HORIBA

pH Meter

D Series

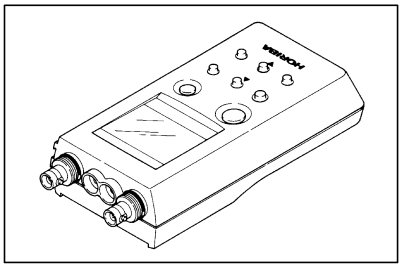
Operation Manual

Measuring ions, conductivity and dissolved oxygen

D-23

D-24

D-25



Thank you for purchasing one of the HORIBA D−20 Series (D−23, D−24, D−25) of handy pH meters.
This operation manual deals with measuring ions, conductivity and dissolved oxygen.
Before using the pH meter, carefully read this operation manual and the operation manual entitled “Operation Manual: Measuring pH and mV,” to ensure correct use of the meter.

HORIBA’s Warranty and Responsibility

Your D−series pH meter 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 to be avoided in the operation manuals
- Any trouble or damage attributable to use of the pH meter in ways or for purposes other than those described in the operation manuals
- If any repairs renovations, disassembly, etc. are performed on this pH meter by any party other than HORIBA or a party authorized by HORIBA
- Any alteration to the external appearance of this pH meter 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

HORIBA also shall not be liable for any damages resulting from any malfunctions of this product, any erasure of data, or any other uses of this product.

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 HORIBA customer support center printed on the back cover of this operation manual.

❑CONTENTS

❑CONTENTS (cont.)

1. Overview of pH meter

This chapter provides the names of the parts of the pH meter, how to connect the electrodes, and how to use the functions.
For how to replace the battery and what to be cautious of when using this meter, please refer to a separate booklet, entitled “Operation Manual: Measuring pH and mV.”

1 Overview of pH meter

1.1 Measurement items

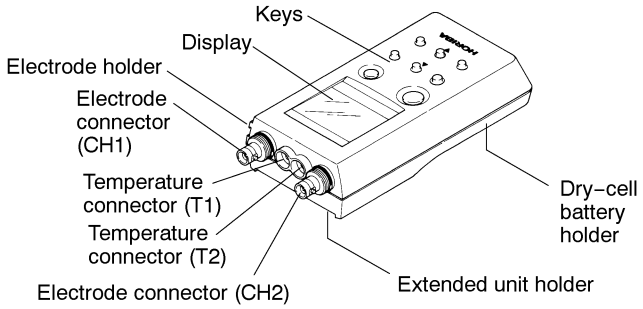
The following table indicates what can be measured using the D−20 Series.

Measurable	Definition	Model of main unit					Required electrode/ standard solution
		D−21	D−22	D−23	D−24	D−25	
pH	Measures the pH of a solution	○	○	○	○	○	pH electrode pH standard solution
ORP (mV)	Measures the ORP(mV) of a solution		○	○	○	○	ORP electrode (pH,Ion electrode)
Ions	Measures the ion concentration of a solution			○			Ion electrode Ion standard solution
Conductivity	Measures the conductivity in a solution				○		Conductivity electrode
Dissolved oxygen	Measures the dissolved oxygen in a solution					○	DO electrode

Note▶▶▶ When measuring pH, mV or ORP, refer to the operation manual entitled, “Operation Manual: Measuring pH and mV.”

1.2 Part names

In the D Series of hand held pH meters, the main unit is comprised of the following parts.



1.3 Electrodes

Electrodes are NOT included when only the main unit is purchased.
Purchase the electrodes below that meet your measuring needs.

- **D−23 (ion electrode)**

  Only the combined type of ion electrode (one that combines an ion selective electrode and a reference electrode) can be connected to the D Series of pH meters.
  Refer to the table of ion electrodes, on page 33.

- **D−24 (conductivity electrode)**

  The standard type of conductivity electrode for the D Series of pH meters is the water−resistant 9382−10D (cell const: 100 m^{-1}).

Note▶▶▶ Conductivity electrodes other than the one mentioned above (See p. 98) can also be connected to the pH meter. However, adverse effects may occur when both a pH electrode and a conductivity electrode are immersed in the same solution. Be sure to measure pH and conductivity separately.

Cell constant and measurement range

Units	Cell constant	Measurement range
SI units (Former units)	100 m^{-1} (1 cm^{-1})	0.000 mS/m to 19.99 S/m (0.00 μS/cm to 199.9 mS/cm)
SI units (Former units)	10 m^{-1} (0.1 cm^{-1})	0.0 μS/m to 1.999 S/m (0.000 μs/cm to 19.99 mS/cm)
SI units (Former units)	1000 m^{-1} (10 cm^{-1})	0.00 mS/m to 199.9 S/m (0.0 μS/cm to 1.999 S/cm)

Note▶▶▶ These measuring ranges are the input values prior to conversion at 25 °C.

- **D−25 (dissolved oxygen [DO] electrode)**

  Field−use electrodes (immersion type) 9550−20D/9550−100D and laboratory−use electrode 9520−10D can be connected to the pH meter.
  Purchase whichever electrodes best suit your application.

1.4 Connecting ion/conductivity/DO electrodes

Connect the electrode to the pH meter by following the below procedures. Use special care to ensure that no water or dirty hands come in contact with the connector during connection procedures.
(The explanatory drawings provided below show the pH meter with an extended unit attached.)

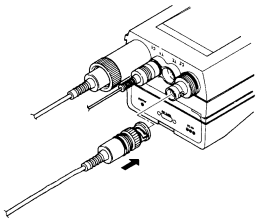
- **Electrode connector (G−R electrode)**

  Connect the ion/conductivity/DO electrode to the CH2 connector.

Ref.▶▶▶ With the D−23, it is possible to connect the electrode to the CH1 connector to measure ions, by changing the channel setting for the ion electrode only.

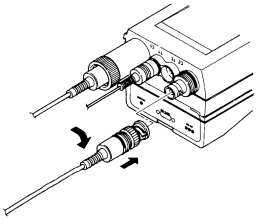
1. Insert the electrode connector making sure to align the connector grooves with the pin in the connector sleeve

on the main unit. Do not use undue force to push in the electrode connector when it is not properly aligned with the connector port.

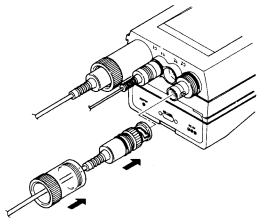


Note▶▶▶ Do not perform this step with wet or dirty hands.

2. Push the electrode connector into the connector port while turning it clockwise, following the grooves.



3. Place the connector cover on the connector. Then push it vertically, until it comes in contact with the face of the main unit.



Note▶▶▶ The water−resistant construction of the pH meter assembly is not maintained if the electrode is not inserted properly.

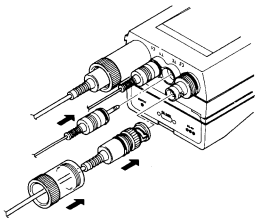
The connector cover for the ion electrode is NOT designed with a water−resistant construction.

● Temperature connector (T electrode)

Connect the ion/conductivity/DO electrode to the T2 connector.

Note▶▶▶ When measuring ions by connecting the ion electrode to the CH1 connector and changing the channel setting for the ion electrode only, connect the electrode to the T1 connector.

1. Insert the temperature connector into the jack on the main unit of the pH meter, while turning the temperature connector. Insert the connector all the way, until it is firmly attached and the O−ring on the main unit of the pH meter can no longer be seen.



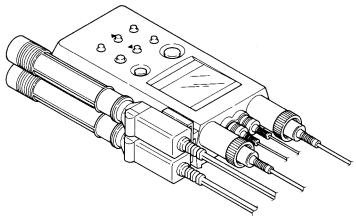
CH1: pH electrode connector (same for entire D−20 Series)
T1: Channel 1 temperature connector (same for entire D−20 Series)
CH2: Ion electrode connector (D−23), conductivity electrode connector (D−24), DO electrode connector (D−25)
T2: Channel 2 temperature connector (D−23, D−24, D−25)

Note▶▶▶ The water−resistant construction of the pH meter assembly is not maintained if the electrode is not inserted sufficiently.

The temperature display on automatic temperature compensation (ATC) will show 25°C when a T electrode has not been inserted or has not been inserted completely.

- **Electrodes can be attached to the main unit.**

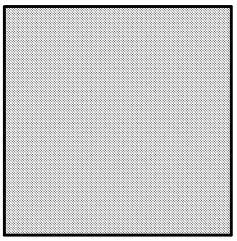
  There is an electrode holder on the right side of the main unit of the pH meter.



Note▶▶▶ To attach two electrodes to the holder, use the sensor adapter.

1.5 Making measurements

When the electrodes to be used are connected properly to the main unit of the pH meter, measurement can take place.
For the D−23, turn to page 13 for measuring ion.
For the D−24, turn to page 41 for measuring conductivity.
For the D−25, turn to page 53 for measuring DO.



Notes

2. D−23 ion measuring

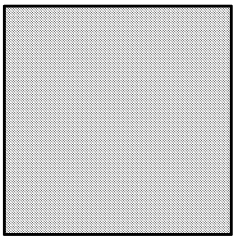
This chapter explains the basic operations involved in measuring ions.

2 D−23 ion measuring

❑Measuring ions (D−23)

This pH meter can measure ions, by using an ion electrode (sold separately). This operation manual contains the following information on measuring ions.

Note▶▶▶ The ion electrode does not have water−resistant specifications.



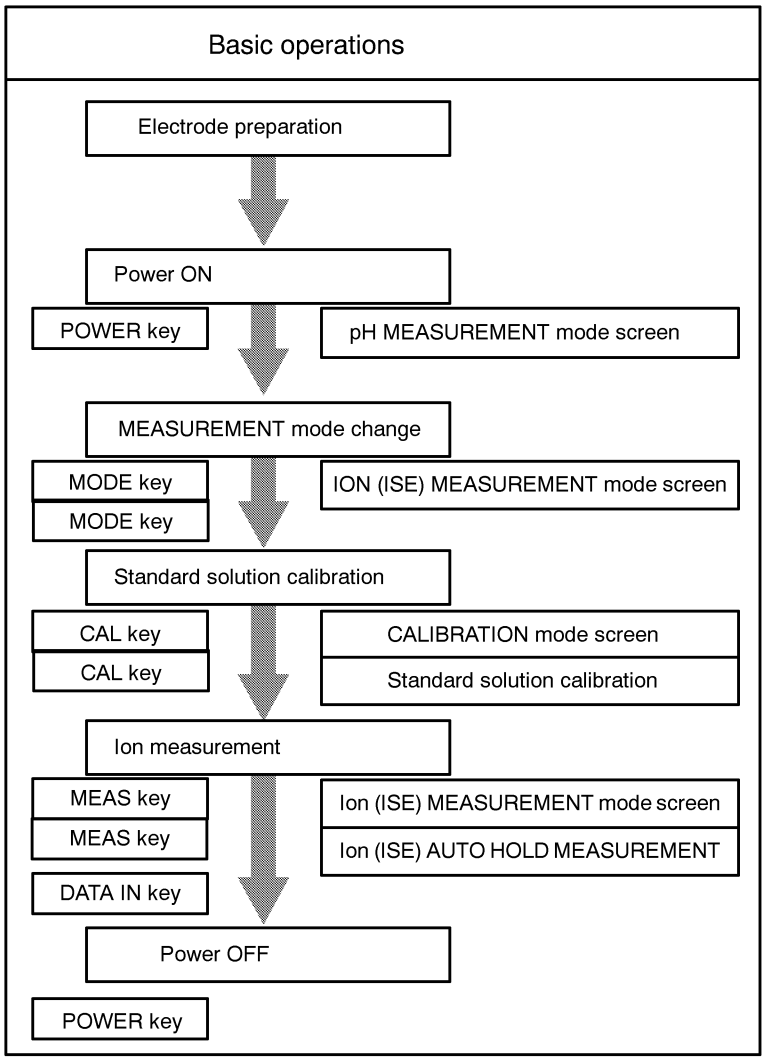
- Only the combined type of electrode (combining an ion selective electrode and a reference electrode) can be connected to the pH meter. Refer to the electrode table on page 33 for the electrode to meet your needs.
- This pH meter makes measurements (i.e., measures a sample after calibrating with a standard solution) by using a calibration curve. ALWAYS calibrate the meter prior to measuring a sample.

Note▶▶▶ The measurement indications may be incorrect until calibration is performed.

This operation manual mainly deals with the operation of the main unit of the D−20 Series of pH meters. Refer to the operation manual for your electrodes, for details on how to handle the electrodes, measurement techniques, and other information.

For information on...		See this section...	On page...
Basic measuring	Measuring K^+ ions for the first time	⇒ Electrode preparation	p. 17
Applicable functions	Measuring ions other than K^+	⇒ ION SEL mode	p. 28
	Using standard solution with mol/L units	⇒ UNIT SEL mode	p. 27
	When ion electrodes are connected to both CH1 and CH2	⇒ pH/ion CH setting	p. 31
	When an extended unit (sold separately) and printer (sold separately) are connected	⇒ Electrode ID no. settings	p. 31
Reference material	Making accurate measurement	⇒ Measuring technique for increased accuracy	p. 23
	Handling electrodes	⇒ Ion electrode maintenance (according to electrode operation manuals or this operation manual)	p. 33
	When an error no. appears during measurement	⇒ Troubleshooting	p. 74
	An overview of measuring ions	⇒ Reference	p. 82

2.1 Measuring ions: basic operational flow (D−23)



2.2 Measuring ions: basic operations (D−23)

This section explains the basic operations involved in measuring ions.

• Electrode preparation

Prepare the electrode(s) by referring to the electrode operation manual.

Chemical solution

Warning

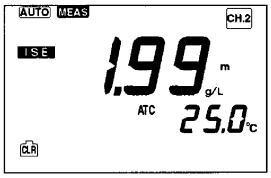
Toxic substances may be used in some ion electrodes. Use caution when handling ion electrodes. If the internal solution in the electrode comes in contact with your hands or skin, wash immediately with water. If the internal solution comes in contact with your eyes, flush immediately with large amounts of water and seek treatment by a physician.

• Turning power ON

1. Remove the protective cap from the electrode.
2. Immerse the electrode in pure (ion exchange) water.

Note▶▶▶ If the pH meter and ion electrode have not been calibrated, the indicated ion value may move outside the display range.

3. Press the POWER key.
   The pH INSTANTANEOUS VALUE MEASUREMENT screen will appear.
4. Press the MODE key twice.
   The ion INSTANTANEOUS VALUE MEASUREMENT screen will appear.



● Standard solution calibration

Calibrate the pH meter using a standard solution with a known concentration.

Perform two or three point calibration before measuring ions.

Note▶▶▶ Selecting the ions to measure

With a D–20 Series pH meter, setting the ion to be measured is done using the load count (charge quantity).

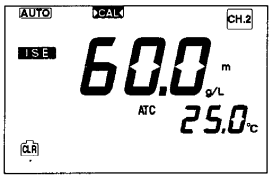
The ion type is set a +1 as the default setting. Refer to ION SEL mode settings, on page 28.

Units

Units are set at g/L as the default setting. To change the units to mol/L, refer to UNIT SEL mode settings, on page 27.

One–point calibration

1. Press the CAL key while in the ion INSTANTANEOUS VALUE MEASUREMENT mode, to select the CALIBRATION mode.



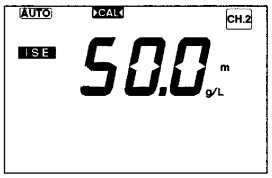
2. Wash the electrode and the liquid junction area again using pure (ion exchange) water, then wipe with filter or tissue paper.

Note▶▶▶ Do not touch or scratch the responsive membrane on the ion electrode.

3. Place the tip of the electrode in the standard solution beaker.
Refer to the electrode operation manual for how to adjust the standard solution.

Note▶▶▶ Mix the standard solution at a constant speed (300 – 500 rpm), using a magnetic stirrer.
Measure the standard solution and the sample that is to be measured while they are at as close to the same temperature as possible.

4. Set the standard solution value by using the ▲ (▼) key to move the value up (down). (The decimal point can be moved by using the MODE key.)

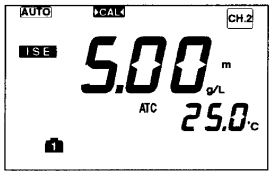


5. Press the CAL key to fix the standard solution value and return to the CALIBRATION mode.

6. Press the CAL key one more time to start calibration.

The measured value will appear, and “HOLD” will flash until the reading stabilizes.
When the measured value stabilizes, “HOLD” will stop flashing and the calibration value will be held as it is.

A 1 will appear, indicating that the pH meter has been calibrated.



Ref.▶▶▶ While "HOLD" is flashing

When calibration is forced: Fix the value using the DATA IN key.

When calibration is cancelled: Clear the hold by pressing the CAL key, again.

Note▶▶▶ To erase the calibration value, press the CAL key while holding down the F key in CALIBRATION mode. This enable the erasing of all calibration values.

Calibrations using two points or more

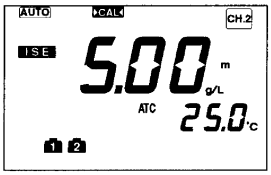
To conduct calibration using two or more points, clear the "HOLD" display using the CAL key, then prepare a standard solution and repeat steps 3. through 6., on page 19. Calibration can be performed using a maximum of three points.

The number of calibration points is displayed in the lower left of the display, as shown below.

Example: One point: 1

Two points: 1 2

Three points: 1 2 3



1. When all calibration operations have been completed, press the MEAS key to return to the ion MEASUREMENT screen. Now, ions can be measured.

Note▶▶▶ If, after returning to the MEASUREMENT mode, the CALIBRATION mode is re−entered and a new calibration conducted, all calibration data will be cleared.
Standard solution that has once been used should not be returned to the original container and should be discarded.

• Ion measuring

1. Wash the tip of the electrode well with pure (ion exchange) water and wipe it with filter or tissue paper.

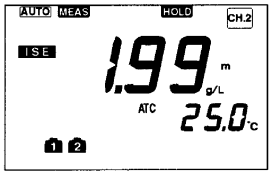
Note▶▶▶ Do not touch or scratch the responsive membrane on the ion electrode.

2. Completely immerse the electrode sensor in the sample solution.

Note▶▶▶ Mix the standard solution at a constant speed (300 − 500 rpm), using a magnetic stirrer.
Measure the standard solution and the sample that is to be measured while they are at close to the same temperature as possible.

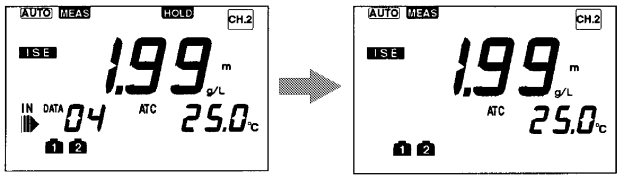
3. Press the MEAS key while on the INSTANTANEOUS VALUE MEASUREMENT screen.

”HOLD” will flash in the display until the indicated value stabilizes.
When the indicated value stabilizes, “HOLD” will stop flashing and remain lit in the display and the indicated value will be maintained in the display.
Once this is done, ion measurement has been completed.



Ref.▶▶▶ The criteria for judging a measured value to be stabilized is a change in potential of 1 mV or less for a 10 second period of time.

To save the data to memory, press the DATA IN key. The memory number will appear and the display will automatically return to the INSTANTANEOUS VALUE MEASUREMENT screen.



Ref.▶▶▶ When the units or type of ion are changed, CLR flashes on the screen. Press the CAL key while holding down the F key in CALIBRATION mode to clear the calibration value.

Note▶▶▶ The input voltage range at which measurement is possible using the D–Series of pH meters is 300 mV. If measurements do not work out satisfactorily, check the voltage at mV measurement.
Some samples are not conducive to good measurement. With such samples, refer to the section entitled “Measuring technique for increased accuracy,” starting on page 23.

- **Turning power OFF**

  1. When operation are finished, press the POWER key to turn OFF the power.

Note▶▶▶ The next time the power is turned ON, the pH meter will start on the pH MEASUREMENT mode.

For information on handling the electrode, refer to the electrode operation manual or the section entitled "Ion electrode maintenance" (starting on page 33) in this operation manual.

2.3 Measuring technique for increased accuracy

Ion electrodes can be used to make a simple measure of ion concentration. For more accurate measurements, however, certain techniques are required. For such information, refer to the electrode operation manual or the procedures explained below.

① Adding ionic strength conditioner to sample

The effects of ionic strength may cause measurement errors.
Conditioning the ionic strength by adding the chemicals shown in Table 2−1 to the sample and standard solution for the corresponding ion electrodes enables accurate measurement.

② pH effect of sample

The pH range for each electrodes is determined by the type of the ion electrode. Check the pH value of each sample to determine whether or not it is within the measurable range. If the pH level is outside the measurable range, adjust the solution using chemicals containing ions other than the ones being measured and ones that may interfere with the measurements.

Additives and usable pH

Ion electrode	Additives (per liter)	Measurable pH
Potassium K^+	5.9 g/L sodium chloride (NaCl)	pH 5 – 11 (Ideal is near neutral)
Calcium Ca^{2+}	7.5 g/L potassium chloride (KCl)	pH 5 – 11 (Ideal is near neutral)
Chloride Cl^-	10 g/L potassium sulfate (KNO_3)	pH 3 – 11 (Ideal is near neutral)
Fluoride F^-	10 g/L potassium sulfate (KNO_3)	pH 4 – 10
Nitrate NO_3^-	No additives	pH 3 – 7
Ammonia NH_3	4 g/L sodium hydroxide (NaOH)	pH 12 or higher

③ Sample measuring environment

A potential slope measured using an ion electrode follows Nernst's equation (See page 82) and is effected by the solution being measured. Also, if the solution is not mixed well enough, the response becomes slow, rendering it impossible to measure low concentrations and causing unsteady measured values. Calibration with standard solution and measuring the sample should be performed using a constant–temperature water bath and while mixing the solutions.

④ Effects of interfering ions on sample

If the sample cannot be measured properly even after taking the preventative measures described in items ① through ③, above, the solution may contain interfering ions.

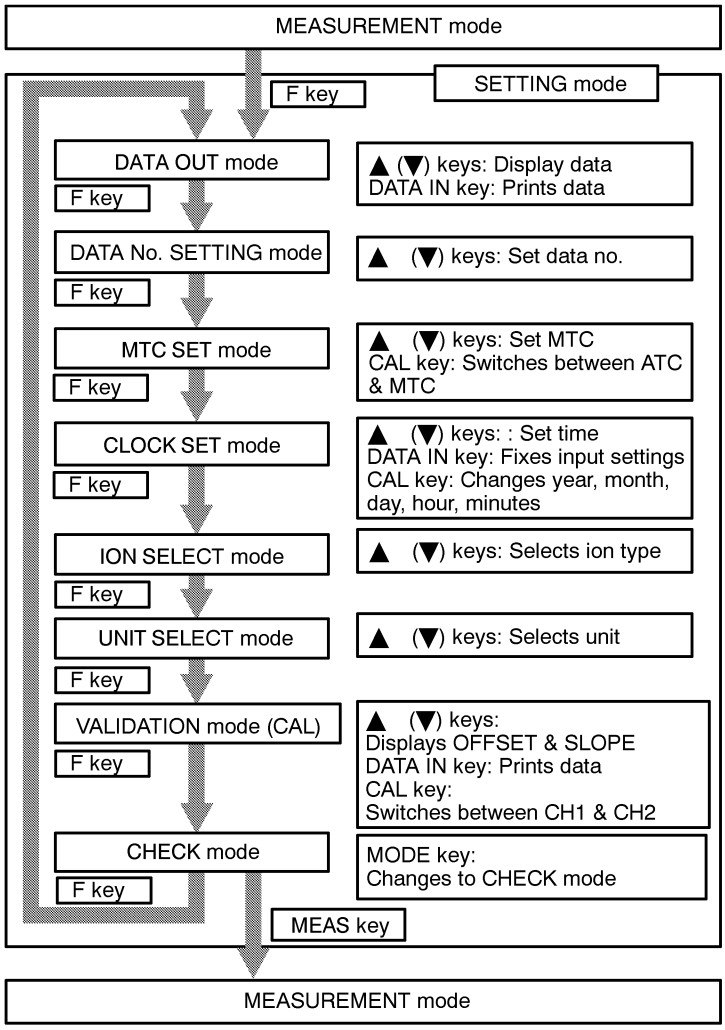
Effects of interfering ions

Ion electrode	Compatible tolerance limits
Potassium K^+	Li^+, Ma^+, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+} = 1,000; NH_4^+ = 70; Cs^+ = 3; Rb^+ = 0.4 (At 10^{-4} mol/L K^+)
Calcium Ca^{2+}	Na^+, K^+, Ba^{2+}, NH_4^+, Mg^{2+} = 1,000; Mn^{2+} = 500; Co^{2+} = 350; Ni^{2+}, Cu^{2+} = 70; Sr^{2+} = 50, Fe^{2+}, Zn^{2+} = 1; Fe^{3+} = 0.1 (At 10^{-4} mol/L Ca^{2+})
Chloride Cl^-	No^{3-}, F^-, HCO^{3-}, SO_4^{2-}, PO_4^{2-} = 1,000; SCN^- = 0.3; MnO_4^- = 0.1; Br^- = 0.03; $S_2O_3^{2-}$, S^{2-}, I^-, Ag^+, Hg^{2+} = must be absent (At 10^{-4} mol/L Ca^{2+})
Fluoride F^-	OH^- = 10 (Within measurable range)
Sulfate NO_3^-	SO_4^{2-} = 1,000; CH_3COO^- = 300; F^- = 200; Cl^- = 40; NO_2^- = 3; I^- = 0.1; ClO_4^- = 0.03; Br^- = 2 (At 10^{-3} mol/L NO_3^-)
Ammonia NH_3	Volatile amino (Within measurable range)

Measurements cannot be made when the compatible tolerance limit multiplied by the concentration of the ions to be measured is greater than the compatible ion concentration.

2.4 Setting mode: basic flow (D−23)

Press the F key while in MEASUREMENT mode to select the SETTING mode, using the following flow.



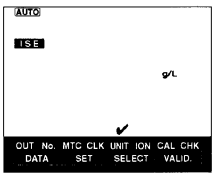
Note▶▶▶ When in the CLOCK SET mode, settings can be made only with an extended unit (sold separately) is connected. Printing is only possible when a printer (not sold by HORIBA) is connected.

2.5 Setting mode (D–23)

This section explains the UNIT SEL and ION SEL modes. For other setting modes, refer to the separate booklet entitled “Operation Manual: Measuring pH and mV.”

❑UNIT SEL mode (Selecting units)

Press the F key while in the MEASUREMENT mode to select the UNIT SEL mode.

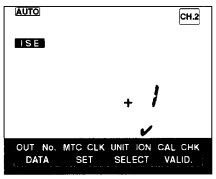


Press the ▲ and ▼ (UP and DOWN) keys to switch between g/L and mol/L. Both CH1 and CH2 use the same units.

Note▶▶▶ Pressing the ▲ and ▼ (UP and DOWN) keys invalidates the calibration data. Conduct calibration again, after making the settings.

❑ION SEL mode (Selecting ion types)

Press the F key while in the MEASUREMENT mode to select the ION SEL mode.

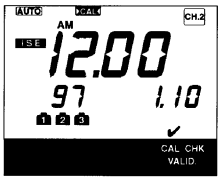


Press the ▲ and ▼ (UP and DOWN) keys to select the type of ion (charge load count).
(+2, +1, −1, −2)
Both CH1 and CH2 use the same units.

Note▶▶▶ Pressing the ▲ and ▼ (UP and DOWN) keys invalidates the calibration data. Conduct calibration again, after making the settings.
Do not make this setting when ion measurement is set for both CH1 an CH2 and different ions are to be measured. Measure the ions by first conducting a direct, calibration using two points or more.

❑VALIDATION mode (calibration history) for ions

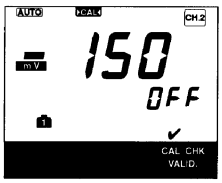
Press the F key to select the VALIDATION mode. Use the CAL key to switch between channels.



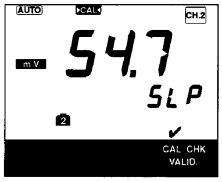
The most recently set year, month and day will be displayed. "−−−" is displayed for the date and time when no extended unit is connected to the pH meter.

Press the CAL key to switch between CH1 and CH2.
"---" is displayed when there is no calibration data.

Press the ▲ (UP) key to light up the 1 and display the potential converted for when the solution is 1 g/L (1 mol/L).



Press the ▲ (UP) key again to light up the 2 (when conducting at least a two–point calibration) and display the slope value.



Press the ▲ (UP) key again, when conducting a three–point calibration, to light up the 3 and display the slope value.

Note▶▶▶ The slope value when conducting a three–point calibration is as follows.

Slope value for 2 :
+1 or +2 ion types: On the strong concentration side
–1 or –2 ion types : On the weak concentration side

Slope value for 3 :
+1 or +2 ion types: On the weak concentration side
–1 or –2 ion types : On the strong concentration side

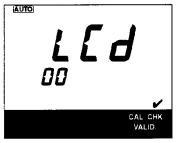
Press the ▲ (UP) key again to return to the most recent date and time display.
Use the ▼ (DOWN) key to return to the most recent date and time screen in reverse order.

2.6 CHECK mode

This section explains the setting mode for item no. 05, “pH/ion CH setting.” For other check modes, refer to the separate booklet entitled “Operation Manual: Measuring pH and mV.”

❑CHECK mode start−up

Press the F key to display the LCD CHECK screen (item no. 00) and enter the CHECK mode.



Start−up screen for CHECK mode

❑Kinds of CHECK modes

Pressing the MODE key while in the opening screen for the CHECK mode enables selection of the following items.

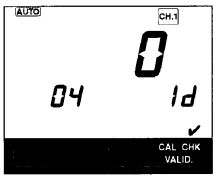
Item no. 00: LCD check
Item no. 01: Battery voltage check
Item no. 02: Temperature zero adjustment
Item no. 03: Automatic power−off setting
Item no. 04: Electrode ID no. setting
Item no. 05: pH/ion CH setting
Item no. 06: Initializing settings
Item no. 08: Calibration frequency setting
Item no. 09: RS−232C output test
Item no. 10: Printing test
Item no. 11: Recorder output zero and span adjustment

Note▶▶▶ Refer to the separate booklet entitled “Operation Manual: Measuring pH and mV” regarding items no. 00 – 03, item no. 06 and items no. 09 – 11.

- **Electrode ID no. settings (item no. 04)**

  Sets the Electrode ID no. When the printer is used to print out the calibration history, it is printed according to the electrode ID numbers.

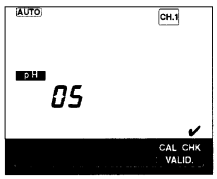
  1. Press the CAL key to switch between CH1 and CH2.
  2. Use the ▲ (UP) and ▼ (DOWN) keys to set the electrode ID no.
     Setting range : 0 – 1999
  3. Use the MODE key to proceed to initialization of settings (item no. 05).

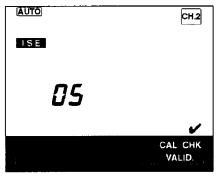


- **pH/ion CH setting (item no. 05)**

  Changes the pH/ion CH (channel) to enable both channels to measure ions.

  1. Press the CAL key to switch between CH1 and CH2.
  2. Use the ▲ or ▼ (UP or DOWN) key to select the pH/ion measurement channel.
  3. Use the MODE key to proceed to initialization of settings (item no. 06)

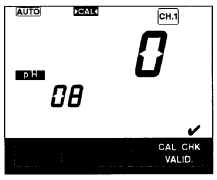




● Calibration frequency setting (item no. 08)

This mode counts the number of measurements performed in AUTO HOLD since the time of the last calibration and enables display of “ERR08” when the number of measurements exceeds the setting. Use this mode to control calibration frequency according to the number of measurements conducted.

1. Press the CAL key to switch between CH1 and CH2.
2. Use the ▲ and ▼ (UP and DOWN) keys to set the calibration frequency.
3. Use the MODE key to proceed to printer connection and printing test (item no. 09).



2.7 Ion electrode maintenance

Refer to the electrode operation manual for how to take care of each kind of electrode.

Ion electrodes

Ion to be measured	Ion type	Slope (*)	Measurement range	Electrode model	Compatible tip model	Reference solution
Potassium K^+	+1	+58 mV	0.04 to 39,000 mg/L	6582 −10C	7682	3.33 mol/L NaCl
Calcium Ca^{2+}	+2	+29 mV	0.4 to 40,080 mg/L	6583 −10C	7683	3.33 mol/L KCl (#300)
Chloride Cl^-	−1	−59 mV	0.4 to 35,000 mg/L	6560 −10C	7660	1 mol/L KNO_3
Fluoride F^-	−1	−59 mV	0.02 to 19,000 mg/L	6561 −10C	7661	3.33 mol/L KCl (#300)
Sulfate NO_3^-	−1	−55 mV	0.06 to 62,000 mg/L	6581 −10C	7681	1 mol/L KCl
Ammonia NH_3	+1	−59 mV	0.1 to 1,000 mg/L	5002 −10C		Included internal solution NH_4Cl

*: Change in the electric potential of the electrode (25°C) when the ion concentration is changed by a factor of 10.

Note▶▶▶ The above electrodes are possibility to change without notice.

Maintenance of the ion electrodes listed in the above table begins, on next page.

● Before using

Before using an electrode, condition the electrode according to the following table, to prepare it for measurement.

Ion electrode	Conditioning agent	Time
Cl^- ion electrode	No conditioning	
F^- ion electrode		
NO_3^- ion electrode	1 mol/L potassium nitrate solution (100 g/L KNO_3)	Approx. 1 h
K^+ ion electrode	0.1 mol/L potassium chloride solution (75 g/L KCl)	Approx. 12 h
Ca^{2+} ion electrode	Tap water	Approx. 3 h
NH_3 ammonia electrode	No conditioning	

● Short–term storage

Immerse electrode in the following solutions, when they are to be stored for up to one day and then reused.

Ion electrode	Storage solution
Cl^- ion electrode	Ion exchange water
F^- ion electrode	
NO_3^- ion electrode	1 mol/L potassium nitrate solution (100 g/L KNO_3)
K^+ ion electrode	0.1 mol/L potassium chloride solution (75 g/L KCl)
Ca^{2+} ion electrode	Tap water
NH_3 ammonia electrode	0.01 mol/L ammonium chloride solution

❑65XX–10C electrode maintenance

Refer to the electrode operation manuals for maintenance concerning other electrode models.

● Long–term storage

1. Remove the tip electrode from the combined electrode and put on the rubber cap.
2. Put on the protective cap. (Do not put water in the protective cap and make sure it is dry.)
3. Store both the tip electrode and the combined electrode in dry condition.
4. To reuse the electrodes, start with the operations explained in the section entitled " ● Before using," above.

● Daily maintenance

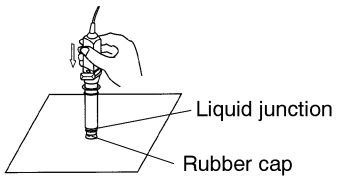
When an electrode has not been used for a long period of time, some of the sample may have entered the reference solution (outer tube) or the reference solution may have become weaker. For this reason, perform the following operations from once a week to once a month to replace the internal solution within the reference electrode (outer tube).

1. Open the internal solution filler port by removing the rubber stopper, then turn the electrode upside down and use a syringe to remove the reference solution.
2. Use the syringe to fill the electrode with the specified reference solution.

The ideal amount of reference solution discharge is only a tiny bit from the liquid junction. If the amount of liquid flowing out is extremely small, the electric potential of the reference electrode will not stabilize and will be affected by the stirrer. In such cases, perform the following operations to make the reference solution seep out from the liquid junction.

Reference solution outflow operations

1. Remove the protective tube from the combined electrode so that the rubber cap is mounted on the tip−type ion electrode part.
2. Remove the rubber stopper from the reference solution filler port on the top part of the electrode.
3. Stand the electrode vertically on a desk or other horizontal surface, with the bottom of the electrode (the side with the rubber cap) facing down. Push the electrode down two or three times, to make the reference solution seep out through the liquid junction.



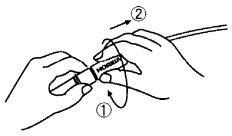
● Filling internal solution (inner tube)

The inner tube of the electrode is of an air−tight construction that allows almost no outflow. Replace the internal solution (inner tube), however, when the electrode has been used for a long period of time and only half or less of the internal solution (inner tube) remains.
(The filling frequency for internal solution varies depending on the usage and storage conditions, but under normal use it is approximately once a year.)

Note▶▶▶ To fill an electrode with internal solution (inner tube), the electrode must be disassembled. Use sufficient care during disassembly.
Items necessary when replacing internal solution (inner tube) are: a syringe, #330 (gel) reference solution, and the reference solution specified for the particular electrode.

● Filling the electrode: disassembly procedure

1. Remove the protective tube and tip−type ion electrode from the combined electrode and put the rubber cap on the tip−type ion electrode part.
2. Remove the rubber stopper from the reference solution (outer tube) filler port, then take out the internal solution using a plunger.
3. Twist the electrode cap by hand and move it approximately 5 to 10 centimeters toward the electrode connector side.

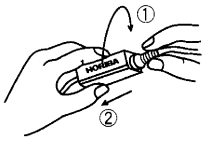


4. Remove the internal body ① of the electrode by holding the electrode cap by hand, then pushing the electrode while it is standing vertically on a desk or other horizontal surface.
5. Move the silicon tube of the internal body ① downward, to expose the internal solution filler port (inner tube).
6. Put the gel−form internal solution (#330) in through the filler port using a syringe and fill the electrode until the internal solution nears the filler port (inner tube).

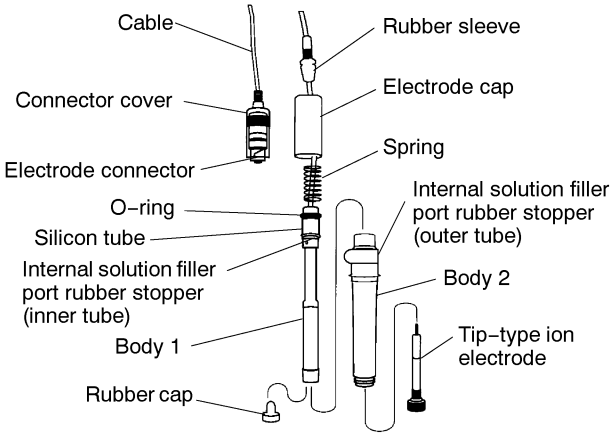
Filling the electrode: assembly procedure

1. Return the silicon tube to its original position and seal the internal solution filler port (inner tube). (Make sure that the filler port is completely sealed.)
2. If the bodies ① or ② or the liquid junction are dirty, wash them with pure (ion exchange) water.
3. Insert body ① into body ②. (Make sure that the O−ring is securely sealed.)
4. Return the spring to the top of body ①.

5. Hold the rubber sleeve in place by hand, then twist the electrode cap to a 90° angle and fit the rubber sleeve into the electrode cap.

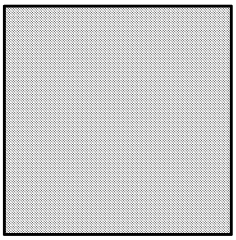


6. Maneuver the parts such that the “HORIBA” logo faces the same direction as the reference solution filler port (outer tube), then fit the cap into body ②.
7. Twist the rubber sleeve to a 90° angle and hold it in place.
8. Use the plunger to fill the electrode with the specified reference solution.
9. Make the internal solution seep out from the liquid junction in accordance with the section entitled “● Daily maintenance”, on page 35.
10. Store the electrode in accordance with the section entitled “● Short−term storage”, on page 34.



Exploded view/assembly drawing

Notes



This chapter explains the basic operations involved in measuring conductivity.

3 D−24 conductivity measuring

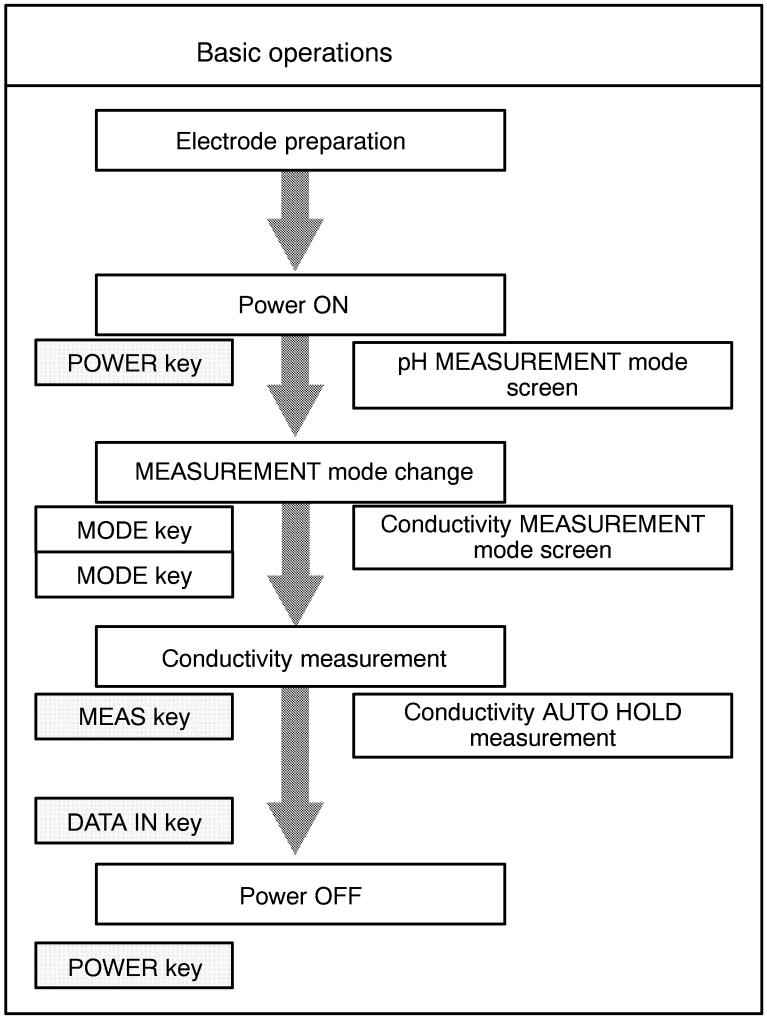
3. D−24 conductivity measuring

❑Measuring conductivity (D−24)

This pH meter can measure conductivity, by using a conductivity electrode (sold separately).
This operation manual contains the following information on measuring ions.
This operation manual mainly deals with the operation of the main unit of the D−20 Series of pH meters. Refer to the operation manual for your electrodes, for details on how to handle the electrodes, measurement techniques, and other information.

For information on...		See this section...	On page...
Basic measuring	Measuring conductivity for the first time	⇒ Electrode preparation	p. 44
Applicable functions	Measuring with new electrodes	⇒ CELL SEL mode	p. 48
	Displays using former units of S/cm	⇒ Setting conductivity units	p. 51
	Accurate measuring	⇒ T.C SET mode	p. 49
Reference material	Three months after using an electrode	⇒ Electrode sensitivity check	p. 85
	How to handle electrode	⇒ Conductivity electrode maintenance (according to electrode operation manuals or this operation manual)	p. 51
	When an error no. appears during measurement	⇒ Troubleshooting	p. 74
	An overview of measuring ions	⇒ Measuring conductivity	p. 88

3.1 Measuring conductivity: basic operational flow (D–24)



3.2 Measuring conductivity: basic operations (D–24)

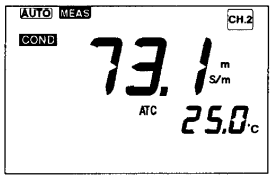
This section explains the basic operations involved in measuring conductivity.

• Electrode preparation

Prepare the electrode by referring to the electrode operation manual.

• Turning power ON

1. Remove the protective cape from the electrode.
2. Immerse the electrode in pure (ion exchange) water.
3. Press the POWER key.
   The pH INSTANTANEOUS VALUE MEASUREMENT screen will appear.
4. Press the MODE key twice.
   The ion INSTANTANEOUS VALUE MEASUREMENT screen will appear.



• Main unit default settings

Set the cell constant the first time that an electrode connected to the main unit of the pH meter.

Note▶▶▶ Cell constant
The cell constant is set as 1.0 x 100 S/m, as the default. To change this setting, refer to the section on CELL SET mode, on page 48.

Temperature coefficient.
The temperature coefficient is set at 2.0 %/°C, as the default.

To change this setting, refer to the section on T.C SET mode, on page 49.

Setting units

The units are set for S/m (SI unit system), as the default. To change the setting to the former units system of S/cm, refer to the section on Setting conductivity unit, on page 51.

● Measuring conductivity

1. Immerse the electrode in the sample.

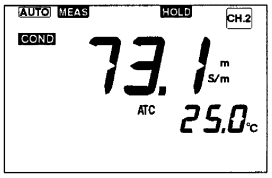
Note▶▶▶ Conductivity is greatly effected by temperature. To measure with increased accuracy, use a constant–temperature water bath to keep the solutions at a constant temperature.

2. Press the MEAS key while on the INSTANTANEOUS VALUE MEASUREMENT screen.

The measured value will appear, and “HOLD” will flash until the reading stabilizes.

When the measured value stabilizes, “HOLD” will stop flashing and the calibration value will be held as it is.

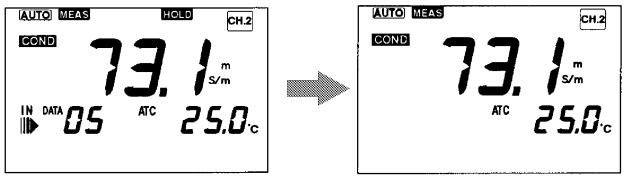
Once this is done, conductivity measurement has been completed.



Ref.▶▶▶ The criteria for judging a measured value to be stabilized is a change in the displayed value of three digits for a 10–second period of time.

Note▶▶▶ Measurements are conducted while the pH meter is on AUTO RANGE CHANGE.

To save the data to memory, press the DATA IN key. The memory number will appear and the display will automatically return to the INSTANTANEOUS VALUE MEASUREMENT screen.



● Turning power OFF

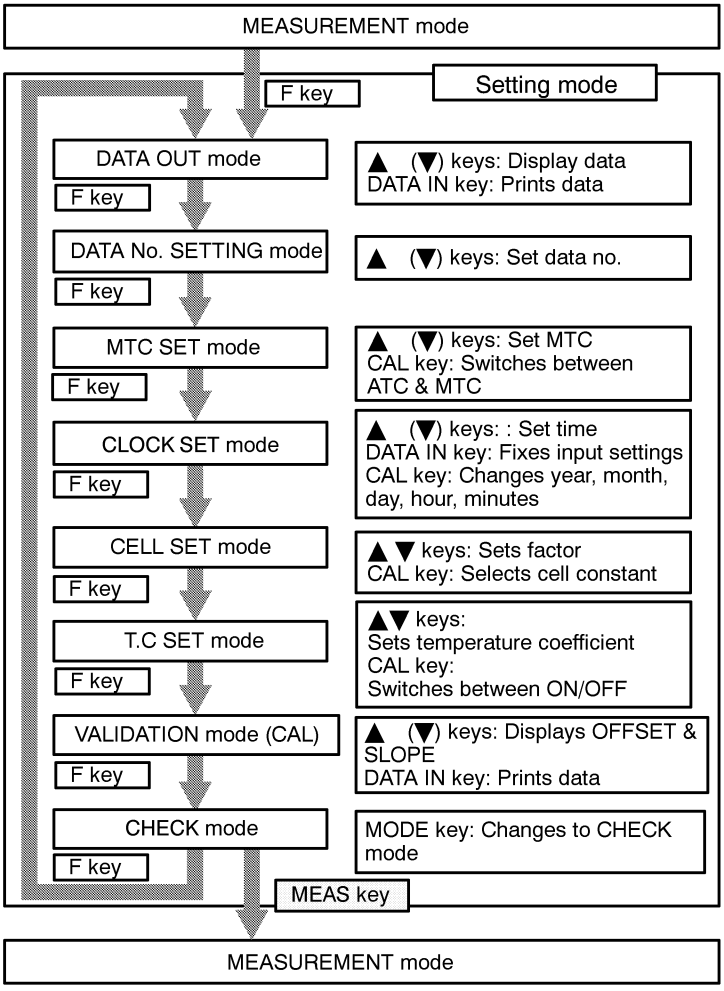
1. When operation are finished, press the POWER key to turn OFF the power.

Note▶▶▶ The next time the power is turned ON, the pH meter will start on the pH MEASUREMENT mode.

For information on handling the electrode, refer to the electrode operation manual or the section entitled “Conductivity electrode maintenance” (p. 51) in this operation manual.

3.3 Setting mode: basic flow (D−24)

Press the F key while in the MEASUREMENT mode to enable the setting mode to be selected using the following flow.



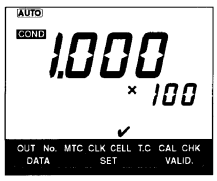
Note▶▶▶ When in the CLOCK SET mode, settings can be made only with an extended unit (sold separately) is connected. Printing is only possible when a printer (not sold by HORIBA) is connected.

3.4 Setting mode (D–24)

This section explains the CELL SET and T.C SET modes. For other setting modes, refer to the separate booklet entitled “Operation Manual: Measuring pH and mV.”

❑CELL SEL mode (Setting cell constant)

Press the F key while in the MEASUREMENT mode to select the CELL SEL mode.



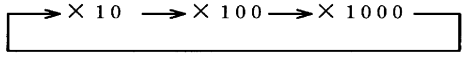
Press the ▲ and ▼ (UP and DOWN) keys to set the cell constant that is written on the electrode label.

Setting range: 0.700 – 1.300

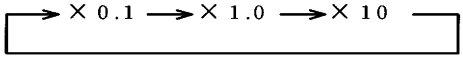
Press the CAL key to select the cell coefficient.

To change the coefficient, use the following procedure.

When the SI units system (m^{-1}) is set:

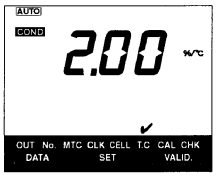


When the former units system (cm^{-1}) is set:



❑T. C SET mode
(Setting temperature coefficient)

Press the F key while in the MEASUREMENT mode to select the T.C SET mode.



Use the ▲ and ▼ (UP and DOWN) keys to set the temperature coefficient.

Setting range: 0.00 – 10.00 (%/°C)

Press the CAL key to switch between input and OFF, for temperature coefficient.

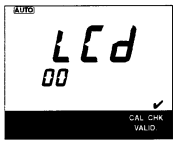
Note▶▶▶ For a detailed explanation, refer to the reference material, on page 90.

3.5 CHECK mode

This section explains the setting mode for conductivity units (item no. 07). For other check modes, refer to the separate booklet entitled “Operation Manual: Measuring pH and mV.”

❑CHECK mode start–up

Press the F key to display the LCD CHECK screen (item no. 00) and enter the CHECK mode.



Start–up screen for CHECK mode

❑Kinds of CHECK modes

Pressing the MODE key while in the opening screen for the CHECK mode enables selection of the following items.

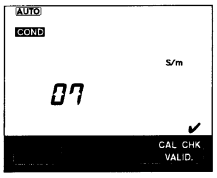
Item no. 00
LCD check
Item no. 01
Battery voltage check
Item no. 02
Temperature display calibration
Item no. 03
Automatic power−off setting
Item no. 04
Electrode ID no. setting
Item no. 06
Initializing settings
Item no. 07
Conductivity units setting
Item no. 08
Calibration frequency setting
Item no. 09
Printer connection and printing test
Item no. 10
RS−232C output check
Item no. 11
Recorder output zero and span adjustment

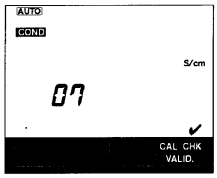
Note▶▶▶ Refer to the separate booklet entitled “Operation Manual: Measuring pH and mV” regarding items other than no. 07.

- **Setting conductivity units (item no. 07)**

  Changes conductivity units (S/m and S/cm).

  1. Press the ▲ or ▼ (UP or DOWN) key to change the conductivity units to S/m or S/cm.





Ref.▶▶▶ For details on units, refer to the section on SI units, on page 90.

3.6 Conductivity electrode maintenance

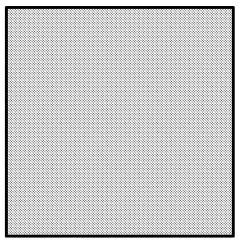
Refer to the electrode operation manuals for how to maintain each electrode.

- **Long–term storage**

  When an electrode will not be used for a long period of time, store it after performing the following procedure.
  Also, perform maintenance on the electrode every three to six months.

  1. Remove the electrode from the pH meter.
  2. Use pure (ion exchange) water to wash away any sample solution that may have adhered to the electrode.
  3. Wash the inside of the protective cap with pure (ion exchange) water, then, after shaking out the water, fill the cap with enough pure (ion exchange) water to soak the sponge.
  4. Place the protective cap on the electrode.

Notes



This chapter explains the basic operations involved in measuring dissolved oxygen (DO).

4 D−25 dissolved oxygen (DO) measuring

4 D−25 dissolved oxygen (DO) measuring

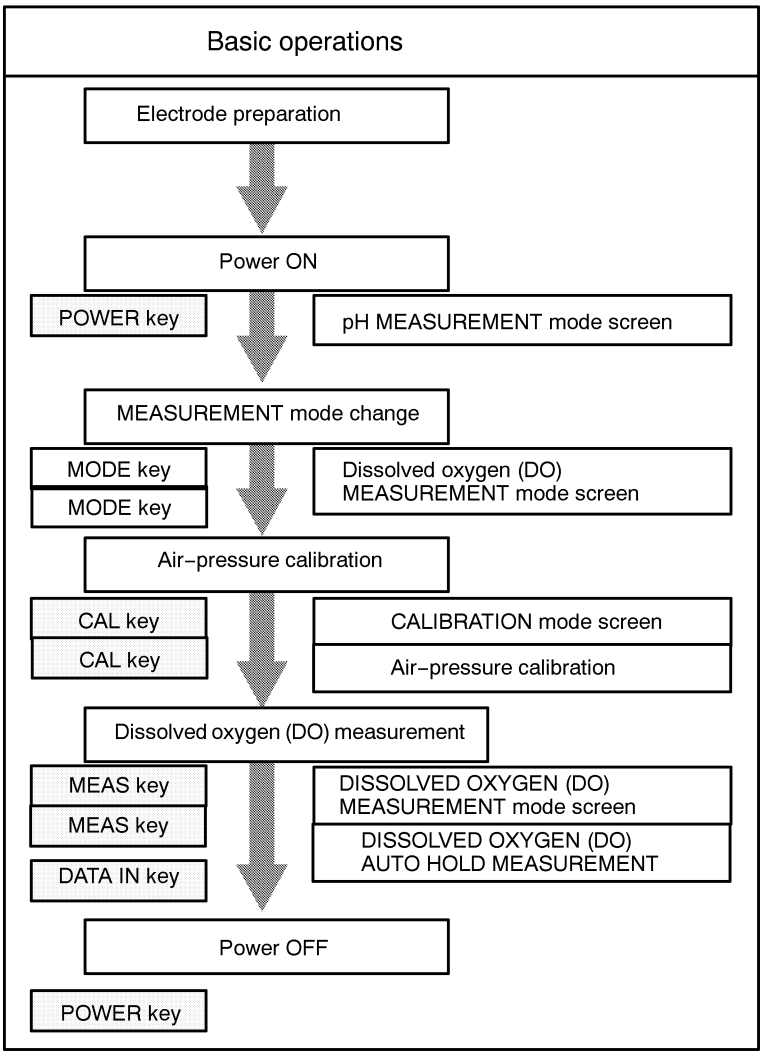
❑Dissolved oxygen (DO) measuring

This pH meter can measure DO, by using a conductivity electrode (sold separately). This operation manual contains the following information on measuring DO.

This operation manual mainly deals with the operation of the main unit of the D−20 Series of pH meters. For details on how to handle electrodes, refer to the operation manual for your electrodes.

For information on...		See this section...	On page...
Basic measuring	Measuring DO for the first time	⇒ Electrode preparation	p. 56
Applicable functions	Greater measuring accuracy	⇒ Measuring technique for increased acuracy	p. 64
	Measuring with seawater	⇒ SAL. SET mode	p. 68
	Measuring at high altitudes	⇒ PRESS SET mode	p. 69
Reference material	How to handle electrode	⇒ Dissolved oxygen electrode maintenance (according to electrode operation manuals or this operation manual)	p. 70
	When an error no. appears during measurement	⇒ Troubleshooting	p. 74
	An overview of measuring DO	⇒ Measuring dissolved oxygen	p. 93

4.1 Measuring dissolved oxygen: basic operational flow (D−25)



4.2 Measuring dissolved oxygen: basic operations (D−25)

This section explains the basic operations involved in measuring conductivity.

● Electrode preparation

Prepare the electrode by referring to the electrode operation manual.

Following the next procedures to prepare electrodes that are being used for the first time or that have not been used for a long period of time.

■ Field−use electrodes (9550−20D/9550−100D)

Chemical solution

Warning

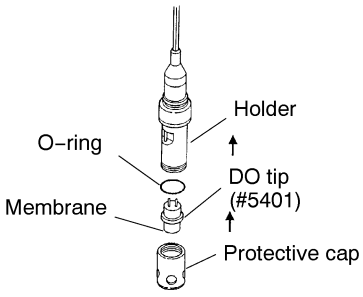
Highly concentrated potassium hydroxide (KOH) is used in the internal solution of the electrode.

If the internal solution in the electrode comes in contact with your hands or skin, wash immediately with water. If the internal solution comes in contact with your eyes, flush immediately with large amounts of water and seek treatment by a physician.

1. Remove the protective cap.
2. Remove the short socket that short circuits the tip of the DO tip, then push it in and attach it to the holder, along with the O−ring.

Note▶▶▶ Be careful not to damage the DO tip membrane.

3. Tighten the protective cap securely onto the holder.



■ Laboratory−use electrode (9520−10D)

Chemical solution

Warning

Highly concentrated potassium hydroxide (KOH) is used in the internal solution of the electrode.

If the internal solution in the electrode comes in contact with your hands or skin, wash immediately with water. If the internal solution comes in contact with your eyes, flush immediately with large amounts of water and seek treatment by a physician.

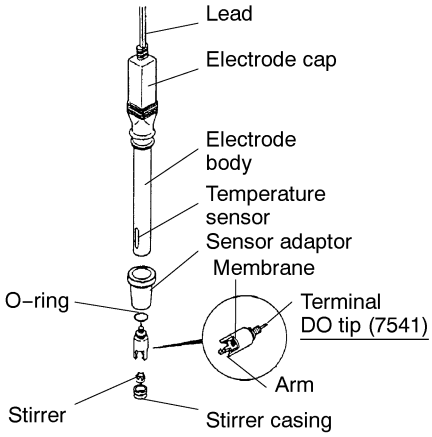
1. Insert the sensor adapter into the electrode body.

Ref.▶▶▶ The sensor adapter is used by attaching it to furan bottle or a conical flask used for electrode storage.

2. Remove the short socket that short circuits the tip of the DO tip, then push it in and attach it to the holder, along with the O−ring.

Note▶▶▶ Be careful not to damage the DO tip membrane.

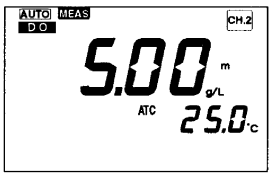
3. Insert the stirrer into the stirrer casing, then mount it on the DO tip arm.



Note▶▶▶ The DO tip package and short socket are necessary when removing the tip from the electrode for storage. Do not dispose of the DO tip package or short socket.

● Turning power ON

1. Press the POWER key.
   The pH INSTANTANEOUS VALUE MEASUREMENT screen will appear.
2. Press the MODE key twice.
   The DO INSTANTANEOUS VALUE MEASUREMENT screen will appear.



● Calibration

To achieve correct measurements, the pH meter must be calibrated prior to making measurements with it.
The D–25 pH meter can be calibrated using a simple one–point air calibration and, when highly precise measurement is required, using a two–point standard solution calibration. This section explains the general air calibration.
If a higher level of precision is required, refer to the section on standard solution calibration, on page 64.

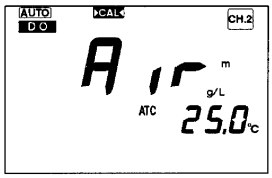
Note▶▶▶ For greater measuring precision, it is necessary to correct for air pressure.

Air–pressure correction

Air pressure is set to 1013 hPa, as the default. To change this setting, refer to refer to the section on PRESS SET mode, on page 69.

1. Remove any drops of liquids from the membrane at the tip of the electrode by either drying it or wiping away the liquid with soft tissue paper or similar material, making sure not to scratch the membrane.

2. Press the CAL key while in the DO INSTANTANEOUS VALUE MEASUREMENT mode, to select the CALIBRATION mode.

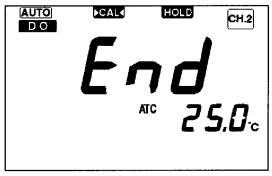


Note▶▶▶ The mode cannot be changed while measurement is taking place in AUTO HOLD (while “HOLD” is flashing on the display).

3. Press the CAL key one more time to start calibration.

The measured value will appear, and “HOLD” will flash until the reading stabilizes.

When the measured value stabilizes, “HOLD” will stop flashing and “End” will appear.



Ref.▶▶▶ **While “HOLD” is flashing**

When calibration is forced: Fix the value using the DATA IN key.

When calibration is cancelled: Clear the hold by pressing the CAL key, again.

4. Press the MEAS key to return to the DO MEASUREMENT screen. This enables DO to be measured.

Note▶▶▶ Conducting calibration again, after returning to the pH MEASUREMENT screen, will clear all the calibration data.

Calibrate using purified air.

(Errors may occur and considerable time may be required before the indicated value stabilizes, if calibration is conducted where there is severe fluctuation in temperature, where there is wind or rain, or close to a heating device.)

Do not hold the sensor holder or electrode body by hand, during or soon before or after calibration.

(The effects of body temperature will cause the indicated value to take more time to stabilize.)

For greater measuring accuracy, perform standard solution

calibration (See p. 64.).
To put the calibration value to the initial (default) settings, press the CAL key while holding down the F key in CALIBRATION mode.

● Measuring DO

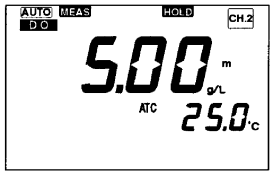
Salinity concentration correction is set at 0.0 ppt, as the default. To change this setting, refer to the section on the SAL. SET mode, on page 68.

1. Immerse the electrode in the sample.

Note▶▶▶ Mix the sample at a constant speed (1000 – 1500 rpm) during measurement, using such as a magnetic stirrer. (Make sure the stirrer does not emit any heat.) With field–use electrodes, measure at a constant flow speed.

2. Press the MEAS key while in the INSTANTANEOUS MEASUREMENT screen.

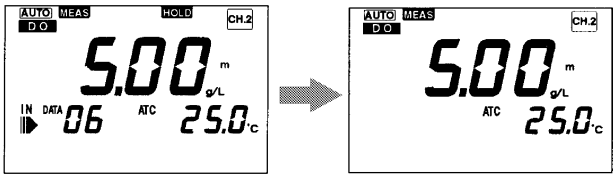
The measured value will appear, and “HOLD” will flash until the reading stabilizes.
When the measured value stabilizes, “HOLD” will stop flashing and the calibration value will be held as it is.
Once this is done, DO measurement has been completed.



Ref.▶▶▶ The criteria for judging a measured value to be stabilized is a change in the displayed value of 10 digits for a 10 second period of time.

To save the data to memory, press the DATA IN key.

The memory number will appear and the display will automatically return to the INSTANTANEOUS VALUE MEASUREMENT screen.



● Turning power OFF

1. When operation are finished, press the POWER key to turn OFF the power.

Note▶▶▶ The next time the power is turned ON, the pH meter will start on the pH MEASUREMENT mode.

For information on handling the electrode, refer to the electrode operation manual or the section entitled “Electrode maintenance” (p. 70) in this operation manual.

4.3 Measuring technique for increased accuracy

Normally, air calibration is used to calibrate the pH meter when measuring DO. When a higher level of measuring precision is required, however, a two–point calibration using standard solution can be employed. When conducting a standard solution calibration anew, erase the previous calibration data.

Note▶▶▶ Caution when calibration with standard solution
Do not allow the electrode to sit in solution that exceeds the usable temperature range (0 – 40 °C).

• Calibrating with standard solution

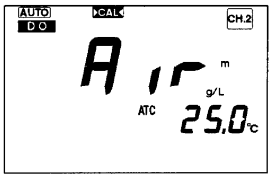
Preparing zero standard solution

Put 50 g sodium sulfate into 1000 mL pure (ion exchange) water and allow it to dissolve completely.

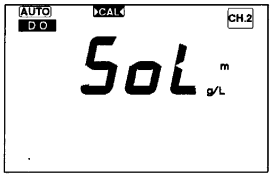
Preparing span standard solution

Put pure (ion exchange) water into a holding vessel, then create an oxygen saturated state by bubbling the water with an air pump.

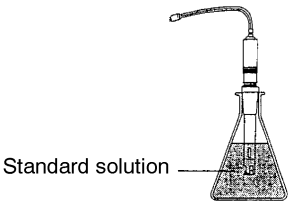
1. Press the CAL while in the INSTANTANEOUS MEASUREMENT mode, to select the CALIBRATION mode.



2. Press the MODE key to display “SoL.”



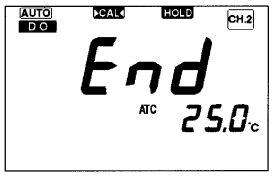
3. Wash the electrode with tap water, then immerse it in the standard solution.



Note▶▶▶ Mix the sample at a constant speed (1000 – 1500 rpm) during measurement, using such as a magnetic stirrer.
(Make sure the stirrer does not emit any heat.)

4. Press the CAL key. The measured value will appear, and “HOLD” will flash until the reading stabilizes.

5. When the measured value stabilizes, “HOLD” will stop flashing and “End” will appear.

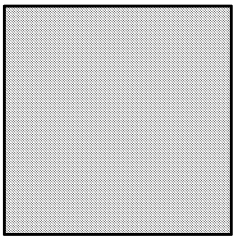


Note▶▶▶ Zero standards solution and span standard solution are detected automatically.

6. To conduct the second calibration in the two−point calibration, repeat steps 3. through 5., above.

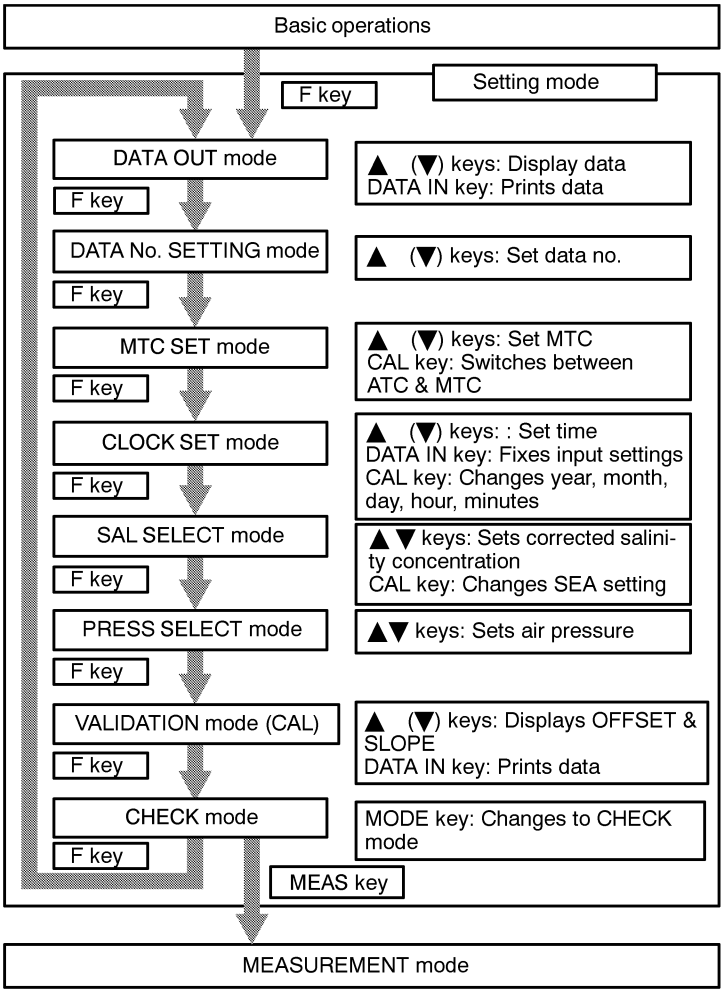
7. To return to the MEASUREMENT mode, press the MEAS key.

Note▶▶▶ Conducting calibration again, after returning to the pH MEASUREMENT screen, will clear all the calibration data.



4.4 Setting mode: basic flow (D−25)

Press the F key while in the MEASUREMENT mode to enable the setting mode to be selected using the following flow.



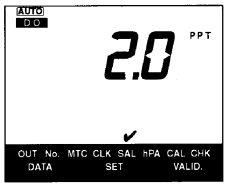
Note▶▶▶ When in the CLOCK SET mode, settings can be made only with an extended unit (sold separately) is connected. Printing is only possible when a printer (not sold by HORIBA) is connected.

4.5 Setting mode (D–25)

This section explains the SAL. SET and PRESS SET modes. For other setting modes, refer to the separate booklet entitled “Operation Manual: Measuring pH and mV.”

❑SAL. SET mode (Setting salinity concentration)

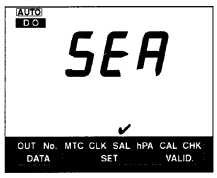
Press the F key while in the MEASUREMENT mode to select the SAL. SEL mode.



Press the ▲ and ▼ (UP and DOWN) keys to set the correction coefficient.

Setting range: 0.0 – 40.0 ppt

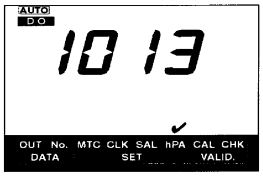
Press the CAL key to switch between coefficient input and SEA.



“SEA” is the salinity setting for seawater. The value is corrected at a salinity concentration of 35 ppt.

❑PRESS SET mode
(Setting air–pressure correction)

Press the F key while in the MEASUREMENT mode, to select the PRESS SET mode.



Press the ▲ and ▼ (UP and DOWN) keys to set the air pressure.

Setting range: 100 – 1990 hPa

4.6 Dissolved oxygen electrode maintenance

Refer to the electrode operation manuals for how to maintain each electrode.

❑Field−use electrode

● Maintenance after daily use

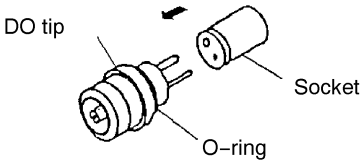
1. Wash the electrode well with tap water.

2. Store the DO tip by immersing it in tap water.

Note▶▶▶ Leave the electrode connector attached to the pH meter.

● Long−term storage

1. Remove the electrode from the pH meter.
2. Wash the electrode well with pure (ion exchange) water, then remove the water drops using a cotton gauze.
3. Remove the DO tip from the holder.
4. Place the socket over the DO tip, then store it by placing it in its original packaging and sealing it air−tight.



• Cleaning electrodes

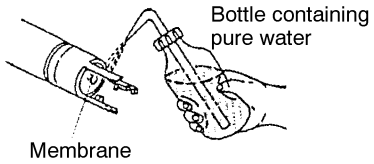
If the electrode membrane is dirty, gently wipe it with soft tissue paper or cotton gauze. Be careful not to press the membrane with too much force.

Note▶▶▶ Use caution not to damage the DO tip membrane.

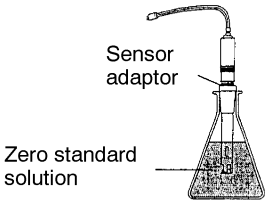
❑Laboratory–use electrode

• Maintenance after daily use

1. Wash the electrode well with pure (ion exchange) water.



2. Store the DO tip by immersing it in zero standard solution.



Note▶▶▶ Leave the electrode connector attached to the pH meter.

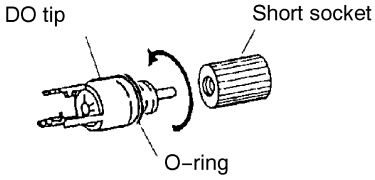
• Long–term storage

1. Remove the electrode from the pH meter.

2. Wash the electrode well with pure (ion exchange) water, then remove the water drops using a cotton gauze.

3. Remove the DO tip from the electrode body.

4. Push the socket onto the DO tip, then store it by placing it in its original packaging and sealing it air−tight.



Note▶▶▶ Be careful not to damage the DO tip membrane.
When using a neutral detergent for cleaning, be careful not to allow the detergent to come in contact with the membrane.
When conducting air calibration after the electrode has been stored, first connect the electrode to the main unit of the pH meter and allow it to stand in the open air for two hours prior to conducting the calibration.

● Cleaning electrodes

Each time a different solution is to be measured, rinse the electrode with pure (ion exchange) water, then wipe off the water drops using clean filter paper or cotton gauze.

This chapter explains the error messages that appear on the main unit of the pH meter.
If an error message is displayed, be sure to take appropriate action.

5 Troubleshooting

5. Troubleshooting

5.1 Troubleshooting

The D−20 Series of pH meters is equipped with a simple error message function, which notifies the operator about the occurrence of operation errors or other problems. Errors or other problems that occur while in the MEASUREMENT mode are announced by an “Error no.” appearing in the lower left−hand corner of the display.

❑Error message chart

Error no.	Message
ERR 01	Memory error
ERR 02	Battery voltage low
ERR 03	Electrode stability error
ERR 04	Asymmetry potential error
ERR 05	Electrode sensitivity error (pH)
ERR 05	Electrode sensitivity error (DO)
ERR 06	Calibration points exceeded
ERR 07	Cannot identify standard solution
ERR 08	Calibration cycle error
ERR 09	Printer error
ERR 10	Concentration calculation error
ERR 11	Exceeds automatic calculation range of cell constant

Note▶▶▶ Refer to the separate booklet entitled “Operation Manual: Measuring pH and mV,” regarding ERR 01, ERR 02, ERR 04, ERR 07 and ERR 09.

● ERR 03 Measured value does not stabilize

Explanation The electric potential did not stabilize within three minutes.

Cause	How to solve problem
Caused by the effects of the sample solution.	Press the MEAS key again while “HOLD” is either flashing or steadily lit in the display, to measure the sample using instantaneous value measurement.
The electrode is dirty.	Clean the electrode.
The electrode is cracked.	Replace the electrode.
The responsive glass membrane of the electrode has been dry for a long time.	Soak the membrane (on the electrode) in pure (ion exchange) water for 24 hours.
The temperature of the sample solution is fluctuating.	Measure after the sample solution temperature stabilizes.

● ERR 05 There is an error in electrode sensitivity (DO)

Explanation If there was something wrong with the DO calibration, re−calibrate after taking the appropriate measures listed below.

Cause	How to solve problem
The settings (temperature, correction of salinity concentration, or air−pressure correction) are wrong.	Reconfirm each setting (temperature, correction of salinity concentration, and air−pressure correction).
There is liquid on the DO tip membrane. (When conducting air calibration)	Let the electrode sit until the liquid dries up or remove the liquid using soft tissue paper, making sure not to scratch the membrane.
There is something wrong with the standard solution. (When conducting standard solution calibration)	Re−prepare the zero and span standard solutions.
The stir is inappropriate.	Stir the solution appropriately (at a constant speed, between 1000 and 15000 rpm). (Make sure the stirrer does not emit heat.)
The electrode is defective.	If the DO tip is dirty, clean it. If the DO tip membrane is damaged or the DO tip is worn out, replace the DO tip.

● ERR 06 No more than three points can be calibrated (Ions)

No more than three kinds of standard solution can be used for calibration. Refer to the section entitled “Standard solution calibration” (p. 18).

- **ERR 08 The number of measurements set for calibration frequency has been exceeded (Ions)**

Explanation | Appears when the number of measurements set for the calibration frequency, when the most recent calibration was conducted, is exceeded.

Perform a new calibration.

- **ERR 10 The concentration cannot be calculated (Ion)**

Explanation | There was something wrong with the ion calibration.

Re-calibrate the pH meter after performing the appropriate measures listed below.

Cause	How to solve problem
There is a problem with the standard solution or settings.	Re-prepare the standard solution and reconfirm the settings.
There is a problem with the ion type setting.	Set the correct ion types.
The responsive membrane is dirty.	Clean the responsive membrane.
There is a problem with the reference solution or it is dirty.	Replace the reference solution with new solution.
The responsive membrane is cracked or worn out.	Replace the electrode.

• ERR 11 There is a problem with the cell constant (Conductivity)

Explanation When the cell constant is 1.3 or above, or 0.7 or below, re−calibrate the pH meter after performing the appropriate measures listed below.

Cause	How to solve problem
There is a problem with the standard solution.	Re−prepare the standard solution.
There is a problem with the electrode settings.	Use a standard electrode for connecting to the D−24.
The electrode is dry or dirty.	Clean the electrode.
The electrode is cracked or worn out.	Replace the electrode.

5.2 More troubleshooting

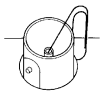
This section explains how to respond to various symptoms of trouble that are not indicated by an error number.
For troubleshooting other than that provided below, refer to the separate booklet entitled “Operation Manual: Measuring pH and mV.”

• The measured value is flashing

The measured ion value exceeds the measurement range (when ion value is displayed).
Measurement range: 99.9 or above
The measured conductivity value exceeds the measurement parameters (when conductivity value is displayed).
Measurement parameters: 0.00 – 19.99 (when cell constant is 100 m^{-1})
The measured DO value exceeds the measurement parameters (when DO value is displayed).
Measurement parameters: 0.00 – 19.99

Cause	How to solve problem
The sample solution is inappropriate.	Change to a sample solution with properties within the measurement range.
The liquid junction is not immersed in the sample solution.	Immerse the electrode in the sample solution all the way until the liquid junction.
The electrode cable has been severed.	Replace the electrode.
The main body of the pH meter is defective.	Check the point described below.
The meter has not been calibrated or it has been calibrated incorrectly.	Calibrate the meter correctly.

Check these points



Short the pin at the center of the electrode connector with the metal part. If the error number disappears when this is done, the meter is normal.

• Readings are scattered

Caused when an AC adapter (sold separately) is connected

Cause	How to solve problem
The stirrer or constant-temperature bath are exerting adverse electronic effects.	Use a dry-cell battery to make measurements. Ground all peripheral devices securely.
The electrode is defective.	Replace the electrode.

● CLR is flashing (during ion measurement)

Concentration cannot be measured correctly.

Cause	How to solve problem
The pH meter is in default status.	Calibrate the pH meter.
The settings have been changed with UNIT ION SELECT.	Calibrate the pH meter.

6. Reference

This chapter provides a simple compilation of information for people who would like to know more details about the functions of the main unit of the pH meter and other measurement principles. This chapter also briefly explains accessories that are available.

6 Reference

6.1 Ion measurement

• Ion concentration measurement

When certain ions exist within the solution that is to be measured, the responsive ion electrode 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 standard. With ion electrodes, 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.

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

E: Measured electric potential (V)

E_o: 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 (96485 $Cmol^{-1}$)

R: General gas constant (8.314 $JK^{-1}\ mol^{-1}$)

T: Absolute temperature (K)

n: Ion charge

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 electrode.

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 Eo, finding the potential E of the ion electrode inside the solution being measured will enable

the ion concentration to be determined.
When actual measurement is performed, the ion electrode 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.6–1. Conducting quantitative analysis using an ion electrode requires either an ion meter that has an antilog calculation function or the creation of a calibration curve using similog graph paper.

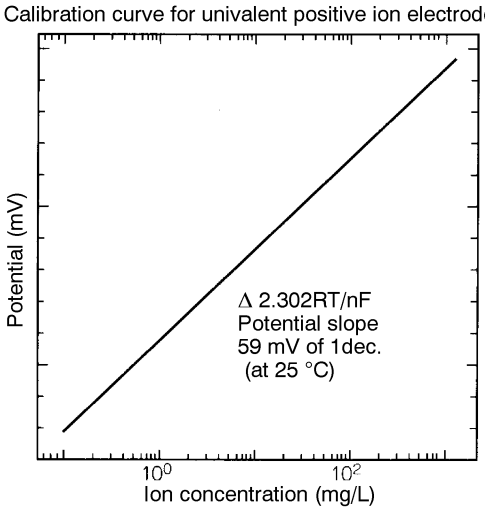


Fig.6–1 Relationship between ion concentration and electric potential

• 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, 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 this 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 ion electrode detection capabilities or linearity.

- **Temperature of standard solution and liquid to be measured**

  The D−20 Series of handy pH meters is equipped with a built−in temperature compensation function. Nevertheless, the temperature of the standard solution during calibration and the temperature of the liquid being measured while it is being measured should be kept as close as possible, to ensure accurate measurement.
  This is because the output of the ion electrode and the reference electrode changes according to changes in temperature. The greater the difference in temperature between the standard solution and the liquid being tested, the larger the errors that may occur in calculation.

- **Handling standard solution after use**

  Standard liquid that has once been used should not be returned to the original container and should be discarded.

- **Storing standard solution**

  Standard solution must be stored in an air−tight container and should be kept in a cool, dark place. If standard solution is not stored in an air−tight container, it will evaporate and become contaminated with impurities, causing the concentration to change.

6.2 Conductivity measuring

- **Electrode sensitivity check**

The cell constant of a conductivity electrode may vary, depending on the sample solution. Check the cell constant by measuring conductivity using the following solutions, at least once every three months.

Cell constant	Corresponding model	KCl standard solution	KCl Weight	Solution temp.	Conductivity value
SI units 100^{-1} (Former units 1 cm^{-1})	9382 −10D	0.01 mol/L	0.7440 g	0 °C	77.4 mS/m (0.774 mS/cm)
				18 °C	122.0 mS/m (1.220 mS/cm)
				25 °C	140.8 mS/m (1.408 mS/cm)

Prepare the potassium chloride standard solution (KCl 0.01 mol/L) by the below procedure.
In addition, if an error of 5 % of more compared with the above values occurs, calibrate the cell constant
(See page 86.).

• preparing potassium chloride standard solution

How to prepare solution

Dry the potassium chloride powder (superior quality commercial potassium chloride or better) for two hours, at 105 °C, then cool it in a desiccator. Measure out the above–listed amount of potassium chloride into a beaker and dissolve it in distilled water. Then, pour into one liter volumetric flask and add distilled water until the indication line.

• Calibrating cell constant

The officially approved cell count for an electrode is written on the electrode label. The constant may fluctuate, however, depending on the conditions of use. For this reason, it is advisable to calibrate the cell constant. Calibrate the cell constant by following the below procedure.

1. Wash the electrode with pure (ion exchange) water two or three times, then wash it another two or three times with potassium chloride standard solution (KCl 0.01 mol/L). Next, immerse the electrode in potassium chloride standard solution (KCl 0.01 mol/L) so that no air bubbles remain within the cell.

Note▶▶▶ When performing the above operation, maintain the temperature of the potassium chloride standard solution at 25°C ± 0.5°C.

2. Press the CAL key while in the CONDUCTIVITY INSTANTANEOUS VALUE MEASUREMENT mode, to select the CALIBRATION mode.
3. Use the ▲ and ▼ (UP and DOWN) keys to set the correct conductivity value (See page 85.).
   (The MODE key can be used to move the decimal place. When this is done, the range automatically changes.)

4. Press the CAL once more, to start calibration.

The measured value will appear, and “HOLD” will flash until the reading stabilizes.

When the measured value stabilizes, “HOLD” will stop flashing, the cell constant will be displayed, and that value will be saved to memory.

Ref.▶▶▶ While “HOLD” is flashing
When calibration is forced: Fix the value using the DATA IN key.
When calibration is cancelled: Clear the hold by pressing the CAL key, again.

5. Press the MEAS key to return to the CONDUCTIVITY MEASUREMENT screen. This enables conductivity to be measured.

Note▶▶▶ Use a constant−temperature bath or other method to keep the standard solution at 25°C ± 0.5°C during measurement. Submerge the electrode to sufficient depth in the standard solution, then slowly mix the solution using a stirrer or similar device.
Standard solution that has once been used should not be returned to the original container and should be discarded.

● Measuring conductivity

"Conductivity" is an index that expresses the ease with which electric current flows through a material. Conductors are categorized either as "electron conductors," such as metals and other substances which use free electrons to conduct electricity, or "ion conductors," such as electrolytic solution or fused salt, which use ions to conduct electricity. This section deals with the kind of conductivity that pertains to ions, especially the conductivity of electrolytic solution that uses water as the solvent. As shown in Fig.6–2, two pole plates with an area A (expressed in m^2) are positioned parallel to each other, separated by distance l (expressed in m), then solution is poured into the cell until full and alternating current is run between the plates.

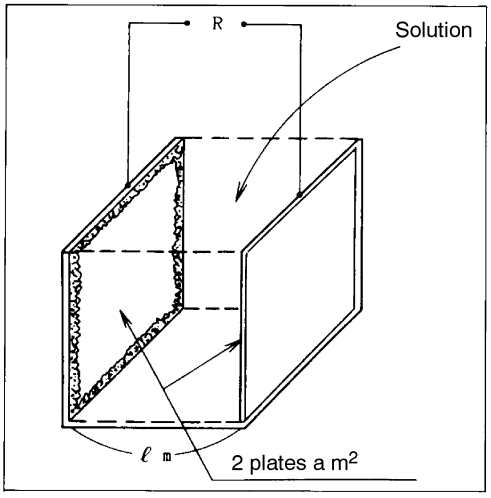


Fig.6–2

Each positive and negative ion in the solution will migrate toward the oppositly charged pole. The result is that current flows through the solution by means of ion conductivity.

When this occurs, resistance R (expressed in Ω), is in inverse proportion to the area A (expressed in m^2) of the pole plates, as is the case with metal and other conductors, and is proportional to the distance l (expressed in m) between the two pole plates. These relationships are expressed by equation 1, below.

$R = r \times l/a = rJ$ Equation 1

R: Resistance (Ω)

r: Specific resistance (Ω·m)

a: Pole plate area (m^2)

l: distance between pole plates (m)

J: Cell constant (m^{-1})

"Specific resistance" (expressed in Ω·m) is an index that indicates the difficulty with which current flows and is a constant determined according to the solution. The inverse of r (expressed in Ω·m), which is L (and is equal to 1/r), is called the "specific conductivity" and is widely used as an index to express the ease with which current flows. Specific conductivity L is generally referred to as simply "conductivity" and is expressed in units of S/m.

Inserting conductivity L (expressed in S/m) into equation 1 results in equation 2, below.

$R = J/L$ Equation 2

As is clear from equation 2, when a conductivity cell having a cell constant J of 1 m^{-1} is used *l* in other words, when a conductivity cell having two pole plates that each have an area A of 1 m^2 and are positioned parallel to each other such that the distance l between the two plates is 1 m is used *l* the inverse of the resistance R of the solution (expressed in Ω) between both pole plates is the conductivity. Conductivity is defined in this way, but it changes according to the temperature of the solution.

The conductivity of a solution is generally expressed as the value when the solution is 25 °C.

● New units (SI units)

New measurement units, called SI units, have been in use of late years. Accordingly, the D-24 also uses SI units. The following conversion table is provided for people who are used to using 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
Cell constant	1 cm^{-1}	⇒	100m^{-1}
	0.1 cm^{-1}	⇒	10m^{-1}
	10 cm^{-1}	⇒	1000m^{-1}
Measurement value	10 μS/cm	⇒	1 mS/m
	1 mS/cm	⇒	100 mS/m
	100 mS/cm	⇒	10 S/m

● Temperature compensation

The conductivity of a solution generally varies greatly, depending on the temperature of the solution. Because the conductivity of a solution is based on its ion conductivity, as explained above, the higher the temperature of the solution the more active its ions and the higher its conductivity. Using a given temperature as the standard (and calling that the standard temperature), the "temperature coefficient" expresses how much change (expressed in %) occurs in conductivity when the temperature of the solution changes by 1℃. The temperature coefficient is expressed in units of "%/℃ (standard temperature)." This temperature coefficient is found by assuming that the conductivity of the sample changes linearly in relation to temperature, whereas the change in conductivity of an actual sample, strictly speaking, follows a curve. The shape of this curve changes, depending on the kind of sample being measured. Most solutions, however, are said to generally have a temperature coefficient of 2 %/℃ (25℃ standard), within a range where the size of the temperature change is not very large.
The D-20s Series of pH meters are equipped with a built-in

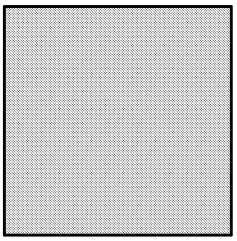
automatic temperature conversion function, enabling them to automatically calculate and display, based on the actual temperature measurement, the conductivity of a sample at 25℃, using a temperature coefficient of 2 %/℃.

• Conductivity and temperature coefficients for various solutions

The following table shows the conductivity (converted to 25 °C) and the temperature coefficient at that time, for various kinds of solution

Substance	Temperature ℃	Concentration wt%	Conductivity S/m	Temp. coefficient %/℃	Substance	Temperature ℃	Concentration wt%	Conductivity S/m	Temp. coefficient %/℃
NaOH	15	5	19.69	2.01	NaCl	18	5	6.72	2.17
		10	31.24	2.17			10	12.11	2.14
		15	34.63	2.49			15	16.42	2.12
		20	32.70	2.99			20	19.57	2.16
		30	20.22	4.50			25	21.35	2.27
		40	11.64	6.48	Na_2SO_4	18	5	4.09	2.36
KOH	15	25.2	54.03	2.09			10	6.87	2.49
		29.4	54.34	2.21			15	8.86	2.56
		33.6	52.21	2.36	Na_2CO_3	18	5	4.56	2.52
		42	42.12	2.83			10	7.05	2.71
NH_3	15	0.1	0.0251	2.46			15	8.36	2.94
		1.6	0.0867	2.38	KCl	18	5	6.90	2.01
		4.01	0.1095	2.50			10	13.59	1.88
		8.03	0.1038	2.62			15	20.20	1.79
		16.15	0.0632	3.01			20	26.77	1.68
HF	18	1.5	1.98	7.20			21	28.10	1.66
		4.8	5.93	6.66	KBr	15	5	4.65	2.06
		24.5	28.32	5.83			10	9.28	1.94
HCl	18	5	39.48	1.58			20	19.07	1.77
		10	63.02	1.56	KCN	15	3.25	5.07	2.07
		20	76.15	1.54			6.5	10.26	1.93
		30	66.20	1.54	NH_4Cl	18	5	9.18	1.98
H_2S0_4	18	5	20.85	1.21			10	17.76	1.86
		10	39.15	1.28			15	25.86	1.71
		20	65.27	1.45			20	33.65	1.61
		40	68.00	1.78			25	40.25	1.54
		50	54.05	1.93	NH_4NO_3	15	5	5.90	2.03
		60	37.26	2.13			10	11.17	1.94
		80	11.05	3.49			30	28.41	1.68
		100.14	1.87	0.30			50	36.22	1.56

(Continues)



Substance	Temperature	Concentration	Conductivity	Temp. coefficient	Substance	Temperature	Concentration	Conductivity	Temp. coefficient
	℃	wt%	S/m	%/℃		℃	wt%	S/m	%/℃
HNO_3	18	6.2	31.23	1.47	$CuSO_4$	18	2.5	10.90	2.13
		12.4	54.18	1.42			5	18.90	2.16
		31	78.19	1.39			10	32.00	2.18
		49.6	63.41	1.57			15	42.10	2.31
		62	49.64	1.57	CH_3COOH	18	10	15.26	1.69
H_3PO_4	15	10	5.66	1.04			15	16.19	1.74
		20	11.29	1.14			20	16.05	1.79
		40	20.70	1.50			30	14.01	1.86
		45	20.87	1.61			40	10.81	1.96
		50	20.73	1.74			60	4.56	2.06

6.3 Measuring dissolved oxygen

• Measuring dissolved oxygen

"Dissolved oxygen (DO)" is the concentration of oxygen that is dissolved in water. DO is essential for the self-cleaning mechanism of rivers and seas and for fish and other aquatic animals. The measurement of DO is also essential for waste-water treatment and water-quality management. The principles of measuring using a DO tip are explained below.

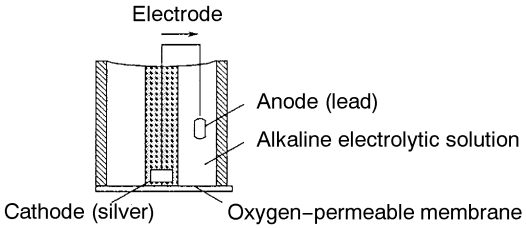


Fig.6-3

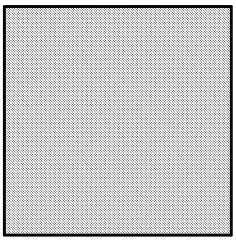
A precious metal (silver) is used as the cathode, tightly adhered to an oxygen-permeable membrane, and a base metal (lead) is used as the anode. Both the cathode and anode are immersed in an alkaline electrolytic solution. The external circuit between the anode and cathode is closed. Oxygen that diffuses through the oxygen-permeable membrane causes the following chain reaction to occur in the cathode and allows current to flow in the external circuit:

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

whereas, the following oxidation reaction occurs at the anode:

$$2Pb \rightarrow 2Pb^{2+} + 4e^-$$

This current is proportional to the amount of oxygen that is diffused through the oxygen-permeable membrane, so measuring the current of the sample enables the DO contained within the sample to be determined.



The DO measuring method that is based on this principle is called the “membrane electrode method.” This is a much simpler and more convenient way of measuring DO than by using chemical analysis, which requires complex pretreatment in order to eliminate the effects of reductants and oxidants in the sample.

● Salinity concentration correction

When a solution is in contact with air and is in a state of perfect equilibrium (a state of saturation), the relationship between the DO contained within the solution (C; expressed in mg/L) and the partial pressure of the oxygen in the air (Ps; expressed in Mpa) is shown by the following equation.

$$C = Ps/H$$

The “H” (expressed as MPa/[mg/L]) in this equation is referred to as the “Henry constant” and has a different value depending on the composition of the solution. Generally, the more concentrated the level of salinity within a solution, the larger H becomes, and, so, the smaller C becomes.
DO tips actually detect the “Ps” that occurs in the above equation. This means that even if a DO tip is immersed in pure water that is saturated with air or in an aqueous solution containing salt, the output current will not change, which gives rise to a problem.
For this reason, it is necessary to correct the salinity concentration, to enable the correct DO to maintain a current, even in an aqueous solution containing salt, and resolve the problem.

• Air pressure correction

The amount of DO in a solution is proportional to the partial pressure of the oxygen contained within the air with which the solution is in contact.
At 25 °C, for example, when water is saturated by air that has an atmospheric pressure of 1013 hPa (1 atmosphere), the DO is 8.11 mg/L. As the elevation at which measurement takes place increases, however, the atmospheric pressure caused by the air decreases. So, when air is made to saturate water at a high elevation, where the air pressure is, for example, 506.5 hPa (which is equal to 1013 hPa × 1/2), the DO will be 4.06 mg/L (which is equal to 8.11 mg/L × 1/2).
As explained above, careful attention must by paid concerning atmospheric pressure, when calibrating a DO meter. Air pressure does not present any special problem when a DO meter is used near sea level, but when it is used at especially high altitudes, it is necessary to correct for the air pressure.
The D−20s Series has a built−in air−pressure correction function.
Set the atmospheric pressure in the pH meter when calibrating and the meter will automatically be calibrated using the air−pressure corrected value. Air−pressure correction is calculated using the below equation.
When calibration is finished, the value derived from this equation is displayed.

$$20.9 \times (P/1013)\ \%$$

P is the air pressure (hPa) set in the meter.

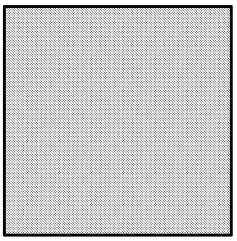


Table 6-1 Saturated DO levels in water at various temperatures (with a salinity concentration of 0.00 ppt)

Temp. (°C)	Saturated DO (mg/L)	Temp. (°C)	Saturated DO (mg/L)	Temp. (°C)	Saturated DO (mg/L)	Temp. (°C)	Saturated DO (mg/L)
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

6.4 Default (initial) settings

Category	Item	Default settings
Common	MEASUREMENT mode	pH
	DATA IN	No. 1
	DATA OUT	No. 1
	Temperature compensation	Automatic temperature compensation (ATC)
	Manual temperature compensation (MTC)	25 °C
	Automatic power−off	30 min (ON)
	Electrode ID	000
	Calibration cycle	0
	Clock (when extended unit is connected)	1997, 1, 1
Ion	Ion type	+1
	Units	g/L
	Channel	CH1: pH; CH2: ions
Conductivity	Units	S/m
	Temperature coefficient	2.0 %/°C (ON)
	Cell constant	1.0 × 100
DO	Salinity	0.0 ppt
	Air pressure	1013 hPa

6.5 Accessories

● Electrodes for D–23 (ion electrodes)

Part name	Model	Accessory no.	Notes
Chloride ion electrode	6560–10C	9003–0145–00	Combined type
Fluoride ion electrode	6561–10C	9003–0146–00	Combined type
Nitric acid ion electrode	6581–10C	9003–0147–00	Combined type
Potassium ion electrode	6582–10C	9003–0148–00	Combined type
Calcium ion electrode	6583–10C	9003–0149–00	Combined type
Ammonia ion electrode	5002–10C	9003–0166–00	Combined type

Tips for ion electrode replacement			
Part name	**Model**	**Accessory no.**	**Notes**
Chloride ion tip	7660	9003–0150–00	For 6560–10C
Fluoride ion tip	7661	9003–0151–00	For 6561–10C
Nitric acid ion tip	7681	9003–0152–00	For 6581–10C
Potassium ion tip	7682	9003–0153–00	For 6582–10C
Calcium ion tip	7683	9003–0154–00	For 6583–10C

Reference internal solution for ion electrodes			
Part name	**Model**	**Accessory no.**	**Notes**
Chloride ion internal solution	301	9037–0067–00	6560–10C for outer tube 50 mL
Fluoride ion Calcium ion internal solution	300	9003–0032–00	6561–10C, 6583–10C for outer tube 250 mL
Nitric acid ion internal solution	302	9037–0066–00	6581–10C for outer tube 50 mL
Potassium ion internal solution	303	9037–0069–00	6582–10C for outer tube 50 mL
Internal solution	330	9037–0052–00	65XX–10C for inner tube 250 mL

● Electrodes for D–24 (conductivity electrodes)

Part name	Model	Accessory no.	Notes
Water–resistant conductivity electrode	9382–10D	9096–0003–00	Water–resistant shape Cell const: 100 m^{-1}

Note▶▶▶ Cell count is within ±10% of the above indicated values.

● Electrodes for D–25 (DO electrodes)

Part name	Model	Accessory no.	Notes
Water–resistant DO electrode	9520–10D	9096–0005–00	Water–resistant shape Laboratory–use
	9550–20D	9096–0006–00	For on–site immersion Cable length: 2 m
	9550–100D	9096–0007–00	For on–site immersion Cable length: 10 m

Tips for Do electrode replacement			
Part name	**Model**	**Accessory no.**	**Notes**
Replacement tip	7541	9074–0002–00	For 9520
	5401	9033–0100–00	For 9550

Accessories and consumable items are available at HORIBA authorized dealers. Place orders by providing the name of the part, model and accessory number.

For technical questions regarding this pH meter, contact the following HORIBA representative.

HORIBA Customer Support Center
Toll-free tel. no. (within Japan):
0120-37-6045

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