MULTI-PROBE

W-20XD Series

W-22XD.23XD

Operation Manual

■

HORIBA

HORIBA's Warranty and Responsibility

Your W-20XD series multi-probe is covered by HORIBA's warranty for a period of one (1) year, under normal use. Although unlikely, if any trouble attributable to HORIBA should occur during this period, necessary exchange or repairs shall be conducted by HORIBA, free of charge. The warranty does not cover the following:

- Any trouble or damage attributable to actions or conditions specifically mentioned in the operation manuals to be avoided
- Any trouble or damage attributable to use of the multi-parameter water quality monitoring system in ways or for purposes other than those described in the operation manuals
- If any repairs renovations, disassembly, etc. are performed on this multi-parameter water quality monitoring system by any party other than HORIBA or a party authorized by HORIBA
- Any alteration to the external appearance of this multi-parameter water quality monitoring system attributable to scratches, dirt, etc. occurring through normal use
- Wear and tear to parts, the exchange of accessories, or the use of any parts not specified by HORIBA

INSTALLATION ENVIRONMENT

This product is designed for the following environment:

→ Installation Categories II
→ Pollution degree 2

LIMITATION OF LIABILITY FOR DAMAGES

HORIBA will not accept responsibility for damage or malfunction that may occur as a result of operation or situation not recommended in this manual. HORIBA shall not be liable for Customer's incidental, consequential or special damages, or for lost profits or business interruption losses, in connection with the operation of the Manufactured Parts, CPU hardware, disk drives or Software.

CE MARKING

CE

W-22XD, W-23XD, W-2000S Series conforms with the following directive(s) and standard(s):
Directives:
the EMC Directive 89/336/EEC, in accordance with Article 10(1) of the Directive
the Low Voltage Directive 73/23/EEC

Standards:
[the EMC Directive] EN61326:1997+A2:2001
(EMISSION : Class B, IMMUNITY For Minimum Requirement Location)
[the Low Voltage Directive] EN61010-1:2001

FCC 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 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.

Unauthorized reprinting or copying of this operation manual

No unauthorized reprinting or copying of all or part of this operation manual is allowed. The utmost care has been used in the preparation of this operation manual. If, however, you have any questions or notice any errors, please contact the local agency, HORIBA office or inquire from the back cover of this operation manual.

Preface

Thank you very much for purchasing HORIBA's "MULTI-PROBE" W-20XD Series.

This device is the sensor probe to be connected to the control unit W-2000S, via cables manufactured by HORIBA, with which multiple water parameters can be measured simultaneously.

The sensor probe can resist the hydraulic pressure at the depth up to 100m. In order to keep the waterproof structure intact. Follow the instructions shown in this manual.

This Operation Manual contains information on the basic way of handling the control unit, notes, etc. for the user.

Be sure to read through the Operation Manual before use.

Symbols employed

The symbols employed herein have the following meanings:

⚠ **WARNING** : Improper use can result in serious injury or even death.

⚠ **CAUTION** : The improper use of the control unit may cause the following dangers:

- Danger of injury
- Danger of damage to the control unit, its peripherals, and data

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

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

Important : Explanation necessary for the proper operation of the instrument

Note : Explanation that is useful and necessary for handling the instrument

☞ : Refer to the item shown.

Symbols employed in screen description

The symbols  and  used in screen description have the following meanings:

 : The letters and numbers in this symbol are blinking on the display (W-2000S).

 : The letters and numbers in this symbol are lighting up on the display (W-2000S).

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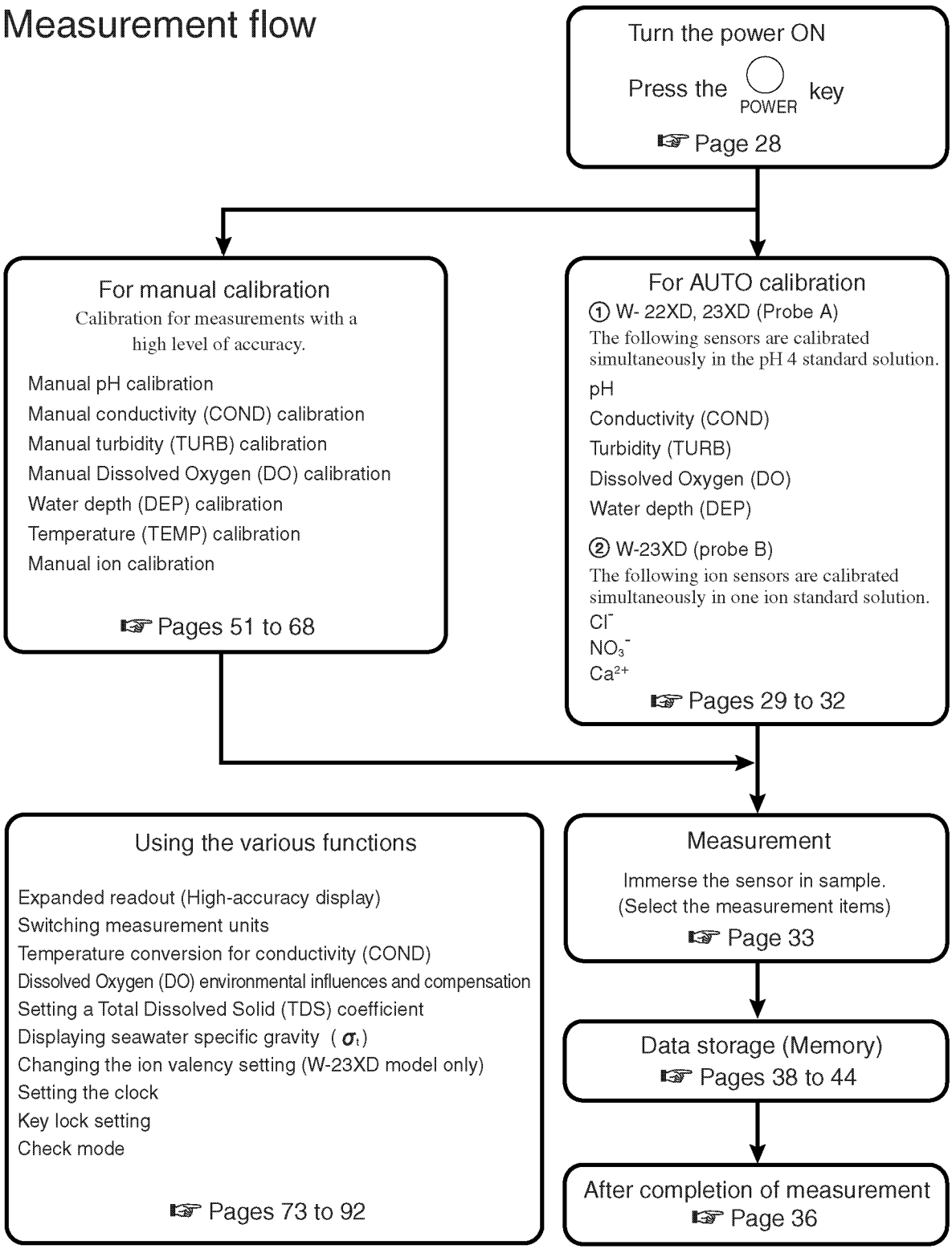
◉ CONTENTS ◉

Measurement flow

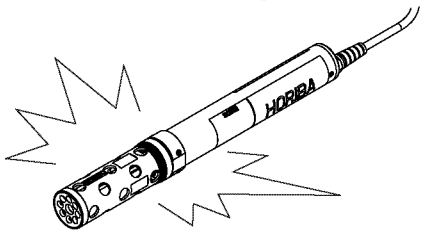


1. Introduction

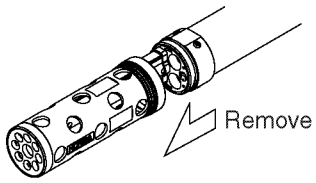
1.1 Notes on handling the control unit

Handling of sensor probe

Do not give a shock to the sensor probe.
The sensor will be damaged.

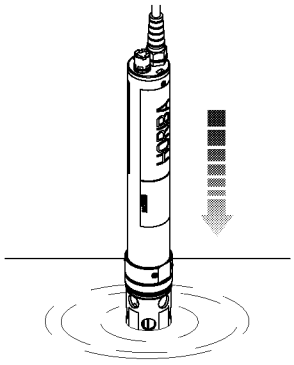


Do not remove the protection cover from the sensor probe to use.
Damage may occur to the sensor.



Slowly lower the sensor probe into the sample.

Dropping it from a height of 1m or more may cause damage to the sensor.
Do not immerse the sensor probe at the depth exceeding 100 m.
The device can resist the hydraulic pressure at the depth up to 100 m.



- The protection cover may rust due to the environment in which it is used. The damage caused by this usage shall not be warranted by the manufacturer. Please contact the local agency which users need to replace periodically.

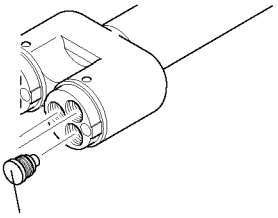
⚠ WARNING

- Fix the sensor probe to the cable or the reel prepared by usetr to use.
- In place with a large distance to the water surface high velocity or with a water flow, fix the sensor probe hook to a point except human body before use for safety purposes.
  Be careful not to leave the sensor probe by mistake. Otherwise, the sensor probe and control unit will fall into the water or a strong shock will occur to operator.

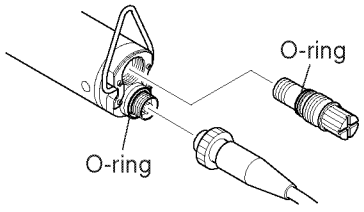
Replacing batteries and sensor of the sensor probe

Do not replace the sensor probe batteries and sensor in the atmosphere of high temperature and humidity.

Put connector plugs in to the sensor probe connectors when sensors are not attached.

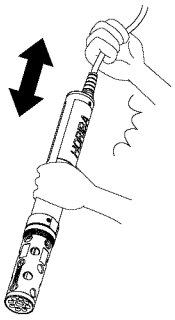


Waterproof function of the battery cover and the sensor connector is maintained by the O-rings. After checking that there are no foreign bodies adhering to the O-rings, apply silicon grease (included) to the fac e of the O-rings and tighten. Be sure to tighiten it to the indicated position. Do not tighten with the O-rings twisted or warped.

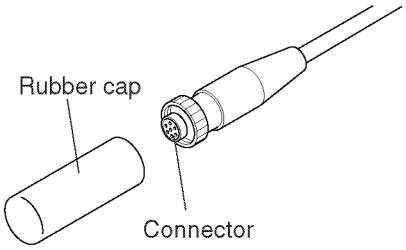


Handling of cable

Do not store the cable with its connector being greatly tensed or bent.
Do not give strong shocks to the connector, or the cable will snap.



If sample waterdrops remain onto the connector section, metal part of the connector is likely to rust. When storing, wipe the area around the connector well and cover it with the rubber cap.



Notes on connecting the cable

1. When connecting the cable, verify that there is no water remaining in the connectors (especially on the probe).
   Wipe the area well shuld there be any water remaining.

⚠CAUTION

- Connecting when there is water inside the connectors will cause the connector pins to rust which will lead to breakage.
- Do not bend the connector pins when wipping it by a rolling pin.

2. Fasten the knurled nut of connector until it dose not turn any more.
   After having tightened by hand as far as it can go, tighten it again a half-turn.
   (Turn the knurled nut with holding the knurled part. Otherwise, it will cause breaking of wire.)

3. The hook with the cable must be attached to the sensor probe to prevent breaking of wire.

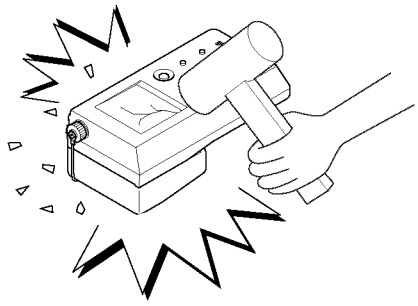
4. Keep the connector of sensor probe well sealed with connector cover L, if the sensor probe is used on automatic data storage mode without relay cable.
   When attaching the connector cover L, verify that there is no water remaining in the connector and connector cover L.
   Wipe the area well shuld there be any water remaining.

⚠CAUTION

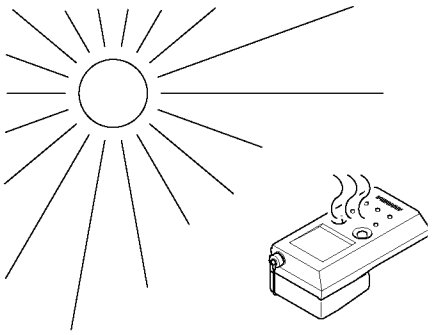
- Using without the connector cover L will cause the connector pins to rust which will leadto breakage.

Handling of the control unit

Do not give a shock to or drop the sensor or control unit.
The sensor or control unit will be damaged.

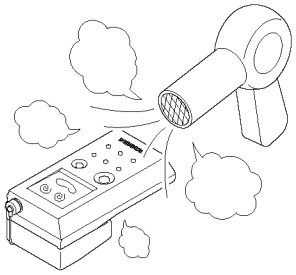


The display part includes LCD. Do not expose the control unit to ultraviolet rays for a long time. Otherwise, the LCD may deteriorate.

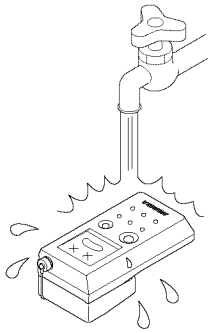


The control unit is water-proof structure (IP-67) when the sensor connector is attached. However, if the control unit has been dropped into water or become wet, wipe up it with soft cloth.

Do not use a hair dryer to dry up the control unit.

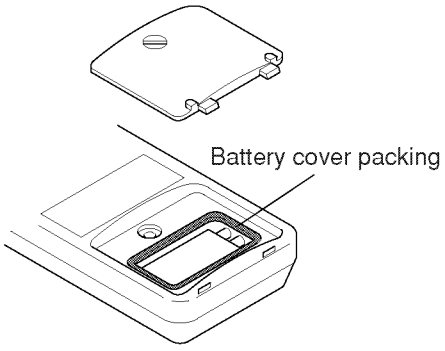


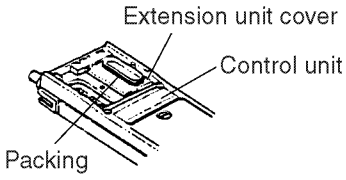
Do not wash directly the conntrol unit using tap water.



Battery replacement of the control unit and the extension unit attachment

Waterproof structure of the control unit is secured by the packing of battery cover and Extension unit cover. Foreign matter on the packing can cause water to enter the control unit. Check for foreign matter on the packing before closing the battery cover and the Extension unit cover.
If the packing is twisted, do not close the battery cover and the Extension unit cover.





For a long use

It's recommended to that replace the packing once a year.
For battery cover packing replacement, contact your sales agent.

Note on place for use

- Do not use the control unit in the atmosphere with ambient temperatures below 0 °C or above 55 °C.
- Avoid strong vibrations or corrosive gases.
- Do not use the control unit near a source of strong electromagnetic field such as high-voltage cables and motors.

Batteries

The improper use of batteries may cause leaks of electrolyte and explosion.

- Set the batteries in place properly paying attention to the plus (+) and minus (-) poles.
- Do not combine old and new batteries or batteries of different types.
- Dry batteries can not be recharged.
- Remove the batteries when not in use for a long time.
- In case of battery inner solution leakage, wipe off it the battery case thoroughly and place new batteries.

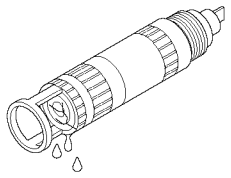
Handling the DO sensor

- In case of breakage of DO sensor diaphragm, replace whole DO sensor or diaphragm.
- Do not tuch the internal solution because caustic alkali.
- When removing the DO sensor from the sensor probe, make sure to attach the short socket (Included).

- Do not give a shock to the DO sensor. The sensor will be damaged.

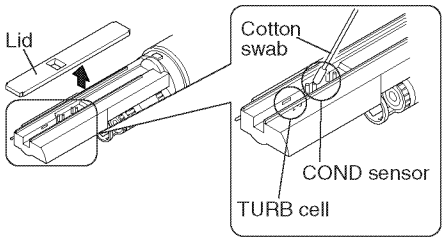
⚠CAUTION

- The DO sensor holds a strong-alkaline solution. Protect the eye and skin from the solution. If there is any solution in the eye or on the skin, immediately use sufficient water to wash off the solution. Consult a doctor without delay.



Handling the COND/TURB sensor unit

When cleaning the COND/TURB sensor unit, use a cotton swab to avoid damage to the TURB cell.

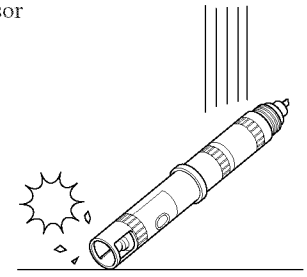


Handling the pH or pH/ORP sensor

The pH or pH/ORP sensor is made of very thin glass. Handle the sensor carefully to avoid a break.

⚠CAUTION

- Be careful not to break the glass on the top of the sensor. Otherwise operator may get hurt with a piece of glass.



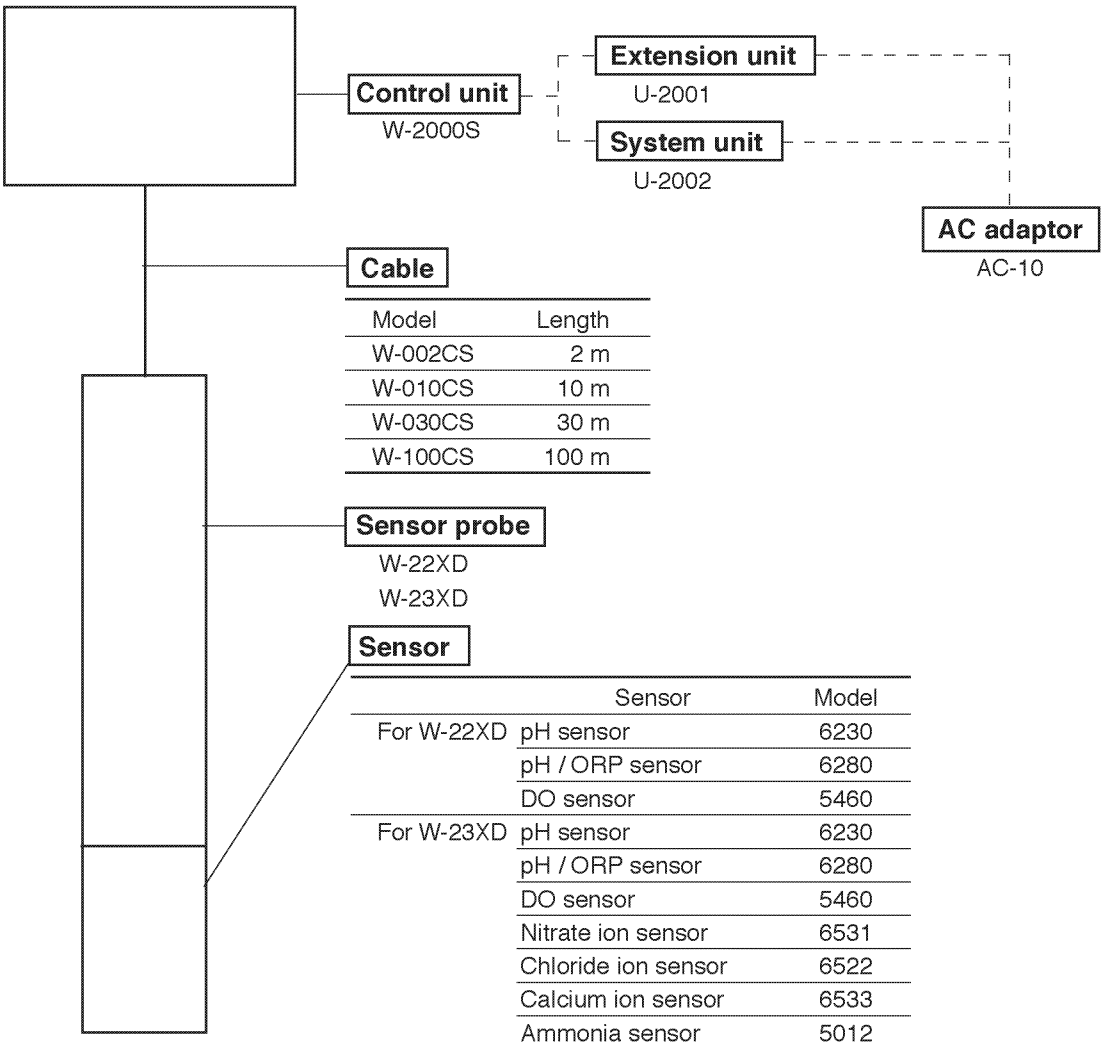
Disposal

Dispose this product as a special waste, otherwise this may affect the environment.

Handling in transportation

- For transportation, use the carrying case (optional accessory) to prevent damage.
- Remove the flow cell from the sensor probe for transportation.

1.2 System composition



Model	Length
W-002CS	2 m
W-010CS	10 m
W-030CS	30 m
W-100CS	100 m

	Sensor	Model
For W-22XD	pH sensor	6230
	pH / ORP sensor	6280
	DO sensor	5460
For W-23XD	pH sensor	6230
	pH / ORP sensor	6280
	DO sensor	5460
	Nitrate ion sensor	6531
	Chloride ion sensor	6522
	Calcium ion sensor	6533
	Ammonia sensor	5012
	Fluoride ion sensor	6530
	Potassium ion sensor	6532

Accessories of sensor probe

Model	Accessories
W-22XD	Sensor probe, Operation manual, Calibration beaker, Probe cap, pH4 standard solution, pH internal solution, pH syringe with needle, Sensor spanner, Connector plug for probe : 2 pieces, Alkaline batteries LR03 (AAA) : 3 pieces, Silicon grease, Sensor O-ring (S8) (10 pieces), Sponge for probe cap (5 pieces)
W-23XD	Sensor probe, Operation manual, Calibration beaker, Probe cap, pH4 standard solution, pH internal solution, pH syringe with needle, Ion one-point standard solution for Cl^-, NO_3^-, Ca^{2+}, Sensor spanner, Connector plug for probe : 5 pieces, Alkaline batteries LR03 (AAA) : 3 pieces Silicon grease, Sensor O-ring (S8) (10 pieces), Sponge for probe cap (5 pieces)

- The included battery is for operational monitoring purpose only. Its life may be shorter than newly replaced one.

2. Before Use

2.1 Introduction to the W-20XD series models

2.1.1 Measurement parameters

Components that can be measured with the W-20XD series models are as follows:

Model	W-22XD	W-23XD
Parameters		
pH	○	○
Dissolved Oxygen (DO)	○	○
Conductivity (COND)	○	○
Salinity (SAL) [Conversion form conductivity]	○	○
Total dissolved solids (TDS) [Conversion form conductivity]	○	○
Specific gravity of seawater [Conversion form conductivity]	○	○
Water temperature (TEMP)	○	○
Turbidity (TURB)	○	○
Water depth (DEP)	○	○
Oxidation Reduction Potential (ORP)	○	○
Chloride ion Cl^-	–	○
Nitrate ion NO_3^-	–	○
Calcium Ca^{2+}	–	○
Fluoride ion F^-	–	○
Potassium ion K^+	–	○
Ammonia gas NH_3	–	○

○ ..... Measurable

2.1.2 Functions of the control unit

Outline of the functions of the control unit is described below.

Feature	Function name	Page
Data obtained during measurement can be saved in the memory.	Manual data storage	Page 38
Data can be automatically saved in the memory at preset time interval.	Auto matic data storage	Page 40
Saved data can be called.	Data calling up	Page 45
The latest date of calibration and its details can be called.	Calibration data calling up	Page 47
Expanded display is available.	Expanded readout	Page 73
Measurement units can be selected.	Measuring unit selection	Page 74

* Other functions are aviable in the check mode. (☞ Page 84)

2.1.3 Functions of the extension unit

In the W-20XD series, optional extension unit allows communications with personal computer through RS-232C, the storage of G.P.S. data, and printer output, and commercial power supply.
Followings two extension units are available.

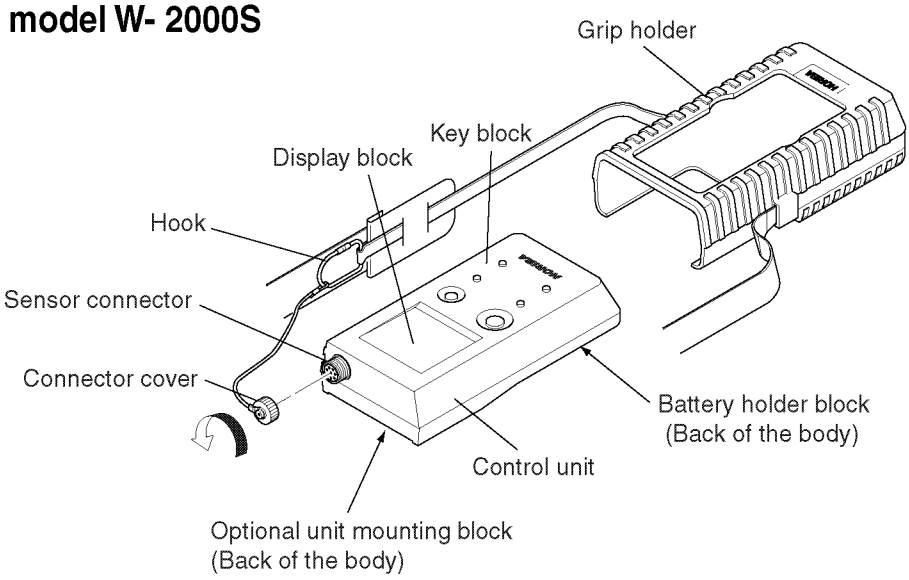
Model/name	Contents	Functions
U-2001 Extension unit	• Extension unit • Software for PC	<RS-232C communication, G.P.S connection, and printer output, AC adaptor> The above functions cannot be used at the same time. One of the connections in these three functions needs to be selected.
U-2002 System unit	• System unit case • Software for PC • G.P.S. unit • Printer set	<RS-232C communication, G.P.S connection, printer output, battery power supply*, AC adaptor> * A battery power supply can be used for 30 consecutive days.

* U-2001 and U-2002 can operate on a commercial power supply through the use of an AC adapter (optional). However, the AC adapter cannot be used for the G.P.S. unit and printer set.

2.2 Names of the parts

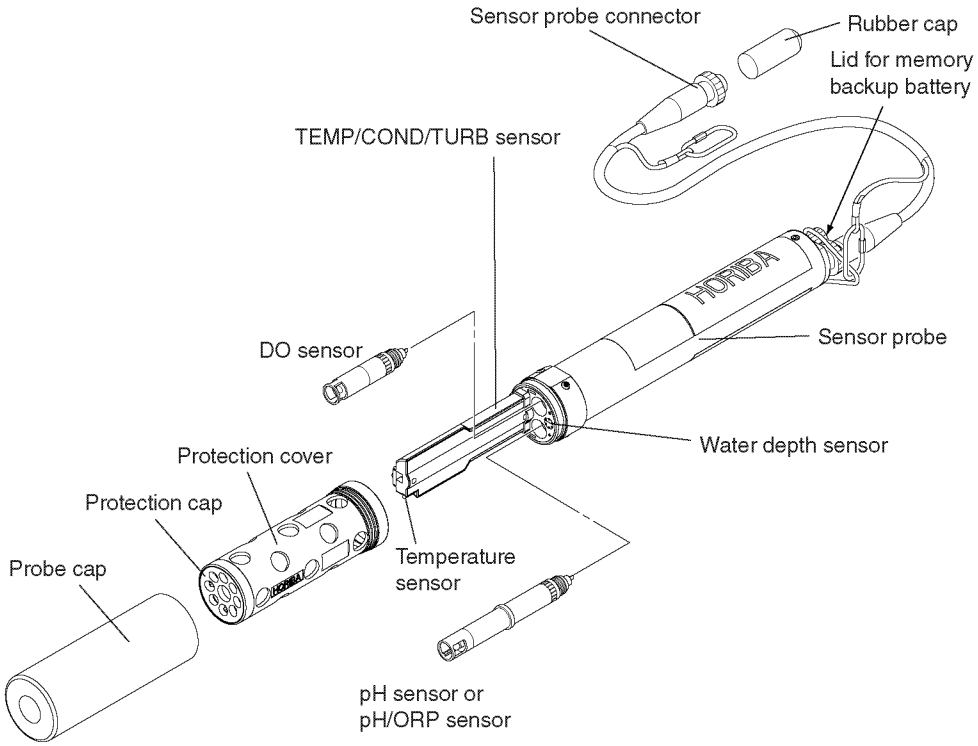
2.2.1 Control unit

For model W- 2000S

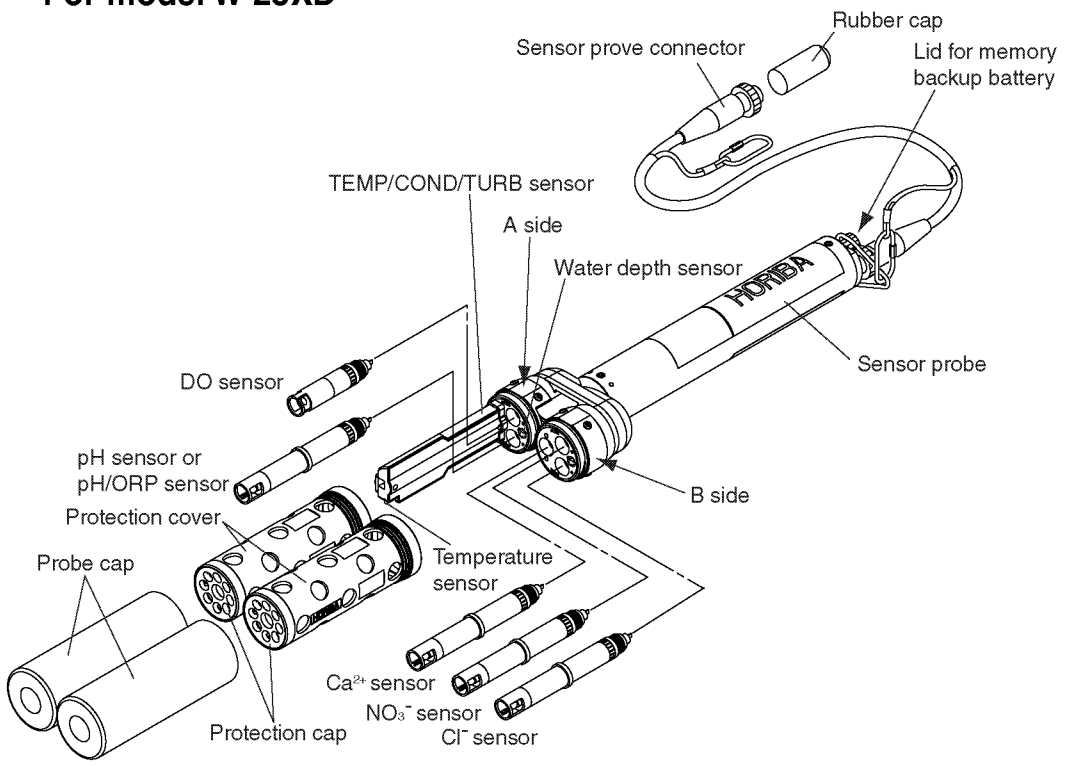


2.2.2 Sensor probe

For model W- 22XD

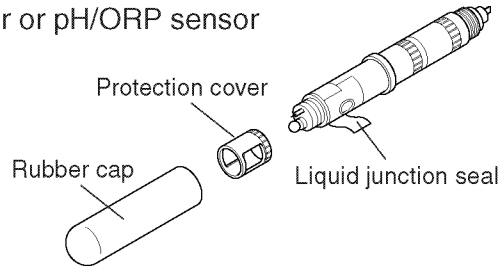


For model W-23XD

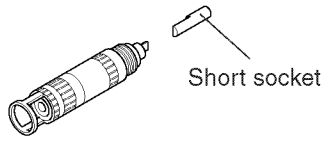


2.2.3 Sensor

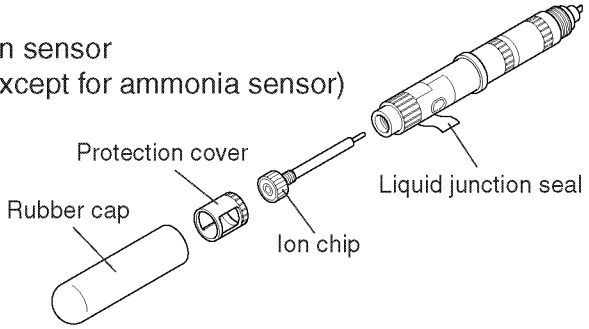
pH sensor or pH/ORP sensor



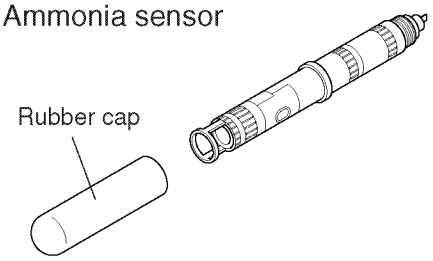
DO sensor



Ion sensor
(except for ammonia sensor)



Ammonia sensor



2.2.4 Use of carrying case

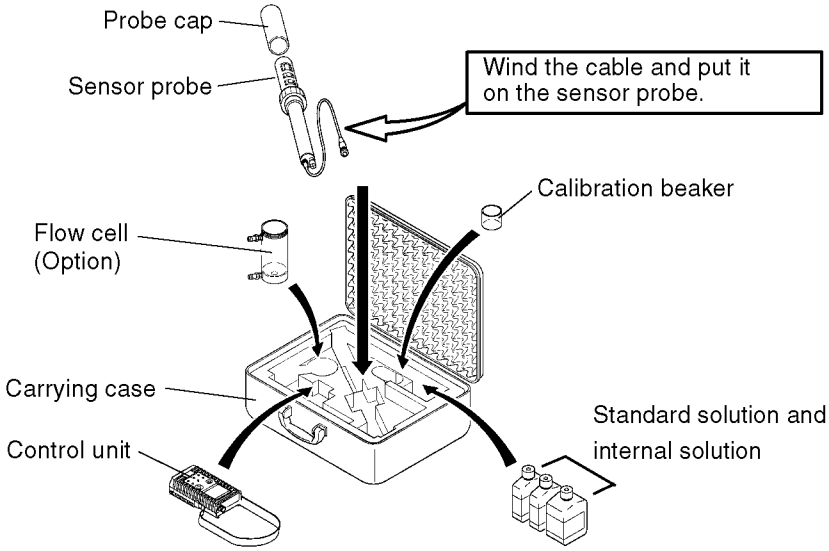
The carring case models W-2010 and W-2030 are applicable to store and transport W-20XD and W-23XD respectively.

Model	Applied to	Storage temperature	Material
W-2010	Cable length 10 m or less	-5 to 60 ˚C	PP, ABS
W-2030	Cable length 30 m or more		

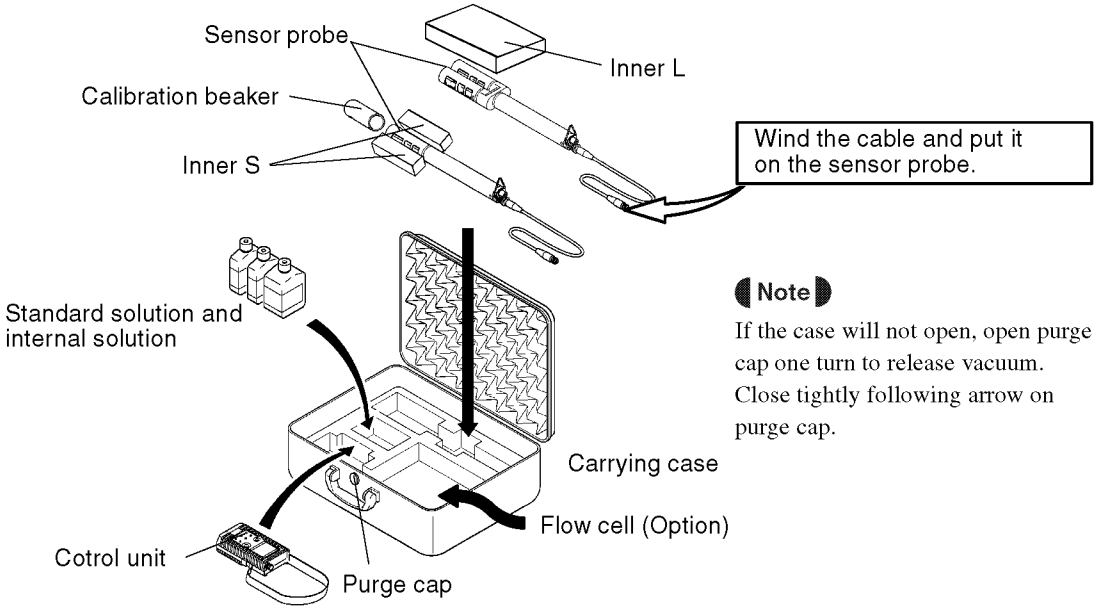
⚠CAUTION

- Do not drop or hit the carring case to protect the units against damage.
- When using the sensor probe with flow cell, separate them for storage.
- Be careful not to catch your finger, when fastening or releasing the laches.

• W-2010



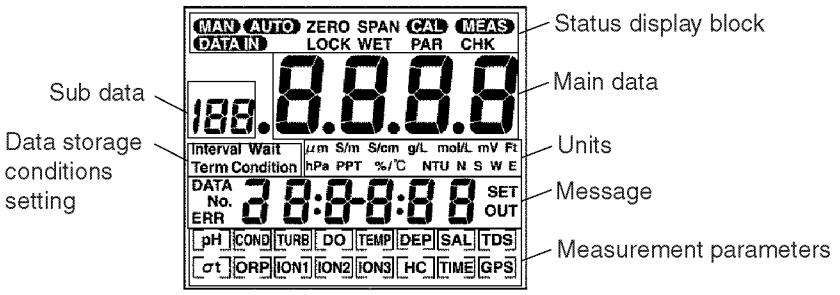
• W-2030



Note

If the case will not open, open purge cap one turn to release vacuum. Close tightly following arrow on purge cap.

2.2.5 Display



Status display

MAN ..... Lit when the data storage and calibration setting is manual.
AUTO ..... Lit when the data storage and calibration setting is automatic.
DATA IN ..... Lit when the data storage operation and the data stroge setting is being performed.
Blinking during calibration.
ZERO ..... Lit in the Zero calibration mode.
SPAN ..... Lit in the Span calibration mode.
CAL ..... Lit in the Calibration mode.
MEAS ..... Lit in the Measurement mode. (Measurements are being made when light up.)
LOCK ..... Lit when the keys are locked.
CHK ..... Lit when the Control unit is in the check mode.

Sub data

Display of the pH, Latitude (degree), Longitude (degree), Year and Check No.

Main data

Display of Measurement data, Latitude (minute, second), Longitude (minute, second), and month and date.

Data storage conditions setting

Interval ..... Lit when data storage time interval is set.
Wait ..... Lit when waiting time is set from the automatic data storage instruction until its start, and during data processing through individual operations.
Term ..... Lit when automatic data storage period is set.

Units

Displays the units for measurement parameters.

Message

Displays the stored data (data mode) and the data No. when the data is stored.
SET ..... Indicates that the Control unit is in Set mode.

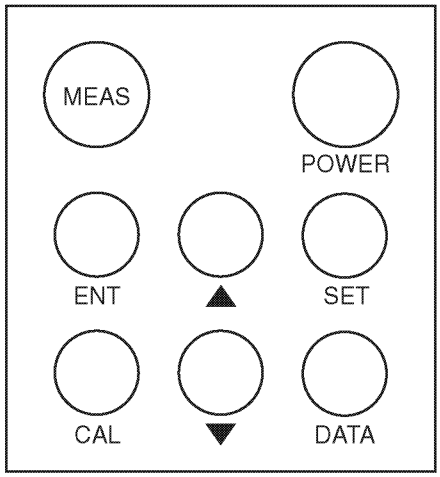
Measurement parameters

Selected parameters to be displayed at Main Data indicator are shown.
Parameters with [ ] : Parameters in brackets [ ] are displayed and their data are stored.
Parameters without [ ] : These parameters are not displayed, but their data are stored.
Refer to page 87, *Measurement parameter setting* for details.

Note

- Because of automatic power off function of the control unit, the indication will disappear if the unit is not operated for about 30 minutes. Turn on the controll unit again to operate it.

2.2.6 Key board



POWER: Power key

Turns the control unit On and Off. After the power is switched on, the initial screen is immediately displayed to indicate the status of the control unit.

MEAS: Measurement key

In the Measurement mode (MEAS is lit), this key switches the measurement parameter.

In addition, pressing the MEAS key returns to the Measurement mode from the Setting, Calibration and Memory Call Up modes.

Note

- Regardless of which mode the control unit is in, it is always possible to return to the Measurement mode by pressing the MEAS key.

ENT: Enter key

In the Measurement mode (MEAS is lit), pressing the ENT key stores the data in memory.
In the Calibration mode (CAL is lit), pressing the ENT key performs calibration.
In the Setting mode, pressing the ENT key switches the setting and fixes entered setting values.

CAL: Calibration key

Pressing the CAL key switches the control unit to the Calibration mode. If automatic data storage is in progress, it is canceled by CAL key.

SET: Set key

Pressing the SET key switches the control unit from the Measurement mode to the Set mode. If the SET key is pressed on the "year, month, day, time" display screen, it switches the control unit to the Check mode.

DATA: DATA key

Pressing the DATA key switches the control unit to the Data mode.

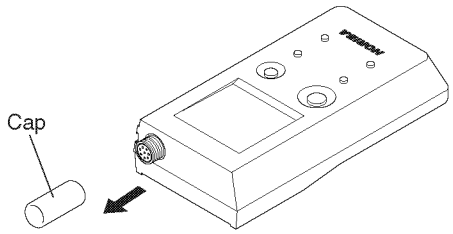
▲▼ : UP/DOWN keys

Use the UP/DOWN (▲▼) keys to set the calibration value in the Manual Calibration.

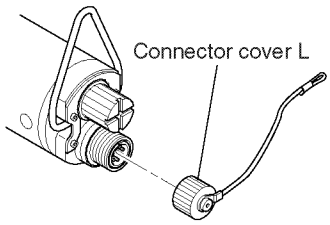
2.3 Setting up the W-20XD series models

2.3.1 Control unit and sensor probe connection

1. Remove the connector cap from the control unit.



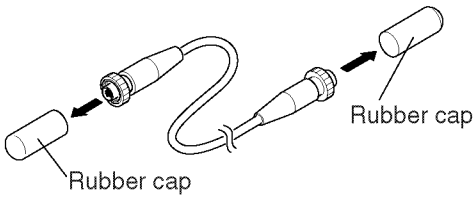
2. Remove the connector cover L from the sensor probe.



Important

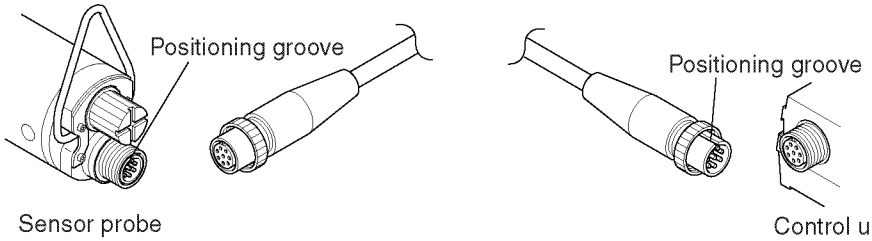
- Attach the removed connector cover L to the hook of the control unit grip holder not to lose it. (☞ page 10).
- The Control unit connector cover and the sensor probe connector cover L are not interchangeable. Use the small one for the control unit connector cover, and the larger one for sensor probe connector cover L.

3. Remove the rubber caps from the cable.



4. Connect the cable to the control unit and sensor probe.

Connect the plug to the control unit connector, and the socket to the sensor probe connector. Align the positioning grooves, fit the cable connectors into the corresponding connectors



Verify that there is no water remaining in the connectors (especially on the probe). It shake the connector of probe and cable after the separation of the connector. Wipe it well by a rolling pin should there be any water remaining before the connection of control unit and sensor probe.
If water or a sample enters the connector inside, WET, CHE is displayed to prevent the formation of rust.

5. Fasten the knurled nut until it does not turn any more.

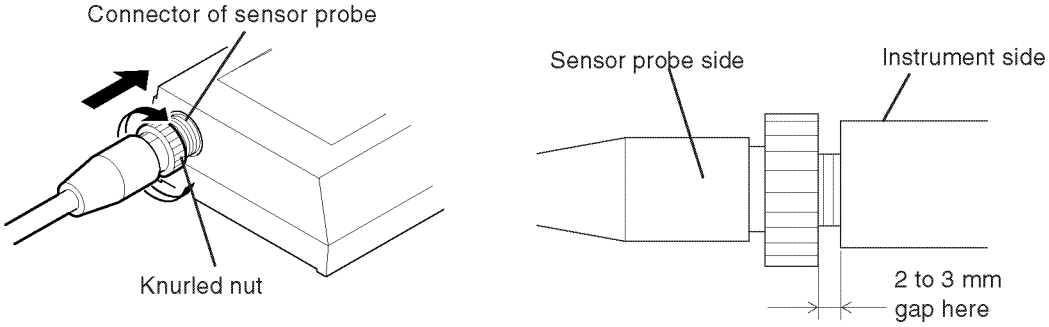
After having tightened by hand, tighten it again a half-turn by tool.

⚠CAUTION

- Turn the knurled nut with holding the knurled part. Otherwise, it will cause breaking of wire.

Important

- The connector cover or sensor probe is not put in the control unit, water proof of structure of the control unit can not be secured.
- Control unit side
  When the sensor probe connector is tightened as far as it can go, a 2 to 3 mm gap is left between the control unit's connector and cable connector.

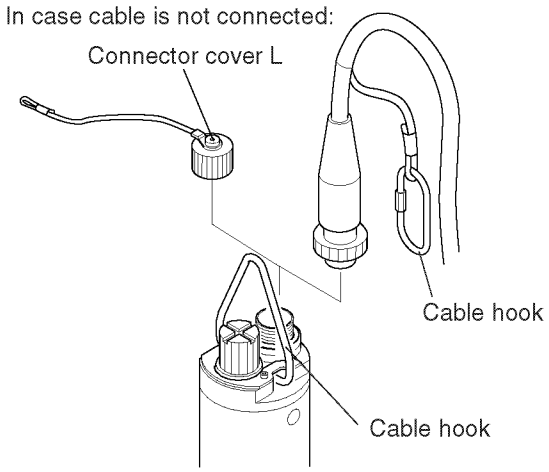


- Sensor probe side
  Pull over the knurled on the O-ring of the sensor probe.

6. Attach the cable hook to the probe hook.

⚠CAUTION

- The hook with the cable must be attached to the sensor probe to prevent breaking of wire.



Important

- Always attach the Connector cover L to the probe connector when the cable is not attached.

2.3.2 Sensor installation

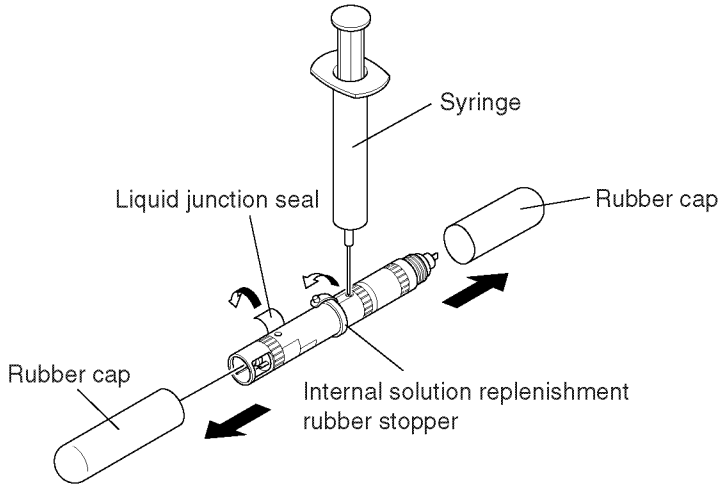
Connect the sensors required.

Preparing pH (pH/ORP) sensor

1. Remove the liquid junction seal and rubber caps.

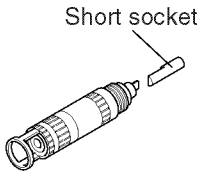
2. Open the internal solution replenishment rubber stopper. Then use a syringe to fill internal solution (#330).

Air bubbles in the internal solution may impair the pressure compensation of the sensor. Avoid air bubbles to enter the inside solution.



Preparing DO sensor

1. Remove the short socket.



Important

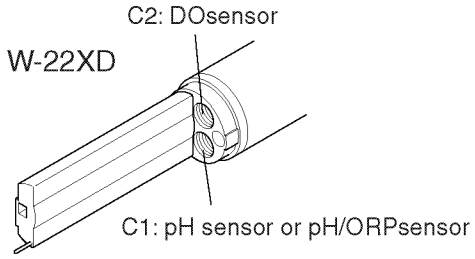
- HORIBA DO sensor uses Diaphragm glavanic battery method.
- Do not throw away the short socket, as it is used for the storage of the DO sensor.
- Always attach the DO sensor to the sensor probe or to the short socket to keep good response. When this is not follwed and left the DO sensor connector naked, the DO reading will become instable and the lifetime will be shorter.
- When the DO sensor connector is left naked for 1 or 2 days, its performance can be retrieved by attaching the shortsocket or connecting to the sensor probe and leaving it for 1 or 2 days. When left naked for a longer period of time, the retrieval may be sucsessful by attaching the necessary parts and leaving it for the same period of time it was left naked. However, when lefted for more than 1 month, the retrrieval is imposible. It is required to replace with new one.

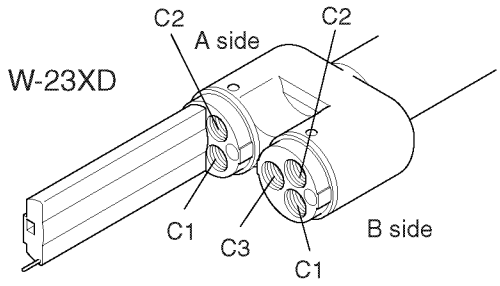
Where to attach

1. The hole on the sensor probe in which each sensor is attached is determined by the type of sensor. Check the type of sensor and the assigned hole before attaching anything.

Important

- Be sure to connect the ion sensor (Cl^-, NO_3^-, Ca^{2+}) to the sensor probe as illustrated. Otherwise, the automatic calibration function would not work.
- Installing the sensor in the wrong hole will damage both the sensor and sensor probe.
- A specific hole, C1 to C3, is not specified for other ion sensors.





A side C1: pH sensor or pH/ORPsensor
C2: DO sensor

B side C1: Cl^- sensor
C2: NO_3^- sensor
C3: Ca^{2+} sensor

Important

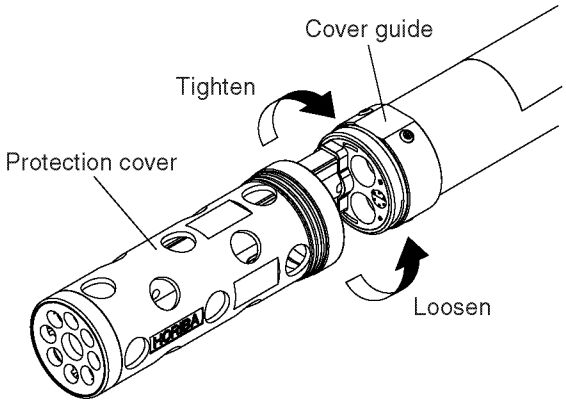
- When the other ion sensors are connected to the sensor probe, C1 to C3 will be indicated as below.
  ION1 → C1, ION2 → C2, ION3 → C3

Installation procedure

Important

- In the W-22XD sensor probes and W-23XD sensor prpbe sideA, install the DO sensor prpbe first and then the pH sensor (pH/ORP sensor). In the W-23XD side B, install the C3 sensor prpbe first.

1. Remove the probe cap and remove the protection cover from the sensor probe.



When the protection cover's screws are firmly fixed in place and cannot be removed by hand, place a spanner on the protection cover and the cover guide to loosen.

Do not try to remove the protection cover by hitting it or giving shocks.

2. Apply silicon grease to the DO sensor's O-rings.

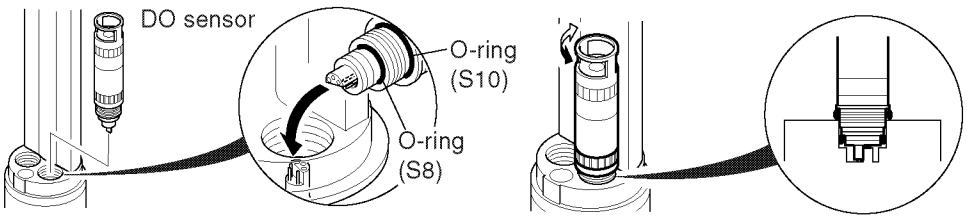
Make sure that no silicon grease gets on the connector.

3. Fit the DO sensor inside the sensor probe hole, being careful to the shape of the connectors.

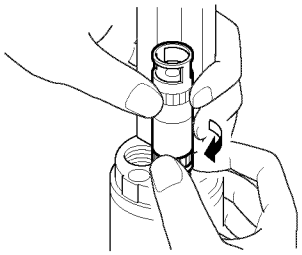
- Make sure that the O-rings is not scratched or twisted. Leakage will cause failures.
- When reconnecting or replacing the DO sensor, replace the O-ring (S8) on the smaller end of the sensor with a new O-rings.

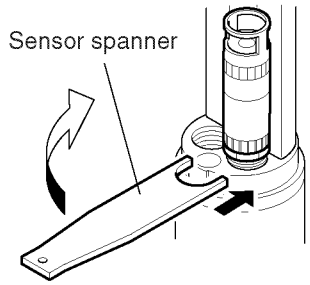
Important

- Press the sensor slightly inward and try turning to check the fit. The sensor cannot be turned if inserted properly.



4. Turn the screw 2 or 3 times by hand and then fully tighten with the sensor spanner.



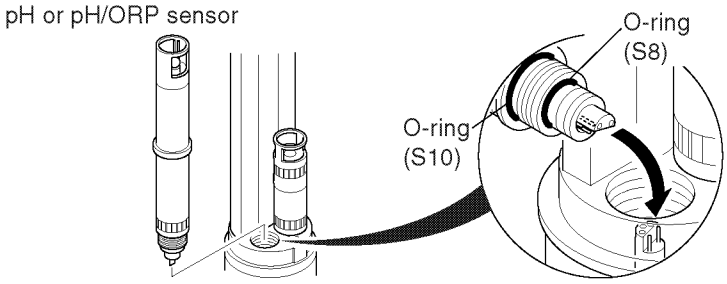


5. Apply silicon grease to the pH or pH/ORP sensor's O-rings.

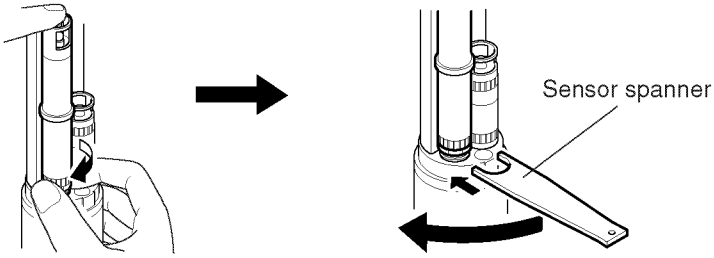
Make sure not to get silicon grease on the connector.

6. Fit the pH or pH/ORP sensor inside the sensor probe hole, being careful to the shape of connectors.

- Make sure that the O-rings is not scratched or twisted. Leakage will cause failures.
- When reconnecting or replacing , pH sensor or pH/ORP sensor replace the O-rings (S8) on the smaller end of the pH sensor or pH/ORP sensor with a new O-rings.



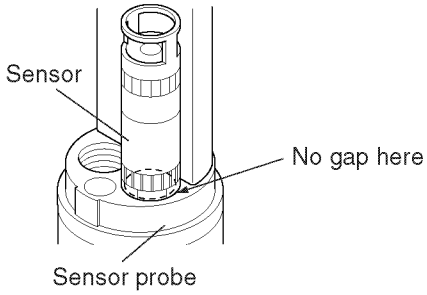
7. Holding the top of the pH or pH/ORP sensor with finger, turn the screw 2 or 3 times by hand and then fully tighten with the sensor spanner.



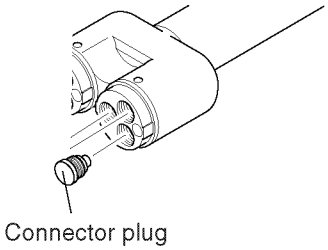
⚠CAUTION

- Unless properly attached, the sensor is not fully waterproof. The sensor is completely fit inside the sensor probe when tightened as far as it will reach.

  Example for DO sensor



- If any of the sensors is not used, be sure to attach a connector plug to the probe instead of the sensor. Otherwise, the sensor probe will not be waterproof.



8. Attach the removed protection cover to the original position of the sensor probe.

Important

- Before attaching each sensor to the sensor probe, do not leave any water drop in the connector.
- Be careful not to contaminate or wet the connector on sensor probe or sensor.

Fasten the guard cover with hand until it touches the end surface. If improperly fastened, it will be loosened and/or humidity inside of the guard cover can not be maintained during storage. Fastening by hand is enough, do not use a spanner or other tool to fasten or the screws may break.

2.3.3 Installation and replacement of the battery

The W-20XD series is shipped from the factory without battery installation. Manganes type batteries included in the accessories. When using the control unit for the first time or replacing the battery, perform the following procedure:

Type of battery:

Control unit (W-2000S) ..... Alkaline battery 6LR61 (or manganese battery 6F22 [006P])
1 piece.
Sensor probe ..... Alkaline batteries LR03 [AAA] (or manganese battery [R03])
3 pieces.

Notes on handling the battery

The improper use of battteries may cause leaks of electrolyte and explosion.

- Set the batteries in place properly paying attention to the plus (+) and minus (–) poles.
- Do not combine old and new batteries or batteries of different types.
- Do not use rechargeable batteries.
- Dry battery can not be recharged.
- Remove the batteries when not in use for a long.
- In case of battery inner solution leakage, wipe off it in the battery case thoroughly and place new battteries.

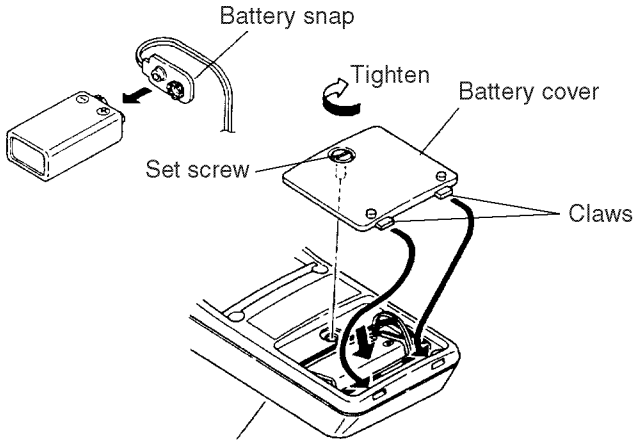
Note

- The battery originally included to the unit is for operational monitoring purpose only, and the service life of the battery is not guaranteed.

Control unit (W-2000S)

1. Loosen the set-screw on the battery cover and remove the cover.
2. Remove any old battery.
3. Fit the battery snaps to a new battery and insert the battery assembly into the control unit.
4. Insert the claws on the battery cover into the grooves in the control unit.
   Then tighten the set screw.

   The battery snap may be loose for some batteries. In such a case use radio pliers and tighten the metal snap fittings.



Important

- When removing the battery snap, do not pull it too strongly.

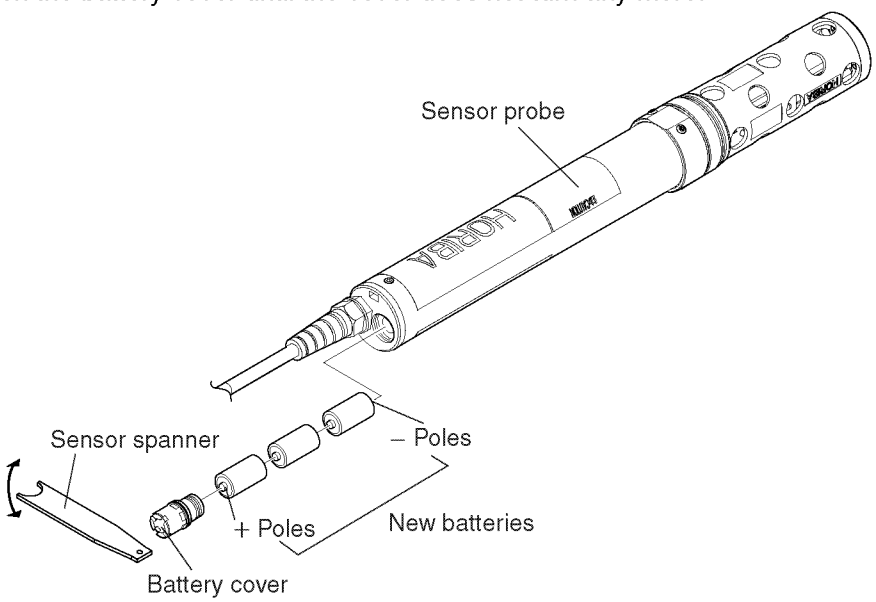
Note

- This battery lasts for three hours at normal temperatures. (Do not use a manganese battery.)
- Battery in the control unit is consumed first then the battery in the sensor probe will be consumed. Batteries last approximately 30 hours in normal temperature. (In case of alkaline battery)
- With Manganes battery, expected life time is one-half of alkaline battery.

Sensor probe

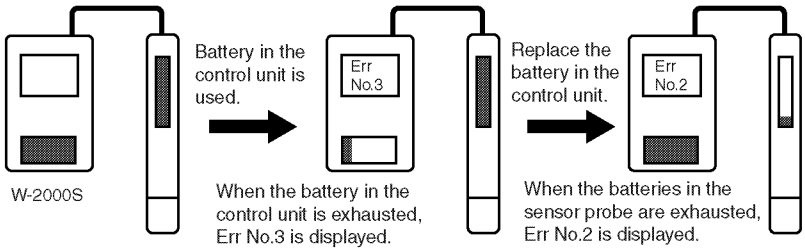
Batteries for sensor probe are used to store data and backup the stored date.

1. Remove the battery cover using a sensor spanner.
2. Remove any old batteries.
3. Insert new batteries making sure that the plus (+) and minus (-) poles match the terminals correctly.
4. To keep the sensor probe water-resistant, use a chip spanner as illustrated below and tighten the battery cover until the cover does not turn any more.



⚠ CAUTION

- When replacing the batteries of the sensor probe, be sure to connect the sensor probe to the control unit. Otherwise, the memory will be reset and all the data saved in the memory will disappear.
- When the sensor probe is connected to the control unit, battery in the control unit is consumed.

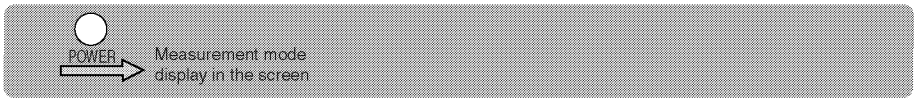


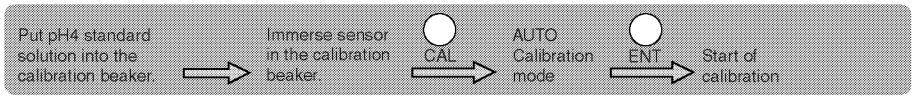
- When the display unit is connected with the sensor probe, electric power is supplied from the battery installed in the display unit to both display unit and sensor probe. If the battery in the display unit is consumed, energy source is swtched to the battery in the sensor probe so that the masurement can be continued. However, in this case, energy is not supplied to the display unit and no indication is given.

MEMO

3. Basic operation

Automatic calibration and measurement of the pH, conductivity (COND), turbidity (TURB), dissolved oxygen (DO), water depth (DEP) and ion (ION1, 2, 3) sensors are explained.

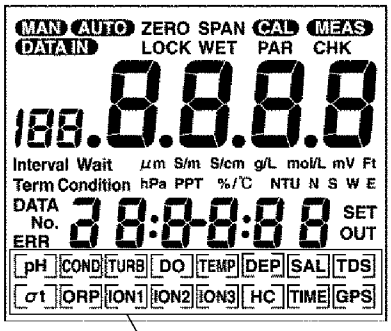




3.1 Key operations and mode switching

Measuring parameters and displays which are switched with the MEAS key

The measurable parameters are displayed. The parameters selected with the MEAS key will be indicated with [ ].



Display

The symbols displayed and their meanings are as follows:

pH ..... pH
COND ..... Conductivity
TURB ..... Turbidity
DO ..... Dissolved Oxygen
TEMP ..... Water temperature
DEP ..... Depth
SAL ..... Salinity
TDS ..... Total dissolved solids
σ_t ..... Specific gravity of seawater
ORP ..... Oxidation reduction potential
ION1 ..... Cl^- (Chloride) ion
ION2 ..... NO_3^- (Nitric acid) ion
ION3 ..... Ca^{2+} (Calcium) ion
TIME ..... Display of date and time
GPS ..... G.P.S. (Global Positioning System) information

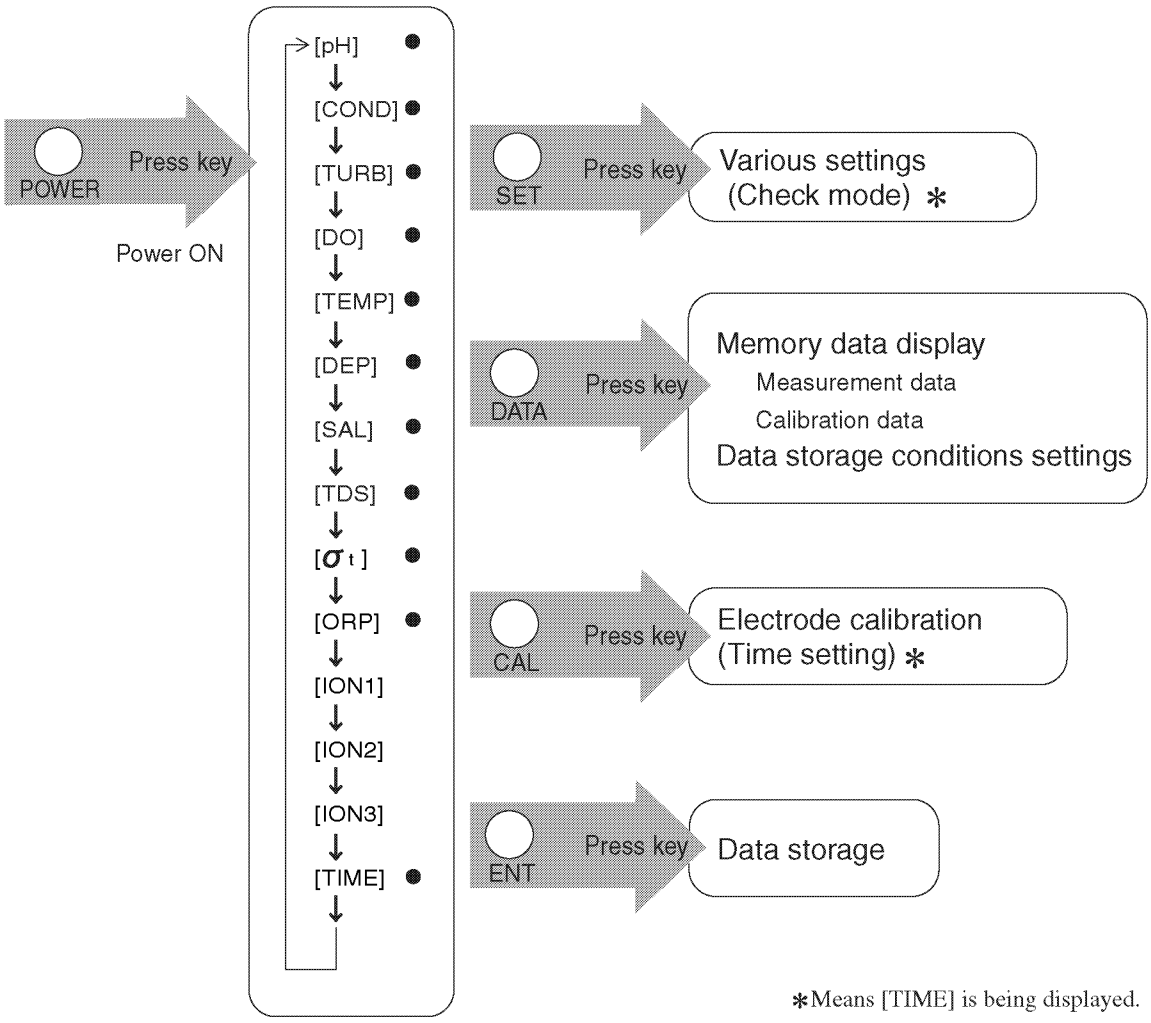
* When optional sensors C1, C2, and C3 are connected to the control unit, ION1, ION2, and ION3 appears for the optional sensors C1, C2, and C3, respectively,

Note

- [GPS] lights up when the optional G.P.S. sensor has been connected to the control unit and position information is received from the G.P.S. during the measurement. For more information, refer to the instruction manual U-2001/U-2002.

W-23XD Measurement mode

(MEAS) When the MEAS key is pressed, the next measurement parameter appears.



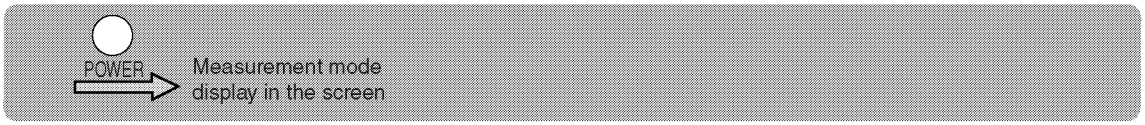
✻Means [TIME] is being displayed.

Note

- The measurement parameters for the W-22XD model are indicated as ●.
- "*Measurement parameter setting*" on page 87 explains how to set the display.

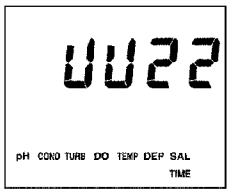
3.2 Operation procedure

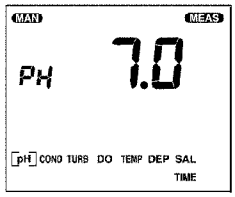
3.2.1 Power ON



1. Press the **POWER** key.

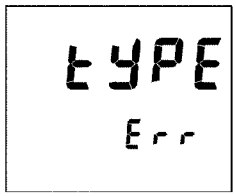
The display will change in the order of All segment display → Sensor detector display → pH Measurement mode.





(In case of W-22XD)

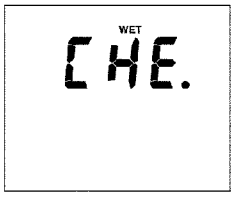
When the sensor probe is not connected,



is displayed.

Before turning ON the control unit, connect the sensor probe properly (☞ Refer to page 15).

Stay water or sample in cable connecting connector



is displayed.

In that case, after turning OFF the power, wipe dirt and water off the connector and then turn the power ON again.

3.2.2 AUTO calibration method

To obtain correct measurement, it is necessary to calibrate the sensor using the standard solution before performing measurement. Previous calibration records shown in calibration data. See page 47 "Calling up The calibration data"

Note

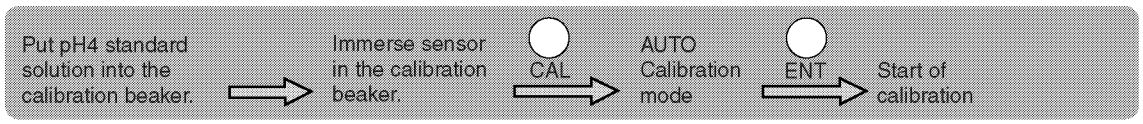
- In the AUTO calibration mode, the pH and COND sensors are calibrated with pH4 standard solution, and the DO and DEP sensors in the atmosphere simultaneously.
  Calibration contents at 25 °C are as follows:
  pH: Calibrate at 4.01 (zero calibration) and the Span is the adjustment value at the factory.
  COND: 0.449 S/m (Span calibration), the Zero is the adjustment value at the factory.
  TURB: 0 NTU (zero calibration), the Span is the adjustment value at the factory.
  DO: 8.52 mg/L (Span calibration), the Zero is the adjustment value at the factory.
  DEP: 0 m (Zero calibration), the Span is the adjustment value at the factory.

Auto-Cal Explanations

When "Auto-Cal" function is used with no calibration record, it will make one point calibration with the value seen below. We recommend to use this function, when no calibration record exists or the calibration is lost, and you're in need for quick & fast calibration
When "Auto-Cal" function is used after manual two-point calibration, please be reminded of the description below. We recommend not to use "Auto-Cal" function when manual two-point calibration is performed already.

	Auto Cal Value	What happens when "Auto Cal" is performed after manual two point calibration	Recommendation
pH	4.01 pH	When "Auto Cal" is performed after two point manual calibration (manual zero calibration and span calibration): 1) The manual zero calibration value will be over written. 2) The slope of the calibration curve calculated by manual calibration will remain unchanged.	
Conductivity	0.449 S/m	"Auto Cal" will over write the mid-range span value (0.090~0.999 S/m) with 0.449 S/m. The span value of the lowest / highest ranges will also be automatically calculated and over-written by mid-range span value. The manual zero calibration value will remain unchanged.	In order to obtain a high accuracy in calibration, we recommend using the standard solution for each range.
Turbidity	0 NTU	The manual zero calibration value will be over-written by "Auto Cal". The manual span calibration value will remain unchanged.	For both manual and "Auto-Cal", make sure the container for the standards is clean and have no contamination. When the standard is contaminated, it will affect the lower turbidity value.
DO	8.52 mg/L	The manual span calibration value will be over-written by "Auto Cal". The manual zero calibration value will remain unchanged.	
Depth	0 m	The 0m amount will be replaced by "Auto Cal" .	

- Values may be unstable if there is temperature fluctuation. Calibrate after waiting for about an hour.

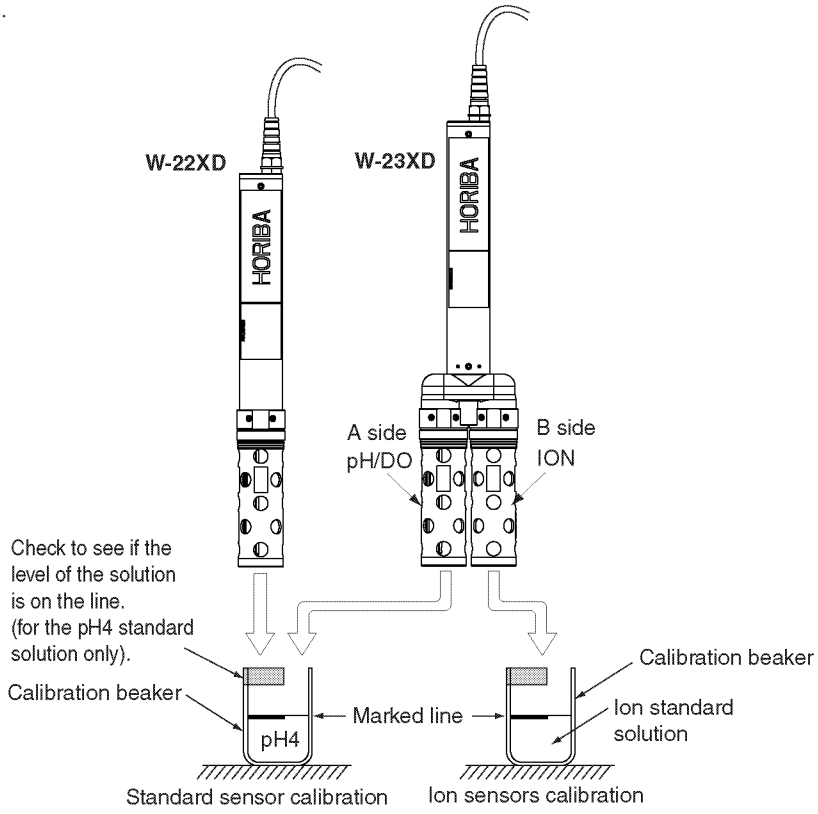


Calibrate with the following procedure.

1. Wash the sensor with distilled water a few times and put the pH4 standard solution into the calibration beaker to the marked line. Then immerse the sensor in it.
For the W-23XD model, immerse the sensor A side.

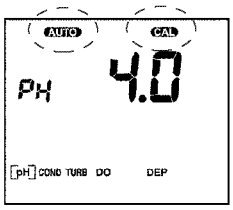
Important

- According to the label indication on the calibration beaker, check to see if the level of the calibration solution is on the label line.



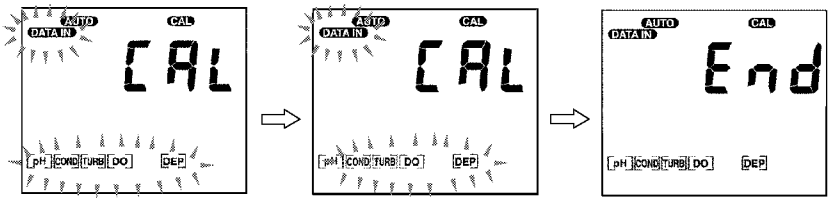
2. Press the **CAL** key, when one of pH, COND, TURB, DO or DEP is selected.

AUTO and CAL appear and the control unit enters the AUTO Calibration mode.



3. Press the **ENT** key to start AUTO Calibration.

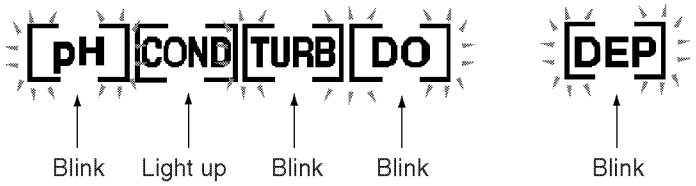
Upon completion of all of the pH, COND, TURB, DO, and DEP, End will be displayed.
During calibration, DATA IN and [ ] for the selected measurement parameter blink. [ ] light up for the parameter of which calibration is finished.



End of calibration

When DATA IN is blinking
To stop the calibration ..... press the CAL key.
To fix the calibration ..... press the ENT key.

Example: When COND calibration is finished:
[ ] for [COND] stops blinking is lit



Note

- For any parameter in which the calibration error has happend, calibration can not be performed, and [ ] indication keeps blinking. If two or more errors happen, an error with a smaller error number appears. (See pages 98 to 100 for these errors and troubleshooting.)
  These calibration errors disappear when the sensor is calibrated properly again, or when the control unit is turned ON again.
- Calibration is performed simulitaneous and independently for all these parameters until each reading becomes stable, but the maximam duration allowed is three minutes. If the reading can not become stable within three minutes, the calibration terminates and calibration error is given to the correspondent parametre(s).

4. Press the **MEAS** key to return to the Measurement mode.

Important

- Neutralize pH 4 standard solution before disposal.

AUTO calibration of the ion sensors (W-23XD model only)

AUTO calibration is possible only for the combination of Cl^-, NO_3^-, Ca^{2+}.
For other ion sensors, the manual calibration is required after setting ion valence described on page 82.
Span calibration value preset for auto calibration corresponds to the concentration of standard solution provided as an accessory or 10 times diluted value of the standard solution.

Important

- Ion sensors take time to give stable indications. Therefore, immerse the ion sensors in standard solution for approximately one hour prior to the calibration. Then calibrate the ion sensors and perfom measurements.

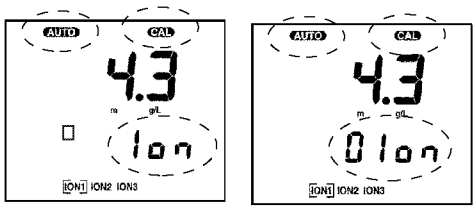
1. Wash the sensor with distilled water a few times. Put the supplied ion standard solution (#130) into the calibration beaker to the marked line. Then immerse the B side of the sensor in it.

2. Enter ion measurement mode at one of ion 1, ion 2 or ion 3.

3. Press the **CAL** key.

AUTO, CAL, and "Ion" appear. The control unit then enters the AUTO Calibration mode.

4. Press the **SET** key.

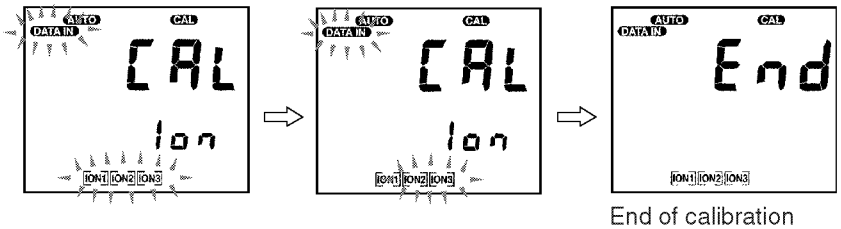


When "Ion" is diplayed:
When 35.5 mg/L, 31.0 mg/L, or 20.1 mg/L is displayed, use these values for span calibration 1 "For Chloride, Nitrate and Calcium ion sensors".

When "0 Ion" is displayed:
When 3.55 mg/L, 3.10 mg/L, or 2.01 mg/L is displayed, use these values for dencity by 1/10 of span calibration 2 "For Chloride, Nitrate and Calcium ion sensors".

5. Press the **ENT** key to start AUTO calibration.

Upon completion of the AUTO calibration of all the ion sensors ION1, ION2, and ION3, End will be displayed.



End of calibration

When DATA IN is blinking
To stop the calibration ..... press the CAL key.
To fix the calibration ..... press the ENT key.

6. Press the **MEAS** key to return to the Measurement mode.

3.2.3 Measurement

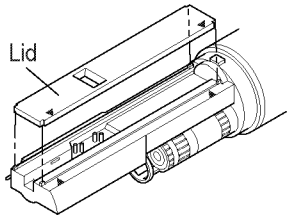
There are three methods to make measurement as follows:

- **Manual storage of data while monitoring the measurement data**
- **Automatic storage of data along the water depth**
- **Automatic and continuous storage of data**

Select one of them according to the measuring purpose.

Important

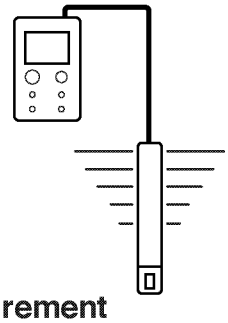
- When immersing the sensor probe in the sample, lower slowly the sensor probe into the sample.
- Dropping it from a height of 1m or more may cause damage to the sensor.
- Do not immerse the sensor probe at the depth of exceeding 100 m.
  The device can resist the hydraulic pressure at the depth up to 100 m.
- Do not remove the COND/TURB lid during calibration or measurement.
- Attach the lid to the cell with fitting four corners and facing ▲ marks each other as illutrated.
- Perform AUTO calibration after attaching the lid again, when the lid has been removed for the cleaning. A slight difference of the fitting position of the lid causes the indication variation of turbidity.



- Contacting with a different kind of metal, protection cover of the sensor probe may cause an error in measurement. Be careful not to let protection cover touch with any metal in measurement.

Manual storage of data while monitoring the measurement data

In this method, measured data are manually stored after comfirming the indication becomes stable. Measurement is made at a shallow point with the sensor probe being connected to the control unit.



1. Preparation for measurement

1. Immerse the sensor probe in the sample, and shake the sensor probe slightly to remove the bubbles around the sensor.
2. Make sure that MAN is displayed on the Measurement mode.
   If AUTO is displayed, switch to MAN display.
   (☞ page 39, Switch to MAN display on the measurement mode)
3. Select the measurement parameters with the MEAS key.
   (☞ page 26, 3.1 Key operations and mode switching.)

Note

- [GPS] lights up when the optional G.P.S. is connected to the control unit and position information is received from the G.P.S.
- The measurement parameters can be changed by setting "*Measurement parameter setting*" described on page 87.

2. Measurement of data

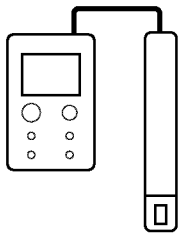
After the indication becomes stable, press ENT key to store the data.
(☞ page 38, 4.1 Manual storage of data while monitoring the measurement data)

Automatic measurement along water depth

Measured data along depth are stored through the automatic data storage function.
Stored data can be taken into the PC with U-2001 extension adapter.

What should be prepared: Rope (which is long enough to reach the depth to be measured) and U-2001 extension adapter.

1. Automatic Data memory condition setting



1. Connect the sensor probe to the control unit.
2. Set the conditions of the automatic data memory. (☞ page 40, 4.2.1 Data memory conditions setting.)
   For example, set the following conditions
   Interval : 2 seconds
   Waiting : 30 seconds (,which is shorter than the time needed from the start of automatic data storage until the solution soaks through the sensor probe).
   Term : 30 minutes (which is longer than the time needed from the start of the storage until the sensor probe reaches the bottom of the water)

Note

- Since the set values are memorized, resetting the condition every time of measurement is not requird.
- In the above example, data storage is started before sensor probe immersion starts and terminated after the sensor probe returns to the air.
  Stored data can be taken in the PC to compile.

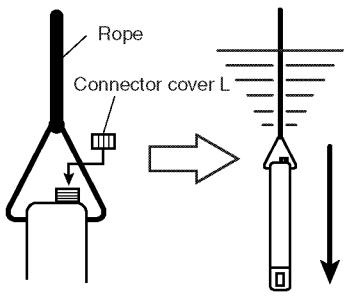
2. Checking the data storage function

Check whether the data can be normally measured according to the procedure of "manual storage of data while monitoring the measurement data".

3. Start of automatic data storage

Follow the procedure of "☞ page 43, 4.2.2. Start of automatic data storage" to operate.

4. Measurement of the data



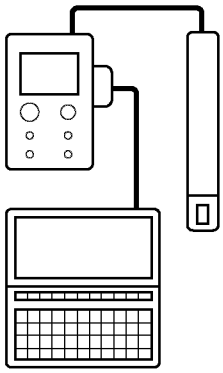
1. Remove the cable from the sensor probe and fit the connector cover L.

Important

- Fit the connector cover L securely.

2. Attach the rope to the sensor probe.
3. Lower the sensor probe into the sample at the rate of about 10 seconds per meter until it reaches the bottom, then raise it from the sample.

5. Compilation of the measured data



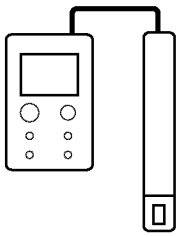
1. Connect the cable to the control unit to the sensor probe supply power.
   When DATA IN is blinking, press the CAL key to stop the automatic data storage.
2. Connect the expansion adapter to take the data into PC.

Automatic and continuous storage of data

In this method, successive measured data are stored in the memory by using the automatic data memory. Stored data can be taken into the PC with U-2001 extension adapter.

What should be prepared: Rope (which is long enough to reach the depth to be measured) and U-2001 extension adapter.

1. Automatic Data memory condition setting



1. Connect the cable and sensor probe to the main unit.
2. Set the conditions of the automatic data memory. (☞ page 40, 4.2.1 Data memory conditions setting.)
   Set the following conditions
   Interval : maximam 24 hours to minimum 2 secods
   Waiting : maximam 24 hours to minimum 2 secods
   Term : 30 days

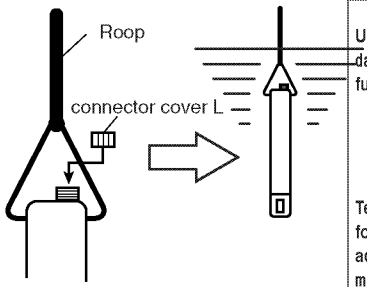
2. Checking the data storage function

Check whether the data can be normally measured according to the procedure of "manual storage of data while monitoring the measurement data".

3. Start of automatic data storage

Follow the procedure of "☞ page 43, 4.2.2. Start of automatic data storage" to operate.

4. Measurement of the data

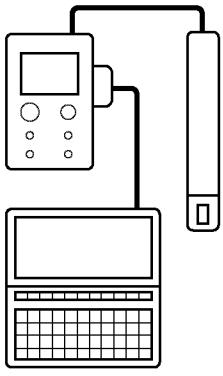


1. Remove the cable from the sensor probe and fit the connector cover L.

Important

1. Fit the connector cover L securely.
2. Attach the rope to the sensor probe.
3. Place the sensor probe at the depth to be measured.

5. Compilation of the measured data



1. Connect the control unit again to the sensor probe and supply power. When DATA IN is blinking, press the CAL key to stop automatic data storage.
2. Connect the extension adapter to take the data into PC.

Notes in obtaining data on depth

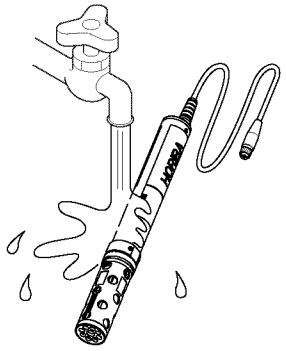
- When the sensor probe is placed at a depth of 100 m or more, the probe may be broken.
  In measurements on the model W-23XD, the Ca^{2+} and NH_4^+ ion sensors can be used only at depth up to 15 m, and the K^+ ion sensor only at depth up to 3 m. This is due to the membrane property.

Notes for reliable measurements

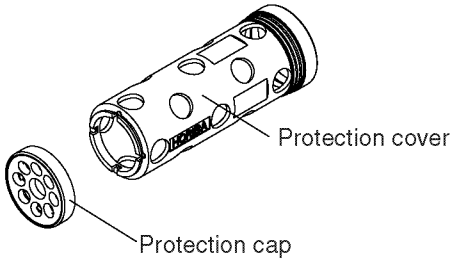
- Any sensor contamination may affect measurements. Conduct AUTO calibration mode to check contamination on sensors approximately once a day for ion measurements and approximately once a week for others.

3.2.4 After completion of measurement

1. Turn off the power of the control unit.
2. Use tap water to completely wash off the sample on the sensor probe and then wipe waterdrops.



Remove the protection cover and completely wash out with tap water the sample water left on the screws. Reinstall the cover after having wiped off the drops of water. If there is any sample (especially sea water) left on the screws, rust may form and may cause the difficulty to detach the protection cover. (☞ Installation procedure, page 19.)
Depending on the level of dirtiness, remove the rubber protection cap from the protection cover and wash out with tap water. Reinstall it after wiping off the drops of water.



3. Pour about 20 mL (about 2 cm from the bottom) of pure water in the probe cap and install it on the sensor probe. Place the rubber cap on the connector and store the control unit in the carrying case. (☞ 2.2.2 Sensor probe, page 10.)

Letting the pH or pH/ORP and DO sensors get dry may cause deterioration of the sensors' performance. Should the sponge inside the probe cap be dried or contaminated, replace it with a clean sponge (included).

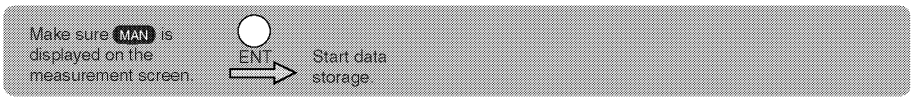
4. Disconnect any cables from the control unit before storing.

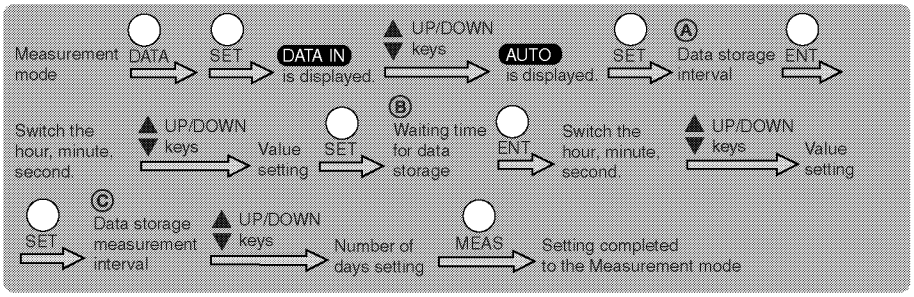
Important

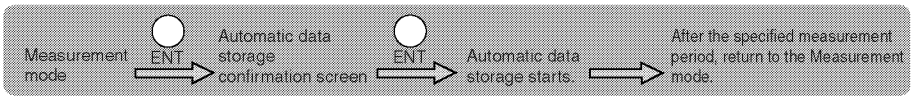
- Do not put water in the probe cap to the ion sensor end (B side) of W-23XD for storage.
- When storing after having disconnected the cables from the sensor probe and the control unit itself, verify that there is no water remaining on the connectors and put in place the rubber cap and connector cover.

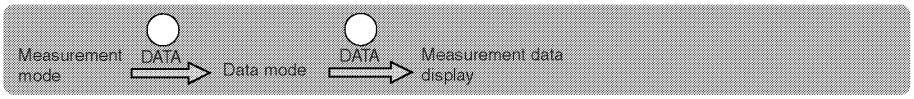
4. Using the data memory function

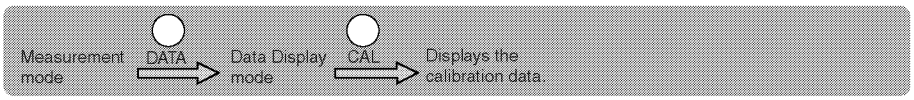
The data memory function can be used to store manually measurement values with associated data numbers and to store automatically measurement values at fixed intervals.









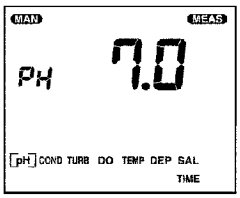


4.1 Manual storage of data while monitoring the measurement data

Make sure MAN is displayed on the measurement screen. → ENT → Start data storage.

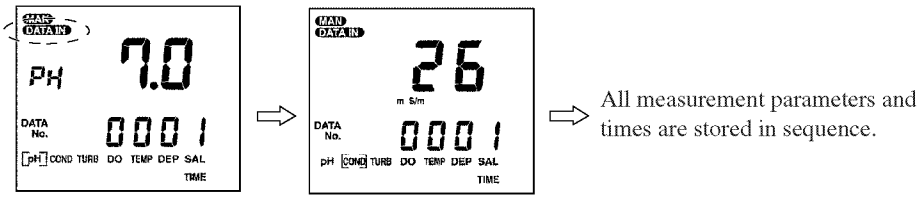
1. Make sure that MAN is displayed on the Measurement mode.

If AUTO is displayed, switch to MAN display.
(☞ page 39, Switch to MAN display on the measurement mode)



2. Press the ENT key.

Data storage starts, DATA IN and the data No. are displayed on the screen, and the measured value to be stored and the measurement parameter are displayed in order at approximately 0.5 second intervals.



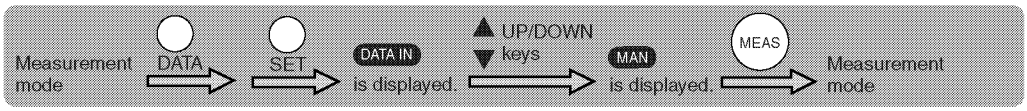
All measurement parameters and times are stored in sequence.

After the data is stored in memory, the screen returns to the original Measurement mode.

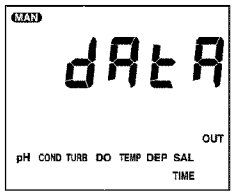
Note

- Up to 2880 sets of data can be stored in the memory.
  When 2880 sets of data have been stored in the memory, ERR 9 appears and no more data can be stored. In this case, clear the data stored refering to "*Data memory clear*" in page 89 to enable store new data.

When AUTO is displayed
Switch to MAN display on the measurement mode

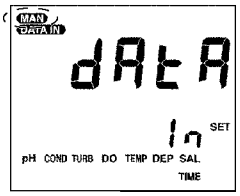


1. Press the **DATA** key in the Measurement mode.



2. Press the **SET** key.
DATA IN is displayed.

3. Press the **UP/DOWN** (▲ ▼) keys to display MAN.



4. Press the **MEAS** key to return to the Measurement mode.

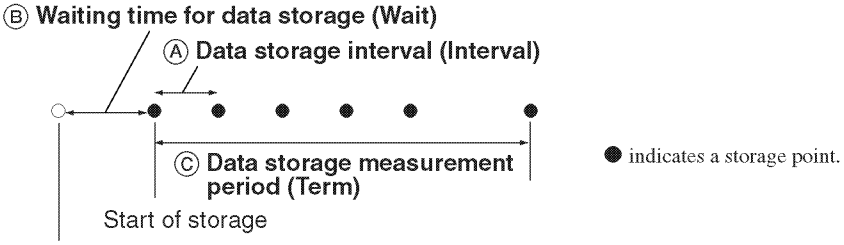
4.2 Automatic data storage

Measured values are stored automatically at preset time intervals. Before using the automatic storage, the following condition settings are required:

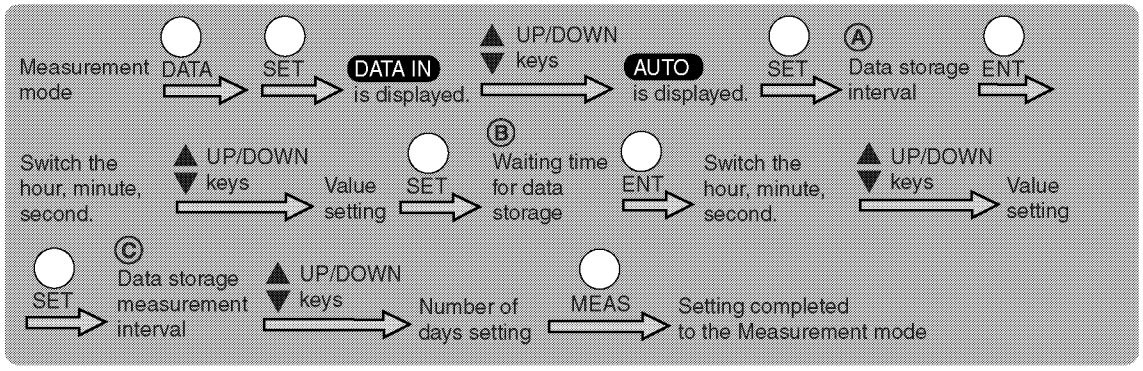
Ⓐ Interval : time interval between two data memory

Ⓑ Wait : time between data memory command and start of data storage
Time should be preset shorter than time required for the sensor probe to reach water surface from operator's hands. With this setting, the data storage commences before reaching water surface and the data from 0 m of water depth can be obtained.

Ⓒ Term : time between start and termination of data storage
Time should be preset longer than time required for sensor probe to reach bottom of water from the start of data storage. With this setting, the data storage still continues after reaching bottom and data can be surely obtained to the bottom.

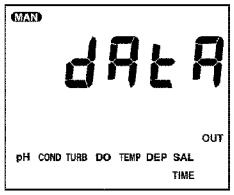


4.2.1 Data memory conditions settings



Condition settings display

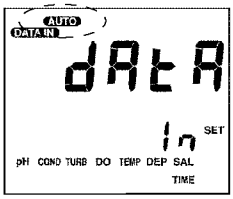
1. Press the **DATA** key in the Measurement mode.



2. Press the **SET** key.

DATA IN is displayed.

3. Press the **UP/DOWN** (▲ ▼) keys to display **AUTO**.



Setting of data storage interval

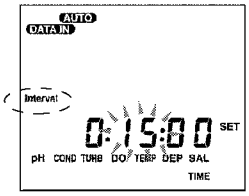
4. Press the **SET** key to display data storage interval Ⓐ setting.

"**Interval**" is displayed.

5. Press the **ENT** key to switch the among "hour", "minute" and "second" and set the value using the **UP/DOWN** (▲ ▼) keys.

(Data storage intervals can be set from 2 seconds to 24 hours.)

The current setting location will blink.



Setting of waiting time for data storage

6. Press the **SET** key to display waiting time for data storage Ⓑ setting.

"**Wait**" is displayed.

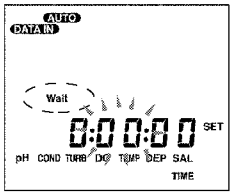
7. Press the **ENT** key to switch among "hour", "minute" and "second" and set the value using the **UP/DOWN** (▲ ▼) keys.

(The waiting time for data storage can be set from 2 seconds to 24 hours.)

The current setting location will blink.

Important

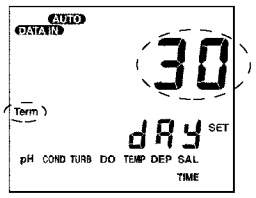
- If wait time is set to "0", the first data is not stored.



Setting of the data storage measurement period

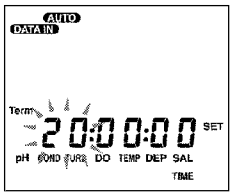
8. Press the **SET** key to display data storage measurement period ⓒ setting. (number of days).
"**Term**" is displayed.

9. Use the **UP/DOWN** (▲ ▼) keys to set the value (number of days).



Setting of less than 24 hours

First set the number of days to 00 then press ENT key to select the "hour/minute/second" setting. Use the UP/DOWN (▲ ▼) keys to set hour, minute and second. During setting, the number to be set blinks.

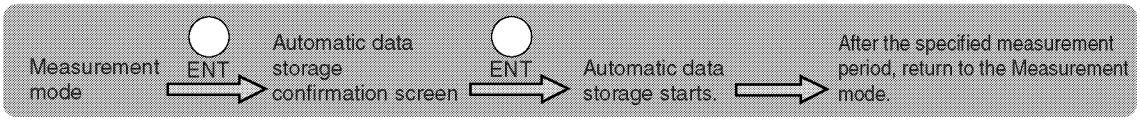


Note

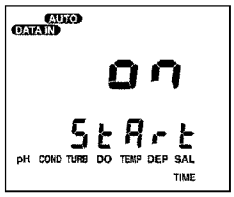
- Press the SET key to return to step 4.

10. When the **MEAS** key is pressed, setting will be completed and the control unit will return to the Measurement mode.

4.2.2 Start of automatic data storage



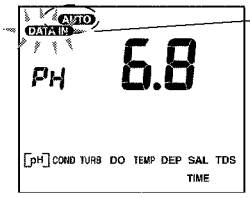
1. Make sure that AUTO is displayed on the Measurement mode.
2. Press the **ENT** key. A confirmation screen will be displayed asking if automatic data storage should start.



Note

- If automatic data storage is not required, press the CAL key to return to the Masurement mode.

3. Press the **ENT** key to start automatic data storage.



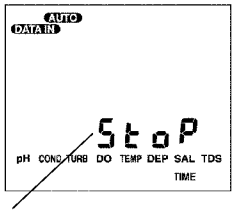
While DATA IN is blinking, the automatic data storage is being executed.

Note

- During the automatic data storage, measurement parameters can be switched by pressing the MEAS key.

Important

- During the automatic data storage, the ENT, SET, and DATA keys do not function and therefore calibration, setting change and stored data display cannot be performed.
- To stop automatic data storage, press the CAL key.



Confirmation display for canceling automatic data storage appears.
To stop the automatic data storage ..... Press the ENT key.
To return to the screen for the automatic data storage ... Press the DATA key.

4. After the preset measurement period is over, DATA IN disappears and the control unit returns to the normal Measurement mode.

Note

- When the control unit is turned on, AUTO lights up and DATA IN blinks if automatic data storage is being performed with the sensor probe.

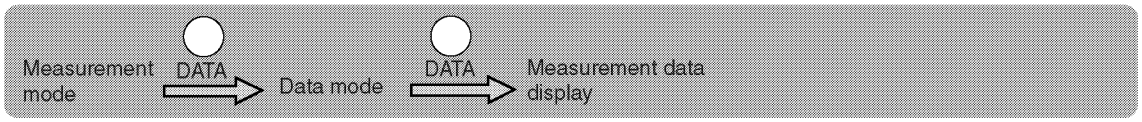
Notes for automatic data storage

- For long-term data storage, replace the sensor probe battery with a new one.
- The connector from the control unit can be renmoved. It can be operated up to 60 hours at room temperature with the battery in the sensor probe (alkaline battery). Life is reduced by approximately one half when manganese batteries are used.
- If the sensor probe is connected to the control unit for monitoring, the control unit battery is first consumed to protect the memory of the sensor.
- When 2880 sets of data have been stored in the memory, ERR 9 appears and no more data can be stored. The automatic data storage is automatically ended and the control unit returns to the normal Measurement mode.
- Because ion sensors need to be calibrated once a day in measurements on the W-23XD model, the maximam recommendable automatic data storage period is one day only.

4.3 Calling up data from the memory

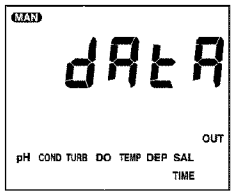
4.3.1 Calling up measurement data

Reading out data that has been stored manually or automatically.



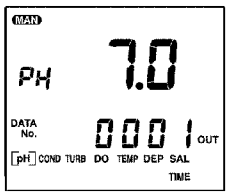
1. Press the **DATA** key in the Measurement mode.

The control unit goes to the DATA mode.



2. Press the **DATA** key.

The measurement data is displayed.
Data required can be displayed by selecting a measurement parameter and data No.



DATA key ..... Selects measurement parameter or memory data No.

When switching measurement parameters : Measurement parameter blinks.
When switching data No. : Data number blinks.

UP/DOWN (▲▼) keys .... Switch measurement parameter or No. which has been selected with the DATA key.

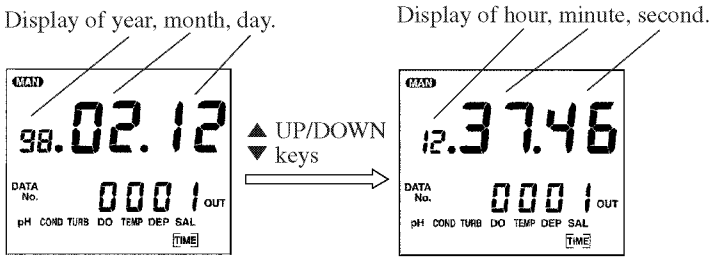
Note

- If the CAL key is pushed, only the data numbers will be displayed, allowing rapid changing of the numbers. Push the UP/DOWN (▲▼) keys to find the number desired, then press the SET key to display the data.

3. Press the **DATA** key.

TIME data

Use the UP/DOWN (▲▼) keys to switch between "Yer, Month, Day" and "Hour, Minute, Second".

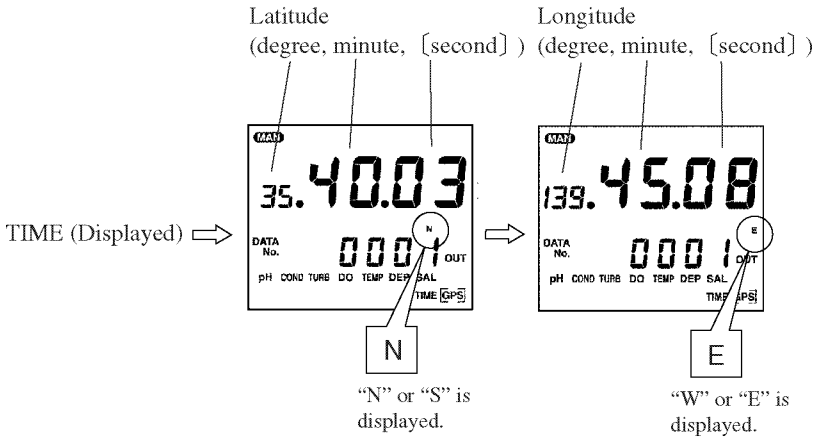


Note

- The time in the automatic memory may have error about 2 seconds.

G.P.S. data (only when G.P.S. data is present)

Use the UP/DOWN (▲ ▼) keys to switch between "Latitude" and "Longitude".



Latitude N → The North latitude S → The South latitude
Longitude E → The East longitude W → The West longitude

ENT key ..... Prints all measurement data displayed from memory.
(when the printer is connected to the control unit)

Useful key function in automatic storage

SET + UP (▲) key ..... Displays the first part of the next data automatically stored.
SET + DOWN (▼) key ..... Displays the first part of the previous data automatically stored.
If there is manual data, then the previous or next manual data is shown.

Display for automatic storage

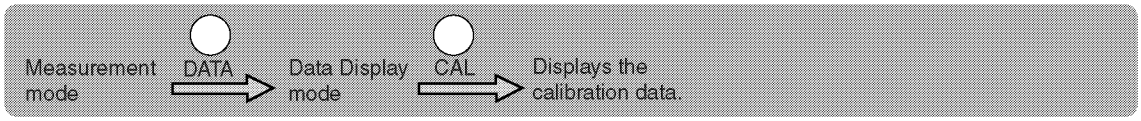
For the first and last data in one sequential automatic storage, the following identification marks are displayed before the data Nos.:
[: displayed for the first data in automatic storage.
] : displayed for the last data in automatic storage.

Note

- When the MEAS key is pressed, data calling is stopped and the control unit returns to the Measurement mode.
- Data is called from the sensor probe so to get one data takes about one second.

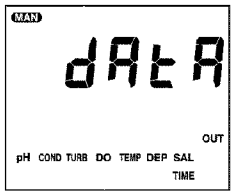
4.3.2 Calling up the calibration data

A calibration data is a record containing the "year, month, day" and "hour and minute" of the last calibration of each measurement parameters and their calibration method. The control unit stores automatically the calibration data.



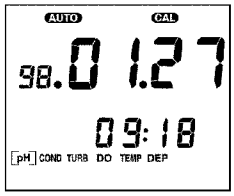
1. Press the **DATA** key in the Measurement mode.

The control unit goes to the DATA Display mode.



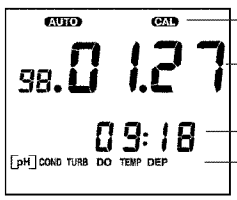
2. Press the **CAL** key.

The calibration log is displayed.



UP/DOWN (▲▼) keys: Switch the measurement parameter.
ENT key: Prints the entire calibration log. (when the printer is connected to the control unit)

Calibration log.



Calibration method
year, month, day
hour, minute
Measurement parameter is indicated with brackets ([ ]).

Calibration method

AUTO CAL	AUTO calibration
MAN ZERO CAL	Manual zero calibration
MAN SPAN CAL	Manual span calibration
MAN ZERO SPAN CAL	Manual zero calibration and span calibration

Note

- Press the MEAS key to cancel the data calling and return to the Measurement mode.

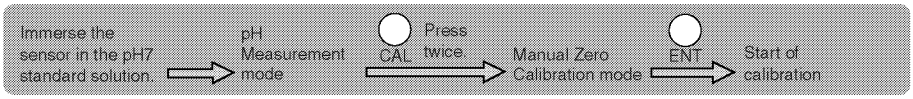
MEMO

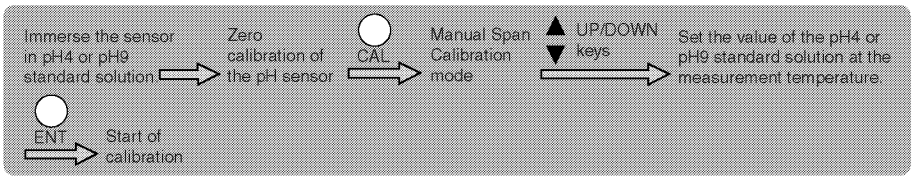
5. Techniques for more accurate measurement

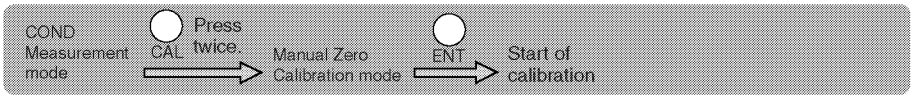
In normal operation, calibration using the AUTO Calibration mode described earlier in the basic operation section provides sufficient accuracy. However, for more accurate measurement, manual calibration is effective. When measurement with high-accurate expanded display is needed, be sure to perform manual calibration.

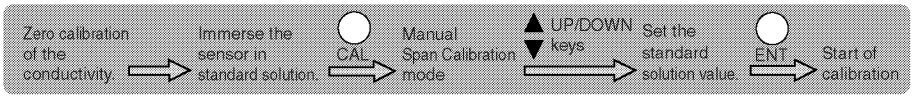
Attention: The expanded display mode is entered automatically when manual calibration is selected.

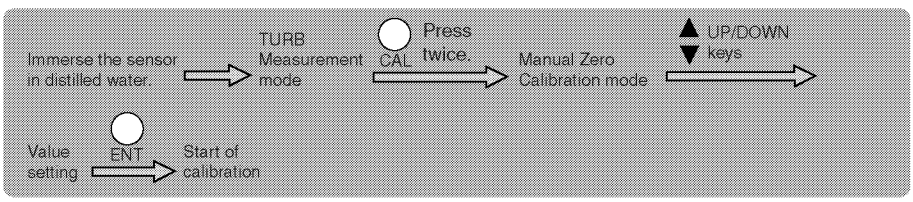
In order to minimize the data difference in two or more meters, proper maintenance and calibration should be performed.

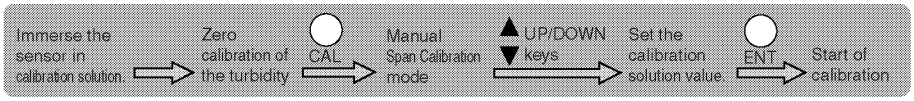


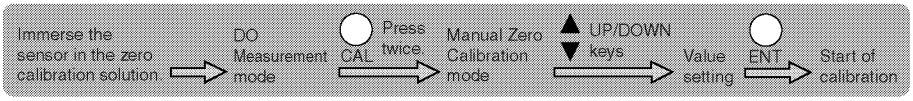


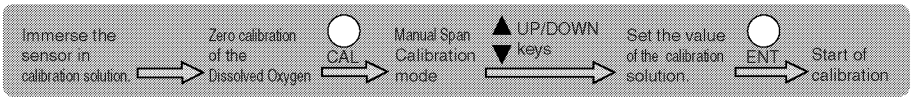


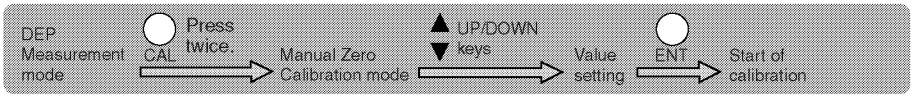


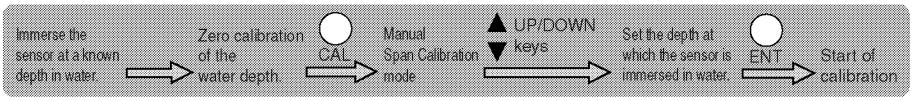


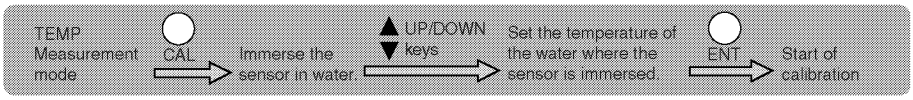


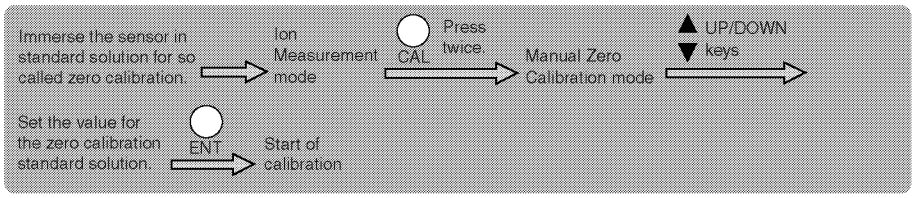


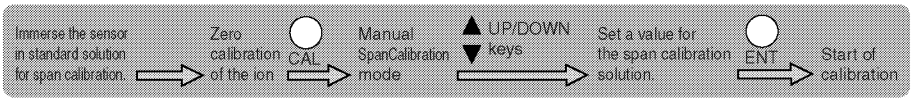












5.1 Manual pH calibration

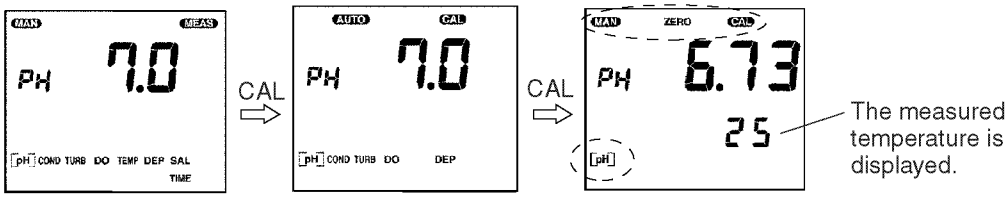
5.1.1 Zero calibration

Immerse the sensor in the pH7 standard solution. → pH Measurement mode (Key operations and mode switching (☞ Page 27)) → CAL Press twice. → Manual Zero Calibration mode → ENT → Start of calibration

1. Wash the sensor two or three times using distilled water, then pour some pH7 standard solution into the calibration beaker, and immerse the sensor in it.
(For the W-23XD, immerse the sensor A side.)

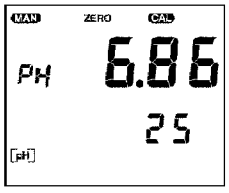
2. Press the **CAL** key twice in the pH Measurement mode.

When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.



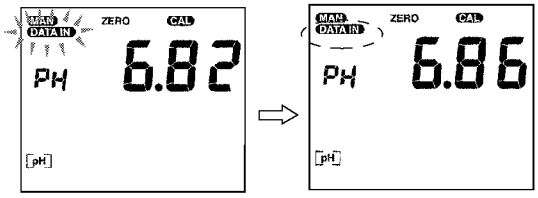
Manual Zero Calibration mode

3. Use the **UP/DOWN** (▲ ▼) keys to input the value of the pH7 standard solution at the measured temperature of standard solution.
(☞ page 109, *8. Reference data*)



4. Press the **ENT** key.

The manual zero calibration starts.

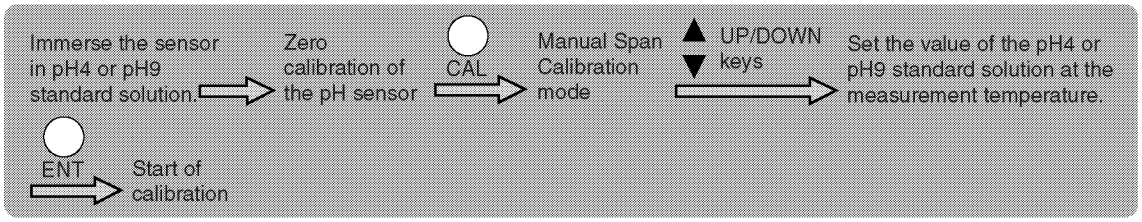


End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

When DATA IN is blinking
To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

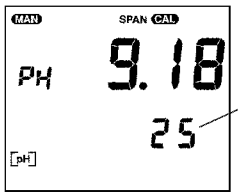
5.1.2 Span calibration



1. Wash the sensor two or three times using distilled water, then pour pH4 or pH9 standard solution into the calibration beaker, and immerse the sensor in it.
(For the W-23XD, immerse the sensor A side.)

2. On the zero calibration of the pH sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
MAN, **SPAN** and **CAL** light up.

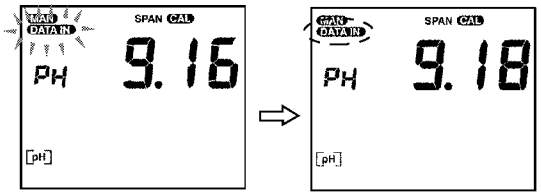
3. Use the **UP/DOWN** (▲ ▼) keys to set the value for the pH4 or pH9 standard solution at the measurement temperature.



The measurement temperature is displayed.

4. Press the **ENT** key.

The manual span calibration starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

When DATA IN is blinking
To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

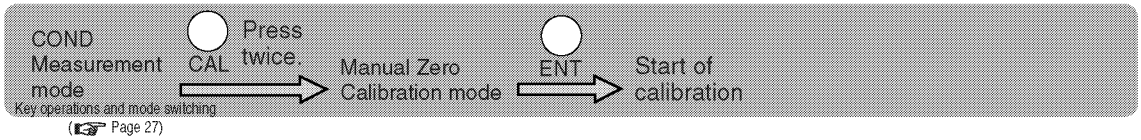
Note

- When the SET and CAL keys are pressed during the manual pH calibration mode, the calibration data for the pH sensor can be deleted.

5.2 Manual conductivity (COND) calibration

The W-20XD series models can measure conductivity (COND) in the range from 0.90 to 9.99 S/m. Depending on the concentration of the sample, these models automatically select the most suitable measuring range from three ranges: 0.0 to 99.9 mS/m, 0.090 to 0.999 S/m, and 0.90 to 9.99 S/m. The zero point is common to the three measuring ranges.

5.2.1 Zero calibration

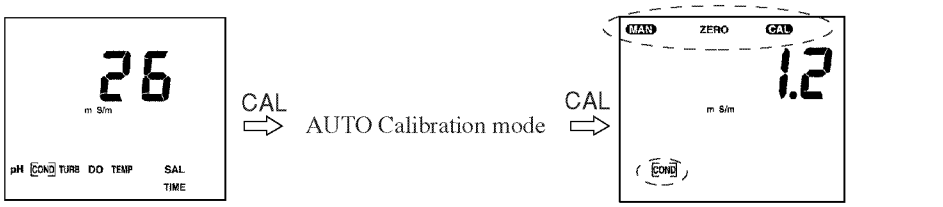


Key operations and mode switching
(☞ Page 27)

1. Wash the conductivity (COND) sensor two or three times using distilled water. Completely remove the water on the sensor and calibrate the instrument in the atmosphere.

2. Press the **CAL** key twice in the Conductivity (COND) Measurement mode.

When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.

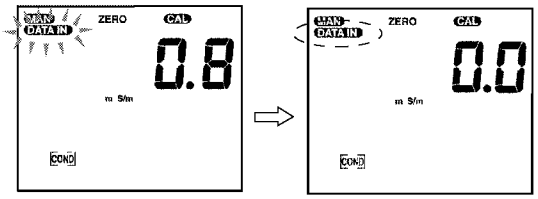


Manual Zero Calibration mode

3. Use the **UP/DOWN** (▲ ▼) keys to set the value to 0.0.

4. Press the **ENT** key.

The manual zero calibration starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

When DATA IN is blinking

To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

5.2.2 Span calibration

Preparation of calibration solution (Potassium chloride (KCl) standard solution)

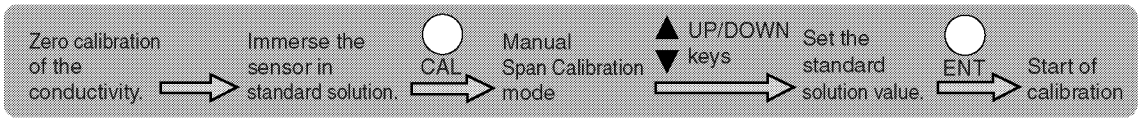
Grind the potassium chloride (KCl) powder (high-grade commercially available) in a mortar. Then dry at 500°C for four hours and leave it to cool in a desiccator.
Consult the following table and weigh potassium chloride (KC1), then prepare three standard potassium chloride (KC1) solutions following the procedure below.

Potassium chloride (KCl) standard solution	Conductivity (COND) value	Potassium chloride (KCl) mass (g) at solution temperature of 25 °C	Calibration range
0.005 mol/L	71.8 mS/m	0.373	0.0 to 99.9 mS/m
0.050 mol/L	0.667 S/m	3.73	0.090 to 0.999 S/m
0.500 mol/L	5.87 S/m	37.2	0.90 to 9.99 S/m

1. Dissolve the weighed Potassium Chloride (KCl) in distilled water.
2. Put the dissolved Potassium Chloride (KCl) into a 1L measuring flask, and fill to the 1L mark with distilled water.

Calibration procedure

Perform the span calibration using the three standard solutions as follows.

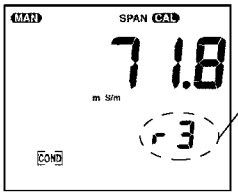


Important

- Keep the temperature of the span standard solution at 25 ± 5 °C.
- Span calibaration should be made from lower to higher concentration.

1. Wash the sensor two or three times using distilled water, then pour standard solution into the calibration beaker, and immerse the sensor in it. (In the case of the W-23XD model, immerse the sensor A side.)
2. On the zero calibration of the conductivity (COND) sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
   MAN, **SPAN** and **CAL** light up.

3. Use the UP/DOWN (▲ ▼) keys to set the standard solution value.



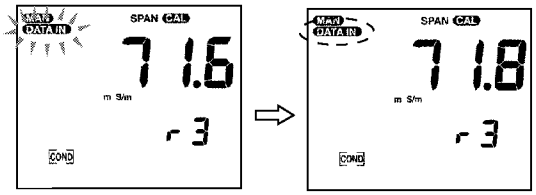
The calibration range is displayed.

Note

- The sensor automatically identifies the calibration solution and the relevant calibration range is displayed.
  - r 1 : 0.90 to 9.99 S/m
  - r 2 : 0.090 to 0.999 S/m
  - r 3 : 0.0 to 99.9 mS/m

4. Press the ENT key.

The manual span calibration starts.



End of calibration

The measured value is displayed during calibration, and DATA IN blinks until the indicated value stabilizes. When the indicated value has stabilized, DATA IN lights up and the calibration finishes.

When DATA IN is blinking

To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

5. Press the CAL key and perform steps 1 to 4 above for calibration, using three standard solutions.

6. Press the MEAS key to return to the Measurement mode.

Note

- When the SET and CAL keys are pressed during the manual Conductivity (COND) Calibration mode, the calibration data for the conductivity (COND) sensor can be deleted.
- Perform the calibration again after deleting the present calibration data when calibration error occurs and the calibration cannot be performed.

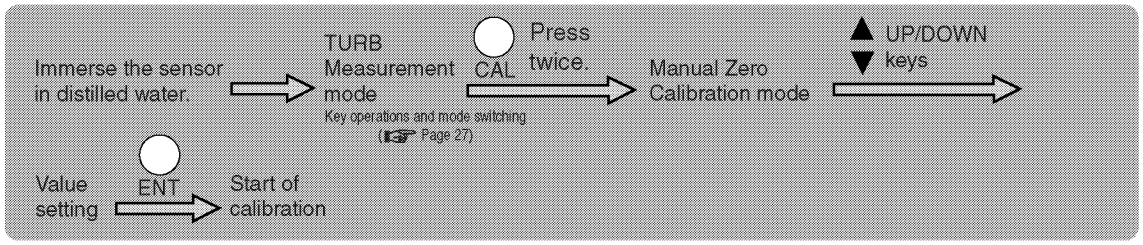
5.3 Manual turbidity (TURB) calibration

5.3.1 Zero calibration

In zero calibration, distilled water is used as a calibration solution. If distilled water can not be obtained, ion exchanged water, which can be considered to have a turbidity of zero, may be used.

Important

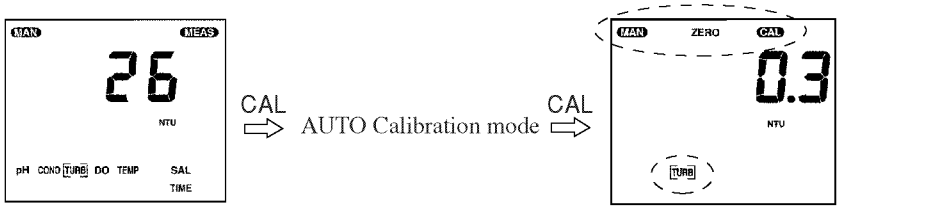
- When the turbidity (TURB) sensor is calibrated, it is particularly important that the probe is completely contamination-free. Do not use a contaminated probe. Otherwise unreliable calibration will result.



1. Wash the sensor two or three times using distilled water, then place distilled water into the calibration beaker, and immerse the sensor in it. (For the W-23XD, immerse the sensor A side.)

2. Press the **CAL** key twice in the Turbidity (TURB) Measurement mode.

When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.

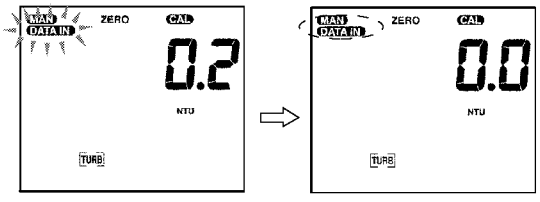


Manual Zero Calibration mode

3. Use the **UP/DOWN** (▲ ▼) keys to set the value to 0.0.

4. Press the **ENT** key.

The manual zero calibration is started.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

When DATA IN is blinking

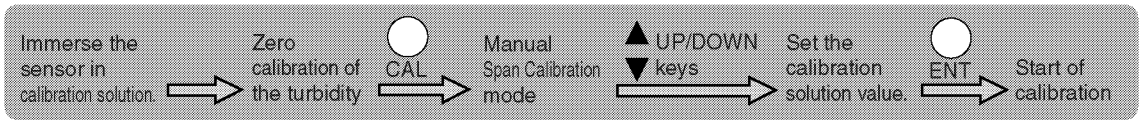
To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

5.3.2 Span calibration

Preparation of calibration solution

Weigh out 5.0 g of hydrazine sulfate, and dissolve it in 400 mL of distilled water. Dissolve 50 g of hexamethylene tetramine in 400 mL of distilled water in anther flask. Mix the two solutions and add distilled water until the total solution volume is 1000 mL, and mix well. Store this solution at a temperature of 25°C ± 3°C for 48 hours. The turbidity value (TURB) of this solution is equivalent to 4000 NTU.
Dilute this solution 5 times (use a pipette to measure 50 mL of the 4000 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus), and use it as span calibration solution of 800 NTU turbidity (TURB).

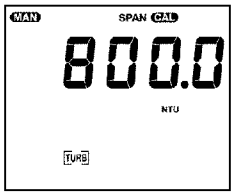
Calibration procedure



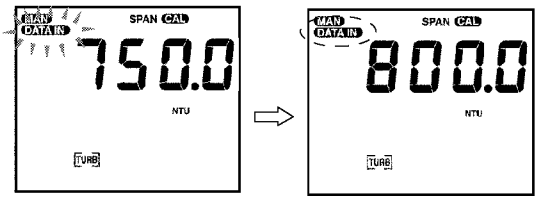
1. Wash the sensor two or three times using distilled water, then pour pH4 or pH9 standard solution into the calibration beaker, and immerse the sensor in it.
(For the W-23XD, immerse the sensor A side.)

2. On the zero calibration of the turbidity (TURB) sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
MAN, **SPAN** and **CAL** light up.

3. Use the **UP/DOWN** (▲ ▼) keys to set the value to 800.0.



4. Press the **ENT** key.
The manual span calibration starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

When DATA IN is blinking

To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

Important

- When it is known beforehand that the sample water has a low turbidity (0 to 100 NTU), calibrate the sensor with calibration solution of 80 NTU. To prepare an 80 NTU calibration solution, dilute the 4,000 NTU solution with distilled water 50 times.

Note

- When the SET and CAL keys are pressed during the manual Turbidity (TURB) Calibration mode, the calibration data for the turbidity (TURB) sensor can be deleted.

5.4 Manual Dissolved Oxygen (DO) calibration

It is necessary to prepare new solution before calibration of the Dissolved Oxygen (DO) sensor.

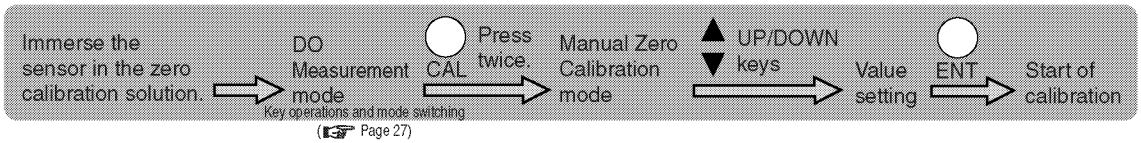
5.4.1 Zero calibration

Use sodium sulfite solution of disloved in ion exchanged water or tap water.

Preparation of calibration solution

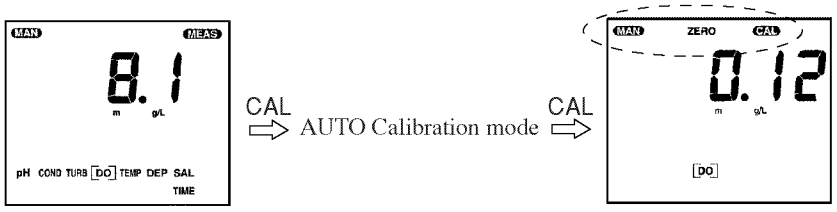
Add approximately 50 g of sodium sulfite to 1,000 mL of water (either ion exchange water or tap water) and stir the mixture to dissolve the sodium sulfite in it.
The calibration beaker (included) cannot be used to manually calibrate the DO sensor. Use a suitable bottle in which the DO sensor can be immersed.

Calibration procedure



1. Wash the sensor 2 to 3 times with pure water and immerese the DO sensor (the A side for the W-23XD model) completely in zero calibration solution.
2. Press the **CAL** key twice in the Dissolved Oxygen (DO) Measurement mode.

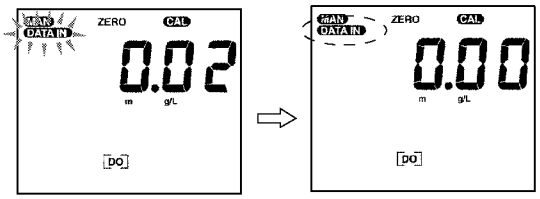
When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.



Manual Zero Caliburation mode

3. After the display has stabilized, use the **UP/DOWN** (▲ ▼) keys to set the value to 0.0.
4. Press the **ENT** key.

The manual zero calibration starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

When DATA IN is blinking

To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

Important

- After zero calibration, clean the sensor sufficiently with tap water.

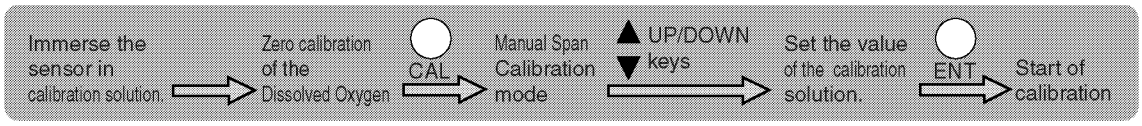
5.4.2 Span calibration

Use ion exchanged water or tap water with saturated dissolved oxygen as the span calibration liquid.

Preparation of standard solution for span calibration

Pour 1 to 2 liters of water into a suitable flask (either ion exchanged water or tap water). Using a air pump, feed air into the water and aerate the solution until oxygen is saturated. The calibration beaker (included) cannot be used to manually calibrate the DO sensor. Use a suitable bottle in which the DO sensor can be immersed.

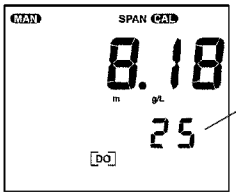
Calibration procedure



1. Wash the sensor two or three times using distilled water, then pour pH4 or pH9 standard solution into the calibration beaker, and immerse the sensor in it.
(For the W-23XD, immerse the sensor A side.)

2. On the zero calibration of the Dissolved Oxygen (DO) sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
MAN, **SPAN** and CAL light up.

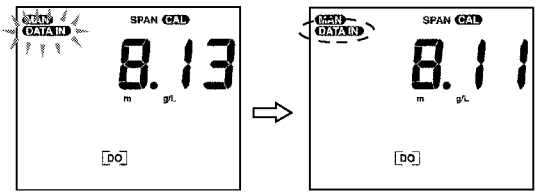
3. After the display has stabilized, use the **UP/DOWN** (▲ ▼) keys to set the amount of saturated dissolved oxygen in water at the its water temperature.



The temperature setting is displayed.
Refer to the table given in page 60 for saturated oxygen and concentration set a value corresponding to the temperature.

4. Press the **ENT** key.

The manual span calibration starts.



End of calibration

The measured value is displayed during calibration, and DATA IN blinks until the indicated value stabilizes. When the indicated value has stabilized, DATA IN lights up and the calibration finishes.

When DATA IN is blinking
To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

Note

- When the SET and CAL keys are pressed during the manual Dissolved Oxygen (DO) calibration mode, the calibration data for the dissolved oxygen (DO) sensor can be deleted.

Amounts of saturated dissolved oxygen in water at various temperatures (salinity=0.0%)

JIS K0101

Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	14.16						
1	13.77	11	10.67	21	8.68	31	7.42
2	13.40	12	10.43	22	8.53	32	7.32
3	13.04	13	10.20	23	8.39	33	7.22
4	12.70	14	9.97	24	8.25	34	7.13
5	12.37	15	9.76	25	8.11	35	7.04
6	12.06	16	9.56	26	7.99	36	6.94
7	11.75	17	9.37	27	7.87	37	6.86
8	11.47	18	9.18	28	7.75	38	6.76
9	11.19	19	9.01	29	7.64	39	6.68
10	10.92	20	8.84	30	7.53	40	6.59

ISO5814

Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	14.62				
1	14.22	11	11.03	21	8.91
2	13.83	12	10.78	22	8.74
3	13.46	13	10.54	23	8.58
4	13.11	14	10.31	24	8.42
5	12.77	15	10.08	25	8.26
6	12.45	16	9.87	26	8.11
7	12.45	17	9.66	27	7.97
8	11.84	18	9.47	28	7.83
9	11.56	19	9.28	29	7.69
10	11.29	20	9.09	30	7.56

AUTO calibration is based on the JIS tables. When the measured data based on ISO are needed, calibration should be done according to the manual span calibration utilizing ISO table.

5.5 Water depth (DEP) calibration

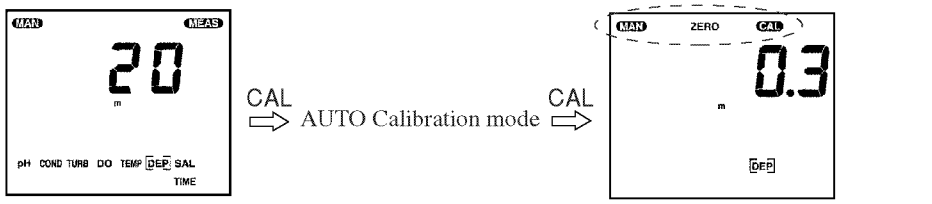
5.5.1 Zero calibration

DEP Measurement mode → CAL (Press twice.) → Manual Zero Calibration mode → ▲▼ (UP/DOWN keys) → Value setting → ENT → Start of calibration

Key operations and mode switching (☞ Page 27)

1. Immerse the sensor in the sample water for approximately 30 minutes so that the sensor probe temperatures becomes the same to the sample water temperature.
2. Press the **CAL** key twice in the Water Depth (DEP) Measurement mode.

When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.



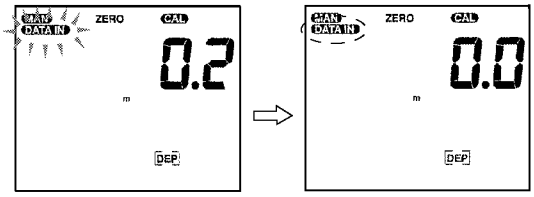
Manual Zero Calibration mode

Important

- Immerse the sensor probe to the depth where the battery cover reaches at water surface. And this level is used as 0 m in depth.

3. Use the **UP/DOWN** (▲ ▼) keys to set the value to 0.0.
4. Press the **ENT** key.

The manual zero calibration starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

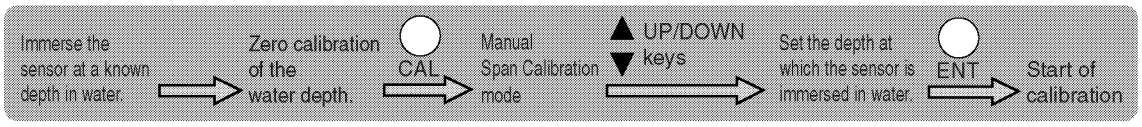
When DATA IN is blinking

To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

Important

- Since the water depth (DEP) sensor is greatly sensible with water temperature, calibrate the sensor at the same temperature as sample water for more accurate measurement.

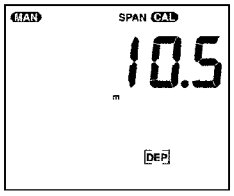
5.5.2 Span calibration



1. Immerse the sensor at a known depth in water. (Set the depth of battery cover as the depth setting.)

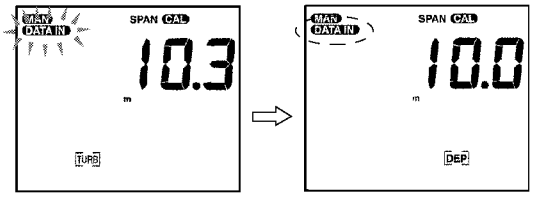
2. On the zero calibration of the water depth (DEP) sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
MAN, **SPAN** and **CAL** light up.

3. Use the **UP/DOWN** (▲ ▼) keys to set the depth at which the battery cover is immersed in water.



4. Press the **ENT** key.

The manual span calibration starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

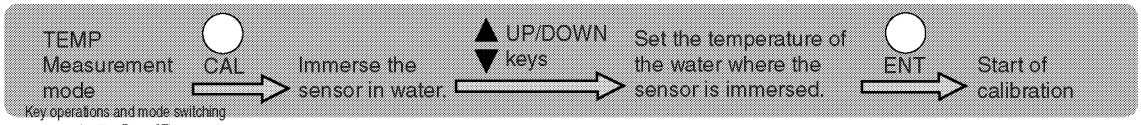
When DATA IN is blinking
To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

Note

- When the SET and CAL keys are pressed during the manual Water depth (DEP) Calibration mode, the calibration data for the water depth (DEP) sensor can be deleted.

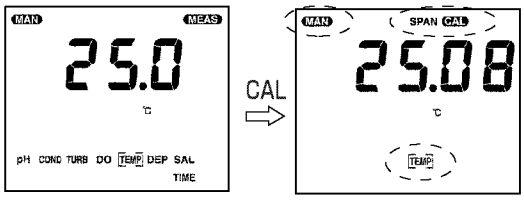
5.6 Temperature (TEMP) calibration



Key operations and mode switching
(☞ Page 27)

1. Press the **CAL** key in the Temperature (TEMP) Measurement mode.

Select the manual calibration mode.

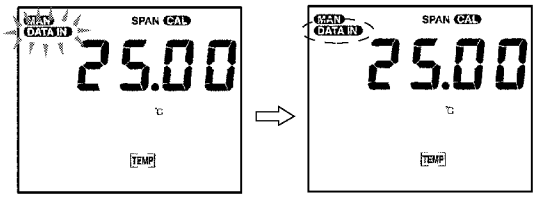


2. Immerse the sensor in water with known temperature.

3. Use the **UP/DOWN** (▲ ▼) keys to set the temperature of the water where the sensor is immersed as a calibration value.

4. Press the **ENT** key.

The manual calibration starts.



End of calibration

The measured value is displayed during calibration, and DATA IN blinks until the indicated value stabilizes. When the indicated value has stabilized, DATA IN lights up and the calibration finishes.

When DATA IN is blinking

To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

Note

- When the SET and CAL keys are pressed during the manual Temperature (TEMP) calibration mode, the calibration data for the temperature (TEMP) sensor can be deleted.

5.7 Operation check using ORP standard solution

Note

- Standard solution is not used for calibration, but to confirm whether or not the electrodes is good.

1. Add one of below listed standard solutions to 250 ml ion exchanged water and mix them well.
   When mixing, the excess quinhydrone (a black powder) will float to the surface of the solution.
2. Immerse a washed and dried ORP electrode in the ORP standard solution and measure the mV value.
3. If the electrode and whole the control unit are working correctly, measured value should be within ± 15 mV to the value listed in the table below.
4. If measurement value das not fall within ± 15 mV of the values listed, measure the solution again after replacing the reference electrode internal solution, removing the dirt lightly rubbing the electrode surface by moisted cotton swab with alcohol or a neutral cleaning agent, by soaking the electrode in diluted nitric acid (1:1 nitric acid).
5. If measurement result within ± 15 mV of the values listed is still not obtained the reference electrode or the control unit may be faulty.
   Either replace the electrode or inspect the control unit.

Important

- If the prepared ORP standard solution is left in open air for one hour or more, the solution may be transformed. For this reason ORP standard solution cannot be stored.
- When measuring sample with low concentrations of oxidants and reductants after conducting an operational check using a standard substance, the measured values may not stabilize or the results of measurement might not be repeatable.
  If this is the case, use the control unit after immersing the electrodes in the sample water sufficiently.

Precautions when measuring actual samples

- Note that when measuring the ORP of solution with extremely low concentrations of oxidants and reductants, such as tap water, well water, or water treated with purifying equipment, there may be less responsiveness, repeatability, and stability, in general.
- When alkaline ion water is left, its ORP undergoes changes significantly. Always measure alkaline ion water promptly.

ORP standard solution

There are two kinds of standards substances. Normally it is sufficient to use one of them that is the closest to the measured value.

Indicated value of ORP standard solution at various temperatures

Temperature (°C)	160-22 Phthalate + quinhydrone	160-51 Neutral phosphate + quinhydrone
5	+274.2	+111.9
10	+270.9	+106.9
15	+266.8	+101.0
20	+262.5	+95.0
25	+257.6	+89.0
30	+253.5	+82.7
35	+248.6	+76.2
40	+243.6	+69.0

5.8 Manual ion calibration (W-23XD model)

It is necessary to prepare a so called zero calibration solution and a span calibration solution according to the ion sensor to be calibrated. When the ion sensors of Cl^-, NO_3^-, and Ca^{2+} are used, the supplied ion standard solution can be used in common. When other sensors are used, it is necessary to set the ion valency first.
(☞ page 80, 6.7 *Changing the ion valency setting*)

5.8.1 Preparation of calibration solution

For Chloride, Nitrate and Calcium ion sensors

To prepare a so called zero calibration solution, dilute the supplied ion standard solution (#130) 10 times with distilled water. The supplied ion standard solution (#130) is used without dilution as a span calibration solution. The zero and span calibration values for each ion sensor are as follows:

Meter indication	ION	Zero calibration value	Span calibration value
ION1	Cl^-	3.55 mg/L	35.5 mg/L
	Chloride	(0.1 mmol/L)	(1 mmol/L)
ION2	NO_3^-	3.10 mg/L	31.0 mg/L
	Nitrate	(50 μmol/L)	(0.5 mmol/L)
ION3	Ca^{2+}	2.01 mg/L	20.1 mg/L
	Calcium	(50 μmol/L)	(0.5 mmol/L)

For Fluoride, Potassium and Ammonia ion sensors

When calibrating any Fluoride, Potassium and Ammonia ion sensor, prepare a 0.1 mol/L standard solution first. Then dilute the standard solution to prepare a so called zero and a span calibration solutions.

Preparing a 0.1 mol/L standard solution

Weigh out the reagents listed below for each ion species and dissolve each reagent in distilled water to obtain one liter of solution.

Ion species	Ion valency	Reagent (Special grade)	Weight	Concentration (mg/L)
Fluoride F^-	−1	Potassium fluoride	5.81 g	1900 mg/L
Potassium K^+	+1	Potassium chloride	7.46 g	3910 mg/L
Ammonia NH_3	−1	Ammonium chloride	5.35 g	1800 mg/L

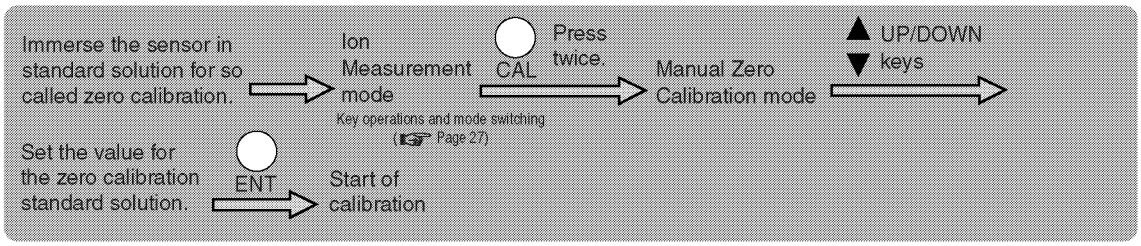
Preparing a calibration solution

To prepare a so called zero calibration solution and a span calibration solution , dilute the 0.1 mol/L standard solution for each ion species1000 and 100 times, respectively.

Ion type	Zero calibration solution	Span calibration solution
Fluoride F^-	1.9 mg/L (0.1 mmol/L)	19 mg/L (1 mmol/L)
Potassium K^+	3.9 mg/L (0.1 mmol/L)	39 mg/L (1 mmol/L)
Ammonia NH_3	1.8 mg/L (0.1 mmol/L) + Sodium hydroxide*	18 mg/L (1 mmol/L) + Sodium hydroxide*

* To prepare ammnia standard solution, place sodium hydroxide (0.4 g per 100 mL) into a standard solution before calibrating the ion sensor. In standard solution with sodium hydroxide, the ammonia content exists as ammonia gas and this changes easily. It is important to use the solution immediately.

5.8.2 Zero calibration



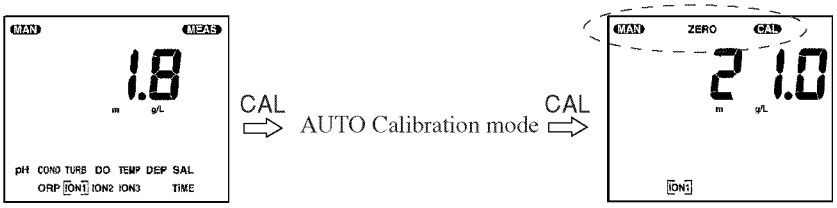
1. Wash the sensor with distilled water a few times. Then pour a so called zero calibration solution into the calibration beaker and immerse the sensor (the B side) into the solution.

Important

- Error messages are not displayed for ion sensor calibration. Immerse the sensor in the calibration solution and check if the measured reading changes according to the ion concentration of the calibration solution before proceeding.

2. Select the measurement mode for each measurement item (ION1, 2, and 3) and press the **CAL** key twice.

When the instrument enters the Manual Zero Calibration mode, **MAN**, **ZERO** and **CAL** light up.

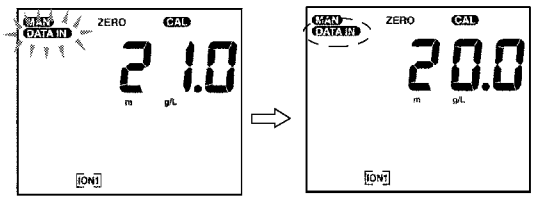


Manual Zero Calibration mode

3. Use the **UP/DOWN** (▲ ▼) keys to set the value for the zero calibration standard solution.

4. Press the **ENT** key.

The manual zero calibration starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

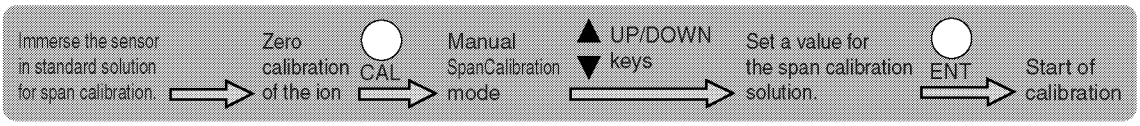
When DATA IN is blinking

To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

Important

- For Chloride, Nitrate and Calcium ion ion sensors, the common zero calibration solution is used. It is necessary to calibrate each of these ion sensors individually.
- For Fluoride, Potassium and Ammonia ion sensors, it is necessary to calibrate each of these ion sensors using individual so called zero calibration solution.

5.8.3 Span calibration



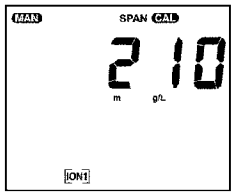
1. Wash the sensor two or three times using distilled water, then pour span calibration solution into the calibration beaker, and immerse the sensor in it.
(For the W-23XD, immerse the sensor B side.)

Important

- Error messages are not displayed for ion sensor calibration. Immerse the sensor in the calibration solution and check if the measured reading changes according to the ion concentration of the standard solution before proceeding.

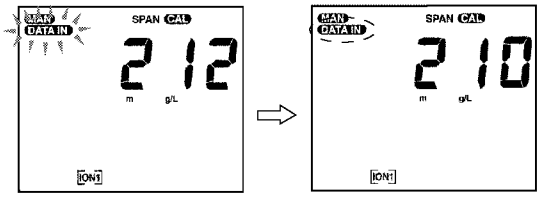
2. On the zero calibration of the ion sensor, press the **CAL** key to make sure that the instrument is in the Manual Span Calibration mode.
MAN, **SPAN** and **CAL** light up.

3. Use the **UP/DOWN** (▲ ▼) keys to set a value for the span calibration solution according to the ion species.



4. Press the **ENT** key.

The manual span calibration starts.



End of calibration

The measured value is displayed during calibration, and **DATA IN** blinks until the indicated value stabilizes. When the indicated value has stabilized, **DATA IN** lights up and the calibration finishes.

When DATA IN is blinking
To stop the calibration ..... Press the CAL key.
To fix the calibration ..... Press the ENT key.

5. Press the **MEAS** key to return to the Measurement mode.

Important

- For Chloride, Nitrate and Calcium ion sensors, the common span calibration solution is used. It is necessary to calibrate each of these ion sensors individually.
- For Fluoride, Potassium and Ammonia ion sensors, it is necessary to calibrate each of these ion sensors using individual span calibration solution.

Note

- When the SET and CAL keys are pressed during the manual ion calibration mode, the calibration data for the relevant ion sensor can be deleted.

5.8.4 Notes on use of ion sensors

<Measuring range>

Use ion sensors within the measuring range of individual ion sensor.

<pH range>

There is a pH range suitable for measurements for each ion sensor. Make ion measurements in its pH range.

<Hindering ion>

Some ion sensors respond to other ions than ions to be measured. Ion with smaller permissible coexistence limits in the table below cause more serious errors. For ion sensors that cannot withstand hindering ions, the responsive membrane will be broken. Handle ion sensors with care.

Model Ion species	Sensor type	① Measurement range ② pH range	Influence of hindering ions The values in parentheses show permissible coexistence limits.	Valency
6522 Cl^-	#7660	① 0.4 to 35,000 mg/L Cl^- (1 to 10^{-5} mol/L Cl^-) ② pH3 to 11 (350 mg/L Cl^-)	Not measurable: $S_2O_3^{2-}$, S^{2-}, I^-, Ag^+, Hg^{2+} Br^- (0.03), MnO_4^- (0.1), SCN^- (0.3) (In the10^{-3} mol/L Cl^-)	−1
6530 F^-	#7661	① 0.02 to 19,000 mg/L F^- (1 to 10^{-6} mol/L F^-) ② pH4 to 10 (20 mg/L F^-)	OH^- (10) (In the measurement range)	−1
6531 NO_3^-	#7681	① 0.62 to 62,000 mg/L NO_3^- (1 to 10^{-6} mol/L NO_3^-) ② pH3 to 7 (62 mg/L NO_3^-)	ClO_4^- (0.02), I^- (0.1), NO_2^- (3), Cl^- (40) F^- (200), CH_3COO^- (300) (In the10^{-3} mol/L NO_3^-)	−1
6532 K^+	#7682	① 0.04 to 39,000 mg/L K^+ (1 to 10^{-6} mol/L K^+) ② pH5 to 11 (3.9 mg/L K^+)	Rb^+ (0.4), Cs^+ (3), NH_4^+ (70) (In the10^{-4} mol/L K^+)	+1
6533 Ca^{2+}	#7683	① 0.4 to 40,080 mg/L Ca^{2+} (1 to 10^{-5} mol/L Ca^{2+}) ② pH5 to 11 (3.9 mg/L Ca^{2+})	Fe^{3+} (0.1), Fe^{2+}, Zn^{2+} (1), Sr^{2+} (50), Ni^{2+}, Cu^{2+} (70), Co^{2+} (350), Mn^{2+} (500) (In the10^{-4} mol/L Ca^{2+})	+2
5012 NH_3	—	① 0.1 to 1,000 mg/L NH_3 (0.1 to 10^{-5} mol/L NH_3) ② Some exist as NH_3 at pH 8 or more. All ammonia components exist as NH_3 at pH 12 or more.	Substance that emits acid and basic gases (Volatile amine)	−1

Important

- The NO_3^- ion sensors cannot be used in seawater.

5.9 Minimize the data difference

5.9.1 Maintenance

Please perform the followings:

DO Sensor

1. Replace the membrane and internal solution: Please follow the procedure from the instruction manual.
2. Plug the sensor to the connector: Make sure the metal wires on the connector is not bent or damaged.

pH (pH/ORP), Ion sensor

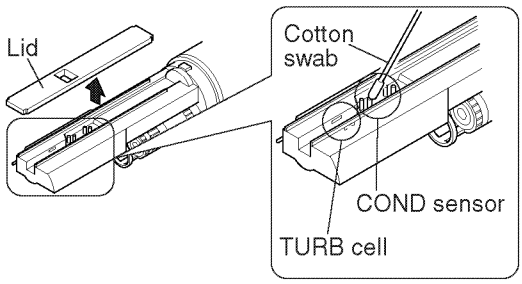
1. Clean the electrode: When electrode is dirty, clean thoroughly.
2. Clean the liquid junction: When liquid junction is clogged and black, use cleaning solution model #220 supplied by HORIBA. Soak the liquid junction over night in this solution.
3. Fill in the reference internal solution: When air bubbles are found in the reference solution, fill in more to remove the air bubbles. After the refill, confirm the solution is oozing out from the liquid junction.

Turbidity Sensor

1. Remove any contamination from around the Turbidity cell, using cotton swab.

Conductivity Sensor

1. Remove any contamination from the conductivity electrodes and make sure to apply the lid.



5.9.2 Calibration

Please perform the following two-point calibration.

Important

- Standard solution should be new and fresh. Do not re-use the standards!!

1. Calibrate the Temperature sensor.
   Calibrate using another temperature sensor.

Important

- Temperature is a very important factor when cross checking data from multiple instruments. Before performing manual calibration, make sure to perform temperature calibration.

2. Calibrate the DO sensor.

(1) Prepare zero standard solution and perform manual zero calibration.

(2) Prepare span standard solution (oxygen saturated water: bubbled in 1-2 liters water for 1 hour or so) and perform manual span calibration.

3. Calibrate the pH (pH/ORP) sensor.

(1)Use standard solution (pH 7) for manual zero calibration.

(2)Use standard solution (pH 4) for manual span calibration.

4. Calibrate the Turbidity sensor.

(1) Prepare zero standard (pure water).
When any contamination or dirt is found in the zero standard solution after the calibration, perform the manual zero calibration again with the new standard.

(2) Perform the manual span calibration using 800NTU standards.

5. Calibrate the Conductivity sensor.

(1) Remove all moisture from the conductivity electrodes thoroughly and perform the manual zero calibration in the air.

(2) Prepare span calibration standards and perform the manual span calibration for three ranges.
*For span standards, dry the KCl powder at 105°C for 2 hours.
*Make sure the standards temperature is 25°C ± 0.5°C.

6. Calibrate the Ion sensors.

Perform two point calibration. Prepare zero and span standards so that the actual sample's expected values comes in between zero and span standards.

7. Calibrate the Depth sensor.

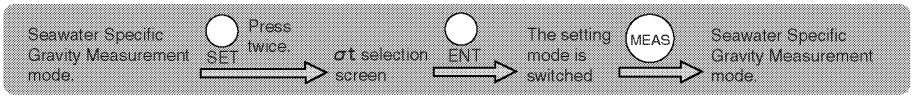
Perform the manual zero calibration in the air, and the manual span calibration at the known depth.

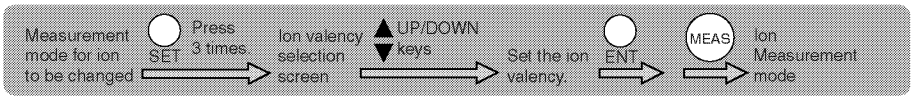
*For better accuracy, it is recommended to prepare the calibration sample at the similar temperature as the actual sample temperature.

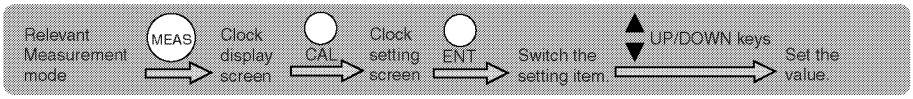
5.9.3 Measurement

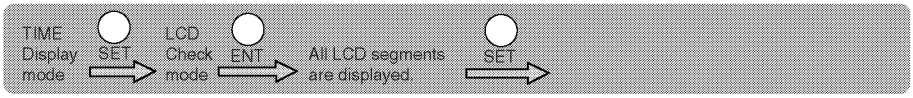
Try to avoid air bubbles or contaminants to the probe when measuring.

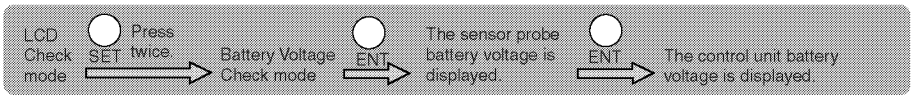
6. Using the various functions

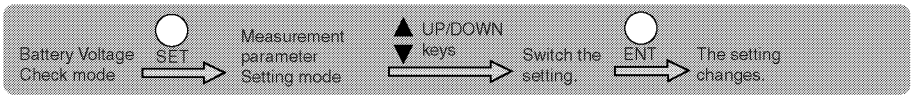


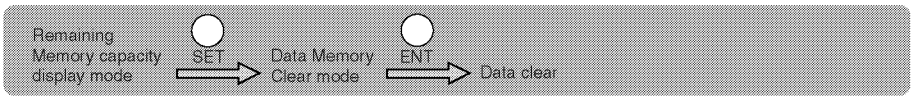


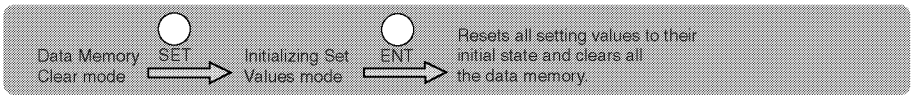


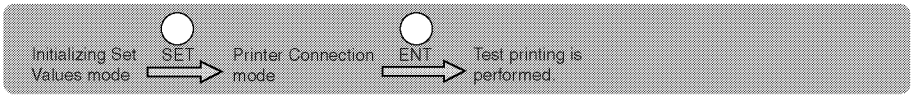






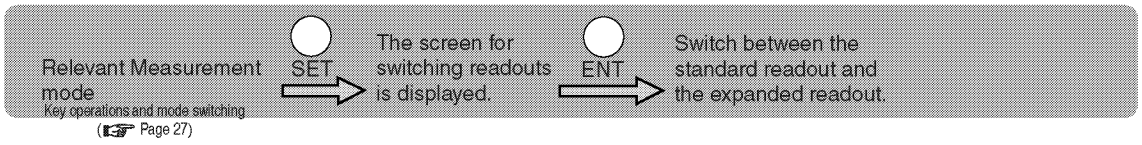






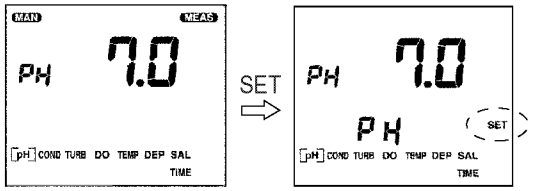
6.1 Switching to Expanded readout (High-accuracy display)

With the exception of oxidation-reduction potential (ORP), it is possible to switch between the Standard readout and the Expanded readout for the measurement value.



1. Press the **SET** key in the relevant Measurement mode.

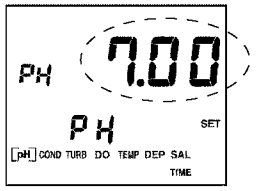
The screen for switching readouts is displayed.



Standard readout

2. Press the **ENT** key.

The screen can be switched between the standard readout and the expanded readout (High-accuracy display).



Expanded readout (High-accuracy display)

Note

- Switch readouts for each measurement parameter.
- Use the manual 2-point calibration (zero and span) when high accuracy is required for expanded readout (High-accuracy display).
- The expanded readout mode is automatically activated when the manual 2-point calibration mode is chosen.

3. Press the **MEAS** key to return to the Measurement mode.

6.2 Selection of measurement units

It is possible to select the measurement units.

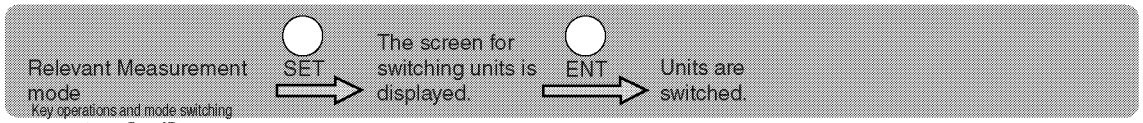
The units which can be selected as follows:

pH ..... pH or mV
Conductivity (COND) ..... S/m or mS/cm
Water depth (DEP) ..... m or ft
Ion concentration (ION) ..... g/L or mol/L
Turbidity (TURB) ..... NTU or mg/L
Dissolved Oxygen (DO) ..... mg/L or % (Oxygen saturation ratio)

Note

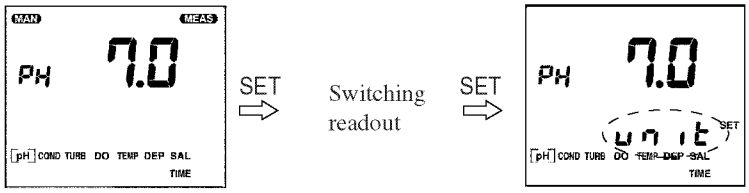
- When the measurement unit for ion is switched, the calibration data is cleared.

In the case of pH, ION, TURB, DO



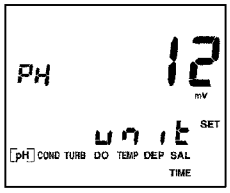
1. Press the **SET** key twice in the relevant Measurement mode.

Confirm that is displayed on the screen for selecting units.



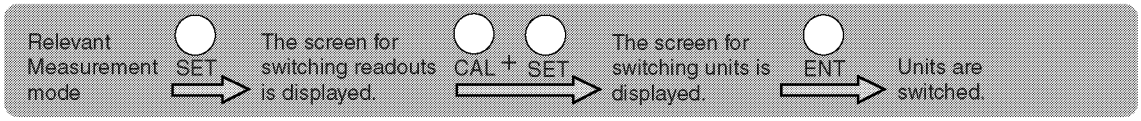
2. Press the **ENT** key.

Units are switched.



3. Press the **MEAS** key to return to the Measurement mode.

In the case of COND and DEP



1. Press the **SET** key in the Relevant Measurement mode.

The screen for switching readout is displayed.

2. Press the **SET** key while holding down the **CAL** key.

Confirm that **uni t** is displayed on the screen for switching units.

3. Press the **ENT** key.

Units are switched.

4. Press the **MEAS** key to return to the Measurement mode.

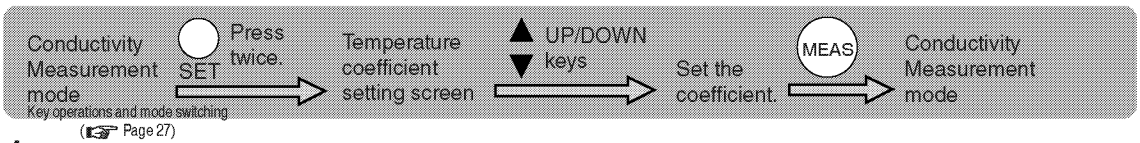
Measurement range and units

Measurement parameter		Measurement range		Measurement units
		Expanded	Standard	
pH		0.00 to 14.00	0.0 to 14.0	pH
		—	−1999 to 1999	mV in pH measurement
Conductivity (COND)	Range 1	0.90 to 9.99	0.9 to 9.9	S/m
		9.0 to 99.9	9 to 99	mS/cm
	Range 2	0.090 to 0.999	0.09 to 0.99	S/m
		0.90 to 9.99	0.9 to 9.9	mS/cm
	Range 3	0.0 to 99.9	0 to 99	mS/m
		0.000 to 0.999	0.00 to 0.99	mS/cm
Turbidity (TURB) *1		0.0 to 800.0	0 to 800	NTU (nephelometric turbidity units) or mg/L
Dissolved oxygen (DO)		0.00 to 19.99	0.0 to 19.9	mg/L
		0.0 to 199.9	0 to 199	%
Water temperature (TEMP)			0.00 to 55.00	0.0 to 55.0 °C
Water depth (DEP)		0.0 to 100.0	0 to 100	m
		0.0 to 330.0	0 to 330	ft
Salinity (SAL)		0.00 to 4.00	0.0 to 4.0	%
Total dissolved solids (TDS) *2	Range 1	5.5 to 65.0	5 to 65	g/L
	Range 2	0.55 to 6.50	0.5 to 6.5	g/L
	Range 3	0.000 to 0.650	0.00 to 0.65	g/L
Seawater specific gravity (σ_t)		0.0 to 50.0	0 to 50	–
Oxygen reduction potential (ORP)		—	−1999 to 1999	mV
Ions 1, 2, and 3	Range 1	0.100 to 0.999	0.10 to 0.99	g/L, mg/L, μ g/L
		0.100 to 0.999	0.10 to 0.99	mol/L, mmol/L, μ mol/L
	Range 2	1.00 to 9.99	1.0 to 9.9	g/L, mg/L, μ g/L
		1.00 to 9.99	1.0 to 9.9	mol/L, mmol/L, μ mol/L
	Range 3	10.0 to 99.9	10 to 99	g/L, mg/L, μ g/L
		10.0 to 99.9	10 to 99	mol/L, mmol/L, μ mol/L

*1: Depending on the concentration range, the minimum turbidity is displayed as follows:
0 to 100 NTU ... 1 NTU for standard readout, 0.1 NTU for expanded readout.
100 to 800 NTU ... 10 NTU for standard readout, 1 NTU for expanded readout.
*2: The TDS range depends on the TDS factor settings. (Above ranges are given for a TDS coefficient of 0.65.)

6.3 Temperature compensation for conductivity (COND)

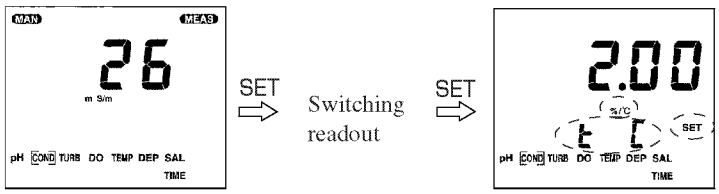
Sample conductivity (COND) varies with temperature, and this control unit uses a temperature compensation coefficient to automatically standardize the conductivity (COND) at 25 °C. The initial setting coefficient is 2 %/°C, which is the generally used.



Key operations and mode switching (☞ Page 27)

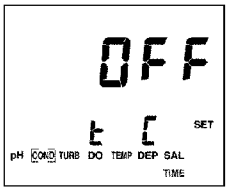
1. Press the **SET** key twice in the Conductivity (COND) Measurement mode.

The screen for setting temperature coefficients is displayed.



2. Use the **UP/DOWN** (▲ ▼) keys to set the coefficient.

The setting range is 0.00 to 3.00 %/°C.



With the ENT key, the temperature compensation is switched between ON and OFF.
When the temperature compensation mode is OFF, measured value is not temperature compensated at 25 °C but at the sample water temperature.

3. Press the **MEAS** key.

The control unit returns to the Conductivity (COND) Measurement mode.

Note

- For temperature coefficients, refer to *Reference data*, page 114 to 115.

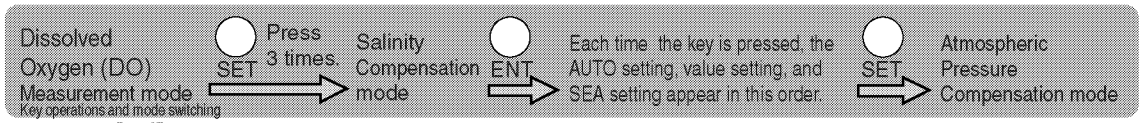
6.4 Environmental influence compensation for Dissolved Oxygen (DO)

6.4.1 Salinity compensation

The dissolved oxygen (DO) value is presented higher than actual value if salinity compensation is not added, because the increase of salinity gives higher DO value. To obtain correct value salinity compensation is needed. The following modes are available for calculation of salinity compensation.

AUTO ..... Salinity compensation is performed automatically with salinity converted from conductivity.

SEA ..... Appropriate compensation for normal seawater (35 ppt) is applied.



1. Press the **SET** key 3 times in the Dissolved Oxygen (DO) Measurement mode.

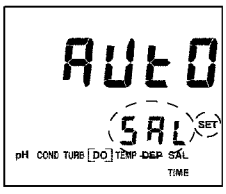
The salinity compensation mode currently set is displayed.

Important

- If the salinity compensation mode currently set is kept, press the MEAS key to return to the Dissolved Oxygen (DO) Measurement mode or press the SET key to select the Pressure Compensation mode.

2. Press the **ENT** key.

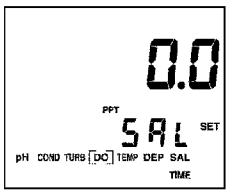
The following screens are displayed in sequence each time the ENT key is pressed: AUTO setting, value setting, SEA setting and AUTO setting.



3. If the salinity is known, use the **UP/DOWN** (▲ ▼) keys to enter the setting value in the screen on which the value is displayed.

For AUTO and SEA setting, this step is not necessary.

The setting range is 0.0 to 40.0 ppt (parts per thousand).

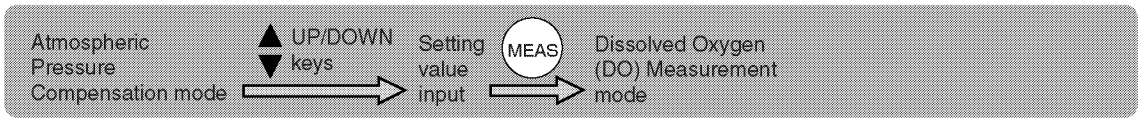


4. When the **SET** key is pressed, setting will be completed and the control unit will enter the Pressure Compensation mode.

5. Press the **MEAS** key to return to the Dissolved Oxygen (DO) Measurement mode.

6.4.2 Atmospheric pressure compensation

Differences in the atmospheric pressure of the measurement location influence the Dissolved Oxygen (DO) measurement. By setting (input) the actual atmospheric pressure of the measurement location into the control unit, it is possible to standardize the measured Dissolved Oxygen (DO) value to a value at the standard atmospheric pressure (1013 hPa).



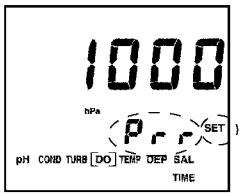
1. When the **SET** key is pressed on the salinity compensation screen, setting will be completed and the control unit will enter the Pressure Compensation mode.

Important

- If the Pressure Compensation mode currently set is not changed, press the MEAS key to enter the Dissolved-Oxygen (DO) Measurement mode.

2. Use the **UP/DOWN** (▲ ▼) keys to input a setting value.

The setting range is 100 to 1999 hPa.



3. When the **MEAS** key is pressed, setting will be completed and the control unit will enter the Dissolved Oxygen (DO) Measurement mode.

Relation between height (m) and atmospheric pressure (hPa)

Height (m)	0	200	400	600	800	1000	1200	1400	1600	1800	2000	3000	3400
Pressure (hPa)	1013	990	966	943	921	899	877	856	835	815	795	701	666

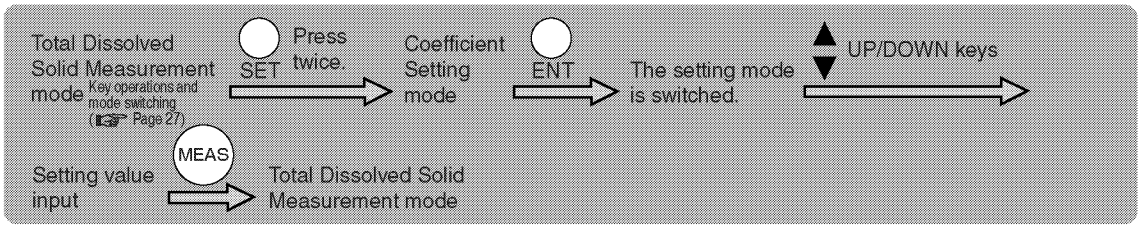
6.5 Setting a total dissolved solid (TDS) coefficient

The total dissolved solid amount (TDS) is a converted value obtained by multiplying the conductivity (COND) by a known coefficient. The coefficient initially set for the control unit is based on a conversion for KCl and $CaCO_3$ solutions and it depends on the conductivity (COND) value as shown below.

Conductivity (COND) (S/m)	Conversion coefficient
< 0.05	0.65
0.05 to 0.5	0.64
0.5 to 1	0.63
1 to 3	0.62
3 to 5	0.61
> 5	0.60

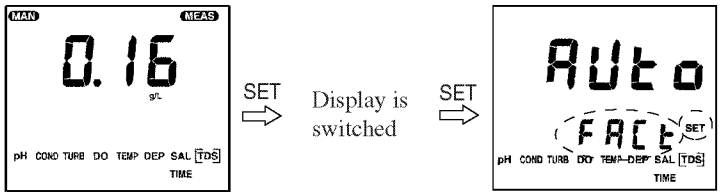
AUTO ..... For automatic calculation of the total dissolved solid (TDS) amount with an initially set coefficient.

Setting value input ..... For determination of the total dissolved solid (TDS) amount by setting any desired conversion coefficient irrespective of the conductivity (COND) value.



1. Press the **SET** key twice in the Total Dissolved Solid (TDS) Measurement mode.

The Coefficient Setting mode currently set is displayed.

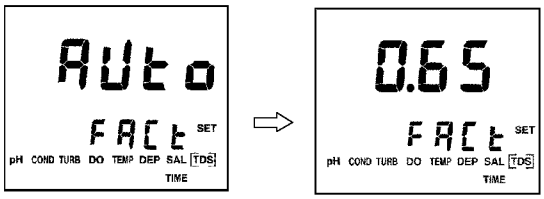


Important

- If the coefficient currently set is not changed, press the MEAS key to enter the Total Dissolved Solid (TDS) Measurement mode.

2. Press the **ENT** key.

The setting mode changes (AUTO/setting value input).



3. Use the **UP/DOWN** (▲ ▼) keys to input a setting value if required.

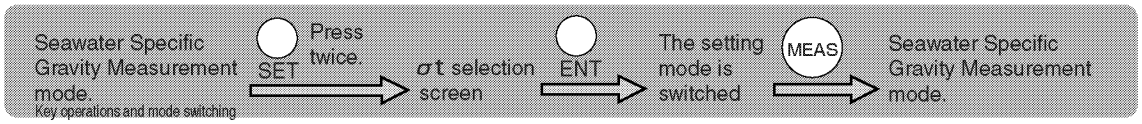
The setting range is 0.50 to 1.00.

4. When the **MEAS** key is pressed, setting will be completed and the control unit will enter the Total Dissolved Solid (TDS) Measurement mode.

6.6 Displaying seawater specific gravity (σ_0, σ_{15})

The specific gravity of seawater varies with temperature. By converting the measured value at certain reference temperature, it is possible to compare measurement results among different temperatures.

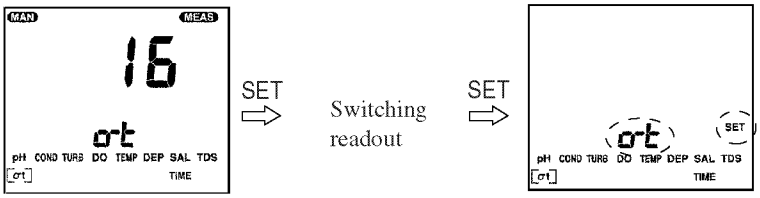
σ_t ..... Specific gravity of seawater at the temperature measured.
σ_0 ..... Seawater specific gravity at 0 °C.
σ_{15} ..... Seawater specific gravity at 15 °C.



Key operations and mode switching
(Page 27)

1. Press the **SET** key twice in the Seawater Specific Gravity (σ_t) Measurement mode.

Seawater specific gravity (σ_t) selection screen is displayed.

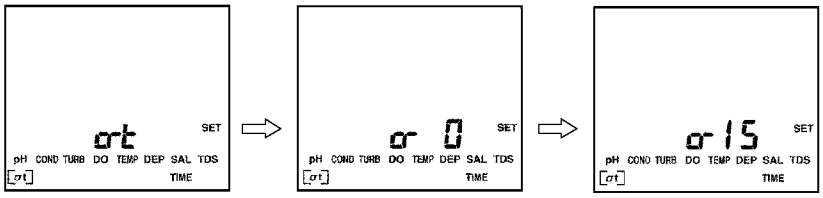


Important

- If the specific gravity currently set is not changed, press the MEAS key to enter the Seawater Specific gravity (σ_t) Measurement mode.

2. Press the **ENT** key.

The setting mode is switched.
($\sigma_0 \rightarrow \sigma_{15} \rightarrow \sigma_t \rightarrow \sigma_0 \ldots$)



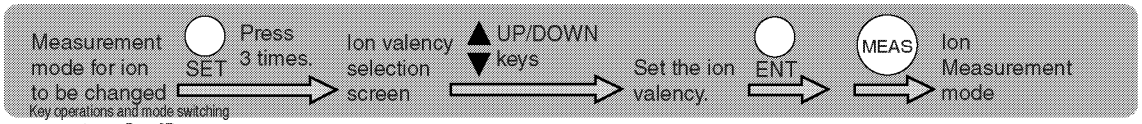
3. When the **MEAS** key is pressed, setting will be completed and the control unit will enter the Seawater Specific Gravity (σ_t) Measurement mode.

Note

- See page 116 about seawater specific gravity.

6.7 Changing the ion valency setting (W-23XD model)

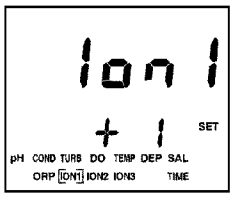
When the ion sensors Cl^-, NO_3^- and Ca^{2+} are used, the ion valency has been already set in the initial settings, and no changes are required.
When F^-, K^+ or NH_3 ion sensors are used, the ion valency must be set.



Key operations and mode switching (☞ Page 27)

1. Press the **SET** key 3 times in the Ion Measurement mode for the ion to be changed.

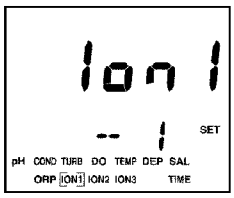
Ion valency selection screen is displayed.



Important

- If the ion valency currently set is not changed, press the MEAS key to enter the Ion Measurement mode.

2. Use the **UP/DOWN** (▲ ▼) keys to set the ion valency and press the **ENT** key.



UP (▲) : −2 → −1 → +1 → +2
DOWN (▼) : −2 ← −1 ← +1 ← +2

Important

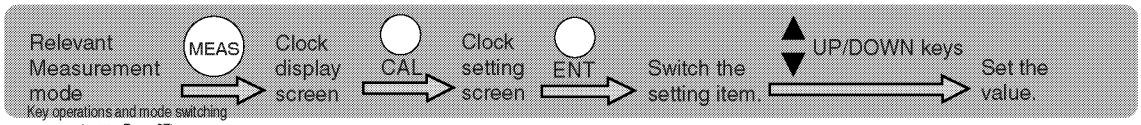
- The calibration data is cleared if the ion valency is changed.

3. When the MEAS key is pressed, the setting will be completed and the control unit will enter the Ion Measurement mode.

Note

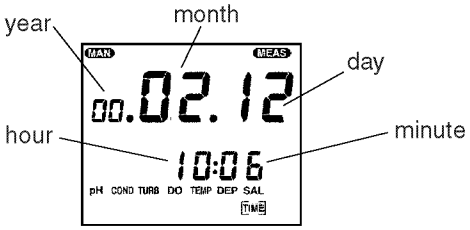
- For the ion valency, refer to page 68.

6.8 Setting the clock



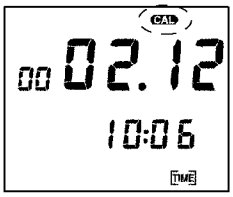
Key operations and mode switching
(☞ Page 27)

1. Use the **MEAS** key in the measurement mode to switch to the clock display screen.



2. Press the **CAL** key.

CAL light up and clock setting screen is displayed.



3. Press the **ENT** key to select the setting parameter.

(year month → day → hour → minute → year ...). The setting parameter will blink.

4. Use the **UP/DOWN** (▲▼) keys to set the value.

5. Press **SET** key to fix the setting.

Note

- When the MEAS key is pressed, the control unit will return to the clock display.

Important

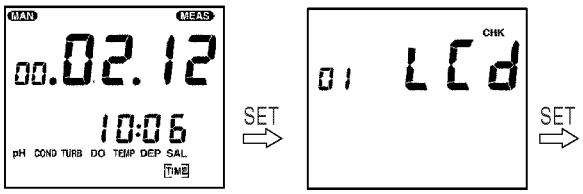
- When the MEAS key is pressed without prior pressing the SET key to display clock, new settings are not efective.

6.9 Key lock setting

If the POWER key is pressed while pressing the UP (▲) key when the power is off, the control unit is turned ON with the key locked and the key lock function works.
With the key locked condition, only the POWER and MEAS keys can be used and [LOCK] is displayed on the screen.
To release this function, turn the control unit OFF first and then ON again.

6.10 Check mode

When the SET key is pressed in the measurement mode showing clock, the control unit performs self-diagnosis check.



Each time the SET key is pressed, the check mode parameter is switched sequentially.

Check mode parameters

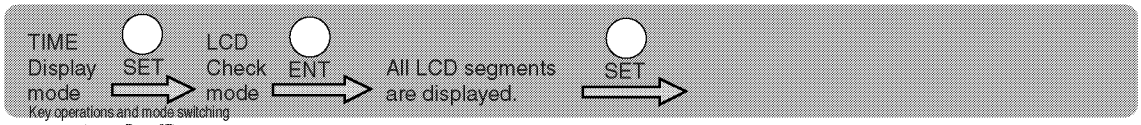
1 :	LCD check	Checks if all LCD segments will be displayed. (☞ Page 85)
2 :	Battery voltage check	Performs a simple battery voltage check for the control unit and sensor probe. (☞ Page 86)
3 :	Measurement parameter setting	Can set the measurement parameter to be stored. (☞ Page 87)
4 :	Remaining memory capacity	Displays the vacant memnory capacity. (☞ Page 88)
5 :	Data memory clear	Clears the data memory. (☞ Page 89)
6 :	Initializing set values	Initializes all memory settings. (☞ Page 90)
7 :	Printer connection, test print	Performs a test print. (☞ Page 92)

Note

- In the check mode, it is possible to return to the Measurement mode by pressing the MEAS key.

6.10.1 LCD check

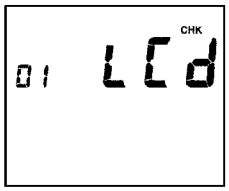
All LCD segments are displayed.



Key operations and mode switching
(☞ Page 27)

1. Press the **SET** key in the Clock Display mode.

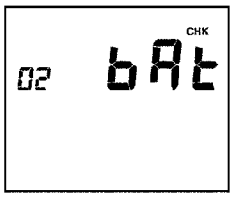
LCD check mode screen is displayed.



2. Press the **ENT** key.

3. Check to see if all LCD segments are displayed.

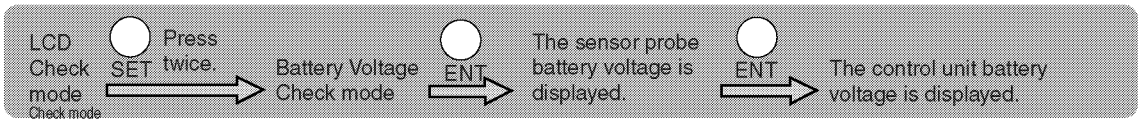
4. When the **SET** key is pressed, the control unit goes to the battery voltage check.



Note

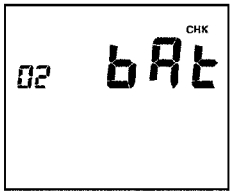
- When the MEAS key is pressed, the control unit returns to the Clock Display mode.

6.10.2 Battery voltage check



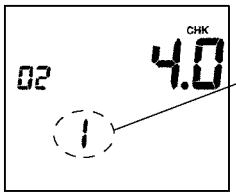
1. Press the **SET** key twice in the LCD Check mode.

Battery Voltage Check mode screen is displayed.



2. Press the **ENT** key.

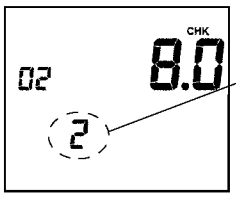
The sensor probe battery voltage is displayed.



1: Sensor probe battery voltage
Criteria
3.0 to 5.0 V : Normal
Less than 3.0 V: Replace the battery.
(Error No. 2 will blink.)

3. Press the **ENT** key.

The control unit battery voltage is displayed.



2: Control unit battery voltage
Criteria
5.5 to 11.0 V : Normal
Less than 5.5 V: Replace the battery.
(Error No.3 will blink.)

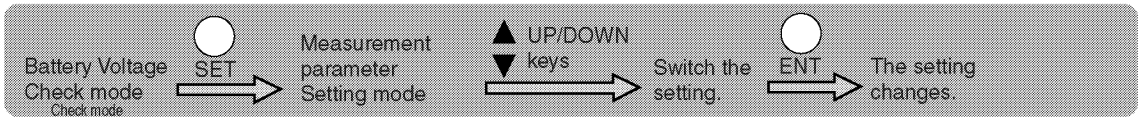
4. When the **SET** key is pressed, the control unit goes to the measurement parameter setting.

Note

- When the MEAS key is pressed, the control unit returns to the Clock Display mode.

6.10.3 Measurement parameter setting

Measuring parameters can be set.

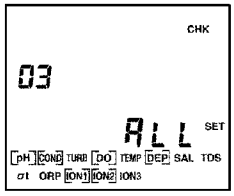


1. Press the **SET** key in the Battery Voltage Check mode.

Display setting mode screen is shown.

2. Use the **UP/DOWN** (▲▼) keys to switch the measurement parameter.

The selected parameter blinks.



3. Press the **ENT** key to switch between [set/ not set] for the blinking parameter.

A parameter for which "set" is selected is indicated with [ ].

Note

- If the temperature is selected at "not set", data for each parameter is not temperature-compensated and is displayed 25 °C .

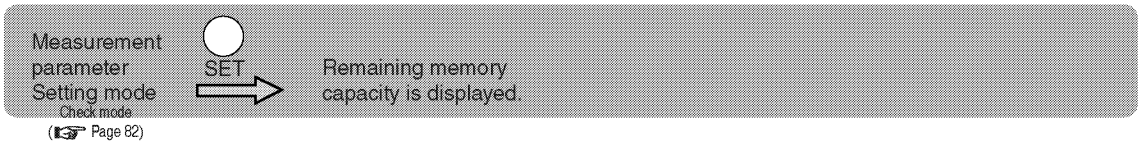
4. When the **SET** key is pressed, the control unit goes to the remaining memory capacity display.

Note

- When the MEAS key is pressed, the control unit returns to the Clock Display mode.

6.10.4 Remaining memory capacity check

The number of date that can be stored is displayed.



Press the **SET** key in the Display Setting mode.

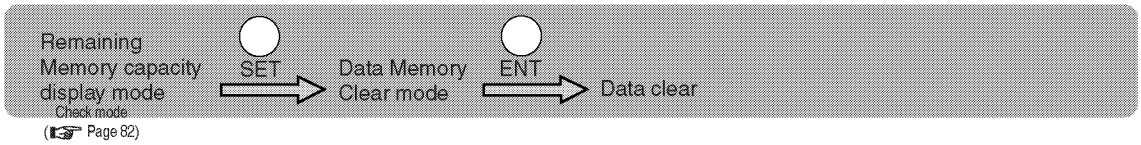
Remaining memory capacity is displayed.

Note

- When the SET key is pressed, the control unit goes to the Data Memory Clear mode.
- When the MEAS key is pressed, the control unit returns to the Clock Display mode.

6.10.5 Data memory clear

All the data memory is cleared.

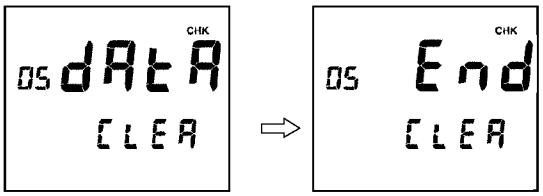


1. Press the **SET** key in the Remaining Memory capacity display mode.

Data memory clear mode screen is displayed.

2. Press the **ENT** key.

The data is cleared.



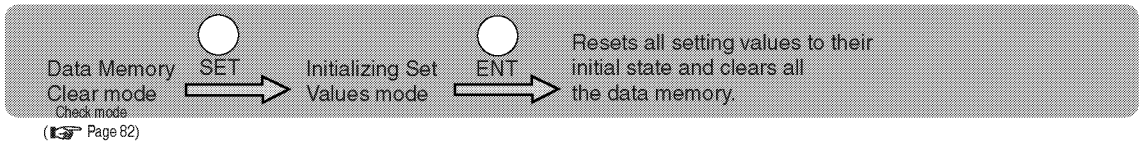
3. When the **SET** key is pressed, the control unit goes to the Memory Initialization mode.

Note

- When the MEAS key is pressed, the control unit returns to the Clock Display mode.

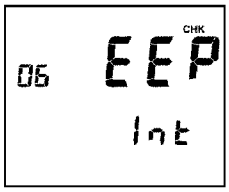
6.10.6 Initializing set values

All setting values are reset to their initial state.



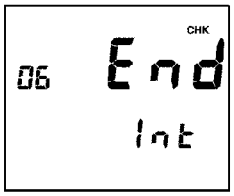
1. Press the **SET** key in the Data Memory Clear mode.

Initializing Set Values mode screen is displayed.



2. Press the **ENT** key.

All setting values are reset to their initial state.



3. When the **SET** key is pressed, the control unit goes to the Printer Connection mode.

Note

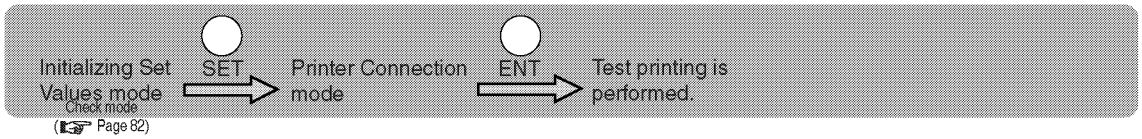
- When the MEAS key is pressed, the control unit return to the Clock Display mode.
- Data stored in the memory remains unchanged.

Initial setting

Parameter	Description	Initial value
Common	Display setting	Standard
	Data storage	Manual
pH	Unit	pH
COND	Unit	S/m
	Temperature coefficient	2.0 %/ °C
DO	Salinity setting	AUTO
	Atmospheric pressure setting	1013 hPa
	Unit	mg/L
TURB	Unit	NTU
DEP	Unit	m
TDS	Coefficient	AUTO
σ t	Unit	σ t
ION	Unit	g/L
ION1	Ion specie	-1
ION2	Ion specie	-1
ION3	Ion specie	+2

6.10.7 Printer connection, test print

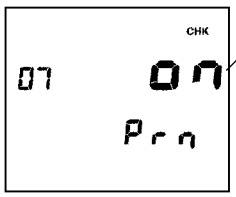
This mode operates only when the extension adapter is connected. A test print is performed if a printer is connected.



Check mode (☞ Page 82)

1. Press the **SET** key in the Initializing Set Values mode.

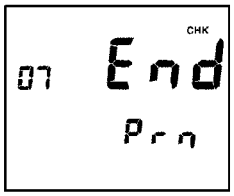
Printer Connection mode screen is displayed.



Displayed as OFF when not connected.

2. Press the **ENT** key to start printing.

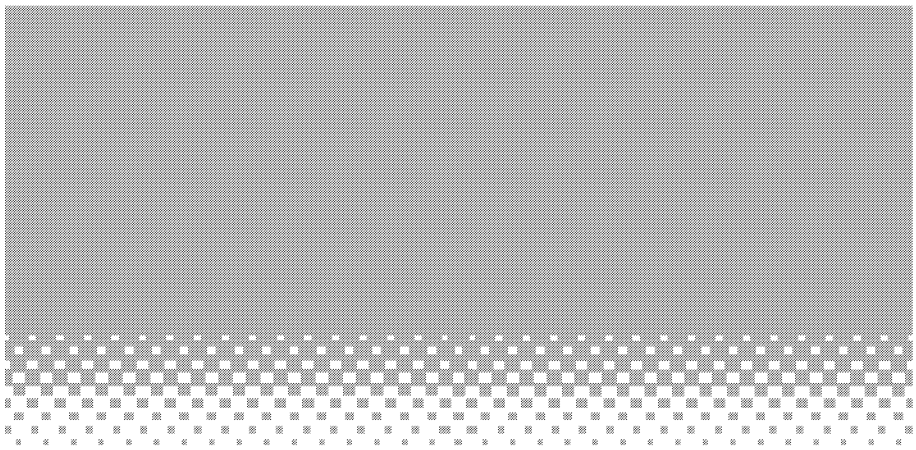
In normal operation, "End" is displayed. If an error has occurred, "Err" is displayed.



3. When the **SET** key is pressed, the control unit will return to the first LCD check mode.

Note

- When the MEAS key is pressed, the control unit returns to the Clock Display mode.



7. Maintenance

7.1 Normal maintenance

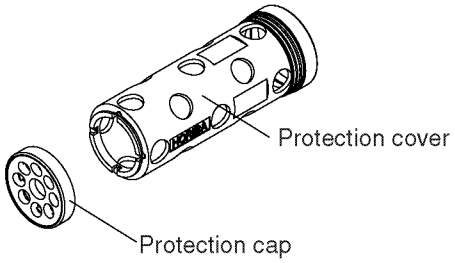
Sensor probe

● Storage

1. Clean the sensor probe with tap water and wipe off contamination.
2. Pour about 20 mL of pure water into the probe cap, install it on the sensor probe.
3. Disconnect all cables from the control unit before storing.
4. Store the probe assembly in the carrying case.

In order to use the instrument regularly for a long time, store it after wiping off all contamination from the cable, sensor probe, and sensors.

Remove the protection cover, and completely wash out with tap water the left over sample on the screws. Reinstall the cover after having wiped off the drops of water. If there is any sample (especially sea water) left over on the screws, rust may form which may prevent the protection cover from being removed. (☞ Installation procedure, page 19.)
Depending on the level of contamination, remove the rubber protection cap from the tip of the protection cover and wash out with tap water. Reinstall it after wiping off the drops of water.



When storing the pH, pH/ORP and DO sensors attached to the probe, make sure to install the probe cap after filling pure water in it.
Letting the pH, pH/ORP and DO sensors get dry may cause deterioration of the sensor's performance. Should the sponge inside the probe cap be contaminated, replace it with a clean sponge (included).

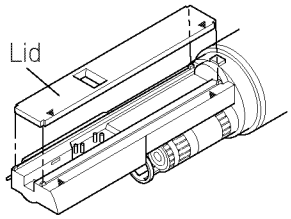
Important

- Do not put water in the probe cap before attaching it to the ion sensor end (B side) of W-23XD.

TEMP/COND/TURB units

● To remove contamination

1. Remove the lid from the cell.
2. Clean the unit with tap water. If the unit is severely contaminated, use a cotton swab to remove contamination.
3. Attach the lid to the cell block before storage. (☞ page 32.)



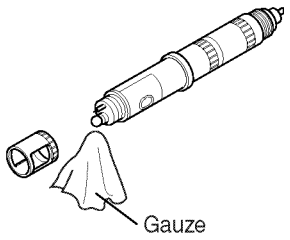
Important

- Attach the lid to the cell in the correct direction.
- Do not remove the COND lid during calibration or measurement.
- Attach the lid to the cell with fitting four corners and facing ▲ marks each other as illustrated.

pH or pH/ORP sensors

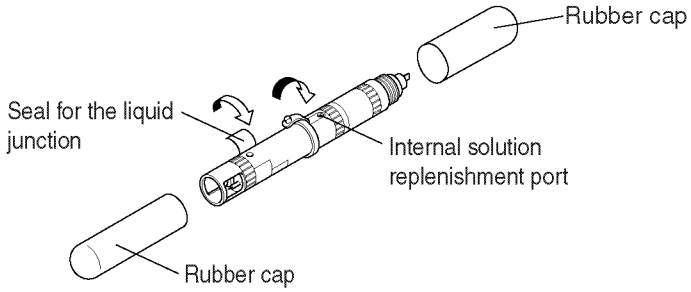
● To remove contamination

Use a piece of gauze dampened with detergent and wipe off contamination.



● Long-term storage

1. Remove the sensor from the sensor probe.
2. Check the internal solution replenishment port is closed. Then, attach a vinyl tape to the liquid junction.
3. Attach the rubber caps .



● Monthly maintenance

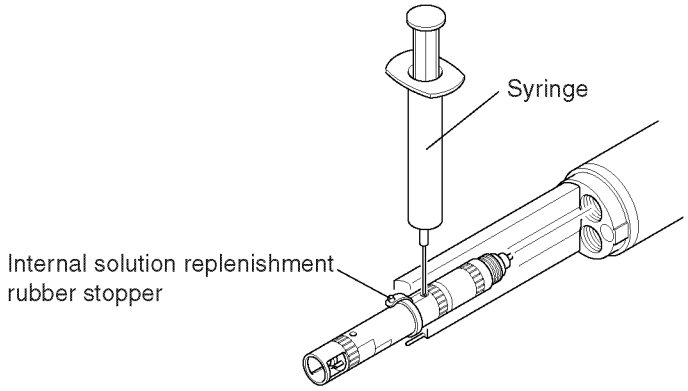
Replace the internal solution as described below:

1. Remove the sensor from the sensor probe using a sensor spanner.
2. Open the internal solution replenishment rubber stopper and remove the internal solution with a syringe.
3. Pour new internal solution (#330) to the level near rubber stopper.
   Air bubbles in the internal solution will impair the sensors' pressure compensation function.

Important

- Shake the sensor to avoid bubbles in the internal solution at the bottom of the sensor.

4. Attach the sensor to the sensor probe.



DO sensor

● To remove contamination

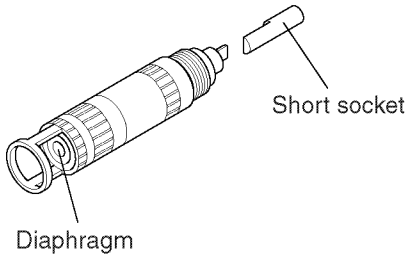
Wipe off contamination with gauze to avoid damage to the diaphragm.

● Long-term storage

1. Remove the sensor from the sensor probe using a sensor spanner.
2. Set the supplied short socket and store the sensor in a cool (0 to 10°C) and dark place.

Important

- Provide the DO sensor with a short socket or connect the sensor to the sensor probe for storage. Otherwise, the sensor may have a shorter life or stable instructions may not be obtained.
- The short socket is used when storing. Do not throw it away.



● Resetting the DO sensor when storing without having installed the short socket.

- HORIBA DO sensor uses Diaphragm glavanic battery method.
- Do not throw away the short socket, as it is used for the storage of the DO sensor.
- Always attach the DO sensor to the sensor probe or to the short socket to keep good response. When this is not follwed and left the DO sensor connector naked, the DO reading will become instable and the lifetime will be shorter.
- When the DO sensor connector is left naked for 1 or 2 days, its performance can be retrieved by attaching the shortsocket or connecting to the sensor probe and leaving it for 1 or 2 days. When left naked for a longer period of time, the retrieval may be sucsessful by attaching the necessary parts and leaving it for the same period of time it was left naked. However, when left for more than 1 month, the retrrieval is imposible. It is required to replace with new one.

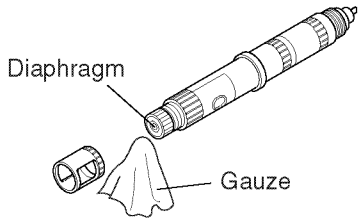
● To replace the diaphragm.

Please read the instruction manual of the DO diaphragm replacement kit. (☞ page 102)

ION sensors (for the W-23XD model only)

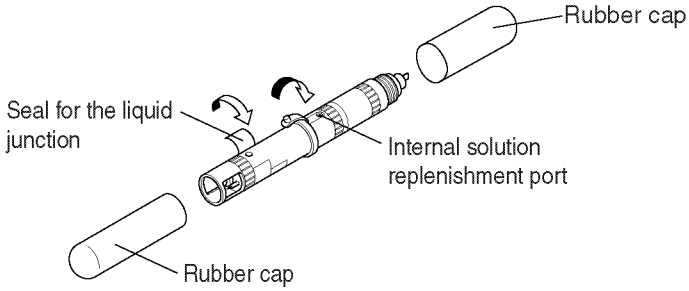
● To remove contamination

Use a piece of gauze dampened with water to wipe off contamination, being careful not to scratch it the diaphragm.



● Long-term storage

1. Use a sensor spanner to remove the sensor from the sensor probe.
2. Check the internal solution replenishment port is closed. Then, attach a vinyl tape for the liquid junction.
3. Attach the rubber caps.



● Maintenance at intervals of one week to one month

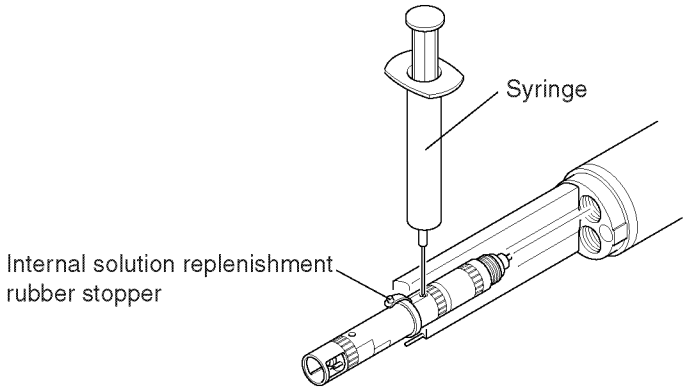
Replace the internal solution as described below:

1. Remove the sensor from the sensor probe using a sensor spanner.
2. Open the internal solution replenishment rubber stoper and remove the internal solution with a syringe.
3. Pour a new internal solution described in the sensor manual to the level near the rubber stopper.

Important

- Shake the sensor to avoid bubbles in the internal solution at the bottom of the sensor.

4. Attach the sensor to the sensor probe.



7.2 Troubleshooting

The control unit has a simple error message function that informs operator of operational errors and failure. Err number is displayed at the bottom of the screen.

● Error message list

Err No.	Designation	Err No.	Designation
1	Sensor memory failure	6	Span calibration error
2	Sensor probe battery voltage drop	7	Calibration stability error
3	Control unit battery voltage drop	8	Printer error
4	Communications error	9	DATA IN error
5	Zero calibration error		

● Error and remedy

Important

- For error numbers from 5 to 7, the calibration error display disappears when a proper calibration is performed after the following remedy, or when the control unit is turned on again. For other errors, the error display disappears after the following remedy is taken.
- Error numbers 2 and 3 are displayed even when using the AC adapter if the sensor probe battery voltage or control unit battery voltage becomes low.

Err NO.	Problem	Cause	Remedy
1	No data can be read from or written into the sensor probe memory.	Internal IC failure	Call your nearest representative for sensor probe repair.
2	Sensor probe battery voltage drop	① Battery voltage drop ② Improper installation of the battery	① Replace the battery. ② Set the batteries in the correct direction.
3	Control unit battery voltage drop	① Battery voltage drop ② Improper installation of the battery	① Replace the battery. ② Set the battery in the correct direction.
4	No communications possible between the control unit and the sensor probe	① Improper connection of the cable. ② Cable disconnection	① Connect the cable properly and turn on the control unit again. ② Call your nearest representative for cable repair.
5	No zero calibration possible	pH • The standard solution is contaminated. • Contamination on the pH glass membrane • Change in concentration of the internal solution for the reference electrode • Cracks in the pH glass electrode COND • The standard solution is contaminated. • The sensor is dirty. • The COND sensor is broken.	pH • Change the standard solution. • Clean the pH glass membrane. • Replace the internal solution. • Replace the sensor. COND • Change the standard solution. • Clean the sensor. • Contact your nearest representative.

Err NO.	Problem	Cause	Remedy
5	Zero calibration not possible	TURB • Air bubles in the cell • Cell contamination DO • Damage of the diaphragm of the DO sensor	TURB • Swing the sensor probe while drwing a large arc. • Clean the cell. DO • Check the sensor and replace it if damaged.
6	Span calibration not possible	DEP • Contamination on the DEP sensor • Damage of the DEP sensor pH • Contamination on the pH glass membrane • Change in concentration of the internal solution for the reference electrode • Cracks in the pH glass electrode COND • The standard solution is not correct. • The standard solution value is set incorrectly. • The COND sensor is broken. TURB • Air bubbles in the cell • Cell contamination • The lid is attached incorrectry. DO • Damage of DO sensor diaphragm • DO sensor is unstable. DEP • Contamination on the DEP sensor • Damage of the DEP sensor TEMP • Damage of the TEMP sensor	DEP • Clean the DEP sensor. • Contact your nearest representative. pH • Clean the pH glass membrane. • Replace the internal solution. • Replace the sensor. COND • Calibrate with correct standard solution. • Delete the calibration data and calibrate the sensor again. (☞ Page 52) • Contact your nearest representative. TURB • Swing the sensor probe while drawing a large arc. • Clean the cell. • Contirm if the lid is attrched crrectoiy, then calibrate the sensor agein. (☞ Page 33) DO • Check the DO sensor and replace it if damaged. • Connect DO sensor to the sensor probe. Calibrate the sensor again 1 day later. DEP • Clean the DEP sensor. • Contact your nearest representative. TEMP • Contact your nearest representative.
7	The calibration value does not become stable within approximately three minutes.	① Sensor contamination ② Dry sensor surface ③ Big temperature change	① Clean each sensor. ② Pour the standard solution into the calibration beaker. Calibrate the sensor again 1 to 2 hours later. ③ Calibrate the sensor in a place at a stable temperature or in a thermostatic oven.

Err NO.	Problem	Cause	Remedy
8	Printer unit failure		Turn OFF the instrument and use the remedy described below. Then turn ON the printer again.
		① Paper has jammed in the printer	① Remove the jammed sheet of paper.
		② Improper connection of printer unit	② Check to see if the printer is properly connected to the instrument.
		③ Printer failure	③ Replace the printer.
			* Contact your nearest representative if the instrument does not recover after replacement of the printer.
9	Data cannot be stored because the memory is full.	No free space in the memory	Delete the data stored in the memory. (☞ Page 89)

● Other troubles

Remedies for various trouble with no eror number are described below.

Problem	Cause	Remedy
No data display	• No batteries	• Set new batteries.
	• Improper position of the positive and negative poles	• Set the batteries properly while paying attention to the positive and negative poles.
	• Battery voltage drop	• Replace the batteries with new ones.
	• Improper control unit battery contact	• Use radio pliers to narrow the positive terminal of the battery snap.
No setting change possible	• Automatic data storage is under way	• Press the CAL key to stop the automatic data storage.
No key operation possible	• The key lock function is working	• Turn OFF the control unit. Then turn ON the control unit again. (☞Page 84)
	• Failure to calibrate the sensor or wrong calibration.	• Calibrate the sensor properly.
Blinking measured value	• Improper measurement sample	• Use a sample that is in the measurement range.
	• Sensor contamination	• Clean each sensor.
	• Poor calibration (The standard solution is contaminated.)	• Carry out correct calibration.
tYPE Err This error is displayed and the operation cannot be performed.	• Improper connection of the cable to the control unit	• Connect the cable to the control unit properly and turn on the control unit again.
	• Battery voltage drop	• Replace the control unit battery.
	• Cable disconnection	• Contact your nearest representative.
	• Control unit inside failure	• Contact your nearest representative.
WET CHE. This error is displayed and the sensor stops working.	• The connector is wet.	• Wipe the connector clean using a dry swab and the like.
	• The cable is deteriorated causing a faulty insulation.	• Replace the cable.
CHK display on the measurement mode.	• Battery voltage of the control unit is decreased to 5.5-6.5 V.	• Replace the control unit battery.

● Cautions in handling the TURB sensor

- Do not soak in a sample of extremely low temperature.
  If there is a rapid temperature change of more than 5°C dew condensation may occur to the sensor. When the sensor happens to dew, soak into the standard solution or sample and then start the measurement.)
- Once dew condensation occurs to the sensor, the same condition is likely to happen again. Dry the sensor as to the following instructions.
  1) Remove the electrode of pH and DO.
  2) Place the sensor in the air for 2 days.

For any abnormal values in the turbidity measurement, refer to the following problems.
Please refer to "7. Maintenance" for specific cleaning instructions.

Problem	Cause	Remedy
The measured value is over scaled.	The sensor is contaminated.	Remove the contamination of the sensor with a cotton swab.
	The bubbles are on the sensor.	Slowly immerse the sensor in the sample.
	The standard solution is contaminated.	Use new standard solution. If calibrated with contaminated standard solution, calibrate again with the new solution.
	The standard solution temperature is lower than the ambient and dew is formed inside the sensor during calibration.	If standard solution temperature is lower than air temperature, soak the sensor in the standard solution for 15 minutes and then start the calibration.
The measured value is under zero.	The sensor is contaminated.	Remove the contamination of the sensor with a cotton swab.
	The bubbles are on the sensor.	Slowly immerse the sensor in the sample.
	The standard solution is contaminated.	Use new standard solution. If calibrated with contaminated standard solution, calibrate again with the new solution.
	If sample temperature is lower than standard solution temperature, the transmitted light of the optical sensor is output in a high amount.	Make the sample and the standard solution temperature to the same temperature condition and then calibrate.
The turbidity value suddenly rises.	The sensor is immersed in a low temperature sample and dew formed inside the optical sensor.	Immerse the sensor into the sample for 15 minutes and then calibrate.

● Reference

#5460 DO Sensor Diaphragm Replacement Kit Operation Manual

This operation manual explains how to replace the DO Sensor (#5460) Diaphragm.

1 This kit comes with the following.

- Diaphragm sheets 10 sheets
- Diaphragm retaining ring 5 pcs.
- O-ring (S9) 5 pcs.
- Internal solution #305 (50 mL) 1 bottle
- Diaphragm retaining plate 1 pc.
- Replacement stand 1 pc.
- Syringe and needle 1 set
- Operation manual 1 sheet

(Control unit accesory diaphragm is 2 sheets.)

2 Diaphragm Replacement

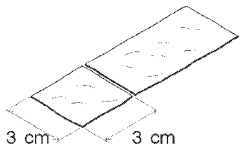
Chemical solution

Caution

The internal solution contains pottasium hydroxide (KOH) solution of high concentration.
If the solution comes in contact with hands or skin, wash immediately with water. If the solution comes in contact with the eyes, flush with ample amounts of water, then seek medical assistance.

1 Cut a diaphragm sheet to about 3 x 3 cm in size.

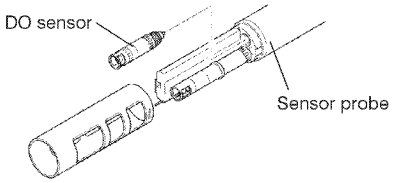
Note▶▶▶ Don't get any fingerprints or dust on the center part of the square.



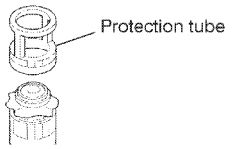
2 Detach the DO sensor from the sensor probe.

Ref▶▶▶ Refer to the U-21.22.23 Operation Manual, section 2.3.2 "Sensor Installation".

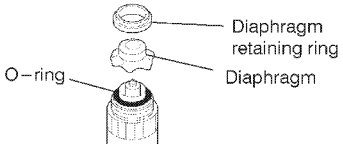
Note▶▶▶ If the short socket is not attached, instability may be seen when the sensor is used again.
Wear vinyl work gloves when handling the sensor. The KOH inside is a strong alkaline and can irritate skin.



3 Detach the protection tube that holds the diaphragm in place. If it is difficult to remove, use some spanner, etc. to remove it.

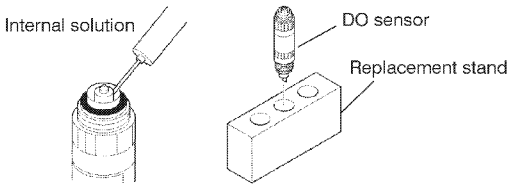


4 Detach the diaphragm retaining ring and diaphragm. Replace the diaphragm retaining ring and diaphragm if damaged or no longer functional.

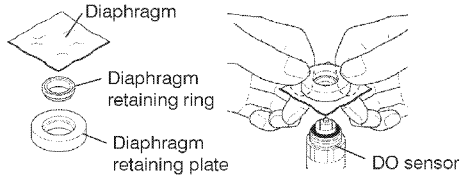


5 Set the sensor in the replacement stand ,and fill the internal solution with the attached syringe until the sensor tip is soaked with the solution.

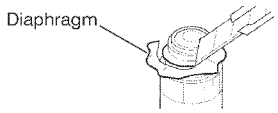
Note▶▶▶ Use the internal solution included in the kit for best performance.
In case some white crystals are seen, wipe them out completely with a Kimwipe®, etc.
In case the internal solution includes white crystals, remove the internal solution and fill up again. If the white crystals cannot be seen, just fill up.



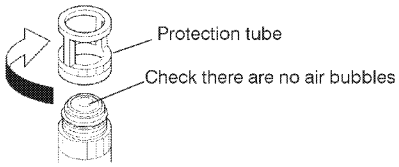
6 Fit the diaphragm retaining ring into the diaphragm retaining plate. Then, lay the diaphragm over the sensor and carefully cover with the ring and plate so that the diaphragm does not wrinkle. Finally, remove the retaining plate.



7 Cut the draped edge of the diaphragm to the shape of the sensor.

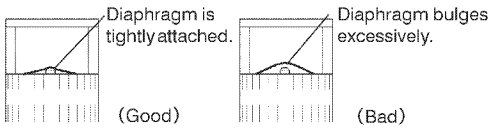


8 Check there are no air bubbles inside the sensor and tighten the protection tube securely.



9 Check the diaphragm bulges upward as shown on the below left and that it is not wrinkled.

Note▶▶▶ Check that span calibration can be made correctly. Sensitivity lowers and response speed slows if the diaphragm is not put correctly.



7.3 Spare parts

Spare parts list

Sensors

Sensor	Model	Spare part number	Compatible probe
pH sensor	6230	9037-0056-00	W-22/23XD
pH/ORP sensor	6280	9037-0057-00	W-22/23XD
DO sensor	5460	9037-0058-00	W-22/23XD
Nitrate ion sensor *	6531	9037-0059-00	W-23XD
Chloride ion sensor *	6522	9037-0060-00	W-23XD
Calcium ion sensor *	6533	9037-0061-00	W-23XD
Ammonia sensor *	5012	9037-0062-00	W-23XD
Fluoride ion sensor *	6530	9037-0063-00	W-23XD
Potassium ion sensor *	6532	9037-0064-00	W-23XD

* A cartridge for ion sensor replacement and reference internal solution are also included in the ion sensors.

Standard and internal solutions

Solution	Model	Spare part number	Remark
pH 4 standard solution (500 mL)	100-4	9003-0016-00	Standard solution for AUTO calibration, which is in addition used for manual pH span calibration.
pH 7 standard solution (500 mL)	100-7	9003-0017-00	Standard solution for pH zero calibration
pH 9 standard solution (500 mL)	100-9	9003-0018-00	Standard solution for manual pH span calibration
Powder for ORP standard solution (250 mL × 10)	160-51	9003-0031-00	Powder for standard solution to be used for checking ORP
Powder for ORP standard solution (250 mL × 10)	160-22	9003-0030-00	
pH reference internal solution (250 mL)	330	9037-0052-00	Replenishment internal solution for pH reference electrode
Ion one-point standard solution (250 mL)	130	9037-0065-00	Standard solution for ion sensor calibration
Nitrate ion sensor reference internal solution (50 mL)	302	9037-0066-00	Replenishment internal solution for the nitrate ion sensor
Chloride ion sensor reference internal solution (50 mL)	301	9037-0067-00	Replenishment internal solution for the chloride ion sensor
Calcium and fluoride ion sensor reference internal solution (250 mL)	300	9003-0032-00	Replenishment internal solution for the Calcium and fluoride ion sensor
Potassium ion sensor reference internal solution (50 mL)	303	9037-0069-00	Replenishment internal solution for the potassium ion sensor
Ammonia sensor reference internal solution (50 mL)	370	9012-0009-00	Replenishment internal solution for the ammonia sensor

Cartridges for ion sensor replacement

Cartridge	Model	Spare part number	Remark
Nitrate ion cartridge	7681	9003-0152-00	Replacement chips for the ion sensors
Chloride ion cartridge	7660	9003-0150-00	
Calcium ion cartridge	7683	9003-0154-00	
Potassium ion cartridge	7682	9003-0153-00	
Fluoride ion cartridge	7661	9003-0151-00	

Others

	Model	Spare part number	Remark
Diaphragm for ammonia sensor (6 pcs.)	–	9037-0070-00	In case of breakage of the ammonia sensor diaphragm, it is used as replacement to restore the sensor.
Calibration beaker XD	–	9037-0086-00	This is used for sensor calibration.
Connector plug for the probe	–	9037-0071-00	When using the sensor probe separately from the control unit, this is used to maintain waterproof of the sensor probe connector.
Sensor spanner	–	9037-0088-00	This is used to connect the sensor to the probe.
DO diaphragm replacement kit	–	9037-0074-00	In case of breakage of the DO sensor diaphragm, it is used in the replacement of the diaphragm to restore the sensor.
Battery cover packing	–	9096-0013-00	Replacement packing to be used for battery box of the control unit.
System unit cover O-ring	–	9096-0014-00	Replacement packing to be used for EXT cover of the control unit.
Sensor O-ring	–	9037-0076-00	Replacement O-ring to be used for connector of pH or pH/ORP sensor and DO sensor.
Probe cap XD	–	9037-0087-00	This cap is to be used when storing the sensor probe.
Battery caver O-ring	–	9037-0084-00	This replacement O-ring is used for the sensor probe battery cover.
Silicon grease	–	9037-0085-00	This silicon grease is applied on the sensor O-ring.
Protection cover packing	–	9037-0091-00	This packing is used with probe cap to secure tightness with protection cover. (sheet packing and O-ring set)
Sponge	–	9037-0089-00	This replacement sponge is used for the probe cap XD.
Protection cap	–	9037-0090-00	This cap is to be attached to the protection cover.

Repair parts

	Model	Spare part number	Remark
Protection cover S	–	G0142940	Use for W-22XD
Protection cover W	–	G0142941	Use for W-23XD
Battery cover for the sensor probe	–	G0061630	Use for W-23XD
Hook of the cable	–	F0023493500	Use for the relay cable.

7.4 Option

Parts name	Model	Remark
Extension adaptor	U-2001	This is applicable to AC adapter connection, RS-232C communication, GPS connection, printer output, and data-collecting software.
System unit *	U-2002-100V U-2002-110V U-2002-220V	This is applicable to AC adapter connection, RS-232C communication, GPS connection, printer output, and data-collecting software. GPS and printer are included in a complete set.
AC adaptor (for 100 V, 110 V, 220 V)	AC-10	AC adapter intended to drive the W-20XD series by AC power supply. This should be used together with U-2001 and U-2002.
Carrying case	W-2010	Compact carrying case for cable below 10 m in length . Large enough to hold flow cell.
Carrying case	W-2030	Bigger-sized carrying case for cable exceeding 30 m in length. Large enough to hold flow cell.
Flow cell	W-2100	Applicable exclusively to W-22XD. To be used for measurement at a pumping up sample.
Probe guard	W-2200	To be used for measurement at a location where there is a flow or a location with a thick sludge layer residing at the bottom.
PC connection cable	—	Nine-pin connection cable to PC.

* Specify the power source voltage of the printer when ordering.

7.5 Basic composition of units

Parts name	Model	Remark
Multi probe	W-22XD	
Multi probe	W-23XD	
Control unit	W-2000S	
Cable	W-002CS	2 m cable
Cable	W-010CS	10 m cable
Cable	W-030CS	30 m cable
Cable	W-100CS	100 m cable

8. Instrument specifications

8.1 Specifications of W-20XD series models

NOTE ○: Applicable
—: Unapplicable

		W-22XD	W-23XD
Control unit W-2000S	Water-proof construction	IP67	IP67
	Mass	Approximately 500 g (including the grip holder)	Approximately 500 g (including the grip holder)
Sensor probe *1	Use in 2-inch well	○	—
	Measurement temperature	0 to 55 °C	0 to 55 °C (except ion)
	Storage temperature	-5 to 60 °C	-5 to 60 °C
	Measurement depth *2	to 100 m	to 100m (except ion)
	Maximum sensor outside diameter	Approximately 47 mm	Approximately 97 mm
	Sensor length	Approximately 390 mm	Approximately 440 mm
	Continuous use available *3	30 days	30 days (except ion)
	Automatic data collection at preset time	○	○
	Mass	Approximately 1.3 kg	Approximately 1.8 kg
Cable			
W-002CS (2 m)	Mass	Approximately 0.4 kg	Approximately 0.4 kg
W-010CS (10 m)	Mass	Approximately 1.0 kg	Approximately 1.0 kg
W-030CS (30 m)	Mass	Approximately 1.5 kg	Approximately 1.5 kg
W-100CS (100 m)	Mass	Approximately 4.6 kg	Approximately 4.6 kg
pH	Measuring principle	Glass electrode method	Glass electrode method
● Two-point calibration	Range	pH0 to 14	pH0 to 14
● Automatic temperature compensation	Resolution	0.01 pH	0.01 pH
	Repeatability	±0.05 pH	±0.05 pH
	Accuracy	±0.1 pH	±0.1 pH
Dissolved Oxygen	Measuring principle	Diaphragm galvanic battery method	Diaphragm galvanic battery method
● Salinity compensation (0 to 40 ppt/Auto)	Range	0 to 19.99 mg/L	0 to 19.99 mg/L
	Resolution	0.01 mg/L	0.01 mg/L
● Automatic temperature compensation	Repeatability	±0.1 mg/L	±0.1 mg/L
	Accuracy	±0.2 mg/L	±0.2 mg/L
Conductivity	Measuring principle	4 AC electrode method	4 AC electrode method
● Auto range	Range	0 to 9.99 S/m	0 to 9.99 S/m
● Automatic temperature compensation (25 °C)	Resolution	0.1 % of full scale	0.1 % of full scale
	Repeatability	±1 %	±1 %
	Accuracy	±3 %	±3 %
Salinity	Measuring principle	Conductivity conversion	Conductivity conversion
	Range	0 to 4 %	0 to 4 %
	Resolution	0.01 %	0.01 %
	Repeatability	±0.1 %	±0.1%
	Accuracy	±0.3 %	±0.3%
Total Dissolved Solid (TDS)	Measuring principle	Conductivity conversion	Conductivity conversion
	Range	0 to 99.9 g/L	0 to 99.9 g/L
● Conversion factor setting	Resolution	0.1 % of full scale	0.1 % of full scale
	Repeatability	±2 g/L	±2 g/L
	Accuracy	±5 g/L	±5 g/L
Seawater specific gravity	Measuring principle	Conductivity conversion	Conductivity conversion
	Range	0 to 50 σ_t	0 to 50 σ_t
● Display σ_t, σ_0, σ_{15}	Resolution	0.1 σ_t	0.1 σ_t
	Repeatability	±2 σ_t	±2 σ_t
	Accuracy	±5 σ_t	±5 σ_t

		W-22XD	W-23XD
Water temperature	Measuring principle	Thermistor method	Thermistor method
	Range	0 to 55 °C	0 to 55 °C
	Resolution	0.01 °C	0.01 °C
	Repeatability	±0.3 °C	±0.3 °C
	Accuracy	±1.0 °C	±1.0 °C
Turbidity (TURB)	Measuring principle	Penetration and scattering method	Penetration and scattering method
● Unit selection	Range (NTU or mg/L)	0 to 800 NTU	0 to 800 NTU
	Resolution	0.1 NTU	0.1 NTU
	Repetability	±3 %	±3 %
	Accuracy	±5 %	±5 %
Water depth	Measuring principle	Pressure method	Pressure method
	Range	0 to 100 m	0 to 100 m
	Resolution	0.1 m	0.1 m
	Repetability	±3 %	±3 %
	Accuracy	±5 %	±5 %
Oxidation reduction	Measuring principle	Platinum electrode method	Platinum electrode method
potential (ORP)	Range	± 1999 mV	±1999 mV
	Resolution	1 mV	1 mV
	Repetability	± 5 mV	±5 mV
	Accuracy	±15 mV	±15 mV
Ions	Measuring principle		Ion electrode method
● Auto range	Resolution	-	0.1 % of full scale
	Repetability	-	±5 % of full scale
	Accuracy	-	±10 % of full scale
	Range		
	Nitrate ion	-	NO_3^-: 0.62 to 62000 mg/L (pH3 to 7: 62 mg/L)
	Chloride ion	-	Cl^-: 0.4 to 35000 mg/L (pH3 to 11: 350 mg/L)
	Calcium ion	-	Ca^{2+}: 0.4 to 40080 mg/L (pH5 to 11: 4.0 mg/L)
	Fluoride ion	-	F^-: 0.02 to 19000 mg/L (pH4 to 10: 20 mg/L)
	Potassium ion	-	K^+: 0.04 to 39000 mg/L (pH5 to 11: 3.9 mg/L)
	Ammonia ion	-	NH_3: 0.1 to 1000 mg/L (pH12 or more)
Simultaneous measurement parameters		10	13

Note: The accuracy rating value is obtained from measurements at intermediate point of the standard solution after two-point calibration (at room temperature and pressure). The repeatability and accuracy rating are expressed as percentages on the full scale (except for salinity).

*1: Organic solvents, strong acids, and strong alkaline solvents cannot be measured.

*2: The maximum depth for ion measurements are 100 m for nitrate ion, chloride ion, fluoride ion, 15 m for calcium ion, ammmonia, and 3 m for potassium ion.

*3: The battery life is estimated based on the data measured automatically at 15 minutes intervals.
Periodical maintenance and calibration is necessary when a lot of shellfishes and seaweeds exist at the measurement point.

MEMO

9. Reference Data

● pH measurement

1. Principle of pH measurement

W-20XD series use the glass electrode method for pH measurements. The glass electrode method measures a potential difference between the glass film for pH and the reference electrode. For more information, refer to JIS Z 8802 pH measurement method.

2. Temperature compensation

The electromotive force generated by the glass electrode changes depending on the temperature of the solution. Temperature compensation is used to compensate for the change in electromotive force caused by temperature.
This function does not compensate the change in pH caused by the temperature of the solution. When pH is to be measured, the temperature of the solution must be recorded along with that pH value, even if a pH meter has automatic temperature compensation function. If the solution temperature is not recorded, the results of the pH measurement may be meaningless.

3. Standard solutions

When measuring pH, the pH meter must be calibrated using standard solution. There are five kinds of standard solutions specified in "JIS Z 8802 pH measurement". For normal measurement, two of standard solutions with pH of 4, 7, and 9 are sufficient to accurately calibrate the meter.
For standard solutions, refer to "JIS Z 8802 pH measurement".

pH 4 standard solution ..... 0.05 mol/L potassium hydrogen phthalate aqueous solution
(Phthalate)
pH 7 standard solution ..... 0.025 mol/L potassium dihydrogenphosphate, 0.025 mol/L disodium
(Neutral phosphate) hydrogenphosphate aqueous solution
pH 9 standard solution ..... 0.01 mol/L sodium tetraborate aqueous solution
(Borate)

pH values of pH standard solutions at various temperatures settings.

Temp. (°C)	pH 4 standard solution Phthalate	pH 7 standard solution Neutral phosphate	pH 9 standard solution Borate
0	4.01	6.98	9.46
5	4.01	6.95	9.39
10	4.00	6.92	9.33
15	4.00	6.90	9.27
20	4.00	6.88	9.22
25	4.01	6.86	9.18
30	4.01	6.85	9.14
35	4.02	6.84	9.10
40	4.03	6.84	9.07
45	4.04	6.84	9.04

4. Pressure compensation diaphragm

W-20XD series can measure pH with high accuracy through the pressure compensation diaphragm without being affected by hydraulic pressure. Attention should be paid to the following points so that the diaphragm may function fully.
Before measurement, fill the reference electrode up to the replenish port with the internal solution using a syringe. When injecting the internal solution, be careful that air bubbles do not get into the solution.

● Conductivity (COND) measurement

1. Four-AC-electrode method

Conductivity is an index of the flow of electrical current in a substance.
Salts dissolved in water are separated into cations and anions. Such solution is called electrolytic solution.
Electrolytic solution has the property of allowing the flow of current according to Ohm's law. This property is referred to as ionic conductivity, since current flow is caused by ion movement in electrolytic solution.
Metals, on the other hand, allow the flow of current by means of electrons. This property is called electronic conductivity, which is distinguished from ionic conductivity.
A cube with 1 m on each side, as shown in Fig. 1, is used to demonstrate an electrolytic solution. Two electrode plates are placed on opposite sides, and the cube is filled with solution. If the resistance between these two electrode plates is represented by r (Ω), the conductivity of the solution L ($S.m^{-1}$) is represented as L=1/r. S stands for Siemens, a unit of measurement of conductance.

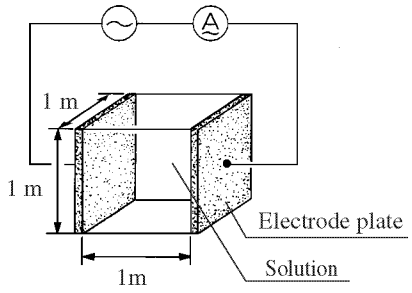


Fig. 1 Definition of conductivity

The most general method for measuring conductivity is based on the above principle, and is called the 2-electrode method.
In the 2-electrode method the influence of polarization cannot be ignored for solutions with high conductivity and conductivity cannot be measure accurately. In addition, contamination on the surface of the electrode increases apparent resistance, resulting in inaccurate measurement of conductivity.
The W-20XD series has adopted the 4-electrode method to overcome these disadvantages of the the 2-electrode method.
As shown in Fig. 2, the W-20XD series uses two voltage-detecting electrodes and two voltage-applying electrodes, for a total of four electrodes. The voltage-detecting electrodes are for detecting AC voltage, and the voltage-applying electrodes are for applying AC voltage.

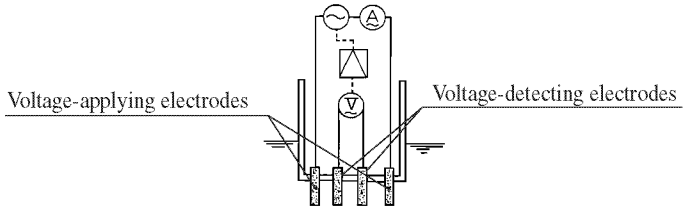


Fig. 2 Principle of the 4-electrode method

Let us assume that the current, I (A), flows in a sample of conductivity L – under automatic control of the voltage-applying electrodes – so that the voltage at the voltage detecting-electrodes, E (V), remains constant at all times. Then, the resistance of the sample, R (Ω), across the voltage-detecting electrodes is represented as R=E/I. The resistance, R, of the sample is inversely proportional to its conductivity, L. Accordingly, a measurement of current, Is, of a standard solution of known conductivity, Ls, enables calculation of conductivity of a sample according to the formula L = Ls (I/Is) from the ratio L : Ls = I : Is.
Even in the 4-electrode method, polarization occurs, since AC current flows in the voltage-applying electrodes. The voltage-detecting electrodes are, however, free from the effects of polarization, since they are separated from the voltage-applying electrodes, and furthermore, current flow is negligible. Therefore, the 4-electrode method is an excellent method to enable measurement of conductivity covering a very high range.

2. SI units

New measurement units, called SI units, have been in use from 1996. Accordingly, the W-20XD series also uses SI units. The following conversion table is provided for people who use the conventional kind of conductivity meter. Note that along with the change in unit systems, the measurement values and cell counts have also changed.

	Former units →	SI units
Measurement	0.1 mS/cm →	0.01 S/m
value	1 mS/cm →	0.1 S/m
	100 mS/cm →	10 S/m

3. Temperature coeffcient

In general, the conductivity of a solution varies largely with its temperature.

The conductivity of a solution depends on the ionic conductivity, described earlier. As the temperature rises, conductivity becomes higher since the movement of the ions becomes more active.

The temperature coefficient shows the change in % of conductivity per °C, with a certain temperature taken as the reference temperature. This is expressed in units of %/°C. The temperature coefficient assumes the premise that the conductivity of a sample changes linearly according to temperature.

Strictly speaking, with actual samples, however, conductivity changes along a curve. Furthermore, the cuve varies with the type of sample. In the ranges of smaller temperature changes, however, samples are said to have the temperature coefficient of 2 %/°C (at reference tempreture 25 °C); this holds for most samples, except in certain special cases. (The temperature coefficients for various types of solutions are listed on the next page.)

The W-20XD series uses an automatic temperature conversion function to calculate conductivity at 25 °C at a temperature coefficient of 2 %/°C, based on the measured value of the temperature. Results are displayed on the readout.

The W-20XD series's temperature conversion function is based on the following formula.

$$L_{25} = L_t / \{ 1 + K (t - 25) \}$$

L_{25} : Conductivity of solution converted to 25 °C
(value displayed on W-20XD)

t : Temperature of solution at time of measurement (°C)

L_t : Conductivity of solution at t (°C)

K : Temperature coeffcient (%/°C)

Conductivity and temperature coefficient for various solutions

Conductivity and related temperature coefficients of representative substances (at 25 °C) are shown in the table below.

Substance	Concentration wt%	Conductivity S/m	Temperature coeffcient %/°C	Temperature °C
NaOH	5	19.69	2.01	15
	10	31.24	2.17	
	15	34.63	2.49	
	20	32.70	2.99	
KOH	25.2	54.03	2.09	15
	29.4	54.34	2.21	
	33.6	52.21	2.36	
	42	42.12	2.83	
NH_3	0.1	0.0251	2.46	15
	1.6	0.0867	2.38	
	4.01	0.1095	2.50	
	8.03	0.1038	2.62	
HCl	5	39.48	1.58	18
	10	63.2	1.56	
	20	76.15	1.54	
	30	66.20	1.54	
H_2SO_4	5	20.85	1.21	18
	10	39.15	1.28	
	20	65.27	1.45	
	40	68.00	1.78	
	50	54.05	1.93	
	60	37.26	2.13	
	100.14	1.87	0.30	
HNO_3	6.2	31.23	1.47	18
	12.4	54.18	1.42	
	31	78.19	1.39	
	49.6	63.41	1.57	
H_3PO_4	10	5.68	1.04	15
	20	11.29	1.14	
	40	20.70	1.50	
	45	20.87	1.61	
	50	20.73	1.74	
NaCl	5	6.72	2.17	18
	10	12.11	2.14	
	15	16.42	2.12	
	20	19.57	2.16	
	25	21.5	2.27	

Substance	Concentration wt%	Conductivity S/m	Temperature coeffcient %/°C	Temperature °C
Na_2SO_4	5	4.09	2.36	18
	10	6.87	2.49	
	15	8.86	2.56	
Na_2CO_3	5	4.56	2.52	18
	10	7.05	2.71	
	15	8.36	2.94	
KCl	5	6.90	2.01	18
	10	13.59	1.88	
	15	20.20	1.79	
	20	26.77	1.68	
	21	28.10	1.66	
KBr	5	4.65	2.06	15
	10	9.28	1.94	
	20	19.07	1.77	
KCN	3.25	5.07	2.07	15
	6.5	10.26	1.93	
NH_4Cl	5	9.18	1.98	18
	10	17.76	1.86	
	15	25.86	1.71	
	20	33.65	1.61	
	25	40.25	1.54	
NH_4NO_3	5	5.90	2.03	15
	10	11.17	1.94	
	30	28.41	1.68	
	50	36.22	1.56	
$CuSO_4$	2.5	10.90	2.13	18
	5	18.90	2.16	
	10	32.00	2.18	
	15	42.10	2.31	
CH_3COOH	10	15.26	1.69	18
	15	16.19	1.74	
	20	16.05	1.79	
	30	14.01	1.86	
	40	10.81	1.96	
	60	4.56	2.06	

● Salinity (SAL) conversion

The W-20XD series is designed to calculate salinity as well as the other parameters.
Note that the "salinity" referred to here is the salinity of sea water. There is a constant relation between conductivity and salinity at certain temperatures.
Therefore, if data on the conductivity and temperature are available, the corresponding salinity can be known. In other words, the salinity measurement of the W-20XD series is based on the principle of calculating the salt content, making use of the measured values of conductivity and temperature.
Note therefore, that measured results of all substances whose conductivity is detected are displayed as salinity. For example, the measured result is displayed as NaCl concentration, even if in fact the sample component is, hydrochloric acid (HCl).

● TDS conversion

TDS is short for Total Dissolved Solids and means the total dissolved solid amount.
The conductivity of a solution is affected by the amount of salinity, minerals, and dissolved gases. That is, conductivity is an index that shows the total amount of all substances in the solution. Of these substances, TDS indicates only the amount of dissolved solids.
TDS can be used for a comparison of the state of substances composed of a single component such as NaCl. However, the use of TDS for the comparison of solutions of different types causes serious errors.
Conductivity and TDS are expressed by the following formulas:

Conductivity in SI units (S/m) ..... TDS(g/L) = L (S/m) × K × 10
TDS(g/L) = L (mS/m) × K ÷ 100
Conductivity in the old units (mS/cm) ..... TDS(g/L) = L (mS/cm) × K
K = TDS coefficient

Initial settings use the values listed in the table (☞ Page 80) that generally uses TDS coefficients.
For accurate TDS comparisons, find the TDS coefficient from measured conductivity values. Then set the value thus obtained and make measurements.

● σ_t conversion

Specific gravity of seawater

The density and specific gravity of seawater are equal numerically and generally are not distinguished strictly. Since seawater density ρ is between 1.000 and 1.031, 1 is subtracted from ρ and σ is obtained by multiplying the value by 1000.
The resultant value is used as the specific gravity of seawater.

$$\sigma = (\rho - 1) \times 1000$$

The density of seawater ρ is expressed by function of temperature, hydraulic pressure, and salinity. The density of seawater σ under the atmospheric pressure is expressed as σ_t. The density of seawater under the atmospheric pressure is determined by temperature and salinity.
The W-20XD Series models make salinity measurement through temperature measurements and conductivity conversion and find σ_t through calculations.
In Japan σ_{15} at 15 °C is called a standard specific gravity and widely used while in foreign countries σ_0 at 0 °C is employed. σ_{15} and σ_0 are determined by the function of salinity.
In ocean surveys, in particular, these values σ_t, σ_{15}, and σ_0 are more widely used than conductivity and salinity and, in the W-20XD Series models, newly added as measurement components.

● Disslved Oxygen (DO) measurement

1. Principle of measurement

The "DO" referred to here means the concentration of oxygen dissolved in water. DO is essential to self-purification of river and sea and to water creatures such as fish. DO measurement is also essential to drainage water treatment and water quality control.

Fig. 3 shows the principle of measurement using a DO sensor.

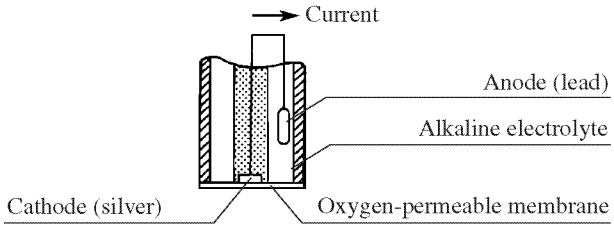


Fig. 3 Principle of DO sensor

A noble metal (silver) is fitted closely to an oxygen-permeable membrane to make the cathode; a base metal (lead) is used as the anode. Both are immersed in an alkaline electrolyte with the anode-to-cathode external circuit closed. Oxygen diffusing through the oxygen-permeable membrane causes a reduction reaction at the cathode; this allows flow of current in the external circuit:

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

At the anode, oxidation reaction occur as follows:

$$2Pb \rightarrow 2Pb2^+ + 4e^-$$

The current is proportional to the quantity of oxygen diffusing through the oxygen-permeable membrane. Accordingly, measurement of the current makes the DO in a sample known.

The DO measuring method based on this principle is called the membrane-electrode method. This method allows convenient measurement of DO, especially when compared with chemical-analysis method, which needs complicated pre-treatment to eliminate the effects of oxidizing or reducing substances.

2. DO correction for salinity

When a solution and air are in contact and in complete equilibrium (saturated), DO: C [mg/L] in the solution, and the oxygen partial-pressure: Ps [MPa] in air are in the following relation:

$$C = Ps/H$$

H [MPa/ (mg/L)] is referred to as Henry's constant, which depends on the composition of the solution. In general, C becomes smaller as the salinity in the solution increases, since H becomes larger.

A DO sensor is intended to detect Ps in the above expression. Therefore, the DO measurement would be in error if the DO sensor were immersed either in air-saturated pure water or in solution with salt. To settle this problem, it is necessary to correct the DO reading based on the salinity of the sample using salinity correction.

Conventional DO meters make this salinity correction by inputting a known salinity value. This poses no problems if the salinity of the sample is known. In general, however, the salinity of the sample is usually not known, and the method is not practical even if the DO meters are equipped with the salinity correction function.

The W-20XD series is capable of measuring the salinity of a sample and automatically correcting the using this function.

3. Features of the W-20XD series DO sensors

In conventional DO measurements, it was necessary to keep the velocity of the flow constant because the velocity of flow led to fluctuate the indication.

In W-20XD Series models, improvements in sensors have made it possible to make measurements with stable indications and with little influence of the velocity of flow.

● Turbidity (TURB) measurement

1. Principle of measurement

From among several types of turbidity-measuring methods available, the W-20XD series uses the light-transmission-scattering method, shown in Fig. 4.

Irradiation of a beam of light onto a sample brings about separation of the beam into (1) the light transmitted through the solution and (2) the light scattered by turbidity components in the sample. In the light-transmission-scattering method, the intensity of both transmitted light and the scattered light are measured using separate receptors, and the turbidity is obtained based on the ratio of the two.

With the W-20XD series, the light source is a pulse-lighting infrared-emission diode. The scattered light is measured at a point 60° offset from the light source. This light transmission scattering method has several advantages, including the fact that (1) the actual color of the sample fluid has little effect on the measurement of turbidity, (2) fluctuations in light in tensity the light source are easily compensated for, and (3) it allow the W-20XD series to be operated with relatively low-power consumption.

The turbidity value differs with the structure of the cell so changes with the instrument.

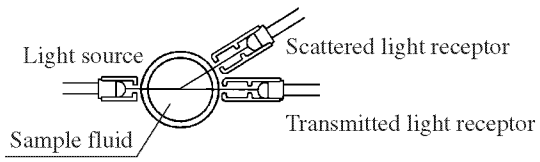


Fig. 4 Principle of the light-transmission-scattering method

2. Standard solution

W-20XD series can perform calibration using formazin (NTU) or kaolin standard solutions as a turbidity standard solution. However, units for the solution used for calibration should be displayed in measurements. Do not use more than 400 mg/L of kaolin standard solution because it increases precipitation speed, resulting in measurement error.

● Depth (DEP) measurement

1. Depth (DEP) measurement

For the W-22XD and W-23XD models, depth measurement can be made through use of a pressure gauge. The principle of the depth measurement uses the relation between depth and pressure.

Although the measurement with the depth sensor is affected by atmospheric pressure, the depth sensor, however, makes zero-point adjustments through the automatic calibration before measurements.

2. Influence of temperature and calibration

The depth sensor depends greatly on temperature. For a wide difference between the temperature at which the sensor has been automatically calibrated and the temperature of the measurement sample, the sensor can make depth measurements with a higher accuracy by the following method:

Immerse the depth sensor of the sensor probe into the sample.

Keep the sensor immersed in the sample for approximately 30 minutes until the temperatures of the sensor and the sample are the same.

Then make the zero calibration of the sensor manually. (☞ Page 61)

● Oxidation reduction potential (ORP) measuremnt

ORP principles

ORP (or "redox potential") is an abbreviation for oxidation-reduction potential. ORP is the energy level (potential) determined according to the state of equilibrium between the oxidants (M^{Z+}) and reductants $M^{(Z-N)+}$) that coexist within a solution.

$M^{z+} + ne^- \Leftrightarrow M^{(z-n)+}$..... ①

If only ① exists within a solution, a metal electrode (platinum, gold, etc.) and a reference electrode are inserted into the solution, forming the ORP measuring system shown in Fig. 5. The difference of potential between two electrodes is generally expressed by the following equation.

$$E = E_0 - \frac{RT}{nF} \ln \frac{a_M{}^{(z-n)+}}{a_M{}^{z+}} \quad \text{.....②}$$

E: Electric potential E_0 : Constant R : Gas constant T : Absolute temperature
n: Electron count F : Faraday constant a : Activity

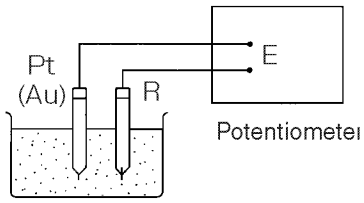


Fig. 5 Measuring mV

For example, for a solution in which trivalent iron ions coexist with bivalent iron ions, equations ① and ② would be as follows.

$Fe^{3+} + e^- \Leftrightarrow Fe^{2+}$..... ①

$$E = E_0 - \frac{RT}{F} \ln \frac{a_{Fe}{}^{2+}}{a_{Fe}{}^{3+}} \quad \text{.....②}$$

When only one type of state of equilibrium ① exists in the solution, the ORP of the solution can be determined uniquely by equation ②. What is important here is that ORP is determined by the ratio of activity between the oxidant (Fe^{3+}) and the reductant (Fe^{2+}) (using the equation $a_{Fe}{}^{2+}/a_{Fe}{}^{3+}$). Actually, however many kinds of states of equilibrium exist simultaneously between various kinds of ions, in most solutions. This means that under actual circumstances, ORP cannot be expressed using the simple equation shown above and that the physical and chemical significance with respect to the solution is not very clear.

In this respect, the value of ORP must be understood to be only one indicator of the property of a solution. The measurement of ORP is widely used, however, as an important index in the analysis of solutions (potentiametric titration) and in the waste water treatment.

Standard electrode (reference electrode) types and ORP

The ORP is obtained comparing with corresponding reference electrode employed.
If different kinds of reference electrodes are used for measurement, the ORP value of the same solution may appear to be different. HORIBA's reference electrode uses Ag/AgCl with 3.33 mol/L KCl as inner solution. According to general technical literature, normal hydrogen electrodes (N.H.E.) are often used as the standard electrode.
The relationship between N.H.E. and the ORP that is measured using an Ag/AgCl with 3.33 mol/L KCl electrode is expressed by the following equation.

$E_{N.H.E.} = E + 206 - 0.7\,(t - 25)mV \qquad t = 0 - 60\,℃$

$E_{N.H.E.}$: Measured ORP value using N.H.E. as the reference electrode

E: Measured ORP value using Ag/AgCl with 3.33 mol/L KCl as the reference electrode

Potential sign

Standard ORP is expressed in the following way, in literature related to electrochemistry and analytical chemistry.

A $Li^{+}+e^{-} \rightarrow Li$

E0=-3.024 V VS N.H.E.

However, in some literature, the "+" and "-" signs are reversed.

B $Li \rightarrow Li^{+}+e^{-}$

E0=+3.024 V VS N.H.E.

In expressions like B, above, the reaction is just reversed and there is no essential difference. But this kind of expression does invite confusion. The majority of the world, today, is consistent in its use of the signs as they are used in A, above. For this reason, HORIBA, too, uses signs concerning ORP that are consistent with A, above.

● Ion measurement

1. Ion concentration measurement

When certain ions exist within the solution that is to be measured, the responsive ion sensor membrane generates an electric potential corresponding to the concentration of the ions. The potential that is generated is measured by the ion meter as potential, using the reference electrode as the reference. With ion sensors, the measured potential and the logarithm of the ion activity within the solution being measured are generally proportional to each other and are expressed in the following way.

$$E = Eo + (2.303\ RT/nF)\ log[\gamma C]$$

E : Measured electric potential (V)
Eo : Standard potential (V), determined according to the system. This includes the standard potential of the reference electrode and the liquid junction potential.
F : Faraday constant (96,485 $Cmol^{-1}$)
R : Gas constant (8.314 $JK^{-1}\ mol^{-1}$)
T : Absolute temperature (K)
n : Ion valency
γ : Activity coefficient
C : Ion concentration (mol/L)

The above formula is called "Nernst's equation" and is the basis for measuring ion concentration using an ion sensor. The part of the above Nernst's equation that reads "2.303 RT/nF" is the change in potential generated when the ion concentration changes by a factor of 10.
This change in potential is called the "potential slope," "incline," "slope," or "Nernst's factor." If the above equation is adhered to when calibrating with standard solution and determining the value of the potential slope and E_0, finding the potential E of the ion sensor inside the solution being measured will enable the ion concentration to be determined.
When actual measurement is performed, the ion sensor measures the ion concentration, so a linear relationship forms between the value of the ion concentration and the electrode potential, if the concentration is plotted on a logarithmic axis, as shown in Fig.6. Conducting quantitative analysis using an ion sensor requires either an ion meter that has an logarithm calculation function or the creation of a calibration curve using semi-logarithmic graph paper.

Calibration curve for univalent positive ion electrode

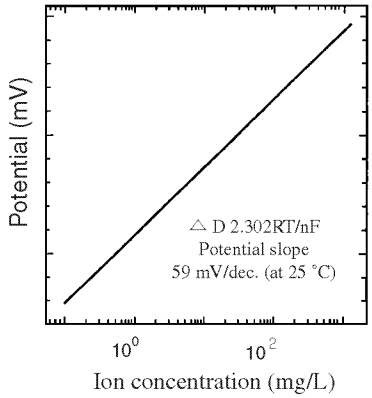


Fig. 6 Relationship between ion concentration and electric potential

2. Standard solution

Finding the ion concentration of the solution being measured requires prior calibration of the ion meter using a prepared standard solution with a known ion concentration. The number of times the meter is to be calibrated depends on the accuracy desired. Calibration is usually performed once a day or prior to making measurements. Calibrating the meter when the standard solution has been mixed using a stirrer or other utensil will improve the electrode responsiveness and measurement stability.

* Basically, at least two standard solutions of different concentrations should be used to calibrate the meter. If the approximate ion concentration of the liquid to be measured is known, standard solutions having lower and higher concentrations than that liquid should be used for calibration. In such cases, the standard solution with the lower ion concentration should have 1/10 the concentration of the standard solution with the higher concentration.
* If the approximate ion concentration of the liquid to be measured is unknown, choose low and high-concentration standard solutions with a larger differential than the 1/10 used in the above example. However, be sure not to exceed the limits of the linear ion sensor detection capabilities.

3. Properties of the ammonia ion sensor

The optional ammonia sensor for the W-23XD model measures ammonia gas (NH_3).

Ammonia gas (NH_3), which is a component in water, and ammonia ion NH_4^+ exist differently depending on pH. (Fig. 7)

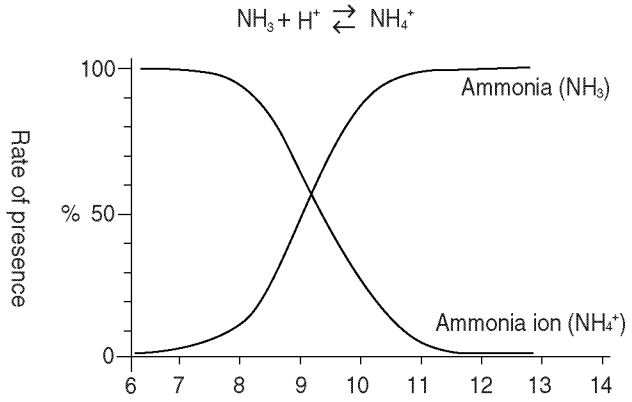


Fig. 7 The pH rates of ammonia and ammonia ions in water.

Before making measurements of only the ammonia (NH_3) in the sample, therefore, it is necessary to only immerse the ion sensor into the sample. Before making measurements of all ammonia components, it is necessary to change ammonia ion (NH_4^+) into ammonia gas (NH_3) by pouring the sample into the calibration beaker and adding approximately 0.3 g of sodium hydroxide.

For any question regarding this product,
please contact your local agency,
or inquire from the Customer Registration
website (www.horiba.co.jp/register).

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