Manual No.3184E R5

INSTRUCTION MANUAL
FOR
SH-ⅣD TYPE O_2 ANALYZER

ENERGY SUPPORT CORPORATION

Safety precautions

Observe the following precautions without fail for safe operation of the equipment.

⚠ WARNING

1. When connecting cables to the terminals of the analyzer or when servicing inside the analyzer, take care to avoid electric shock. When servicing electrical parts, be sure to turn the power off.
2. Connect the grounding wire to prevent accidents caused by electric shock.
3. When fabricating the gas inlet/outlet pipes or disconnecting pipes for maintenance inside the analyzer, be sure to shut off the gas source valve to prevent accidents caused by gas intoxication or oxygen deficiency.
4. To prevent gas intoxication and oxygen deficiency, test gas leaks after fabricating the gas inlet/outlet pipes or performing maintenance service of piping inside the analyzer. Route the gas outlet at a safe place provided with the atmospheric pressure.

⚠ CAUTION

1. To prevent electric shock, always check that the power supply wiring is correct and secure and that the power source voltage of this device matches the supply voltage before turning on the power switch.
2. To prevent gas intoxication and oxygen deficiency, check that the gas inlet/outlet pipes of the analyzer are correct and secure without leaks before opening the gas source valve.
3. To prevent burns, do not touch the transmission unit, sensor unit (detector, etc.) and their periphery during operation and shortly after operation because these portions are very hot. If you need maintenance services around these portions, wear heat resistand glove or the like and carefully work to prevent burns.
4. A caution mark shown on the right is attached around the power unit where electric shock can occur. Turn off the power to work around the wiring even where electric shock mark is not attached because the wiring circuit may cause electric shock.

5. Be sure to close the gas source valve to perform maintenance services of the piping system when the sample gas contains toxic contents to prevent gas intoxication.
6. A mark shown on the right is attached around the transmission unit and sensor unit (detector, etc.) where you may be burned.
   There are hot portions due to radiated heat even if the hot caution mark is not attached; take care to work around such portions.

7. Observe the cautions and operation methods described in this manual to operate this equipment safely. If the description is neglected during operation of the equipment, electric shock, gas intoxication, oxygen deficiency, burns, damage or deterioration of this equipment or damage to the final product (device, etc.) may be caused.
8. The purpose of this valve is a flow adjustment, and not flow stop.
   The inner part is damaged when the valve is excessively turned.
   Please install the stop valve, when you need a complete flow stop.

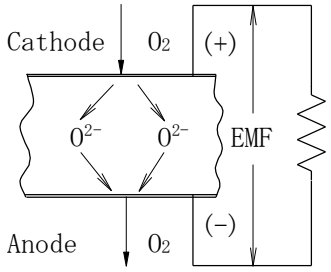
Warranty

1. Term: The term of warranty for a single unit purchase shall be one year.
   Note, however, that in the case of equipment installation, the term of warranty shall be the same as that for the equipment.
2. Conditions: The delivered product shall be replaced or repaired free of charge in the case of trouble of failure caused by inadequate design, manufacture or material that occurs within the period of the above-stated term of warranty provided that the product has been stored, installed, and used appropriately.
   Appropriate use refers to the following:
   (1) The operating and installation requirements described in the specifications and instruction manual for the instrument shall be met.
   (2) The operating condition of the instrument shall be confirmed and maintenance performed.
   Note that the following cases are not subject to warranty in the period of the above-stated term of warranty:
   [1] Trouble caused by an error in use (i.e. incorrect operation due to not following the instructions in the manual).
   [2] Trouble caused by repair, modification, overhaul, and the like performed by anyone apart from ENERGY SUPPORT CORP. Insulators.
   [3] Trouble caused by fire or acts of God (including induction lightening surge).
   [4] Trouble caused by inadequate storage (e.g. storage in a hot and humid environment) or inadequate care (e.g. allowing mold to grow)
   (Note) Consumable or consumable-like parts are not subject to warranty.
3. Range: The range of warranty is limited to the range of delivery by ENERGY SUPPORT CORP.
4. Exemption of liability:
   ENERGY SUPPORT CORP. shall not be liable for ane secondary damage accompanying trouble with the product delivered by ENERGY SUPPORT CORP. (any loss or lost profits resulting from controlling or recording using the product delivered by ENERGY SUPPORT CORP. or any loss or lost profits with equipment in which the product delivered by ENERGY SUPPORT CORP. Insulators is installed).
   Safety devices shall be installed by the customer.

CONTENTS

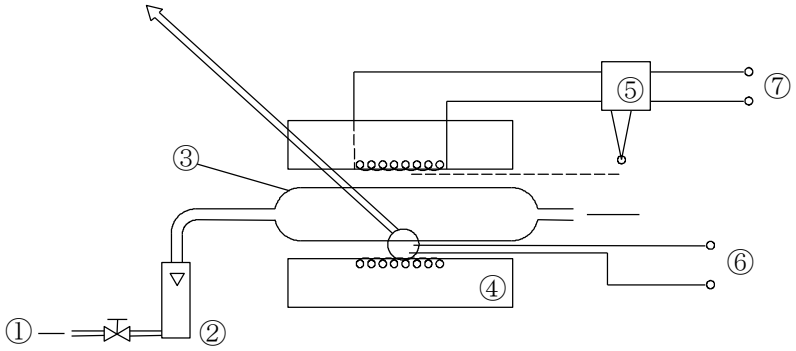
1. Theory of measurement

The cubic system solid solution prepared by adding calcia (CaO), yttria (Y_2O_3), etc. to zirconia (ZrO_2) is a solid electrolyte (sensor cell) transmitting oxygen ion (O^{2-}) at high temperature. When electrodes (porous) are equipped both sides of the solid electrolyte and gases of different oxygen concentrations are placed on each electrode, oxygen ion transmission occurs and an electromotive force is generated between the electrodes.



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

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



① Sample gas inlet
② Flowmeter
③ Sensor cell
④ Electric furnace
⑤ Temperature controller
⑥ Cell electromotive force
⑦ Power supply

The relationship between the electromotive force of the sensor cell and oxygen concentration is expressed by the following equation:

$$EMF = -\frac{RT}{4F} \ln \frac{PO_2(S)}{PO_2(A)} \quad (V)$$

where EMF : Electromotive force of the detection cell (mV)

R : Gas constant (8.314 $J \cdot mol^{-1} \cdot K^{-1}$)

T : Absolute temperature of solid electrolyte (usually 1123° K)

F : Faraday constant ($9.649 * 10^4 c \cdot mol^{-1}$)

$PO_2(A)$: Oxygen concentration in standard gas (Air) (20.6 vol%)

$PO_2(S)$: Oxygen concentration in sample gas (vol%)

The above equation can be transformed as follows:

$$PO_2(S) = 20.6\ Exp\left(-\frac{4F}{RT}\cdot EMF\right)$$

Oxygen concentration in sample gas, $PO_2(S)$, can be derived from this equation by measuring the cell electromotive force (EMF).

The SH-ⅣD type O_2 Analyzer includes this solid electrolyte (sensor cell) in the sensor device of the transmitter and the cell is heated to a constant temperature (850℃) with a heater. The sample gas is pressed into GAS IN and contacts to the sensor cell and generates a cell electromotive force (EMF) corresponding to the oxygen concentration in the sample gas. This electromotibe force is operated by the digital circuit in the Analyzer and displayed and output as the directly-readable oxgen concentration (vol%).

2. Method of installation

2-1 Condition of installation site

Since there is a fear of gas poisoning and oxygen deficiency, pipes at the entrance and exit for the gas must be constructed without any leaks. Route the gas outlet at a safe place provided with the atmospheric pressure.

- Low in mechanical vibration.
- Low in concentration of corrosive gases (F, HF, C1, HC1, SO_2, H_2S, etc.).
- Place where silicone rubber packing or silicone tube in not used.
- Little temperature change and near ambient temperature.
- No direct high radiation of heat.
- Little effect of electric noise
- Low in moisture and dust.

Note the following points for measuring gas used with this analyzer.

- If the measuring gas contains corrosive gases (e.g. F, HF, C1, HC1, SO2, H2S), the sensor cell may deteriorate in a short time.
- If the measuring gas contains toxic substances (e.g. Si, Pb, P, Zn, Sn, As), the sensor cell may deteriorate in a short time.
- A large quantity of Si, in particular, can be generated when siliceous material (e.g. paint, mold removal aids, packing, piping material) is heated.
  Before the initial start-up of the furnace or the first start-up after repair work, detach the analyzer and heat the empty furnace sufficiently.
- If the analyzer is used in an environment that may generate corrosive gases or toxic substances, the use of an activated carbon filter or the like is recommended.

2-2 Piping

Since there is a fear of gas poisoning and oxygen deficiency, pipes at the entrance and exit for the gas must be constructed without any leaks. Route the gas outlet at a safe place provided with the atmospheric pressure.

The piping is extremely important for obtaining a correct measurement. Note the following before doing piping.

① Material of pipes

- Using the ppm range: Use copper or stainless steel pipes.
- Using the % range: Organic material such as Teflon, Viton, vinyl, and nylon can be used.

Note) • When organic material is used, select a material that will withstand the temperature of the introduced measuring gas.

- Silicon tube lets the oxygen in the air penetrate, thus increasing the indication value.

  The use of siliceous piping or packing may cause the sensor to deteriorate in a short time. Therefore, never use a silicon tube or silicon packing.

② Oil elimination from metal piping

- Clean the inner surface of copper or stainless steel pipes of oil or organic substances using a volatile cleaning solvent or the like, and then thoroughly purge using N2 gas or air.

Note) Oil or organic substances attached in the inner surface of metal pipes gradually mix into the measuring gas and burn in the vicinity of the heated sensor, thus reducing the indication value.

③ Do not provide a gas pocket in the piping.

- Do not provide a large container in the piping.
- Make the piping as short as possible and with a simple structure.

Note) Having a large gas pocket (filter or activated carbon filter) or having a long pipe will prolong the time required to replace the measuring gas, thus increasing wasted time and the response time. Make the gas pocket as small as possible and the pipes as short as possible.

④ Elimination of corrosive gas

- For F, HF, C1, HC1, and SOx

  [A] Take note of the service life of activated carbon.

  [B] Take note of the dissolved oxygen in water when washing in it.

⑤ Removal of liquid in piping

- When the dew point of the gas to be measured is higher than the ambient temperature:

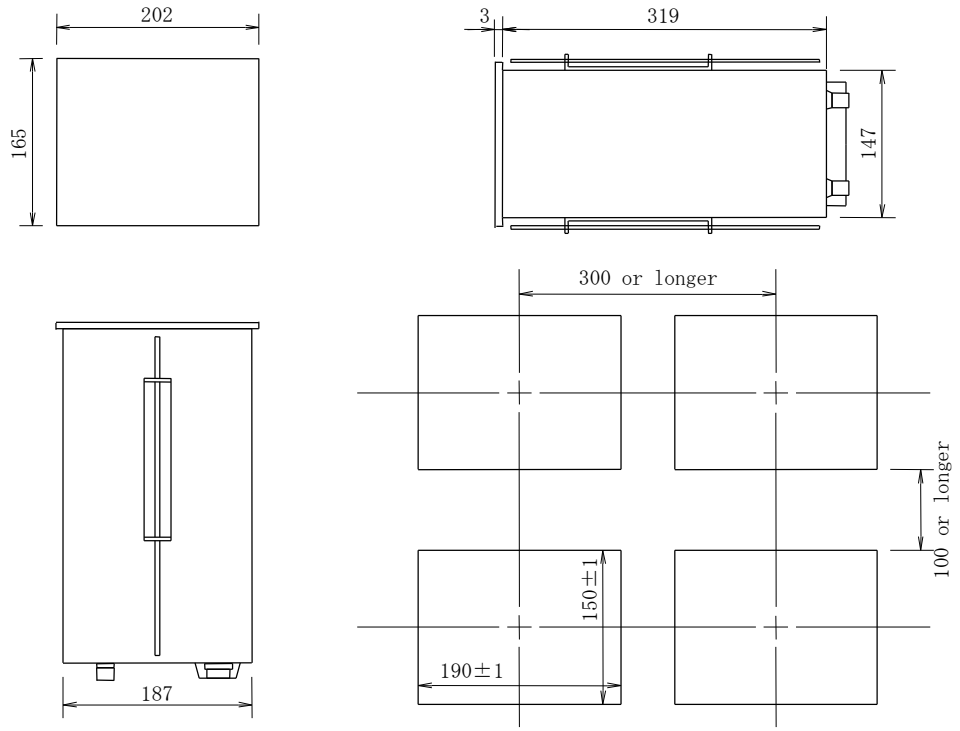
  Provide a trap or electronic cooler in the piping to remove the liquid.

  Lay the draining pipe slanting downwards so that the liquid can flow smoothly.

⑥ Building a standard gas bottle into the piping will be convenient for gas calibration.

2-3 Installation and panel dimensions

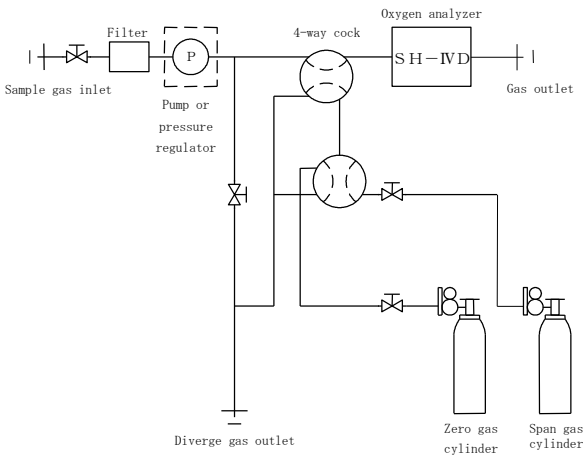
External form of the main body of the Analyzer



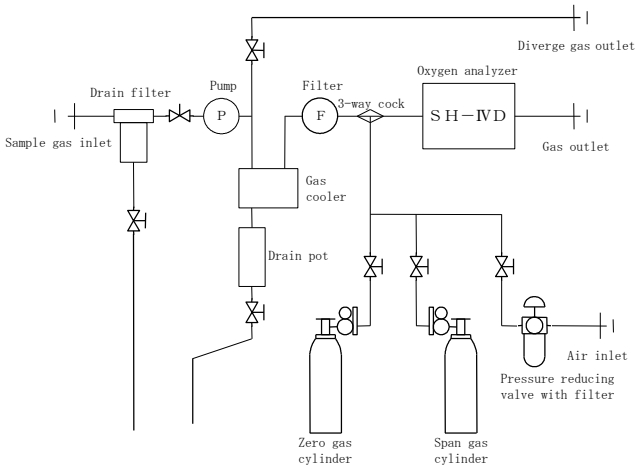
Panel dimensions

2-4 Example of piping

Flow 1 (ppm range)



Flow 2 (% range)

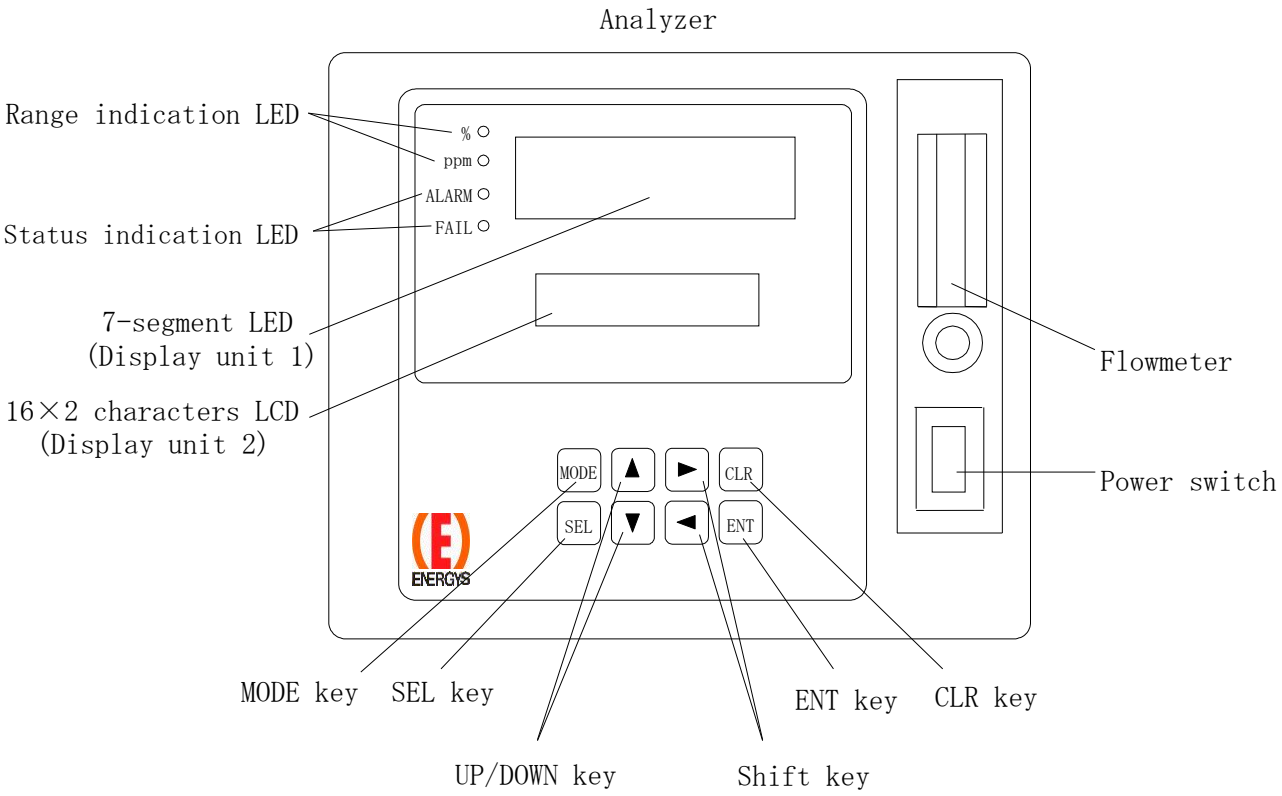


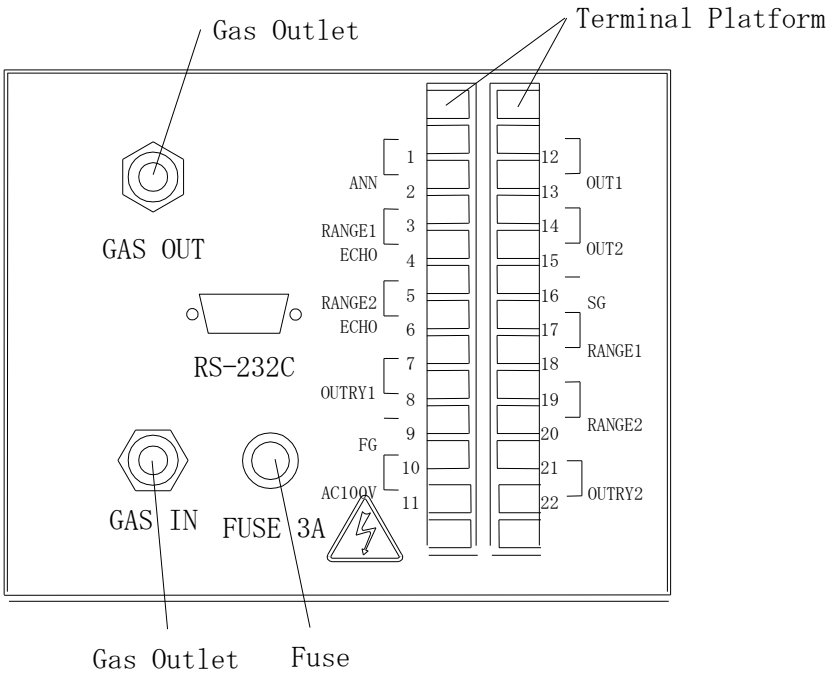
Note) When the sample pressure is 0.1 MPa or more, use a pressure regulator
When the sample pressure is 3 kPa or less, use a suction pump.
When the sample pressure is 3 to 0.1 MPa, neither a pump nor pressure regulator is required.

When the pressure fluctuation is large, a pressure regulator is required even if within the range given on the left.

3. Names and functions of parts

3-1 Exterior view of the panel

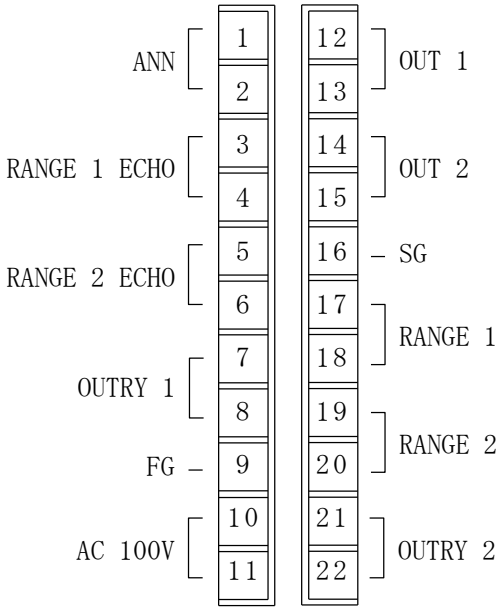




3-2 Names and functions of parts

Name	Function
1. Power switch	Turns the power supply ON and OFF.
2. 7-segment LED (Display unit 1)	Temperature rising time: Sensor cell temperature is blinked and displayed. Mesurement time: Oxygen concentration is displayed. Abnormal time: Error code is displayed.(Refer to Page 19,20)
3. 16×2 characters LCD (Display unit 2)	Upper display: Setting menu is displayed(Refer to Page 8) Lower display: Setting item or setting data is displayed (Refer to Page 9 through 11)
4. Range indication LED	% LED: Lit when oxygen concentration is 0.100% or more in the state of oxygen concentration measurement. ppm LED: Lit when oxygen concentration is 999ppm or less in the state of oxygen concentration measurement.
5. Status indication LED	ALARM LED: Lit when the alarm results from the upper or lower limit of the oxygen concentration. FAIL LED: Lit for occurrence of E-7 through E-14 errors
6. MODE Key	Measurement state: It shifts to a setting menu selection state. Setting menu selection state: It shifts to a measurement state. Setting item selection state: It shifts to a setting menu selection state.
7. SEL Key	Setting menu selection state: It shifts to a setting item selection state.(Setting item or data is displayed.) Setting item selection state: A setting item and setting data are switched. (Lower LCD) Setting data change state: It shifts to a setting item selection state.
8. UP/DOWN Key	Setting menu selection state: A setting menu is switched. (Upper LCD) Setting data change state: A setting data is increased or decreased / switched.
9. SHIFT Key	Setting item selection state: It shifts to a setting data change state. Setting data change state: Digit of numeral value displayed at the Lower LCD is shifted.
10. CLR Key	Error reset: Error display is reset.Enter key returnes is to the measurement mode.
11. ENT Key	Data renewal Calibration implementation
12. Flowmeter	Sets the flow rate of sample gas to 500 ± 50 mℓ/min.

3-3 Arrangement of terminals



ANN:	Alarm output
RANGE 1 ECHO:	ECO back contact output when range 1 is used
RANGE 2 ECHO:	ECO back contact output when range 2 is used
OUTRY 1	Concentration high alarm contact output
FG:	RANGE GROUND
AC 100V:	Power supply terminal
OUT 1	O_2 concentration current output (4-20 mA)
OUT 2	O_2 concentration voltage output (0-1V (0-10mV))
SG:	SIGNAL GROUND
RANGE 1:	Remote range 1 switching input
RANGE 2:	Remote range 2 switching input
OUTRY 2	Concentration low alarm contact output

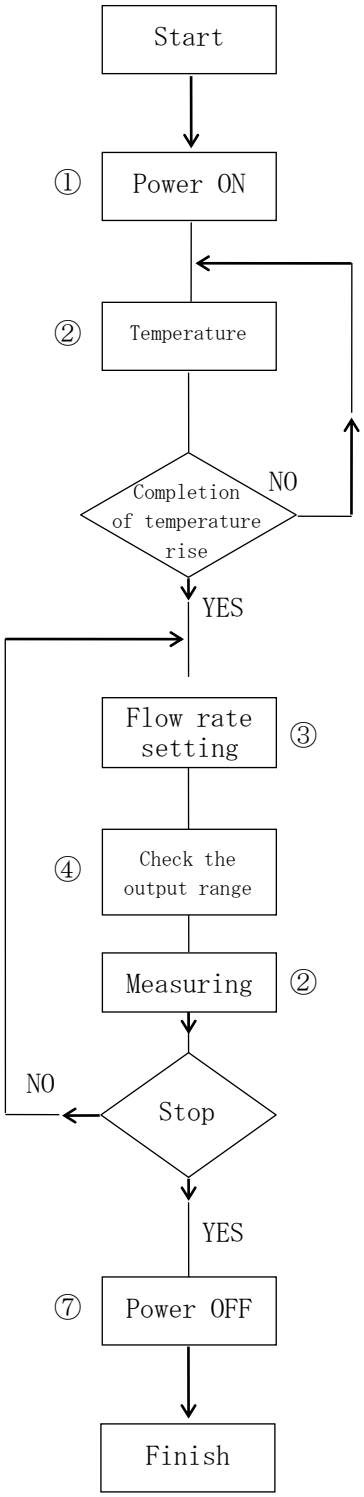
(terminal screw: M3)

4. Operation

4-1 Operation procedure

After wirings and pipings are confirmed to be in correct condition, measurement shall be carried out by the following procedure:

Start and stoppage



The termperature rise of the transmitter begins 1 to 2 sec. after Power is ON.

The sensor temperature is displayed flickering on the display unit 1. (ca. 20 min.)

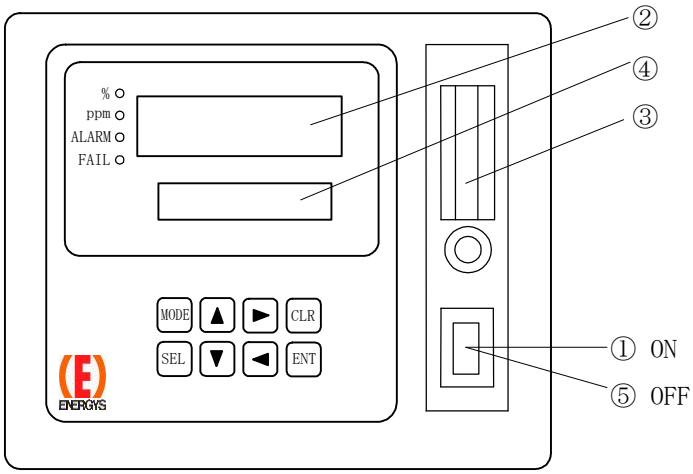
The temperature rise completes at 820℃ and the O_2 measurement is executed.
Concentration of calibration gas can be set after the temperature has been raised.

Set the flow rate of measuring gas to 500 ± 50 mℓ/min.

Check the outoput range (RANGE1/RANGE2) on the display unit 2.

Measuring the oxygen concentration.

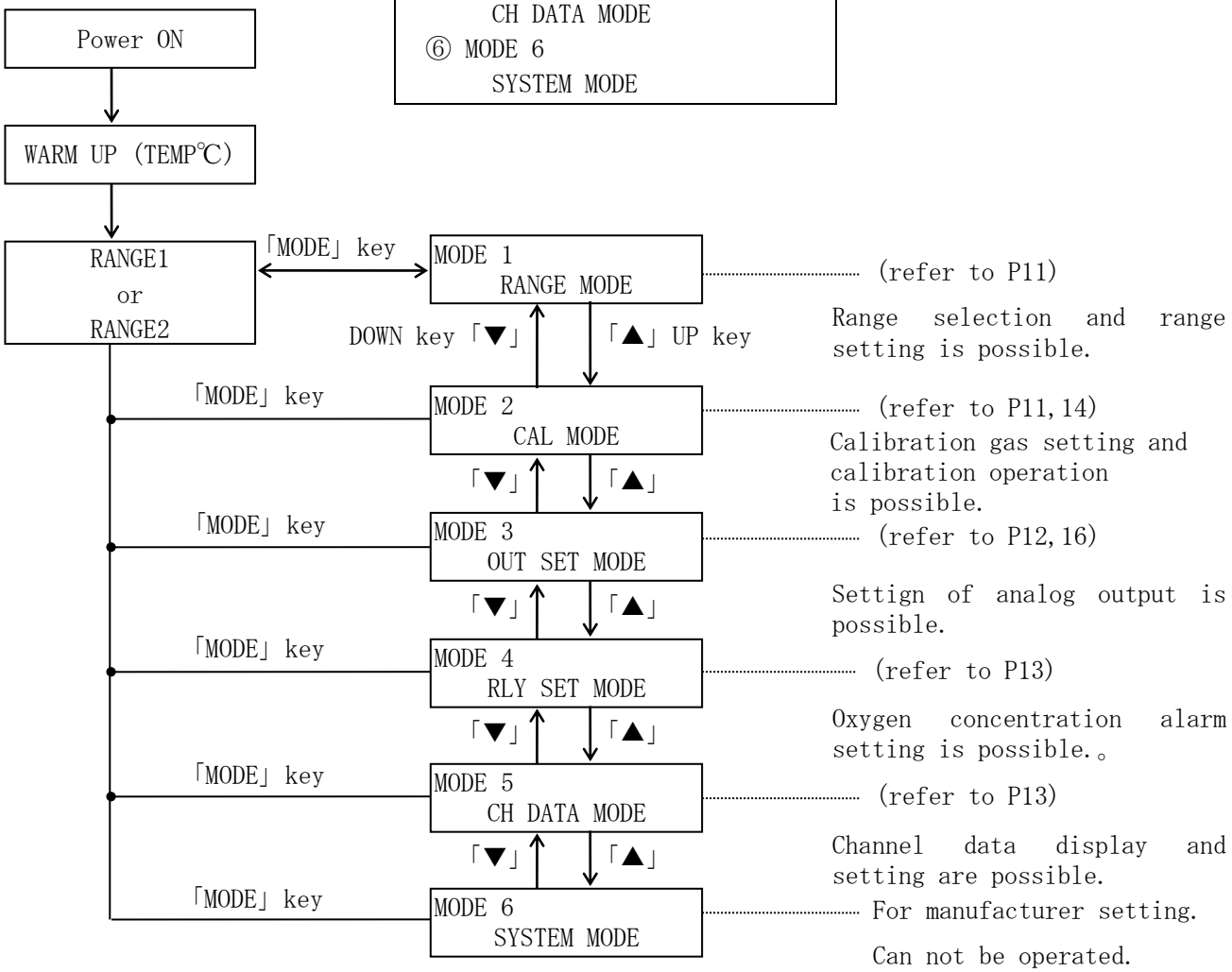
Stop the measuring gas and turn off the power.



4-2 Key operation

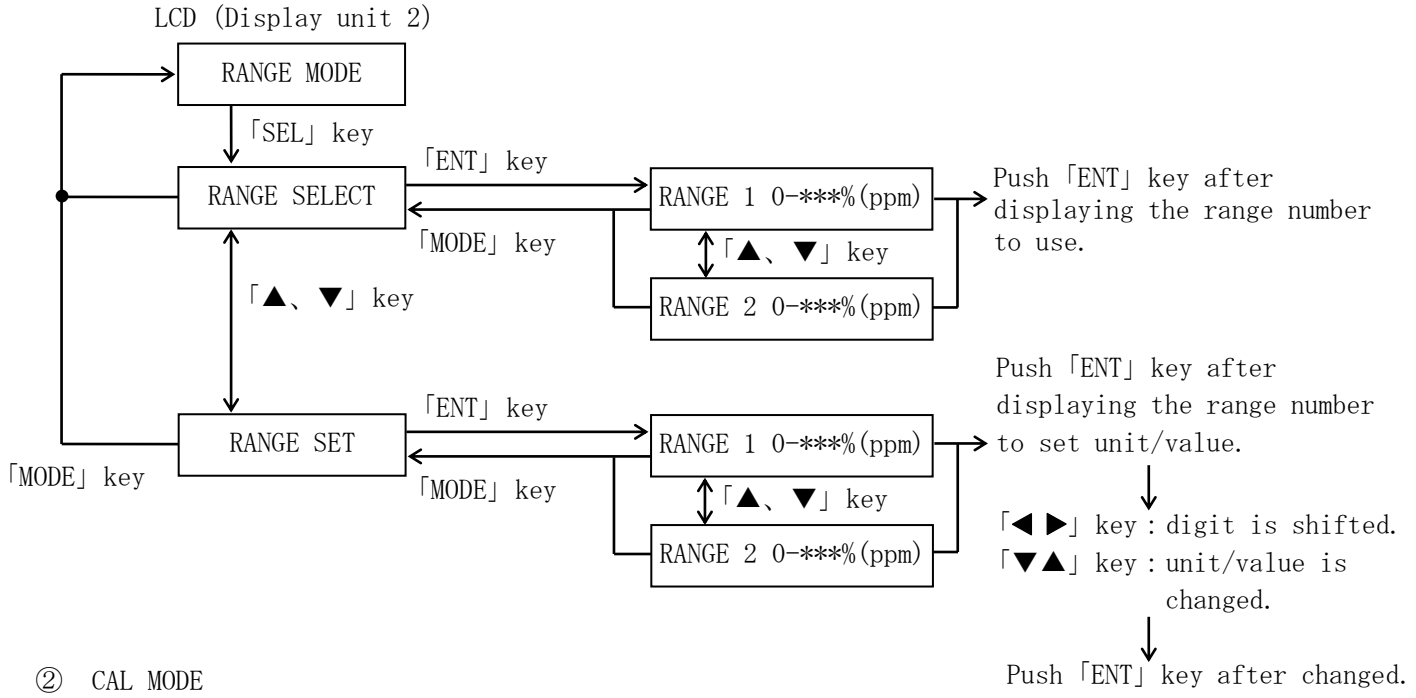
Function by key operation has the following 6 types.

LCD (Display unit 2) display
① MODE 1 RANGE MODE ② MODE 2 CAL MODE ③ MODE 3 OUT SET MODE ④ MODE 4 RLY SET MODE ⑤ MODE 5 CH DATA MODE ⑥ MODE 6 SYSTEM MODE



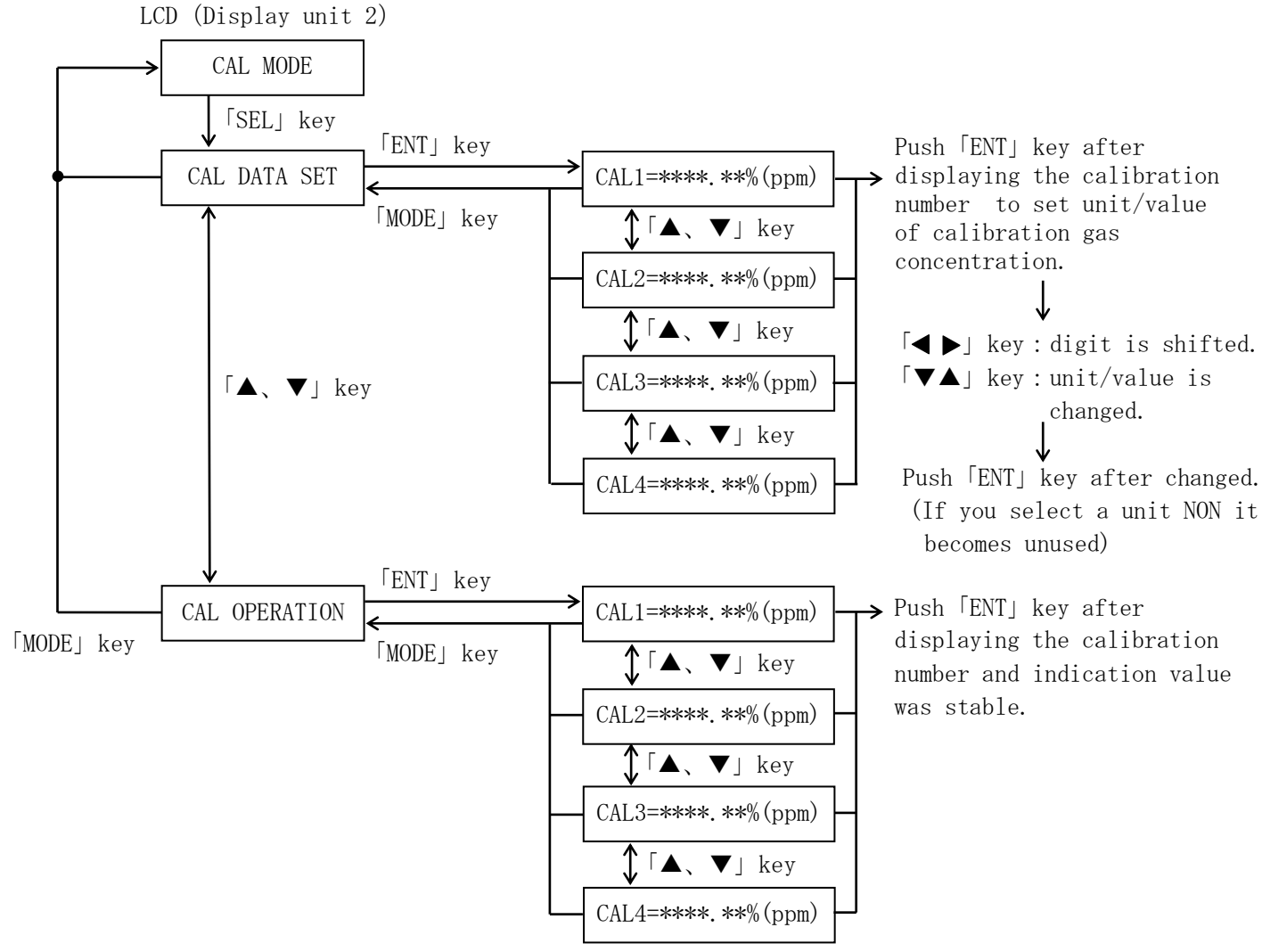
① RANGE MODE

This mode is used for setting the range selection and range values.



② CAL MODE

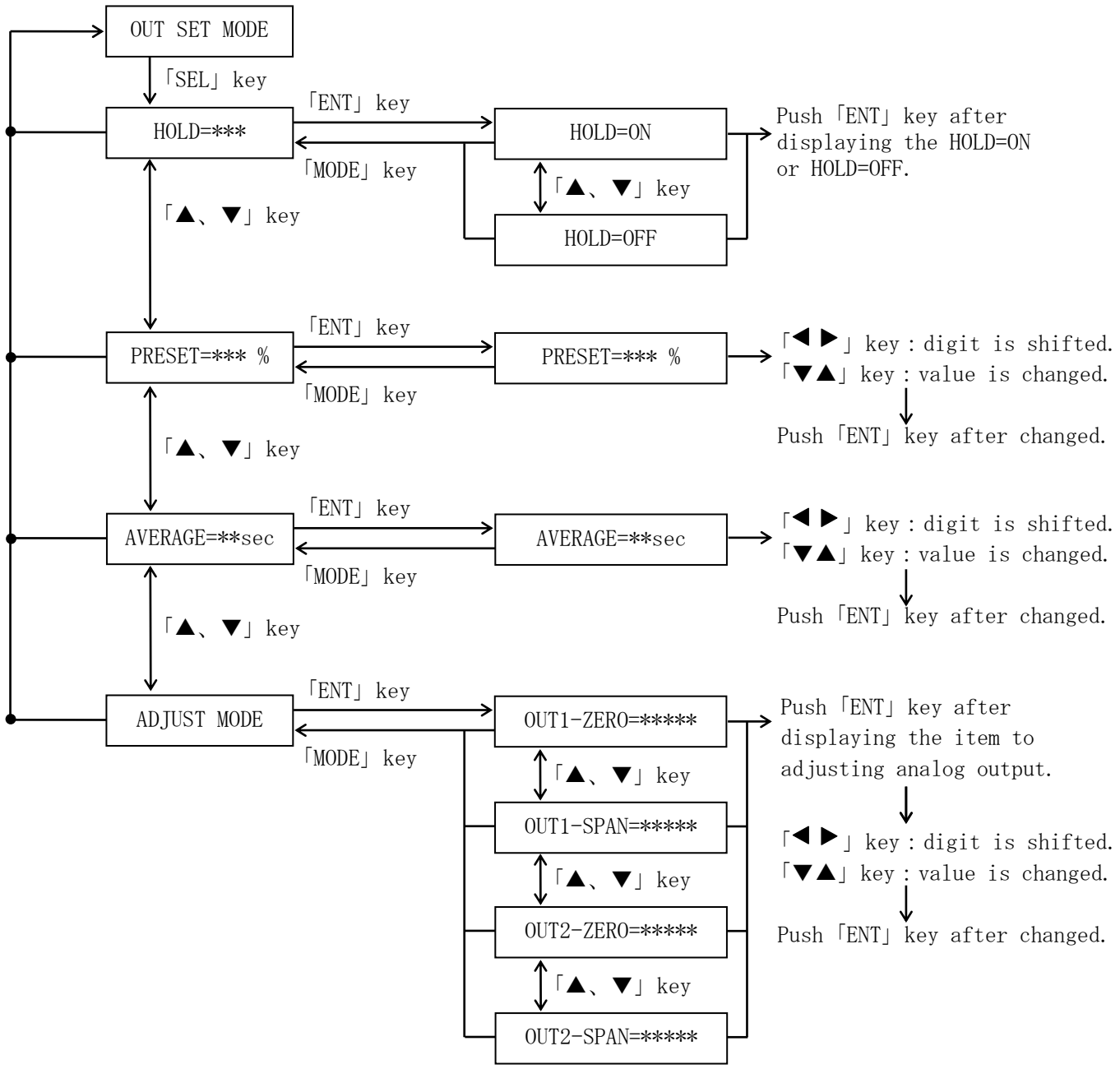
This mode is used for setting the calibration gas concentration and calibration operation.



③ OUT SET MODE

This mode is used for choosing hold, setting pre-set, setting moving average and adjusting output

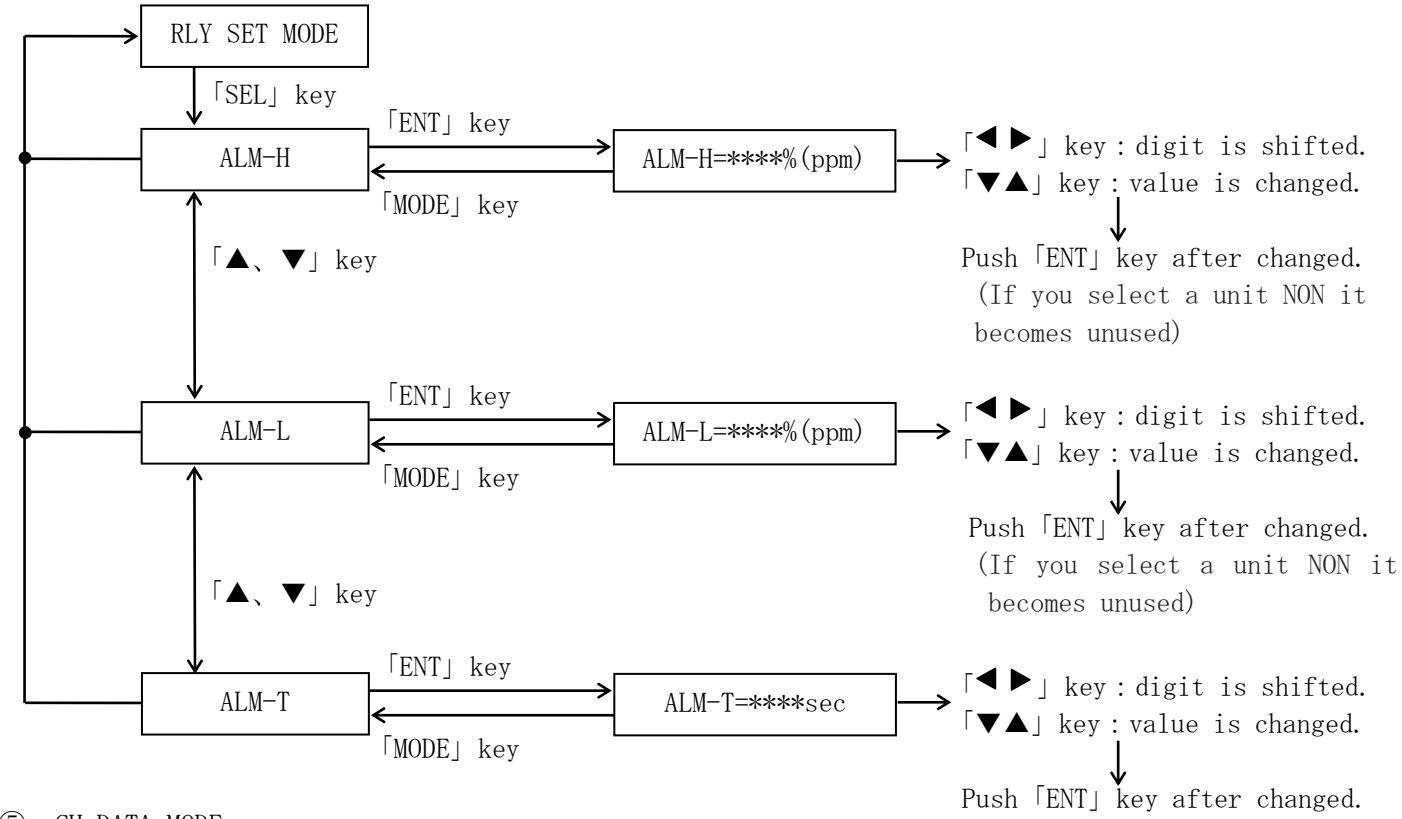
LCD (Display unit 2)



④ RLY SET MODE

This mode is used for setting concentration upper limit warning, concentration lower limit warning and concentration warning detection time.

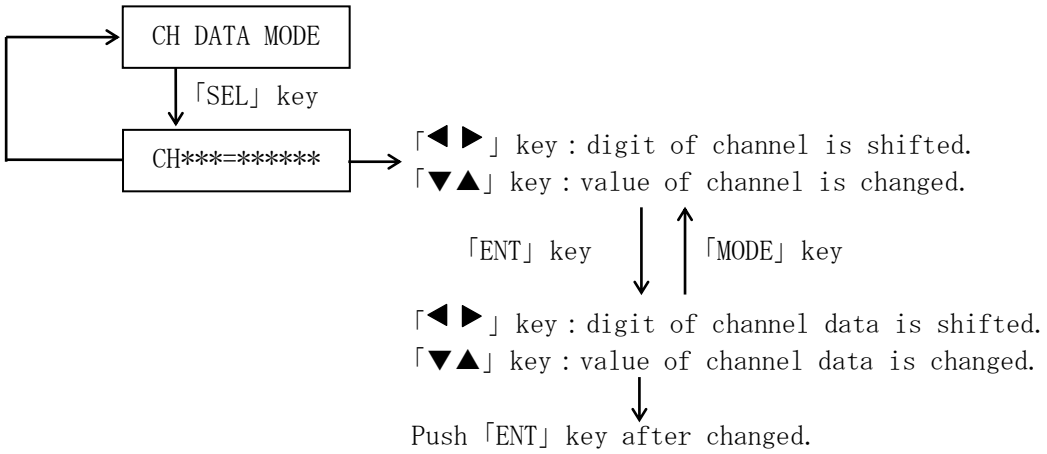
LCD (Display unit 2)



⑤ CH DATA MODE

This mode is used for setting channel data.

LCD (Display unit 2)



4-3 Gas calibration

Gas calibration is necessary for maintaining the measurement accuracy.

Perform gas calibration at the start of operation and then monthly after that.

Note) Gas calibration has been performed according to the customer's range specifications before shipping and that calibration gas concentration has been set as the initial value.

When the number of calibration gases and gas concentrations deviate from the customer's specifications, it is necessary to change the calibration gas concentration before performing calibration.

4-3-1 Selection of calibration gas

When gas is to be provided by the customer, refer to the following table for selection of the calibration gas concentration and the number of gas bottles.

For accuracy, ZERO and SPAN calibrations of each measuring range are desirable.

Refer to the following standard for the corresponding measuring range and ZERO gas concentration or SPAN gas concentration.

ZERO gas concentration = Corresponding measuring range 5 - 20% FS

SPAN gas concentration = Corresponding measuring range 80 - 95% FS

When the SPAN gas concentration of the low concentration measuring range is very close to the ZERO gas concentration of the high concentration measuring range, one concentration can be used for both. In this case, use the SPAN gas concentration setting of the low concentration measuring range and set NON as the ZERO gas concentration setting of the high concentration measuring range.

Values in ( ) are recommended for more accurate calibration.

Table for selecting operating range, calibration gas concentration, and number of calibration gases.

RANGE1 [low concentration measuring range]	RANG2 [high concentration measuring range]	CAL1 [Zero gas of range1]	CAL2 [Span gas of range1]	CAL3 [Zero gas of range2]	CAL4 [Span gas of range2]
0 ～ 1%	0 ～ 100%	00.10%	(0009%)	0000%	0100%
0 ～ 10%	0 ～ 100%	001.0%	0009%	0000%	0000%
0 ～ 1%	0 ～ 25%	00.10%	(0009%)	0000%	020.6%
0 ～ 1%	0 ～ 10%	00.10%	0009%	0000%	0000%
0 ～ 1000ppm	0 ～ 25%	0100ppm	(0900ppm)	0000%	020.6%
0 ～ 100ppm	0 ～ 25%	0010ppm	0900ppm	(0002%)	020.6%
0 ～ 10ppm	0 ～ 1000ppm	0002ppm	0009ppm	0100ppm	0900ppm
0 ～ 100ppm	0 ～ 1000ppm	0010ppm	0090ppm	0000ppm	0900ppm

When the number of calibration points must be reduced with consideration for the gas bottle (e.g. reducing the 4-point calibration to 3-point calibration), it is necessary to cancel the setting for the unused calibration gas concentration and corresponding memory data.

To cancel such a setting, set NON for the unused calibration gas concentration. When you neglect this cancellation procedure and perform the calibration with the unused setting value, correct measurement may not be obtained.

The same operation must be performed when the customer's number of calibration points is different from the number of calibration points that have been set before shipping.

4-3-2 Gas calibration procedure

Gas calibration

① Flow the SPAN calibration gas at a flow rate of 500±50mℓ/min.

Wait until the indication value stable; wait until the output fluctuation is within ±0.5 %FS/min.

② Set of the calibration gas concentration and calibration operate from a CAL MODE. (refer to P10, 11)

Note) When the calibration error occurs, clear it with the CLR key ⇒ENT key and refer to the troubleshooting notes on P29.

③ Flow the ZERO calibration gas at a flow rate of 500±50mℓ/min.

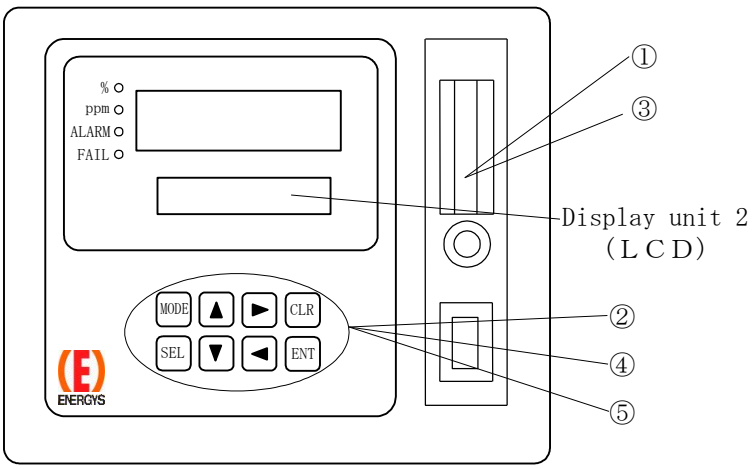
Wait until the indication value is stable; wait until the output fluctuation is within ±0.5 %FS/min.

④ Set of the calibration gas concentration and calibration operate from a CAL MODE. (refer to P10, 11)

Note) When the calibration error occurs, clear it with the CLR key ⇒ENT key and refer to the troubleshooting notes on P29.

Note) Repeat the above operation for the number of calibration gases.

⑤ Push several times of "MODE" key and return display of the LCD (Display unit 2) to RANGE1 or RANGE2.



4-4 PC communication

This device connects with the serial communication of the PC and can perform a monitor, the renewal of data. The communication method has access to RS-232C, DSUB-9 pin male connector, DTE, and 3 line async is serial. The communication condition can choose only a kind of speed (CH035) and parity (CH036) by setting. Data long 8 bits, 1 stop bit are fixed. It is connected to the PC with DSUB-9 pin cable of the cross connection.

Can use the command of the following tables.

①Command

No.	Command format	Explanation	Remarks
1	ch:xxx=nnnnn ch,xxx=nnnnn	Write in data nnnnn at channel xxx.	
2	start	Transmit oxygen concentration measuring consecutively.	Write in on/off at CH037. Appoint the transmission distance in CH038.
3	stop	Stop the consecutive transmission of the oxygen concentration.	

※ The terminal cord is CR+LF.

②Inquiry

No.	Command format	Reply	Explanation
1	?ch:xxx ?ch,xxx	Ch,xxx=nnnnn	Read data of channel xxx.
2	?o2	O2□□□□=nnnnnnppm O2□□□□=nnnnnn%	Refer for oxygen concentration.
3	?emf	EMF□□□=nnnnnn	Refer for cell electromotive force.
4	?temp	TEMP□□=nnnnnn	Refer for cell temperature.
5	?tcemf	TCEMF□=nnnnnn	Refer for thermocouple electromotive force.
6	?cjtemp	CJTEMP=nnnnnnn	Refer for cold water point of contact temperature.
7	?out	OUT□□□=nnnnmA,nnnnnmV OUT□□□=nnnnmA,nnnnnV	Refer for the recorder output.

※ The terminal cord is CR+LF.

5. Maintainance

⚠ CAUTION

To avoid an electric shock, shut off power before performing maintenance on wiring of the power supply. For the maintenance of wiring other than the power supply, shut off the power as well unless you

5-1 Receiver adjustment

5-1-1 Analog output adjustment method

4-20mA SPAN adjustment

①Display OUT1-SPAN=***** from OUT SET MODE.(Refer to P12)
②No adjustment is required if the current output is 20±0.01 mA. Push several times of "MODE" key and return indication of the LCD (indicator 2) to RANGE1 or RANGE2.
③If the current output is out of 20±0.01 mA, adjust the numbers to 20 mA using 「▲、▼」 and 「◀、▶」 keys.
④Press 「ENT」 key. (The changed data is written.)

4-20mA ZERO adjustment

①Display OUT1-ZERO=***** from OUT SET MODE.(Refer to P12)
②No adjustment is required if the current output is 4±0.01 mA. Push several times of "MODE" key and return indication of the LCD (indicator 2) to RANGE1 or RANGE2.
③If the current output is out of 4±0.01 mA, adjust the numbers to 4 mA using 「▲、▼」 and 「◀、▶」 keys.
④Press 「ENT」 key. (The changed data is written.)

0-10mV(0-1V) SPAN adjustment

①Display OUT2-SPAN=***** from OUT SET MODE.(Refer to P12)
②No adjustment is required if the current output is 10±0.01 mV(1±0.001V). Push several times of "MODE" key and return indication of the LCD (indicator 2) to RANGE1 or RANGE2.
③If the current output is out of 10±0.01 mV(1±0.001V), adjust the numbers to 10 mV (1V)using 「▲、▼」 and 「◀、▶」 keys.
④Press 「ENT」 key. (The changed data is written.)

0-10mV(0-1V) ZERO adjustment

①Display OUT2-ZERO=***** from OUT SET MODE.(Refer to P12)
②No adjustment is required if the current output is 0±0.01 mV(0±0.001V). Push several times of "MODE" key and return indication of the LCD (indicator 2) to RANGE1 or RANGE2.
③If the current output is out of 0±0.01 mV(0±0.001V), adjust the numbers to 0 mV (0V)using 「▲、▼」 and 「◀、▶」 keys.
④Press 「ENT」 key. (The changed data is written.)

CAUTION

To avoid burns, shut off the power and let it cool down before performing maintenance on the transmitter units. Note that other parts may be very hot as well.

5-1-2 Procedure for exchanging the sensor

(1) Remove four screws in the corners and top of the housing and remove the housing upward.

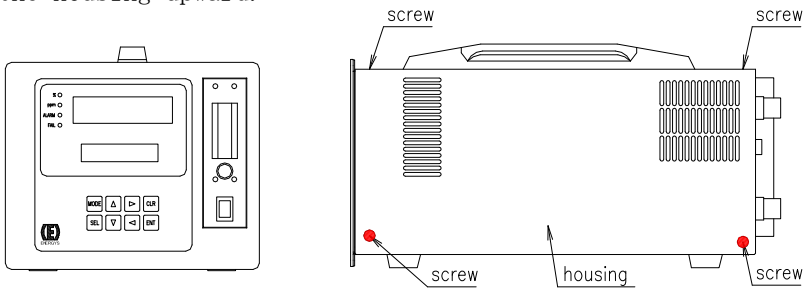


Fig. 1

(2) Loosen the tightening plugs fixed to the transmitter unit sealing device on the both sides of the transmitter unit and then remove the gas inlet and outlet piping.

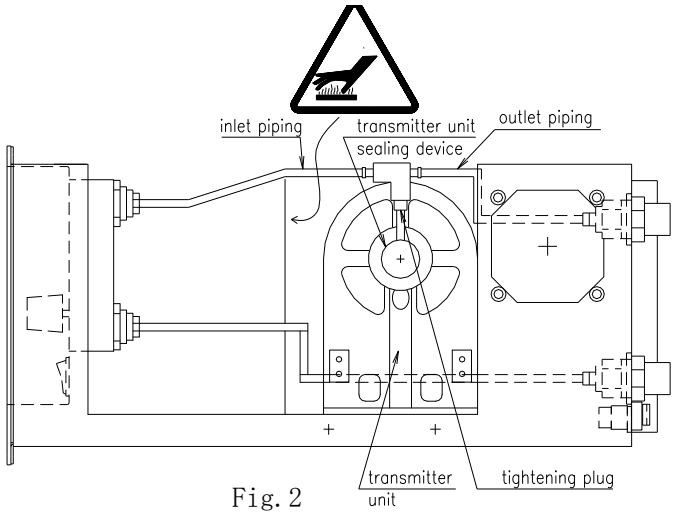


Fig. 2

(3) Remove the CELL lead wires, + - , connected to 3 and 4 of the terminal platform of the transmitter unit.

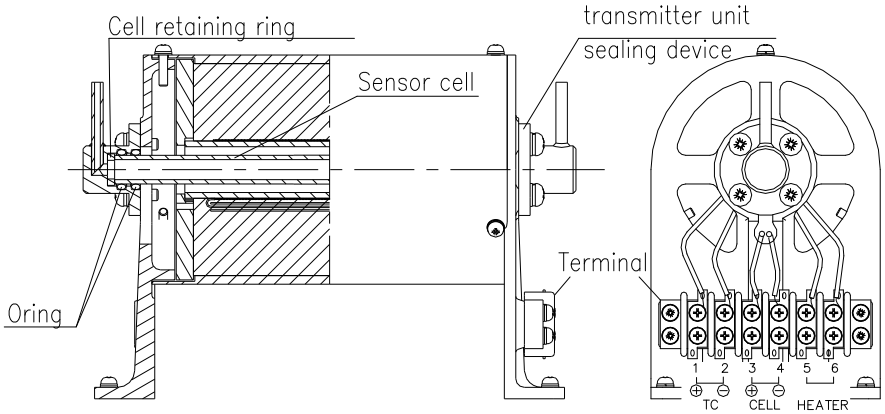


Fig. 3

(4) Remove screws (each 4 on one side) for fixing the transmitter unit sealing device and pull out the transmitter unit sealing device slowly outward to the same direction as the axis of the screws.

(Note: Remove the transmitter unit sealing device from the side the terminal platform is equipped.)

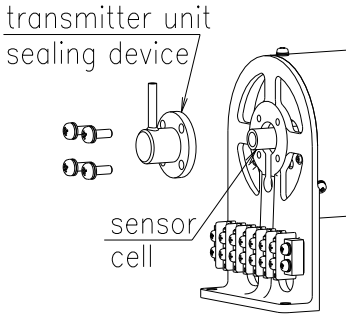


Fig. 4

(5) Remove the O-ring(two on one side) and cell retaining ring(one on one side) located in the transmitter unit sealing device.

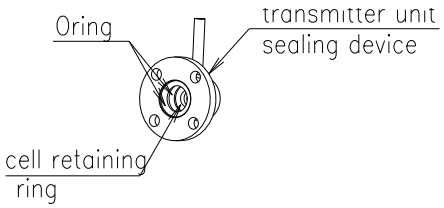


Fig. 5

(6) Pull out the sensor cell gently to the side the terminal platform is equipped.

(7) Insert the new sensor cell from the side of the terminal platform with the cell lead wire backward. Place the cell lead wire in the round hole on the lower side of the transmitter unit.

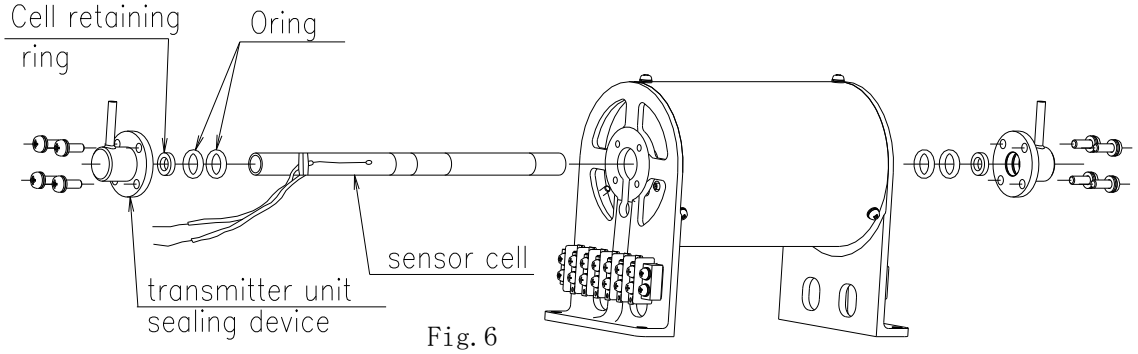


Fig. 6

(8) Match the position of the projecting portion of the detection cell sides is substantially equal. Apply a thin coat fluorine grease(Heat-resistant temperature 260 ℃ or higher) to 10mm range from both ends of the detection cell outer peripheral surface.(Wipe off the fluorine grease adhering to the outside of the specified range.)

(9) Attach the cell retaining ring (one on one side) and the O ring (two on one side) for the transmitter unit sealing device. Inserted the transmitter unit sealing device from the opposite side of the terminal block to the sensor cell and align the screw holes of the originating unit and screwed. In this case, leave holding lightly by hand detection cell edge surface of the side of the terminal block.

(10) Next,the side of the terminal stand inserts transmitter unit sealing device in a sensor cell equally and screwed.

(11) Connect the cell lead wires, ⊕ ⊖, to 3 and 4 of the terminal platform. Refer to Fig. 3.

(12) Connect the gas inlet and outlet piping. Refer to Fig. 2.

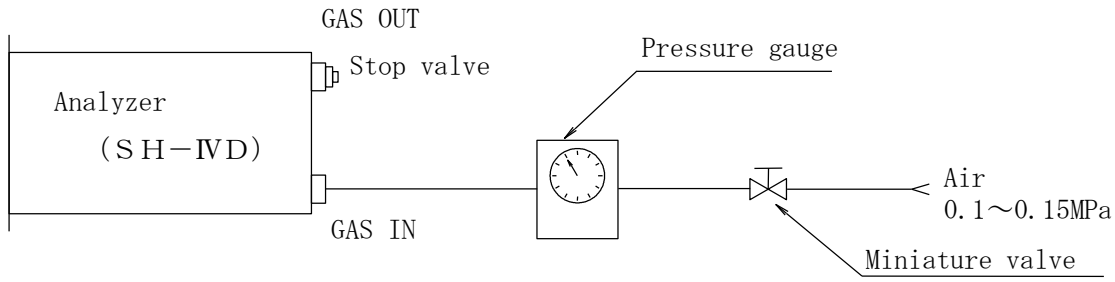
(13) Perform leak check. (Refer to P21)

(14) Screw the housing. Refer to Fig. 1.

5-1-3 Leak test

Order	Procedure	Remarks
1	Stop the GAS OUT rear of the Analyzer with PT 1/4 stop cock.	
2	Pressurize with air of approx. 0.1 MPa from GAS IN side by the flow diagram shown below.	Keep the valve in front of the flowmeter fully open.
3	Preform the leak test of all joints including GAS IN, GAS OUT, flowmeter inlet and outlet, transmitter inlet and outlet.	Perform the leak test with Mondu solution. (soap soln.)
4	Check the leak by pressure drop. ① Close the miniature valve at the position the pressure gauge indicates ca. 0.1 MPa and stood for ca. 5 min. ② Read the pressuer gauge after 5 min. and read it again 10 min. later. ③ Derive the difference between the two readings, ΔP. It stands the test when ≦ 1kPa.	Criteron: ΔP ≦ 1kPa If Δ P ＞ 1kPa, perform item 3 again and repair the leak and perform item 4.

Flow diagram of leak test



5-2 About transmitter

Please download the Safety Data Sheet (SDS) for IsoWool Blanket (artificial mineral fiber) used in the transmitter unit of this product from our homepage.

6. Error

6-1 Error display

When abnormality occurs, display an errno to 7- segment LED or LCD.

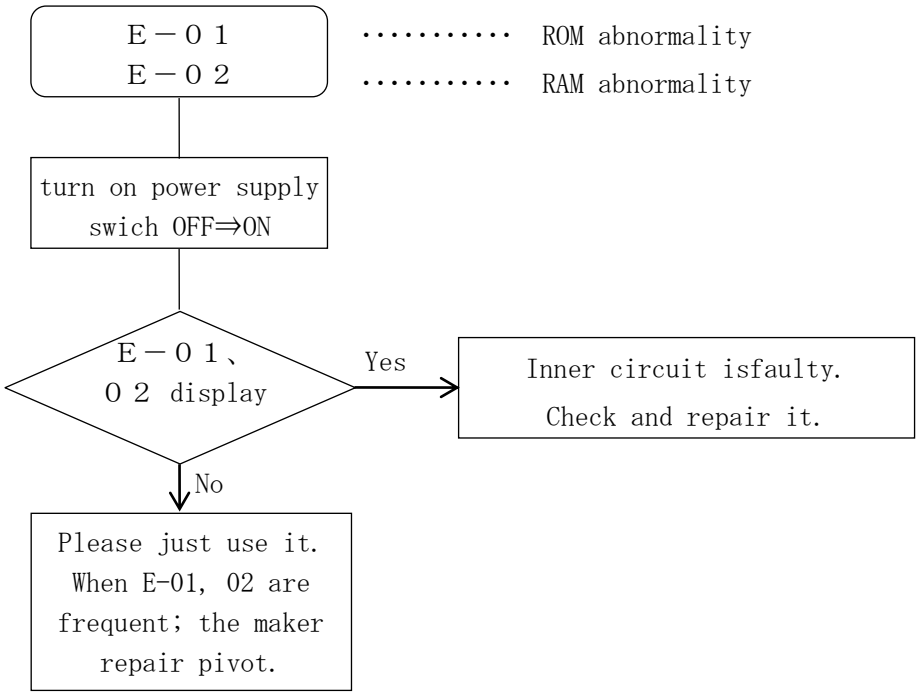
An oxygen concentration operation function and the heater control continue by the contents of the error automatically then or cancel it.

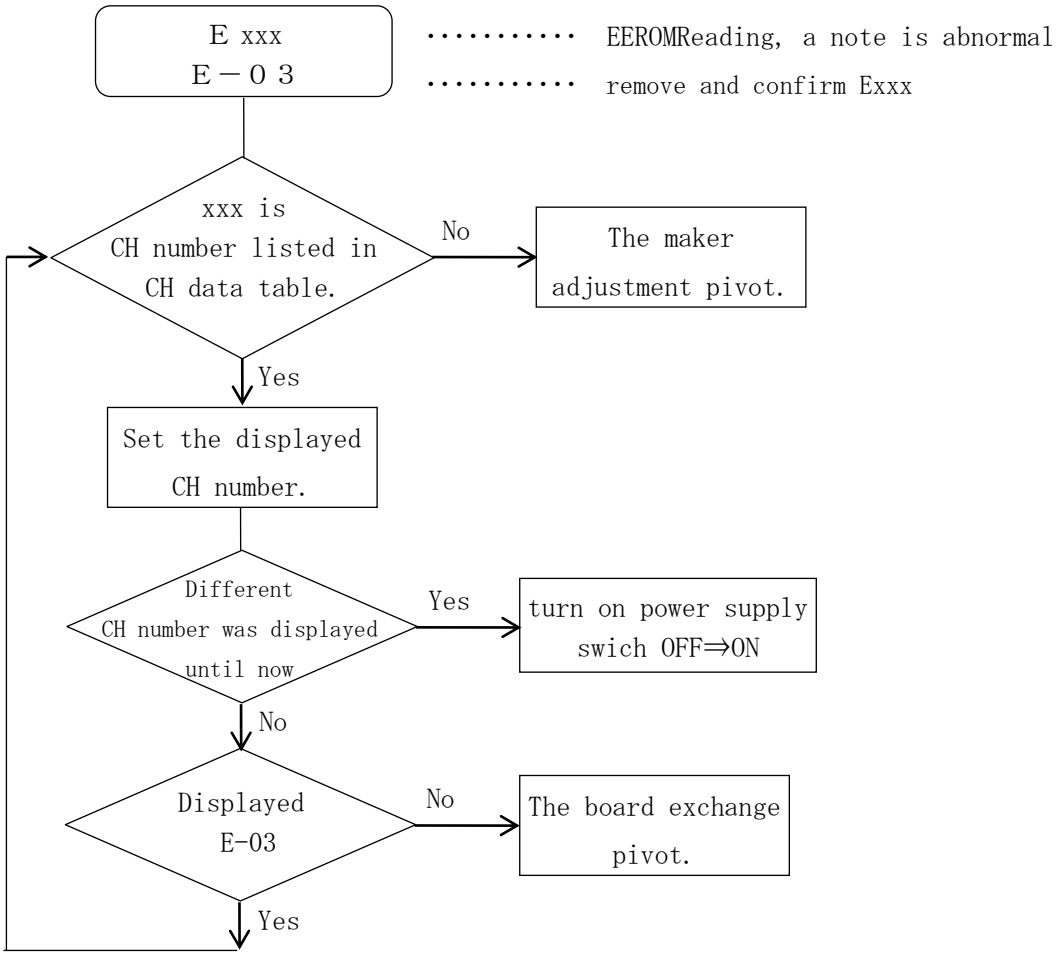
LED	LCD	Contents	Cancellation	Movement
E-01	—	ROM error	Automatically return	Non-movement
E-02	—	RAM error	Automatically return	Non-movement
Exxx	—	Abnormality of reading data of EEROM	Normal value note	Measurement cancellation
Exxx	—	Abnormality of note movement for EEROM	Normal value note	Measurement cancellation
E-03	—	remove and confirm Exxx	Normal value note	Measurement cancellation
E-07	—	Analyzer cooling is abnormal	CLR-ENT	Measurement cancellation
—	Key swich error	The key pressing detection is abnormal	Automatically return	Continuation movement
—	LCD error	LCD control abnormality	Automatically return	Continuation movement
E-10	—	Elevated temperature abnormality	CLR-ENT	Measurement cancellation
E-11	—	Cell temperature low abnormality	CLR-ENT	Measurement cancellation
E-12	—	Cell temperature high abnormality	CLR-ENT	Measurement cancellation
E-13	—	Thermocouple disconnection	CLR-ENT	Measurement cancellation
E-14	—	Thermocouple reverse wiring	CLR-ENT	Measurement cancellation
E-15	—	Thermistor disconnection	CLR-ENT	Measurement cancellation
E-20	—	Cell electromotive force abnormality	Automatically return	Continuationt thermoregulate
—	Cal 1 error	Calibration abnormality 1	Automatically return	Continuation movement
—	Cal 2 error	Calibration abnormality 2	Automatically return	Continuation movement
—	Cal 3 error	Calibration abnormality 3	Automatically return	Continuation movement
—	Cal 4 error	Calibration abnormality 4	Automatically return	Continuation movement
—	Parity error	Communication abnormality parity	Automatically return	Automatically return
-	Overrun error	Communication abnormality overrun	Automatically return	Automatically return
-	Packet error	Communication abnormality packet	Automatically return	Automatically return

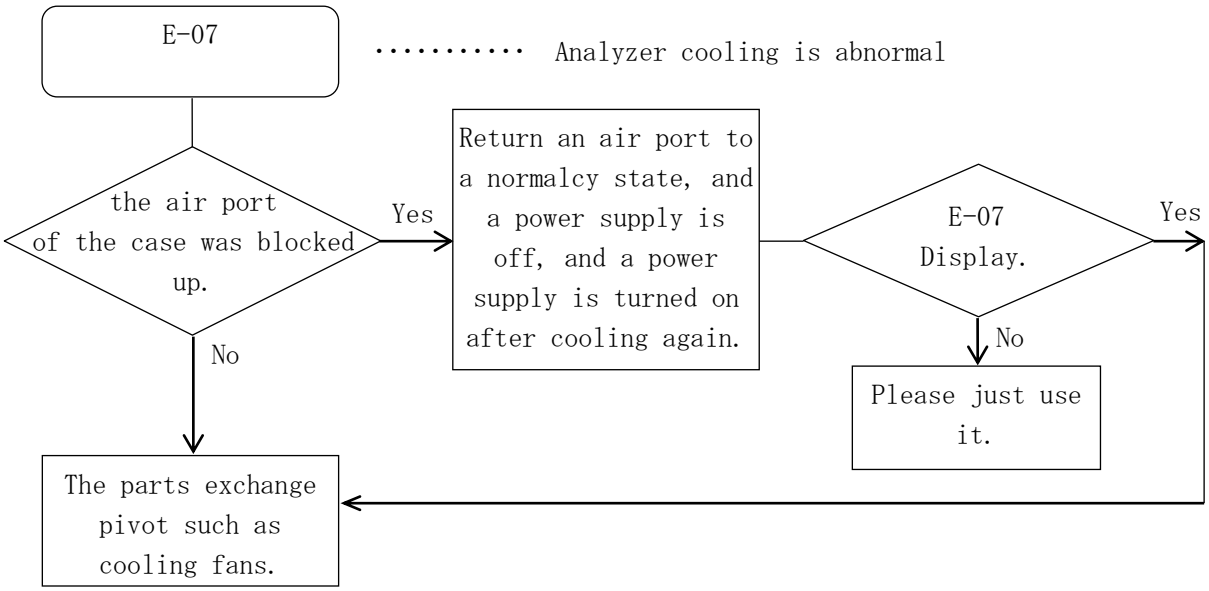
* As for the indication of the LED, E-01, E-02 do not flash on and off.
  The indication of 7 other Segou LED flashes on and off.
* As for the abnormality of EEROM, an abnormal channel number is displayed by LCD.
 (position of xxx out of the table)
*Continuationt thermoregulate : The oxygen density operation stops,
and the heater control continues.
* Measurement cancellation : The oxygen density operation stops,
and the heater control stops, too.

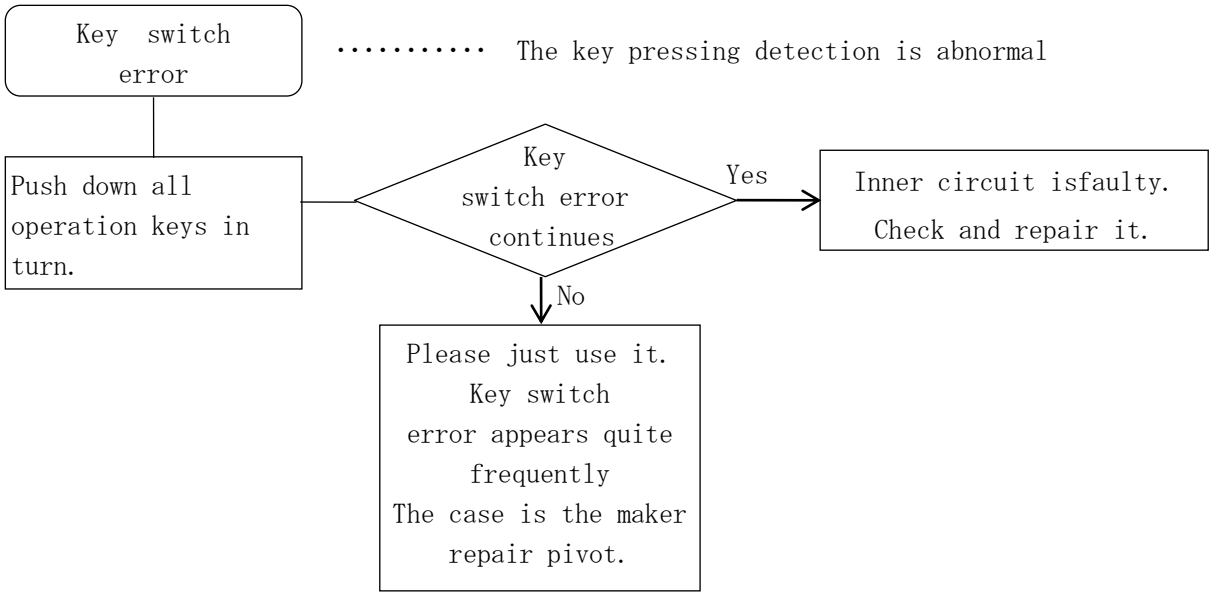
LED or LCD	Standard
E-01	At the time of start, when the check sum of the program cord does not accord.
E-02	At the time of start, when an RAM check is abnormal.
Exxx	When the check sum of the CH data which began to read at the time of start does not match or there are data out of a range.
Exxx	When cannot renew data.
E-03	When removed all Exxx.
E-07	When the temperature of the cold water point of contact is beyond a standard.
Key swich error	When detected keys consecutive pressing more than 30 seconds.
LCD error	When there is not a reply by communication with the LCD.
E-10	When elevated temperature is not finished within setting time.
E-11	When cell temperature decreased than a set point.
E-12	When cell temperature rose than a set point.
E-13	When it is more than 20mV at the age of R thermocouple more than 40mV at the age of K thermocouple.
E-14	When it became less than -50 degrees Celsius in terms of temperature.
E-15	When the partial pressure ratio became than 0.95.
E-20	When cell electromotive force fell than -50mV.
Cal 1 error	When cell electromotive force of calibration gas No. 1 became outside a tolerance range.
Cal 2 error	When cell electromotive force of calibration gas No. 2 became outside a tolerance range.
Cal 3 error	When cell electromotive force of calibration gas No. 3 became outside a tolerance range.
Cal 4 error	When cell electromotive force of calibration gas No. 4 became outside a tolerance range.
Parity error	When parity abnormality occurred at the time of the reception.
Overrun error	When the next data have been sent before handling reception data.
Packet error	When framing abnormality occurred at the time of the reception.

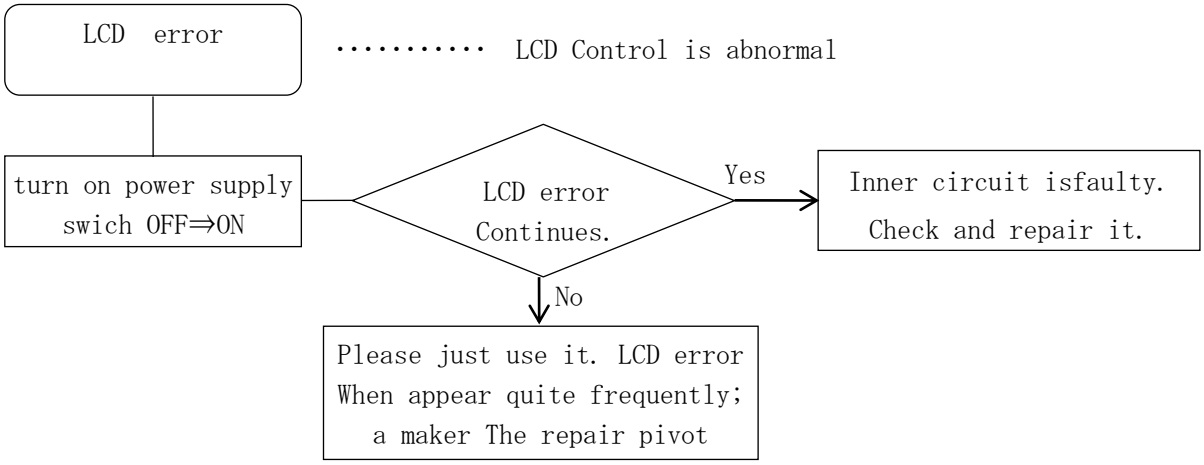
6-2 How to cope with errors

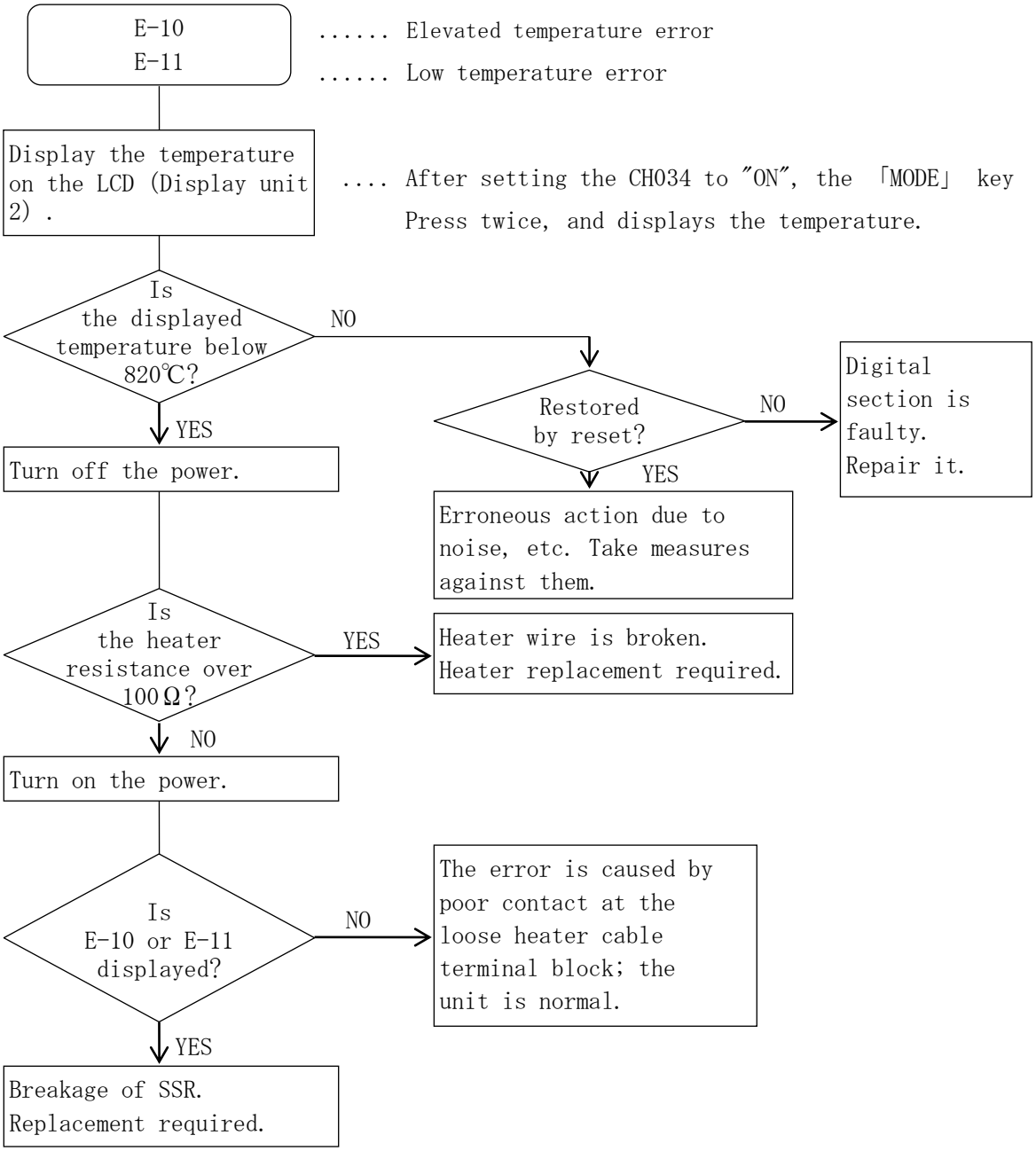

E－０１
E－０２
ROM abnormality
RAM abnormality
turn on power supply
swich OFF⇒ON
E－０１、
０２ display
Yes
Inner circuit isfaulty.
Check and repair it.
No
Please just use it.
When E-01, 02 are
frequent; the maker
repair pivot.

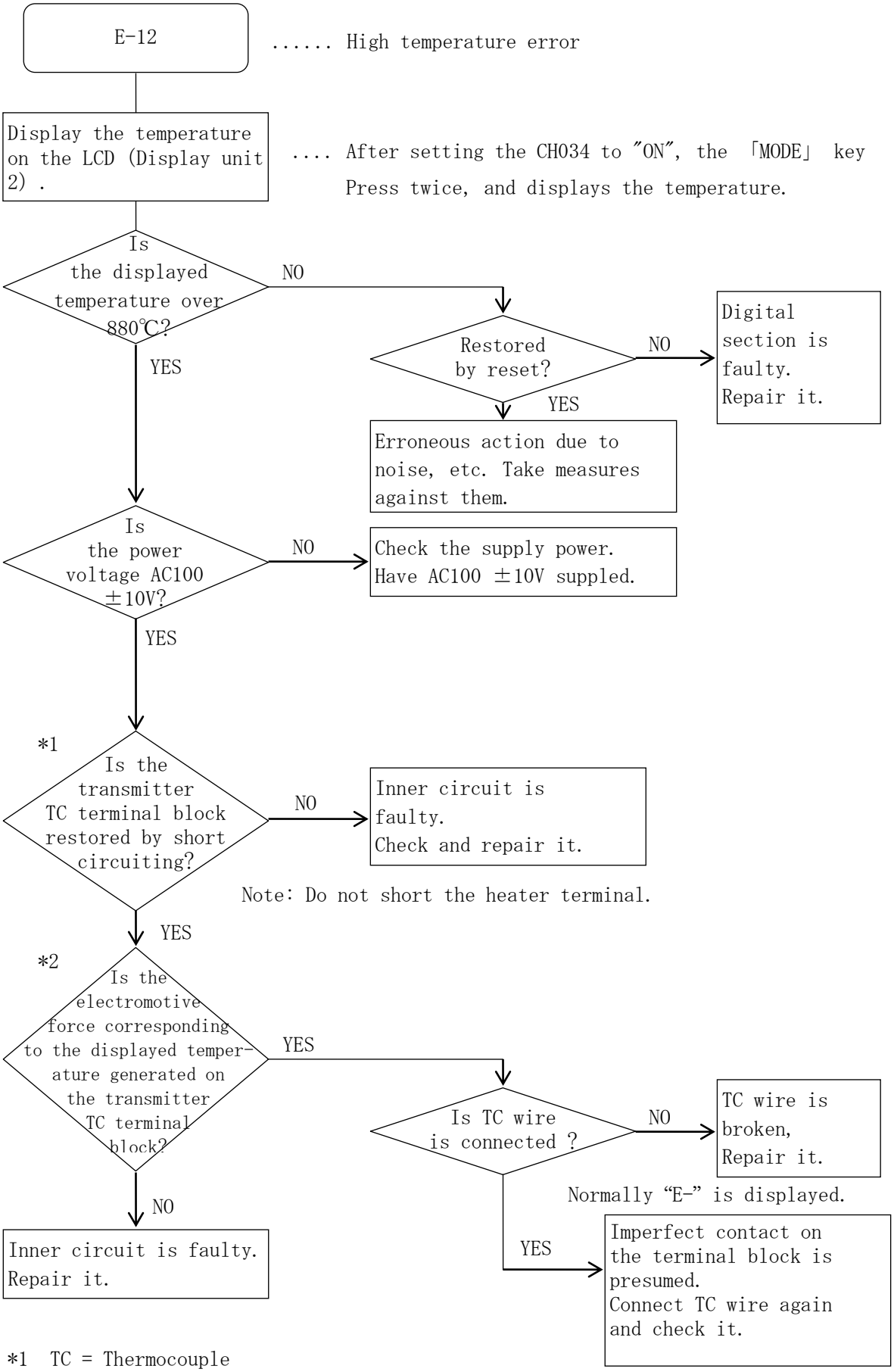

E xxx
E－０３
EEROMReading, a note is abnormal
remove and confirm Exxx
xxx is
CH number listed in
CH data table.
No
The maker
adjustment pivot.
Yes
Set the displayed
CH number.
Different
CH number was displayed
until now
Yes
turn on power supply
swich OFF⇒ON
No
Displayed
E-03
No
The board exchange
pivot.
Yes


E-07
Analyzer cooling is abnormal
the air port of the case was blocked up.
Yes
No
Return an air port to a normalcy state, and a power supply is off, and a power supply is turned on after cooling again.
E-07 Display.
Yes
No
Please just use it.
The parts exchange pivot such as cooling fans.


Key switch error
The key pressing detection is abnormal
Push down all operation keys in turn.
Key switch error continues
Yes
Inner circuit isfaulty. Check and repair it.
No
Please just use it. Key switch error appears quite frequently The case is the maker repair pivot.

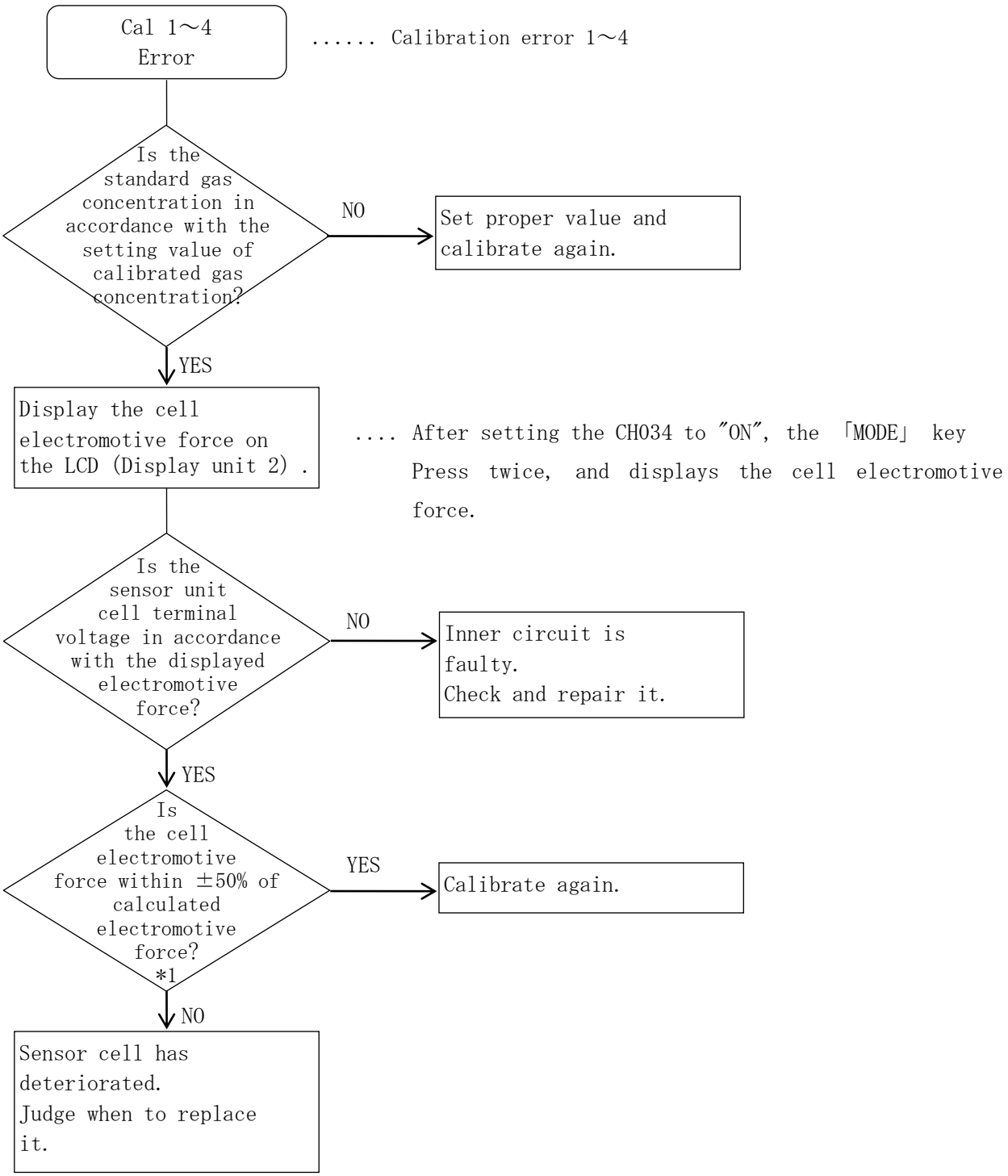

LCD error
LCD Control is abnormal
turn on power supply swich OFF⇒ON
LCD error Continues.
Yes
Inner circuit isfaulty. Check and repair it.
No
Please just use it. LCD error When appear quite frequently; a maker The repair pivot


E-10
E-11
..... Elevated temperature error
..... Low temperature error
Display the temperature on the LCD (Display unit 2) .
.... After setting the CH034 to "ON", the 「MODE」 key Press twice, and displays the temperature.
Is the displayed temperature below 820℃?
NO
YES
Turn off the power.
Restored by reset?
NO
YES
Digital section is faulty. Repair it.
Erroneous action due to noise, etc. Take measures against them.
Is the heater resistance over 100Ω?
YES
Heater wire is broken. Heater replacement required.
NO
Turn on the power.
Is E-10 or E-11 displayed?
NO
The error is caused by poor contact at the loose heater cable terminal block; the unit is normal.
YES
Breakage of SSR. Replacement required.

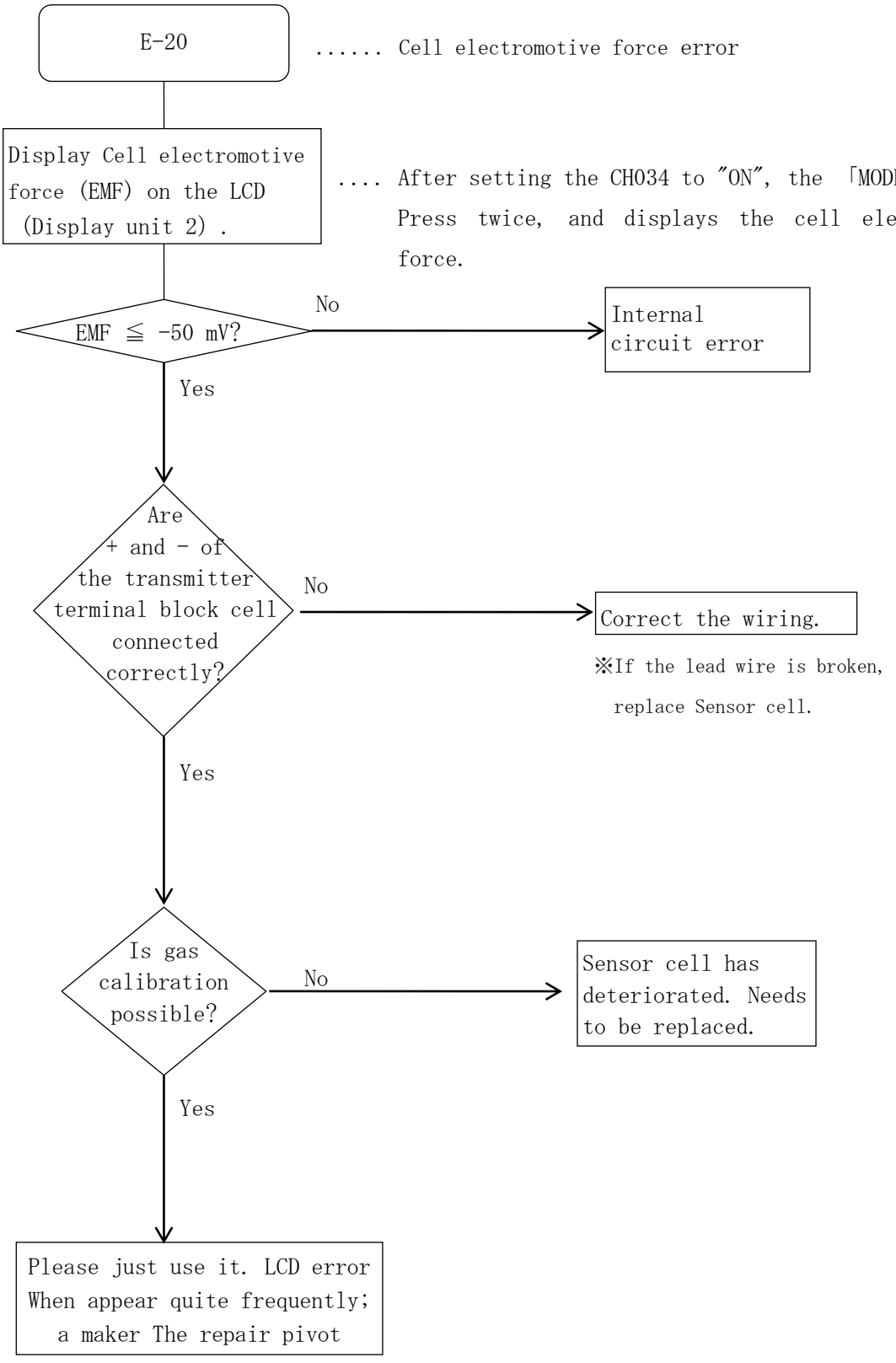


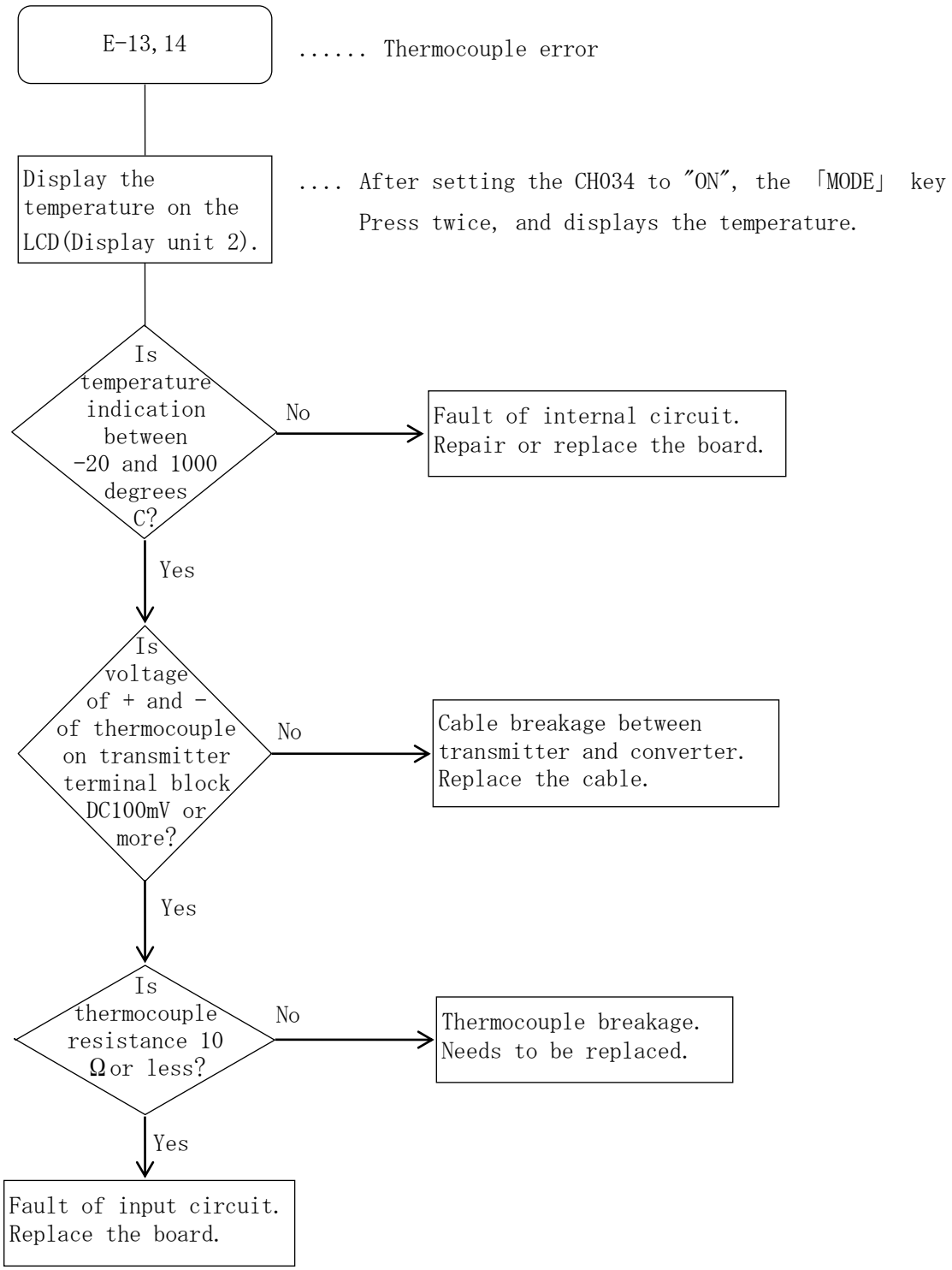
*1 TC = Thermocouple

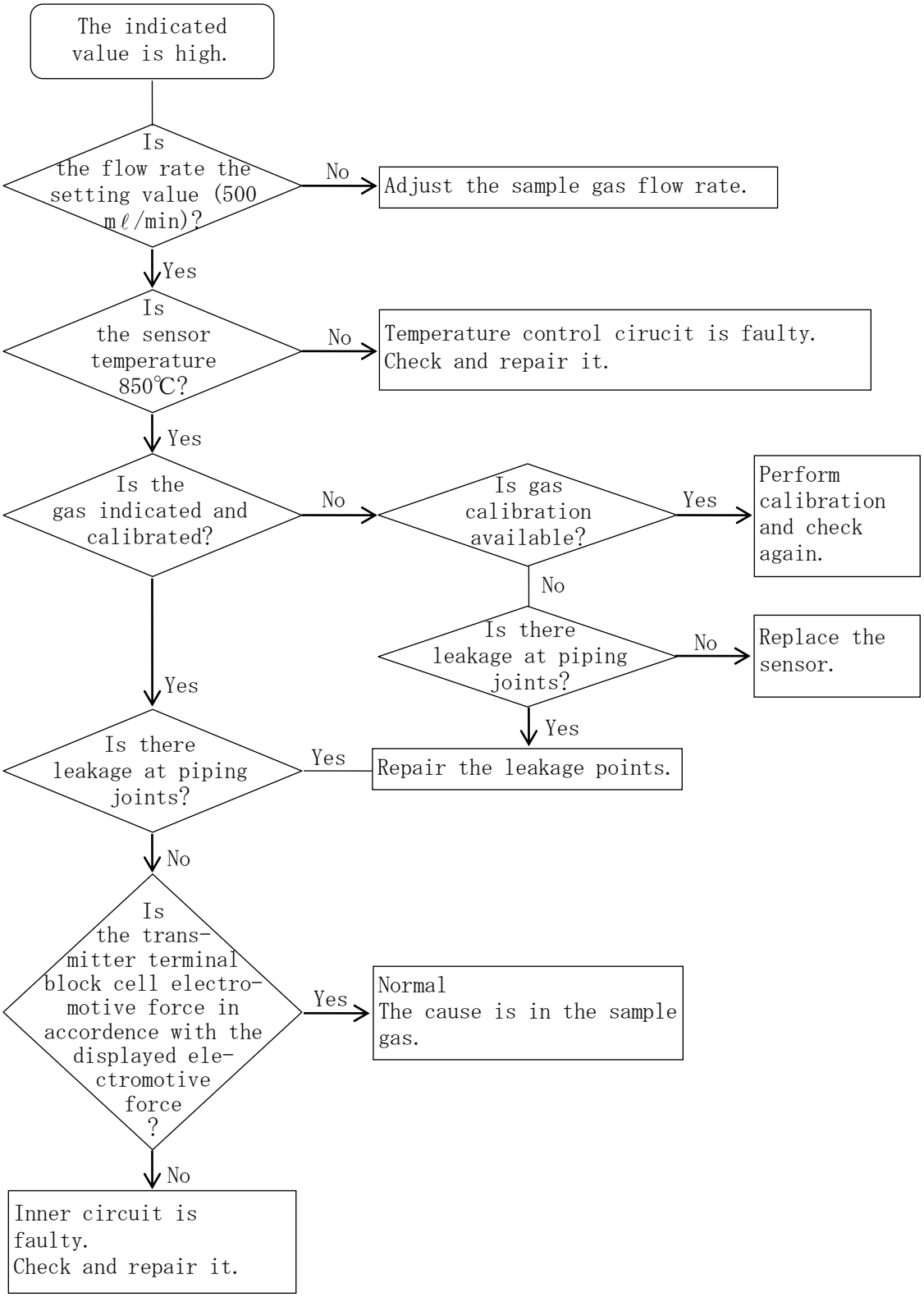
*2 Refer to page 43 for the table of relationship between the temperature and R-thermocouple-standard thermal electromotive force.

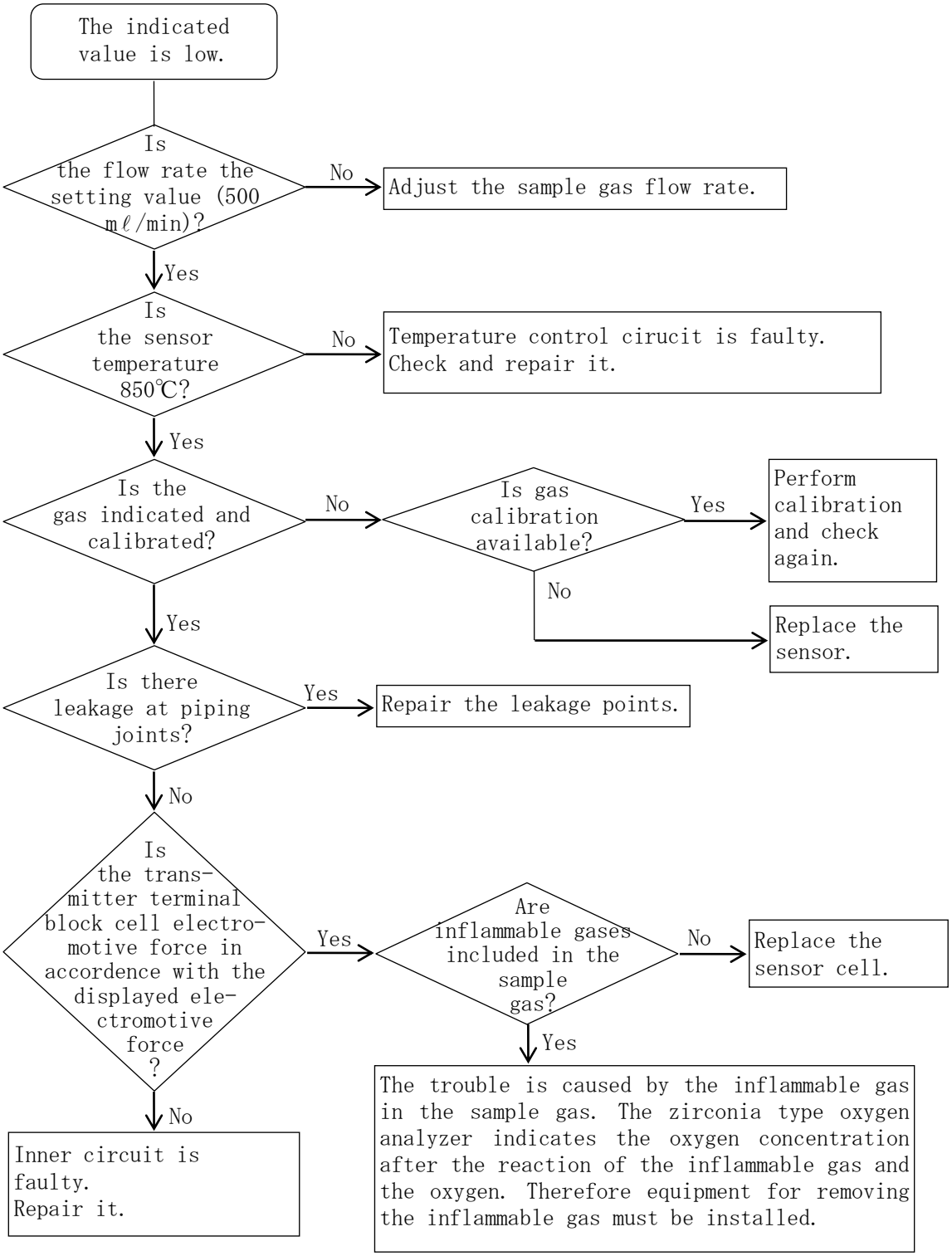


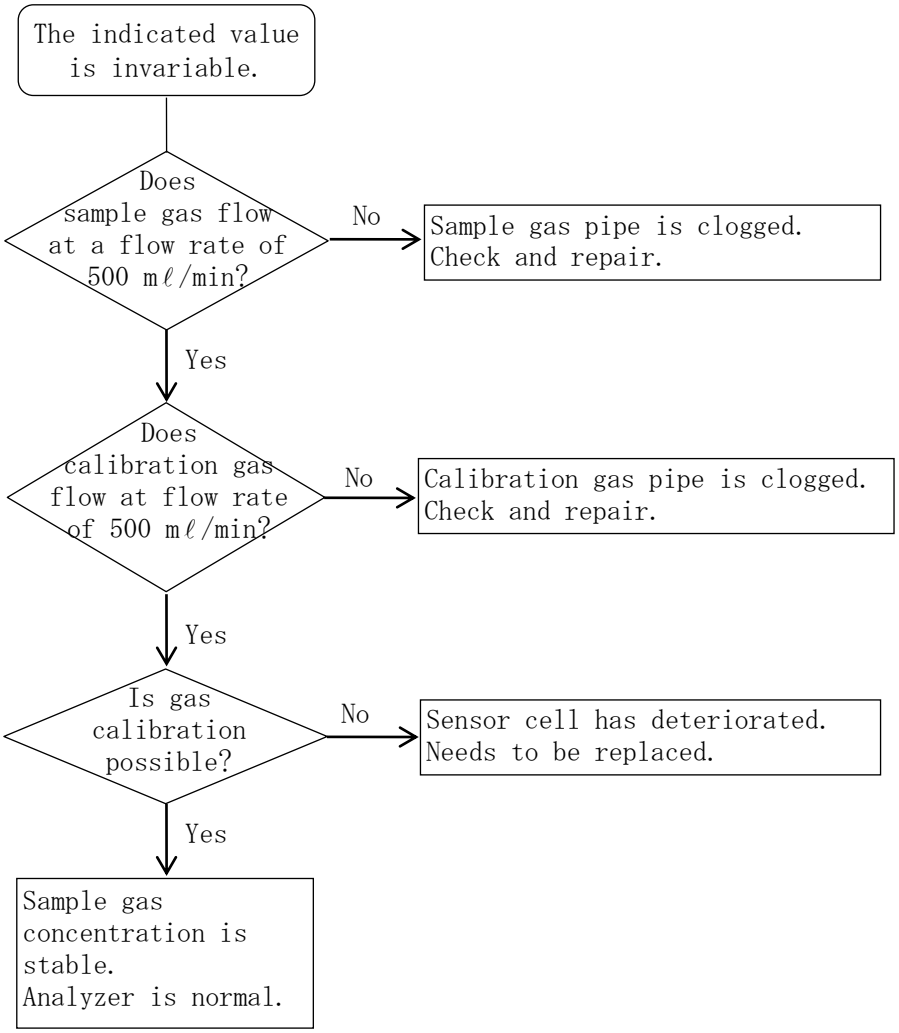
*1 When the calculated cell electromotive force is |20 mV|, is the cell electromotive force within the calculated cell electromotive force by ±10 mV?
Characteristic diagram of cell electromotive force and the oxygen concentration can be found in 38 and 39 pages.

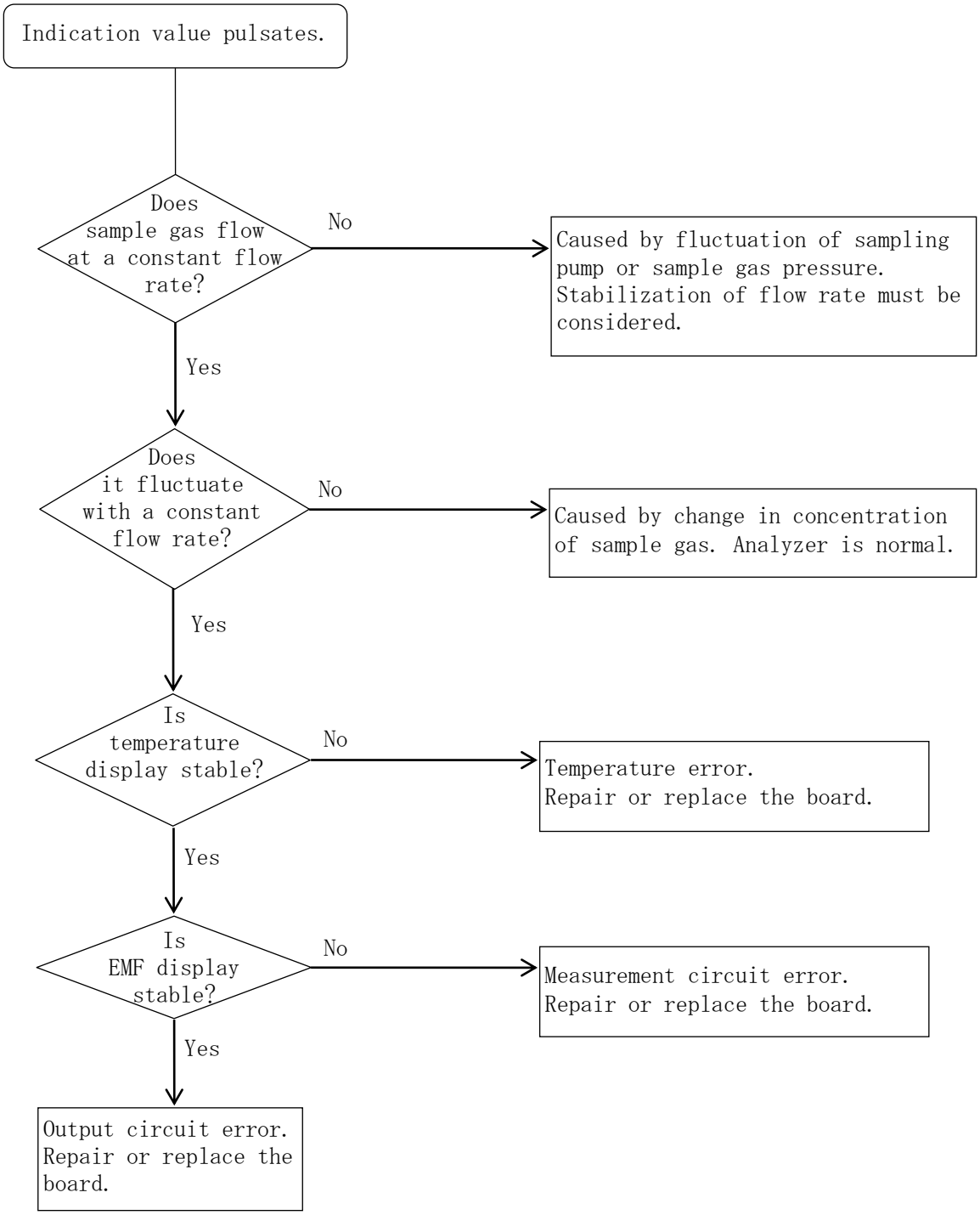

E-20
..... Cell electromotive force error
Display Cell electromotive force (EMF) on the LCD (Display unit 2) .
.... After setting the CH034 to "ON", the 「MODE」 key Press twice, and displays the cell electromotive force.
EMF ≦ -50 mV?
No
Internal circuit error
Yes
Are + and - of the transmitter terminal block cell connected correctly?
No
Correct the wiring.
※If the lead wire is broken, replace Sensor cell.
Yes
Is gas calibration possible?
No
Sensor cell has deteriorated. Needs to be replaced.
Yes
Please just use it. LCD error When appear quite frequently; a maker The repair pivot

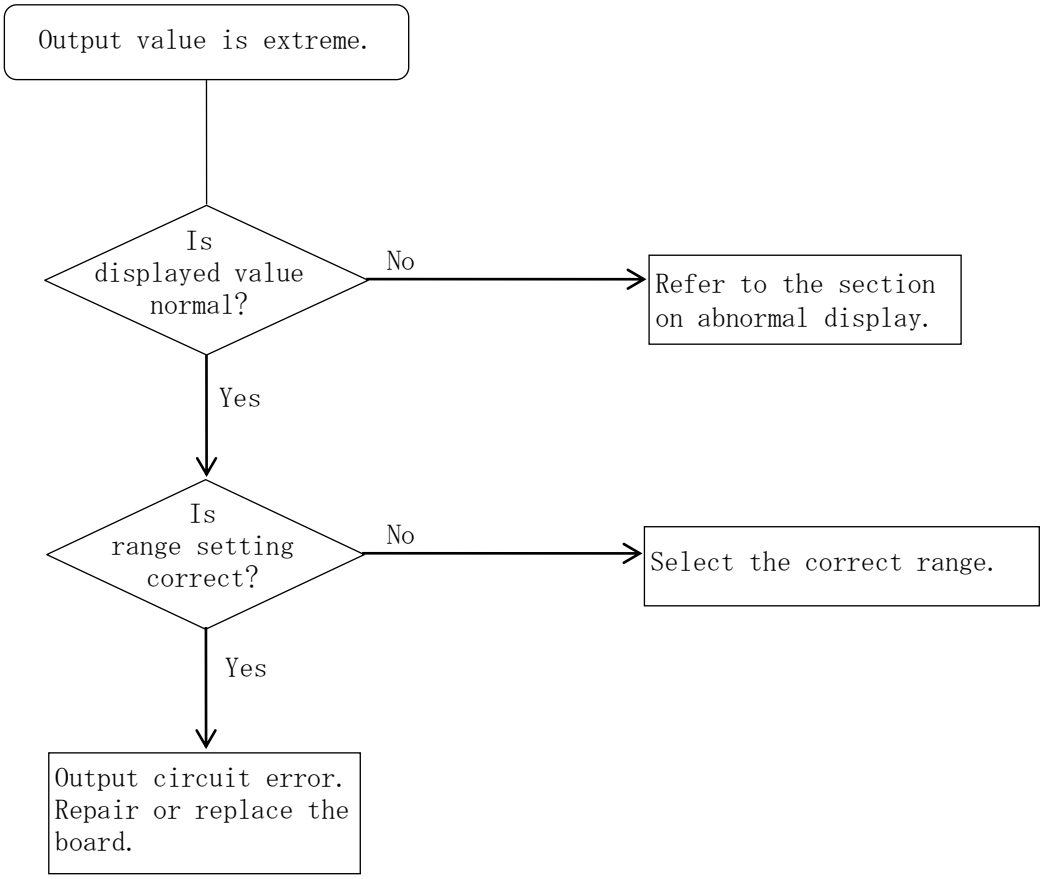

E-13,14
..... Thermocouple error
Display the temperature on the LCD(Display unit 2).
.... After setting the CH034 to "ON", the 「MODE」 key Press twice, and displays the temperature.
Is temperature indication between -20 and 1000 degrees C?
No
Fault of internal circuit. Repair or replace the board.
Yes
Is voltage of + and - of thermocouple on transmitter terminal block DC100mV or more?
No
Cable breakage between transmitter and converter. Replace the cable.
Yes
Is thermocouple resistance 10 Ωor less?
No
Thermocouple breakage. Needs to be replaced.
Yes
Fault of input circuit. Replace the board.

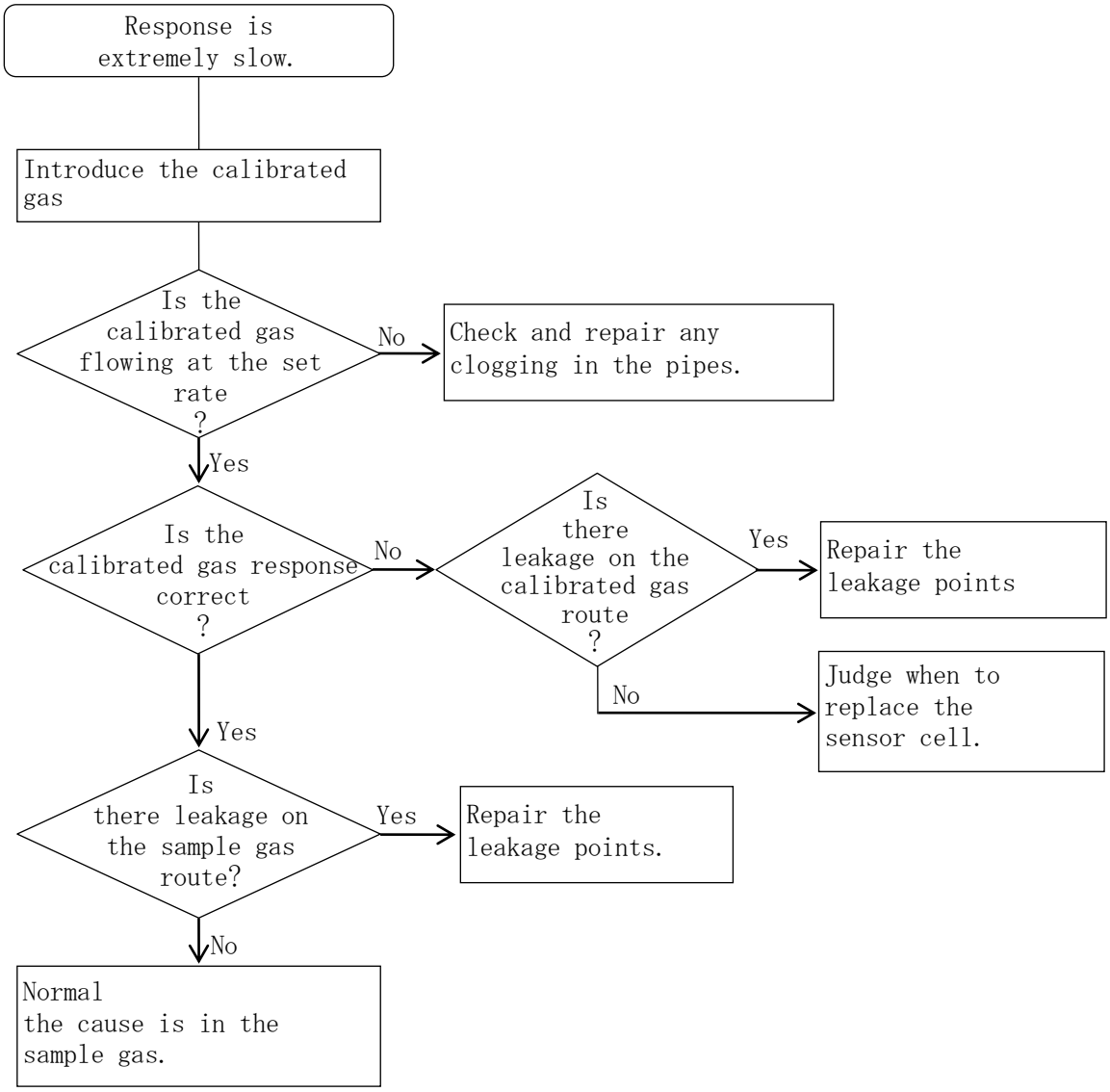

The indicated value is high.
Is the flow rate the setting value (500 mℓ/min)?
No
Adjust the sample gas flow rate.
Yes
Is the sensor temperature 850℃?
No
Temperature control cirucit is faulty. Check and repair it.
Yes
Is the gas indicated and calibrated?
No
Is gas calibration available?
Yes
Perform calibration and check again.
No
Is there leakage at piping joints?
No
Replace the sensor.
Yes
Yes
Is there leakage at piping joints?
Yes
Repair the leakage points.
No
Is the trans-mitter terminal block cell electro-motive force in accordence with the displayed ele-ctromotive force ?
Yes
Normal
The cause is in the sample gas.
No
Inner circuit is faulty.
Check and repair it.

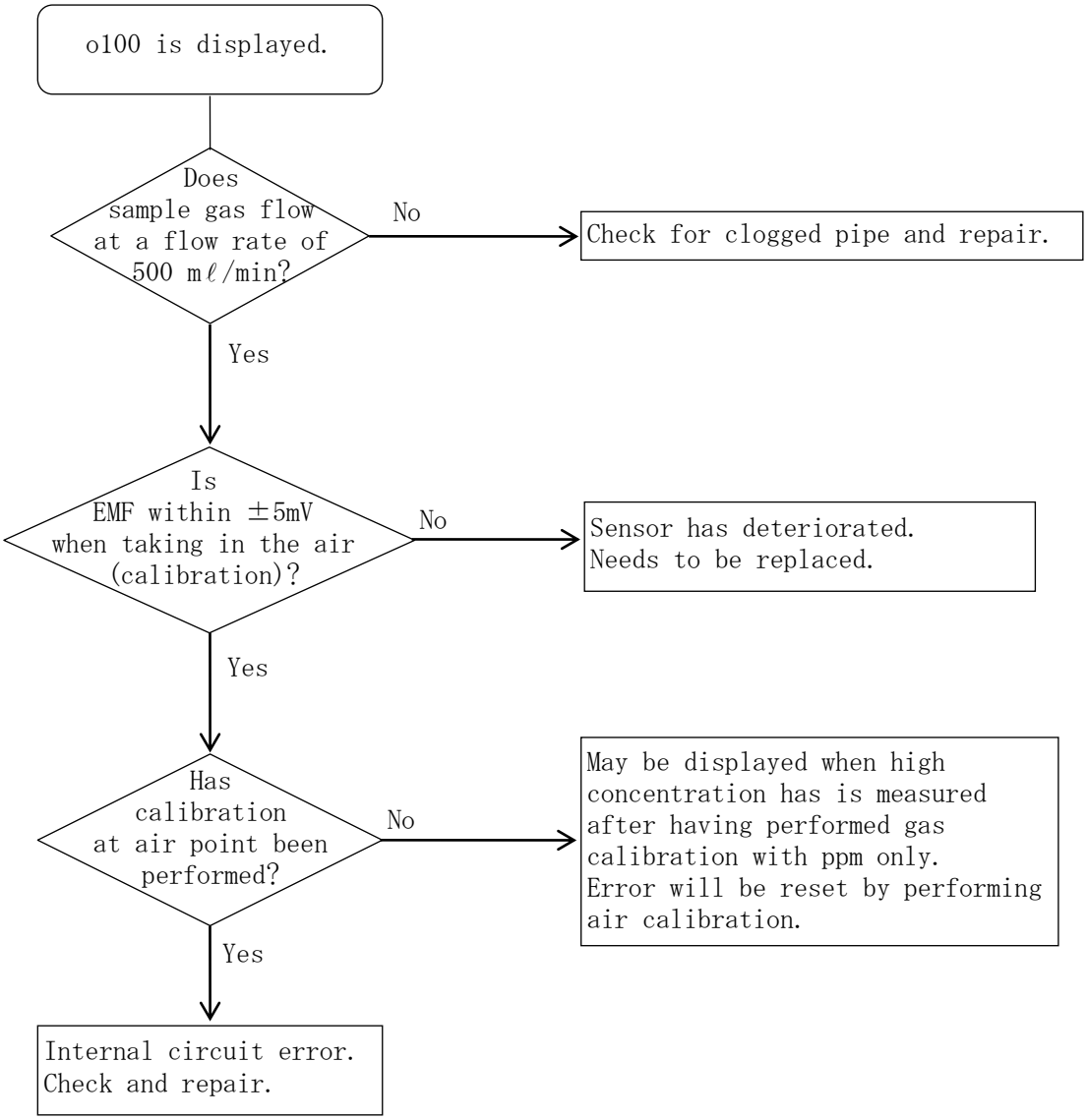

The indicated value is low.
Is the flow rate the setting value (500 mℓ/min)?
No
Adjust the sample gas flow rate.
Yes
Is the sensor temperature 850℃?
No
Temperature control cirucit is faulty. Check and repair it.
Yes
Is the gas indicated and calibrated?
No
Is gas calibration available?
Yes
Perform calibration and check again.
No
Replace the sensor.
Yes
Is there leakage at piping joints?
Yes
Repair the leakage points.
No
Is the trans-mitter terminal block cell electro-motive force in accordence with the displayed ele-ctromotive force ?
Yes
Are inflammable gases included in the sample gas?
No
Replace the sensor cell.
Yes
The trouble is caused by the inflammable gas in the sample gas. The zirconia type oxygen analyzer indicates the oxygen concentration after the reaction of the inflammable gas and the oxygen. Therefore equipment for removing the inflammable gas must be installed.
No
Inner circuit is faulty.
Repair it.

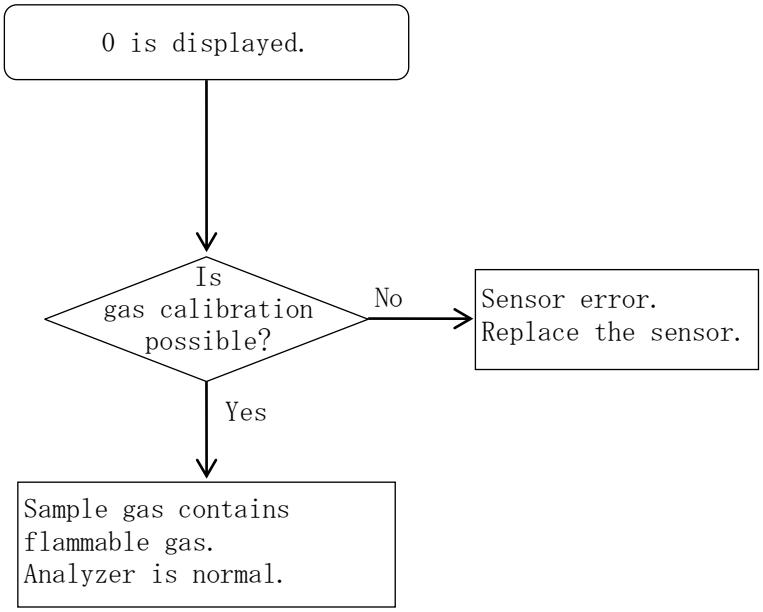

The indicated value is invariable.
Does sample gas flow at a flow rate of 500 mℓ/min?
No
Sample gas pipe is clogged. Check and repair.
Yes
Does calibration gas flow at flow rate of 500 mℓ/min?
No
Calibration gas pipe is clogged. Check and repair.
Yes
Is gas calibration possible?
No
Sensor cell has deteriorated. Needs to be replaced.
Yes
Sample gas concentration is stable. Analyzer is normal.


Indication value pulsates.
Does sample gas flow at a constant flow rate?
No
Caused by fluctuation of sampling pump or sample gas pressure. Stabilization of flow rate must be considered.
Yes
Does it fluctuate with a constant flow rate?
No
Caused by change in concentration of sample gas. Analyzer is normal.
Yes
Is temperature display stable?
No
Temperature error. Repair or replace the board.
Yes
Is EMF display stable?
No
Measurement circuit error. Repair or replace the board.
Yes
Output circuit error. Repair or replace the board.

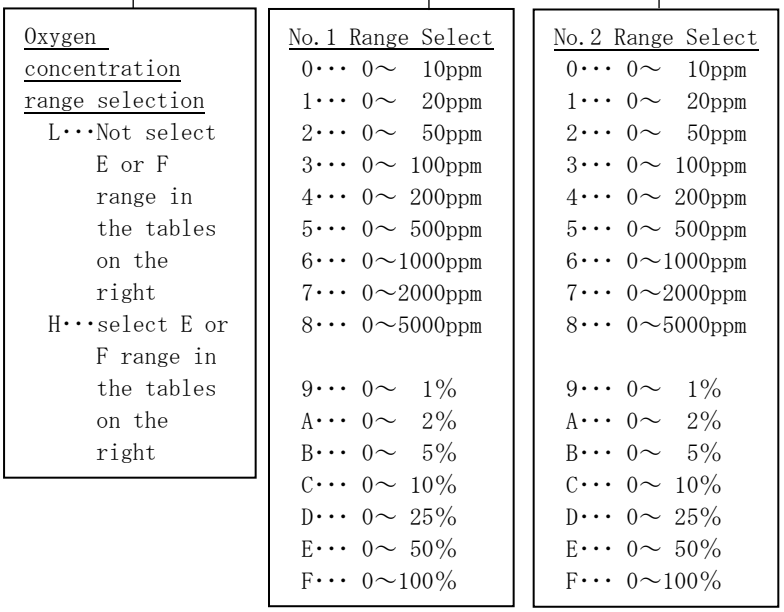

Output value is extreme.
Is displayed value normal?
No
Refer to the section on abnormal display.
Yes
Is range setting correct?
No
Select the correct range.
Yes
Output circuit error. Repair or replace the board.


Response is extremely slow.
Introduce the calibrated gas
Is the calibrated gas flowing at the set rate ?
No
Check and repair any clogging in the pipes.
Yes
Is the calibrated gas response correct ?
No
Is there leakage on the calibrated gas route ?
Yes
Repair the leakage points
No
Judge when to replace the sensor cell.
Yes
Is there leakage on the sample gas route?
Yes
Repair the leakage points.
No
Normal
the cause is in the sample gas.


o100 is displayed.
Does sample gas flow at a flow rate of 500 mℓ/min?
No
Check for clogged pipe and repair.
Yes
Is EMF within ±5mV when taking in the air (calibration)?
No
Sensor has deteriorated. Needs to be replaced.
Yes
Has calibration at air point been performed?
No
May be displayed when high concentration has is measured after having performed gas calibration with ppm only. Error will be reset by performing air calibration.
Yes
Internal circuit error. Check and repair.


0 is displayed.
Is
gas calibration
possible?
No
Sensor error.
Replace the sensor.
Yes
Sample gas contains
flammable gas.
Analyzer is normal.

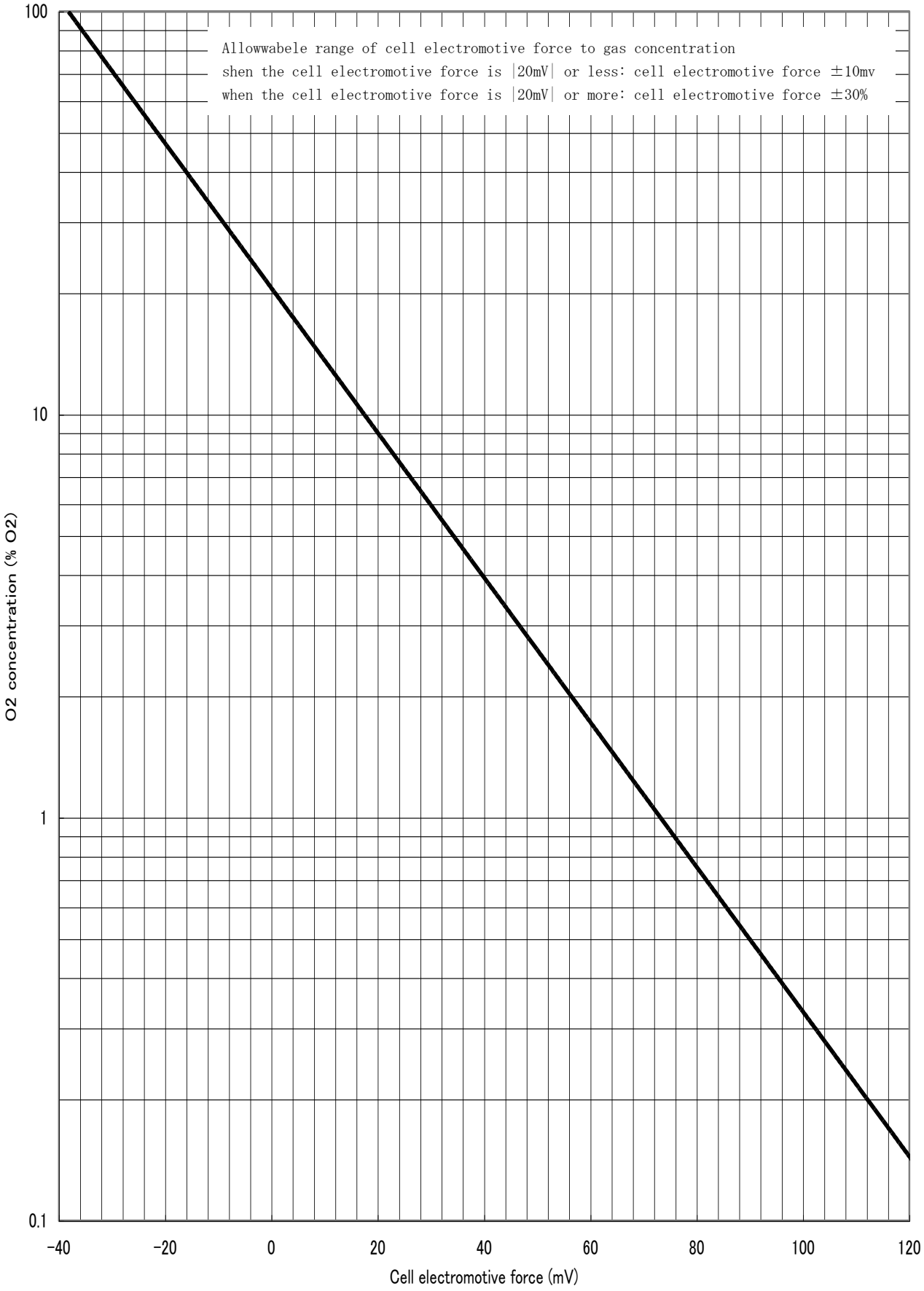
7. Specifications

Type	SH-ⅣD type
Shape CAT. No. Output Signal	Portable type RS-258400-1＊ ＊ ＊＊ (0-10mV/4-20mA) RS-258400-2＊ ＊ ＊＊ (0-1V/4-20mA) Proces type RS-258401-1＊ ＊ ＊＊ (0-10mV/4-20mA) RS-258401-2＊ ＊ ＊＊ (0-1V/4-20mA) 
Measuring range	2-range selection from 0-10, 20, 50, 100, 200, 500, 1000, 2000, 5000 ppmO_2 0-1, 2, 5, 10, 25, 50, 100%O_2 (Two ranges which are normally used)
Response time (from gas inlet)	% range 5 sec. or less (90% response) ppm range 10 sec. or less (90% response)
Accuracy (Repeatability)	% range ± 0.5% FS ppm range ± 1% FS
Output	DC 0-1V Output resistance 1kΩ (or DC 0-10 mV Output resistance 10Ω) 4-20 mA Load resistance 600Ω or less
Contact output	Error detection signal、Concentration alram Measuring range (ECHO BACK) Contact capacity DC 30V 2A (Resistance load)
Contact input	Measuring range remote changeover
Communication function	RS-232C (D-SUB9 pin)
Sampling system	Forced supply from the outside
Sample gas flow rate	To be stabe in a range of 500 ± 50 mℓ/min.
Reference gas	Atmospheric air
Ambient temperature	-5 ～ 40℃
Warm-up time	Approx. 20 min.
Outside dimensions	202W x 165H x 342D
Panel dimensions	190(±1)W x 150(±1)H
Gas connection port	Rc1/4 female screw
Weight	Approx. 6 kg
Power supply	AC 100V ± 10V; 50/60 Hz
Max power consumption	200VA

Note: When the sample gas flow rate of 500 mℓ/min cannot be introduced by the direct forced supply from the outside, a separate sampling unit is required.

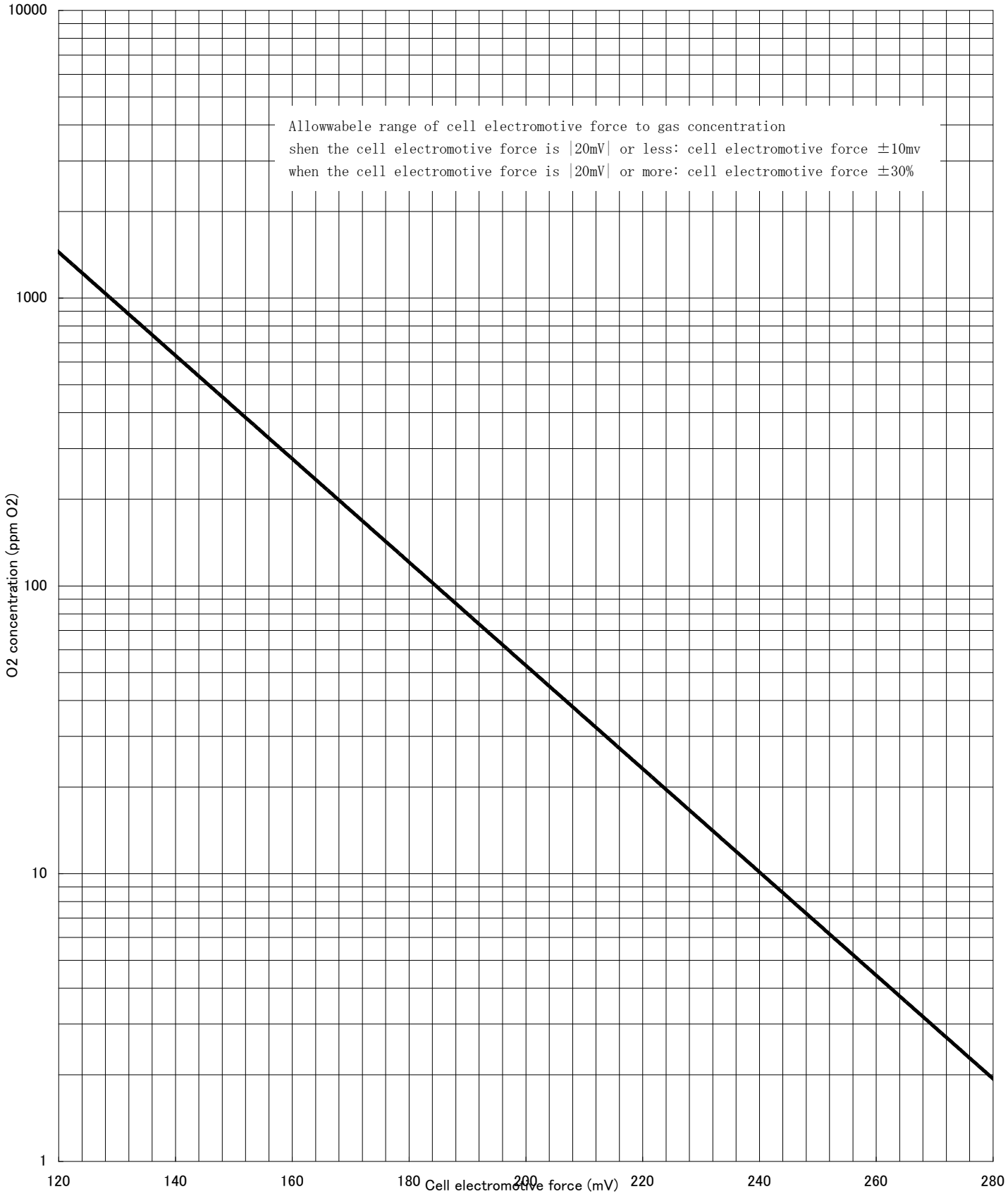
Characteristic graph of cell electromotive force

and O_2 concentration (% O_2)



Characteristic graph of cell electromotive force

and O_2 concentration (ppm O_2)



Conversion table of temperature and R thermo couple standard electromotive force

Temperature ℃	R thermocouple Electromotive force mV	Temperature ℃	R thermocouple Electromotive force mV	Temperature ℃	R thermocouple Electromotive force mV	Temperature ℃	R thermocouple Electromotive force mV
-50	-0.226	380	3.201	810	8.073	1240	13.786
-40	-0.188	390	3.304	820	8.197	1250	13.926
-30	-0.145	400	3.408	830	8.321	1260	14.066
-20	-0.100	410	3.512	840	8.446	1270	14.207
-10	-0.051	420	3.616	850	8.571	1280	14.347
0	0.000	430	3.721	860	8.697	1290	14.488
10	0.054	440	3.827	870	8.823	1300	14.629
20	0.111	450	3.933	880	8.950	1310	14.770
30	0.171	460	4.040	890	9.077	1320	14.911
40	0.232	470	4.147	900	9.205	1330	15.052
50	0.296	480	4.255	910	9.333	1340	15.193
60	0.363	490	4.363	920	9.461	1350	15.334
70	0.431	500	4.471	930	9.590	1360	15.475
80	0.501	510	4.580	940	9.720	1370	15.616
90	0.573	520	4.690	950	9.850	1380	15.758
100	0.647	530	4.800	960	9.980	1390	15.899
110	0.723	540	4.910	970	10.111	1400	16.040
120	0.800	550	5.021	980	10.242	1410	16.181
130	0.879	560	5.133	990	10.374	1420	16.323
140	0.959	570	5.245	1000	10.506	1430	16.464
150	1.041	580	5.357	1010	10.638	1440	16.605
160	1.124	590	5.470	1020	10.771	1450	16.746
170	1.208	600	5.583	1030	10.905	1460	16.887
180	1.294	610	5.697	1040	11.039	1470	17.028
190	1.381	620	5.812	1050	11.173	1480	17.169
200	1.469	630	5.926	1060	11.307	1490	17.310
210	1.558	640	6.041	1070	11.442	1500	17.451
220	1.648	650	6.157	1080	11.578	1510	17.591
230	1.739	660	6.273	1090	11.714	1520	17.732
240	1.831	670	6.390	1100	11.850	1530	17.872
250	1.923	680	6.507	1110	11.986	1540	18.012
260	2.017	690	6.625	1120	12.123	1550	18.152
270	2.112	700	6.743	1130	12.260	1560	18.292
280	2.207	710	6.861	1140	12.397	1570	18.431
290	2.304	720	6.980	1150	12.535	1580	18.571
300	2.401	730	7.100	1160	12.673	1590	18.710
310	2.498	740	7.220	1170	12.812	1600	18.849
320	2.597	750	7.340	1180	12.950	1610	18.988
330	2.696	760	7.461	1190	13.089	1620	19.126
340	2.796	770	7.583	1200	13.228	1630	19.264
350	2.896	780	7.705	1210	13.367	1640	19.402
360	2.997	790	7.827	1220	13.507	1650	19.540
370	3.099	800	7.950	1230	13.646	1660	19.677

Channel data (CH) list

CH	Content	Initial value	Range	Unit	Remarks
000	Version Display				Show program version
001	Range selection	1	1 ～ 2		Selection of Range 1 or Range 2 (External contact priority)
002	Setting the range 1	1000	1 ～ 9999		The upper limit is 100 if the %. The lower limit is 10 if the ppm.
003	Unit of Range 1	ppm	ppm / %		Rewritten and range values are also initialized (including communication)
004	Setting the Range 2	25	1 ～ 9999		The upper limit is 100 if the %. The lower limit is 10 if the ppm.
005	Unit of Range 2	%	ppm / %		Rewritten and range values are also initialized (including communication)
006	Hold settings at the time of alarm occurrence	OFF	OFF / ON		OFF: preset (holding the value of the CH007) ON: hold (held in the alarm immediately before the occurrence value)
007	Analog output preset value	0	0 ～ 100	%	When CH006 is OFF (preset), held in the specified percentage of the value of 4-20mA / 0-10mV / 0-1V
008	Analog output moving average	1	0 ～ 10	sec	
009	Analog current output zero adjustment	0	-1000 ～ 1000		The value to be added to the D / A calibration values at 4mA output (user adjustment value)
010	Analog current output span adjustment	0	-2000 ～ 2000		The value to be added to the D / A calibration values at 20mA output (user adjustment value)
011	Analog voltage output zero adjustment	0	-1000 ～ 1000		The value to be added to the D / A calibration values at 0mV/0V output (user adjustment value)
012	Analog voltage output span adjustment	0	-2000 ～ 2000		The value to be added to the D / A calibration values at 10mV/1V output (user adjustment value)
013	Setting Calibration gas concentration 1	10.00	0.10 ～ 9999.99		The upper limit is 100 if the %. The lower limit is 10 if the ppm.
014	Setting Calibration gas concentration 2	100.00	0.10 ～ 9999.99		For concentration setting of calibration gas 2 (The upper limit is 100.00 if the %.)
015	Setting Calibration gas concentration 3	1000.00	0.10 ～ 9999.99		For concentration setting of calibration gas 3 (The upper limit is 100.00 if the %.)
016	Setting Calibration gas concentration 4	20.60	0.10 ～ 9999.99		For concentration setting of calibration gas 4 (The upper limit is 100.00 if the %.)
017	Unit of Calibration gas concentration 1	ppm	NON, ppm, %		
018	Unit of Calibration gas concentration 2	ppm	NON, ppm, %		
019	Unit of Calibration gas concentration 3	ppm	NON, ppm, %		
020	Unit of Calibration gas concentration 4	%	NON, ppm, %		
021	Concentration high alarm	100.0	1 ～ 9999		(range from 0.1 to 100.0 if the %)
022	Concentration high alarm unit	%	NON, ppm, %		

CH	Content	Initial value	Range	Unit	Remarks
023	Concentration low alarm	0	0 ～ 9999		(range from 0.0 to 99.9 if the %)
024	Concentration low alarm unit	ppm	NON, ppm, %		
025	Concentration alarm detection time	1	0 ～ 3600	sec	
026	Analog output primary delay	0	0 ～ 10	sec	
027					
028					
029					
030					
031	Oxygen concentration value		—		
032	Cell electromotive force		—	mV	
033	Sensor temperature		—	℃	
034	LCD display selection	OFF	OFF / ON		OFF: NoN ON: EMF and temperature
035	Communication speed setting baud rate	9600	600 … 19200	bps	Selected from 600, 1200, 2400, 4800, 9600, 19200 (bps) Recommended by the maker value: 9600 (bps)
036	Communication settings parity	NON	NON, odd, even		
037	Setting communication mode	OFF	OFF / ON		OFF: Normal ON: measurements continuous sending
038	Transmission interval	1.0	0.1 ～ 9999.9	sec	Transmission interval in the case of setting the ON in CH037
039	Power frequency	60	50 / 60	Hz	50/60 選択
040					
041	Password	****	0 ～ 9999		For maker setting

The contents of this manual are subject to change without notice for improvement.

ENERGY SUPPORT

For inquiries regarding product handling, please contact us or our distributors.
Inquiry form URL：https://www.energys.co.jp/english/inq/all.php
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