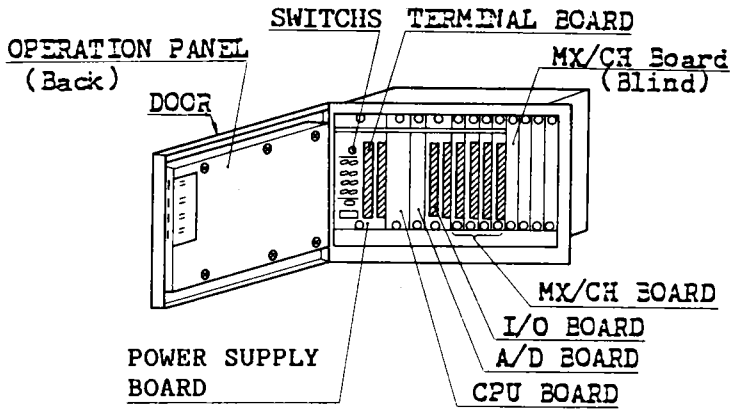


Figure 5.9 Board Disposition View

To remove any of the circuit boards see Figure 5.10.
Firmly grasp each of the nailatches and pull until they snap into their outermost position. Then remove the shipping lock screws on either side of the nailatches. Now the circuit board can be removed by grasping the nailatches and pulling the board straight out.

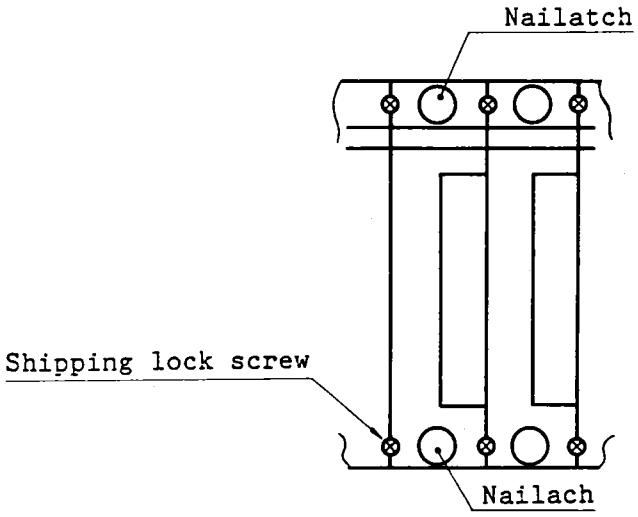


Figure 5.10 Removal of the Board

The circuit boards should be wired in the following order: 1. All detector terminal boards. 2. MX/CH boards. 3. I/O board. 4. Power supply board (with AC power connected last).

(2) Select the proper wire for the job. To select the proper wire you must consider the total distance between the detector and the converter and you need to know the upper temperature that the wire will be exposed to. For distances in excess of 980 feet use 14 AWG wire. For shorter runs 16 AWG wire may be used. It is recommended that the cabling be installed in conduit, with the heater and signal cables in separate conduits.
The heater cable should be overall shielded 2 conductor and the signal cable should be 6 conductor overall shielded. For temperatures less than 195 Deg. F use cable insulated with PVC such as Alpha Cable Corp. part number 5610/1604 (signal cable). For temperatures up to 360 Deg. F use cable insulated with Teflon and Fiberglas braid over shield such as Alpha Cable Corp. part number 2920/6 (signal cable).

(3) Proceed with wiring the detectors. See Figure 5.11 for cable terminations. To connect the heater, the phenolic insulation cover must be removed by loosening the screws on either side.

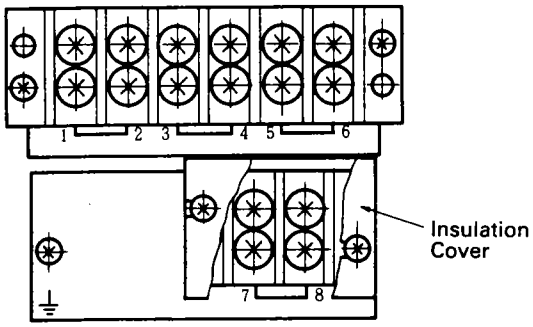


Figure 5.11 Detector Terminal Board Configuration

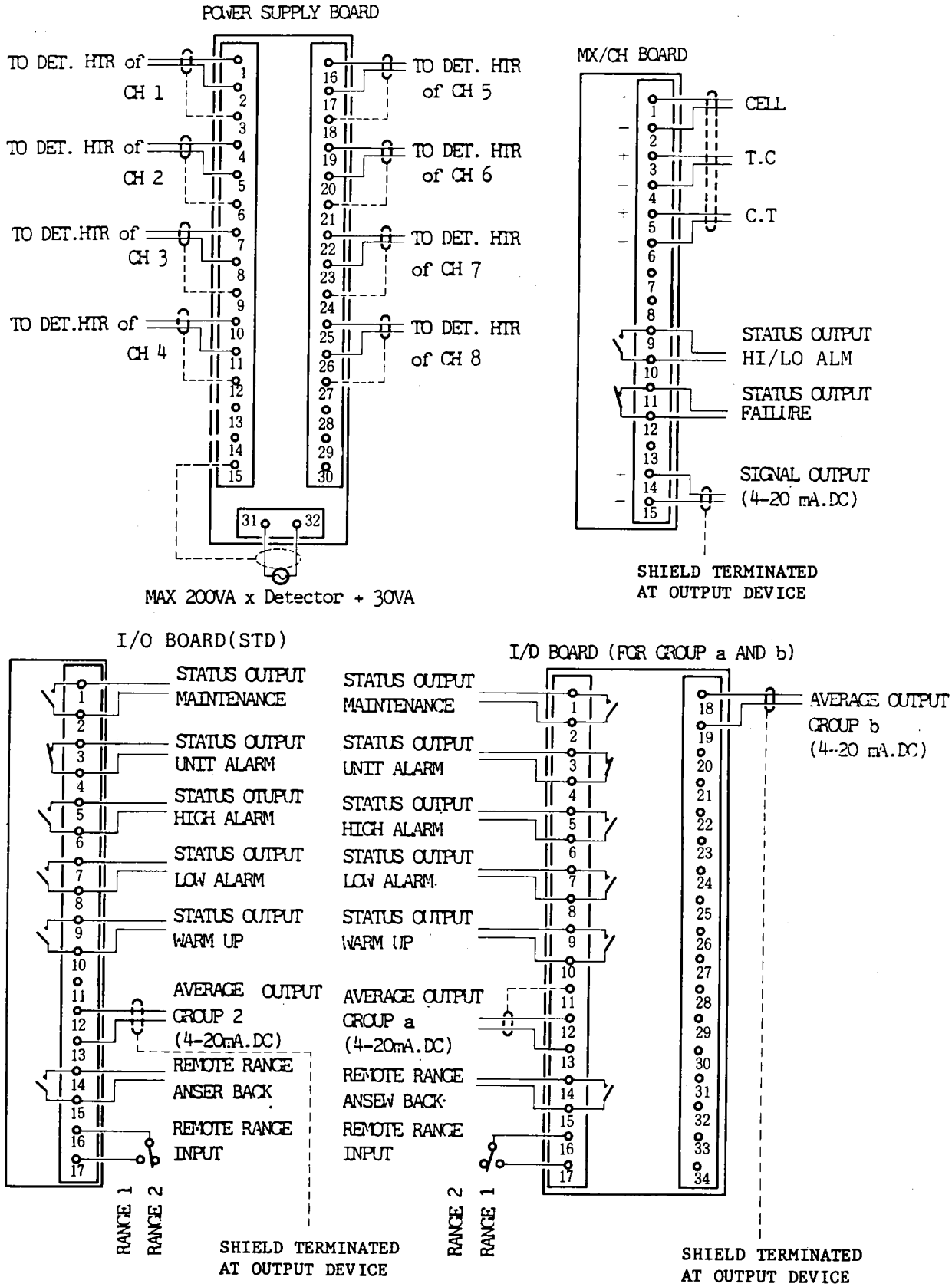


Figure 5.12 Converter Terminal Arrangement

The total lead loop resistance between the detector and the converter should not exceed 10 Ohms. The diameter of the multi-conductor cable should not exceed 0.551 inches (14mm). Use crimp on type solderless lugs on all cable tips for secure connection to the terminals.

Note: If the detector is used at an ambient temperature beyond 140 Deg. F, do not use solderless lugs with insulation sleeves and insulation tape. These materials are not resistant to high temperature. If they are burnt, corrosive gases will be generated which will corrode the terminals. At these temperatures use nickel plated solderless lugs.

(4) Cable conduits.
It is recommended that cable conduit pipes with an outer diameter of 1 inch (nominal) or flexible conduit pipes with an outer diameter of 3/4 inch be used. The conduit holes (1.06 inch nominal) are available on the bottom of the detector and converter.

(5) Noise considerations.
a. Separate the signal cable from the heater as much as possible. The signal cable carries low level DC voltage and the heater carries high level AC voltage. Putting the heater and signal cables in separate conduits will prevent noise from being induced onto the signal cable.
b. Ground the signal cable shield at the detector side only. Ground the heater cable shield at the converter only.
c. Connect the ground terminal on the bottom of the converter and detector to earth ground. Resistance to ground must be 100 Ohms or less.

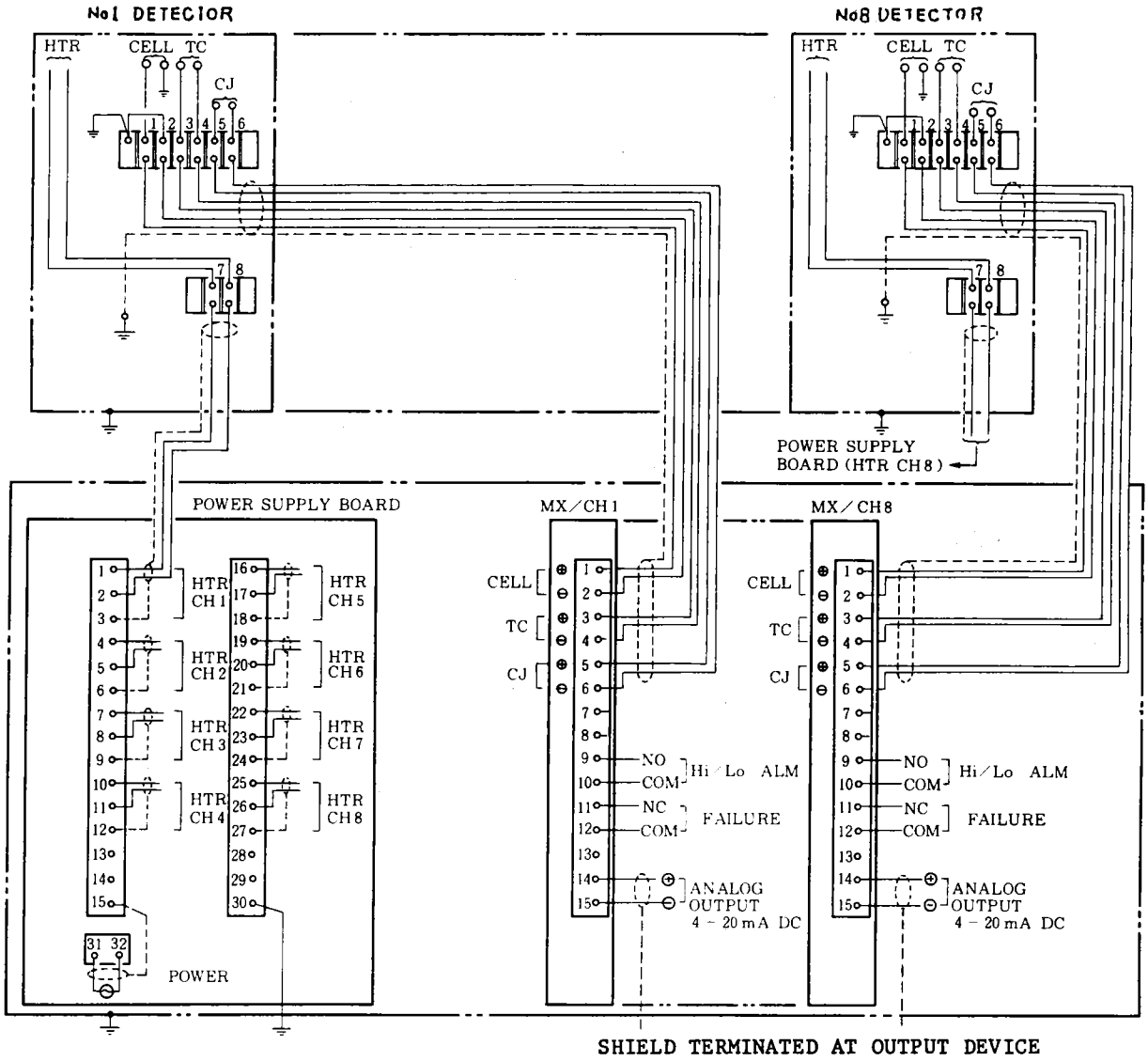


Figure 5.13 Wiring Diagram between the Converter and the Detector

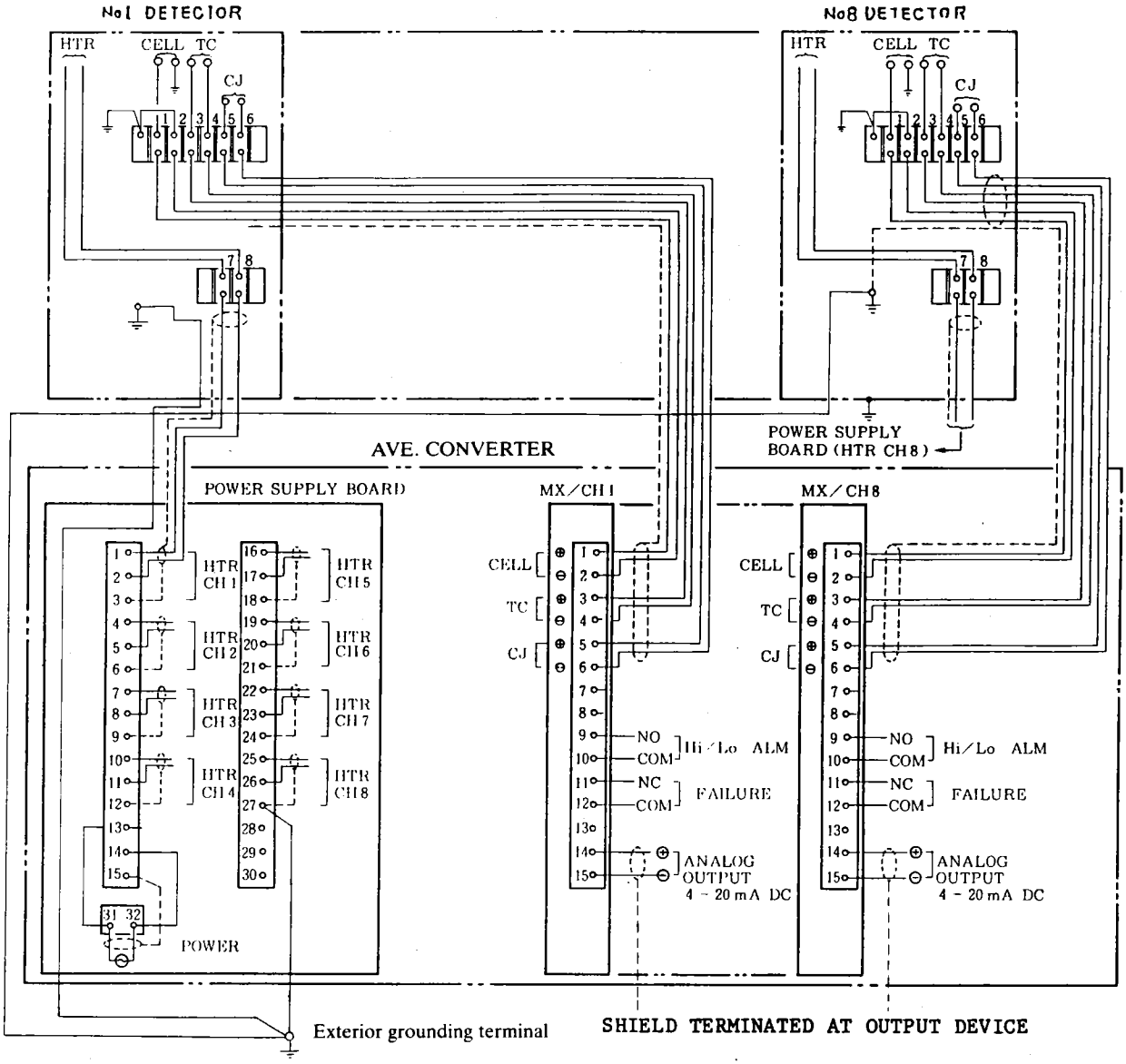


Figure 5.14 Wiring Connection Diagram (When Impossible to Wire Grounding from the Grounding Terminal of the Detector Case)

5.2.2 Piping—See Figure 5.15

Calibration gas and reference air piping.

If the ambient temperature around the detector is greater than 140 deg. F (60 deg. C) then heat resistant pipes and couplings must be used for connecting calibration gas and reference air.

(1) Calibration gas piping.
A stop valve should be installed between the calibration gas inlet and the calibration gas cylinder. This valve should be closed at all times except during calibration.

(2) Reference air piping.
Normally there is no need to supply reference air to this analyzer since it uses natural convection to draw ambient air to the reference side of the cell. Reference air should be supplied to the analyzer only if the atmosphere around the detector has a high concentration of contaminants, if the humidity varies significantly or if the probe length is longer than 2 meters (6.6 feet). Reference air needs to be free of dust, moisture, and oil. To maintain repeatability, the flow rate of the reference should be regulated at approximately 800 ml/min.

(3) Air purge piping.
If the converter is used in an environment that has corrosive gases present, such as wet chlorine, or H_2S, it is recommended that the converter is purged with air. Connect a copper or stainless steel tube to the air purge fitting supplied on the bottom of the converter. The purge air pressure should be maintained at a constant 7.2 PSIG (0.5 kg/square cm).

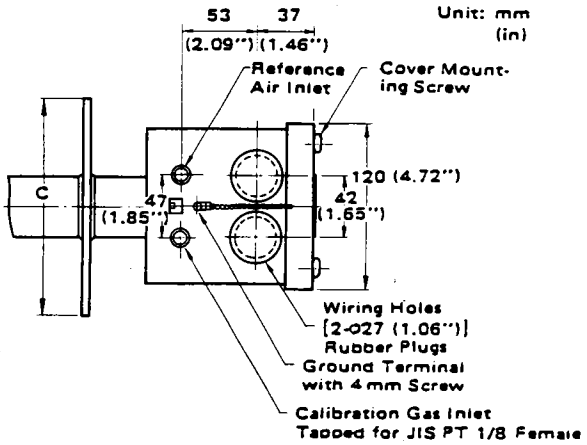


Figure 5.15 Pipe Connection Details

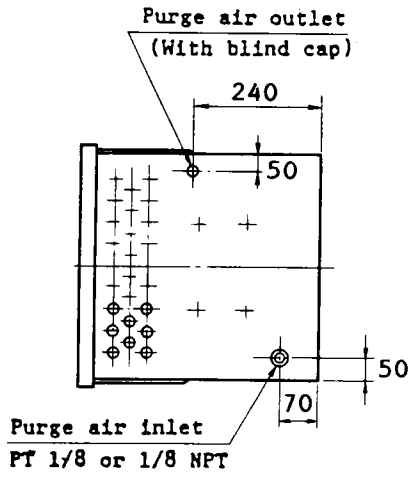


Figure 5.16 Converter Air Purge Connections

5.3 Installation Considerations for Model Z021D-H

When installing the Model Z021D-H high temperature oxygen detector, several considerations must be taken into account. They would include:

(1) The preferred mounting is vertically at an angle of not more than 5°. The reason for this is that the weight of the probe itself may cause it to sag or even break off.
If the detector mounting is made in the horizontal axis, special caution must be taken as to temperature vs. probe length (the higher the temperature, the shorter the length).

(2) Since water is a product of combustion, special care must be taken to prevent condensation from forming. This can be done by insulating the probe adapter to maintain the internal gas temperature above its dew point.

(3) If the detector electronic junction box is heated by radiant heat to temperatures higher than 150°C (302°F), it is recommended that a thermal barrier be placed between the junction box and the source of said radiant heat.

(4) Positive pressure applications. When the internal flue has a positive pressure, a restricting type device such as a valve must be placed on the probe adapter gas outlet to prevent extremely high sample flows from disturbing the temperature control of the detector's zirconia element.

(5) Negative pressure applications. When negative pressure applications are to be sampled, attach the air ejector supplied to the probe adapter gas outlet and follow the operational procedures suggested in the main instrument manual.

(6) Horizontal mounting. When installing the Model Z021D-H in a horizontal position, as previously discussed, the assembly should be mounted in such a way as to have the detector assembly in the "up" position with the ejector assembly in the "down" position. This should be done to prevent any possible detector damage should condensation form within the adaptor assembly.

(7) Sample gas returned to the flue. When it is desired to return the sample gas to the flue and the air ejector is used, the tube size becomes critical. A 3/8 to 1/2 inch tube should be used to allow the ejector to operate efficiently.

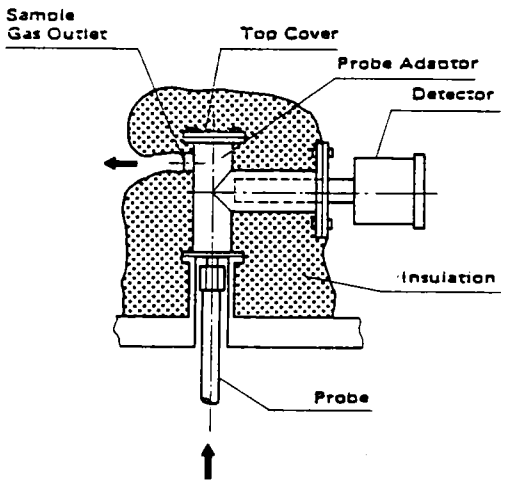


Figure 5.17 Installing the High Temperature Detector

(8) Preheating the ejector air supply. When using the air ejector, it is necessary to preheat the ejector air supply to prevent condensation from forming in the ejector assembly itself when the flue gas and the ejector air combine. This can easily be done by wrapping the ejector air supply tubing several times around the adaptor assembly itself or around the side arm where the detector probe is mounted.

Please refer to Figures 5.18, 5.19 and 5.20 for additional comments.

Should any questions remain or if you require assistance in any way, please do not hesitate to contact your local YOKOGAWA representative.

THIS TUBING IS NOW AVAILABLE IN VARIOUS METALS IF DESIRED.

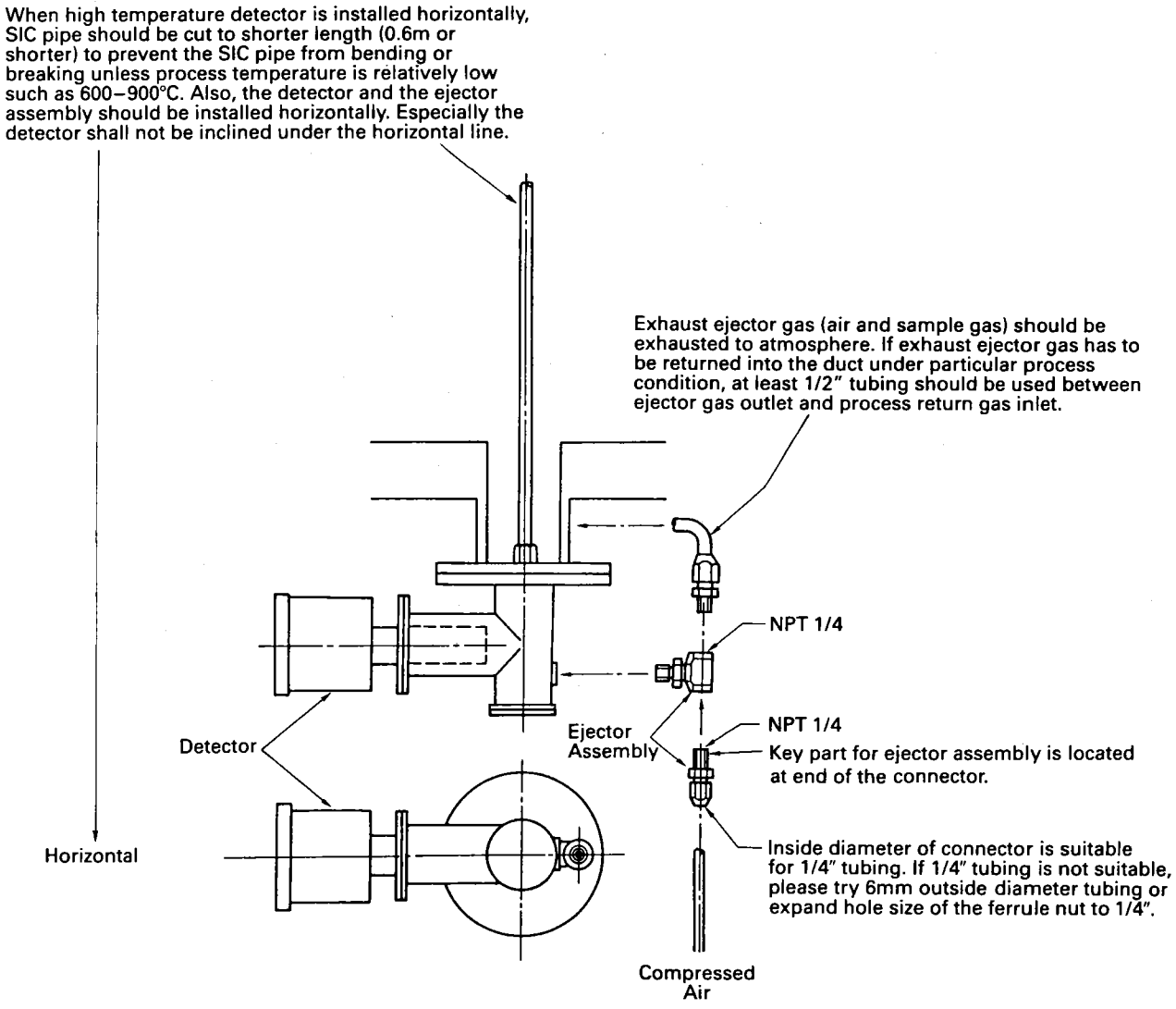


Figure 5.18 Installation of High Temperature Detector

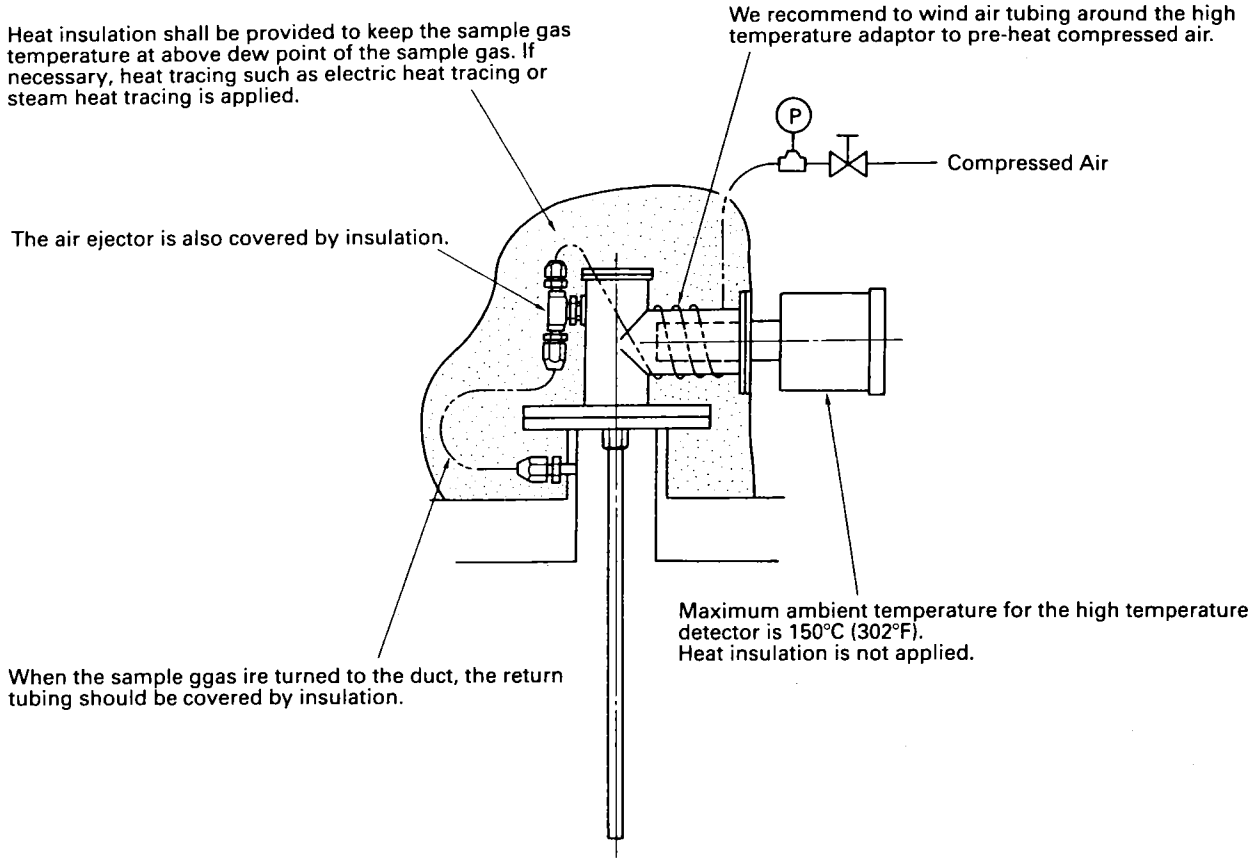


Figure 5.19 Heat Insulation for High Temperature Detector with—Sample Gas Return

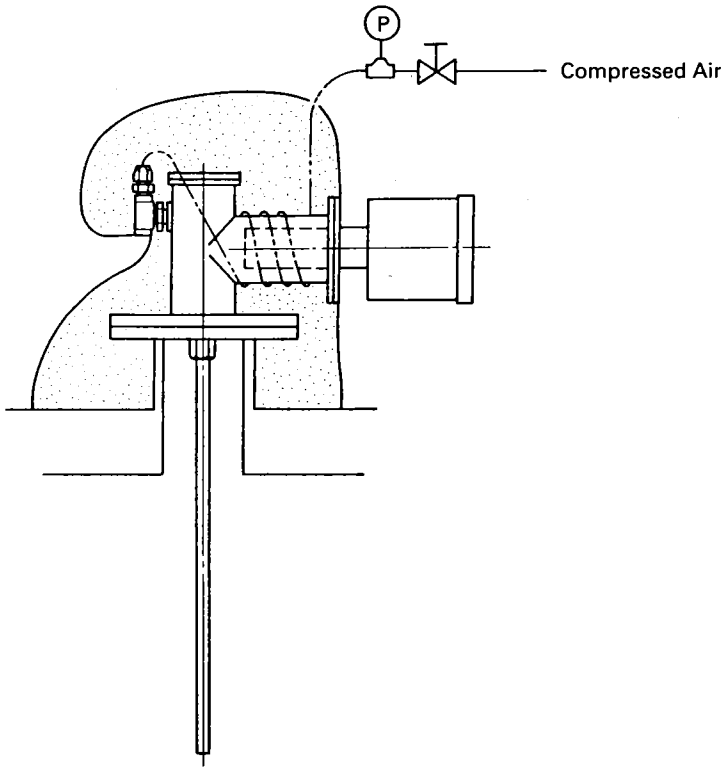


Figure 5.20 Heat Insulation for High Temperature Detector W/O Sample Gas Return

6. OPERATION

6.1 Preparations before Operation

(1) Before turning power on please verify that all wiring is correctly connected per Figure 5.13. Then confirm the following points:
   a. Make sure that the ground wire on the converter is connected to true earth ground.
   b. Then confirm that none of the signal or heater cables are shorted to ground. Also check the insulation resistance of each cable. Each heater cable should have a resistance of 5 megaohms or greater between detector and case (internal ground.) Disconnect the cable from terminals 1&2 of channel 1 MX/CH board and disconnect the cables from terminals 1 and 2 of the power supply board. Measure the insulation resistance between power supply cable 1 or 2 and MX/CH board cable 2. Repeat this test for each MX/CH board and each power supply terminal. Use an insulation resistance tester rated 500V DC.

(2) Checking the power supply.
   a. Make sure that all switches on the power supply card are turned off. Then turn on the main power supply switch and measure the voltage between terminals 13 & 14 and 31 & 32. The voltage should be +/-10% of the nominal line voltage. For example, if your nominal supply voltage is 115 VAC then the measured voltage needs to be between 104 and 126 VAC to be acceptable.
   b. Visually inspect the connector attached to the operation panel to make sure that it is fully attached.
   c. The power supply voltage to the analyzer can be selected by setting a jumper as shown in Figure 6.3. The location of this jumper on the power supply card is shown on Figure 6.1. To change the supply voltage jumper, turn off the main power supply and disconnect the wiring. Remove the shipping lock screws on either side of the nailatches, grasp the nailatches and pull the card out of the chassis. The connector wiring is color coded and shown in Figure 6.1.

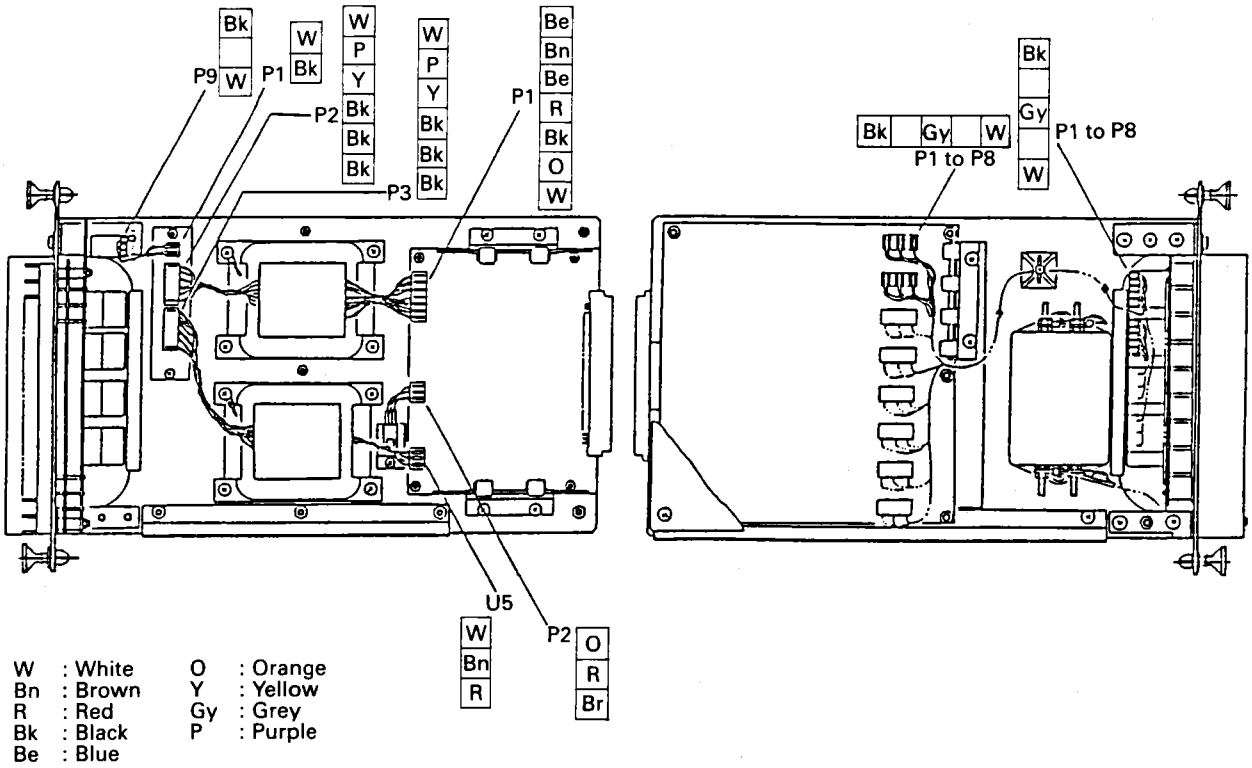


Figure 6.1 Connector Position in the Power Supply Board

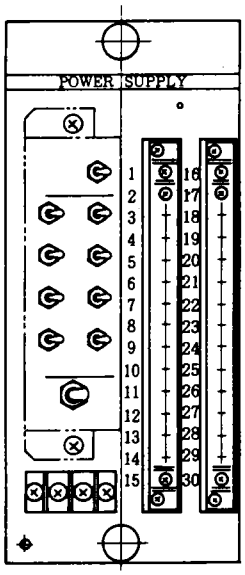


Figure 6.2 Front of Power Supply Board

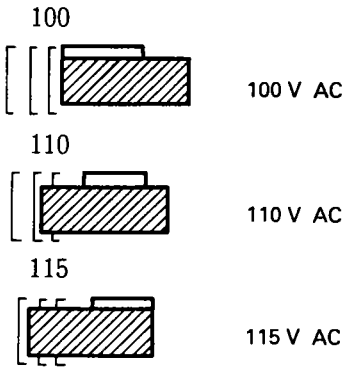


Figure 6.3 Connecting Position for the Power Supply and the Connectors (P1, P2)

(3) Open the operation panel and confirm the settings of the 8 slide switches located on the inside edge. The initial position of these switches should be as shown in Figure 6.4.

Note 1: Switch 1 controls whether the buttons on the front panel of the converter work or not. This is provided for security. Switch 2 determines if the output (4 to 20mA) of the individual channels are held or not held during calibration or while setting parameters are being changed in the maintenance mode. Switch 3 allows the user to determine whether the output range can be selected by external contact (remote) or by manual switch on the converter (local). Switch 4 allows the user to select one of two ranges when Switch 3 is set to Local. Switches 5, 6, 7 & 8 set various calibration parameters which are explained in the section on the automatic calibration function.

(4) The CPU board is equipped with battery backed up clock. The unit is shipped with the battery installed on the CPU. To prevent premature discharge of the battery it has a plastic insulation sleeve over the outer contact retainer clip. It is necessary to remove this insulation before starting the unit up. See Figure 6.5 for location of the battery and the insulation.

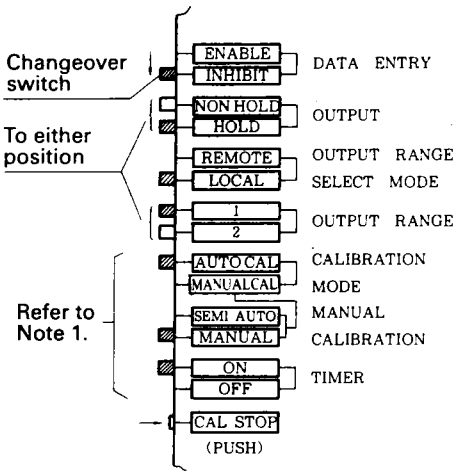


Figure 6.4 Changeover Switch

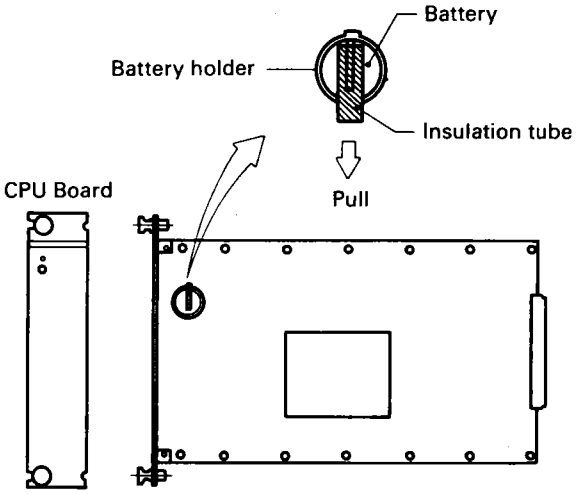


Figure 6.5 Battery Holder

(5) Battery back up
The data stored in RAM of the CPU card is backed up by a battery which is mounted on the CPU card (Figure 6.5 or Figure 10.6). The data which is battery backed up is listed below.
When the AV8G is shipped from the factory, the battery is disabled by an insulating sleeve which covers one of the battery contacts. This prevents premature battery discharge, which will help extend the life of the battery. When the RAM is lost (either due to power failure plus low battery or power failure plus disconnected battery) the memory goes to the default settings. These default settings are also listed below.

Function		Initial set value
STD GAS CONC	SPAN	20.6% O_2
	ZERO	1.00% O_2
OUTPUT RANGE	1	0 to 25% O_2
	2	0 to 25% O_2
AVE GROUPING	a	CH1, CH2
	b	None
HIGH ALARM SET		25.0% O_2
LOW ALARM SET		1.00% O_2
CAL INTERVAL (d)		0 day
WAIT TIME (h)		0 hr
CAL TIME (min)		0 min
STAB TIME (min)		5 min

(6) Removal of a channel from the averaged output, several conditions will result in the automatic removal of a channel from the averaged output (s).
i) When a channel is removed from service for calibration, it is automatically removed from the averaged output (s). It is not included in the averaged output again until the STABilization time has elapsed after calibration of that particular channel.
ii) When the converter defects a FAILure condition, that particular channel is removed from the averaged output (s) until that failure condition is corrected and that channel is reset (by pressing the reset button on the channel card).

6.2 Start up Procedure

Start up the analyzer by the following procedure in the order outlined below:

Note: Make sure that all switches on the power supply card are turned off before proceeding.

6.2.1 Basic Start up Procedure

(1) Turning the power ON.
   a. Turn the converter power switch ON.
   b. Turn the heater switches ON for the channels being put into service.
   c. Turn the converter amplifier switch ON.
   d. Confirm that warm up is completed by observing green ready lamp over each board. Each lamp should be lit.

(2) Setting the measuring and calibration parameters.
   a. Standard gas concentration entry.
   b. Set output range 1.
   c. Set output range 2.
   d. Set average output 1.
   e. Set average output 2.
   f. Enter high alarm set point.
   g. Enter low alarm set point.
   h. Enter the calibration interval.*
   i. Enter the time of the initial calibration.*
   j. Enter the length of the calibration.*
   k. Enter the calibration stabilization time.**

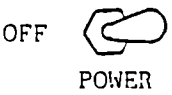
(3) Perform zero and span calibration for each channel. See section 9.5.

(4) Return the analyzer to the measurement mode and verify that the green READY lamp for each channel is lit.

   * These functions are used for automatic or semi-automatic calibration only.

   ** This function is valid for manual or automatic calibration.

6.2.2 Start up Operation

Step	Name of Part	Method and Condition	Result
1	POWER switch	→ ON  	
2	HEATER switch CH [n] switch (n: CH No.)	→ ON  	
3	AMP switch	→ ON  	o Each board RDY ☼ o CH [1] o DATA - - - - o ☼ MEASURE
4	MODE key	→ Press MODE (MEAS/MAINT) □	o ☼ MAINTENANCE o DATA c c c c
5	FUNCTION key	→ Press FUNCTION □	o [1] FUNCTION (Selection) o CH [1] ⋮ Confirm temperature of each channel cell become stable at 750°C. [n] o READY LAMP light successively from the channel reached 750°C. o Until READY LAMP light value of output signal is equivalent to 0 $\%O_2$.
6	STD GAS CONC entry	Refer to 9-7	
7	STAB TIME entry	Refer to 9-16	

Step	Name of Part	Method and Condition	Result
8	CAL OPN operation	Refer to 9-5	
9	MODE key	→ Press MODE (MEAS/MAINT) □	o ☼ MEASURE o CH [n] (Select by CH key) o DATA [3.00] Display show correct O_2 concentration value in the furnace after CAL OPN.

6.2.3 The Start up Operation Independently for Each CH

The operation procedures for the independent start up for the channel which maintenance work has already been finished, are shown as undermentioned.

(1) Turn OFF the HEATER SW of the CH.

↓

(2) Turn ON the HEATER SW of the CH.

↓

(3) Push the RST SW on the CH BOARD of the CH for 1-2 sec by using a sharp end pin like a ball pen.

↓

(4) When the FAIL LAMP for the CH on the front panel turned OFF, and perform the MAINTENANCE MODE to FUNCTION 1, confirm the CELL TEMPERATURE of CH is increasing.

↓

(5) If unobtainable the condition described in the above (4), perform again the procedure described in (3) so that the condition described in (4) can be obtained.

6.3 Zero and Span CALIBRATION

Use the ZERO and SPAN gas for these adjustments. The basic calibration procedure is described below which details please refer to paragraph 9.5 "CAL OPN operation".

Basic calibration procedure

(1) Select the channel to calibrate.

↓

(2) Set to the MAINTENANCE mode.

↓

(3) Input the calibration gas concentration value, and store the value.
(STD GAS ENTRY operation)

↓

(4) Supply zero gas or span gas to the detector.
(Whichever supply first does not matter)

↓

(5) Perform zero, and span calibration.
(CAL OPN operation)

↓

(6) Set to the MEASURE mode.

Note 1. The calibration must be performed with both zero and span. By only either of the two, calibration cannot be performed correctly.

Note 2. When the STAB TIME of the FUNCTION [F] is in entry (The time is set to 5 min. when shipment.) until the time expires, cannot operate the calibration for the next channel. During the STAB TIME the lamp for FUNCTION LED ([3]) lights on and off.

Note 3. Regarding the concentration condition for zero gas and span gas.
(1) Zero gas concentration: 0.5 to 10 Vol%O_2 N_2 bal.
(2) Span gas concentration: 4.0 to 21 Vol%O_2 N_2 bal.
(3) The concentration ratio of span gas to zero gas.

$$\frac{\text{Span gas concentration}}{2} \geqq \text{zero gas concentration}$$

(Example)
When the concentration of span gas is 10 Vol%O_2, the concentration of zero gas is 5 Vol%O_2 or below. Which means the range 0.5 to 5 Vol%O_2 is usable.

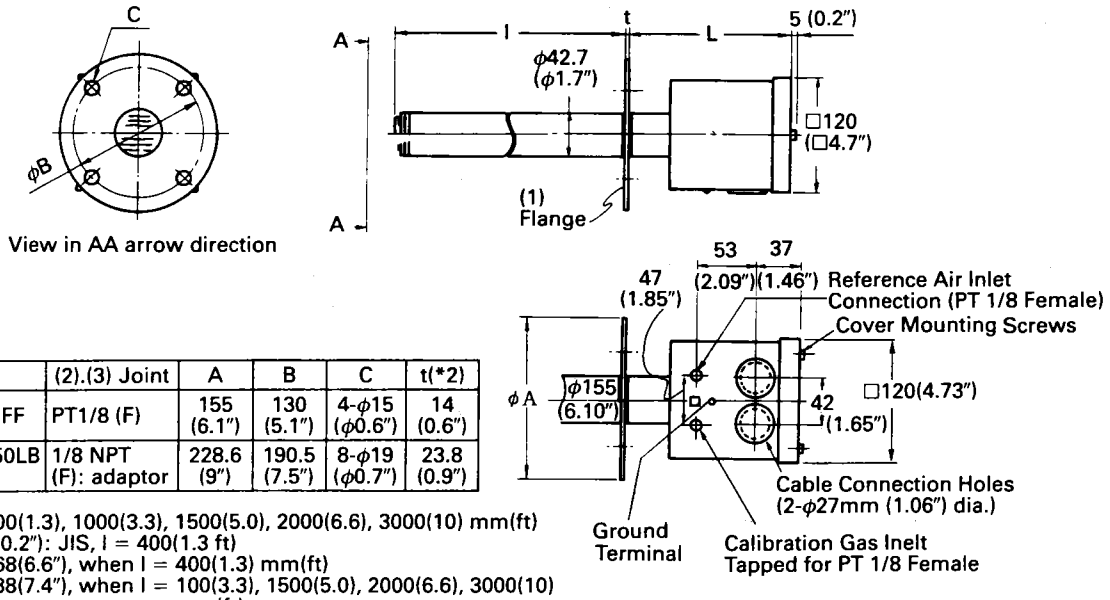
Note 4. When the concentration of the SPAN GAS to be used is changed, must recalibrate after ENTRY with the following concentration range.
(20.0 to 21.0 Vol%O_2) – (4 to 19.9% Vol%O_2)
(For example when change the concentration of the SPAN GAS (21.0 Vol%O_2) to (15.0 Vol%O_2), must perform once the calibrating operation after ENTRY.

Note 5. After finish the calibration for zero point and span point, must close the stop valve. If neglect, may become a cause of damaging or blocking the cell by the occurrence of the drain or solid sulpher in the piping used for the calibration.

7. NAMES AND FUNCTIONS OF COMPONENTS

7.1 Detector

Unit: mm
(in)



Flange	(2).(3) Joint	A	B	C	t(*2)
JIS5K 65A FF	PT1/8 (F)	155 (6.1")	130 (5.1")	4-φ15 (φ0.6")	14 (0.6")
ANSI 48 150LB RF	1/8 NPT (F): adaptor	228.6 (9")	190.5 (7.5")	8-φ19 (φ0.7")	23.8 (0.9")

(*1) l = 400(1.3), 1000(3.3), 1500(5.0), 2000(6.6), 3000(10) mm(ft)
(*2) t = 5(0.2"): JIS, l = 400(1.3 ft)
(*3) L = 168(6.6"), when l = 400(1.3) mm(ft)
L = 188(7.4"), when l = 100(3.3), 1500(5.0), 2000(6.6), 3000(10) mm(ft)
Low temperature detector (Z0Z1D-L)

Figure 7.1 External View and Dimensions of Detector

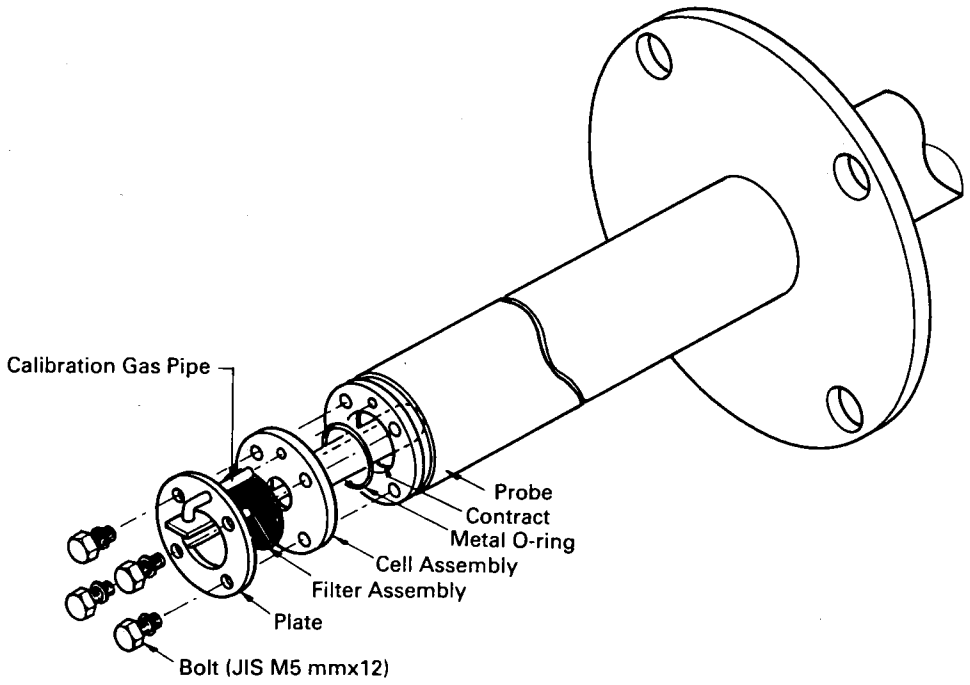


Figure 7.2 Sensor

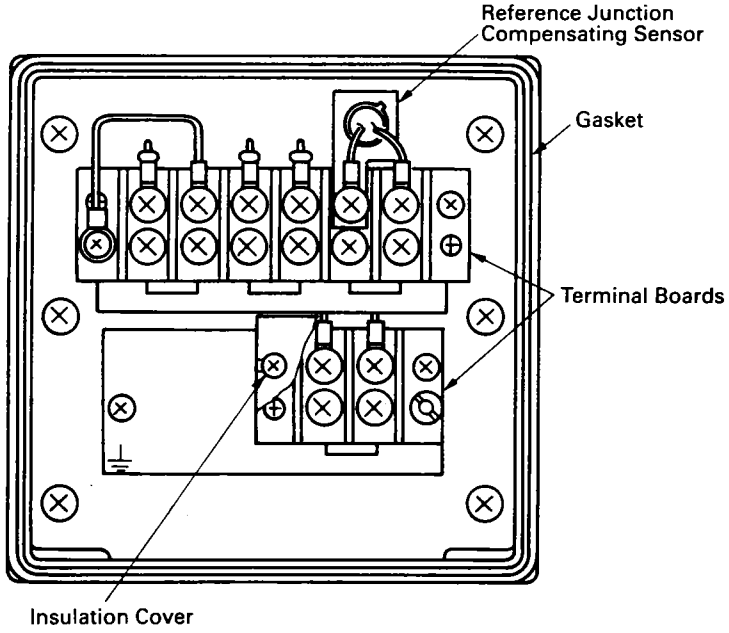


Figure 7.3 Terminal Boards

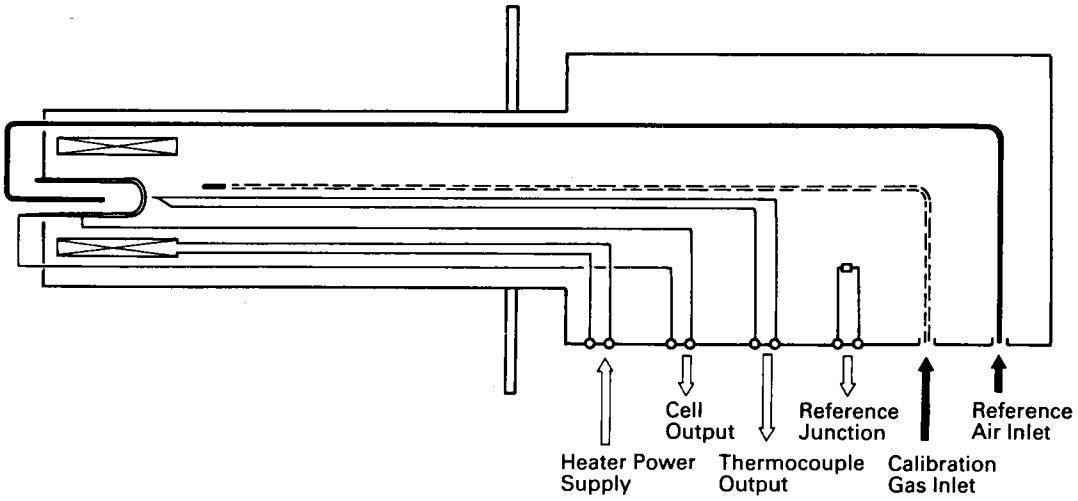


Figure 7.4 Detector Configuration

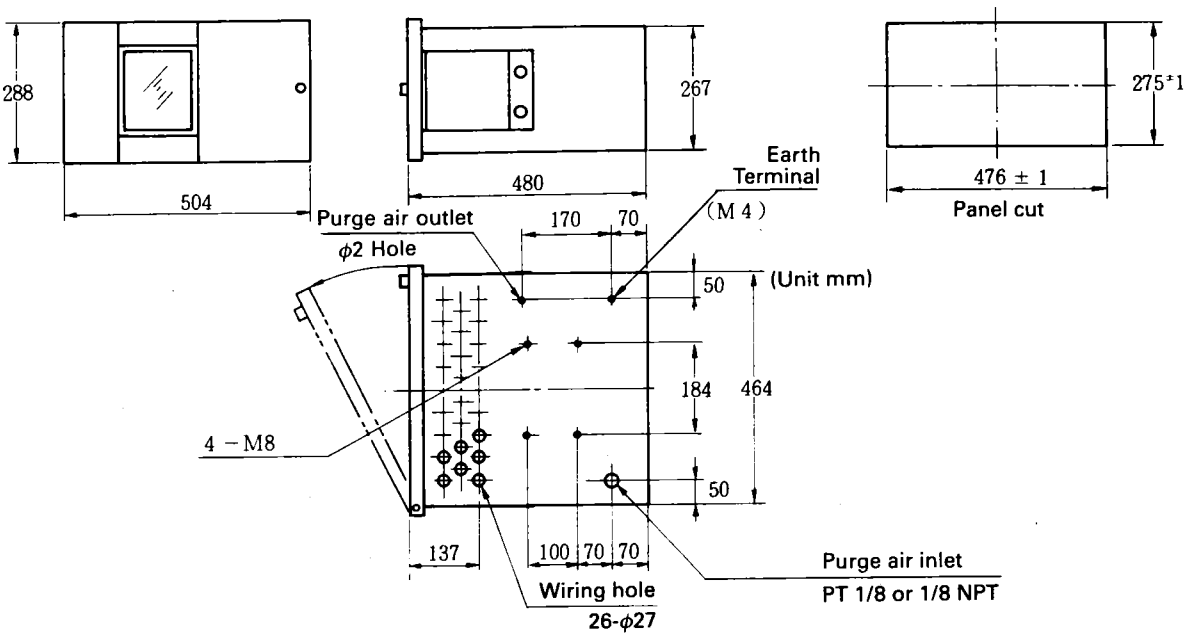


Figure 7.5 External Dimension of Converter

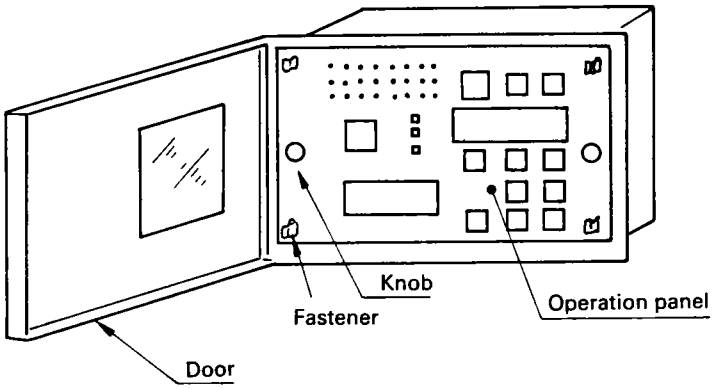


Figure 7.6 Open the Door Panel

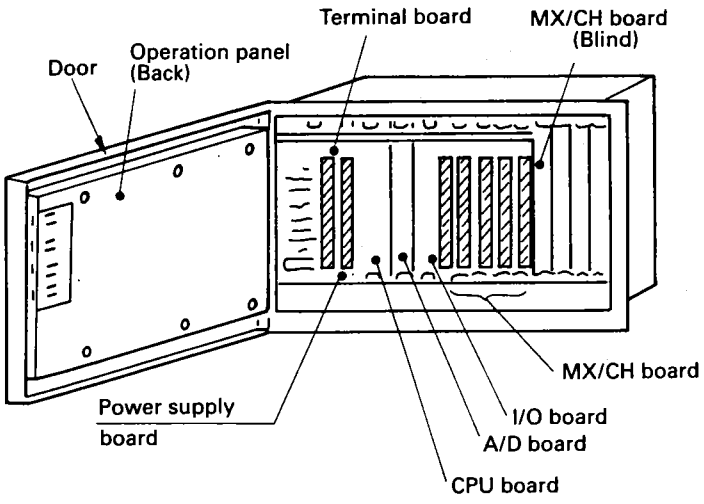


Figure 7.7 Board Disposition View

7.2 Description of the Digital Display Panel

The display panel is made up of 5 sections:
1. Unit mode indicator.
2. Channel number display.
3. Data display.
4. Channel status indicator.
5. Function status display.

UNIT MODE INDICATOR: These 3 LED's indicate the mode that the analyzer is operating in. MEASURE means that 0 to 25 vol.%O_2 will be indicated in the data display for the channel or group of channels shown in the channel number indicator. When the MAINTENANCE LED is lit, the functions shown in the upper right hand corner of the converter operation panel can be displayed. UNIT ALARM lights in response to failures of the CPU or the A/D converter.

CHANNEL NUMBER DISPLAY: This display shows the current channel number for which data is being displayed. It can also indicate group A or group B when average O_2 concentration is being displayed.

DATA DISPLAY: In the normal measure mode the data display will indicate 0 to 25 volume %O_2 concentration. For concentrations greater than 25% or if the cell temperature exceeds 780 degrees C the display will indicate 1--- which means overange.

The digital display shifts the decimal point automatically at 11.0% vol.O_2. From zero to ten percent the resolution of the display will be to the nearest hundredth of a percent (5.01 vol.%O_2 for example).

In the maintenance mode the following parameters can be shown in the data display: Cell EMF (mV), Cell temperature (degrees C), Correction rate (mV for span and percent for zero), Standard gas concentration (zero and span in %), Fail check (error messages indicating the nature of the failure), Output range 1 & 2 (range in % O_2), High alarm setpoint (% O_2), Low alarm setpoint (% O_2), Calibration interval (days), Wait time (hours), Calibration time (minutes), Stabilization time (minutes).

CHANNEL STATUS INDICATOR: This is a three level annunciator for each channel. It indicates if the probes are READY (to measure), in concentration ALARM, or if any of the probes have failed.

FUNCTION STATUS DISPLAY: When in the maintenance mode, the function display will indicate which maintenance or setting function is being shown in the data display.

The data display can also show other information such as error messages, battery status, recalibration notification, alarm messages and others.

ERROR MESSAGES:

E--1	Cell Failure
E--2	Cell Temperature Too Low
E--3	Cell Temperature Too High
E--4	Analog Circuit Failure
E--5	Abnormal Calibration Value
0000	Digital Circuit Failure
oooo	Digital Circuit Normal

The above messages appear in the data display when one of the error conditions occurs. See the troubleshooting section of the manual on what to do next.

cccc Indicates that the analyzer is in the maintenance mode. A maintenance status output contact on the I/O board is energized when the analyzer is put into this mode.

---- Indicates that the analyzer is waiting for input from the keyboard or from internal operations. Examples of waiting for keyboard input are STD GAS CONC, CORR RATE, entering AVE GROUPING, or waiting for PASSWORD ENTRY when going into the maintenance mode. When a FAIL CHECK is requested, the analyzer performs a search for any error conditions.

1--- Indicates an overange condition. This will occur if any of the following conditions exist:
a. Oxygen concentration is greater than 25%.
b. Cell output is less than -15mV or greater than 200mV.
c. Cell temperature exceeds 780 degrees C.

2--- Indicates that the battery voltage is too low and it requires replacement. This indication will occur only when a FAIL CHECK is performed in the maintenance mode. In the measure mode, a low battery condition will be indicated by the measure lamp flashing.

3--- Indicates that the STANDARD GAS CONC (calibration gas) memory is lost and that recalibration is required. This indication will occur only when a FAIL CHECK is performed in the maintenance mode. In the measure mode the measure lamp will flash when this condition occurs.

4--- Indicates that a low oxygen concentration alarm exists. This indication occurs only when a FAIL CHECK is performed in the maintenance mode. In the measure mode this is indicated by an alarm lamp on the channel status annunciator.

5--- Indicates that a high oxygen concentration alarm exists. This indication occurs only when a FAIL CHECK is performed in the maintenance mode. In the measure mode this is indicated by an alarm lamp on the channel status annunciator.

The contents of the display description panel are explained below.

(1) Numerical display.

Display	Details of Display
[ ][n][n][n] : O_2 value in Vol. % (n: O_2 value)	1) Oxygen concentration of 25 vol. % O_2 or less is displayed. 2) For oxygen concentration greater than 25 vol. %, overrange [1][-][-][-] is displayed. 3) The decimal point shifts automatically near 11.0 vol. % O_2. (Example) [ ][0.][1][0] [ ][9.][9][9] [1][0.][9][9] [ ][1][1.][0] [ ][2][1.][0]
[ ][n][n][n] : CELL EMF n: Cell emf — unit: mV	1) The cell electromotive force (emf) mV — corresponding to the oxygen concentration in the measurement gas — is displayed. 2) This value is displayed only in MAINTENANCE mode.
[ ][n][n][n] : CELL TEMP n: Cell temperature — unit: °C	1) Displayed in °C 2) This value is displayed only in MAINTENANCE mode.
[ ][n][n][n] : Calibration coefficient (n: Coefficient)	1) The calibration coefficient at ZERO and SPAN adjustments is displayed. For the SPAN calibration coefficient, the cell emf (mV) is displayed. For the ZERO calibration coefficient, the ratio between the actual cell emf and logical value are displayed in percent. 2) A margine for the maximum cell calibration limit can be grasped by this coefficient. SPAN calibration range: ±10 mV ZERO calibration range: 120 to 70 of the logical value. 3) This value is displayed only in MAINTENANCE mode.

(2) Conditional display.

Display	Details of Display
⊏⊏⊏⊏ : MAINT MODE	1) Displays when the MEAS/MAINTENANCE mode selector switch is set to MAINTENANCE. 2) The analog output is held immediately before the mode is selected to MAINTENANCE. 3) The MAINTENANCE contact output turns ON.
— — — — : ENRTY.RECALL wait During FAIL CHECK ON	1) Displays until the following key operations are performed or until the results of the operations are displayed. o STD GAS ENTRY key. o STD GAS RECALL key. o For average grouping entry 2) Display only in the case of "MAINT" mode.
1 — — — : OVERRANGE	1) Displays when the oxygen concentration in the measurement gas is 25 vol. % O_2 or higher. 2) Displays when the cell emf is greater than 200 mV or less than -15 mV. 3) Displays when the cell temperature is higher than 780°C.
2 — — — : REPLACE BATTERY MEAS FLASHING	1) Displays when the battery is too low, its replacement is required. 2) In MEAS mode, the only MEAS lamp flashes and the oxygen concentration is displayed. 3) Displays when the FAIL CHECK is performed in MAINTENANCE mode.
3 — — — : RECALIBRATING — WAIT MEAS FLASHING	1) Displays when the calibration gas concentration memory is lost, and recalibration is required. 2) In MEAS mode, the only MEAS lamp flashes and the oxygen concentration is displayed. This display value corresponds to the cell output logical value. 3) Displays when the FAIL CHECK is performed in MAINTENANCE mode.
4 - - - : BELOW LOWER LIMIT ALARM	1) Alarm lamp of the channel light when O_2 concentration decreased below lower limit alarm entry value. 2) Display is for Oxygen concentration. 3) When in the average grouping excluded from the group. 4) Produce low alarm contact point output. 5) Display when perform fail check operation under MAINT MODE.

5 | - | - | -	: ABOVE HIGHER LIMIT ALARM	1) Alarm lamp of the channel light when O_2 concentration increased above higher alarm limit entry value. 2) Display is for Oxygen concentration. 3) When in the average grouping excluded from the group. 4) Produce high alarm contact point output. 5) Display when perform fail check operation under MAINT MODE.

(3) Abnormality display (error code display)
The two cases for abnormal display are as follows:
(a) When a failure occurs which causes a FAIL lamp to come on, indicating a failed channel.
(b) When a unit failure occurs (a failure common to all the channels) are the UNIT ALARM lamp comes on.
In either case, put the converter into the MAINT mode and select function 4-FAIL CHECK.
Then use the CH key to select the channel to be checked. The error code, if one exists, will then be displayed. The following table defines the meaning of the various error codes and the effect they have on the status of the detector heater power source.

Display	Definition	Detector heater power source
E - - 1	CELL FAILURE	Only abnormal channel off
E - - 2	TEMP TOO LOW	
E - - 3	TEMP TOO HIGH	
E - - 4	ANALOG CIRCUIT FAIL	
E - - 5	CAL VALUE ABNORMAL	On
□□□□	DIGITAL CIRCUIT FAIL	All channel off
▣▣▣▣	NORMAL	On

NOTE: E--4 can be caused by failing to turn on the channel heater switch of the Power Supply Board.

8. OPERATION OF CONVERTER

8.1 Operation Panel Outline

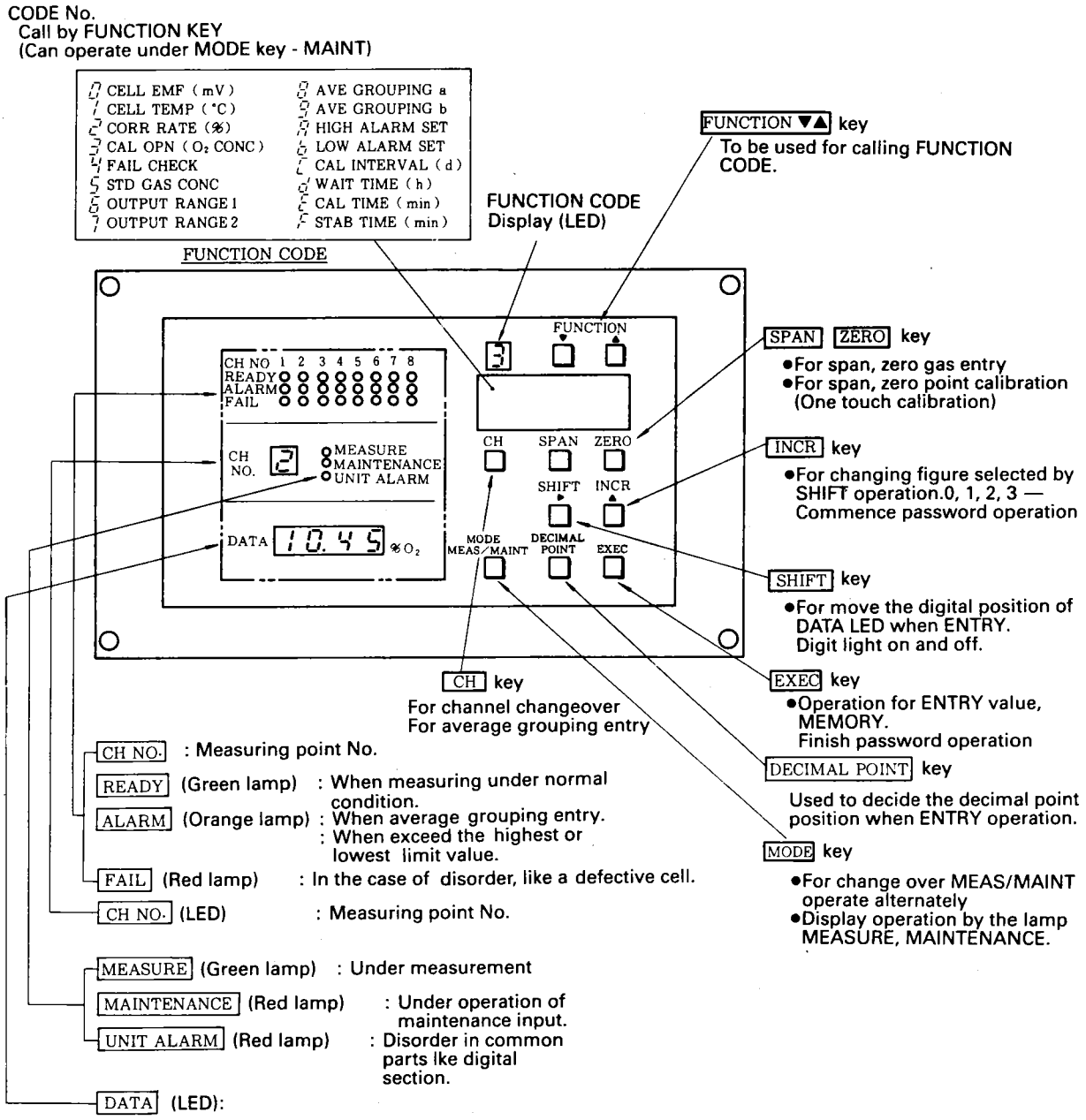


Figure 8.1 Operation Panel

8.2 Operating Procedures

The analyzer permits the following operations.

(1) MEAS/MAINT MODE CHANGE OVER OPERATION
(2) CELL EMF (mV) CONFIRM OPERATION
(3) CELL TEMP (^{o}C) CONFIRM OPERATION
(4) CORR RATE CONFIRM OPERATION
(5) CAL OPERATION
(6) FAIL CHECK OPERATION
(7) STD GAS CONCENTRATION ENTRY OPERATION
(8) OUTPUT RANGE 1 ENTRY OPERATION
(9) OUTPUT RANGE 2 ENTRY OPERATION
(10) AVE GROUPING a ENTRY OPERATION
(11) AVE GROUPING b ENTRY OPERATION
(12) HIGH ALARM SET ENTRY OPERATION
(13) LOW ALARM SET ENTRY OPERATION
(14) PASS WORD OPERATION
(15) CHANGE OVER SWITCH OPERATION
(16) STAB TIME ENTRY OPERATION
(17) CAL INTERVAL ENTRY OPERATION
(18) WAIT TIME ENTRY OPERATION
(19) CAL TIME ENTRY OPERATION

Operation 17, 18, and 19 only work on units set up to perform automatic calibration. To see how these functions work refer to the automatic calibration manual (Flow setting Unit).

9. FUNCTION

Available functions of the converter are as follows.

CODE NO.	FUNCTION
0	CELL EMF (mV)
1	CELL TEMP (°C)
2	CORR RATE (%)
3	CAL OPN (O_2 CONC)
4	FAIL CHECK
5	STD GAS CONC
6	OUTPUT RANGE 1
7	OUTPUT RANGE 2
8	AVE GROUPING a
9	AVE GROUPING b
A	HIGH ALARM SET
b	LOW ALARM SET
C	CAL INTERVAL (d)
d	WAIT TIME
E	CAL TIME (min)
F	STAB TIME (min)

Notes: AVE GROUPING b, CAL INTERVAL (d), WAIT TIME CAL TIME are optional.

9.1 MEAS/MAINT MODE Changeover Operation

1. Press the MODE (MEAS/MAINT) button on the operation panel. The green measure lamp on the operation panel will go out and the red maintenance lamp will come on. The data display will indicate cccc which notifies the user that the analyzer is in the maintenance mode. If the data display indicates P--- this means that the ENABLE/INHIBIT switch (located on the inside of the operation panel) is in the ENABLE position. ENABLE allows the user to change program settings in the MAINT MODE. To provide security, a password is required to enter the MAINT MODE with the ENABLE switch on. It is possible to enter the MAINT MODE when the ENABLE/INHIBIT switch is in the INHIBIT position. However, the user may only view the desired maintenance function without being able to change any parameters. At any time when the analyzer is in the MAINT MODE it can be returned to MEAS MODE by simply pressing the MODE (MAINT/MEAS) button.

Step	Name	Method and Condition	Result
1	MODE key	⟶ Press MODE MEAS/MAINT □	o ☼ MEASURE o CH n o DATA 2.51 ↕ o ☼ MAINTENANCE o DATA c c c c o When press mode key MEAS/MAINT MODE CHANGE reciprocally. o Data 2.51 on the display to an example of O_2 concentration in the furnace.

9.2 CELL EMF (mV) Confirming Operation

(1) Verify the analyzers setting or operation FUNCTIONS. The procedure to view the setting or operation FUNCTIONS is to first enter the MAINT MODE as described in Section 9.1. This activates the FUNCTION cursor keys on the operation panel. The righthand key selects the next function (the arrow pointing up) and the lefthand key moves back to the previous function. As different functions are selected, the FUNCTION DISPLAY next to the function keys indicate which parameter is being shown in the DATA DISPLAY. For example, to display the cell output in mV (CELL EMF) put the instrument in the MAINT MODE and press the righthand function key once. The FUNCTION DISPLAY should now indicate a 0 (zero) and the DATA DISPLAY will show the CELL EMF. A table relating the function number to the actual function to be displayed is directly below the FUNCTION DISPLAY and function keys on the operation panel. For your convenience that table is duplicated below.

Function Code	Function Description
0	CELL EMF (mV)
1	CELL TEMP (degrees C)
2	CORR RATE (%)
3	CAL OPN (cal. operation)
4	FAIL CHECK
5	STD GAS CONC (%)
6	OUTPUT RANGE 1
7	OUTPUT RANGE 2
8	AVE GROUPING a
9	AVE GROUPING b
A	HIGH ALARM SET (%)
b	LOW ALARM SET (%)
c	CAL INTERVAL (days)
d	WAIT TIME (hours)
e	CAL TIME (minutes)
f	STAB TIME (minutes)

(2) CELL EMF (mV) confirming operation

Step	Name	Method and Condition	Result
1	MODE key	→ Push MODE key MODE MEAS/MAINT □	o ☼ MAINTENANCE o DATA [c c c c]
2	FUNCTION key	→ Push FUNCTION key FUNCTION □	o ☼ MAINTENANCE o [0] FUNCTION (Select) o CH [n] (Display CH No. when measuring) o DATA [n n n] (Display electromotive force of CH No. when measuring)
3	CH key	→ Push CH key CH □	o ☼ MAINTENANCE o [0] FUNCTION o CH [1] (Select: For example indicate CH No. 1) o DATA [51.8] (mV) (Display electromotive force of CH No. 1)

9.3 CELL TEMPERATURE Confirming Operation

Step	Name	Method and Condition	Result
1	MODE key	→ Push MODE key MODE MEAS/MAINT □	o ☼ MAINTENANCE o DATE c c c c
2	FUNCTION key	→ Push FUNCTION key FUNCTION □	o ☼ MAINTENANCE o 1 FUNCTION (Select) o CH n (Display CH No. when measuring) o DATA 750 (°C) (Display cell temperature of CH No. when measuring)
3	CH key	→ Push CH key CH □	o ☼ MAINTENANCE o 1 FUNCTION o CH 1 (Select: For example indicate CH No. 1) o DATE 750 (°C) (Display cell temperature of CH No. 1

9.4 CORR RATE Operation

The correction rate allows the user to determine the rate at which cell output is changing between calibration intervals. The instrument stores information about the previous calibration which can be recalled through the correction rate function. Use the procedure outlined in Section 9.2 to access the CORR RATE function. The CH (channel) key on the operation panel permits the selection of the specific channel that the DATA DISPLAY will show data on.

Correction rate is calculated for zero and span. For span, it simply stores the mV output for the last span calibration. Pressing the SPAN key on the operation panel with the CORR RATE function active will display the correction rate in mV for span.

Correction rate for zero is handled a little differently. Since the absolute value of the zero gas oxygen concentration can be selected by the user, the instrument ratios the actual mV of zero gas calibration to mV theoretical (using the Nearest equation) for that particular zero gas. This ratio is then multiplied by 100 and can be displayed by pressing the ZERO key with the CORR RATE function active.

The maximum allowable correction rate for span is +/- 10 mV. The allowable range for correction on zero is 70 to 120. When this condition is exceeded during calibration E--5 will be shown in the DATA DISPLAY indicating that the calibration value is abnormal. This probe should be recalibrated. If the display still indicates E--5 then the cell should be replaced.

The correction rate can be used to predict the life of the oxygen analyzer cell. The correction rate for zero and span can plotted versus time. After several calibration periods each curve can be extrapolated to estimate the point in time when the cell is likely to fail.

Step	Name	Method and Condition	Result
1	MODE key	→ Push MODE key MODE MEAS/MAINT □	o ☼ MAINTENANCE o DATA [c c c c]
2	FUNCTION key	→ Push FUNCTION key FUNCTION □	o ☼ MAINTENANCE o [2] FUNCTION (Select) o DATA [- - - -] o CH [n] (Indicate CH No. when MEAS)
3	SPAN key	→ Push SPAN key SPAN ☼ □	o ☼ MAINTENANCE o [2] FUNCTION o CH [1] (Select) o DATA [- 1.3] (mV) (Span point calibration coefficient for CH No. 1)
4	ZERO key	→ Push ZERO key SPAN ☼ □	o ☼ MAINTENANCE o [2] FUNCTION o CH [1] o DATA [9 8] (%) (Zero point calibration coefficient for CH No. 1)

9.5 CAL OPN How to Perform a Manual Calibration

Several steps have to be completed before a calibration can be performed. First, calibration gas must be connected to the detector to be calibrated. The detector has a check gas port which is normally stopped with a screw plug. Two calibration gases must supplied-zero and span. Zero gas must be between 0.5 and 10% O_2 concentration with the balance being nitrogen. Span gas must be between 4.0 and 21.0% O_2 concentration. In order to maintain high accuracy, the ratio of span gas concentration to zero gas concentration must be 2 or greater. Also, the rate at which calibration gas must flow to the detector should be regulated at approximately 600 ml/min (1.27 SCFH). This can be handled by a rotameter of the appropriate size.

The next that must be completed is setting the AV8G for the calibration gases to be used. Refer to Section 9.7 for details on how to enter new values for zero and span gas.

For this example assume that zero gas is 1.05% O_2 and span gas is 20.9% O_2 concentration. We will also assume that these gas values have already been entered according to the procedure outlined in Section 9.7.

Now put the instrument in the MAINT MODE and select the function 3- CAL OPN. Then use the CH key to select the probe to be calibrated. Now introduce span gas to the detector through the check gas port at a rate of 600 ml/min (1.27 SCFH). Observe the DATA DISPLAY and wait for the value to become stabilized. When the display is stable press SPAN and EXEC and the span calibration is complete. Zero calibration is very similar to span calibration. Disconnect the span gas from the check gas port of the detector and connect zero gas instead. Allow zero gas to flow into the detector at a rate of 600 ml/min and wait for the DATA DISPLAY to stabilize. When the display is stable then press ZERO and EXEC. Calibration is now completed. The AV8G has several modes of automatic calibration which are described in great detail later in this manual.

(1) CAL OPN operation
This operation is to perform zero point or span point calibration. As an example shown here the case of the zero and span gas concentration to be 1.00, 21.0 vol % O_2 respectively.

NOTE: 1. Complete all the steps to perform calibration even if E--5 occurs (the message for abnormal calibration value). If E--5 does not clear after completion of the calibration, then carefully check the calibration gas piping for leaks or blockage as well as verifying the flow rate of the calibration gas. The flowrate should be 1.27 SCFH ± 10%. Repeat the zero and span calibration again. If E--5 is still displayed it means that the zirconia cell for that detector can no longer be calibrated and it must be replaced.

Step	Name	Method and Condition	Result
1	MODE key	→ Push MODE key. MODE MEAS/MAINT	o ☼ MAINTENANCE o DATA [c c c c]
2	FUNCTION key	→ Push FUNCTION key FUNCTION	o ☼ MAINTENANCE o [3] FUNCTION (Select) o CH [n] (Display CH No. when measuring) o DATA [n n n n] (Display Oxygen concentration when measuring)
3	CH key	→ Push CH key CH	o ☼ MAINTENANCE o [3] FUNCTION o CH [1] (Select: As an example indicate CH No. 1) o DATA [3.28] (Indicate O_2 concentration of CH No. 1 inside the furnace in the stage the calibration not having been completed.)

Step	Name	Method and Condition	Result
4	Span gas	→ Introduce span gas into the detector (600 mℓ/min)	o ☼ MAINTENANCE o [3] FUNCTION o CH [1] o DATA [20.3] o Wait until the indication become stabilized.
	Span Key	→ Push SPAN Key SPAN ☼ [ ]	
5	EXEC key	→ Push EXEC key EXEC [ ]	o ☼ MAINTENANCE o [3] FUNCTION o CH [1] o DATA [21.0] O SPAN ☼ o No sooner than push the SPAN key EXEC point calibration complete.
6	Zero gas	→ Introduce zero gas into the detector. (600 mℓ/min)	o ☼ MAINTENANCE o [3] FUNCTION o CH [1] o SPAN ☼ o DATA [2.11] o Wait until the indication become stabilized.
	ZERO Key	→ Push ZERO Key ZERO ☼ [ ]	

Step	Name	Method and Condition	Result
7	EXEC Key	→ Push EXEC key EXEC □	o ☼ MAINTENANCE o [3] FUNCTION o CH [1] o DATA [1.00] o ZERO ☼ o No sooner than push EXEC key ZERO point calibration complete.
8	MODE key	→ Push MODE key MODE MEAS/MAINT □	o ☼ MEASURE o CH [1] o DATA [3.00] o Display indicates the correct O_2 concentration value in the furnace.

9.6 FAIL Check

1) If the FAIL lamp comes on, it indicates a failure of that particular channel. To identify the nature of the failure use the following procedure.

For the following example, assume the current measuring channel is No.1 and that the FAIL lamp for channel No.2 comes on.

Step	Name	Method and Condition	Result
1	MODE key	→ Push MODE key MODE MEAS/MAINT	o ☼ MAINTENANCE o DATA c c c c
2	FUNCTION key	→ Push FUNCTION key FUNCTION	o ☼ MAINTENANCE o [4] FUNCTION (Select) o CH [1] (CH No. when MEAS) o DATA □ □ □ □ (Indication of normal)
3	CH key	→ Push CH key CH	o ☼ MAINTENANCE o [4] FUNCTION o CH [2] (Select) o DATA E - - n (n is a numeral)

2) If the UNIT ALARM light, that means there exist a failure in the common parts.
Check and find out the condition of the failure by the following operation.

Step	Name	Method and Condition	Result
1	MODE key	→ Push MODE key MODE MEAS/MAINT	o ☼ MAINTENANCE o DATA [c c c c]
2	FUNCTION key	→ Push FUNCTION key FUNCTION	o ☼ MAINTENANCE o [4] FUNCTION (Select) o DATA [E - - n] Indication of abnormality (n: Numeral)

Note 1. Contents detected by FAIL CHECK operation are as follows:

[2 - - -]	(Battery replacement)	[E - - 1]	(Cell abnormal)
[E - - 4]	(Analog part abnormal)	[3 - - -]	(Waiting for recalibration)
[E - - 2]	(Temperature abnormal (Low))	[E - - 5]	(Calibration value abnormal)
[4 - - -]	(Lower alarm limit)	[E - - 3]	(Temperature abnormal (High))
[ ]	(Digital part abnormal)	[5 - - -]	(Higher alarm limit)

Note 2. When found FAIL produced in any specified CH, turn off the heater switch of the channel, then perform the check to find out whereabout the FAIL. After perform the check, if such FAIL eliminated, perform the re-start operation for the channel by the following procedures.

(1) Turn on the heater switch of the channel

(2) Press the RST switch on the CH board of the channel for 1 to 2 second by a sharp pointed head of something like a ball pen.

(3) Confirm the FAIL lamp for the channel on the front panel turns off, indication 0.00 displayed, and the ALM lamp lights.

(4) When the procedures described in above (3) cannot be achieved, perform once again the operation described in (2) so that can achieve the condition described in (3).

Note) Unable to perform the ENTRY operation during the STABILIZED TIME.

9.7 The STD GAS CONC Function

Before the initial calibration of this instrument it is necessary to purchase calibration gas for zero and span. Zero gas can have a range of 0.5% to 10.0% oxygen with the balance being nitrogen. Span gas can be in the range of 4.0 to 21.0% oxygen with the balance being nitrogen. To achieve maximum accuracy the ratio of span gas to zero gas concentration should be 2 or greater.

Once these gases are available, it is necessary to enter the concentration values of these gases using the STD GAS CONC function. To enter new value for these gases it is necessary to put the ENABLE/INHIBIT switch in the ENABLE position (located on the back of the operation panel). Put the converter in the MAINT MODE and enter the password (007). Before entering the password the DATA DISPLAY will show ---. Press the INCR key and the DATA DISPLAY will have three zeros in it. The far left zero will be flashing, index the SHIFT key until the right-hand zero is flashing. Index the INCR (increment) key until a 7 appears then press EXEC. Select function 5 STD GAS CONC. Press the ZERO key and the previous value stored in memory will be shown in the DATA DISPLAY.

Use the SHIFT key to move to the digit that requires change and index the INCR key until the value for that digit appears then use the SHIFT key to move to the next digit that requires change and repeat the procedure until all the digits in the DATA DISPLAY appear correctly then press EXEC.

The procedure to enter a new value for span gas concentration is almost identical to that of zero except that it starts with the SPAN key being pressed. All other steps are the same.

The decimal point can be shifted when setting zero and span gas concentration. Before pressing EXEC for span and zero gas index the DECIMAL POINT key until the decimal point moves to the proper position in the DATA DISPLAY then press EXEC.

(1) STD GAS CONC ENTRY operation
This operation is to input STD GAS concentration used for ZERO, SPAN point calibration. Every time STD GAS concentration change, input operation is necessary. - common to all channel -
Undermentioned is an example of input operation when ZERO, SPAN gas concentration is 1.23 vol % O_2, 21.0 vol % O_2 respectively.

Step	Name	Method and Condition	Result
1	PASS WORD operation	Refer to Section 9.14	o ☼ MAINTENANCE o DATE [c c c c]
2	FUNCTION key	→ Push FUNCTION key FUNCTION □	o ☼ MAINTENANCE o [5] FUNCTION (Select) o DATA [- - - -]
3	ZERO key	→ Push ZERO key ZERO ☼ □	o ☼ MAINTENANCE o [5] FUNCTION o DATA [0 0 0 0] o Previous input value.
4	SHIFT key	→ Push SHIFT key SHIFT □	o ☼ MAINTENACE o [5] FUNCTION o ZERO ☼ o DATA [0 0 0 0] o Left second digit lights on and off. o Light on and off, moves every time one digit to right.

Step	Name	Method and Condition	Result
5	INCR key	→ Push INCR key INCR	o ☼ MAINTENACE o [5] FUNCTION o ZERO ☼ o DATA 0 0 0
6	SHIFT key	→ Push SHIFT key SHIFT	o ☼ MAINTENANCE o [5] FUNCTION o ZERO ☼ o DATA 0 1 0 0
7	INCR key	→ Push INCR key INCR	o ☼ MAINTENANCE o [5] FUNCTION o ZERO ☼ o DATA 0 1 2 0
8	SHIFT key	→ Push SHIFT key SHIFT	o ☼ MAINTENANCE o [5] FUNCTION o ZERO ☼ o DATA 0 1 2 0
9	INCR key	→ Push INCR key INCR	o ☼ MAINTENANCE o [5] FUNCTION o ZERO ☼ o DATA 0 1 2 3

Step	Name	Method and Condition	Result
10	DECIMAL POINT key	→ Push DECIMAL POINT key DECIMAL POINT □	o ☼ MAINTENANCE o [5] FUNCTION o ZERO ☼ o DATA [0 1.2 3] o The decimal point moves from left to right.
11	EXEC key	→ Push EXEC key EXEC □	o ☼ MAINTENANCE o [5] FUNCTION o ZERO ☼ o DATA [1.2 3] Notes: [1.230] input possible, but extreme left digit should be either 0 or 1.
12	SPAN key	→ Push SPAN key SPAN ☼ □	o ☼ MAINTENANCE o [5] FUNCTION o DATA [0 0 0 0] o Previous input value
13	SHIFT key	→ Push SHIFT key SHIFT □	o ☼ MAINTENANCE o [5] FUNCTION o DATA [0 0 0 0]

Step	Name	Method and Condition	Result
14	INCR key	→ Push INCR key INCR	o ☼ MAINTENANCE o [5] FUNCTION o SPAN ☼ o DATA 0 2 0 0
15	SHIFT key	→ Push SHIFT key SHIFT	o ☼ MAINTENANCE o [5] FUNCTION o SPAN ☼ o DATA 0 2 0 0
16	INCR key	→ Push INCR key INCR	o ☼ MAINTENANCE o [5] FUNCTION o SPAN ☼ o DATA 0 2 : 0
17	DECIMAL POINT key	→ Push DECIMAL POINT key DECIMAL POINT	o ☼ MAINTENANCE o [5] FUNCTION o SPAN ☼ o DATA 0 2 . 0 o The decimanl point moves from left to right.

Step	Name	Method and Condition	Result
18	EXEC key	→ Push EXEC key EXEC □	o ☼ MAINTENANCE o [5] FUNCTION o SPAN ☼ o DATA [2 1 . 0]
19	ENABLE/INHIBIT change over switch	→ Change to INHIBIT  	o ☼ MAINTENANCE o [5] FUNCTION o SPAN ☼ o DATA [2 1 . 0]

9.8 OUTPUT RANGE [1] ENTRY Operation

This operation is to decide which range should be selected as No. 1 output range among 3 ranges, 0 to 5, 0 to 10, 0 to 25 vol % O_2, - common to all channels.

As an example of input, indicate the range of 0 to 5 vol % O_2.

Step	Name	Method and Condition	Result
1	PASS WORD operation	Refer to Section 9.14	o ☼ MAINTENANCE o DATA [c c c c]
2	FUNCTION key	→ Push FUNCTION key FUNCTION [□]	o ☼ MAINTENANCE o [6] FUNCTION (Select) o CH [1] o DATA [0 - 10] o Previous input value
3	INCR key	→ Push INCR key INCR [□]	o ☼ MAINTENANCE o [6] FUNCTION o CH [1] o DATA [0 - 10] [0 - 25] [0 - 05] (Select) o Every time push the key display change as shown above.

Step	Name	Method and Condition	Result
4	EXEC key	→ Push EXEC key EXEC	o ☼ MAINTENANCE o [6] FUNCTION o CH [1] o DATA [0 - - 5]
5	ENABLE/INHIBIT change over switch	→ Change to INHIBIT ENABLE INHIBIT DATA ENTRY	o ☼ MAINTENANCE o [6] FUNCTION o CH [1] o DATA [0 - - 5]

9.9 Setting OUTPUT RANGE 2

In addition to being able to set a scaling factor to OUTPUT RANGE 1, the AV8G can also store a second range which can be selected REMOTEly by a contact closure to the instrument. The procedure for entering the second range is identical to setting OUTPUT RANGE 1 outlined in Section 9.8 except function 7 is selected- OUTPUT RANGE 2.

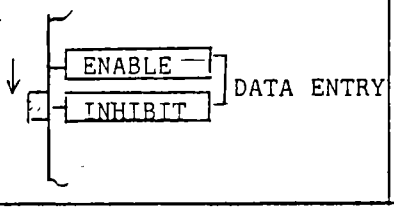
If no further changes are going to be made to the setting parameters the ENABLE/INHIBIT switch should be returned to the INHIBIT position. Either output range can be selected manually or remotely. Manual selection can be made if the REMOTE/LOCAL switch on the rear of the operation panel is in the LOCAL position by toggling the OUTPUT RANGE 1/2 switch to get the desired range.

If for example you want an external controller to determine the scaling of the output range then you could use a contact output from the controller to switch the scaling factor from OUTPUT RANGE 1 to OUTPUT RANGE 2. This external contact would be brought to terminals 16 & 17 on the I/O board. If your control scheme requires the analyzer to notify the control of what range it's in the the REMOTE RANGE ANSWER BACK contacts can be used. This is also located on the I/O board terminals 14 & 15.

If no further changes are going to be made to the setting parameters the ENABLE/INHIBIT switch should be returned to the INHIBIT position.

(1) OUTPUT RANGE [2] ENTRY operation
This operation is to decide which range should be selected as No. 2 output range among 3 ranges, 0 to 5, 0 to 10, 0 to 25 vol % O_2. It also possible to input the same range as No. 1 range. (All channel common.)
As an example of input indicate 0 t0 10 vol % O_2. -

Step	Name	Method and Condition	Result
1	PASS WORD operation	Refer to Section 9.14	o ☼ MAINTENANCE o DATA [c c c c]
2	FUNCTION key	→ Push FUNCTION key FUNCTION [ ]	o ☼ MAINTENANCE o [7] FUNCTION (Select) o CH [2] o DATA [0 - 25] o Previous input value

Step	Name	Method and Condition	Result
3	INCR key	→ Push INCR key INCR □	o ☼ MAINTENANCE o [7] FUNCTION o CH [2] o DATA [0 - 25] [0 - 05] [0 - 10] (Select) o Every time push INCR key display of range changes as shown above.
4	EXEC key	→ Push EXEC key EXEC □	o ☼ MAINTENANCE o [7] FUNCTION o CH [2] o DATA [0 - 1 0]
5	ENABLE/INHIBIT change over switch	→ Change to INHIBIT 	o ☼ MAINTENANCE o [7] FUNCTION o CH [2] o DATA [0 - 1 0]

9.10 Determining which Channels will be Included in AVE GROUP a

One of the most useful features of the AV8G is its ability to measure the output of a user defined group and calculate the average of that group. This average can be displayed or output. In addition, the AV8G can optionally calculate the average for a second group and display and output that value.

The purpose of these features is to reduce the burden on your control system for I/O and computations. This section shows how to identify which channels will be included in the average.

The first step is to determine which probes (channel numbers) are desired to be part of the average. Then the instrument should be put into the MAINT MODE with the ENABLE/INHIBIT switch in the ENABLE position. Follow the password entry procedure and then select function 8- AVE GROUP a. The CHANNEL DISPLAY will show the letter A indicating group A is being set. Now the CHANNEL STATUS INDICATOR alarm lamps will indicate the channel to be included in the average for group a. Press the CH key to add a new channel to the group. The alarm lamp for that channel will flash until the EXEC key is pressed. This procedure should repeated until all the channels that are desired are added to the group.

When channels are to be deleted from the group, the CH key must be pressed a second time before pressing EXEC. After all changes have been made examine the alarm lamps of the CHANNEL STATUS INDICATOR and make sure that the alarm lamps of the channels to be included in the group are lit.

Before returning to the MEAS MODE verify that the ENABLE/INHIBIT switch is in the INHIBIT position.

(1) AVE GROUP [a] ENTRY operation

This operation is to show how to make a combination for [a] group with whichever other channels. The maximum possible number of channels be able to combine are 8 channels. The concentration output signal indicates that value as an avarage concentration for all channels combined. But the channel under FAIL or MAINTENANCE is automatically eliminated and indicate the average output value of the channels left. As an example below is the case of as combination of channels, 1, 2, 3.

Step	Name	Method and Condition	Result
1	PASS WORD operation	Refer to Section 9.14	o ☼ MAINTENANCE o DATA [c c c c]
2	FUNCTION	→ Push FUNCTION key FUNCTION [ ]	o ☼ MAINTENANCE o DATA [- - - -] o [8] FUNCTION (Select) o CH [A] o CH No. 1 2 3 4 5 6 7 8 READY ALARM ☼ ☼ FAIL o Previous input point, CH No. 1, 3, 5 ALARM lamp light.

Step	Name	Method and Condition	Result
3	CH key	→ Push CH key Every time push CH key ALARM lamp lighting on and off moves from 1 to 8. CH □	o ☼ MAINTENANCE o DATA - - - - o [9] FUNCTION o CH [b] o CH No. 1 2 3 4 5 6 7 8 ALARM ☼ ☼ ☼ ↑ light on and off (Select)
4	EXEC key	→ Push EXEC key EXEC □	o ☼ MAINTENANCE o DATA - - - - - o [8] FUNCTION o CH [A] o CH No. 1 2 3 4 5 6 7 8 ALARM ☼ ☼ ☼ ↑ light
5	CH key	→ Push CH key CH □	o ☼ MAINTENANCE o DATA - - - - o [8] FUNCTION o CH [A] o CH No. 1 2 3 4 5 6 7 8 ALARM ☼ ☼ ☼ ☼ ↑ light on and off (Select)

Step	Name	Method and Condition	Result
6	EXEC key	⟶ Push EXEC key EXEC	∘ MAINTENANCE ∘ DATA - - - - ∘ [8] FUNCTION ∘ CH [A] ∘ CH No. 1 2 3 4 5 6 7 8 ALARM
7	CH key	⟶ Push CH key CH	∘ MAINTENACE ∘ DATA - - - - ∘ [8] FUNCTION ∘ CH [A] ∘ CH No. 1 2 3 4 5 6 7 8 ALARM light on and off (Select)
8	EXEC key	⟶ Push EXEC key EXEC	∘ MAINTENANCE ∘ DATA - - - - ∘ [8] FUNCTION ∘ CH [A] ∘ No. 1 2 3 4 5 6 7 8 ALARM
9	CH key	⟶ Push CH key CH	∘ MAINTENANCE ∘ DATA - - - - ∘ CH [A] ∘ CH No. 1 2 3 4 5 6 7 8 ALARM light on and off (Select)

Step	Name	Method and Condition	Result
10	CH key	⟶ Push CH key CH □	∘ ☼ MAINTENANCE ∘ DATA - - - - ∘ [8] FUNCTION ∘ CH [A] ∘ CH No. 1 2 3 4 5 6 7 8 ALARM ☼ ☼ ☼ ☼ ↑ light on and off (Select)
11	ENABLE/INHIBIT change over switch	⟶ Change to INHIBIT ↓ ENABLE INHIBIT DATA ENTRY	∘ NOT PRESSING EXEC KEY, BY OTHE FUNCTION OR MODE CHANGE OVER, CH NO. 5 DISAPPEAR.

9.11 Determining which Channels will be Included in AVE GROUP b

As an option the AV8G can have a second output that represents the average of a second user defined group. This system is flexible enough to allow the same channel to be in group a and group b at the same time.

Assigning channels to average group b is essentially the same as the procedure for assigning channels to average group a described in Section 9.9. The only difference is function selection, now function 9- AVE GROUP b should be selected when in the MAINT MODE.

Note: Even if the analyzer does not have the option for second averaged output, the above procedure can be used to display the average oxygen concentration of group b.

(1) AVE GROUP [b] ENTRY operation
This operation is to show how to make a combination for [b] group with whichever other channels. The maximum possible number of channels be able to combine are 8 channels. The concentration output signal indicates the value as an average concentration for all channels combined. But the channel under FAIL or MAINTENANCE is automatically eliminated and indicate the average output value of the channels left. Also can entry overlapping with Grouping [a].

Step	Name	Method and Condition	Result
1	PASS WORD operation	Refer to Section 9.14	o ☼ MAINTENANCE o DATA [c c c c]
2	FUNCTION	→ Push FUNCTION key FUNCTION [ ]	o ☼ MAINTENANCE o DATA [- - - -] o [9] FUNCTION (Select) o CH [b] o CH No. 1 2 3 4 5 6 7 8 READY ALARM ☼ ☼ FAIL o Previous input point, CH No. 1, 3, 5 ALARM lamp light.

Step	Name	Method and Condition	Result
3	CH key	→ Push CH key Every time push CH key ALARM lamp lighting on and off moves from 1 to 8. CH □	o ☼ MAINTENANCE o DATA - - - - o [9] FUNCTION o CH [h] o CH No. 1 2 3 4 5 6 7 8 ALARM ☼ ☼ ☼ ↑ light on and off (Select)
4	EXEC key	→ Push EXEC key EXEC □	o ☼ MAINTENANCE o DATA - - - - o [9] FUNCTION o CH [A] o CH No. 1 2 3 4 5 6 7 8 ALARM ☼ ☼ ☼ ↑ light

Following Procedures are same as AVE GROUPING [a] (Refer 9-10).

9.12 Setting HIGH ALARM SET Function

A high oxygen concentration alarm set point can be entered into the AV8G. This high setpoint is common to all the channels. Each individual probe (channel) has an alarm contact output on terminals 9 & 10 of each MX/CH board. This relay will energize when the oxygen concentration for that channel exceeds the high alarm setpoint. There is also a common alarm relay (called the STATUS OUTPUT HIGH ALARM) which is located on terminals 5 & 6 of the I/O board. This relay energizes when any channel is in high alarm.

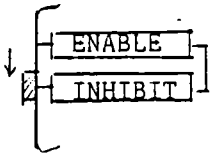
The procedure for entering high alarm set points is very simple. First, the instrument must be put into the MAINT MODE and the password must be entered. Then function A must be selected to perform HIGH ALARM SET. The DATA DISPLAY will show the last high alarm set point or the default value (25%). To change the current set point use the SHIFT key to select the digit to be changed and index the INCR key until the desired value appears for that digit. Repeat this procedure until all digits requiring change show the proper value in the DATA DISPLAY, then press the EXEC key.

Remember to put the ENABLE/INHIBIT switch back into the INHIBIT position.

(1) HIGH ALARM SET ENTRY operation
This operation is to set the highest limit of the ALARM for the concentration value, - common to all channels.

As an example, indicate 3.50 vol % O_2.

Step	Name	Method and Condition	Result
1	PASS WORD operation	Refer to Section 9.14	o ☼ MAINTENANCE o DATA [c c c c]
2	FUNCTION	→ Push FUNCTION key FUNCTION [□]	o ☼ MAINTENANCE o [A] FUNCTION (Select) o CH [H] o DATA [0 4.0 0] o Previous input value
3	SHIFT key	→ Push SHIFT key SHIFT [□]	o ☼ MAINTENANCE o [A] FUNCTION o CH [H] o DATA [0 4. 0 0]
4	INCR key	→ Push INCR key INCR [□]	o ☼ MAINTENANCE o [A] FUNCTION o CH [H] o DATA [0 3 0 0]

Step	Name	Method and Condition	Result
5	SHIFT key	→ Push SHIFT key FUNCTION □	o ☼ MAINTENANCE o [A] FUNCTION o CH [H] o DATA 0 3 0 0
6	INCR key	→ Push INCR key SHIFT □	o ☼ MAINTENANCE o [A] FUNCTION o CH [H] o DATA 0 3 5 0
7	DECIMAL POINT key	→ Push DECIMAL POINT key Every time push the key the decimal point moves one digit from left to right. DECIMAL POINT □	o ☼ MAINTENANCE o [A] FUNCTION o CH [H] o DATA 0 3.5 0 ↑ (Select) (IN THE EXAMPLE NO NEED TO TRANSFER)
8	EXEC key	→ Push EXEC key EXEC □	o ☼ MAINTENANCE o [A] FUNCTION o CH [H] o DATA 3.5 0
9	ENABLE/INHIBIT chanve over switch	→ Change to INHIBIT 	o ☼ MAINTENANCE o [A] FUNCTION o CH [H] o DATA 3.5 0

9.13 Setting LOW ALARM SET Function

The AV8G also has a low alarm set point available. As with the high alarm, this setpoint is common to all channels. Each MX/CH board uses the same contact output on terminals 9 & 10 as the high alarm for the low alarm contact output. This does not represent a conflict since it is impossible for a channel to be in high and low alarm at the same time.

The low alarm is identified by a unique STATUS OUTPUT LOW ALARM contact output on terminals 7 & 8 on the I/O board. This relay is energized when a low alarm occurs on any channel.

The procedure for entering the new low alarm set point is the same as for entering a new high alarm set point except that function B- LOW ALARM SET is selected when the MAINT MODE is entered. Then using the SHIFT, INCR, and EXEC keys the new set point may be entered.

Be sure to put the ENABLE/INHIBIT switch back into the INHIBIT position before returning to the MEAS MODE.

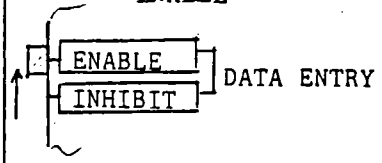
(1) LOW ALARM SET ENTRY operation
This operation is to set the lowest limit of the alarm of the O_2 concentration value, - common to all channels.

As an example of the input, indicate 1.00 vol. % O_2.

Step	Name	Method and Condition	Result
1	PASS WORD operation	Refer to Section 9.14	o ☼ MAINTENANCE o DATA [c c c c]
2	FUNCTION	→ Push FUNCTION key FUNCTION [ ]	o ☼ MAINTENANCE o [b] FUNCTION (Select) o CH [L] o DATA [2.5 0] o Previous input value
3	The input procedure of the set value is equivalent to 3 ~ 7 of the HIGH ALARM SET.		
4	EXEC key	→ Push EXEC key EXEC [ ]	o ☼ MAINTENANCE o [b] FUNCTION o CH [L] o DATA [1.0 0]
5	ENABLE/INHIBIT change over switch	→ Change to INHIBIT ENABLE / INHIBIT DATA ENTRY	o ☼ MAINTENANCE o [b] FUNCTION o CH [L] o DATA [1.0 0]

9.14 PASS WORD Operation

This unlock method is used for various DATA ENTRY. If not make the figure equal to that already stored by this operation, the ENTRY operation thereafter become difficult.

Step	Name	Method and Condition	Result
1	ENABLE/INHIBIT change over switch	→ Change to ENABLE 	o MEASURE o CH [n] o DATA [n n n n] Measuring condition
2	MODE key	→ Push MODE key MODE MEAS/MAINT	o MAINTENANCE o CH [P] o DATA [- - -]
3	INCR key	→ Push INCR key INCR	o MAINTENANCE o CH [P] o DATA [0 0 0]
4	SHIFT key	→ Push SHIFT key 2 times SHIFT	o MAINTENANCE o CH [P] o DATA [0 0 0]
5	INCR key	→ Push INCR key INCR	o MAINTENANCE o CH [P] o DATA [0 0 7] o 007 is input as PASS WORD
6	EXEC key	→ Push EXEC key EXEC	o MAINTENANCE o DATA [c c c c]

9.15 Operation for the Changeover

Operation for the changeover switch following are the list of conditions changed by the changeover switch locating at the bottom of the panel of the converter.

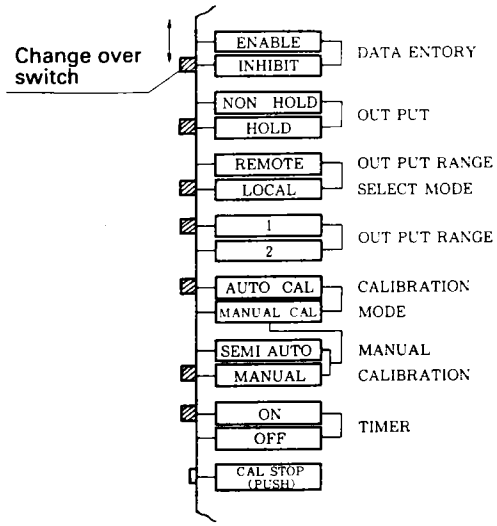


Figure 9.15 Changeover Switch

<table>
<tr><th></th><th>Name</th><th>Switch position</th><th>Condition</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">DATA ENTRY</td><td>ENABLE</td><td>Use only for input of FUNCTION DATA</td></tr>
<tr><td>INHIBIT</td><td>Disable the input function of DATA but all call functions work.</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">OUTPUT</td><td>NON HOLD</td><td>In MAINTENANCE MODE, produce output for measured value at every moment per each channel.</td></tr>
<tr><td>HOLD</td><td>In MAINTENANCE MODE, hold the channel only under calibration, but averaging output is all ways NON-HOLD.</td></tr>
<tr><td rowspan="4">3</td><td rowspan="4">OUTPUT RANGE SELECT MODE</td><td rowspan="3">REMOTE</td><td>Changeover output range possible by the remote contact point signal.
<table><tr><th>REMOTE SWITCH (STATUS)</th><th>OUTPUT RANGE</th><th>CONTACT POINT for ANSWER BACK (STATUS)</th></tr><tr><td>CLOSE</td><td>1</td><td>ON</td></tr><tr><td>OPEN</td><td>2</td><td>OFF</td></tr></table></td></tr>
<tr><td>LOCAL</td><td>By using the changeover switch in the converter, switchover to OUTPUT RANGE [1] or [2] become possible, butremote changeover is impossible.</td></tr>
</table>

	Name	Switch position	Conditiion
4	OUTPUT RANGE	1	Produce output the range having been made input in item 6(8). All channels become same range.
		2	Produce output the range having been made input item 6(9). All channels become same range.
5	CALIBRATION MODE (Refer to Note 1)	AUTO CAL	Perform zero span point calibration automatically per each set calibration cycle.
		MANUAL CAL	For the operation MANUAL CALIBRATION described in next item 6.
6	MANUAL CALIB-CALIBRATION (Refer to Note 1.)	SEMI AUTO	Perform only once manually zero, span point calibration.
		MANUAL	Perform manually, zero or span gas flow, or calibration.
7	TIMER (Refer to Note 1.)	ON	AUTO CAL MODE OPERATION START
		OFF	Clear the counter, return to the first position when the operation for AUTO CAL MODE started. (WAIT TIME ZERO) By this operation all ENTRY values for AUTO CAL mode are not cleared.
8	CAL STOP (PUSH)	PUSH SWITCH (MOMENTARY)	By pushing this switch, stop the calibrating operation half way. Operation in the MODE either AUTO or MANUAL IS POSSIBLE. The stabilized time starts from when switch ON.

Note 1 Perform the function when provided the automatic calibrating function.

9.16 Setting the Calibration Parameters CAL INTERVAL, WAIT TIME, CAL TIME, & STAB TIME

The calibration parameters CAL INTERVAL, WAIT TIME, and CAL TIME were designed to be used with the flow control unit for automatic calibration. In this mode the AV8G can control the flow of zero and span gas to the detectors via an external flow control unit. This set-up permits either fully automatic, semi-automatic, or a manual calibration by the converter. For complete details of the system refer to Section of this manual.

The STAB TIME (stabilization time) function can be used with or without the flow control unit. When calibration gas is sent to the probe through the check gas port while the analyzer is installed, it takes some time before stack gases purge the cell of the calibration gas. The output of the analyzer will not be very useful until it represents only stack gas oxygen concentration. Therefore the AV8G allows the user to enter a STABilization TIME in minutes to delay that channel from being included in the averaged output until the stabilization time has passed. This will prevent a "bump" in the output of the analyzer which could give problems to the control system.

The procedure for entering the STAB TIME involves entering the MAINT MODE and entering the password. Then function F- STAB TIME must be selected. The legal range for stabilization is 0 to 32 minutes. Use the SHIFT key to get the digit in the DATA DISPLAY to be changed and index the INCR key until the proper value for that digit appears. Repeat this procedure until all the digits in the DATA DISPLAY read correctly. Now press EXEC to enter this new value into memory. Return to the MEAS MODE and put the ENABLE/INHIBIT switch back into the INHIBIT position.

(1) Stabilized time
Stabilized time is the time spent from when the supply of the calibration gas suspended until when the calibration gas in the cell replaced with the measured gas, which can be set optionally in the range of 0 to 32 min. Can operate in the case of both standard and automatic calibrating function providing. The stabilized time starts after finish zero span calibration, also even when only supplying zero or span gas, from right after suspending the supply. Until the stabilized time finish, the channel is separated from the averaging group. Also in the case when the automatic calibrating function is provided cannot flow the calibration gas of other channels. During the stabilized time the lamp of FUNCTION LED [3] lights on and off. Followings show make ENTRY in the stabilized time from 0 min to 2 min.

Step	Name	Method and condition	Result
1	Pass word operation	**Refer to Section 9.14**	☼ MAINTENANCE DATA c c c c
2	FUNCTION key	→ Push FUNCTION □	☼ MAINTENANCE F FUNCTION DATA 0 0 0
3	SHIFT key	→ Push SHIFT □	☼ MAINTENANCE F FUNCTION DATA 0 0 0
4	INCR key	→ Push INCR □	☼ MAINTENANCE F FUNCTION DATA 0 0 0
5	EXEC key	→ Push EXEC □	☼ MAINTENANCE F FUNCTION DATA 2
6	ENABLE/INHIBIT Changeover switch	→ Changeover to INHIBIT ↓ ENABLE / INHIBIT DATA ENTRY	☼ MAINTENANCE F FUNCTION DATA 2

10. MAINTENANCE

To maintain the O_2 analyzer in good operating condition, it is necessary to perform daily maintenance and checks. The maintenance interval may vary depending on the installation site conditions. However, maintenance checks are required at least once a month or once a year.

10.1 The Contents of Maintenance Checks

(1) Display calibration
Perform this calibration in accordance with the ZERO calibration procedure in 6.3.

(2) Check and cleaning of the detector probe tip.
If dust accumulates on the filter, remove it using a brush. For the probe with adaptor, clean inside the probe adaptor.

(3) Calibration gas
Confirm from time to time the calibration gas is surely being supplied.
In the case when automatic calibrating function is provided, when the calibration gas is not being supplied the function becomes abnormal, so pay a special attention for the supply of the gas specially to the point of the remained gas in the cylinder, also the normal range of supply pressure 0.2 to 0.5 kg/cm^2.

10.2 Cleaning the Calibration Gas Pipe

Clean the calibration gas pipe observing the following procedures.

Apply pneumatic instrument air at approx. 1.4 kg/cm2 (19.9 pci) into the calibration pipe as shown in Figure 10.1. If the calibration pipe is clogged, insert a steel wire in the pipe to remove the obstruction.

If the entrance of the calibration gas pipe is clogged, use air or steel wire to remove the obstruction in the same manner as the pipe cleaning procedure.

If the sensor assembly is rinsed in water, dry the assembly before remounting it.

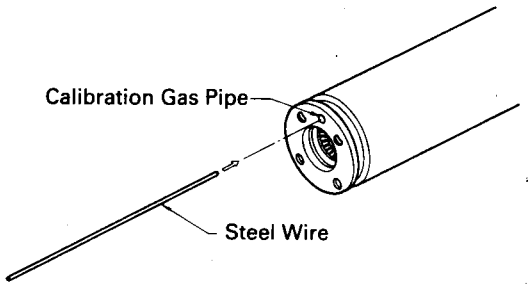


Figure 10.1 Cleaning the Calibration Gas Pipe

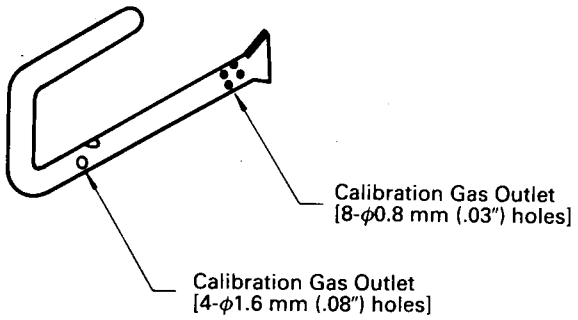


Figure 10.2 Cleaning the U-Pipe

Notes:

1. For disassembly and reassembly of the cell, refer to 9.3.
2. The calibration pipe inner diameter is 3 mm (0.12 in.). Do not insert a steel wire longer than 400 mm (15.75 in.) in the calibration pipe.
3. If the calibration pipe cannot be cleaned, contact your nearest YOKOGAWA service center/sales agent.

10.3 Cell Replacement

Pass the span gas at a rated volume and turn the converter power OFF. Remove the detector from the stack. Replace the detector in the following procedure when the cell temperature is sufficiently low.

(1) Removing the detector

a. Remove four bolts ① from the cell assembly.

b. Remove U-pipe ③ together with plate ④ from the cell assembly.

c. While rotating cell assembly ⑥ clockwise, remove it from contact ⑧. O-ring ⑦ is inserted between the cell assembly and the probe. Do not loose it when disassembling the cell assembly and use care so as not to scratch the surface of the O-ring.

(2) Mounting method

a. Check that spiral type contact ⑧ is not missing.

b. Install metal O-ring ⑦ in the groove on cell assembly ⑥. While rotating cell assembly ⑥ clockwise, insert it in the probe. Match all holes with mating ones.

c. Insert U-pipe ③ in filter assembly ⑤ and install it with plate ④. Orient the finer filter mesh toward cell assembly ⑥.

d. Insert bolt ① in washer ② and secure filter assembly ⑤ and cell assembly ⑥. Match the center of the filter and cell assembly. Tighten all bolts uniformly.

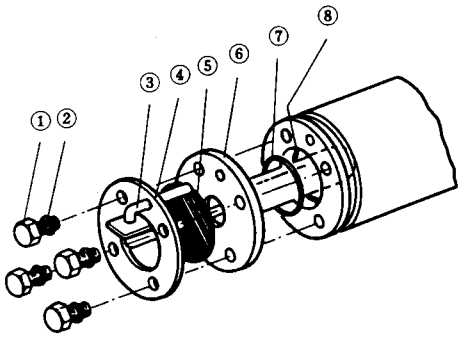


Figure 10.3 Cell Assembly Replacement

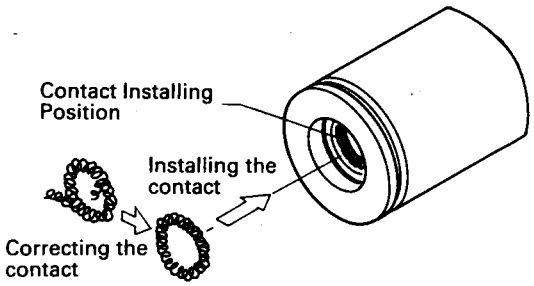


Figure 10.4 Contact Replacement

Note: When reinstalling the cell assembly ⑥, use new O-ring ⑦, contact ⑧ and filter assembly ⑥.
Before installing the contact ⑧, check that it has a perfect ring shape.
If end of the contact is protected from the ring, correct it. Next, install the contact to the place shown in Figure 10.4.
Confirm that the contact is perfectly installed in the groove.

10.4 Fuse Replacement

As preventive maintenance, replace the fuse every two years.

(1) Open the operation panel of the converter, turn all switches at the power supply board off.

(2) Pull out the power supply board, turn the cap of the fuse holder anticlockwise (To the arrow direction), then the cap can be removed together with the fuse.

(3) Confirm that the new fuse rating is the same as the old one. If so, insert the new fuse in the fuseholder and secure the fuseholder cap.

Notes:

1. CH fuse rating: 250V 2A (P/N MF51 NR)
   Amplifier fuse rating: 250V 1A (P/N MF51 NR)
   Tubular type fuse with 5.2 mm (0.20 in.) dia. and 20 mm (0.79 in.) long.
   JIS C6575 fuse or equivalent is recommended.
2. Check that the fuseholder interior is clean. If it is dirty, clean it.
   The dirty fuseholder interior can cause poor contact.

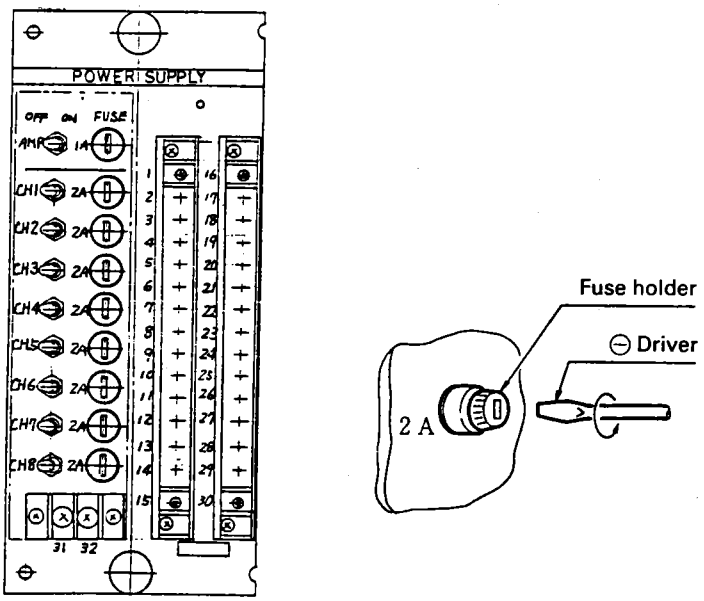


Figure 10.5 Fuse Replacement

10.5 Battery Replacement

(1) The battery holder is attached on the upside front of the CPU board printed board. (Refer Figure 10.6.)
(2) Wipe the new battery with a dry cloth and install it to the polarity is correct.
Plus is outside, pay attention when perform taking out or insert the battery not to break the battery clamp.

Notes:
1. Battery specifications.
Type: Lithium battery.
Model: CR2430 Sanyo Electric or equivalent.
Nominal voltage: 3V
2. Cautions
Do not solder any leadwire to the battery directly.
Do not charge the batter.
Do not bent or put into a fire.
Do not apply shock, do not attempt to disassemble.

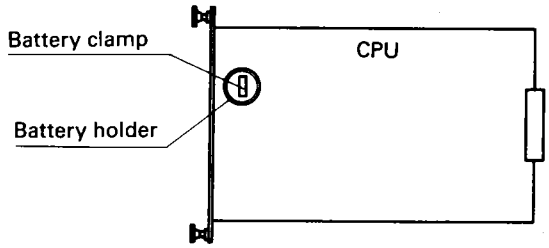
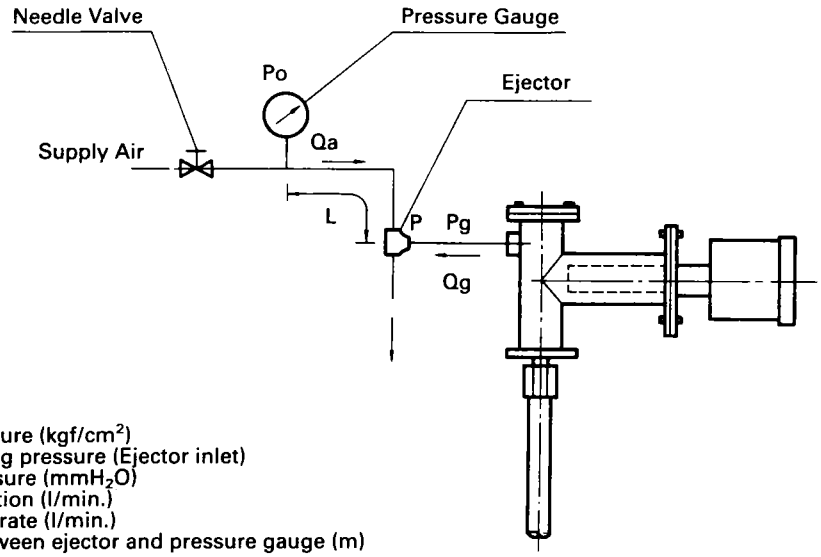


Figure 10.6 Battery Replacement

10.6 Maintenance and Checks of High Temperature Detector

The maintenance and checks for the high temperature type detectors are described below.

a. Cleaning the internal probe.
Remove the detector top cover and clean the probe interior using a suitable tool.
b. Cleaning the auxiliary ejector or sample gas control needle valve.
Clean the auxiliary ejector outlet nozzle or sample gas control needle valve as necessary.
c. Checking the auxiliary ejector pressure.
Check that the auxiliary ejector supply pressure meets the specified pressure.



Po: Setting pressure (kgf/cm²)
P: Ejector driving pressure (Ejector inlet)
Pg: Suction pressure (mmH₂O)
Qa: Air consumption (l/min.)
Qg: Suction flow rate (l/min.)
L: Distance between ejector and pressure gauge (m)

Figure 10.7

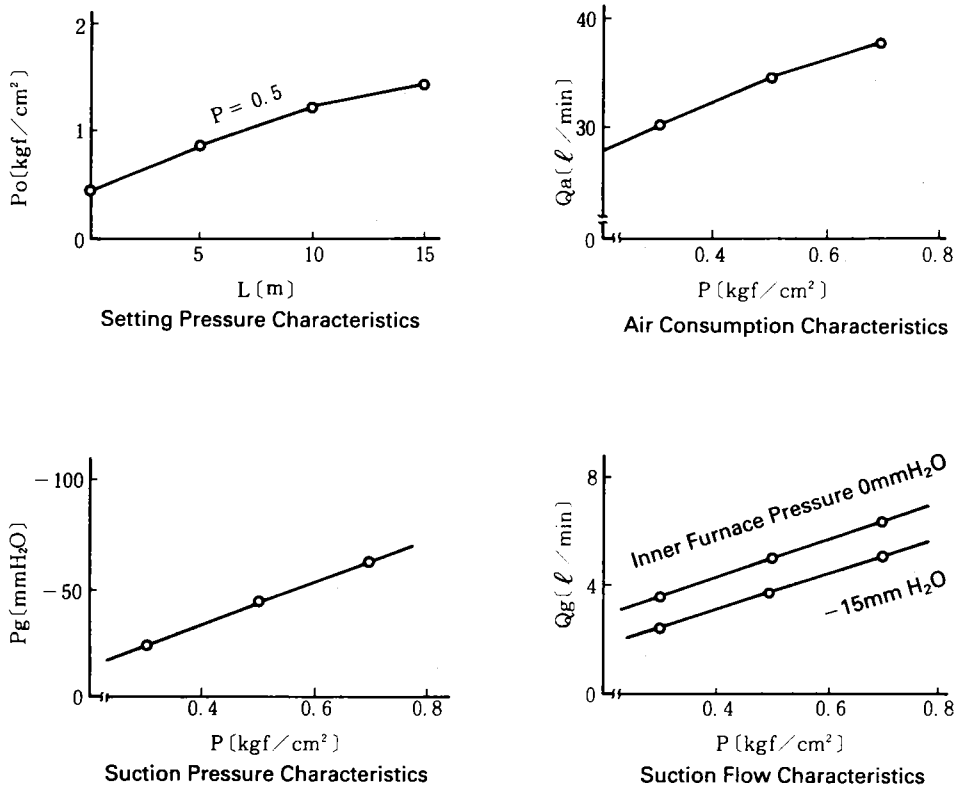


Figure 10.8

All above data are based on the standard auxiliary ejector (AX460).

11. PRINCIPLE OF OPERATION

The solid electrolyte (zirconia porcelain) exhibits conductivity to oxygen ions at high temperatures. Accordingly, if a zirconia element with platinum electrodes on the internal and external surfaces is heated and gases with different oxygen partial pressures are allowed to contact the surfaces, the zirconia element will exhibit the properties of an oxygen concentration cell.

More specifically, oxygen molecules turn into oxygen ions with the addition of electrons at the electrode (cathode) with a higher oxygen partial pressure. The oxygen ions then move through the solid electrolyte to the anode where they release electrons and thus turn back into oxygen molecules.

Cathode: $O_2 + 4e \rightarrow 2O^{2-}$

Anode: $2O^{2-} \rightarrow O_2 + 4$

Electromotive force E (emf) mV developed accross the two electrodes through this reaction is obtained by Nernst's formula as follows:

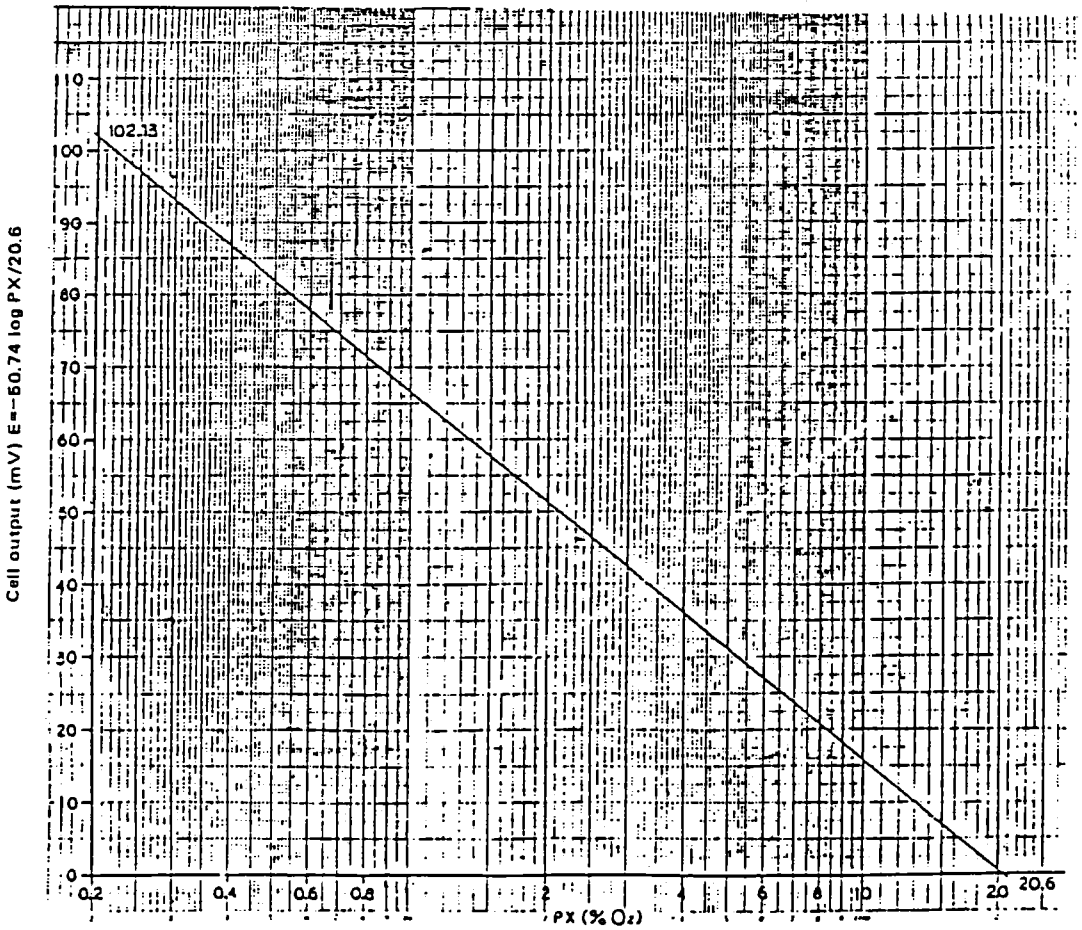
$$E = -\frac{RT}{nF} \ln \frac{PX}{PA} \quad \cdots\cdots (1)$$

Where,
R: Gas constant.
T: Absolute temperature.
n: 4
F: Farady constant.
PX: Oxygen concentration (%) on measurement gas for zirconia element.
PA: Oxygen concentration (%) on comparison air for zirconia element - normally 20.95% O_2.

If the cell set temperature is 750°C, the above formula is transformed as follows:

$$E = -50.74 \log \frac{PX}{PA} \quad \cdots\cdots (2)$$

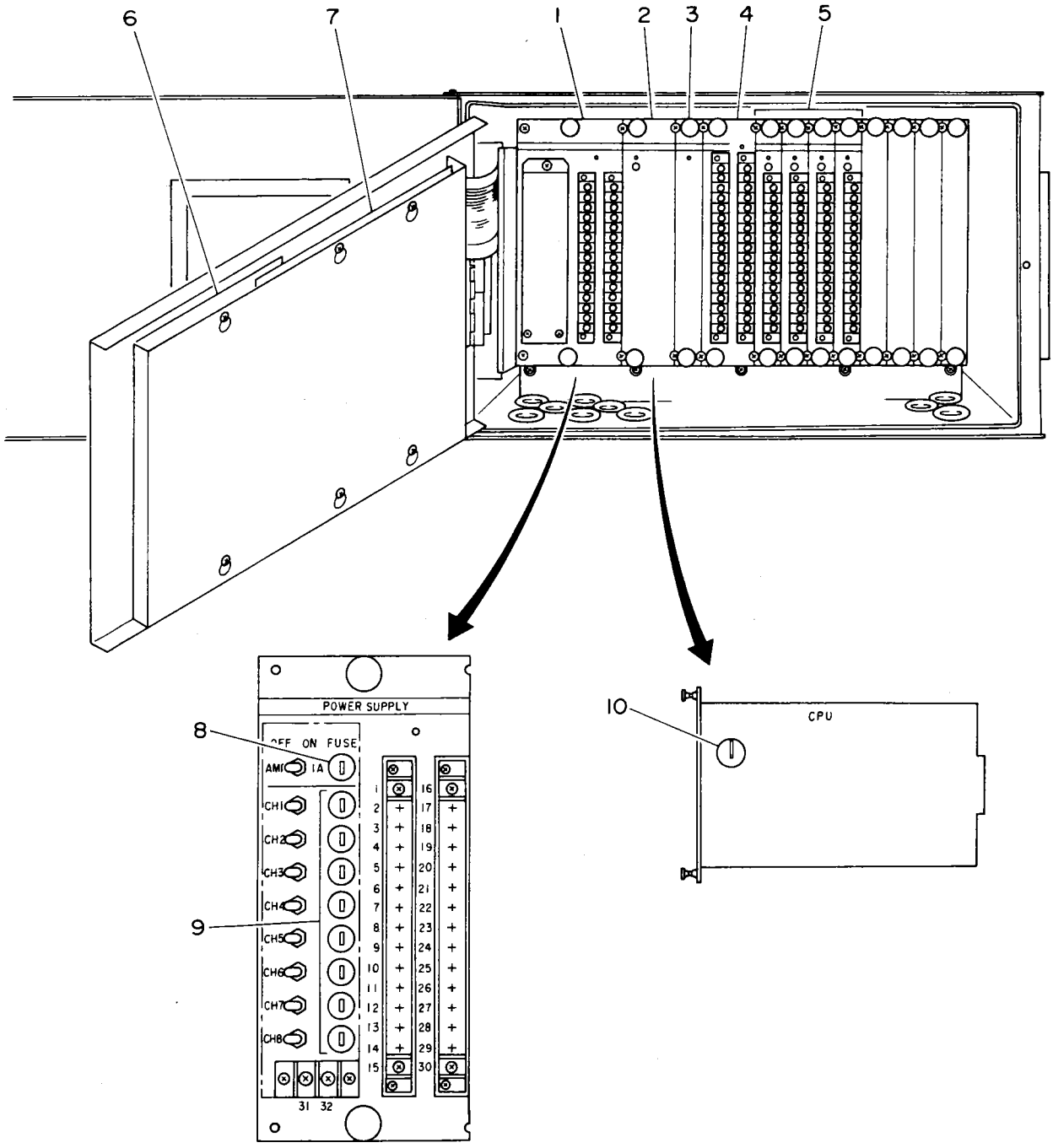
This analyzer heats the zirconia element to a specified temperature. The measurement gas then flows on one side of the element and the reference air flows on the opposite side. Consequently, an emf proportionally to the ratio of the oxygen concentration in the measurement gas to the oxygen concentration in the reference air is developed, which enables the oxygen concentration in the reference measurement gas to be measured.



Oxygen Concentration and Cell emf.

Customer Maintenance Parts List

Model AV8G
AVERAGING CONVERTER



YOKOGAWA
Yokogawa Electric Corporation

 1st Edition : Dec. 1987 (YK) CMPL 11M3D1-01E

Item	Part No.	Qty	Description
1	E7000DA	1	Power Supply Board Assembly 4 CH
	E7000DB	1	Power Supply Board Assembly 8 CH
2	E7000FA	1	CPU Board Assembly
	E7000FN	1	CPU Board Assembly with Auto Calibration
3	E7000GA	1	A/D Board Assembly
4	E7000HR	1	I/O Board Assembly with Averaging b
	E7000HT	1	I/O Board Assembly with Averaging and Auto Calibration
5	E7000JA	2 to 8	Mx/CH Board
6	E7000CK	1	Key Card
7	E7000CT	1	Display Card
8	G9012ZF	1	Fuse, 1A
9	G9016ZF	2 to 8	Fuse, 2A
10	K9119UA	1	Battery