Water Quality Meter (two-wire transmitter)
HQ-300

Instruction Manual

CODE:M001667A–3200665203–GZ0000451377A

Preface

This manual describes the operation of the Water Quality Meter (two-wire transmitter), HQ-300.
Be sure to read this manual before using the product to ensure proper and safe operation of the product. Also safely store the manual so it is readily available whenever necessary.

Product specifications and appearance, as well as the contents of this manual are subject to change without notice.

Warranty and responsibility

HORIBA Advanced Techno, Co., Ltd. warrants that the Product shall be free from defects in material and workmanship and agrees to repair or replace free of charge, at option of HORIBA Advanced Techno, Co., Ltd., any malfunctioned or damaged Product attributable to responsibility of HORIBA Advanced Techno, Co., Ltd. for a period of one (1) year from the delivery unless otherwise agreed with a written agreement. In any one of the following cases, none of the warranties set forth herein shall be extended;

- Any malfunction or damage attributable to improper operation
- Any malfunction attributable to repair or modification by any person not authorized by HORIBA Advanced Techno, Co., Ltd.
- Any malfunction or damage attributable to the use in an environment not specified in this manual
- Any malfunction or damage attributable to violation of the instructions in this manual or operations in the manner not specified in this manual
- Any malfunction or damage attributable to any cause or causes beyond the reasonable control of HORIBA Advanced Techno, Co., Ltd. such as natural disasters
- Any deterioration in appearance attributable to corrosion, rust, and so on
- Replacement of consumables

HORIBA Advanced Techno, Co., Ltd. SHALL NOT BE LIABLE FOR ANY DAMAGES RESULTING FROM ANY MALFUNCTIONS OF THE PRODUCT, ANY ERASURE OF DATA, OR ANY OTHER USES OF THE PRODUCT.

Trademarks

Company names and brand names are either registered trademarks or trademarks of the respective companies. (R), (TM) symbols may be omitted in this manual.

HART® COMMUNICATION PROTOCOL

This product is a “HART REGISTERED” products device that is certified by the FieldComm Group to conform to the HART Communication Protocol.

Compatible with HART Protocol Revision 7 HART® is a registered trademark of FieldComm Group

Regulations

Conformable Directive

This equipment conforms to the following directives and standards:

EMC: EN61326-1
Class A, Industrial electromagnetic environment

RoHS: EN50581
9. Industrial monitoring and control instruments

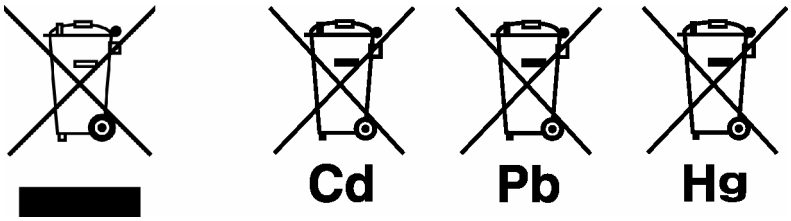
Warning: This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Note

When the sensor cable, the transmission cable, or the contact input cable is extended to 30 m or longer, the surge test specified in the EMC directive for CE marking is not applied.

Information on disposal of electrical and electronic equipment and disposal of batteries and accumulators

The crossed out wheeled bin symbol with underbar shown on the product or accompanying documents indicates the product requires appropriate treatment, collection and recycle for waste electrical and electronic equipment (WEEE) under the Directive 2012/19/EU, and/or waste batteries and accumulators under the Directive 2006/66/EC in the European Union.
The symbol might be put with one of the chemical symbols below. In this case, it satisfies the requirements of the Directive 2006/66/EC for the object chemical.
This product should not be disposed of as unsorted household waste.
Your correct disposal of WEEE, waste batteries and accumulators will contribute to reducing wasteful consumption of natural resources, and protecting human health and the environment from potential negative effects caused by hazardous substance in products.
Contact your supplier for information on applicable disposal methods.



FCC rules

Any changes or modifications not expressly approved by the party responsible for compliance shall void the user's authority to operate the equipment.

■ Warning

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.

Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Korea certification

■ A급 기기 (업무용 방송통신기자재)

이 기기는 업무용(A급) 전자파적합기기로서 판매자 또는 사용자는 이 점을 주의하시기 바라며, 가정외의 지역에서 사용하는 것을 목적으로 합니다.

For Your Safety

Hazard classification and warning symbols

Warning messages are described in the following manner. Read the messages and follow the instructions carefully.

- **Hazard classification**

⚠DANGER	This indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This is to be limited to the most extreme situations.
⚠WARNING	This indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠CAUTION	This indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

- **Warning symbols**

Description of what should be done, or what should be followed

Description of what should never be done, or what is prohibited

Safety precautions

This section provides precautions for using the product safely and correctly and to prevent injury and damage. The terms of DANGER, WARNING, and CAUTION indicate the degree of imminency and hazardous situation. Read the precautions carefully as it contains important safety messages.

⚠ WARNING
If there is a possibility of lightning, install a lightning arrester in two locations, one on the transmitter side and the other on the power supply side.
Strong acid hazard If diluted hydrochloric acid enters your eyes, it could irritate mucous membranes and eventually result in blindness. When handling hydrochloric acid, be sure to wear protective goggles, gloves, and mask. If it enters your eyes, immediately rinse it off with plenty of water for at least 15 minutes and consult a doctor (during eye washing, open your eyelids well with your fingers so that water completely reaches the entire eyeball and eyelid). If the acid gets on a human body or clothing, it could cause burns (chemical burns). Therefore, throw off your clothing immediately and rinse it off with plenty of water.

⚠ CAUTION
When installing a transmitter on the wall, do not mount it on a wall with insufficient strength, such as plaster board.
If corrosive gas is present in the installation environment, supply clean instrument air from the air purge port of the transmitter, and then discharge it from the other air purge port.
Before opening/closing the transmitter case, be sure to cut off the power supply.
Before performing wiring for the power supply lines and sensor lines, be sure to cut off the power supply.
Install a power supply switch (e.g., breaker) to turn ON/OFF the power of the transmitter.
Be sure to connect the ground terminal (⏚) of the transmitter (class D grounding) to maintain the functional safety.
When opening/closing the transmitter cover, be careful so that nothing that could deteriorate the internal insulation, such as rainwater or dust, enters inside the transmitter.
Operating the transmitter outside the rated voltage range could cause a malfunction. Check the power supply voltage supplied for the transmitter.
When opening/closing the transmitter front cover, be careful so that your fingers will not be caught by the cover.
In order to maintain the enclosed structure (IP65) inside the transmitter, insert a seal pin and tighten the unused cable gland.
The pH sensor is made of glass. Applying a shock or excessive force could damage the sensor. Be extremely careful when handling it.

⚠ CAUTION
The ORP sensor is made of glass. Applying a shock or excessive force could damage the sensor. Be extremely careful when handling it.
The fluoride ion sensor is made of fragile lanthanum fluoride and glass. Applying a shock or excessive force could damage the sensor. Be extremely careful when handling it.
Although the internal solution for the DO sensor is neutral, if it gets on your clothing or skin through the broken diaphragm of the sensor, rinse it off well. If it enters your eyes, wash your eyes immediately.
Do not scratch the diaphragm of the DO sensor. The diaphragm is made of a thin film. Do not scratch it by hitting the film surface with a hard object or pressing it excessively.
Before performing sorting work for disposal, be sure to confirm that the power is not supplied.

Product Handling Information

Operational precautions

Use of the product in a manner not specified by the manufacturer may impair the protection provided by the product. And it may also reduce product performance.
Exercise the following precautions:

- Do not press the operation keys using the tip of your fingernail or a tool with a sharp edge.
- Do not use solutions such as organic solvents.
- Do not immerse the product in diluted hydrochloric acid for a long time.

Disposal of the product

When disposing of the product, follow the related laws and/or regulations of your country.

Manual Information

Description in this manual

Note

This interprets the necessary points for correct operation and notifies the important points for handling the product.

Reference

This indicates the part where to refer for information.

Tip

This indicates reference information.

Contents

How To Use This Instruction Manual

Before using the product for the first time, perform the setting and calibration.

About the unit

Overview

About installation and wiring

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Setting

About calibration

Calibration

About maintenance

Maintenance

Troubleshooting

Troubleshooting

Technical Data

Overview

What is HQ-300?

- **Multi water quality meter**

  Six aspects of water quality concentration can be measured. The following six types of sensor can be connected: pH sensor, ORP sensor, DO sensor, fluoride ion sensor, electrical conductivity sensor, and electrical resistivity sensor. Note that only one type of these sensors can be connected at a time.

  The measurement of fluoride ion is offered as an option. A standard product can't measure fluoride ion.

- **Two-wire transmitter**

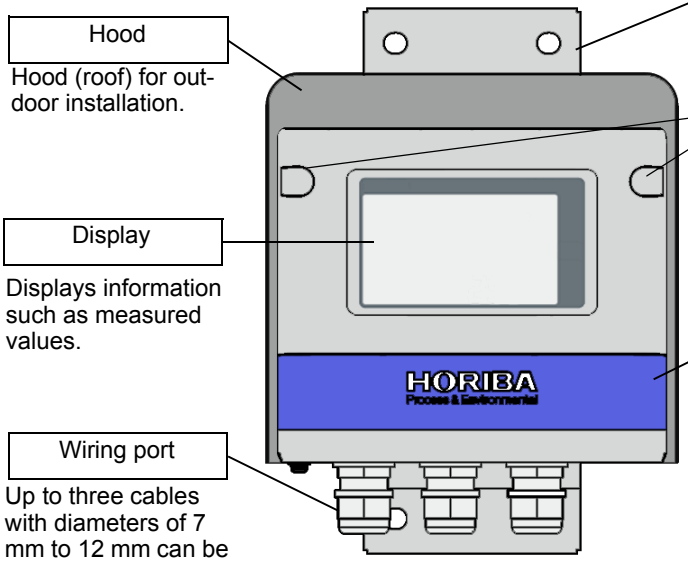
  In order to transmit analog signals, 4 mA to 20 mA is output to the power supply line.

- **Compatibility with HART communication**

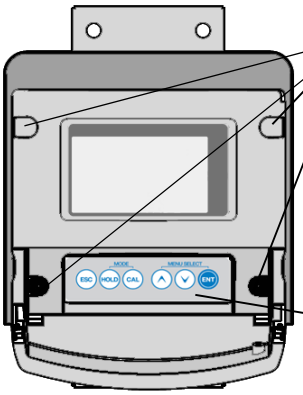
  The HART signal is superimposed on 4 mA to 20 mA in order to perform digital communication.
  The HQ-300 is compatible with HART protocol 7.

Name and function of each part

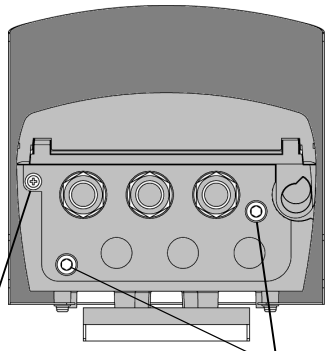
Transmitter



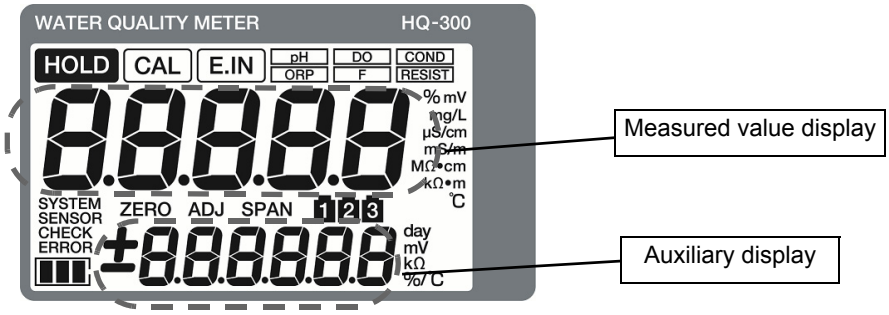
When the front cover is open



Bottom



Display



Lamp	Notation used in this document	Description
HOLD	HOLD	Lights up in hold mode. Blinks when a contact is input or when the machine is in a hold state due to an error.
CAL	CAL	Lights up in calibration mode.
E.IN	External hold input	Lights up when a contact signal for the cleaning unit is input to the external hold input terminal.
SYSTEM ERROR	System error	Lights up when an E-90, E-91, or E-92 system error occurs.
SENSOR ERROR	Sensor error	Lights up when any of the sensor errors from E-11 to E-72 occurs.
SENSOR CHECK	Sensor check	Lights up while the sensor is being checked when the temperature sensor type is set to Auto.
pH	pH measurement	Lights up when pH measurement is selected.
ORP	ORP measurement	Lights up when ORP measurement is selected.
DO	DO measurement	Lights up when DO measurement is selected.
F	Fluoride ion measurement	Lights up when fluoride ion measurement is selected.
COND	Electrical conductivity measurement	Lights up when electrical conductivity measurement is selected.
RESIST	Electrical resistivity measurement	Lights up when electrical resistivity measurement is selected.

Operation key section

The operation keys are used to switch the contents to be displayed, to input setting values, and to perform calibration.
The values and items can be changed while the display is blinking.
When you set a value or item currently blinking by using the ▲/▼ (up/down) key and then press the ENT key, the setting will flash and then be set.

Key	Notation used in this document	Description/operation	
ESC	ESC key (Escape)	Used to return to the previous menu. Return to the previous display while setting. Cancel a setting value while blinking.	
		Holding down (2 seconds)	Holding down this key in hold mode will switch to measurement mode.
HOLD	HOLD key (Hold)	Holding down (2 seconds)	Holding down this key in measurement mode will switch to hold mode. Holding down this key in HOLD mode will switch to measurement mode.
CAL	CAL key (Calibration)	You can change the number of calibration points or perform calibration again.	
		Holding down (2 seconds)	Holding down this key until the CAL lamp lights up will switch to calibration mode.
▲ ▼	▲ key ▼ key (Selection)	You can change the displayed item or setting value by pressing the ▲/▼ keys. When you change values, pressing either of these keys increases or decreases the value by one. Holding down these keys increases or decreases the value continuously. The scrolling direction is reversed for the ▲ key and ▼ key. If you press one of these keys too much pressing the other key.	
ENT	ENT key (Entry and Set)	Press this key to set the setting value or calibration value. **Note** **If you return to the previous menu by pressing the ESC key, no changes are made.**	

Note

Do not press the operation keys using the tip of your fingernail or a tool with a sharp edge.

Installation

Installation environment

In order to use this product in a stable condition, the installation location must meet the following requirements.

Transmitter

- Location that is well-ventilated
- Location where the ambient temperature is between −20°C and 60°C
- Location with low heat
- Location without direct sunlight
- Location without direct high radiant heat
- Location where the relative humidity is between 5% to 90%
- Location that is not exposed to any chemicals
- Location with low mechanical vibration
- Location where maintenance and wiring can be performed
- Location without powder dust and corrosive gas
- Location largely unaffected by environmental noise
- Altitude of 2,000 m or less
- The power supply voltage is within the power-supply voltage range (21 V to 32 V DC).

Sensor

- Location where inspections and maintenance can be performed for the sensor
- Location where a liquid to be measured does not have any bubbles
- The liquid to be measured does not affect the liquid contact materials of the sensor

Note

We recommend that you separately install a cleaning unit when you use a liquid to be measured that contains an excessive amount of suspended solids (SS).

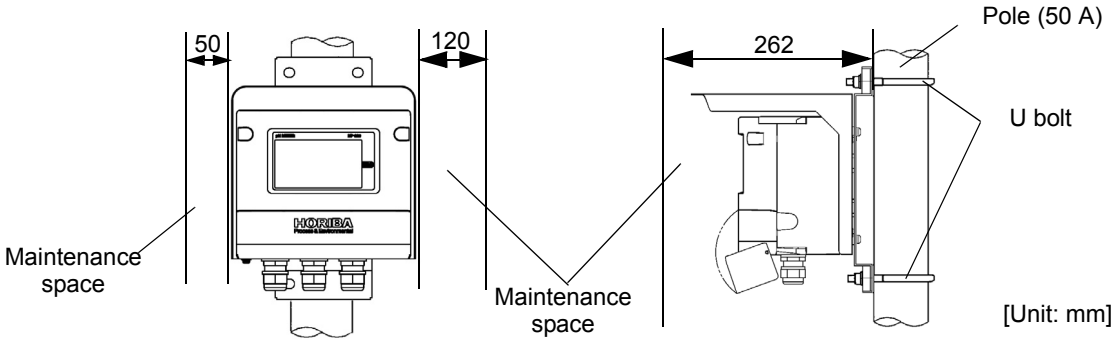
Installation procedure

■ Transmitter

Mount the transmitter onto a pole (50 A) or on the wall.

● When mounting onto a pole

Use a U bolt to secure the mounting plate and pole.

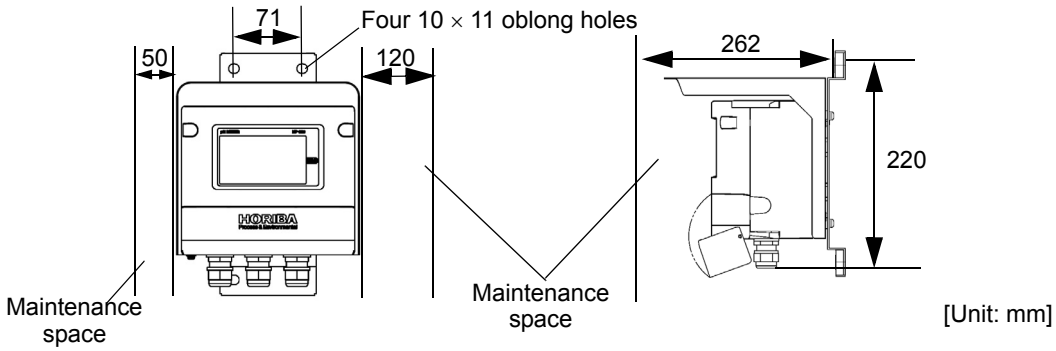


● When mounting onto the wall

⚠ CAUTION

When installing a transmitter on the wall, do not mount it on a wall with insufficient strength, such as plaster board.

Secure the product onto the wall using the four oblong holes in the mounting plate.

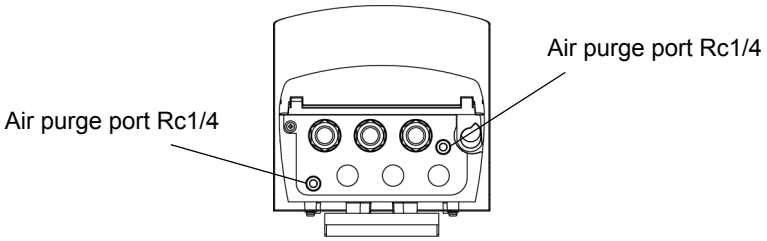


Note

Provide a space for performing maintenance of this product.

● Air purge port

⚠ CAUTION
If corrosive gas is present in the installation environment, supply clean instrument air from the air purge port of the transmitter, and then discharge it from the other air purge port.
In order to maintain the enclosed structure (IP65) inside the transmitter, insert a seal pin and tighten the unused cable gland.



■ Sensor

● pH sensor/ORP sensor/fluoride ion sensor

There are mainly the following two types of sensor installation methods:

- a method that uses the sensor by assembling it into the holder and directly inserting it into the liquid to be measured (immersion type holder),
- and the other method that uses the sensor by assembling it into the holder and directly inserting it into the piping line (flow chamber type holder).

For details on how to handle each holder, refer to the instruction manual provided with the product.

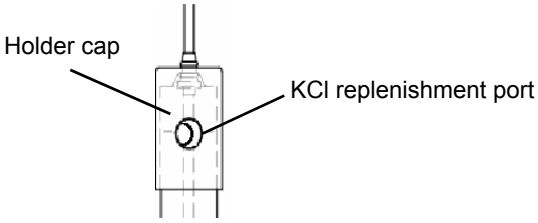
● For the immersion type holder

1. **Make sure that the tip of the sensor is immersed in the liquid to be measured even when the surface level of the liquid to be measured fluctuates.**
2. **Make sure that the surface level of the holder's internal solution (KCl) is at least 10 cm from the surface level of the liquid to be measured.**

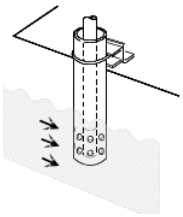
Note

If the surface level of the holder's internal solution (KCl) decreases, be sure to replenish it.

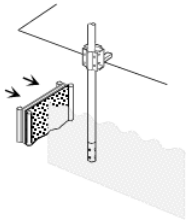
3. **Turn the holder cap at the top of the holder by approximately 1/3 of a turn to open it, so that the atmospheric pressure is applied inside the holder.**



4. **The maximum flow rate is 2 m/s. But the holder may still be deformed with a flow rate lower than the above maximum flow rate. In order to avoid this, take a preventive measure against a flow rate increase according to the following procedure.**



A pipe of approximately 50 A to 100 A with holes at the tip is installed and the holder is inserted through this pipe.



A partition plate is installed on the upstream side to Increasing the particles additional effect. This is possible when a partition plate can be attached to both side grooves, such as side ditches.

● For the flow chamber type holder

- Be sure to install a bypass line for the piping line.

Note

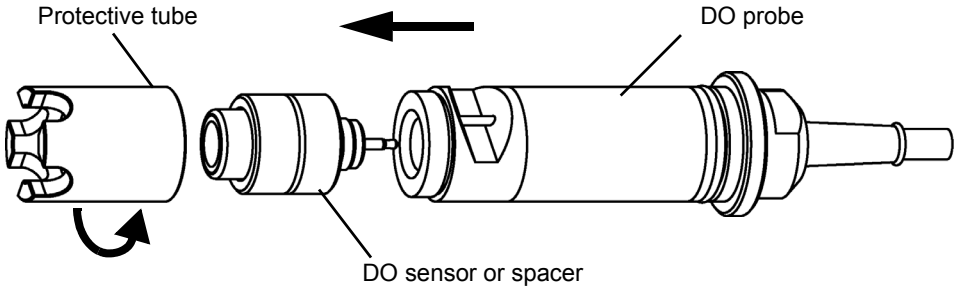
If there is no bypass line, you need to stop the entire equipment when you perform maintenance or replacement of sensors.

- Before inspecting the sensors, close the valve located upstream of the holder. Failure to do so may cause an overflow of the holder's internal solution.
- If the flow rate is too high, it may cause indication variations. If the flow rate is excessively low, it will cause a delay in response. Adjust the flow rate according to the measurement conditions.
- Install a strainer on the inlet side when measuring liquid an excessive amount of suspended solids (SS).

● DO sensor

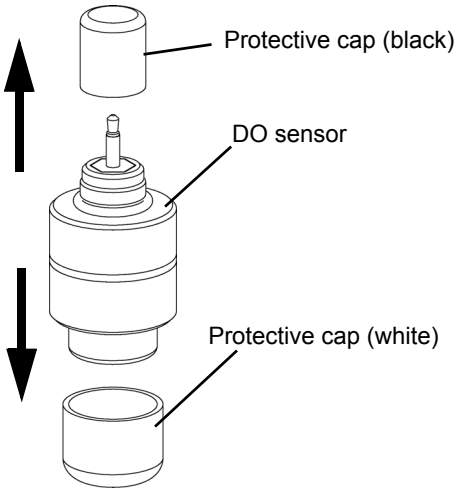
● Installation procedure

1. **Remove the protective tube for the DO probe, and then remove the DO sensor (or spacer).**
When you purchase a new DO probe, a spacer is inserted.

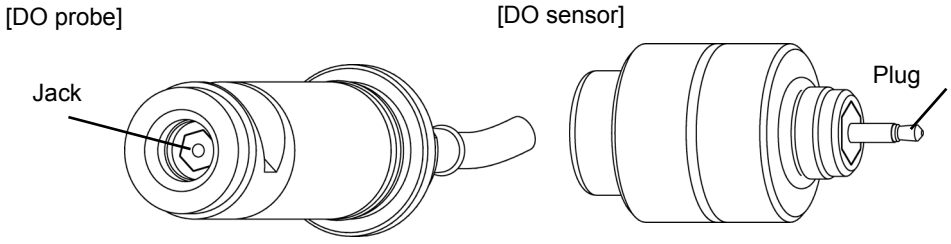


2. **Take a new DO sensor out of the package.**

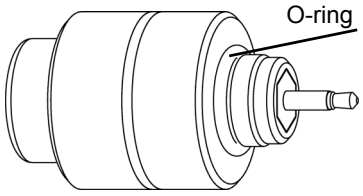
3. **Remove the protective caps on both ends of the DO sensor.**
These protective caps (white) contain pure water to prevent drying.



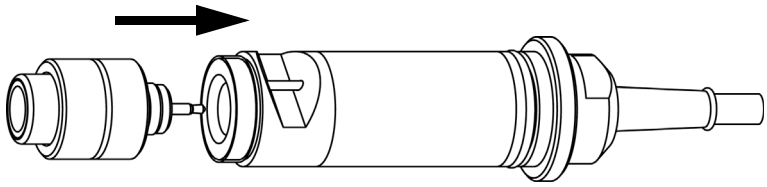
4. **Check if moisture is present around the jack of the DO probe and plug of the DO sensor. If there is any moisture, wipe it off completely.**



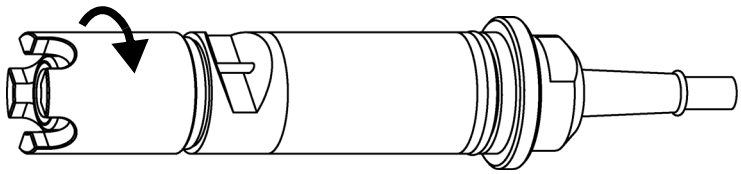
5. **Check that an O-ring is attached to the DO sensor.**



6. **Insert the DO sensor into the DO probe.**



7. **Screw the protective tube into the DO probe completely.**



8. **After the sensor installation, leave it as it is according to the following table.**

Sensor model	Settling time
5505	5 min
5510	10 min

9. **After the sensor is settled, perform setting of the sensor on the transmitter.**
For the operational procedure, refer to “The DO sensor” (page 112).

10. **After the above setting, perform calibration.**
Refer to “Calibration” (page 119).

● Electrical conductivity sensor/electrical resistivity sensor

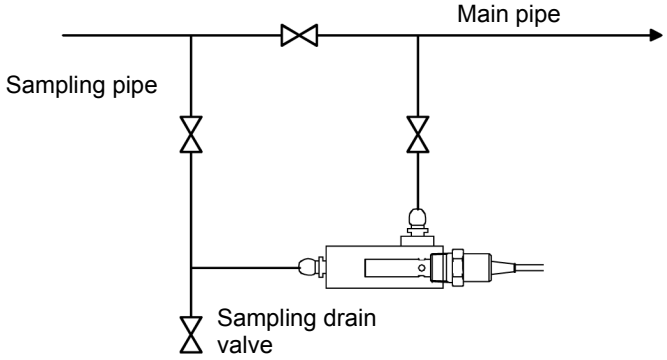
● Sensor installation procedure for ensuring correct measurement

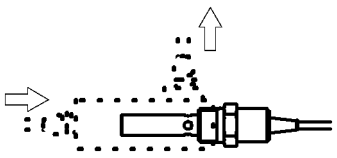
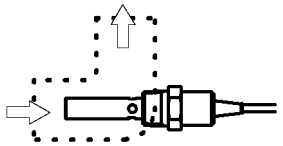
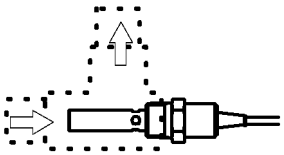
The basic conditions for correct measurement are that there are no bubbles and the sensor surroundings are filled with a well stirred sample. In principle, there should be no influence from the pressure or flow rate. As a secondary effect, however, there is an influence from the dissolution of carbon dioxide or generation of bubbles. The dissolution of carbon dioxide has a large influence in the pure water area, while the generation and adhesion of bubbles has an influence on the measured values of the electrical conductivity and electrical resistivity. To prevent bubbles in the inline, it is effective to measure the value while the pressure remains applied. To prevent the generation of bubbles, install a flow rate adjustment valve downstream of the sensor and apply pressure to the sensor. Closing the valve located upstream of the sensor decreases the pressure around the sensor. As a result, the dissolved gas will turn into bubbles and this may influence the measurement. In addition, if the water temperature increases or salt is supplied, the dissolved gas will turn into bubbles and then adhere to the sensor, and this may also influence the measured value. Set the sensor holder with an orientation that helps vent the bubbles.

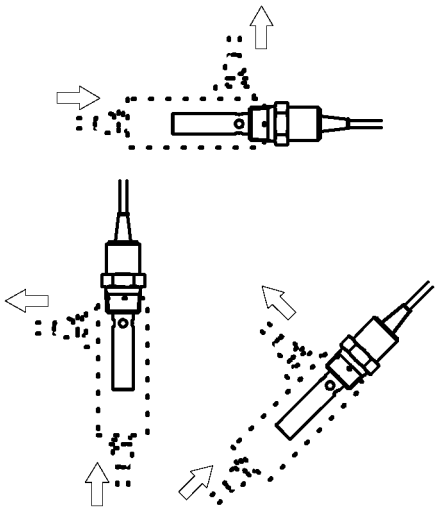
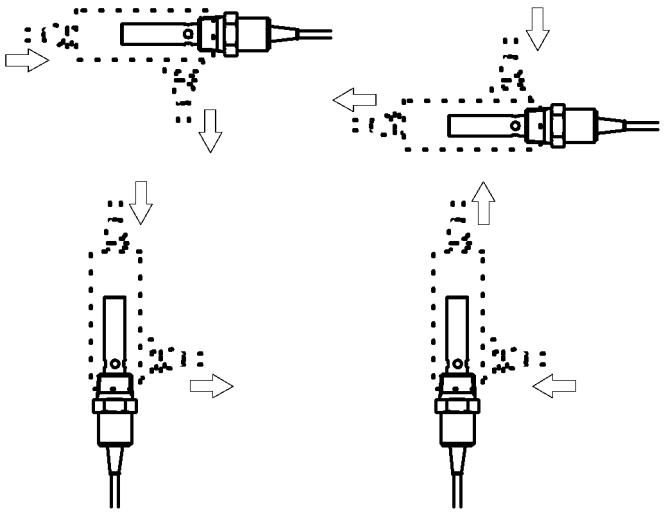
● Installation of electrical conductivity/electrical resistivity measurement sensor for pure water

In principle, there should be no influence from flow rate during electrical conductivity and electrical resistivity measurements. However, when the electrical resistivity or electrical conductivity of a sample similar to pure water is measured, dissolved carbon dioxide within the air may increase the electrical conductivity value (decrease the electrical resistivity). For a fluororesin pipe, in particular, as the gas easily permeates through the pipe, the amount of dissolved carbon dioxide changes due to the flow rate or pressure of the sample, and this eventually influences the measured value. When you perform sampling, use a pipe with clean material and low gas permeability. In addition, place a sensor as close as possible to the main pipe, so that an appropriate flow rate (not excessively low) can be maintained. When you measure the electrical resistivity of ultra-pure water using a sensor holder, locate a flow rate adjustment valve downstream of the sensor and set the flow rate to 1 L/min or above. In an ultra-pure water plant, branch the sampling pipe at approximately one inch from the main pipe, and then install an electrical resistivity sensor after the maintenance valve. A valve for applying an appropriate amount of back pressure is provided for the collection line on the downstream side of the sensor. The electrical resistivity sensor is generally installed at the corner of the pipe, facing upstream, by using an elbow joint or tee joint. The higher the flow rate, the shorter time it takes to stabilize. Maintain a sufficient flow rate over 10 L/min. Install a sampling valve for calibration near the sensor.

It is not recommended that you directly mount the valve onto the main pipe. This is because the fluid does not flow along the sensor and maintenance cannot be performed.



Example of installation drawing	
When using an optional sensor holder sold by HORIBA Advanced Techno. Co., Ltd.	
Example of exclusively designed holder	
	

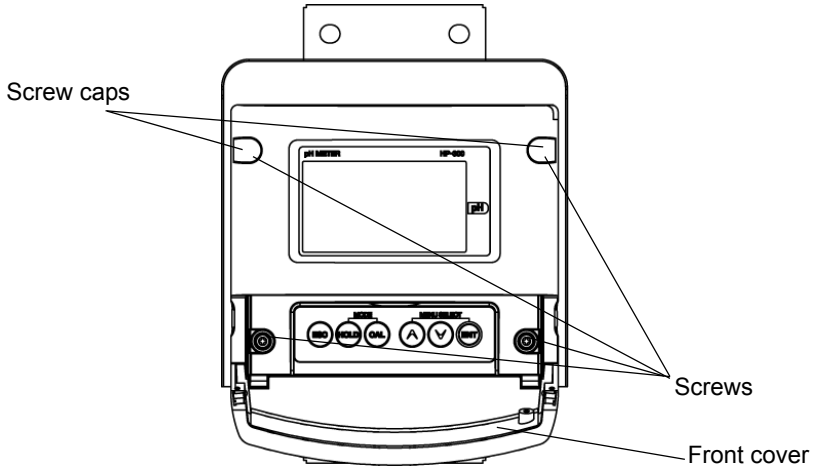
Appropriate installation direction	Inappropriate installation direction
	

Wiring connection

⚠ CAUTION
Before opening/closing the transmitter case, be sure to turn OFF the power supply.
When opening/closing the transmitter cover, be careful so that nothing that could deteriorate the internal insulation, such as rainwater or dust, enters inside the transmitter.
When opening/closing the transmitter front cover, be careful so that your fingers will not be caught by the cover.

How to open the transmitter cover

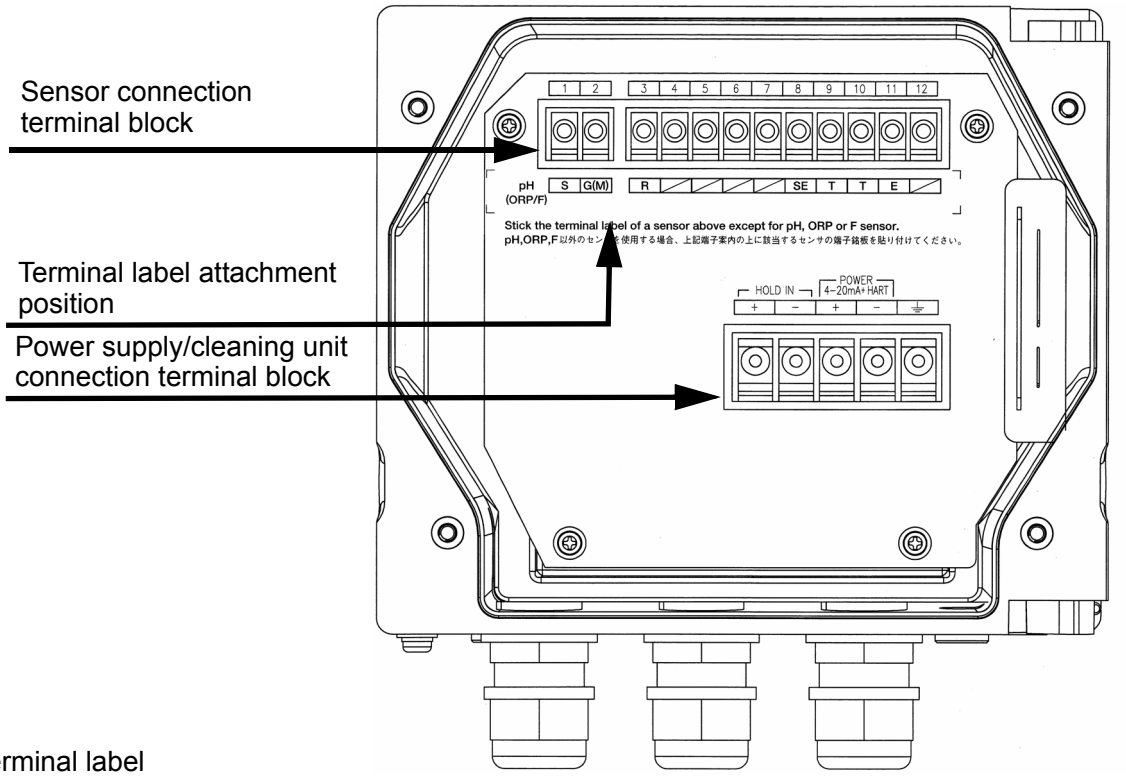
1. **Remove the two rubber screw caps located at the front top of the transmitter. Be sure not to lose the screw caps, as they will be reattached after completing the procedure.**
2. **Open the front cover.**
3. **Fully loosen the four screws at the front of the transmitter. At this point, make sure that the screws are pushed to the front by springs.**
4. **Open the transmitter front case.**



Note

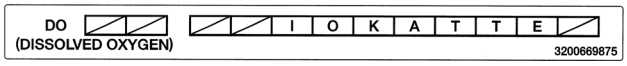
- **The front case screws are configured so that they will not fall off. Turn the screws counterclockwise until they are pushed to the front by springs.**
- **Wipe off any moisture on the outer surface of the case.**

● Terminal block

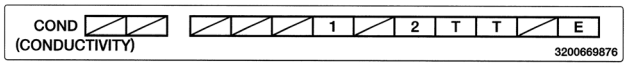


Terminal label

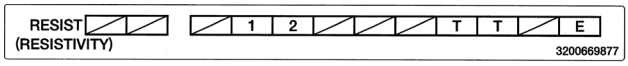
For DO sensor



For electrical conductivity sensor



For electrical resistivity sensor



● Power supply/cleaning unit connection terminal block

Connect the power supply line (21 V to 32 V DC). Insert the load resistance (250 Ω to 500 Ω) into either side of the power supply lines to monitor the 4 mA to 20 mA output and perform HART communication.

A terminal for connecting the cleaning unit output line is provided to hold the 4 mA to 20 mA output in synchronization with the cleaning unit operation.

● Sensor connection terminal block

Connect one of the following sensors: pH sensor, ORP sensor, DO sensor, fluoride ion sensor, electrical conductivity sensor, and electrical resistivity sensor.

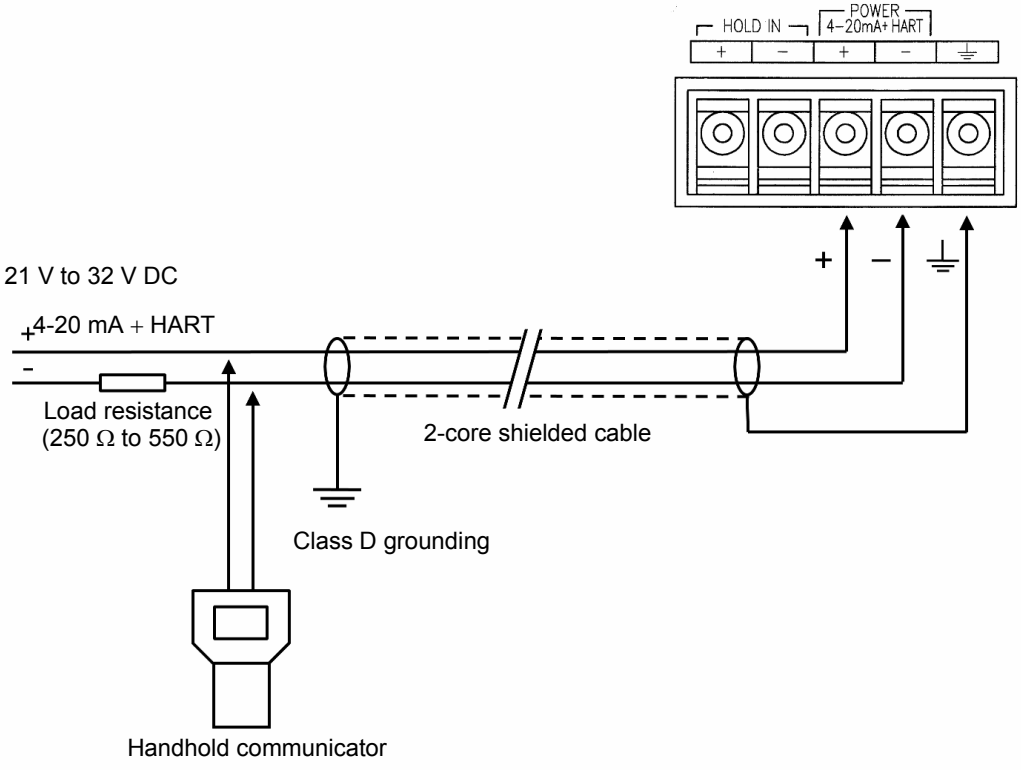
Terminal labels for the DO sensor, electrical conductivity sensor, and electrical resistivity sensor are included in the package as accessories. When you use any sensors except for the pH sensor, ORP sensor, DO sensor, and fluoride ion sensor, attach the terminal label of the relevant sensor to the location below the terminal block.

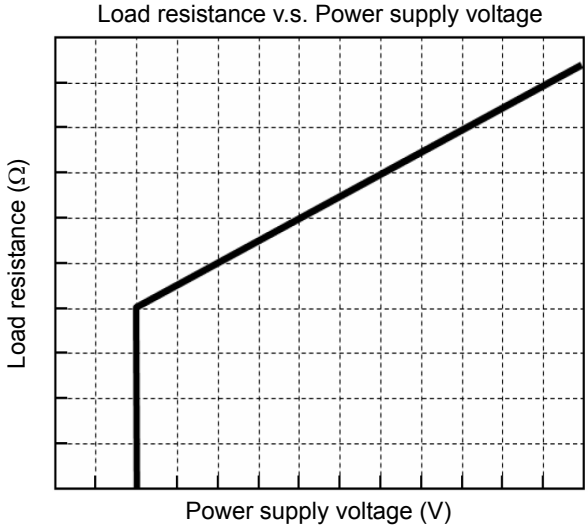
Power supply connection

⚠ WARNING
If there is a possibility of lightning, install a lightning arrester in two locations, one on the transmitter side and the other on the power supply side.

⚠ CAUTION
Before performing wiring for the power supply lines and sensor lines, be sure to turn OFF the power supply.
Install a power supply switch (e.g., breaker) to turn ON/OFF the power of the transmitter.
Be sure to connect the ground terminal (⏚) of the transmitter (class D grounding) to maintain the functional safety.
Operating the transmitter outside the rated voltage range could cause a malfunction. Check the power supply voltage supplied for the transmitter.

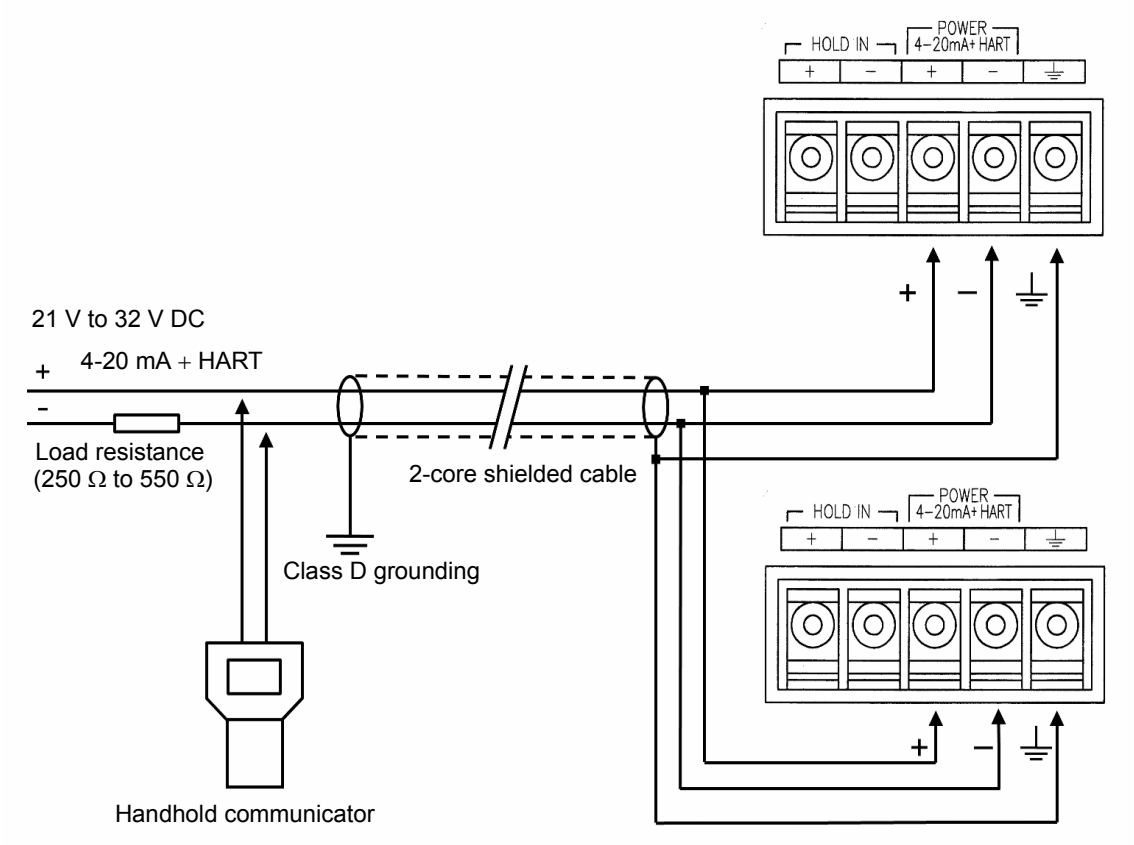
Connect the 24 V DC (21 V to 32 V DC) power supply line.
Insert the load resistance into either side of the power supply lines to monitor the 4 mA to 20 mA output and perform HART communication. For the load resistance value, select the resistance within the specified range according to the graph of “Relationship between load resistance and power supply voltage”. A resistance over 250 Ω is required to perform HART communication.
Use a 2-core shielded cable for the power supply cable. Connect the transmitter side to the ground terminal of the transmitter, and then ground the power supply side (class D grounding).





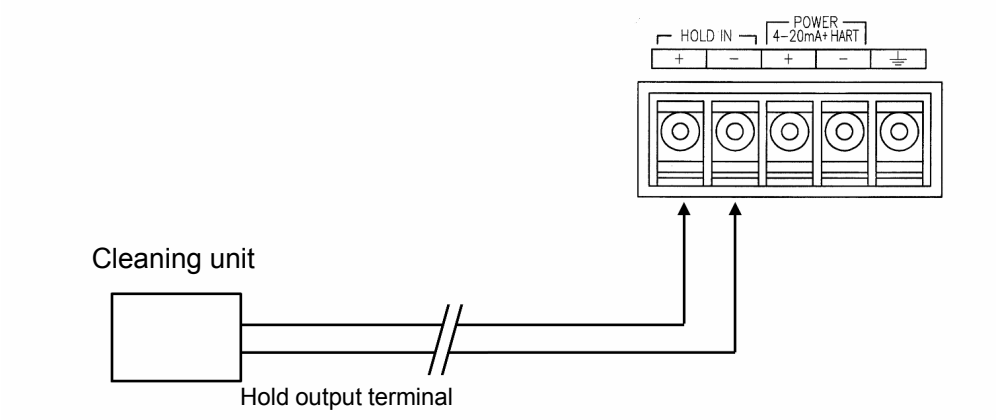
● Multi-drop link (HART communication)

A maximum of 15 units can be connected for the multi-drop link.
Although it is possible to vary the analog output during the multi-drop link, it is recommended that it should be fixed to 4 mA. A maximum current of 12 mA current flows when the power is supplied.
The allowable power supply cable length during the multi-drop link is 800 m (Equivalent input resistance: Approximately 50 kΩ, equivalent input capacity: Approximately 0.01 uF).



■ Cleaning unit connection

When the transmitter is used in combination with the cleaning unit manufactured by HORIBA Advanced Techno, the analog output can be on hold in synchronization with the cleaning unit operation.
Connect the cleaning unit to the external hold input terminal (HOLD IN) according to the following drawing.



Note

There is no distinction of in the polarity when connecting the cleaning unit manufactured by HORIBA Advanced Techno to the external hold input terminal (HOLD IN).
For details on the cleaning unit hold output, refer to the instruction manual for the relevant cleaning unit.

Tip

When the cleaning unit signal is input to the external hold input terminal (HOLD IN), the HOLD lamp on the display starts blinking, the E.IN lamp lights up, and analog output is set on hold.

■ Sensor connection

● Sensor model list

Sensor type	Model	Specifications	Temperature sensor	Connection method
pH sensor	6108	General-purpose dome pH sensor	1 kΩ (0°C)	(1)
	6108G	General-purpose dome pH sensor (gel)		
	6109	Fixed sleeve pH sensor		
	6110	General-purpose pH sensor		
	6151	Hydrofluoric acid-resistant pH sensor		
	6152	Alkali-resistant pH sensor		
	6171	Hydrofluoric acid-resistant pH sensor (tip exchange type)		(2)
	6172	Alkali-resistant pH sensor (tip exchange type)		
	6173	Oil-resistant pH sensor (tip exchange type)		
	6174	General-purpose pH sensor (tip exchange type)		
	8200	KCl no-supply type pH sensor	None	(4)
	8300	KCl no-supply type pH sensor	6.8 kΩ (25°C)	(3)

Sensor type	Model	Specifications	Temperature sensor	Connection method
ORP sensor	6805	General-purpose ORP sensor (platinum)	None	(4)
	6815	General-purpose ORP sensor (platinum + gold plate)		
	6870	General-purpose ORP sensor (tip exchange type)	6.8 kΩ (25°C)	(2)
	2500	KCl no-supply type ORP sensor	None	(4)
Fluoride ion sensor	1009	General-purpose fluoride ion sensor	1 kΩ (0°C)	(3)
DO sensor	5505	Film thickness: 50 μm		(5)
	5510	Film thickness: 100 μm		
Electrical conductivity sensor	ESH-001	2-electrode electrical conductivity sensor (cell constant 0.01)		(6)
	ESH-01	2-electrode electrical conductivity sensor (cell constant 0.1)		
	ESH-1	2-electrode electrical conductivity sensor (cell constant 1)		
	FS-01F-C-SL	Sanitary electrical conductivity sensor		
	ESH-01-C-S-SN			
Electrical resistivity sensor	ERF-001	2-electrode electrical resistivity sensor		(7)

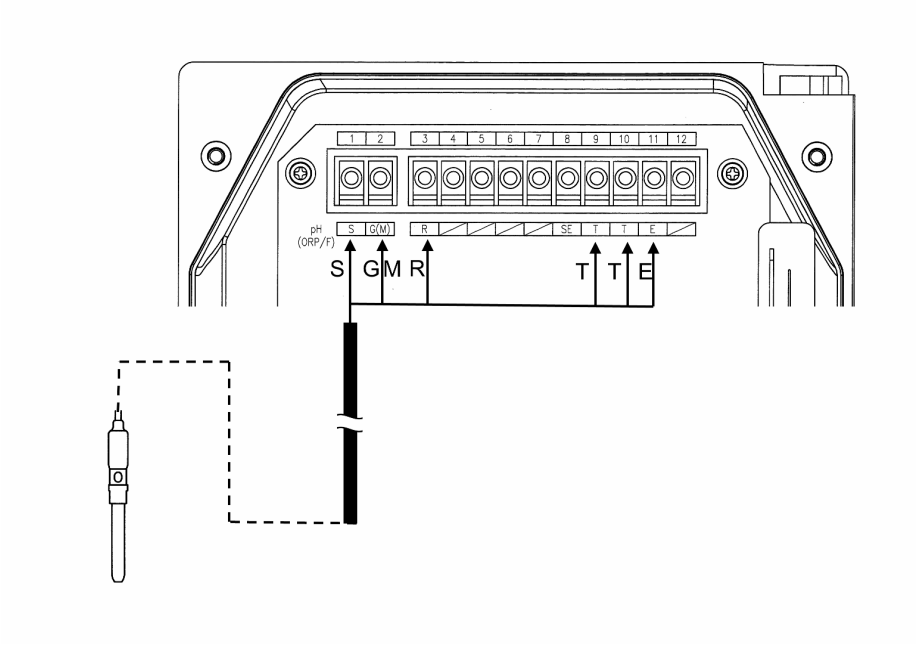
● Handling for the sensor cable

A high isolation cable is used for the sensor cable. Take care regarding the following points when handling it.

- Do not splash water on the cable terminals or terminal block, or soil them with finger marks or oil. It will reduce insulation.
  Reduced insulation could cause indication instability. Constantly maintain the cable in a clean and dry state.
  If it becomes soiled, wipe it off with alcohol, etc., and dry it completely.
- In order to facilitate the calibration, inspection and replacement of the sensor, ensure a sufficient length for the sensor cable when performing wiring.
- When performing wiring, separate the sensor cables and relay cables from the surrounding inductive devices, such as motors, and also from their power supply cables.

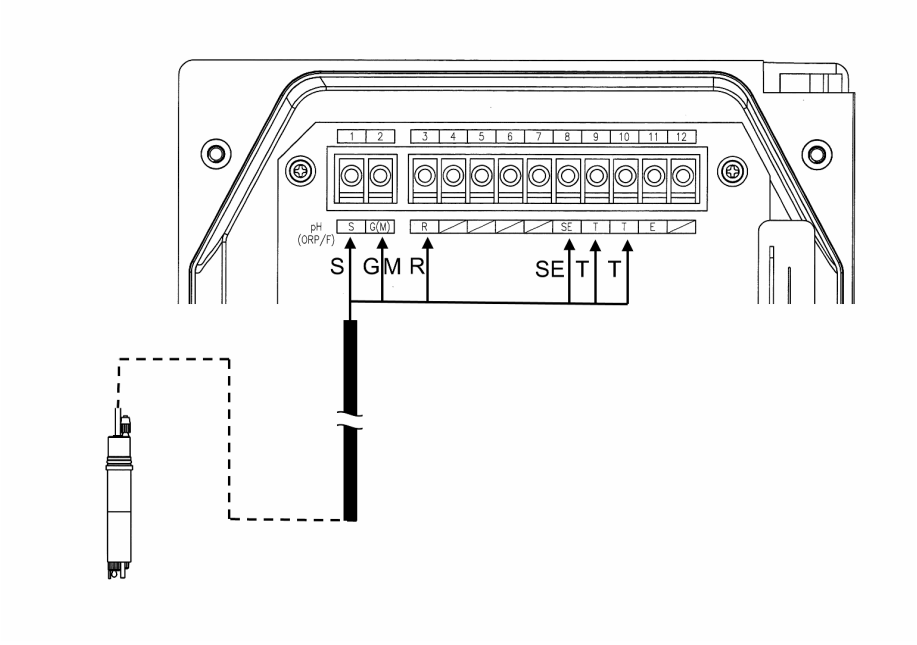
Connection method (1)

Sensor type: pH sensor and ORP sensor
Sensor terminal: S, G, R, T, T, E or S, M, R, T, T, E



Connection method (2)

Sensor type: pH sensor and ORP sensor
Sensor terminal: S, G, R, SE, T, T or S, M, R, SE, T, T

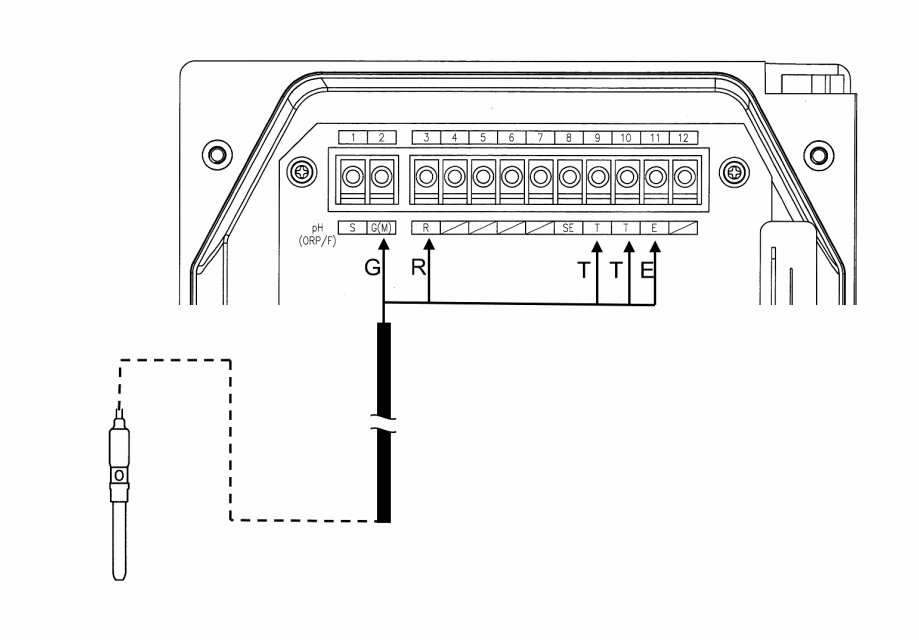


Note

When you use a this type sensor, enter the sensor setting mode described in "Setting menu" (page 28) and change the settings according to "The electrode (SE) of the sensor" (page 33)/ (page 80).

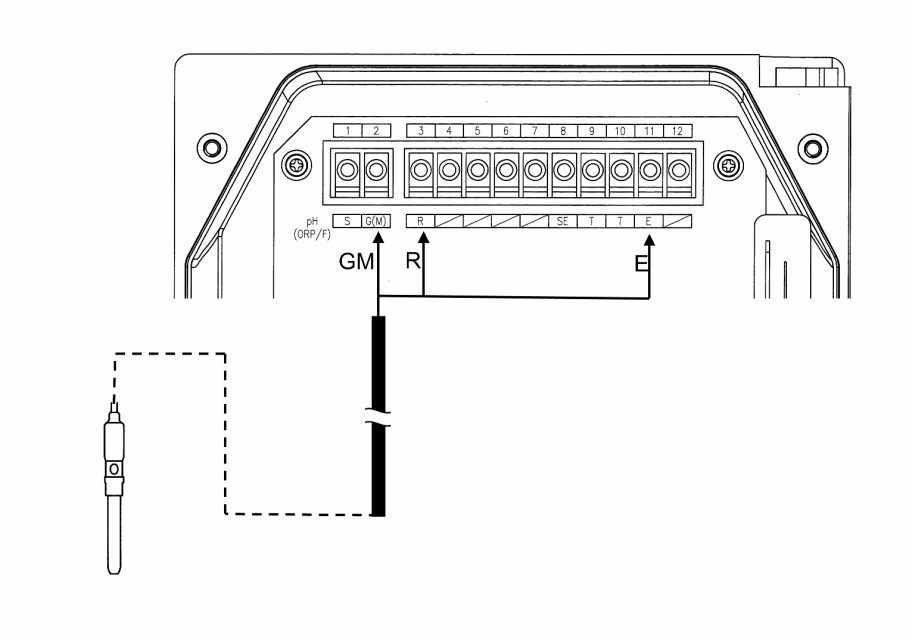
Connection method (3)

Sensor type: pH sensor, fluoride ion sensor
Sensor terminal: G, R, T, T, E



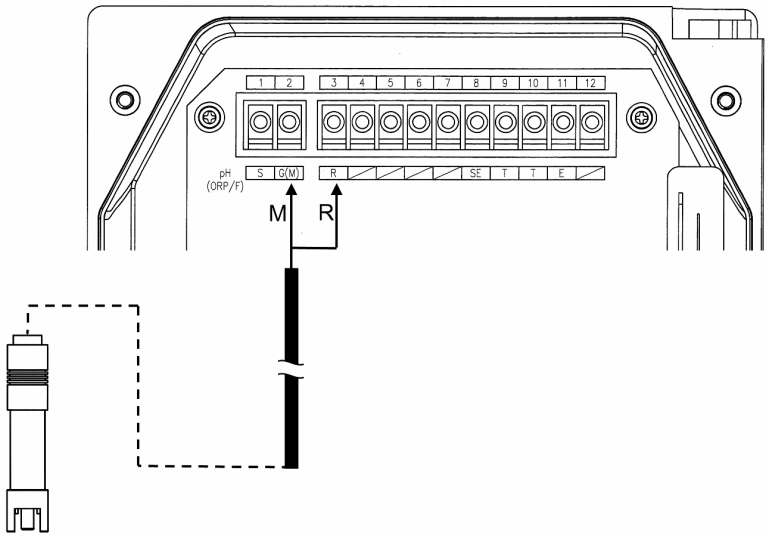
Connection method (4)

Sensor type: pH sensor and ORP sensor
Sensor terminal: G, R, E or M, R, E



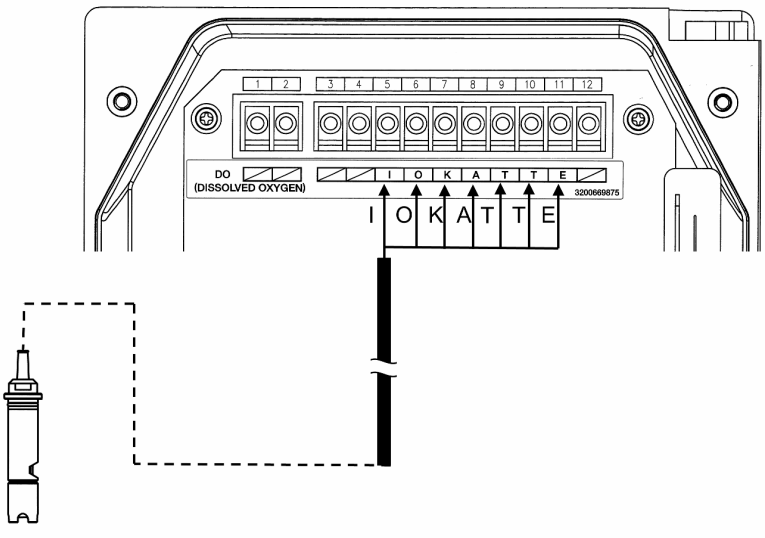
Connection method (5)

Sensor type: ORP sensor
Sensor terminal: M, R



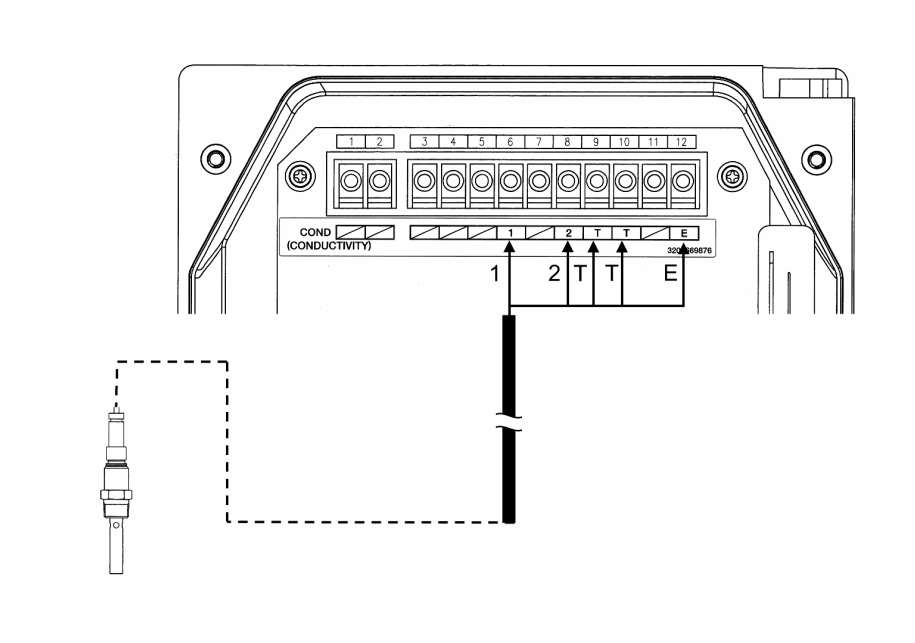
Connection method (6)

Sensor type: DO sensor
Sensor terminal: I, O, K, A, T, T, E



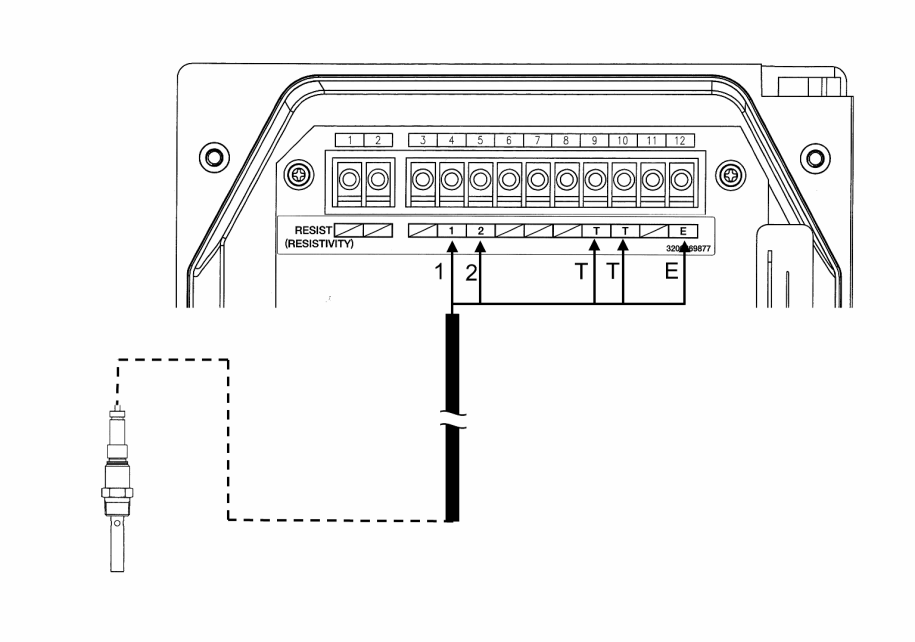
Connection method (7)

Sensor type: Electrical conductivity sensor
Sensor terminal: 1, 2, T, T, E



Connection method (8)

Sensor type: Electrical resistivity sensor
Sensor terminal: 1, 2, T, T, E



● Cable extension for pH sensor, ORP sensor, and fluoride ion sensor

When you extend a sensor cable, be sure to use the following cables manufactured by HORIBA Advanced Techno.

- Dedicated extension cable (C-5A)
- Dedicated relay box (CT-50pH or TB-25pH)

The sensor cable length can be extended up to 50 m (when the standard sensor cable length is 5 m, it can be extended up to 45 m).

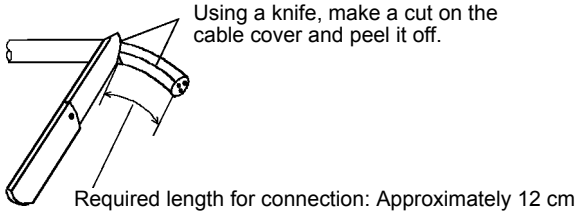
It is recommended that you store the dedicated extension cable in the conduit pipe for anti static purposes due to induction or vibration. In this case, put the wiring lines near this product through a flexible tube (conduit).

When the flexible tube is directly connected to this product, perform the appropriate processing so that the outer air or water will not enter inside the product.

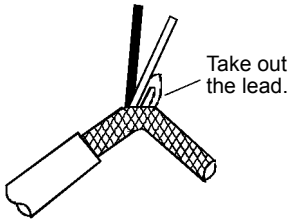
● C-5A cable terminal treatment procedure

Perform terminal treatment according to the following procedure.

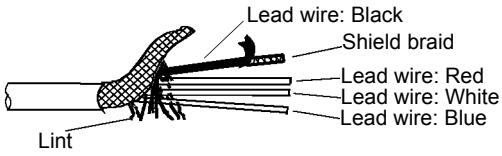
1. **Peel off the cable cover.**



2. **Break a portion at the base of the shield braid and remove the lead wire.**

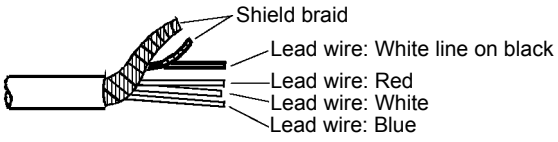


3. **Remove the lint completely from the base.**

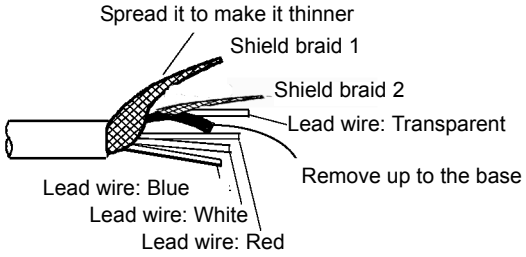


4. **Peel off the cover of the lead wire (black) and remove the shield braid.**
Leave a small amount of cover so that the shield braid of the lead wire (black) will not contact the major shield braid.

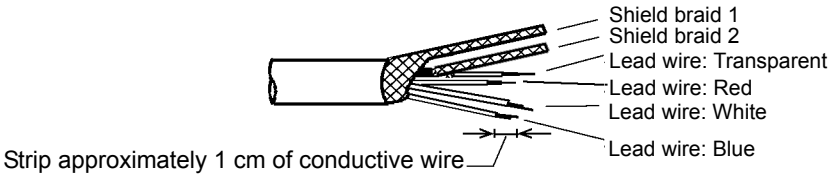
5. **Take out the lead wire with a white line on a black background from the shield braid of the lead wire (black).**



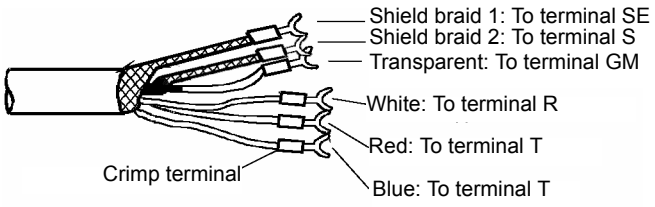
6. **Remove the cover of the lead wire (white line on black).**
Be sure to remove the cover (conductive plastic: white line on black) up to the base with a transparent line.



7. **Strip approximately 1 cm of the conductive wire for all the lead wires.**
When stripping the conductive wire from the cover, be careful not to cut the conductive wire.
Cover shield braid 1 and shield braid 2 with a shrinkage tube to prevent a short circuit.



8. **Put the crimp terminal into the conductive wire and crimp it completely using a crimp tool.**



9. **Pull the terminal to set that it is crimped completely.**

● Extension of DO sensor cable

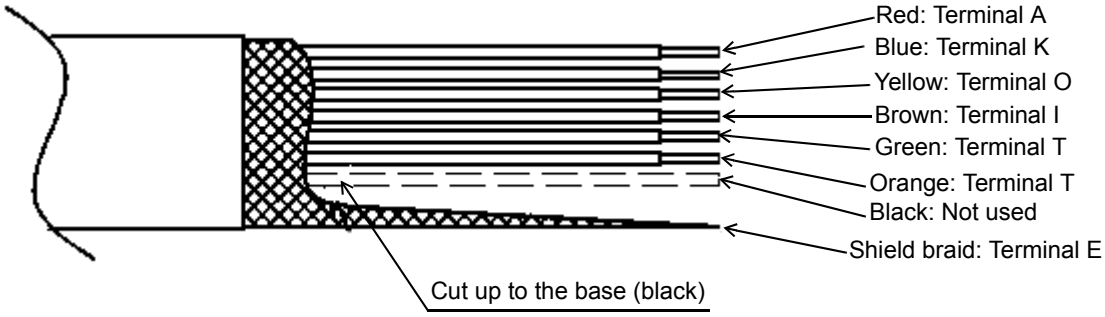
When you extend a sensor cable, be sure to use the following cables manufactured by HORIBA Advanced Techno.

- Dedicated extension cable (C-7E)
- Dedicated relay box (CT-20DO and CT-50D)

The maximum extension distance from the meter's main unit to the sensor is 50 m.

It is recommended that you store the dedicated extension cable in the conduit pipe for anti static purposes due to induction or vibration. In this case, put the wiring lines near the meter through a flexible tube (conduit).

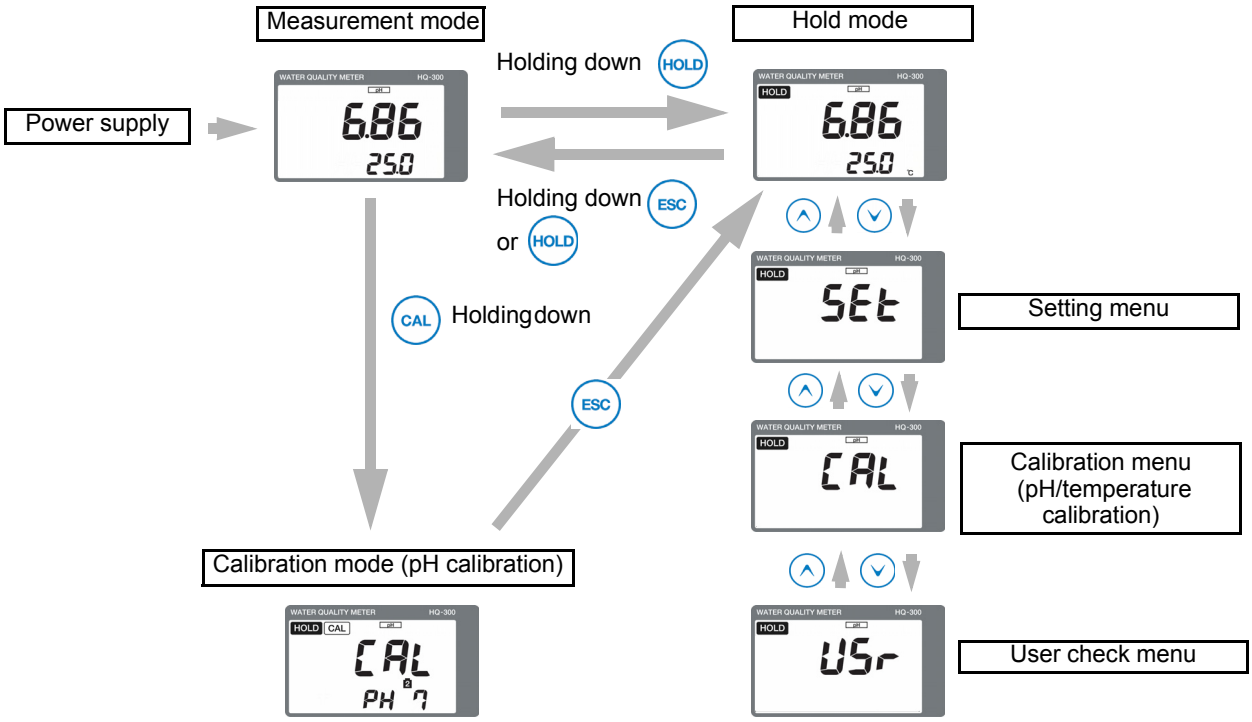
● C-7E cable terminal treatment procedure



pH Measurement

Description of mode and menu

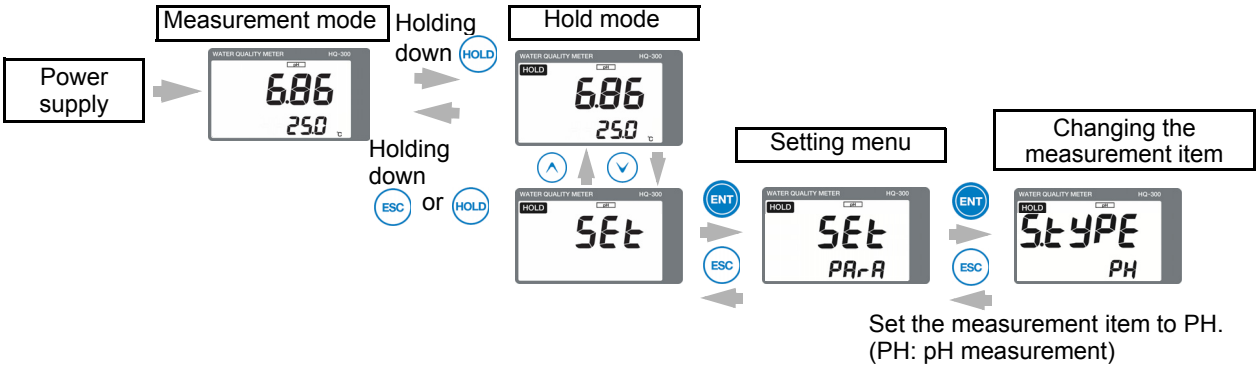
■ Modes and menus in each measurement mode



Description of mode/menu	Description	Reference page
Measurement mode	Performs measurement and analog output control. Allows you to check the calibration values or set and check the moving average count (damping factor) during measurement.	37
Calibration mode (pH calibration)	pH calibration is performed.	40
Hold mode (Measurement output hold)	Stops measurement and output and performs various settings.	-
Setting menu	Allows you to set all parameters related to measurement, such as the assignment of detector information input or output before starting operation.	28
Calibration menu (pH/temperature calibration)	The following three types of calibration can be performed: pH calibration, temperature calibration, and pH manual input calibration (the pH calibration is the same as the calibration mode).	40
User check menu	The output status and measured values can be checked. The setting value can be reset to the default value.	37

Setting menu

■ Measurement item switching



Operational procedure for setting the measurement item

ENT blink the auxiliary value, ▲▼ changes the setting value, ESC cancels the value, ENT set the value and holding down HOLD return to measurement mode.

■ Functions available with setting menus

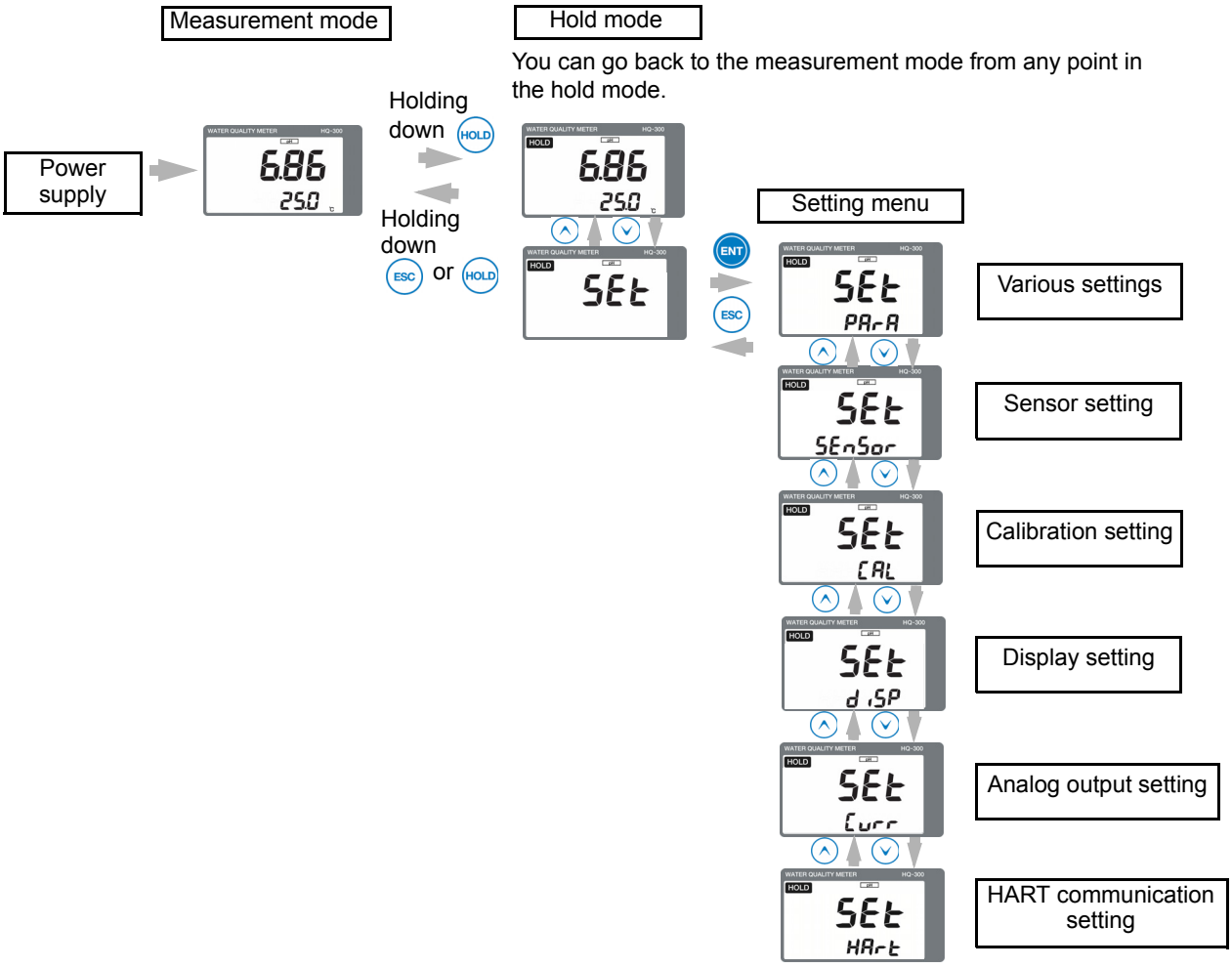
Setting item		Description	Default setting		Reference page
			Displayed character	Meaning	
Setting the sensors	The temperature sensor	Select either automatic or manual to identify the temperature sensor type.	Auto	Automatic identification	32
	The temperature of the liquid to be measured	When a sensor with no internal temperature sensor is used, the temperature of the liquid to be measured should be set manually.	25	25°C	32
	The diagnostics function	Select the diagnostics function for the sensor.	g	Glass sensor diagnostics	33
	The electrode (SE) of the sensor	Sets the presence of a electrode (SE) for the sensor.	no	No electrode (SE)	33
	The temperature compensation coefficient	Sets the temperature compensation coefficient of the measured pH value.	0.000	0.000 pH/°C	33
	The reference compensation temperature	Sets the reference compensation temperature of the measured pH value.	25	25°C	33

Setting item		Description	Default setting		Reference page
			Displayed character	Meaning	
Calibration setting	The calibration type	Select either auto calibration or basic calibration.	Auto	Auto calibration	33
	The number of calibration points	Sets the number of calibration points during basic calibration.	2	Two-point calibration	33
	The automatic stability judgment function	Sets whether to enable or disable the automatic stability judgment during basic calibration.	yES	Enabled	34
	The automatic stability judgment criteria	Sets the judgment level of the automatic stability judgment during basic calibration.	nor	Normal level	34
Display setting	The auxiliary display	Sets whether or not to display the measured temperature value.	t	Temperature display	34
	Display limit at over range	Select whether or not to display the measured pH value or measured temperature value if they exceed the measurement ranges, respectively.	yES	Not displayed	34
Analog output setting	The analog output range	Sets the measurement range of the pH to be assigned to the analog output (4 mA to 20 mA).	0-14	pH0 to pH14	34
	The 4 mA analog output value	Sets the pH value to be assigned to 4 mA when the analog output range can be set manually.	0.00	pH0.00	35
	The 20 mA analog output value	Sets the pH value to be assigned to 20 mA when the analog output range can be set manually.	14.00	pH14.00	35
	The HOLD function	Select whether or not to stop the analog output (latest value, preset) in the hold mode or calibration mode.	Hold	Latest value hold	35
	The HOLD output value	Sets the manually pH value when the HOLD function is set to preset.	14.00	pH14.00	35
	The burnout function	Sets whether or not to burn out the analog output at the occurrence of an error.	non	Disabled	35
HART communication setting	The polling address	Sets the polling address of HART communication.	0	Address 0	36
	The analog output fix mode	Sets whether or not to fix the analog output to 4 mA.	off	Analog output is not fix mode	36
	The number of preambles	Sets the number of preambles.	5	5	36
	The write protect mode	Sets the write protect mode.	oFF	OFF	36
	Checking the device ID	Allows you to check the value of the device ID.	-	-	36

Setting item		Description	Default setting		Reference page
			Displayed character	Meaning	
Various settings	The measurement item switching	Switches the measurement item.	PH	pH	32
	The moving average count	Sets the moving average count (damping factor) of the measured pH value.	1	1 time	32
	The automatic return	Select whether or not to return the hold mode to the measurement mode automatically.	yES	Enabled	32
	The automatic return time	Sets the time before the automatic return is performed when automatic return is enabled.	2	2 hours	32

How to enter the setting menu

1. **Turn ON the power.**
2. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
3. **Press the ▲/▼ key to display SEt in the measured value display, and then press ENT to enter the setting menu.**



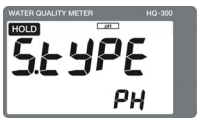
Setting menu display item

Setting value change Entry and Set Cancel

Various settings

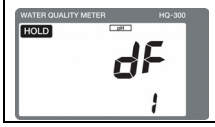
ENT

ESC



The measurement item switching

Switches to the measurement item to be used.
Setting range: PH, orP, do (dissolved oxygen), C (electrical conductivity), r (electrical resistivity)



The moving average count

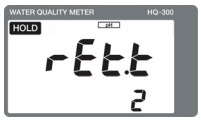
Sets the moving average count (damping factor) of the measured pH value.
Setting range: 1 to 50 times

The automatic return

Select whether or not to return the hold mode to the measurement mode automatically.

During setting change and calibration, automatic return is not performed even when the automatic return function is set to "yES".
Setting range: yES, no

Displayed only when the automatic return function is set to "yES"



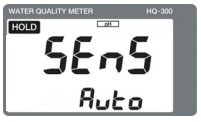
The automatic return time

Sets the time before the automatic return is performed when automatic return is enabled.
Setting range: 1 hour to 24 hours

Setting the sensors

ENT

ESC

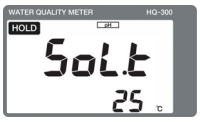


The temperature sensor

Select either automatic or manual to identify the temperature sensor type.

When "Auto" is set, the temperature sensor type is identified automatically.
When a sensor with no internal temperature sensor is used, set this to "non".
Setting range: non, Auto, 500 Ω, 1 kΩ, 6.8 kΩ, 10 kΩ

Displayed only when the temperature sensor function is set to "non"



The temperature of the liquid to be measured

When a sensor with no internal temperature sensor is used, the temperature of the liquid to be measured should be set manually.
Setting range: 0°C to 100°C

The diagnostics function

Select the diagnostics function for the sensor.
“non”: No diagnostics
“g”: Diagnostics on glass sensing membrane cracks
“gr”: Diagnostics on glass sensing membrane cracks + liquid junction resistance failure
When “gr” is selected, this function is activated only for the sensor with a electrode (SE).
Setting range: non, g, gr

The electrode (SE) of the sensor

Sets the presence of a electrode (SE) for the sensor.
Be sure to set this function when the sensor has a electrode (SE).
no: No electrode (SE)
yES: Electrode (SE) provided

The temperature compensation coefficient

Sets the temperature compensation coefficient of the measured pH value.
Set the pH change value per 1°C.

Normally, it is not necessary to change the setting from 0.000.
Setting range: –0.100 pH/°C to 0.100 pH/°C

The reference compensation temperature

Sets the reference compensation temperature of the measured pH value.

Normally, it not necessary to change the setting from 25°C.
Setting range: 5°C to 95°C

Calibration setting

ENT

ESC

The calibration type

Select the calibration method.
Auto calibration: Calibration using a standard solution with either a combination of pH4 and pH7 or pH7 and pH9
Basic calibration: Calibration using an optional standard solution
Normally, auto calibration should be selected.
Setting range: Auto, bASic

Displayed only when the calibration type is set to “basic calibration”

The number of calibration points

Sets the number of calibration points when the basic calibration is selected.
Setting range: 1, 2, 3

Displayed only when the calibration type is set to “basic calibration”

The automatic stability judgment function

Sets whether to enable or disable the automatic stability judgment during basic calibration.
When the automatic stability judgment is enabled, the stability status of the pH value is automatically judged (assessed) during the standard solution calibration, and display value is on held.
Setting range: yES, no

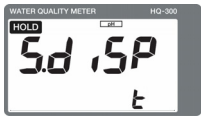
Displayed only when the calibration type is set to “basic calibration” and the automatic stability judgment function is set to “yES”

The automatic stability judgment criteria

Sets the judgment level of the automatic stability judgment during basic calibration.
When the variation in the pH value measured for 10 seconds falls under the following conditions, the system judges that the value has been stabilized. This indicates the sensitivity (SLOPE) per pH value (Unit: mV).
Low (Lo): 0.03 pH, Normal (nor): 0.02 pH, High (Hi): 0.01 pH
setting range: Lo, nor, Hi

Display setting

The auxiliary display



Sets whether or not to display the measured temperature value in the measurement mode screen.
non: Measured temperature value is not displayed
t: Measured temperature value is displayed
Setting range: non, t

Display limit at over range

Select whether or not to display the measured pH value or measured temperature value if they exceed the measurement ranges, respectively.

yES: Values outside the range are not displayed
pH: 0 to 14, Temperature: 0°C to 100°C
no: Values outside the range are displayed
pH:–1 to 15, Temperature:–10°C to 110°C
(When the temperature sensor is set to Auto)
Temperature: –20°C to 130°C (When the temperature sensor is not set to Auto)
Setting range: yES, no

Analog output setting

The analog output range

Sets the measurement range of the pH to be assigned to the analog output (4 mA to 20 mA).
oPt: Allows you to set a manually pH value.
Other: Select the measurement range of a specific pH.
Setting range: oPt, 0 pH to 14 pH, 0 pH to 10 pH, 0 pH to 8 pH, 2 pH to 12 pH, 3 pH to 11 pH, 4 pH to 14 pH, 4 pH to 10 pH, 6 pH to 14 pH

Displayed only when the analog output range is set to “oPt”

The 4 mA analog output value

Sets the measurement range of the pH to be assigned to 4 mA when the analog output range is set to oPt.
Setting range: –1.00 pH to 15.00 pH

Displayed only when the analog output range is set to “oPt”

The 20 mA analog output value

Sets the measurement range of the pH to be assigned to 20 mA when the analog output range is set to oPt.
Setting range: –1.00 pH to 15.00 pH

The HOLD function

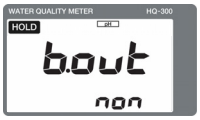
Sets the analog output in the hold mode and calibration mode.
CAL: In the hold mode, the analog output is on hold at the latest value. However, it is not on hold in the calibration mode.
HoLd: The analog output is on hold at the latest value.
PrES: The analog output is on hold at a manually pH value.
Setting range: CAL, HoLd, PrES

Displayed only when the above setting is “PrES”

The HOLD output value

Sets a manually measured pH value to be output in the hold mode when the HOLD function is set to PrES.
Setting range: –1.00 pH to 15.00 pH

The burnout function



Sets whether or not to burn out the analog output at the occurrence of an error.
non: Burnout function is disabled
out.4: Burnout lower limit setting (3.6 mA output)
out.20: Burnout upper limit setting (21 mA output)
Setting range: non, out.4, out.20

Note

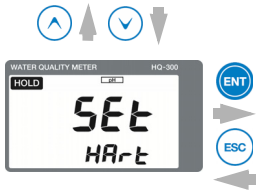
Burnout function

In case of a sensor error or system error, the analog output can be changed to the upper or lower limit setting (burnout function).

- **When the burnout upper limit setting is selected, the analog output will change to 21 mA if an error occurs.**
- **When the burnout lower limit setting is selected, the analog output will change to 3.6 mA if an error occurs.**

For details on the burnout occurrence conditions, refer to “Analog output conditions” (page 65).

HART communication setting

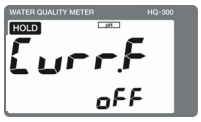


The polling address

Sets the polling address of HART communication.
Setting range: 0 to 63

Select an address except for 0 for the multi-drop link.

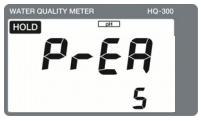
The analog output fix mode



Sets whether or not to fix the analog output to 4 mA.
on: The analog output is fixed to 4 mA.
oFF: The analog output is not fixed to 4 mA.
Setting range: on, oFF

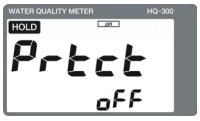
It is recommended that you set this function to ON for the multi-drop link. When this function is set to ON, the burnout and preset settings are disabled.

The number of preambles



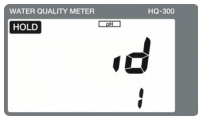
Sets the number of preambles.
Setting range: 2 pcs. to 20 pcs.

The write protect mode



Sets the write protect mode.
on: Change of various settings using the HART communication is disabled.
oFF: Change of various settings using the HART communication is enabled.
Setting range: on, oFF

Checking the device ID



Allows you to check the value of the device ID assigned to the transmitter.

The device ID cannot be changed.

Measurement mode

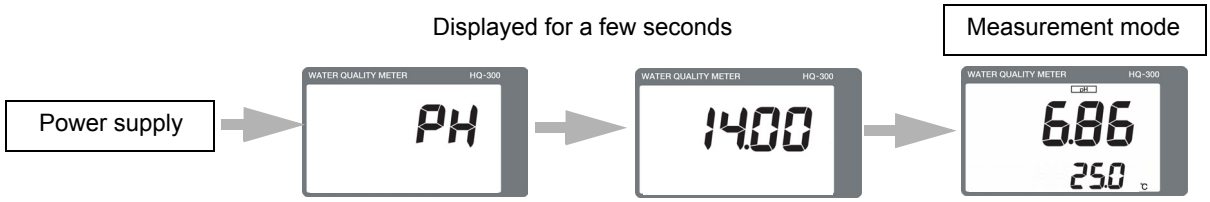
■ Functions available with the measurement mode

The following information can be displayed in the auxiliary display during measurement.
The moving average count (damping factor) is not only displayed but can also be changed.

Display information	Description	Reference page
Measured value display	Displays the measured temperature.	38
Calibration data display	Displays various calibration data of sensors.	
Moving average count display	Allows you to specify the moving average count (damping factor) of the measured pH value.	

■ How to enter the measurement mode

1. **Turn ON the power.**
The measurement target is displayed in the measured value display.
The measurement range is displayed and the system enters measurement mode.
The measured value is displayed and measurement starts. This is the measurement mode state.



2. **Press the ▲/▼ key to switch the screen.**
By switching the screen, you can change the moving average count (damping factor) and check the calibration data.

Note

Be sure to perform calibration of sensors before measurement. Refer to “Calibration” (page 40).

Measurement mode display item

▲ ▼ Setting value change ENT Entry and Set ESC Cancel

Measured value display

Power supply

Displays the measured pH value in the measured value display and the measured temperature value in the auxiliary display.

This is not displayed when the temperature display is disabled (Setting menu → Display setting → “The auxiliary display” (page 34)).

▲ ▼

Calibration data display

ENT ESC

Checking the calibration point

Displays the calibration point (pH value) during the previous calibration.
However, if manual calibration was performed, this displays “AdJ”.

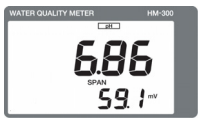
▲ ▼

Checking the zero (STD) value

Displays the asymmetry potential (STD) of pH7.
(Unit: mV)

▲ ▼

Checking the span (SLOPE) value



This indicates the sensitivity (SLOPE) per pH value.
(Unit: mV)

▲ ▼

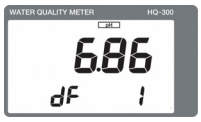
Checking the elapsed days from the previous calibration

Displays the elapsed days from the previous calibration date.

If the power is turned OFF, counting of days for that period is interrupted. When the power is turned ON, counting of days resumes.
The count is not initialized even when the power is turned OFF.

Moving average count display

▲ ▼



Sets the moving average count (damping factor) of the measured pH value.
Use the ▲/▼ key to set the moving average count.
Setting range: 1 to 50 times

Tip

Moving average count

If the measured pH value is not stabilized, you can stabilize it by setting the moving average count. The setting range is from 1 time to 50 times. The time averaging processing is performed during the period from one second to 50 seconds.

Example 1) When the moving average count is set to 10 times, the average value for the previous 10 seconds is updated every one second.

Example 2) When the moving average count is set to 1 time, averaging processing will not be performed.

Calibration

Calibration type

There are the following four calibration types: pH calibration (Auto, Basic), manual input calibration, and temperature calibration.
For details on the number of calibration points and standard solution for each calibration type, refer to the following table.

Calibration type		Remarks	Reference page
pH calibration	Auto calibration	Auto calibration is a general calibration. The number of calibration points is two. The pH4, pH7, and pH9 standard solutions can be used. Calibration is performed by using the pH7 standard solution for the first calibration point, and either the pH4 or pH9 standard solution for the second point. The calibration data is updated automatically. **Note** **Normally, auto calibration should be selected.**	44
	Basic calibration	With the basic calibration, it is possible to use a combination of standard solutions that are not available with the auto calibration. The number of calibration points can be selected from among 1 point, 2 points, and 3 points. For details on the setting, refer to “The number of calibration points” (page 33). Use the 2, 4, 7, 9, 10 or a manually standard solution. The stability judgment level of the standard solution can be selected. A standard solution matching function is provided. For details on the setting, refer to “The automatic stability judgment criteria” (page 34). Stability judgment function can be selected. For details on the setting, refer to “The automatic stability judgment function” (page 34). **Note** **For the three-point calibration, be sure to use the pH7, acid, and alkaline standard solutions. In this case, a manually standard solution cannot be used.**	46
	Manual calibration	During asymmetry potential (Std) calibration, the asymmetry potential of the sensor is manually input. During sensor sensitivity (SLP) calibration, the electromotive force of the sensor per pH value is manually input.	53
Temperature calibration		Allows you to correct the measured temperature value manually.	51

Reference

- **For details on the setting “Auto” or “bASic”, refer to “Calibration setting” (page 33).**
- **For details on the standard solution type, refer to “Standard solution” (page 73).**

Note

- **When the power is turned ON for the first time or sensors are replaced, be sure to perform calibration using the standard solution.**
- **Do not reuse the standard solution.**
- **The automatic stability judgment is a function to judge whether the pH value has been stabilized by reading the pH variations during calibration.**
  If the pH variations measured for 10 seconds have become smaller after 10 seconds from the start of stability judgment, the pH value is considered to be stable and the value is then on hold.
  When the automatic stability judgment is set to "no", although the stability judgment is performed in the same manner as the automatic judgment, the value is not on hold even when the value is judged to be stable.
- **According to the automatic stability judgment criteria, the value is judged to be stable when the variations measured for 10 seconds are under the following conditions with a simple increase or decrease: "Hi": 0.01 pH or less, "nor": 0.02 pH or less, "Lo": 0.03 pH or less.**
- **It is recommended that you use a standard solution similar to the liquid to be measured (acid/alkaline).**
  For acid: pH4-pH7 For alkaline: pH7-pH9
- **The reference value of the pH standard solution varies depending on the temperature. To perform the calibration as accurately as possible, be sure that the standard solution temperature is almost the same as the liquid to be measured.**
- **Normally for pH calibration, use two of the following types of standard solution: pH7 standard solution, pH4 standard solution, and pH9 standard solution.**
- **In general, use the pH7 standard solution and pH4 standard solution for measuring an acid liquid to be measured, and use the pH7 standard solution and pH9 standard solution for measuring an alkaline liquid to be measured.**
- **When immersing a sensor from one standard solution into a different one or from the cleaning water (pure water), wipe off the residual water droplets on the sensor.**
- **After using the standard solution, perform neutralization processing before draining it.**

■ Before performing pH calibration

● Items to prepare

Standard solution to be used

● Transmitter

Set the transmitter to the calibration mode.
Hold down the CAL key in the measurement mode. "HOLD" and "CAL" are displayed in the upper left section and the calibration mode screen appears.

Note

Before lifting up the sensor, set the analog output on hold.

● Sensor

Lift up the sensor. If it is contaminated, follow the sensor cleaning procedure below.

● pH sensor cleaning procedure

⚠ WARNING

Strong acid hazard

If diluted hydrochloric acid enters your eyes, it could irritate mucous membranes and eventually result in blindness.

When handling hydrochloric acid, be sure to wear protective goggles, gloves, and mask.
If it enters your eyes, wash your eyes with plenty of water for at least 15 minutes and consult a doctor (during eye washing, open your eyelids well with your fingers so that water completely reaches the entire eyeball and eyelids).
If the acid gets on a human body or clothing, it could cause burns (chemical burns). Therefore, throw off your clothing immediately and rinse it off with plenty of water.

If the characteristics are not returned in [1], perform the procedure in [2] (or [3] as the next step). If the characteristics are still not returned, it can be considered that the sensor life has expired. In this case, replace the sensor.

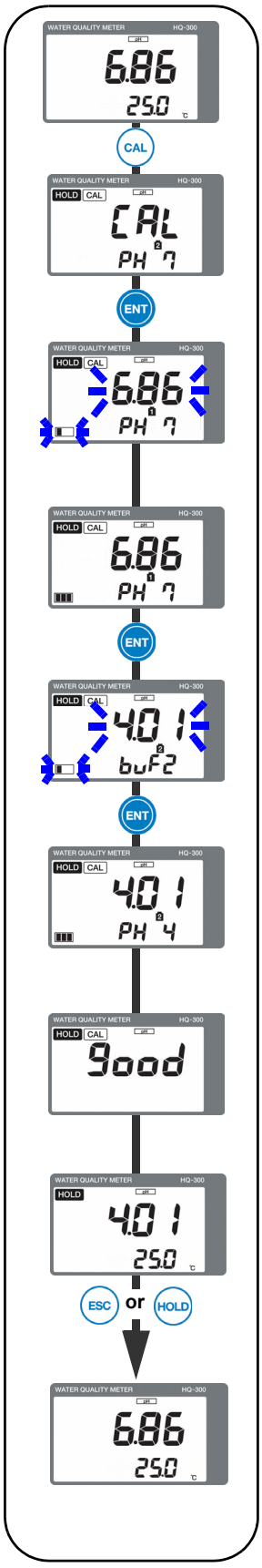
	Contamination in general	Removal soft contamination Organic substances Fiber Algae	Removal of adhesive contamination Oils Organic substances	Removal of hard contamination Calcium salt Inorganic salt	Remarks
Common procedure Rinse with pure water and wipe off the contamination with gauze	[1]	[1]	[1]	[1]	
Wipe off the contamination with gauze moistened with organic solvent and rinse it off with pure water	[2]	[2]	[2]	-	
Wipe off the contamination with gauze moistened with neutral detergent and rinse it off with pure water	-	[3]	[3]	-	
Immerse the sensor in diluted hydrochloric acid (1 mol/L) for 15 seconds and rinse it off with pure water (Repeat the step)	[3]	-	-	[2]	**Note** **Do not immerse the product in diluted hydrochloric acid for a long time.**

Auto calibration common functions

The following functions are available during auto calibration.

Function		Operational description
1	Recalibration function	Allows you to perform calibration again using the same standard solution. Pressing the CAL key starts the stability judgment.
2	Auto step function	After the stability judgment for the first point is confirmed, when the sensor is immersed in the standard solution for the second point, the second point stability judgment automatically starts.

Auto calibration operational procedure



1. **Hold down the CAL key in the measurement mode.**

2. **The calibration mode screen is displayed. Immerse the sensor into the pH7 standard solution, and then press the ENT key to start the calibration for the first point.**

3. **The measured value keeps blinking and the indicator at the lower left increases continuously.**

4. **After the stability judgment, the measured value lights up and all the indicators at the lower left also light up.**
   If you wish to perform the calibration again, press the CAL key under this condition.

5. **Next, immerse the sensor into the pH4 or pH9 standard solution and wait for a while, or press the ENT key to start the calibration for the second point.**
   The measured value keeps blinking and the indicator at the lower left increases continuously.

6. **After the stability judgment, the measured value lights up and all the indicators at the lower left also light up. This completes the calibration for the second point. Then, the next screen is automatically displayed.**

7. **The measured value display flashes, indicating “good”, and the calibration value is updated.**

8. **After the calibration value is updated, the hold mode screen is displayed.**

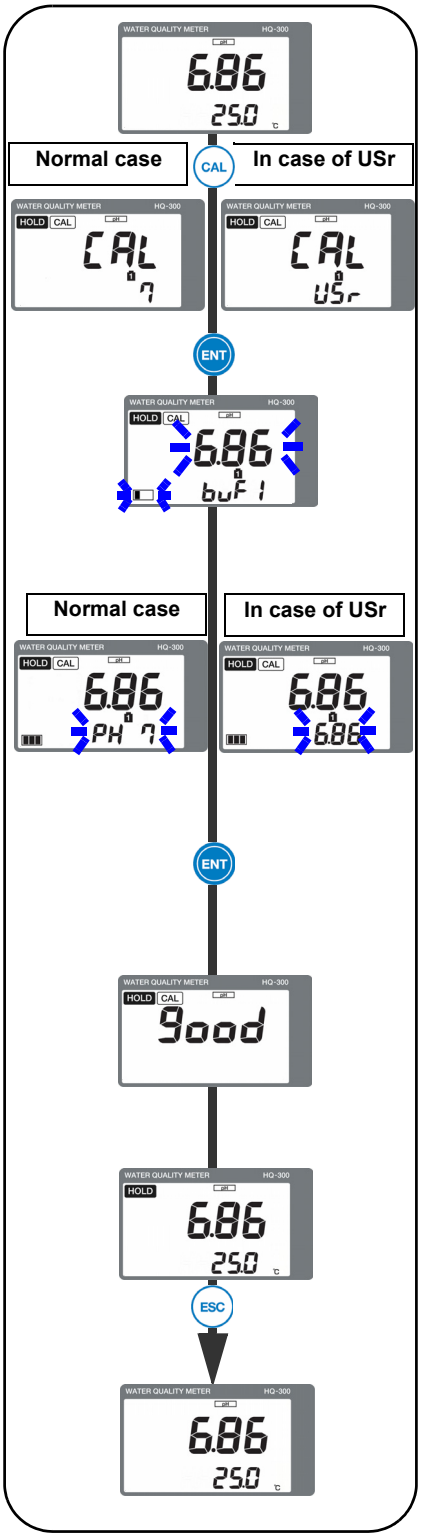
9. **Hold down either the ESC or HOLD key to return to the measurement mode.**

■ Basic calibration common function

The following functions are available during basic calibration.

Function		Operational description
1	Standard solution type change function	Allows you to change the standard solution type. Using the ▲/▼ key, change the combination of standard solutions displayed in the auxiliary display to the standard solution to be used this time. When using a manually standard solution for calibration, display “USr” (The standard solution cannot be selected manually for the three-point calibration).
2	Change function for the number of calibration points	Allows you to change the number of calibration points. Whenever the CAL key is pressed, the number of calibration points will change to 1 point, 2 points, 3 points, and 1 point, in this order. Change to the number of calibration points to be used this time.
3	Recalibration function	Allows you to perform calibration again using the same standard solution. Pressing the CAL key starts the stability judgment.
4	Standard solution matching function	Displays the judged standard solution in the auxiliary display after the stability judgment. If the displayed standard solution is different from the currently used standard solution, it can be changed. Using the ▲/▼ key, change to the standard solution to be used this time.

Basic calibration operational procedure (One-point calibration)



1. Hold down the CAL key in the measurement mode.

2. The calibration mode screen is displayed. Immerse the sensor into the standard solution, and then press the ENT key to start the calibration. At this point, the standard solution type and the number of calibration points can be changed.
   Operational procedure ⇒ “Basic calibration common function” (page 45)

3. Start the stability judgment of the standard solution. The measured value keeps blinking and the indicator at the lower left increases continuously. Once the value has been stabilized, all indicators at the lower left light up and the following screen is automatically displayed.

4. The most similar standard solution type starts blinking in the auxiliary display. Press the ENT key to set the standard solution. Matching and recalibration of the standard solution can be performed.
   Operational procedure Þ “Basic calibration common function” (page 45)

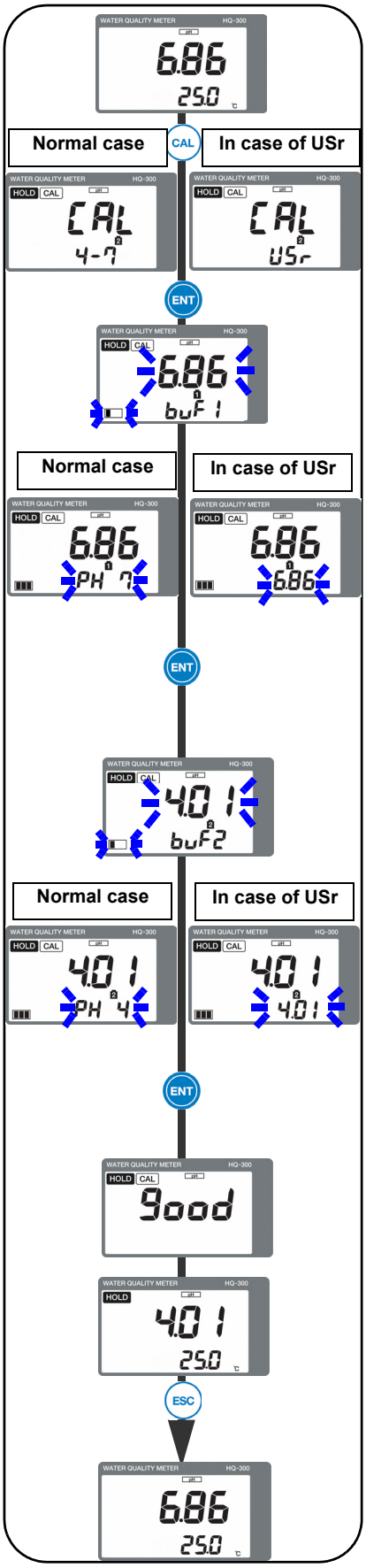
   When “USr” is set
   The measured value that has been judged to be stabilized starts blinking in the auxiliary display. Using the ▲/▼ key, display the currently used standard solution and press the ENT key to set the standard solution.

5. The measured value display flashes, indicating “good”, and the calibration value is updated.

6. After the calibration value is updated, the hold mode screen is displayed.

7. Press the ESC key to return to the measurement mode.

Basic calibration operational procedure (Two-point calibration)



1. Hold down the CAL key in the measurement mode.

2. The calibration mode screen is displayed. Immerse the sensor into the standard solution, and then press the ENT key to start the calibration. At this point, the standard solution type and the number of calibration points can be changed.
Operational procedure ⇒ “Basic calibration common function” (page 45)

3. Start the stability judgment of the standard solution. The measured value keeps blinking and the indicator at the lower left increases continuously. Once the value has been stabilized, all indicators at the lower left light up and the following screen is automatically displayed.

4. The most similar standard solution type starts blinking in the auxiliary display. Press the ENT key to set the standard solution, and then start calibration of the standard solution for the second point. Matching and recalibration of the standard solution can be performed.
Operational procedure ⇒ “Basic calibration common function” (page 45)

   When “USr” is set
   The measured value that has been judged to be stabilized starts blinking in the auxiliary display. Using the ▲/▼ key, press the ENT key to set the standard solution according to the currently used standard solution, and then start calibration of the standard solution for the second point.

5. The measured value keeps blinking and the indicator at the lower left increases continuously. Once the value has been stabilized, all indicators at the lower left light up and the following screen is automatically displayed.

6. The most similar standard solution type starts blinking in the auxiliary display. Press the ENT key to set the standard solution. Matching and recalibration of the standard solution can be performed.
Operational procedure ⇒ “Basic calibration common function” (page 45)

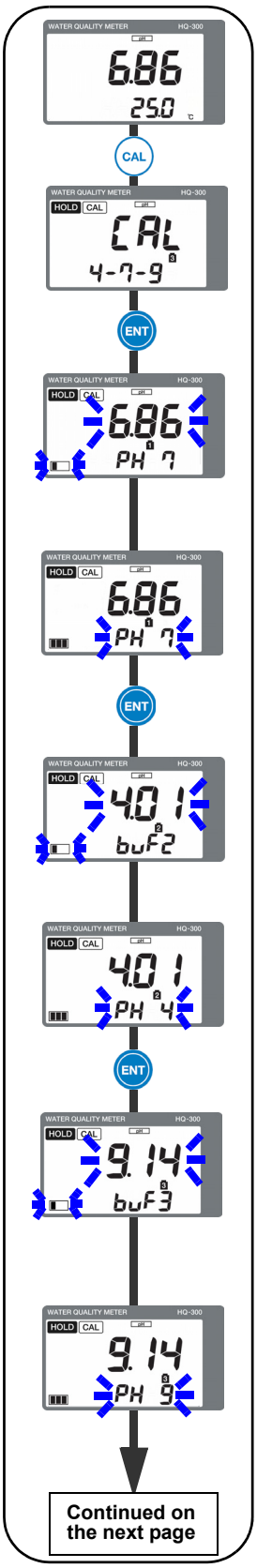
   When “USr” is set
   The measured value that has been judged to be stabilized starts blinking in the auxiliary display. Using the ▲/▼ key, display the currently used standard solution and press the ENT key to set the standard solution.

7. The measured value display flashes, indicating “good”, and the calibration value is updated.

8. After the calibration value is updated, the hold mode screen is displayed.

9. Press the ESC key to return to the measurement mode.

Basic calibration operational procedure (Three-point calibration)



1. Hold down the CAL key in the measurement mode.

2. The calibration mode screen is displayed. Immerse the sensor into the standard solution, and then press the ENT key to start the calibration. At this point, the standard solution type and the number of calibration points can be changed.
Operational procedure ⇒ “Basic calibration common function” (page 45)

3. Start the stability judgment of the pH7 standard solution. The measured value keeps blinking and the indicator at the lower left increases continuously. Once the value has been stabilized, all indicators at the lower left light up and the following screen is automatically displayed.

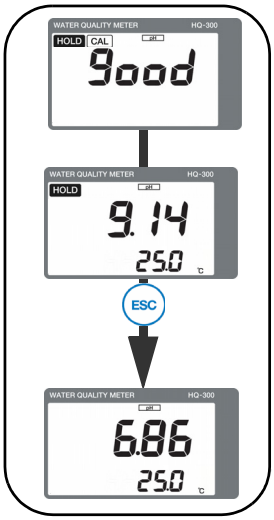
4. Press the ENT key to set the standard solution, and then start calibration of the standard solution for the second point. Recalibration can be performed.
Operational procedure ⇒ “Basic calibration common function” (page 45)

5. The measured value keeps blinking and the indicator at the lower left increases continuously. Once the value has been stabilized, all indicators at the lower left light up and the following screen is automatically displayed.

6. The most similar standard solution type starts blinking in the auxiliary display. Press the ENT key to set the standard solution, and then start calibration of the standard solution for the third point. Matching and recalibration of the standard solution can be performed.
Operational procedure ⇒ “Basic calibration common function” (page 45)

7. The measured value keeps blinking and the indicator at the lower left increases continuously. Once the value has been stabilized, all indicators at the lower left light up and the following screen is automatically displayed.

8. The most similar standard solution type starts blinking in the auxiliary display. Press the ENT key to set the standard solution. Matching and recalibration of the standard solution can be performed.
Operational procedure ⇒ “Basic calibration common function” (page 45)



9. **The measured value display flashes, indicating "good", and the calibration value is updated.**

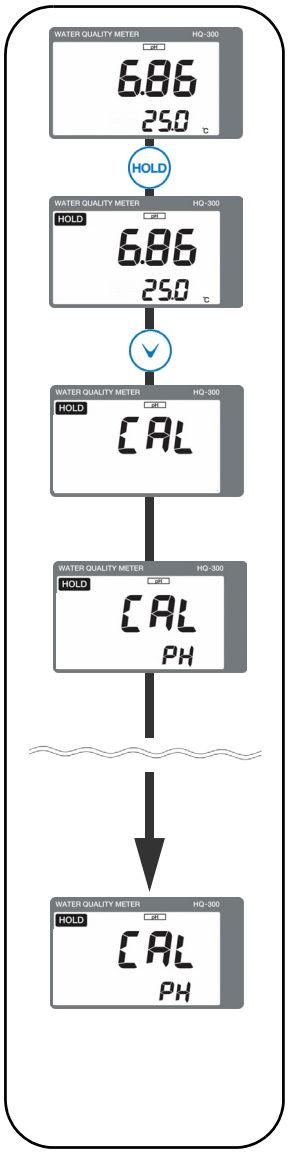
10. **After the calibration value is updated, the hold mode screen is displayed.**

11. **Press the ESC key to return to the measurement mode.**

Tip

- **If you wish to cancel the calibration in the middle of the process, press the ESC key. The display will return to the calibration menu or hold mode without changing the calibration data.**
- **If an error occurs different from setting value at standard solution, resolve the problem according to the instructions indicated associated with the error code.**
- **To continue and set other calibration items, press the ▲/▼ key to select the setting item.**
- **When the temperature sensor type "SEnSor" is set to "non" in the setting menu, calibration is performed at 25°C, regardless of the solvent temperature setting in "SoL.t".**

■ Operational procedure for entering the calibration menu from the hold mode



1. **Hold down the HOLD key in the measurement mode.**

2. **“HOLD” is displayed in the upper left section and the hold mode is activated.**

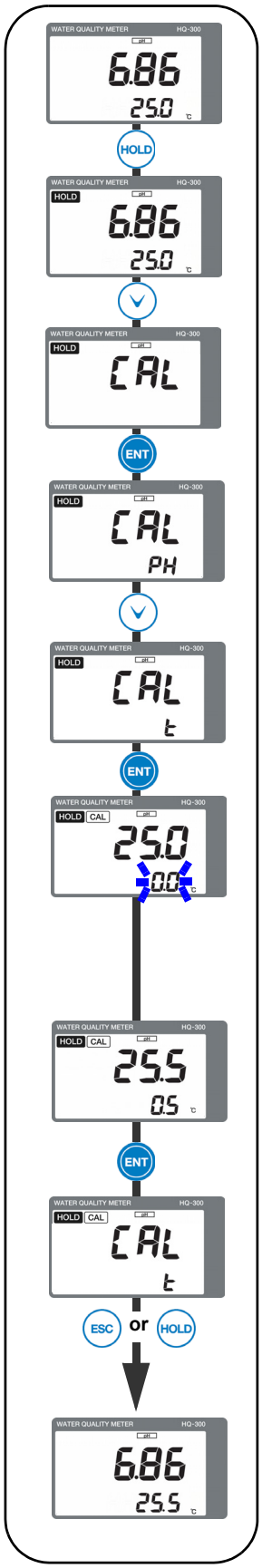
3. **Press the ▼ key twice to display CAL in the measured value display, and then press the ENT key.**

4. **“PH” is displayed in the auxiliary display.**

5. **From this point, different screens will appear depending on the calibration type. For details, refer to the relevant page on the operational procedure.**

6. **Return to the top screen for pH calibration.**

Temperature calibration operational procedure



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated.**

3. **Press the ▼ key twice to display CAL in the measured value display, and then press the ENT key.**

4. **"PH" is displayed in the auxiliary display.**

5. **Press the ▼ key to display "t" in the auxiliary display, and then press the ENT key.**

6. **The temperature calibration mode is activated and the auxiliary display starts blinking.**
   Press the ▲/▼ key to adjust the value so that the value displayed in the measured value display reaches the water temperature.
   ▲ key: The value increases by 0.1°C.
   ▼ key: The value decreases by 0.1°C.
   The setting range is from –5.0°C to 5.0°C.

7. **Press the ENT key.**
   The temperature calibration coefficient is updated.
   This completes the temperature calibration.

8. **The display returns to the calibration menu.**
   Hold down either the ESC or HOLD key.

9. **The display returns to the measurement mode.**

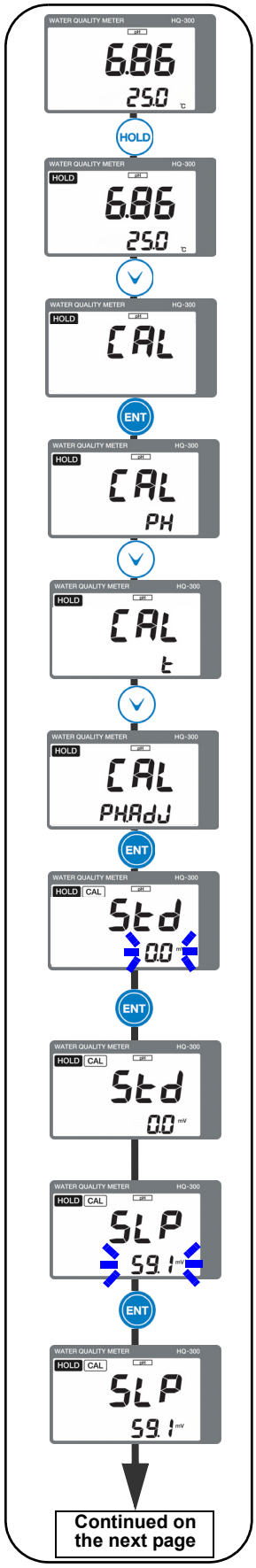
Note

- **Immerse the sensor into the liquid at a known temperature and ensure the sensor reaches the water temperature.**
- **When the hold mode is activated, the analog output will be the output value set in the setting menu (Refer to "Analog output setting" (page 34)).**
- **When the temperature sensor type "SEnSor" is set to "non" in the setting menu, the temperature calibration mode cannot be activated.**

Tip

- **If you wish to cancel the calibration in the middle of the process, press the ESC key. The display will return to the calibration menu without updating the calibration data.**
- **To continue and perform other calibration operations, press the ▲/▼ key to select the item.**

■ pH manual input calibration operational procedure



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated.**

3. **Press the ▼ key twice to display CAL in the measured value display, and then press the ENT key.**

4. **"PH" is displayed in the auxiliary display.**

5. **Press the ▼ key to display "t" in the auxiliary display.**

6. **Press the ▼ key to display "PH.AdJ" in the auxiliary display, and then press the ENT key.**

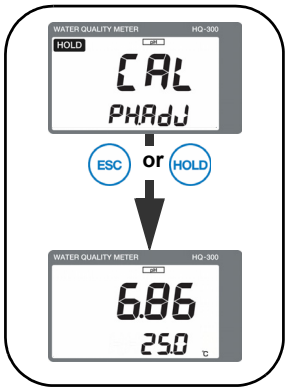
7. **The pH manual input calibration mode is activated and the auxiliary display starts blinking.**
   Press the ▲/▼ key to enter the asymmetry potential (Std).
   ▲ key: The value increases by 0.1 mV.
   ▼ key: The value decreases by 0.1 mV.
   The setting range is from –90.0 mV to 90.0 mV.

8. **Press the ENT key to set the asymmetry potential (Std). The sensor sensitivity (SLP) input screen is then displayed.**

9. **The auxiliary display starts blinking.**
   Press the ▲/▼ key to enter the electromotive force (sensor sensitivity (SLP)) value per pH.
   ▲ key: The value increases by 0.1 mV.
   ▼ key: The value decreases by 0.1 mV.
   The setting range is from 40.0 mV to 65.0 mV.

10. **Press the ENT key.**
    The sensor sensitivity (SLP) value is updated.
    This completes the pH manual input calibration. The display returns to the calibration menu.

Continued on the next page



11. **"PH.AdJ" is displayed in the auxiliary display.**

12. **Hold down either the ESC or HOLD key to return to the measurement mode.**

Tip

If you wish to cancel the calibration in the middle of the process, press the ESC key. The display will return to the calibration menu without updating the calibration data.

Maintenance procedure

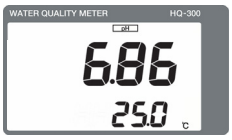
■ User check menu

The user check menu allows you to check the display, analog output, and sensor data, and initialize the preset value.

● How to enter the user check menu

1. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
2. **Press the ▲/▼ key to display USr in the measured value display, and then press the ENT key to enter the user check menu.**

Measurement mode



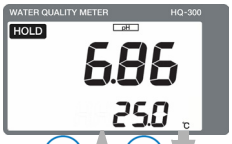
Holding down HOLD

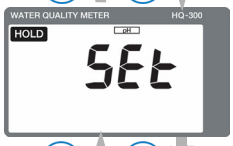
Holding down ESC

or HOLD

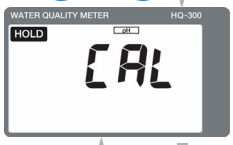
Hold mode

You can go back to the measurement mode from any point in the hold mode.



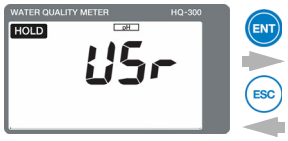


Setting menu



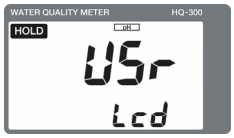
Calibration menu (pH/temperature calibration)

User check menu



ENT

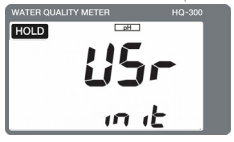
ESC



Display check

Analog output check

Sensor data check

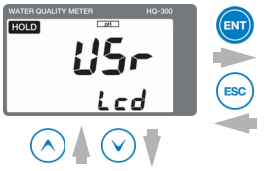


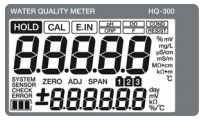
Initialization

User check menu display item

Setting value change Entry and Set Cancel

Display check

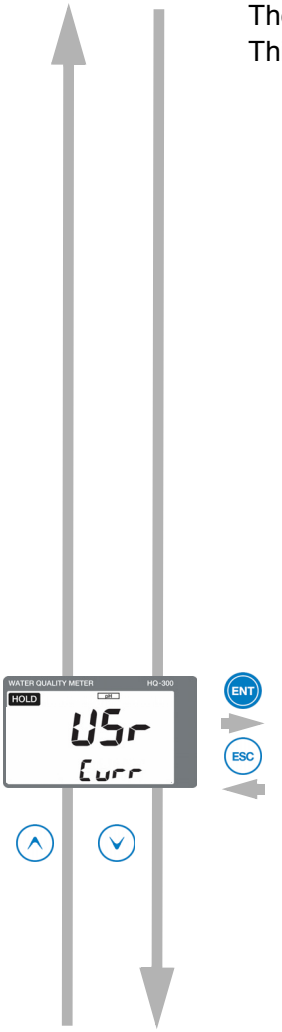




Turns on the light of the entire LCD display.
This is used when you check the display.

Analog output check

The analog output is changed to the following current values.
This is used when you check the analog output (loop check).

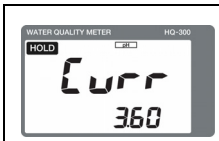


For checking the 21 mA output (Upper limit current at the time of burnout)

For checking the 20 mA output

For checking the 12 mA output

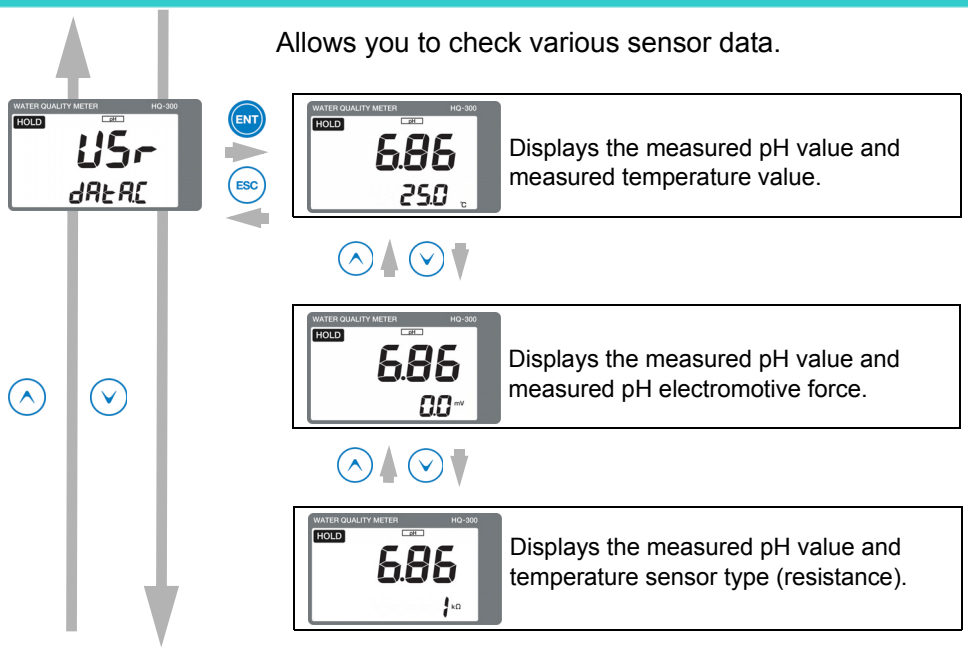
For checking the 4 mA output



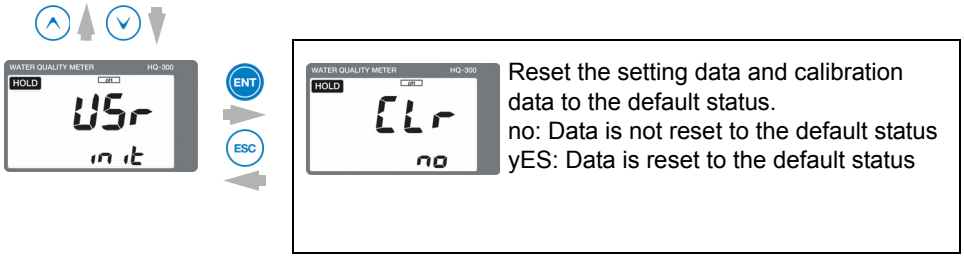
For checking the 3.6 mA output (Lower limit current at the time of burnout)

Sensor data check

Allows you to check various sensor data.



Initialization



Sensor maintenance

This section describes the maintenance procedure for general pH sensors.
For details, refer to the instruction manual for the relevant sensor.

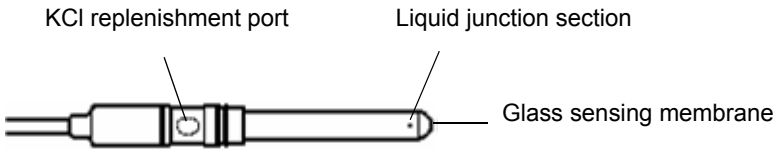
Sensor cleaning

Contamination on the sensor could cause a delay in response, indication drifting, or instability. Inspect the tip of the sensor (glass membrane) and liquid junction periodically and maintain a clean state by rinsing off the contamination with water, etc.
After cleaning the sensor, perform calibration.

Note

If a cleaning unit is installed, stop the operation of the cleaning unit and perform maintenance for the sensor.
Before performing the procedure, turn OFF the power to this product or switch it to the hold mode by holding down the HOLD key.

pH sensor single view



● pH sensor cleaning procedure

⚠ WARNING

Strong acid hazard

If diluted hydrochloric acid enters your eyes, it could irritate mucous membranes and eventually result in blindness.

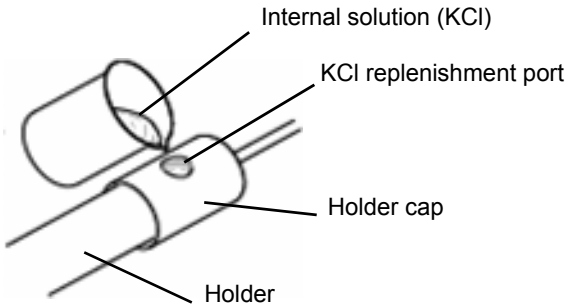
When handling hydrochloric acid, be sure to wear protective goggles, gloves, and mask.
If it enters your eyes, immediately rinse it off with plenty of water for at least 15 minutes and consult a doctor (during eye washing, open your eyelids well with your fingers so that water completely reaches the entire eyeball and eyelid).
If the acid gets on a human body or clothing, it could cause burns (chemical burns). Therefore, throw off your clothing immediately and rinse it off with plenty of water.

If the characteristics are not returned in [1], perform the procedure in [2] (or [3] as the next step). If the characteristics are still not returned, it can be considered that the sensor life has expired. In this case, replace the sensor.

	Contamination in general	Removal of soft contamination Organic substances Fiber Algae	Removal of adhesive contamination Oils Organic substances	Removal of hard contamination Calcium salt Inorganic salt	Remarks
Common procedure Rinse with pure water and wipe off the contamination with gauze	[1]	[1]	[1]	[1]	
Wipe off the contamination with gauze moistened with organic solvent and rinse it off with pure water	[2]	[2]	[2]	-	
Wipe off the contamination with gauze moistened with neutral detergent and rinse it off with pure water	-	[3]	[3]	-	
Immerse the sensor in diluted hydrochloric acid (1 mol/L) for 15 seconds and rinse it off with pure water (Repeat the step)	[3]	-	-	[2]	**Note** **Do not immerse the product in diluted hydrochloric acid for a long time.**

KCl internal solution replenishment

In order to ensure correct measurement, the liquid surface of the sensor internal solution (3.33 mol/L KCL solution) must be at least 10 cm higher than the liquid surface of the liquid to be measured. Replenish the internal solution periodically so that the liquid surface will not fall under this level.



Note

- **As KCl is used as the pH sensor internal solution, it is harmless to the human body. However, wear protective gear such as gloves and protective goggles.**
- **The internal solution can be drained through the sink as it is.**

Storage

Do not allow the tip of the sensor (glass membrane) and liquid junction to become dry. Pour tap water in the provided protective cap and cover it onto the tip of the sensor when storing the sensor. In addition, seal the internal solution replenishment port to prevent the inside of the sensor from drying.

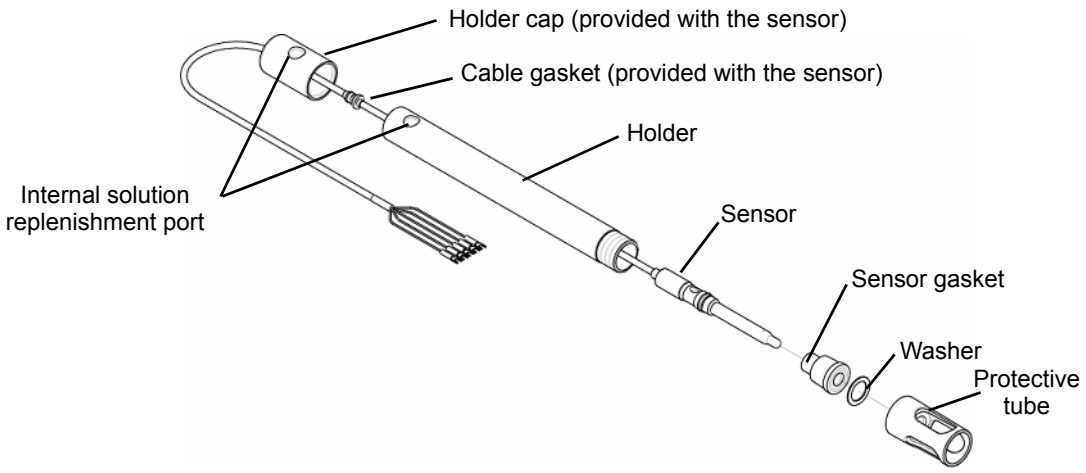
Sensor replacement procedure

CAUTION

The pH sensor is made of glass. Applying a shock or excessive force could damage the sensor. Be extremely careful when handling it.

Note

Prepare the silicon grease for installing the holder cap.
This section describes the typical sensor holder. For details, refer to the relevant instruction manual.

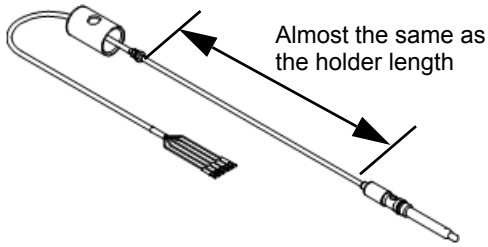


1. **Remove the holder cap, and then drain the internal solution from the holder completely.**
2. **Remove the protective pipe and washer from the tip of the holder, and then remove the sensor gasket from the holder.**
3. **Hold the sensor when removing the sensor gasket.**
4. **Remove the sensor from the top of the holder.**

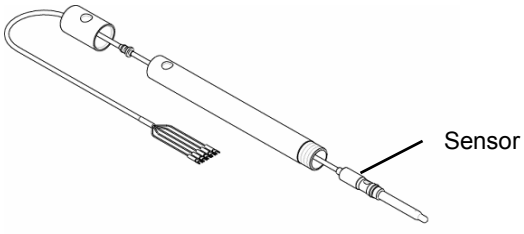
Note

Dispose the pH sensor as industrial waste.

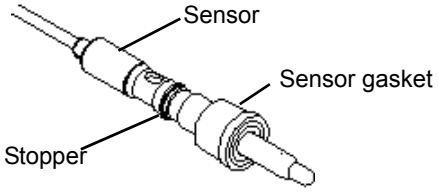
5. **Rinse off contamination from the holder, sensor gasket, washer, and protective pipe with alcohol, etc., and then dry them completely.**
6. **Move the positions of the holder cap and cable gasket approximately up to the holder length.**



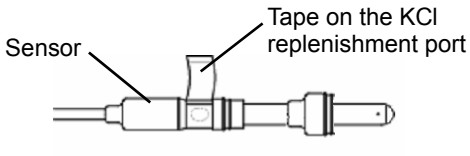
7. **Put a new sensor through the holder from the top and draw it from the bottom.**



8. **Put the sensor gasket on the sensor until it approximately reaches the stopper.**



9. **Remove the tape from the KCl replenishment port of the sensor.**

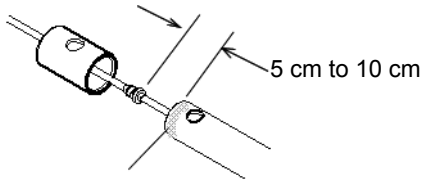


Note

- **If you do not remove the tape from the KCl replenishment port of the sensor, measurement cannot be performed correctly.**
- **In order to avoid leakage of internal solution, when removing the tape, be sure to orient the KCl replenishment port upward.**
- **As the protective cap will be reused for storage, do not dispose of it.**

10. **Push the sensor gasket into the holder, insert the washer, and then tighten the protective pipe.**

11. **Adjust the cable gasket so that the distance from the holder cap to the top of the holder is 5 cm to 10 cm.**



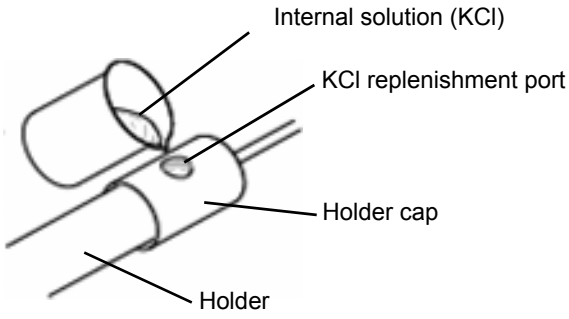
12. **Coat the entire circumference of the holder top with silicon grease.**

13. **Fit the holder cap onto the holder.**

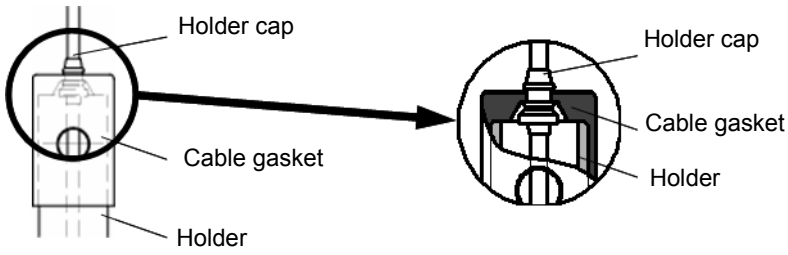
14. **Inject new internal solution from the replenishment port up to the internal solution injection level.**

Tip

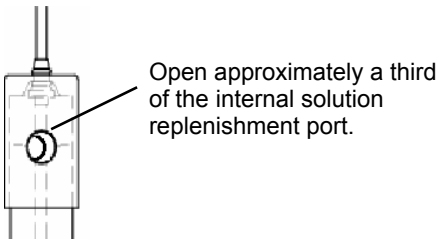
Approximately 500 mL of the internal solution is necessary for a 1 m holder.



15. **Pinch the cable gasket and slightly pull it out from the holder cap.**



16. **Open approximately a third of the internal solution replenishment port. This completes the preparation.**



Note

Check the following.

- **The protective cap of the sensor has been removed**
- **The tape on the KCl replenishment port of the sensor has been removed**
- **A third of the replenishment port on the holder has been opened**

■ Troubleshooting

● Measures for pH sensor failure

If a failure occurs in the pH sensor manufactured by HORIBA Advanced Techno, check the currently used pH sensor according to the following troubleshooting method. If the problem persists after checking and troubleshooting, please contact HORIBA Advanced Techno.

Symptom / Possible cause	Calibration cannot be performed	Instable indication	Slow response	No indication change	Internal solution reduction in a short period	Foreign matter inside reference electrode	Short lifetime	Troubleshooting
Glass membrane/reference electrode cracks	√	√	-	√	√	√	-	The sensor cannot be used. Replace it.
Contamination on glass membrane	√	√	√	√	-	-	-	Rinse off the contamination with tap water, etc.
Dry glass membrane	√	√	√	-	-	-	-	Immerse the sensor in tap water for approximately one hour before using it.
Contamination/clogging in liquid junction	√	√	-	√	-	-	-	Rinse off the contamination with tap water, etc.
Insufficient reference electrode internal solution	√	√	√	-	-	√	-	Replenish the reference electrode internal solution.
Cap remains attached	√	√	√	√	-	-	-	Remove the cap before using the sensor.
Internal solution replenishment port is not open	√	√	-	-	-	√	-	Open the internal solution replenishment port.
Glass membrane is scratched during cleaning	√	-	-	-	-	-	√	The sensor cannot be used. Replace it.
Terminal is not connected completely	√	√	-	-	-	-	-	Connect the terminal using the cable specified by HORIBA Advanced Techno, according to the instruction manual.
There is no liquid junction	-	-	-	-	√	√	-	Change to the sleeve type sensor, or replace the current sensor with a new one as soon as possible.
Old standard solution is used	√	-	-	-	-	-	-	Use new standard solution.
Hydrofluoric acid is mixed in the liquid to be measured	√	-	√	√	-	-	√	The glass is dissolved by hydrofluoric acid. It is recommended that you replace the sensor as soon as possible. Examine the use of a hydrofluoric acid-resistant sensor.
Back flow of the liquid to be measured	√	√	-	-	-	√	√	Replace the reference electrode internal solution, or replace the sensor.
Electrical conductivity of the liquid to be measured is below 10 mS/m (0.1 mS/cm)	-	√	√	-	-	-	-	Measurement cannot be performed. Contact HORIBA Advanced Techno.

● Measures for values outside the measurement range

If the measured pH value is outside the measurement range, the displayed measured value is blinking.
Perform the procedure according to the following table.

Possible cause	Corrective action
The sensor is not immersed in the liquid to be measured	Immerse the sensor under the target liquid level, even if this level fluctuates.
The protective cap of the sensor is attached	Remove the protective cap.
● Wiring of the sensor cable is wrong Wiring for the G and R lines, in particular, is disconnected ● Wiring of the relay cable is wrong	Check for looseness of screws or incorrect wiring in the terminal blocks of this product and relay box.

■ Analog output conditions

<table>
<tr><td colspan="3">C.HoLd
(HOLD setting)</td><td colspan="3">HoLd
(Latest value hold)</td><td colspan="3">CAL
(Latest value hold/
continuous output during
calibration)</td><td colspan="3">PrES
(Setting value hold)</td></tr>
<tr><td colspan="3">b.out
(Burnout setting)</td><td>non</td><td>out.4</td><td>out.20</td><td>non</td><td>out.4</td><td>out.20</td><td>non</td><td>out.4</td><td>out.20</td></tr>
<tr><td colspan="3">Measurement mode</td><td colspan="3">Measured value</td><td colspan="3">Measured value</td><td colspan="3">Measured value</td></tr>
<tr><td rowspan="5"></td><td rowspan="5"></td><td>E-21 to E-25</td><td rowspan="3">Latest value hold</td><td rowspan="3">3.6 mA</td><td rowspan="3">21 mA</td><td rowspan="3">Latest value hold</td><td rowspan="3">3.6 mA</td><td rowspan="3">21 mA</td><td rowspan="3">Preset value</td><td rowspan="3">3.6 mA</td><td rowspan="3">21 mA</td></tr>
<tr><td>E-71 to E-72</td></tr>
<tr><td>E-90 to E-92</td></tr>
<tr><td colspan="2">External hold input ON</td></tr>
<tr><td>E-21 to E-25</td><td rowspan="3">Latest value hold</td><td rowspan="3">3.6 mA</td><td rowspan="3">21 mA</td><td rowspan="3">Latest value hold</td><td rowspan="3">3.6 mA</td><td rowspan="3">21 mA</td><td rowspan="3">Preset value</td><td rowspan="3">3.6 mA</td><td rowspan="3">21 mA</td></tr>
<tr><td>E-71 to E-72</td></tr>
<tr><td>E-90 to E-92</td></tr>
<tr><td colspan="3">Hold mode (excluding pH calibration)</td><td rowspan="3">Latest value hold</td><td rowspan="3">3.6 mA</td><td rowspan="3">21 mA</td><td rowspan="3">Latest value hold</td><td rowspan="3">3.6 mA</td><td rowspan="3">21 mA</td><td rowspan="3">Preset value</td><td rowspan="3">3.6 mA</td><td rowspan="3">21 mA</td></tr>
<tr><td></td><td>E-90 to E-92</td></tr>
<tr><td colspan="2">External hold input ON</td></tr>
<tr><td></td><td>E-90 to E-92</td><td>Latest value hold</td><td>3.6 mA</td><td>21 mA</td><td>Latest value hold</td><td>3.6 mA</td><td>21 mA</td><td>Preset value</td><td>3.6 mA</td><td>21 mA</td></tr>
<tr><td colspan="3">pH calibration</td><td rowspan="7">Latest value hold</td><td rowspan="7">3.6 mA</td><td rowspan="7">21 mA</td><td rowspan="7">Measured value</td><td rowspan="7">3.6 mA</td><td rowspan="7">21 mA</td><td rowspan="7">Preset value</td><td rowspan="7">3.6 mA</td><td rowspan="7">21 mA</td></tr>
<tr><td></td><td>E-11 to E-15</td><td colspan="3" rowspan="2">Latest value hold</td></tr>
<tr><td></td><td>E-21 to E-25</td></tr>
<tr><td></td><td>E-90 to E-92</td></tr>
<tr><td colspan="2">External hold input ON</td></tr>
<tr><td></td><td>E-11 to E-15</td><td colspan="3" rowspan="2">Latest value hold</td></tr>
<tr><td></td><td>E-21 to E-25</td></tr>
<tr><td></td><td>E-90 to E-92</td><td>Latest value hold</td><td>3.6 mA</td><td>21 mA</td><td>Latest value hold</td><td>3.6 mA</td><td>21 mA</td><td>Preset value</td><td>3.6 mA</td><td>21 mA</td></tr>
<tr><td colspan="3">Temperature calibration</td><td rowspan="5">Latest value hold</td><td rowspan="5">3.6 mA</td><td rowspan="5">21 mA</td><td rowspan="5">Latest value hold</td><td rowspan="5">3.6 mA</td><td rowspan="5">21 mA</td><td rowspan="5">Preset value</td><td rowspan="5">3.6 mA</td><td rowspan="5">21 mA</td></tr>
<tr><td></td><td>E-21 to E-27</td></tr>
<tr><td></td><td>E-90 to E-92</td></tr>
<tr><td colspan="2">External hold input ON</td></tr>
<tr><td></td><td>E-21 to E-27</td></tr>
<tr><td></td><td>E-90 to E-92</td><td>Latest value hold</td><td>3.6 mA</td><td>21 mA</td><td>Latest value hold</td><td>3.6 mA</td><td>21 mA</td><td>Preset value</td><td>3.6 mA</td><td>21 mA</td></tr>
</table>

Error codes

This product has a function to display various error codes.
An error code blinks in the auxiliary display.

Error code description

Error display		Error display priority*1	Error name	Description	When to occur
E-11	SENSOR ERROR	9	Response speed error	The pH sensor response is slow during calibration of the standard solution	pH calibration*2
E-12		10	Sensor sensitivity error	The pH sensor sensitivity is poor during calibration of the standard solution	
E-13		11	Asymmetry potential error	The pH7 electromotive force (asymmetry potential) is large during calibration of the standard solution	
E-14		12	Standard solution error	The specified standard solution is not used	
E-15		13	Standard solution temperature error	When the pH10 temperature is 55°C or above	
E-21		4	Temperature sensor disconnection	The lead wire of the temperature sensor is disconnected	During measurement and pH calibration*2*3
E-22		5	Temperature sensor shorted-circuited	The lead wire of the temperature sensor is shorted-circuited	
E-25		8	Temperature measurement outside range	● When the temperature sensor type is set to Auto The temperature is below −5°C or above 105°C ● When the temperature sensor type is set individually The temperature is below −20°C or above 130°C	
E-27		8	Temperature calibration error	The temperature is below −20°C or above 130°C	During temperature calibration
E-71		6	Glass membrane error	The pH sensing membrane is cracked	During measurement
E-72		7	Reference electrode error	The liquid junction of the reference electrode is clogged (This is only effective when there is a electrode (SE)	
E-90	SYSTEM ERROR	1	System error	Internal communication error	At all times (System error)
E-91		2		The memory data, such as the setting values, calibration values, are lost	
E-92		3		A/D converter operation failure	

∗1: Two or more errors cannot be displayed at the same time. If multiple errors occur, the error with the smallest priority number is displayed.

∗2: If an error from E-11 to E-15 occurs, recalibration can be performed. However, if an error from E-21 to E-25 occurs during calibration, recalibration cannot be performed.
Take a corrective action according to “Corrective actions” (page 67).

∗3: If there is no temperature sensor (the temperature sensor type is set to “non”), no error is displayed.

Tip

When an error code is displayed, the HOLD lamp starts blinking, and the analog output will be the output value set in the setting menu. Refer to “The HOLD function” (page 35).

Corrective actions

When an error code is displayed, take corrective actions according to the table below.

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-11 (Response speed error)	If the value is not stabilized for at least 5 minutes during calibration stability judgment	● Reset by the ESC key ● Reset by recalibration	● Contamination on the sensor ● The sensor has been dry for a long period of time	Clean the sensor. Refer to “Sensor cleaning” (page 58). If the glass membrane is dry, it deteriorates the response. Immerse the sensor in pure water for the entire day and night, and then perform calibration of the standard solution again.
			There is a large difference in temperature between the liquid to be measured and standard solution	Wait until the temperature of the sensor temperature compensation element is stabilized, and then perform calibration of the standard solution.
E-12 (Sensor sensitivity error)	If the sensor sensitivity (SLOPE) deviates from the specified range during calibration of two points or more An error occurs under the following conditions: SLOPE < 40 mV/pH or SLOPE > 65 mV/pH		● Contamination on the sensor ● Glass sensor is cracked ● Sensor internal solution error ● Insufficient amount of internal solution	● Clean the sensor. Refer to “Sensor cleaning” (page 58). ● If the sensor is broken, replace it. ● For the internal solution replenishment type, if the amount of internal solution is insufficient, replenish it. ● For the internal solution non-supply type, if no white powder can be seen inside the solution, replace the sensor. ● If discoloration or alteration of the internal solution is detected, replace the entire internal solution with a new one. ● If old standard solution is used, perform calibration using new standard solution. ● Use the proper standard solution.
E-13 (Asymmetry potential error)	If the asymmetry potential (STD) deviates from the specified range during calibration An error also occurs under the following conditions: STD > 90 mV or STD < −90 mV		● Contamination on the sensor ● Discoloration of internal solution ● Contamination of internal solution ● Abnormality or deterioration of pH standard solution	
E-14 (Standard solution error)	● During calibration of two points or more, if the difference in the pH value of those solutions is less than 2.0 ● During three-point calibration, if any kind of standard solution (acid, alkaline or pH7) is lack. ● If the judged standard solution does not fall under the category of pH2, pH4, pH7, pH9, or pH10		● Insufficient difference in pH (pH2 or less) ● Sensor failure ● Abnormality or deterioration of pH standard solution	
E-15 (Standard solution temperature error)	If the temperature is 55°C or above when calibration is performed using the pH10 standard solution		The solution temperature is 55°C or above with the pH10 standard solution	Decrease the solution temperature.

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-21 (Temperature sensor disconnection)	● When the temperature sensor is 500/1k: If the resistance of the temperature sensor is approximately 1.58 kΩ or above (the 1 kΩ temperature sensor is approximately 150°C or above) ● When the temperature sensor is 6.8k/10k/Auto: If the resistance of the temperature sensor is approximately 14.8 kΩ or above (the 10 kΩ temperature sensor is approximately 150°C or above)	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the sensor with a new one. Refer to “Sensor replacement procedure” (page 60).
			Sensor without temperature sensor	Set the sensor type to “non”. Refer to “The temperature sensor” (page 32).
			Wiring error of the sensor cable and relay cable	Check that the wiring between T and T is not open.
E-22 (Temperature sensor shorted-circuited)	● When the temperature sensor is 500/1k/Auto: If the resistance of the temperature sensor is approximately 400 Ω or less (the 500 Ω temperature sensor is approximately −27°C or less) ● When the temperature sensor is 6.8 k/10 k: If the resistance of the temperature sensor is approximately 4.84 kΩ or less (the 6.8 kΩ temperature sensor is approximately −50°C or above)		Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the sensor with a new one. Refer to “Sensor replacement procedure” (page 60).
			Wiring error of the sensor cable and relay cable	Check that the wiring between T and T is not shorted.
E-25 (Temperature measurement outside range)	● Temperature type: “Auto” The temperature is below −5°C or above 105°C ● Temperature type: set a resistance temperature −20°C or above 130°C		Temperature error of the liquid to be measured	Maintain the temperature of the liquid to be measured within the operating temperature range of the sensor.
			Incorrect setting of temperature sensor type	Set the correct temperature sensor type. Refer to “The temperature sensor” (page 32).
			Temperature sensor resistance error	The temperature sensor is faulty. Replace the sensor with a new one.
E-27 (Temperature calibration error)	If the temperature is below −20°C or above 130°C	When the mode is switched from the temperature calibration mode using the ESC key	Temperature error of the liquid to be measured	Maintain the temperature of the liquid to be measured within the operating temperature range of the sensor.
			Incorrect setting of temperature sensor type	Set the correct temperature sensor type. Refer to “The temperature sensor” (page 32).
			Temperature sensor resistance error	The temperature sensor is faulty. Replace the sensor with a new one.

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-71 (Glass membrane error)	If the impedance between the sensing membrane of the sensor and the reference electrode or electrode (SE) is approximately 100 kΩ or less	When the condition stated on the left is reset	The sensor is not immersed in the liquid to be measured.	Immerse the sensor into the liquid to be measured.
			The specified relay cable and relay box are not used.	Use the specified relay cable and relay box.
			The sensing membrane of the sensor is cracked.	Replace the sensor with a new one. Refer to “Sensor replacement procedure” (page 60).
E-72 (Reference electrode error)			There is no internal solution for the reference electrode.	Replenish the internal solution.
			The liquid junction of the reference electrode is clogged.	Clean the sensor. If the problem cannot be resolved even after cleaning, replace the sensor with a new one.
			Sensor cable disconnection	Replace the sensor with a new one. Refer to “Sensor replacement procedure” (page 60).
			The currently used sensor does not have a electrode (SE).	Set the electrode (SE) of the sensor to “no”. Refer to “The electrode (SE) of the sensor” (page 33). Set the diagnostics to “non” and “g”. Refer to “The diagnostics function” (page 33).
E-90 (System error)	Internal communication error	Turning the power OFF and then ON	Internal system error	Turn OFF the power and turn it back ON. If the system error persists, contact HORIBA Advanced Techno.
E-91 (System error)	The memory data, such as the setting values, calibration values, are lost			
E-92 (System error)	A/D converter operation failure			

Sensor diagnostics function

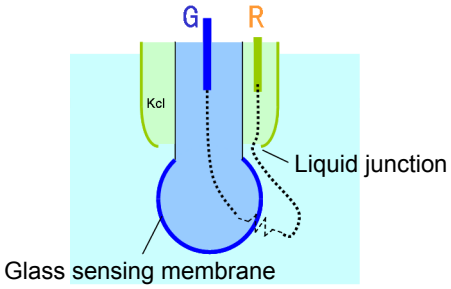
This product features a diagnostics function for the pH sensor. The diagnostics function is used to detect cracks on the glass sensing membrane of the sensor and clogging of the reference electrode (liquid junction). Note that this function may not be performed properly depending on the sensor type and operating environment. This section describes the details of this function.

■ Diagnostics type

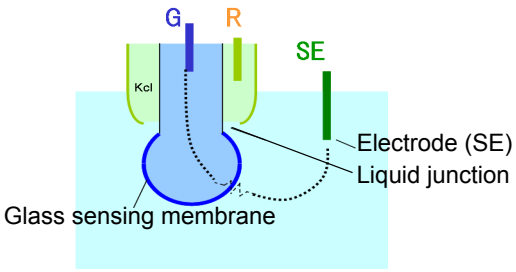
There are the following two types of diagnostics for the pH sensor.

● Glass sensing membrane cracks detection (glass membrane error)

AC voltage is applied between the glass sensing membrane and the electrode (SE) or reference electrode to measure the impedance (resistance) between the glass sensing membrane and electrode (SE) or reference electrode. If the measured resistance falls below the specified threshold, an E-71 (sensing membrane error) alarm occurs.



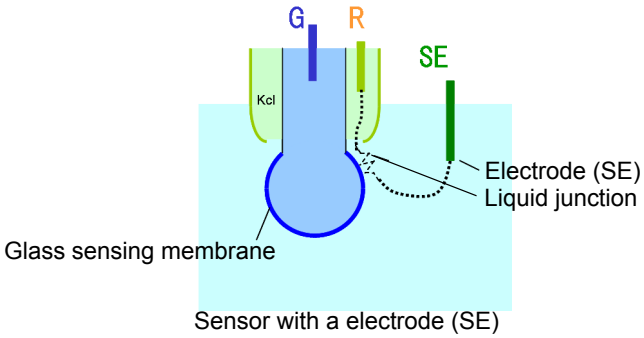
Sensor without a electrode (SE)



Sensor with a electrode (SE)

● Liquid junction resistance error detection (reference electrode error)

AC voltage is applied between the reference electrode and electrode (SE) to measure the impedance (resistance) between the reference electrode and electrode (SE). If the measured resistance exceeds the specified threshold, an E-72 (reference electrode error) alarm occurs.



Sensor with a electrode (SE)

Details of diagnostics according to the pH sensor type

For the pH sensor without a electrode (SE) (sensors such as 6110, 6108, 6109, 6151, 6152, 8200, and 8300)

This sensor only detects glass sensing membrane (g) cracks.

For the pH sensor with a electrode (SE) (sensors such as 6171, 6172, 6173, and 6174)

This sensor detects both glass sensing membrane (g) cracks and liquid junction resistance (r) errors.

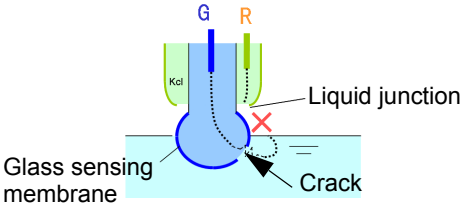
Cases where the diagnostics function is not performed properly

Note that the diagnostics function may not be performed properly depending on the sensor type and operating environment. This section describes examples of cases where the diagnostics function is not performed properly.

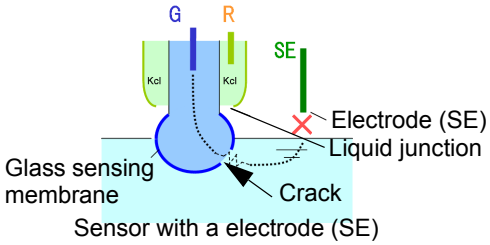
When the sensor is not in contact with the liquid to be measured

If the sensor is not in contact with the liquid to be measured, the diagnostics function is not performed properly.

- Even if there are cracks in the glass sensing membrane, a sensing membrane error (E-71) alarm will not occur.
- Even if the reference electrode functions properly, a reference electrode error (E-72) alarm will occur.



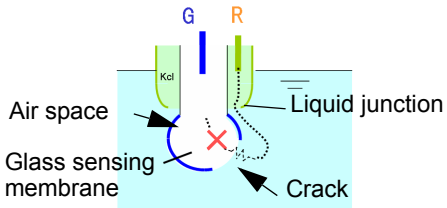
Sensor without a electrode (SE)



Sensor with a electrode (SE)

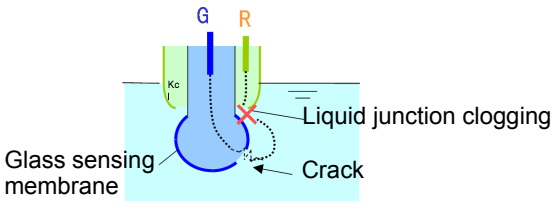
If an air space exists inside the glass sensing membrane

When glass sensing membrane cracks occur, if an air space exists inside the glass sensing membrane, the resistance between the electrodes can no longer be measured properly due to air insulation. In such case, no sensing film error (E-71) alarm will occur.



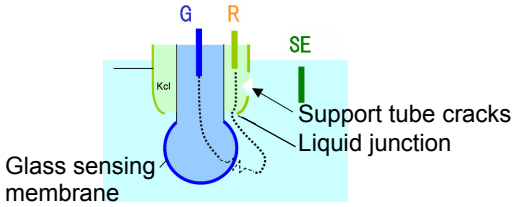
If the liquid junction of the sensor without a electrode (SE) is clogged

When the liquid junction of the sensor without a electrode (SE) is clogged, if the resistance of the liquid junction is large, no sensing film error (E-71) alarm will occur regardless of the presence of glass sensing membrane cracks.



If there are cracks in the reference electrode support tube for the sensor with a electrode (SE)

If there are cracks in the reference electrode support tube for the sensor with a electrode (SE), the liquid junction resistance becomes smaller. In this case, no reference electrode error (E-72) will occur.



If the electrical conductivity of the liquid to be measured is below 10 mS/m (0.1 mS/cm)

If the electrical conductivity of the liquid to be measured is below 10 mS/m (0.1 mS/cm), the diagnostics function is not performed properly in principle.
In this case, disable the diagnostics function and perform the operation.

- Even if there are cracks in the glass sensing membrane, a sensing film error (E-71) alarm may not occur.
- Even if the reference electrode functions properly, a reference electrode error (E-72) alarm may occur.

Tip

For details on changing the diagnostics settings, refer to “The diagnostics function” (page 33).

Standard solution

The following table indicates the pH values of the specified pH standard solutions at different temperatures.

Temperature (°C)	pH2 standard solution (Oxalate)	pH4 standard solution (Phthalate)	pH7 standard solution (Neutral phosphate)	pH9 standard solution (Borate)	pH10 standard solution (Carbonate)
0	1.67	4.00	6.98	9.46	10.32
5	1.67	4.00	6.95	9.40	10.24
10	1.67	4.00	6.92	9.33	10.18
15	1.67	4.00	6.90	9.28	10.12
20	1.68	4.00	6.88	9.22	10.06
25	1.68	4.01	6.86	9.18	10.01
30	1.68	4.02	6.85	9.14	9.97
35	1.69	4.02	6.84	9.10	9.92
40	1.69	4.04	6.84	9.07	9.89
45	1.70	4.05	6.83	9.04	9.86
50	1.71	4.06	6.83	9.01	9.83
55	1.72	4.08	6.83	8.98	-
60	1.72	4.09	6.84	8.96	-
70	1.74	4.13	6.84	8.92	-
80	1.77	4.16	6.86	8.88	-
90	1.79	4.20	6.88	8.85	-
95	1.81	4.23	6.89	8.83	-

Options

Parts name	Model	Specifications	
pH standard solution pH standard solution pH standard solution	#100-4 #100-7 #100-9	Standard solution for pH4 (accuracy ±0.02 pH) Standard solution for pH7 (accuracy ±0.02 pH) Standard solution for pH9 (accuracy ±0.02 pH)	500 mL 500 mL 500 mL
pH standard powder pH standard powder pH standard powder	#150-4 #150-7 #150-9	Standard powder for pH4 (accuracy ±0.05 pH) Standard powder for pH7 (accuracy ±0.05 pH) Standard powder for pH9 (accuracy ±0.05 pH)	10 packs included 10 packs included 10 packs included
Reference electrode internal solution	#300	3.33 mol/L KCl solution	250 mL Note) Two bottles 500 mL are required for each 1 m holder.
Powder for reference electrode internal solution	#350	KCl powder 500 g	1 bottle

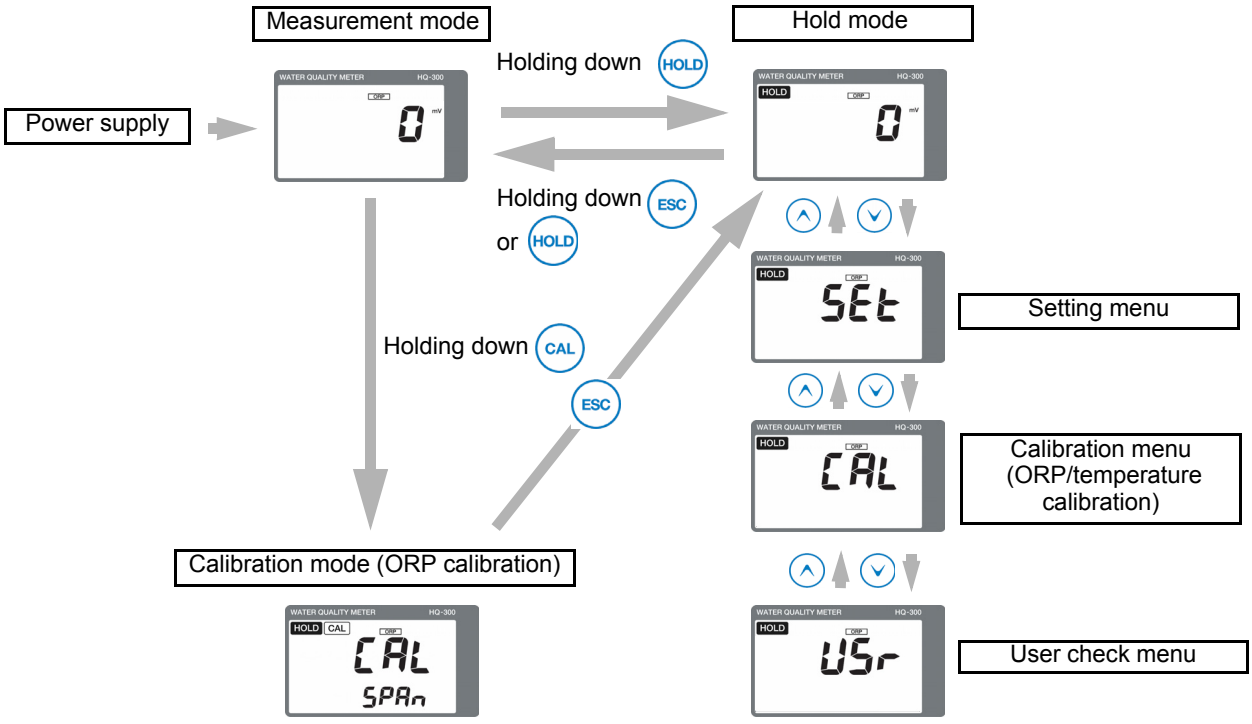
Parts name	Model	Specifications				
		Type	Temperature compensation element	Operating temperature	Liquid junction structure	Lead length
pH sensor	6110-50B	General-purpose	1 kΩ (0°C)	0°C to 60°C	Ceramic junction	5 m
	6108-50B	General-purpose dome type		−10°C to 100°C		
	6109-50B	Fixed sleeve type		−10°C to 80°C	Sleeve	
	6151-50B	For hydrofluoric acid-resistant		−10°C to 60°C	Ceramic junction	
	6152-50B	For alkali-resistant				
	6171-50B	Tip exchange type for hydrofluoric acid-resistant				
	6172-50B	Tip exchange type for alkali-resistant				
	6173-50B	Tip exchange type for oil-resistant				
	6174-50B	General-purpose tip exchange type				
	8200	Immersion type KCl non-supply type	None	0 to 50°C		
	8300	Immersion type KCl non-supply type	6.8 kΩ (25°C)			

Parts name	Model	Specifications
Holder	CH-101 series	Immersion type holder
	HIBX series	Immersion type holder for tip exchange sensor (617X series)
	CF-301 series	Flow chamber type holder (pressure type) JIS 10K 25A FF
	CF-401S	Flow chamber type holder (pressure type/SUS) JIS 10K 25A FF
	CF-501	Flow chamber type holder for tip exchange sensor (617X series)
Cleaning unit	UCH/UCF series	Ultrasonic cleaning unit (immersion/flow chamber type)
	JCH/JCF series	Water (air) jet cleaning unit (immersion/flow chamber type)
	BCH series	Brush cleaning unit (immersion type)
	CCH series	Chemical cleaning unit (immersion type)
	CBCH series	Chemical cleaning unit with a brush (immersion type)

ORP Measurement

Description of mode and menu

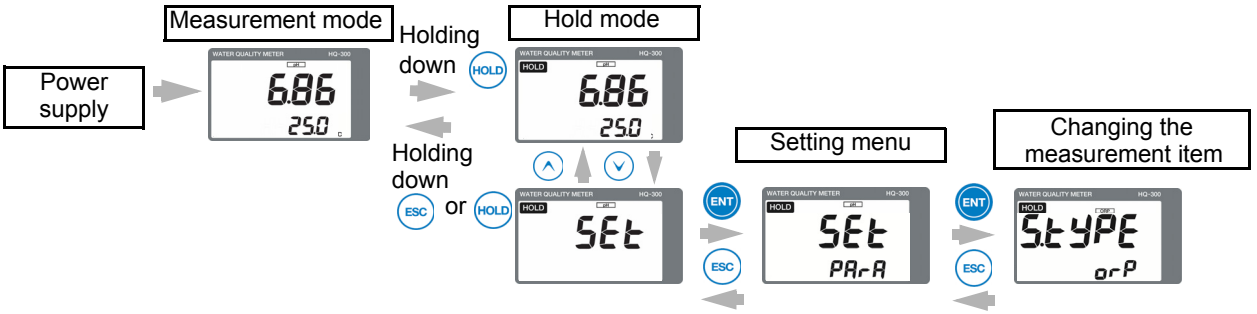
■ Modes and menus in each measurement mode



Description of mode/menu	Description	Reference page
Measurement mode	Performs measurement and analog output. Allows you to check the calibration values or set and check the moving average count (damping factor) during measurement.	83
Calibration mode (ORP SPAN calibration)	Allows you to perform the ORP SPAN calibration.	89
Hold mode (Measurement output hold)	Stops measurement and output and performs various settings.	-
Setting menu	Allows you to set all parameters related to measurement, such as the assignment of detector information input or output before starting operation.	76
Calibration menu (ORP/temperature calibration)	The following three types of calibration can be performed: ORP SPAN calibration, ORP ADJ calibration, and temperature calibration (the ORP SPAN calibration is the same as the calibration mode).	85
User check menu	The output status and measured values can be checked. The setting value can be reset to the default value.	83

Setting menu

■ Measurement item switching



Operational procedure for setting the measurement item

ENT blink the auxiliary value, ▲▼ changes the setting value, ESC cancels the value, ENT set the value and holding down HOLD return to measurement mode.

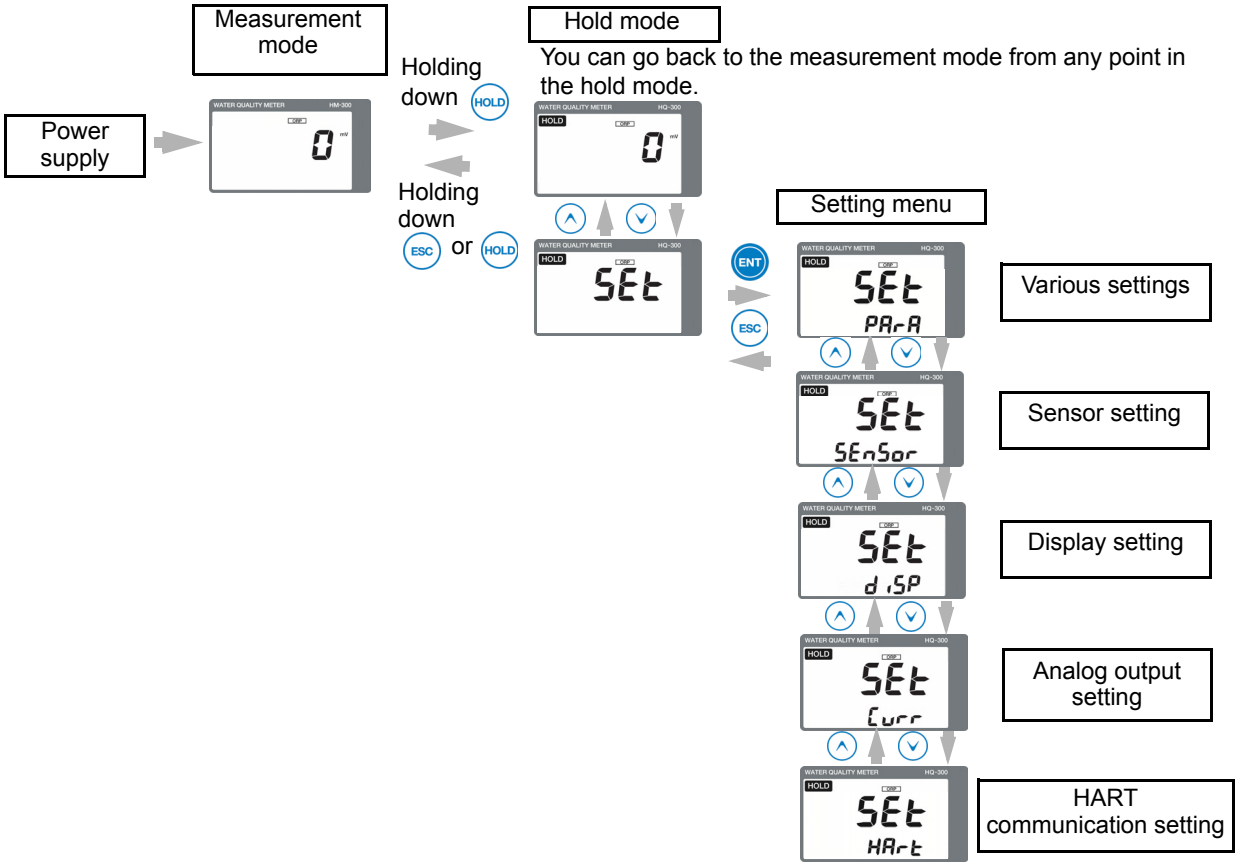
■ Functions available with setting menus

Setting item		Description	Default settings		Reference page
			Displayed character	Meaning	
Setting the sensors	The temperature sensor	Select either automatic or manual to identify the temperature sensor type.	non	None	79
	The diagnostics function	Select the diagnostics function for the sensor.	no	Disabled	79
	The electrode (SE) of the sensor	Sets the presence of a electrode (SE) for the sensor.	no	No electrode (SE)	80
Display setting	The auxiliary display	Sets whether or not to display the measured temperature value.	non	None	80
	Display limit at over range	Select whether or not to display the measured ORP value or measured temperature value if they exceed the measurement ranges, respectively.	yES	Not displayed	80

Setting item		Description	Default settings		Reference page
			Displayed character	Meaning	
Analog output setting	The analog output range	Sets the measurement range of ORP to be assigned to the analog output (4 mA to 20 mA).	±2000	–2000 mV to 2000 mV	80
	The 4 mA analog output value	Sets the ORP value to be assigned to 4 mA when the analog output range can be set manually.	–2000	–2000 mV	80
	The 20 mA analog output value	Sets the ORP value to be assigned to 20 mA when the analog output range can be set manually.	2000	2000 mV	81
	The HOLD function	Select whether or not to stop the analog output (latest value, preset) in the hold mode.	HoLd	Latest value hold	81
	The HOLD output value	Sets a manually ORP value when the HOLD function is set to PrES.	2000	2000 mV	81
	The burnout function	Sets whether or not to burn out the analog output at the occurrence of an error.	non	Disabled	81
HART communication setting	The polling address	Sets the polling address of HART communication.	0	Address 0	82
	The analog output fix mode	Sets whether or not to fix the analog output to 4 mA.	off	Analog output is not fix mode	82
	The number of preambles	Sets the number of preambles.	5	5 time	82
	The write protect mode	Sets the write protect mode.	oFF	OFF	82
	Checking the device ID	Allows you to check the value of the device ID.	-	-	82
Various settings	The measurement item switching	Switches the measurement item.	orP	ORP	79
	The moving average count	Sets the moving average count (damping factor) of the measured ORP value.	1	1 time	79
	The automatic return	Select whether or not to return the hold mode to the measurement mode automatically.	yES	Enabled	79
	The automatic return time	Sets the time before the automatic return is performed when automatic return is enabled.	2	2 hours	79

How to enter the setting menu

1. **Turn ON the power.**
2. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
3. **Press the ▲/▼ key to display SEt in the measured value display, and then press ENT to enter the setting menu.**



Setting menu display item

Setting value change Entry and Set Cancel

Various settings

ENT

ESC

The measurement item switching

Switches to the measurement item to be used.
Setting range: PH, orP, do (dissolved oxygen), C (electrical conductivity), r (electrical resistivity)

The moving average count

Sets the moving average count (damping factor) of the measured ORP value.
Setting range: 1 to 50 times

The automatic return

Select whether or not to return the hold mode to the measurement mode automatically.

During setting change and calibration, automatic return is not performed even when the automatic return function is set to yES.
Setting range: yES, no

Displayed only when the automatic return function is set to "yES"

The automatic return time

Sets the time before the automatic return is performed when automatic return is enabled.
Setting range: 1 hour to 24 hours

Setting the sensors

ENT

ESC

The temperature sensor

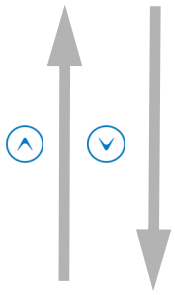
Select either automatic or manual to identify the temperature sensor type.

When Auto is set, the temperature sensor type is identified automatically.
When a sensor with no internal temperature sensor is used, set this to "non".
Setting range: non, Auto, 500 Ω, 1 kΩ, 6.8 kΩ, 10 kΩ

The diagnostics function

Select the diagnostics function for the sensor.
no: No diagnostics
yES: Diagnostics on liquid junction resistance error

When "yES" is selected, this function is activated only for the sensor with a electrode (SE).
Setting range: no, yES

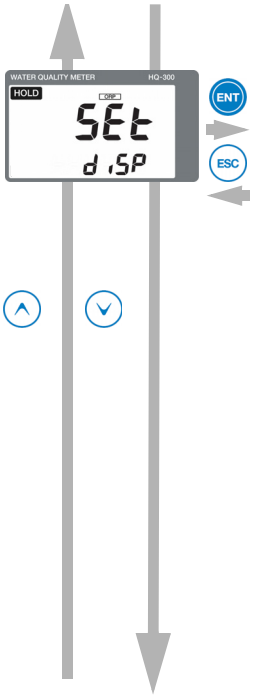


The electrode (SE) of the sensor

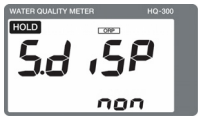
Sets the presence of a electrode (SE) for the sensor.

Be sure to set this function when the sensor has a electrode (SE).
no: No electrode (SE)
yES: Electrode (SE) provided

Display setting



The auxiliary display



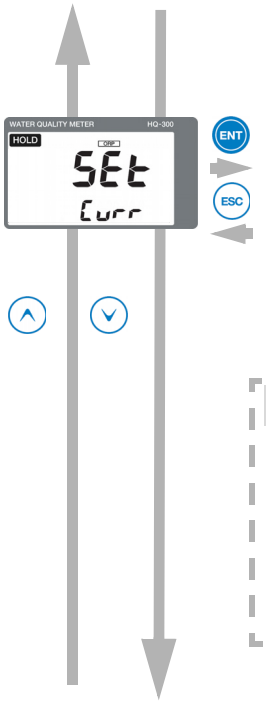
Sets whether or not to display the measured temperature value in the measurement mode screen.
non: Measured temperature value is not displayed
t: Measured temperature value is displayed
Setting range: non, t

Display limit at over range

Select whether or not to display the measured ORP value or measured temperature value if they exceed the measurement ranges, respectively.

yES: Values outside the range are not displayed
ORP: –2000 mV to 2000 mV, Temperature: 0°C to 100°C
no: Values outside the range are displayed
ORP: –2200 mV to 2200 mV, Temperature: –10°C to 110°C
(When the temperature sensor is set to Auto)
Temperature: –20°C to 130°C (When the temperature sensor is not set to Auto)
Setting range: yES, no

Analog output setting



The analog output range

Sets the measurement range of ORP to be assigned to the analog output (4 mA to 20 mA).
oPt: Allows you to set a manually ORP value.
Other: Select the range of the specific ORP.
Setting range: oPt, ±2000 mV, ±1400 mV, ±1000 mV, ±700 mV, ±350 mV

Displayed only when the analog output range is set to “oPt”

The 4 mA analog output value

Sets the measurement range of the ORP to be assigned to 4 mA when the analog output range is set to “oPt”.
Setting range: –2200 mV to 2200 mV

Displayed only when the analog output range is set to “oPt”

The 20 mA analog output value

Sets the measurement range of the ORP to be assigned to 20 mA when the analog output range is set to oPt.
Setting range: –2200 mV to 2200 mV

The HOLD function

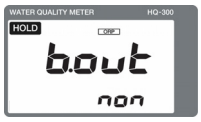
Sets the analog output in the hold mode.
HoLd: The analog output is on hold at the latest value.
PrES: The analog output is on hold at a manually ORP value.
Setting range: HoLd, PrES

Displayed only when the HOLD setting is “PrES”

The HOLD output value

Sets a manually measured ORP value to be output in the hold mode when the HOLD function is set to PrES.
Setting range: –2200 mV to 2200 mV

The burnout function



Sets whether or not to burn out the analog output at the occurrence of an error.
non: Burnout function is disabled
out.4: Burnout lower limit setting (3.6 mA output)
out.20: Burnout upper limit setting (21 mA output)
Setting range: non, out.4, out.20

Note

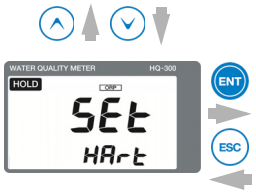
Burnout function

In case of a sensor error or system error, the analog output can be changed to the upper or lower limit setting (burnout function).

- **When the burnout upper limit setting is enabled, the analog output will change to 21 mA if an error occurs.**
- **When the burnout lower limit setting is enabled, the analog output will change to 3.6 mA if an error occurs.**

For details on the burnout occurrence conditions, refer to “Analog output conditions” (page 101).

HART communication setting

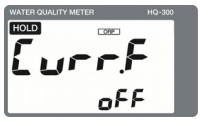


The polling address

Sets the polling address of HART communication.
Setting range: 0 to 63

Select an address except for 0 for the multi-drop link.

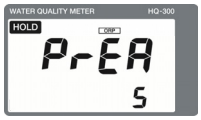
The analog output fix mode



Sets whether or not to fix the analog output to 4 mA.
on: The analog output is fixed to 4 mA.
oFF: The analog output is not fixed to 4 mA.
Setting range: on, oFF

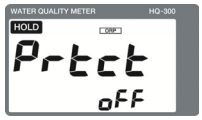
It is recommended that you set this function to ON for the multi-drop link. When this function is set to ON, the burnout and preset settings are disabled.

The number of preambles



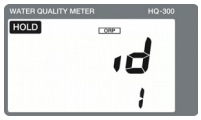
Sets the number of preambles.
Setting range: 2 pcs. to 20 pcs.

The write protect mode



Sets the write protect mode.
on: Change of various settings using the HART communication is disabled.
oFF: Change of various settings using the HART communication is enabled.
Setting range: on, oFF

Checking the device ID



Allows you to check the value of the device ID assigned to the transmitter.

The device ID cannot be changed.

Measurement mode

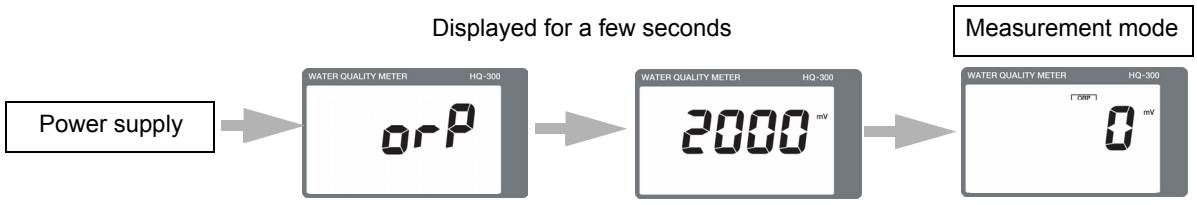
■ Functions available with the measurement mode

The following information can be displayed in the auxiliary display during measurement.
The moving average count (damping factor) is not only displayed but can also be changed.

Display information	Description	Reference page
Measured value display	Displays the measured temperature.	84
Moving average count display	Allows you to specify the moving average count (damping factor) of the measured ORP value.	

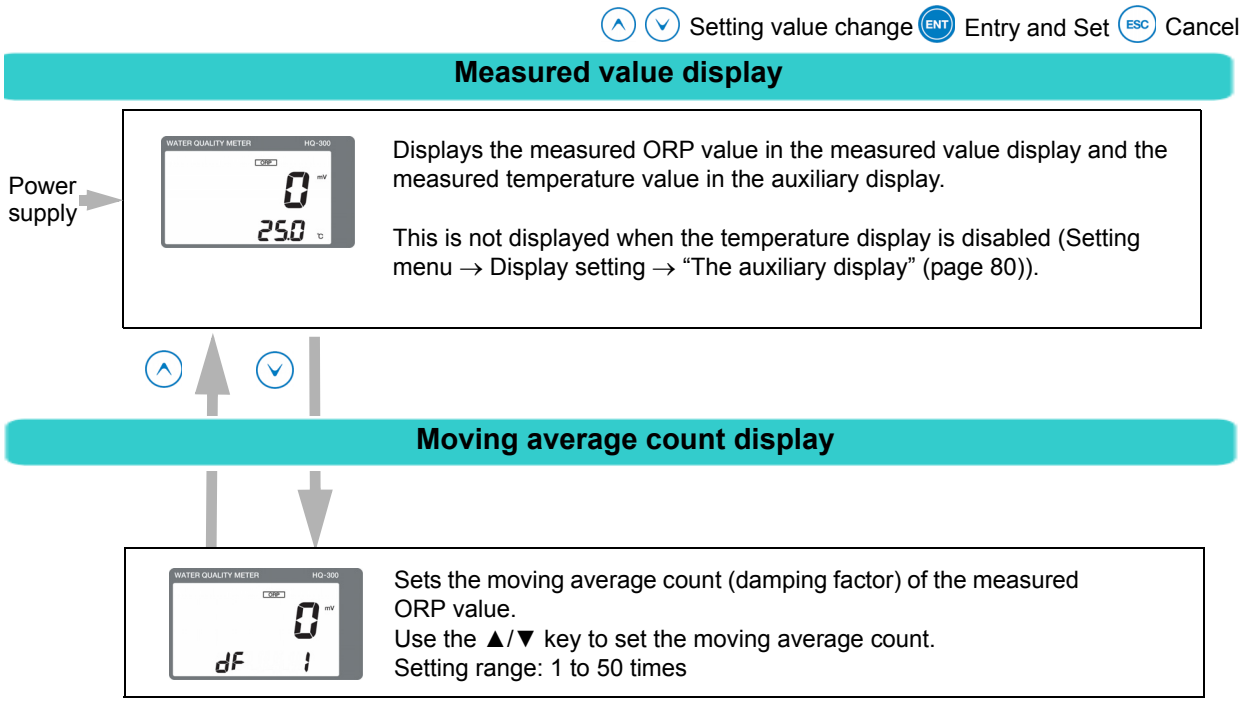
■ How to enter the measurement mode

1. **Turn ON the power.**
The measurement target is displayed in the measured value display.
The measurement range is displayed and the system enters measurement mode.
The measured value is displayed and measurement starts. This is the measurement mode state.



2. **Press the ▲/▼ key to switch the screen.**
By switching the screen, you can change the moving average count (damping factor).

Measurement mode display item



Tip

Moving average count
If the measured ORP value is not stabilized, you can stabilize it by setting the moving average count. The setting range is from 1 time to 50 times. The time averaging processing is performed during the period from one second to 50 seconds.

Example 1) When the moving average count is set to 10 times, the average value for the previous 10 seconds is updated every one second.
Example 2) When the moving average count is set to 1 time, averaging processing will not be performed.

Calibration

Note

The ORP meter is calibrated as a voltmeter. This product features an output adjustment function according to the shift and span. However, the ORP meter is not adjusted in accordance with the standard solution, as with the pH meter. Under normal usage, calibration according to the shift and span is not necessary. The ORP solution is used to be only verified within the appropriate range or not range.
In this document, the term "calibration" is used when the ORP meter is adjusted as a voltmeter. The term "sensitivity check" is used when verification is performed using the standard solution.

■ Calibration type

Type	Remarks	Reference page
SPAN calibration	The ORP meter is calibrated using the reference voltage generator. This span calibration is a function to make the ORP meter correspond to the reference voltage. As the ORP meter is not calibrated according to the standard solution, as with the pH meter, do not use this function to perform calibration using the ORP standard solution. If span calibration is performed on purpose for the measured ORP potential, the calibration condition of the transmitter as a voltmeter can no longer be maintained. This span calibration is not necessary for any cases except when the gain is changed intentionally.	87
ADJ calibration	The ORP ADJ calibration is a shift function to adjust the value to 0 mV when the input is short-circuited. Although this function can be used to intentionally shift the measured ORP value, the calibration condition of the transmitter as a voltmeter can no longer be maintained. This operation is not necessary for any cases except when you wish to shift the value intentionally.	88
Temperature calibration	Performs calibration of the temperature. As the temperature compensation is not performed for the ORP meter, it is not necessary to precisely calibrate the thermometer. Perform calibration only when the temperature calibration is absolutely necessary.	90

■ Before performing ORP calibration

● Items to prepare

Reference voltage generator

● Transmitter

Set the transmitter to the calibration mode.
Hold down the CAL key in the measurement mode. "HOLD" and "CAL" are displayed in the upper left section and the calibration mode screen appears.

Sensor

CAUTION

Before performing wiring for the power supply lines and sensor lines, be sure to turn OFF the power supply.

When performing SPAN calibration

Remove the ORP sensor from the sensor terminal block. Connect the M and R lines on the terminal block to the reference voltage generator.

When performing ADJ calibration

Remove the ORP sensor from the sensor terminal block. Short-circuit the M and R lines on the terminal block using electric wires.

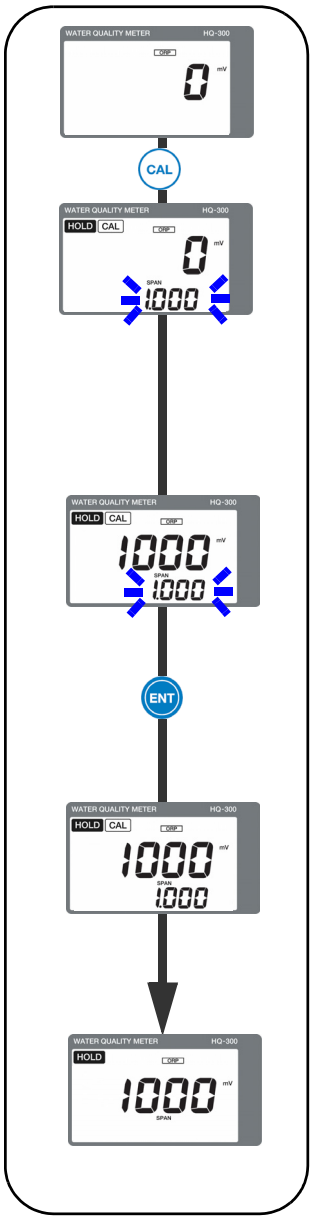
When performing temperature calibration

It is not necessary to remove the sensor.

After the calibration, reconnect the ORP sensor and resume the measurement.

■ ORP SPAN calibration operational procedure

Before calibration, confirm that the reference voltage generator is connected to the M and R lines on the sensor terminal block.
After the calibration, reconnect the ORP sensor and resume the measurement.



1. **Hold down the CAL key in the measurement mode.**

2. **The display will switch to the ORP SPAN calibration menu, and the current measured value is displayed in the measured value display and the currently set coefficient is blinking in the auxiliary display.**

3. **Output 1 V from the reference voltage generator.**

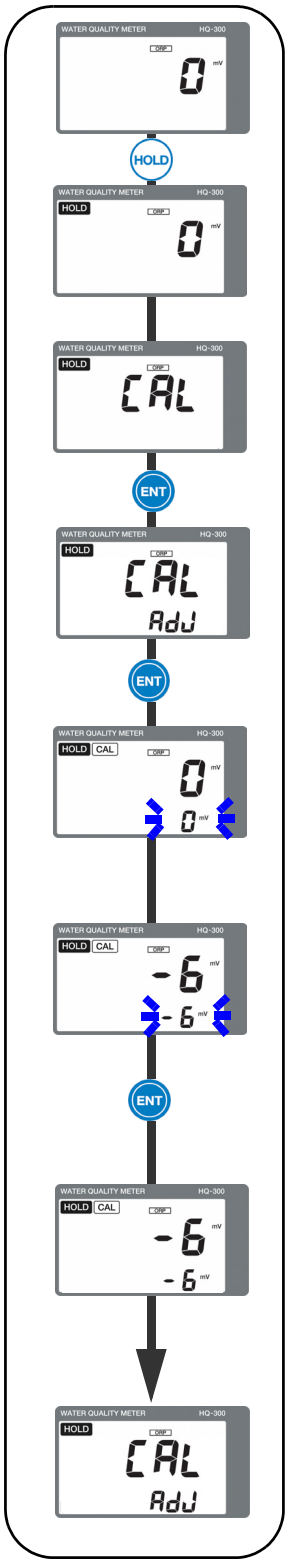
4. **Press the ▲/▼ key to increase/decrease the coefficient and adjust the measured value to 1 V.**
▲ key: The value increases by 0.001.
▼ key: The value decreases by 0.001.
The setting range is from 0.500 to 1.500.
Press the ENT key.

5. **The auxiliary display flashes, and the ORP SPAN calibration coefficient is updated.**

6. **Display the hold mode screen.**

■ ORP ADJ calibration operational procedure

Before calibration, confirm that the M and R lines are short-circuited on the sensor terminal block. After the calibration, reconnect the ORP sensor and resume the measurement.



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated.**
   Press the ▼ key twice.

3. **Display CAL in the measured value display, and then press the ENT key.**

4. **"AdJ" is displayed in the auxiliary display. Press the ENT key.**

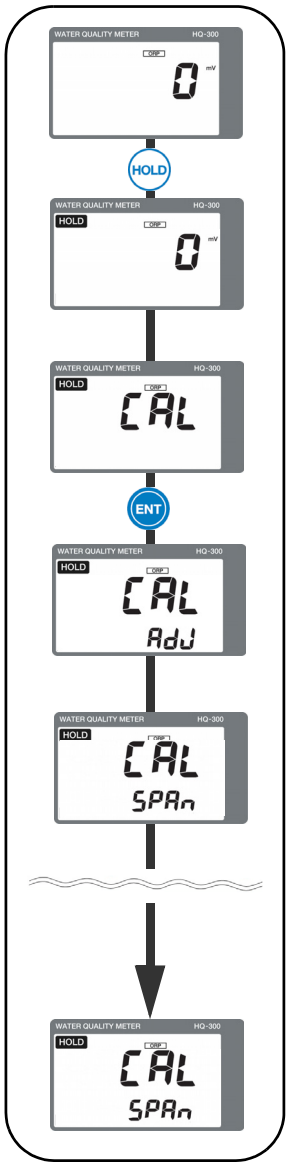
5. **The display will switch to the ORP ADJ calibration menu, and the current measured value is displayed in the measured value display and the currently set offset value (mV) is blinking in the auxiliary display.**

6. **Press the ▲/▼ key to enter the shift value.**
   ▲ key: The value increases by 1 mV.
   ▼ key: The value decreases by 1 mV.
   The setting range is from –200 mV to 200 mV.
   Press the ENT key.

7. **The auxiliary display flashes, and the ORP ADJ calibration is updated.**

8. **Display the hold mode screen.**

■ Operational procedure for entering the calibration menu from the hold mode



1. **Hold down the HOLD key in the measurement mode.**

2. **“HOLD” is displayed in the upper left section and the hold mode is activated.**
   Press the ▼ key twice.

3. **Display CAL in the measured value display, and then press the ENT key.**

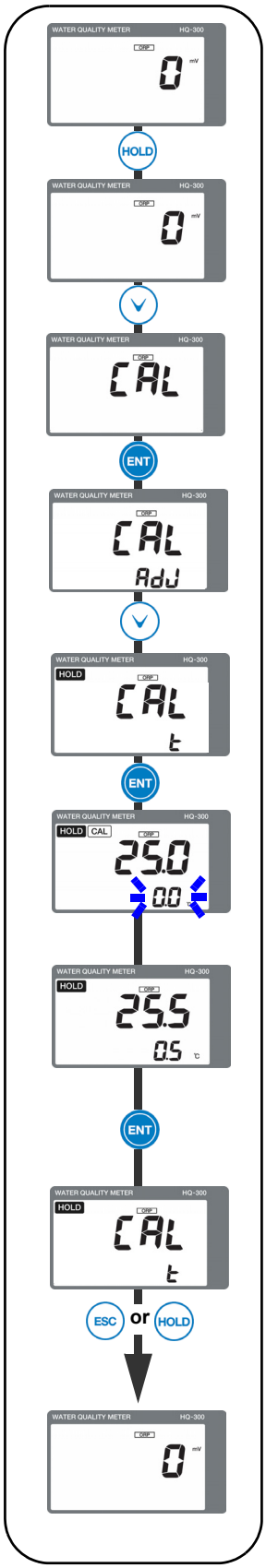
4. **“AdJ” is displayed in the auxiliary display. Press the ▼ key.**

5. **“SPAn” is displayed in the auxiliary display.**

6. **From this point, different screens will appear depending on the calibration type. For details, refer to the relevant page on the operational procedure.**

7. **Return to the top screen for ADJ calibration.**

■ Temperature calibration operational procedure



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated.**
   Press the ▼ key twice.

3. **Display CAL in the measured value display, and then press the ENT key.**

4. **"AdJ" is displayed in the auxiliary display. Press the ▼ key.**

5. **Display "t" in the auxiliary display, and then press the ENT key.**

6. **The temperature calibration mode is activated and the auxiliary display starts blinking.**

7. **Press the ▲/▼ key to adjust the value so that the value displayed in the measured value display reaches the water temperature.**
   ▲ key: The value increases by 0.1°C.
   ▼ key: The value decreases by 0.1°C.
   The setting range is from –5.0°C to 5.0°C.

8. **Press the ENT key.**
   The temperature calibration coefficient is updated.
   This completes the temperature calibration. The display returns to the calibration menu.

9. **Hold down either the ESC or HOLD key to return to the measurement mode.**

Note

- **Immerse the sensor into the liquid at a known temperature and ensure the sensor reaches the water temperature.**
- **When the hold mode is activated, the analog output will be the output value set in the setting menu (Refer to "Analog output setting" (page 80)).**
- **When the temperature sensor type "SEnSor" is set to "non" in the setting menu, the temperature calibration mode cannot be activated.**

Tip

- **If you wish to cancel the calibration in the middle of the process, press the ESC key. The display will return to the calibration menu without updating the calibration data.**
- **To continue and set other calibration items, press the ▲/▼ key to select the setting item.**

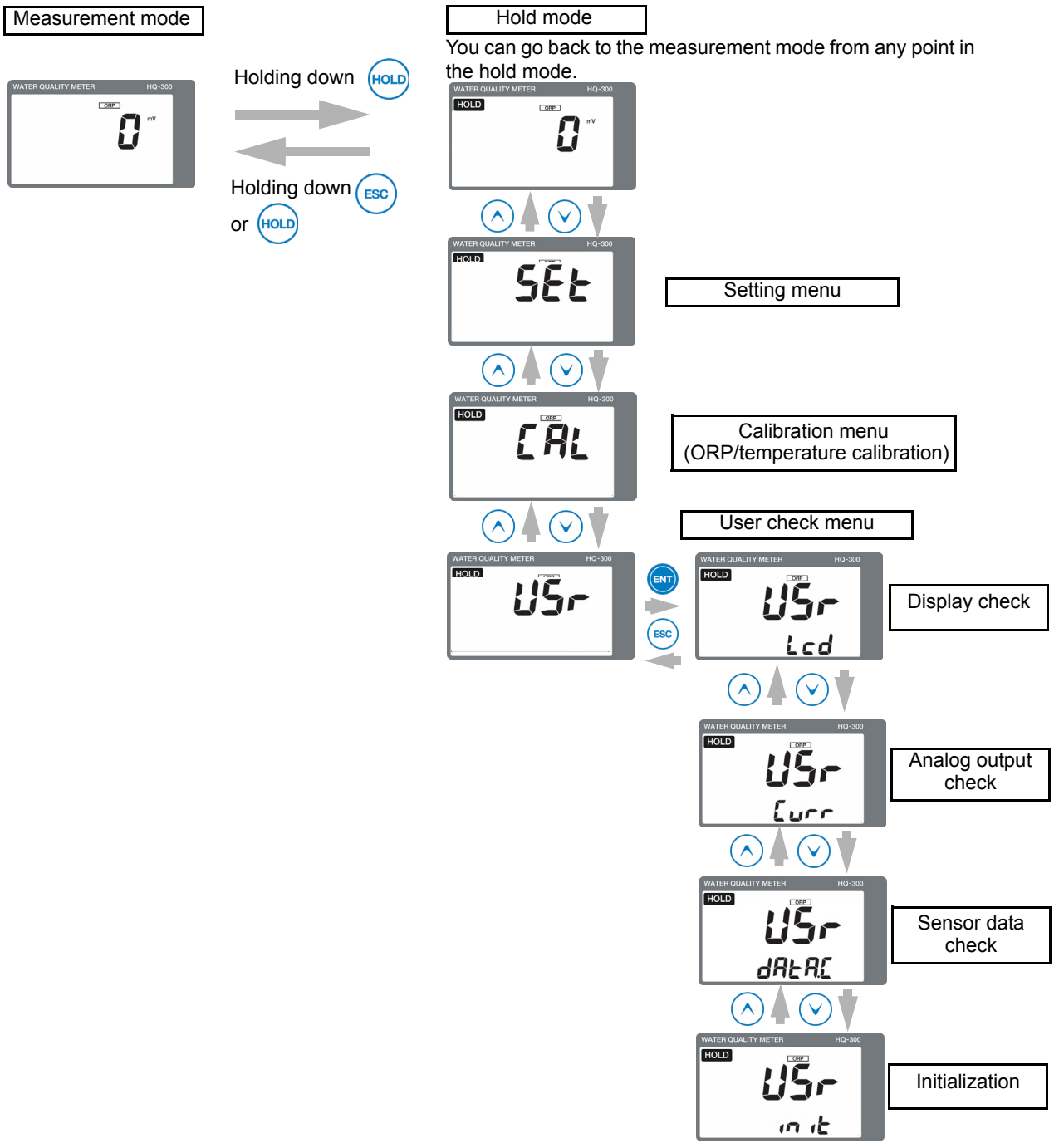
Maintenance procedure

■ User check menu

The user check menu allows you to check the display, analog output, and sensor data, and initialize the setting value.

● How to enter the user check menu

1. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
2. **Press the ▲/▼ key to display USr in the measured value display, and then press the ENT key to enter the user check menu.**



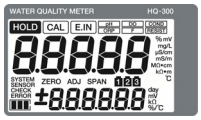
■ User check menu display item

Setting value change ENT Entry and Set ESC Cancel

Display check

ENT

ESC



Turns on the light of the entire LCD display.
This is used when you check the display.

Analog output check

The analog output is changed to the following current values.
This is used when you check the analog output (loop check).

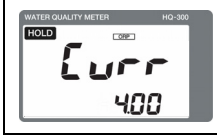
ENT

ESC

For checking the 21 mA output (Upper limit current at the time of burnout)

For checking the 20 mA output

For checking the 12 mA output

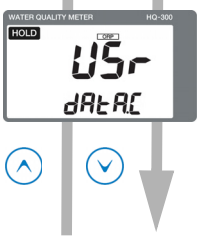


For checking the 4 mA output

For checking the 3.6 mA output (Lower limit current at the time of burnout)

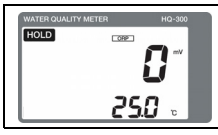
Sensor data check

Allows you to check various sensor data.

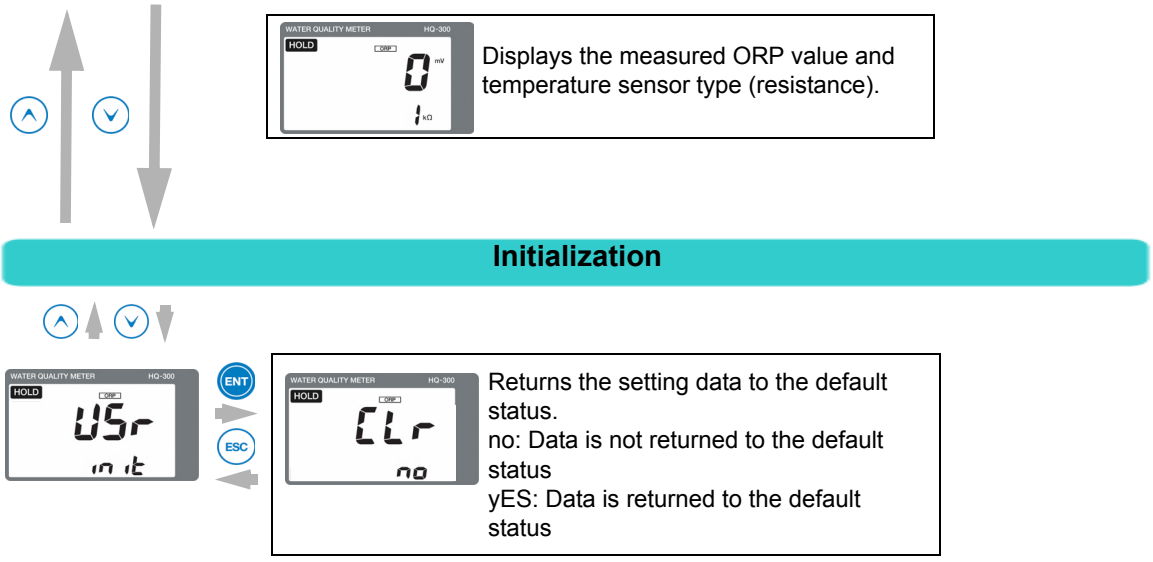


ENT

ESC



Displays the measured ORP value and measured temperature value.



Sensor maintenance

This section describes the maintenance procedure for general ORP sensors.
For details, refer to the instruction manual for the relevant sensor.

Sensitivity check

This section describes the sensitivity check procedure for maintaining accuracy.

Note

- **Use the ORP potential made of the ORP standard substance (HORIBA model "#160-22") within two hours after the powder is resolved.**
- **Do not reuse the standard solution.**
- **When the hold mode is activated, the analog output will be the output value set in the setting menu. Refer to "The HOLD function" (page 81).**

Sensitivity check procedure

1. **Immerse the sensor in the standard solution and check that the reading indicates 260 mV ±20 mV.**
   At this point, if the value is adjusted to the standard potential using ADJ or SPAN calibration, the calibration status of the transmitter will be discarded. Although the analog output not set on hold, you can check the sensitivity in the measurement mode.
2. **Hold down the CAL key until the CAL lamp lights up.**
   The ORP SPAN calibration mode is displayed and you can check the ORP sensitivity.

Holding down the CAL key

3. **Perform calibration according to the procedure described in "Operational procedure for entering the calibration menu from the hold mode" (page 89).**

● Reading using ORP standard solution

Standard solution temperature (°C)	Standard solution #160-22 (mV)
0	+277.5
5	+274.2
10	+270.9
15	+266.8
20	+262.5
25	+257.6
30	+253.5
35	+248.6
40	+243.6

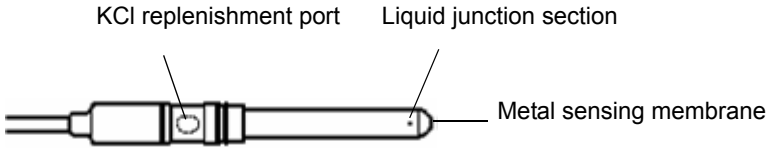
■ Sensor cleaning

Contamination on the sensor could cause a delay in response, indication drifting, or instability. Inspect the tip of the sensor (metal sensing membrane) and liquid junction periodically and maintain a clean state by rinsing off the contamination with water, etc.

Note

If a cleaning unit is installed, stop the operation of the cleaning unit and perform maintenance for the sensor.
Before performing the procedure, turn OFF the power to this product or switch it to the hold mode by holding down the HOLD key.

● ORP sensor single view



● ORP sensor cleaning procedure

⚠ WARNING

Strong acid hazard

If diluted hydrochloric acid enters your eyes, it could irritate mucous membranes and eventually result in blindness.

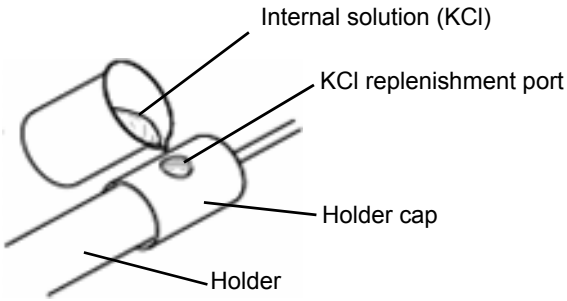
When handling hydrochloric acid, be sure to wear protective goggles, gloves, and mask.
If it enters your eyes, immediately rinse it off with plenty of water for at least 15 minutes and consult a doctor (during eye washing, open your eyelids well with your fingers so that water completely reaches the entire eyeball and eyelid).
If the acid gets on a human body or clothing, it could cause burns (chemical burns). Therefore, throw off your clothing immediately and rinse it off with plenty of water.

If the characteristics are not returned in [1], perform the procedure in [2] (or [3] as the next step). If the characteristics are still not returned, it can be considered that the sensor life has expired. In this case, replace the sensor.

	Contamination in general	Removal of soft contamination Organic substances Fiber Algae	Removal of adhesive contamination Oils Organic substances	Removal of hard contamination Calcium salt Inorganic salt	Remarks
Common procedure Rinse with pure water and wipe off the contamination with gauze	[1]	[1]	[1]	[1]	
Wipe off the contamination with gauze moistened with organic solvent and rinse it off with pure water	[2]	[2]	[2]	-	
Wipe off the contamination with gauze moistened with neutral detergent and rinse it off with pure water	-	[3]	[3]	-	
Immerse the sensor in diluted hydrochloric acid (1 mol/L) for 15 seconds and rinse it off with pure water (Repeat the step)	[3]	-	-	[2]	**Note** **Do not immerse the product in diluted hydrochloric acid for a long time.**

● KCl internal solution replenishment

In order to ensure correct measurement, the liquid surface of the sensor internal solution (3.33 mol/L KCL solution) must be at least 10 cm higher than the liquid surface of the liquid to be measured.
Replenish the internal solution periodically so that the liquid surface will not fall under this level.



● Storage

Do not allow the tip of the sensor (metal sensing membrane) to become dry. Pour tap water in the provided protective cap and cover it onto the tip of the sensor when storing the sensor. In addition, seal the internal solution replenishment port to prevent the inside of the sensor from drying.

Sensor replacement procedure

CAUTION

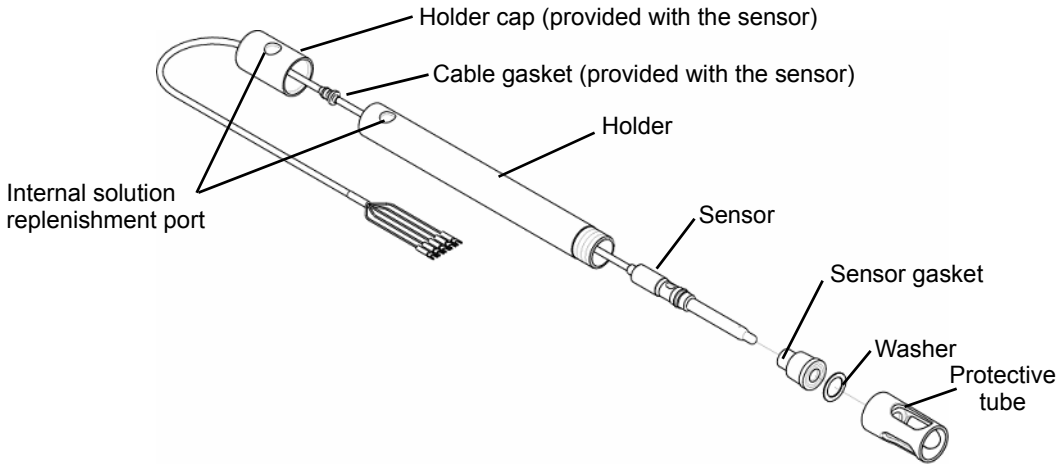
The ORP sensor is made of glass. Applying a shock or excessive force could damage the sensor. Be extremely careful when handling it.

Note

Prepare the silicon grease for installing the holder cap.
This section describes the typical sensor holder. For details, refer to the relevant instruction manual.

Note

- **As KCl is used as the ORP sensor internal solution, it is harmless to the human body. However, wear protective gear such as gloves and protective goggles.**
- **The internal solution can be drained through the sink as it is.**



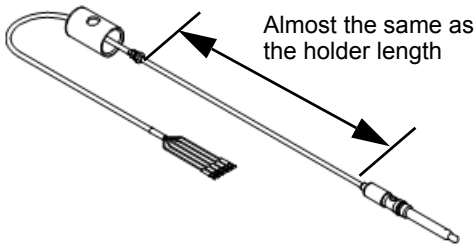
1. **Remove the holder cap, and then drain the internal solution from the holder completely.**
2. **Remove the protective pipe and washer from the tip of the holder, and then remove the sensor gasket from the holder.**
3. **Hold the sensor when removing the sensor gasket.**
4. **Remove the sensor from the top of the holder.**

Note

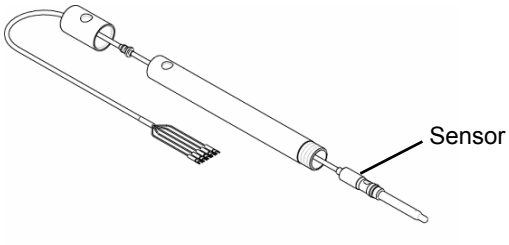
Handle the ORP sensor as industrial waste.

5. **Rinse off contamination from the holder, sensor gasket, washer, and protective pipe with alcohol, etc., and then dry them completely.**

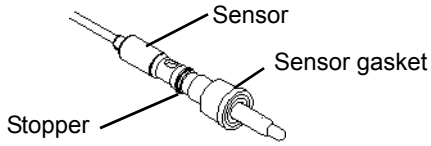
6. **Move the positions of the holder cap and cable gasket approximately up to the holder length.**



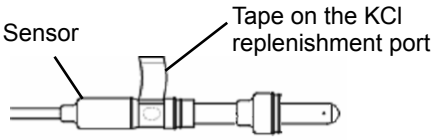
7. **Put a new sensor through the holder from the top and draw it from the bottom.**



8. **Put the sensor gasket on the sensor until it approximately reaches the stopper.**



9. **Remove the sensor protective cap and tape from the KCl replenishment port of the sensor.**

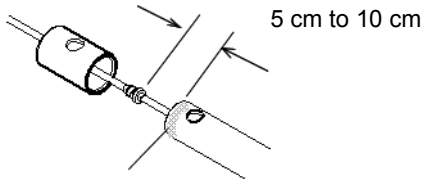


Note

- **If you do not remove the tape from the KCl replenishment port of the sensor, measurement cannot be performed correctly.**
- **In order to avoid leakage of internal solution, when removing the tape, be sure to orient the KCl replenishment port upward.**
- **As the protective cap will be reused for storage, do not dispose of it.**

10. **Push the sensor gasket into the holder, insert the washer, and then tighten the protective pipe.**

11. **Adjust the cable gasket so that the distance from the holder cap to the top of the holder is 5 cm to 10 cm.**

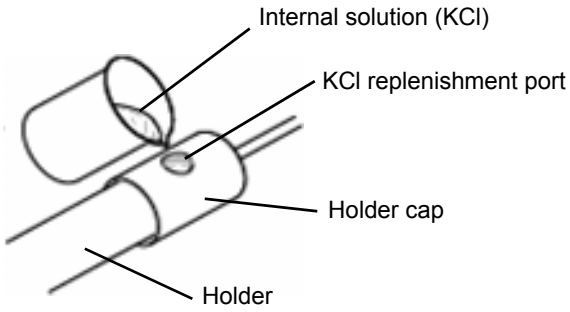


12. **Coat the entire circumference of the holder top with silicon grease.**

13. **Inject new internal solution from the replenishment port up to the internal solution injection level.**

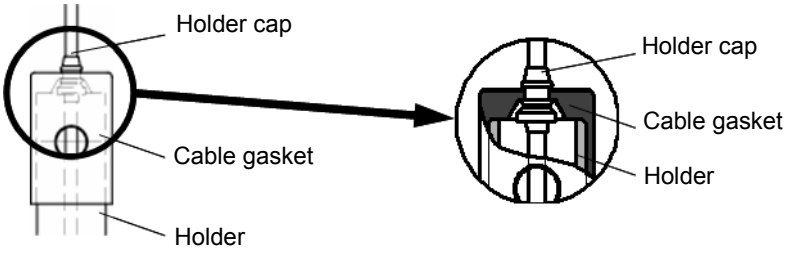
Tip

Approximately 500 mL of internal solution is necessary for a 1 m holder.

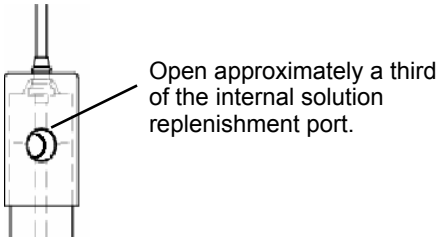


14. **Fit the holder cap onto the holder.**

15. **Pinch the cable gasket and slightly pull it out from the holder gasket.**



16. **Open approximately a third of the internal solution replenishment port. This completes the preparation.**



Note

Check the following.

- **The protective cap of the sensor has been removed**
- **The tape on the KCl replenishment port of the sensor has been removed**
- **A third of the replenishment port on the holder has been opened**

■ Troubleshooting

● Measures for ORP sensor failure

If a failure occurs in the ORP sensor manufactured by HORIBA Advanced Techno, check the currently used ORP sensor according to the following troubleshooting method. If the failure persists after checking and troubleshooting, please contact HORIBA Advanced Techno.

Symptom / Possible cause	Calibration cannot be performed	Instable indication	Slow response	No indication change	Internal solution reduction in a short period	Foreign matter inside reference electrode	Short lifetime	Troubleshooting
Metal sensing membrane/ reference electrode cracks	√	√	-	√	√	√	-	The sensor cannot be used. Replace it.
Contamination on metal sensing membrane	√	√	√	√	-	-	-	Rinse off the contamination with tap water, etc.
Dry metal sensing membrane	√	√	√	-	-	-	-	Immerse the sensor in tap water for approximately one hour before using it.
Contamination/clogging in liquid junction	√	√	-	√	-	-	-	Rinse off the contamination with tap water, etc.
Insufficient reference electrode internal solution	√	√	√	-	-	√	-	Replenish the reference electrode internal solution.
Cap remains attached	√	√	√	√	-	-	-	Remove the cap before using the sensor.
Internal solution replenishment port is not open	√	√	-	-	-	√	-	Open the internal solution replenishment port.
Terminal is not connected completely	√	√	-	-	-	-	-	Connect the terminal using the cable specified by HORIBA Advanced Techno, according to the instruction manual.
There is no liquid junction (ceramics)	-	-	-	-	√	√	-	Change to the sleeve type sensor, or replace the current sensor with a new one as soon as possible.
Old standard solution is used	√	-	-	-	-	-	-	Use new standard solution.
Back flow of the liquid to be measured	√	√	-	-	-	√	√	Replace the reference electrode internal solution, or replace the sensor.
Hydrofluoric acid is mixed in the liquid to be measured	√	-	√	√	-	-	√	The glass is dissolved by hydrofluoric acid. It is recommended that you replace the sensor as soon as possible. Examine the use of a hydrofluoric acid-resistant sensor.
Electrical conductivity of the liquid to be measured is below 10 mS/m (0.1 mS/ cm)	-	√	√	-	-	-	-	Measurement cannot be performed. Contact HORIBA Advanced Techno.

● Measures for values outside the measurement range

If the measured ORP value is outside the measurement range, the displayed measured value is blinking.
Perform the procedure according to the following table.

Possible cause	Corrective action
The sensor is not immersed in the liquid to be measured	Immerse the sensor under the target liquid level, even if this level fluctuates.
The protective cap of the sensor is attached	Remove the protective cap.
● Wiring of the sensor cable is wrong Wiring for the M and R lines, in particular, is disconnected. ● Wiring of the relay cable is wrong	Check for looseness of screws or incorrect wiring in the terminal blocks of this product and relay box.

● Analog output conditions

C.HoLd (HOLD setting)			HoLd (Latest value hold)			PrES (Setting value hold)		
b.out (Burnout setting)			non	out.4	out.20	non	out.4	out.20
Measurement mode			Measured value			Measured value		
		E-21 to E-25	Latest value hold	3.6 mA	21 mA		3.6 mA	21 mA
		E-72						
		E-90 to E-92						
	External hold input ON					Setting value		
		E-21 to E-25						
		E-72						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
Hold mode			Latest value hold					
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON					Setting value		
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
ORP calibration			Latest value hold					
		E-21 to E-25						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON					Setting value		
		E-21 to E-15						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
Temperature calibration			Latest value hold					
		E-21 to E-27						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON					Setting value		
		E-21 to E-27						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA

Error codes

This product has a function to display various error codes.
An error code blinks in the auxiliary display.

Error code description

Error display		Error display priority*1	Error description	Description	When to occur
E-21	SENSOR ERROR	4	Temperature sensor disconnection	The lead wire of the temperature sensor is disconnected	During measurement During calibration*2
E-22		5	Temperature sensor shorted-circuited	The lead wire of the temperature sensor is shorted-circuited	
E-25		7	Temperature measurement outside range	● When the temperature sensor type is set to Auto The temperature is below −5°C or above 105°C ● When the temperature sensor type is set individually The temperature is below −20°C or above 130°C	During measurement*2
E-27		7	Temperature calibration error	The temperature is below −20°C or above 130°C	During temperature calibration
E-72		6	Reference electrode error	The liquid junction of the reference electrode is clogged (This is only effective when there is a electrode (SE))	During measurement
E-90	SYSTEM ERROR	1	System error	Internal communication error	At all times (System error)
E-91		2	System error	The memory data, such as the setting values, calibration values, are lost	
E-92		3	System error	A/D converter operation failure	

*1: Two or more errors cannot be displayed at the same time. If multiple errors occur, the error with the smallest priority number is displayed.

*2: If there is no temperature sensor (the temperature sensor type is set to “non”), no error is displayed.

Tip

When an error code is displayed, the HOLD lamp starts blinking, and the analog output will be the output value set in the setting menu. Refer to “The HOLD function” (page 81).

■ Corrective actions

This product has a function to display various error codes.

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-21 (Temperature sensor disconnection)	● When the temperature sensor is 500/1 k: If the resistance of the temperature sensor is approximately 1.58 kΩ or above (the 1 kΩ temperature sensor is approximately 150°C or above) ● When the temperature sensor is 6.8 k/10 k/ Auto: If the resistance of the temperature sensor is approximately 14.8 kΩ or above (the 10 kΩ temperature sensor is approximately 150°C or above)	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the sensor with a new one. Refer to “Sensor replacement procedure” (page 97).
			Sensor without temperature sensor	Set the sensor type to “non”. Refer to “The temperature sensor” (page 79).
			Wiring of the sensor cable and relay cable is wrong	Check that the wiring between T and T is not open.
E-22 (Temperature sensor shorted-circuited)	● When the temperature sensor is 500/1 k/Auto: If the resistance of the temperature sensor is approximately 400 Ω or less (the 500 Ω temperature sensor is approximately −27°C or less) ● When the temperature sensor is 6.8 k/10 k: If the resistance of the temperature sensor is approximately 4.84 kΩ or less (the 6.8 kΩ temperature sensor is approximately −50°C or above)	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the sensor with a new one. Refer to “Sensor replacement procedure” (page 97).
			Wiring of the sensor cable and relay cable is wrong	Check that the wiring between T and T is not shorted.
E-25 (Temperature measurement outside range)	● Temperature type: Auto The temperature is below −5°C or above 105°C ● Temperature type: Individual The temperature is below −20°C or above 130°C	When the condition stated on the left is reset	the liquid to be measured temperature error	Maintain the liquid to be measured temperature within the operating temperature range of the sensor.
			Incorrect setting of temperature sensor type	Set the correct temperature sensor type. Refer to “The temperature sensor” (page 79).
			Temperature sensor resistance error	The temperature sensor is faulty. Replace the sensor with a new one. Refer to “Sensor replacement procedure” (page 97).

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-27 (Temperature calibration error)	The temperature is below −20°C or above 130°C	When the mode is switched from the temperature calibration mode using the ESC key	the liquid to be measured temperature error	Maintain the liquid to be measured temperature within the operating temperature range of the sensor.
			Incorrect setting of temperature sensor type	Set the correct temperature sensor type. Refer to “The temperature sensor” (page 79).
			Temperature sensor resistance error	The temperature sensor is faulty. Replace the sensor with a new one. Refer to “Sensor replacement procedure” (page 97).
E-72 (Reference electrode error)	If the impedance between the reference electrode for the ORP sensor and electrode (SE) is approximately 100 kΩ or above	When the condition stated on the left is reset	There is no internal solution for the reference electrode	Replenish the internal solution.
			The liquid junction of the reference electrode is clogged	Clean the sensor. If the problem cannot be resolved even after cleaning, replace the sensor with a new one. Refer to “Sensor replacement procedure” (page 97).
			Sensor cable disconnection	Replace the sensor with a new one. Refer to “Sensor replacement procedure” (page 97).
			The currently used sensor does not have a electrode (SE) and there is no short-circuit plate.	The diagnostics function is not available. Set the diagnostics function to “non”. Refer to “The diagnostics function” (page 79).
E-90 (System error)	Internal communication error	Turning the power OFF and then ON	Internal system error	Turn OFF the power and turn it back ON. If the system error persists, contact HORIBA Advanced Techno.
E-91 (System error)	The memory data, such as the setting values, calibration values, are lost			
E-92 (System error)	A/D converter operation failure			

Sensor diagnostics function

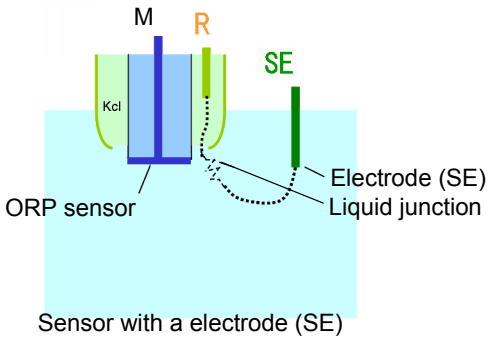
This product features a diagnostics function for the ORP sensor. The diagnostics function is used to detect clogging of the reference electrode (liquid junction). Note that this function may not be performed properly depending on the sensor type and operating environment. This section describes the details of this function.

Details of diagnostics

There are the following types of diagnostics for the ORP sensor.

Liquid junction resistance error detection (reference electrode error)

AC voltage is applied between the reference electrode and electrode (SE) to measure the impedance (resistance) between the reference electrode and electrode (SE). If the measured resistance exceeds the specified threshold, an E-72 (reference electrode error) alarm occurs.



Details of diagnostics according to the ORP sensor type

For the ORP sensor without a electrode (SE) (sensors such as 6805 and 6815)

The diagnostics function is not available for this sensor.

For the ORP sensor with a electrode (SE) (sensors such as 6870)

This sensor can detect a liquid junction resistance (reference electrode error).

Cases where the diagnostics function is not performed properly

Note that the diagnostics function may not be performed properly depending on the sensor type and operating environment. This section describes examples of cases where the diagnostics function is not performed properly.

When the sensor is not in contact with the liquid to be measured

If the sensor is not in contact with the liquid to be measured, the diagnostics function is not performed properly.

- Even if the reference electrode functions properly, a reference electrode error (E-72) alarm will occur.

If there are cracks in the reference electrode support tube for the sensor with a electrode (SE)

If there are cracks in the reference electrode support tube for the sensor with a electrode (SE), the liquid junction resistance becomes smaller. In this case, no reference electrode error (E-72) will occur.

● If the electrical conductivity of the liquid to be measured is below 10 mS/m (0.1 mS/cm)

If the electrical conductivity of the liquid to be measured is below 10 mS/m (0.1 mS/cm), the diagnostics function is not performed properly in principle. In this case, disable the diagnostics function and perform the operation.

- Even if the reference electrode functions properly, a reference electrode error (E-72) alarm may occur.

Tip

For details on changing the diagnostics settings, refer to "The diagnostics function" (page 79).

Options

Parts name	Model	Specifications	
ORP standard powder	#160-22	Powder for ORP standard solution	10 packs included
Reference electrode internal solution	#300	3.33 mol/L KCl solution	250 mL Note) Two bottles (500 mL) are required for each 1 m holder.
Powder for reference electrode internal solution	#350	KCl powder 500 g	1 bottle

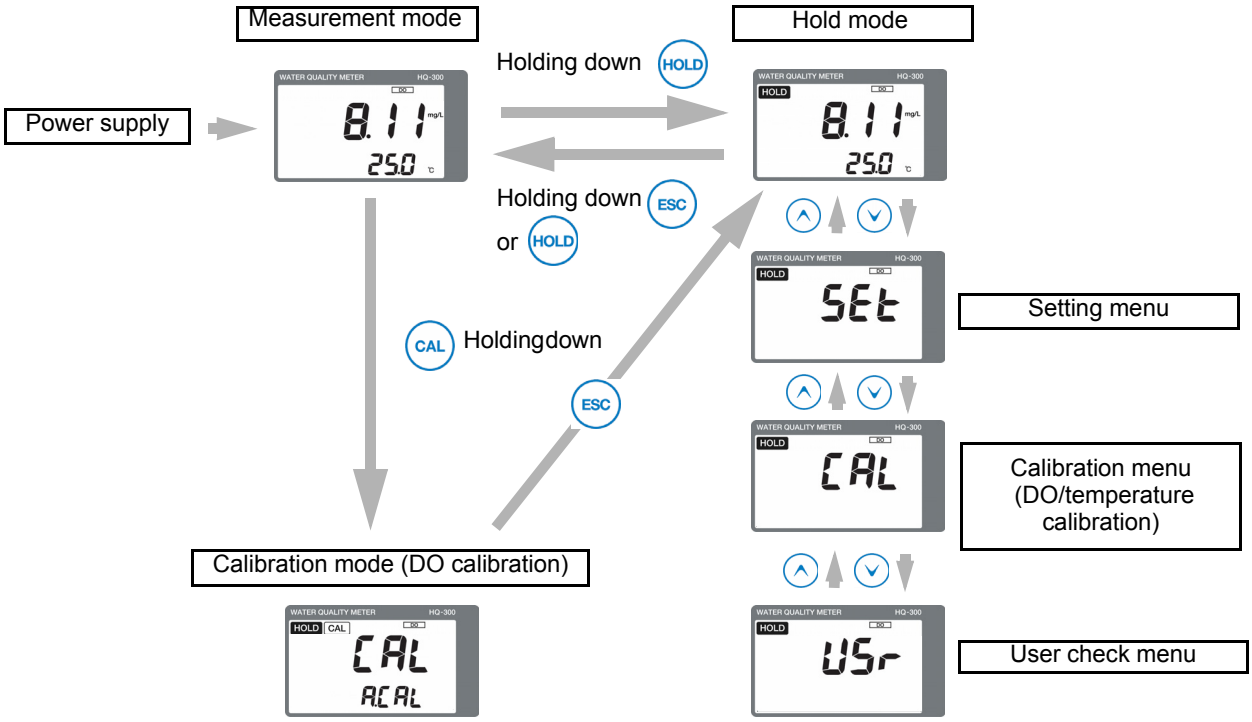
Parts name	Model	Specifications				
		Type	Temperature compensation element	Operating temperature	Liquid junction structure	Lead length
ORP sensor	6805	ORP sensor [platinum]	None	0°C to 80°C	Ceramic junction	5 m
	6815	ORP sensor [platinum + gold plate]		0°C to 80°C		
	2500	Immersion type ORP sensor [platinum] KCl no-supply type		0°C to 50°C		
	6870-60B	Tip exchange type	6.8 kΩ (25°C)	0°C to 60°C		6 m

Parts name	Model	Specifications
Holder	CH-101 series	Immersion type holder
	HIBX series	Immersion type holder for tip exchange sensor (6870)
	CF-301 series	Flow chamber type holder (pressure type) JIS 10K 25A FF
	CF-401S	Flow chamber type holder (pressure type/SUS) JIS 10K 25A FF
	CF-501	Flow chamber type holder for tip exchange sensor (6870)
Cleaning unit	UCH/UCF series	Ultrasonic cleaning unit (immersion/flow chamber type)
	JCH/JCF series	Water (air) jet cleaning unit (immersion/flow chamber type)

Dissolved Oxygen (DO) Measurement

Description of mode and menu

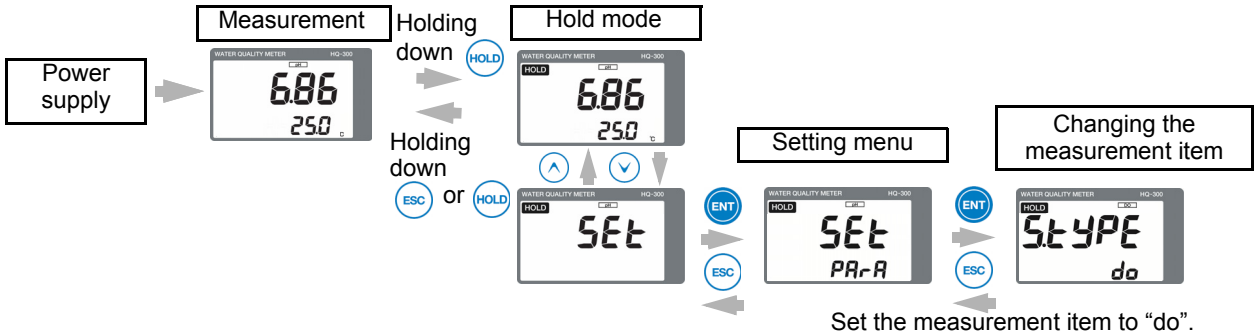
■ Modes and menus in each measurement mode



Description of mode/menu	Description	Reference page
Measurement mode	Performs measurement and analog output control. Allows you to check the calibration values or set and check the moving average count (damping factor) during measurement.	116
Calibration mode (DO calibration)	Performs DO calibration.	119
Hold mode (Measurement output hold)	Stops measurement and output and performs various settings.	-
Setting menu	Allows you to set all parameters related to measurement, such as the assignment of detector information input or output before starting operation.	108
Calibration menu (DO/temperature calibration)	The following two types of calibration can be performed: DO calibration and temperature calibration (the DO calibration is the same as the calibration mode).	85
User check menu	The output status and measured values can be checked. The setting value can be reset to the default value.	37

Setting menu

■ Measurement item switching



Operational procedure for setting the measurement item

ENT blink the auxiliary value, ∧∨ changes the setting value, ESC cancels the value, ENT set the value and holding down HOLD return to measurement mode.

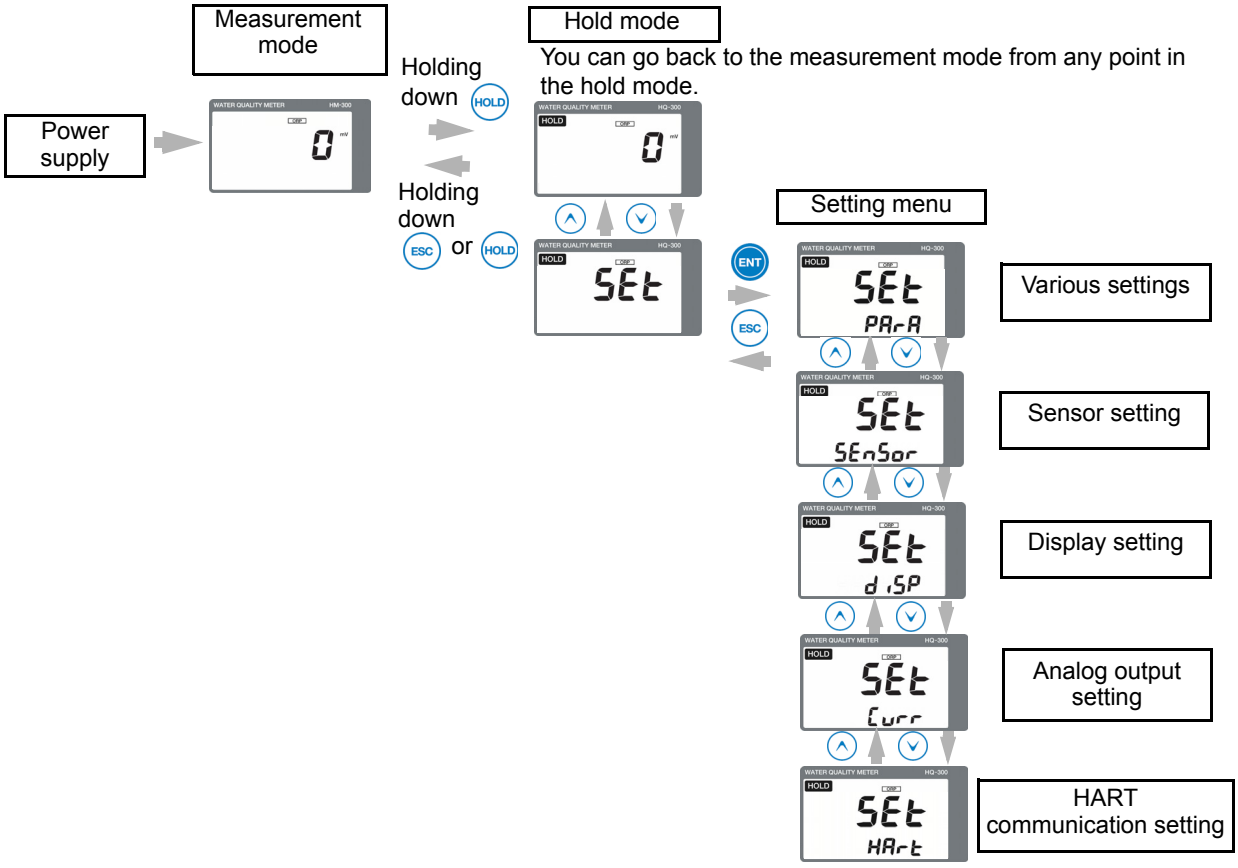
■ Functions available with setting menus

Setting item		Description	Default settings		Reference page
			Displayed character	Meaning	
Setting the sensors	The DO sensor	Allows automatic selection of the DO sensor type.	5505	Sensor model 5505	112
	The diagnostics function	Select the diagnostics function for the sensor.	yES	Diagnostics is performed	112
Calibration setting	The calibration type	Select either auto calibration or basic calibration.	Auto	Auto calibration	112
Display setting	The auxiliary display	Sets whether or not to display the measured temperature value.	t	Temperature display	112
	Display limit at over range	Select whether or not to display the measured DO value or measured temperature value if they exceed the measurement ranges, respectively.	yES	Not displayed	112

Setting item		Description	Default settings		Reference page
			Displayed character	Meaning	
Analog output setting	The analog output range	Sets the measurement range of DO to be assigned to the analog output (4 mA to 20 mA).	0-20	0 mg/L to 20 mg/L	113
	The 4 mA analog output value	Sets the DO value to be assigned to 4 mA when the analog output range can be set manually.	0.00	0.00 mg/L	113
	The 20 mA analog output value	Sets the DO value to be assigned to 20 mA when the analog output range can be set manually.	20.00	20.00 mg/L	113
	The HOLD function	Select whether or not to stop the analog output (latest value, preset) in the hold mode or calibration mode.	Hold	Latest value hold	113
	The HOLD output value	Sets a manually measured DO value when the HOLD function is set to preset.	20.00	20.00 mg/L	113
	The burnout function	Sets whether or not to burn out the analog output at the occurrence of an error.	non	Disabled	114
HART communication setting	The polling address	Sets the polling address of HART communication.	0	Address 0	115
	The analog output fix mode	Sets whether or not to fix the analog output to 4 mA.	off	Analog output is not fix mode	115
	The number of preambles	Sets the number of preambles.	5	5	115
	The write protect mode	Sets the write protect mode.	oFF	OFF	115
	Checking the device ID	Allows you to check the value of the device ID.	-	-	115
Various settings	The measurement item switching	Switches the measurement item.	do	DO measurement	111
	The moving average count	Sets the moving average count (damping factor) of the dissolved oxygen concentration.	1	1 time	111
	Salinity correction value setting	This should be specified when the liquid to be measured contains salts.	0.0	Salinity concentration 0.0%	111
	The compensation formulae	The compensation formulae for the temperature and salinity.	PrE	Conventional formula	111
	The automatic return	Select whether or not to return the hold mode to the measurement mode automatically.	yES	Enabled	111
	The automatic return time	Sets the time before the automatic return is performed when automatic return is enabled.	2	2 hours	111

How to enter the setting menu

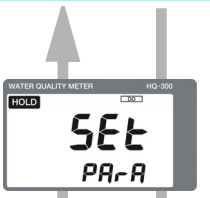
1. **Turn ON the power.**
2. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
3. **Press the ▲/▼ key to display SEt in the measured value display, and then press ENT to enter the setting menu.**



■ Setting menu display item

▲ ▼ Setting value change ENT Entry and Set ESC Cancel

Various settings



ENT

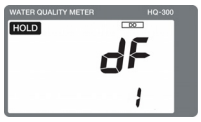
ESC

The measurement item switching

Switches to the measurement item to be used.
Setting range: PH, orP, do (dissolved oxygen), C (electrical conductivity), r (electrical resistivity)

▲ ▼

The moving average count



Sets the moving average count (damping factor) of the dissolved oxygen concentration.
Setting range: 1 to 50 times

▲ ▼

The compensation formulae

Select one of the compensation formulae for the temperature and salinity.
PrE: Conventional formula (JIS K0120:2013)
iSo: New formula (ISO5814:2012)

▲ ▼

Salinity correction value setting

When the liquid to be measured contains salts, the value can be corrected a according to salinity.
To perform the salinity correction, it is necessary to measure the salinity concentration of the liquid to be measured in advance.Setting range: 0.0 to 5.0%

▲ ▼

The automatic return

Select whether or not to return the hold mode to the measurement mode automatically.

During setting change and calibration, automatic return is not performed even when the automatic return function is set to yES.
Setting range: yES, no

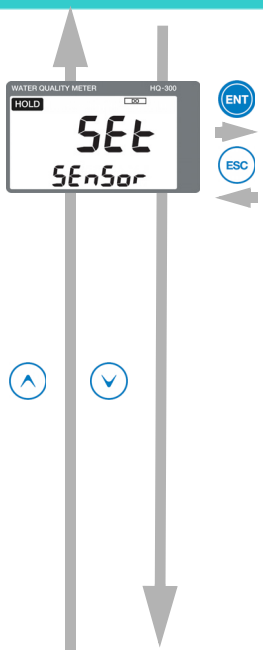
▲ ▼

Displayed only when the automatic return function is set to "yES"

The automatic return time

Sets the time before the automatic return is performed when automatic return is enabled.
Setting range: 1 hour to 24 hours

Setting the sensors



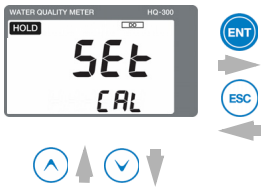
The DO sensor

Sets the model of the DO sensor to be connected.
Setting range: 5505 and 5510

The diagnostics function

Select the diagnostics function for the sensor.
yES: Diaphragm damage and leakage are detected.
no: No diagnostics
Setting range: yES, no

Calibration setting

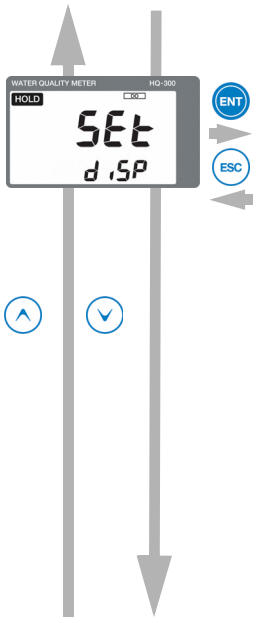


The calibration type

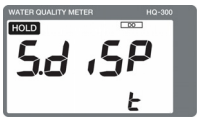
Select the calibration method.
Auto calibration: In this mode, simplified zero calibration and span calibration are automatically performed.
Basic calibration: In this mode, the details of calibration can be selected manually.

Normally, auto calibration should be selected.
Setting range: Auto, bASic

Display setting



The auxiliary display

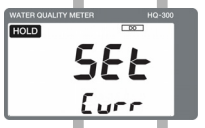


Sets whether or not to display the measured temperature value in the measurement mode screen.
non: Measured temperature value is not displayed
t: Measured temperature value is displayed
Setting range: non, t

Display limit at over range

Select whether or not to display the measured DO value or measured temperature value if they exceed the measurement ranges, respectively.
yES: Dissolved oxygen concentration: 0.00 mg/L to 20.00 mg/L
Temperature: 0.0°C to 50.0°C
no: Dissolved oxygen concentration: 0.00 mg/L to 22.00 mg/L
Temperature: –10.0°C to 110.0 °C

Analog output setting



ENT

ESC

The analog output range

Sets the measurement range of DO to be assigned to the analog output (4 mA to 20 mA).
oPt: Allows you to set a manually DO value.
Other: Select the measurement range of the specific DO.
Setting range: oPt, 0 mg/L to 20 mg/L, 0 mg/L to 15 mg/L, 0 mg/L to 10 mg/L, 0 mg/L to 5 mg/L

Displayed only when the analog output range is set to “oPt”

The 4 mA analog output value

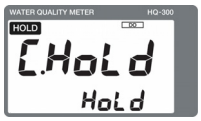
Sets the measurement range of the ORP to be assigned to 4 mA when the analog output range is set to oPt.
Setting range: 0.00 mg/L to 22.00 mg/L

Displayed only when the analog output range is set to “oPt”

The 20 mA analog output value

Sets the measurement range of the ORP to be assigned to 20 mA when the analog output range is set to oPt.
Setting range: 0.00 mg/L to 22.00 mg/L

The HOLD function

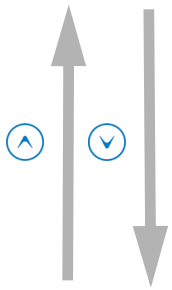


Sets the analog output in the hold mode.
HoLd: The analog output is on hold at the latest value.
PrES: The analog output is on hold at a manually measured DO value.
Setting range: HoLd, PrES

Displayed only when the HOLD setting is “PrES”

The HOLD output value

Sets a manually measured DO value to be output in the hold mode when the HOLD function is set to PrES.
Setting range: 0.00 mg/L to 22.00 mg/L



The burnout function

Sets whether or not to burn out the analog output at the occurrence of an error.
non: Burnout function is disabled
out.4: Burnout lower limit setting (3.6 mA output)
out.20: Burnout upper limit setting (21 mA output)
Setting range: non, out.4, out.20

Note

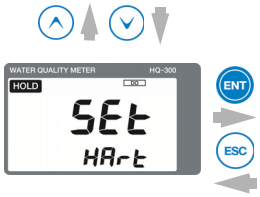
Burnout function

In case of a sensor error or system error, the analog output can be changed to the upper or lower limit setting (burnout function).

- **When the burnout upper limit setting is enabled, the analog output will change to 21 mA if an error occurs.**
- **When the burnout lower limit setting is enabled, the analog output will change to 3.6 mA if an error occurs.**

For details on the burnout occurrence conditions, refer to “Analog output conditions” (page 136).

HART communication setting



The polling address

Sets the polling address of HART communication.
Setting range: 0 to 63

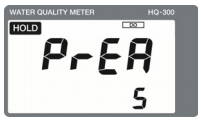
Select an address except for 0 for the multi-drop link.

The analog output fix mode

Sets whether or not to fix the analog output to 4 mA.
on: The analog output is fixed to 4 mA.
oFF: The analog output is not fixed to 4 mA.
Setting range: on, oFF

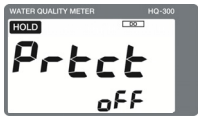
It is recommended that you set this function to ON for the multi-drop link. When this function is set to ON, the burnout and preset settings are disabled.

The number of preambles



Sets the number of preambles.
Setting range: 2 pcs. to 20 pcs.

The write protect mode



Sets the write protect mode.
on: Change of various settings using the HART communication is disabled.
oFF: Change of various settings using the HART communication is enabled.
Setting range: on, oFF

Checking the device ID

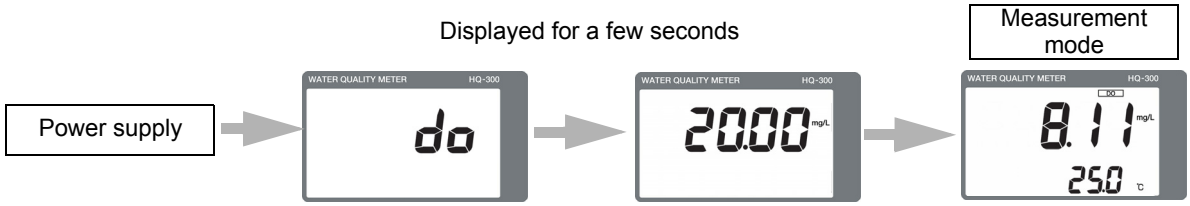
Allows you to check the value of the device ID assigned to the transmitter.

The device ID cannot be changed.

Measurement mode

How to enter the measurement mode

1. **Turn ON the power.**
The measurement target is displayed in the measured value display.
The measurement range is displayed and the system enters measurement mode.
The measured value is displayed and measurement starts. This is the measurement mode state.



2. **Press the ▲/▼ key to switch the screen.**
By switching the screen, you can change the moving average count (damping factor) and check the calibration data.

Note

Be sure to perform calibration of sensors before measurement. Refer to "Calibration" (page 119).

Functions available with the measurement mode

The following information can be displayed in the auxiliary display during measurement.
The moving average count (damping factor) is not only displayed but can also be changed.

Display information	Description	Reference page
Measured value display	Displays the measured temperature.	117
Saturation degree display	Displays the saturation degree of the DO.	
Calibration data display	Displays various calibration data of sensors.	
Moving average count display	Sets the moving average count (damping factor) of the dissolved oxygen concentration.	118

Measurement mode display item

Setting value change (ENT) Entry and Set (ESC) Cancel

Measured value display

Power supply

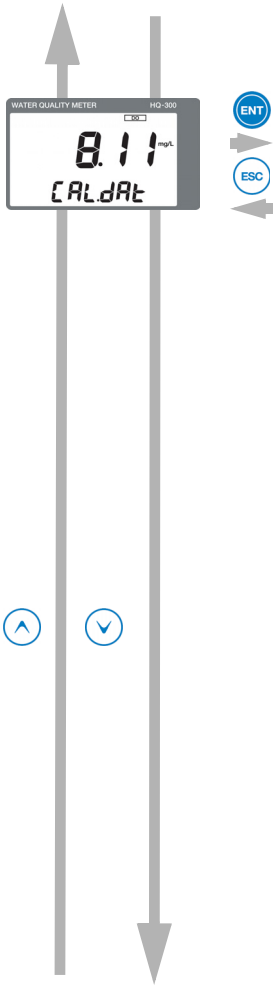
Displays the measured DO value in the measured value display and the measured temperature value in the auxiliary display.

This is not displayed when the temperature display is disabled (Setting menu → Display setting → “The auxiliary display” (page 112)).

Saturation degree display

Displays the saturation degree of the DO.

Calibration data display



Checking the zero (STD) value

Displays the zero value. (Unit: mg/L)

Checking the span (SLOPE) value

Displays the span sensitivity. (Unit: %)

Checking the elapsed days from the previous calibration

Displays the elapsed days from the previous calibration date.

If the power is turned OFF, counting of days for that period is interrupted. When the power is turned ON, counting of days resumes.
The count is not initialized even when the power is turned OFF.

Moving average count display

Sets the moving average count (damping factor) of the measured DO value.
Use the ▲/▼ key to set the moving average count.

Tip

Moving average count
If the measured DO value is not stabilized, you can stabilize it by setting the moving average count. The setting range is from 1 time to 50 times. The time averaging processing is performed during the period from one second to 50 seconds.

Example 1) When the moving average count is set to 10 times, the average value for the previous 10 seconds is updated every one second.
Example 2) When the moving average count is set to 1 time, averaging processing will not be performed.

Calibration

■ Calibration type

There are the following three calibration types: dissolved oxygen calibration (Auto, Basic) and temperature calibration.
For details on the characteristics of each calibration type, refer to the following table.

Calibration type			Remarks	Reference page
DO calibration	Auto calibration	Atmospheric calibration	During zero calibration, the zero signal of the sensor is automatically calibrated through the internal electrical circuit. During span calibration, calibration is performed with reference to the oxygen in the atmosphere. In both types of calibration, the sensor remains attached to the probe and left as it is in the atmosphere during calibration.	121
		Solution calibration	During zero calibration, the zero signal of the sensor is automatically calibrated through the internal electrical circuit. During span calibration, calibration is performed by immersing the sensor in the span solution (air saturated water).	122
	Basic calibration	Simplified two-point calibration	During zero calibration, the zero signal of the sensor is automatically calibrated through the internal electrical circuit. During span calibration, calibration is performed with reference to the oxygen in the atmosphere. In both types of calibration, the sensor remains attached to the probe and left as it is in the atmosphere during calibration.	123
		Atmospheric span calibration	Span calibration is performed with reference to the oxygen in the atmosphere.	124
		Zero solution calibration	Zero calibration is performed by immersing the sensor in the zero solution (sodium sulfite solution).	125
		Span solution calibration	Span calibration is performed by immersing the sensor in the span solution (air saturated water).	124
Temperature calibration			Allows you to correct the measured temperature value manually.	127

Note

When performing the atmospheric calibration, pull the probe out of the solution, and wipe the membrane surface with a dry cloth, etc. so that there are no residual water droplets. Do not leave the probe in the atmosphere for a long period of time, as doing so could generate bubbles inside.

Reference

For details on the setting “Auto” or “bASic”, refer to “The calibration type” (page 112).

Tip

To perform the measurement accurately, use the span solution for the basic calibration.

Before performing DO calibration

Items to prepare

Calibration solution to be used

Precautions for solution calibration

- Using a tool, for example magnet stirrer, generate a flow rate over 25 cm/s in the calibration solution.
  If the flow rate is low, a high span sensitivity is set.
- Set the probe in place so that the metal section on the side of the DO sensor is completely immersed in the solution.
- Saturated water containing salts can also be used for calibration. In this case, before performing calibration, separately measure the salinity concentration in the solution and then set salinity correction (Refer to “Salinity correction value setting” (page 111)).

The following calibration solutions are required depending on the calibration type.

Name	Creation method
Span solution (Air saturated water)	(Example) Prepare a 500 mL beaker, an air pump, and a bubbler. Pour approximately 500 mL of water in the beaker and perform bubbling for 15 to 30 minutes. Then, leave it as it is for approximately one minute.
Zero solution (Sodium sulfite solution)	Dissolve 20 g of sodium sulfite solution in 100 mL of water. (Approximately 20%) Increase the amount of solution as necessary. The solution can be used for a day, approximately.

Transmitter

Set the transmitter to the calibration mode.
Hold down the CAL key in the measurement mode. “HOLD” and “CAL” are displayed in the upper left section and the calibration mode screen appears.

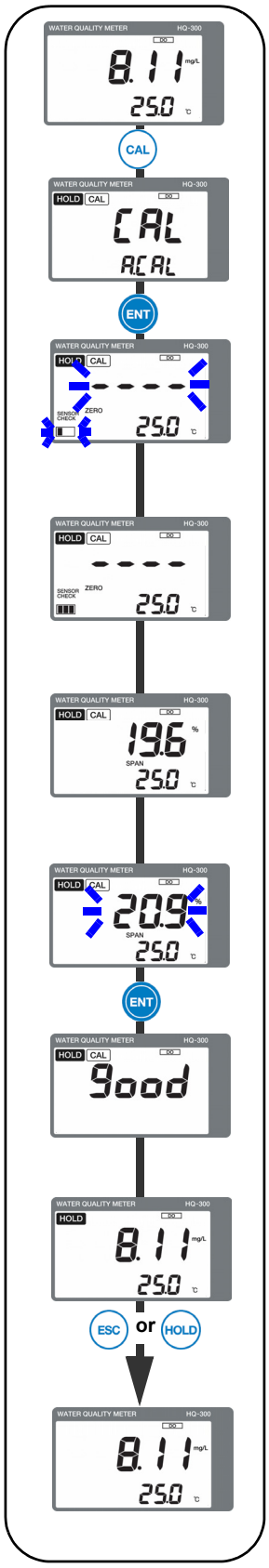
Note

Before lifting up the sensor, set the analog output on hold.

Sensor

Lift up the sensor. If it is contaminated, rinse off the contamination and coating with water and maintain a clean state.

■ Auto calibration (atmospheric calibration) operational procedure



1. **Hold down the CAL key in the measurement mode. The display returns to the previously used calibration menu. At this point, the solution calibration may be displayed. In such a case, press the ▲ key to display the atmospheric calibration.**

2. **The atmospheric calibration screen is displayed. Leave the DO sensor in the atmosphere, and then press the ENT key to start the zero calibration.**

3. **The automatic stability judgment for the zero calibration starts. The measured value keeps blinking and the indicator at the lower left increases continuously.**

4. **Once the value has been stabilized, all the indicators at the lower left light up. This completes the zero calibration.**

5. **Next, the atmospheric span calibration automatically starts.**

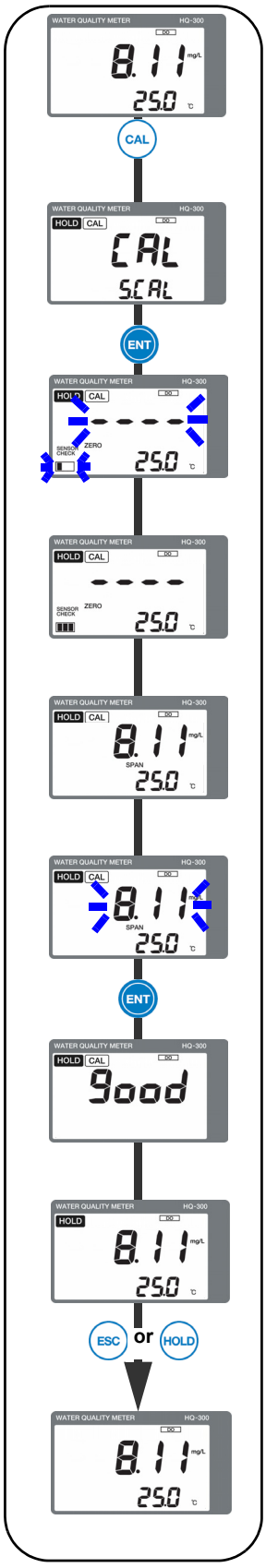
6. **The measured value starts blinking.**
   Once the measured value has been stabilized, press the ENT key to complete the span calibration.

7. **The measured value display flashes, indicating “good”, and the calibration value is updated.**

8. **After the calibration value is updated, the hold mode screen is displayed.**

9. **Hold down either the ESC or HOLD key to return to the measurement mode.**

■ Auto calibration (solution calibration) operational procedure



1. **Hold down the CAL key in the measurement mode. The display returns to the previously used calibration menu. At this point, the atmospheric calibration may be displayed. In such a case, press the ▼ key to display the solution calibration.**

2. **The solution calibration screen is displayed. Press the ENT key to start the zero calibration.**

3. **The automatic stability judgment for the zero calibration starts. The measured value keeps blinking and the indicator at the lower left increases continuously.**

4. **Once the value has been stabilized, all the indicators at the lower left light up. This completes the zero calibration.**

5. **Next, immerse the sensor in the air saturated water to perform span calibration.**
   The span calibration automatically starts.

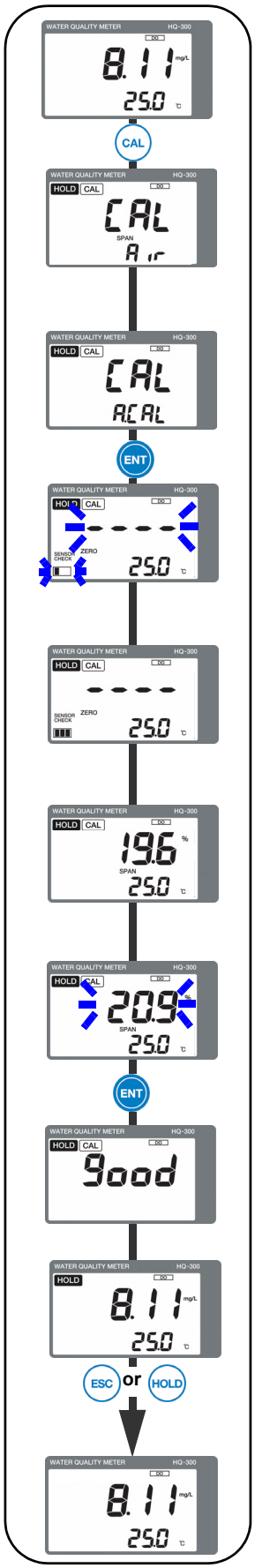
6. **The measured value starts blinking. Once the measured value has been stabilized, press the ENT key.**

7. **The measured value display flashes, indicating “good”, and the calibration value is updated.**

8. **After the calibration value is updated, the hold mode screen is displayed.**

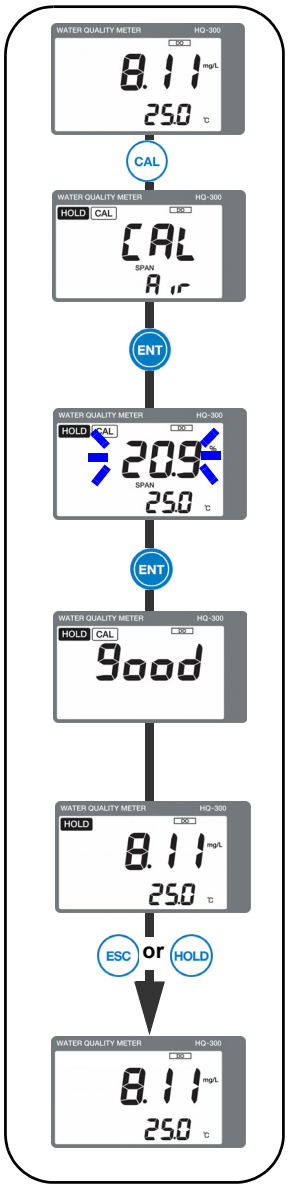
9. **Hold down either the ESC or HOLD key to return to the measurement mode.**

Basic calibration (simplified two-point calibration) operational procedure



1. **Hold down the CAL key in the measurement mode.**
2. **The atmospheric calibration screen is displayed.**
3. **Leave the DO sensor in the atmosphere, and then press the ENT key to start the zero calibration.**
4. **The automatic stability judgment for the zero calibration starts. The measured value keeps blinking and the indicator at the lower left increases continuously.**
5. **Once the value has been stabilized, all the indicators at the lower left light up. This completes the zero calibration.**
6. **Next, the atmospheric span calibration automatically starts.**
7. **The measured value starts blinking. Once the measured value has been stabilized, press the ENT key.**
8. **The measured value display flashes, indicating “good”, and the calibration value is updated.**
9. **After the calibration value is updated, the hold mode screen is displayed.**
10. **Hold down either the ESC or HOLD key to return to the measurement mode.**

Basic calibration (atmospheric span calibration) operational procedure



1. **Hold down the CAL key in the measurement mode.**

2. **The atmospheric span calibration screen is displayed. Leave the DO sensor in the atmosphere, and then press the ENT key to start the span calibration.**

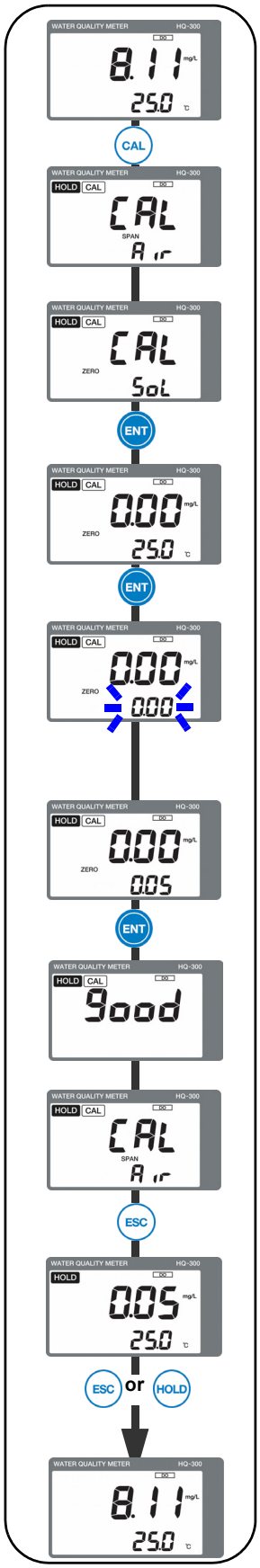
3. **The measured value starts blinking. Once the measured value has been stabilized, press the ENT key.**

4. **The measured value display flashes, indicating “good”, and the calibration value is updated.**

5. **After the calibration value is updated, the hold mode screen is displayed.**

6. **Hold down either the ESC or HOLD key to return to the measurement mode.**

■ Basic calibration (zero solution (Sodium sulfite solution) calibration) operational procedure



1. **Hold down the CAL key in the measurement mode.**

2. **Press the ▼ key to switch to the zero solution calibration screen.**

3. **Immerse the sensor in the zero solution (sodium sulfite solution). Press the ENT key to start the zero calibration.**

4. **Once the measured value has been stabilized, press the ENT key.**

5. **"0.00" displayed in the auxiliary display starts blinking, allowing you to set the DO value. Press the ▲/▼ key to set the value. The change the value is not necessary in usual case. 0.00 mg/L of settings is suitable at almost cases. If the correct DO value of the zero solution is clear, then you can set and charge to this DO value.**
   ▲ key: The value increases by 0.01 mg/L.
   ▼ key: The value decreases by 0.01 mg/L.
   The measurement range is from 0.00 mg/L to 0.30 mg/L.

6. **Once the DO value setting is completed, press the ENT key.**

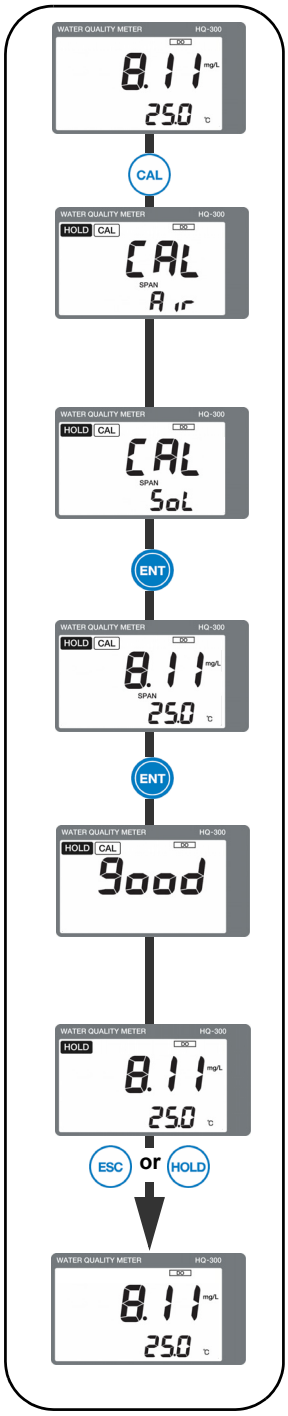
7. **The measured value display flashes, indicating "good", and the calibration value is updated.**

8. **If no span calibration is necessary, press the ESC key. To continue and perform the span calibration, select the atmospheric span calibration or span solution calibration using the ▲/▼ key, and then press the ENT key. For details on the calibration procedure, refer to "Basic calibration (atmospheric span calibration) operational procedure" (page 124) and "Basic calibration (span solution (air saturated water) calibration) operational procedure" (page 126).**

9. **After the calibration value is updated, the hold mode screen is displayed.**

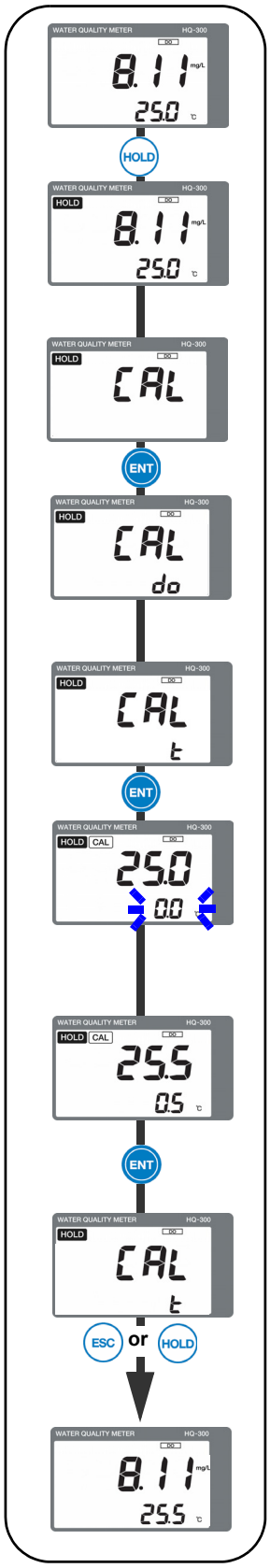
10. **Hold down either the ESC or HOLD key to return to the**

■ Basic calibration (span solution (air saturated water) calibration) operational procedure



1. Hold down the CAL key in the measurement mode.
2. Press the ▼ key twice to switch to the span solution calibration screen.
3. Immerse the sensor in the span solution (air saturated water). Press the ENT key to start the span calibration.
4. Once the measured value has been stabilized, press the ENT key.
5. The measured value display flashes, indicating “good”, and the calibration value is updated.
6. After the calibration value is updated, the hold mode screen is displayed.
7. Hold down either the ESC or HOLD key to return to the measurement mode.

■ Temperature calibration operational procedure



1. **Hold down the HOLD key in the measurement mode.**

2. **“HOLD” is displayed in the upper left section and the hold mode is activated. Press the ▼ key twice.**

3. **Display CAL in the measured value display, and then press the ENT key.**

4. **“do” is displayed in the auxiliary display. Press the ▼ key.**

5. **Display “t” in the auxiliary display, and then press the ENT key.**

6. **The temperature calibration mode is activated and the auxiliary display starts blinking.**

7. **Press the ▲/▼ key to adjust the value so that the value displayed in the measured value display reaches the water temperature.**
   ▲ key: The value increases by 0.1°C.
   ▼ key: The value decreases by 0.1°C.
   The setting range is from –5.0°C to 5.0°C.

8. **Press the ENT key.**
   The temperature calibration coefficient is updated.
   This completes the temperature calibration. The display returns to the calibration menu.

9. **Hold down either the ESC or HOLD key to return to the measurement mode.**

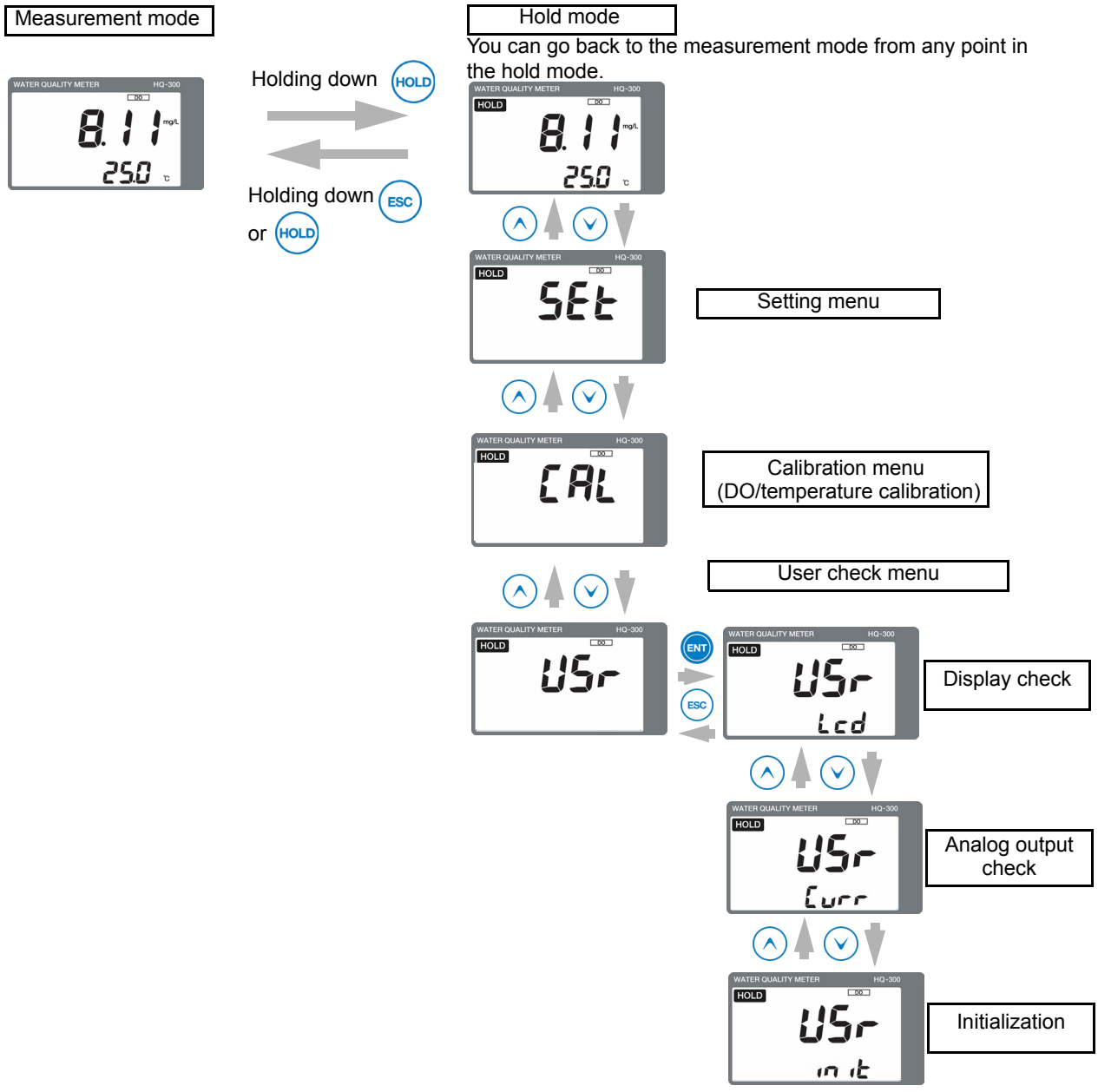
Maintenance procedure

■ User check menu

The user check menu allows you to check the display and analog output, and initialize the setting value.

● How to enter the user check menu

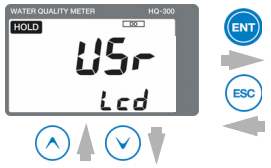
1. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
2. **Press the ▲/▼ key to display USr in the measured value display, and then press the ENT key to enter the user check menu.**

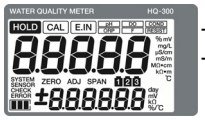


■ User check menu display item

▲ ▼ Setting value change ENT Entry and Set ESC Cancel

Display check

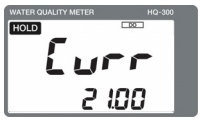




Turns on the light of the entire LCD display.
This is used when you check the display.

Analog output check

The analog output is changed to the following current values.
This is used when you check the analog output (loop check).



For checking the 21 mA output
(Upper limit current at the time of burnout)

For checking the 20 mA output

For checking the 12 mA output

For checking the 4 mA output

For checking the 3.6 mA output
(Lower limit current at the time of burnout)

Initialization

Returns the setting data and calibration data to the default status.
no: Data is not returned to the default status
yES: Data is returned to the default status

Sensor maintenance

This section describes the maintenance procedure for general DO sensors.
For details, refer to the instruction manual for the relevant sensor.

● Sensor cleaning

Contamination on the sensor could cause a delay in response, indication drifting, or instability. Inspect the tip of the sensor periodically and maintain a clean state by rinsing off the contamination and coating with water, etc.
It is recommended that you perform sensor cleaning at the same time as the calibration. In this case, perform calibration after the cleaning.

Note

Be extremely careful so as not to scratch the diaphragm of the DO sensor.

● Replacement of diaphragm cap and internal solution

● Before replacement

Check the thickness of a new diaphragm to be attached according to the following table. Then, enter the sensor setting mode from the setting menu (“How to enter the setting menu” (page 110)) and change the settings according to (“The DO sensor” (page 112)).

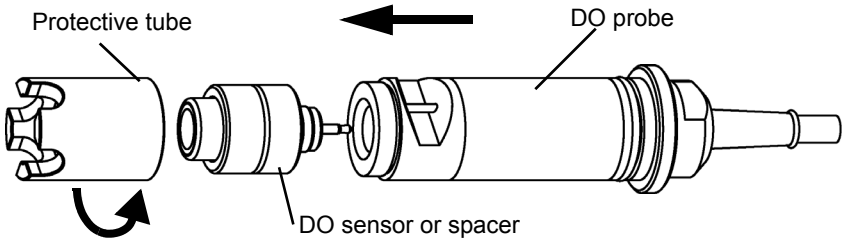
Diaphragm kit product model	Diaphragm thickness	Appearance	Sensor model setting
307S-5	50 μm		5505
307S-10	100 μm		5510

Note

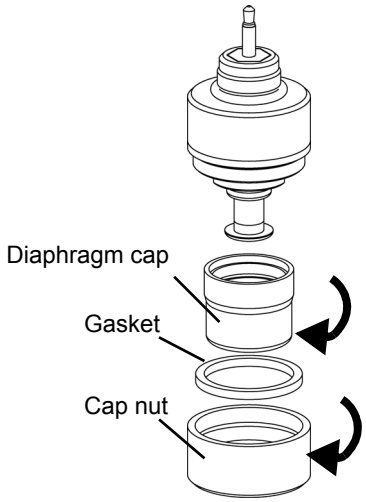
Once the diaphragm cap is attached, it cannot be reused.

● Replacement procedure

1. **Remove the protective tube of the DO probe, and then remove the DO sensor (or spacer).**



2. **Remove the cap nut, gasket, and diaphragm cap of the DO sensor, in this order.**

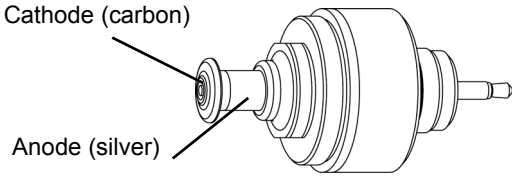


Note

- **As KCl is used as the DO sensor internal solution, it is harmless to the human body. However, wear protective gear such as gloves and protective goggles.**
- **The internal solution can be drained through the sink as it is.**

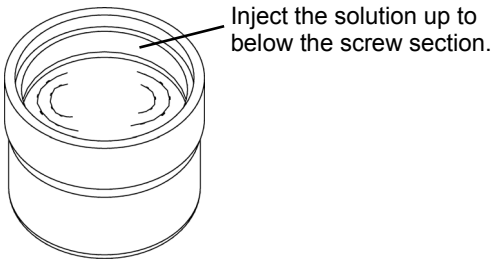
3. **Clean the electrodes (anode and cathode) of the DO sensor with pure water and wipe it off.**

If pure water is not available, you can use tap water.



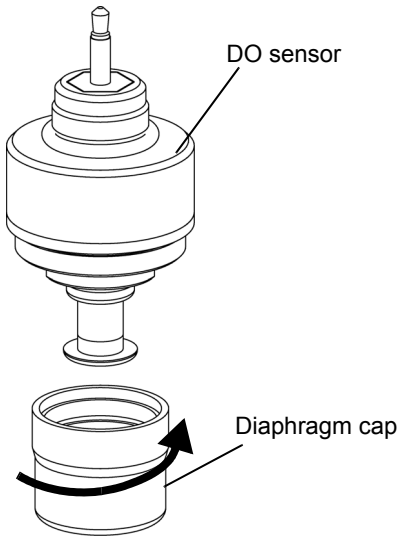
If there is contamination on the cathode, moisten a soft cloth, etc., with water and wipe it off.

4. **Inject the internal solution into the new diaphragm cap. For the amount of solution to be injected, refer to the table below.**

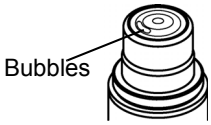


If there are bubbles inside the internal solution, drain the internal solution and inject it again up to the specified point.

5. **Screw the diaphragm cap into the DO sensor.**



6. **Check that there are no bubbles in the diaphragm.**

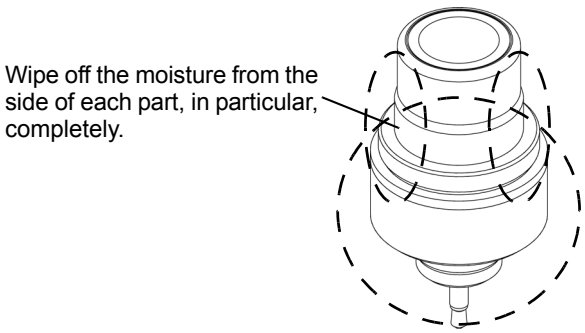
	Good	Wrong
Presence of bubbles		
Remarks	No bubbles	Bubbles are present

If there are bubbles inside the internal solution, remove the diaphragm cap and inject the internal solution again, and then screw the cap into the DO sensor.

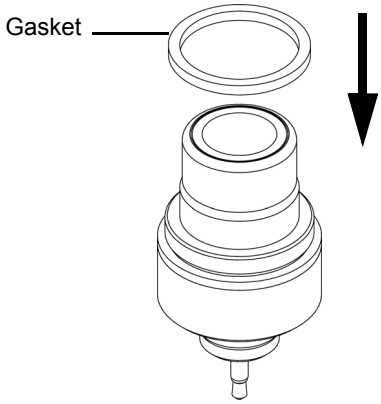
Note

Some bubbles may remain in the screw section of the diaphragm cap. Be sure to observe the specified injection amount.
If there are bubbles inside the internal solution, drain the internal solution once and inject it again up to the specified point.

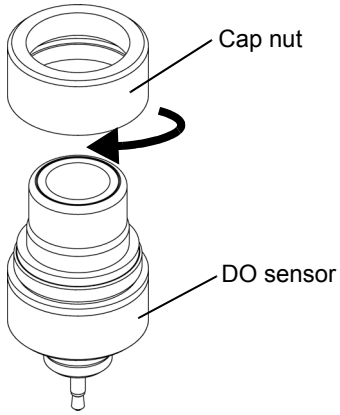
7. **Wipe off the moisture from the surroundings of the diaphragm cap and DO sensor completely.**



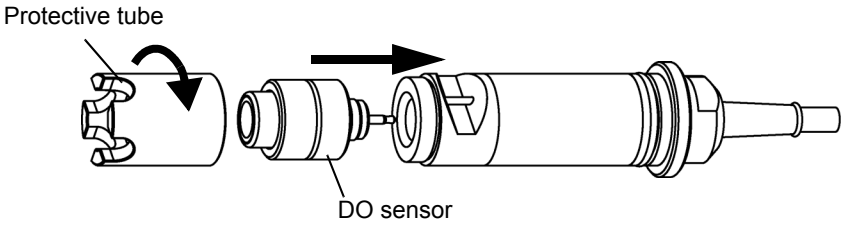
8. **Attach a new gasket.**



9. **Screw the cap nut into the DO sensor completely.**



10. **Insert the DO sensor into the DO probe, and then screw in the protective pipe completely.**



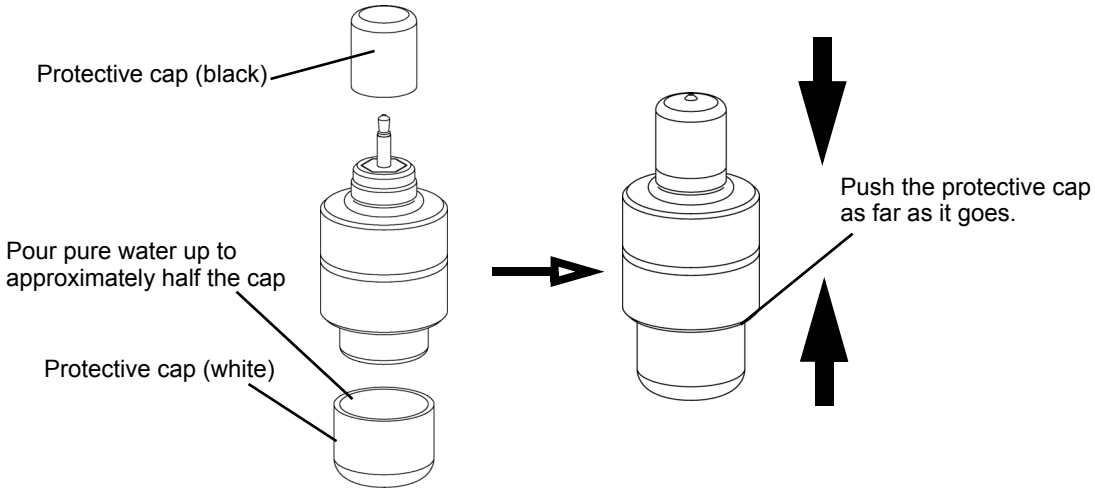
11. **If the diaphragm cap has been replaced, perform the sensor settings on the transmitter. It takes a while until the membrane is stabilized. Leave the sensor as it is according to the following table.**
For the operational procedure, refer to “The DO sensor” (page 112).

Sensor model	Diaphragm thickness	Settling time
5505	50 μm	30 min
5510	100 μm	60 min

12. **After the above setting, perform calibration.**
For the operational procedure, refer to “Calibration” (page 119).

● DO sensor storage

Pour pure water in the protective cap (white) up to approximately half the cap, and cover the cap onto the tip of the DO sensor when storing the sensor.
At this point, be sure that there is no residual air within the cap.
In addition, put the protective cap (black) on the plug section.



Note

- **Remove the protective cap during measurement.**
- **If pure water is not available, you can use tap water.**

■ Troubleshooting

● Measures for DO sensor failure

If a failure occurs in the DO sensor manufactured by HORIBA Advanced Techno, check the currently used DO sensor according to the following troubleshooting method. If the problem persists after checking and troubleshooting, please contact HORIBA Advanced Techno.

Symptom / Possible cause	Instable indication	A wrong value is displayed	Slow response	Troubleshooting
The diaphragm is damaged	-	√	-	Replace the diaphragm cap. Refer to “Replacement of diaphragm cap and internal solution” (page 130). If the diaphragm damage occurs frequently, it is possible that the diaphragm is installed in a location where foreign matter adheres. In such a case, change the installation location.
Bubbles are attached to the sensor	√	√	-	Prevent bubbles from forming in the liquid to be measured.
Bubbles form due to a high flow rate	√	√	-	Adjust the flow rate.
The surface level of the liquid to be measured fluctuates and as a result, the liquid contact area of the sensor fluctuates	√	√	-	Take measures to prevent the surface level of the liquid to be measured from changing.
A sudden liquid temperature change occurs	√	-	-	Install the sensor where a sudden liquid temperature change does not occur.
The terminal block screws are loose or there is a contact failure in the terminal block	√	√	-	Tighten the screws completely.
The terminal block insulation has deteriorated	√	√	-	Remove any moisture and contamination from the terminal block.
The sensor is contaminated	-	√	-	Wipe off the contamination using alcohol.
The sensor is not immersed in the liquid to be measured	-	√	-	Take measures to prevent the surface level of the liquid to be measured from changing.
The sensor cable is disconnected or shorted	-	√	-	Check the sensor cable.
The flow rate is low	-	√	√	Maintain a sufficient flow rate for the liquid to be measured replacement.
The concentration of the liquid to be measured is not constant (if a tank is installed)	√	-	√	Thoroughly stir the liquid to be measured. Or, install the sensor where the concentration can be kept constant.
The setting value is not appropriate	-	√	-	Review “The DO sensor” (page 112). Review “Salinity correction value setting” (page 111).

Measures for values outside the measurement range

If the measured DO value is within the measurement range, the measured value is blinking. Perform the procedure according to the following table.

Possible cause	Corrective action
The sensor is not immersed in the liquid to be measured	Install the sensor so that it is immersed in the liquid to be measured even when its surface level fluctuates.
● Wiring of the sensor cable is wrong Wiring for the A and K lines, in particular, is disconnected ● Wiring of the relay cable is wrong	Check for looseness of screws or incorrect wiring in the terminal blocks of this product and relay box.

Analog output conditions

C.HoLd (HOLD setting)		HoLd (Latest value hold)			PrES (Setting value hold)		
b.out (Burnout setting)		non	out.4	out.20	non	out.4	out.20
Measurement mode		Measured value			Measured value		
	E-21 to E-25	Latest value hold	3.6 mA	21 mA		3.6 mA	21 mA
	E-71 to E-75						
	E-90 to E-92						
	External hold input ON				Preset value		
	E-21 to E-25						
	E-71 to E-75						
	E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
Hold mode		Latest value hold					
	E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON				Preset value		
	E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
DO calibration		Latest value hold					
	E-11 to E-13						
	E-21 to E-25						
	E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON				Preset value		
	E-11 to E-13						
	E-21 to E-25						
	E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
Temperature calibration		Latest value hold					
	E-21 to E-27						
	E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON				Preset value		
	E-21 to E-27						
	E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA

Error code description

This product has a function to display various error codes.
An error code blinks in the auxiliary display.

Error display		Error display priority*1	Error description	Details	When to occur
E-11	SENSOR ERROR	10	Electrical zero calibration stability error	The circuit during zero calibration is not stable	During calibration*2
E-12		11	Span calibration error	The sensor current during span (sensitivity) calibration is low	
E-13		12	Zero calibration error	The sensor current during zero calibration is high	
E-21		4	Temperature sensor disconnection	The lead wire of the temperature sensor is disconnected	During measurement and calibration*2
E-22		5	Temperature sensor shorted-circuited	The lead wire of the temperature sensor is shorted-circuited	
E-25		9	Temperature measurement outside range	The measured temperature value is below −5°C or above 55°C	
E-27		9	Temperature calibration error	A temperature calibration failure occurred	Only during temperature calibration
E-71		6	Diagnostics (membrane breakage)	The sensor sensing membrane is broken	During measurement and calibration*2
E-72		7	Diagnostics (immersion)	The sensor tip is not completely insert	
E-75		8	Sensor error	The wire between sensors A and K is shorted-circuited	
E-90	SYSTEM ERROR	1	System error	Meter internal communication error	At all times (System error)
E-91		2	System error	The memory data, such as the setting values, calibration values, are lost	
E-92		3	System error	A/D converter operation failure	

*1: Two or more errors cannot be displayed at the same time. If multiple errors occur, the error with the smallest priority number is displayed.

*2: If an error from E-11 to E-13 occurs, recalibration can be performed. However, if error E-21 or E-22 occurs during calibration, recalibration cannot be performed.
Take a corrective action according to “Analog output conditions” (page 136).

Tip

When an error code is displayed, the HOLD lamp starts blinking, and the analog output will be the output value set in the setting menu. Refer to “The HOLD function” (page 113).

Corrective actions

When an error code is displayed, take corrective actions according to the table below.

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-11 (Electrical zero calibration stability error)	During zero calibration, the circuit is not stabilized even after one minute has elapsed	● Reset using the ESC key ● Reset by recalibration	● Circuit board failure ● Influence of exogenous noise	Check that the terminals are installed appropriately (class D installation). Turn OFF the power and turn it back ON. If the system error persists even after recalibration, contact HORIBA Advanced Techno.
E-12 (Span calibration error)	This error occurs when the sensor sensitivity is below 70% of the default standard value during calibration	● Reset using the ESC key ● Reset by recalibration	● The sensor sensitivity has deteriorated ● The sensor diaphragm is damaged (e.g., by a pin hole)	Replace the sensor.
E-13 (Zero calibration error)	This error occurs when the zero value deviates from ±2% of the default standard value during calibration	● Reset using the ESC key ● Reset by recalibration	● The concentration of the sodium sulfite solution, if it is used, is low ● Calibration has not been performed correctly or the meter main unit is broken	● Recreate the solution. ● Once the measured value has been stabilized, press the ENT key. ● If the problem persists even after performing calibration by disconnecting the A and K lead wires, the meter transmitter is broken.
E-21 (Temperature sensor disconnection)	If the resistance of the temperature sensor is approximately 1.58 kΩ or above (the 1 kΩ temperature sensor is approximately 150°C or above)	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the DO probe with a new one.
			Wiring of the sensor cable and relay cable is wrong	Check that the wiring between T and T is not open.
E-22 (Temperature sensor shorted-circuited)	If the resistance of the temperature sensor is approximately 0.8 kΩ or less (the 1 kΩ temperature sensor is approximately −50°C or less)	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the DO probe with a new one.
			Wiring of the sensor cable and relay cable is wrong	Check that the wiring between T and T is not shorted.
E-25 (Temperature measurement outside range)	The temperature is below −5°C or above 55°C	When the condition stated on the left is reset	The wiring between T and T is open (The lead wire is disconnected)	Check the wiring.
			Temperature sensor failure	Check that the resistance between T and T is within the range from 1.00 kΩ to 1.21 kΩ (If the temperature sensor is faulty, replace the DO probe).
			The solution temperature is 55°C or above	Decrease the solution temperature below 55°C.

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-27 (Temperature calibration error)	The temperature is below −5°C or above 55°C	When the mode is switched from the temperature calibration mode by the ESC key	Temperature sensor failure	Check that the resistance between T and T is within the range from 1.00 kΩ to 1.21 kΩ (If the temperature sensor is faulty, replace the DO probe).
E-71 Diagnostics (membrane breakage)	If the impedance of the DO sensor diaphragm is approximately below 20 kΩ	When the condition stated on the left is reset	The diaphragm is damaged The internal solution flows out The probe cable has an insulation failure	Refer to “DO sensor diagnostics function” (page 140).
E-72 Diagnostics (immersion)	If water has entered the DO probe jack section	When the condition stated on the left is reset	The sensor is not completely insert The seal ring is damaged	Refer to “DO sensor diagnostics function” (page 140).
E-75 Sensor error	If sensor signals A and K are short-circuited	When the condition stated on the left is reset	● The sensor wire connection is wrong ● The sensor is damaged ● The DO probe is damaged	1. Remove the DO sensor from the probe (If the error can be reset, the sensor could be damaged). 2. Disconnect wiring for the DO probe (If the error can be reset, the DO probe could be damaged). 3. If the error cannot be reset in steps 1 and 2 above, this product could be broken. In such a case, contact HORIBA Advanced Techno.
E-90 (System error)	Meter internal communication error	Turning the power OFF and then ON	Internal system error	Turn OFF the power and turn it back ON. If the system error persists, contact HORIBA Advanced Techno.
E-91 (System error)	The memory data, such as the setting values, calibration values, are lost			
E-92 (System error)	A/D converter operation failure			

DO sensor diagnostics function

This product features a diagnostics function for the DO sensor. The diagnostics function is used to detect breakage of the sensor membrane and sensor immersion. Note that this function may not be performed properly depending on the operating environment and sample type. This section describes the details of this function.

■ Diagnostics type

There are the following two types of diagnostics for the DO sensor.

● Diagnostics (membrane breakage)

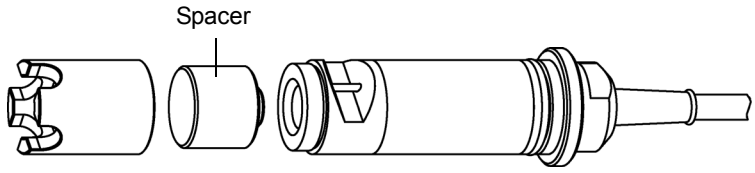
⚠ CAUTION

Although the internal solution for the DO sensor is neutral, if it gets on your clothing or skin through the broken diaphragm of the sensor, rinse it off well. If it enters your eyes, wash your eyes immediately.

If the DO sensor diaphragm is damaged, an error (E-71) is displayed. Replace the DO sensor according to “Replacement of diaphragm cap and internal solution” (page 130).
If the E-71 error persists even after replacing the DO sensor, the DO probe cable has an insulation failure.Replace the DO probe with a new one.

Follow the procedure below to check for an insulation failure of the DO probe cable.

1. **Remove the DO sensor from the DO probe, and then attach the spacer provided with the DO probe (DO-1100).**



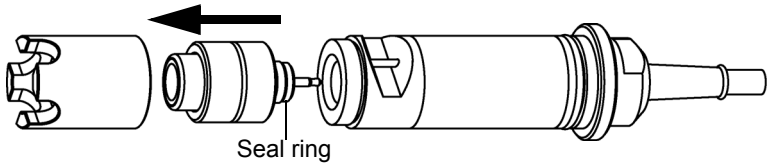
2. **Set the sensor to the normal measurement condition (immersed in the liquid to be measured).**
3. **If an E-71 error is displayed, the DO probe cable has an insulation failure.**

● Diagnostics (immersion)

⚠ CAUTION

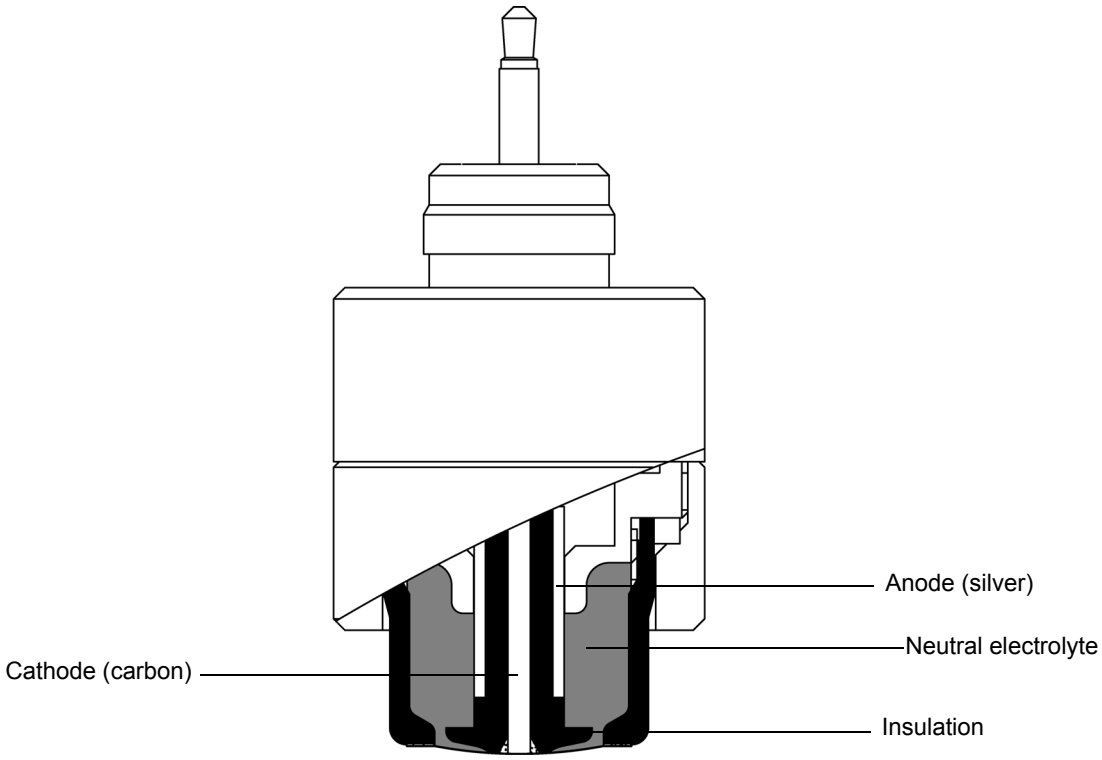
Do not scratch the diaphragm of the DO sensor. The diaphragm is made of a thin film. Do not scratch it by hitting the film surface with a hard object or pressing it excessively.

When the DO probe is immersed in the solution, an error (E-72) is displayed. Remove the DO sensor from the DO probe and check if the seal ring is damaged. If it is damaged, replace the seal ring.
If it is not damaged, the DO sensor may not be installed correctly. Wipe off the moisture from the inside of the socket and dry it completely. Then, firmly attach the DO sensor.



Measurement principle

The following shows the structure of the diaphragm type polarographic sensor. The sensor is provided with an anode made of silver in a neutral electrolyte partitioned with a PFA (fluorine resin film) gas-permeable membrane. Its cathode is made of carbon adhered to the diaphragm.



The dissolved oxygen within the liquid to be measured permeates the PFA film and causes the following electrochemical reactions on the cathode surface.

Cathode reaction $O_2+2H_2O+4e^- \rightarrow 4OH^-$

Anode reaction $Ag+Cl^- \rightarrow AgCl+e^-$

Voltage is applied from the transmitter between these two electrodes and current flows when the oxygen undergoes reaction. The amount of current is proportional to the oxygen partial pressure within the liquid to be measured. Based on this principle, you can measure the dissolved oxygen by detecting the current. In addition, the permeability of the oxygen that permeates the diaphragm varies depending on the temperature, and the amount of the air saturated oxygen within the water also varies depending on the temperature. Due to this, temperature detection and correction calculation are executed. If the liquid to be measured flow rate is small, there will be a concentration gradient on the surface of the diaphragm. In order to avoid this, it is necessary to obtain at least the specified flow rate.

Technical reference

The dissolved oxygen meters generally output a dissolved oxygen concentration by mg/L using an equation for the compensation of salinity and temperature, because the saturated dissolved oxygen concentration mg/L is affected by salinity and temperature.

In the dissolved oxygen meters with a detector using these measurement principles, membrane galvanic cell, membrane polarographic method, fluorescence method, the signal from the detector is not the reflection of the dissolved oxygen concentration, but a linear signal to the partial pressure of the dissolved oxygen.

On the other hand, partial pressure of the dissolved oxygen is not influenced by salinity.

The detector outputs the signal independent from salinity, though the concentration of the dissolved oxygen is decreased by the salinity.

The partial pressure of the saturated dissolved oxygen is not influenced by temperature in normal temperature, though it is influenced a little by the partial pressure of water vapor varied with temperature.

The concentration of the dissolved oxygen is calculated with the compensation for these characteristics and also for the temperature dependence of the detector (permeability of the membrane).

Conventionally the formula of Truesdale 1955 is adopted for the relationship of saturated dissolved oxygen with temperature and salinity.

In recent years the formula of Benson 1984 is adopted in the ISO5814:2012.

In the materials of JIS, some chapters including description about the dissolved oxygen were revised and will be revised according to the ISO5814:2012 (Already revised in JIS K0102: 2016).

The concentration of saturated dissolved oxygen derived from these two formulae differs from each other slightly.

The definition of the salinity is different from each other for detail.

(The salinity based on the chlorinity for Truesdale 1955, based on practical salinity based on the conductivity for Benson 1984)

Results from two formulae are shown on the “Concentration of saturated dissolved oxygen in water (JIS K0120:2013)” (page 143) and “Concentration of saturated dissolved oxygen in water (ISO5814:2012)” (page 144)

The dissolved oxygen meter described on this manual has a function to select which ever formula user wants.

■ Concentration of saturated dissolved oxygen in water (JIS K0120:2013)

[Unit: mg/L]

Temperature (°C)	Salinity(%)										
	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5	5
0	14.16	13.74	13.32	12.90	12.48	12.06	11.64	11.22	10.80	10.38	9.96
1	13.77	13.37	12.96	12.55	12.14	11.73	11.33	10.92	10.51	10.10	9.70
2	13.40	13.01	12.61	12.22	11.82	11.42	11.03	10.63	10.24	9.84	9.45
3	13.05	12.66	12.28	11.89	11.51	11.13	10.74	10.36	9.98	9.59	9.21
4	12.70	12.33	11.96	11.59	11.21	10.84	10.47	10.10	9.72	9.35	8.98
5	12.37	12.01	11.65	11.29	10.93	10.57	10.21	9.85	9.48	9.12	8.76
6	12.06	11.71	11.36	11.01	10.66	10.31	9.96	9.61	9.26	8.91	8.55
7	11.76	11.42	11.08	10.74	10.40	10.06	9.72	9.38	9.04	8.70	8.36
8	11.47	11.14	10.81	10.48	10.15	9.82	9.49	9.16	8.83	8.50	8.17
9	11.19	10.87	10.55	10.23	9.91	9.59	9.27	8.95	8.63	8.31	7.99
10	10.92	10.61	10.30	9.99	9.68	9.37	9.06	8.75	8.44	8.12	7.81
11	10.67	10.37	10.07	9.76	9.46	9.16	8.86	8.55	8.25	7.95	7.65
12	10.43	10.13	9.84	9.55	9.25	8.96	8.67	8.37	8.08	7.78	7.49
13	10.20	9.91	9.63	9.34	9.05	8.77	8.48	8.20	7.91	7.63	7.34
14	9.98	9.70	9.42	9.14	8.86	8.59	8.31	8.03	7.75	7.47	7.20
15	9.76	9.49	9.22	8.95	8.68	8.41	8.14	7.87	7.60	7.33	7.06
16	9.56	9.30	9.04	8.77	8.51	8.24	7.98	7.72	7.45	7.19	6.93
17	9.37	9.11	8.86	8.60	8.34	8.09	7.83	7.57	7.31	7.06	6.80
18	9.19	8.94	8.68	8.43	8.18	7.93	7.68	7.43	7.18	6.93	6.68
19	9.01	8.77	8.52	8.28	8.03	7.79	7.54	7.30	7.05	6.81	6.56
20	8.84	8.60	8.37	8.13	7.89	7.65	7.41	7.17	6.93	6.69	6.45
21	8.68	8.45	8.22	7.98	7.75	7.51	7.28	7.05	6.81	6.58	6.34
22	8.53	8.30	8.07	7.84	7.61	7.39	7.16	6.93	6.70	6.47	6.24
23	8.39	8.16	7.94	7.71	7.49	7.26	7.04	6.81	6.59	6.36	6.14
24	8.25	8.03	7.81	7.58	7.36	7.14	6.92	6.70	6.48	6.26	6.04
25	8.12	7.90	7.68	7.46	7.25	7.03	6.81	6.59	6.38	6.16	5.94
26	7.99	7.77	7.56	7.35	7.13	6.92	6.70	6.49	6.28	6.06	5.85
27	7.87	7.66	7.44	7.23	7.02	6.81	6.60	6.39	6.18	5.97	5.75
28	7.75	7.54	7.33	7.12	6.92	6.71	6.50	6.29	6.08	5.87	5.66
29	7.64	7.43	7.23	7.02	6.81	6.61	6.40	6.19	5.99	5.78	5.57
30	7.53	7.33	7.12	6.92	6.71	6.51	6.30	6.10	5.89	5.69	5.48
31	7.43	7.22	7.02	6.82	6.61	6.41	6.21	6.00	5.80	5.60	5.39
32	7.33	7.12	6.92	6.72	6.52	6.31	6.11	5.91	5.71	5.50	5.30
33	7.23	7.03	6.82	6.62	6.42	6.22	6.02	5.82	5.61	5.41	5.21
34	7.13	6.93	6.73	6.53	6.33	6.13	5.92	5.72	5.52	5.32	5.12
35	7.04	6.84	6.64	6.44	6.23	6.03	5.83	5.63	5.43	5.23	5.02
36	6.95	6.75	6.55	6.34	6.14	5.94	5.74	5.54	5.33	5.13	4.93
37	6.86	6.66	6.45	6.25	6.05	5.85	5.64	5.44	5.24	5.03	4.83
38	6.77	6.57	6.36	6.16	5.96	5.75	5.55	5.34	5.14	4.93	4.73
39	6.68	6.48	6.27	6.07	5.86	5.66	5.45	5.24	5.04	4.83	4.63
40	6.60	6.39	6.18	5.97	5.77	5.56	5.35	5.14	4.94	4.73	4.52

Concentration of saturated dissolved oxygen in water (ISO5814:2012)

[Unit: mg/L]

Temperature (°C)	Salinity (Sp*)				
	0	9	18	27	36
0	14.62	13.73	12.89	12.11	11.37
1	14.22	13.36	12.55	11.79	11.08
2	13.83	13.00	12.22	11.49	10.80
3	13.46	12.66	11.91	11.20	10.54
4	13.11	12.34	11.61	10.93	10.28
5	12.77	12.03	11.33	10.66	10.04
6	12.45	11.73	11.05	10.41	9.81
7	12.14	11.44	10.79	10.17	9.58
8	11.84	11.17	10.54	9.94	9.37
9	11.56	10.91	10.29	9.71	9.16
10	11.29	10.66	10.06	9.50	8.97
11	11.03	10.42	9.84	9.29	8.78
12	10.78	10.19	9.63	9.09	8.59
13	10.54	9.96	9.42	8.90	8.42
14	10.31	9.75	9.22	8.72	8.25
15	10.08	9.54	9.03	8.55	8.09
16	9.87	9.35	8.85	8.38	7.93
17	9.67	9.15	8.67	8.21	7.78
18	9.47	8.97	8.50	8.05	7.63
19	9.28	8.79	8.34	7.90	7.49
20	9.09	8.62	8.18	7.75	7.35
21	8.92	8.46	8.02	7.61	7.22
22	8.74	8.30	7.88	7.47	7.09
23	8.58	8.14	7.73	7.34	6.97
24	8.42	8.00	7.59	7.21	6.85
25	8.26	7.85	7.46	7.09	6.73
26	8.11	7.71	7.33	6.97	6.62
27	7.97	7.58	7.20	6.85	6.51
28	7.83	7.45	7.08	6.73	6.40
29	7.69	7.32	6.96	6.62	6.30
30	7.56	7.20	6.85	6.52	6.20
31	7.43	7.07	6.74	6.41	6.10
32	7.31	6.96	6.63	6.31	6.01
33	7.18	6.84	6.52	6.21	5.92
34	7.07	6.73	6.42	6.11	5.83
35	6.95	6.63	6.32	6.02	5.74
36	6.84	6.52	6.22	5.93	5.65
37	6.73	6.42	6.12	5.84	5.57
38	6.62	6.32	6.03	5.75	5.48
39	6.52	6.22	5.93	5.66	5.40
40	6.41	6.12	5.84	5.58	5.32

Temperature (°C)	Salinity (Sp*)				
	0	9	18	27	36
41	6.31	6.03	5.75	5.50	5.25
42	6.21	5.94	5.67	5.41	5.17
43	6.12	5.84	5.58	5.33	5.09
44	6.02	5.75	5.50	5.25	5.02
45	5.93	5.67	5.42	5.18	4.95

Note

∗: The practical salinity (Sp) is the salinity defined with the electrical conductivity of the sea water. The practical salinity consists of defining a single reference point (S = 35) on the scale as having the same electrical conductivity as a reference potassium chloride (KCl) solution 32.4356 g/1 kg at 15° C and atmospheric pressure.

Options

Parts name	Model	Specifications	Recommended replacement cycle
DO sensor	5505	Operating temperature range: 0°C to 50°C Working pressure range: 0 MPa to 0.5 MPa Material: PFA Film thickness: 50 μm	3 years
	5510	Operating temperature range: 0°C to 50°C Working pressure range: 0 MPa to 0.5 MPa Material: PFA Film thickness: 100 μm	3 years
Diaphragm kit 50	-	Diaphragm cap (50 μm), internal solution 50 mL, gasket	1 years
Diaphragm kit 100	-	Diaphragm cap (100 μm), internal solution 50 mL, gasket	1 years
O-ring	-	Attached to EPDM and DO sensor	1 years

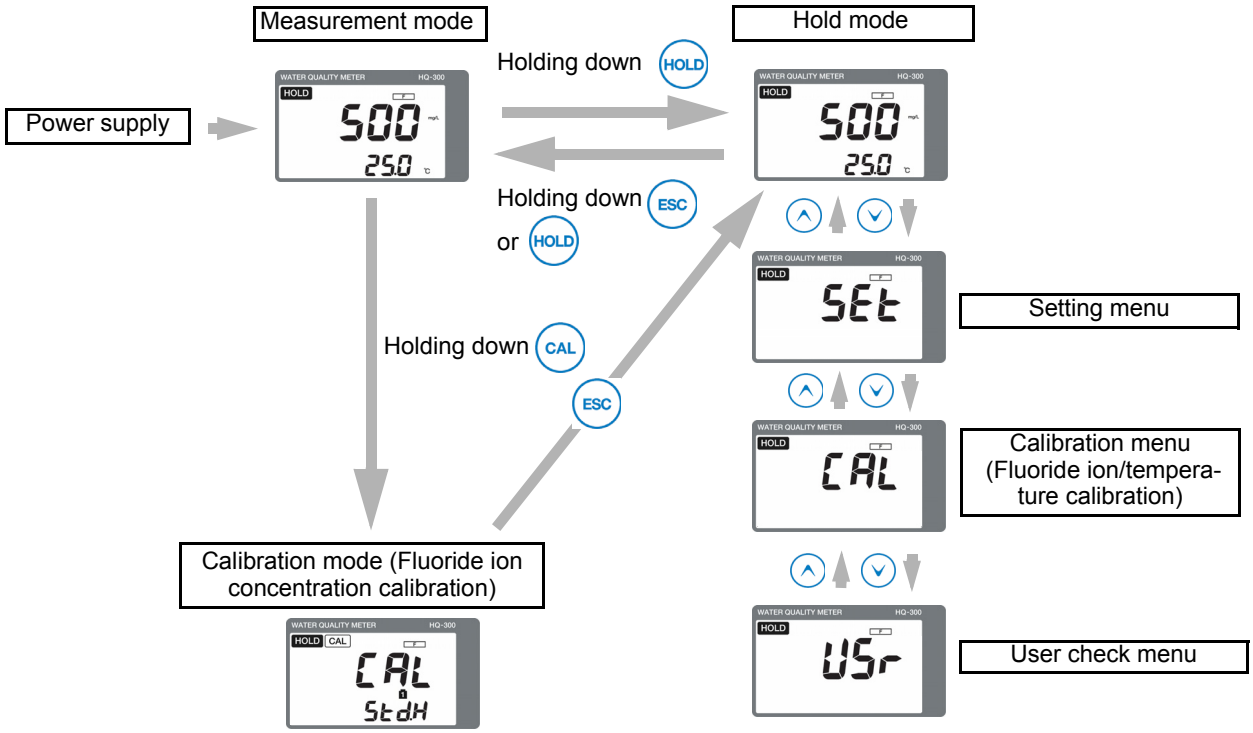
Parts name	Model	Specifications
Holder	DH-101	Specify the length of the immersion type holder.
	NH-10	Specify the length and material of the submerged type holder.
Bracket	SP-601	Specify the length of the bracket for the immersion type holder.
	MH-60	Specify the length of the bracket for the immersion type holder.
Probe	DO-1100	Immersion type (supply type) PPO Titanium EPDM

Fluoride Ion Measurement

Description of mode and menu

The measurement of fluoride ion is offered as an option.A standard product can't measure fluoride ion.

■ Modes and menus in each measurement mode

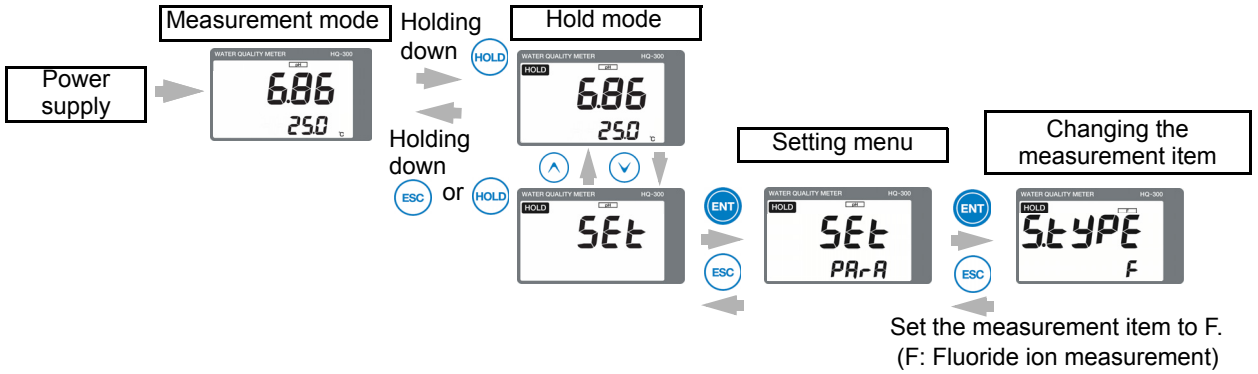


Description of mode/menu	Description	Reference page
Measurement mode	Performs measurement and analog output. Allows you to check the calibration values or set and check the moving average count (damping factor) during measurement.	156
Hold mode (Measurement output hold)	Stops measurement and output and performs various settings.	-
Calibration mode (Fluoride ion calibration)	Allows you to perform the fluoride ion calibration.	158
Setting menu	Allows you to set all parameters related to measurement, such as the assignment of detector information input or output before starting operation.	150
Calibration menu (Fluoride ion/temperature calibration)	The following three types of calibration can be performed: fluoride ion calibration, temperature calibration, and manual input calibration (the fluoride ion calibration is the same as the calibration mode).	158

Description of mode/menu	Description	Reference page
User check menu	The output status and measured values can be checked. The setting value can be reset to the default value.	169

Setting menu

■ Measurement item switching



Operational procedure for setting the measurement item

ENT blink the auxiliary value, ∧∨ changes the setting value, ESC cancels the value, ENT set the value and holding down HOLD return to measurement mode.

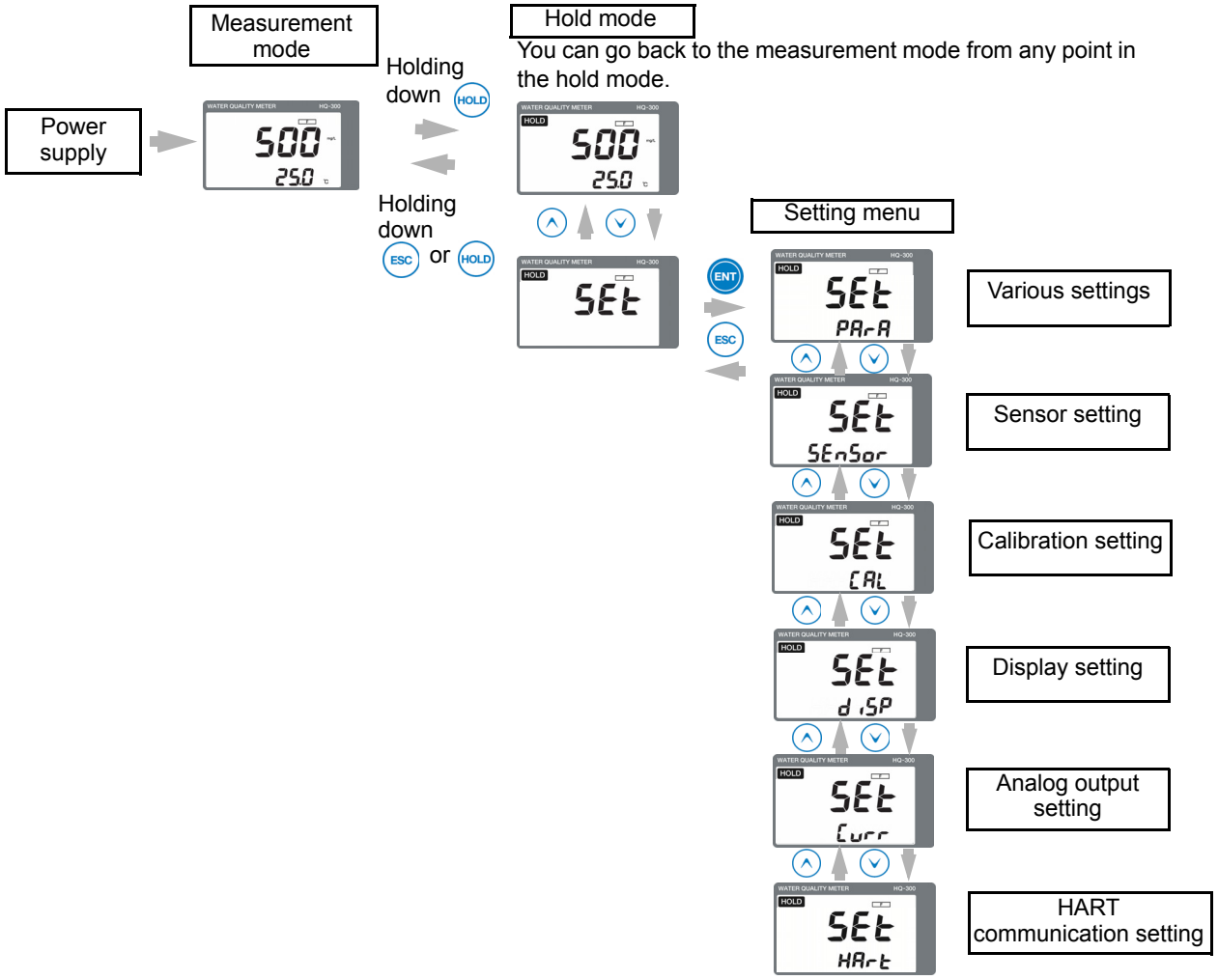
■ Functions available with setting menus

Setting item		Description	Default settings		Reference page
			Displayed character	Meaning	
Setting the sensors	The temperature sensor	Select the temperature sensor type.	1 k	Platinum resistance temperature detector: 1 kΩ	151
	The fluoride ion measurement range	Sets the fluoride ion measurement range.	1000	1000 mg/L	151
	The concentration at the isothermal point of intersection	Sets the concentration at the isothermal point of intersection.	9	9 mg/L	151
	The potential at the isothermal point of intersection	Sets the potential at the isothermal point of intersection.	17	17 mV	152
Calibration setting	The calibration value on the high concentration side	Sets the calibration value on the high concentration side.	1000	1000 mg/L	152
	The calibration value on the low concentration side	Sets the calibration value on the low concentration side.	100	100 mg/L	152
Display setting	The auxiliary display	Sets whether or not to display the measured temperature value.	t	Temperature display	152
	Display limit at over range	Select whether or not to display the measured fluoride ion value or measured temperature value if they exceed the setting ranges, respectively.	yES	Not displayed	152

Setting item		Description	Default settings		Reference page
			Displayed character	Meaning	
Analog output setting	The 4 mA analog output value	Sets the measured fluoride ion value to be assigned to 4 mA.	0	0 mg/L	153
	The 20 mA analog output value	Sets the measured fluoride ion value to be assigned to 20 mA.	1000	1000 mg/L	153
	The HOLD function	Select whether or not to stop the analog output (latest value, preset) in the hold mode or calibration mode.	HoLd	Latest value hold	153
	The HOLD output value	Sets a manually measured fluoride ion value when the HOLD function is set to preset.	1000	1000 mg/L	153
	The burnout function	Sets whether or not to activate a burnout function at the occurrence of an error.	non	Disabled	153
HART communication setting	The polling address	Sets the polling address of HART communication.	0	Address 0	154
	The analog output fix mode	Sets whether or not to fix the analog output to 4 mA at the time of multi-drop link.	off	Analog output is not fix mode	154
	The number of preambles	Sets the number of preambles.	5	5	154
	The write protect mode	Sets the write protect mode.	oFF	OFF	154
	Checking the device ID	Allows you to check the value of the device ID.	-	-	154
Various settings	The measurement item switching	Switches the measurement item.	F	F	151
	The moving average count	Set the moving average count of the measured fluoride ion value.	20	20 time	151
	The automatic return	Select whether or not to return the hold mode to the measurement mode automatically.	yES	Enabled	151
	The automatic return time	Sets the time before the automatic return is performed when automatic return is enabled.	2	2 hours	151

How to enter the setting menu

1. **Turn ON the power.**
2. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
3. **Press the ▲/▼ key to display SEt in the measured value display, and then press ENT to enter the setting menu.**



Setting menu display item

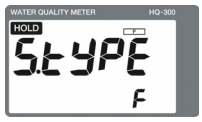
Setting value change Entry and Set Cancel

Various settings

ENT

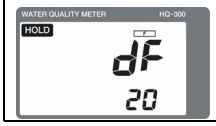
ESC

The measurement item switching



Switches to the measurement item to be used.
Setting range: PH, orP, do (dissolved oxygen), F (fluoride ion) C (electrical conductivity), r (electrical resistivity)

The moving average count



Sets the moving average count (damping factor) of the measured fluoride ion value.
Setting range: 1 to 50 times

The automatic return

Select whether or not to return the hold mode to the measurement mode automatically.

During setting change and calibration, automatic return is not performed even when the automatic return function is set to "yES".
Setting range: yES, no

Displayed only when the automatic return function is set to "yES"

The automatic return time

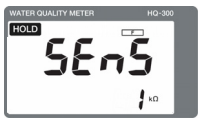
Sets the time before the automatic return is performed when automatic return is enabled.
Setting range: 1 hour to 24 hours

Setting the sensors

ENT

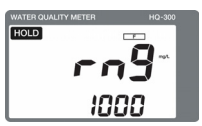
ESC

The temperature sensor



Select either automatic or manual to identify the temperature sensor type.
When a sensor with no internal temperature sensor is used, set this to "non".
Setting range: non, 1 kΩ, 10 kΩ

The fluoride ion measurement range



Sets the measurement range.
Setting range: 10.0, 20.0, 50, 100, 200, 500, 1000, 2000, 5000, 10000 (mg/L)

The concentration at the isothermal point of intersection

Sets the concentration at the isothermal point of intersection.
Setting range: 1 mg/L to 10000 mg/L

The potential at the isothermal point of intersection

Sets the potential at the isothermal point of intersection.
Check the instruction manual for the sensor to be connected.
Setting range: –200 mV to 200 mV

Calibration setting

The calibration value on the high concentration side

Sets the standard solution concentration during calibration.

The setting range differs depending on the specified measurement range.
Refer to “Allowable setting range list” (page 155).

The calibration value on the low concentration side

Sets the 1/10 standard solution concentration during calibration.

The setting range differs depending on the specified measurement range.
Refer to “Allowable setting range list” (page 155).

Display setting

The auxiliary display

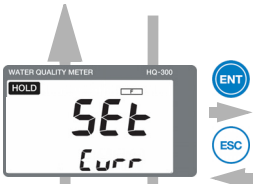
Sets whether or not to display the measured temperature value in the measurement mode screen.
non: Measured temperature value is not displayed
t: Measured temperature value is displayed
Setting range: non, t

Display limit at over range

Select whether or not to display the measured fluoride ion concentration value or measured temperature value if they exceed the measurement ranges, respectively.

yES: Values outside the range are not displayed
Fluoride ion: The setting range differs depending on the measurement range.
Refer to “Allowable setting range list” (page 155).
Temperature: 0°C to 100°C
no: Values outside the range are displayed
Fluoride ion: The setting range differs depending on the measurement range.
Refer to “Allowable setting range list” (page 155).
Range: yES, no

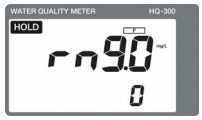
Analog output setting



ENT

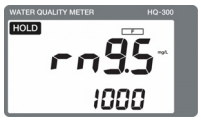
ESC

The 4 mA analog output value



Sets the measurement range of the fluoride ion concentration to be assigned to 4 mA.
Setting range: The setting range differs depending on the measurement range.
Refer to “Allowable setting range list” (page 155).

The 20 mA analog output value



Sets the measurement range of the fluoride ion concentration to be assigned to 20 mA.
Setting range: The setting range differs depending on the measurement range.
Refer to “Allowable setting range list” (page 155).

The HOLD function

Sets the analog output in the hold mode.

HoLd: The analog output is on hold at the latest value.
PrES: The analog output is or hold at a manually measured fluoride ion value.
Setting range: HoLd, PrES

Displayed only when the HOLD setting is “PrES”

The HOLD output value

Sets a manually measured fluoride ion value to be output in the hold mode when the HOLD function is set to PrES.
Setting range: The setting range differs depending on the measurement range.
Refer to “Allowable setting range list” (page 155).

The burnout function

Sets whether or not to burn out the analog output at the occurrence of an error.
non: Burnout function is disabled
out.4: Burnout lower limit setting (3.6 mA output)
out20: Burnout upper limit setting (21 mA output)
Setting range: non, out.4, out.20

Note

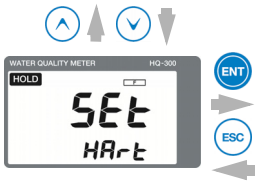
Burnout function

In case of a sensor error or system error, the analog output can be changed to the upper or lower limit setting (burnout function).

- **When the burnout upper limit setting is enabled, the analog output will change to 21 mA if an error occurs.**
- **When the burnout lower limit setting is enabled, the analog output will change to 3.6 mA if an error occurs.**

For details on the burnout occurrence conditions, refer to “Analog output conditions” (page 178).

HART communication setting

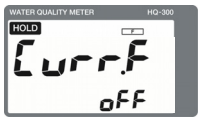


The polling address

Sets the polling address of HART communication.
Setting range: 0 to 63

Select an address except for 0 for the multi-drop link.

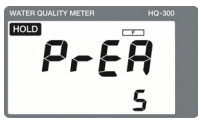
The analog output fix mode



Sets whether or not to fix the analog output to 4 mA.
on: The analog output is fixed to 4 mA.
oFF: The analog output is not fixed to 4 mA.

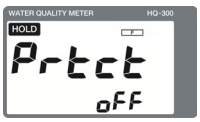
Setting range: on, oFF
It is recommended that you set this function to ON for the multi-drop link. When this function is set to ON, the burnout and preset settings are disabled.

The number of preambles



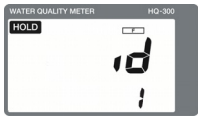
Sets the number of preambles.
Setting range: 2 pcs. to 20 pcs.

The write protect mode



Sets the write protect mode.
on: Change of various settings using the HART communication is disabled.
oFF: Change of various settings using the HART communication is enabled.
Setting range: on, oFF

Checking the device ID



Allows you to check the value of the device ID assigned to the transmitter.

The device ID cannot be changed.

● Allowable setting range list

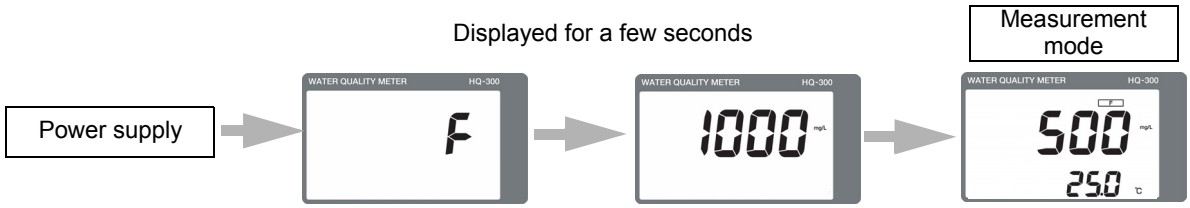
The setting range of the function varies depending on the specified fluoride ion concentration measurement range in “rng”. Perform setting according to the following table.

Screen	Description	Setting range (mg/L)									
		10.0	20.0	50	100	200	500	1000	2000	5000	10000
		Allowable setting/display range									
Std.H	Standard solution concentration setting during calibration	5.0 to 10.0	10.0 to 20.0	25 to 50	50 to 100	100 to 200	250 to 500	500 to 1000	1000 to 2000	2500 to 5000	5000 to 10000
Std.L	1/10 standard solution concentration setting during calibration	0.1 to 2.0	0.2 to 4.0	1 to 10	1 to 20	2 to 40	5 to 100	10 to 200	20 to 400	50 to 1000	100 to 2000
rng.C	Displayed when the non-display setting for outside the range is set to “yES”	0.0 to 10.0	0.0 to 20.0	0 to 50	0 to 100	0 to 200	0 to 500	0 to 1000	0 to 2000	0 to 5000	0 to 10000
rng.C	Displayed when the non-display setting for outside the range is set to “no”	0.0 to 11.0	0.0 to 22.0	0 to 55	0 to 110	0 to 220	0 to 550	0 to 1100	0 to 2200	0 to 5500	0 to 11000
rng.0	4 mA output value setting for analog output	0.0 to 11.0	0.0 to 22.0	0 to 55	0 to 110	0 to 220	0 to 550	0 to 1100	0 to 2200	0 to 5500	0 to 11000
rng.S	20 mA output value setting for analog output	0.0 to 11.0	0.0 to 22.0	0 to 55	0 to 110	0 to 220	0 to 550	0 to 1100	0 to 2200	0 to 5500	0 to 11000
PrES	Manually setting HOLD output value for analog output	0.0 to 11.0	0.0 to 22.0	0 to 55	0 to 110	0 to 220	0 to 550	0 to 1100	0 to 2200	0 to 5500	0 to 11000
FAct.b	Calibration curve intercept coefficient value setting	−5.0 to 5.0	−10.0 to 10.0	−25 to 25	−50 to 50	−100 to 100	−250 to 250	−500 to 500	−1000 to 1000	−2500 to 2500	−5000 to 5000

Measurement mode

How to enter the measurement mode

1. **Turn ON the power.**
The measurement target is displayed in the measured value display.
The measurement range is displayed and the system enters measurement mode.
The measured value is displayed and measurement starts. This is the measurement mode state.



2. **Press the ▲/▼ key to switch the screen.**
By switching the screen, you can change the moving average count (damping factor) and check the calibration data.

Note

Be sure to perform calibration of sensors before measurement. Refer to "Calibration" (page 158).

Functions available with the measurement mode

The following information can be displayed in the auxiliary display during measurement.
The moving average count (damping factor) is not only displayed but can also be changed.

Display information	Description	Reference page
Measured value display	Displays the measured temperature.	157
Calibration data display	Displays various calibration data of sensors.	
Moving average count display	Sets the moving average count (damping factor) of the measured fluoride ion value.	

Measurement mode display item

▲ ▼ Setting value change ENT Entry and Set ESC Cancel

Measured value display

Power supply

Displays the measured fluoride ion concentration value in the measured value display and the measured temperature value in the auxiliary display.

This is not displayed when the temperature display is disabled (Setting menu → Display setting → "The auxiliary display" (page 152)).

Calibration data display

ENT

ESC

Displaying the asymmetry potential (STD) value

Displays the asymmetry potential (STD). (Unit: mV)

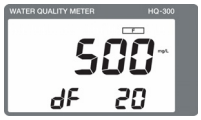
Displaying the sensitivity (SLOPE) value

Displays the sensitivity (SLOPE) value. (Unit: mV)

Checking the elapsed days from the previous calibration

Displays the elapsed days from the previous calibration date.
If the power is turned OFF, counting of days for that period is interrupted. When the power is turned ON, counting of days resumes.
The count is not initialized even when the power is turned OFF.

Moving average count display



Sets the moving average count (damping factor) of the measured fluoride ion value.
Use the ▲/▼ key to set the moving average count.
Setting range: 1 to 50 times

Tip

Moving average count
If the measured fluoride ion value is not stabilized, you can stabilize it by setting the moving average count.
The setting range is from 1 time to 50 times. The time averaging processing is performed during the period from one second to 50 seconds.

Example 1) When the moving average count is set to 10 times, the average value for the previous 10 seconds is updated every one second.
Example 2) When the moving average count is set to 1 time, averaging processing will not be performed.

Calibration

There are the following two calibration types: fluoride ion concentration calibration and temperature calibration.

Calibration type		Remarks	Reference page
Fluoride ion calibration	Standard solution calibration	Performs calibration using the standard solution. The number of calibration points can be selected from 1 point or 2 points. For the one-point calibration, the standard solution with the concentration that is most similar to the measurement range is used. For the two-point calibration, the standard solution with the concentration that is most similar to the measurement range, and the standard solution with 1/10 concentration, are used.	162, 163
	Manual calibration	For the calibration curve gradient coefficient (FAct.A), the gradient coefficient of the sensor is manually input. For the calibration curve intercept coefficient (FAct.b), the intercept coefficient of the sensor is manually input.	167, 168
Temperature calibration		Allows you to correct the measured temperature value manually.	165

Note

- **When the power is turned ON for the first time or sensors are replaced, be sure to perform calibration using the standard solution.**
- **The automatic stability judgment is a function to judge whether the measured fluoride ion value has been stabilized by reading the variations in the measured value during calibration. If variations in the measured fluoride ion value for 10 seconds have become smaller after 10 seconds from the start of stability judgment, the fluoride ion measured value is considered to be stable and the value is then on hold.**
- **If standard solution of 100 mg/L or less is used, the reading value may fluctuate even after the stability judgment. For this reason, if you use the standard solution of 100 mg/L or less, wait for approximately 15 minutes after the stability judgment and then complete the calibration.**

● Adjustment of fluoride ion standard solution

For the two-point calibration, adjust the following two types of standard solution: 1/10 standard solution and standard solution.
For the one-point calibration, adjust the standard solution.

● Creation method of undiluted standard solution (1000 mgF^-/L)... (A)

1. **Dry an appropriate amount of special grade sodium fluoride at 110°C for a few hours.**
2. **Put it in the desiccator and cool it.**
3. **Measure 2.210 g of sodium fluoride.**
4. **Add pure water to make a total of 1 L.**

● Creation method of undiluted standard solution (10000 mgF^-/L)... (B)

1. **Dry an appropriate amount of special grade sodium fluoride at 110°C for a few hours.**
2. **Put it in the desiccator and cool it.**
3. **Measure 22.10 g of sodium fluoride.**
4. **Add pure water to make a total of 1 L.**

● Creation method of supporting liquid (1 mol KNO_3/L)... (C)

1. **Measure 100 g of special grade potassium nitrate.**
2. **Add pure water and dissolve it completely.**
3. **Add more pure water to make a total of 1 L.**

● Adjustment procedure of various fluoride ion standard solutions

Measurement range (mg/L)	Adjustment of 1/10 standard solution	Adjustment of standard solution
0 to 10	Add pure water to 0.5 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.	Add pure water to 5 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.
0 to 20	Add pure water to 1.0 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.	Add pure water to 10 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.
0 to 50	Add pure water to 2.5 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.	Add pure water to 25 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.
0 to 100	Add pure water to 5.0 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.	Add pure water to 50 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.
0 to 200	Add pure water to 10 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.	Add pure water to 100 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.
0 to 500	Add pure water to 25 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.	Add pure water to 250 mL of the undiluted solution (A) and 50 mL of supporting liquid (C) to make a total of 500 mL.
0 to 1000	Add pure water to 5.0 mL of the undiluted solution (B) and 50 mL of supporting liquid (C) to make a total of 500 mL.	Add pure water to 50 mL of the undiluted solution (B) and 50 mL of supporting liquid (C) to make a total of 500 mL.
0 to 2000	Add pure water to 10 mL of the undiluted solution (B) and 50 mL of supporting liquid (C) to make a total of 500 mL.	Add pure water to 100 mL of the undiluted solution (B) and 50 mL of supporting liquid (C) to make a total of 500 mL.
0 to 5000	Add pure water to 25 mL of the undiluted solution (B) and 50 mL of supporting liquid (C) to make a total of 500 mL.	Add pure water to 250 mL of the undiluted solution (B) and 50 mL of supporting liquid (C) to make a total of 500 mL.

Note

- **Do not mix the sodium fluoride solution with acid liquid. Toxic hydrofluoric acid will be generated.**
- **Put the sodium fluoride solution in a polypropylene container and seal it when storing it. Putting it in a glass container could decrease the fluoride ion concentration.**
- **Potassium nitrate is a strong oxidant. If it undergoes reaction with a substance that is susceptible to oxidation, an explosion may occur.**
- **Dispose of the used standard solution according to the related laws and/or regulations.**
- **Do not reuse the standard solution.**

■ Before performing fluoride ion calibration

● Items to prepare

Standard solution to be used

● Transmitter

Set the transmitter to the calibration mode.
Hold down the CAL key in the measurement mode. “HOLD” and “CAL” are displayed in the upper left section and the calibration mode screen appears.

Note

Before lifting up the sensor, set the analog output on hold.

● Sensor

Lift up the sensor. If it is contaminated, follow the sensor cleaning procedure below.

Note

If standard solution of 100 mg/L or less is used, the reading value may fluctuate even after the stability judgment. For this reason, if you use the standard solution of 100 mg/L or less, wait for approximately 15 minutes after the stability judgment and then complete the calibration.

● Fluoride ion sensor cleaning procedure

⚠ WARNING

Strong acid hazard

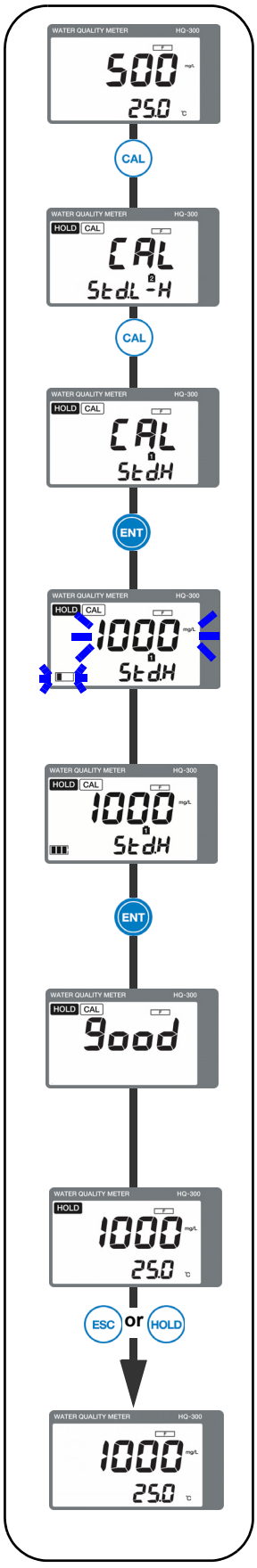
If diluted hydrochloric acid enters your eyes, it could irritate mucous membranes and eventually result in blindness.

When handling hydrochloric acid, be sure to wear protective goggles, gloves, and mask.
If it enters your eyes, wash your eyes with plenty of water for at least 15 minutes and consult a doctor. (During eye washing, open your eyelids well with your fingers so that water completely reaches the entire eyeball and eyelids).
If the acid gets on a human body or clothing, it could cause burns (chemical burns). Therefore, throw off your clothing immediately and rinse it off with plenty of water.

If the characteristics are not returned in [1], perform the procedure in [2] (or [3] as the next step). If the characteristics are still not returned, it can be considered that the sensor life has expired. In this case, replace the sensor.

	Contamination in general	Removal of soft contamination Organic substances Fiber Algae	Removal of adhesive contamination Oils Organic substances	Removal of hard contamination Calcium salt Inorganic salt	Remarks
Common procedure Rinse with pure water and wipe off the contamination with gauze	[1]	[1]	[1]	[1]	
Wipe off the contamination with gauze moistened with organic solvent and rinse it off with pure water	[2]	[2]	[2]	-	
Wipe off the contamination with gauze moistened with neutral detergent and rinse it off with pure water	-	[3]	[3]	-	
Immerse the sensor in diluted hydrochloric acid (1 mol/L) for 15 seconds and rinse it off with pure water (Repeat the step)	[3]	-	-	[2]	**Note** **Do not immerse the product in diluted hydrochloric acid for a long time.**

One-point calibration operational procedure



1. **Hold down the CAL key in the measurement mode.**

2. **The two-point calibration mode screen is displayed. Press the CAL key.**

3. **The one-point calibration mode screen is displayed. Immerse the sensor into the standard solution with the concentration specified in the "Std.H" standard solution concentration setting during calibration, and then press the ENT key to start the calibration for the first point.**

4. **The measured value keeps blinking and the indicator at the lower left increases continuously.**

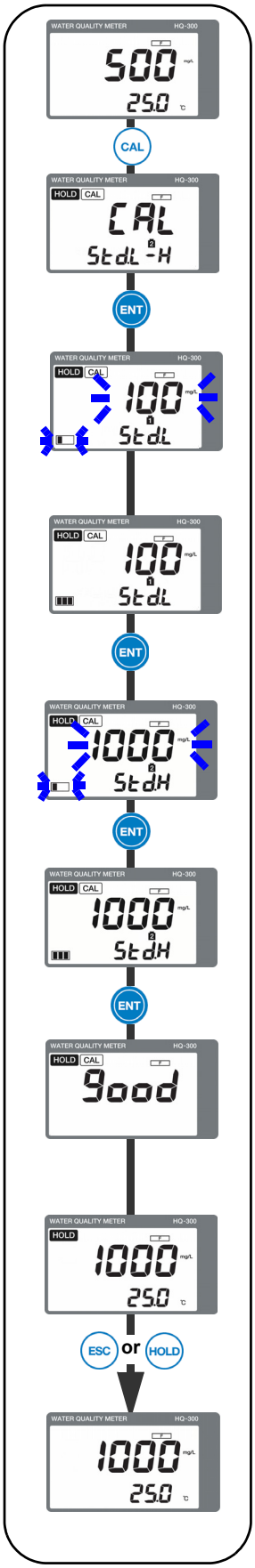
5. **After the stability judgment, the measured value lights up and all the indicators at the lower left also light up. Press the ENT key to complete the calibration for the first point.**
   If you wish to perform the calibration again, press the CAL key under this condition.

6. **The measured value display flashes, indicating "good", and the calibration value is updated.**

7. **After the calibration value is updated, the hold mode screen is displayed.**

8. **Hold down either the ESC or HOLD key to return to the measurement mode.**

Two-point calibration operational procedure



1. Hold down the CAL key in the measurement mode.

2. The two-point calibration mode screen is displayed. Immerse the sensor into the standard solution with the concentration specified in the “Std.L” 1/10 standard solution concentration setting during calibration, and then press the ENT key to start the calibration for the first point.

3. The measured value keeps blinking and the indicator at the lower left increases continuously.

4. After the stability judgment, the measured value lights up and all the indicators at the lower left also light up. Press the ENT key to complete the calibration for the first point. If you wish to perform the calibration again, press the CAL key under this condition.

5. Immerse the sensor into the standard solution with the concentration specified in the “Std.H” standard solution concentration setting during calibration, and then press the ENT key to start the calibration for the second point.

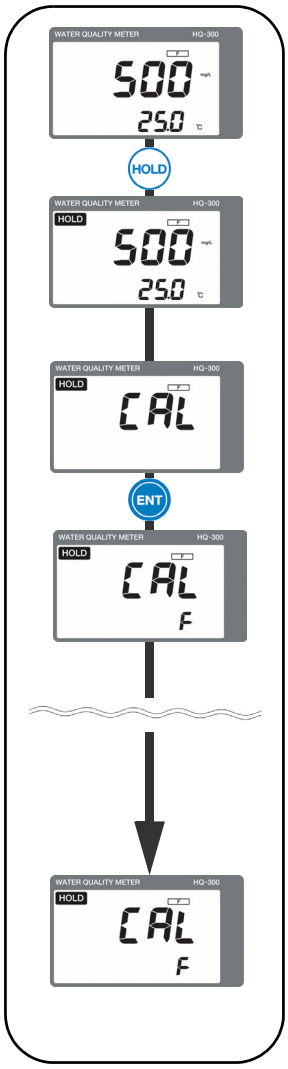
6. After the stability judgment, the measured value lights up and all the indicators at the lower left also light up. Press the ENT key to complete the calibration for the second point. If you wish to perform the calibration again, press the CAL key under this condition.

7. The measured value display flashes, indicating “good”, and the calibration value is updated.

8. After the calibration value is updated, the hold mode screen is displayed.

9. Hold down either the ESC or HOLD key to return to the measurement mode.

■ Operational procedure for entering the calibration menu from the hold mode



1. **Hold down the HOLD key in the measurement mode.**

2. **“HOLD” is displayed in the upper left section and the hold mode is activated. Press the ▼ key twice.**

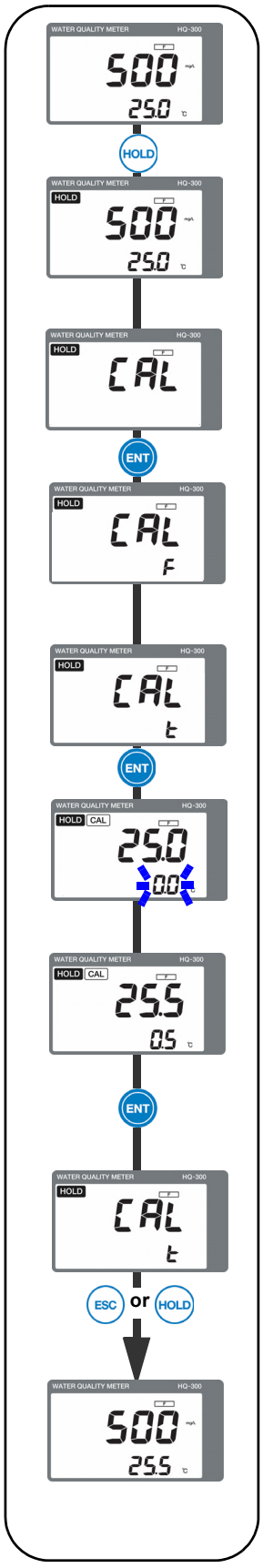
3. **Display CAL in the measured value display, and then press the ENT key.**

4. **“F” is displayed in the auxiliary display.**

5. **From this point, different screens will appear depending on the calibration type. For details, refer to the relevant page on the operational procedure.**

6. **Return to the top screen for F calibration.**

Temperature calibration operational procedure



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated.**
   Press the ▼ key twice.

3. **Display CAL in the measured value display, and then press the ENT key.**

4. **"F" is displayed in the auxiliary display. Press the ▼ key.**

5. **Display "t" in the auxiliary display, and then press the ENT key.**

6. **The temperature calibration mode is activated and the auxiliary display starts blinking.**

7. **Press the ▲/▼ key to adjust the value so that the value displayed in the measured value display reaches the water temperature.**
   ▲ key: The value increases by 0.1°C.
   ▼ key: The value decreases by 0.1°C.
   The setting range is from –5.0°C to 5.0°C.

8. **Press the ENT key.**
   The temperature calibration coefficient is updated.
   This completes the temperature calibration. The display returns to the calibration menu.

9. **Hold down either the ESC or HOLD key to return to the measurement mode.**

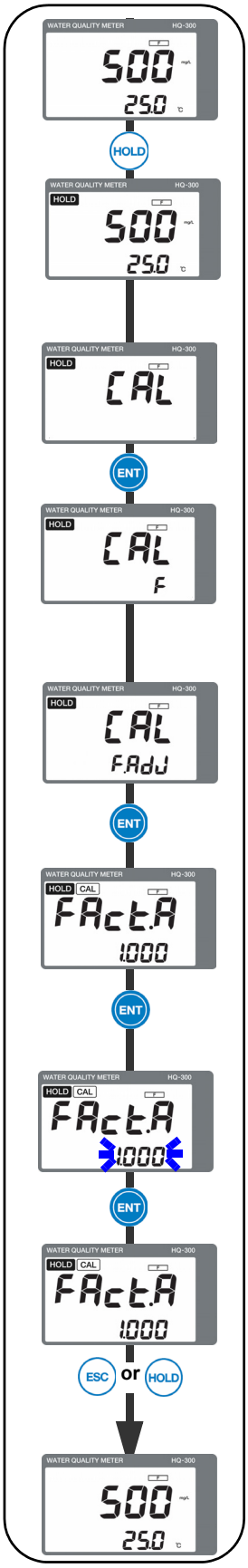
Note

- **Immerse the sensor into the liquid at a known temperature and ensure the sensor reaches the water temperature.**
- **When the hold mode is activated, the analog output will be the output value set in the setting menu (Refer to "Analog output setting" (page 153)).**
- **When the temperature sensor type "SEnSor" is set to "non" in the setting menu, the temperature calibration mode cannot be activated.**

Tip

- **If you wish to cancel the calibration in the middle of the process, press the ESC key. The display will return to the calibration menu without updating the calibration data.**
- **To continue and set other calibration items, press the ▲/▼ key to select the setting item.**

■ Operational procedure for calibration curve gradient coefficient for fluoride ion manual input calibration



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated. Press the ▼ key twice.**

3. **Display CAL in the measured value display, and then press the ENT key.**

4. **"F" is displayed in the auxiliary display. Press the ▼ key.**

5. **Display "F.Adj" in the auxiliary display, and then press the ENT key.**

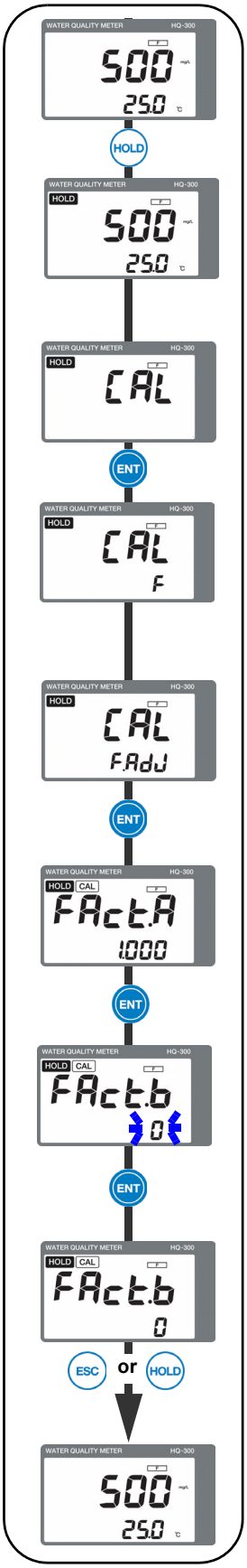
6. **Display "FAct.A" in the measured value display, and then press the ENT key.**
   Press the ▲/▼ key. The calibration curve gradient coefficient setting mode is activated and the auxiliary display starts blinking.
   ▲ key: The value increases by 0.001.
   ▼ key: The value decreases by 0.001.
   The setting range is from 0.500 to 2.000.

7. **Press the ENT key to set the calibration curve gradient coefficient.**

8. **Hold down either the ESC or HOLD key.**

9. **Press the ESC key to return to the measurement mode.**

■ Operational procedure for calibration curve intercept coefficient for fluoride ion manual input calibration



1. Hold down the HOLD key in the measurement mode.

2. “HOLD” is displayed in the upper left section and the hold mode is activated.
Press the ▼ key twice.

3. Display CAL in the measured value display, and then press the ENT key.

4. “F” is displayed in the auxiliary display. Press the ▼ key.

5. Display “F.Adj” in the auxiliary display, and then press the ENT key.

6. Display “FAct.A”, and then press the ▼ key.

7. Press the ENT key. The calibration curve intercept coefficient setting mode is activated and the auxiliary display starts blinking.
Press the ▲/▼ key to enter the intercept coefficient.
The setting range differs depending on the fluoride ion measurement range setting.
Refer to “Allowable setting range list” (page 155).

8. Press the ENT key to set the calibration curve intercept coefficient.

9. Hold down either the ESC or HOLD key to return to the measurement mode.

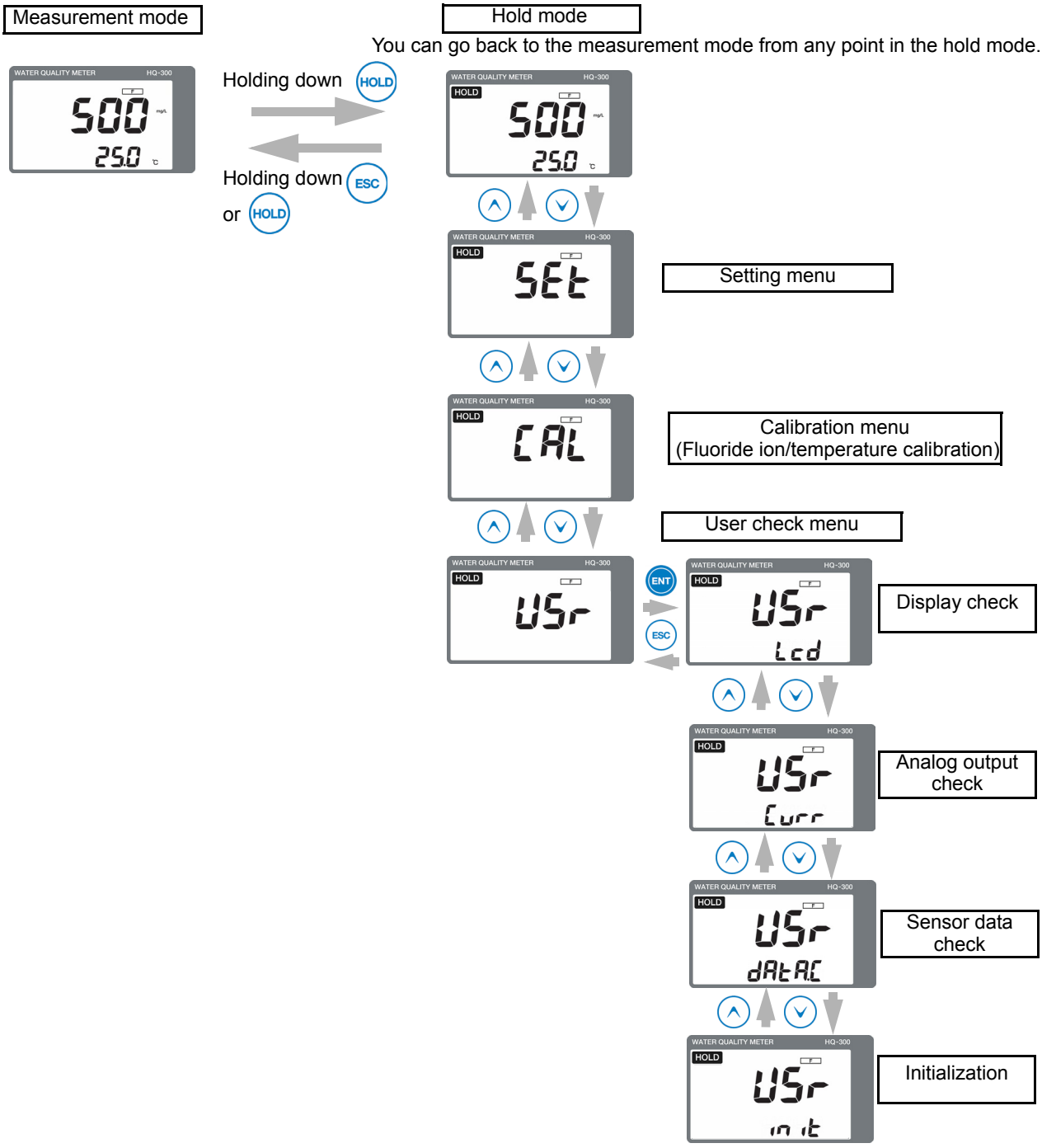
Maintenance procedure

■ User check menu

The user check menu allows you to check the display, analog output, and sensor data, and initialize the setting value.

● How to enter the user check menu

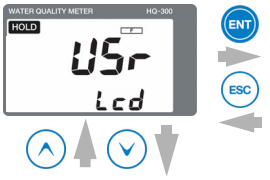
1. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
2. **Press the ▲/▼ key to display USr in the measured value display, and then press the ENT key to enter the user check menu.**

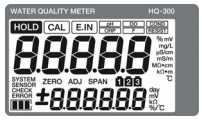


■ User check menu display item

▲ ▼ Setting value change ENT Entry and Set ESC Cancel

Display check

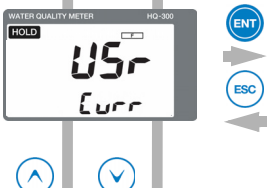


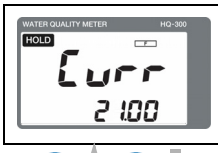


Turns on the light of the entire LCD display.
This is used when you check the display.

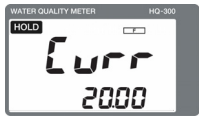
Analog output check

The analog output is changed the following current values.
This is used when you check the analog output (loop check).





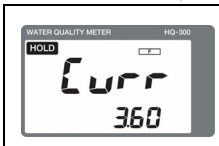
For checking the 21 mA output
(Upper limit current at the time of burnout)



For checking the 20 mA output

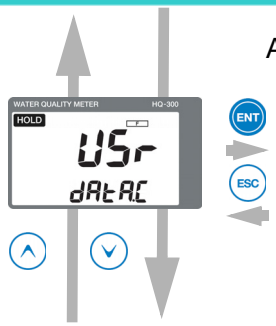
For checking the 12 mA output

For checking the 4 mA output



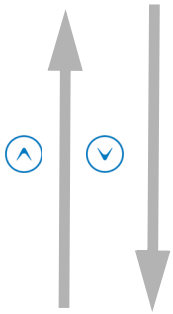
For checking the 3.6 mA output
(Lower limit current at the time of burnout)

Sensor data check

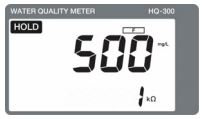


Allows you to check various sensor data.

Displays the measured fluoride ion value and measured temperature value.

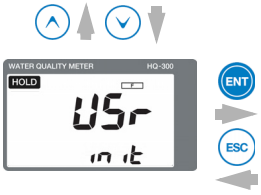


Displays the measured fluoride ion concentration value and measured fluoride ion concentration value.



Displays the measured fluoride ion concentration value and temperature sensor type (resistance).

Initialization



Returns the setting data and calibration data to the default status.
no: Data is not returned to the default status
yES: Data is returned to the default status

■ Sensor maintenance

This section describes the maintenance procedure for general fluoride ion sensors.
For details, refer to the instruction manual for the relevant sensor.

● Sensor cleaning

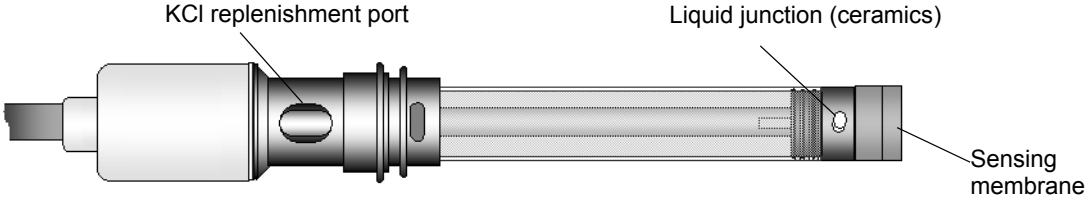
The sensing membrane at the tip of the sensor is made of mirror polished lanthanum fluoride, which is highly fragile. If it is scratched, the characteristics will deteriorate. Do not touch it with your bare hand or expose it to foreign matter.

Contamination on the sensor could cause a delay in response, indication drifting, or instability. Inspect the tip of the sensor (glass membrane) and liquid junction periodically and maintain a clean state by rinsing off the contamination with water, etc.
After cleaning the sensor, perform calibration.

Note

If the sensor is embedded in the holder, removing the protective pipe may spill out the internal solution.
Clean the sensor while the protective tube remains attached.

● Fluoride ion sensor single view



● Fluoride ion sensor cleaning procedure

⚠ WARNING

Strong acid hazard

If diluted hydrochloric acid enters your eyes, it could irritate mucous membranes and eventually result in blindness.

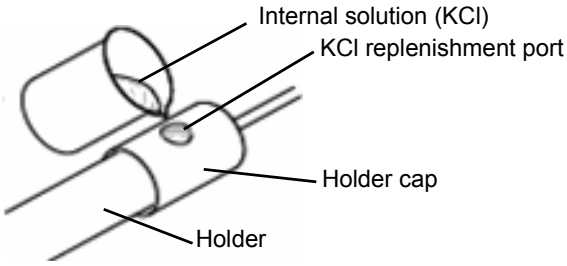
When handling hydrochloric acid, be sure to wear protective goggles, gloves, and mask.
If it enters your eyes, immediately rinse it off with plenty of water for at least 15 minutes and consult a doctor (during eye washing, open your eyelids well with your fingers so that water completely reaches the entire eyeball and eyelid).
If the acid gets on a human body or clothing, it could cause burns (chemical burns). Therefore, throw off your clothing immediately and rinse it off with plenty of water.

If the characteristics are not returned in [1], perform the procedure in [2] (or [3] as the next step). If the characteristics are still not returned, it can be considered that the sensor life has expired. In this case, replace the sensor.

	Contamination in general	Removal of soft contamination Organic substances Fiber Algae	Removal of adhesive contamination Oils Organic substances	Removal of hard contamination Calcium salt Inorganic salt	Remarks
Common procedure Rinse with pure water and wipe off the contamination with gauze	[1]	[1]	[1]	[1]	
Wipe off the contamination with gauze moistened with organic solvent and rinse it off with pure water	[2]	[2]	[2]	-	
Wipe off the contamination with gauze moistened with neutral detergent and rinse it off with pure water	-	[3]	[3]	-	
Immerse the sensor in diluted hydrochloric acid (1 mol/L) for 15 seconds and rinse it off with pure water (Repeat the step)	[3]	-	-	[2]	**Note** **Do not immerse the product in diluted hydrochloric acid for a long time.**

● KCl internal solution replenishment

In order to ensure correct measurement, the liquid surface of the sensor internal solution (3.33 3mol/L KCL solution) must be at least 10 cm higher than the liquid surface of the liquid to be measured. Replenish the internal solution periodically so that the liquid surface will not fall under this level.



Note

- **As KCl is used as the fluoride ion sensor internal solution, it is harmless to the human body. However, wear protective gear such as gloves and protective goggles.**
- **The internal solution can be drained through the sink as it is.**

● Storage

After cleaning the sensor with pure water, wipe off the water droplets with tissue paper and store the sensor in the open air.
Tie the sensor with a vinyl tape so that the internal solution will not spill out from the KCl inlet.
Attach the protective cap to the tip of the sensor and put the sensor in a case to store it.

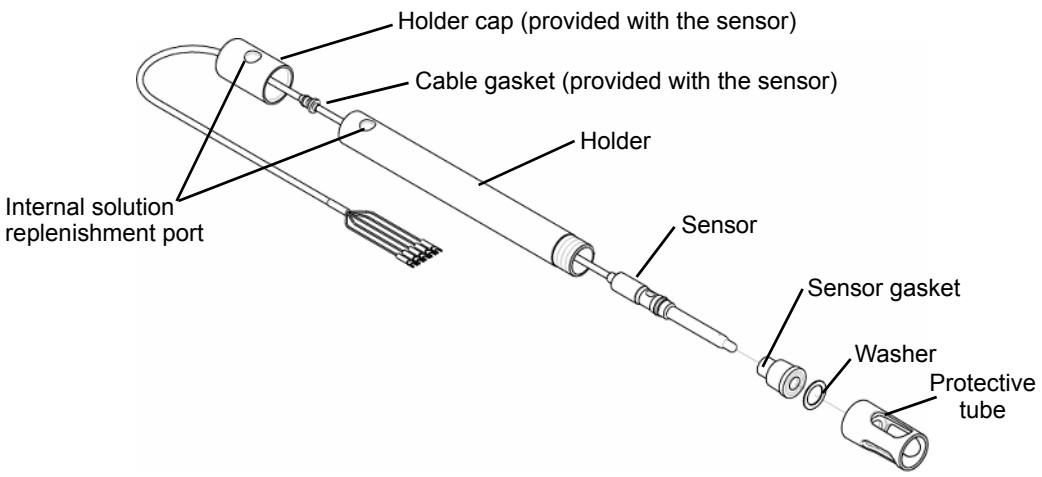
● Sensor replacement procedure

⚠ CAUTION

The fluoride ion sensor is made of fragile lanthanum fluoride and glass. Applying a shock or excessive force could damage the sensor. Be extremely careful when handling it.

Note

Prepare the silicon grease for installing the holder cap.
This section describes the typical sensor holder. For details, refer to the relevant instruction manual.

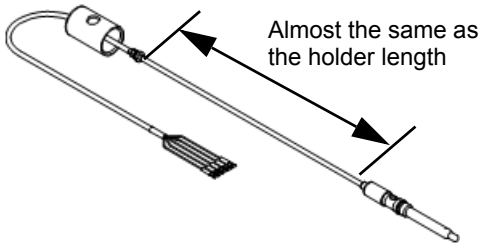


1. **Remove the holder cap, and then drain the internal solution from the holder completely.**
2. **Remove the protective pipe and washer from the tip of the holder, and then remove the sensor gasket from the holder.**
3. **Hold the sensor when removing the sensor gasket.**
4. **Remove the sensor from the top of the holder.**

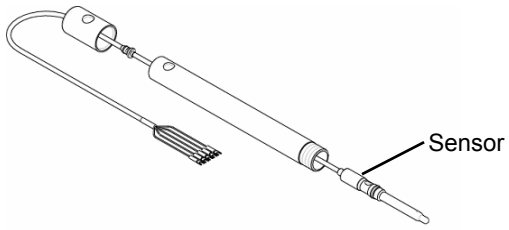
Note

Handle the fluoride ion sensor as industrial waste.

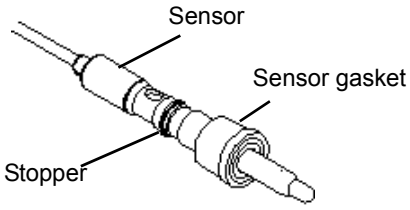
5. **Rinse off contamination from the holder, sensor gasket, washer, and protective pipe with alcohol, etc., and then dry them completely.**
6. **Move the positions of the holder cap and cable gasket approximately up to the holder length.**



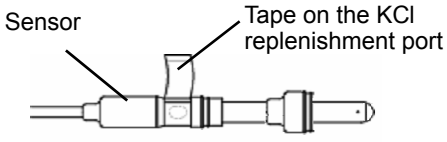
7. **Put a new sensor through the holder from the top and draw it from the bottom.**



8. **Put the sensor gasket on the sensor until it approximately reaches the stopper.**



9. **Remove the tape from the KCl replenishment port of the sensor.**

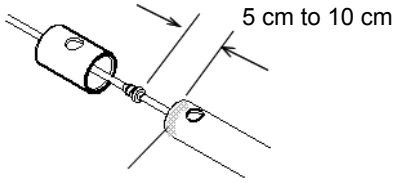


Note

- **If you do not remove the tape from the replenishment port of the sensor, measurement cannot be performed correctly.**
- **In order to avoid leakage of internal solution, when removing the tape, be sure to orient the KCl replenishment port upward.**
- **As the protective cap will be reused for storage, do not dispose of it.**

10. **Push the sensor gasket into the holder, insert the washer, and then tighten the protective pipe.**

11. **Adjust the cable gasket so that the distance from the holder cap to the top of the holder is 5 cm to 10 cm.**



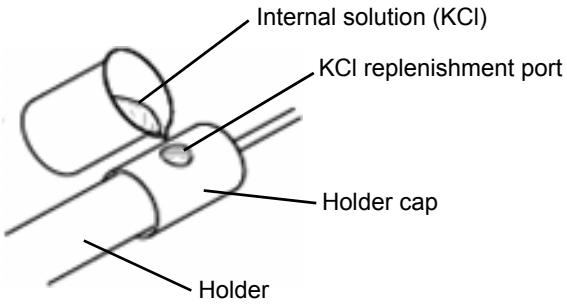
12. **Coat the entire circumference of the holder top with silicon grease.**

13. **Fit the holder cap onto the holder.**

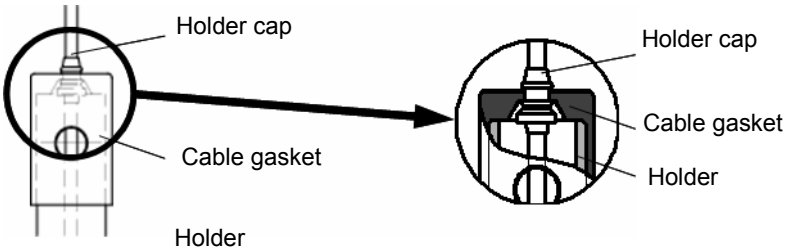
14. **Inject new internal solution from the replenishment port up to the internal solution injection level.**

Tip

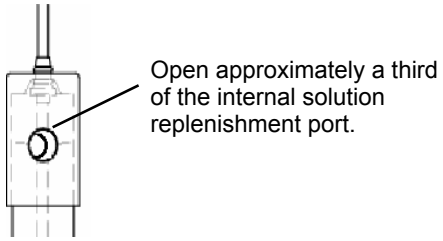
Approximately 500 mL of internal solution is necessary for a 1 m holder.



15. **Pinch the cable gasket and slightly pull it out from the holder cap.**



16. **Open approximately a third of the internal solution replenishment port. This completes the preparation.**



Note

Check the following.

- **The protective cap of the sensor has been removed**
- **The tape on the KCl replenishment port of the sensor has been removed**
- **A third of the replenishment port on the holder has been opened**

■ Troubleshooting

● Measures for fluoride ion sensor failure

If a failure occurs in the sensor manufactured by HORIBA Advanced Techno, check the currently used sensor according to the following troubleshooting method. If the failure persists after checking and troubleshooting, please contact the dealer.

Symptom / Possible cause	Calibration cannot be performed	Instable indication	Slow response	No indication change	Internal solution reduction in a short period	Foreign matter inside reference electrode	Short lifetime	Troubleshooting
Sensing membrane/reference electrode cracks	√	√	-	√	√	√	-	The sensor cannot be used. Replace it.
Contamination on sensing membrane	√	√	√	√	-	-	-	Rinse off the contamination with tap water, etc.
Dry sensing membrane	√	√	√	-	-	-	-	Immerse the sensor in tap water for approximately one hour before using it.
Contamination/clogging in liquid junction (ceramics)	√	√	-	√	-	-	-	Rinse off the contamination with tap water, etc.
Insufficient reference electrode internal solution	√	√	√	-	-	√	-	Replenish the reference electrode internal solution.
Cap remains attached	√	√	√	√	-	-	-	Remove the cap before using the sensor.
Internal solution replenishment port is not open	√	√	-	-	-	√	-	Open the internal solution replenishment port.
Terminal is not connected completely	√	√	-	-	-	-	-	Connect the terminal using the cable specified by HORIBA Advanced Techno, according to “Sensor connection” (page 18).
There is no liquid junction (ceramics)	-	-	-	-	√	√	-	Replace the sensor.
Old calibration solution is used	√	-	-	-	-	-	-	Use new calibration solution.
Hydrofluoric acid is mixed in the sample	√	-	√	√	-	-	√	The glass deteriorates due to hydrofluoric acid. Replace it ahead of time.
Sample back flow	√	√	-	-	-	√	√	Replace the reference electrode internal solution, or replace the sensor. Use new standard solution.
Electrical conductivity of the sample is below 500 μS/cm	-	√	√	-	-	-	-	Measurement cannot be performed. Contact HORIBA Advanced Techno.

● Measures for values outside the measurement range

If the measured fluoride ion value is outside the measurement range (below 0 or above the measurement range), the measured value is blinking.
Perform the procedure according to the following table.

Possible cause	Corrective action
The sensor is not immersed in the liquid to be measured	Install the sensor so that it is immersed in the liquid to be measured even when the surface level of the liquid to be measured changes.
The protective cap of the sensor is attached	Remove the protective cap.
● Wiring of the sensor cable is wrong Wiring for the G and R lines, in particular, is disconnected ● Wiring of the relay cable is wrong	Check for looseness of screws or incorrect wiring in the terminal blocks of this product and relay box.

■ Analog output conditions

C.HoLd (HOLD setting)			HoLd (Latest value hold)			PrES (Setting value hold)		
b.out (Burnout setting)			non	out.4	out.20	non	out.4	out.20
Measurement mode			Measured value			Measured value		
		E-21 to E-25	Latest value hold	3.6 mA	21 mA		3.6 mA	21 mA
		E-72						
		E-90 to E-92						
	External hold input ON					Preset value		
		E-21 to E-25						
		E-72						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
Hold mode								
		E-90 to E-92	Latest value hold	3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON					Preset value		
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
Fluoride ion calibration								
		E-11 to E-13						
		E-21 to E-25						
		E-90 to E-92	Latest value hold	3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON					Preset value		
		E-11 to E-13						
		E-21 to E-25						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
Temperature calibration								
		E-21 to E-27						
		E-90 to E-92	Latest value hold	3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON					Preset value		
		E-21 to E-27						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA

Error codes

This product has a function to display various error codes.
An error code blinks in the auxiliary display.

Error code description

Error display		Error display priority*1	Error description	Description	When to occur
E-11	SENSOR ERROR	8	Response speed error	The fluoride ion sensor response is slow during calibration of the standard solution	During fluoride ion calibration*2
E-12		9	Sensor sensitivity error	The fluoride ion sensor sensitivity is poor during calibration of the standard solution	
E-13		10	Asymmetry potential error	The fluoride ion electromotive force (asymmetry potential) is large during calibration of the standard solution	
E-21		4	Temperature sensor disconnection	The lead wire of the temperature sensor is disconnected	During measurement and fluoride ion calibration*2, *3
E-22		5	Temperature sensor shorted-circuited	The lead wire of the temperature sensor is shorted-circuited	
E-25		7	Temperature measurement outside range	The temperature is below −20°C or above 130°C	
E-27		7	Temperature calibration error	The temperature is below −20°C or above 130°C	During temperature calibration
E-90	SYSTEM ERROR	1	System error	Internal communication error	At all times (System error)
E-91		2	System error	The memory data, such as the setting values, calibration values, are lost	
E-92		3	System error	A/D converter operation failure	

*1: Two or more errors cannot be displayed at the same time. If multiple errors occur, the error with the smallest priority number is displayed.

*2: If an error from E-11 to E-13 occurs, recalibration can be performed. However, if an error from E-21 to E-25 occurs during calibration, recalibration cannot be performed.
Take a corrective action according to “Corrective actions” (page 180).

*3: If there is no temperature sensor (the temperature sensor type is set to “non”), no error is displayed.

Tip

When an error code is displayed, the HOLD lamp starts blinking, and the analog output will be the output value set in the setting menu. Refer to “The HOLD function” (page 153).

Corrective actions

When an error code is displayed, take corrective actions according to the table below.

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-11 (Response speed error)	If the value is not stabilized for at least 5 minutes during calibration stability judgment	● Reset by the ESC key ● Reset by recalibration	● Contamination on the sensor ● The sensor has been dry for a long period of time	Clean the sensor. If the sensing membrane is dry, it deteriorates the response. Immerse the sensor in pure water for the entire day and night, and then perform calibration of the standard solution again.
			There is a large difference in temperature between the liquid to be measured and standard solution	Wait until the temperature of the sensor temperature compensation element is stabilized, and then perform calibration of the standard solution.
E-12 (Sensor sensitivity error)	If the sensor sensitivity (SLOPE) deviates from the specified range during calibration of two points or more An error occurs under the following conditions: SLOPE < 40 mV SLOPE > 65 mV	● Reset by the ESC key ● Reset by recalibration	● Contamination on the sensor ● The sensing membrane is cracked ● Sensor internal solution error ● Insufficient amount of internal solution	● Clean the sensor. ● If the sensor is broken, replace it. ● For the internal solution replenishment type, if the amount of internal solution is insufficient, replenish it. ● For the internal solution non-supply type, if no white powder can be seen inside the solution, replace the sensor. ● If discoloration or alteration of the internal solution is detected, replace the entire internal solution with a new one. ● If old standard solution is used, perform calibration using new standard solution. ● Use the proper standard solution.
E-13 (Asymmetry potential error)	If the asymmetry potential (STD) deviates from the specified range during calibration An error also occurs under the following conditions: STD 90 mV or STD 90 mV	● Reset by the ESC key ● Reset by recalibration	● Contamination on the sensor ● Discoloration of internal solution ● Contamination of internal solution ● Abnormality or deterioration of standard solution	

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-21 (Temperature sensor disconnection)	● When the temperature sensor is 1 k: If the resistance of the temperature sensor is approximately 1.58 kΩ or above (the 1 kΩ temperature sensor is approximately 150°C or above) ● When the temperature sensor is 10 k: If the resistance of the temperature sensor is approximately 14.8 kΩ or above (When the 10 kΩ temperature sensor is approximately 150°C or above)	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions described on the left. Replace the sensor with a new one.
			Sensor without temperature sensor	Set the sensor type to “non”. Refer to “The temperature sensor” (page 151).
			Wiring of the sensor cable and relay cable is wrong	Check that the wiring between T and T is not open.
E-22 (Temperature sensor shorted-circuited)	● When the temperature sensor is 1 k: If the resistance of the temperature sensor is approximately 400 Ω or less ● When the temperature sensor is 10 k: If the resistance of the temperature sensor is approximately 4.84 kΩ or less	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions described on the left. Replace the sensor with a new one.
			Wiring of the sensor cable and relay cable is wrong	Check that the wiring between T and T is not shorted.
E-25 (Temperature measurement outside range)	The temperature is below −20°C or above 130°C	When the condition stated on the left is reset	the liquid to be measured temperature error	Maintain the liquid to be measured temperature within the operating temperature range of the sensor.
			Incorrect setting of temperature sensor type	Set the correct temperature sensor type. Refer to “The temperature sensor” (page 151).
			Temperature sensor resistance error	The temperature sensor is faulty. Replace the sensor with a new one.
E-27 (Temperature calibration error)	The temperature is below −20°C or above 130°C	When the mode is switched from the temperature calibration mode using the ESC key	the liquid to be measured temperature error	Maintain the liquid to be measured temperature within the operating temperature range of the sensor.
			Incorrect setting of temperature sensor type	Set the correct temperature sensor type. Refer to “The temperature sensor” (page 151).
			Temperature sensor resistance error	The temperature sensor is faulty. Replace the sensor with a new one.

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-90 (System error)	Internal communication error	Turning the power OFF and then ON	Internal system error	Turn OFF the power and turn it back ON. If the system error persists, contact HORIBA Advanced Techno.
E-91 (System error)	The memory data, such as the setting values, calibration values, are lost			
E-92 (System error)	A/D converter operation failure			

■ Sensor rating

Product name	Fluoride ion sensor	
Model	1009	
the liquid to be measured conditions	pH range	4 pH to 8 pH (within the range up to 0.2 mg/L) 4 pH to 10 pH (within the range up to 20 mg/L) 4 pH to 12 pH (within the range up to 2000 mg/L)
	Temperature range	0 °C to 40 °C
	Electrical conductivity	500 μs/cm or above
	Flow rate range	1 cm/sec to 20 cm/sec
Sensor structure	Structure	Submerged type
	Sensing membrane	Lanthanum fluoride
	Reference electrode	Ag/AgCl, internal solution KCL3.3 mol/L replenishment type
	Liquid junction section	Ceramic double-junction
	Temperature compensation element	Pt1000 Ω (0°C)
	Cable length	5 m
External dimensions	12ϕ mm × 175 (L) mm (excluding cable and protrusions)	
Mass	Approx. 200 g	

Note

- **This monitoring function detects the free fluoride ions within water. It does not necessarily mean that it detects fluorine completely. If a complex is contained, the measured value will be lower than that measured according to the JIS method.**
- **There may be some measured value errors depending on the pH value. Use near neutral solution.**

Options

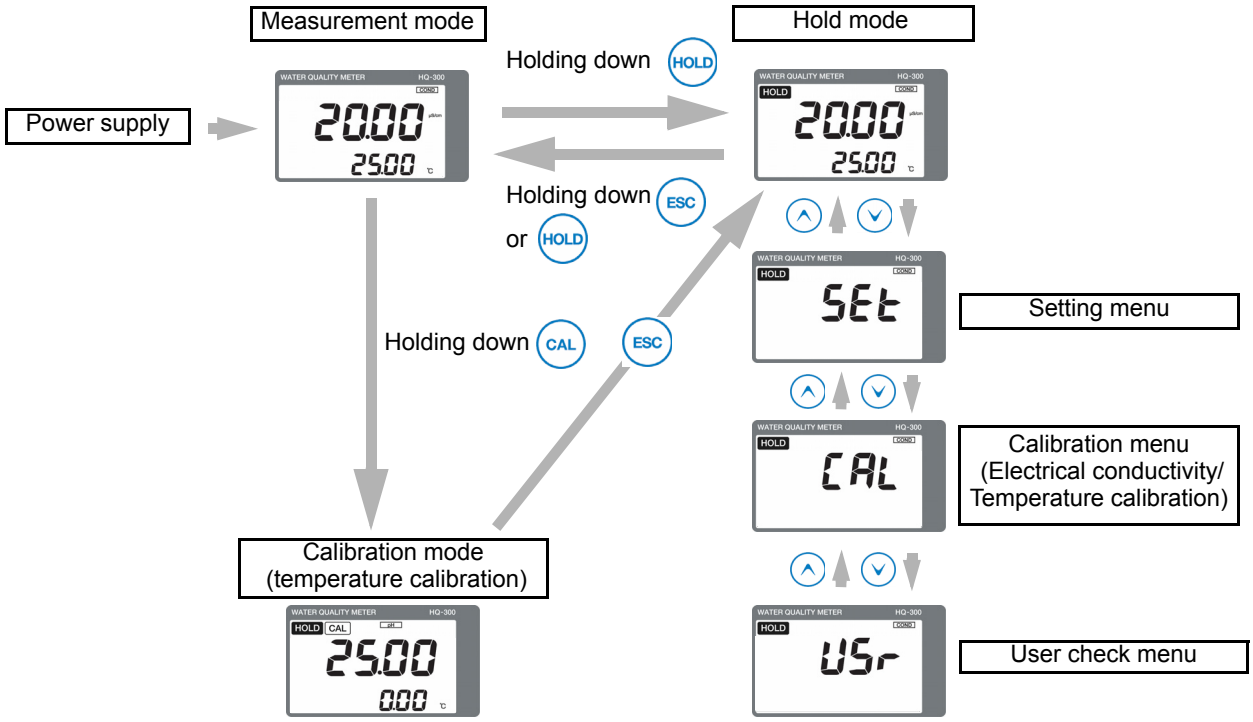
Parts name	Model	Specifications
Cleaning unit	JCH/JCF series	Water (air) jet cleaning unit (immersion/flow chamber type)
	CCH series	Chemical cleaning unit (immersion type)
Holder	CH-101 series	Immersion type holder
	CF-301 series	Flow chamber type holder (pressure type) JIS 10K 25A FF

Parts name	Model	Specifications
Reference electrode internal solution	#300	3.33 mol/L KCl solution (250 mL) Note) Two bottles (500 mL) are required for each 1 m holder.
Powder for reference electrode internal solution	#350	KCl powder 500 g (one bottle)
Fluoride ion sensor	1009	-

Electrical Conductivity Measurement

Description of mode and menu

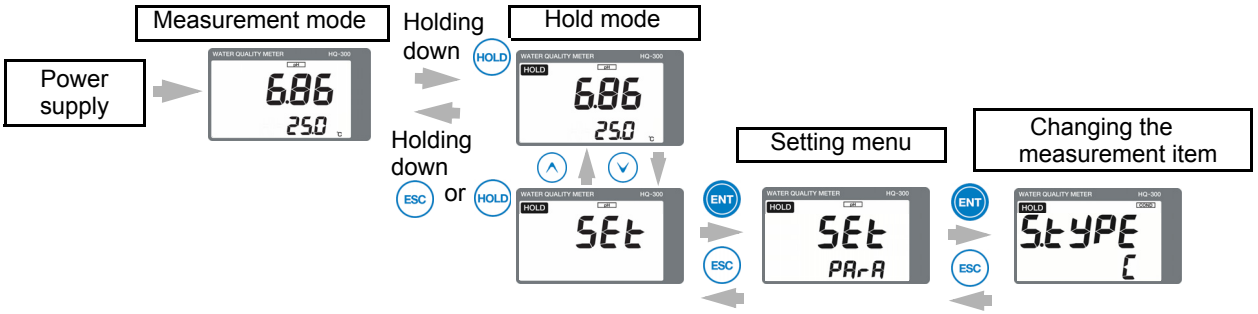
■ Modes and menus in each measurement mode



Description of mode/menu	Description	Reference page
Measurement mode	Performs measurement and analog output. Allows you to check the calibration values or set and check the moving average count (damping factor) during measurement.	195
Calibration mode (Temperature calibration)	Performs temperature calibration.	197
Hold mode (Measurement output hold)	Stops measurement and output and performs various settings.	-
Setting menu	Allows you to set all parameters related to measurement, such as the assignment of detector information input or output before starting operation.	185
Calibration menu (Electrical conductivity/ Temperature calibration)	The following two types of calibration can be performed: Electrical conductivity and temperature calibration (the temperature calibration is the same as the calibration mode).	197
User check menu	The output status and measured values can be checked. The setting value can be reset to the default value.	195

Setting menu

■ Measurement item switching



Set the measurement item to C.
(C: Electrical conductivity measurement)

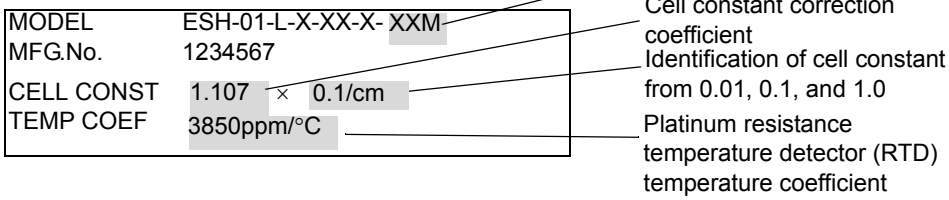
Operational procedure for setting the measurement item

ENT blink the auxiliary value, ∧∨ changes the setting value, ESC cancels the value, ENT set the value and holding down HOLD return to measurement mode.

■ Sensor setting

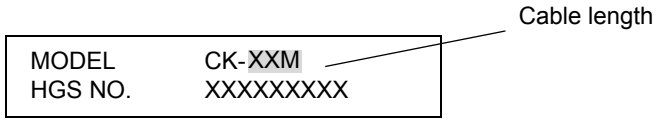
Enter the value written on the sensor label.

Example of label



*There is no description of the cable length for the connector type sensor.
Enter the cable length value written on the extension cable.

When an extension cable is used, enter the cable length written on the cable label.



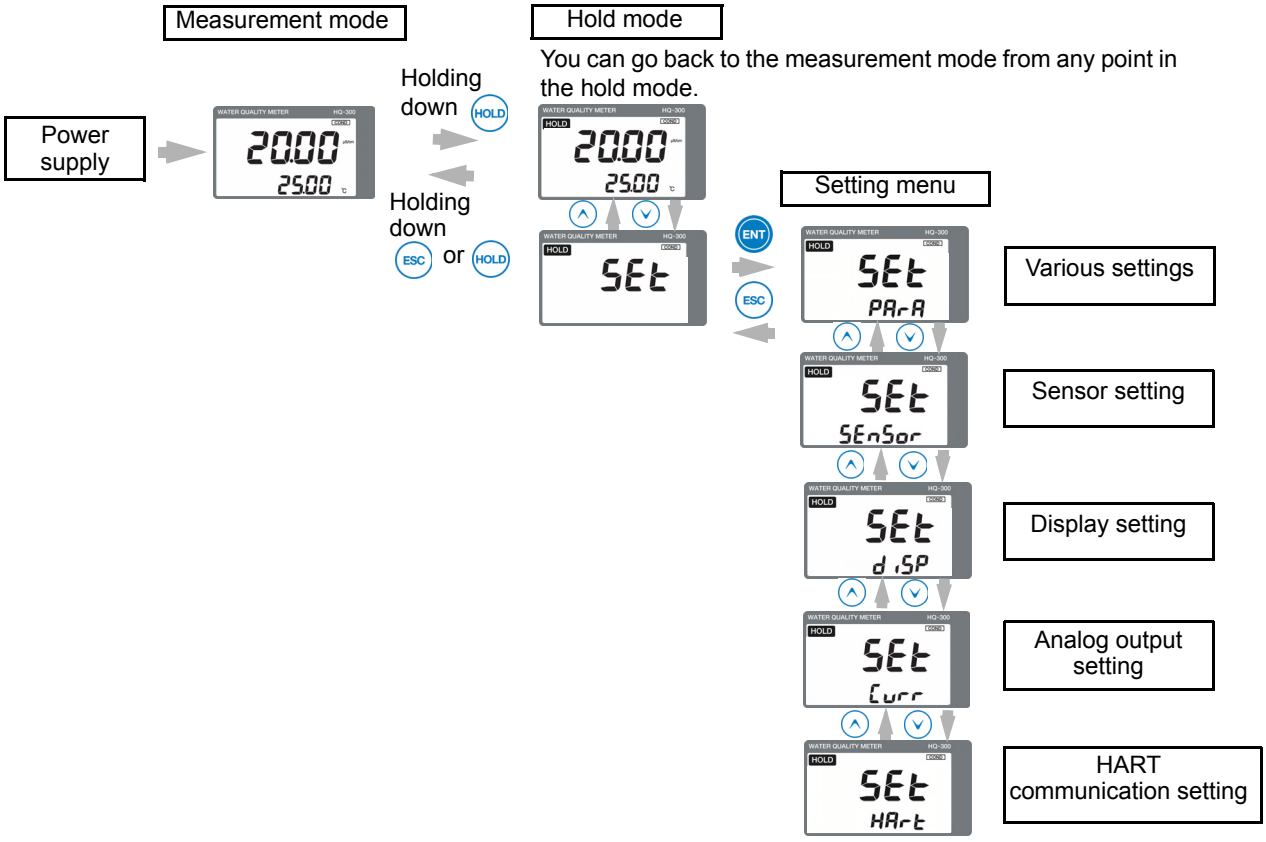
■ Functions available with setting menus

Setting item		Description	Default settings		Reference page
			Displayed character	Meaning	
Setting the sensors	The cell constant	Select the cell constant of the sensor.	0.1	Cell constant 0.1	190
	The cell constant correction coefficient	Sets the cell constant correction coefficient of the sensor. Enter the value written on the sensor label.	1.000	1.000	190
	The temperature coefficient	Sets the temperature coefficient of the built-in temperature sensor for the sensor.	3850	3850 ppm/°C	190
	The resistance correction value	Sets the resistance compensation value of the built-in temperature sensor for the sensor. Enter the value only when it is written on the sensor label.	0.00	0.00 Ω	190
	The cable length	Sets the cable length of the sensor.	10	10 m	190
	The measurement range	Sets the measurement range to be used.	20.00	20 μS/cm	190
	The temperature compensation	Select the temperature compensation calculation method.	nACL	NaCl temperature compensation	190
	The temperature compensation coefficient	Sets the temperature for the reference compensation	2.00	2.00%/°C	191
	The reference compensation temperature	Sets the coefficient for the temperature for compensation	25	25°C	191
Display setting	The auxiliary display	Sets whether or not to display the measured temperature value.	t	Temperature display	191
	Display limit at over range	Select whether or not to display the measured electrical conductivity value or measured temperature value if they exceed the measurement range, respectively.	yES	Not displayed	191
	The temperature display digit	Select whether to display the measured temperature value down to one or two decimal places.	0.01	Down to two decimal places is displayed	191
Analog output setting	The 4 mA analog output value	Sets the measured electrical conductivity value to be assigned to 4 mA when the analog output range is manually.	0.00	0 μS/cm	192
	The 20 mA analog output value	Sets the measured electrical conductivity value to be assigned to 20 mA when the analog output range is manually.	20.00	20 μS/cm	192
	The HOLD function	Select whether or not to stop the analog output (latest value, preset) in the hold mode or calibration mode.	HoLd	Latest value hold	192
	The HOLD output value	Sets a manually measured electrical conductivity value when the HOLD function is set to preset.	20.00	20 μS/cm	192
	The burnout function	Sets whether or not to burn out the analog output at the occurrence of an error.	non	Disabled	192

Setting item		Description	Default settings		Reference page
			Displayed character	Meaning	
HART communication setting	The polling address	Sets the polling address of HART communication.	0	Address 0	193
	The analog output fix mode	Sets whether or not to fix the analog output to 4 mA.	off	Analog output is not fix mode	193
	The number of preambles	Sets the number of preambles.	5	5	193
	The write protect mode	Sets the write protect mode.	oFF	OFF	193
	Checking the device ID	Allows you to check the value of the device ID.	-	-	193
Various settings	The measurement item switching	Switches the measurement item.	C	COND	189
	The moving average count	Sets the moving average count (damping factor) of the measured electrical conductivity value.	1	1 time	189
	Unit setting	Select the display unit of the measured electrical conductivity value.	Conv	μS/cm	189
	TDS conversion coefficient setting	Sets the TDS conversion coefficient when the TDS concentration is selected.	0.50	0. 50	189
	The automatic return	Select whether or not to return the hold mode to the measurement mode automatically.	yES	Enabled	189
	The automatic return time	Sets the time before the automatic return is performed when automatic return is enabled.	2	2 hours	189

How to enter the setting menu

1. **Turn ON the power.**
2. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
3. **Press the ▲/▼ key to display SEt in the measured value display, and then press ENT to enter the setting menu.**



■ Setting menu display item

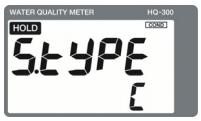
▲ ▼ Setting value change ENT Entry and Set ESC Cancel

Various settings

ENT

ESC

The measurement item switching



Switches to the measurement item to be used.
Setting range: PH, orP, do (dissolved oxygen), C (electrical conductivity), r (electrical resistivity)

▲ ▼

The moving average count

Sets the moving average count (damping factor) of the measured electrical conductivity value.
Setting range: 1 to 50 times

▲ ▼

Unit setting

Select the display unit of the measured electrical conductivity value.
Setting range: Conv (µS/cm), SI (mS/m), tdS (mg/L)

▲ ▼

Displayed only when the unit is set to “tdS”

TDS conversion coefficient setting

Sets the TDS conversion coefficient when the TDS concentration is selected.
TDS is a value obtained when the electrical conductivity is multiplied by the TDS conversion coefficient. In general, the conversion using the KCl or $CaCO_3$ solution is used as a reference.
Setting range: 0.30 to 1.00

▲ ▼

The automatic return

Select whether or not to return the hold mode to the measurement mode automatically.

During setting change and calibration, automatic return is not performed even when the automatic return function is set to “yES”.
Setting range: yES, no

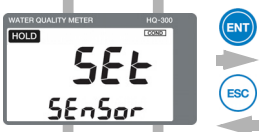
▲ ▼

Displayed only when the automatic return function is set to “yES”

The automatic return time

Sets the time before the automatic return is performed when automatic return is enabled.
Setting range: 1 hour to 24 hours

Setting the sensors



ENT

ESC

The cell constant

Sets the cell constant of the sensor.
Setting range: 1.0, 0.1, 0.01

The cell constant correction coefficient

Sets the cell constant correction coefficient of the sensor.
Enter the value written on the sensor label.
Setting range: 0.001 to 5.000

The temperature coefficient

Sets the temperature coefficient of the built-in temperature sensor for the sensor.
Setting range: 3500 to 4000

The resistance correction value

Sets the resistance compensation value of the built-in temperature sensor for the sensor.
Enter the value only when it is written on the sensor label.
Setting range: –5.00 Ω to 5.00 Ω

The cable length

Sets the cable length of the sensor.
Setting range: 1 m to 50 m

The measurement range

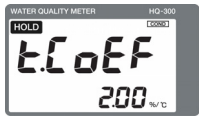
Sets the measurement range to be used.
For details on the options, refer to “Measurement range setting” (page 194).
Setting range: Varies depending on the selected unit and cell constant

The temperature compensation

Select the temperature compensation calculation method.
nACL: Temperature compensation according to the NaCl temperature characteristic
t.CoEF: Temperature coefficient of electrical conductivity %/°C and a manually reference temperature
non: No temperature compensation
Setting range: nACL, t.CoEF, non

Displayed only when the temperature compensation is set to “t.CoEF”

The temperature compensation coefficient



Sets the coefficient for the temperature compensation.
This indicates how much % the electrical conductivity changes per 1°C with reference to the specified temperature.
Setting range: –3.00%/°C to 3.00%/°C

Displayed only when the temperature compensation is set to “nACL” or “t.CoEF”

The reference compensation temperature

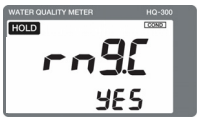
Sets the temperature for the reference compensation.
The reference temperature is the temperature to be used as a reference when determining the temperature coefficient.
Setting range: 5°C to 95°C

Display setting

The auxiliary display

Sets whether or not to display the measured temperature value in the measurement mode screen.
non: Measured temperature value is not displayed
t: Measured temperature value is displayed
Setting range: non, t

Display limit at over range



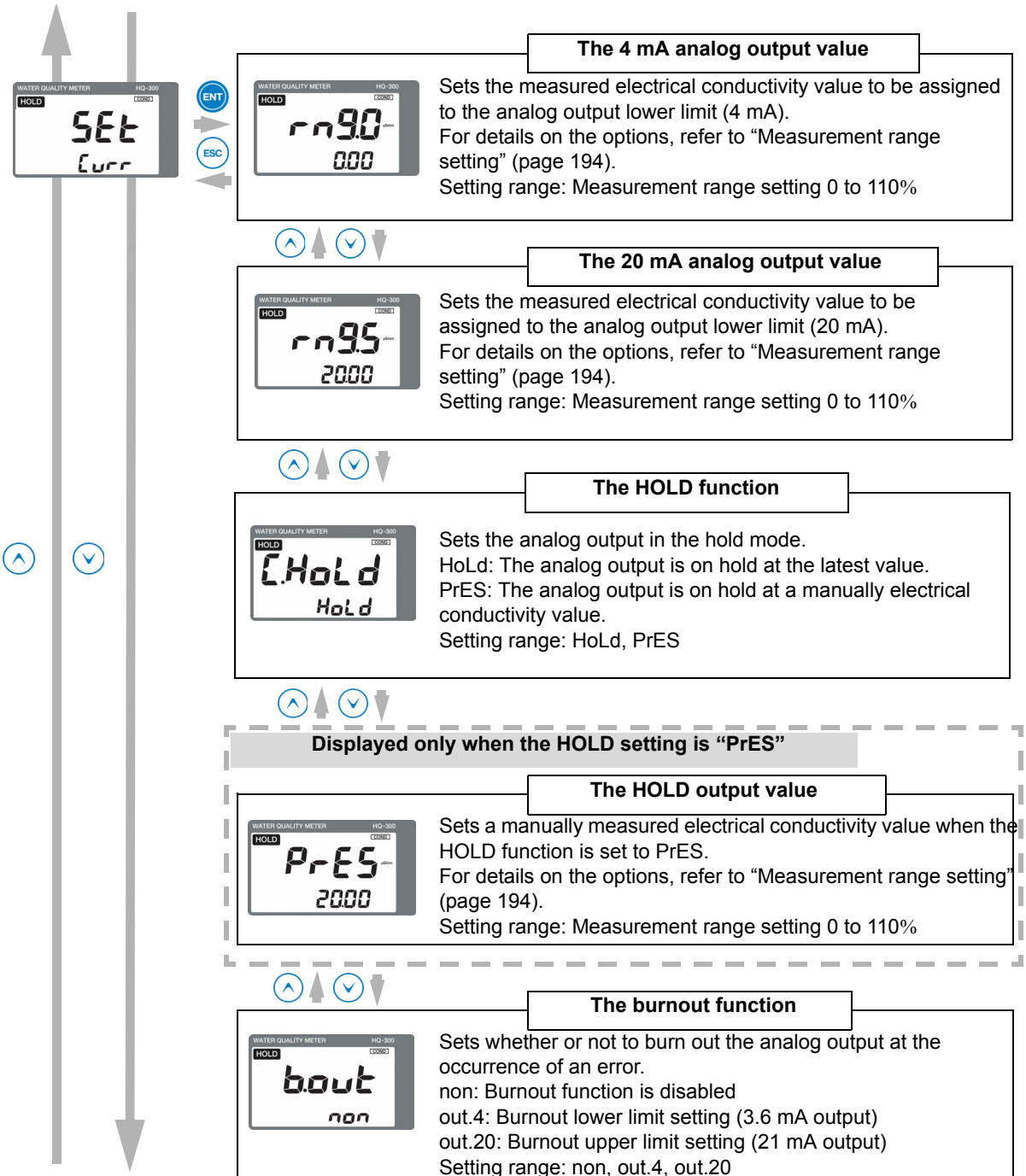
Select whether or not to display the measured electrical conductivity value or measured temperature value if they exceed the measurement range, respectively.

yES: Electrical conductivity: 0 to the electrical conductivity set in “Setting the measurement range”
Temperature: 0°C to 100°C
no: Electrical conductivity: 0 to the electrical conductivity set in “Setting the measurement range”+10%
Temperature: 0°C to 160°C
Setting range: yES, no

The temperature display digit

Select whether to display the measured temperature value down to one or two decimal places.
Setting range: 0.1 and 0.01

Analog output setting



The 4 mA analog output value

Sets the measured electrical conductivity value to be assigned to the analog output lower limit (4 mA).
For details on the options, refer to “Measurement range setting” (page 194).
Setting range: Measurement range setting 0 to 110%

The 20 mA analog output value

Sets the measured electrical conductivity value to be assigned to the analog output lower limit (20 mA).
For details on the options, refer to “Measurement range setting” (page 194).
Setting range: Measurement range setting 0 to 110%

The HOLD function

Sets the analog output in the hold mode.
HoLd: The analog output is on hold at the latest value.
PrES: The analog output is on hold at a manually electrical conductivity value.
Setting range: HoLd, PrES

Displayed only when the HOLD setting is “PrES”

The HOLD output value

Sets a manually measured electrical conductivity value when the HOLD function is set to PrES.
For details on the options, refer to “Measurement range setting” (page 194).
Setting range: Measurement range setting 0 to 110%

The burnout function

Sets whether or not to burn out the analog output at the occurrence of an error.
non: Burnout function is disabled
out.4: Burnout lower limit setting (3.6 mA output)
out.20: Burnout upper limit setting (21 mA output)
Setting range: non, out.4, out.20

Note

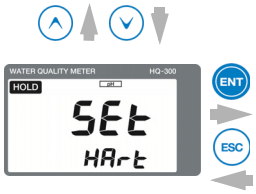
Burnout function

In case of a sensor error or system error, the analog output can be changed to the upper or lower limit setting (burnout function).

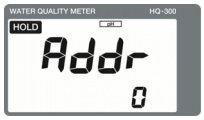
- **When the burnout upper limit setting is enabled, the analog output will change to 21 mA if an error occurs.**
- **When the burnout lower limit setting is enabled, the analog output will change to 3.6 mA if an error occurs.**

For details on the burnout occurrence conditions, refer to “Analog output conditions” (page 205).

HART communication setting



The polling address



Sets the polling address of HART communication.

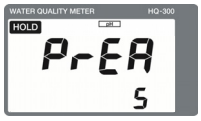
Select an address except for 0 for the multi-drop link.
Setting range: 0 to 63

The analog output fix mode

Sets whether or not to fix the analog output to 4 mA.
on: The analog output is fixed to 4 mA.
oFF: The analog output is not fixed to 4 mA.

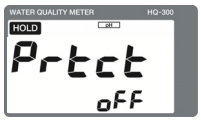
It is recommended that you set this function to ON for the multi-drop link. When this function is set to ON, the burnout and preset settings are disabled.
Setting range: on, oFF

The number of preambles



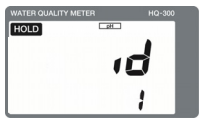
Sets the number of preambles.
Setting range: 2 pcs. to 20 pcs.

The write protect mode



Sets the write protect mode.
on: Change of various settings using the HART communication is disabled.
oFF: Change of various settings using the HART communication is enabled.
Setting range: on, oFF

Checking the device ID



Allows you to check the value of the device ID assigned to the transmitter.

The device ID cannot be changed.

TDS

TDS is an abbreviation of Total Dissolved Solids.
The electrical conductivity of the solution is attributed to the amount of salinity, minerals, and dissolved gases. The electrical conductivity is an index of the total amount of all substances contained in the solution. The TDS, on the other hand, indicates only the total dissolved solids among them.
The TDS can be used to precisely compare the status of a substance made of a single component, such as NaCl. However, there will be a large error when different types of solution are compared.
The electrical conductivity and TDS are expressed using the following formulas:

Electrical conductivity in SI units (mS/m): TDS (mg/L) = L (mS/m) × K × 10
Electrical conductivity in conventional units (μS/cm): TDS (mg/L) = L (μS/cm) × K

K = TDS conversion coefficient, L = Electrical conductivity

Measurement range setting

The measurement range setting options differ depending on the combination of the cell constant and unit.
For details on the options, refer to the following table.

Unit	Cell constant						
	0.01		0.1			1.0	
Conv (μS/cm)	2.000	20.00	2.000	20.00	200.0	200.0	2000
SI (mS/m)	0.2000	2.000	0.2000	2.000	20.00	20.00	200.0
tdS (mg/L)	2.00	20.0	2.00	20.0	200	200	2000

Measurement mode

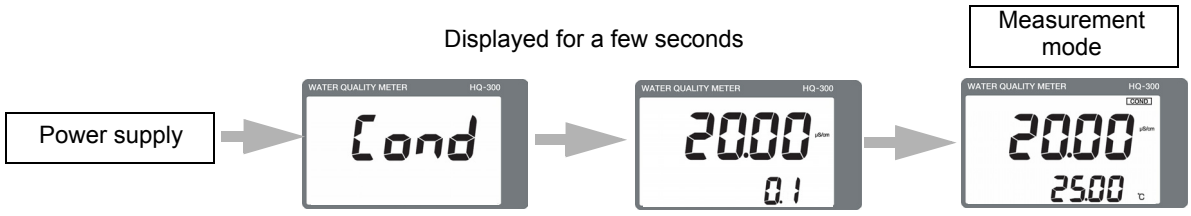
Functions available with the measurement mode

The following information can be displayed in the auxiliary display during measurement.
The moving average count (damping factor) is not only displayed but can also be changed.

Display information	Description	Reference page
Measured value display	Displays the measured temperature.	196
Moving average count display	Sets the moving average count (damping factor) of the measured electrical conductivity value.	

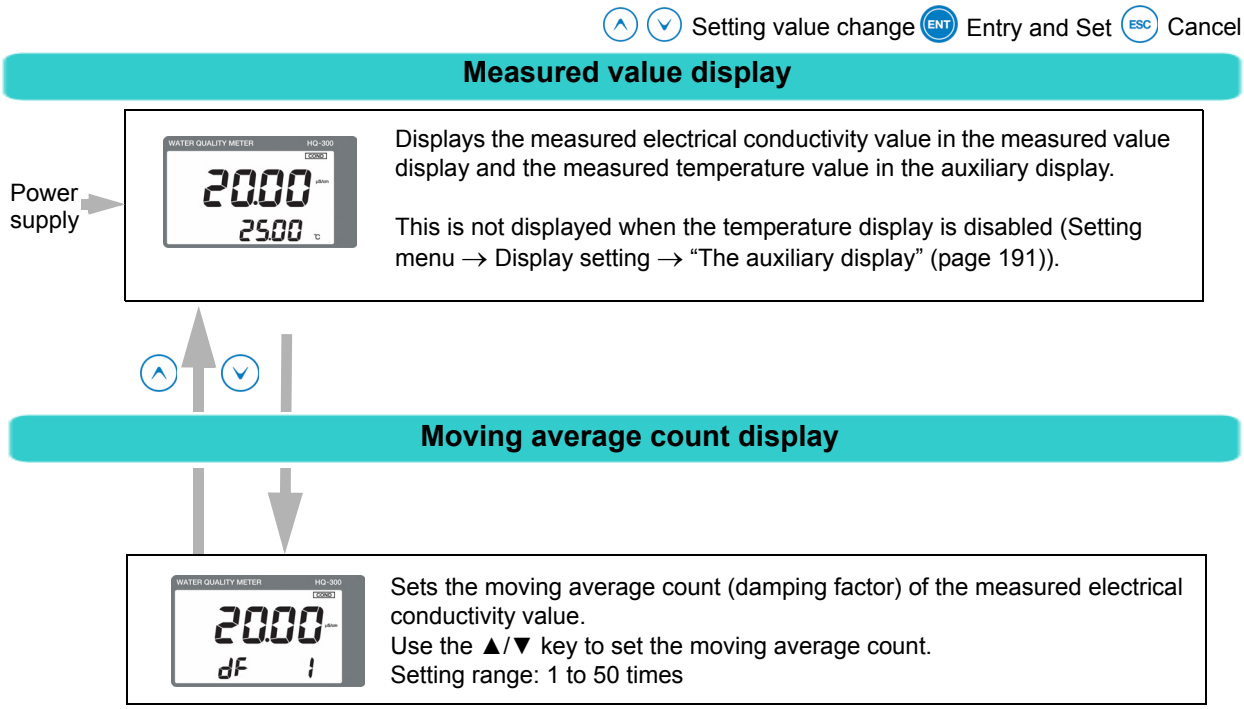
How to enter the measurement mode

1. **Turn ON the power.**
The measurement target is displayed in the measured value display.
The measurement range is displayed and the system enters measurement mode.
The measured value is displayed and measurement starts. This is the measurement mode state.



2. **Press the ▲/▼ key to switch the screen.**
By switching the screen, you can change and check the moving average count (damping factor).

Measurement mode display item



Tip

Moving average count
If the measured electrical conductivity value is not stabilized, you can stabilize it by setting the moving average count.
The setting range is from 1 time to 50 times. The time averaging processing is performed during the period from one second to 50 seconds.

Example 1) When the moving average count is set to 10 times, the average value for the previous 10 seconds is updated every one second.
Example 2) When the moving average count is set to 1 time, averaging processing will not be performed.

Calibration

■ Calibration type

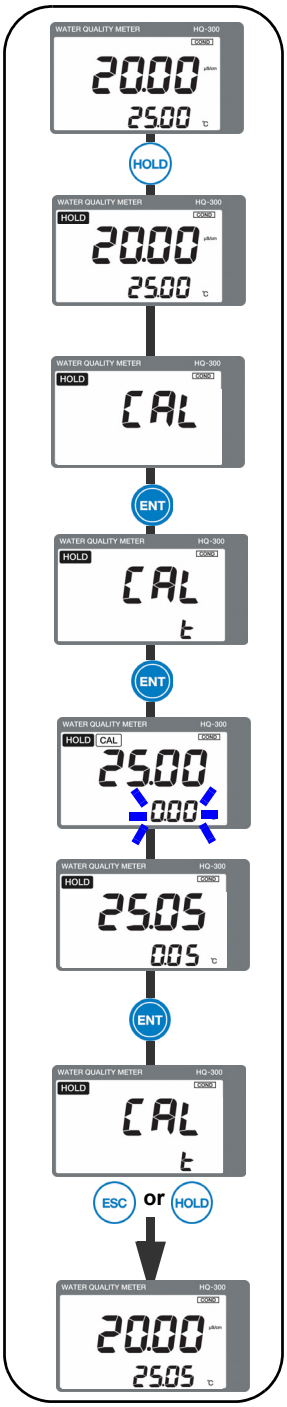
Type	Remarks	Reference page
Temperature calibration	Allows you to input the temperature manually.	199
Zero point adjustment	Performs zero adjustment of the electrical conductivity. This adjustment is not necessary for any cases except when you change the measured value on purpose.	199
Correction coefficient (span) adjustment	Performs span adjustment of the electrical conductivity. This adjustment is not necessary for any cases except when you change the measured value on purpose.	200

■ Before performing electrical conductivity calibration

● Transmitter

Set the transmitter to the hold mode.
Hold down the CAL key in the measurement mode. “HOLD” and “CAL” are displayed in the upper left section and the calibration mode screen appears.

Temperature calibration operational procedure



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated.**

3. **Press the ▼ key twice to display CAL in the measured value display, and then press the ENT key.**

4. **Display "t" in the auxiliary display, and then press the ENT key.**

5. **The temperature calibration mode is activated and the auxiliary display starts blinking.**

6. **Press the ▲/▼ key to adjust the value so that the value displayed in the measured value display reaches the water temperature.**
   ▲ key: The value increases by 0.1°C.
   ▼ key: The value decreases by 0.1°C.
   The setting range is from −5.0°C to 5.0°C.

7. **Press the ENT key.**
   The temperature calibration coefficient is updated.
   This completes the temperature calibration. The display returns to the calibration menu.

8. **Hold down either the ESC or HOLD key to return to the measurement mode.**

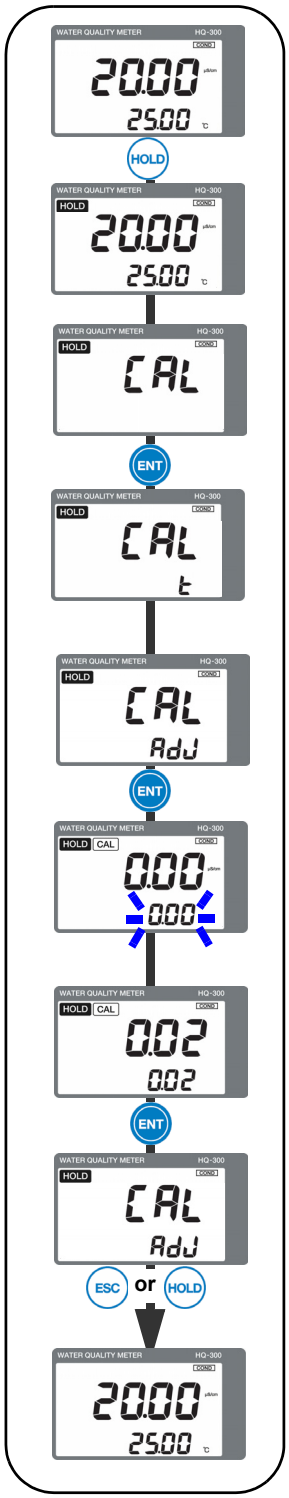
Note

- **Immerse the sensor into the solution at a known temperature and ensure the sensor reaches the water temperature.**
- **When the hold mode is activated, the analog output will be the output value set in the setting menu (Refer to "Analog output setting" (page 192)).**

Tip

To continue and perform other calibration operations, press the ▲/▼ key to select the setting item.

Zero point adjustment



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated.**
   Press the ▼ key twice.

3. **Display CAL in the measured value display, and then press the ENT key.**

4. **"t" is displayed in the auxiliary display.**

5. **Press the ▼ key to display "Adj" in the auxiliary display. Press the ENT key.**

6. **The zero point adjustment mode is activated and the auxiliary display starts blinking.**

7. **Press the ▲/▼ key to set the zero point correction coefficient.**
   The setting range is ±10% of the value set in "The measurement range" (page 190).

8. **Press the ENT key.**
   The correction coefficient is updated.
   This completes the zero point adjustment.
   The display returns to the calibration menu.

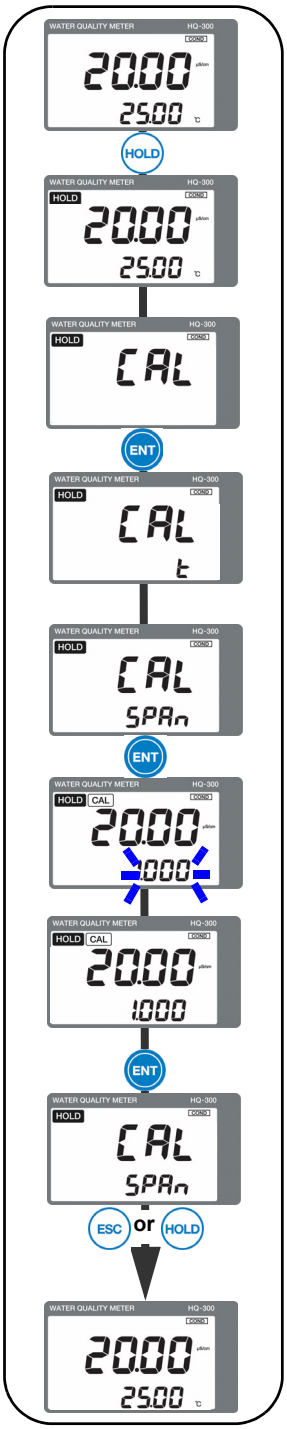
9. **Hold down either the ESC or HOLD key to return to the measurement mode.**

Tip

Perform the zero point adjustment while the sensor is lifted up in the atmosphere.
At this point, check if water droplets adhere to the sensor. If there are any water droplets, wipe them off.

Correction coefficient (span) adjustment

Adjust the correction coefficient so that the measured value matches the reference electrical conductivity meter.



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated.**
   Press the ▼ key twice.

3. **Display CAL in the measured value display, and then press the ENT key.**

4. **"t" is displayed in the auxiliary display.**

5. **Press the ▼ key twice, to display SPAN in the auxiliary display. Press the ENT key.**

6. **The adjustment mode is activated and the auxiliary display starts blinking.**

7. **Press the ▲/▼ key to set the correction coefficient.**
   Set the correction coefficient so that the value displayed in the measured value display reaches the reference value.
   ▲ key: The value increases by 0.001.
   ▼ key: The value decreases by 0.001.
   The setting range is from 0.700 to 1.300.

8. **Press the ENT key.**
   The correction coefficient is updated.
   This completes the adjustment of the correction coefficient (span).
   The display returns to the calibration menu.

9. **Hold down either the ESC or HOLD key to return to the measurement mode.**

Note

- **Normally, it is not necessary to adjust the correction coefficient.**
  However, only when the cell constant changes due to deterioration of the sensor, etc., adjust the correction coefficient.
- **The calibration operation and sensor setting are independent operations. This calibration does not change the sensor settings.**
  To return the original settings, set the correction coefficient to 1.000.

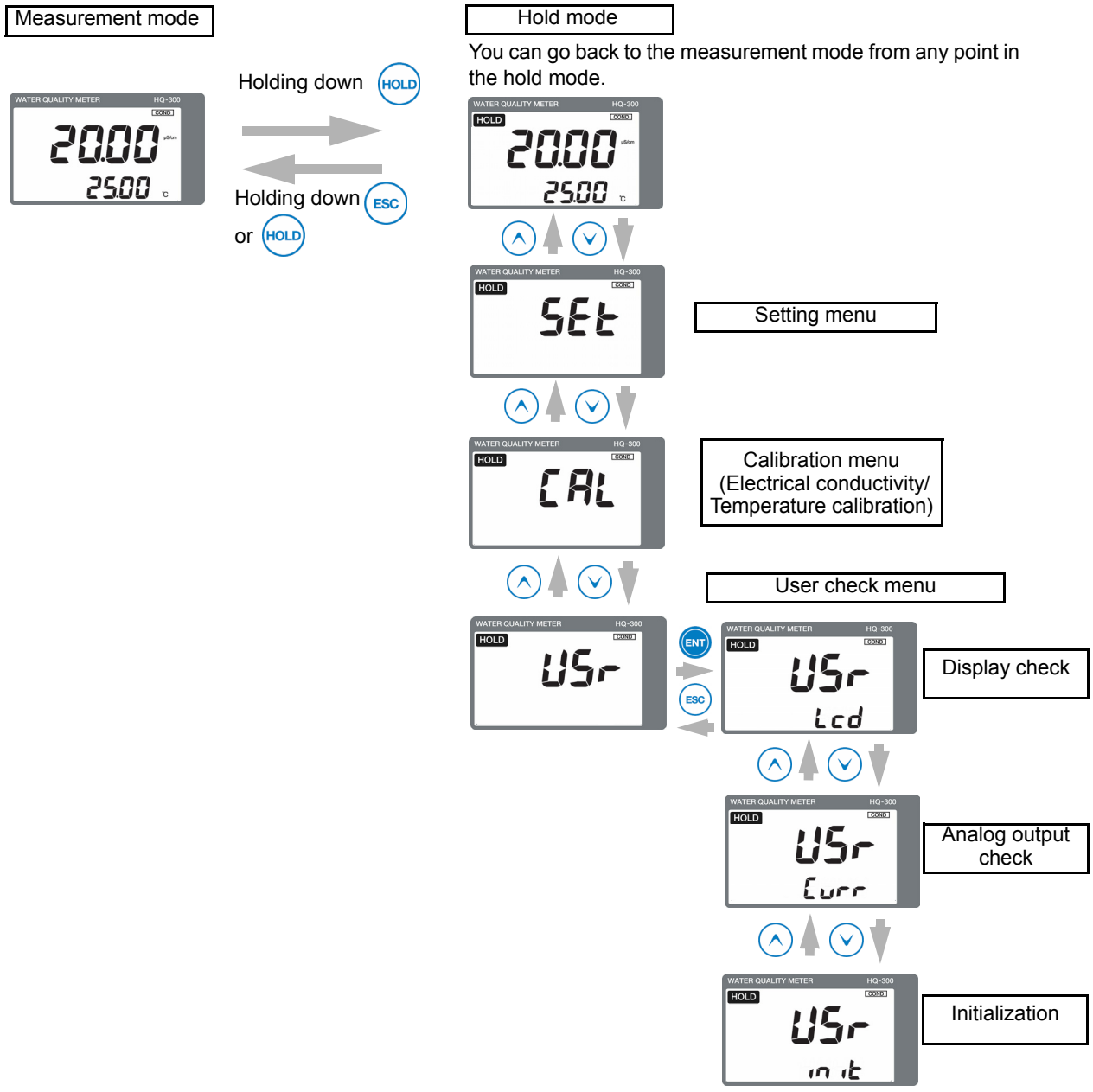
Maintenance procedure

■ User check menu

The user check menu allows you to check the display and analog output, and initialize the setting value.

● How to enter the user check menu

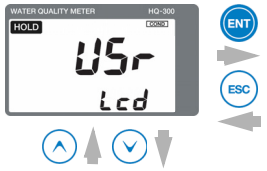
1. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
2. **Press the ▲/▼ key to display USr in the measured value display, and then press the ENT key to enter the user check menu.**

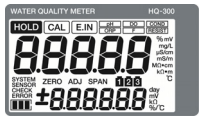


■ User check menu display item

Setting value change ENT Entry and Set ESC Cancel

Display check

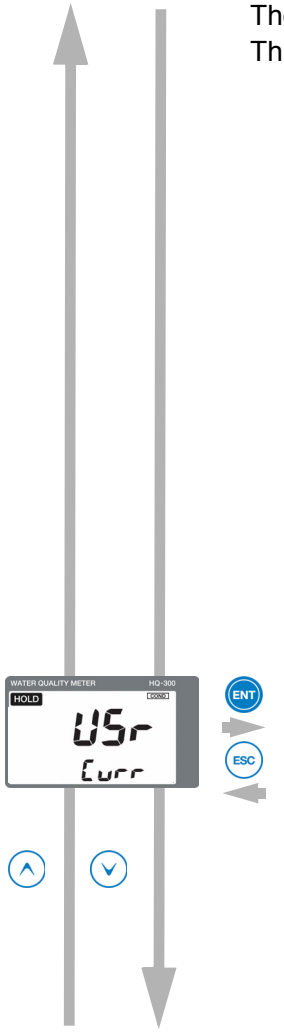


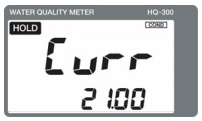


Turns on the light of the entire LCD display.
This is used when you check the display.

Analog output check

The analog output is changed the following current values.
This is used when you check the analog output (loop check).



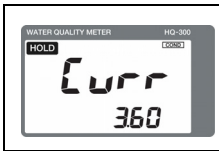


For checking the 21 mA output (Upper limit current at the time of burnout)

For checking the 20 mA output

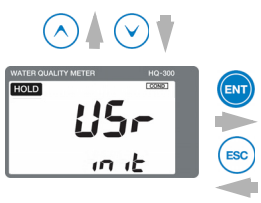
For checking the 12 mA output

For checking the 4 mA output



For checking the 3.6 mA output (Lower limit current at the time of burnout)

Initialization



Returns the setting data and calibration data to the default status.

no: Data is not returned to the default status
yES: Data is returned to the default status

■ Troubleshooting

● Measures for sensor failure

If a failure occurs in the sensor manufactured by HORIBA Advanced Techno, check the currently used sensor according to the following troubleshooting method. If the problem persists after checking and troubleshooting, please contact HORIBA Advanced Techno.

Symptom / Possible cause	Instable indication	A wrong value is displayed	Slow response	Troubleshooting
Bubbles are attached to the sensor	√	√	-	Prevent bubbles from forming in the liquid to be measured.
Bubbles form due to a high flow rate	√	√	-	Adjust the flow rate.
The surface level of the liquid to be measured fluctuates and as a result, the liquid contact area of the sensor fluctuates	√	√	-	Take measures to prevent the surface level of the liquid to be measured from changing.
A sudden liquid temperature change occurs	√	-	-	Install the sensor where a sudden liquid temperature change does not occur.
The terminal block screws are loose or there is a contact failure in the terminal block	√	√	-	Tighten the screws completely.
The terminal block insulation has deteriorated	√	√	-	Remove any moisture and contamination from the terminal block.
The sensor is contaminated	-	√	-	If the sensor is microbially contaminated, wipe off the contamination using alcohol. For sensors made of stainless steel or titanium, if rust has occurred, immerse the sensor in the 5% concentration nitric acid and remove the rust.
The sensor is not immersed in the liquid to be measured	-	√	-	Take measures to prevent the surface level of the liquid to be measured from changing.
The sensor cable is disconnected or shorted	-	√	-	Check the sensor cable.
The flow rate is low	-	-	√	Maintain a sufficient flow rate for the liquid to be measured replacement.
The concentration of the liquid to be measured is not constant (if a tank is installed)	√	-	√	Thoroughly stir the liquid to be measured. Or, install the sensor where the concentration can be kept constant.
The setting value is not appropriate	-	√	-	Review “Setting the sensors” (page 190). ● Setting the cell constant correction coefficient ● Setting the temperature coefficient ● Setting the resistance correction value ● Setting the cable length ● Setting the temperature compensation ● Selecting the temperature compensation and setting the calculation method ● Setting the temperature compensation coefficient ● Setting the reference compensation temperature

● Measures for values outside the measurement range

If the measured electrical conductivity value is outside the measurement range, the measured value is blinking.
Perform the procedure according to the following table.

Possible cause	Corrective action
The sensor is not immersed in the liquid to be measured	Immerse the sensor under the target liquid level, even if this level fluctuates.
● Wiring of the sensor cable is wrong Wiring for lines 1 and 2, in particular, is disconnected ● Wiring of the relay cable is wrong	Check for looseness of screws or incorrect wiring in the terminal blocks of this product and relay box.

■ Analog output conditions

<table>
<tr><td colspan="3">C.HoLd
(HOLD setting)</td><td colspan="3">HoLd
(Latest value hold)</td><td colspan="3">PrES
(Setting value hold)</td></tr>
<tr><td colspan="3">b.out
(Burnout setting)</td><td>non</td><td>out.4</td><td>out.20</td><td>non</td><td>out.4</td><td>out.20</td></tr>
<tr><td colspan="3">Measurement mode</td><td colspan="3">Measured value</td><td colspan="3">Measured value</td></tr>
<tr><td rowspan="5"></td><td rowspan="2"></td><td>E-21 to E-22</td><td rowspan="2"></td><td rowspan="2">3.6 mA</td><td rowspan="2">21 mA</td><td rowspan="2"></td><td rowspan="2">3.6 mA</td><td rowspan="2">21 mA</td></tr>
<tr><td>E-90 to E-92</td></tr>
<tr><td colspan="2">External hold input ON</td><td colspan="3" rowspan="2">Latest value hold</td><td colspan="3" rowspan="2">Preset value</td></tr>
<tr><td>E-21 to E-22</td></tr>
<tr><td></td><td>E-90 to E-92</td><td>3.6 mA</td><td>21 mA</td><td></td><td>3.6 mA</td><td>21 mA</td></tr>
<tr><td colspan="3">Hold mode</td><td rowspan="3" colspan="3">Latest value hold</td><td rowspan="3" colspan="3"></td></tr>
<tr><td></td><td>E-90 to E-92</td><td>3.6 mA</td><td>21 mA</td><td></td><td>3.6 mA</td><td>21 mA</td></tr>
<tr><td colspan="2">External hold input ON</td><td colspan="3">Preset value</td></tr>
<tr><td></td><td>E-90 to E-92</td><td>3.6 mA</td><td>21 mA</td><td></td><td>3.6 mA</td><td>21 mA</td></tr>
<tr><td colspan="3">Electrical conductivity calibration</td><td rowspan="5" colspan="3">Latest value hold</td><td rowspan="5" colspan="3"></td></tr>
<tr><td rowspan="3"></td><td>E-21 to E-22</td></tr>
<tr><td>E-90 to E-92</td><td>3.6 mA</td><td>21 mA</td><td>3.6 mA</td><td>21 mA</td></tr>
<tr><td colspan="2">External hold input ON</td><td colspan="3">Preset value</td></tr>
<tr><td>E-21 to E-22</td></tr>
<tr><td></td><td>E-90 to E-92</td><td>3.6 mA</td><td>21 mA</td><td></td><td>3.6 mA</td><td>21 mA</td></tr>
<tr><td colspan="3">Temperature calibration</td><td rowspan="5" colspan="3">Latest value hold</td><td rowspan="5" colspan="3"></td></tr>
<tr><td rowspan="3"></td><td>E-21 to E-27</td></tr>
<tr><td>E-90 to E-92</td><td>3.6 mA</td><td>21 mA</td><td>3.6 mA</td><td>21 mA</td></tr>
<tr><td colspan="2">External hold input ON</td><td colspan="3">Preset value</td></tr>
<tr><td>E-21 to E-27</td></tr>
<tr><td></td><td>E-90 to E-92</td><td>3.6 mA</td><td>21 mA</td><td></td><td>3.6 mA</td><td>21 mA</td></tr>
</table>

Error code description

Error Display		Error display priority*1	Error description	Description	When to occur
E-21	SENSOR ERROR	4	Temperature sensor disconnection	The lead wire of the temperature sensor is disconnected	During measurement and calibration*2
E-22		5	Temperature sensor shorted-circuited	The lead wire of the temperature sensor is shorted-circuited	
E-27		6	Temperature calibration outside range	The measured temperature value during temperature calibration is below −10°C or above 160°C	During temperature calibration
E-90	SYSTEM ERROR	1	System error	Meter internal communication error	At all times (System error)
E-91		2	System error	The memory data, such as the setting values, calibration values, are lost	
E-92		3	System error	A/D converter operation failure	

∗1: Two or more errors cannot be displayed at the same time. If multiple errors occur, the error with the smallest priority number is displayed.

∗2: If an E-21 to E-27 error occurs during calibration, recalibration cannot be performed.
Take a corrective action according to “Corrective actions” (page 207).

Tip

When an error code is displayed, the HOLD lamp starts blinking, and the analog output will be the output value set in the setting menu. Refer to “The HOLD function” (page 192).

Corrective actions

When an error code is displayed, take corrective actions according to the table below.

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-21 (Temperature sensor disconnection)	If the resistance of the temperature sensor is approximately 1.616 kΩ or above (When the temperature sensor is approximately 160°C or above)	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the sensor with a new one.
			Wiring of the sensor cable and relay cable is wrong	Check that the wiring between T and T is not open.
E-22 (Temperature sensor shorted-circuited)	If the resistance of the temperature sensor is approximately 0.692 kΩ or less (The temperature sensor is approximately −80°C or less)	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the sensor with a new one.
			Wiring of the sensor cable and relay cable is wrong	Check that the wiring between T and T is not shorted.
E-27 (Temperature measurement outside range)	If the measured temperature during temperature calibration is below −10°C or above 160°C	When the calibration mode is exited and the temperature falls within the normal measurement temperature range	Temperature error of the liquid to be measured (Below −10°C or above 160°C)	Maintain the temperature of the liquid to be measured within the operating temperature range of the sensor.
			Error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the sensor with a new one.
E-90 (System error)	Meter internal communication error	Turning the power OFF and then ON	Inside the product	Turn OFF the power and turn it back ON. If the system error persists, contact HORIBA Advanced Techno.
E-91 (System error)	The memory data, such as the setting values, calibration values, are lost			
E-92 (System error)	A/D converter operation failure			

Measurement principle

■ Measurement of electrical conductivity

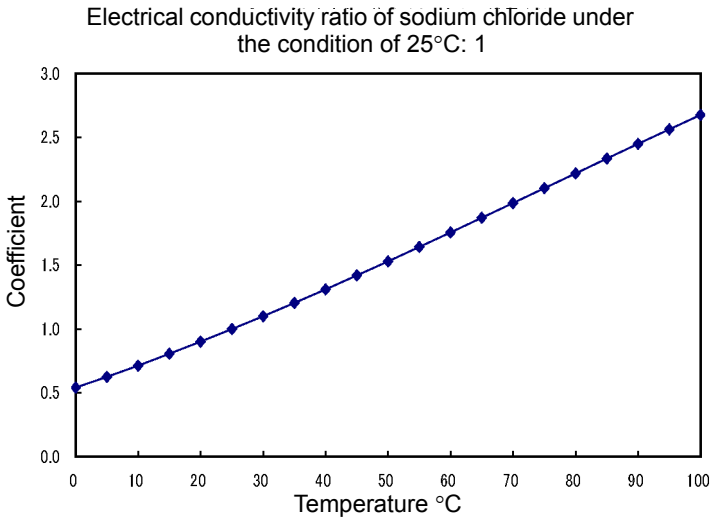
● Temperature compensation calculation

This section describes the principle of the temperature compensation for the electrical conductivity.

● Method using NaCl characteristic

When the main compound of the salt contained in the sample is sodium chloride, select the method to perform temperature compensation using the NaCl characteristic.
The electrical conductivity of the sodium chloride aqueous solution varies at the following ratio with reference to the electrical conductivity at 25°C.
From this table, a manually temperature ratio is obtained, and the electrical conductivity at 25°C is then obtained.
The following table shows the results tested by HORIBA Advanced Techno, Co., Ltd.

Temperature (°C)	Electrical conductivity ratio of NaCl	Coefficient
0	0.542	1.845
5	0.626	1.596
10	0.715	1.399
15	0.806	1.240
20	0.902	1.109
25	1.000	1.000
30	1.101	0.908
35	1.205	0.830
40	1.312	0.762
45	1.420	0.704
50	1.531	0.653
55	1.643	0.609
60	1.757	0.569
65	1.872	0.534
70	1.987	0.503
75	2.103	0.476
80	2.219	0.451
85	2.335	0.428
90	2.450	0.408
95	2.564	0.390
100	2.677	0.374



Note

In the pure water zone, temperature compensation for pure water is automatically activated.

● Method by entering the temperature coefficient

The electrical conductivity of the aqueous solution varies depending on the temperature. In general, when the solution temperature increases by 1°C, the electrical conductivity increases by approximately 2% with reference to the electrical conductivity at 25°C.
The approximate expression will be as follows:

$$C_{(T)} = C_{(25)} \times (1 + 0.01 \times \alpha \times (T - 25))$$

$C_{(T)}$: Electrical conductivity of T°C solution
$C_{(25)}$: Electrical conductivity (reference) of 25°C solution
α: Temperature coefficient of electrical conductivity (Unit: %)
T: Manually temperature T°C

The temperature coefficient varies depending on the solution type and concentration. It is within the range from 0.5 to 2.5. Entering the temperature coefficient executes the temperature compensation calculation for estimating the electrical conductivity at 25°C. As long as 2% is entered for the temperature coefficient, almost all aqueous solutions can be supported.
If the temperature coefficient of the solution is known, enter the value.
When you enter 0 for the temperature coefficient, the pure electrical conductivity without temperature compensation can be obtained.

In general, the reference temperature for the temperature compensation is 25°C. However, temperatures other than 25°C is available for the reference temperature.
When the electrical conductivity at T°C is known, given that the reference temperature is ST, the electrical conductivity $C_{(ST)}$ at the reference temperature can be obtained using the following formula:

$$C_{(ST)} = C_{(T)} / (1 + 0.01 \times \alpha \times (T - ST))$$

$C_{(ST)}$: Electrical conductivity (reference) of ST°C solution
$C_{(T)}$: Electrical conductivity of T°C solution
α: Temperature coefficient of electrical conductivity (Unit: %)
T: Manually temperature T°C
ST: Reference temperature ST°C

Note

If you have changed the reference temperature, use the temperature coefficient after the reference temperature change.
In the pure water zone, temperature compensation for pure water is automatically activated.

● Pure water characteristic

The electrical conductivity of pure water is measured as a sum of the electrical conductivity based on dissociation of the water molecules and impurity ions.

$C_{(T)} = F_{(T)} + G_{(T)}$

$C_{(T)}$: Electrical conductivity of T°C solution

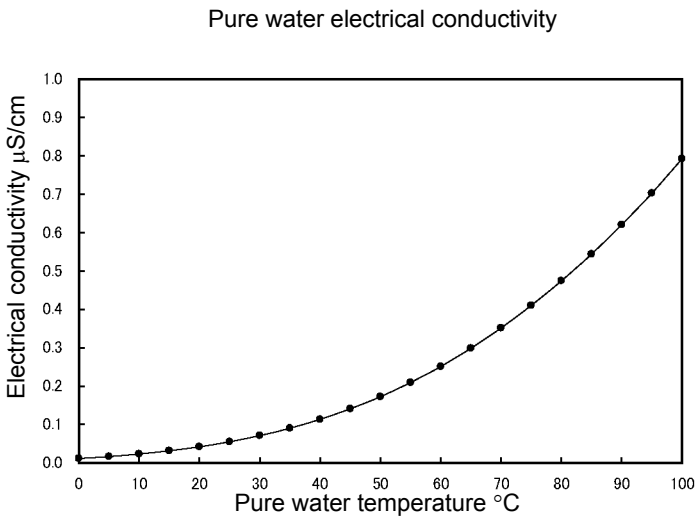
$F_{(T)}$: Electrical conductivity of T°C pure water

$G_{(T)}$: Electrical conductivity based on T°C impurity ions

Electrical conductivity of pure water

The electrical conductivity of pure water is generated by dissociation of the water molecules. The dissociation of the water molecules is significantly affected by the temperature change.
The electrical conductivity of pure water is measured using the continuous temperature functions created in accordance with the tables of ASTM D 1125-91 and JISK0130-1995.

Temperature (°C)	Electrical conductivity (μS/cm)
0	0.012
5	0.017
10	0.023
15	0.031
20	0.042
25	0.055
30	0.071
35	0.090
40	0.114
45	0.141
50	0.173
55	0.210
60	0.251
65	0.299
70	0.352
75	0.410
80	0.474
85	0.544
90	0.621
95	0.703
100	0.793



■ Temperature measurement

For the element RTD for temperature measurement, the resistance temperature detector whose resistance at 0°C is 1000 Ω is adopted. As a characteristic of this resistance temperature detector, the resistance becomes higher when the temperature increases. It is 1385 Ω (standard) at 100°C. Variations in resistance at 0°C during manufacturing influence the temperature measurement accuracy.

Variations in the temperature element are corrected according to an algorithm that was not conventionally available for this product. The resistance for a temperature element of 0°C is screened and the value is entered to correct all temperature resistances. When you enter the value, all temperature resistances are corrected, even when the RTD has a different temperature coefficient.

As a result of the adoption of this new temperature measurement algorithm, a temperature accuracy of ±0.2°C has been achieved. However, the temperature calibration mode is additionally provided, so that the temperature calibration can be performed by comparing with a higher-accuracy thermometer. In the temperature calibration mode, the resistance at 0°C is also corrected in correspondence with the reference temperature.

In addition, the RTD input value at 0°C and the correction value for the temperature calibration are individually stored, so that the temperature calibration value can be returned to the original value.

The sensor for which the RTD resistance at 0°C is not screened can be used without correction. In this case, however, the accuracy will be ±0.5°C.

The longer the cable length, the higher the measured resistance value is. Entering the cable length executes the calculation for canceling the resistance of the electric wire.

The 0°C screening is performed with reference to the state (equilibrium state obtained when water and ice are agitated in the atmosphere), instead of the thermometer.

Options

● Sensor (standard)

Model	Specifications				
	Shape	Cell constant	Liquid contact material	Connection	Connection bore
ESH-001-L-S-ST-Y10M	Short cell (Cell length: 60 mm)	0.01/cm	SUS316, PVDF, FPM	Lead: 10 m	R (PT)3/4
ESH-01-L-S-ST-Y10M		0.1/cm			
ESH-1-L-S-ST-Y10M		1.0/cm			
ESH-001-C-S-ST		0.01/cm		Connector	
ESH-01-C-S-ST		0.1/cm			
ESH-1-C-S-ST		1.0/cm			
ESH-001-L-S-LG-Y10M	Long cell (Cell length: 110 mm)	0.01/cm		Lead: 10 m	
ESH-01-L-S-LG-Y10M		0.1/cm			
ESH-1-L-S-LG-Y10M		1.0/cm			
ESH-001-C-S -LG		0.01/cm		Connector	
ESH-01-C-S -LG		0.1/cm			
ESH-1-C-S -LG		1.0/cm			

● Flow chamber type holder

Model	Specifications			
	Shape	Liquid contact material	Temperature of the liquid to be measured	Pressure of the liquid to be measured
EFA-30	ESD sensor (For short cell)	PVC	0°C to 50°C	0 MPa to 0.1 MPa
EFA-30P		PVDF	0°C to 100°C	0 MPa to 0.1 MPa
EFA-30S		SUS316		0 MPa to 0.5 MPa
EFA-31	ESL sensor (For long cell)	PVC	0°C to 50°C	0 MPa to 0.1 MPa
EFA-31P		PVDF	0°C to 100°C	0 MPa to 0.1 MPa
EFA-31S		SUS316		0 MPa to 0.5 MPa

● Sanitary sensor

Model	Specifications				
	Shape	Cell constant	Liquid contact material	Connection	Connection bore
FS-01FC-SL15A	Flow chamber	0.1/cm	SUS316L, PTFE, FKM	Connector	15 A ferrule
FS-01FC-SL-1.0S					IDF/ISO 1S ferrule
FS-01FC-SL-1.5S					IDF/ISO 1.5S ferrule
FS-01FC-2.0S					IDF/ISO 2S ferrule
FS-01FC-SL-2.5S					IDF/ISO 2.5S ferrule
ESH-01C-S-SN-1.5S	Sanitary sensor insertion type		SUS316L, PEEK, FKM		IDF/ISO 1.5S ferrule

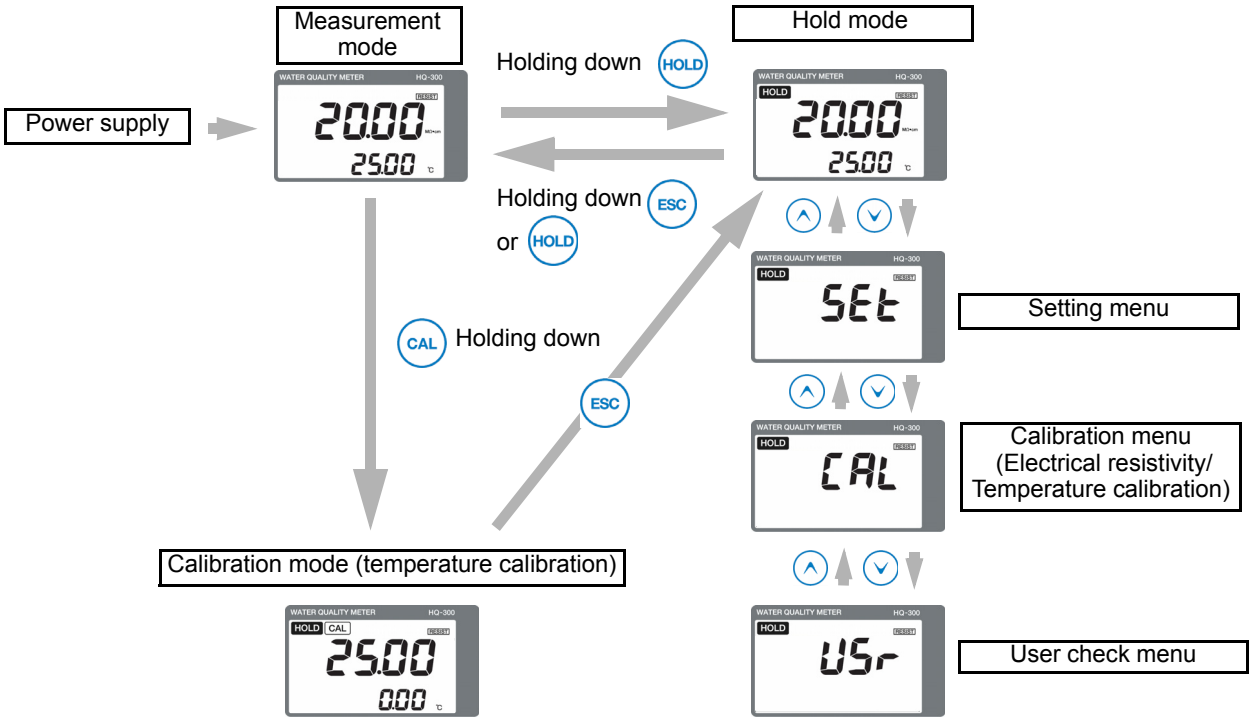
● Extension cable, relay box

Parts name	Model	Specifications	
Extension cable	C-5C	Specify the dedicated cable length for the electrical conductivity sensor.	Lead
	CK-10M	Cable length: 10 m	Connector
	CK-20M	Cable length: 20 m	
	CK-30M	Cable length: 30 m	

Electrical Resistivity Measurement

Description of mode and menu

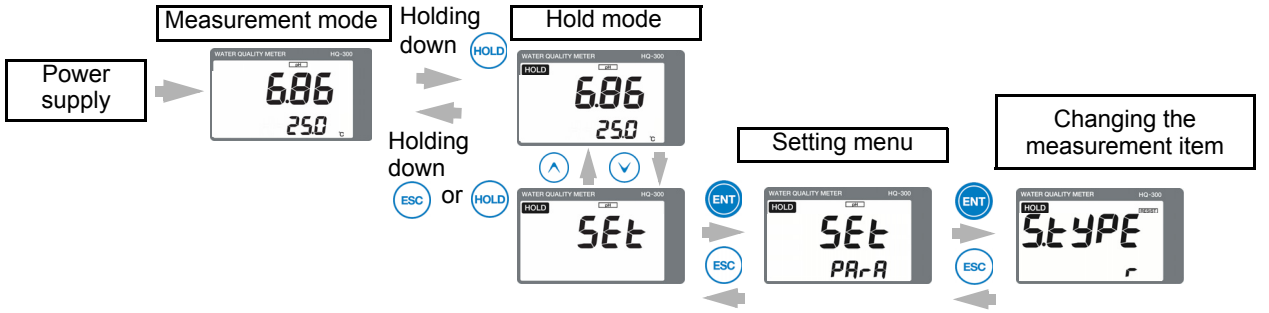
■ Modes and menus in each measurement mode



Description of mode/menu	Description	Reference page
Measurement mode	Performs measurement and analog output Allows you to check the calibration values or set and check the moving average count (damping factor) during measurement.	225
Calibration mode (Temperature calibration)	Performs temperature calibration.	227
Hold mode (Measurement output hold)	Stops measurement and output and performs various settings.	-
Setting menu	Allows you to set all parameters related to measurement, such as the assignment of detector information input or output before starting operation.	214
Calibration menu (Electrical resistivity/ Temperature calibration)	The following two types of calibration can be performed: electrical resistivity and temperature calibration (the temperature calibration is the same as the calibration mode).	227
User check menu	The output status and measured values can be checked. The setting value can be reset to the default value.	225

Setting menu

■ Measurement item switching



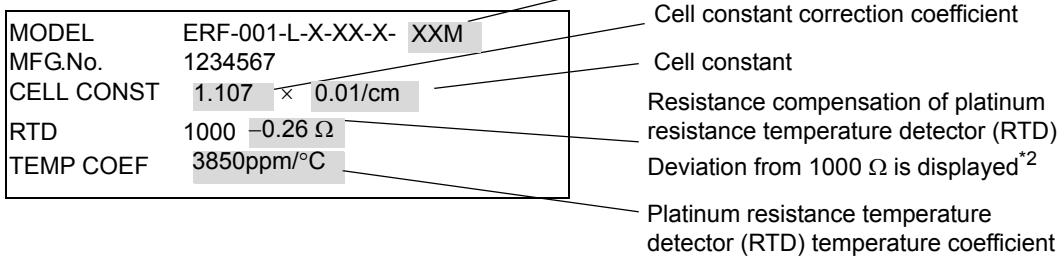
Operational procedure for setting the measurement item

ENT blink the auxiliary value, ∧∨ changes the setting value, ESC cancels the value, ENT set the value and holding down HOLD return to measurement mode.

■ Sensor setting

Enter the value written on the sensor label.

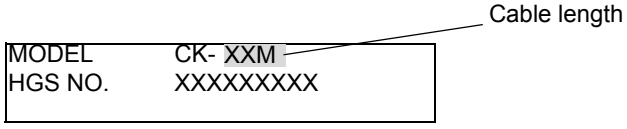
Example of label



*1 There is no description of the cable length for the connector type sensor. Enter the cable length value written on the extension cable.

*2 Set this item only when there is a description.

When an extension cable is used, enter the cable length written on the cable label.



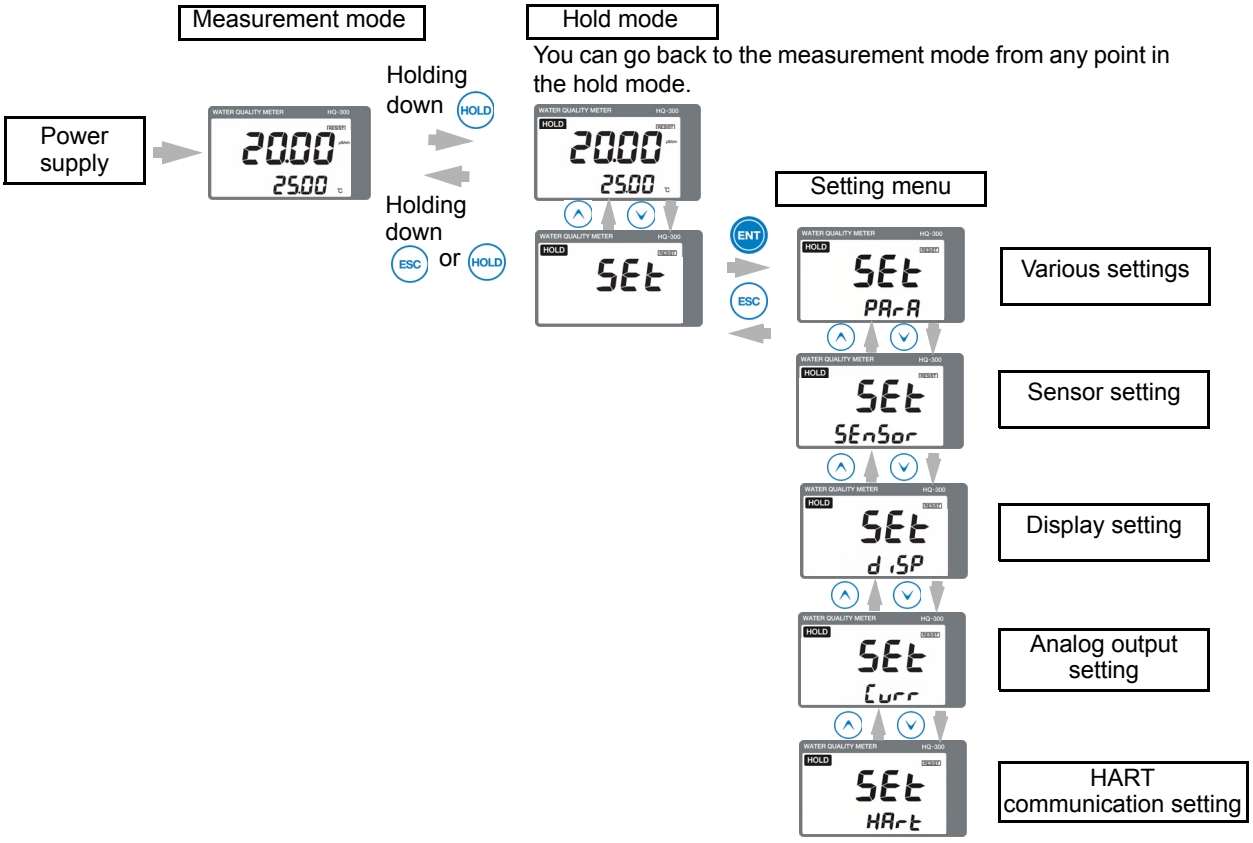
■ Functions available with setting menus

Setting item		Description	Default settings		Reference page
			Displayed character	Meaning	
Setting the sensors	Display the cell constant	Displays the cell constant of the sensor.	0.01	Cell constant 0.01	219
	The cell constant correction coefficient	Sets the cell constant correction coefficient of the sensor. Enter the value written on the sensor label.	1.000	1.000	219
	The temperature coefficient	Sets the temperature coefficient of the built-in temperature sensor for the sensor.	3850	3850 ppm/°C	219
	The resistance correction value	Sets the resistance compensation value of the built-in temperature sensor for the sensor. Enter the value only when it is written on the sensor label.	0.00	0.00 Ω	219
	The cable length	Sets the cable length of the sensor.	10	10 m	219
	The measurement range	Sets the measurement range to be used.	20.00	20.00 MΩ·cm	219
	The clip	Sets the value to fix the measured value on appearance (clip setting value).	20.00	20.00 MΩ·cm	220
	The temperature compensation	Select whether or not to perform the temperature compensation according to the temperature characteristic of pure water.	PurE	Temperature compensation is performed	220
	Selecting the temperature compensation and the calculation method	Select the temperature compensation calculation method.	nACL	NaCl temperature compensation	220
	The temperature compensation coefficient	Sets the temperature for the reference compensation	2.00	2%/°C	220
	The reference compensation temperature	Sets the coefficient for the temperature for compensation	25	25°C	220
Display setting	The auxiliary display	Sets whether or not to display the measured temperature value.	t	Temperature display	221
	Display limit at over range	Select whether or not to display the measured electrical resistivity value or measured temperature value if they exceed the measurement ranges, respectively.	yES	Not displayed	221
	The temperature display digit	Select whether to display the measured temperature value down to one or two decimal places.	0.01	Down to two decimal places is displayed	221

Setting item		Description	Default settings		Reference page
			Displayed character	Meaning	
Analog output setting	The 4 mA analog output value	Sets the measured electrical resistivity value to be assigned to 4 mA when the analog output range is manually.	0.00	0.00 MΩ·cm	221
	The 20 mA analog output value	Sets the measured electrical resistivity value to be assigned to 20 mA when the analog output range is manually.	20.00	20.00 MΩ·cm	221
	TheTheThe HOLD function	Select whether or not to stop the analog output (latest value, preset) in the hold mode or calibration mode.	HoLd	Latest value hold	221
	TheThe HOLD output value	Sets a manually measured electrical resistivity value when the HOLD function is set to preset.	20.00	20.00 MΩ·cm	221
	The burnout function	Sets whether or not to burn out the analog output at the occurrence of an error.	non	Disabled	221
HART communicatio n setting	The polling address	Sets the polling address of HART communication.	0	Address 0	223
	The analog output fix mode	Sets whether or not to fix the analog output to 4 mA at the time of multi-drop link.	off	Analog output is not fix mode	223
	The number of preambles	Sets the number of preambles.	5	5	223
	The write protect mode	Sets the write protect mode.	oFF	OFF	223
	Checking the device ID	Allows you to check the value of the device ID.	-	-	223
Various settings	The measurement item switching	Switches the measurement item.	r	RESIST	218
	The moving average count	Sets the moving average count (damping factor) of the measured electrical resistivity value.	10	10 time	218
	Unit setting	Select the display unit of the measured electrical resistivity value.	Conv	MΩ·cm	218
	The ultra-pure water value	Sets the TDS conversion coefficient when the TDS concentration is selected.	18.23	18.23 MΩ·cm	218
	The automatic return	Select whether or not to return the hold mode to the measurement mode automatically.	yES	Enabled	218
	The automatic return time	Sets the time before the automatic return is performed when automatic return is enabled.	2	2 hours	218

How to enter the setting menu

1. **Turn ON the power.**
2. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
3. **Press the ▲/▼ key to display SEt in the measured value display, and then press ENT to enter the setting menu.**



■ Setting menu display item

▲ ▼ Setting value change ENT Entry and Set ESC Cancel

Various settings

ENT

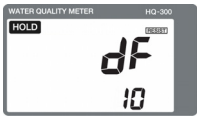
ESC

The measurement item switching

Switches to the measurement item to be used.
Setting range: PH, orP, do (dissolved oxygen), C (electrical conductivity), r (electrical resistivity)

▲ ▼

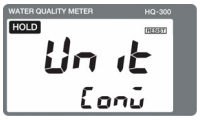
The moving average count



Sets the moving average count (damping factor) of the measured electrical resistivity value.
Setting range: 1 time to 120 times

▲ ▼

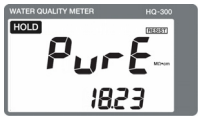
Unit setting



Select the display unit of the measured electrical resistivity value.
Setting range: Conv (MΩ•cm), SI (kΩ•m)

▲ ▼

The ultra-pure water value



Sets the ultra-pure water value. For this product, although the value of 18.23 MΩ•cm is set as a standard for ultra-pure water, you can select other values as well. The display item differs depending on the setting value for the unit.
Setting range: 18.18 MΩ•cm, 18.23 MΩ•cm, 18.24 MΩ•cm
(181.8 kΩ•m, 182.3 kΩ•m, 182.4 kΩ•m)

▲ ▼

The automatic return

Select whether or not to return the hold mode to the measurement mode automatically.

During setting change and calibration, automatic return is not performed even when the automatic return function is set to "yES".
Setting range: yES, no

▲ ▼

Displayed only when the automatic return function is set to "yES"

The automatic return time

Sets the time before the automatic return is performed when automatic return is enabled.
Setting range: 1 hour to 24 hours

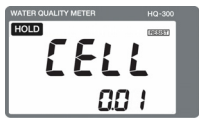
▲ ▼

Setting the sensors

ENT

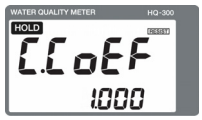
ESC

Display the cell constant



Displays the cell constant of the sensor.

The cell constant correction coefficient



Sets the cell constant correction coefficient of the sensor.
Enter the value written on the sensor label.
Setting range: 0.001 to 5.000

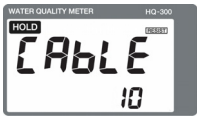
The temperature coefficient

Sets the temperature coefficient of the built-in temperature sensor for the sensor.
Normally, it not necessary to change the setting from 3850 ppm/°C.
Setting range: 3500 ppm/°C to 4000 ppm/°C

The resistance correction value

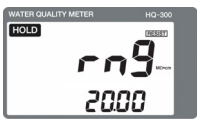
Sets the resistance compensation value of the built-in temperature sensor for the sensor. The resistance compensation value is indicated only on the label of the certified sensor.
Setting range: –5.00 Ω to 5.00 Ω

The cable length



Sets the cable length of the sensor.
Setting range: 1 m to 50 m

The measurement range



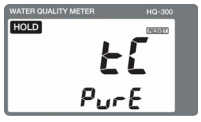
Sets the measurement range to be used.
The display item differs depending on the setting value for the unit.
Setting range: 2.000 MΩ•cm, 20.00 MΩ•cm
(20.00 kΩ•m, 200.0 kΩ•m)

The clip

Sets the value to fix the measured value on appearance (clip setting value).
If the measured value is within the range from the clip setting value to the maximum value of the measurement range, both the display and analog output are fixed to the clip setting value. If the measured value exceeds the maximum value of the measurement range, the clip function will be reset and the measured value starts blinking.

Setting range: 0 to maximum value of measurement range

The temperature compensation



Select whether or not to perform the temperature compensation according to the temperature characteristic of pure water. For details on the temperature compensation, refer to “Measurement of electrical resistivity” (page 236).
PurE: Temperature compensation is performed
non: No temperature compensation
Setting range: PurE, non

Displayed only when the temperature compensation is set to “PurE”

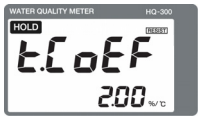
Selecting the temperature compensation and the calculation method

Select the temperature compensation calculation method.
nACL: Temperature compensation according to the NaCl temperature characteristic
t.CoEF: Temperature coefficient of electrical conductivity %/°C and a manually reference temperature

If the temperature coefficient of the impurity is known, enter the value for the temperature compensation coefficient setting.
Setting range: nACL, t.CoEF

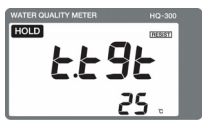
Displayed only when the above setting is“t.CoEF”

The temperature compensation coefficient



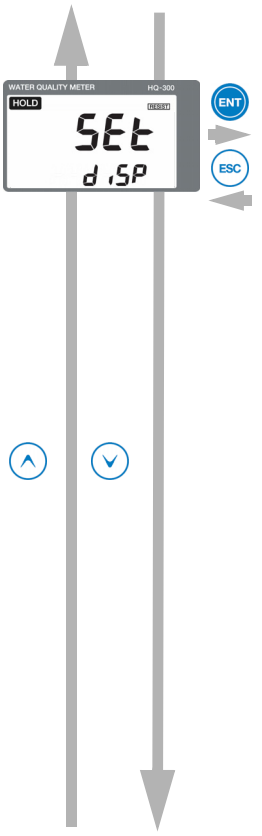
Sets the coefficient for the temperature compensation.
Enter the known temperature coefficient.
When the temperature coefficient is 0%/°C, temperature compensation is performed according to the temperature coefficient of pure water only.
Setting range: –3.00%/°C to 3.00%/°C

The reference compensation temperature

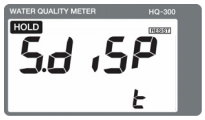


Sets the temperature for the reference compensation.
The electrical resistivity is compensated for according to the temperature specified here.
Normally, the reference temperature for the normal operation is 25°C.
Setting range: 5°C to 95°C

Display setting

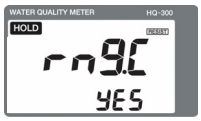


The auxiliary display



Sets whether or not to display the measured temperature value in the measurement mode screen.
non: Measured temperature value is not displayed
t: Measured temperature value is displayed
Setting range: non, t

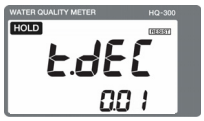
Display limit at over range



Select whether or not to display the measured electrical resistivity value or measured temperature value if they exceed the measurement ranges, respectively.

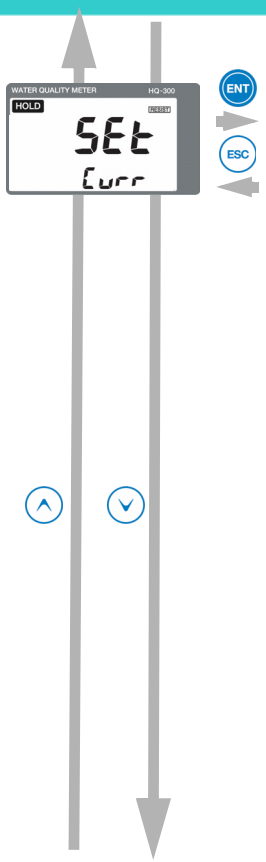
yES: Electrical resistivity: 0.000 MΩ•cm to 2.000 MΩ•cm, or 0.00 MΩ•cm to 20.00 MΩ•cm
0.00 KΩ•m to 20.00 KΩ•m, or 0.0 KΩ•m to 200.0 KΩ•m
Temperature: 0.00°C to 100.00°C
no: Electrical resistivity: 0.000 MΩ•cm to 10.000 MΩ•cm, or 0.00 MΩ•cm to 100.00 MΩ•cm
0.00 KΩ•m to 100.00 KΩ•m, or 0.0 KΩ•m to 1000.0 KΩ•m
Temperature: –10.00°C to 110.00°C
Setting range: yES, no

The temperature display digit

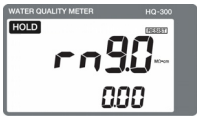


Select whether to display the measured temperature value down to one or two decimal places.
Setting range: 0.1 and 0.01

Analog output setting

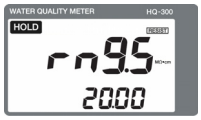


The 4 mA analog output value



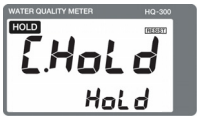
Sets the measured electrical resistivity value to be assigned to 4 mA.
For details on the options, refer to “Measurement range setting” (page 224).
Setting range: Varies depending on the unit setting and measurement range setting

The 20 mA analog output value



Sets the measured electrical resistivity value to be assigned to 20 mA.
For details on the options, refer to “Measurement range setting” (page 224).
Setting range: Varies depending on the unit setting and measurement range setting

The HOLD mode



Sets the analog output in the hold mode.

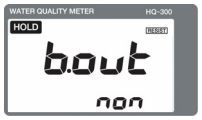
HoLd: The analog output is on hold at the latest value.
PrES: The analog output is on hold at a manually measured electrical resistivity value.
Setting range: HoLd, PrES

Displayed only when the HOLD setting is “PrES”

The HOLD output value

Sets a manually measured electrical resistivity value when the HOLD function is set to PrES.
For details on the options, refer to “Measurement range setting” (page 224).
Setting range: Varies depending on the unit setting and measurement range setting

The burnout function



Sets whether or not to burn out the analog output at the occurrence of an error.
non: Burnout function is disabled
out.4: Burnout lower limit setting (3.6 mA output)
out.20: Burnout upper limit setting (21 mA output)
Setting range: non, out.4, out.20

Note

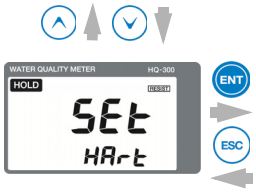
Burnout function

In case of a sensor error or system error, the analog output can be changed to the upper or lower limit setting (burnout function).

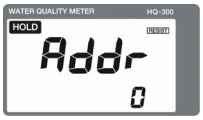
- **When the burnout upper limit setting is enabled, the analog output will change to 21 mA if an error occurs.**
- **When the burnout lower limit setting is enabled, the analog output will change to 3.6 mA if an error occurs.**

For details on the burnout occurrence conditions, refer to “Analog output conditions” (page 233).

HART communication setting



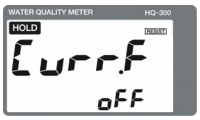
The polling address



Sets the polling address of HART communication.
Setting range: 0 to 63

Select an address except for 0 for the multi-drop link.

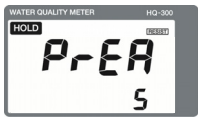
The analog output fix mode



Sets whether or not to fix the analog output to 4 mA.
on: The analog output is fixed to 4 mA.
oFF: The analog output is not fixed to 4 mA.
Setting range: on, oFF

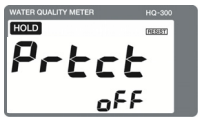
It is recommended that you set this function to ON for the multi-drop link. When this function is set to ON, the burnout and preset settings are disabled.

The number of preambles



Sets the number of preambles.
Setting range: 2 pcs. to 20 pcs.

The write protect mode



Sets the write protect mode.
on: Change of various settings using the HART communication is disabled.
oFF: Change of various settings using the HART communication is enabled.
Setting range: on, oFF

Checking the device ID

Allows you to check the value of the device ID assigned to the transmitter.

The device ID cannot be changed.

● Measurement range setting

The measurement range setting options differ depending on the unit setting.
The analog output setting range differs depending on the measurement range setting.
For details, refer to the table below.

Unit	Cell constant (0.01)	
	Measurement range	Analog output setting range
Conv (MΩ•cm)	2.000	0.000 to 10.000
	20.00	0.00 to 100.00
Si (kΩ•m)	20.00	0.00 to 100.00
	200.0	0.0 to 1000.0

Measurement mode

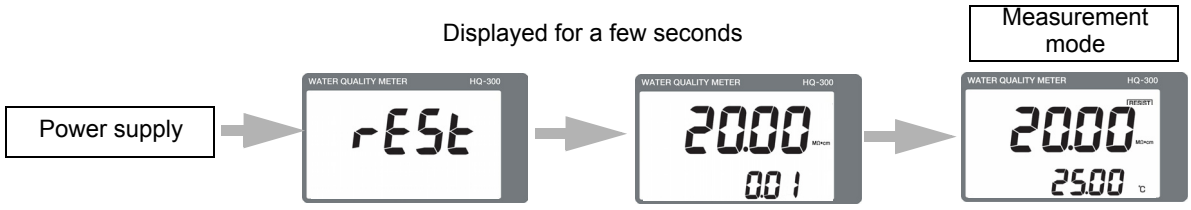
■ Functions available with the measurement mode

The following information can be displayed in the auxiliary display during measurement.
The moving average count (damping factor) is not only displayed but can also be changed.

Display information	Description	Reference page
Measured value display	Displays the measured temperature.	226
Moving average count display	Allows you to set the moving average count (damping factor) of the measured electrical resistivity value.	

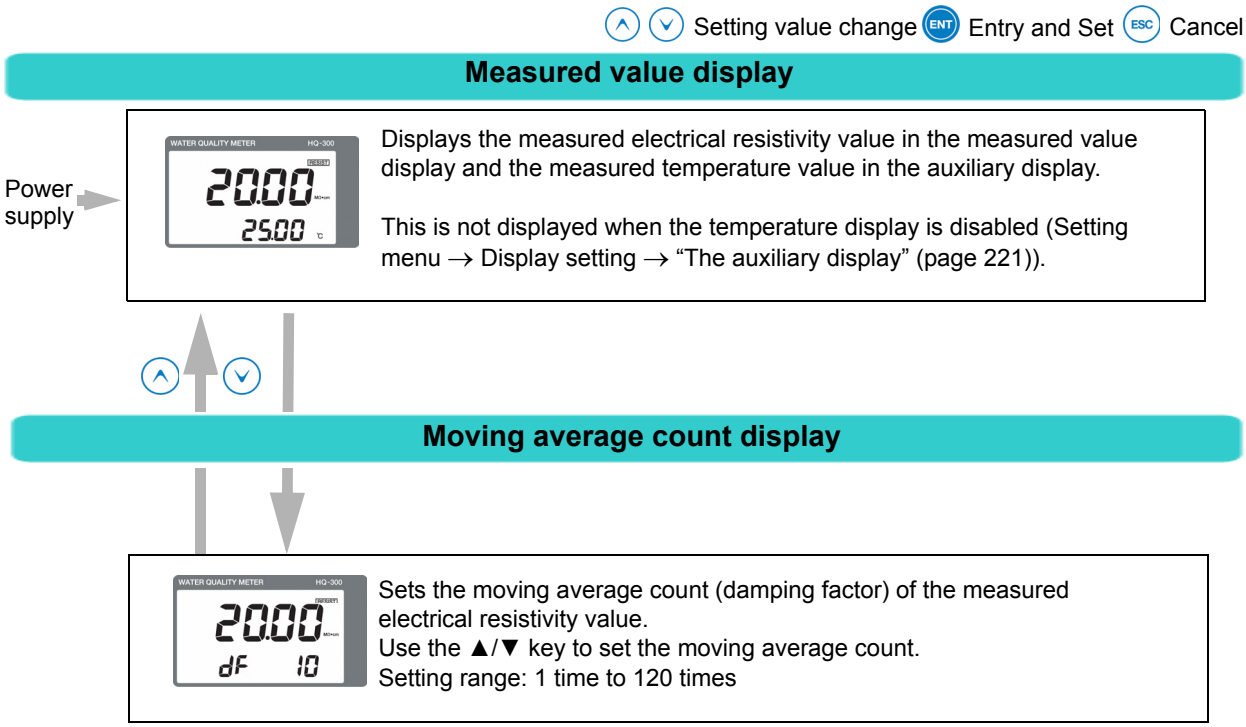
■ How to enter the measurement mode

1. **Turn ON the power.**
The measurement target is displayed in the measured value display.
The measurement range is displayed and the system enters measurement mode.
The measured value is displayed and measurement starts. This is the measurement mode state.



2. **Press the ▲/▼ key to switch the screen.**
By switching the screen, you can change and check the moving average count (damping factor).

Measurement mode display item



Tip

Moving average count
If the measured electrical resistivity value is not stabilized, you can stabilize it by setting the moving average count.
The setting range is from 1 time to 120 times. The time averaging processing is performed during the period from one second to 120 seconds.

Example 1) When the moving average count is set to 10 times, the average value for the previous 10 seconds is updated every one second.
Example 2) When the moving average count is set to 1 time, averaging processing will not be performed.

Calibration

■ Calibration type

Type	Remarks	Reference page
Temperature calibration	Allows you to input the temperature manually.	228
Correction coefficient (span) adjustment	Performs span adjustment of the electrical resistivity. This adjustment is not necessary for any cases except when you change the measured value on purpose.	229

■ Before performing electrical resistivity calibration

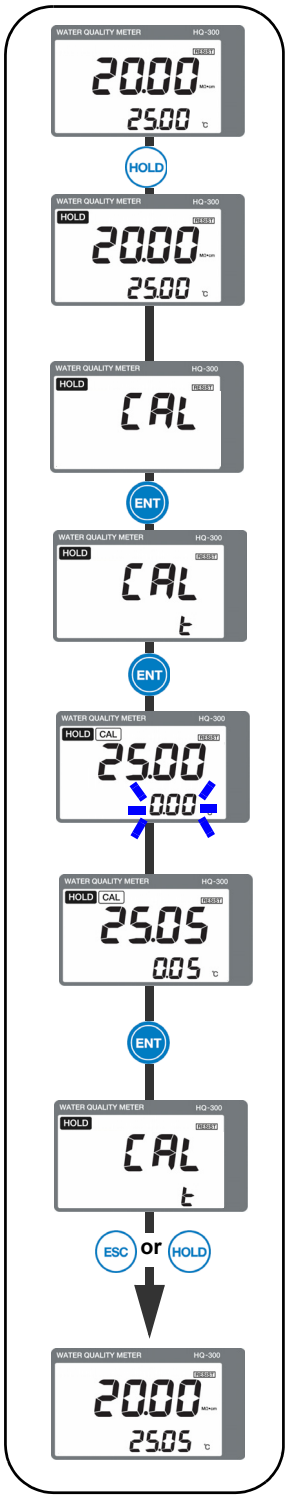
● Transmitter

Set the transmitter to the hold mode.
Hold down the HOLD key in the measurement mode. HOLD is displayed in the upper left section and the analog output is on hold.

Note

Before lifting up the sensor, set the analog output on hold.

Temperature calibration operational procedure



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated.**

3. **Press the ▼ key to display CAL in the measured value display, and then press the ENT key.**

4. **Display "t" in the auxiliary display, and then press the ENT key.**

5. **The temperature calibration mode is activated and the auxiliary display starts blinking.**

6. **Press the ▲/▼ key to adjust the value so that the value displayed in the measured value display reaches the water temperature.**
   ▲ key: The value increases by 0.01°C.
   ▼ key: The value decreases by 0.01°C.
   The setting range is from −5.00°C to 5.00°C.

7. **Press the ENT key.**
   The temperature calibration coefficient is updated.
   This completes the temperature calibration. The display returns to the calibration menu.

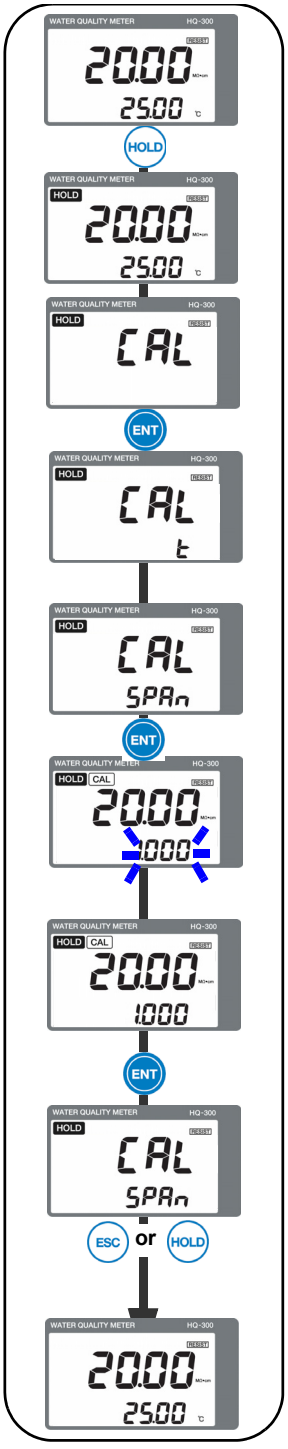
8. **Hold down either the ESC or HOLD key to return to the measurement mode.**

Tip

- **If you wish to cancel the calibration in the middle of the process, press the ESC key. The display will return to the calibration menu without updating the calibration data.**
- **To continue and perform other calibration operations, press the ▲/▼ key to select the setting item.**

Correction coefficient (span) adjustment

Adjust the correction coefficient so that the measured value matches the reference electrical resistivity meter.



1. **Hold down the HOLD key in the measurement mode.**

2. **"HOLD" is displayed in the upper left section and the hold mode is activated.**

3. **Press the ▼ key twice to display CAL in the measured value display, and then press the ENT key.**

4. **"t" is displayed in the auxiliary display.**

5. **Press the ▼ key twice to display SPAN in the auxiliary display. Press the ENT key.**

6. **The adjustment mode is activated and the auxiliary display starts blinking.**

7. **Press the ▲/▼ key to set the correction coefficient.**
   Set the correction coefficient so that the value displayed in the measured value display reaches the reference value.
   ▲ key: The value increases by 0.001.
   ▼ key: The value decreases by 0.001.
   The setting range is from 0.700 to 1.300.

8. **Press the ENT key.**
   The correction coefficient is updated.
   This completes the adjustment of the cell constant correction coefficient (span).
   The display returns to the calibration menu.

9. **Hold down either the ESC or HOLD key to return to the measurement mode.**

Note

- **Normally, it is not necessary to adjust the correction coefficient (span).**
  However, only when the cell constant changes due to deterioration of the sensor, etc., adjust the correction coefficient (span).
- **The calibration operation and sensor setting are independent operations. This calibration does not change the sensor settings.**
  To return the original settings, set the correction coefficient to 1.000.

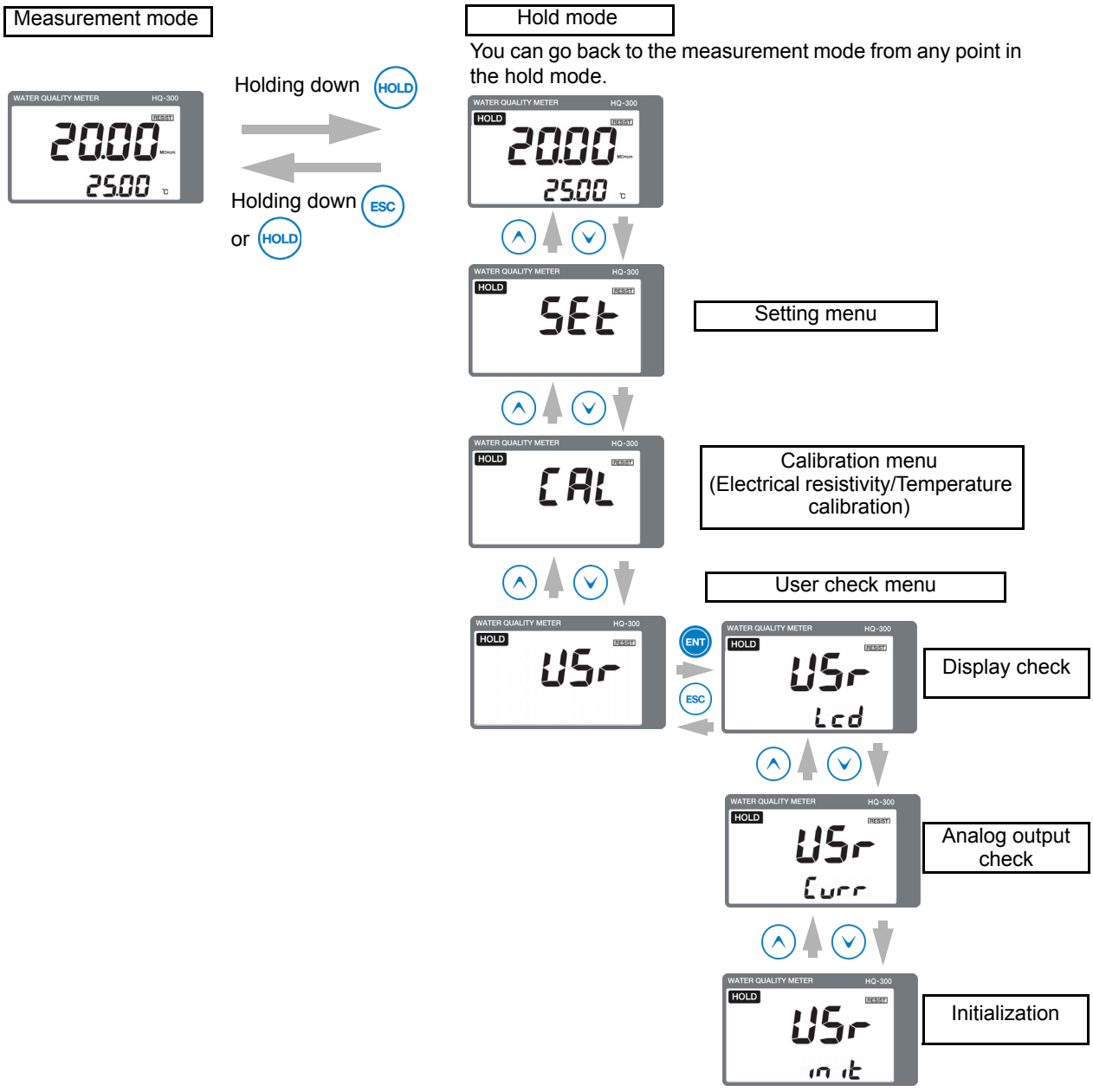
Maintenance procedure

■ User check menu

The user check menu allows you to check the display and analog output, and initialize the setting value.

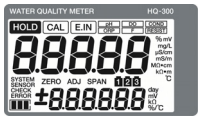
● How to enter the user check menu

1. **Hold down the HOLD key until the HOLD lamp lights up in the measurement mode.**
2. **Press the ▲/▼ key to display USr in the measured value display, and then press the ENT key to enter the user check menu.**



■ User check menu display item

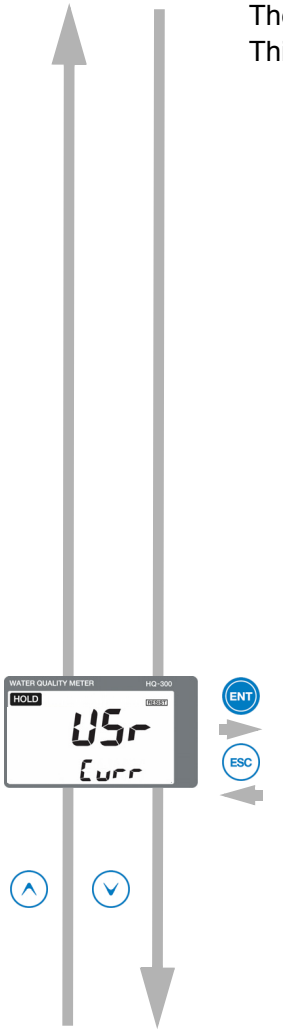
Display check

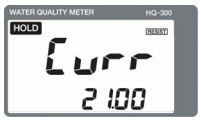


Turns on the light of the entire LCD display.
This is used when you check the display.

Analog output check

The analog output is changed the following current values.
This is used when you check the analog output (loop check).





For checking the 21 mA output (Upper limit current at the time of burnout)

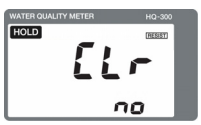
For checking the 20 mA output

For checking the 12 mA output

For checking the 4 mA output

For checking the 3.6 mA output (Lower limit current at the time of burnout)

Initialization



Returns the setting data and calibration data to the default status.
no: Data is not returned to the default status
yES: Data is returned to the default status

■ Troubleshooting

● Measures for sensor failure

If a failure occurs in the sensor manufactured by HORIBA Advanced Techno, check the currently used sensor according to the following troubleshooting method. If the problem persists after checking and troubleshooting, please contact HORIBA Advanced Techno.

Symptom / Possible cause	Instable indication	A wrong value is displayed	Slow response	Troubleshooting
Bubbles are attached to the sensor	√	√	-	Prevent bubbles from forming in the liquid to be measured.
Bubbles form due to a high flow rate	√	√	-	Adjust the flow rate.
The surface level of the liquid to be measured fluctuates and as a result, the liquid contact area of the sensor fluctuates	√	√	-	Take measures to prevent the surface level ofthe liquid to be measured from changing.
A sudden liquid temperature change occurs	√	-	-	Install the sensor where a sudden liquid temperature change does not occur.
The terminal block screws are loose or there is a contact failure in the terminal block	√	√	-	Tighten the screws completely.
The terminal block insulation has deteriorated	√	√	-	Remove any moisture and contamination from the terminal block.
The sensor is contaminated	-	√	-	If the sensor is microbial contaminated, wipe off the contamination using alcohol. For sensors made of stainless steel or titanium, if rust has occurred, immerse the sensor in the 5% concentration nitric acid and remove the rust.
The sensor is not immersed in the liquid to be measured	-	√	-	Take measures to prevent the surface level of the liquid to be measured from changing.
The sensor cable is disconnected or shorted	-	√	-	Check the sensor cable.
The flow rate is low	-	-	√	Maintain a sufficient flow rate for the liquid to be measured replacement.
The concentration of the liquid to be measured is not constant (if a tank is installed)	√	-	√	Thoroughly stir the liquid to be measured. Or, install the sensor where the concentration can be kept constant.
The setting value is not appropriate	-	√	-	Review “Setting the sensors” (page 219). ● Setting the cell constant correction coefficient ● Setting the temperature coefficient ● Setting the resistance correction value ● Setting the cable length ● Setting the temperature compensation ● Selecting the temperature compensation and setting the calculation method ● Setting the temperature compensation coefficient ● Setting the reference compensation temperature

● Measures for values outside the measurement range

If the measured electrical resistivity value is outside the measurement range, the measured value is blinking.
Perform the procedure according to the following table.

Possible cause	Corrective action
The sensor is not immersed in the liquid to be measured	Immerse the sensor under the target liquid level, even if this level fluctuates.
● Wiring of the sensor cable is wrong Wiring for lines 1 and 2, in particular, is disconnected ● Wiring of the relay cable is wrong	Check for looseness of screws or incorrect wiring in the terminal blocks of this product and relay box.

■ Analog output conditions

C.HoLd (HOLD setting)			HoLd (Latest value hold)			PrES (Setting value hold)		
b.out (Burnout setting)			non	out.4	out.20	non	out.4	out.20
Measurement mode			Measured value			Measured value		
		E-21 to E-22		3.6 mA	21 mA		3.6 mA	21 mA
		E-90 to E-92						
	External hold input ON		Latest value hold			Preset value		
		E-21 to E-22						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
Hold mode			Latest value hold					
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON					Preset value		
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
Electrical resistivity calibration			Latest value hold					
		E-21 to E-22						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON					Preset value		
		E-21 to E-22						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
Temperature calibration			Latest value hold					
		E-21 to E-27						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA
	External hold input ON					Preset value		
		E-21 to E-27						
		E-90 to E-92		3.6 mA	21 mA		3.6 mA	21 mA

Error code description

Error display		Error display priority*1	Error description	Description	When to occur
E-21	SENSOR ERROR	4	Temperature sensor disconnection	The lead wire of the temperature sensor is disconnected	During measurement and calibration*2
E-22		5	Temperature sensor shorted-circuited	The lead wire of the temperature sensor is shorted-circuited	
E-27		6	Temperature calibration error	The temperature is below −10°C or above 110°C	During temperature calibration
E-90	SYSTEM ERROR	1	System error	Internal communication error	At all times (System error)
E-91		2	System error	The memory data, such as the setting values, calibration values, are lost	
E-92		3	System error	A/D converter operation failure	

*1: Two or more errors cannot be displayed at the same time. If multiple errors occur, the error with the smallest priority number is displayed.

*2: If an E-21 or E-22 error occurs during calibration, recalibration cannot be performed. Take a corrective action according to “Corrective actions” (page 235).

Tip

If an error code is displayed, the HOLD display starts blinking and the analog output is fixed to the latest value before the occurrence of the error.

Corrective actions

When an error code is displayed, take corrective actions according to the table below.

Error codes	Occurrence condition	Reset condition	Possible cause	Corrective action
E-21 (Temperature sensor disconnection)	If the resistance of the temperature sensor is approximately 1.423 kΩ or above (When the temperature sensor is approximately 110°C or above)	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the sensor with a new one.
			Wiring of the sensor cable and relay cable is wrong	Check that the wiring between T and T is not open.
E-22 (Temperature sensor shorted-circuited)	If the resistance of the temperature sensor is approximately 0.962 kΩ or above (When the temperature sensor is approximately −10°C or below)	When the condition stated on the left is reset	Resistance error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the sensor with a new one.
			Wiring of the sensor cable and relay cable is wrong	Check that the wiring between T and T is not shorted.
E-27 (Temperature measurement outside range)	If the measured temperature during temperature calibration is below −10°C or above 110°C	When the calibration mode is exited and the temperature falls within the normal measurement temperature range	Temperature error of the liquid to be measured (Below −10°C or above 110°C)	Maintain the temperature of the liquid to be measured within the operating temperature range of the sensor.
			Error between T and T of the sensor	The sensor has a problem if the resistance meets the occurrence conditions. Replace the sensor with a new one.
E-90 (System error)	Meter internal communication error	Turning the power OFF and then ON	Internal system error	Turn OFF the power and turn it back ON. If the system error persists, contact HORIBA Advanced Techno.
E-91 (System error)	The memory data, such as the setting values, calibration values, are lost			
E-92 (System error)	A/D converter operation failure			

Measurement principle

■ Measurement of electrical resistivity

● Temperature compensation calculation

The electrical resistivity is a reciprocal of the electrical conductivity.
This section describes the principle of the temperature compensation for the electrical conductivity.

● Pure water characteristic

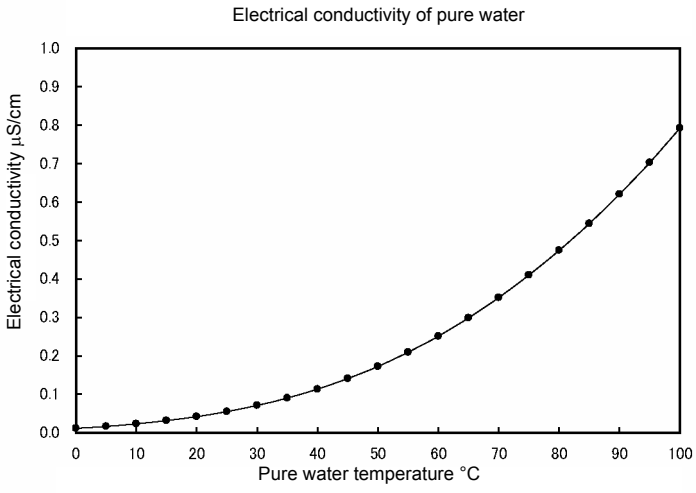
The electrical conductivity of pure water is measured as a sum of the electrical conductivity based on dissociation of the water molecules and impurity ions.

$C_{(T)}=F_{(T)}+G_{(T)}$
$C_{(T)}$: Electrical conductivity of T°C solution
$F_{(T)}$: Electrical conductivity of T°C pure water
$G_{(T)}$: Electrical conductivity based on T°C impurity ions

● Electrical conductivity of pure water

The electrical conductivity of pure water is generated by dissociation of the water molecules. The dissociation of the water molecules is significantly affected by the temperature change.
The electrical conductivity of pure water is measured using the continuous temperature functions created in accordance with the tables of ASTM D 1125-91 and JISK0130-1995.

Temperature (°C)	Electrical conductivity (µS/cm)
0	0.012
5	0.017
10	0.023
15	0.031
20	0.042
25	0.055
30	0.071
35	0.090
40	0.114
45	0.141
50	0.173
55	0.210
60	0.251
65	0.299
70	0.352
75	0.410
80	0.474
85	0.544
90	0.621
95	0.703
100	0.793



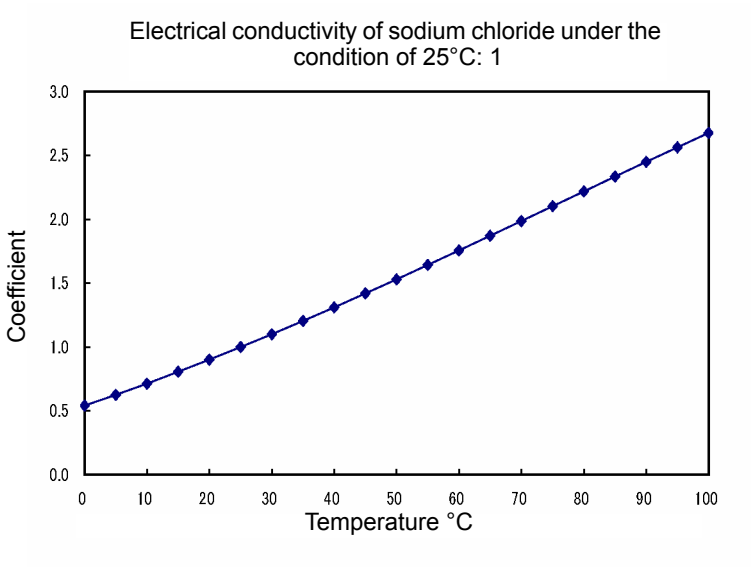
● Electrical conductivity based on impurity ions

The selected method is used for the calculation of electrical conductivity based on impurity ions. As described later, the method will be either “Method using NaCl characteristics” or “Method by entering the temperature coefficient”.

● Method using NaCl characteristic

When the main compound of the salt contained in the sample is sodium chloride, select the method to perform temperature compensation using the NaCl characteristic.
The electrical conductivity of the sodium chloride aqueous solution varies at the following ratio with reference to the electrical conductivity at 25°C.
From this table, a manually temperature ratio is obtained, and the electrical conductivity at 25°C is then obtained.
The following table shows the results tested by HORIBA Advanced Techno, Co., Ltd.

Temperature (°C)	Electrical conductivity ratio of NaCl	Coefficient
0	0.542	1.845
5	0.626	1.596
10	0.715	1.399
15	0.806	1.240
20	0.902	1.109
25	1.000	1.000
30	1.101	0.908
35	1.205	0.830
40	1.312	0.762
45	1.420	0.704
50	1.531	0.653
55	1.643	0.609
60	1.757	0.569
65	1.872	0.534
70	1.987	0.503
75	2.103	0.476
80	2.219	0.451
85	2.335	0.428
90	2.450	0.408
95	2.564	0.390
100	2.677	0.374



● Method by entering the temperature coefficient

The electrical conductivity of the aqueous solution varies depending on the temperature. In general, when the solution temperature increases by 1°C, the electrical conductivity increases by approximately 2% with reference to the electrical conductivity at 25°C.
The approximate expression will be as follows:

$C_{(T)}=C_{(25)}\times(1+0.01\times\alpha\times(T-25))$

$C_{(T)}$: Electrical conductivity of T°C solution
$C_{(25)}$: Electrical conductivity (reference) of 25°C solution
α: Temperature coefficient of electrical conductivity (Unit: %)
T: Manually temperature T°C

The temperature coefficient varies depending on the solution type and concentration. It is within the range from 0.5 to 2.5. Entering the temperature coefficient executes the temperature compensation calculation for estimating the electrical conductivity at 25°C. As long as 2% is entered for the temperature coefficient, almost all aqueous solutions can be supported.
If the temperature coefficient of the solution is known, enter the value.
When you enter 0 for the temperature coefficient, the pure electrical conductivity without temperature compensation can be obtained.
In general, the reference temperature for the temperature compensation is 25°C. However, temperatures other than 25°C is available for the reference temperature.
When the electrical conductivity at T°C is known, given that the reference temperature is ST, the electrical conductivity $C_{(ST)}$ at the reference temperature can be obtained using the following formula:

$C_{(ST)}=C_{(T)}/(1+0.01\times\alpha\times(T-ST))$

$C_{(ST)}$: Electrical conductivity (reference) of ST°C solution
$C_{(T)}$: Electrical conductivity of T°C solution
α: Temperature coefficient of electrical conductivity (Unit: %)
T: Manually temperature T°C
ST: Reference temperature ST°C

Note

If you have changed the reference temperature, use the temperature coefficient after the reference temperature change.

Temperature measurement

For the element RTD for temperature measurement, the resistance temperature detector whose resistance at 0°C is 1000 Ω is adopted. As a characteristic of this resistance temperature detector, the resistance becomes higher when the temperature increases. It is 1385 Ω (standard) at 100°C. Variations in resistance at 0°C during manufacturing influence the temperature measurement accuracy.

Variations in the temperature element are corrected according to an algorithm that was not conventionally available for this product. The resistance for a temperature element of 0°C is screened and the value is entered to correct all temperature resistances. When you enter the value, all temperature resistances are corrected, even when the RTD has a different temperature coefficient.

As a result of the adoption of this new temperature measurement algorithm, a temperature accuracy of ±0.2°C has been achieved. However, the temperature calibration mode is additionally provided, so that the temperature calibration can be performed by comparing with a higher-accuracy thermometer. In the temperature calibration mode, the resistance at 0°C is also corrected by matching with the reference temperature.

In addition, the RTD input value at 0°C and the correction value for the temperature calibration are individually stored, so that the temperature calibration value can be returned to the original value.

The sensor for which the RTD resistance at 0°C is not screened can be used without correction. In this case, however, the accuracy will be ±0.5°C.

The longer the cable length, the higher the measured resistance value is. Entering the cable length executes the calculation for canceling the resistance of the electric wire.

The 0°C screening is performed with reference to the state (equilibrium state obtained when water and ice are agitated in the atmosphere), instead of the thermometer.

Options

Parts name	Model	Specifications		Remarks
Sensor	ERF-001L-T-10M	Cell constant Liquid contact material Lead length Resistance temperature detector temperature coefficient	(0.01/cm) (Titanium as standard) (10 m as standard) (3850 ppm/°C)	Cable unit
	ERF-001C-T	Cell constant Liquid contact material Resistance temperature detector temperature coefficient	(0.01/cm) (Titanium as standard) (3850 ppm/°C)	Connector type (Cable is required separately)
Flow chamber type holder	EFA-30	Liquid contact material Temperature of the liquid to be measured Pressure of the liquid to be measured	(PVC) (0°C to 50°C) (0 MPa to 0.1 MPa)	ERF sensor
	EFA-30P	Liquid contact material Temperature of the liquid to be measured Pressure of the liquid to be measured	(PVDF) (0°C to 100°C) (0 MPa to 0.1 MPa)	
	EFA-30S	Liquid contact material Temperature of the liquid to be measured Pressure of the liquid to be measured	(SUS316) (0°C to 100°C) (0 MPa to 0.5 MPa)	
Cable	CK-10M	Cable length	10 m	Connector type sensor (ERF-001C-T) Connection cable
	CK-20M	Cable length	20 m	
	CK-30M	Cable length	30 m	

Data

Specification

■ Common Specifications

Product name	Water Quality Meter (two-wire transmitter)	
Model	HQ-300	
Measurement item	pH, ORP, Dissolved oxygen, Fluoride ion (optional), Electrical conductivity, Electrical resistivity*1	
Analog output	Output type	4 mA to 20 mA DC
	Load resistance	550 Ω max. (when power supply voltage is 24 V DC)*2
	Linearity	Within ±0.08 mA
	Repeatability	Within ±0.02 mA
	Output range	To be selected from the fixed ranges or set as desired within the measurement range
	Error output	Burnout function (selectable from 3.6 mA and 21 mA)
	Hold function	Selectable from among the latest value hold, setting value hold, and continuous output during calibration*3
HART communication	Protocol revision	7
	Burst mode	Not supported
	Multi-drop connection	15 transmitters max. (selectable from transmission output fixed at 4 mA and not fixed)*4
Hold input (Contact input)	Number of input points	1
	Contact type	No-voltage “a” contact
	Condition	ON resistance: 40 Ω (max.) Open-circuit voltage: 1.2 V DC (max.) Short-circuit current: 21 mA DC (max.)
	Contact function	Analog output hold
Operating temperature range	−20°C to 60°C (no freezing)	
Operating Humidity range	Relative humidity 5% to 90% (no condensation)	
Storage temperature	−25°C to 65°C	
Power supply	Rated voltage	24 V DC (Power-supply voltage range: 21 V DC to 32 V DC)
	Power consumption	0.6 W or less
Compatible standards	CE marking	EMC:EN61326-1 class A, industrial electromagnetic environment RoHS:EN50581, 9.Industrial monitoring and control instruments
	FCC rules	Part 15 Class A
	KC mark	Class A

Structure	Installation	Outdoor installation type
	Installation method	50 A pole-mounted or wall-mounted
	Protection class	IP65
	Material of case	Aluminum alloy (coated with epoxy-modified melamine resin)
	Material of mounting brackets	SUS304
	Material of hood	SUS304 (coated with epoxy-modified melamine resin)
	Material of display window	Polycarbonate
	Display element	Reflective monochrome LCD
External dimensions	180 (W) mm × 155 (H) mm × 115 (D) mm (excluding brackets)	
Mass	Mainframe: approx. 2.8 kg, hood and bracket: approx. 1 kg	

■ pH measurement specifications

Suitable sensors	pH sensor (6108, 6108G, 6109, 6110, 6151, 6152, 6171, 6172, 6173, 6174, 8200, 8300, etc.)*5		
Measurement range	pH		pH0 to pH14 (display range: pH−1 to pH15)
	Temperature		0°C to 100 °C ● When the automatic identification function of temperature sensor type is used, the display range is -10°C to 110°C) ● When the temperature sensor type is set manually, the display range is −20°C to 130°C
Resolution	pH		0.01 pH
	Temperature		0.1°C
Accuracy	pH	Repeat-ability	Within ±0.03 pH at equivalent input
		Linearity	Within ±0.03 pH at equivalent input
	Temperature	Repeat-ability	Within ±0.3°C at equivalent input
		Linearity	Within ±0.3°C at equivalent input
Temperature compensation	Compatible temperature element		Platinum resistance temperature detector: 1 kΩ (0°C)
			Positive characteristic resistance temperature detector: 500 Ω (25°C), 6.8 kΩ (25°C), 10 kΩ (25°C)
	Element selection method		Manual switching or automatic identification of temperature sensor type (also possible without temperature compensation)
	Temperature compensation range		0°C to 100°C
Calibration	Calibration method		Automatic calibration or manual calibration
	Number of calibration points		Selectable from one, two, or three points
	Standard solution type		pH2,4,7,9,10 Manually standard solution usable during manual calibration (with a difference 2 pH or more)
	Added functions		Automatic identification of standard solution type Automatic potential stability judgment Calibration error automatic judgment Calibration history
	Temperature		One-point comparison calibration

Diagnostics	Calibration error	Asymmetry potential error, sensitivity error, response time error, temperature calibration outside range, standard solution identification error
	Sensor error	Glass response membrane cracks Liquid junction resistance error*6 Temperature sensor short-circuit, temperature sensor disconnection, and temperature measurement outside range
	Transmitter error	Internal communication abnormality, ADC abnormality, memory abnormality

■ ORP measurement specifications

Suitable sensors	ORP sensors (6805, 6815, 6870, 2500, etc.)*5		
Measurement range	ORP		-2000 mV to 2000 mV (display range: -2200 mV to 2200 mV)
	Temperature		0°C to 100 °C (When the automatic identification function of temperature sensor type is used, the display range is -10°C to 110°C) (When the temperature sensor type is set manually, the display range is -20°C to 130°C)
Resolution	ORP		1 mV
	Temperature		0.1°C
Accuracy	ORP	Repeat-ability	Within ±5 mV at equivalent input
		Linearity	Within ±5 mV at equivalent input
	Temperature	Repeat-ability	Within ±0.3°C at equivalent input
		Linearity	Within ±0.3°C at equivalent input
Display Temperature	Compatible temperature element		Platinum resistance temperature detector: 1 kΩ (0°C)
			Positive characteristic resistance temperature detector: 500 Ω (25°C), 6.8 kΩ (25°C), 10 kΩ (25°C)
	Element selection method		Manual switching or automatic identification of temperature sensor type (also possible without temperature compensation)*7
Calibration	ORP adjustment		Manual offset adjustment (-200 mV to 200 mV) Manual sensitivity adjustment (0.500 to 1.500)
	Temperature		One-point comparison calibration
Diagnostics	Sensor error		Liquid junction resistance error*6 Temperature sensor short-circuit, temperature sensor disconnection, and temperature measurement outside range
	Transmitter error		Internal communication abnormality, ADC abnormality, memory abnormality

■ Dissolved oxygen (DO) measurement specification

Suitable sensors	DO sensor (5505, 5510), DO probe (DO-1100)*5		
Measurement range	DO		0 mg/L to 20 mg/L (display range: 0 mg/L to 22 mg/L)
	Saturation degree		0 to 200% (display range: 0% to 200%)
	Temperature		0°C to 50 °C (display range: -10°C to 110°C)
Resolution	DO		0.01 mg/L
	Saturation degree		1%
	Temperature		0.1°C
Accuracy	DO	Repeat-ability	Within ±0.5% of full scale at equivalent input
		Linearity	Within ±0.5% of full scale at equivalent input
	Temperature	Repeat-ability	Within ±0.3°C at equivalent input
		Linearity	Within ±0.3°C at equivalent input
Temperature compensation	Compatible temperature element		Platinum resistance temperature detector: 1 kΩ (0°C) Embedded in dedicated probe DO-1100
	Temperature compensation range		0°C to 50°C
Calibration	Calibration method		Atmospheric calibration or saturated liquid calibration
	Number of calibration points		Atmospheric calibration: 1 point Saturated liquid calibration: 2 point
	Added functions		Salinity correction (0.0% to 5.0%) Calibration error automatic identification Calibration history
	Temperature		One-point comparison calibration
Diagnostics	Calibration error		Zero calibration error, sensitivity error, temperature calibration outside range
	Sensor error		Rupture of membrane Immersion Temperature sensor short-circuit, temperature sensor disconnection, and temperature measurement outside range
	Transmitter error		Internal communication abnormality, ADC abnormality, memory abnormality

■ Fluoride ion measurement specifications(optional)*10

Suitable sensors	Fluoride ion sensor (1009)*5		
Measurement range	Fluoride ion		0 mg/L to 10000 mg/L (display range: 0 mg/L to 11000 mg/L)
			Selectable range 10 mg/L, 20 mg/L, 50 mg/L, 100 mg/L, 200 mg/L, 500 mg/L, 1000 mg/L, 2000 mg/L, 5000 mg/L, 10000 mg/L
	Temperature		0°C to 100 °C (display range: -20°C to 130°C)
Resolution	Fluoride ion		0.1mg/L :10, 20 mg/L range 1mg/L:50, 100, 200 mg/L range 10mg/L:500, 1000, 2000 mg/L range 100mg/L:5000, 10000 mg/L range
	Temperature		0.1°C
Accuracy	Fluoride ion	Repeat-ability	Within ±7% of full scale at equivalent input
		Linearity	Within ±10% of full scale at equivalent input
	Temperature	Repeat-ability	Within ±0.3°C at equivalent input
		Linearity	Within ±0.3°C at equivalent input
Temperature compensation	Compatible temperature element		Platinum resistance temperature detector: 1 kΩ (0°C) Positive characteristic resistance temperature detector: 10 kΩ (25°C)
	Temperature compensation range		0°C to 100°C
Calibration	Calibration method		Manual calibration
	Number of calibration points		Selectable from one or two points
	Standard solution type		First point: standard solution with the concentration of 50% to 100% of setting range Second point: standard solution with the concentration of 1% to 20% of the setting range
	Added functions		Calibration error automatic identification Calibration history
	Temperature		One-point comparison calibration
Diagnostics	Calibration error		Asymmetry potential error, sensitivity error, response time error, temperature calibration outside range
	Sensor error		Temperature sensor short-circuit, temperature sensor disconnection, and temperature measurement outside range
	Transmitter error		Internal communication abnormality, ADC abnormality, memory abnormality

■ Electrical conductivity measurement specifications

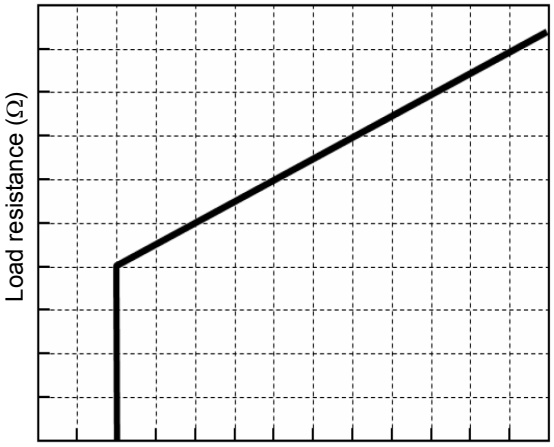
Suitable sensors	2-electrode electrical conductivity measurement sensor (ESH, FS series)*5				
Measurement range	Cell constant (/cm)	Unit	0.01 (ESH-001)	0.1 (ESH-01 / FS -01)	1.0 (ESH-1)
	Conductivity*8	μS/cm	0.000 to 2.000 0.00 to 20.00	0.000 to 2.000 0.00 to 20.00 0.0 to 200.0	0.0 to 200.0 0 to 2000
		mS/m	0.0000 to 0.2000 0.000 to 2.000	0.0000 to 0.2000 0.000 to 2.000 0.00 to 20.00	0.00 to 20.00 0.0 to 200.0
	TDS*8	mg/L	0.00 to 2.00 0.0 to 20.0	0.00 to 2.00 0.0 to 20.0 0 to 200	0 to 200 0 to 2000
	Temperature	°C	0°C to 100°C (display range: -10°C to 160°C)		
Resolution	Conductivity TDS		As shown in the table above		
	Temperature		0.01°C		
Accuracy	Conductivity	Repeat-ability	Within ±0.5% of full scale at equivalent input		
		Linearity	Within ±0.5% of full scale at equivalent input		
	TDS	Repeat-ability	Within ±1.5% of full scale at equivalent input		
		Linearity	Within ±1.5% of full scale at equivalent input		
	Temperature	Repeat-ability	Within ±0.1°C at equivalent input		
		Linearity	Within ±0.3°C at equivalent input		
Temperature compensation	Compatible temperature element		Platinum resistance temperature detector: 1 kΩ (0°C)		
	Compensation method		Temperature characteristic of NaCl (reference temperature: 5°C to95°C) Manually temperature coefficient input (reference temperature: 5°C to 95°C, temperature coefficient: -3 to 3%/°C) No temperature compensation		
	Temperature compensation range		0°C to 100°C (calculation is extended for temperature below 0°C and over 100°C)		
Calibration	Conductivity		Input of correction coefficient of cell constant		
	TDS		Conversion in accordance with manually coefficient (0.30 to 1.00)		
	Temperature		One-point comparison calibration		
Diagnostics	Sensor error		Temperature sensor short-circuit, temperature sensor disconnection, and temperature measurement outside range		
	Transmitter error		Internal communication abnormality, ADC abnormality, memory abnormality		

■ Electrical resistivity measurement specifications

Suitable sensors	2-electrode electrical resistivity sensor (ERF-001 series)*5		
Measurement range	Resistivity	MΩ•cm	0.000 to 2.000 0.00 to 20.00*9
		kΩ•m	0.00 to 20.00 0.0 to 200.0*9
	Temperature	°C	0°C to 100°C (display range: -10°C to 110°C)
Resolution	Resistivity		As shown in the table above
	Temperature		0.01°C
Accuracy	Resistivity	Repeat-ability	Within ±0.1% of full scale at equivalent input
		Linearity	Within ±0.5% of full scale at equivalent input
	Temperature	Repeat-ability	Within ±0.1°C at equivalent input
		Linearity	Within ±0.3°C at equivalent input
Temperature compensation	Compatible temperature element		Platinum resistance temperature detector: 1 kΩ (0°C)
	Compensation method		Temperature characteristic of NaCl (reference temperature: 5°C to95°C) Manually temperature coefficient input (reference temperature: 5°C to 95°C, temperature coefficient: -3 to 3%/°C) No temperature compensation
	Temperature compensation range		0°C to 100°C (calculation is extended for temperature below 0°C and over 100°C)
Calibration	Resistivity		Input of correction coefficient of cell constant
	Temperature		One-point comparison calibration
Added functions	Ultra-pure water resistivity selection		Selectable from 18.23 MΩ•cm (standard), 18.18 MΩ•cm, 18.24 MΩ•cm Selectable from 182.3 kΩ•m, 181.8 kΩ•cm, 182.4 kΩ•cm
	Clip function		When the measured value is between the specified electrical resistivity and the upper limit of the measurement range, the specified electrical resistivity is displayed as the measured value.
Diagnostics	Sensor error		Temperature sensor short-circuit, temperature sensor disconnection, and temperature measurement outside range
	Transmitter error		Internal communication abnormality, ADC abnormality, memory abnormality

∗1: Only one of these item is selectable by setting.
∗2: The max. load resistance can be used within the rage shown in the below graph. When HART communication is performed, the minimum load resistance is 250 Ω

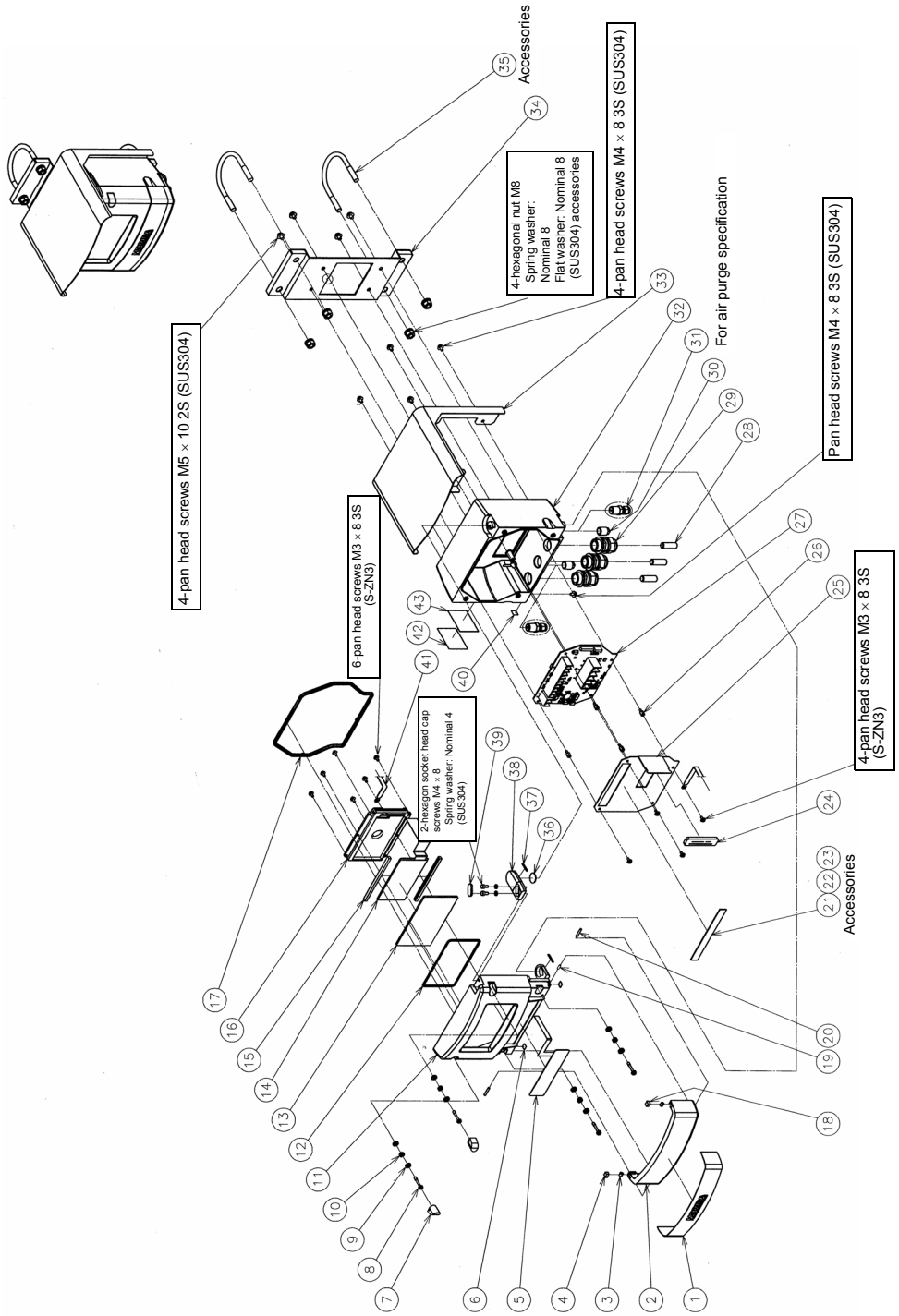
Load resistance v.s. Power supply voltage



∗3: Continuous output during calibration of hold function can be used only when pH measurement is selected.
∗4: When multi-drop connection is performed, the max. cable length is about 800 m.
∗5: The measurement range is different by sensor type. For detail, see specifications of each sensor.
∗6: Liquid junction resistance error is able to be used the following sensors only with a liquid ground electrode. pH sensor: 6174, 6172, 6173 and 6174, ORP sensor: 6870
∗7: ORP sensor, such as 6805 and 6815, cannot display temperature value.
∗8: Electrical conductivity measurement and TDS measurement cannot be selected at the same time.
∗9:0.0 MΩ•cm to 100.0 MΩ•cm (0 kΩ•m to 1000 kΩ•m) can be displayed when no temperature compensation is performed.
∗10:The measurement of fluoride ion is offered as an option. A standard product can't measure fluoride ion.

Disposal procedure

When disposing of this product, follow the related laws and/or regulations of your country.
This product consists of the following components.



No.	Name	Component	Qty
1	Nameplate	PVC	1
2	Front cover	ADC12	1
3	Press-fit plunger	POM, SUS631	2
4	Plunger gasket L	Q	1
5	Key sheet	PET	1
6	Protective sheet L	PVC	2
7	Screw caps	Q	2
8	Screws	SUS304	4
9	Spring cap	SUS304	8
10	Compression spring	SUS304WPB	4
11	Top case	ADC12	1
12	Window plate gasket	Q	1
13	Display panel	PET	1
14	LCD	Glass	1
15	LCD gasket	Q	2
16	LCD holder	ADC12	1
17	Case gasket	Q	1
18	Plunger gasket R	Q	1
19	Collar	PET	2
20	Parallel pin	SUS304	2
21	Terminal label DO	PET	1
22	Terminal label COND	PET	1
23	Terminal label RESIST	PET	1
24	Cable clamp	Q	1
25	Terminal cover	PC	1
26	Spacer	C3604BD	4
27	Printed circuit board	FR4, etc.	1
28	Seal pin	PVC	3
29	Cable gland	Nylon 66, EPDM	3
30	Plug	SUS304	2
31	Half union	SUS316	2
32	Bottom case	ADC12	1
33	Roof	SUS304	1
34	Pole bracket	SUS304	1
35	U bolt	SUS304	2
36	Plate	PTFE	1
37	Protective sheet U	PVC	2
38	Upper hinge	ADC12	1
39	Screw cap 2	Q	1
40	Function ground nameplate	PET	1
41	FG cable	Flexible PVC, Cu	1
42	Laminate	PVC	1
43	Rating plate	PET	1

When segregating the printed circuit board for disposal

If it is necessary to segregate the internal printed circuit board for disposal, dissemble the product according to the following procedure.

Items to prepare

- Phillips screwdriver
- Wrench

Disassembly procedure

CAUTION

Before performing sorting work for disposal, be sure to set that the power is not supplied.

1. **Open the transmitter cover (for details on how to open the cover, refer to "How to open the transmitter cover" (page 14)).**
2. **Disconnect all the wire connections from the terminal block inside the transmitter.**
3. **Remove the four screws securing the terminal cover (No. 25). Also remove the FG cable (No. 41) that is tightened together with one of the screws.**
4. **Remove the cable clamp (No. 24) fitted in the terminal cover (No. 25).**
5. **Remove the terminal cover (No. 25).**
6. **Remove the four spacers (No. 26) securing the printed circuit board (No. 27).**
7. **Remove the flat cable for the LCD (No. 14) and key sheet (No. 5) that is connected to the two connectors on the printed circuit board (No. 27).**
8. **Remove the printed circuit board from the transmitter.**

Terminology

Terms	Description
Two-wire transmitter	A transmitter that allows transmission between the power supply line and 4 mA to 20 mA signal lines on a single cable pair
4-20 mA	This is the analog current output, and also called the analog output or loop current.
Auto calibration	Auto calibration
Basic calibration	Manual calibration
CAL	Calibration
COND	An abbreviation of Electrical Conductivity
24 V DC	A type of power to be supplied to the transmitter 24 V DC is basically used for the two-wire transmitter
DO	An abbreviation of Dissolved Oxygen
Class D grounding	Grounding resistance of 100 Ω or less
F	An abbreviation of Fluoride Ion
HART communication	An abbreviation of Highway Addressable Remote Transducer A standard for performing digital communication by superimposing the 1200 Hz/2200 Hz current signal to the loop current
HOLD	An operation to stop the analog output change
IP	A protection class Classification of dust-proof and waterproof properties
KCL solution	Internal solution (potassium chloride solution) for the pH sensor, ORP sensor, and fluoride ion sensor
LCD	A liquid crystal display
ORP	An abbreviation of Oxidation-Reduction Potential
pH	An abbreviation of Potential of Hydrogen
RESIST	An abbreviation of Electrical Resistivity
RTD	An abbreviation of Resistance Temperature Detector. This is a temperature sensor.
RTD temperature correction coefficient	A coefficient for correcting variations of the temperature sensor
SI unit	An international system of units This is a system of units composed of seven basic units (m, kg, s, A, K, cd and mol).
SS	An abbreviation of Suspended Solids. Suspended or floating substances. Substances that are not dissolved but suspended within the water.
TDS	An abbreviation of Total Dissolved Solids
Moving average	An operation to average and output the detected values of each sensor
Air purge	Preventing the corrosive gas from entering the inside of the transmitter using the instrument air
Error codes	Numbers for indicating the error status of the transmitter. It is expressed as “E-XX”.
Extension cable	A cable to be used for extending the sensor cable
Temperature coefficient	An indication of a change in the concentration or resistance per 1°C
Temperature sensor	A temperature sensor built in the sensor Four types of temperature sensor, 500 Ω, 1 kΩ, 6.8 kΩ, and 10 kΩ are supported.
Temperature compensation	An operation to compensate the change of the liquid to be measured concentration due to the temperature
Cable length	The length of sensor cable
Calibration	An operation to make the detected value of the sensor correspond to the standard solution, etc.
Calibration mode	A mode for performing calibration (the analog output is on hold)

Terms	Description
Diagnostics	Sensor error detection function
Cell constant	The value determined by the shape of the electrical conductivity sensor and electrical resistivity sensor. The measurement range varies depending on the cell constant.
Cell constant correction coefficient	A coefficient for correcting variations in the cell constant of each sensor
Sensor	pH sensor, ORP sensor, fluoride ion sensor, DO sensor, electrical conductivity sensor, and electrical resistivity sensor
Cleaning unit	A sensor cleaning device
Operation keys	Key switches for operating the transmitter
Measurement mode	The mode activated after the power is turned ON (this mode should be used during measurement)
Terminal block	A terminal for connecting the power supply cable and sensor cable
Damping factor	Moving average
Relay box	A terminal block box to be used for extending the sensor cable
Distributer	A two-wire power supply with integrated power supply and load resistance
Device ID	A unique identification signal assigned to each HART communication device
Analog output	Analog current (4 mA to 20 mA) output
Electrical conductivity sensor	An electrical conductivity sensor
Holding down	An operation to hold down an operation key for approximately two seconds
Burnout	An operation to change the analog output to 3.6 mA or 21 mA to indicate a status error
Electrical resistivity sensor	Electrical resistivity sensor
Standard solution	A solution used as a reference for sensor calibration
Lightning arrester	An element that absorbs the lightning surge voltage and current
Hood	A cover on the transmitter for protection from rainwater and direct sunlight
Load resistance	A resistance for detecting 4 mA to 20 mA from the power supply line of the two-wire transmitter. It is also called as the loop resistance or reception resistance.
Flash	A state that the LCD display blinks quickly a few times and the setting is confirmed
Preambles	A synchronization signal to be sent at the start of HART communication
Transmitter	A device for converting the sensor signal to the 4 mA to 20 mA analog signal
Polling address	An address signal to be assigned for identification of each connection device when multi-drop link is performed
Hold mode	Various setting modes (the analog output is on hold)
Holder	An aid for fixing the sensor onto the sample tank or sample piping
Multi-drop link	A parallel connection of multiple HART communication-compatible devices
Menus	Various setting menus (various menus are provided in each mode)
Mode	There are the following three modes: measurement mode, calibration mode, and hold mode
Write protect	Prohibition of setting change by the HART communication command
Loop current	This is an analog current output, and also called as the analog output or 4 mA to 20 mA.
Range cut	Not displaying any values outside the range

Display code table

Abbrev.	Official name	Description
A.StAb	Auto Stability	Automatic stability judgment function
A.CAL	Auto Calibration	Auto calibration
A.rEt	Auto Return	Automatic restoration
Addr	Polling Address	Polling address
AdJ	Adjust	Adjustment
Air	Air	Atmospheric calibration
Auto	Auto	Auto calibration
b.out	Burn Out	Burnout
bASiC	Basic	Basic calibration
buF2	Buffer 2	Second standard solution
C.CoEF	Cell Coefficient	Cell constant correction coefficient
C.HoLd	Current Hold	Analog output hold
C.rng	Current range	Analog output range
CAbLE	Cable	Cable
CAL	Calibration	Calibration
CAL.P	Calibration Point	Number of calibration points
CAL.t	Calibration Type	Calibration type
CELL	Cell	Cell
CLiP	Clip	Clip
CLr	Clear	Initialization
Curr	Current	Analog output
Curr.F	Current Fix	Analog output fixing
dAtA.C	Data Check	Data check
dF	Dampening Factor	Moving average
diSP	Display	Display
do	DO (Dissolved Oxygen)	Dissolved oxygen
F	F-(Fluoride ions)	Fluoride ion
F.AdJ	F- Adjust	Fluoride ion adjustment
FACt.A	Factor A	Gradient
FACt.b	Factor B	Intercept
good	Good	Calibration success
HArt	HART	HART
id	Device ID	Device ID
init	Initialize	Initialization
LCd	LCD	Liquid crystal
PArA	Parameter	Variable
PH	pH (Potential Hydrogen, Power of Hydrogen)	pH
PH7	pH7	pH7
PHAdJ	pH Adjust	pH adjustment
PrEA	Preamble	Preambles
PrES	Preset	Preset
Prot	Write Protect Mode	Write protect mode
PurE	Pure Water	Pure water

Abbrev.	Official name	Description
rEt.t	Return Time	Automatic restoration time
rng.C	Range Cut	Range cut
rng	Range	Range
rng.0	Range Zero	4 mA output for analog output
rng.S	Range Span	20 mA output for analog output
rtdC	RTD Coefficient	RTD coefficient
rtdr	RTD Resistor	RTD resistance
S.CAL	Span Calibration	Span calibration
S.diSP	Sub Display	Auxiliary screen
S.tdS	Set TDS	TDS conversion
SAL	Salinity	Salinity
SELF.C	Self Check	Diagnostics
SEnS	Sensor	Sensor
SEnSor	Sensor	Sensor
SLP	Slope	Sensor sensitivity
SoL.t	Solution Temperature	Solution temperature
SPAn	Span	Span
StAb.L	Stability Level	Reference for stability
Std	Standard	Asymmetry potential
Std.C	Standard Concentration	Concentration at isothermal point of intersection
Std.EL	Standard Electric Potential	Potential at isothermal point of intersection
Std.H	Standard Hi	High-concentration standard solution
Std.L	Standard Lo	Low-concentration standard solution
t	Temperature	Temperature
t.CoEF	Temperature Coefficient	Temperature coefficient
t.dEC	Temperature Decimal Point	Decimal point position for temperature display
t.rEF	Temperature Reference	Reference compensation temperature
t.tgt	Temperature Target	Reference temperature
tC	Temperature Compensation	Temperature compensation
tCS	Temperature Compensation System	Temperature compensation calculation method
Unit	Unit	Unit

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