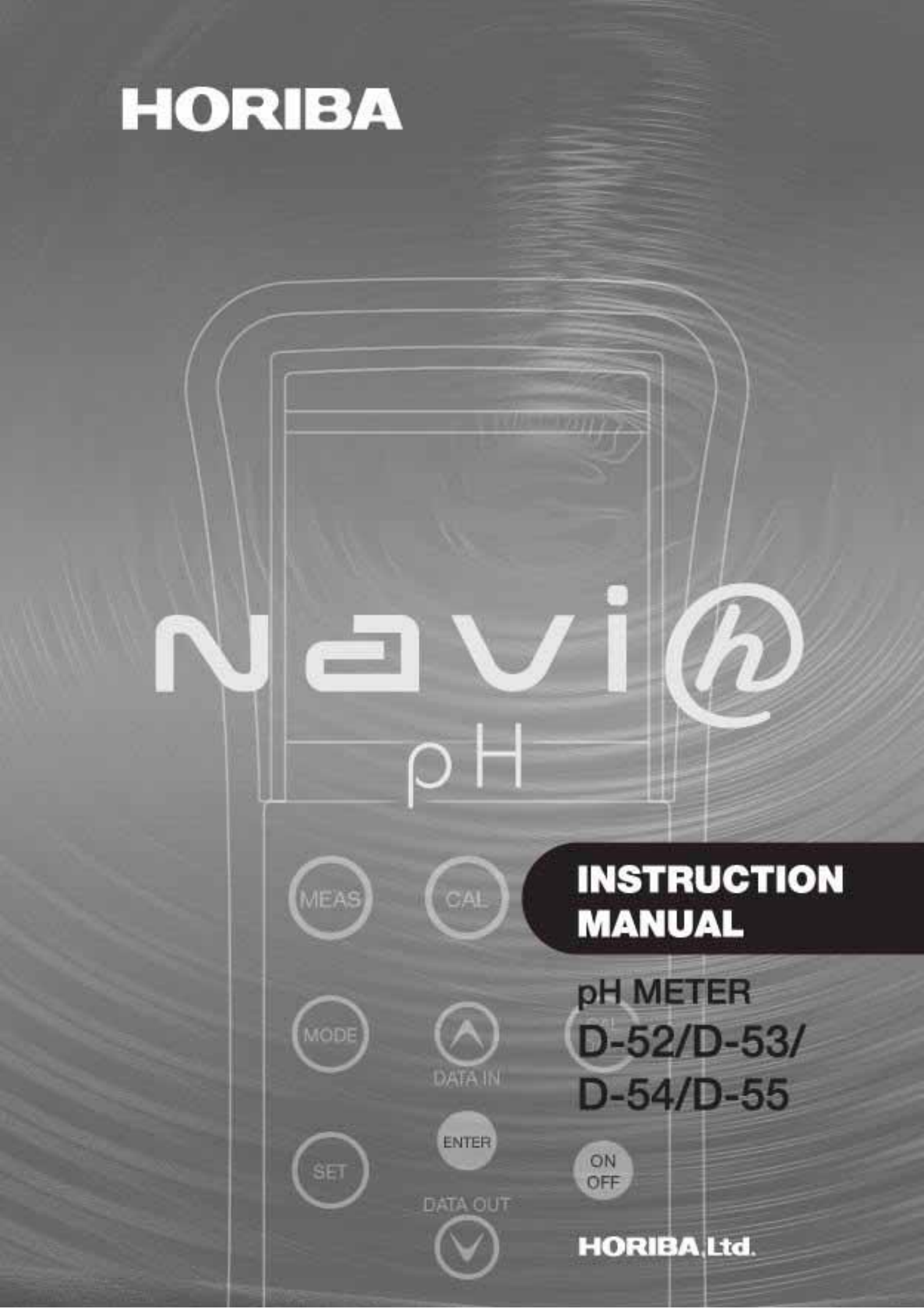
HORIBA



INSTRUCTION MANUAL

pH METER
D-52/D-53/
D-54/D-55

HORIBA, Ltd.

Preface

Thank you for purchasing one of the D-50 Series pH meters.
This meter is designed with a compact body that can be held in one hand and features a water-resistant construction Note 1. It has a large-sized LCD display, which enables to use the varied functions by simple operations, and especially will be convenient to use on-location.
Carefully read this manual before using the meter.

Note 1: The water-resistant construction of this meter conforms to IP-67 of IEC 529, entitled “Water resistant testing and protection against penetration by solid matter for electrical machinery and equipment.” To maintain the water-resistant construction of this meter, follow the instructions in this manual when using the meter.

IP-67 standards

・Dust does not get into internal parts.

・Water does not flow into internal parts when the meter is submerged 1 m below the surface of the water for 30 minutes, at a temperature differential between the water and the device of 5 ℃ or less.

HORIBA's Warranty and Responsibility

Your 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 meter in ways or for purposes other than those described in the operation manuals

・If any repairs renovations, disassembly, etc. are performed on this 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 service center printed on the back cover of this operation manual.

■ CE Marking

This product is in conformity with the following directives and standards:

Directives:The EMC Directives 89/336/EEC
The Electrical Product Safety Directive 73/23/EEC

Standards: EN61326: 1997+A1:1998
(EMISSION: Class B, IMMUNITY Category: Minimum Requirement)
EN61010-1: 2001

Installation Environment

This product is designed for the following environment.
- Pollution degree 2
- Measurement category **I**

WARNING:Do Not use the equipment for measurements within measurement categories
II , **III** and **IV** .

■ FCC Warning

This equipment has been tested and found to comply withthe limits for a Class A digital device, pursuant to part 15 of the FCC Rules.
These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.
This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be
required to correct the interference at his own expense.

■ Type and Definition of Signal Words

For the safety use, the meter is equipped with the Warning Labels to alert every operator and user to the possible risk and danger. Before using understanding each message.
The meaning of signal words are as follows:

(WARNING) This indicates an potentially hazardous situation which, if not avoided, will result in death or serious injury.

(CAUTION) This indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert unsafe practices.

■ Safety Precautions

For the safety use, be sure to read the following precautions:

⚠ WARNING:

- Do not use any unspecified AC adapters.
  Heat or fire may occur to cause fire or accidents.
- Do not disassemble or modify the meter.
  Heat or fire may occur to cause fire or accidents.

⚠ CAUTION:

- Do not use the serial communication or AC adapter in the place that may possibly contact with moisture.
  It may cause fire, electric shock, or breakage.
- Part of the electrode is made of glass; handle with care not to break it.

● Indication

⚠ WARNING

This indicates an potentially hazardous situation which, if not avoided, will result in death or serious injury.

⚠ CAUTION

This indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert unsafe practices.

— Note ———

This mark indicates the operation requires a special care and attention.

— Ref. ———

This mark indicates to which the reader should go for reference.

— **HINT!** ———

This mark indicates reference information.

■ Cautionary Items

● Precautions

- ●Do not give physical shock to the meter like dropping or hitting.
- ●Do not immerse the meter into alcohol, organic solvent, strong acid, strong alkaline, and other similar solutions. The meter contains ABS resin, acrylic resin, and various rubber products in its body.
- ●Do not use a hair-dryer for drying the meter. When the meter is dropped into water or get wet, wipe it using soft cloth.
- ●Perform the key operation by the fingers, not by the hard object like metal stick or rod.
- ●Be careful not to let water into the meter when the electrode connector is empty or the AC adapter or serial communications cable has been connected. In those states, the meter is not water-proof.
- ●To disconnect the electrode cable or interface cable, pull them out with holding the connector part. Do not pull the cable part; it may cause a breakage.
- ●Do not remove the battery gasket or twist it.
- ●When opening the battery case, make sure that no foreign matter is attached to the battery gasket.
- ●Do not use any unspecified batteries ; it may cause a breakage.

● Location of use and storage

- ●The place which room temperature is at 0 ℃ to 45 ℃
- ●The place which relative humidity is under 80% and free from condensation

Do not use or store the meter at;

- ●The place of much dust
- ●The place with strong vibration
- ●The place with direct sunlight
- ●The place with corrosive gas generation
- ●The place near from an air-conditioner
- ●The place with direct wind

● Move and Transportation of the meter

To transport the meter, use the packaging box at the delivery. Transportation by any unspecified packing methods may cause a breakage.

● Disposal

Standard solution used for the calibration must be under neutralization before the disposal. As for the disposal of the meter, treat it as an industrial waste.

CONTENTS

CONTENTS

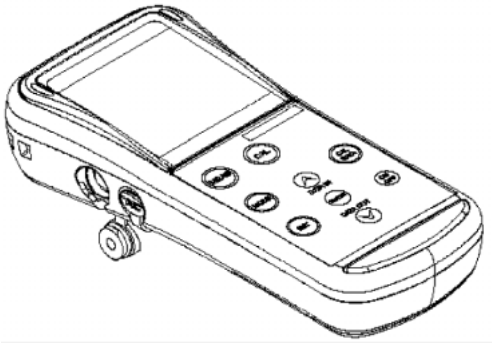
1 Overview of the Meter

This chapter explains the part names, how to connect the electrodes, how to replace the batteries, and precautions when using the meter.

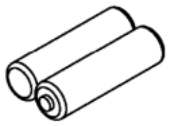
1.1 Package contents

The following items are shipped with each HORIBA pH meter package.

Meter (main unit) 1 unit



Dry-cell batteries 2 pcs.

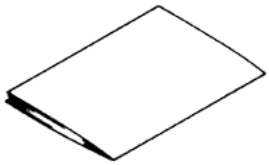


Strap 1 pc

Soft case **1 pc**

Protective cap **1 pc (D-53,54,55)**

Operation manual **1 book**



Note

To take measurements, you will need electrode(s).
Refer to “7.10 Spare and optional parts” page 208 when purchasing the electrode(s).

1.2 Functions

The D-50 Series features the following functions.

● Measurement items

Items	Model				Required electrode/ standard solution
	D-52	D-53	D-54	D-55	
pH	○	○	○	○	pH electrode, pH standard solution
ORP (mV)	○	○	○	○	ORP electrode
ION	–	○	–	–	ION electrode, Ion standard solution
Conductivity	–	–	○	–	Conductivity electrode, Conductivity standard solution
Dissolved oxygen	–	–	–	○	DO electrode
Temperature	○	○	○	○	–

● Functions

An overview of the functions found on HORIBA D-50 Series is shown below.

Function	Explanation	Model				Page No.
		D-52	D-53	D-54	D-55	
Data memory	Enables a maximum of 300 items to be stored.	○	○	○	○	page 65
pH repeatability check	Displays the difference between the calibration value and measured value after calibration.	○	○	○	○	page 32

Function	Explanation	Model				Page No.
		D-52	D-53	D-54	D-55	
pH calibration history display	Displays the date of calibration, asymmetrical potential and sensitivity.	○	○	○	○	page 68
Relative mV display	Displays mV when the measured potential is shifted to 0 mV.	○	○	○	○	page 38
ION calibration history display	Displays date of calibration and the offset potential/ sensitivity.	–	○	–	–	page 70
Clock	The date and time are displayed.	○	○	○	○	page 73
Auto Power OFF	Turns ON/OFF setting that automatically turns power OFF if no keys are touched for 30 minutes.	○	○	○	○	page 94
RS-232C communications	Enables communication with a computer, using RS-232C.	○	○	○	○	page 99
Printer output	Prints the contents of the memory (printer sold separately).	○	○	○	○	page 129
Commercial power supply	Enables the use of commercial power, using an AC adapter (sold separately).	○	○	○	○	page 18

● Setting Items

Function	Explanation	Model				Page No.
		D-52	D-53	D-54	D-55	
pH standard solution setting	Enables standard solution used for calibration to be changed to NIST and US specifications settings.	○	○	○	○	page 77
pH temperature compensation	Enables temperature compensation to be conducted in pH Measurement mode, either manually or using a temperature sensor.	○	○	○	○	page 80
Auto data memory	Stores data automatically at an interval of 2 sec. to 24 hours.	○	○	○	○	page 81
pH calibration frequency setting	Sets the next calibration time according to the number of measurements made after calibration.	○	○	○	○	page 83
Sample ID	ID No. of the sample	○	○	○	○	page 84
Ion unit	Toggles between g/L and mol/L.	—	○	—	—	page 85
Ion slope	Displays the valence of measured ion.	—	○	—	—	page 86

Function	Explanation	Model				Page No.
		D-52	D-53	D-54	D-55	
COND unit	Toggles between S/m and S/cm.	–	–	◯	–	page 86
COND temperature coefficient	Automatically or manually sets a temperature coefficient for a sample.	–	–	◯	–	page 87
DO salinity compensation	Compensates for salinity of sample.	–	–	–	◯	page 88
DO atmospheric pressure compensation	Compensates for atmospheric pressure at measurement site.	–	–	–	◯	page 89

Note

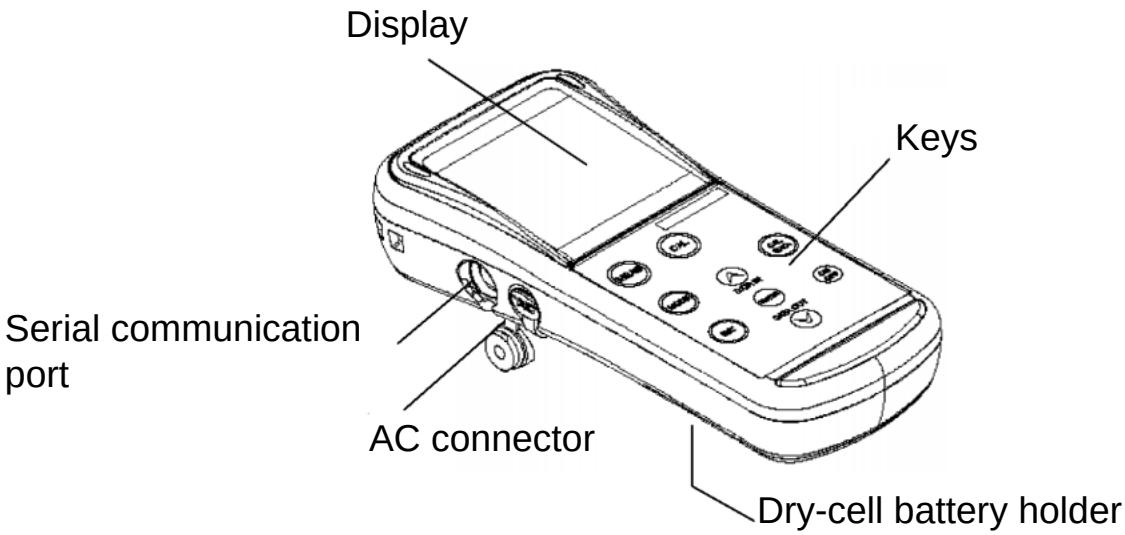
RS-232C communications and the printer cannot be used simultaneously.

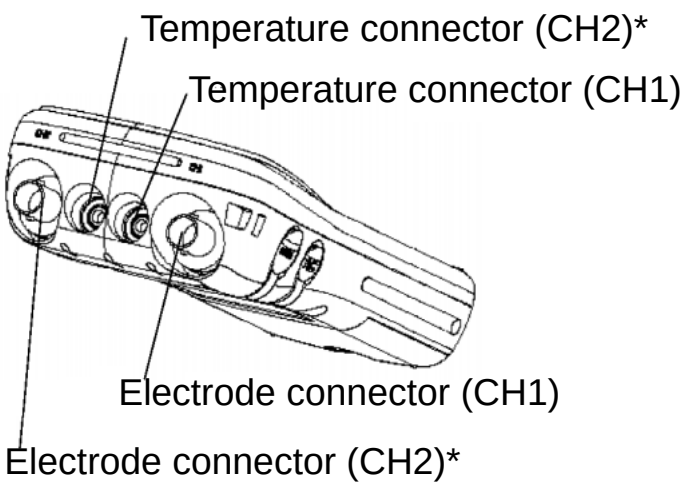
● Functions in Maintenance mode

Function	Explanation	Page No.
LCD check	Enables check for whether or not all LCD segments are displayed.	page 91
Battery voltage check	Enables simple check of battery voltage.	page 92
Temperature display calibration	Adjusts the display of the temperature sensor to the actual temperature.	page 93
Auto Power OFF	Sets the function that automatically turns the power OFF if no keys are touched 30 minutes.	page 94
pH/ION CH setting (D-53 only)	Changes pH/ION measurement channel.	page 95
Remaining data memory	Displays the remaining memory.	page 96
Data memory clear	Deletes data in memory.	page 96
Initializing settings	Initializes all settings to the default values.	page 97
Printing test	Conducts a printing test.	page 98

1.3 Part names

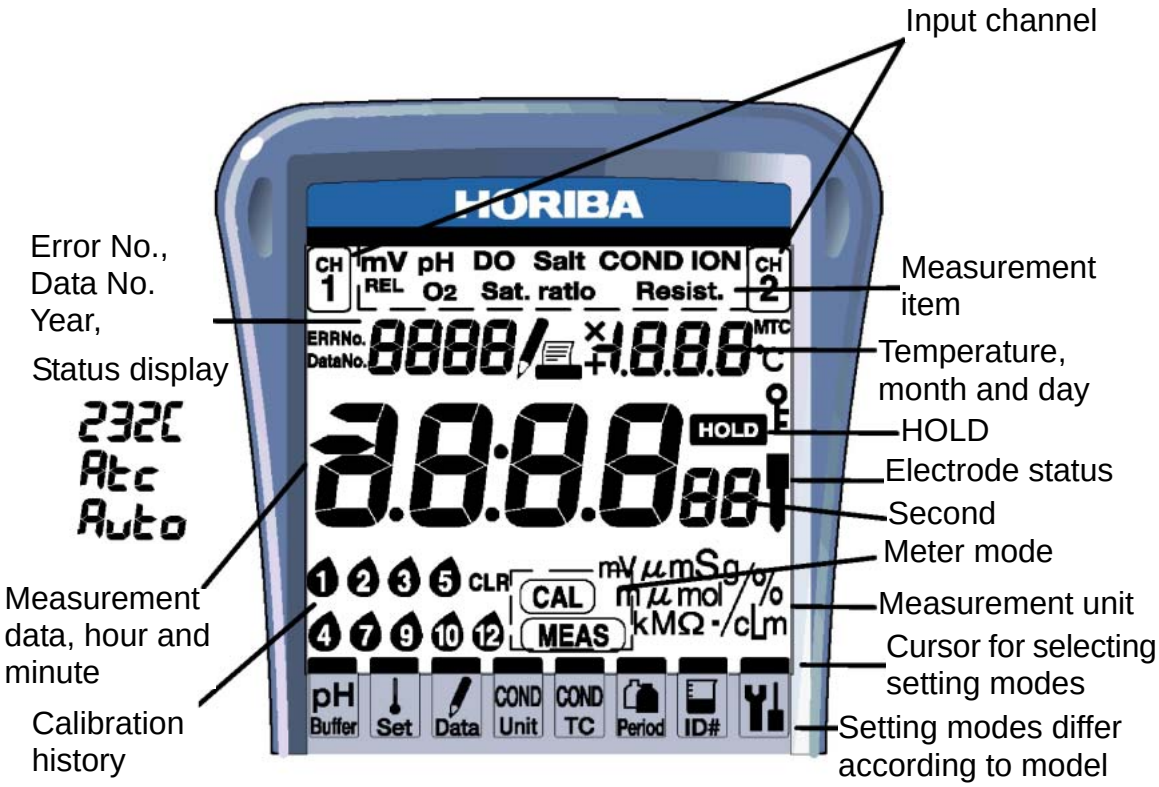
The D-52/53/54/55 pH meters have the following parts:





* The D-52 has CH1 only.

1.4 Explanation of display



Part name	Display	Contents
Input channel	CH 1	Input channel 1
	CH 2	Input channel 2
Measurement item	mV	Displayed when measuring mV
	pH	Displayed when measuring pH
	DO	Displayed when measuring dissolved oxygen
	COND	Displayed when measuring conductivity
	ION	Displayed when measuring ions
	REL	Displayed in mV Measurement mode, when relative mV is being set
Error No.	ERRNo.	Displayed when an error is generated

Part name	Display	Contents
Data No.	DataNo.	Displayed when the data number has been set.
Status display	001	Shows error number and data number.
	Auto Blinking / Displayed	Displayed when AUTO data memory is being performed.
	232C	Displayed when the serial communication is active.
	Atc	Displayed when temperature compensation function or automatic temperature compensation has been set.
	n.St	Displayed when NIST standard is selected at pH standard solution.
	USA	Displayed when US standard is selected at pH standard solution.
	CuSt	Displayed when custom standard is selected at pH standard solution.
–		Displayed during data memory function (for 3 sec.). Displayed while data in memory is being called up and when manual data memory is being called up, or blinks when automatic data memory is being called up.
–		Displayed when a printer is connected. (Sometimes displayed when a computer is connected depending on the computer.)
–	MTC	Displayed during manual temperature compensation. Not displayed during automatic temperature compensation.

Part name	Display	Contents
HOLD		Displayed while the data is held (HOLD status). Blinks during measurement or calibration.
Electrode status		(Only in pH Measurement mode) Not displayed: Normal Blinking: Cleaning is needed. Constant display: Replacement time is approaching.
Calibration history		Calibration history display: Displayed after calibration for pH and ION electrodes as calibration history.
		When no calibration data is available: Displayed when no calibration has been performed for pH and ION electrodes.
Meter mode		Displayed when in Measurement mode.
		Displayed when in Calibration mode.

1.5 Operation keys

This section describes the functions of the keys.

	Name	Description
	MEAS key	Returns to the Measurement mode. Starts measurement.
	MODE key	Selects measurement item.
	SET key	Selects setting item.
	CAL key	Enters the Calibration mode. Starts calibration.
	UP key	Executes the data memory function. Increases numerical value.
	ENTER key	Establishes the setting.
	DOWN key	Calls up data memory. Decreases numerical value.
	CAL DATA key	Calls up calibration data.
	ON/OFF key	Turns ON/OFF the power. This key takes effect only after pressed for one second to prevent accidental operation.

Note

The automatic power-off function is a default setting for this meter. The power is automatically turned OFF if no operation is performed after a period of approximately 30 minutes.

1.6 Connecting the electrodes

Connect the electrodes to the meter using the following procedure:

Note

- Do not allow any water to come into contact with the connector.
- Do not touch the connector with uncleaned hands.
- Hold the metal portion when turning the electrode conenctor.

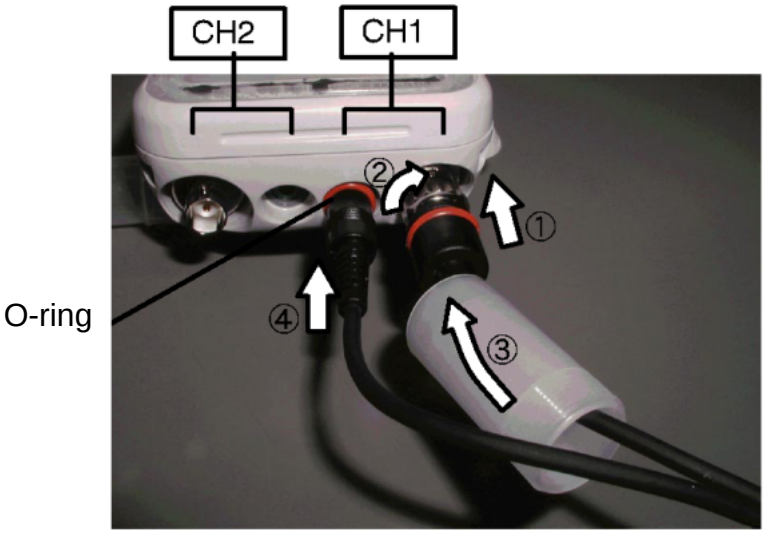
The following connectors are used depending on electrode type:

CH1	Electrode connector:	pH/ORP electrode
	Temperature connector:	Temperature electrode for CH1
CH2	Electrode connector:	ION electrode (D-53) Conductivity electrode (D-54) DO electrode (D-55)
	Temperature connector:	Temperature electrode for CH2

Connect the pH/ORP electrode to CH1.
Connect the ion/conductivity/DO electrode to CH2.

● Electrode connector (G-R electrode)

Ion/Conductivity/DO electrode pH/ORP electrode



1. Insert the electrode connector, making sure to align the connector grooves with the pins in the connector port on the main unit (see photo, ①). Do not push the electrode with undue force when the pins are not properly aligned.
2. Push the electrode connector into the connector port while turning it clockwise, following the grooves (see photo, ① and ②).
3. Push the connector cover over the connector (see photo, ③), being careful to push it straight on without turning it.

Note

The meter will be waterproof only if this cover is placed properly over the connector.

● Temperature connector

1. Insert the temperature connector into the jack on the main unit until the O-ring on the electrode cannot be seen at all (see photo, ④).

Note

The meter will not be waterproof if the electrode is not inserted properly.

Note

When the temperature electrode is not connected (or is connected improperly), the automatic temperature compensation (ATC) will be 25°C.

1.7 Inserting/replacing the dry-cell batteries

The dry-cell batteries are not placed in the meter before shipping. To insert the batteries, follow the procedure below.
Note that if “ERR 2” appears on the display while using the meter, it indicates that the charge of the dry-cell batteries is running low. When this occurs, replace the batteries promptly.
Dry-cell battery type: AA alkaline

Note

• Insert the batteries, paying attention to the orientation of the battery poles (“ + ”and “ - “).

• Removing the batteries will erase the clock data. To save the clock data, remove and replace the batteries while the meter is connected to the AC adapter (sold separately).

•Replace the batteries only after turning the power OFF. Any saved data will not be lost.

• When opening and closing the battery cover, be careful that no water gets inside the meter.

• Check that the rubber packing is not twisted and no foreign matter is stuck to it. Otherwise the meter may no longer be waterproof.

Note

The life of the batteries included with the meter may be short because the batteries were used for the operation check before shipping.

To insert/replace the batteries

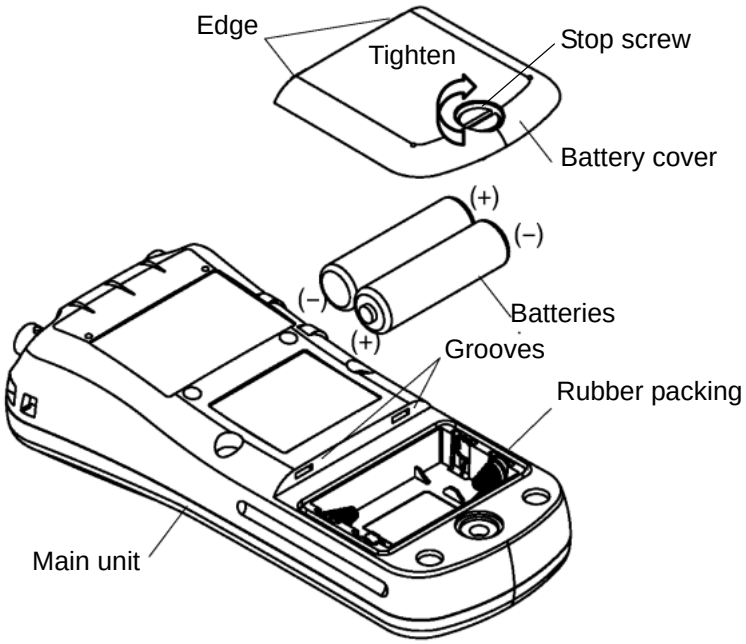
1. Loosen the screw of the battery cover by using a coin or screwdriver, etc. The cover is constructed so that the stop screw cannot be completely removed and lost.
2. Pull up the screw, and remove the battery cover by sliding it out.

3. If there are old batteries inside, remove them.

4. Place the new batteries in the meter, verifying the orientation of the poles (“+” and “-”).

5. Check that the rubber packing is not twisted and no foreign matter is stuck to it.

6. Insert the edge of the battery cover into the grooves on the meter, and then tighten the stop screw.



Note

Check that the rubber packing is twisted and no foreign matter is stuck to it. Otherwise the meter may no longer be waterproof.

Battery life

The table below shows the battery life of alkaline batteries during continuous use. The life of manganese batteries is about a half of the alkaline batteries.

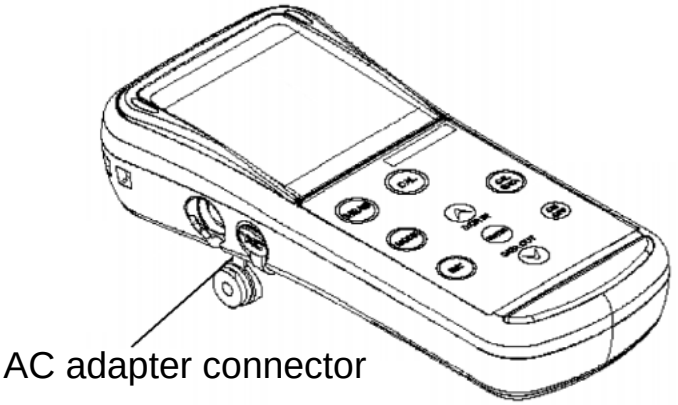
Model	Battery life
D-52, 53, 55	approx. 200 hours
D-54	approx. 100 hours

1.8 Connecting the AC adapter

When using the meter with an AC power supply, use the designated AC adapter (option).

AC adapter specifications

Supply voltage range	100 - 200 V AC
Frequency range	50/60 Hz
Current rating	Max 370 mA
Class2 Power supply	
Equipment protected by double insulation	
Indoor use only	
Supply voltage fluctuations allowed up to ± 10%	



Note

When the AC adapter is connected, the meter is no longer waterproof.
Be careful not to let water get into the meter.

1.9 Using the protective cap (D-53/54/55)

For meters having two electrode connector channels, be sure to use the protective cap when using only one channel, in order to protect the unused connector

2 Taking Measurements

This chapter explains how to take basic measurements.

2.1 Turning the meter ON/OFF

Pressing the ON/OFF key turns the power on/off. The ON/OFF key functions when it is pressed continuously for about one second to protect against accidental operation.

2.2 Settings required before measurement

The built-in clock allows you to record the date of calibration and data memory storage. When using the meter for the first time, be sure to set this clock.

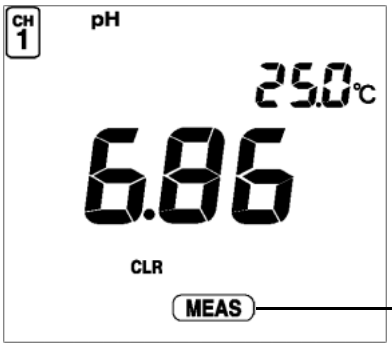
Ref.
“3.3 Displaying and setting the clock” page 72

2.3 Measurement modes

The D-50 Series of pH meters have an Instantaneous Value Measurement mode and an Auto Hold Measurement mode for all components of the solution being measured.

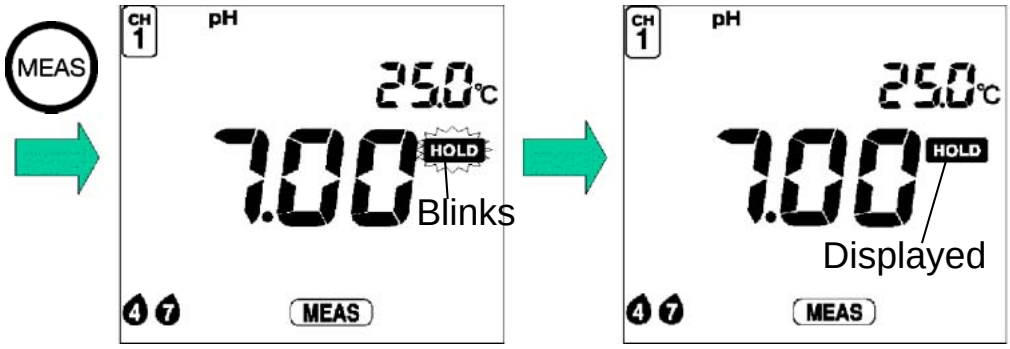
● Instantaneous Value Measurement mode

The D-50 Series of pH meters perform instantaneous value measurement as the default measurement mode when the power is first turned ON and when the auto hold measurement is cancelled or cleared.
For this reason, the screen displayed when the meter is in the Instantaneous Value Measurement mode is called the "initial screen" in this manual.



● Auto Hold Measurement mode

Auto Hold Measurement mode maintains the display of the value measured when the meter automatically judges that the measured value has stabilized. Press the MEAS key with the initial screeen displayed to make “ HOLD ”blink on the display. When the measured value becomes stable, “ HOLD ”will stop blinking and remain displayed, and the measured value will remain displayed. To clear the hold status or “ stabilized ”value (when “ HOLD ”is blinking), press the MEAS key.

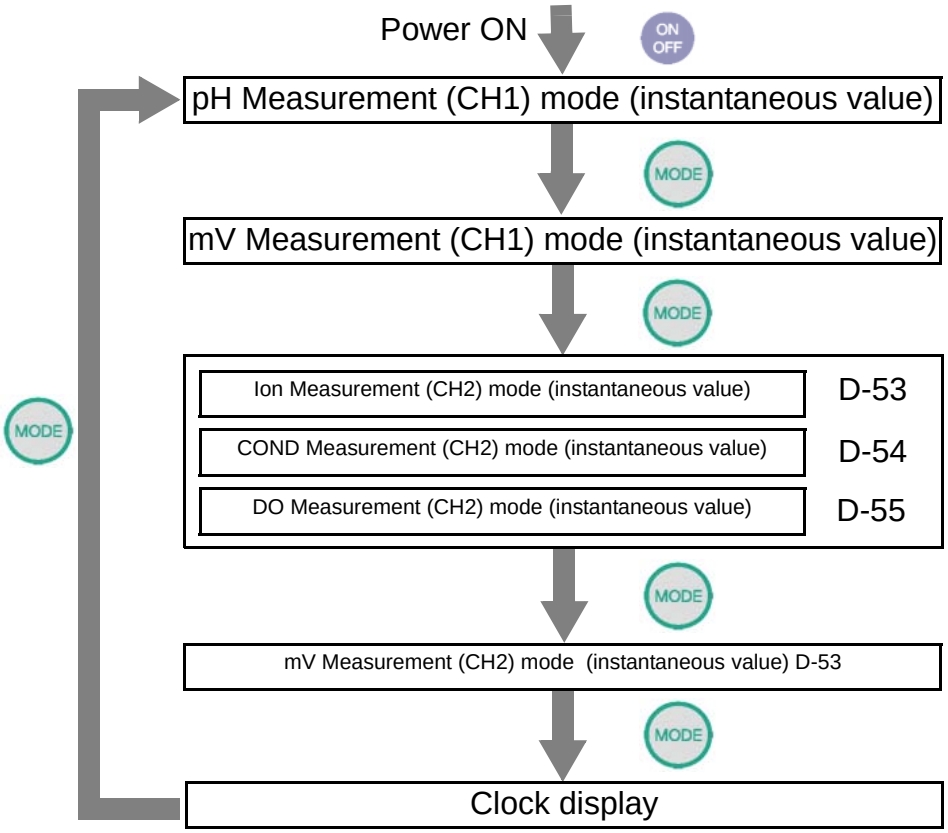


Criteria for judging stability

pH, ORP, ION measurement	:	Within ±1 mV variance in potential after 10 seconds
Conductivity measurement	:	Within ±3-digit variance after 10 seconds
DO measurement	:	Within ±3-digit variance after 10 seconds
Temperature measurement	:	Within ±2ºC variance after 10 seconds

2.4 Selecting the measurement modes

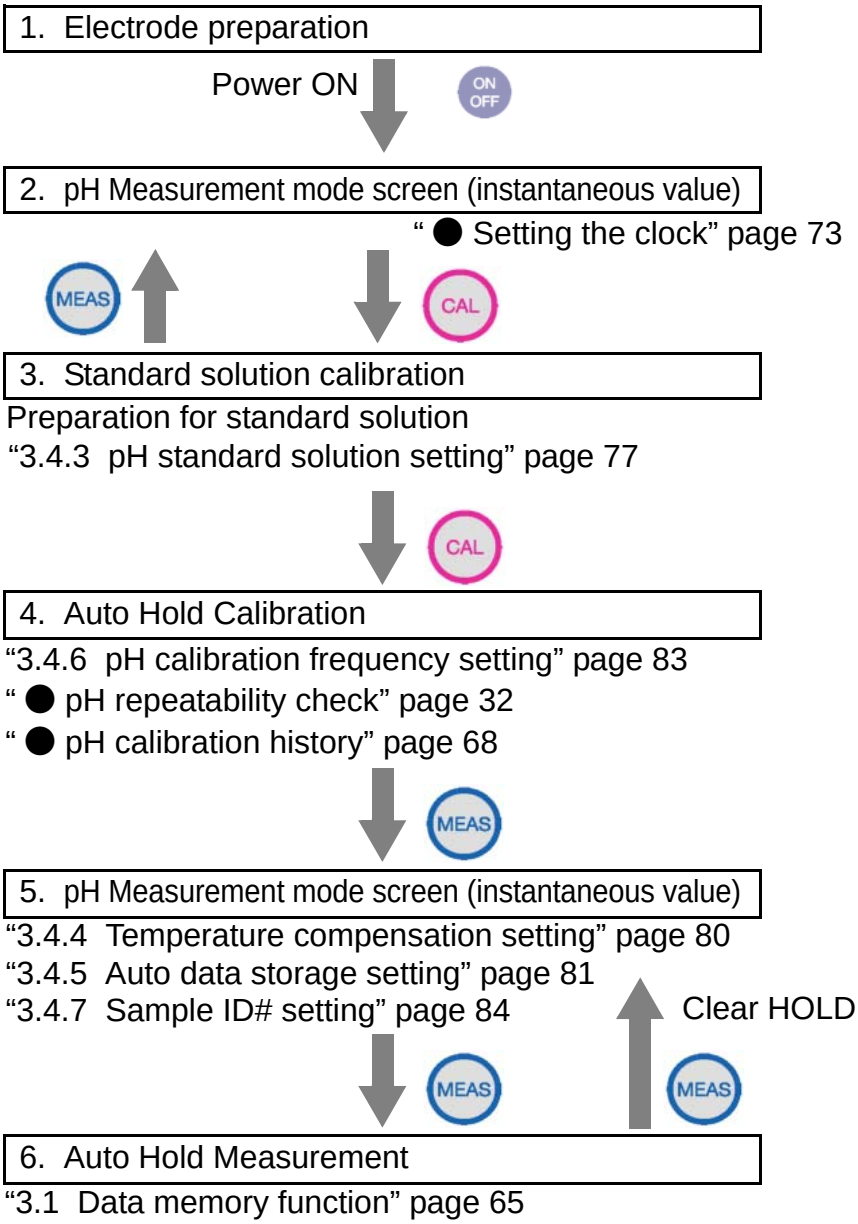
Pressing the MODE key changes the measurement mode. The last measurement mode item is the clock display. Pressing the MODE key once more returns the display to the first measurement mode.



2.5 Measuring pH

The following shows the operational flow for pH measurement.

● Measuring pH: basic operational flow



● Electrode preparation

Refer to the electrode instruction manual and make sure you have the necessary electrode(s).
Plastic-body pH electrode: 9621-10D
Glass-body pH electrode: 9611-10D
pH (micro) electrode: 9669-10D
pH (sleeve) electrode: 9677-10D

Chemical solution

Caution

The liquid inside the electrode is highly concentrated potassium chloride (3.33 mol/L KCl). 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.

Glass fragments

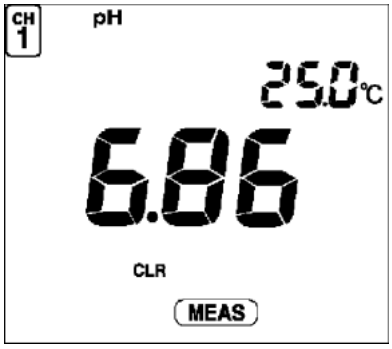
Caution

Glass fragments can cause injury.
The outer tube of the electrode and the tip of the electrode are made of glass. Use care not to break them.

● Entering the pH Measurement mode

1. Press the ON/OFF key.

The initial screen will appear.



● Standard solution calibration

Perform a one-point calibration for making simple pH measurements; for more accurate measurements, perform at least a two-point calibration.

Note

Up to three points can be used for calibration. If you perform calibration for a fourth points, “ERR06 Calibration point error” is displayed.

Standard solutions for calibration are defaulted to pH 2, pH 4, pH 7, pH 9, and pH 12.

Ref.

“3.4.3 pH standard solution setting” page 77

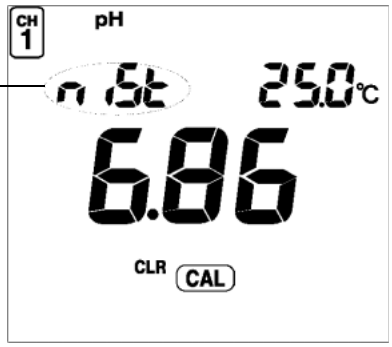
This section will explain how to conduct a two-point calibration using pH 7 and pH 4 standard solutions.

Calibration procedure

1. Press the CAL key while in the pH Measurement mode.

The meter enters the Calibration mode and >CAL< is displayed.

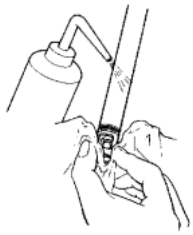
Displayed item differs depending on the standard solution setting.



Note

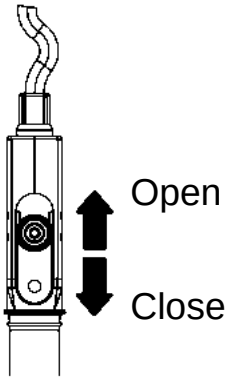
The mode cannot be changed during Auto Hold calibration (while “HOLD” is blinking or continually displayed.

2. Wash the tip of the electrode well with pure (de-ionized) water, and then wipe with filter paper or tissue paper.



3. Open the internal solution filler port.

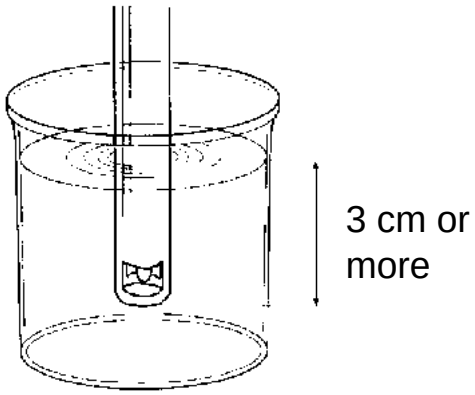
Leave the port open while calibration is taking place.



Calibration at first point

1. Immerse the tip of the electrode in a beaker containing pH 7 standard solution.

Immerse the pH electrode in the sample at least three centimeters.



2. Press the CAL key to start calibration.

The measured value will be displayed, and "HOLD" will blink until the reading stabilizes.

When the value stabilizes, "HOLD" will stop blinking and the calibrated value will be displayed.

The 7 bottle mark will be displayed, indicating that calibration was conducted with pH7 standard solution

Note

To stop the calibration:
Press the CAL key while the HOLD mark is blinking.
To establish the calibration:
Press the ENTER key while the HOLD mark is blinking.
To redo the calibration:
Press the CAL key after the HOLD mark is displayed.

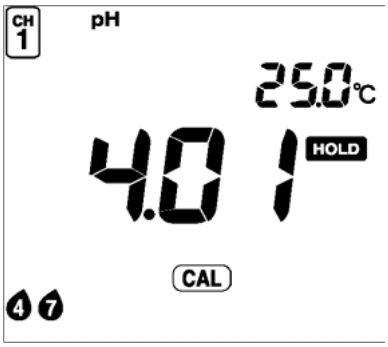
Calibration at second point

1. Wash the electrode well again with pure (de-ionized) water, and then wipe with filter paper or tissue paper.
2. Immerse the tip of the electrode in a beaker containing pH 4 standard solution.
3. Press the CAL key to start calibration.

   The measured value will be displayed, and "HOLD" will blink until the reading stabilizes.

   When the value stabilizes, "HOLD" will stop blinking and the calibrated value will be displayed.

   The 4 bottle mark will be displayed, indicating that calibration was conducted with pH 4 standard solution.



4. Press the MEAS key to return to the pH Measurement screen.

Note

While calibrations are being performed in the Calibration mode, redoing a calibration only updates the calibration data for the pertinent standard solution. If a calibration is redone after the meter is returned to the Measurement mode, however, the calibration is conducted on the initial status of the meter; i.e., all the previous calibration data is cleared.

Note

The example of calibration at second point has explained the calibration process using the order from pH 7 to pH 4. However, the calibration order of the standard solutions can be arbitrarily chosen.

Electrode status

You can check the status of the electrode after calibration.

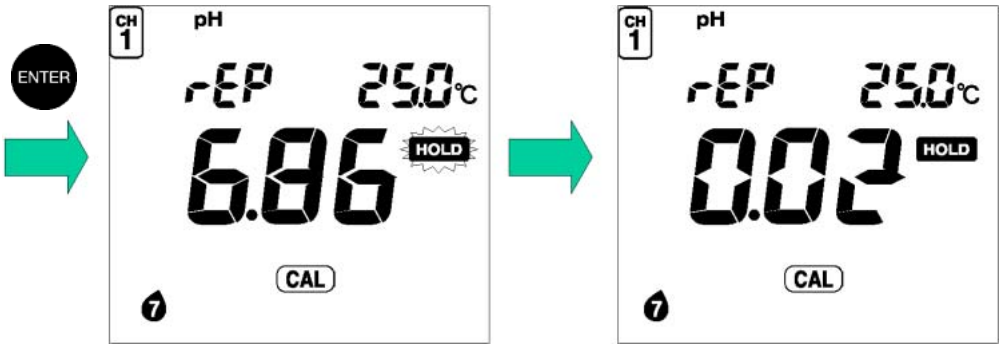
Item	Description
,ERR Not displayed	The electrode is in good condition. Electrode sensitivity is from 93% to 100%.
Blinking	Electrode sensitivity has dropped to the level of 90% to 93%. •Make sure that you are using the right standard solution. •Clean the electrode. “ ● Washing the electrodes” page 142
Displayed	Electrode sensitivity has dropped to the level of 85% to 90%. “● ERR No.05 Electrode sensitivity error (pH)” page 160
ERR No.04	Asymmetrical potential error “ ● ERR No.04 Asymmetric potential error” page 159
ERR No.05	Sensitivity error “● ERR No.05 Electrode sensitivity error (pH)” page 160

● pH repeatability check

The repeatability of the calibration can be checked if the calibration has been performed with pH 7 standard solution of NIST or US.
The repeatability check is operable only once after calibration.

1. After calibration and while still in the Calibration mode, immerse the electrode in pH 7 standard solution and press the ENTER key.

   The difference between the calibrated value and measured value is displayed.



Note

There is no problem in measurement accuracy if the difference is within ± 0.05 pH.

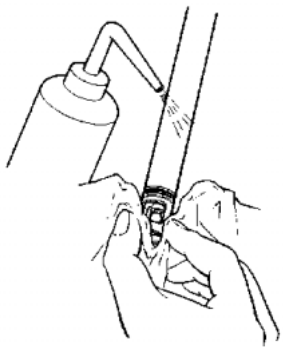
● Clearing calibrated values

To clear all the calibrated values:

1. Set the pH meter to the Calibration mode.
2. Press the CAL key while holding the SET key down.

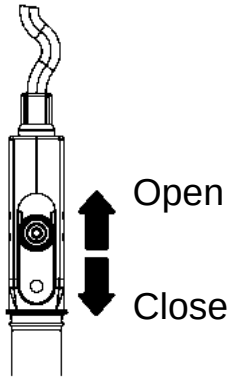
● Measuring pH

1. Wash the tip of electrode well with pure (de-ionized) water, and then wipe with filter paper or tissue paper.



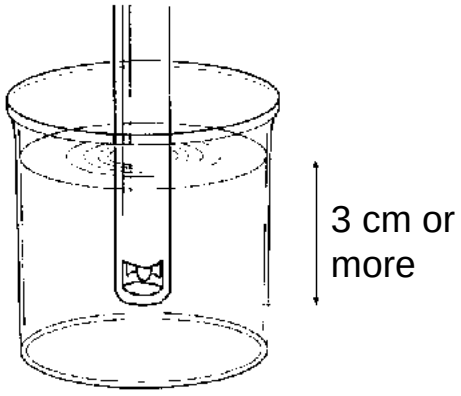
2. Open the internal solution filler port.

Leave the port open while measurement is taking place.



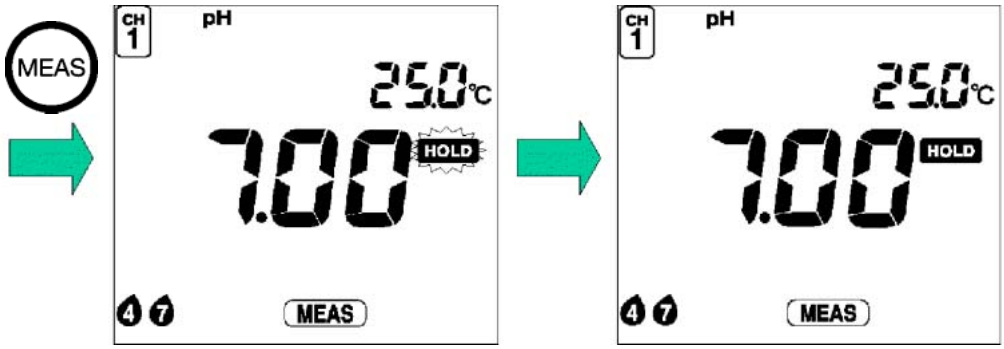
3. Immerse the electrode all the way in the sample.

Immerse the pH electrode in the sample at least three centimeters.



4. Press the MEAS key with the initial screeen displayed.

“ HOLD ”will blink until the reading stabilizes.
When the indicated value stabilizes, “ HOLD ”will stop blinking and will be displayed. The indicated value will remain displayed continually.



Ref.

Refer to the “ Criteria for judging stability” page 23 for the criteria for judging the stability of the readout.

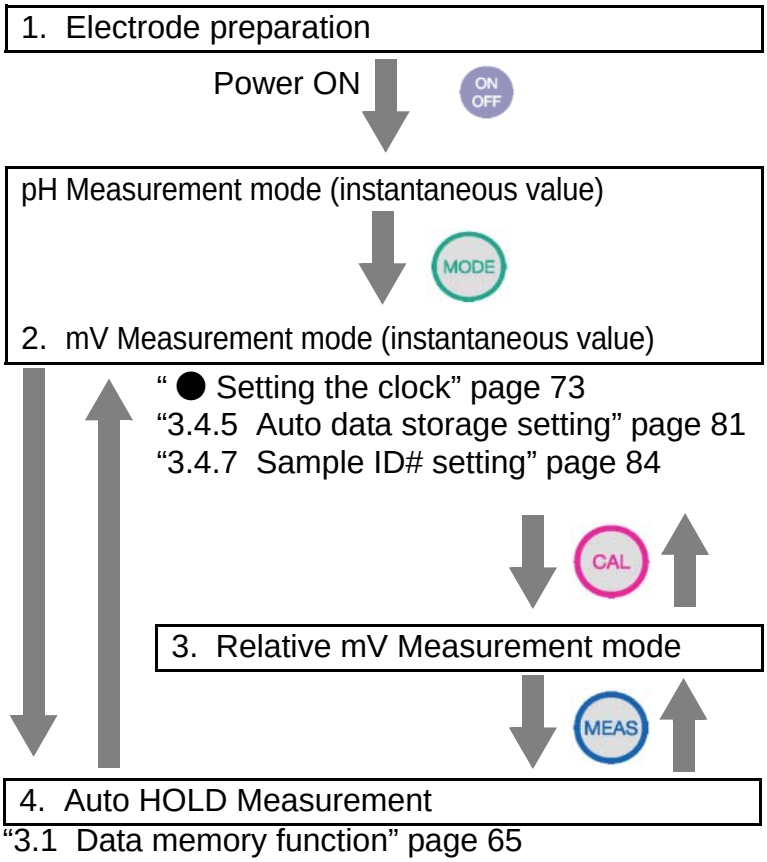
Note

When measurement data is held using Instantaneous Value Measurement or Auto Hold Measurement, you can store that data in the memory by pressing the ▲ key. See “3.1 Data memory function” page 65.

2.6 Measuring ORP

The following shows the operational flow for ORP measurement.

● ORP measurement operational flow



● Electrode preparation

To measure the ORP (oxidation-reduction potential) of a solution, use a platinum electrode especially designed for that purpose.

Note

mV measurement with the pH electrode shows the potential of the electrode. This measurement is useful for checking samples and the performance of the electrode.

Refer to the electrode instruction manual and make sure you have the correct electrode.

● Measuring ORP

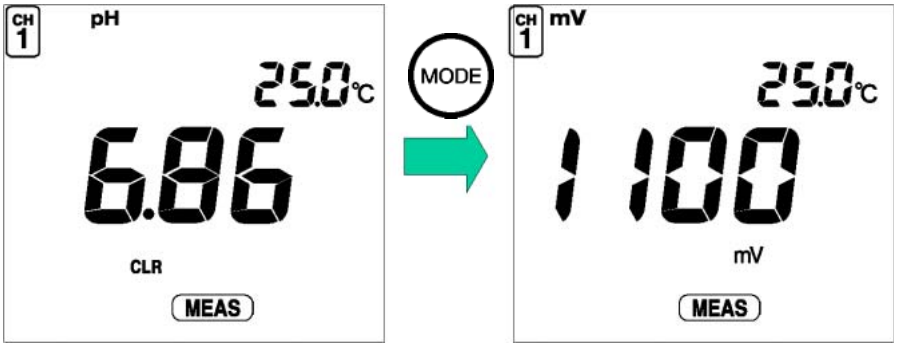
1. Immerse the electrode all the way in the sample solution.

Note

For accurate measurements, be sure to immerse the electrode in the sample at least three centimeters.

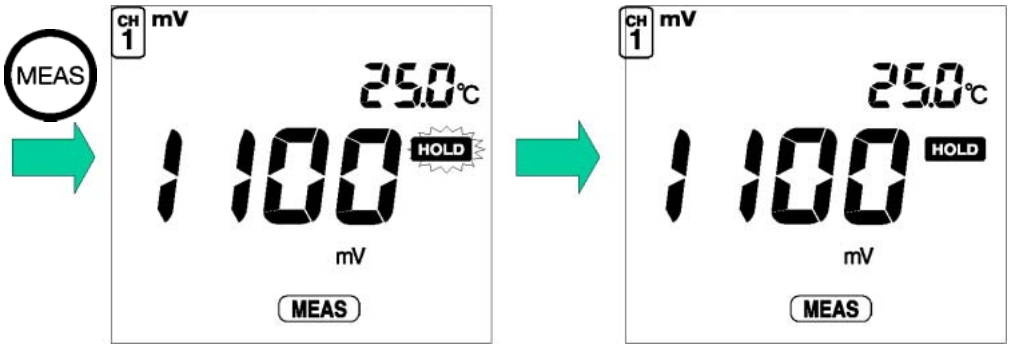
2. Press the MODE key, once.

The ORP Instantaneous Value Measurement screen will appear.



3. Press the MEAS key with the initial screeen displayed.

"HOLD" will blink on the display until the reading stabilizes.
When the value stabilizes, "HOLD" will stop blinking and will be displayed continually. The indicated value will remain displayed, and ORP measurement is completed.



Ref.

Refer to the “ Criteria for judging stability” page 23 for the criteria for judging the stability of the readout.

Note

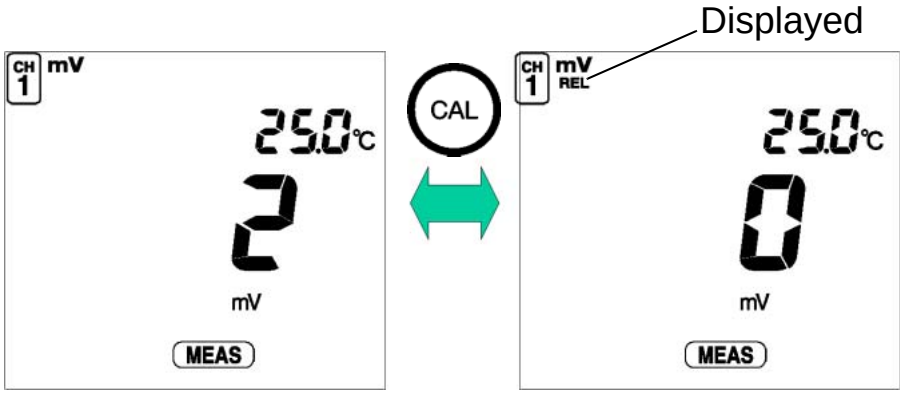
If the data is to be saved to the memory, press the ▲ key. See “3.1 Data memory function” page 65.

● Measuring relative mV

This meter can measure relative potential difference by shifting the measured potential to zero. (A potential without compensation is called absolute mV.)

1. Press the CAL key in the mV Instantaneous Value Measurement mode.

REL is displayed under mV and the current reading value becomes the offset potential used for compensation, and the meter will display the relative mV instantaneous value.



2. Press the CAL key again.

The meter returns to the absolute mV display.

Note

Potential compensation during relative mV measurement does not affect the displayed pH value.

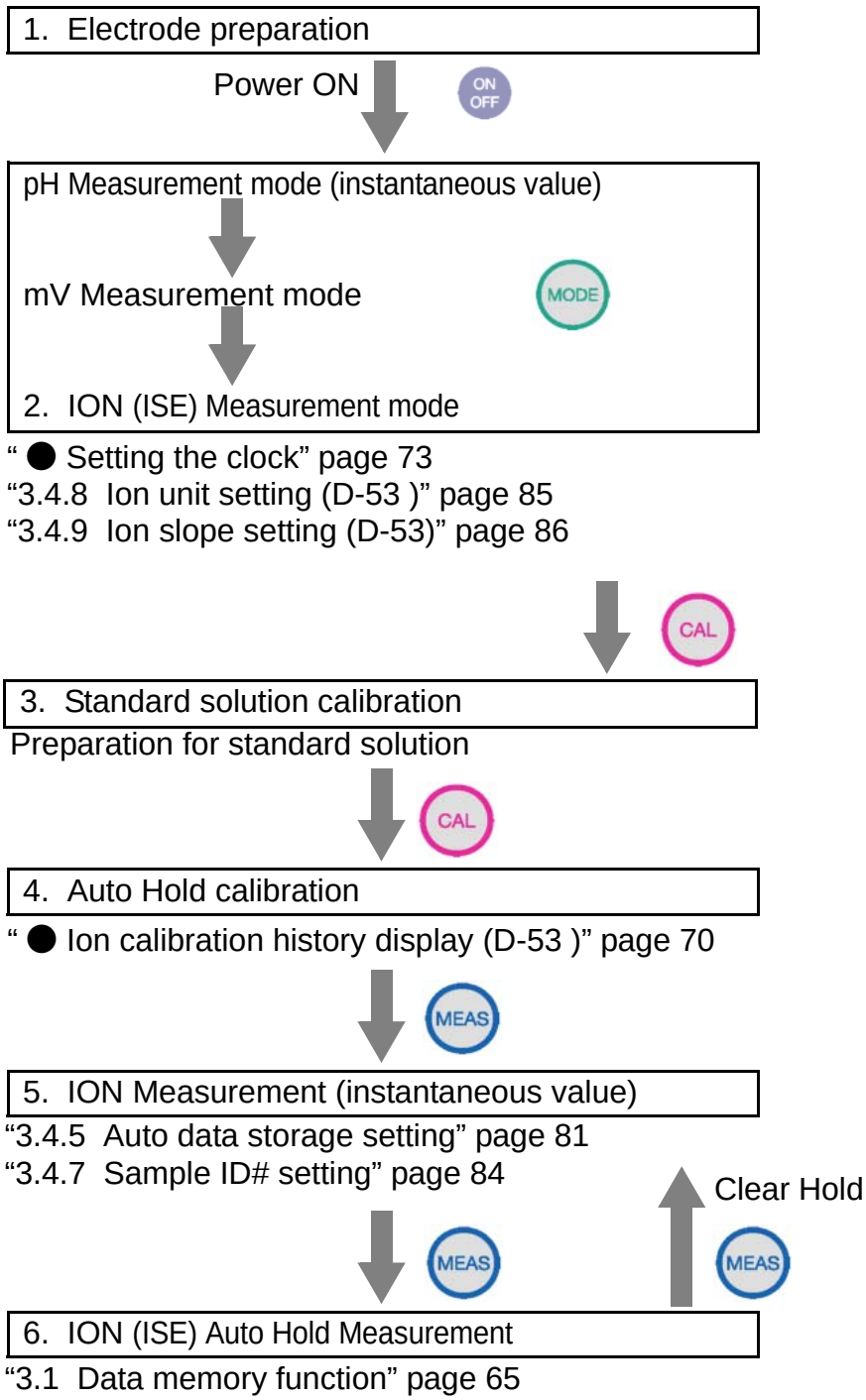
Ref.

For how to check the status of the ORP electrode, refer to “ ● ORP standard solution” page 183.

2.7 Ion measurement (D-53)

The following shows the operational flow for ION measurement.

● Ion measurement operational flow



● Electrode preparation

Refer to the electrode instruction manual and make sure you have the correct electrode.

Chemical solution

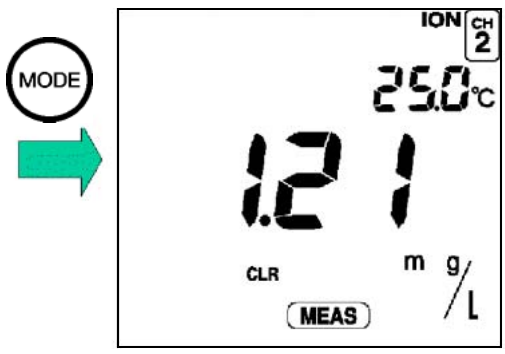
Caution

Toxic substances may be used in some ION electrodes. Use caution when handling them. 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.

● Entering the ION Measurement mode

1. Press the MODE key in the pH Instantaneous Value Measurement mode to enter the ION Measurement mode.

The ION Instantaneous Value Measurement screen will appear.



● Standard solution calibration

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

Note

Selecting the ions to be measured

The ION to be measured is set using the load count (charge quantity).

The ION slope is set at +1 as the default setting.

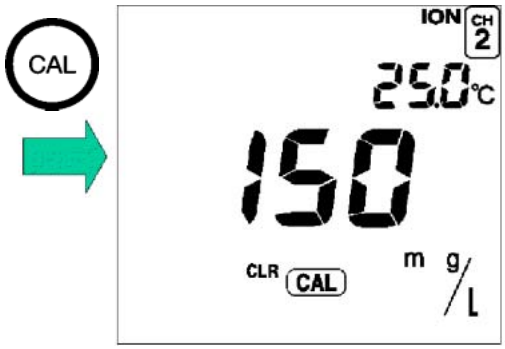
Refer to “3.4.9 Ion slope setting (D-53)” page 86

Units

Units are set at g/L as the default setting. To change the units to mol/L, refer to “3.4.8 Ion unit setting (D-53)” page 85.

Calibration at first point

1. Press the CAL key while in the ION Instantaneous Value Measurement mode, to select the Calibration mode.



2. Wash the electrode well with pure (de-ionized) water, and then wipe with filter paper 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.

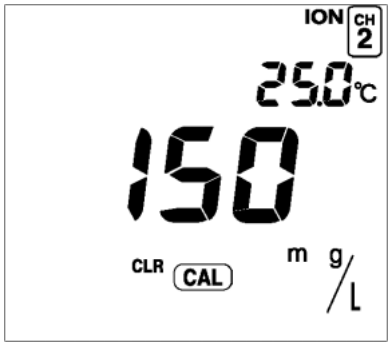
Ref.

Refer to the electrode instruction 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.

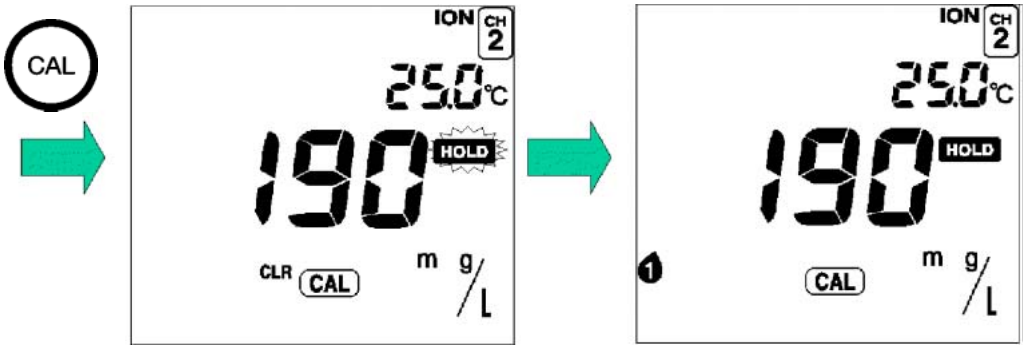
4. Set the standard solution value by using the ▲ or ▼ key to move the value up or down. (The decimal point can be moved by using the ENTER key.)



5. Press the CAL key to start calibration.

The measured value will be displayed, and "HOLD" will blink until the reading stabilizes. When the measured value stabilizes, "HOLD" will stop blinking and the calibrated value will be displayed.

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



Ref.

While “HOLD” is blinking

To cancel calibration: Clear the hold by pressing the CAL key, again.

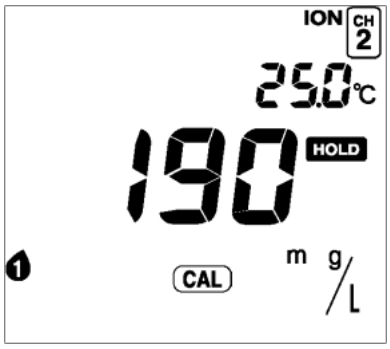
To fix the calibration value: Fix the value using the ENTER key.

Calibrations using two or three points

To conduct calibration using two or three points, clear the “HOLD” display using the CAL key, prepare a standard solution, and repeat steps 3 through 5.

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.



1. When all calibration operations have been completed, press the MEAS key to return to the ION Measurement screen.

Note

Do not return any used standard solution to the original container. Discard it.

Note

While calibration is being performed in the calibration mode, redoing calibration for a standard solution updates the calibrated values for the standard solution only.

If calibration is redone after returning to the measurement mode, however, the calibration will be performed in the initial state of the meter, resulting in the clearing of all the previous calibration data.

Ref.

To clear calibrated values, refer to “ ● Clearing calibrated values” page 32.

● Ion measurement

1. Wash the tip of electrode well with pure (de-ionized) water, and then wipe with filter paper or tissue paper.

Note

Do not touch or scratch the responsive membrane on the ION electrode.

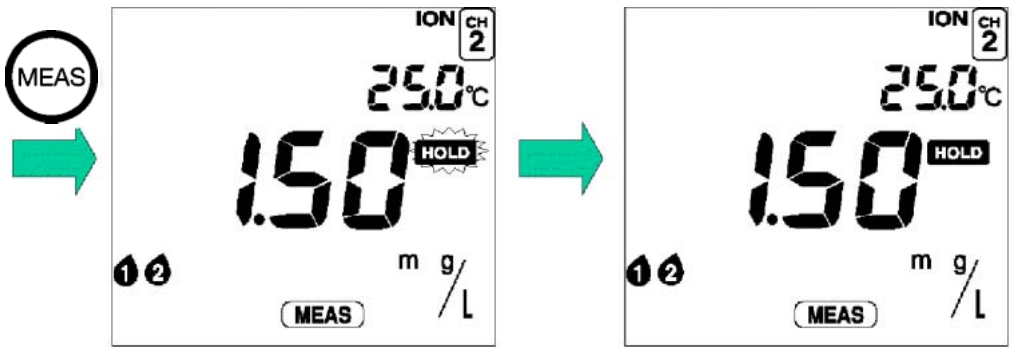
2. Immerse the electrode in the sample to a sufficient depth (at least 3 cm).

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 with the initial screeen displayed.

"HOLD" will blink on the display until the reading stabilizes.
When the value stabilizes, "HOLD" will stop blinking and will be displayed continually. The indicated value will remain displayed.



Ref.

Refer to the “ Criteria for judging stability” page 23 for the criteria for judging the stability of a readout.

Note

When the meter is in the Instantaneous Value Measurement mode or the measurement value is on HOLD in the Auto Hold Measurement mode, you can store the measurement data by pressing the ▲ key. See “3.1 Data memory function” page 65.

Note

The input voltage range at which measurement is possible using the meter is ± 800 mV. If measurements do not work out satisfactorily, check the voltage during mV measurement. Also, some samples are not conductive to good measurement.

● Measuring technique for increased accuracy

ION electrodes can be used to take a simple measurement of ION concentration. For more accurate measurement, however, certain techniques are required. Refer to the electrode instruction manual or the procedures explained below for more information.

① Adding ionic strength conditioner to sample

One source of measurement error is the influence of ionic strength. Adjusting the ionic strength by adding chemicals to the sample and standard solution for the corresponding ION electrodes will result in accurate measurements.

② pH effect of sample

The possible pH measurement range for each electrode is determined by the type and construction 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, modify the solution using chemicals containing ions other than the ones being measured or ones that may interfere with the measurement.

Additives and pH range

ION electrode	Additives (per liter)	pH range
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 186) and is affected 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 inconsistent measurements. Calibration with standard solution and measurement of the sample should be performed using a temperature bath and while stirring 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, the solution may contain interfering ions.

Effects of interfering ions

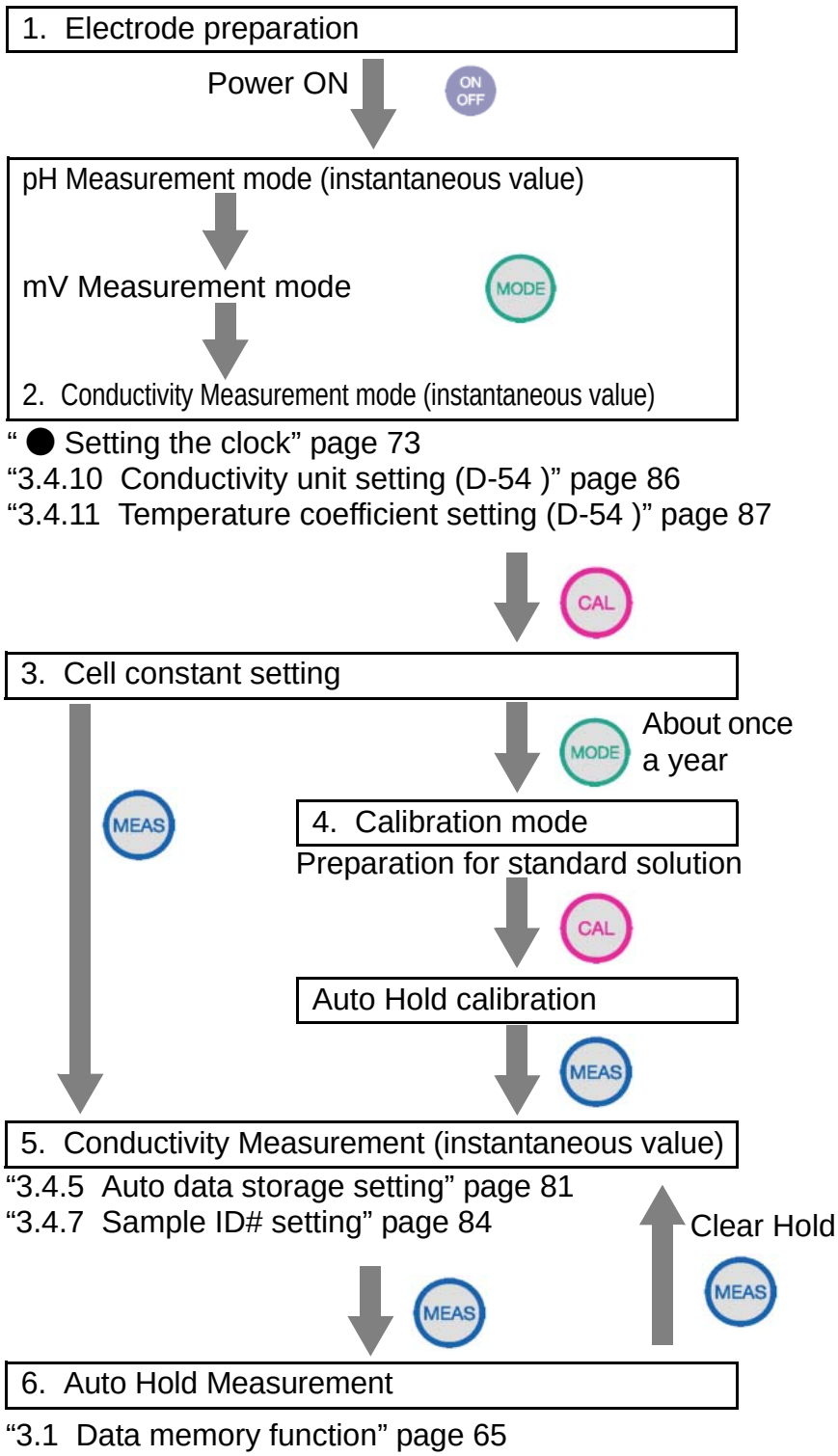
ION electrode	Compatible tolerance limits
Potassium K^+	Li^+, Ma^+, Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+} = 1,000; NH_4^+ = 70; Cs^+ = 3; Rb^+ = 0.4 (at 10^{-4} mol/L K^+)
Calcium Ca^{2+}	Na^+, K^+, Ba^{2+}, NH_4^+, Mg^{2+}= 1,000; Mn^{2+}= 500; Co^{2+}= 350; Ni^{4+}, Cu^{2+}= 70; Sr^{2+}= 50; Fe^{2+}, 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-} = 1000; SCN^-= 0.3; MnO_4^-= 0.1; Br^-= 0.03; $S_2O_3^{2-}$, S^{2-}, I^-, Ag^+, Hg^{2+}= not possible (at 10^{-3} mol/L Cl^-)
Fluoride F^-	OH^- = 10 (within measurable range)
Nitrate NO_3^-	SO_4^{2-} = 1000; 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.

2.8 Conductivity measurement (D-54)

The following shows the operational flow for conductivity measurement.

● Measuring conductivity: basic operational flow



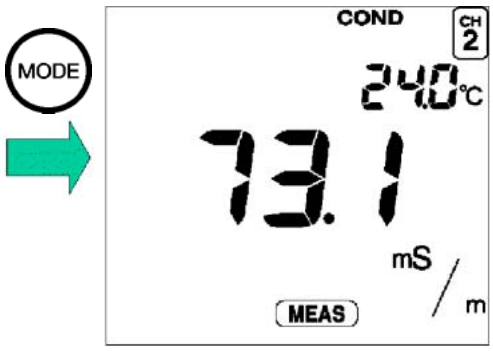
● Electrode preparation

Refer to the electrode instruction manual and make sure you have the correct electrode.

● Entering the Conductivity Measurement mode

1. Remove the electrode protective cap from the electrode.
2. Immerse the electrode in pure (de-ionized) water.
3. Select the Conductivity Measurement mode when the pH Instantaneous Value Measurement screen is displayed by pressing the MODE key.

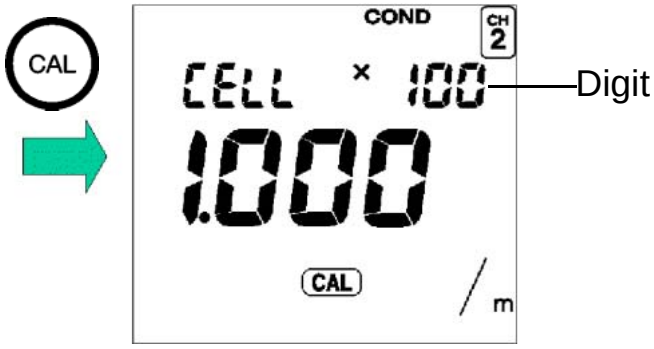
   The Conductivity Instantaneous Value Measurement screen will appear.



● CELL SET mode (Setting cell constant)

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

1. To enter the CELL SET mode, press the CAL key while in the Measurement mode.



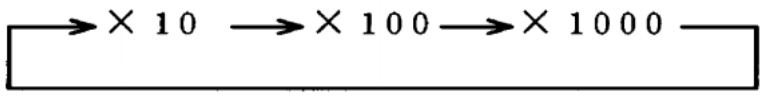
2. Change the digit number using the ENTER key.

3. Press the ▲ and ▼ keys to set the cell constant written on the electrode label.

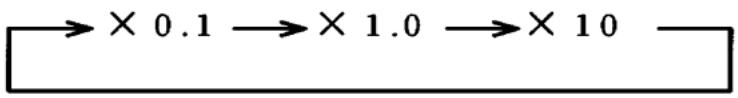
Setting range: 0.700 – 1.300

To change the coefficient, use the following procedure.

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



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



Note

Temperature coefficient

The default value of the temperature coefficient is set at 2.00%/ºC.

To change this setting, refer to “3.4.11 Temperature coefficient setting (D-54)” page 87.

Unit Setting

The default value of unit is S/m (SI unit system).

To change this setting to the former unit system S/cm, refer to “3.4.10 Conductivity unit setting (D-54)” page 86.

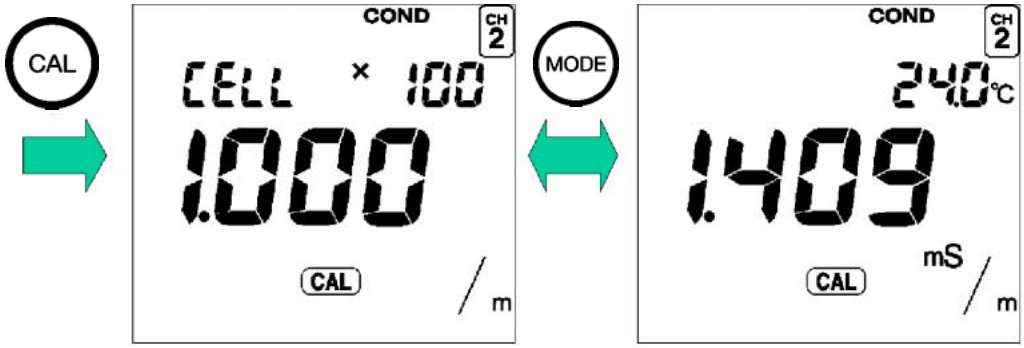
● Calibrating the cell constant

The cell constant of the electrode changes as the electrode is used. Calibrate the cell constant once a year or so.
Calibrating the cell constant will update it to match the condition of the current electrode.

Note

The cell constant is calibrated with a standard solution of potassium chloride.
To prepare a standard solution of potassium chloride, refer to “ ● Preparing potassium chloride standard solution” page 190.

1. Immerse the electrode in the standard solution of potassium chloride.
2. Enter the Calibration mode by pressing the MODE key in the CELL SET mode.



3. Enter the value of the standard solution used for calibration in the Calibration mode using the ▲ and ▼ keys.

Ref.

“ ● Conductivity and temperature coefficients for various solutions” page 195

Note

When the temperature conversion has been set to ON when setting the temperature coefficient, calibration is performed with the converted temperature.

4. Start the calibration by pressing the CAL key.

   HOLD is displayed and the calibration is completed.

   To redo the calibration, press the CAL key once more.

5. Press the MEAS key to enter the Measurement mode.

Note

If any calibration error occurs, take it as a indication that the electrode has gone bad. Replace the old electrode with a new one.

● Measuring conductivity

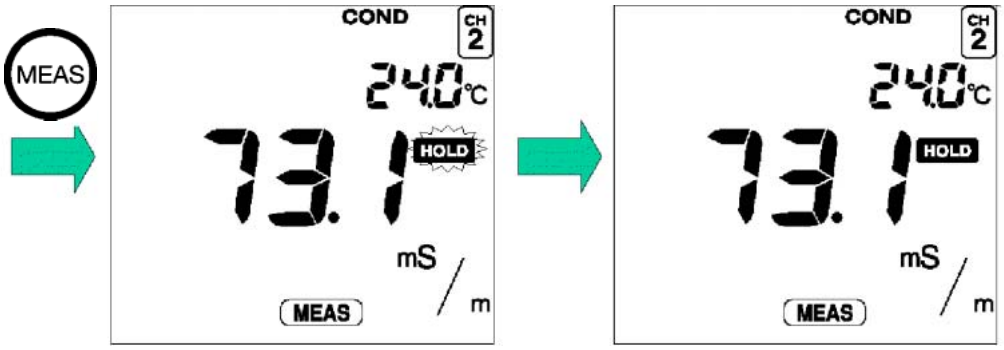
1. Immerse the electrode in the sample.

Note

Conductivity is greatly affected by temperature.
To measure with increased accuracy, use a temperature bath to keep the solutions at a constant temperature.

2. Press the MEAS key with the initial screeen displayed.

The measured value will be displayed, and "HOLD" will blink until the reading stabilizes. When the measured value stabilizes, "HOLD" will stop blinking and the measured value will remain displayed, and measurement will be completed.



Ref.

Refer to the " Criteria for judging stability" page 23 for the criteria for judging the stability of a readout.

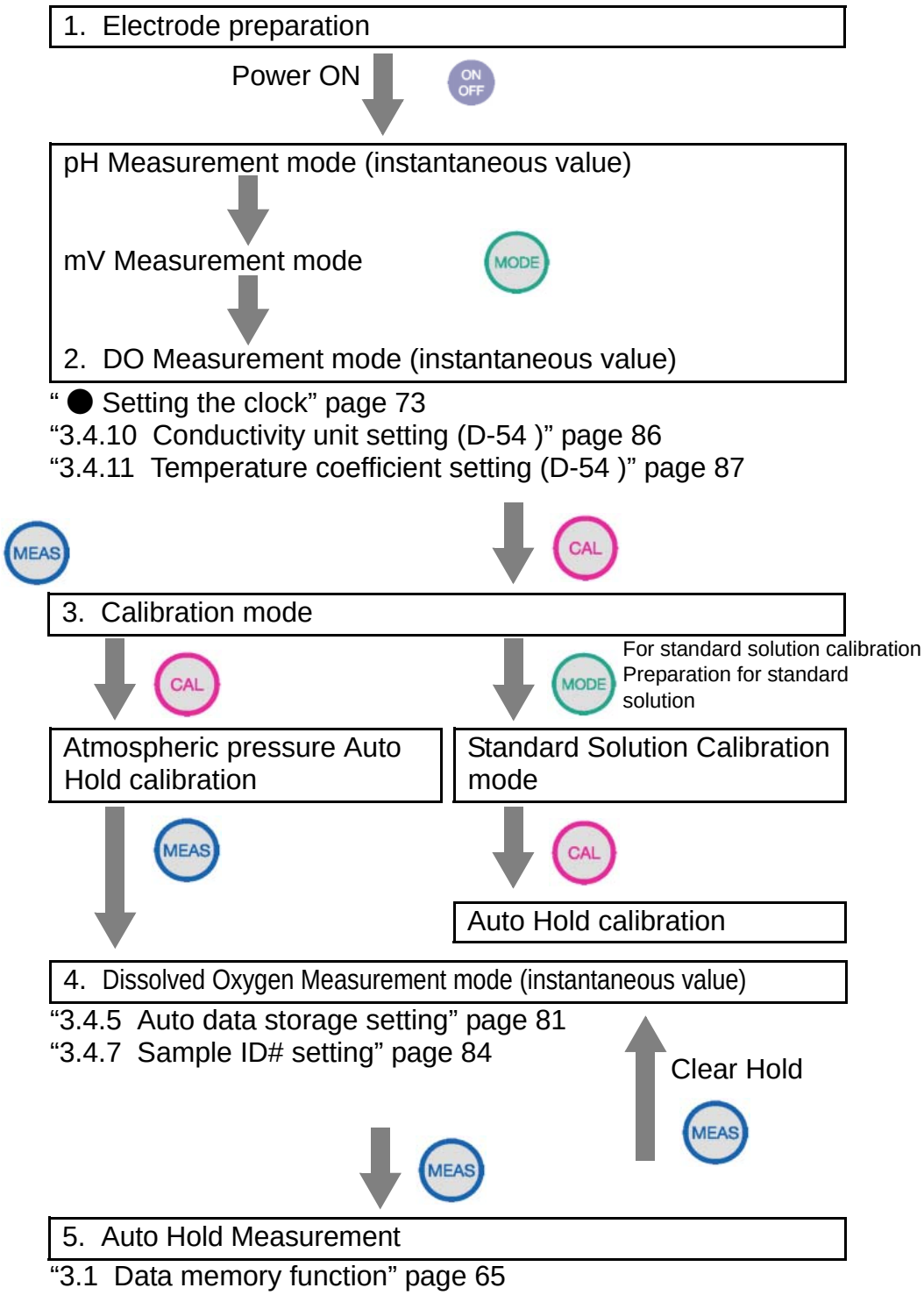
Note

When the meter is in the Instantaneous Value Measurement mode or the measurement value is on HOLD in the Auto Hold Measurement mode, you can store the measurement data by pressing the ▲ key. "3.1 Data memory function" page 65.

2.9 Dissolved oxygen (DO) measurement (D-55)

The following shows the operational flow for dissolved oxygen (DO) measurement.

● Measuring dissolved oxygen: basic operational flow



● Electrode preparation

Refer to the electrode instruction manual and make sure you have the correct electrode.

Chemical solution

Caution

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.

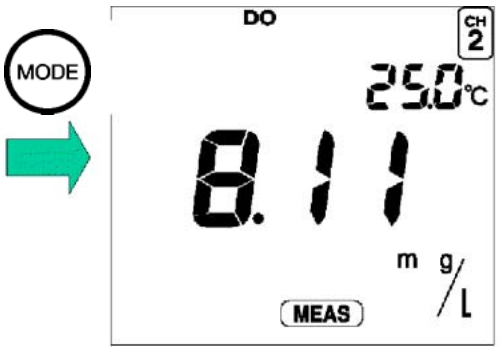
Note

When storing the electrode with the tip removed, the tip packaging and short socket are required, so do not throw them away when unpacking the electrode.

● Entering DO Measurement mode

1. Press the MODE key while the measurement screen is displayed.

The DO Instantaneous Value Measurement screen will appear.



● Air calibration

To achieve correct measurements, the pH meter must be calibrated prior to taking measurements with it.
The D-50 Series 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 “ ● Calibrating with standard solution” page 61.

Note

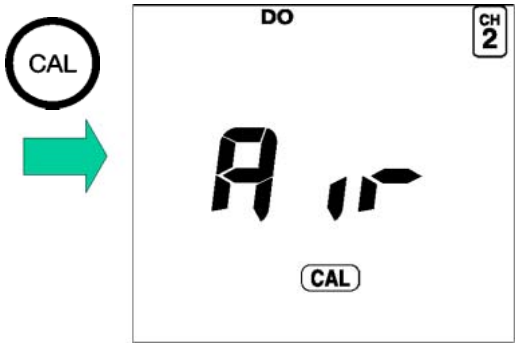
For greater measurement precision, it is necessary to correct for air pressure.

Air-pressure correction

Air pressure is set to 1013 hPa, as the default. To change this setting, refer to “3.4.13 DO atmospheric pressure compensation setting (D-55)” page 89.

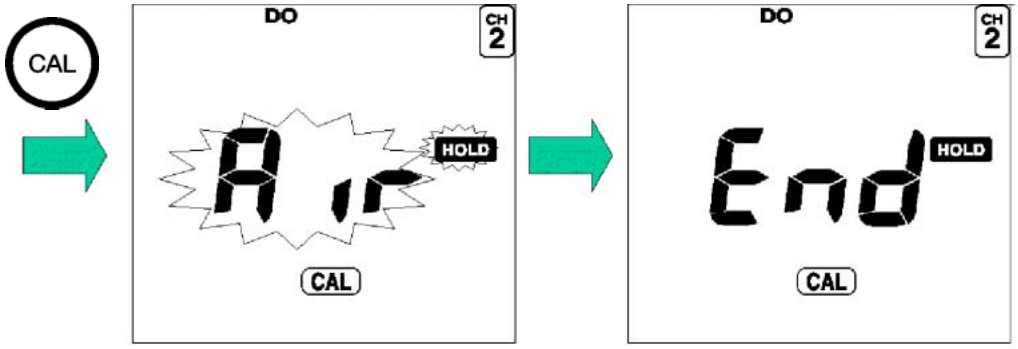
1. Remove any liquids from the membrane at the tip of the electrode by either drying it or wiping away the liquid with soft tissue paper, making sure not to scratch the membrane.

2. Press the CAL key while in the DO Instantaneous Value Measurement mode, to select the Calibration mode.



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

The measured value will be displayed, and “HOLD” will blink until the reading stabilizes. When the measured value stabilizes, “HOLD” will stop blinking and the “End” will be displayed.



Note

The mode cannot be changed while measurement is taking place in Auto Hold (while “HOLD” is blinking on the display).

Note

While “HOLD” is blinking

To cancel calibration: Clear the hold by pressing the CAL key, again.

To fix the calibration value: Fix the value using the ENTER key.

4. Press the MEAS key to return to the DO MEASUREMENT screen.

Note

Calibrate using purified air.
(Errors may occur and considerable time may be required before the reading stabilizes, if calibration is conducted where there is severe fluctuation in temperature, where there is wind or rain, or close to a heater.)
Do not hold the sensor holder or electrode body with your hand, during or soon before/after calibration. The effects of body temperature will cause the reading to take more time to stabilize.
To set the calibration value to the initial (default) settings, press the CAL key while holding down the SET key in the CALIBRATION mode.

Note

When calibration is being performed in the calibration mode, redoing calibration for a standard solution updates the calibrated values for the standard solution only.
If calibration is redone after returning to the measurement mode, however, the calibration will be performed in the initial state of the pH meter, resulting in clearing all the previous calibration data.

● Measuring DO

Salinity concentration correction is set at 0.0 ppt, as the default. To change this setting, refer to “3.4.12 DO salinity compensation setting (D-55)” page 88.

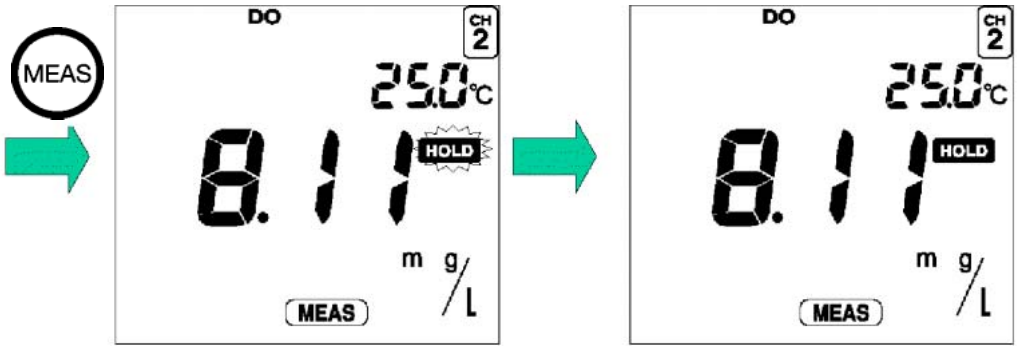
1. Immerse the electrode in the sample.

Note

Mix the sample at a constant speed (1000 – 1500 rpm) during measurement, using a magnetic stirrer. When the sample temperature rises due to the stirrer, use a temperature bath.
With field-use electrodes, measure at a constant flow speed (about 30 cm in 2 seconds).

2. Press the MEAS key while the Instantaneous Measurement screen is displayed.

The measured value will be displayed, and
“ HOLD ”will blink until the reading stabilizes. When the measured value stabilizes, “HOLD” will stop blinking and the calibrated value will be displayed.



Ref.

Refer to “ Criteria for judging stability” page 23 for the criteria for judging the stability of the readout.

To store the data, press the ▲ DATA IN key.
The memory number will appear and the display will automatically return to the Instantaneous Value Measurement screen.

● Calibrating with standard solution

Normally, air calibration is used to calibrate the meter when measuring DO. When a higher level of measuring precision is required, however, a two-point calibration using standard solution can be employed.
Calibration order for zero standard solution and span calibration solution is arbitrary. The meter automatically determines the standard solution.

Preparing zero standard solution

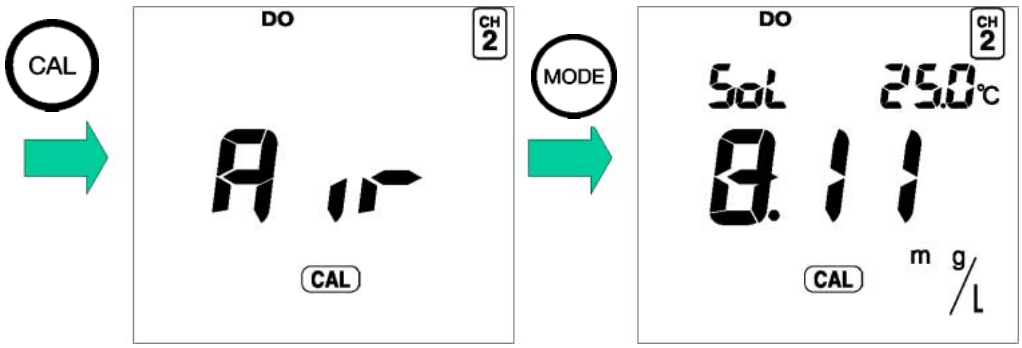
Put 50 g sodium sulfate into 1000 ml of de-ionized water and mix it until it dissolves completely.

Preparing span standard solution

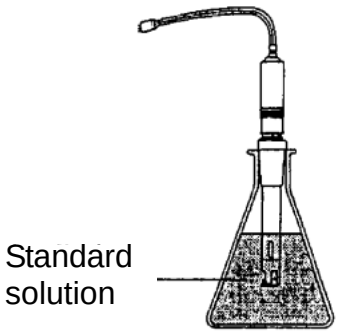
Put de-ionized water into a container, and create an oxygen-saturated state by bubbling the water with an air pump.

Calibration procedure

1. Press the CAL key with the initial screeen displayed, to select the Calibration mode.
2. Press the MODE key to display “SoL”.



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



Note

Mix the sample at a constant speed (1000 – 1500 rpm) during measurement, using magnetic stirrer. When the sample temperature rises due to the stirrer, use a temperature bath.
With field-use electrodes, measure at a constant flow speed (about 30 cm in 2 seconds).

4. Press the CAL key.

"HOLD" will blink until the reading stabilizes.

Note

While "HOLD" is blinking
To cancel calibration: Clear the hold by pressing the CAL key, again.
To fix the calibration value: Fix the value using the ENTER key.

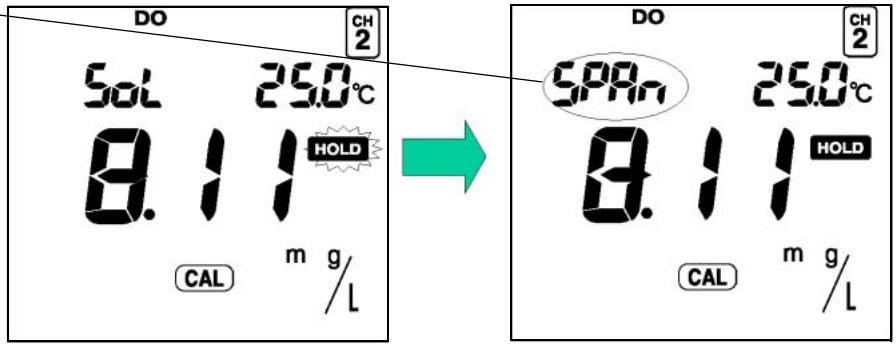
After the readout value stabilizes, the HOLD is displayed to indicate that the calibration is completed.

When the span standard solution is used:

SPAn

0

When the zero standard solution is used:



Note

Zero standard solution and span standard solution are detected automatically.

5. To conduct the second calibration in the two-point calibration, repeat steps 3 and 4.

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

Note

When calibration is being performed in the calibration mode, redoing calibration for a standard solution updates the calibrated values for the standard solution only.
If calibration is redone after returning to the measurement mode, however, the calibration will be performed in the initial state of the pH meter, resulting in clearing all the previous calibration data.

3 Functions

This chapter describes the various functions of the meter.

3.1 Data memory function

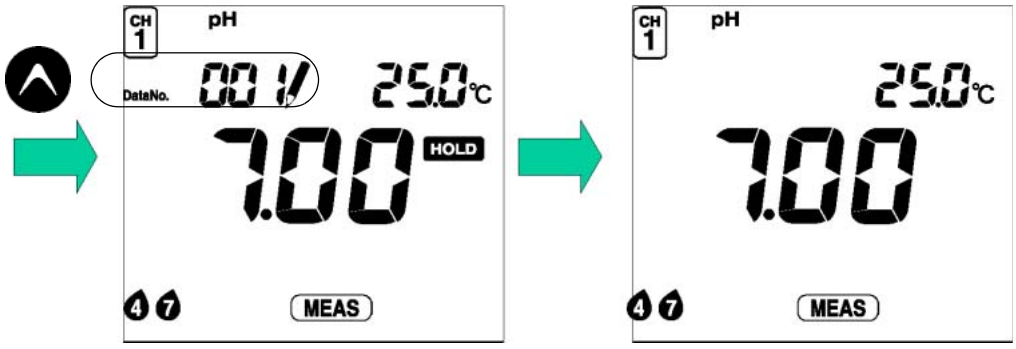
The measured data can be stored automatically or manually.

● Auto data memory

You can automatically store the data at certain intervals using this function. For the setting procedure, refer to “3.4.5 Auto data storage setting” page 81

● Data memory

In all measurement modes, you can store data when the instantaneous value is measured or the measured value is held (HOLD status) during the Auto HOLD measurement by pressing the ▲ key.
The measurement reading is stored along with the temperature, data, HOLD value/instantaneous value, ATC/MTC, calibration point (only for pH and ION measurement), and sample ID at the time the measurement was taken.
After the data number is displayed, the screen returns to the initial screeen. Up to 300 items of data can be stored in the memory. If the number of data items exceeds the maximum limit, ERR 10 is displayed and no more data can be stored.



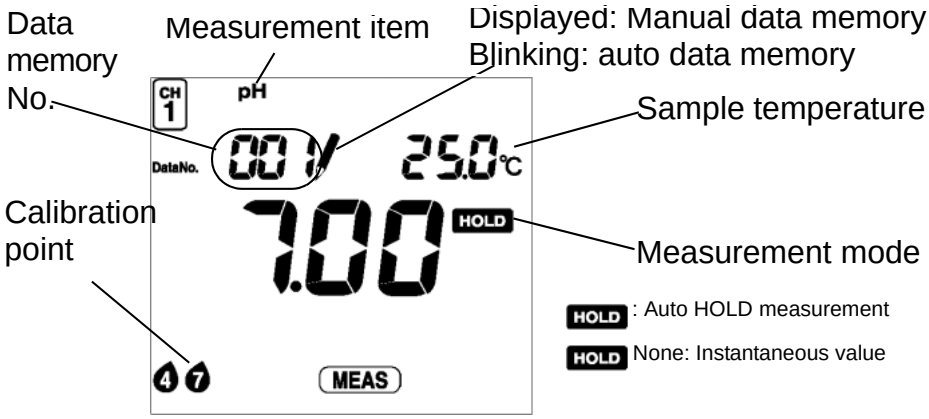
Note

Data cannot be stored unless the value has stabilized or in the CAL mode.

When the data is stored, an ID number for that specific measurement can be registered (see “3.4.7 Sample ID# setting” page 84).

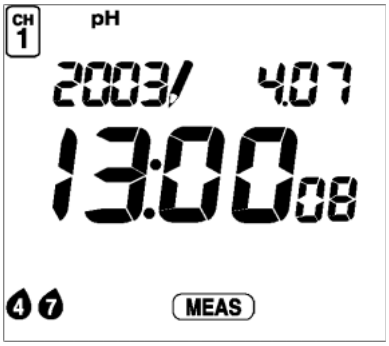
● Calling up memory data

1. Press the ▼ key in the Measurement mode to load measurement data.



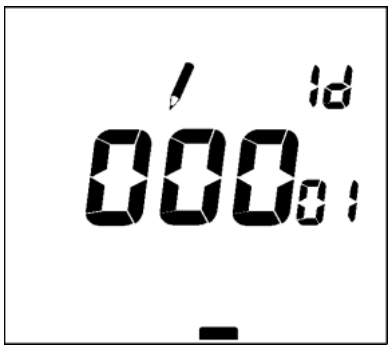
Select and load the desired memory data item using the ▲ and ▼ keys. The displayed number returns to 0 after 300, the maximum number.

2. Press the MODE key to display the data and time.



Select the desired data item using the ▲ and ▼ keys.

3. Press the MODE key to display the ID.



Select the desired data item using the ▲ and ▼ keys.

Note

If an error occurs while a data number is being displayed, the error number will NOT be displayed. When using a printer (sold separately), press the ENTER key while in the DATA OUT mode to print the data.

3.2 pH calibration history display

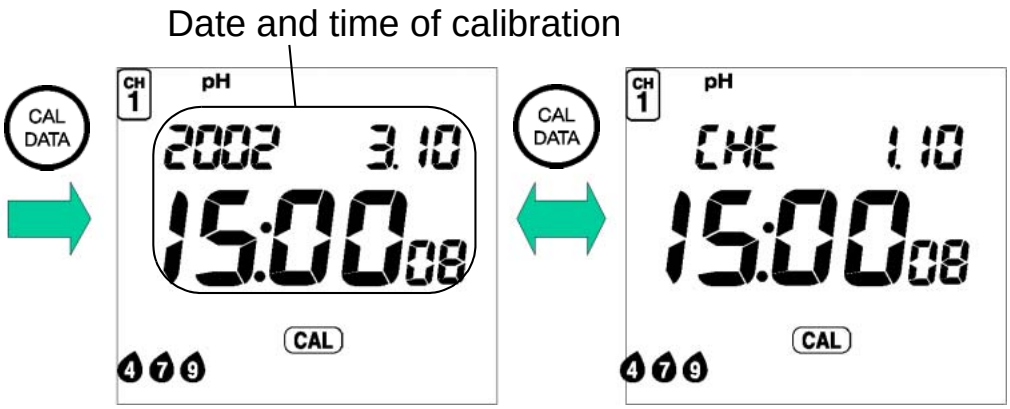
The latest calibration and repeatability check information can be checked.

Ref.

Refer to “ pH repeatability check ”on page 32.

● pH calibration history

1. Press the CAL DATA key in the pH Measurement mode.



Latest calibration date Latest check date

2. Pressing the CAL DATA key toggles between the latest calibration date and the latest check date.

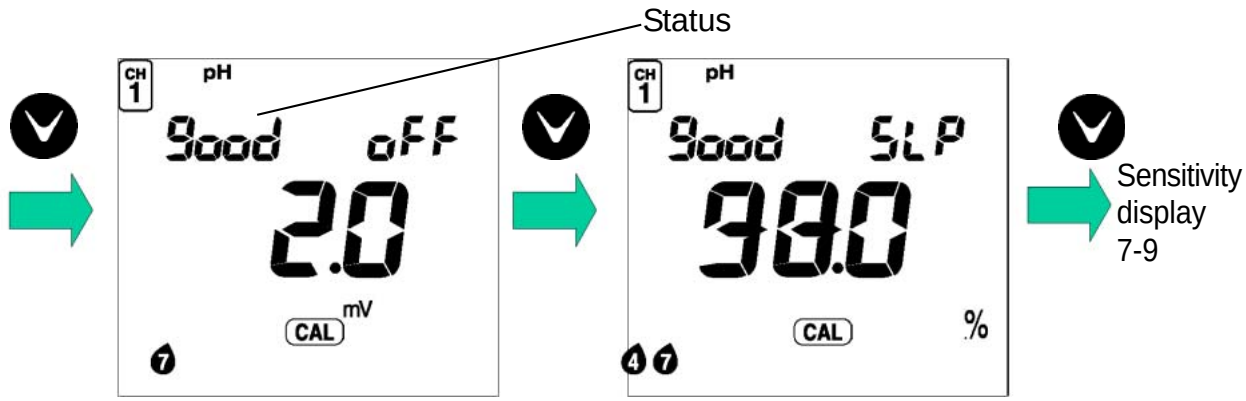
Note

The latest check date is not displayed if no repeatability check has been performed.

Latest calibration data

1. Press the ▼ key with latest calibration date displayed.

   The asymmetrical potential will be displayed.



Asymmetrical potential display Sensitivity display 4-7

Example of 3-point calibration

2. Press the ▼ key to show sensitivity display.

Status display

Good	When the meter is in a good condition
CHE	When the electrode needs washing
bAd	When the electrode is old and is going bad

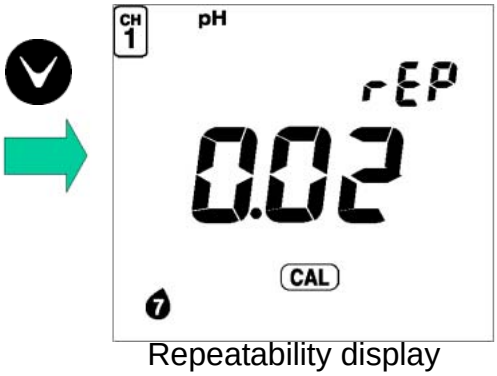
Ref.

Refer to “ Asymmetrical potential display ”on page 175.

pH latest check data

1. Press the ▼ key with latest check date displayed.

   The repeatability display will appear.

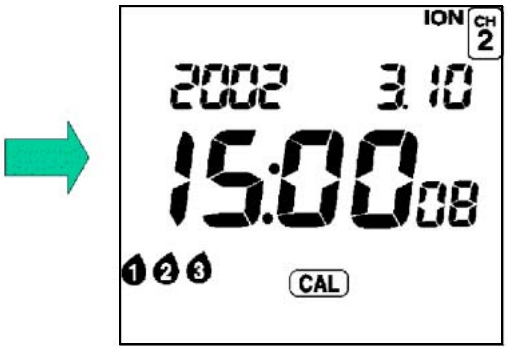


Repeatability display

● Ion calibration history display (D-53)

1. Press the CAL DATA key in the ION Measurement mode.

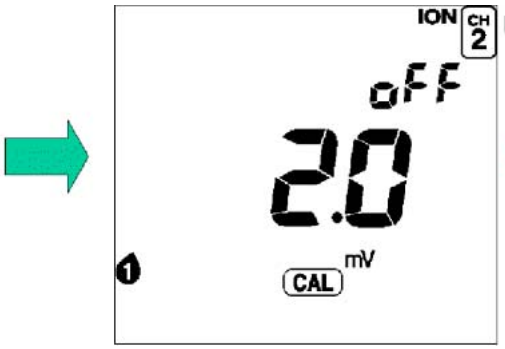
The latest ION measurement calibration date will be displayed.



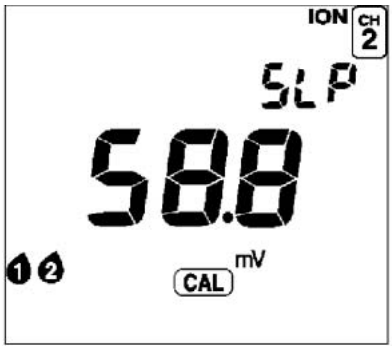
Latest calibration date

2. Using the ▼ key, toggle between the latest calibration date display and the ION offset potential display, and sensitivity display(s).

latest calibration date → ION offset potential display → sensitivity display 1 → sensitivity display 2 (in the case of 3-point calibration)



Ion offset potential display



Sensitivity display 1

Sensitivity display 2

Note

The sensitivity is shown as follows in a 3-point calibration. Note that the symbol meanings are different than those notifying the completion of calibration.

Sensitivity for 1 2:

Ion slope of +1 and +2: sensitivity for high concentration side
Ion slope of -1 and -2: sensitivity for low concentration side

Sensitivity for 2 3:

Ion slope of +1 and +2: sensitivity for low concentration side
Ion slope of -1 and -2: sensitivity for high concentration side

Press the ▲ key once more to return to the latest calibration date display. You can also return to the latest calibration date display by pressing the ▼ key in the reverse order.

Criteria for ION offset potential and sensitivity

Ion offset potential is the referential potential used to determine whether the calibration was conducted successfully or the usable life of the electrode has been exceeded.
The following table shows the normal range of the ION offset potential and sensitivity. If any such values are out of the range shown below, you need to clean the electrode and perform calibration again. If you obtain a value out of the range even after re-calibration, the electrode needs to be replaced.

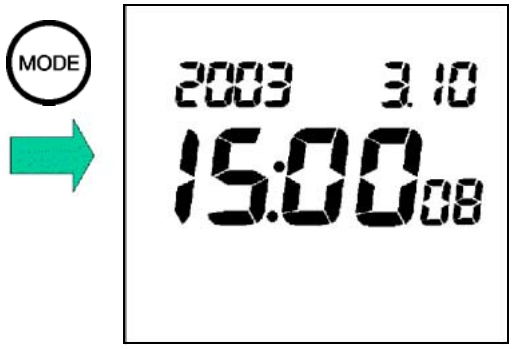
Electrode	Ion offset potential		Sensitivity
	1 mol/L	1 g/L	
Cl^-	27 ± 50 mV	116 ± 50 mV	-57.5 ± 5 mV
F^-	-180 ± 50 mV	-103 ± 50 mV	-60 ± 5 mV
NO_3^-	-55 ± 70 mV	43 ± 70 mV	-54.5 ± 6 mV
K^+	115 ± 60 mV	23 ± 60 mV	57.5 ± 5 mV
Ca^{2+}	29 ± 40 mV	-17 ± 40 mV	28.5 ± 3 mV

3.3 Displaying and setting the clock

The clock needs to be when the meter is used for the first time or after replacing the batteries.

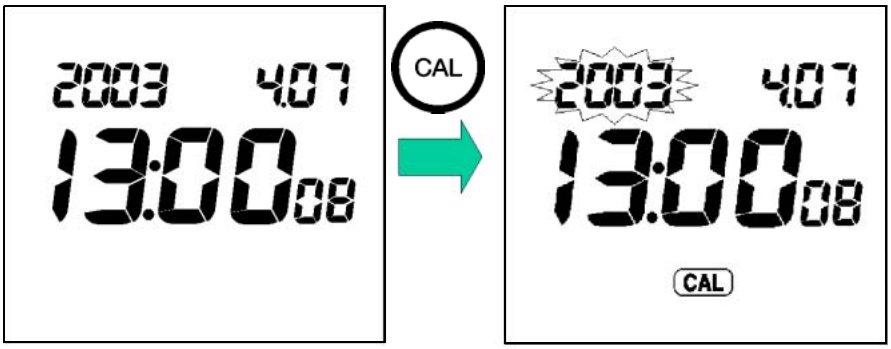
● Displaying the clock

Press the MODE key in the Measurement mode to display the clock.



● Setting the clock

1. Press the CAL key when the Clock Display screen is displayed to show the Setting screen for the clock.



2. Switch the display to year, month, day, hour, minute, and second using the ENTER key. You can set a numerical value using the ▲ and ▼ keys.

Note

Set the seconds to “00” sec. Pressing the ENTER key sets it to “00”.

3. After setting the clock, press the ENTER key to update the setting.

Pressing the CAL key at this time returns you to the Clock Display screen without changing the current setting.

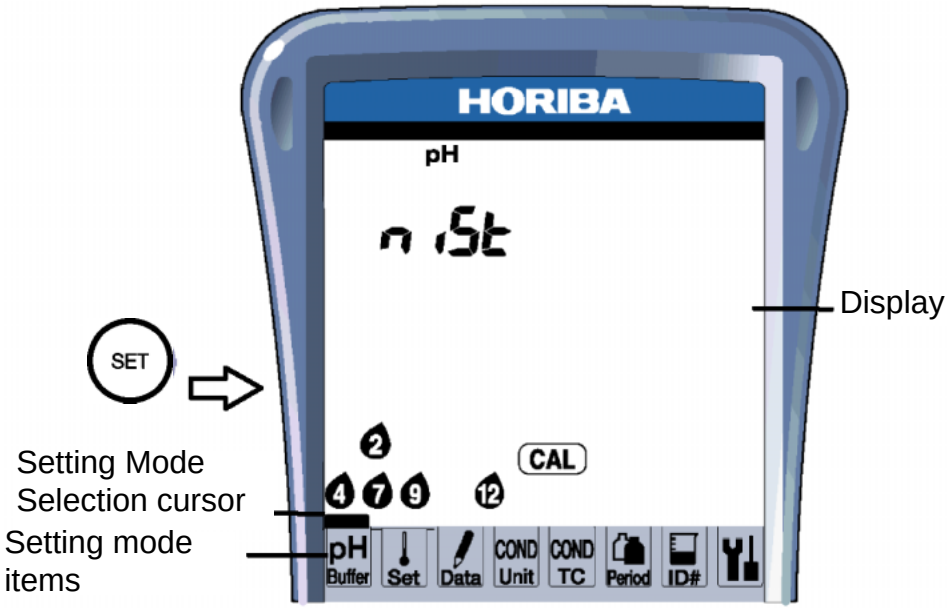
4. Press the MODE key to return to the Measurement mode.

3.4 Setting modes

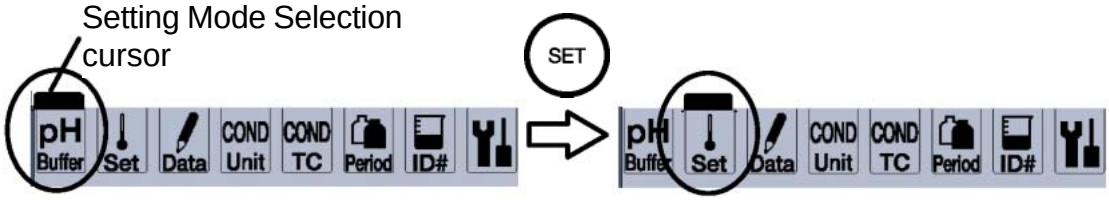
Selecting the Setting mode expands the uses of the meter.

3.4.1 Entering the Setting mode

1. Press the SET key in the Measurement mode. The Setting Mode Selection cursor appears at the left-bottom of the screen to indicate that the Setting mode is active.



2. Pressing the SET key moves the Setting Mode Selection cursor one by one to allow you to select the Setting mode of your choice.



Note

Selectable Setting modes are different depending on the meter model.

3. Press the MEAS key to return to the Measurement mode from the Setting mode.

3.4.2 Display and description

Display	Name	Description	Model				Page No.
			D-52	D-53	D-54	D-55	
	pH Buffer	Sets the standard solution for pH calibration.	○	○	○	○	page 77
	Temperature Compensation	Selects the Auto/Manual mode for temperature compensation.	○	○	○	○	page 80
	Data Memory	Selects the Auto/Manual mode for data memory function.	○	○	○	○	page 81
	Calibration Frequency Setting	Sets the number of days between pH electrode calibrations.	○	○	○	○	page 83
	ID #	Sets a number for a measured sample and stores its data.	○	○	○	○	page 84
	Maintenance	Sets various maintenance-related settings.	○	○	○	○	page 89

Display	Name	Description	Model				Page No.
			D-52	D-53	D-54	D-55	
ION Unit	ION Unit	Sets the unit for ION measurement.	—	○	—	—	page 85
ION Slope	ION Slope	Selects ION slope (number of electric charges).	—	○	—	—	page 86
COND Unit	COND Unit	Sets the unit for conductivity measurement.	—	—	○	—	page 86
COND TC	COND TC	Sets the temperature coefficient for the sample to be measured in the Conductivity Measurement mode.	—	—	○	—	page 87
DO Salt	DO Salt	Sets the salinity compensation value for DO measurement.	—	—	—	○	page 88
DO hpa	DO hpa	Sets the atmospheric pressure compensation for DO measurement.	—	—	—	○	page 89

3.4.3 pH standard solution setting

The meter allows you to select the standard solution specifications used for calibration from among the NIST standard, US standard (USA), and use-defined standard (CUST).

NIST standard	When using the standard solution required by NIST standards
	Bottle mark ❷ ❹ ❼ ❾ ⓬
US standard (USA)	When using the standard solution required by US standards
	Bottle mark ❷ ❹ ❼ ❿ ⓬
Custom (CUST)	When using a user-defined standard solution
	Bottle mark ❶ ❷ ❸

Ref.

Refer to “Types of pH standard solution ”on “● Types of pH standard solutions” page 176.

Note

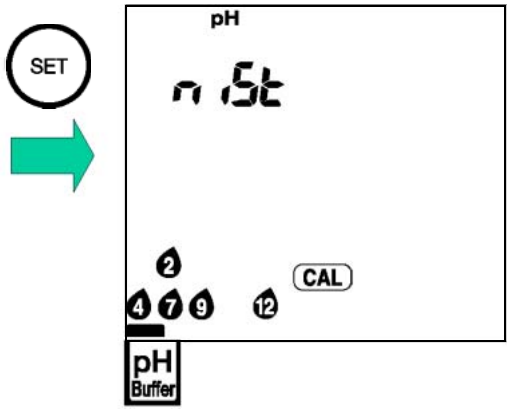
The calibrated value for pH 7 standard solution is different between the NIST standards and US standards.

NIST standard: pH 6.86 (at 25°C)

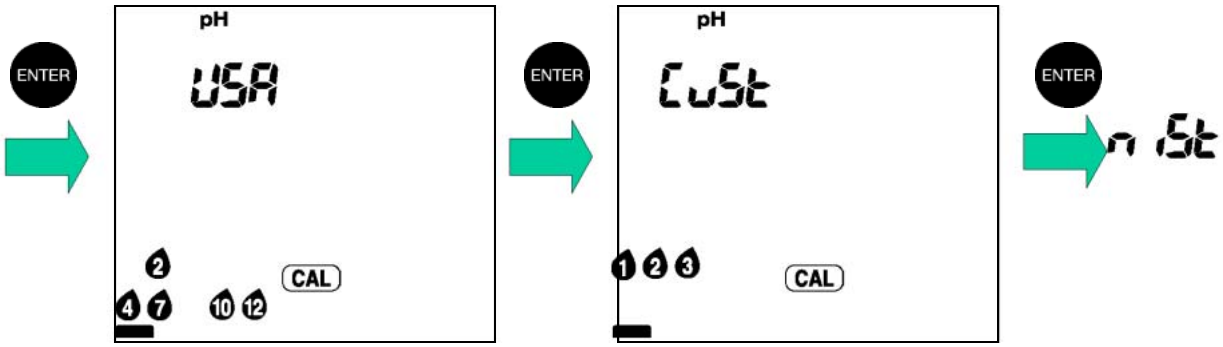
US standard: pH 7.00 (at 25°C)

Changing the standard solution setting

1. Press the SET key in the Measurement mode and select the pH Buffer Setting mode.



2. Press the ENTER key to toggle between NIST standard, US standard (USA) and a user-defined standard (CUST).



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

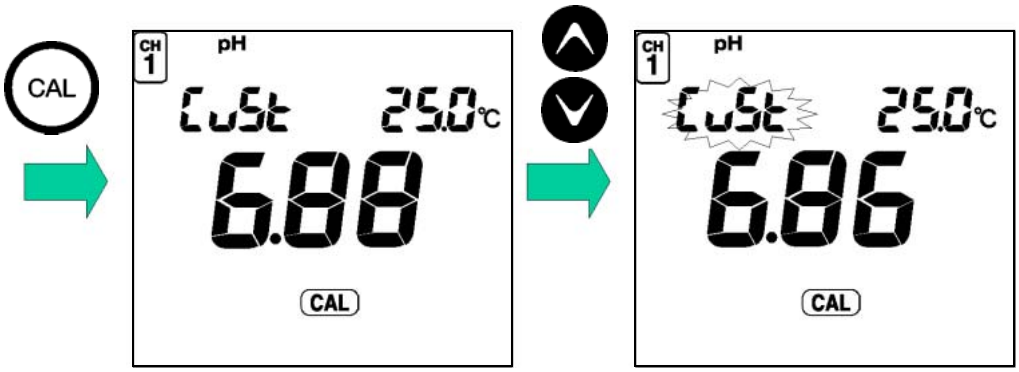
Calibration using a user-defined standard (CUST)

1. Press the CAL key in the pH Measurement mode to select the Calibration mode.

“>CAL<“ will be displayed.

2. Set the pH value of the standard solution used for calibration using the ▲ and ▼ keys.

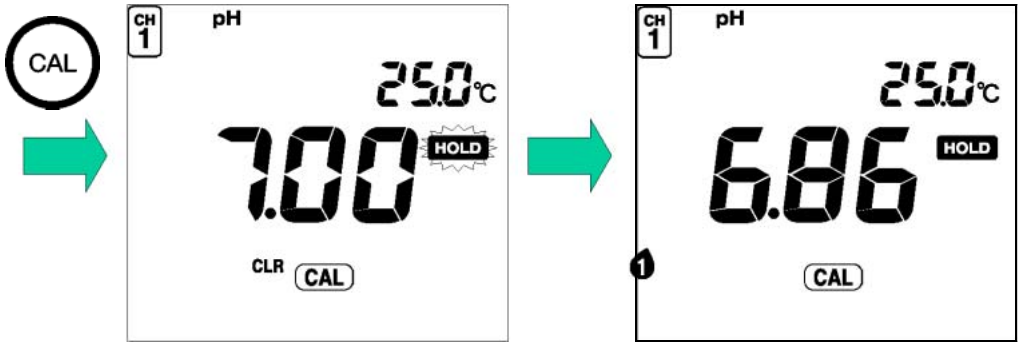
While the setting is being made, “CuSt” will blink.



3. Press the CAL key to start the calibration.

The measured value will be displayed, and “ HOLD ”will blink until the reading stabilizes.

When the measured value stabilizes, “HOLD” will stop blinking and the calibrated value will be displayed.

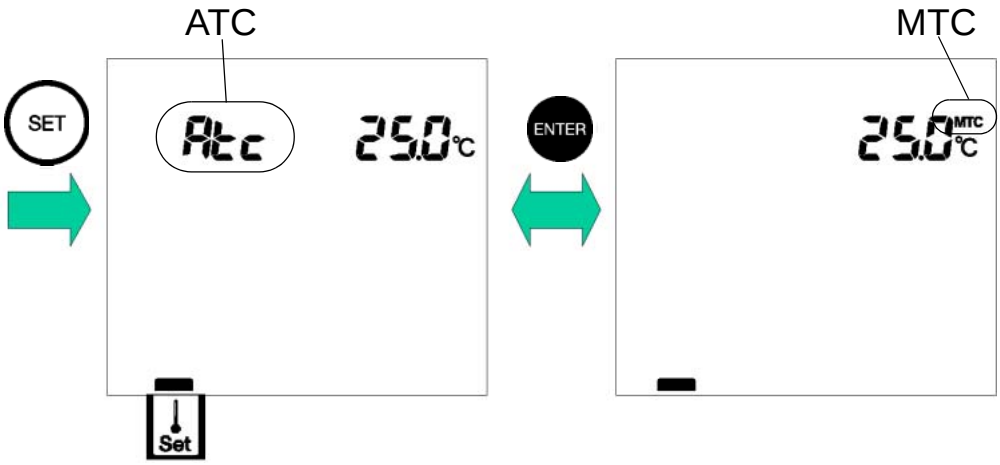


Note

Perform the calibration for the second and third point following the same procedure.

3.4.4 Temperature compensation setting

1. Press the SET key in the Measurement mode to enter the Temperature Compensation Setting mode.
2. Pressing the ENTER key toggles between MTC and ATC settings.



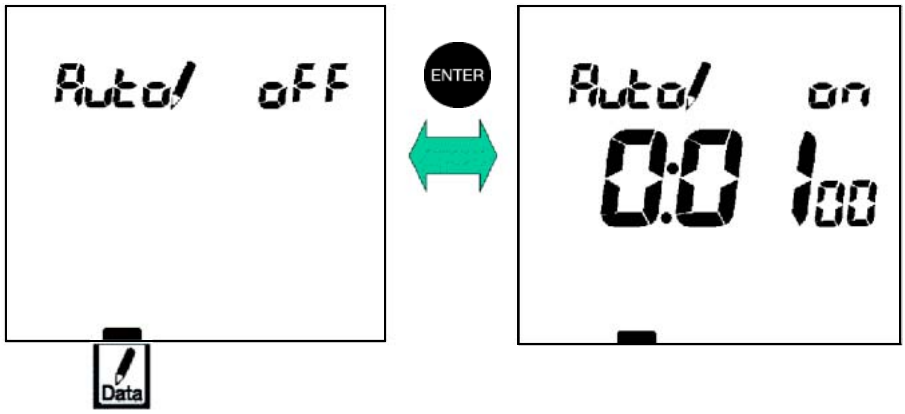
ATC
Automatic temperature compensation (when using a temperature sensor of the electrode)
ATC is displayed.
When a temperature sensor is connected, the current temperature is automatically displayed.
(When no temperature sensor is connected, the display shows 25◦C.)

MTC
Manual temperature compensation (when an electrode temperature sensor is not being used and the temperature of the solution is known before hand)
MTC is displayed.
Set the temperature using the ▲ and ▼ keys.
Setting range: 0.0 to 100.0◦C

3.4.5 Auto data storage setting

You can set the meter to automatically store data at certain intervals.

1. Cancel the Auto Power OFF function.
2. Press the SET key in the Measurement mode to enter the Data Storage Setting mode.
3. Pressing the ENTER key toggles auto data storage function ON and OFF.



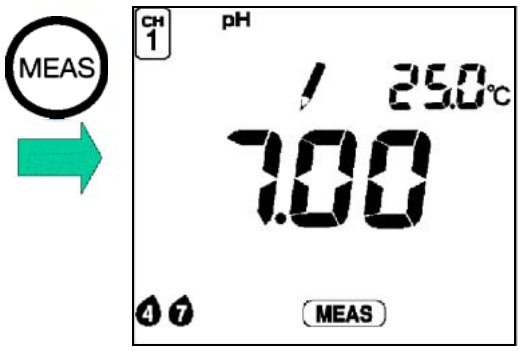
Memory interval setting

1. Press the MODE key to toggle between hour, minute, and second.
2. Specify a numerical value using the ▲ and ▼ keys.

   Setting range: 24 hours to 2 seconds

Carrying out auto data storage

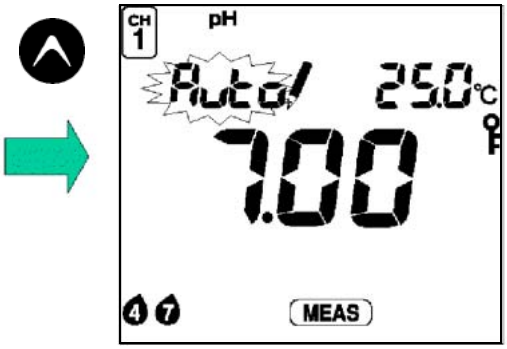
1. Press the MEAS key to return to the Measurement mode.



2. Press the ▲ key.

Automatic data storage will commence.

The first data is recorded when the preset time has reached the preset starting time.



Note

Do not turn the power ON/OFF during automatic data storage. The reliability of stored data may be compromised depending on when the ON/OFF key was pressed.

3. Press the CAL key.

Automatic data storage will end.

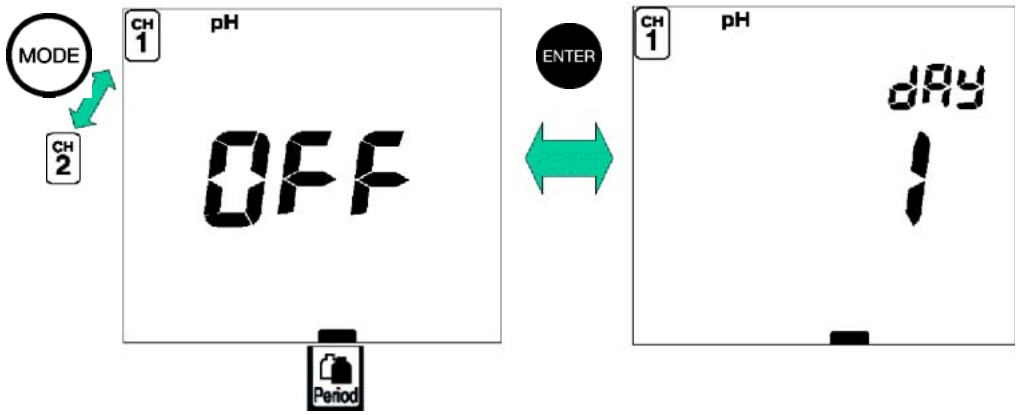
Note

During automatic data storage, the MEAS, MODE, SET, ENTER, and CAL DATA keys cannot be used. Data recording time will differ ± 1 seconds from the time set by the storage interval. If the number of stored data items exceeds 300, data storage will stop and the error message “ERR No. 10” will be displayed.

3.4.6 pH calibration frequency setting

If you set a number of days in the calibration frequency setting, ERR 8 (calibration frequency error) will be displayed after the specified days have passed since the last calibration.

1. Press the SET key in the Measurement mode to select the Calibration Interval Setting mode.
2. Pressing the ENTER key toggles the calibration frequency setting between ON and OFF.



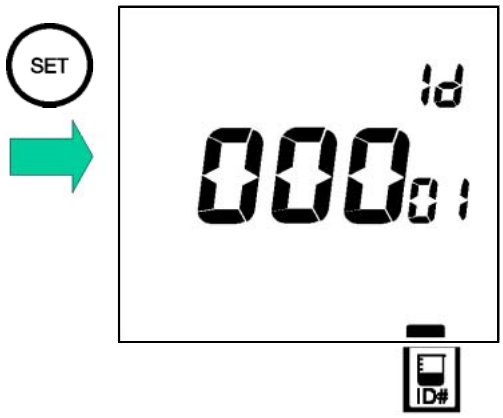
3. Pressing the MODE key toggles between CH1 and CH2 (D-53).
4. Specify a numerical value using the ▲ and ▼ keys.

   Setting range: 1 to 400 days

3.4.7 Sample ID# setting

Setting the sample ID# records its sample ID number as well as the measured data at time the data is stored.

1. Press the SET key in the Measurement mode to enter the ID# Setting mode.

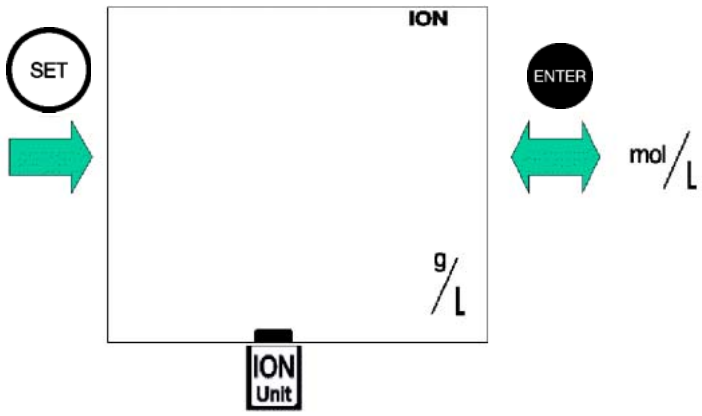


2. Use the ENTER key to select the digit.
3. Specify a numerical value using the ▲ and ▼ keys.

   Setting range: 00000 to 99999

3.4.8 Ion unit setting (D-53)

1. Press the SET key in the Measurement mode and select the ION Unit Setting mode.
2. Pressing the ENTER key toggles between g/L and mol/L for the unit setting.

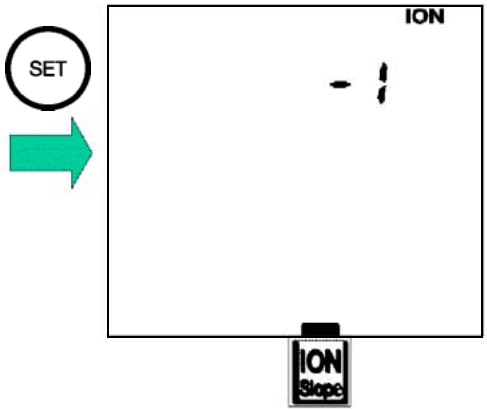


Note

It is not possible to set different units for CH1 and CH2. Once the unit is changed, the previous calibration data will be lost.

3.4.9 Ion slope setting (D-53)

1. Press the SET key in the Measurement mode and select the ION Slope Setting mode.



2. Specify a numerical value using the ▲ and ▼ keys.

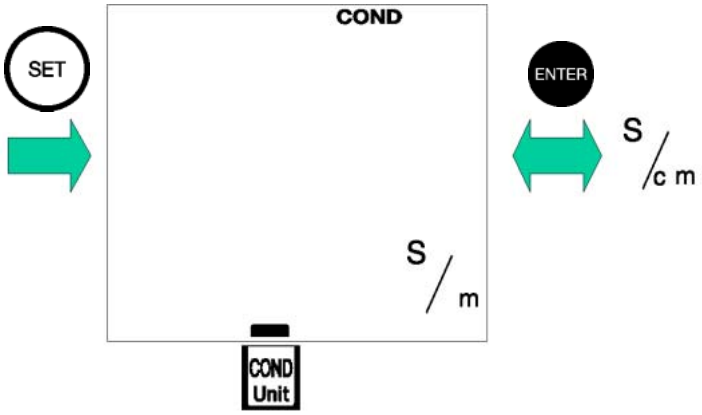
   Setting range: -2, -1, +1, +2

Note

Once the ION slope is changed, the previous calibration data will be lost. Different ION slopes cannot be set for CH1 and CH2.

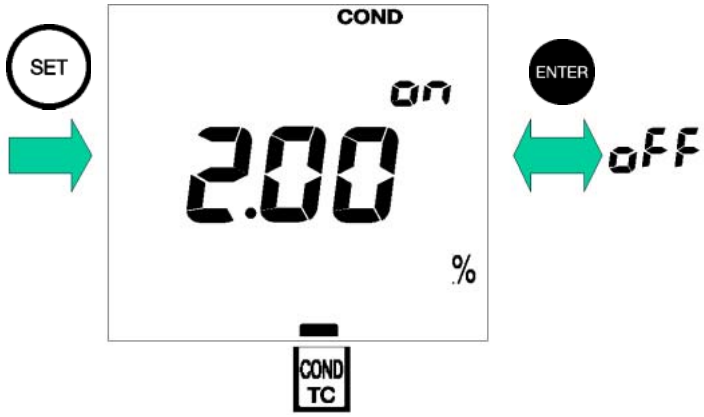
3.4.10 Conductivity unit setting (D-54)

1. Press the SET key in the Measurement mode and select the COND Unit Setting mode.
2. Use the ENTER key to toggle between S/m and S/cm units.



3.4.11 Temperature coefficient setting (D-54)

1. Press the SET key in the Measurement mode and select the COND TC Setting mode.
2. Pressing the ENTER key toggles the temperature conversion ON and OFF.

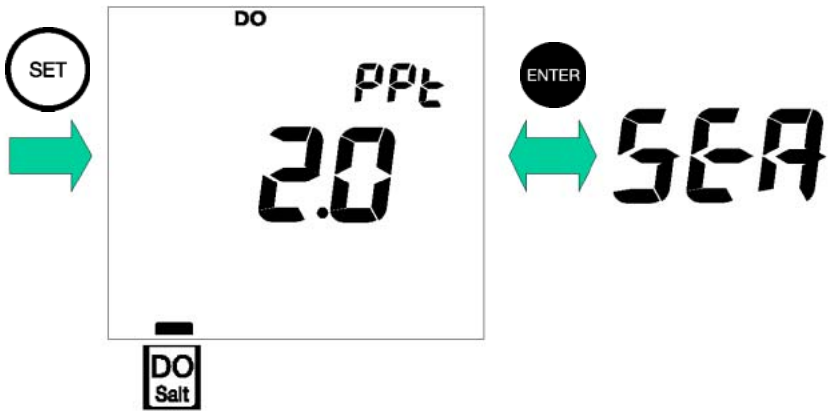


3. Specify a numerical value for the temperature coefficient using the ▲ and ▼ keys.

   Setting range: 0.00 to 10.00% per ℃

3.4.12 DO salinity compensation setting (D-55)

1. Press the SET key in the Measurement mode and select the DO Salt Setting mode.
2. Pressing the ENTER key toggles between seawater salinity (SEA) and a user-defined value.



3. Specify a numerical value using the ▲ and ▼ keys.

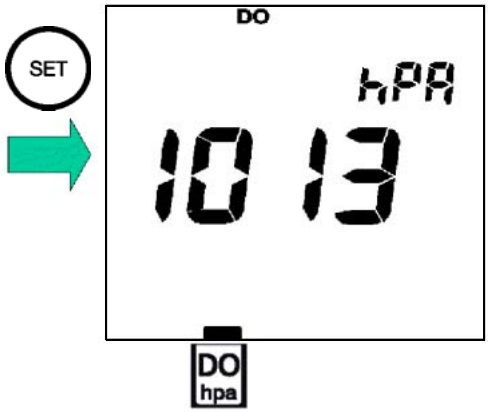
   Setting range: 0.0 to 40.0 ppt

Note

The predefined seawater salinity (SEA) is 35 ppt.

3.4.13 DO atmospheric pressure compensation setting (D-55)

1. Press the SET key in the Measurement mode and select the DO hpa Setting mode.

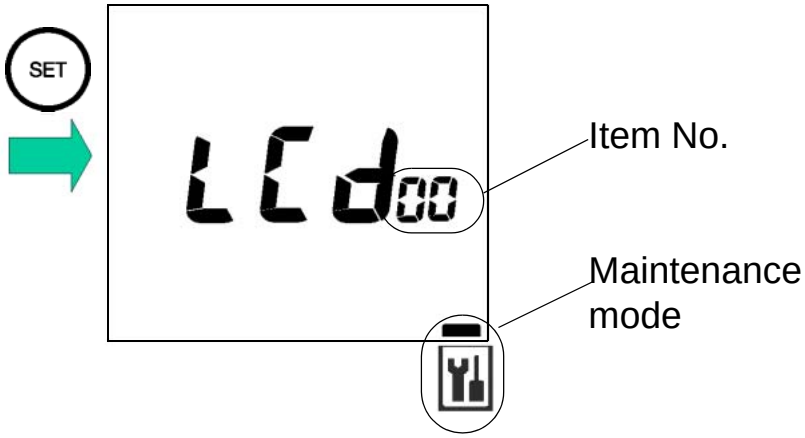


2. Specify a numerical value using the ▲ and ▼ keys.

Setting range: 100 to 1999 hPa

3.4.14 Maintenance mode

Press the SET key in the Measurement mode and select the Maintenance mode. The LCD CHECK screen (Item No. 00) will appear.



● Maintenance setting items

Use the MODE key to toggle between Maintenance mode items.

Item No.	Item	Description	Page No.
00	LCD check	Enables check to see if all LCD segments are displayed.	page 91
01	Battery voltage check	Enables simple battery voltage check.	page 92
02	Temperature zero adjustment	Carries out temperature calibration when the temperature sensor is immersed in a liquid of known temperature.	page 93
03	Automatic power-off setting	Turns Automatic Power-off function ON/OFF and sets time period after which the power will be turned off when no keys are touched.	page 94
04	pH/ION CH setting	Enables CH 1 and CH 2 to be used and both channels to be set for pH measurement (ION measurement).	page 95
05	Remaining data memoriy	Displays number of data items that can still be stored.	page 96
06	Data memory clear	Clears all data in the data memory.	page 96
07	Initialization of setting	Initializes all settings to default values.	page 97
08	Printer con-nection and printing test	Carries out a printing test.	page 98

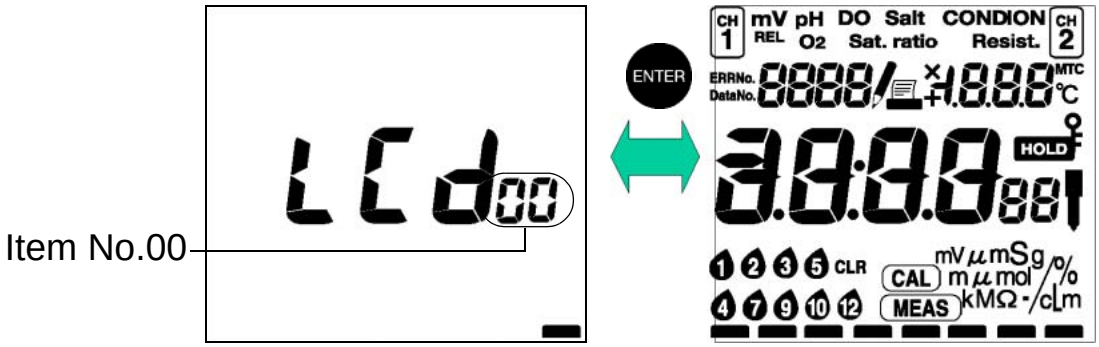
● LCD check [item No. 00]

Displays all segments of the LCD.

1. Press the MODE key in the Maintenance mode to show item No. 00.

2. Press the ENTER key.

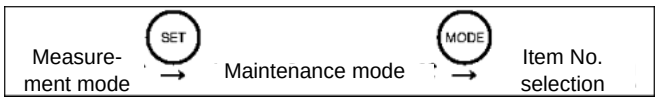
Compare the LCD screen with this diagram to confirm that all segments of the LCD are displayed.



3. Use the MODE key to proceed to the Battery voltage check (item No. 01).

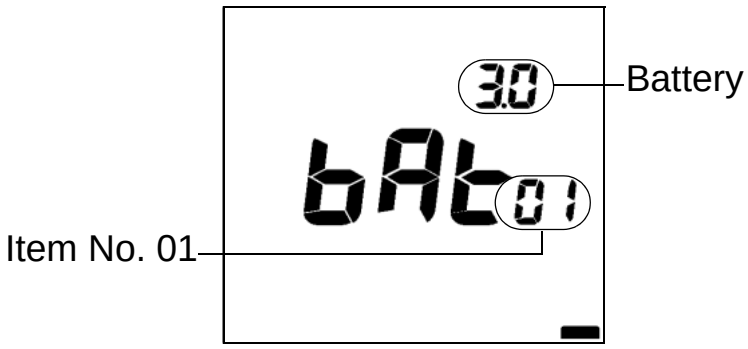
HINT!

Entering the Maintenance mode



● Battery voltage check [item No. 01]

The battery voltage (V) is displayed.



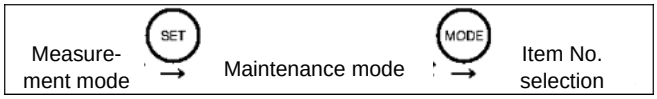
Note

The battery voltage alarm is set at approximately 2.2 V. The measured voltage for batteries depends on the current. The voltage shown in this mode will be a little lower than the actual voltage.

1. Use the MODE key to proceed to temperature zero adjustment (item No. 02).

HINT!

Entering the Maintenance mode



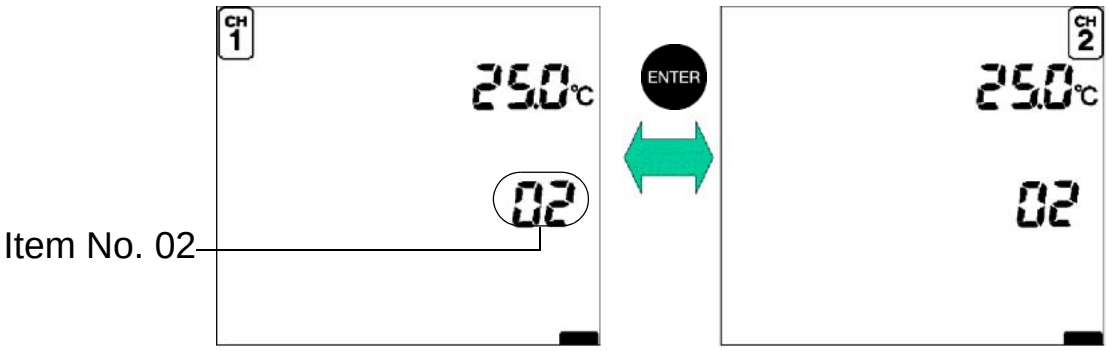
● Temperature zero adjustment [item No. 02]

This mode uses a known temperature to calibrate the temperature compensation value. This mode is used when calibrating the temperature of the thermometer.

1. Press the ENTER key to toggle between CH1 and CH2.

2. Immerse the electrode in a liquid with a known temperature, and set the temperature using the ▲ and ▼ keys.

Setting range: 0.0 to 100.0 °C



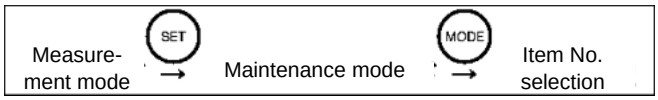
Note

The temperature sensor attached to the electrode maintains an accuracy of ±1°C, even without calibration. The above mode should be used when a greater precision than ±1°C is required.

3. Use the MODE key to proceed to Automatic power-off setting (item No. 03).

HINT!

Entering the Maintenance mode



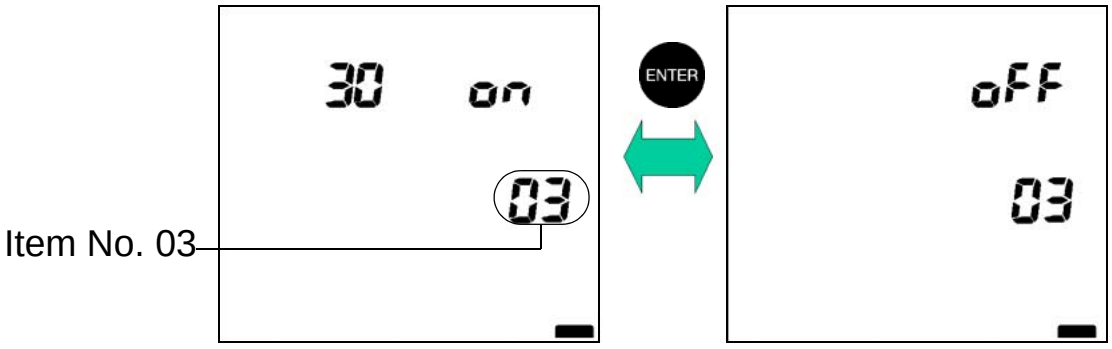
● Automatic power-off setting [item No. 03]

This turns the Automatic Power-off function ON/OFF and sets the time until the power is turned off.
When the Automatic Power-off function is set to ON, the power to the meter automatically turns off if the keys are not operated for the set amount of time.

1. Press the ENTER key to toggle between ON and OFF.

When set to ON, set the time for the power to be turned OFF using the ▲ and ▼ keys.

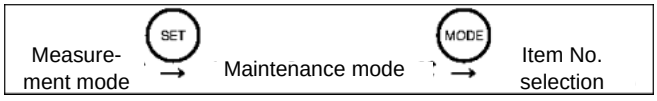
Setting range: 1 to 30 minutes



2. Use the MODE key to proceed to pH/ION CH setting (item No. 04).

HINT!

Entering the Maintenance mode

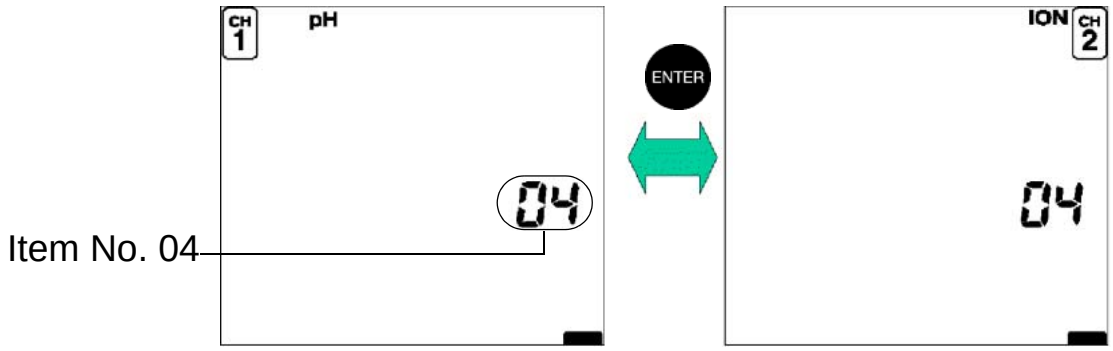


● pH/ION CH setting [item No. 04] (D-53)

Both channels can be used to measure the pH and ions.

1. Press the ENTER key to toggle between CH1 and CH2.

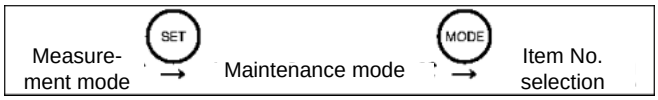
2. Use the ▲ or ▼ keys to select the pH/ION measurement channel.



3. Press the MODE key to proceed to Remaining data memory (item No. 05).

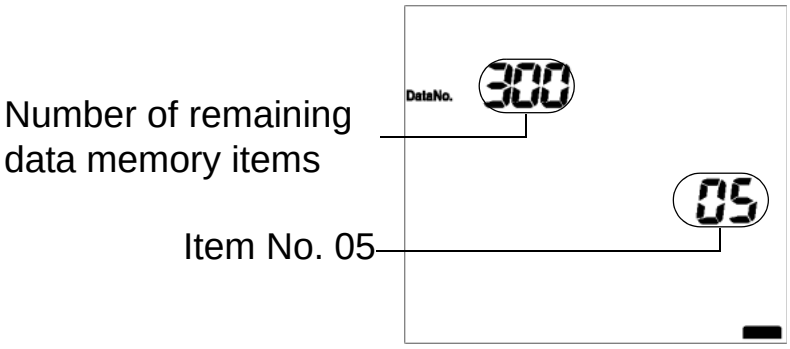
HINT!

Entering the Maintenance mode



● Remaining data memory [Item No. 05]

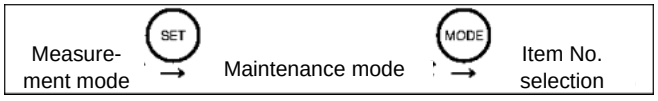
Displays the number of data items that can still be stored.



1. Press the MODE key to proceed to Data memory clear (item No. 06).

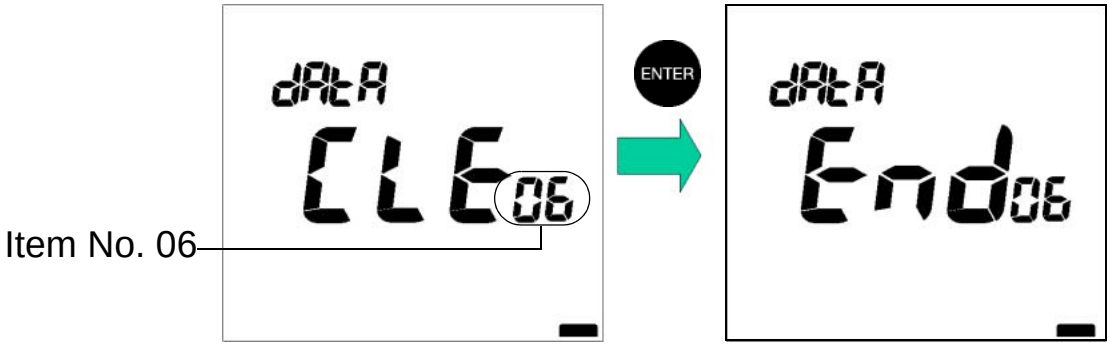
HINT!

Entering the Maintenance mode



● Data memory clear [Item No. 06]

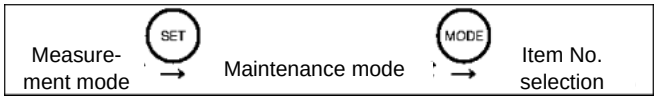
1. Pressing the ENTER key clears all the data stored in the memory.



2. Press the MODE key to proceed to Initialization of setting (item No. 07).

HINT!

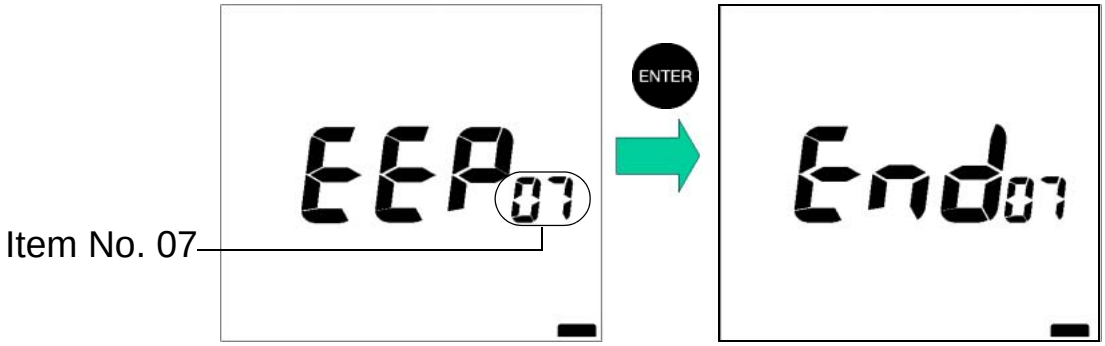
Entering the Maintenance mode



● Initialization of setting [item No. 07]

This mode returns all settings to the default settings. Use this mode to return the pH meter to the original settings when the meter was purchased.

1. Press the ENTER key to initialized the settings.



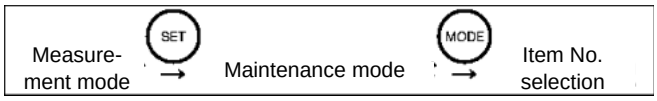
2. Use the MODE key to proceed to Printer connection and printing test (item No. 08).

Ref.

The setting values to be initialized are shown on page 202.

HINT!

Entering the Maintenance mode

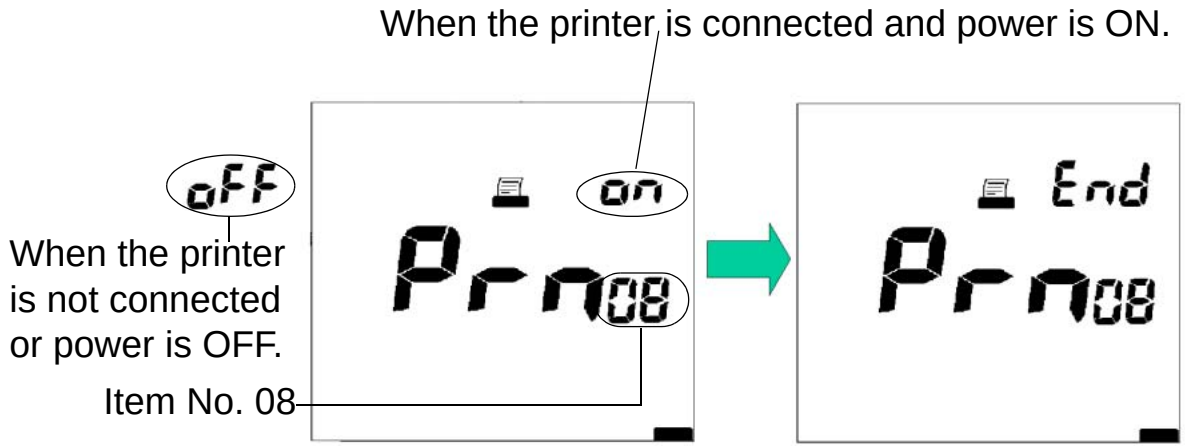


● Printer connection and printing test [item No. 08]

A printing test is conducted if a printer is connected.

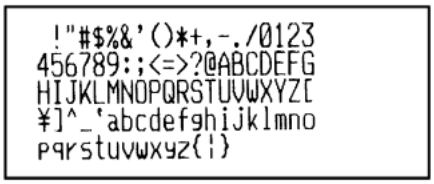
1. Press the ENTER key to start the printing test.

When conditions are normal, “End” is displayed.
When conditions are not normal, “Err” is displayed.



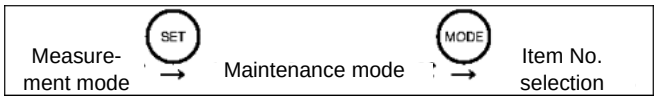
2. Press the MODE key to return to the first item in the maintenance modes, LCD check.

Test print format



HINT!

Entering the Maintenance mode



4 RS-232C communications

This chapter describes the use of RS232C communications and its communication commands.

4.1 Cautions before use

Use caution regarding the following points, when using RS-232C communications.

- Use the following designated cable for connecting to the computer.
  Part name: PC cable for 50 Series
  Part number: 9096004800
- Make sure that the data transfer formats for the meter and computer match. The following data transfer format is used by the meter.
  Baud rate: 2400 bps
  Character length: 8 bits
  Parity: None
  Stop bits: 1

Note

If the data transfer formats differ, communications errors may occur or the on-line mode may not start up, and RS-232C communications cannot proceed normally. If the transfer format is changed, turn the power to both the pH meter and the computer OFF, and then ON again.

- When creating a program for RS-232C, put the meter in the ON-LINE mode by entering an on-line command at the beginning of the program. The control switches become invalid when the meter is in the ON-LINE mode, and the RS-232C Communications mode is enabled (“LOCK” is displayed.) The ON-LINE mode is cleared when the power is turned OFF.

- If data is requested but not received, create the program structure to have the data request repeated after a short waiting time. This will provide more reliable communications.
- If RS-232C communications is not used, cover the RS-232C port with a rubber cap.
- This system does not carry out control using DCD, CTS or DSR. Note this point when creating a program.

4.2 Command list

Use <CR><LF> as the terminator for serial communication commands.
All the commands (except the ON-LINE/OFF-LINE command) are valid only in the ON-LINE mode. (An error message is returned in the OFF-LINE mode.)
The meter returns a response to any operation made in the following format:

OK<CR><LF>

If the pH meter does not accept the operation, it returns an error message in the following format:

ER,n<CR><LF>

n=0: Communication error
1: When a non-existent command is input.
2: When a timing command is input to which the meter cannot respond.
3: When the numerical value in the command is out of the setting range.

● On-line operations commands

Command item	Command		Page No.
	Header	Command code	
On-line/off-line	C	OL	page 104
Halt potential hunting		BR	page 108
pH Measurement mode designation		PH	page 104
mV Measurement mode designation		MV	page 105
Ion Measurement mode designation		IO	page 106
Conductivity Measurement mode designation		CO	page 106
DO Measurement mode designation		DO	page 107
Start measurement		MS	page 107
Start pH standard solution calibration		CP	page 108
Start ion calibration		CI	page 109
Start conductivity cell constant calibration		CD	page 110
Start DO calibration		CA	page 111
Clear calibration		CC	page 111
Data clear		DC	page 112
Data In designation		IN	page 112
Power Off		OF	page 112

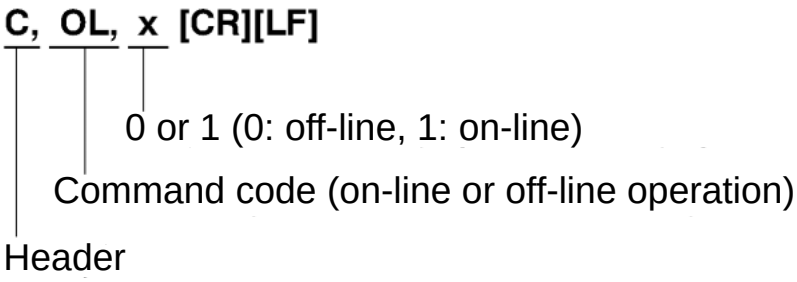
● Request data commands

Meters that can use commands	Request for ...	Command		Page No.
		Header	Command code	
All	pH calibration history	R	PC	page 114
D-53	Ion calibration history		IC	page 116
All	Clock data		OT	page 118
	Measurements		MD	page 119
	Number of stored data items		MC	page 121
	Memory data		MS	page 122
	Model inquiry	A	RS	page 125
	Software version inquiry		AV	page 125

4.3 On-line operation commands

This section explains the commands that control the operation of the pH meter.

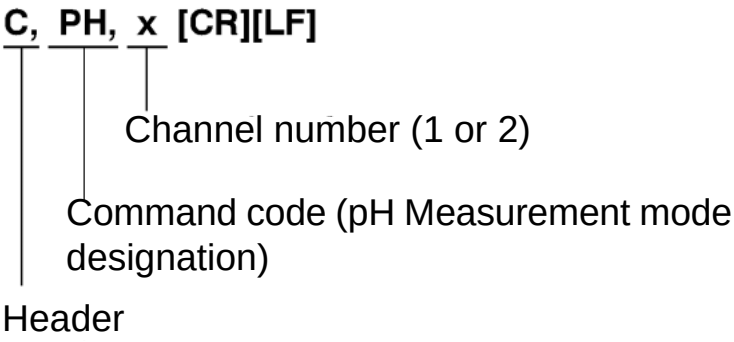
● ON-LINE/OFF-LINE command format



Note

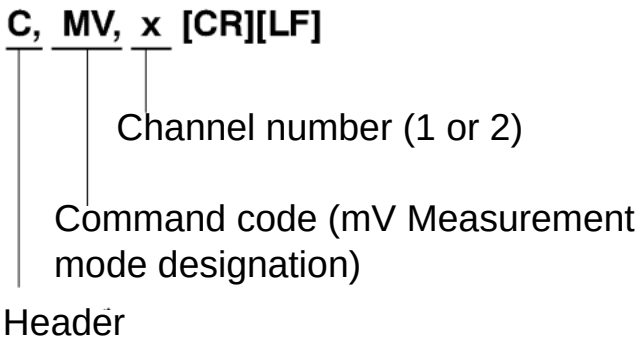
Switching between on-line and off-line. When the meter is switched from off-line to on-line, the status of the pH meter is the same as when a command has been received. “LOCK” is displayed.

● pH Measurement mode designation command format



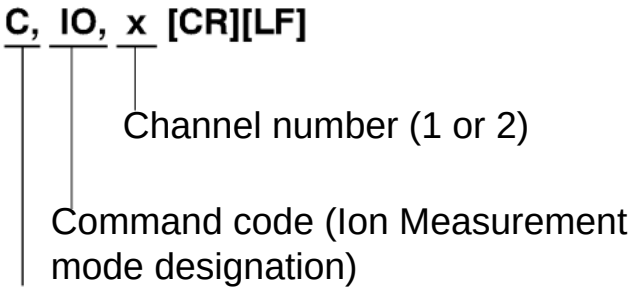
- This command is always valid when on-line.
- The meter changes the status to pH Instantaneous display for the selected channel number.
- This command is valid only when the settings for CHECK mode item no. 05 (pH/ION CH setting) match. If the settings do not match, this response will occur: ER, 2 [CR][LF] (operational error).
- Channel No. 2 is only available on the D-53 model.

● mV Measurement mode designation command format



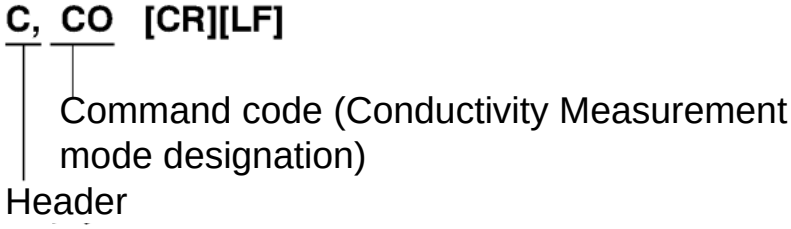
- This command is always valid when on-line.
- The meter changes the status to mV Instantaneous display for the selected channel number.
- Channel No. 2 is only available on the D-53 model.

● Ion Measurement mode designation command format (D-53)



- This command is always valid when on-line.
- The meter changes the status to Ion Instantaneous Value display for the selected channel number.
- This command is valid only when the settings for MAINTENANCE mode item no. 05 (pH/ION CH setting) match on the D-53. If the settings do not match, this response will occur: ER, 2 [CR][LF] (operational error).
- When this command is sent (with the exception of the D-53 model), the reply is: ER, 2 (operational error).

● Conductivity Measurement mode designation command format (D-54)



- This command is always valid when on-line.
- The meter changes the status to Conductivity Instantaneous Value display
- When this command is sent (with the exception of model D-54), the reply is: ER, 2 [CR][LF] (operational error).

● Dissolved Oxygen Measurement mode designation command format (D-55)

C, DO [CR][LF]

Command code (Dissolved Oxygen Measurement mode designation)

Header

- This command is always valid when on-line.
- The meter enters the Dissolved Oxygen Instantaneous Value display.
- If this command is sent to D-53 or 54 produces ER,2 (operational error).

● Start measurement command format

C, MS, x [CR][LF]

Channel number (1 or 2)

Command code (Start measurement)

Header

- When the meter status is Instantaneous Measurement, Auto Hold Measurement will start.
- If the command is issued during a measurement hold or during calibration, the meter will return to the initial screeen status.

● Halt potential hunting command format

C, BR, x [CR][LF]

Channel number (1 or 2)

Command code (Measurement halt)

Header

- This command is valid when on-line only during measurement on AUTO HOLD.
- Issuing this command halts measurement on AUTO HOLD.

● Start pH standard solution calibration command format

C, CP, x [CR][LF]

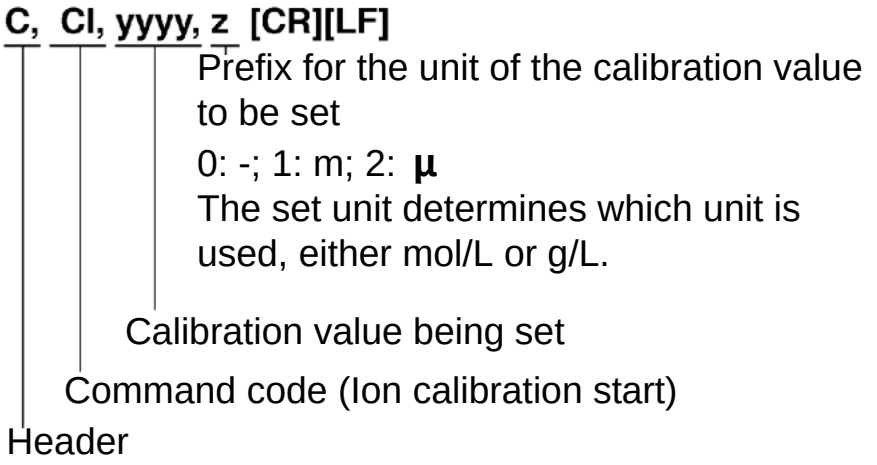
Channel number (1 or 2)

Command code (pH standard solution calibration start)

Header

- This command is valid when on-line, during pH measurement, or when “HOLD” is displayed.
- This command is valid only when the meter is set for NIST or US calibration.
- Issuing this command starts the pH standard solution calibration.

● Start ion calibration command format (D-53)



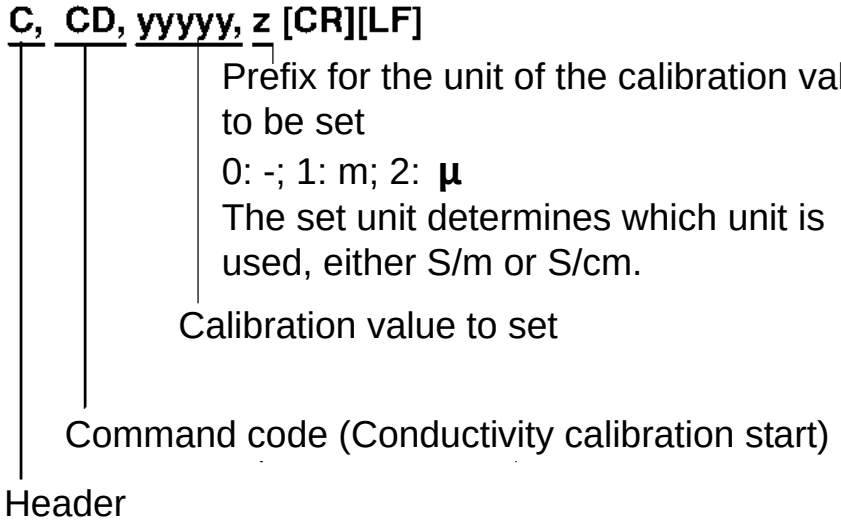
- This command is valid when on-line, in ion measurement, or while “HOLD” is displayed.
- If the start calibration command is sent while in the Measurement mode, the previous calibration values will be cleared.

Setting ranges for calibration values

When the units are mg/L, µmol/L, mmol/L or µmol/L:

- 0.00 - 9.99
  ([SP][SP]X or [SP]X.X are also possible.)
- 10.0 - 99.9
  ([SP]XX is also possible.)
  [SP]100 - [SP]999

● Start conductivity cell constant calibration command format (D-54)



- This command is valid when on-line, when conductivity measurement or calibration are on HOLD.
- This command starts the calibration of the conductivity cell constant.

Setting ranges for calibration values

- When units are µS/m: 0.0 – 999.9 (only one place to the right of the decimal)
- When units are mS/m or S/m: 0.0000 – 199.9
- After calibration is completed, the cell constant/ coefficient will appear on the screen and be stored in the memory.

● Start DO calibration command format (D-55)

C, CA, y [CR][LF]

Calibration method to be set (one digit)
0: Air calibration
1: Standard solution calibration

Command code (DO calibration start)

Header

- This command is valid when on-line, when DO measurement or calibration are on HOLD.
- After calibration is finished, “ END ”will be displayed and the calibration coefficient will be stored in the memory.

● Clear calibration command format

C, CC, x [CR][LF]

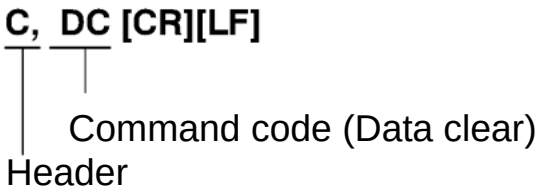
Channel number (1 or 2)

Command code (Calibration clear)

Header

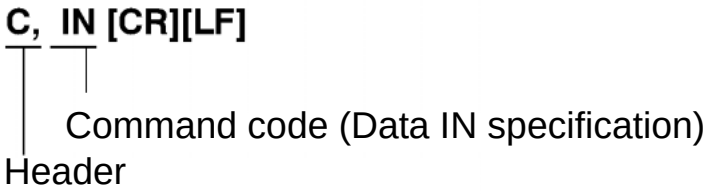
- This command is valid when on-line, when “HOLD” is being displayed for ION or pH calibration.
- When a pH electrode is being calibrated, the pH standard calibration value is cleared.
- When an ION electrode is being calibrated, the ION standard calibration is cleared.
- The calibration value of the channel being displayed currently will be cleared.

● Data clear command format



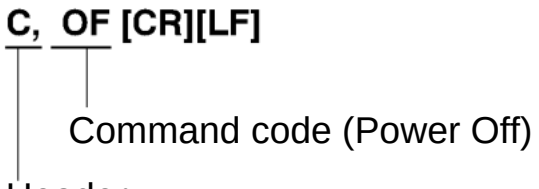
•This command clears the data stored in the memory.

● Data IN specification command format



•Valid only when manual data memory is set.

● Power Off command format



4.4 Data request commands and responses

This section explains the commands that request meter data.

● Format of responses from meter

When no operation can be received

ER, n [CR][LF]

n = 0: Communications error
1: Command code does not exist
2: Unacceptable timing entered
3: Data exceeds range

When operation has been received

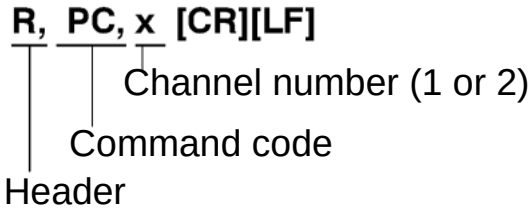
A. When data is requested, the result of the request is sent out according to each format.
B. When an operation command has been issued, “OK” is sent back.

Format

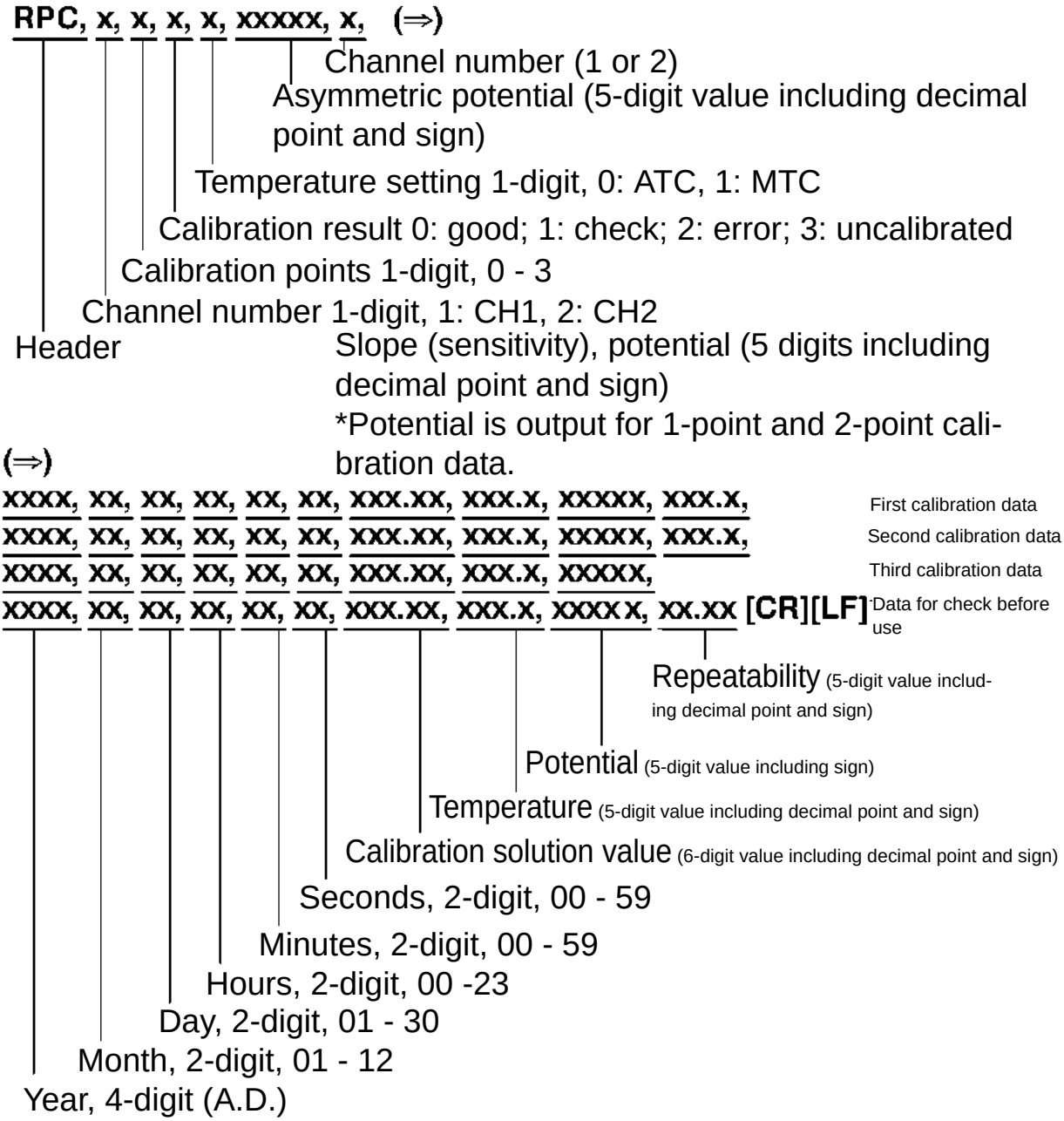
OK [CR][LF]

● pH calibration history request command and response

Request command format



pH meter response format



- The format is of fixed length. When there is no data, enter a [SP].
- The latest calibration date and time are output.
- The calibration data is transmitted only for the number of calibration points used.
- The date and time when the latest calibration was performed is output as the calibration date/time.
- The slope is valid only for calibration with 2 or more points and the slope value for the third point will be a space.
- If the check before use has been performed, this data will be sent after calibration data is transmitted.

Slope data

Slope data is output as the calibration coefficient A between each point multiplied by 100.
When results exceed 999.9 or are negative, the output is [SP][SP][SP][SP][SP].
During calibration, an error response will be issued.
The year/month/day are output for each calibration point.

● Ion calibration history request command and response (D-53)

Request command format

R, IC, x [CR][LF]

- Channel number, 1-digit, 1: 1CH 2: 2CH
- Command code
- Header

pH meter response format

RIC, x, x, x, x, xxxxx, (⇒)

- Asymmetric potential (5-digit value including decimal point and sign)
- Temperature setting 1-digit, 0: ATC, 1: MTC
- Calibration result 0: good; 1: check; 2: error
- Calibration points 1-digit, 0-3
- Channel number 1-digit, 1: CH1, 2: CH2
- Header

Slope (sensitivity), potential (5 digits including decimal point and sign)
*Potential is output for 1-point and 2-point calibration data.

(⇒)
xxxx, xx, xx, xx, xx, xx, xx.xx, x, x, xxx.x, xxxxx, xxx.x, First calibration data
xxxx, xx, xx, xx, xx, xx, xx.xx, x, x, xxx.x, xxxxx, xxx.x, Second calibration data
xxxx, xx, xx, xx, xx, xx, xx.xx, x, x, xxx.x, xxxxx, [CR][LF] Third calibration data

- Potential (5-digit value including sign)
- Temperature (5-digit value including decimal point and sign)
- Unit 0: mol/L, 1: g/L
- Sub unit 0: none; 1: μ; 2: m
- Calibration solution value (5-digit value including decimal point and sign)
- Seconds, 2-digit, 00-59
- Minutes, 2-digit, 00 - 59
- Hours, 2-digit, 00 -23
- Month, 2-digit, 01 - 12
- Month, 2-digit, 01 - 12
- Year, 4-digit (A.D.)

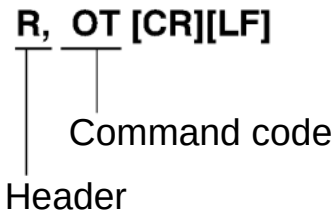
- The format is of fixed length. When there is no data, enter a [SP].
- The latest calibration date and time are output.

Slope data

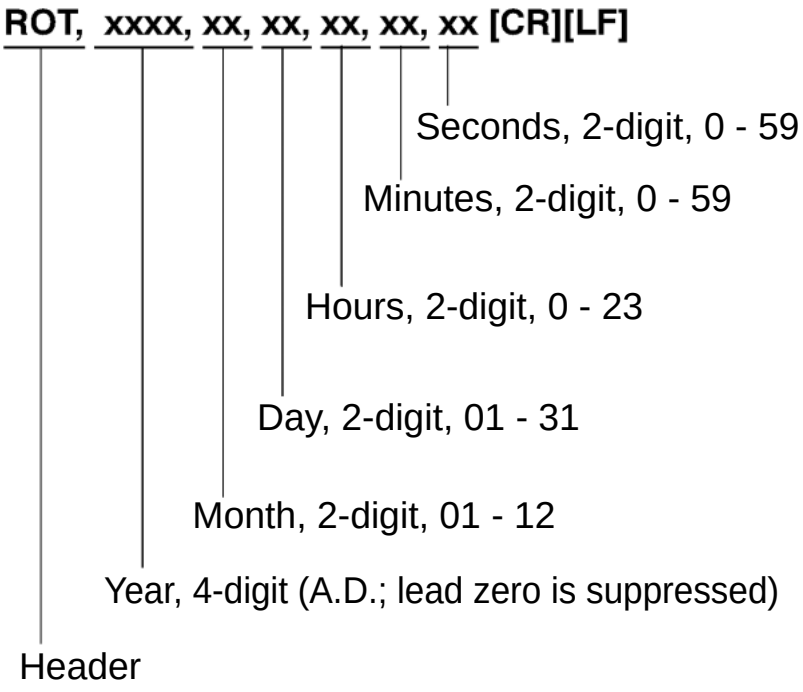
- When results exceed 999.9 or are negative, the output is [SP][SP][SP][SP][SP].
- The year/month/day are output for each calibration point.

● Clock data request command and response

Request command format

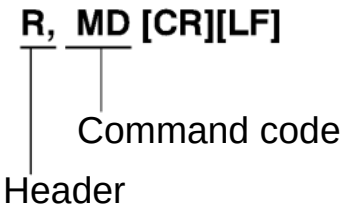


pH meter response format

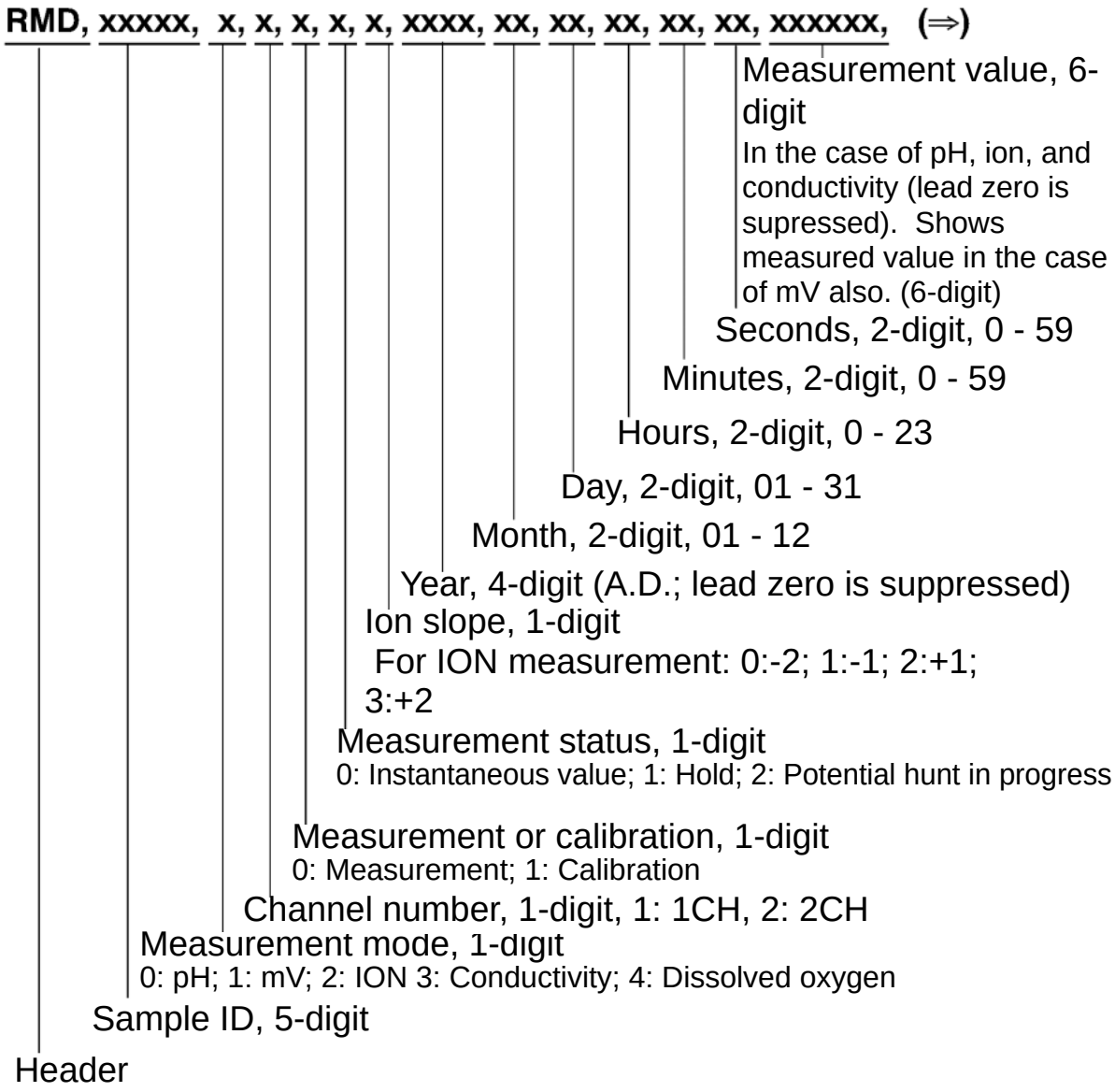


● Measurement request command and response

Request command format



pH meter response format



(⇒) x, x, x, xxxxx, xxxxx, xx [CR][LF]

Error code
Error No. display, 2-digit
(One error No. which takes precedence over others is output.)
When the measurement/calibration type is
0: The latest data is output regardless of occurrence of measurement errors.
1: [SP] is output when any calibration error is produced.

Potential, 5-digit
(Lead zero is suppressed.)

Temperature (5-digit including decimal point), -10.0 to 100.0
Right-aligned with blank digits filled with spaces.

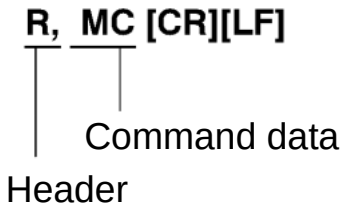
Temperature setting, 1-digit, 0:ATC; 1: MTC

Unit, 1-digit
(Ion) 0: mol/L; 1: g/L
(Conductivity) 0: S/cm; 1: S/m
(pH) 0: None
(DO) 0: mg/L
(mV) 0: mV

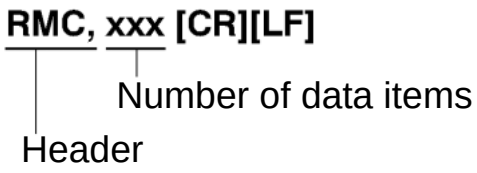
Supplementary unit, 1-digit
0: none; 1: μ; 2: m; 3: k; 4: M

● Request command for number of stored data items and its response

Request command format

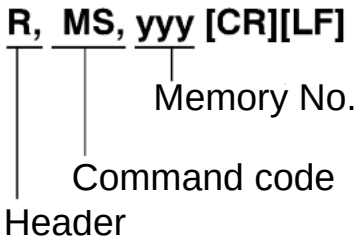


Meter response format

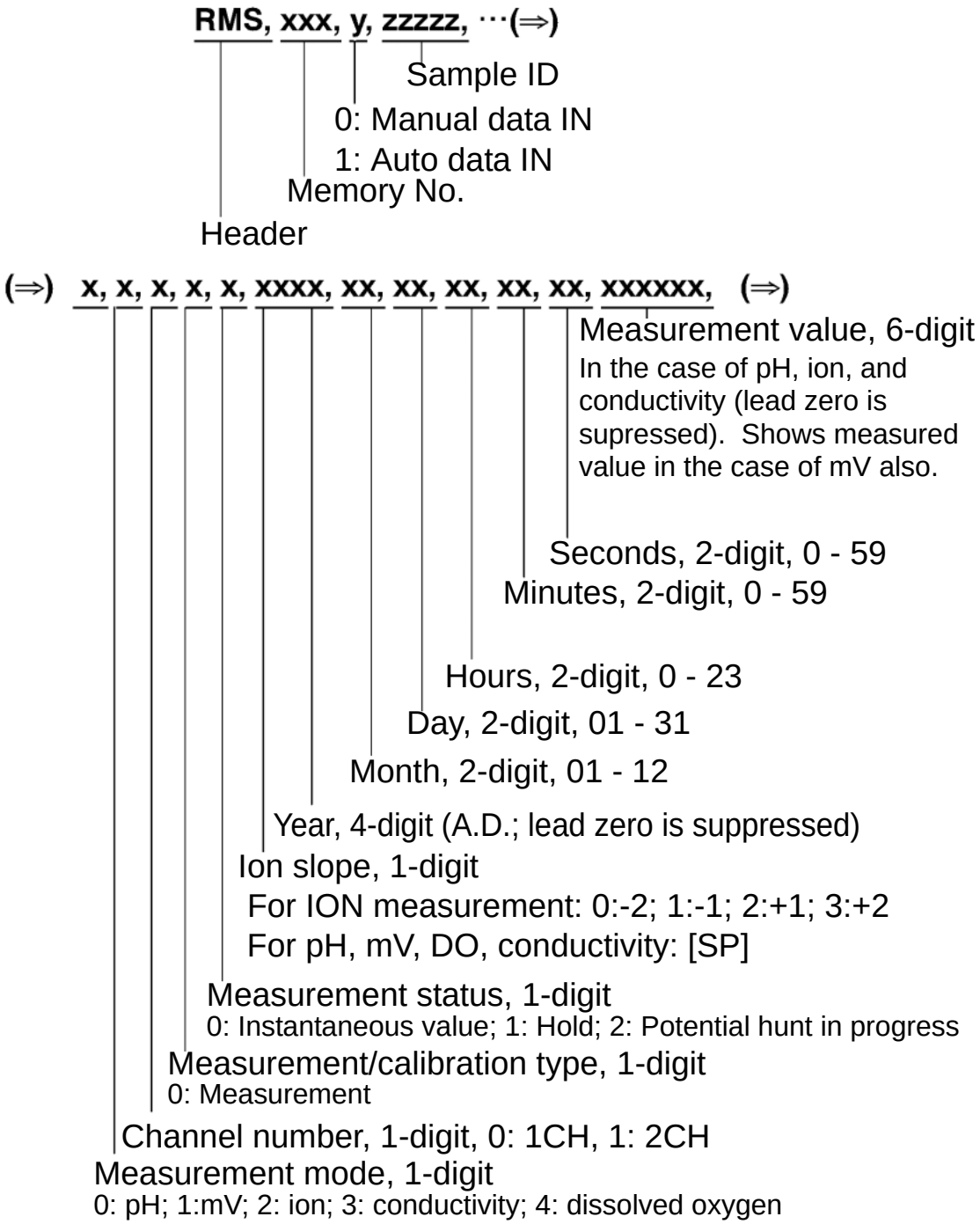


● Request command for memory data and its response

Request command format



Meter response format



(⇒) x, x, x, xxxxx, xxxxx, xx [CR][LF]

Error code
Error No. display, 2-digit
(One error No. which takes precedence over others is output.)
When the measurement/calibration type is
0: The latest data is output regardless of occurrence of measurement errors.
1: [SP] is output when any calibration error is produced.

Potential, 5-digit
(Lead zero is suppressed.)

Temperature (5-digit including decimal point), -10.0 to 100.0
Right-aligned with blank digits filled with spaces.

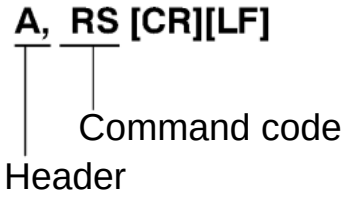
Temperature setting, 1-digit, 0:ATC; 1: MTC

Unit, 1-digit
(Ion) 0: mol/L; 1: g/L
(Conductivity) 0: S/cm; 1: S/m
(pH) 0: none
(DO) 0: mg/L
(mV) 0: mV

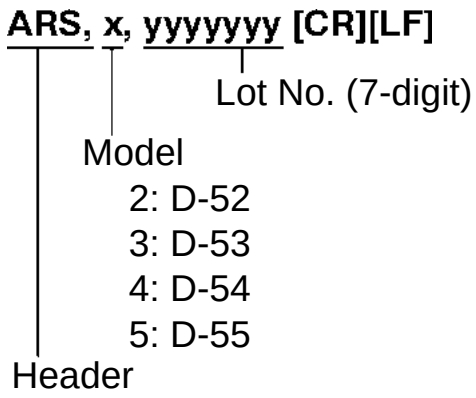
Supplementary unit, 1-digit
0: none; 1: μ; 2: m; 3: k; 4: M

● Request command for model and its response

Request command format

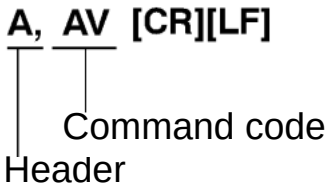


Meter response format

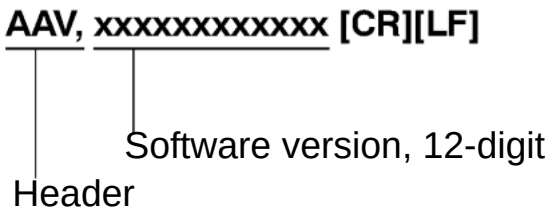


● Request command for software version and its response

Request command format



Meter response format



4.5 Communication example using the HyperTerminal

For reference, communication using the HyperTerminal that comes with Windows is described here.

1. Open the HyperTerminal.

[Start] > [Programs] > [Accessories] > [Communications] > [HyperTerminal]

The HyperTerminal program (Hypertrm.exe) is activated.

2. Make the setting for name, connection, and port.

Select the COM port of the PC currently being used for the port setting.

3. Set the COM port of the PC and set the transmission parameters as follows:

Baud rate: 2400 bps

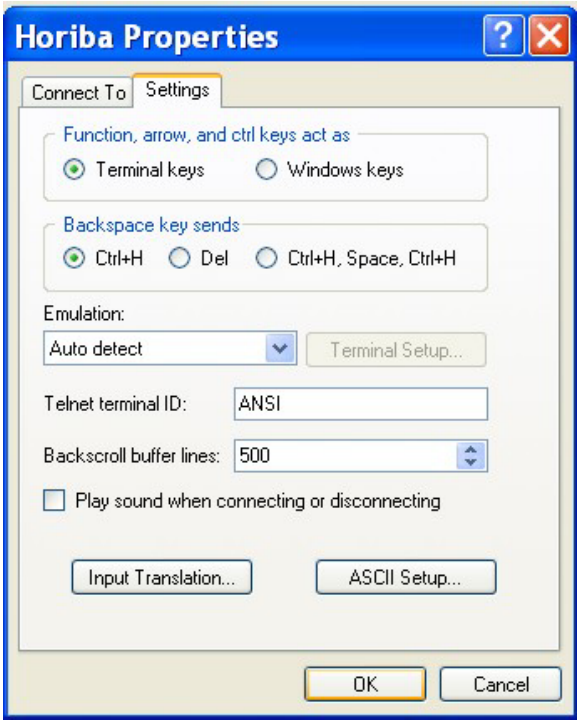
Character length: 8 bits

Parity: none

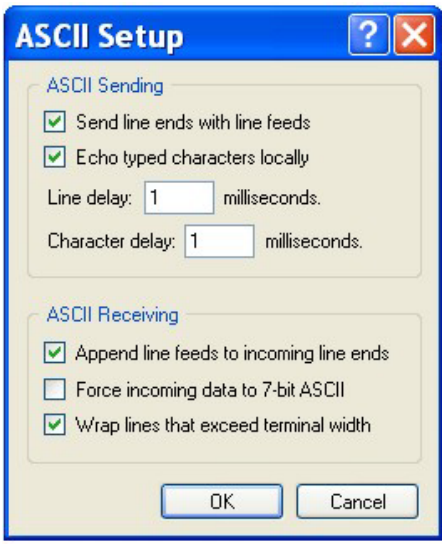
Stop bit: 1 bit

4. Make the settings in the properties dialog box.

[File] > [Properties] > [Settings]



[File] > [Properties] > [Settings] > [ASCII Setup]



Note

You can check the contents transmitted via HyperTerminal by enabling the “Echo typed characters locally (E)” option.

5. Command input

If a command is input, the corresponding response data is sent back.

Command input should be completed within 10 seconds.

Be sure to first set the meter to the On-line mode using the On-line/Off-line command.

Note

Windows® is a registered trademark of Microsoft Corporation.

5 Printer

This chapter explains the printer connection, the times printing takes place, and printing formats.

5.1 Connecting the printer

The following printers are compatible with D-52/53/54/55.

Printers

- Citizen CBM-910-24RJ100-A (Normal paper)
- Seiko DPU-H245AS-A03A (Heat-sensitive paper)

Attach the printer cable to the printer output connector.

Note

Connect your printer only after turning OFF the power to the main unit of the meter.

Ref.

For the layout of the connector terminals for the printer output cable, refer to “7.9 Pin layout of special cables” page 207.

Note

When a printer is not connected, remove the printer cable from the meter and put the rubber cap securely over serial communication connector.
Be sure to use a cable that matches the printer.

5.2 Printer setting

Set up the printer using these settings:

- Printer output baud rate: 2400 bps
- Bit length: 8 bits
- Parity: none

Setting for a plain paper printer (CBM-910)

Set DIP switch No. 6 to ON and No. 7 to OFF, and prepare the printer paper and ink ribbon. Keep the LF key held down. The printer prints only when the LF key is being pressed.

Setting for a thermal paper printer (DPU-H245AS)

Prepare printer paper and turn ON the power switch with the FEED and CHARGE switches held down. Set the baud rate of the printer to the above value, referring to the instruction manual for the printer.

Start the function setting mode of the printer and change it to the above settings.

5.3 Printer output timing

The printer prints at the following times:

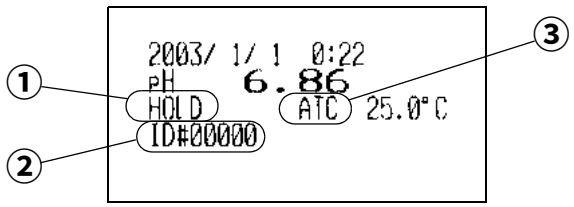
- When pressing the ENTER key after Auto Hold or while the instantaneous value is being displayed in the Measurement mode.
- When the manual data memory storage is performed in the Measurement mode.
- When pressing the ENTER key while in the Data Memory Call mode.
- When calibration or check is performed in the Calibration mode.
- When the ENTER key is pressed in the calibration history display.
- When test printing is selected while in the Maintenance mode.

5.4 Printing format

The following are sample printouts.

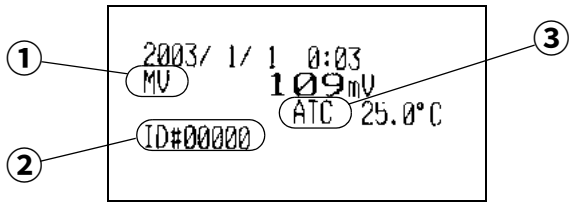
5.4.1 When the ENTER key is pressed in the Measurement mode

● pH Measurement mode



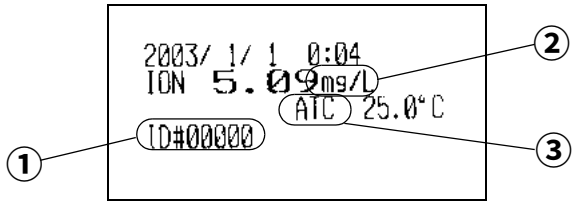
① When the data is the data confirmed with Auto Hold, “HOLD” is shown. Nothing is displayed for the instantaneous value measurement.
② ID#: 5 digits
③ Temperature compensation setting
Manual mode: MTC
Auto mode: ATC

● mV Measurement mode



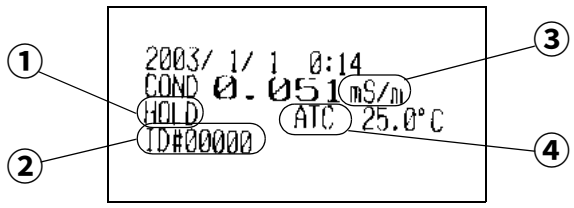
① REL is displayed during relative mV measurement.
② ID#: 5 digits
③ Temperature compensation setting
Manual mode: MTC
Auto mode: ATC

● ION Measurement mode



① ID#: 5 digits
② Unit: g/L, mg/L, μg/L, mol/L, mmol/L, μmol/L
③ Temperature compensation setting
Manual mode: MTC
Auto mode: ATC

● COND Measurement mode



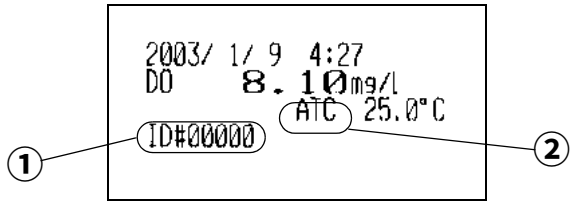
① When the data is the data confirmed with Auto Hold, “HOLD” is shown. Nothing is displayed for the instantaneous value measurement.

② ID#: 5 digits

③ Unit: S/m, mS/m, μS/m, S/cm, mS/cm, μS/cm

④ Temperature compensation setting
Manual mode: MTC
Auto mode: ATC

● DO Measurement mode



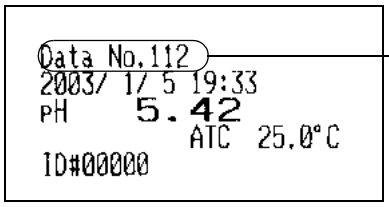
① ID#: 5 digits

② Temperature compensation setting
Manual mode: MTC
Auto mode: ATC

5.4.2 When the manual data memory storage is performed in the Measurement mode

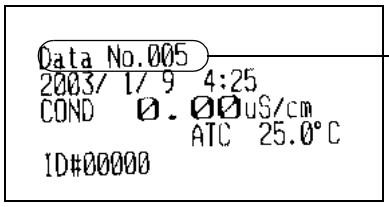
The printer prints the data memory No. in the first line and the data in accordance with the format same with the one in “5.4.1 When the ENTER key is pressed in the Measurement mode” P.132.

● Example in the pH Measurement mode



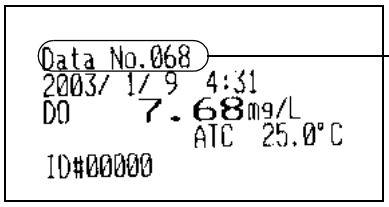
Data memory number

● Example in the COND Measurement mode



Data memory number

● Example in the DO Measurement mode



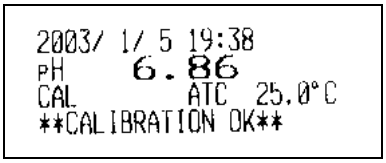
Data memory number

5.4.3 When the ENTER key is pressed in the Data Memory Call screen

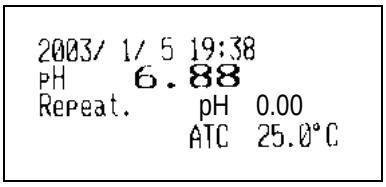
The format is the same as that described in “5.4.2 When the manual data memory storage is performed in the Measurement mode” page 134.

5.4.4 When calibration or check is performed in the Calibration mode

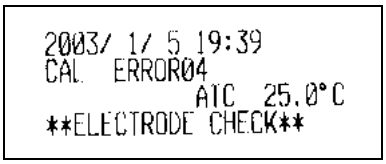
pH calibration



When calibration is performed

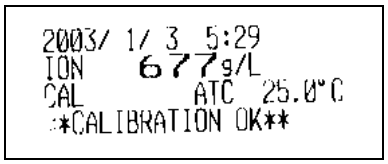


When pH repeatability is checked



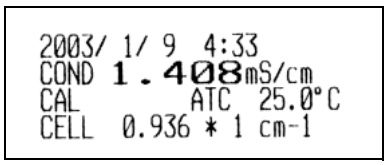
When an error has occurred

ION



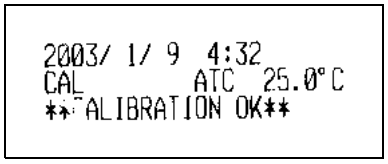
When calibration is performed

COND cell constant calibration

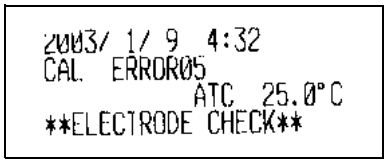


When calibration is performed

DO atmospheric pressure calibration

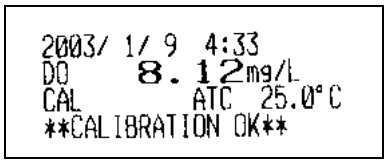


When calibration is performed

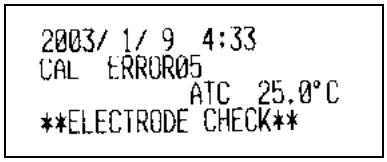


When an error has occurred

DO standard solution calibration



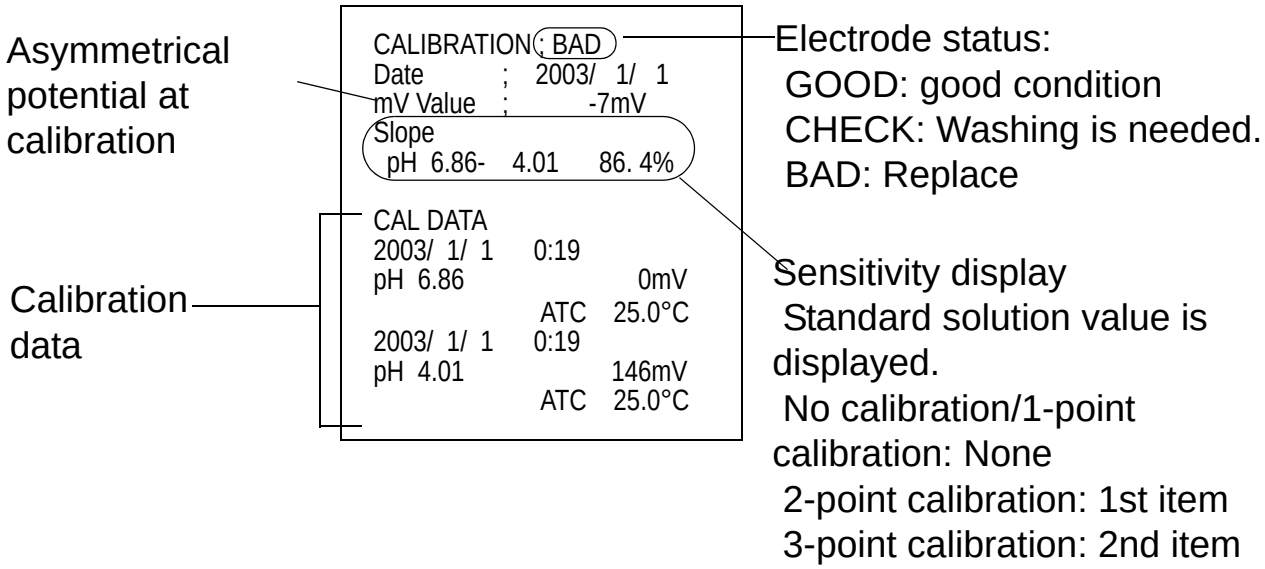
When calibration is performed



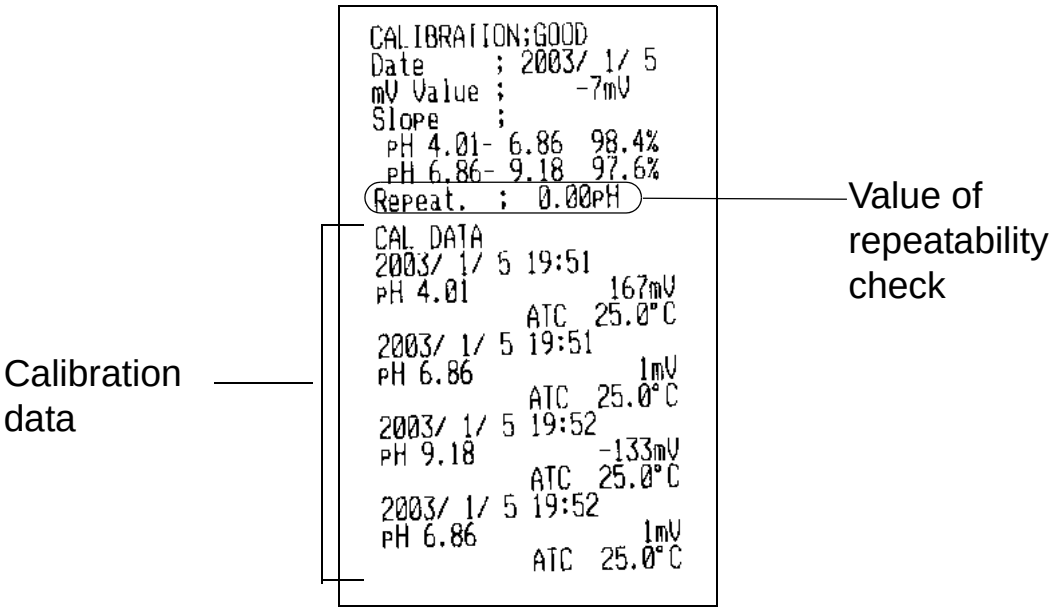
When an error has occurred

5.4.5 When the ENTER key is pressed in the calibration history display

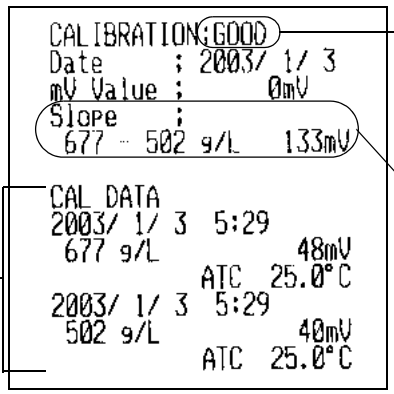
● pH calibration history (without check data)



● pH calibration history (with check data)



● Ion calibration history

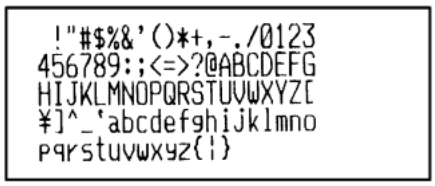


GOOD: Calibration is performed

Calibration data

Sensitivity display
Standard solution value is displayed.
No calibration/1-point calibration: None
2-point calibration: 1st item
3-point calibration: 2nd item

5.4.6 Test printing format in the Maintenance mode



6 Maintenance and Troubleshooting

This chapter explains how to perform daily meter maintenance and how to deal with error messages.
Daily maintenance is vital in assuring accurate measurement and preventing breakdowns before they occur. Maintenance of the electrodes is especially important; if ignored, various problems and erroneous measurements may result. This meter is equipped with a convenient error message function. If an error message is displayed, be sure to take appropriate action.

6.1 pH (ORP) electrode maintenance

Maintain your electrodes by referring to the following information or to the operation manuals for the electrodes.

Injury warning

Caution

Glass fragments can cause injury.
The outer tube of the electrode and the tip of the electrode are made of glass.
Use care not to break them.

The following explanation is for pH electrodes (9621-10D) ORP electrodes should be cared for in the same manner.

● Maintenance after daily use

After taking measurements, wash the electrode using pure water (de-ionized water), wipe off the water from the electrode with filter paper or tissue paper, and store it with its cap on.

Note

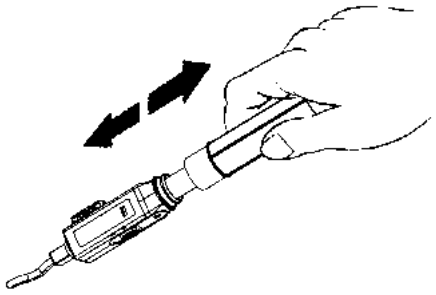
The liquid junction may become clogged if the electrode is left in distilled water.

● Extended storage

When an electrode is not to be used for a long period of time, store the electrode after performing the following steps. Also, replace the reference solution every three to six months, using the method explained below.

1. Remove the electrode from the pH meter.

2. Remove the protective cap from the electrode.

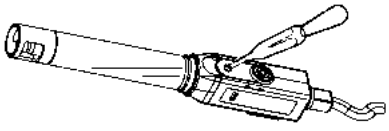


Chemical warning

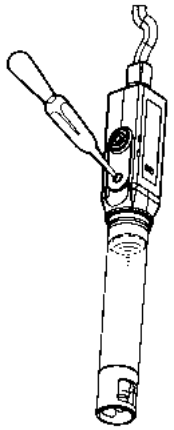
Caution

The liquid inside the electrode is highly concentrated potassium chloride (3.33 mol/L KCl).
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.

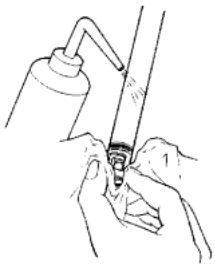
3. Open the internal solution filler port and use a syringe to remove the internal solution.



4. Fill the electrode with new internal solution (#300), until it nears the opening.



5. Wash the tip of the electrode well with pure (de-ionized) water and wipe it with filter paper or tissue paper.



6. If the liquid on the inside of the electrode cap has dried, wash the inside of the electrode cap with pure (de-ionized) water, and then, after shaking out the water, fill the cap with enough pure water to soak the sponge.

Note

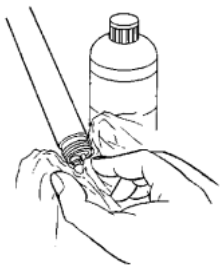
If the solution inside the protective cap for the electrode has dried up and the electrode has not been used for an extended period of time, the response speed of the electrode may be slower (and its sensitivity lower) than before.

● Washing the electrodes

If the tip of the pH electrode is extremely dirty, the speed of its response may slow and it may cause errors in measurement. If the electrode is so dirty that it cannot be cleaned by rinsing with pure (de-ionized) water, wash the electrode using the most appropriate method below.

General dirt & oily grime

Wipe the dirt/grime off using cotton gauze that contains a neutral detergent.



Inorganic grime

Rinse using a hydrochloric acid solution or cleaning liquid (#220) of approximately 1 mol/L. Be sure not to soak the electrode in strong acid for a long period of time.

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

* Change in the electric potential of the electrode (25ºC) when the ION concentration changes by a factor of 10.

Note

The above electrodes are subject to change without notice.

Maintenance of the ION electrodes listed in the above table is described on the 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 hr
K^+ ION electrode	0.1 mol/L potassium chloride solution (75 g/L KCl)	Approx. 12 hr
Ca^{2+} ION electrode	Tap water	Approx. 3 hr
NH_3 ammonia electrode	No conditioning	

● Short-term storage

Immerse electrodes 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	de-ionized 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

6.2.1 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 the electrode protective cap on. (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 a dry place.
4. To reuse the electrodes, start with the operations explained in the section entitled “ ● Before using” page 144.

● 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 weak. 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).

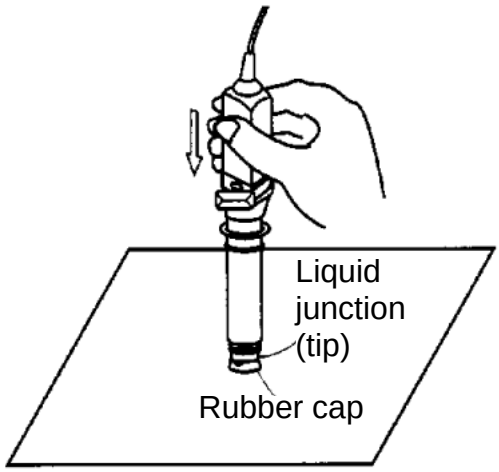
1. Open the internal solution filler port by removing the rubber stopper, turn the electrode upside down, and use a syringe to remove the reference solution.
2. Use the syringe to fill the electrode with the specified reference solution.

Ideally, a tiny amount of the reference solution should flow from the tip of the electrode. If the amount of liquid flowing out is extremely small, however, 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

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)

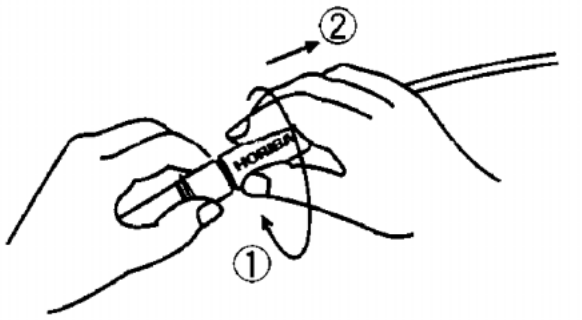
The inner tube of the electrode is of an air-tight construction that allows almost no outflow. Replace the internal solution (inner tube), however, if the electrode has been used for a long period of time and only half or less of the internal solution remains.
(The filling frequency for the internal solution varies depending on 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 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 electrode part.
2. Remove the rubber stopper from the reference solution (outer tube) filler port, and take out the internal solution using a syringe.
3. Twist the electrode cap by hand and move it approximately 5 to 10 centimeters toward the electrode connector.

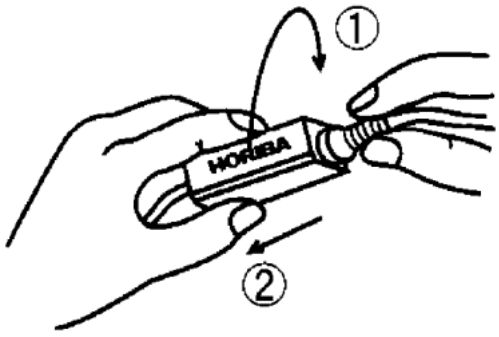


4. Remove the internal body of the electrode by holding the electrode cap by hand, and then pushing the electrode while it is standing vertically on a desk or other horizontal surface.
5. Move the silicon tube from the internal body downward, to expose the internal solution filler port (inner tube).
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.

Filling the electrode: assembly procedure

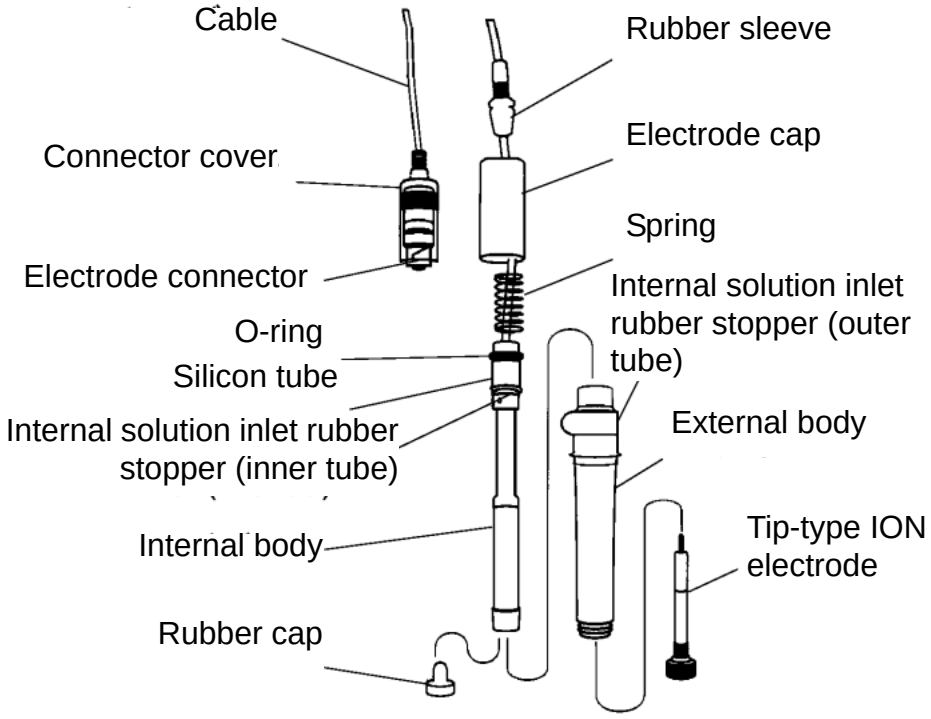
1. Return the silicon tube to its original position and seal the internal solution filler port (inner tube). (Make sure that the filler port is completely sealed.)
2. If the bodies (internal and external) or the liquid junction (tip) are dirty, wash them with pure (de-ionized) water.
3. Insert the internal body into the external body. (Make sure that the O-ring is properly in place.)
4. Return the spring to the top of the internal body.
5. Hold the rubber sleeve in place by hand, then twist the electrode protective cap 90º and fit the rubber sleeve into the electrode protective cap.



6. Maneuver the parts so that the “HORIBA” logo faces the same direction as the reference solution filler port (outer tube), then put the cap on the external body.
7. Twist the rubber sleeve 90º and hold it in place.
8. Use the syringe 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” page 146.

10. Store the electrode in accordance with the section entitled “ ● Short-term storage” page 145.



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

6.4 Dissolved oxygen electrode maintenance

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

6.4.1 Field-use electrode

● Maintenance after daily use

1. Wash the electrode well with tap water.

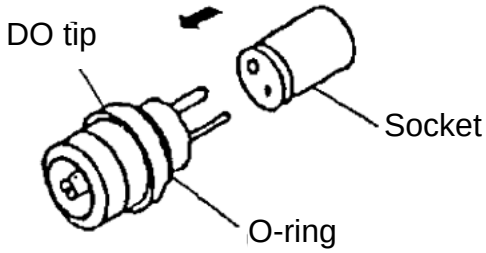
2. Store the DO tip by immersing it in tap water.

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 (de-ionized) water, and then remove the water drops using cotton gauze.
3. Remove the DO tip from the holder.
4. Place the socket over the DO tip, and 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 push on the membrane with too much force.

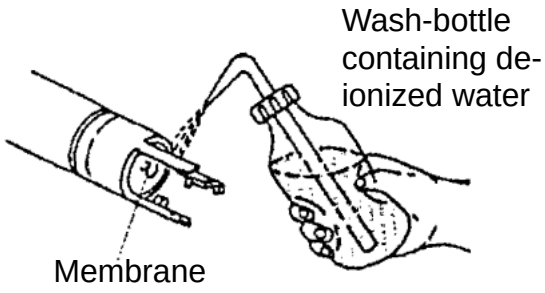
Note

Use caution not to damage the DO tip membrane.

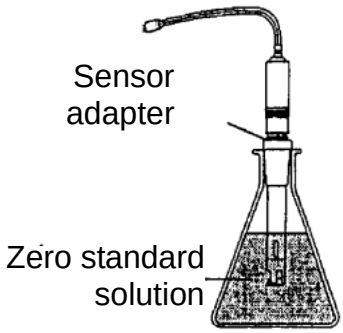
6.4.2 Laboratory-use electrode

● Maintenance after daily use

1. Wash the electrode well with pure (de-ionized) water.



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

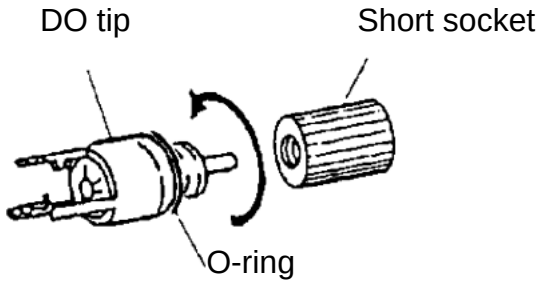


Note

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 (de-ionized) water, and then remove the water drops using cotton gauze.
3. Remove the DO tip from the electrode body.
4. Push the socket onto the DO tip, and 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 (de-ionized) water, and then wipe off the water drops using clean filter paper or cotton gauze.

6.5 Troubleshooting

The meter is equipped with a simply error-message function to notify the operator that an operation error or problem with the equipment has occurred. 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.

6.5.1 Error message chart

ERR No.	Message	Explanation
01	Memory error	Data cannot be read from or written to the internal memory.
02	Battery voltage low	The battery voltage is low.
03	Electrode stability error	The electric potential did not stabilize within three minutes.
04	Asymmetric potential error	pH: The asymmetric potential of the electrode is 45 mV or more.
05	Electrode sensitivity error	pH: The electrode sensitivity is either 105% or more or 85% or less than the theoretical sensitivity. DO: The electrode sensitivity is out of the standard.
06	Max. calibration points exceeded	pH: No more than three points can be calibrated.
07	Cannot identify standard solution	pH: The pH meter cannot identify the standard buffer.
08	Calibration cycle error	pH: Exceeds the calibration cycle setting.
09	Printer error	There is a problem with the printer.
10	Data memory over	The number of data items has exceeded the limit of the memory.
11	Cell constant out of range	COND: Cell constant is out of automatic calculation range.

● ERR No. 01 Memory error

Explanation

Data cannot be read from or written to the internal memory.

Cause	How to solve problem
The pH meter does not start operating correctly even after the power is turned ON.	Take the battery from the pH meter, and disconnect the AC adapter. Then press the ON/OFF key for about 10 seconds.
The internal IC is defective.	Seek repairs at your nearest retail outlet or HORIBA service station.

● ERR No. 02 Battery voltage low

Explanation

The battery has insufficient voltage.

Cause	How to solve problem
The battery voltage is low. (Battery voltage: 2.2V or less)	Replace the dry-cell battery.

Note

The measured value cannot be guaranteed when ERR No. 02 is displayed.

● ERR No.03 Electrode stability error

Explanation

The electric potential did not stabilize within three minutes.

Cause	How to solve problem
This is caused by the sample solution (when the sample solution is pure water or another solution with low conductivity or the pH concentration or temperature change).	Press the MEAS key again while “HOLD” is either brinking or steadily lit in the display, to measure the sample using instantaneous value measurement.
The electrode is dirty.	Wash 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 (de-ionized) water for 24 hours.
The temperature of the sample solution is fluctuating.	Measure after the sample solution temperature stabilizes.

● ERR No.04 Asymmetric potential error

Explanation

The asymmetric potential of the electrode is 45 mV or more.

Cause	How to solve problem
The electrode is dirty.	Wash the electrode.
The electrode is cracked.	Replace the electrode.
The reference solution concentration is fluctuating.	Replace the internal solution in the reference electrode.
The electrode is not connected correctly.	Connect the electrode correctly.
The electrode is not submerged deeply enough to cover the liquid junction (tip).	Immerse the electrode in the sample at least three centimeters deep.
There is problem with the standard solution.	Prepare new standard solution.

● ERR No.05 Electrode sensitivity error (pH)

Explanation

The electrode sensitivity is either 105% or more or 85% or less than the theoretical sensitivity.

Cause	How to solve problem
The electrode is dirty.	Wash the electrode.
The electrode is cracked.	Replace the electrode.
Calibration was not performed correctly.	Redo the calibration correctly.
There is a problem with the standard solution.	Use fresh standard solution.
The electrode is not connected correctly.	Connect the electrode correctly.
Electrode is not submerged deeply enough to cover reference junction.	Immerse the electrode in the sample at least three centimeters deep.

● ERR No.05 Electrode sensitivity error (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 evaporates 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)	Prepare new zero and span standard solutions.
The stirring is inappropriate.	Stir the solution appropriately (at a constant speed, between 1000 and 1500 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 it.

● ERR No.06 Max. calibration points exceeded

Explanation

Calibration was performed on a fourth calibration point.

Cause	How to solve problem
Calibration was performed on a fourth calibration point.	Limit the number of calibration points to three. This error message is cleared by setting the pH meter to Measurement mode.

Note

This error does not affect calibration data obtained from previous three calibration points.

Ref.

Refer to “ ● Standard solution calibration” page 27.

● ERR No.07 Cannot identify standard solution

Explanation

If the automatic standard-solution identification function of the meter does not work, recalibrate the meter after performing the appropriate measures below.

Cause	How to solve problem
There is a problem with the standard solution.	Prepare new standard solution.
There is a problem with the standard solution setting.	Check the NIST or US standards settings and the kind of standard solution used for calibration, and make sure they match.
The responsive membrane is dry or dirty.	Measure after washing the responsive membrane and soaking it in pure (de-ionized) water for 24 hours.
The reference solution is contaminated.	Replace the reference solution with new solution.
The responsive membrane is damaged or worn out.	Replace the electrode.

● ERR No.08 Calibration cycle error

Explanation

This error appears when the number of measurements set for the calibration cycle has been exceeded since the last calibration was conducted.

Calibrate again.

● ERR No.09 Printer error

Explanation

If a problem occurs with the printer, turn OFF the power to the meter, perform the appropriate measure below, and turn the power to the meter back ON.

Cause	How to solve problem
The printer paper is jammed.	Remove the jammed paper.
There is no printer paper.	Load the printer with paper.
There is a problem with the printer connection.	Reconnect the printer after making sure there is nothing wrong with the connector parts.
The printer is defective.	Replace the printer.

● ERR No.10 Data memory over

Explanation

The number of data items has exceeded the limit of the memory.

Cause	How to solve problem
Memory over	Delete data stored in the memory after confirming their contents.

● ERR No.11 Cell constant out of range

Explanation

The cell constant is out of the range of 0.7 to 1.3. Delete data stored in the memory after confirming their contents.

Cause	How to solve problem
COND electrode is at the end of its useful life.	Replace the electrode.
Improper standard solution	Prepare new standard solution.

6.5.2 More troubleshooting

This section explains how to respond to various symptoms of trouble that are not indicated by an error number.

● Nothing shows up on the display when the power is turned ON

Cause	How to solve problem
No batteries	Place batteries in the meter.
The batteries are loaded with the poles reversed.	Re-insert the batteries with the poles correctly oriented.
The battery voltage is low.	Remove the old batteries and correctly insert new dry-cell batteries. Or connect the unit to the optional AC adapter.

● The indicated value fluctuates

When there is a problem with the electrode...

Cause	How to solve problem
The responsive membrane is dry or dirty.	Wash the responsive membrane.
The responsive membrane is damaged or worn out.	Replace the electrode.
There are air bubbles on the electrode.	Shake the electrode to remove the air bubbles.

Cause	How to solve problem
There is no reference solution remaining.	Fill the electrode with new reference solution, as noted in the electrode operation manual.
The wrong reference solution is being used.	Use the correct reference solution.

When there is a problem with the main unit of the pH meter...

Cause	How to solve problem
There is a motor or other device causing electrical interference.	Move the meter to a place where it is not subject to dielectric effects. Be sure to ground devices that are using commercial electricity.
The electrode is not connected correctly.	Connect the electrode correctly.

When there is a problem with the sample solution...

Cause	How to solve problem
The liquid junction is not immersed in the sample solution.	Immerse the electrode in the sample solution up until the liquid junction or deeper.
Some effects of the sample	Determine if this is the cause by measuring with a stable standard solution.

● The response is slow

Cause	How to solve problem
Some effects of the sample	Response time may slow down, depending on the properties of the sample solution.
The electrode is dry or dirty.	Wash the responsive membrane.
The electrode is cracked or worn out.	Replace the electrode.
There is a problem with the reference solution.	Fill the electrode with new reference solution, as noted in the electrode instruction manual.

● The indicated value does not change, or there is absolutely no response

Cause	How to solve problem
The key-lock function is ON.	Turn the power OFF, and then turn it back ON again.
The system is locked.	Turn the power OFF, and then turn it back ON again.
The electrode connector is not attached correctly.	Attach the electrode connector correctly.
The electrode is defective. (the responsive membrane is cracked.)	Replace the electrode.
pH meter is defective.	Contact your local HORIBA distributor.

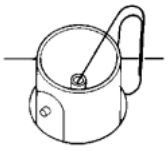
● The measured value is blinking

The pH value exceeds the measurement range (when pH value is displayed).
Measurement range: pH 0.00 – pH 14.00
The mV value exceeds the measurement parameters (when mV value is displayed).
Display range: ±1999 mV
The ION measurement value is out of the range (in the ION mode).
Display range: 99.9 or above
The measured conductivity value exceeds the measurement parameters (when conductivity value is displayed).
Display range: 0.00 – 19.99 (when cell constant is 100 m^{-1})
The measured DO value exceeds the measurement parameters (when DO value is displayed).
Display range: 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 or deeper.
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 this point

As shown in the diagram, use a jumper wire or bent paper clip to short the meter by touching both the center pin and some metal part in the electrode connector.
If the flaching measured value disappears when this done, the meter is nomal.



● CLR is flashing (during ION measurement)

Concentration cannot be measured correctly.

Cause	How to solve problem
The pH meter is in default (initial-ized) status.	Calibrate the pH meter.

● The temperature display is blinking.
The temperature display does not change from 25ºC.

The temperature measurement exceeds the measurement range.

Measurement range: -10 – 100.0ºC

Cause	How to solve problem
The temperature of the sample solution exceeds the measurement range.	Check the temperature of the sample solution and change to a sample solution that has a temperature within the measurement range.
The thermistor connection within the electrode is severed or shorted.	Measure the resistance of the temperature sensor connector. If it is 50 kΩ or more at room temperature, replace the electrode.
The electrode connector is not attached properly.	Attach the electrode connector properly, so that the O-ring on the temperature connector disappears from sight.
The main unit of the meter may be defective.	In Temperature Display Calibration mode (See “ ● Temperature zero adjustment [item No. 02]” page 93), check whether or not the “Minus” display appears, regardless of whether or not there is a tempera-ture connector.
There is a problem with the setting for the temperature display calibration mode (see page 93).	Initialize the settings (see page 97).

● Measurements are not repeatable

Cause	How to solve problem
Some effects of the sample solution	The pH or other properties of the sample solution may have changed over time, making repeatability poor.
The responsive membrane is dry or dirty.	Wash the responsive membrane.
There is not enough reference solution or it is dirty.	Replace the reference solution with new solution.
The responsive membrane is cracked or worn out.	Replace the electrode.

● When the printer will not print even though it is connected

Check the following points:

- Is the printer turned ON?
- Has a printer error occurred?
- Is there printing paper? Has the paper jammed?
- When running a test print according to the manual, does it print out correctly?

7 Reference

This chapter provides a simple compilation of information for those who would like to know about the functions of the main unit of the meter and other measurement principles in greater detail.
It also serves as a reference for spare and optional parts.

7.1 pH measurement

● pH measurement and temperature

The temperature of the solution being inspected is an important parameter in the accurate measurement of pH. There are many possible sources of errors during measurement, such as the state of the solution junction potential, asymmetric potential, and reference solution pH concentration, but all of these items contain factors that change with temperature. The best way to minimize these potential causes of errors is to keep the temperature of the pH standard solution uniform at the time of calibration.

● Liquid junction potential

"Liquid junction potential" is the electric potential that occurs to a greater or lesser degree at the liquid junction. The size of the electric potential differs depending on the type of solution, the temperature of the solution, and the structure of the liquid junction.

When solutions of different compositions come in contact, ION diffusion occurs on the contact surface between the two solutions. The ions are of various sizes, so a difference occurs in the diffusion transfer speed.

As diffusion proceeds, a difference in charges occurs on the contact surface of the two solutions, giving rise to a difference in potential. This potential works to reduce the transfer speed of fast ions and increase the speed of slow ions, ultimately achieving a state of equilibrium when the transfer speed of the positive and negative ions on the contact surface of the two solutions is equal. In this state of equilibrium, the potential at the contact surface between the two solutions is called the "liquid junction potential." A large liquid junction potential means measurements will be very inaccurate.

● Asymmetric potential

The glass electrode is immersed in a pH 7 reference solution. When the electrode is immersed in the pH 7 solution, both the internal and external sides of the electrode membrane are supposed to take on a pH of 7, making the potential 0. In actuality, however, a potential does occur. This potential is called "asymmetric potential." The size of the asymmetric potential differs depending on any stress that may have occurred during the processing of the glass and the shape and compositions of the glass. Asymmetric potential also changes depending on the degree of contamination of the reference solution and the state of the glass membrane. Also, if the electrode membrane dries out, a large asymmetric potential will occur, giving rise to measurement errors.

● Temperature compensation

The electromotive force generated by the glass electrode changes depending on the temperature of the solution. “Temperature compensation” is used to compensate for the change in electromotive forces caused by temperature. There is absolutely no relation between the change in pH caused by the temperature of the solution and temperature compensation. This is often misunderstood. When pH is to be measured, the temperature of the solution when the pH is measured must be recorded along with that pH value, even if a meter that has automatic temperature compensation is used. If the solution temperature is not recorded, the results of the pH measurement are relatively meaningless.

● Types of pH standard solutions

When measuring pH, the pH meter must be calibrated using a standard solution. There are several kinds of standard solutions. For normal measurement, three standard solutions—with a pH of 4, 7, and 9—are sufficient to accurately calibrate the meter.

- pH 1.68 standard solution: Oxalate
  0.05 mol/L tetra-potassium oxalate aqueous solution
- pH 4.00 standard solution: Phthalate
  0.05 mol/L potassium hydrogen phthalate aqueous solution
- pH 6.86 standard solution: Neutral phosphate
  0.025 mol/L potassium dihydrogen phosphate, 0.025 mol/L sodium dihydrogenphosphate aqueous solution
- pH 9.18 standard solution: Borate
  0.01 mol/L tetra-sodium boric acid (boric sand) aqueous solution
- pH 12.45 standard solution: Saturated calcium hydroxide solution

pH values of pH standard solutions at various temperatures (NIST (former NBS) settings)

Temp. (°C)	pH 1.68 standard solution Oxalate	pH 4.00 standard solution Phthalate	pH 6.86 standard solution Neutral phosphate	pH 9.18 standard solution Borate	pH 12.45 standard solution Saturated calcium hydroxide solution
0	1.666	4.003	6.984	9.464	13.423
5	1.668	3.999	6.951	9.395	13.207
10	1.670	3.998	6.923	9.332	13.003
15	1.672	3.999	6.900	9.276	12.810
20	1.675	4.002	6.881	9.225	12.627
25	1.679	4.008	6.865	9.180	12.454
30	1.683	4.015	6.853	9.139	12.289
35	1.688	4.024	6.844	9.102	12.133
38	1.691	4.030	6.840	9.081	12.043
40	1.694	4.035	6.838	9.068	11.984
45	1.700	4.047	6.834	9.038	11.841

Note

When the standard solutions use US settings, the pH 7 values shown in the following table are different and pH 9 becomes pH 10 (see next page).

pH values of pH 7 and pH 10 standard solutions at various temperatures (US-standard settings)

Temp. (°C)	pH 7 standard solution Neutral phosphate	pH 10 standard solution Carbonate
0	7.119	10.318
5	7.086	10.245
10	7.058	10.178
15	7.035	10.117
20	7.015	10.061
25	7.000	10.011
30	6.988	9.965
35	6.979	9.925
40	6.973	9.888
45	6.969	9.856

Note

Calibration is performed using Nernst's equation with the above values.

● Using standard solutions

Standard solutions are used to calibrate the scale of the pH meter employed to measure the unknown pH of a solution. Standard solutions of pH 4, 7, and 9 are used in combination according to the particular conditions of the solution that is to be inspected.

When the approximate pH value is desired (1-point calibration)

Use the pH 7 standard solution or a standard solution that approximates the pH value of the solution that is to be inspected.

When it is known beforehand whether the test solution is acidic or alkaline (2-point calibration)

Acidic: Use the pH 4 and 7 standard solutions.
Alkaline: Use the pH 7 and 9 standard solutions.

When an unknown solution is to be inspected (3-point calibration)

Use the pH 4, 7, and 9 standard solutions.

Other

When finding the pH of other solutions, perform 2-point or 3-point calibration using pH 2, 4, 7, 9, or 12 standard solutions randomly, then measure the test solution.

7.2 mV (oxidation-reduction potential [ORP]) measurement

● ORP principles

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

For one type of equilibrium in a solution:

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

If only ① exists within a solution, a metal electrode (platinum, gold, etc.) and a reference electrode are inserted into the solution, forming the ORP measuring system shown in Fig. 1. Measuring the potential (ORP) that exists between the two electrodes enables the potential to generally be expressed by the following equation.

$$E = E_0 - \frac{RT}{nF} \ln \frac{aM^{(z-n)+}}{aM^{z+}} \qquad \cdots\cdots ②$$

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

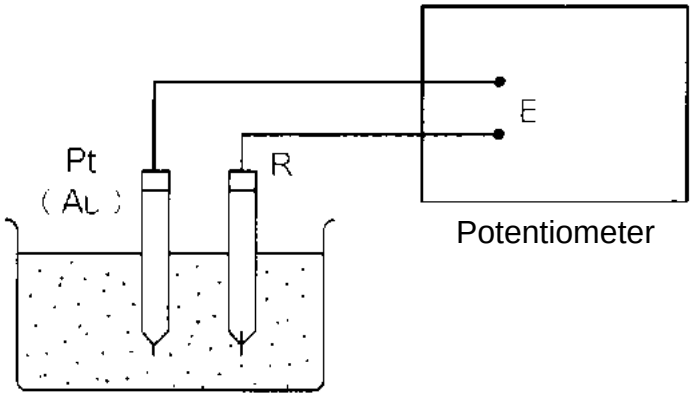


Fig. 1 ORP measuring system

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

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

$$E = E_0 - \frac{RT}{F} \ln \frac{aFe^{2+}}{aFe^{3+}} \quad \text{•••••• ②'}$$

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

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

Recently, various claims have appeared regarding this matter. For example, that a high degree of ORP is effective in sterilization, or that drinking water that has a low ORP reduces the chance of illness by reacting with the activated oxygen in the cells of the body. ORP is used as an index for alkaline drinking water.

● Standard electrode (reference electrode) types and ORP

The ORP of a solution that is obtained through measurement is a value that corresponds to the reference electrode employed. If different kinds of reference electrodes are used for measurement, the ORP value of the same solution may appear to be different.

HORIBA uses Ag/AgCl with 3.33 mol/L KCl as the reference solution for reference electrodes. According to general technical literature, standard hydrogen electrodes (N.H.E.) are often used as the standard electrode. The relationship between N.H.E. and the ORP that is measured using an Ag/AgCl with 3.33 mol/L KCl electrode is expressed by the following equation.

$E_{N.H.E.}$= E+206-0.7(t-25) mV t = 0 – 60ºC

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

E : Measured ORP value using Ag/AgCl with 3.33 mol/L

KCl as the reference electrode

● Potential sign

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

A) $Li^+ + e^- \rightarrow Li$

E_0=-3.024 V VS N.H.E.

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

B) $Li \rightarrow Li^+ + e^-$

E_0=+3.024 V VS N.H.E.

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

● ORP standard solution

There are two kinds of standards substances. Under normal circumstances, it is sufficient to use only that type of substance which is closest to the measured value.

Indicated value of ORP standard solution at various temperatures (mV)

temp. (ºC)	160 - 22 Phthalic-acid chloride + quinhydrone	160 - 51 Neutral phosphate + quinhydrone
5	+274.2	+111.9
10	+270.9	+106.9
15	+266.8	+101.0
20	+262.5	+95.0
25	+257.6	+89.0
30	+253.5	+82.7
35	+248.6	+76.2
40	+243.6	+69.0

Operation check using standard solution

Note

Standard solution is not used only for the calibration of the meter, but to confirm whether or not the condition of electrodes is good.

1. Add 250 mL pure (de-ionized) water to one packet of any of the previously listed standard solutions and mix well. (When mixing, the excess quinhydrone [a black powder] will float to the surface of the solution.)
2. Immerse a washed and dried ORP electrode in the ORP standard solution and measure the mV value.
3. If the electrode and the meter itself are working correctly, numerical values within ± 15 mV of those listed in Table 1 should be obtained.
4. If measurements falling within 15 mV of the values listed above are not obtained using this method, measure the solution again after replacing the reference electrode internal solution and removing any dirt from the surface of the metal electrode by moistening a cotton swab with alcohol or a neutral cleaning agent and lightly rubbing the electrode or by soaking the electrode in diluted nitric acid (1:1 nitric acid).
5. If measurements within 15 mV of the values are still not obtained after re-measuring, the reference electrode or the meter may be faulty. Either replace the electrode or have the meter inspected.

Note

If the prepared ORP standard solution is allowed to stand in open air for one hour or more, it may undergo transformation. For this reason prepared ORP standard solution cannot be stored.
When measuring a solution that has low concentrations of oxidants and reductants after conducting an operational check using a standard substance, the measured values may not stabilize or the results of measurement might not be repeatable. If this is the case, use the meter after immersing the electrodes in the solution again and mixing it thoroughly.

● Precautions when measuring actual samples

- Note that when measuring the ORP of a solution that has extremely low concentrations of oxidants and reductants (such as tap water, well water, or water treated with purifying equipment), there may be less responsiveness, repeatability, and stability, in general.
- When alkaline water is allowed to stand, its ORP undergoes considerable changes. Always measure alkaline ION water promptly.

7.3 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, 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:

$E=E_0+(2.303RT/nF) \log \gamma C$

E: Measured electric potential (V)

E_0: Standard potential (V), determined according to the system. This includes the standard potential of the reference electrode and the liquid junction potential.

F: Faraday constant (96,480 $Cmol^{-1}$)

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 Nernst's equation that reads “2.303 RT/nF” is the change in potential generated when the ION concentration changes by a factor of 10. This change in potential is called the potential slope, incline, slope, or Nernst's factor. If the above equation is adhered to when calibrating with standard solution and determining the value of the potential slope and E_0, finding the potential E of the ION 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. 2. 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.

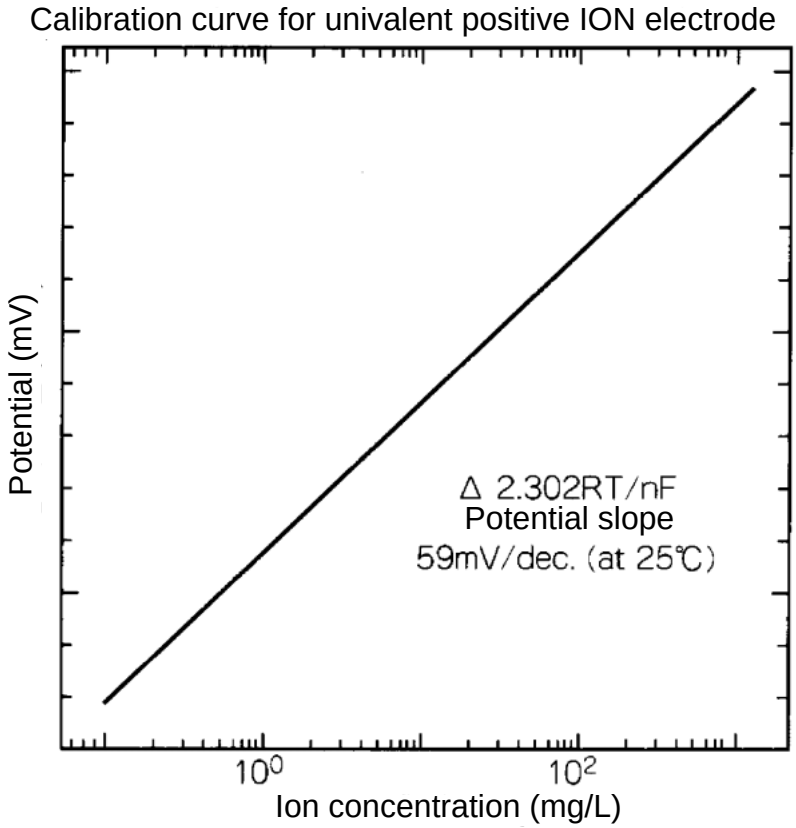


Fig. 2 Relationship between ION concentration and electric potential

● 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 meter 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 solution that has been used should not be returned to the original container. It 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.

7.4 Conductivity measurement

● 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	Electrode model	KCl standard solution	KCl Weight	Solution temp.	Conductivity value
SI units 100 m^{-1} (former unit designation 1 cm^{-1})	9382 -10D	0.01 mol/L	0.7440 g	0ºC	77.4 mS/m (0.774 mS/cm)
				18ºC	122.0 mS/m (1.220 mS/cm)
				25ºC	140.8 mS/m (1.408 mS/cm)

Prepare the potassium chloride standard solution (KCl 0.01 mol/L) using the procedure below.
In addition, if an error of 5% of more compared to the above values occurs, calibrate the cell constant (See page 52).

● 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 ºC, then cool it in a desiccator. Measure out the above-listed amount of potassium chloride into a beaker and dissolve it in de-ionized water. Then, pour this solution into 1-liter volumetric flask and add de-ionized water until the indication line.

● 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. 3, 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 it is full and alternating current is run between the plates.

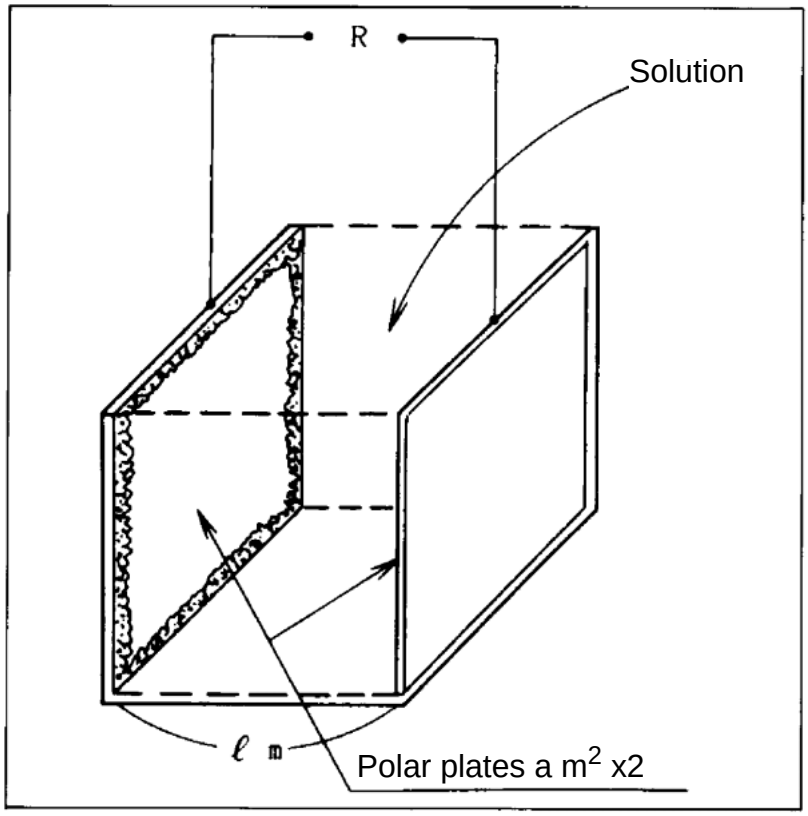


Fig. 3 Conductivity cell example

Each positive and negative ION in the solution will migrate toward the oppositely 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 x 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 (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) 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 25ºC.

● New units (SI units)

New measurement units, called SI units, have come into use in recent years. Accordingly, the meter 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}	⇒	100 m^{-1}
	0.1 cm^{-1}	⇒	10 m^{-1}
	10 cm^{-1}	⇒	1000 m^{-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 1ºC. The temperature coefficient is expressed in units of “%/ºC (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%/ºC (25ºC

standard), within a range where the size of the temperature change is not very large.
The meter is 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 25ºC, using a temperature coefficient of 2%/ºC.

● Conductivity and temperature coefficients for various solutions

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

Sub-stance	Temp. (ºC)	Conc. (wt%)	Cond. (S/m)	Temp. coef. (%/°C)	Sub-stance	Temp. (ºC)	Conc. (wt%)	Cond. (S/m)	Temp. coef. (%/°C)
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			—	—	—

Sub-stance	Temp. (ºC)	Conc. (wt%)	Cond. (S/m)	Temp. coef. (%/°C)	Sub-stance	Temp. (ºC)	Conc. (wt%)	Cond. (S/m)	Temp. coef. (%/°C)
H_2S0_4	18	5	20.85	1.21	NH_4Cl	18	5	9.18	1.98
		10	39.15	1.28			10	17.76	1.86
		20	65.27	1.45			15	25.86	1.71
		40	68.00	1.78			20	33.65	1.61
		50	54.05	1.93			25	40.25	1.54
		60	37.26	2.13	NH_4NO_3	15	5	5.90	2.03
		80	11.05	3.49			10	11.17	1.94
		100.14	1.87	0.30			30	28.41	1.68
		—	—	—			50	36.22	1.56
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

7.5 Dissolved oxygen measurement

● Measuring dissolved oxygen

"Dissolved oxygen" (DO) is the concentration of oxygen that is dissolved in water. DO is essential in 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 measurement using a DO tip are explained below.

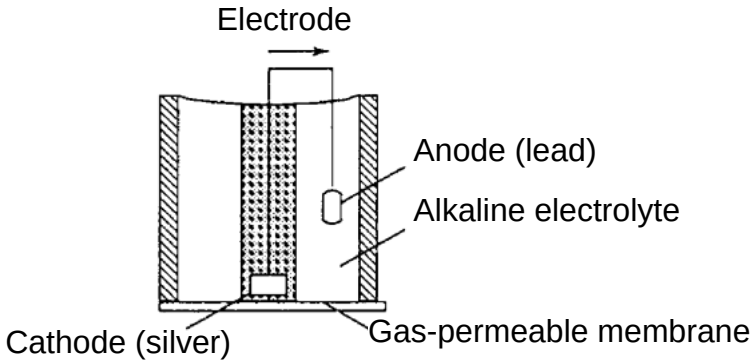


Fig. 4 DO tip measurement

A precious metal (silver) is used as the cathode, which is tightly affixed 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 measurement 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 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 higher the salinity concentration within a solution, the larger H becomes, and, consequently, 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 in which the solution is in contact.

At 25ºC, 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 to 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-55 meter 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 equation below.

When calibration is finished, the value derived from this equation is displayed.

Compensated value = (1013/P) x measured value

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

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

Temp. (ºC)	Saturated DO (mg/L)	Temp. (ºC)	Saturated DO (mg/L)	Temp. (ºC)	Saturated DO (mg/L)	Temp. (ºC)	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

7.6 Specifications

● Measurement target

Target	Item	Description	D-52	D-53	D-54	D-55
pH	Measurement principle	Glass electrode	○	○	○	○
	Display range	pH -2.00 – 16.00				
	Measurement range	pH 0.00 – 14.00				
	Resolution	0.01 pH				
	Repeatability	±0.01 pH ±1digit				
Temp.	Measurement principle	Thermistor	○	○	○	○
	Measurement range	0.0 – 100.0 ºC				
	Resolution	0.1 ºC				
	Repeatability	±0.1 ºC ±1digit				
mV	Measurement range	±1999 mV	○	○	○	○
	Resolution	1 mV				
	Repeatability	±1 mV ±1digit				
Ion	Measurement principle	ION electrode	–	○	–	–
	Measurement range	0.00 μg/L – 999 g/L(mol/L)				
	Resolution	3-digit valid numbers				
	Repeatability	±0.5% ±1 digit of full scale				

Target	Item	Description	D-52	D-53	D-54	D-55
Conductivity	Measurement principle	2 AC bipola method	–	–	○	–
	Measurement range	Cell constant 100 m^{-1} 0.000 mS/m – 19.99 S/m Cell constant 10 m^{-1} 0.0 μS/m – 1.999 S/m Cell constant 1000 m^{-1} 0.00 mS/m – 1999.9 S/m				
	Resolution	0.05% of full scale				
	Repeatability	±0.5% ±1 digit of full scale				
Dissolved Oxygen	Measurement principle	Membrane galvanic cell	–	–	–	○
	Measurement range	0.00 – 19.99 mg/L				
	Temperature compensation	0 – 40 ºC				
	Resolution	0.01 mg/L				
	Repeatability	±0.1 mg/±1 digit				

● Items in common among meter models

Data memory capacity	Max. 300 pieces of data
Power	Dry cell batteries type:AA alkaline with automatic power OFF function
Ambient temperature	0 – 45 ºC
Dimensions	170(H) × 80(W) × 40(D) mm
Mass of main unit (including batteries)	300 g (D-52) 330 g (D-53,54,55)

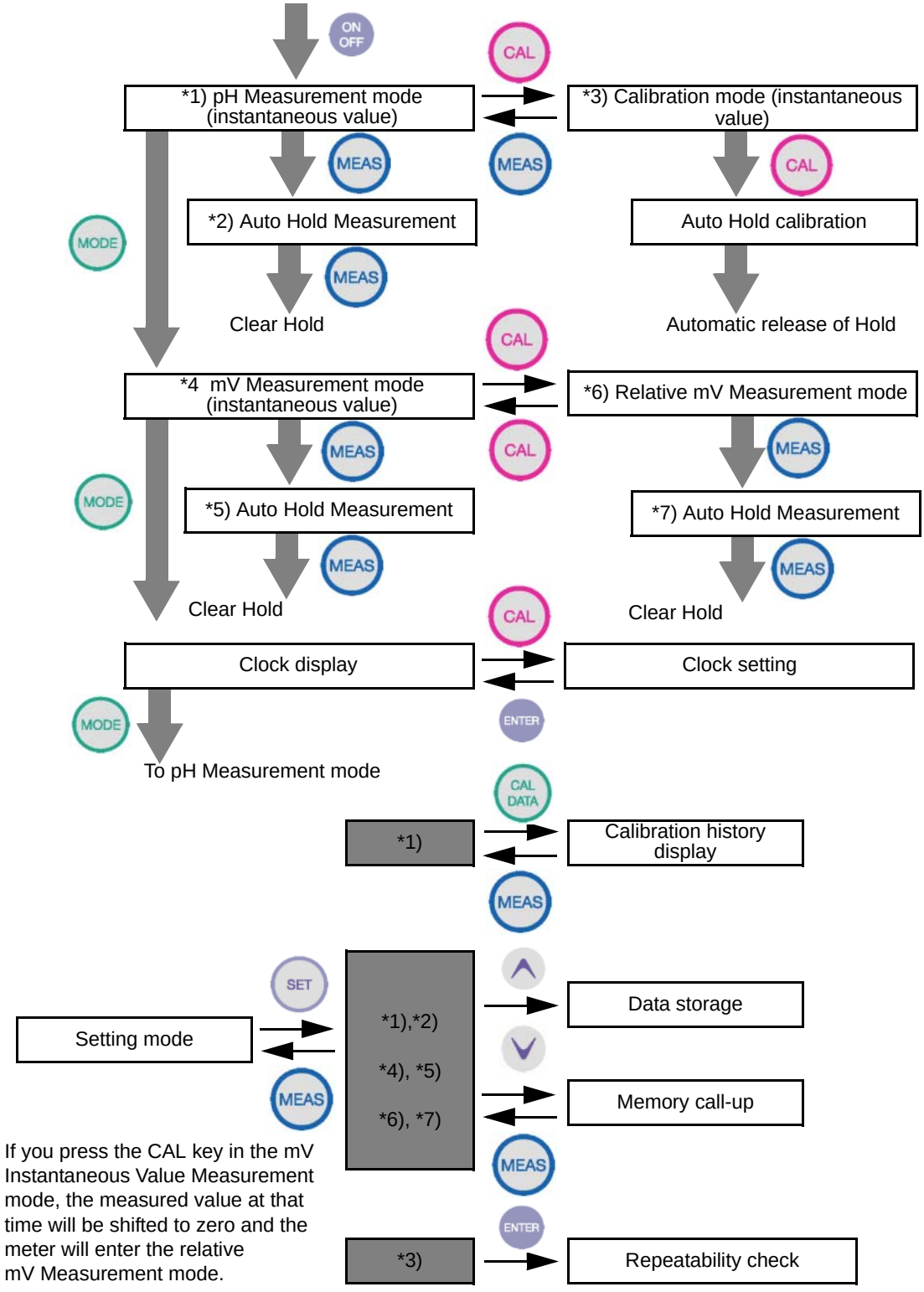
7.7 Default settings

Category	Item	Default values
Common setting	Temperature compensation	Automatic temperature compensation
	Manual temperature compensation	25 ºC
	Automatic power OFF	Approx. 30 min (ON)
	Sample ID	00000
	Calibration cycle	OFF
	Auto data memory	OFF
pH	Standard calibration solution	NIST
	Calibration setting	Asymmetric potential: 0mV Sensitivity: 100%
Ion	Ion slope	+1
	Unit	g/L
	Channel setting	CH1: pH, CH2: ion
Conductivity	Unit	S/m
	Temperature coefficient	2.0 %/ºC (ON)
	Cell constant	1.0 x 100 m^{-1}
Dissolved oxygen	Salinity	0.0 ppt
	Air pressure	1013 hPa

7.8 Operation flowcharts

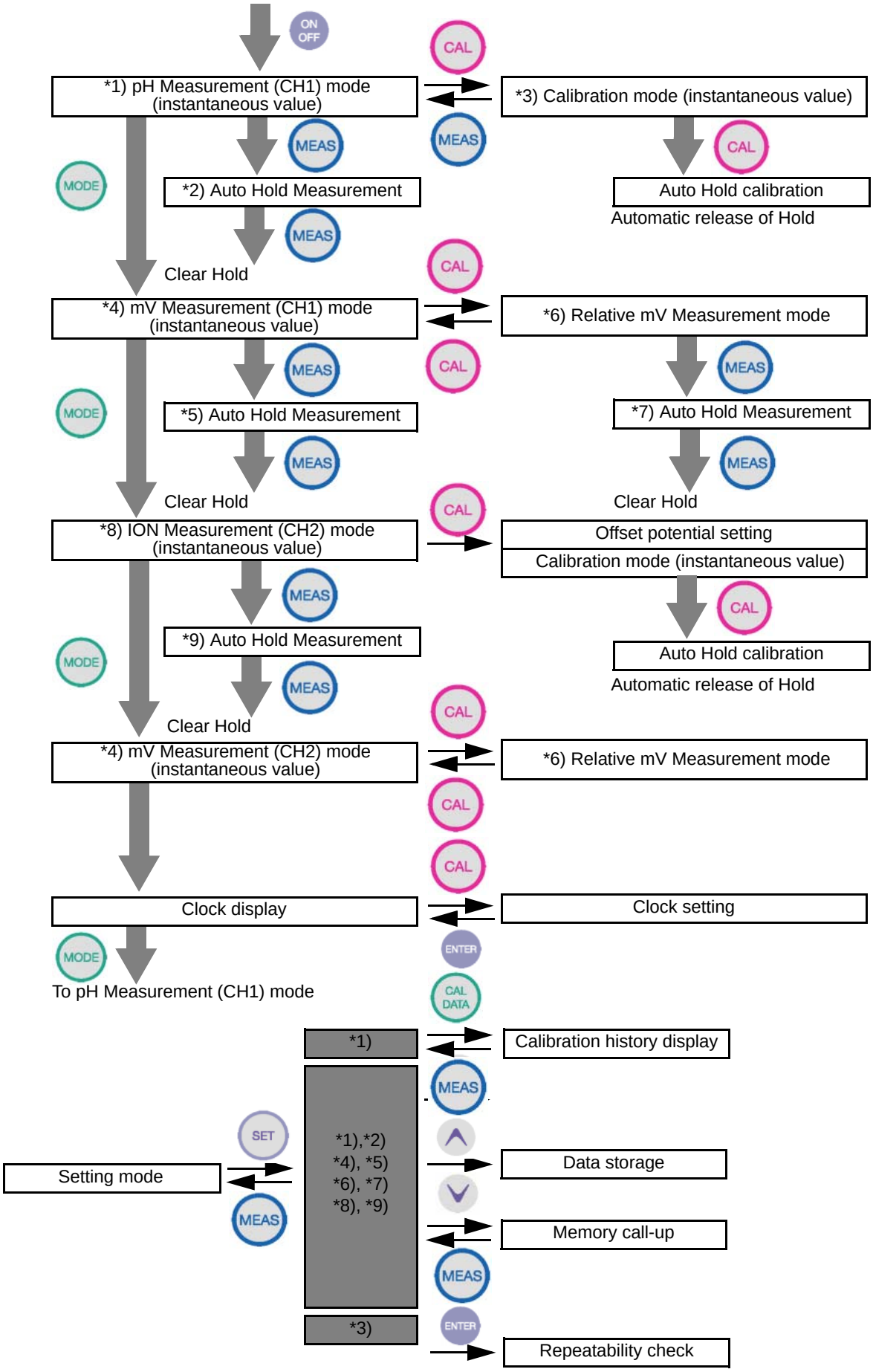
The following summarizes the operational flow for each of the pH meter models.

● D-52 basic operation flow

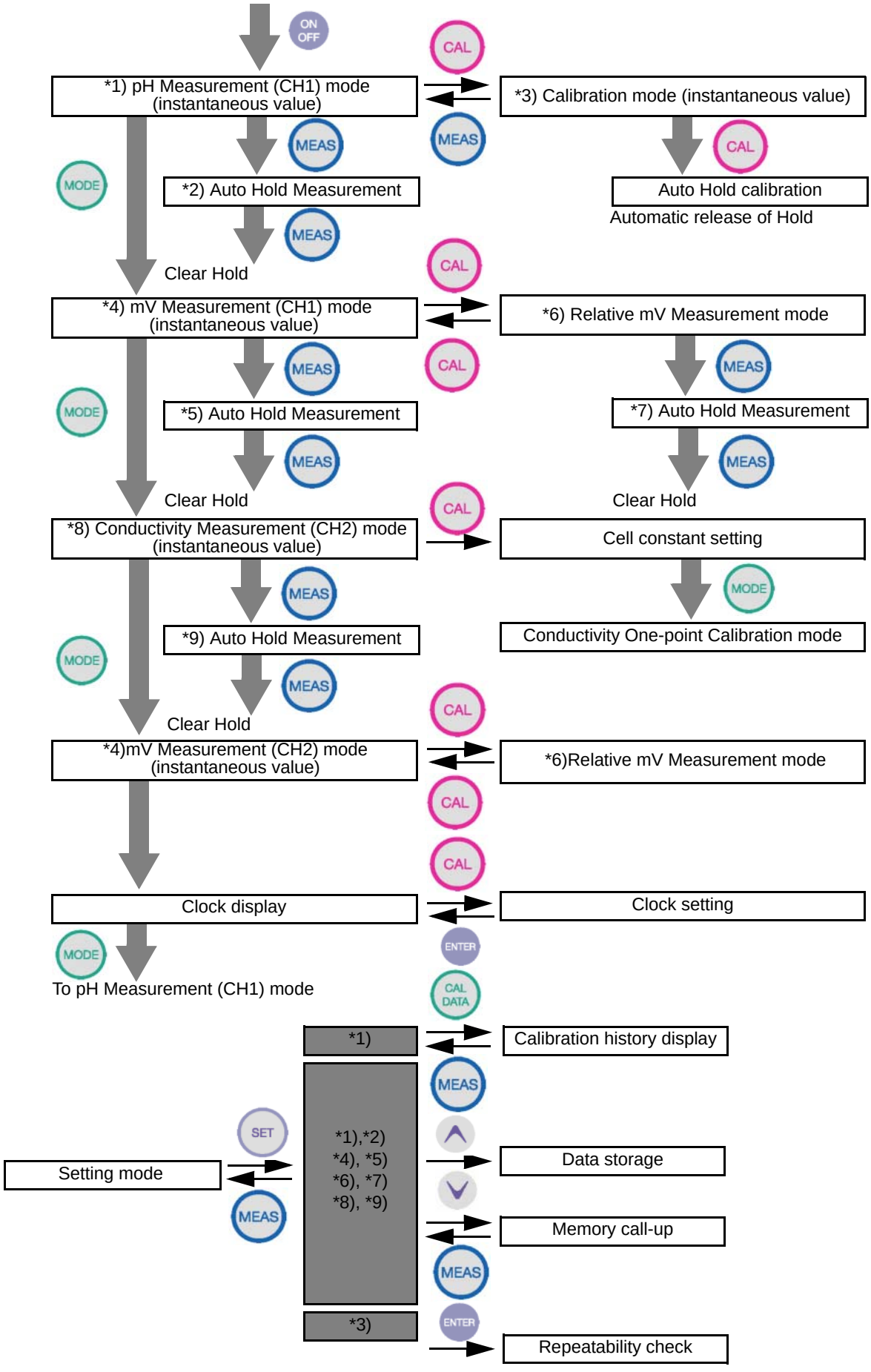


If you press the CAL key in the mV Instantaneous Value Measurement mode, the measured value at that time will be shifted to zero and the meter will enter the relative mV Measurement mode.

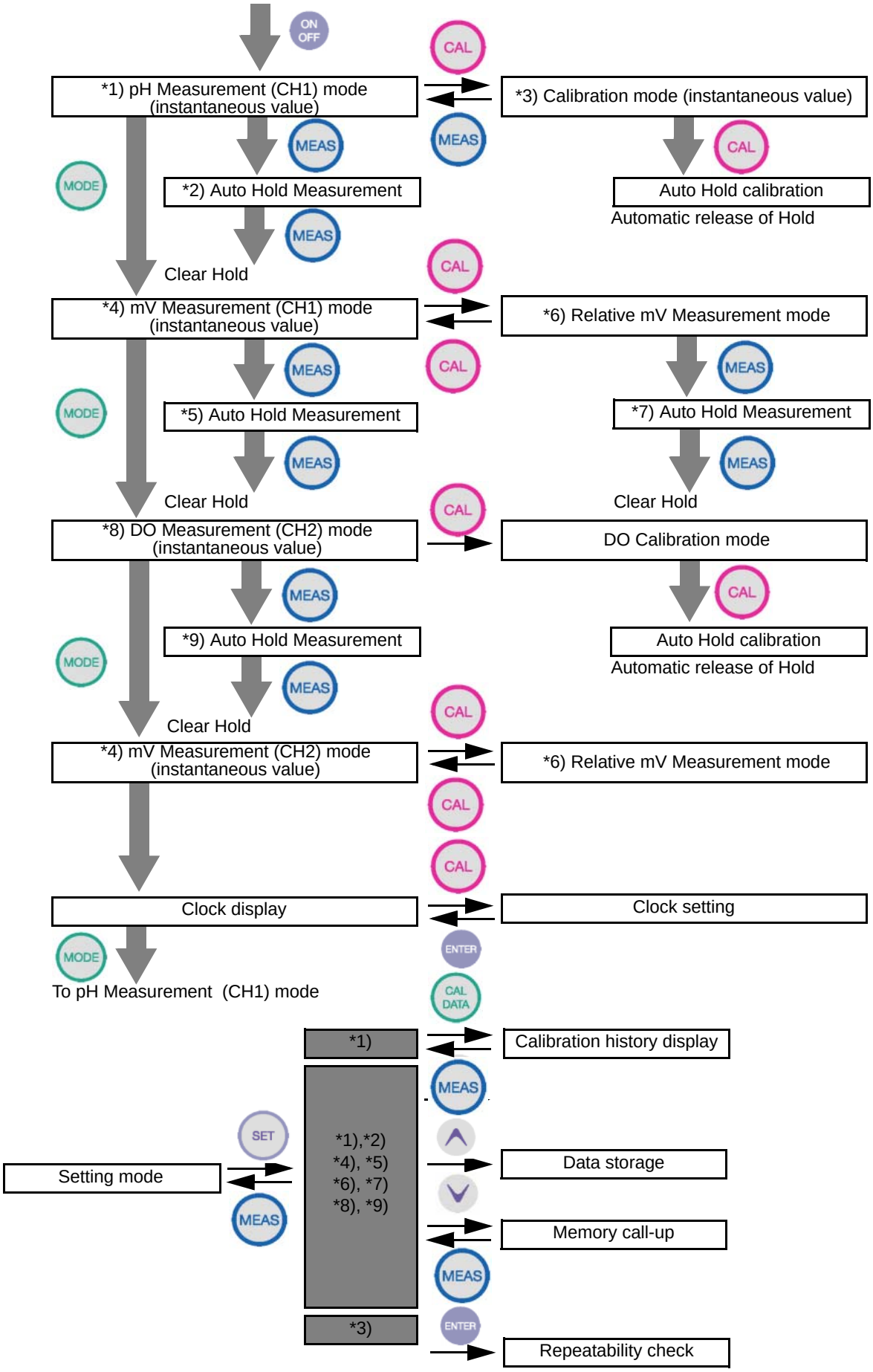
● D-53 basic operation flow



● D-54 basic operation flow



● D-55 basic operation flow



7.9 Pin layout of special cables

7.9.1 RS-232C communications cable

Meter main unit		Printer
MINI DIN8M		D-SUB 9-PIN
2;CTS	—	7;RTS
3;TXD	—	2;RXD
4;GND	—	5;GND
5;RXD	—	3;TXD

7.9.2 Cable for CITIZEN printer

CBM-910-24RJ100-A

Meter main unit		Printer
MINI DIN8M		D-SUB 25-PIN
2;CTS	—	20;BUSY
3;TXD	—	3;RXD
4;GND	—	7;GND
5;RXD	—	2;TXD

7.9.3 Cable for SEIKO printer

DPU-H245AS-A03A

Meter main unit		Printer
MINI DIN8M		D-SUB 25-PIN
2;CTS	—	8;BUSY
3;TXD	—	3;DATA
4;GND	—	5;GND
5;RXD	—	2;OPEN

7.10 Spare and optional parts

This section lists spare and optional parts for the pH meter.
These parts are available through HORIBA distributors. Place an order specifying their name, model, and part number.

7.10.1 Spare parts list

● pH electrode (with built-in temperature sensor)

Part name	Model	Part number	Remarks
D-50 series standard electrode	9621-10D	9096001700	Plastic-body electrode (for immersion measurement)
F-50 series standard electrode	9611-10D	9096001800	Glass-body electrode (reinforced responsive glass)
Laboratory-use electrode for slurry samples	9677-10D	9096002000	Built-in washable reference electrode (reinforced responsive glass)
Laboratory-use electrode for micro samples	9669-10D	9096001900	Electrode incorporating temperature sensor compatible with micro sample measurement Tip: ϕ3, 55 mm

● pH electrode (without built-in temperature sensor)

Part name	Model	Part number	Remarks
Low-end electrode	6066-10C	9003013400	Glass-body electrode
Electrode for NMR tubes	6069-10C	9003013500	Tip: ϕ3, 180 mm

● ORP electrode (with built-in temperature sensor)

Part name	Model	Part number	Remarks
Standard ORP electrode	9300-10D	9096000400	Flat platinum type

● ORP electrode (without built-in temperature sensor)

Part name	Model	Part number	Remarks
ORP electrode (without built-in temperature sensor)	6861-10C	9003013100	Bar-shaped platinum type

● ION electrode for D-53

Part name	Model	Part number	Remarks
Chloride ION electrode	6560-10C	9003014500	Combined ION electrode
Fluoride ION electrode	6561-10C	9003014600	Combined ION electrode
Nitric acid ION electrode	6581-10C	9003014700	Combined ION electrode
Potassium ION electrode	6582-10C	9003014800	Combined ION electrode
Calcium ION electrode	6583-10C	9003014900	Combined ION electrode
Ammonia ION electrode	5002-10C	9003016600	Combined ION electrode

Spare tip for ION electrode

Part name	Model	Part number	Remarks
Chloride ION tip	7660	9003015000	For 6560-10C
Fluoride ION tip	7661	9003015100	For 6561-10C
Nitric acid ION tip	7681	9003015200	For 6581-10C
Potassium ION tip	7682	9003015300	For 6582-10C
Calcium ION tip	7683	9003015400	For 6583-10C

Internal reference solution for ION electrodes

Part name	Model	Part number	Remarks
Internal reference solution for chloride ion	301	9037006700	6560-10C For outer tube: 50 mL
Internal reference solution for fluoride ion	300	9003003200	6561-10C, 6583-10C For outer tube: 250mL
Internal reference solution for nitric acid ion	302	9037006600	6581-10C For outer tube
Internal reference solution for potassium ion	303	9037006900	6582-10C For outer tube: 50mL
Internal reference solution	330	9037005200	For all 65XX-10C For inner tube: 250mL

COND electrode for D-54

Part name	Model	Part number	Remarks
Water-proof type conductivity electrode	9382-10D	9096000300	Water-proof Cell constant 100 m^{-1}
Conductivity electrode	3551-10D *1)	9056000800	For low conductivity Cell constant 10 m^{-1}
	3553-10D *1	9056001000	For high conductivity Cell constant 1000 m^{-1}
Flow-through type conductivity electrode	3561-10D *1)	9056001100	For low conductivity Cell constant 10 m^{-1}
	3562-10D *1)	9056001200	General purpose Cell constant 100 m^{-1}
	3573-10C *1)	9056001300	For high conductivity Cell constant 1000 m^{-1}
	3574-10C *1)	9056001400	For micro samples Cell constant 1000 m^{-1}

*1): The pH electrode and conductivity electrode interfere with each other when both are immersed in the same sample container and measurements are made at the same time. Make sure each measurement is made one at a time with only one electrode in the sample.

Note

Actual cell constants vary within ±10% of the above values.

● DO electrode

Part name	Model	Part number	Remarks
Water-proof DO electrode	9520-10D	9096000500	Water-proof type For laboratory use
	9551-20D	9096002300	On-site immersion type Cable length 2 m
	9551-100D	9096002400	On-site immersion type Cable length 10 m

DO electrode spare tip

Part name	Model	Part number	Remarks
Spare tip	7541	9074000200	For 9520
	5401	9033010000	For 9551

● pH standard solution

Part name	Model	Part number	Remarks
pH2 standard solution	100-2	9003001500	500 mL Accuracy: ±0.02 pH
pH4 standard solution	100-4	9003001600	
pH7 standard solution	100-7	9003001700	
pH9 standard solution	100-9	9003001800	

Part name	Model	Part number	Remarks
pH2 standard solution powder	150-2	9003002600	Makes 500mL (10 packets) Accuracy: ±0.05 pH
pH4 standard solution powder	150-4	9003002700	
pH7 standard solution powder	150-7	9003002800	
pH9 standard solution powder	150-9	9003002900	

● Standard solution for ORP check

Part name	Model	Part number	Remarks
Standard solution for ORP check	160-51	9003003100	ORP 95 mV For Ag/AgCl electrode at 20ºC
	160-22	9003003000	ORP 262 mV For Ag/AgCl electrode at 20ºC

● Internal reference solution

Part name	Model	Part number	Remarks
Internal reference solution	#300	9003003200	250 mL

● Cleaning liquid

Part name	Model	Part number	Remarks
Cleaning liquid for electrodes	#220	9096002500	For pH, ORP, and ION electrodes

7.10.2Options

Part name			Part number	Remarks
AC adapter for the pH meter	AC adapter		9096003100	Be sure to purchase the cable when purchasing the AC adapter.
	Cable	For Japan	9096003200	
		For US	9096003300	
		For Europe	9096003400	
Plain paper printer	Printer	For Japan	9096003500	
		For US	9096003600	
		For Europe	9096003700	
	Printer cable		9096003800	
	Roll paper		9096003900	
	Ink ribbon		9096004000	
Serial cable			9096004800	
Data collection software			9096005000	For PC
Soft case			9096005100	
Strap			9096005200	For the meter
Stand for electrode			9096002700	
Stand arm			9096002800	
Protective cap			9096002900	For the meter

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

HORIBA,Ltd.

First edition:August 2003
CODE：I1001379000