



**Instructions manual**

**IN SITU OXYGEN  
ANALYZER  
For high temperature**

**TYPE: ZFKH zirconia analyser**



## PREFACE

This document is the general user guide for Fuji Electric oxygen analyzer probe ZFKH. It provides all instructions on how the product should be installed, operated and maintained. It also proposes suggestions to optimize the analyzers performance and lifetime. The ZFKH probe is to be linked to one of the Fuji Electric oxygen analyser controllers ZKMA or ZKMB. See relevant user manuals.

This manual is intended for technically qualified personnel who are appropriately trained and who possess the relevant knowledge in the area of measurement and control technology.

First read this instruction manual carefully until an adequate understanding is acquired, and then proceed to installation, operation and maintenance of the analyzer.

Particular attention must be paid to **information, warning texts, and instructions for equipment**. These are indicated by respective pictograms. They serve to safeguard the safety of operators and facilities and help you to avoid operating errors which can cause major injuries and damages.

This manual is an inherent part of the delivery. For reasons of clarity, it is not possible to cover all possible designs of the described system. Please contact us if you wish to set up, operate or maintain the device differently to the instructions given here.



- Read this **instruction manual** and the **technical documentation delivered with your equipment** carefully to get a thorough understanding of how this zirconia oxygen analyzer works prior to installing, operating and maintaining the zirconia oxygen analyzer.
- The specification of this zirconia oxygen analyzer may be subject to change without previous notice for improvements of the product.
- Under no circumstances should this zirconia oxygen analyzer be modified without permission.
- If any trouble should occur because of having been modified without permission, we won't be responsible for it anyway.
- This instruction manual should be kept in custody by a person who *actually* operates the zirconia oxygen analyzer.
- After reading this manual, it should always be kept in a place which allows the person who operates it to refer to any time as required.
- A due consideration should be given so that this instruction manual is delivered to a final user certainly.

Manufacturer : RB-Technologies S.A.R.L on behalf of Fuji Electric France S.A.S.  
Type : Described in the nameplate put on the main body  
Date of manufacturing : Described in the nameplate put on the main body  
Product nationality : FRANCE

## **SAFETY ADVICE**

These operating instructions use the following symbols as important security device for the user. They are always located within the chapter at points where the information is required. The security advice must be observed and followed at all times.

Those safety precautions are ranked in 2 levels, "CAUTION" and "PROHIBITION".

 <b>CAUTION</b>	If handled wrongly, a dangerous situation may occur, and medium trouble or slight injury may be caused.
 <b>PROHIBITION</b>	Items which must not be done are noted.

In this endeavor, the operator is requested to observe the legal accident prevention regulations for all work at all times, and, according to the given circumstances, do everything to prevent damage to persons and assets.

## **OPERATION**

The Oxygen analyzer is composed of the controller (ZKMA or ZKMB), an electronic data interpreting device which is used in conjunction with the ZFKH probe for the continuous measurement of the O<sub>2</sub> concentration in combustion flue gases in the superstoichiometric area.

It is assumed that plant planning, mounting, installation, commissioning, maintenance and service work will be carried out by sufficiently trained personnel and that this work will be checked by responsible skilled personnel. If needed, Fuji Electric can be sought to provide training on the analyzers.

It must be particularly noted that :

- the operation complies with the technical data and specifications regarding permissible use, mounting, connection, environment and operating conditions (refer to the contract documents, the device user information, rating plates etc.) as well as the provided documentation.
- work will be carried out in accordance with the local, plant-specific circumstances and with regard to the operational risks and directives.
- all the measures required to reliable and safe operation, e.g. for transportation and storage as well as maintenance and service, are maintained.

## **INTENDED USE**

The product described here has left the factory in a flawless, safe and checked condition and it must be maintained exclusively in the manner that is described by the manufacturer. Equally, the proper transportation, professional storage and setup as well as the careful operation and maintenance, are critical for the reliable and safe operation of the device.

Authorized qualified personnel must be used to install and operate this product. They must be familiar with the security advice and warnings specified here and ensure they can be implemented flawlessly. Unqualified persons working on the device or the warning information provided on the device not being observed could result in serious personal injury and / or damage to property.

The device is being used as intended if the device is being used solely for the application specified in the technical description. Auxiliary devices or those from other manufacturers must be recommended or authorized by Fuji Electric.

Provided the safety information and operating directives specified in this manual are observed, this device should not present any risks in terms of damage to property or the health of personnel.

## **HAZARDS FROM ELECTRICAL EQUIPMENT**

The equipment can be used in industrial electrical power installations. Always switch off the power when working on mains connections or mains voltage. Reattach any removed protection and protection against accidental contact before connecting the supply voltage.

Damage to health or equipment may result from improper use or improper handling. Therefore, to avoid damage, always observe the respective security advice.

## **PREVENTING MEASURES**

If the oxygen analyzer is used in conjunction with control and steering technology, the operator must ensure that any breakdown or failure of the analyzer device does not cause inadmissible damage or dangerous operating states.

To avoid faults which could cause direct or indirect personal or material damage, the operator must ensure that:

- the responsible maintenance personnel can be reached at any time and as quickly as possible
- the maintenance personnel are trained to correctly respond to faults with the equipment and the associated malfunctions
- in the case of doubt, the faulty equipment can be switched off immediately
- a switch-off does not lead to direct disorders

## **AVOIDING CONSEQUENTIAL DAMAGES**

To avoid consequential damages in the event of failure, which could cause direct or indirect personal or material damage, ensure that qualified personnel can assess the faults and initiate appropriate measures to tackle them.

## **ENVIRONMENTALLY CORRECT BEHAVIOUR**

The Fuji Electric oxygen analyzers are designed and constructed in accordance with ecological aspects. The structural components can be separated easily from each other, sorted accordingly and then recycled.

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The specifications of the analyzers will be changed without prior notice for further product improvement. Modification of the analyzer is strictly prohibited unless a written approval is obtained from the manufacturer. Fuji Electric will not bear any responsibility for a trouble caused by such a modification.

This instruction manual shall be stored by the person who actually uses the converter. After reading through the manual, be sure to keep it near at hand for future reference. This instruction manual should be delivered to the end user without fail.

## CAUTION ON SAFETY

**Prior to operating this analyzer, read this “Caution on safety” carefully.**

In the precautions shown here, important contents on safety are included. So, be sure to observe them. The safety precautions have been ranked into “CAUTION” and “PROHIBITION”.



- Install this product in a place or room compatible with the conditions set forth in “instruction manual”. The use at a place not conforming to the installation conditions may result in an electric shock, a fire and incorrect operation.
- When this product is mounted on a furnace which is under operation, take utmost care with blow-out from the furnace. It might get a burn and/or toxic gas fumes.
- In the case of the wiring work, be careful not to drop foreign matters including wire chips into the junction box. Otherwise, a fire, failure or malfunction may result.
- Connect a power source compatible with the specified rating. Connection of power source different from the rating might cause a fire.
- Before doing the wiring work, be sure to turn off the main power. Otherwise, it may result in getting electric shock.
- Use proper wiring materials according to the rating of apparatus. If a wiring material which is not bearable to the rating is employed, it might cause a fire.
- Never do the work at a place where rain water splashes the product directly.
- A failure to observe this instruction may result in getting an electric shock or failure.



- In case where combustible gas is contained in the measured gas, check the gas composition and specifications carefully before using. Otherwise, the original performance is not displayed, and there is a danger of explosion.
- Do the work in a condition where the main power has been turned off. If the work is done power on, there is a fear of getting electric shock.
- Never touch the detector by bare hand. Indeed, there is a fear of getting burned. Because the operating temperature of the detector (tip of ceramic heater) is about 800 °C probe surface temperature is also high.
- Before cleaning the flow guide tube, turn off the main power and cool the tube down fully. There is a fear of getting a burn.
- Don't use any other renewal part than those designated by the maker. Otherwise, the original performance is not fully displayed and a trouble or failure may result.
- Never do the work at a place where rain water splashes the product directly.
- A failure to observe this instruction may result in getting an electric shock or failure.



- For a failure which cannot be judged even if referring to the instruction manual, be sure to ask the nearest dealer or Fuji Electric adjustment serviceman for repair. If disassembled without a thought for the outcome, an accident or injury could result.

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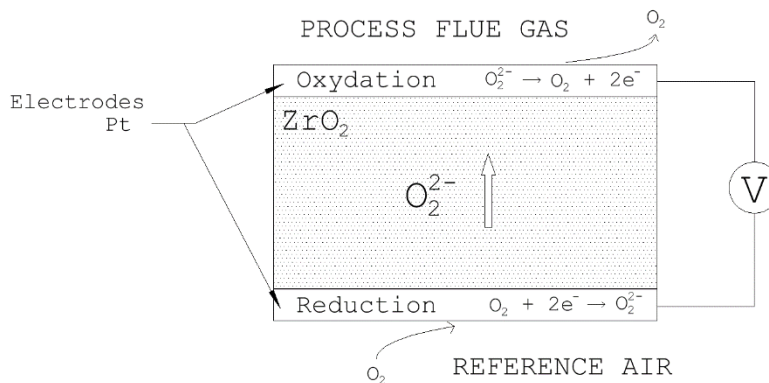
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## 1. INTRODUCTION

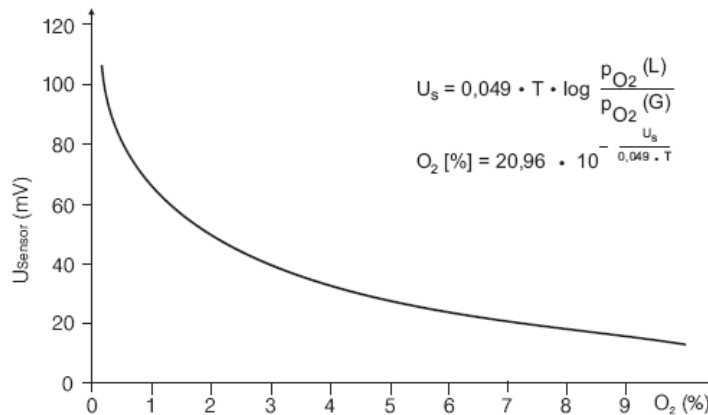
### 1.1 GENERAL DESCRIPTION OF OXYGEN ZIRCONIA SENSOR

This zirconia oxygen analyzer makes use of conductivity that a solid electrolyte composed mainly of zirconia ( $ZrO_2$ ) allows only oxygen ion to pass through at high temperature. This is an oxygen sensor which measures an electromotive force produced by difference in oxygen concentration between gas to be measured and reference air based on the principle of oxygen concentration cell.

The  $O_2$  measuring cell functions as an electrochemical concentration cell and generates a direct voltage, which depends upon the absolute temperature  $T$  and the logarithm of the  $O_2$  concentration ratio or  $O_2$  partial pressure ratio on the reference electrode and  $O_2$  outer electrode.



If specimen gas is fed to the outer electrode and a reference gas with a known  $O_2$  concentration, such as air (20.96 %), to the inner electrode, at a constant temperature the logarithmic relationship illustrated below occurs between the probe voltage  $U$  and the oxygen concentration of the specimen gas.



Sensor characteristic  $U = f(O_2)$

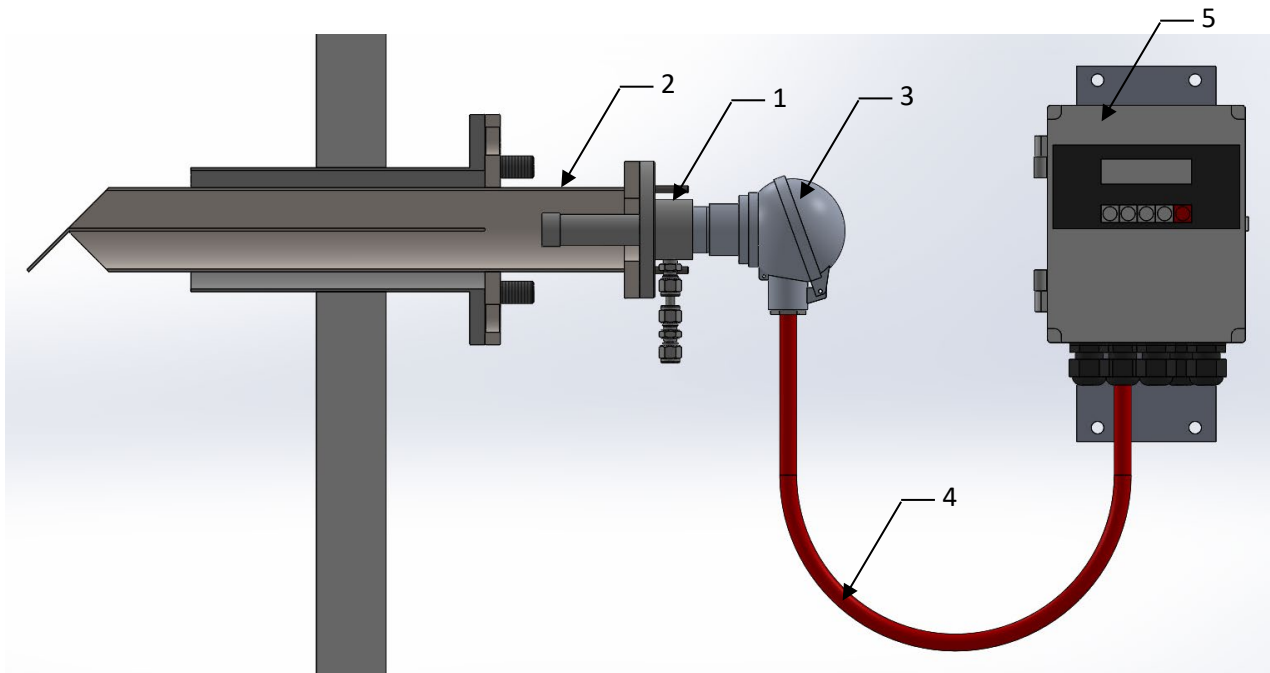
The conversion of the sensor voltage into oxygen concentration is performed by a electronic converter also called "controller".



## 2 ANALYZER DESCRIPTION

### 2.1 ANALYZER CONFIGURATION & WORKING PRINCIPLE

The general configuration of the analyzer is shown on the below sketch :

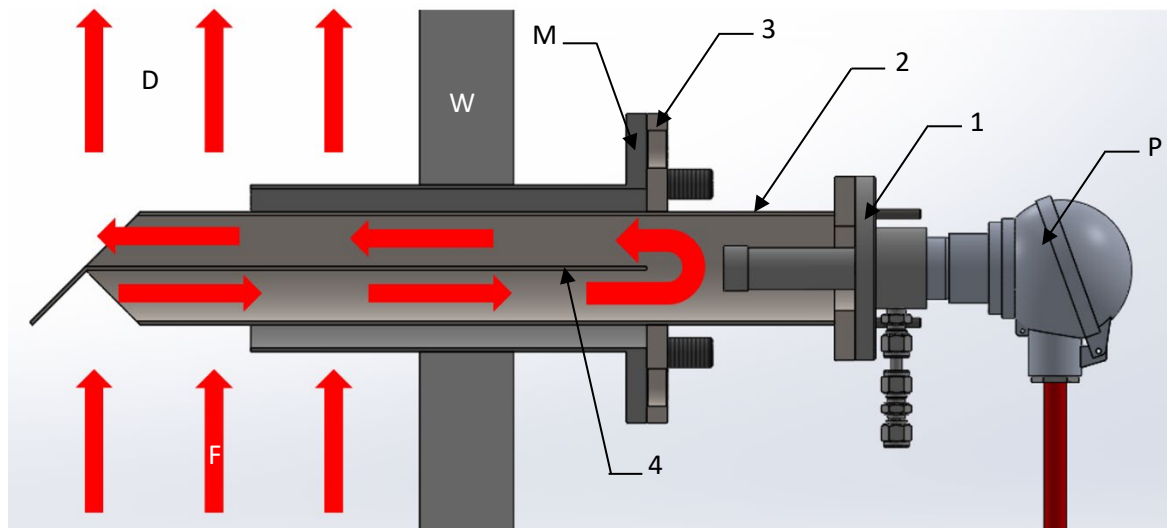


NBR	DESIGNATION
1	ZFKH PROBE – Mounted on the Guide Tube, in contact with process exhaust gas
2	GUIDE TUBE – Mounted on the furnace mating flange
3	PROBE JUNCTION BOX – Integrated to the ZFKH PROBE
4	O2 SYSTEM SPECIAL HIGH TEMPERATURE CABLE
5	CONTROLLER – At remote place with electrical connection to probe
-	OPTION - CUSTOM ASSEMBLY & LABELING
-	OPTION - CALIBRATION SET: Necessary pressure reducer, flowmeter, valves and tubing to perform calibration
-	CALIBRATION LINE & CALIBRATION GAS CYLINDERS

#### 2.1.A ZFKH PROBE

Fuji Electric O<sub>2</sub> analyzers are in-situ, which means that they are in direct contact with the flue gas to be analyzed. Instead of putting the probe in the core of the furnace, Fuji Electric judge more convenient to lead the flue gas from the core of the furnace to the probe thanks to a system called “By-Pass Tube” or “Guide Tube” on which the probe itself is mounted.

Therefore, the combustion gas flows in the furnace duct and comes towards the end of the deflecting tube. Thanks to a pressure difference phenomenon, the combustion flue gas stream is led inside the tube and flows to the sensor, turns back in the tube and is then rejected to the furnace duct.



1	Probe Mounting Flange	4	Deflecting Plate	F	Flue Gas Flow
2	By-Pass Tube	P	ZFKH probe	D	Flue Gas Duct
3	By-Pass Tube Mounting Flange	M	Mating Flange	W	Furnace Wall

#### Features:

1. Analyzed gas temperature <math><600^{\circ}\text{C}</math> whatever the temperature of flue gas is.
2. The condensates and solid or liquid unburnt compounds are trapped before reaching the probe. This prevents Zirconia Oxide damage and lengthens the probe lifetime.
3. Response time is optimized due to the flow speed.
4. The probe is mounted outside the furnace. This enables easy maintenance and replacement.

The tube design can be customized to fit the combustion unit at best (Flange, material, insertion length, insulation depending on tube size and flue gas T).

### 2.1.B CONTROLLER ASSEMBLY

2 control devices are needed to operate the analyzer:

1. the controller from which the probe is heated, regulated and operated
2. the calibration system which intends to send reference gas to the probe for calibration and maintenance purposes.

Controller and calibration system can be installed in a remote location from the probe.

1. Probe and controller can be installed at a distance up to 100m. This provides high flexibility for transmitter location.
2. Oxygen values are displayed at ground level on site.
3. Control devices can be installed in an appropriate place regarding the industrial environment.
4. All controller functions (calibration, automatic calibration, blow-down) must be operated from the same place.

Fuji Electric controller and calibration panel shall be either wall mounted or installed on site on self-standing racks.

## 2.2 DESCRIPTION OF ANALYZER PROBE

The probe is the sensitive device of the system. It is an assembly of a zirconia sensor and metallic enclosure.

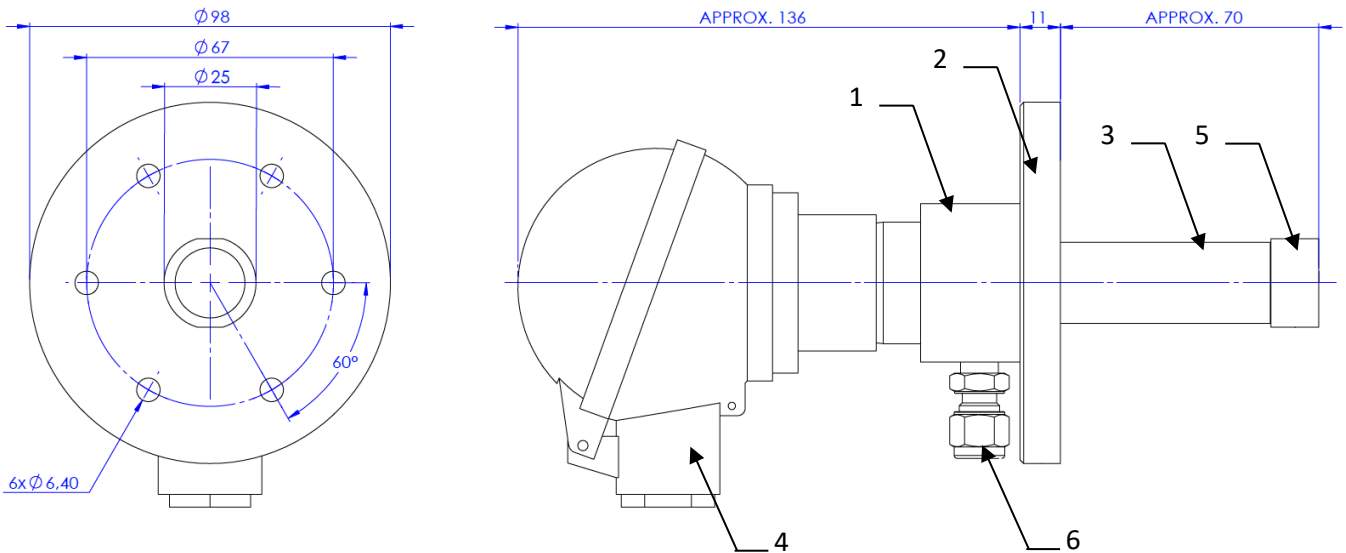
The probe features a full metallic body. The oxygen sensor is fixed into the probe body so that the sensitive part is located into the probe nose.

In order to prevent the clogging of the probe nose and to protect the sensor, an Inconel mesh filter is fitted at the extremity of the nose. This filter is not a flame-arrestor and can be replaced on site while the probe is energized.

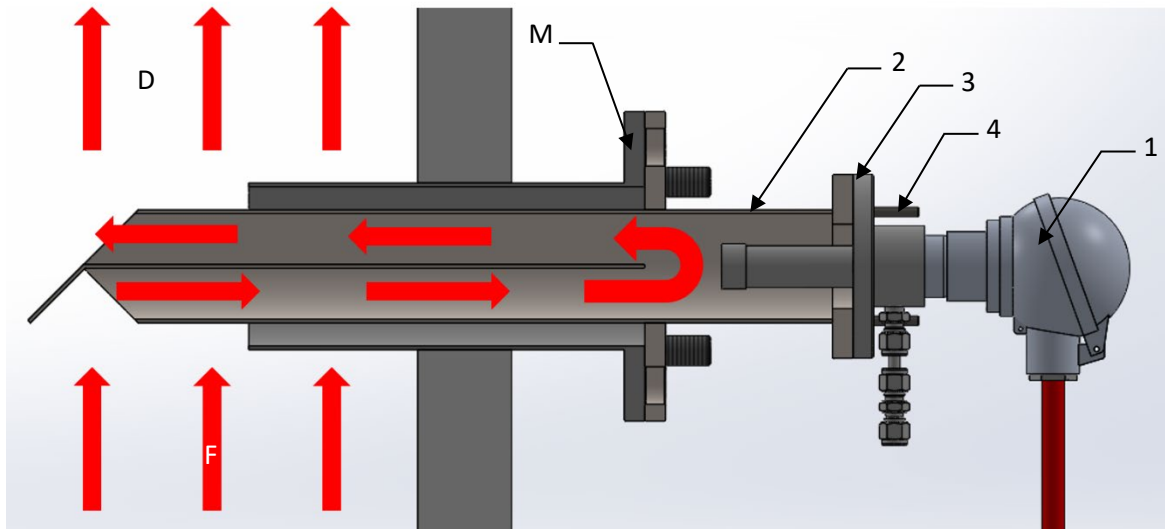
The probe is mounted on the deflecting tube with M5 nuts on a  $\varnothing 98\text{mm}$  counter flange (3).

The calibration gas inlet (6) is placed on the mounting flange. This connection for 4/6mm Stainless steel tubing aims at sending calibration gas samples for the calibration system to the sensor enclosed in the probe.

The probe is assembled with a high temperature junction-box to connect the cable and ensure probe electrical connection to remote converter.



1	Probe Body	5	Probe Inconel Filter*
2	Probe Mounting Flange	6	Calibration Gas Inlet
3	Probe Nose*		
4	Junction Box for electrical connection to converter		



1	ZFKH Probe	3	Probe Gasket
2	Guide Tube	4	6 Mounting M5 Nuts&Bolts
M	Mating Flange	D	Furnace Duct

## PROBE SPECIFICATIONS

<b>MEASUREMENT PRINCIPLE</b>	Zirconia Oxide Probe	<b>APPLICATION</b>	In situ O <sub>2</sub> % measurement in Combustion Flue Gas for process control
<b>IN SITU SAMPLING SYSTEM</b>	Made to order Flow Guide Tube (“By-Pass Tube”) inserted into the flue gas duct. See relevant data sheet	<b>PROBE FILTERS</b>	Alumina (50µm) and quartz paper Inconel mesh protective filter
<b>MEASURED GAS T°</b>	120 to +1500°C depending on deflecting tube material and shape	<b>MEASURED GAS PRESSURE</b>	-3 to +3kPa (-306 to +306mmH <sub>2</sub> O)
<b>RESPONSE TIME</b>	<7s for 90% of final value (from calibration gas inlet)	<b>DETECTOR MOUNTING</b>	Horizontal plane up to to +90° (nose down)
<b>HAZARDOUS AREA CERTIFICATION</b>	N/A	<b>PROBE ENCLOSURE</b>	Dust/rain-proof structure IP65
<b>HEATER POWER SUPPLY</b>	Provided by the converter Rated voltage: 115 or 230V AC Rated frequency; 50/60Hz	<b>THERMOCOUPLE</b>	Type R or K
<b>CALIBRATION GAS</b>	20,9%vol.O <sub>2</sub> in N <sub>2</sub> balance (Instr. Air) 1%vol. O <sub>2</sub> in N <sub>2</sub> balance recommended flowrate : 15-30NL/h	<b>CALIBRATION GAS INLET</b>	Ø6mm or Ø1/4” double ferrule connector (as specified at order)
<b>REFERENCE AIR INLET</b>	Spontaneous by a sintered metal drain	<b>COMPATIBLE CONTROLLER</b>	REMOTE CONVERTER TYPE ZKM CONTROLLER see relevant manual
<b>OUTER DIMENSIONS (L × max. dia.)</b>	218mm × 100mm	<b>WEIGHT</b>	Probe : approx. 2kg Flow Guide tube : approx. 10kg (depends on tube length and flange size)
<b>STORAGE CONDITIONS</b>	Sensing element: -20 to +70°C Flow Guide Tube: -10 to +100°C	<b>FINISH</b>	Raw metal and epoxy painted junction box

### 3. INSTALLATION

#### 3.1. INSTALLATION OF PROBE SIDE

##### 3.1.1. LOCATION

#### CAUTION

Install this product at a place compatible with the following conditions. The use of it at a place not conforming the installation conditions specified in this manual could cause an electric shock, a fire or incorrect operation.

It is recommended to mount the detector by selecting the places shown below:

- Place where there is a space which allows doing daily check and wiring work
- Place where there is little vibration, dust and humidity
- Place where peripheral air environment is non-corrosive.
- Place where there are no electric appliances producing noise trouble (e.g., motor, transformer and appliances bringing about electromagnetic induction trouble and electrostatic induction trouble) nearby the detector
- Place where ambient temperature and humidity are -20 to +60°C and less than 95%RH.

**Make sure the classification of the mounting area is compliant to this certification.**

##### 3.1.2. INSTALLATION PROCEDURE

The probe and deflecting tube are delivered separately. Any leakage in the mounted assembly would potentially lead to a mistaking measurement by injecting parasite ambient air into the probe environment. To ensure an appropriate sealing, all the necessary gaskets for tube and probe mounting are furnished with the material.

**Particular care must be taken to ensure the perfect sealing of the assembly and the correct orientation of the bypass flowguide tube.**

To install Fuji Electric Analyzer on your furnace duct, proceed to the following operations :

1. Mount the Deflecting tube on the mating flange. Sealing must be ensured with provided mating flange gasket
2. Mount the probe on the deflecting tube. Sealing must be ensured with provided detector gasket.  
WARNING: If the plant is running, the probe must be heated up before being mounted on deflecting tube.
3. Connect the probe calibration gas connection to calibration panel
4. Wire the probe to the transmitter

## **MOUNTING OF THE PROBE**

### **CAUTION**

When mounting the detector on a furnace which is under operation, take utmost care about the blowout from the furnace; otherwise, there is a fear of getting a burn.

Since the detector is made of porcelain of zirconia, there is a case where it breaks due to drop or impact. So, be sufficiently careful.

Use a plain washer for the mounting screw and mount on the flange of flow guide tube at 6 locations. Do not forget the gasket between probe and flow guide tube to ensure the sealing.

## 3.2. INSTALLATION OF CONTROLLER AND CALIBRATION KIT

### 3.2.1. LOCATION

Analyzers transmitter and calibration systems are designed to be installed remotely from the probe. End-users can thus choose a location which provides good accessibility and protection.

It is recommended to mount the detector by selecting the places shown below:

- Place where space is available for periodic inspection and wiring work
- A place not subjected to radiated heat from a heating furnace, etc.
- Place where the flue gas flow is significant  $>0.5\text{m}\cdot\text{s}^{-1}$
- Place where there is a space which allows doing daily check and wiring work
- Place where vibration, dust and humidity are minimized
- Place where peripheral air environment-corrosiveness is minimized.
- Place where ambient temperature and humidity are  $-20$  to  $+50^{\circ}\text{C}$  and less than 95%RH.
- Place where the material marking corresponds to the area classification
- Away from electrical devices that may cause noise trouble (such as motor and transformer), and equipment that may cause electromagnetic or electrostatic induction trouble.

To ease the wiring and maintenance operations, secure at least 100 mm of space between the converter and nearby wall. Also secure a space of opening the front cover for wiring work and maintenance.

Secure a cable wiring space under the case.

Above all, end-user must ensure that the installation area classification complies with the device markings in terms of ambient temperature and gas classification.

### 3.2.2. PROCEDURE

Transmitters and calibration systems shall be installed **wall-mounted** or **self-standing** depending on space availability on-site.

If a specific panel is provided on site transmitters and calibration systems can be delivered separately. Customer will then have to mount the devices on the panel and make all wiring and piping work.

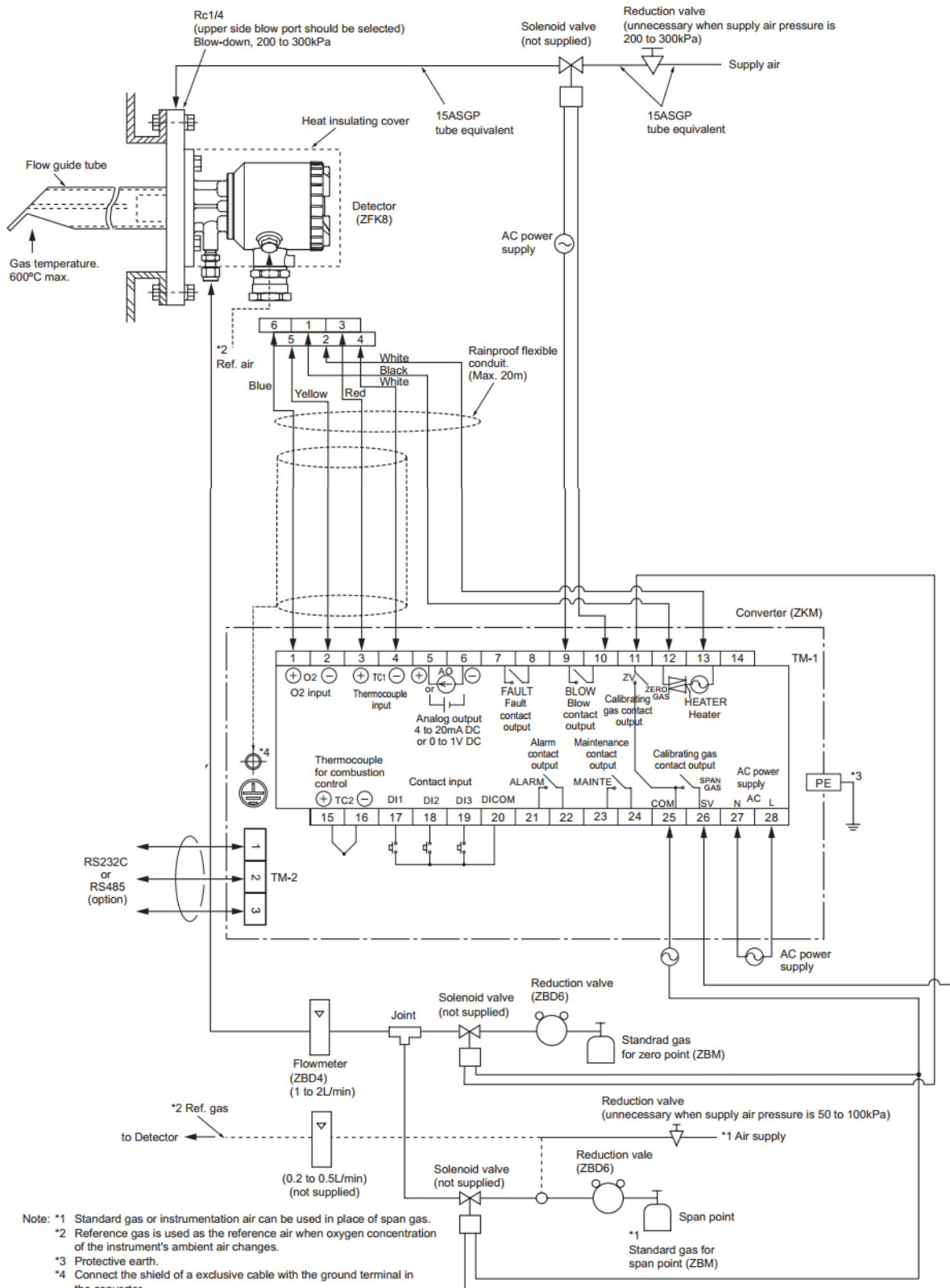
If a panel is required, transmitters and calibration panel are delivered together, assembled and eventually wired on the panel. Customer just has to make the last wiring work to make the analyzer ready to use.

If there are no available space for wall-mounting the analyzers, transmitter and calibration systems can be delivered on self-standing racks. Devices are completely assembled and tested. Customer will have to make final piping and wiring job to make the analyzer ready to use.

**4. CONNECTION BETWEEN PROBE SIDE & TRANSMITTER SIDE**

**4.1. GENERAL CONNECTION DIAGRAM**

Probe, Converter and calibration system must be connected according to the wiring diagram. Specific Wiring Diagrams are delivered with the material, please refer to these wiring diagrams.





## 4.2. WIRING



### CAUTION



: Wiring work must be carried out with all power supplies turned off. Otherwise, electric shock may result.



: Be sure to ground Probe and Converter. (Class D grounding)

BEFORE WIRING, power voltage for the converter must conform to that for the detector to be connected

The wiring must be done POWER OFF after transmitter mounting on a proper structure (ex : shelter, skid )

Refer to the Wiring diagram to ensure a proper wiring.

To ensure a perfect sealing, tighten cable glands with the appropriate tool.

Ensure that the probe is correctly connected to the ground by the specific screw.

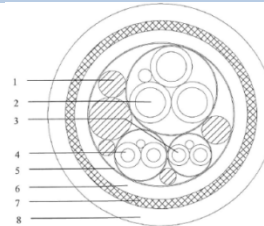
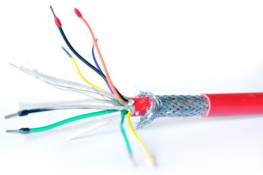
For the probe, ensure that the aluminum junction box is properly closed.

For the transmitter, ensure that the front panel is properly closed and screwed back.

Use Fuji Electric cable to connect the oxygen transmitter to the junction box.  
This cable is designed for Fuji Electric analyzers:

Picture of bare cable

Sketch



**1 Filling Stems**

**3 conducting cables 2.5mm<sup>2</sup>:**

**-Green : Ground connection**

**-Black & White : Probe heater power supply**

*Soft copper core ; Polyester isolation*

*Assembled under aluminium/polyester tape with a continuity cable*

**2**

**2 conducting cables 0.5mm<sup>2</sup> - Yellow & Green : Thermocouple R**

*Soft Cu/Ni core ; P.V.C isolation*

*Assembled under aluminium/polyester tape with a continuity cable*

**3**

**2 conducting cables 0.5mm<sup>2</sup> - Orange & Black : Probe signal**

*Soft tinned Cu core ; P.V.C isolation*

*Assembled under aluminium/polyester tape with a continuity cable*

**4**

**5 Protective Tape**

**6 P.V.C intermediate sheath**

**7 Armoured protection : galvanized-steel plait**

**8 External P.V.C sheath**

**CAUTION:**

In the case of the wiring work, be careful not to drop foreign matters including wire chips inside the junction box. Otherwise, this might cause a fire, failure or incorrect operation.

Connect a power source compatible with the rating. Connection of a power source not conforming to the rating may cause a fire.

Before proceeding with the wiring work, be sure to turn off the main power supply.

Under no circumstances the work must be done at a place where water splashes the product directly.

The wiring work in ex-proof classified area must be performed by qualified persons only.

Any damage or break of the cable would consequently distort the thermocouple and damage the sensor

#### **4.2.1. CONTROLLER SIDE WIRING**

On controller side, power supply wiring and special cable wiring must be performed.

Cables must be fixed to the installation in order to prevent any mechanical damage or excessive draw that could damage the probe cable gland.

It is necessary to provide adequate protection of the exclusive cable, which connects the detector to converter, using wire protection tube, etc. Separate these cables from the power cable (noise prevention).

It is recommended to keep the wire for output signals as far as possible (more than 30cm) from the power line and heavy current lines to prevent induced noise. Also, wherever possible use a shielded cable and earth one point of the shield.

#### **4.2.2. PROBE WIRING**

Please refer to corresponding wiring diagram to wire the probe to the intermediary junction box and converter

### **4.3. PIPING**

#### **CAUTION:**

Any leak in gas connections may cause measurement faults and inefficient calibration procedures.

Piping refers to the connection between the gas distribution system (transmitter side) to the probe and deflecting tube accessories (probe side).

It is recommended to use  $\varnothing 4\text{-}\varnothing 6\text{mm}$  316L stainless steel tubing.

The length is determined regarding the distance between probe and transmitter and the way the tube will reach the probe.

The installation and connection of the pipe is performed by end-user.

Any leak in gas connections may cause measurement faults and inefficient calibration procedures.

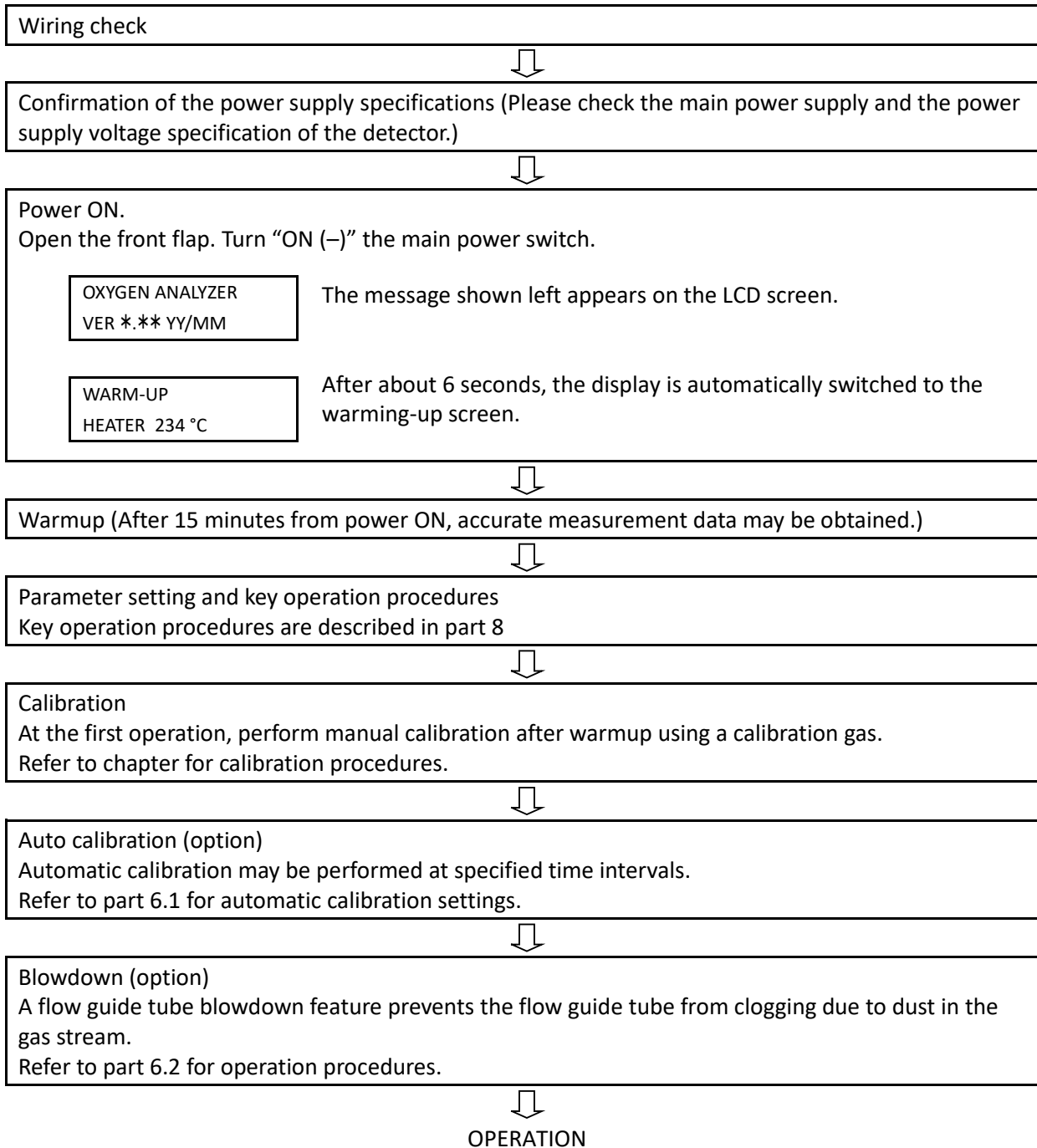
Refer to the general connection diagram to pipe the system properly.

Use  $\varnothing 4\text{-}\varnothing 6\text{mm}$  stainless steel tubing and refer to below diagram for proper pneumatic connection of analyzer system.

## 5. COMMISSIONING & SHUTDOWN

### 5.1. COMISSIONING

Preparation can be performed after installation or on the bench. The commissioning steps are shown below:



By turning the power on after completed piping and wiring, the transmitter turns on and the probe warm-up starts. The sensor usually takes approximately 30 minutes to reach the operation temperature which is 800°C for O<sub>2</sub> probes.

These high temperatures allow the oxygen transfer through the zirconia bridge but also protect the probe by accelerating the oxidation of chemicals around the ceramic surface. In other words, organic compounds are burnt by the high temperature before reaching the zirconia surface. At low temperature, these organic chemicals get absorbed in the microscopic pores of the zirconia ceramic, which damages the sensor almost irreversibly. Moisture is accelerating this phenomenon below the dew point.

As a consequence, it is important to make sure that zirconia sensors are not exposed to organic components when they are cold or warming-up. They can then be mounted in two ways: either they are wired and heated up before being mounted on the deflecting tube while the combustion process is operating, or they can be installed and warmed up before the process start-up.

Once the analyzers are installed and heated up, a calibration shall be performed to make the analyzer give an accurate measured value.

## **5.2. SHUTDOWN**

By turning the analyzer power off, the transmitter shuts and the probe progressively cools down.

As explained in the previous paragraphs, the analyzer shall not be shut off while exposed to flue gas samples or dewed conditions.

In case of short-term shutdown (about 1 week) of furnace, it is recommended to keep the power supply of the detector (converter) turned "ON" to prevent the probe pollution by residual organic components coming from the inside of the furnace. If the probes are cooled down, possible deterioration of platinum electrodes in the detector and destruction of the wet sensor element (depending on the condition in furnace and/or ambient conditions) due to power ON-OFF.

In case of the detector with an ejector (option), shutdown the air source.

In case of long-term shutdown of furnace, turn off the power of the detector (converter) after the peripheral air of the detector inside the furnace (especially, temperature and humidity) has become an air environment. Or, turn off the power after taking the detector out of the furnace and leaving it as is 15 minutes or more.

When flow booster or blow off system is in use, stop the air supply.

Repeated start-ups and shutdowns of the combustion unit may expose the sensors to unusual amounts of unburnt compounds. In this case it is recommended to clean the sensors by injecting ambient air on the sensor at low flow rate for a couple of minutes. The filter will have to be changed more frequently.

If the power is turned on in a dewed condition, it leads to the failure of detector. Stop the operation following the procedures described below.

In case of short-term shutdown (about 1 week) of furnace

- Keep the power supply of the detector (converter) turned "ON". This can prevent the detector from getting dewed.

Also, note that if "ON-OFF" is repeated in a condition where the detector has dewed (according to the furnace and ambient conditions), the detector might fail.

- When flow booster or blow off system is in use, stop the air supply to the ejector.

In case of long-term shutdown of furnace

- Turn off the power of the detector (converter) after the peripheral air of the detector inside the furnace (especially, temperature and humidity) has become an air environment. Or, turn off the power after taking the detector out of the furnace and leaving it as is 15 minutes or more.
- When flow booster or blow off system is in use, stop the air supply.

## 6. CALIBRATION & BLOWDOWN

### 6.1. CALIBRATION

In order to maintain good accuracy, proper calibration using calibration gas is necessary. The following 4 methods of calibration are possible. The converter language

Manual calibration: calibration fully manual.

Auto calibration: calibration operated by solenoid valves at defined frequency

Remote calibration: to operate a calibration from control desk.

All calibration: calibration operated by solenoid valves but launched by the operator.

#### 6.1.1. PREPARATION

1. Perform wiring and piping correctly referring to Item **4.3**. At this time, the main plug of standard gas should be left open. Since high pressure is present at piping connections, use blind-nut type joints and take special care with regard to air-tightness. Calibration gas flow should be 30NL/h.
2. Set the oxygen concentration in standard gas cylinder to be used.
3. Set the range for calibration

### **6.1.2. CALIBRATION**

Description

- Span/zero is calibrated once by key operation.
- Calibration must be made in the order of span then zero.
- Perform calibration after a calibration gas is supplied to the detector and the output signal of the detector becomes stable.
- If your calibration system is not automatic, the operator shall perform open and close operations, or adjust the flow rate of calibration gas.
- During calibration, if the analog output hold function (maintenance hold) is enabled, the analog output signal is held at the set value. Even after the calibration, the hold is maintained during the set time as a measurement recovery time.

See ZKM controller user manual for a detailed description of the calibration menus.



## 7. ANALYZERS CHECKS, MAINTENANCE & AFTER SALES SERVICE

### CAUTION:

- Carefully read the Technical Instruction delivered by Fuji Electric before performing any manipulation of Fuji Electric products.
- Fuji Electric is not responsible for damages created by the application of maintenance procedures outside of Fuji Electric workshop.
- The handling of Fuji Electric equipment must be performed in compliance to Fuji Electric procedure by qualified operators.
- All operation and step of this procedure must be performed power-off and in safe area. If the work is done while current is flowing, there is a risk of getting an electric shock.
- All handling must be performed in a clean and adapted room.
- The probe shall be held by the aluminum head with a protected vice. Take care that the aluminum head is not damaged nor distorted.
- The operation temperature of the detector (tip of the ceramic heater) is about 800°C and the surface temperature is also very high. So, never touch it by bare hand. Otherwise, there is a fear of getting a burn.
- Before proceeding with the cleaning of the flow guide tube, turn off the main power and cool the tube down fully and then, do the work. Otherwise, there is a fear of getting a burn.
- Don't use other renewal parts than those designated by the maker. Otherwise, the original performance is not displayed fully and an accident or failure could come about.
- Dispose of the renewal parts including the maintenance parts as an incombustible article.

*Fuji Electric can supervise some maintenance operation on your demand.*

### 7.1. CHECKS

Analyzers required periodical checks and maintenance, to ensure the accuracy of the measurement and the perfect safety of the installation.

Basic checks are listed below:

#### **Mechanical Checks**

For safety reasons, it is important to check that the ex-proof structure of the probe is correctly maintained over time.

Check that probe cable gland remains tightened. It is possible to retighten the cable gland directly. However, if you have any doubt or if you notice any deterioration, it must be replaced.

Over time, the gaskets between mounting flange can be deteriorated and leaks may appear on the installation. If you have any doubt or if you notice any deterioration, it must be replaced.

Calibration gas cylinders get empty over time. It is recommended to check that calibration gas is still available when calibrating the probe.

Check that the deflecting tube allow the flue gas to pass through without any obstacle. If it is clogged by solid materials, it is possible to sweep the tubes

Probe filter must be replaced before they are clogged.

If you notice that the frequency you must sweep the tube and replace the filter is

When the filter replacement frequency is too high, it is recommended to think about reconsidering the tube design to limit the maintenance operations. Please refer to your Fuji Electric representative to get further information on how to design the sampling system according to the flue gas specifications. Many solutions exist.

### **Analyzer operation Check**

If lags are observed between the expected oxygen concentration and the measured value, it can be useful to inject calibration gas to the probe and check its sensitivity and accuracy.

If the sensor reactivity is sufficient, the calibration should suppress the lag. If it is not, the gentle blowing of ambient air on the sensor for a couple of minutes leads to the probe regeneration.

Perform the check periodically for using the product always in good condition. Especially, perform the checks shown in table below. Moreover, perform the periodic check at a time of checking the furnace or every 6 months.

	Check	Details of
Daily check	Execution of span & zero calibration	When the converters are in use: By injecting reference gas to the probe, check sensor voltage once a month as a rough standard. (refer to the instruction manuals of the converters)
	Check for looseness of cable gland.	On junction box, retighten the cable gland or if the packing is found deteriorated, replace. On probe, cable gland must not be dismantled. Dismantling the cable gland may break the sensor.
	Check of residue in calibration gas cylinder	Check it by a primary pressure gauge.
	Check of blowdown (when blowdown nozzle is fitted)	Referring to each instruction manual of the converters check at 200 to 300kPa {2 to 3kgf/cm <sup>2</sup> }
Periodic check	Check for leak from packing fitted between flow guide tube and mating flange and gasket of probe.	If either of the packing and gasket or both of them are found deteriorated, replace with new gasket and replace the packing (not included in scope of supply).
	Check by disconnecting for clogging or corrosion of flow guide tube.	Check following the procedure in Item <b>7.2.1.3</b> .

	Removing detector, check for loading of filter of detector.	When it is necessary to replace the filter, refer to Item <b>7.2.1.2.</b>
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## **7.2. MAINTENANCE**

### **7.2.1. DAILY MAINTENANCE**

#### **7.2.1.1. GENERAL RECOMMENDATIONS**

According to the observations and checks, daily maintenance operations shall be adapted to each application. Usually these operations consist in replacing the probe filters and gaskets, clearing the deflecting tube, cleaning the probe flame-arrestor, replacing the gas cylinders and regenerating the sensor.

The replacement frequency of detector, probe filter and detector gaskets as well as maintenance periods of flow guide tube differ depending on the working conditions and on the components of measured gas and the amount of dust.

The average replacement frequencies are shown below. These values are to be considered as rough standards and shall be adapted to each application.

<b>Component</b>	<b>Maintenance or Replacement Frequency</b>
ZFKH Probe	Average 5 years lifetime
Probe Filter	Average 6 months interval
Detector Gasket	Average 6 month interval
Flow Guide Tube	When Clogged or corroded

### **7.2.1.2. FILTER REPLACEMENT**

- Turning the power to the detector “OFF”, lower the surface temperature of the tip (at the ceramic filter side) by cooling down fully with the air.
- After having been cooled down fully, remove the filter frame from the detector.
- Screw a new probe filter to the detector and then, tighten till the filter does not move any longer.

### **7.2.1.3. DEFLECTING TUBE MAINTENANCE**

- After removing the flow guide tube from the furnace wall and then, from the detector, cool the tube down fully in the air.
- Remove dust sticking to the outside of the flow guide tube by water-washing with the use of a scrubbing brush.
- Remove dust sticking to the inside of the flow guide tube by using a metallic rod. (Clean so that tube is through at least about 3/4 part of the whole interior.)
- For the flow guide tube for high dust, remove together dust sticking around the gas outlet

### **7.2.1.4. FUSE REPLACEMENT**

If a fuse blows, turn off the power switch, and replace the fuse after investigating the cause and making any necessary repairs.

See ZKM controller user manual for detailed information.

	No.	Description
<b>Consumables</b>	1	Probe Filter
	2	Detector Gasket
	3	Flame-arresting Nose
<b>Spare parts</b>	3	Probe for replacement
	4	Flow guide tube

### 7.2.1.5. TROUBLE SHOOTING LIST

Symptoms	Probable causes	Checking methods (normal value)	Remedy
No display	Converter fuse blown out	Check the fuse and supply voltage specification.	Replace fuse Check power supply voltage
Indication does not change or slow response	Filter and/or flow guide tube clogged	Visual check of filter and flow guide tube for contamination or clogging. Check for loosen and gas leaks at piping connections and mounting place of detector.	Clean or replace filter Tighten pipe connections
	Detector element deterioration	Change over between zero and span gas and check if 5 minutes or longer is needed for 90% response.	Replace detector element
	Decrease in flow velocity of exhaust gas	Check response to process gas after shutting down calibration gas. Move the direction (mounting position) of "arrow" of the flow guide slightly.	Increase process gas flow into the flow guide tube.
Temperature alarm continues for more than 10 min. after power switched ON	Break of wiring Wrong wiring Source voltage is too low.	Ohmic check of wiring Wiring check Check of supply voltage specification	Replacement Correct wiring Check supply voltage
	Break of thermocouples	Ohmic check	Replace detector element
	Blown heater fuse	Ohmic check of fuse	Replace fuse
	Break in detector heater	Check heater resistance 50 to 55Ω for 115V, 200 to 250Ω for 220V (Excluding wiring resistance)	Replace detector element
Automatic calibration is not possible	Difference between calibration gas concentration and its setting	Check the set value for calibration gas concentration.	Set proper value
	Wrong parameters setting	Check automatic calibration intervals.	Set proper parameters
	The calibration is prohibited in the contact input of the external terminal block.	Check if the calibration is not prohibited in the contact input of the external terminal block.	Set proper parameters Correct wiring
	The heater is set to off at the contact input of the external terminal block.	Check if the heater is set to off at the contact input of the external terminal block.	Set proper parameters Correct wiring

Zero and/or span alarm	Difference between calibration gas concentration and its setting or misconnection between zero and span gas	Check the set value for calibration gas concentration.	Set proper value
		Check piping.	Correct wiring
Indication too high or too low	Loose flange and its surroundings Deteriorated O-rings	Check for gas leaks in detector and mounting part of flow guide tube flange.	Tighten mounting screws Replace detector element
		Check for leaks from the outside.	Seal
	Detector is faulty.	Check for gas leaks at calibration gas inlet. Check detector element voltage (mV) for higher or lower than other detector when flowing zero gas.	<ul style="list-style-type: none"> <li>• Tighten connectors</li> <li>• Replace detector element</li> </ul>
	Abnormal detector element temperature	Refer to check items for detector temperature alarm described above.	<ul style="list-style-type: none"> <li>• Replace detector element</li> </ul>
	Indication difference between dry and wet base measurement	Oxygen concentration is higher in dry base.	<ul style="list-style-type: none"> <li>• Normal</li> </ul>
Disconnection detection error	Break of thermocouples Break of detector element Wrong wiring	Ohmic check of wiring Wiring check	<ul style="list-style-type: none"> <li>• Replace the defective parts.</li> <li>• Correct wiring</li> <li>• Turn on/off the power supply.</li> </ul>
Range cannot be switched.	“Range setting” is set in the contact input setting.	Check if “Range setting” is set in the contact input setting.	Cancel “Range setting” in the contact input setting.

Troubles	Probable causes	Check procedures (normal)	Remedies
Indication is fixed. Indication response is slow.	Clogging of ceramic filter of detector and flow guide tube interior	Check visually for fouling of ceramic filter of detector and clogging of flow guide tube interior with dust.	Clean or exchange ceramic filter, if need be.
	Leak from detector gasket	Check for looseness of each joint and sealing of mounted part.	Retighten or Replace Detector gasket
	Deterioration of detector	Check by changing zero calibration gas over to span calibration gas and vice versa if it takes more than 5 minutes for 90% response.	Replace detector.
	Decrease of exhaust gas flowing velocity	Check exhaust gas responding time after stop of calibration gas supply.	Increase amount of exhaust gas inside flow guide tube to be taken in. Clean flow guide tube.
Temperature alarm continues coming on despite 20 minutes having elapsed after turning on power.	Disconnection of cable	Check continuity.	Replace cable.
	Error in wiring	Check wiring.	Wire correctly.
	Low supply voltage	Check if supply power is as specified.	Supply correct power.
	Disconnection of thermocouple	Check continuity. Check if resistance across terminals	Replace detector.
	Blown-off of fuse of converters (ZRM and ZRN)	Check continuity of fuse.	Exchange fuse(s). (Refer to each instruction manual of converters (ZRM and ZRN).
	Disconnection of detector heater	Check heater resistance as follows (exclusive of wiring resistance): For 100V : 50 to 55Ω For 200V : 200 to 250Ω	Replace detector.
Indication is too high or too low.	Looseness of flange mounted part or deterioration of detector gasket or packing (not included in scope of supply).	Check sealing of detection unit, flow guide tube and flange mounted part.	Retighten mounting screw. Exchange O-ring. Exchange packing (not included in scope of supply)
		Check for leak in from periphery.	Shield
	Deterioration of detector	Check sealing of calibration gas supply port. Check at a time of running zero and span calibration gases if detector output (mV) is higher or lower than others. (Refer to Table in Item "6.3").	Retighten calibration gas joint. Replace detector.
	Abnormality of detector temperature	Check indicated temperature of converter.	
	Change of oxygen concentration peripheral air of terminal box or very high humidity	Check oxygen concentration of peripheral air of terminal box is 20.6Vol%.	Use reference gas inlet.



## **7.2.2. SHUTDOWN MAINTENANCE**

To ensure the maintenance, the traceability and the operability of the analyzers, Fuji Electric takes care of your equipment during the unit shutdown periods.

During the combustion unit shutdowns, the analyzers shall be dismantled by the maintenance operators. The deflecting tube shall be inspected as well as the mating flanges. Calibration system sealing and operability shall also be inspected. According to these observations, the cleaning, replacement or redesign of the tube will be planned.

Each dismantled probe shall be tagged to ensure traceability then be sent back to Fuji Electric France factory in Clermont-Ferrand (63), France.

Our operators systematically disassemble the probes. After the probe cleaning and replacement of used parts. The probes are heated up and tested.

A diagnostic report is issued to sum up the operability of each sensor. Then improvement proposal are made.

Fuji Electric agrees to make sure that all analyzers are repaired and sent back on site before the process start-up.

### 7.2.3. DETECTOR STANDARD OUTPUT VOLTAGE

For the output voltage of the detector, refer to the standard output table below.

Oxygen concentration (Vol%)	Detector (ZFK2) output (Unit: mV)
0.01	168.15
0.05	132.68
0.1	117.41
0.5	81.94
1.0	66.67
1.2	62.65
1.4	59.25
1.5	57.73
1.6	56.31
1.8	53.71
2.0	51.39
2.2	49.29
2.4	47.37
2.5	46.47
2.6	45.61
2.8	43.98
3.0	42.46
3.5	39.06
4.0	36.12
4.5	33.52
5.0	31.20
5.5	29.10
6.0	27.18
6.5	25.42
7.0	23.79
7.5	22.27

Oxygen concentration (Vol%)	Detector (ZFK2) output (Unit: mV)
8.0	20.84
8.5	19.51
9.0	18.25
10.0	15.93
11.0	13.83
12.0	11.91
13.0	10.14
14.0	8.51
15.0	6.99
16.0	5.57
17.0	4.23
18.0	2.97
19.0	1.78
20.0	0.65
20.6	0.00
21.0	-0.42
22.0	-1.45
23.0	-2.43
24.0	-3.37
25.0	-4.27
30.0	-8.28
35.0	-11.68
40.0	-14.62
45.0	-17.22
50.0	-19.54



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