PHB-90 SERIES
PHB-92, 93, 94, 95, 96
pH METERS

Operator's Manual

OMEGA ENGINEERING, INC.
An OMEGA Technologies Company

WARRANTY

OMEGA warrants this unit to be free of defects in materials and workmanship and to give satisfactory service for a period of 13 months from date of purchase. OMEGA Warranty adds an additional one (1) month grace period to the normal one (1) year product warranty to cover handling and shipping time. This ensures that our customers receive maximum coverage on each product. If the unit should malfunction, it must be returned to the factory for evaluation. Our Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective it will be repaired or replaced at no charge. However, this WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of being damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components which wear or which are damaged by misuse are not warranted. These include contact points, fuses, and triacs.

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Return Requests/Inquiries

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To avoid processing delays, also please be sure to include:

1. **Returnee's name, address, and phone number.**
2. **Model and Serial numbers.**
3. **Repair Instructions.**

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. That way our customers get the latest in technology and engineering.

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WARNING

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

CONTENTS

Preface

This manual explains the operation of members of the PHB-90 Series, with the exception of the PHB-91. We hope you use this manual both as a guide to understanding the basic operation of the pH meter, and, later on as a reference.
This manual covers the following points.

- •Operations and situations which must be avoided since they may damage the pH meter.
- •Differences between members of the PHB-90 Series
- •The naming and functions of the various parts making up the pH meter and the electrode, and various attachments.
- •How to calibrate and conduct measurements.
- •Data memory functions, and transmission to peripheral pH meters through the RS-232C interface.
- •The use of the built-in printer.
- •Daily care of the pH meter.
- •Simple troubleshooting.
- • Additional information helpful for conducting more accurate and efficient pH measurements.

First of all, please read the sections dealing with forbidden operations, and descriptions of the parts of the pH meter. After this, try testing samples according to the procedure shown in the manual. The pH meter is extremely easy to use, and we feel sure that users will become accustomed to its operation very quickly.
However, instructions for assembling the electrode stand, connecting the electrode to the meter and loading printer paper in the printer are only given in the first chapter; see this chapter for a description of these procedures.

This manual used several marks in the text so that the descriptions will be easy to understand. The meanings of the marks is stated below.

Shows the page no. and item which should be referred to in relation to the contents of the description.

Carries a caution or comment related to the procedure for parameter settings, calibrations, measuring and so on.

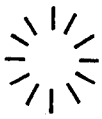
States the key operations and other procedures that should be performed when stopping during an operation or shifting to another operation related to the procedure for parameter settings, calibrations, measuring and so on.

Input Error

Shows the key operations when a value is erroneously input.

States the operating procedure and cautions when there are other measures for calibration and measuring.

This mark is used on the page that describes the RS-232C interface. This indicates that when the command format explanation cannot fit on one line due to space, the command format is continued on the next line.

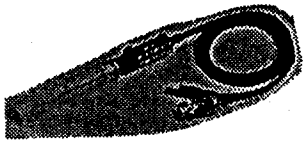


The mark, which is written on the display, shows that the part surrounded by it is flickering.

CHECKING CONTENTS

The system package contains the following accessories. Check that none of the items listed below is missing or damaged.

(2)



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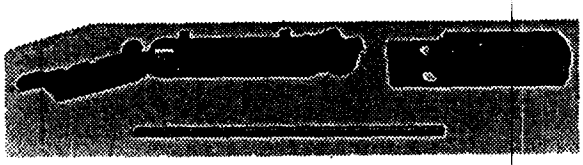

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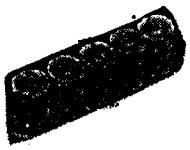


1. pH Meter	1 set
2. Electrode	1 pc
For PHB-92 to PHB-95 PHE-9820 electrode with 3 ft. cable	
For PHB-94 PHE-9821 electrode with 3 ft. cable	
3. Electrode Stand	1 set
4. Polyethylene Beaker, 50ml	3 pcs
5. Reference Solution 250 ml	1 bottle
6. Grounding Wire	1 pc
7. Printer paper, PHB-95, 96	5 rolls
8. Instruction Manual	1 copy
AC Adaptor	1 pc.

SITUATIONS TO BE AVOIDED

•Do not allow water or other liquids to come in contact with the main body of the pH meter. Liquids can damage the instrumentation. To clean the pH meter, wipe with a soft cloth such as silicon cloth. Do not use solvents such as thinner.

•Do not touch electrode and pH meter connectors with dirty hands, or allow them get wet. High insulation is required for the electrode connectors and the ph meter. If they are dirtied or come in contact with water, these insulating properties may deteriorate, causing unstable readings, or erroneous measurements. In certain situations the electrode itself may suffer irreparable damage.

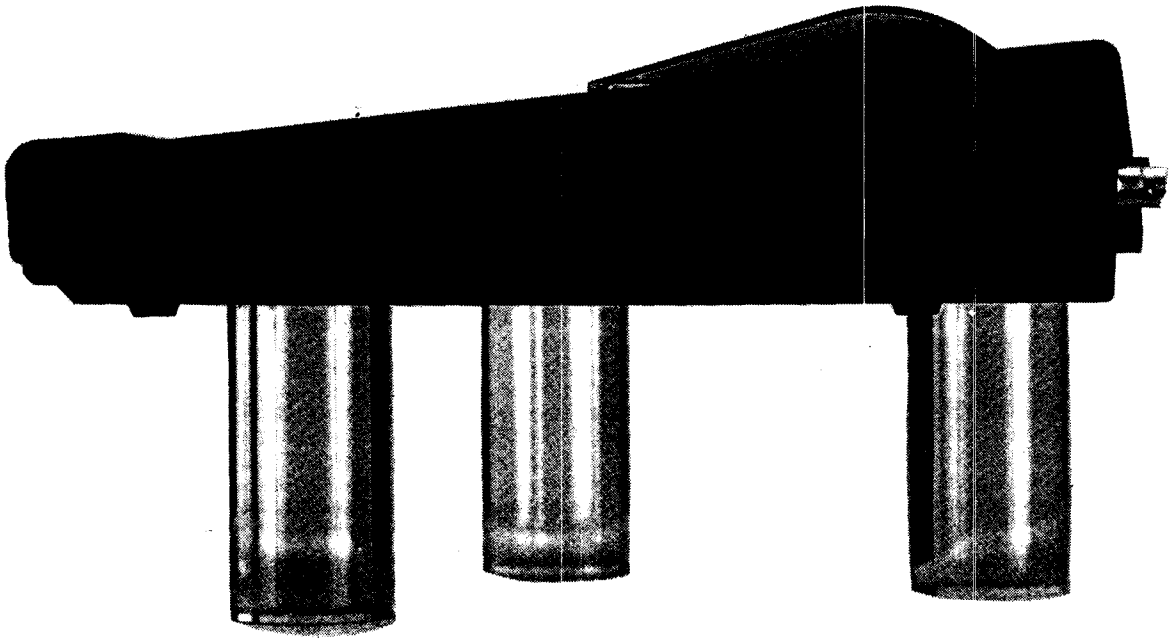
•Do not hit the electrode.
The tip of the electrode is a thin glass membrane, so it must be handled with care. If it is knocked against a hard object or handled in a rough manner, it may break or crack, making measurements and calibration impossible.
The electrode cap should always be attached when the electrode is not in use.

•Do not use the pH meter in the following situations:
-where ambient temperature is outside the range 5-45°C;
-in dusty places;
-in humid places;
-in places subject to strong vibration;
-near a large electric motor or transformer;
-in places subject to corrosive gases.

•Do not subject the pH meter to shock.

•Do not operate the switches with a hard object such as a pencil or metal rod.

•When not using the adaptor, remove it from the power outlet.

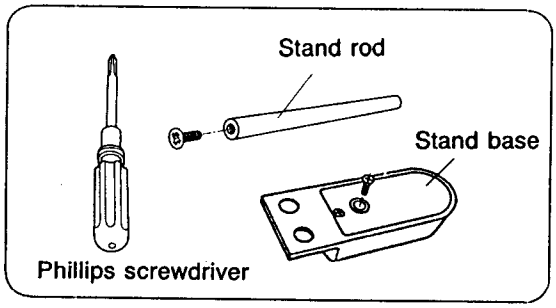


This chapter is intended for those using a pH meter for the first time. It explains the initial preparations which must be made before beginning measurements, such as assembling the electrode stand, and loading the printer paper, and then explains the procedure for conducting calibration with standard buffers and making pH measurements.
The best shortcut to mastering the operation of an instrument is to actually use it. Prepare the electrode and printer, then conduct calibration and measurements as shown in this chapter.
Note that since this chapter is primarily for the purpose of getting accustomed to the basic operation of the pH meter, more advanced techniques have been intentionally omitted. If, while working through this chapter, a switch or key not explained is accidentally operated, turn the pH meter OFF, then start the whole procedure over again.

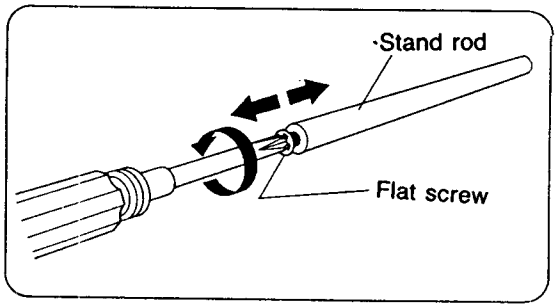
BASIC TUTORIAL

Step 1: Assembling Electrode Stand

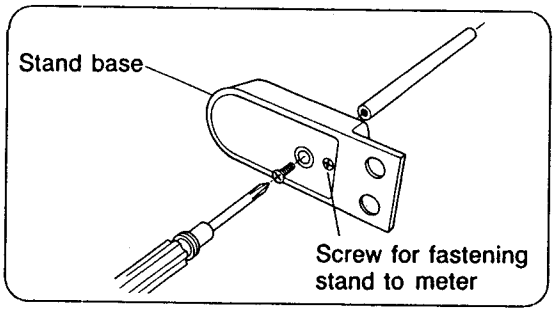
The first step is to assemble the electrode stand, and attach it to the side of the meter.



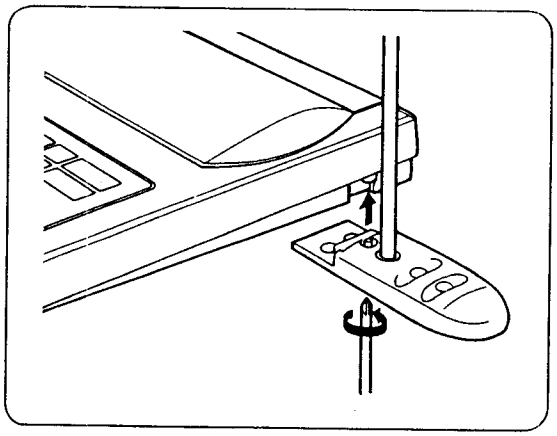
1. Open the plastic bags containing the stand base, the stand rod, and the electrode arm.



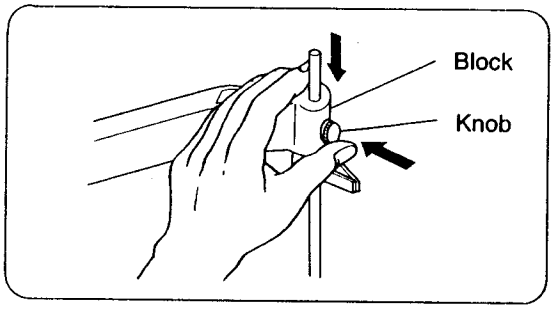
2. Remove the flat screw from the stand rod.



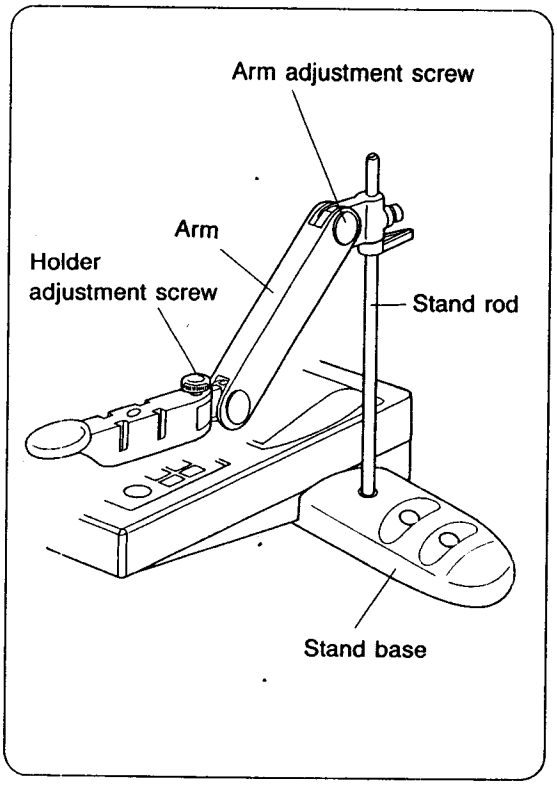
3. Screw the stand rod firmly to the stand base.



4. Attach the stand base to either side of the meter. The diagram shows the stand base being attached to the right side of the meter.



5. Loosen the knob on the swivel part of the arm and, while pressing the knob, insert the stand rod into the round hole on the electrode arm block.
   The electrode arm can be adjusted to the desired height by moving it while adjusting the knob.

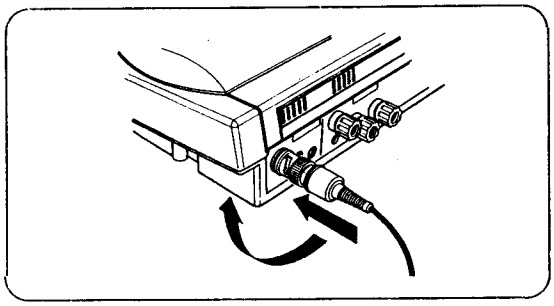


6. Adjust the vertical and horizontal tension of the arm with the two larger adjustment screws.

NOTE:
When moving the device, tighten the fastening screw so the arm does not swing around.

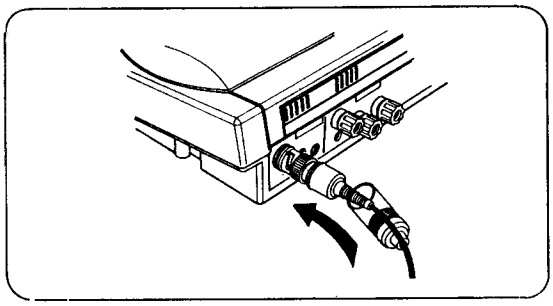
Step 2: Attaching the Electrode

When connecting the electrode to meter, be sure no to get any connectors wet, or touch them with dirty hands.

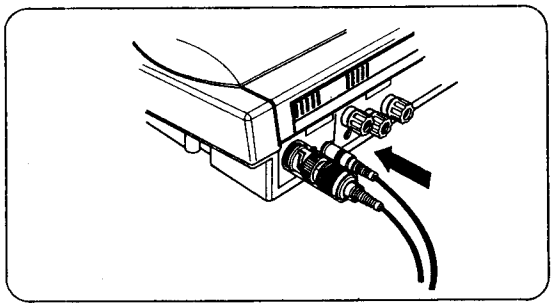


Electrode Connector (CE)

1. Place the CE connector over the receptor on the main unit, making sure the grove in the connector slides over the small knob on the receptor. Do not push the connector without first making sure the knob and grove are properly aligned.
   Rotate the connector clockwise in the direction of the groove. Do not force the connector against direction of the groove.

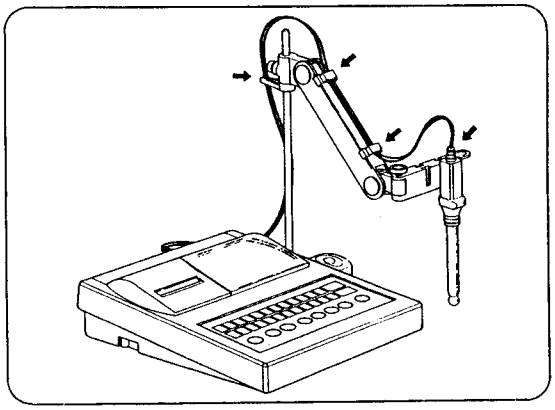


2. Place the protective cover over the connector.



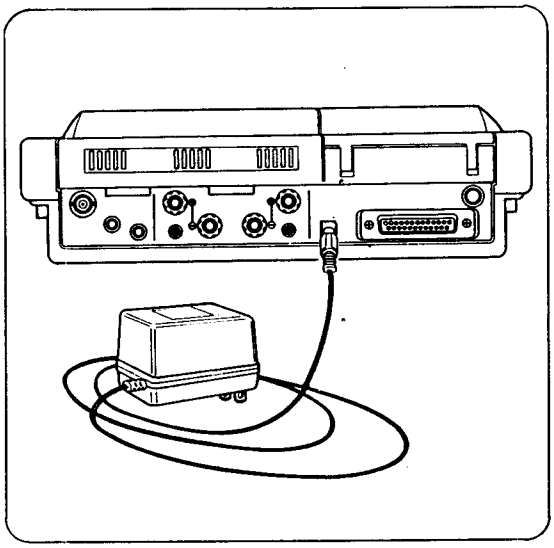
Temperature Connector (T)

3. Insert the connector securely in the input jack marked on the main unit.



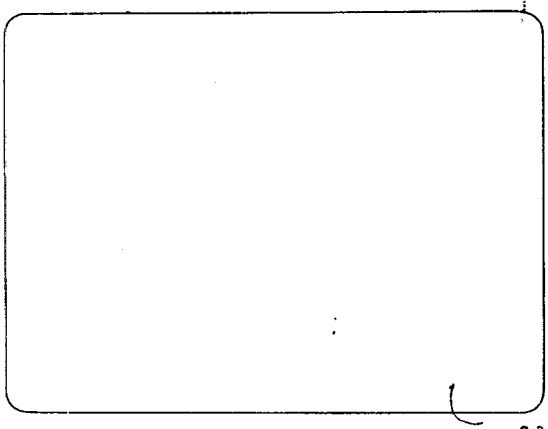
4. Feed the lead wire along the arm as shown. Hold down the holder section and insert the electrode into the holder.

Step 3: Attaching AC Adaptor



The pH meter operates on direct current.
Connect the AC adaptor.

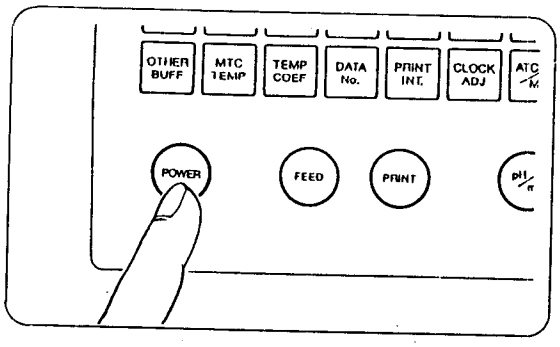
Step 4: Turning Power ON



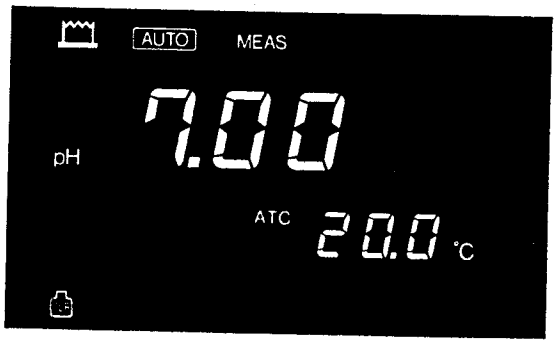
picture missing

1. Immerse the electrode in tap water.

NOTE:
If the power supply is turned on after the electrode has been left in the open air, ERR 1 (pH over range) will be displayed.



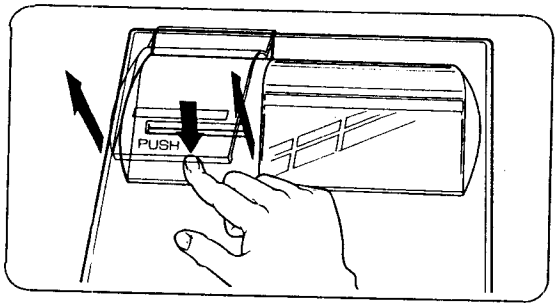
2. Press **POWER** to turn ON.



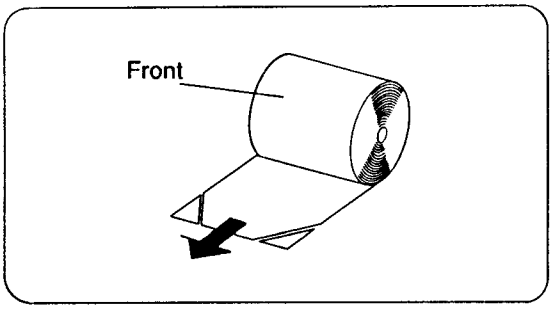
3. After **POWER** has been pressed, the display will read something similar to the diagram, and the printer head will move to the starting (leftmost) position, if your pH meter is PHB-95 or PHB-96.
   Arbitrary values will be displayed for the pH value and the temperature.

Step 5: Setting Printer Paper PHB-95 PHB-96

The built-in printer is not loaded with paper at the time of purchase. Load the paper roll according to the following procedure.

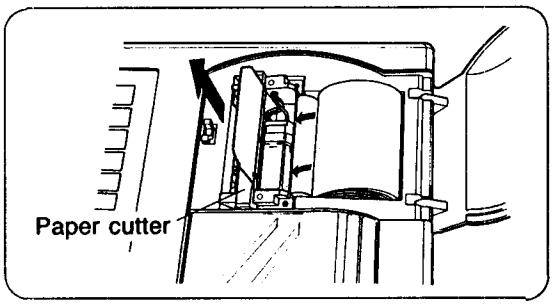


1. Open the printer cover by lightly pressing the area marked PUSH to release the catch.

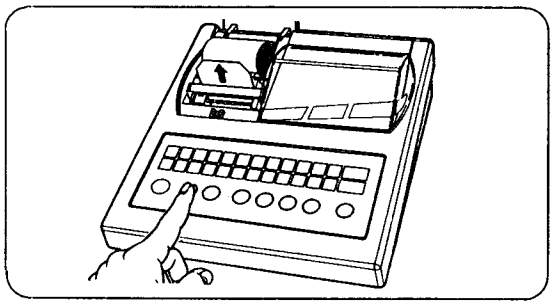


2. Cut the printer paper as shown in the figure.

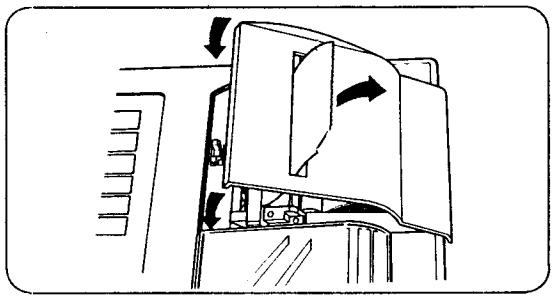
NOTE:
The paper used in the printer has a thermosensitive coating. This thermosensitive surface must face the print head.



3. Slide the end of the printer paper into the printer as shown,
and when the end reappears in front of the paper cutter, pull it out a little.



4. Press the FEED key until about an inch of paper emerges from the printer.



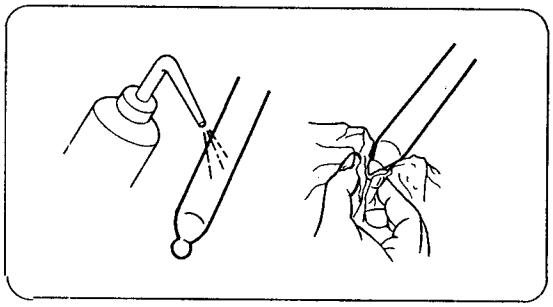
5. Pass the end of the printer paper through the slit in the printer cover, then close the cover.

NOTES:
- ***Use the recommended printer paper PHB-90-RP.***
- ***Do not use the printer without any paper.***

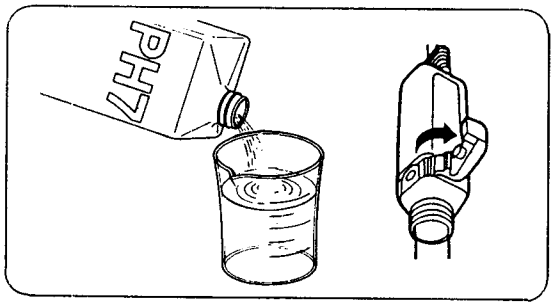
Step 6: Standard Buffer Calibration

From this point we start actual operation. In the examples below, calibration is conducted with standard buffers of pH 7 and pH 4. The temperature of the reference solution will be displayed for the temperature value, and pH value will be displayed according to appended table on page 111 in response to that temperature. In the display described below, pH value is displayed for 25°C.

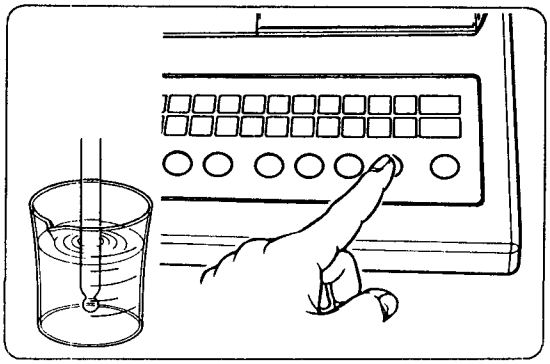
1. Press the **CLR** key together with the **▶CAL◀** Key to delete any previous bottle marks. (This step is not necessary if the **CLR** bottle mark is already display.)
   The display and values will not change when the key is pressed.



2. Rinse the electrode, including the liquid junction, throughly in distilled or deionized water, then wipe dry with filter paper or tissue paper.

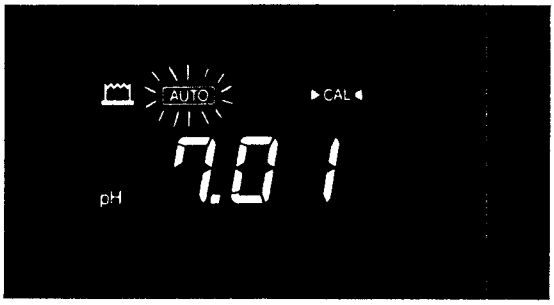


3. Pour pH 7 buffer into the polyethylene beaker. Open the rubber cap of the reference solution filling port. (This inlet should be left open while calibrations are being carried out.)

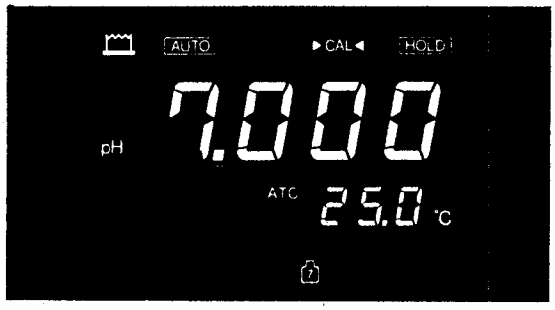


4. Immerse the electrode in pH 7 buffer and press **CAL**.

M-1207

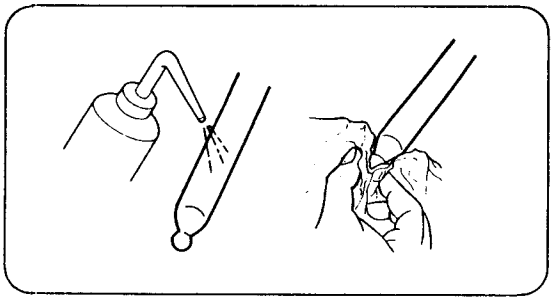


5. ▶CAL◀ will be displayed, MEAS will disappear, and AUTO will flash until readings stabilize.

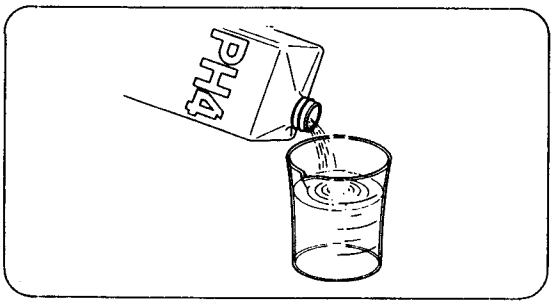


6. When readings stabilize, the indicated value will be displayed, AUTO will stop flashing, HOLD will be displayed, and the bottle mark indicating the pH 7 buffer will be displayed. (If the meter has a built-in printer, the calibrated value will be printed out.)

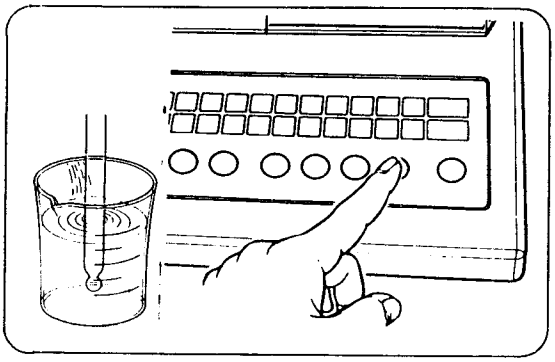
   Two digits are displayed past the decimal point during stabilizing of the readout. When automatic calibration is completed, the readout displays three digits.



7. The meter is now ready to calibrate using the pH 4 standard buffer. Rinse the electrode, including the liquid junction, once more in distilled or deionized water, then wipe dry with filter paper or tissue paper.



8. Pour pH 4 buffer into the polyethylene beaker.



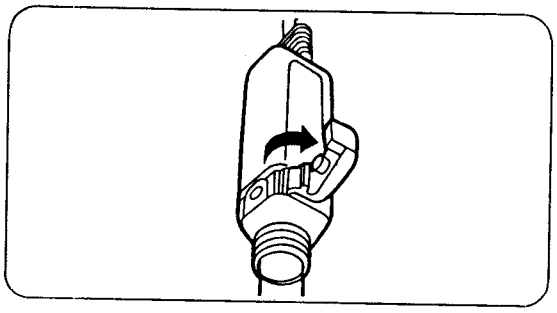
9. Immerse the electrode in the standard buffer and press **CAL**.

10. ▶**CAL**◀ will be displayed, and **AUTO** will flash until reading stabilize.

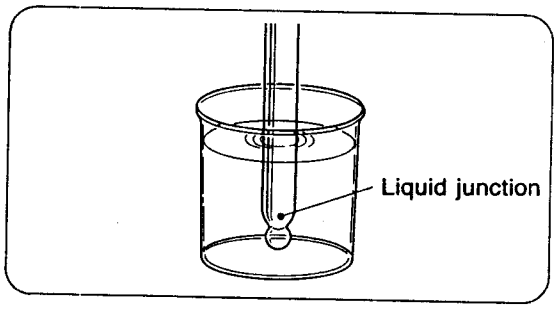
11. When readings stabilize, **AUTO** will stop flashing, **HOLD** will be displayed, and the bottle mark indicating the pH 4 buffer will be displayed. (If the meter has a built-in printer, the calibrated value will be printed out.)

Calibration using standard buffers of pH7 and pH4 is now complete. Two bottle marks indicating the standard buffers used will be displayed.

Step 7: Measuring pH



1. Open the rubber cap of the reference solution filling port. (This inlet should be left open while measurements are being carried out.)



2. Prepare a quantity of sample solution sufficient to cover the liquid junction, then place the electrode in the sample.

Setting Keys

FUNCTION ●

The seven square keys discussed below become operational only after the FUNCTION key is pressed. If Function is pressed, an LED lights up.

OTHER BUFF — Sets the calibrated value when using a buffer other than pH 2, 4, 7, 10, or 12.

MTC TEMP — Sets the temperature when conducting temperature compensation in manual mode.

TEMP COEF — Sets temperature coefficient of sample.

CLOCK ADJ — Sets month, day, hour, and minute.

ATC/MTC — Changes between automatic temperature compensation (ATC) using the ternperature sensor, and manual temperature compensation (MTC) using a preset temperature value.

CLOCK — Changes display to clock mode.

OTHER CAL — Starts calibration with a buffer other than pH 2, 4, 7, 10, and 12.

1	2	3	4
5	6	7	8
9	0	+/–	•

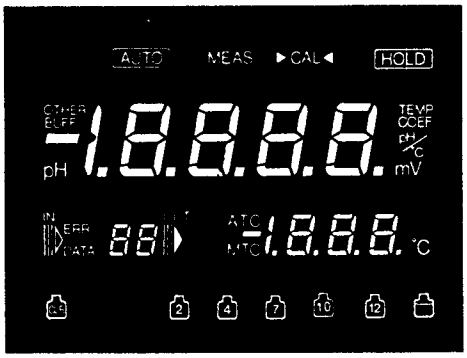
Inputs values for the following parameters.

—Temperature for manual temperature compensation (MTC) [°C]
—Other buffer pH value
—Sample temperature coefficient [pH/°C]
—Clock adjustment [month, day, hour, minute]

ENT — Enters the values specified by the above keys.

Reading Display

The PHB-90 Series uses a large, fluorescent light tube display. In addition to measured pH values, such things as the solution temperature at measurement, and various marks indicating pH meter status are also displayed.
Flashing letters and numbers on the display indicate that the meter is waiting for the input of new numerical values.



MEAS ▶CAL◀

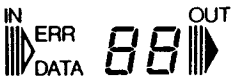
Indicates the pH meter is at present calibrating or measuring. MEAS indicates measuring, **▶CAL◀** calibrating.

AUTO HOLD

Indicates whether auto-hold mode or manual mode has been selected. If **AUTO** is on, the unit is in auto-hold mode; if **AUTO** is off, the unit is in manual mode.
When calibration or measurements are carried out in the auto-hold mode, **AUTO** will flash on and off until the electric potential has stabilized, whereupon **AUTO** will stop flashing, and **HOLD** will be displayed.

This section of the display shows the following values.

- Measured value [pH, mV]
- Hour, minute
- Other buffer [pH]
- Temperature coefficient [pH/°C]



This section of the display shows the following values.

- No. of data being stored;
- Error no.

This section of the display shows the following values.

- Temperature at measurement [°C]
- Temperature compensation value set in manual mode (MTC) [°C]
- Month, day

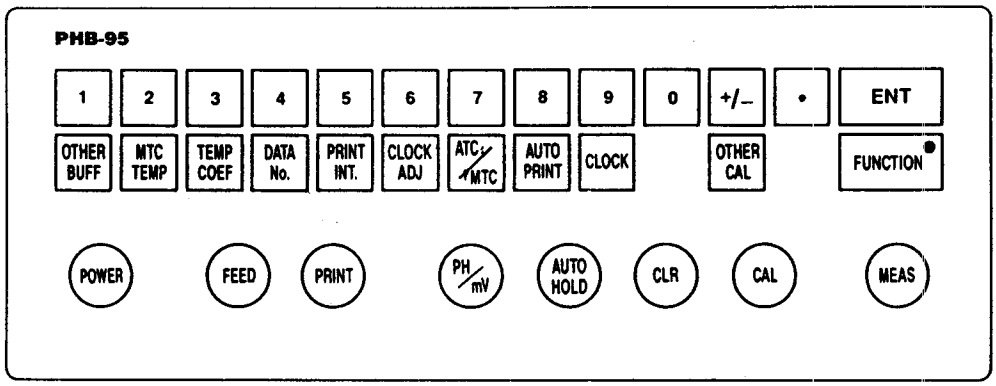
ATC and MTC indicate whether temperature compensation is in automatic mode (ATC) or manual mode (MTC). When in manual mode, MTC will flash on and off while the temperature compensation value is being entered.

Indicates the Standard buffers used in calibration.

Indicates calibrated values have been canceled.

KEYS AND DISPLAY PHB-95

The diagram below shows the layout of the keypad on the PHB-95 front panel.
When a key has been pressed and is functional, a single beep will sound.
When a key has not been accepted, three beeps will sound.
When an error has occurred and the error number has been displayed, two beeps will sound.



Operation Keys

POWER Turns meter ON and OFF.

FEED Feeds printer paper. Paper is fed while this key is pressed.

PRINT Prints calibrated or measured values.

PH/mV Tells pH meter to display measured values in pH or mV.

AUTO HOLD Tells pH meter to conduct calibration or measurements in Auto-Hold mode or Manual mode.

CLR Erases the calibrated values and any data in the memory.

CAL Starts calibration with standard buffers (pH 2, 4, 7, 10, or 12).

MEAS Starts measurement.

Setting Keys

FUNCTION ●

The ten square keys discussed below become operational only after the FUNCTION key is pressed. If FUNCTION is pressed, an LED lights up.

OTHER BUFF — Sets the calibrated value when using a buffer other than pH 2, 4, 7, 10, or 12.

MTC TEMP — Sets the temperature when conducting temperature compensation in manual mode.

TEMP COEF — Sets temperature coefficient of sample.

DATA No. — Sets the first data number to be printed out.

PRINT INT. — When programming the pH meter in manual mode to print out data at specified intervals, this key is used to set the interval in seconds.

CLOCK ADJ — Sets month, day, hour, and minute.

ATC/MTC — Changes between automatic temperature compensation (ATC) using the temperature sensor, and manual temperature compensation (MTC) using a preset temperature value.

AUTO PRINT — When this key is pressed in auto-hold mode, readings are printed out automatically after they have stabilized. In manual mode, this key causes measurement results to be printed out at a specified interval.

CLOCK — Changes display to clock mode.

OTHER CAL — Starts calibration with a buffer other than pH 2, 4, 7, 10, and 12.

1	2	3	4
5	6	7	8
9	0	+/–	•

Inputs values for the following parameters.

—Print interval time [sec.]
—Data number
—Temperature for manual temperature compensation (MTC) [°C]
—Other buffer pH value
—Sample temperature coefficient [pH/°C]
—Clock adjustment [month, day, hour, minute]
—Print interval time [sec.]
—Data number

ENT — Enters the values specified by the above keys.

Reading Display

The PHB-90 Series uses a large, fluorescent light tube display. In addition to measured pH values, such things as the solution temperature at measurement, and various marks indicating pH meter status are also displayed.
Flashing letters and numbers on the display indicate that the meter is waiting for the input of new numerical values.

Indicates that calibrated values and measurements will be printed out automatically.

MEAS ▶CAL◀

Indicates the pH meter is at present calibrating or measuring MEAS indicates measuring, ▶**CAL**◀ calibrating.

AUTO HOLD

Indicates whether auto-hold mode or manual mode has been selected. If **AUTO** is on, the unit is in auto-hold mode; if **AUTO** is off, the unit is in manual mode.
When calibration or measurements are carried out in the auto-hold mode, **AUTO** will flash on and off until the electric potential has stabilized, whereupon **AUTO** will stop flashing, and **HOLD** will be displayed.

This section of the display shows the following values.

- Measured value [pH, mV]
- Hour, minute
- Other buffer [pH]
- Temperature coefficient [pH/°C]
- Print out interval [sec.]

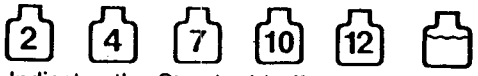
This section of the display shows the following values.

- No. of data being stored;
- Error no.;
- Sec.;
- Printed data no.

This section of the display shows the following values.

- Temperature at measurement [°C]
- Temperature compensation value set in manual mode (MTC) [°C]
- Month, day

ATC and MTC indicate whether temperature compensation is in automatic mode (ATC) or manual mode (MTC). When in manual mode, MTC will flash on and off while the temperature compensation value is being entered.

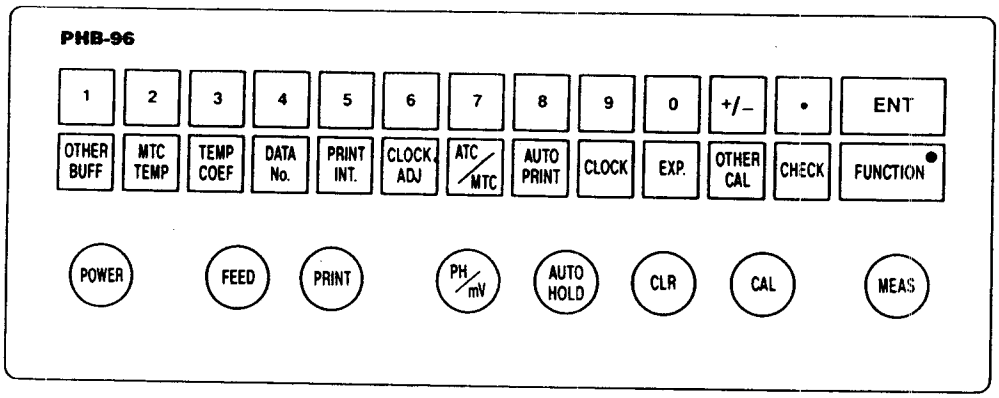


Indicates the Standard buffers used in calibration.

Indicates calibrated values have been canceled.

KEYS AND DISPLAY PHB-96

The diagram below shows the layout of the keypad on the PHB-96 front panel.
When a key has been pressed and is functional, a single beep will sound.
When a key has not been accepted, three beeps will sound.
When an error has occurred and the error number has been displayed, two beeps will sound.



Operation Keys

POWER — Turns meter ON and OFF.

FEED — Feeds printer paper. Paper is fed while this key is pressed.

PRINT — Prints calibrated or measured values.

PH/mV — Tells pH meter to display measured values in pH or mV.

AUTO HOLD — Tells pH meter to conduct calibration or measurements in Auto-Hold mode or Manual mode.

CLR — Erases the calibrated values and any data in the memory.

CAL — Starts calibration with standard buffers (pH 2, 4, 7, 10, or 12).

MEAS — Starts measurement.

Setting Keys

FUNCTION

The twelve square keys discussed below become operational only after the FUNCTION key is pressed. If FUNCTION is presse, an LED lights up.

OTHER BUFF — Sets the calibrated value when using a buffer other than pH 2, 4, 7, 10, or 12.

MTC TEMP — Sets the temperature when conducting temperature compensation in manual mode.

TEMP COEF — Sets temperature coefficient of sample.

DATA No. — Sets the first data number to be printed out.

PRINT INT. — When programming the pH meter in manual mode to print out data at specified intervals, this key is used to set the interval in seconds.

CLOCK ADJ — Sets month, day, hour, and minute.

ATC/MTC — Changes between automatic temperature compensation (ATC) using the temperature sensor, and manual temperature compensation (MTC) using a preset temperature value.

AUTO PRINT — When this key is pressed in auto-hold mode, readings are printed out automatically after they have stabilized. In manual mode, this key causes measurement results to be printed out at a specified interval.

CLOCK — Changes display to clock mode.

EXP. — Increases accuracy of displayed readings to 1/1000 pH, or 1/10 mV.

OTHER CAL — Starts calibration with a buffer other than pH 2, 4, 7, 10, and 12.

CHECK — Checks the operation of hardware.

1 2 3 4
5 6 7 8
9 0 +/- .

Inputs values for the following parameters.

—Temperature for manual temperature compensation (MTC) [°C]
—Other buffer pH value
—Sample temperature coefficient [pH/°C]
—Clock adjustment [month, day, hour, minute]
—Print interval time [sec.]
—Data number

ENT — Enters the values specified by the above keys.

Reading Display

The PHB-96 uses a large, fluorescent light tube display. In addition to measured pH values, such things as the solution temperature at measurement, and various marks indicating pH meter status are also displayed.
Flashing letters and numbers on the display indicate that the meter is waiting for the input of new numerical values.

Indicates that calibrated values and measurements will be printed out automatically.

MEAS ▶CAL◀

Indicates the pH meter is at present calibrating or measuring. MEAS indicates measuring, **▶CAL◀** calibrating.

AUTO HOLD

Indicates whether auto-hold mode or manual mode has been selected. If **AUTO** is on, the unit is in auto-hold mode; if **AUTO** is off, the unit is in manual mode.
When calibration or measurements are carried out in the auto-hold mode, **AUTO** will flash on and off until the electric potential has stabilized, whereupon **AUTO** will stop flashing, and **HOLD** will be displayed.

This section of the display shows the following values.
- Measured value [pH, mV]
- Hour, minute
- Other buffer [pH]
- Temperature coefficient [pH/°C]
- Print out interval [sec.]

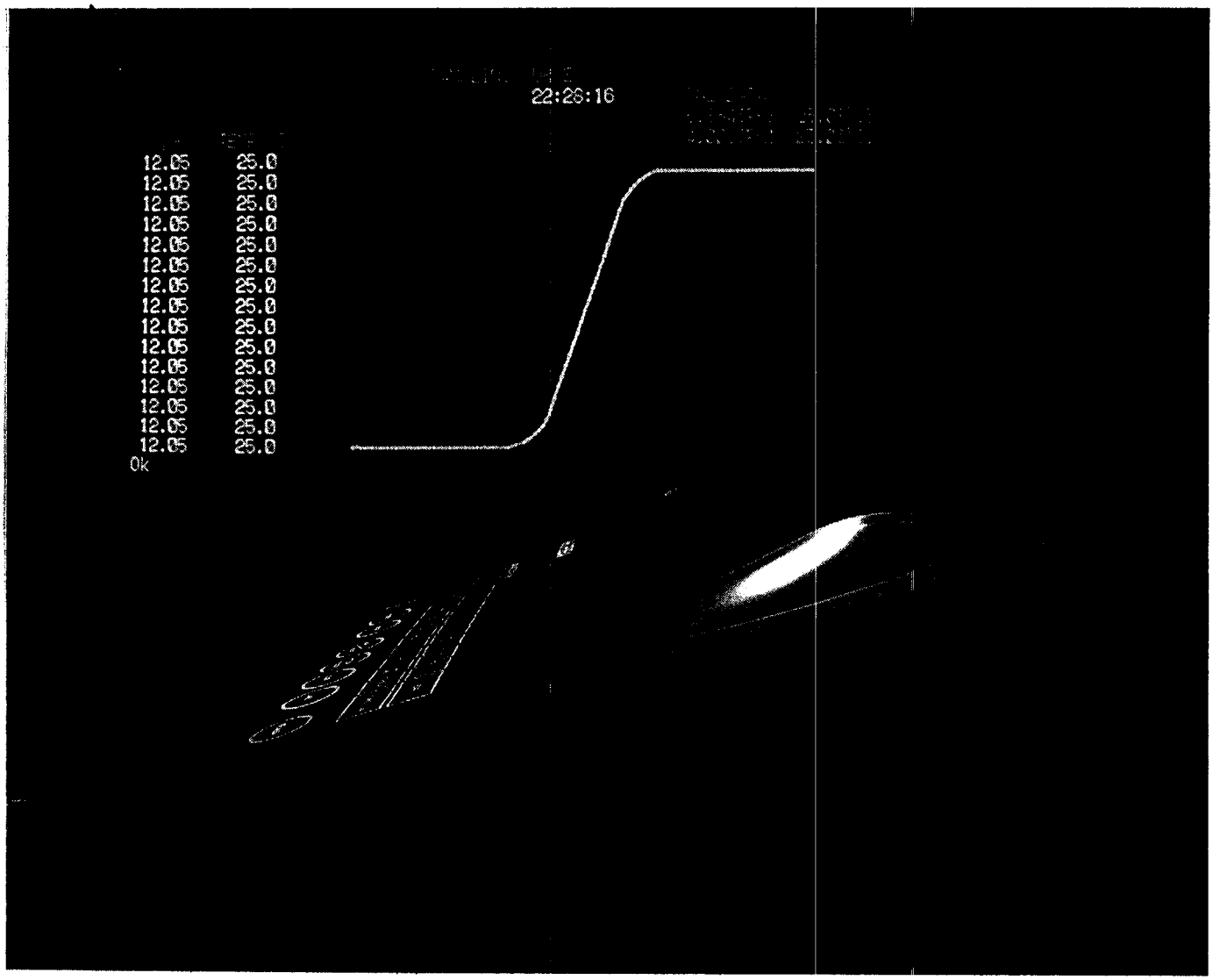
This section of the display shows the following values.
- No. of data being stored;
- Error no.;
- Sec.;
- Printed data no.

This section of the display shows the following values.
- Temperature at measurement [°C]
- Temperature compensation value set in manual mode (MTC) [°C]
- Month, day

ATC and MTC indicate whether temperature compensation is in automatic mode (ATC) or manual mode (MTC). When in manual mode, MTC will flash on and off while the temperature compensation value is being entered.

Indicates the Standard buffers used in calibration.

Indicates calibrated values have been canceled.



SETTING CONDITIONS

CLOCK AND CALENDAR PHB-94 PHB-95 PHB-96

The pH meter has a built-in clock, enabling the time and date to be printed out together with measured data. Before using the pH meter for the first time, it is necessary to set the clock. An internal battery keeps clock and calendar settings current, so there is no need to reset the clock every time power is turned back on.

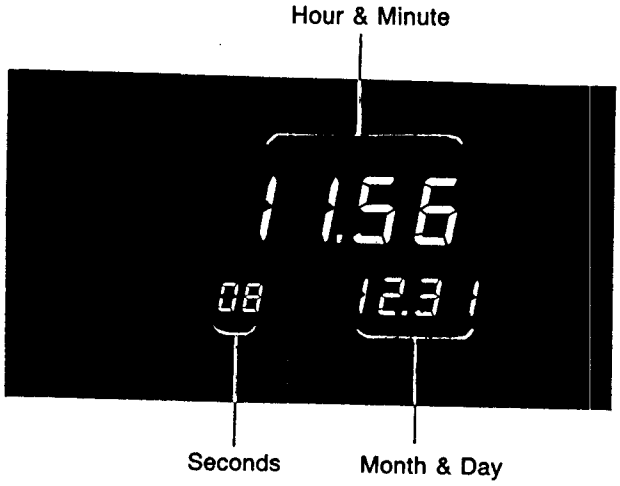
FUNCTION

1. Press **FUNCTION** (LED lights).

CLOCK

2. Press **CLOCK**. The display will show the time, as shown in the diagram below.

To escape from this display, press the pH/mV key.



Setting Data and time (From 11:56, December 31 to 18:25, March 8)

CLOCK ADJ

3. Press **CLOCK ADJ.**
The digits indicating seconds will be reset to 00, and the first digit of the month (in this case "1") will flash.

To cancel this operation: Press ENT.

Setting the Month

0 3

4. Enter the month(in this case"'03")with the numerical keys. 12 will be replaced by 3, and the first digit of the day (in this case "1") will flash.

Input Error

If a value is erroneously input: Press ***CLOCK ADJ*** *and then input the correct value.*

Although the month was entered as 03, only 3 is displayed.

NOTE:
It is always necessary to input two digits for the month, January through September must be preceded by 0.

Setting the Day

0 8

5. Enter the day (in this case "08") with the numerical keys. 31 will be replaced by 08, and the first digit of the hour (in this case "1") will flash.

Input Error

If a value is erroneously input: Press ***CLOCK ADJ*** *and then input the correct value.*

Setting the Hour

1 8

6. Enter the hour (**18**, since the device uses the 24-hour clock) with the numerical keys. 11 will be replaced by 18, and the first digit of the minutes (in this case, 5) will begin to flash.

Input Error

If a value is erroneously input: Press ***CLOCK ADJ*** *and then input the correct value.*

Setting the Minutes

[2] [5]

7. Enter the minutes (in this case "25") with the numerical keys 56 will be replaced by 25, and the display will stop flashing.

Input Error

If a value is erroneously input: Press ***CLOCK ADJ*** *and then input the correct value.*

[ENT]

8. Press **ENT**. The time is entered.

To end this setting: Press ***FUNCTION*** *(The LED goes out)*

NOTES:

- ***Initially the clock does not adjust for leap years, so the clock must be set on the first February 29. After it has been set once, it will adjust for successive leap years automatically.***
- ***Time must correspond to 24-hour clock***

OTHER BUFFERS pH VALUE PHB-94 PHB-95 PHB-96

It is possible to specify one buffer having a pH other than 2, 4, 7, 10, or 12.

Specifiable range: 0.000-14.000.

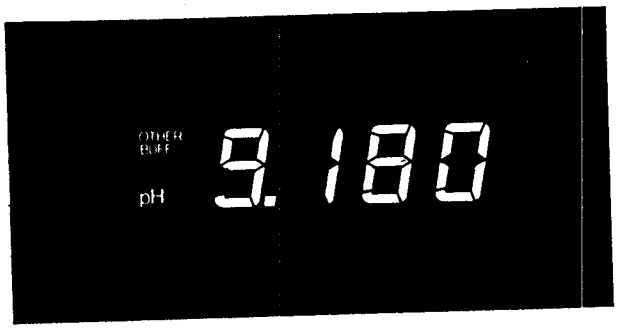
☞ *For mode details, refer to "CALIBRATION" on p.54.*

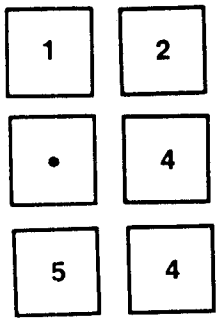
Changing pH from 9.180 to 12.454

1. Press **FUNCTION**. (LED lights).

2. Press **OTHER BUFF**. The **OTHER BUFF** and the current pH value will flash.

*To cancel this operation: Press **ENT**.*

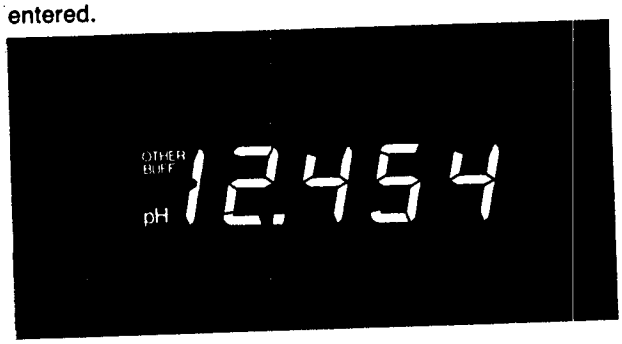




3. Enter the pH value with the numerical keys. There is no need to erase the previous setting beforehand; it will be erased as the new value is entered.

Input Error

*If a value is erroneously input: Press **OTHER BUFF** and then input the correct value.*



4. Press **ENT**.
The value entered with the numerical keys will be sent to the internal memory as the pH data for the calibration buffer. The display will be held in stasis for two seconds, and the pH value shown, and then the screen will change to the display shown before the mode was initiated.

*To end this setting: Press **FUNCTION** (The LED goes out.)*

MANUAL TEMPERATURE COMPENSATION PHB-94 PHB-95 PHB-96

The PHB-90 Series features both automatic and manual temperature compensation. Automatic temperature compensation (ATC) utilizes the thermistor, and manual temperature compensation (MTC) refers to temperature compensation conducted according to a temperature value for the sample. In the letter case, it is necessary to set a temperature value.

Specifiable range: 0.0-100.0°C

Changing the temperature from 22.0°C to 32.5°C

FUNCTION

1. Press **FUNCTION.** (LED lights)

MTC TEMP

2. Press **MTC TEMP.**
MTC and the present temperature will flash.

*To cancel this operation: Press **ENT.***

3 2 • 5

3. Enter the new temperature value (32.5°C) with the numerical keys.
There is no need to erase the previous setting beforehand; it will be erased as the new value is entered.

Input Error

*If a value is erroneously input: Press **MTC TEMP** and then input the correct value.*

If a value outside this range is entered, three beeps will sound, and the input value will be ignored.

4. Press **ENT**.
   The value entered with the numerical keys will be the new temperature compensation value. **MTC** will stop flashing.

*To end this setting: Press **FUNCTION** (The LED goes out.)*

NOTES:

- ***Entered values will be converted to the nearest single decimal place.***
  *e.g. 7.05 + **ENT** → 7.1*
- ***Entered values less than 1 not preceded by "0" will be automatically displayed as preceded by "0".***
  *e.g. .8 + **ENT** → 0.8*
- ***Entered values will automatically be displayed to one decimal place.***
  *e.g. 32 + **ENT** → 32.0*

TEMPERATURE COEFFICIENT PHB-94 PHB-95 PHB-96

The pH value to be measured will vary according to the temperature. Moreover, the degree of variation will differ with the properties of the sample. When the measurement temperature varies, you may use the temperature calculation function to project the pH value at 25°C.
Calculation Formula:

$$pH_{25} = pH_t - \alpha(t - 25)$$

where,

pH_{25} : pH value at 25°C
pH_t : pH value at t°C
α : temperature coefficient (pH/°C)
t : sample temperature (°C)
(in manual temperature compensation mode, t becomes the specified value)

Below is the procedure for difining α in the above equiation.

Specifiable range: −0.100 to 0.100

Changing the value from 0.037 to −0.054

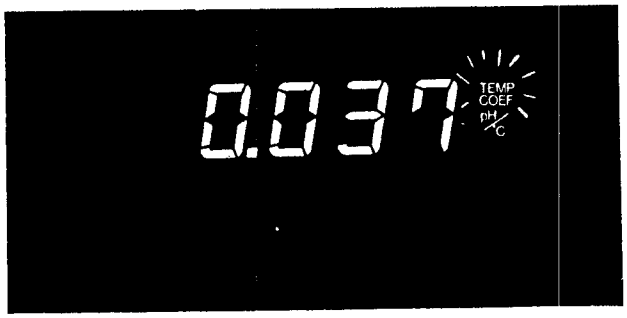
[FUNCTION]

1. Press **FUNCTION**. (LED lights).

[TEMP COEF]

2. Press **TEMP COEF**. The **TEMP COEF** and the current temperature coefficient will flash.

*To cancel the procedure in flashing mode: Press **ENT**.*



[+/−] [0] [•] [0] [5] [4]

3. Enter the temperature coefficient with the numerical keys.
There is no need to erase the previous setting beforehand. It will be erased as the new value is entered.

If a value outside this range is entered, three beeps will sound, and the input value will be ignored.

Input Error

If a value is erroneously input: Press ***TEMP COEF*** *and then input the correct value.*

ENT

4. Press **ENT**.
   The value entered with the numerical keys will be set as the new temperature coefficient. The display will be held in stasis for two seconds, and the temperature coefficient shown.
   The **TEMP COEF** will stop flashing, and the pH value calculated using the new temperature coefficient will be displayed.

To end this setting: Press ***FUNCTION*** *(The LED goes out)*

NOTES:

- ***Entered values less than 1 not preceded by "0" will be automatically displayed as preceded by "0".***
  *e.g. .038 + **ENT** → 0.038*
- ***Entered values will automatically be displayed to three decimal places.***
  *e.g. 0.04 + **ENT** → 0.040*
- ***To cancel the temperature conversion, set the temperature coefficient to 0.000***

DATA NUMBERS PHB-95 PHB-96

In order to manage measurement data more easily, it is possible to assign printed data with a serial number. The data number will increase by one increment for each measurement. The starting number must be an integer.

Specifiable range:

1-99 (to define serial number printout)
0 (to cancel serial number printout)

Changing the starting number (from 61 to 1)

FUNCTION

1. Press **FUNCTION** (LED lights).

DATA No.

2. Press **DATA NO.** The **DATA** and the current starting number will flash.

*To cancel the procedure during operation: Press **ENT**.*

1

3. Enter the starting number (1) with the numerical keys. There is no need to erase the previous setting beforehand; it will be erased as the new value is entered.

If a value outside this range is entered, three beeps will sound, and the input value will be ignored.

ENT

4. Press **ENT**.
The value entered with the numerical keys will be set as the new starting number. The display will be held in stasis for two seconds, and the starting number shown, and then the screen will change to the display shown before the mode was initiated.

*To end this setting: Press **FUNCTION**. (The LED goes out)*

PRINTING INTERVAL PHB-95 PHB-96

If Auto-Print is selected in the manual mode, measurement data will be printed out automatically at a specified interval.

Specifiable range: 10-19999

Changing 90 sec. to 12 sec

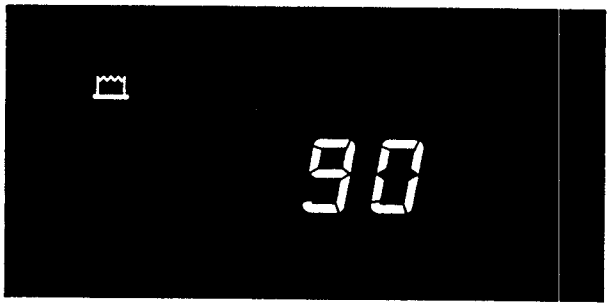
FUNCTION

1. Press **FUNCTION**. (LED lights).

Refer to "Interval Printing" on p.70.

PRINT INT.

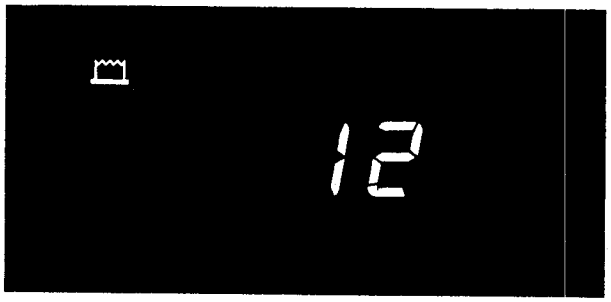
2. Press **PRINT INT.** The ⌨ mark and the current print interval will be displayed and flash.



*To cancel the procedure during operation: Press **ENT**.*

1 2

3. Enter the print interval 12 using the numerical keys. There is no need to erase the previous setting beforehand; it will be erased as the new value is entered.



Input Error

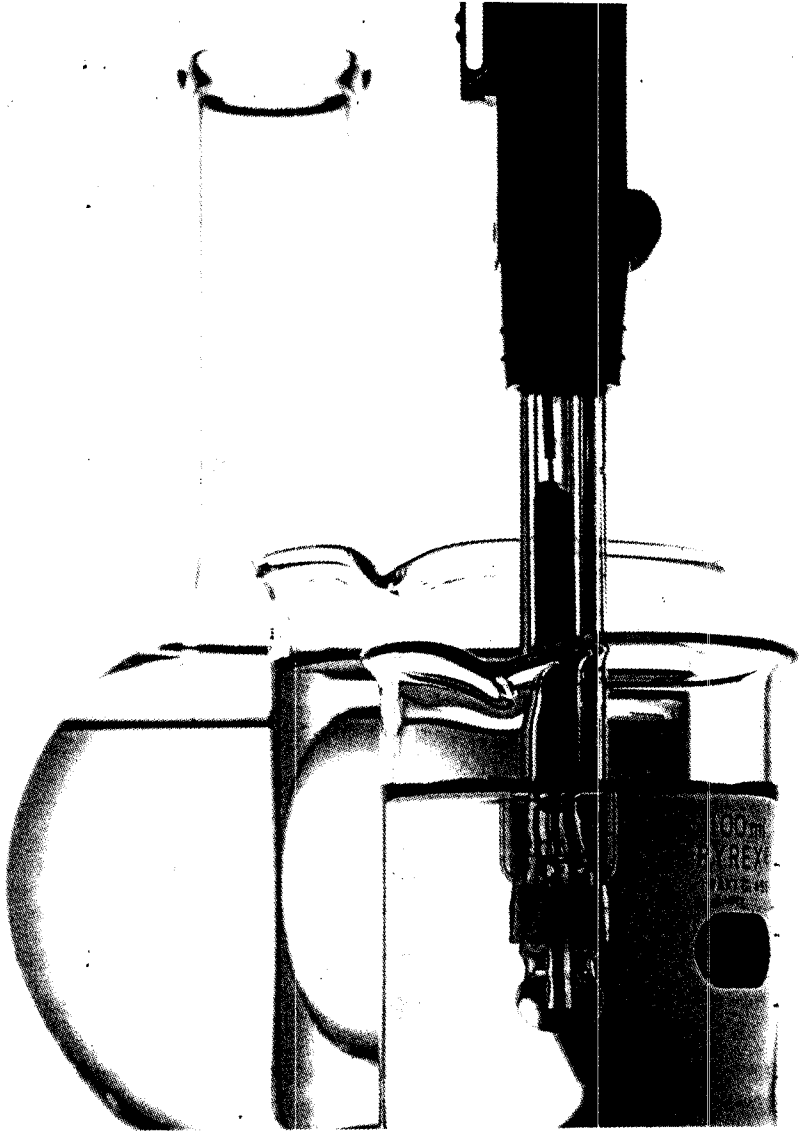
*If a value is erroneously input: Press **PRINT INT.** and then the correct value.*

If a value from 0 to 9 is entered, interval-print will not be carried out. If any other value outside this range is entered, three beeps will sound, and the input value will be ignored.

ENT

4. Press **ENT**.
The value entered using the numerical keys will be the new print interval. The display will be held in stasis for two seconds, and the temperature coefficient shown, and then the screen will change to the display shown before the mode was initiated. The ⌨ mark will stop flashing.

*To end this setting: Press **FUNCTION**. (The LED goes out.)*



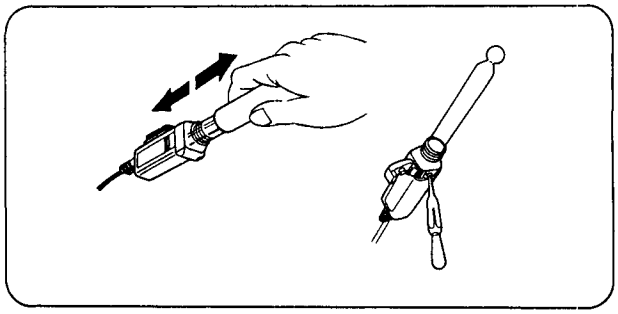
CALIBRATION AND MEASUREMENT

PREPARATION

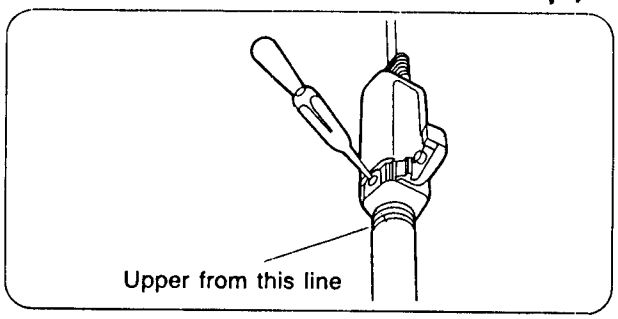
Electrode

When the electrode is used for the first time, follow the preparation procedure given below.

1. Remove the electrode cap and open the rubber cap of the reference solution filling port, then remove the old reference solution .



2. Add fresh reference solution until it reaches the line on the electrode cap. Reference solution should be 3.33 mKCl. M

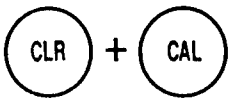


3. Rinse the electrode, including the liquid junction, thoroughly in deionized or distilled water, then wipe dry with filter paper or tissue paper.

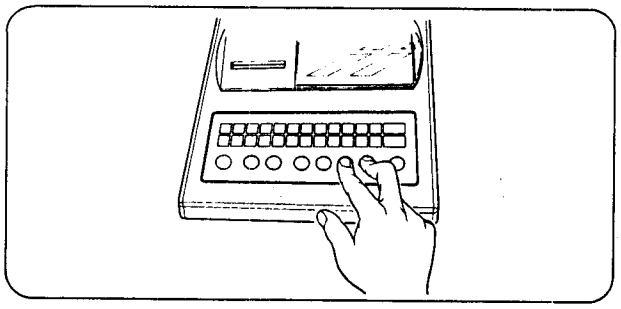
NOTE:
If the responsive glass membrane is dry, soak it in buffer 4.0 or 7.0 least 8 hours before attempting to use the pH meter.

Erase the previous Calibrated values

Erase the previous calibrated values. All values are delete at once; it is not possible to specify individual values.



1. Press **CLR** together with **CAL**.
   If **CAL** and then **CLR** are pressed, the commands are not accepted.



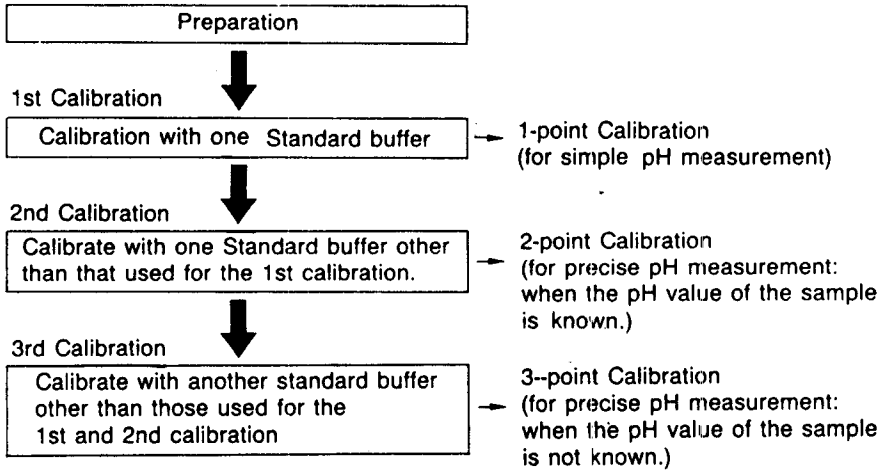
2. All calibrated values in memory will be erased, the bottle marks indicating the calibrated values will disappear from the screen, and the CLR mark will be displayed.

Load the Printer Paper PHB-95 PHB-96

If you have model PHB-95 or 96, load the printer paper as described on Pages 10-11.

CALIBRATION

The pH meter can conduct 1-point, 2-point or 3-point calibration, using a total of six types of standard buffer: the memorized standard buffers, and a further buffer defined using the Other Buffer function. For simple measurements, 1-point calibration is sufficient, but for more accurate measurements, 2-point or 3-point calibration becomes necessary.



NOTE:
When performing the 2nd and 3rd calibrations, if calibrated again using the same standard chemicals used for the 1st and 2nd calibration, the calibration values for each will be changed.

Calibrations modes

The following two modes are available for calibration.

Auto-Hold Mode : Calibration is carried out automatically after the meter has judged that electrode potential has stabilized.

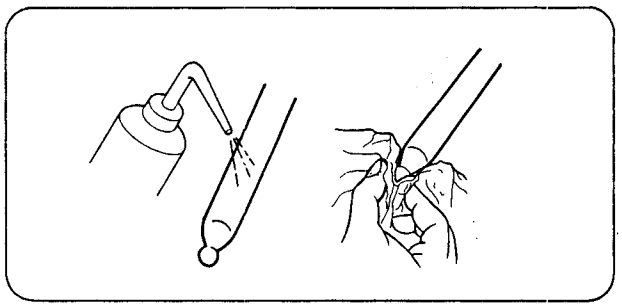
Manual Mode : Calibration carried out automatically after user has judged that electrode potential has stabilized.

Calibration in Auto-Hold Mode

1st Calibration

Check that [AUTO] is displayed. If not, press **AUTO HOLD** to display [AUTO] Calibration procedure is given below.

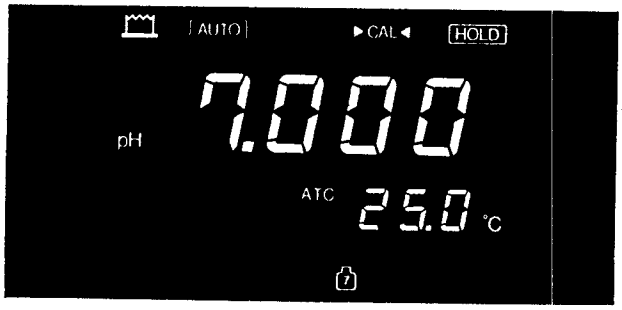
1. Rinse the electrode, including the liquid junction, thoroughly in deionized or distilled water, then wipe dry with filter paper or tissue paper.



2. Open the rubber cap of the reference solution filling port. This port should be left open during calibration.
3. Immerse the electrode into the standard buffer to be calibrated, and press **CAL**. ▶**CAL**◀ will be displayed, and [AUTO] will flash until readings stailize.

*To cancel calibration after pressing **CAL**, press **CAL** again.*

4. When readings stabilize, the calibrated value will be displayed, and printed out when is displayed. [AUTO] will stop flashing, and [HOLD] and the bottle mark of the buffer used will be displayed (Models PHB-92, PHB-93 and PHB-94 are not fitted with printer).



Calibration with 1st buffer is now complete.

2nd and 3rd Calibration Repeat the procedure for calibration with 1st buffer using a different buffer.

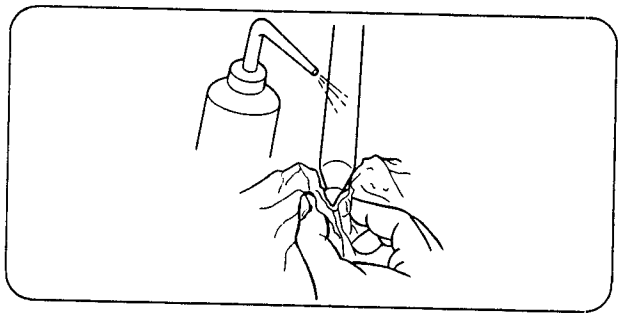
NOTES:

- ***If any of errors ERR 4, ERR 5, or ERR 6 are generated during calibration, refer to "Troubleshooting with Error Numbers" (p.83) These errors relate to electrode malfunction, and although calibration will be carried out regardless of the error message, the resultant calibrated value may be inaccurate.***
- ***When using a standard buffer of pH other than 2, 4, 7, 10, or 12, press OTHER CAL instead of CAL. For more information, refer to "Calibration with Standard buffers having pH Values Other than 2, 4, 7, 10, and 12" on p.58.***
- ***If calibration is attempted with 4 or more buffers an error is generated, and ERR 8 is displayed.***
- ***If calibration is conducted with a buffer which has already been used, the latter calibration will be stored in memory.***
- ***Recalibration cannot be conducted after it has shifted from calibration mode to measurement mode. In this case, clear the calibration value presently stored, and start calibration again.***

Calibration in Manual Mode

1st Calibration Check that AUTO is not displayed. If it is, press **AUTO HOLD** and select the manual mode (AUTO will stop being displayed).

1. Rinse the electrode, including the liquid junction, thoroughly in distilled or deionized water, then dry with filter paper or tissue paper.

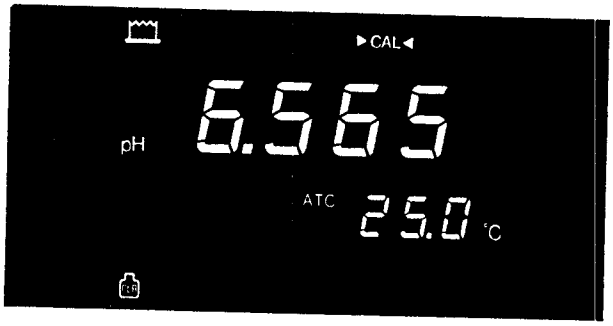


2. Open the rubber cap of the reference solution filling port. This port should be left open during calibration.

CAL

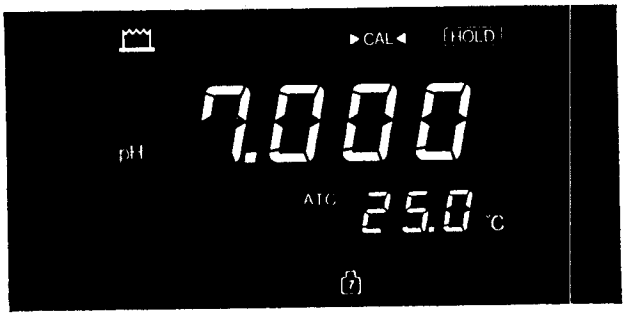
3. Immerse the electrode into the standard buffer to be calibrated, then after readings have stabilized, press **CAL** (▶**CAL**◀ will be displayed).

*To cancel calibration after pressing **CAL**, press **CAL** again.*



4. Calibration will be carried out immediately after **CAL** is pressed, the calibrated value will be printed out (when is displayed), and the bottle mark of the buffer used will be displayed. Note that displayed readings will be held in stasis for two seconds after **CAL** is pressed.

*Once calibration is completed, and measurements have been started with **MEAS**, **CAL** will no longer respond. This is to protect the calibrated values. To restart calibration, it is necessary to erase the calibrated values first.*



Calibration with 1st buffer is now complete.

2nd and 3rd Calibration

Repeat procedure for calibration with 1st buffer using different buffers.

NOTES:

- ***If calibration is conducted with a reagent which has already been used, the latter calibration will be stored in memory.***
- ***If any of errors ERR 4, ERR 5, or ERR 6 are generated during calibration, refer to "Troubleshooting with Error Numbers" (p.83) before recalibrating.***

Calibrating with Standard Buffers having pH Values Other than 2, 4, 7, 10, and 12

PHB-94 | PHB-95 | PHB-96

It is possible to specify one (and only one) solution having a pH value other than 2, 4, 7, 10, and 12 for use in calibration. In this case, **OTHER CAL** is used.

☞ *The method for specifying a different buffer is given in the section entitled "OTHER BUFFERS pH VALUE" on page 43.*

OTHER CAL

The procedure in both auto-hold and manual modes is almost the same as that used when setting buffer of pH 2, 4, 7, 10, or 12, the only difference being that **OTHER CAL** is pressed instead of **CAL**..

It is possible to include the user-specified buffer in 2-point and 3-point calibrations in combination with buffers of pH 2, 4, 7, 10, and 12.

NOTES:

- ***In contrast to the standard buffers of pH 2, 4, 7, 10, and 12, the other buffer can calibrate only using a pH value that corresponds to a certain temperature.***
  Therefore, when calibrating and measuring with the other buffer, measure at the same temperature as when calibrating.
  When the temperatures at calibration and measuring are different, a deviation will be produced in the measuring result.
  In such a case, recalibrate with the other buffer by matching the measuring sample temperature again.
- ***When setting the other buffer, 0 is automatically input for the third digit below the decimal point.***

MEASUREMENTS

In addition to normal measurement, it is possible to use the temperature coefficient to convert pH changes caused by temperature to the standard pH and then conduct measurements.

Two Measuring Modes

It is possible to take measurements in tw modes.
Choose the appropriate mode according to the sample or measurement conditions.

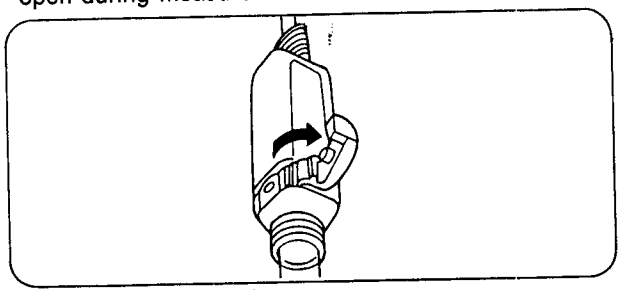
Auto-Hold Mode
The pH meter judges whether the electrode potential has stabilized, and then holds the measured value.

Manual Mode
Measured values are displayed in succession.

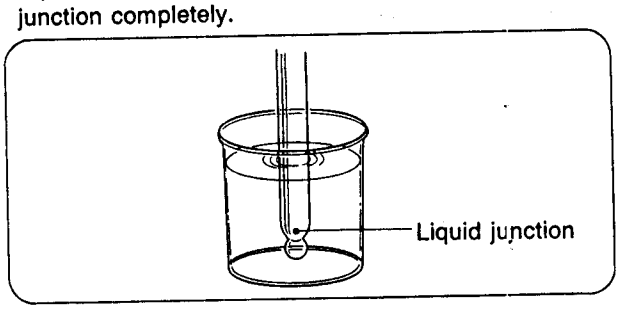
Before Measuring

In order to conduct accurate pH measurements, it is necessary to be well acquainted with the operation, and to use the electrode (which is placed in direct contact with the sample solution) correctly. When making measurements, be sure of the following points.

- Leave the rubber cap of the reference solution filling port on the electrode open during measurements.



- Dip the electrode in the sample solution deep enough to cover the liquid junction completely.



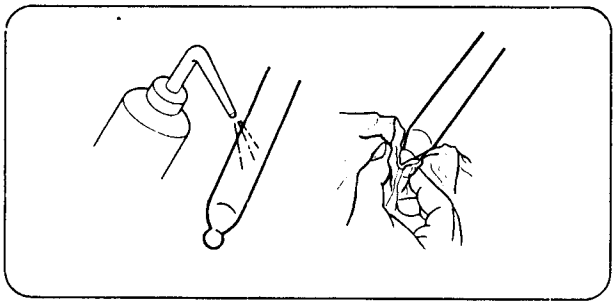
- Mix the sample solution well with a stirrer or similar object to improve contact between the electrode and the sample.
- When measuring more than one sample solution, rinse the electrode well after each sample.

Measurement in Auto-Hold Mode

Check that the meter is in auto-hold mode. If [AUTO] is not displayed, press **AUTO HOLD** and place the pH meter in auto-hold mode. Measurement procedure is given below.

AUTO HOLD

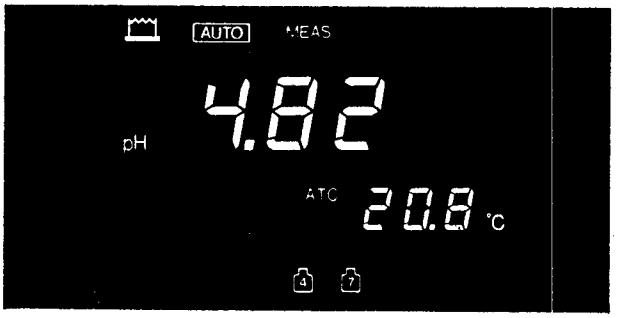
1. Rinse the electrode, including the liquid junction, thoroughly in deionized or distilled water, then wipe dry with filter paper or tissue paper.



2. Open the rubber cup of the reference solution filling port. This inlet should be left open during measurements.

MEAS

3. Dip the electrode into the sample to be measured, and press **MEAS**. [AUTO] will flash until readings stabilize.



*To cancel measurements, press **MEAS** again. [AUTO] will stop flashing.*

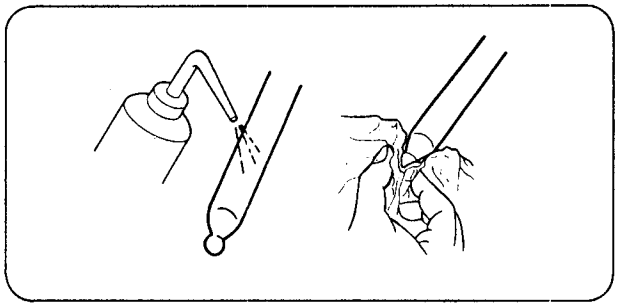
NOTE:
After measuring is finished, rinse the electrode in accordance with the maintenance items on Page 74.

Measurement in Manual Mode

Check that the meter is in manual mode. If AUTO is displayed, press **AUTO HOLD** and place the meter in manual mode (AUTO will no longer be displayed).

AUTO HOLD

1. Rinse the electrode, including the liquid junction, thoroughly in deionized or distilled water, then wipe dry with filter paper or tissue paper.

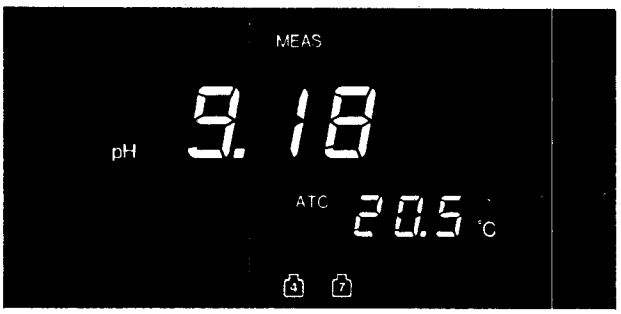


2. Open the rubber cup of the reference solution filling port. This port should be left open during measurements.

MEAS

3. Dip the electrode into the sample to be measured, and press **MEAS**. Measured values will be displayed for two seconds, then canceled automatically, and followed by successive measured values.

*To cancel measurements, press **MEAS** again.*



NOTE:
After measuring is finished, rinse the electrode in accordance with the maintenance item on pages 74 and 75.

Measuring with Temperature Coefficient

PHB-94 | PHB-95 | PHB-96

It is possible to convert the pH value of a sample measured at a temperature other than 25°C, to the pH value at 25°C. This conversion can be made **in either auto-hold or manual mode**. The procedure is as follows.

FUNCTION

1. Press **FUNCTION**. (**LED** lights)

The setting procedure is given on page 46.

TEMP COEF

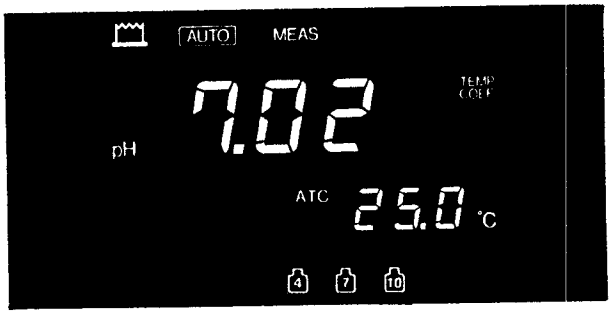
2. Press **TEMP COEF** to set the temperature coefficient.

3. Open the rubber cap of the reference solution filling port. This port should be left open during measurements.

MEAS

4. Immerse the electrode into the sample to be measured, and press **MEAS**. The measured value will be converted to the value at 25°C, then displayed and printed out (if printer function is available).

*To cancel measurements: Press **MEAS** again.*



*As long as **TEMP COEF** is displayed, all displayed measurements will be converted measurements.*

NOTE:
If the temperature coefficient of the sample solution is not known, it is necessary to set the coefficient to 0.000 (temperature conversion will not take place).

DATA ARRANGEMENT

DATA MEMORY PHB-93 PHB-94

A maximum of 100 pairs of data can be stored and called up at any time. Each data pair may consist of measured value (pH or mV) and the temperature displayed at measurement, or a calibrated value and temperature displayed at calibration.

Storing Data

DATA IN.

1. Pressing **DATA IN** when the desired value is displayed will cause that value to be stored in the pH meter memory.

2. The **DATA** followed by the data number will be displayed, and the display will be held in stasis for approximately one second.

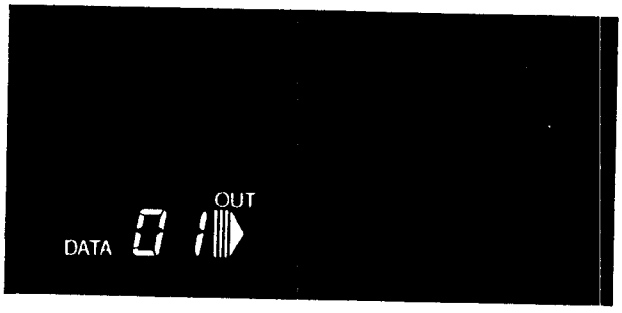
3. After one second has elapsed, the screen will change to the display shown before the operation was initiated.

Recalling Data

Stored data can be recalled in the order they were stored, beginning with item no. 1. Data cannot be recalled for specified data nos., or in reverse order, etc.

DATA OUT

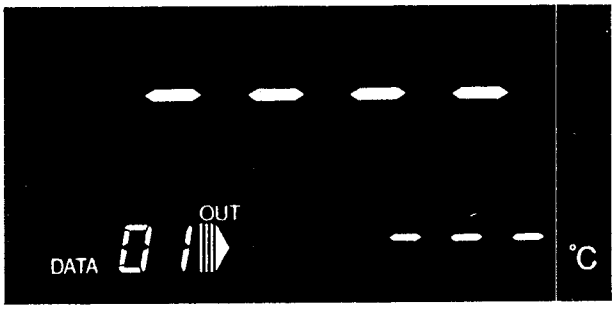
Press **DATA OUT**. The **DATA** followed by the data number, and the stored data value will be displayed.



*To cancel this operation: Press **pH/mV**.*

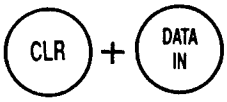
*The display data item number will increment each time **DATA OUT** is pressed. Data can be recalled at high speed by pressing **DATA OUT** continuously.*

When a particular memory position is empty
When there is no data stored in a particular memory position, dashes indicating null values will be displayed, as shown below.

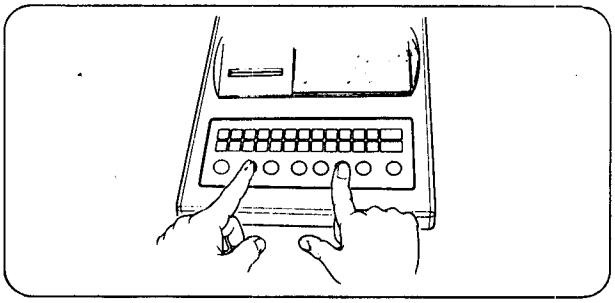


Erasing Data

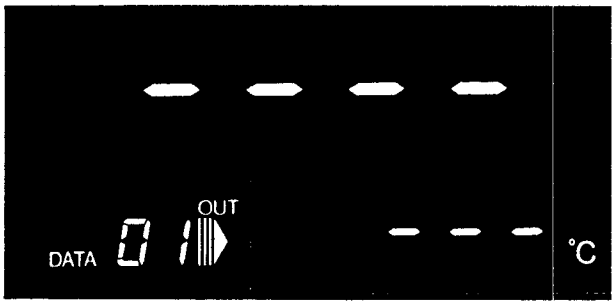
Data are erased by pressing **CLR** and **DATA IN** together. Note that this will cause all data in memory to be erased at once.



1. Press **CLR** and **DATA IN** together.



2. Press **DATA OUT** and check that all values have been erased. If they have been correctly erased, dashes indicating null values will be displayed in all memory positions.



DATA PRINTING PHB-95 PHB-94

The built-in thermal printer has three printing methods: automatic, manual and interval printing.

Automatic printing: 🖷 + AUTO
Manual printing: Possible anytime
Interval printing: 🖷

Automatic Printing

The printer automatically prints after operations such as calibration and measurement are completed. Print using **AUTO PRINT** (🖷 mark goes on) in the auto-hold mode.
However, when **CAL** is pressed in the manual mode for calibration, the printer automatically prints.

1. Turn on AUTO by pressing **AUTO HOLD**.

2. Press **FUNCTION**. (**LED** lights)

3. Press **DATA NO.**

4. Set the start number of the data to be printed. When a data number is not required, set the data number to "0".

☞ *The method for specifying a data number is given on page 48.*

5. Press **AUTO PRINT**.
The 🖷 mark indicating automatic printing will be displayed in the upper left on the screen.

6. The above completes preparations for automatic printing. When conducting calibration and measurement, data is printed automatically.

Printing format:

Calibration

When ATC:
```
12/25 19:18
   CAL.     pH  6.865
                25.0°C
```

When MTC:
```
12/25 19:20
   CAL.     pH  4.008
             M  25.0°C
```

Calibration finished:
```
** CALIBRATION OK **
```

When error generated:
```
* ELECTRODE  CHECK *
```

Measurement	pH	mV
When ATC:	5/18 15:31 NO. 2 pH 5.97 25.0°C	5/18 15:32 NO. 4 80 mV 25.0°C
When MTC:	5/18 15:32 NO. 3 pH 5.61 M 20.0°C	
EXP:	5/18 15:33 NO. 5 pH 5.714 25.0°C	5/18 15:48 NO. 7 161.9mV 25.0°C
Temp coeff:	5/18 15:35 *pH 5.52 25.0°C	———
Without data No.:	5/18 15:36 pH 5.27 25.0°C	5/18 15:39 111 mV 25.0°C

Manual Printing

Press **PRINT** to immediately print the calibration value and measured value displayed on the screen. This printing is not restricted by the auto-hold and the manual mode.

Printing format:

pH	mV
5/18 15:49 NO. 8 pH 4.09 25.1°C	5/18 15:49 NO. 9 173 mV 25.0°C

NOTES:
- ***The data number increases each time PRINT is pressed while data numbers are being printed.***
- ***The clock display (screen) cannot be printed.***

Interval Printing

Data is printed automatically at each time interval optionally set.
This printing is available for carrying out long-term monitoring measurements.

FUNCTION

1. Press **FUNCTION**. (**LED** lights)

PRINT INT.

2. Set the print interval with **PRINT INT.** Be sure to set it for 10 sec. or more.

The method for specifying interval time is given on page 49.

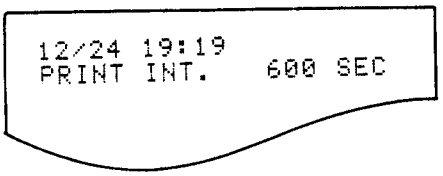
NOTE:
The data number increases for each interval and is printed. When a data number is not required, set the data number to "0".

AUTO HOLD

3. Set to Manual mode using **AUTO HOLD**.
(AUTO goes out)

AUTO PRINT

4. Press **AUTO PRINT**. The mark will be displayed in the upper left on the screen. Data will be printed when this key is pressed, and the print interval count will start.



To stop the interval printing: Press AUTO HOLD. In addition, stop printing when changing to the clock display.

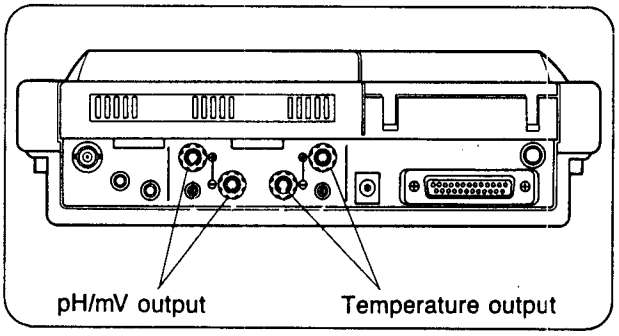
FUNCTION

5. Press **FUNCTION** (**LED** goes out)

NOTE:
Set the print interval to "0". When it is set to "0", interval printing will start when conducting manual calibration and when printing.

ANALOG OUTPUT

Two types of data are continually being sent to the analog output terminals on the rear of the pH meter. These terminals can be attached to a recorder.



Items of Data Output

- pH/mV value
- Temperature Value

Data and Output Voltage

Data is output as linear voltage value. The correspondence between data and voltage is as follows. (Output Impedance: 1 kΩ)

pH output

Value	Output
pH 0	−0.7 V DC
pH 7	0.0 V DC
pH 14	0.7 V DC

mV output

Value	Output
−1999 mV	−1.0 V DC
0 mV	0.0 V DC
1999 mV	1.0 V DC

Temperature output

Value	Output
0.0°C	0.0 V DC
100.0°C	1.0 V DC

NOTE:
Measurements are sent to the output terminals even while the display is on hold. However, when recalling stored data, and during display of the clock, the output value remains fixed at the last value sent to the terminals before data recall or the clock display was initiated.
The output voltage is set when the pH meter shipped from the factory, however if it begins to differ from the displayed value, it can be adjusted by using the Voltage Output Adjustment Control.

MAINTENANCE AND TROUBLESHOOTING

CARE OF ELECTRODE

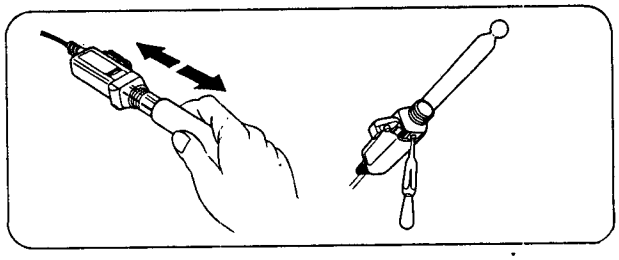
When using after a long period

Perform the same operations as in section "When using for the first time" on Page 52.

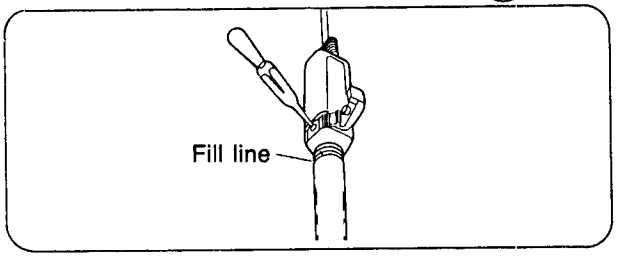
When Storing for Long Periods

Before storing the electrode for a long period, prepare it by following the maintenance procedure given below.
This procedure should also be conducted as a regular maintenance routine once every three to six months.

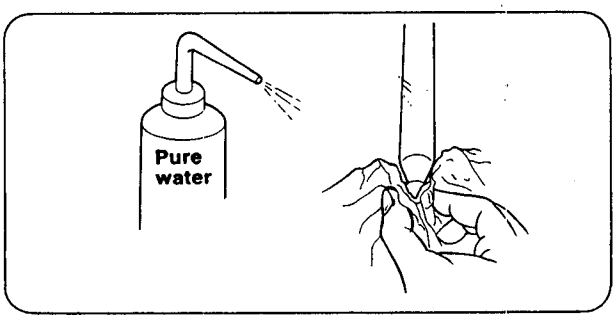
1. Remove the electrode cap and open the rubber stopper of the reference solution filling port, then remove the old reference solution with a dropper.



2. Add fresh reference solution until it reaches the line on the electrode cap
   The reference solution shoud be 3.33 mKCl



3. Rinse the electrode, including the liquid junction, thoroughly in deionized or distilled water, then wipe dry with filter paper or tissue paper. Also, if the reference solution inside the electrode cap has dried up, clean the cap with distilled or deionized water, then after shaking off any excess water, add just enough buffer 4.0 or 7.0 to the sponge inside the cap to saturate it.

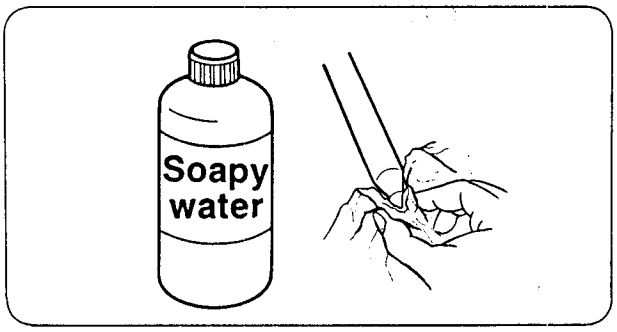


When the Electrode is Very Dirty

Dirt on the tip of the electrode is a major cause of slow response and measurement errors. When the electrode is too dirty to rinse with pure water, clean it by the most suitable of the methods given below.

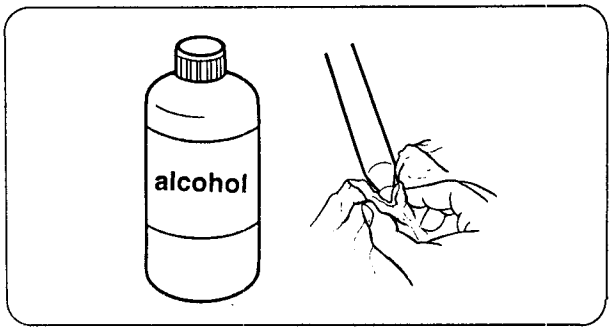
•Ordinary Dirt

Wipe with gauze or other soft cloth soaked in soapy water.



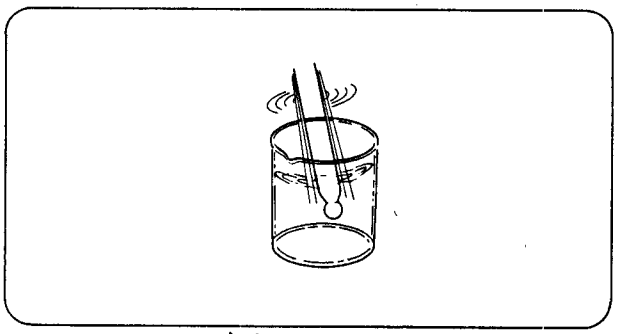
•Oil-Related Dirt

Wipe with gauze or other soft cloth soaked in alcohol.



•Dirt containing Inorganic Substances

Rinse the electrode in hydrochloric acid of 1 normal or 1 molar concentration*. Be sure not to leave the electrode soaking in strong acid.



*1 normal concentration of hydrochloric acid: hydrochloric acid diluted to one part in ten.

TROUBLESHOOTING FOR ERROR NUMBERS

The pH meter is equipped with a set of simple error messages to inform the user of operational errors and other problems. These error messages are displayed as error numbers, and are accompanied by an error alarm in the form of two short beeps.
An alarm also sounds when a key which is not operational in the current mode is pressed, however this alarm does not signify an error, and to distinguish it from the error alarm, three beeps are sounded.

There is a total of eight error messages, and these are listed below.

ERR 1	**pH range over**
ERR 2	**mV range over**
ERR 3	**Temperature range over**
ERR 4	**Asymmetry potential generated**
ERR 5	**Electrode sensitivity decrease**
ERR 6	**Still unstable after 3 minutes**
ERR 7	**Amplifier error**
ERR 8	**Calibration with 4 or more buffers.**

Before troubleshooting for error numbers

Turn off the ERR number display before troubleshooting, as described below.

ERR 1 **ERR 2** **ERR 3**	**The ERR number will go off automatically if it is within the measuring range.**
ERR 4 **ERR 5**	**Press CAL and CLR together.**
ERR 6	**Press MEAS twice when measuring.** **Press CAL twice when calibrating.**
ERR 7	**Turn off the power supply.**
ERR 8	**Press CAL and CLR together.**

ERR 4 Asymmetry potential generated.

Cause	Action
Dirty electrode.	Rinse electrode.
Broken electrode.	Replace electrode.
Bad buffer.	Prepare new batch of buffer.
Altered concentration of reference solution.	Replace or refill reference solution.

ERR 5 Electrode Sensitivity Decrease.

Cause	Action
Dirty electrode.	Rinse electrode.
Incorrect calibration.	Recalibrate.
Bad buffer.	Prepare new batch of buffer.
Broken electrode.	Replace electrode.

ERR 6 Still unstable after 3 minutes.

Cause	Action
Dirty electrode.	Rinse electrode.
Low sample conductivity.	Try measuring again in manual mode.
Glass response membrane of electrode left dry for long period.	Soak in buffer 4.0 or 7.0 for 8 hours.
Sample temperature fluctuating.	Re-measure after temperature stabilizes.
Broken electrode.	Replace electrode.

ERR 7 Amp malfunction. (on PC board)

Cause	Action
pH meter malfunction.	Contact OMEGA. (Need to send in for inspect and advise)

ERR 8 Calibration with four or more Buffers.

Action: Calibrate with 3 or fewer types of standard buffer. (See page 59.)

OTHER PROBLEMS

Below is a list of problems which may not be assigned an error number.

Nothing is displayed after power is on.

Cause	Action
AC adaptor not properly attached?	Attach AC adaptor correctly.
AC adaptor broken?	Replace AC adaptor.

Unstable display

Cause	Action
Liquid junction not in full contact with sample?	Immerse electrode in sample up to liquid junction.
Electrode broken?	Replace electrode.
Nearby motor etc. causing external induction?	Take measurements away from inductive influence.
Electrode dirty?	Clean electrode.

Slow response.

Cause	Action
Electrode broken?	Replace electrode.
Electrode dirty?	Clean electrode.

Display does not change; pH meter does not respond.

Cause	Action
pH meter in hold status?	Release hold status.
Electrode broken?	Replace electrode.
Internal program running unchecked?	Turn off, then on again.

Display missing

Action: Check visually.
For the PHB-96, an initial diagnosis is possible by the self-diagnostic function (See P.82)

There is a difference between the value indicated and the value output.

Action: Contact OMEGA.
For the PHB-96, an initial diagnosis is possible by the self-diagnostic function. (See P.82)

Cannot be controlled with the computer.

Action: Contact OMEGA.
Perform an initial diagnosis using the self-diagnostic function.

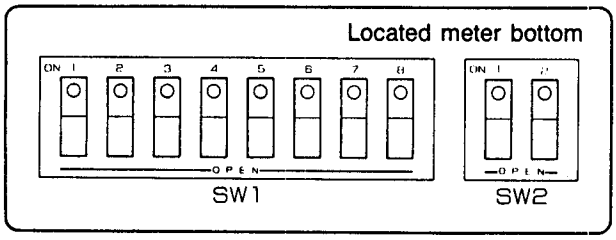
SELF-DIAGNOSTIC PHB-96

The self-check routine is initiated with **CHECK**.

The following parameters are checked.

Fluorescent display tube
Input amplifier
Analog output
RS-232C interface
The self-check routine is initiated as follows.

1. Set the loop-back test switches (SW2) as shown below.



2. Press **FUNCTION**. The LED will light up, indicating that the function switch has been activated.

3. Press **CHECK**.

•Diagnosis of the fluorescent light tube.
All the elements of the fluorescent light tube should light up. Any element which does not light up probably indicates a malfunction.

•Diagnosis of Analog output.

After approximately 10 seconds have elapsed, **CH.1** will be displayed. This indicates that the analog output unit is currently being checked.

•Diagnosis of RS-232C interface.

After approximately 10 more seconds, the displayed channel no. changes to **CH.2**, indicating that the RS-232C interface is being checked.

NOTE:
During the self-check routine, both the pH and temperature values sent to the analog output terminal are 0 mV.

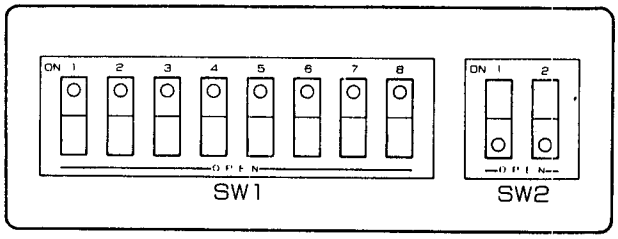
•Printed out of Diagnosis result.

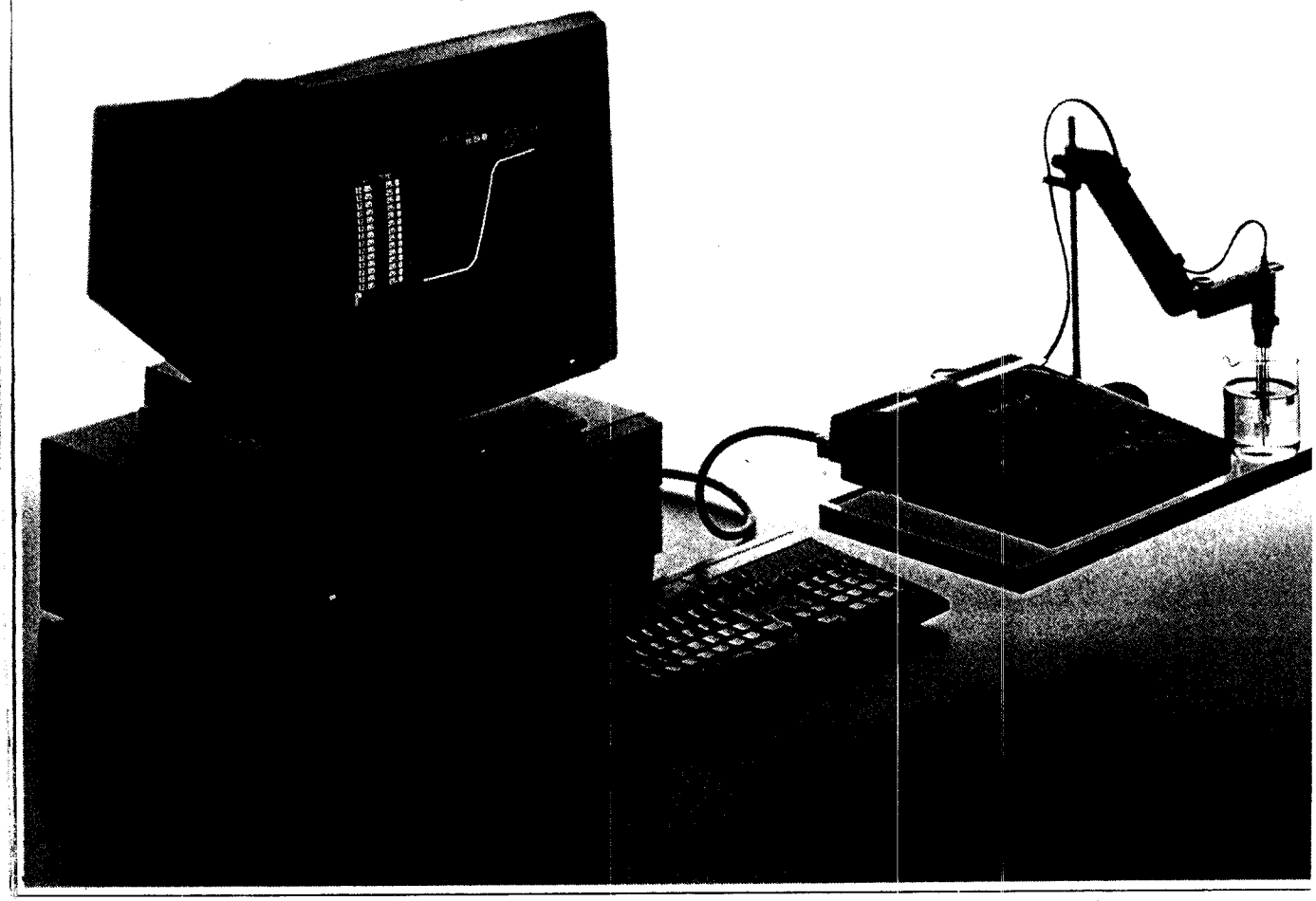
When the self-check is completed, a self-diagnosis similar to that shown below is printed out automatically. This printout will enable the user to check the operation of the pH meter.

pH	INPUT	OK
TEMP	INPUT	ERROR
RS-232C		OK
PRINTER		OK

OK indicates normal operation, and **ERROR** indicates a malfunction of some sort.

4. After running the check, set the loop-back test keys of SW2 back to OPEN position, as shown below.





RS-232C INTERFACE TRANSMISSION PROTOCOL

PRECAUTIONS TO BE TAKEN

1. Ensure that the transmission format of both pH meter and computer are the same.

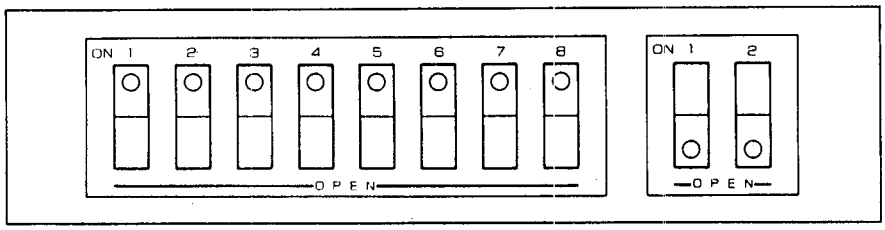
2. When writing a program, insert an on-line command to place the pH meter in the on-line mode. When in on-line mode, the operation keys will cease to function, and RS-232C transmission will be possible. On-line mode is canceled by turning the pH meter off.

3. Structure any programs so that if data is not sent immediately upon request, the computer will request data again after a short period. This will make data transmission more successful.

4. When not using the RS-232C terminal, place the protective cap over it.

SETTING BAUD RATE AND TRANSMISSION FORMAT

Before turning the power on, set the transmission format by the Dip switches on the back of the pH meter.



SW. 1 SW. 2

SW1

1 ON (fixed)

Baud Rate

	9600	4800	2400	1200	600	300
2	ON	OFF	ON	OFF	ON	OFF
3	ON	ON	OFF	OFF	ON	ON
4	ON	ON	ON	ON	OFF	OFF

5 character length . . .ON: 8 bit, OFF: 7 bit

6 parity . . . . . ON: even, OFF: odd

7 parity . . . . . ON: valid, OFF: invalid

8 stop bit. . . . . .ON: 2 bit, OFF: 1 bit

SW2

1 OFF (fixed)

2 OFF (fixed)

COMMAND CODES

Command Name		Code	
		Header	Item
Data Request	Clock Data	R	CL
	OTHER BUFF Value		OB
	TEMP COEF Value		TC
	MTC TEMP Value		MT
	DATA No. Value		DN
	Memorized Data No.		SN
	Memorized Data		SD
	Print Interval Value		PI
Data Setting	MTC TEMP Value	S	MT
	OTHER BUFF Value		OB
	TEMP COEF Value		TC
	DATA No. Value		DN
	Clock Data		CL
	Print Interval Value		PI
Switching Operation	On-line/Off-line	C	OL
	mV/pH		MV
	MTC/ATC		MT
	AUTO HOLD ON/OFF		AH
	AUTO PRINT ON/OFF		AP
	Expanded Display ON/OFF		EX
	Clock Display ON/OFF		CL
Execution A	Feed		FD
	DATA IN		DI
	DATA OUT		DO
	Calibration Clear		CC
	Memorized Data Clear		DC
	Print		PR
Execution B	Start Manual Calibration		CM
	Start Manual Other Buffer Calibration		OM
	Start Manual Measurement		MM
Execution C	Start Auto-Hold Calibration		CA
	Start Auto-Hold Other Buffer Calibration		OA
	Start Auto-Hold Measurement		MA
	Start Self-Check		CK
Stop sequence Potential Follow-Up; Self-Check			BR

Data request

It is possible to conduct the following 8 types of data request from the computer.

1. Clock Data
2. Other Buffer Value
3. Temperature Coefficiency
4. Manual Temperature Value
5. Data Number
6. Memorized Data Number
7. Memorized Data
8. Print Interval Time

These execution commands result in a constant format response being issued from the pH meter. If a command is not accepted by the meter, the following response format is returned to the computer:

E R, O [CR] [LF]

If a command is not accepted by the meter, the following response format is returned to the computer:

When there is no item code (i.e., when it has not been input or has been dropped), no response is forthcoming from the pH meter.
Below are the command formats for each execution command, and the formats of the responses issued from the pH meter.

1. Clock Data

R, C L [CR] [LF]

Header: R
Item code: C L
CR: Carriage Return
LF: Line Feed

The response to this from the pH meter takes the following form:

C L, x x, x x, x x, x x, x x [CR] [LF]

Item code: C L
Month: x x
Day: x x
Hour: x x
Minute: x x
Second: x x

2. Other Buffer Value (pH value of user-specified buffer)

R, O B [CR] [LF]

Header: R
Item code: O B

The response to this from the pH meter takes the following form:

O B, x x. x x x [CR] [LF]

- x x. x x x: Other buffer value (to 3 decimal places: total 6 digits)
- **O B**: Item code

3. Temperature Coefficiency

R, T C [CR] [LF]

- **T C**: Item code
- **R**: Header

The response to this from the pH meter takes the following form:

T C, x x. x x x [CR] [LF]

- x x. x x x: Temperature coefficiency (to 3 decimal places: total 6 digits)
- **T C**: Item code

4. Manual Temperature Value

R, M T [CR] [LF]

- **M T**: Item code
- **R**: Header

The response to this from the pH meter takes the following form:

M T, x x x. x [CR] [LF]

- x x x. x: Manual temperature value (to 1 decimal place)
- **M T**: Item code.

5. Data Number

R, D N [CR] [LF]

- **D N**: Item code
- **R**: Header

The response to this from the pH meter takes the following form:

D N, x x [CR] [LF]

- x x: Data number: 0 to 99
- **D N**: Item code

6. Memorized Data Number

R, S N [CR] [LF]

- **S N**: Item code
- **R**: Header

The response to this from the pH meter takes the following form:

S N, x x x [CR] [LF]

- x x x: Data number: 0 to 100
- **S N**: Item code

7. Memorized Data

R, S D x x [CR] [LF]
- R, : Header
- S D : Item code
- x x : Data number: 0 to 99

The response to this from the pH meter takes the following form:

S D, x x, x x, x x, x x, x x, x x (—)
- S D : Item code
- x x : Data number (2 digits)
- x x : Month (2 digits)
- x x : Day (2 dighits)
- x x : Hour (2 digits)
- x x : Minute (2 digits)
- x x : Second (2 digits)

(—) x, x, x x x x x, x x x. x [CR][LF]
- x : Range code { 0 ... pH (ATC) / 1 ... pH (MTC) / 2 ... mV }
- x : Temperature conversion { 0 ... no conversion / 1 ... conversion }
- x x x x x : pH or mV value (5 digits)
- x x x. x : Temperature

8. Print Interval Time

R, P I [CR][LF]
- R, : Header
- P I : Item code

The response to this from the pH meter takes the following form:

P I, x x x x x [CR][LF]
- P I, : Item code
- x x x x x : Print interval time (5-digit integer)

Data Setting

It is possible to conduct the following 6 types of data setting from the computer.

1. Manual Temperature Value
2. Other Buffer Value
3. Temperature Coefficiency
4. Data Number
5. Clock Data
6. Print Interval Time

These execution commands result in a constant format response being issued from the pH meter. If a command is not accepted by the meter, the following response format is returned to the computer:

E R, O [CR][LF]

If a command is accepted by the meter, the following data is sent to the computer.
When there is no item code (i.e., when it has not been input or has been dropped), no response is forthcoming from the pH meter.
Below are the command formats for each data request command, and the formats of the responses issued from the pH meter.

OK [CR] [LF]

E R, O [CR][LF]

1. Manual Temperature Value (MTC)

S, M T, x x x. x [CR][LF]

Header: **S,** — Item code: **M T,** — Data to be set: x x x. x

2. Other Buffer Value

S, O B, x x. x x x [CR] [LF]

Header: **S,** — Item code: **O B,** — Data to be set: x x. x x x

3. Temperature Coefficiency

S, T C, +/– x. x x x [CR] [LF]

Header: **S,** — Item code: **T C,** — Data to be set: +/– x. x x x

4. Data Number

S, D N, x x [CR][LF]

- Data number (2 digits)
- Item code
- Header

5. Clock Data

S, C L, x x, x x, x x, x x, x x [CR] [LF]

- Second (2 digits)
- Minute (2 digits)
- Hour (2 digits)
- Day (2 digits)
- Month (2 digits)
- Item code
- Header

6. Print Interval Time

S, P I , x x x x x [CR] [LF]

- Print interval time (5 dighits)
- Item code
- Header

Switching Operation

It is possible to conduct the following 7 types of on-line operation from the computer.

1. On-line/Off-line
2. mV/pH
3. MTC/ATC
4. AUTO HOLD ON/OFF
5. AUTO PRINT ON/OFF
6. Expanded Display ON/OFF
7. Clock Display ON/OFF

These execution commands result in a constant format response being issued from the pH meter. If a command is not accepted by the meter, the following response format is returned to the computer:

E R, O [CR] [LF]

If a command is not accepted by the meter, the following response format is returned to the computer:

OK [CR] [LF]

When there is no item code (i.e., when it has not been input or has been dropped), no response is forthcoming from the pH meter. Below are the command formats for each execution command, and the formats of the responses issued from the pH meter.

1. On-line/Off-line

C, O L, x [CR] [LF]

- Header: C
- Item code: O L
- Input 0 or 1: x
  - 0 ... off-line
  - 1 ... on-line

2. mV/pH

C, M V, x [CR] [LF]

- Header: C
- Item code: M V
- Input 0 or 1: x
  - 0 ... mV
  - 1 ... pH

3. MTC/ATC

C, M T, x [CR] [LF]

- Header: C
- Item code: M T
- Input 0 or 1: x
  - 0 ... ATC
  - 1 ... MTC

4. AUTO HOLD ON/OFF

C, A H, x [CR] [LF]

- Header: C
- Item code: A H
- Input 0 or 1: x
  - 0 ... AUTO HOLD OFF
  - 1 ... AUTO HOLD ON

5. AUTO PRINT ON/OFF

C, A P, x [CR] [LF]

- C, A P, : Item code
- x : Input 0 or 1 { 0 ... AUTO PRINT OFF / 1 ... AUTO PRINT ON }
- C : Header

6. Expanded Display ON/OFF

C, E X, x [CR][LF]

- C, E X, : Item code
- x : Input 0 or 1 { 0 ... Expanded Display OFF / 1 ... Expanded Display ON }
- C : Header
- [CR][LF]

7. Clock Display

C, C L, x

- C, C L, : Item code
- x : Input 0 or 1 { 0 ... Clock Display OFF / 1 ... Clock Display ON }
- C : Header

Execution A

It is possible to conduct the following 6 types of on-line operation from the computer.

1. Paper Feed
2. Data In
3. Data Out
4. Calibration Clear
5. Memorized Data Clear
6. Print

These execution commands result in a constant format response being issued from the pH meter. If a command is not accepted by the meter, the following response format is returned to the computer:

E R, O [CR][LF]

If a command is accepted by the meter, the following response format is returned to the computer:

O K [CR][LF]

When there is no item code (i.e., when it has not been input or has been dropped), no response is forthcoming from the pH meter.
Below are the command formats for each execution command, and the formats of the responses issued from the pH meter.

1. Paper Feed

C, F D, X [CR][LF]

- Header: C,
- Item code: F D,
- Input line numbers to be fed: X — 1 to 9 or 0 (0 is input to specify 10 lines).

2. Data In

C, D I [CR][LF]

- Header: C,
- Item code: D I

3. Data Out

C, D O [CR][LF]

- Header: C,
- Item code: D O

4. Calibration Clear

C, C C [CR][LF]

- Header: C,
- Item code: C C

5. Memorized Data Clear

C, D C [CR] [LF]

Item code

Header

6. Print

C, P R [CR] [LF]

Item code

Header

Execution B

It is possible to conduct the following 3 types of on-line operation from the computer.

1. Starting Calibration in Manual Mode
2. Starting Other Buffer Calibration in Manual Mode
3. Starting Measurements in Manual Mode

These execution commands result in a constant format response being issued from the pH meter. If a command is not accepted by the meter, the following response format is returned to the computer:

E R, x |CR||LF|

x: Error Number
0: Operational Error by User
1: pH Range Over
2: mV Range Over
3: Temperature Range Over
8: Buffer Alarm

When there is no item code (i.e., when it has not been input or has been dropped), no response is forthcoming from the pH meter.
Below are the command formats for each execution command, and the formats of the responses issued from the pH meter.

1. Starting Calibration in Manual Mode

C, C M |CR||LF|

C: Header
M: Item code

The response to this from the pH meter takes the following form:

C M, x x, x x, x x, x x, x x, x, x x. x x x, (→)

- pH value (to 3 decimal places: total 6 digits)
- Temperature compensation (0...ATC / 1...MTC)
- second (2 digits)
- Minute (2 digits)
- Hour (2 digits)
- Day (2 digits)
- Month (2 digits)
- Identification code

(→) x x x x x. x, x x x. x, x, x, **O** |CR||LF|

- Electrode response error (0 ... no error / 1 ... error)
- Asymmetric potential error (0 ... no error / 1 ... error)
- Temperature value (to 1 decimal places: total 5 digits)
- mV value (to 1 decimal places: total 7 digits)

2. Starting Calibration in Manual Mode

C, O M |CR||LF|
- C, : Header
- O M : Item code

The response to this from the pH meter takes the following form:

O M, x x, x x, x x, x x, x x, x, x x. x x x, (—)
- O M : Identification code
- x x : Month (2 digits)
- x x : Day (2 digits)
- x x : Hour (2 digits)
- x x : Minute (2 digits)
- x x : Second (2 digits)
- x : Temperature compensation {0 ... ATC; 1 ... MTC}
- x x. x x x : pH value (to 3 decimal places: total 6 digits)

(—) x x x x x. x, x x x. x, x, x, O [CR] [LF]
- x x x x x. x : mV value (to 1 decimal places: total 7 digits)
- x x x. x : Temperature value (to 1 decimal places: total 5 digits)
- x : Asymmetric potential error {no ... no error; 1 ... error}
- x : Electrode response error {0 ... no error; 1 ... error}
- O : Fixed

3. Starting Measurements in Manual Mode

C, M M |CR||LF|
- C, : Header
- M M : Item code

The response to this from the pH meter takes the following form:

M M, x x, x x, x x, x x, x x, x, x, (—)
- M M : Identification code
- x x : Month (2 digits)
- x x : Day (2 digits)
- x x : Hour (2 digits)
- x x : Minute (2 digits)
- x x : Second (2 digits)
- x : Range {0 ... pH (ATC); 1 ... pH (MTC); 2 ... mV}
- x : Temperature compensation {0 ... no conversion; 1 ... conversion} Only valid in pH mode

(—) x x x x x x x, x x x. x, x, x |CR||LF|
- x x x x x x x : pH value or mV value
- x x x. x : Temperature value (to 1 decimal place: total 5 digits) It becomes measurement value when in mV mode.
- x : pH/mV outside measurable range {0 ... no error; 1 ... error}
- x : Temperature outside measurable range {0 ... no error; 1 ... error}

Execution C

It is possible to conduct the following 3 types of on-line operation from the computer.

1. Starting Calibration in Auto-Hold Mode
2. Starting Other Buffer Calibration in Auto-Hold Mode
3. Staring Measurements in Auto-Hold Mode
4. Starting Self-Check Routine

These execution commands result in a constant format response being issued from the pH meter. If a command is not accepted by the meter, the following response format is returned to the computer:

E R, X [CR] [LF]

Error Number
0: Operational Error by User
1: Outside Measurable pH Range
2: Outside Measurable mV Range
3: Outside Measurable Temperature Range
8: Buffer Alarm

If a command is accepted by the meter, the following response format is returned to the computer:

O K [CR] [LF]

When there is no item code (i.e., when it has not been input or has been dropped), no response is forthcoming from the pH meter.
Below are the command formats for each execution command, and the formats of the responses issued from the pH meter.

1. Starting Calibration in Auto-Hold Mode

C, C A [CR] [LF]

Item code
Header

The response to this from the pH meter takes the following form:

C A, x x, x x, x x, x x, x x, x, (–)

Temperature compensation {0 ... ATC / 1 ... MTC}
Second (2 digits)
Minute (2 digits)
Hour (2 digits)
Day (2 digits)
Month (2 digits)
Item code

(–) x x. x x x, x x x x x x x, x x x. x, x, x, x, [CR] [LF]

Electrode stability error {0 ... no error / 1 error}
Electrode response error {0 ... no error / 1 ... error}
Asymmetric potential error {0 ... no error / 1 ... error}
Temperature value (to 1 decimal place: total 5 digits)
mV value
pH value (to 3 decimal places: total 6 digits)

2. Starting Other Buffer Calibration in Auto-Hold Mode

C, O A [CR] [LF]
- C, : Header
- O A : Item code

O A, x x, x x, x x, x x, x x, x, (—)
- O A : Item code
- x x : Month (2 digits)
- x x : Day (2 digits)
- x x : Hour (2 digits)
- x x : Minute (2 digits)
- x x : Second (2 digits)
- x : Temperature compensation { 0 ... ATC, 1 ... MTC }

(—) x x. x x x, x x x x x x x, x x x. x, x, x, O [CR] [LF]
- x x. x x x : pH value (to 3 decimal places: total 6 digits)
- x x x x x x x : mV value
- x x x. x : Temperature value (to 1 decimal place: total 5 digits)
- x : Asymmetric potential error { 0 ... no error, 1 ... error }
- x : Electrode response error { 0 ... no error, 1 ... error }
- O : Electrode stability error { 0 ... no error, 1 ... error }

3. Starting Measurements in Auto-Hold Mode

C, M A [CR] [LF]

- C: Header
- M A: Item code

The response to this from the pH meter takes the following form:

M A, x x, x x, x x, x x, x x, x, x, (→)

- M A: Identification code
- x x: Month (2 digits)
- x x: Day (2 digits)
- x x: Hour (2 digits)
- x x: Minute (2 digits)
- x x: Second (2 digits)
- x: Range (0 ... pH (ATC) (1 ... pH (MTC) (2 ... MV)
- x: Temperature compensation {0 ... no conversion / 1 ... conversion} Only valid when in pH mode
- (→)

(→) x x x x x x x, x x x. x, x, x [CR] [LF]

- (→)
- x x x x x x x: pH value or mV value
- x x x. x: Temperature value (to 1 decimal place: total 5 digits) If becomes measurement value when in mV mode.
- x: pH/mV outside measurable range {0 ... no error / 1 ... error}
- x: Temperature outside measurable range {0 ... no error / 1 ... error}
- [CR] [LF]

4. Starting Self-Check Routine

C, C K [CR] [LF]

- C: Header
- C K: Item code

C K, x x, x x, x x, x x, x x, x, x, x [CR] [LF]

- C K: Identification code
- x x: Month (2 digits)
- x x: Day (2 digits)
- x x: Hour (2 digits)
- x x: Minute (2 digits)
- x x: Second (2 digits)
- x: pH input check {0 ... normal / 1 ... error}
- x: Temperature input check {0 ... normal / 1 ... error}
- x: Printer check {0 ... normal / 1 ... error}
- [CR] [LF]

Stop Sequence

This operation can be done by entering the following command on the computer.

C, B R [CR] [LF]

Item code

Header

When the operation is accepted, the following response comes back to the computer from the pH meter.

O K [CR] [LF]

SAMPLE PROGRAM

The following is an example program showing how the RS-232C I/F is controlled from a microcomputer.
The program is written in NEC N-88 BASIC(86) to run on a NEC PC-9801 computer.

```
10 '*************************************************************************
20 '*                                                                       *
30 '*              pH METER  PHB-90 Series  RS-232C DEMONSTRATION PROGRAM   *
40 '*                                                                       *
50 '*              COPYRIGHT(C) Omega Eng.                                  *
60 '*              ALL RIGHT RESERVED                                       *
70 '*                                                                       *
80  SCREEN 3,0,0,1
90  CONSOLE 0,25,0,1
100 COLOR 4
110 DIM PH(1000), TEMP(1000)
120 DIM PH$(1000),TEMP$(1000)
130 CLS 1:CLS 2
140  LOCATE 25,1:PRINT "::::: RS-232C DEMO PROGRAM :::::"
150  LOCATE 15,3:PRINT "<<pH METER'S DIPSWITCH NO. 1,3-8:ON 2,9,10:OFF>>"
160  LOCATE 15,4:PRINT "<<pH METER POWER ON!>>"
170  LOCATE 15,6:PRINT "  HIT ANY KEY!!!"
180  IF INKEY$="" THEN GOTO 180
190   GOSUB *ONLINE
200  IF OLINP$="ER" THEN GOSUB *INPER
210  IF OLINP$="OK" THEN GOTO 240
220  GOTO 130
230 '
240 CLS 1
250  LOCATE 25,1:PRINT "::::: RS-232C DEMO PROGRAM :::::"
260  LOCATE 22,2:INPUT " DO YOU NEED CALIBRATION  <Y/N>";CL$
270  IF CL$)< "Y" THEN GOTO 430
280 '******************** CAL SET MAIN ********************
290  FOR NUM=1 TO 2
300    LOCATE 22,3:PRINT "*** CALIBRATION SET ***"
310    LOCATE 22,4:PRINT USING " PLEASE INPUT NO. # BUFFER";NUM
320    LOCATE 22,5:PRINT " READY? =>  HIT ANY KEY!!!"
330    IF INKEY$="" THEN GOTO 330
340     GOSUB *CALSET
350    LOCATE 1,2:PRINT "CAL [pH] TEMP [°C]"
360    LOCATE 2,NUM+2:PRINT PH$(NUM)
370    LOCATE 9,NUM+2:PRINT TEMP$(NUM)
380  NEXT NUM
390  BEEP
400  LOCATE 22,6:PRINT "CAL SET OK !!! "
410 CNT=0
420 '********************* MEASURE MAIN *********************
430  LOCATE 22,7:PRINT "*** MANUAL MODE MEASURE ***"
440  LOCATE 22,8 :INPUT "INPUT INTERVAL TIME (1-1000)[SEC] =";INSEC
450  LOCATE 22,9 :INPUT "INPUT RENGE WIDTH  pH LOW [pH]=";PHL
460  LOCATE 22,10:INPUT "                   pH HIGH [pH]=";PHH
470  LOCATE 22,11:PRINT " READY? =>  HIT ANY KEY!!!"
480  IF INKEY$="" THEN GOTO 480
490 CLS 1
500 CONSOLE 4,17,0,1
510  LOCATE 30,0:PRINT "SAMPLING CURVE"
520  IF CL$)<"Y" THEN GOTO 560
530  LOCATE 55,1:PRINT "CAL DATA "
540  LOCATE 55,2:PRINT USING "@[PH]  @[°C]";PH$(1),TEMP$(1)
550  LOCATE 55,3:PRINT USING "@[PH]  @[°C]";PH$(2),TEMP$(2)
560  LOCATE 3,3:PRINT "pH "
570  LOCATE 9,3:PRINT "TEMP °C"
580   GOSUB *GRAPH
590   GOSUB *TIME
600 TMDOT=0
610 SSTART=SECT
620 INTVAL= 0
630 COUNT=1
640 TNOW=-1
650  FOR NUM=3 TO 123
660     GOSUB *TIME
670    LOCATE 70,1 :PRINT SNOW
680    LOCATE 40,1 :PRINT TIME$
690    IF INTVAL>0 THEN GOTO 660
700     GOSUB *MEASURE
710   GYOU=NUM+1
720    IF GYOU>20 THEN GYOU=20
730    LOCATE 1,GYOU :PRINT USING "&         &";PH$(NUM) ,TEMP$(NUM)
740     GOSUB *PDOT
750  NEXT NUM
760   GOSUB *OFLINE
770 END
780 '-------------------------- SUBROUTINE --------------------------
790 '------------ ONLINE --------------
800 *ONLINE
810      OPEN "COM:E83NN" AS #1
820       PRINT #1,"C,OL,1"
830       INPUT #1,OLINP$
840       PRINT #1,"C,AP,0"
850      CLOSE #1
860 RETURN
870 '---------- INPUT ERROR ----------
880 *INPER
890      LOCATE 15,6:PRINT "pH METER SET UP ERROR "
900      LOCATE 15,7:PRINT "pH METER POWER OFF =>POWER ON "
```

```
910      LOCATE 15,8:PRINT "HIT ANY KEY!!! "
920      IF INKEY$="" THEN GOTO 920
930 RETURN
940 '------------ CAL SET --------------
950 *CALSET
960     OPEN "COM:E83NN" AS #1
970      IF NUM=1 THEN PRINT #1,"C,CC"
980      IF NUM=1 THEN INPUT #1,OLINP$
990      PRINT #1,"C,CM"
1000      INPUT #1,CH$,MOU$,DAY$,HR$,MIN$,SEC$,ATC$,PH$(NUM),MV$,TEMP$(NUM)
1010      COUNT=COUNT+1
1020     CLOSE #1
1030 RETURN
1040 '------------ GRAPH --------------
1050 *GRAPH
1060     PHW=PHH-PHL
1070     IF PHW=<.5 THEN SP=5 :GOTO 1080
1073     IF PHW=<1 THEN SP=10 :GOTO 1080
1075     IF PHW=<5 THEN SP=50 ELSE SP=100
1080     FOR I=PHL*100 TO PHH*100 STEP SP
1090       H=40+INT(300/(PHH-PHL)*CNT*SP/100)
1100       LINE(180,H )-(190,H),2:LINE(190,H)-(600,H),1,,&HAAAA
1110       CNT=CNT+1
1120     NEXT I
1130     LINE(180, 40)-(180,340),2
1140     LINE(180,340)-(600,340),2
1150     LOCATE 17,2 :COLOR 2:PRINT PHH
1160     LOCATE 17,12:PRINT ""
1170     LOCATE 17,21:PRINT PHL:
1180     LOCATE 12,21:PRINT "[pH]"
1190     IF INSEC *<5    THEN SP=2:   GOTO 1270
1200     IF INSEC *<10   THEN SP=4:   GOTO 1270
1210     IF INSEC *<50   THEN SP=20:  GOTO 1270
1220     IF INSEC *<100  THEN SP=40:  GOTO 1270
1230     IF INSEC *<500  THEN SP=200: GOTO 1270
1240     IF INSEC *<1000 THEN SP=400: GOTO 1270
1250     IF INSEC *<5000 THEN SP=2000:GOTO 1270
1260     IF INSEC  >5000 THEN SP=8000:GOTO 1270
1270     FOR I=SP    TO INSEC*12  STEP SP
1280       S=180+INT(I*10/INSEC *3)
1290       LINE(S,340)-(S,330),2:LINE(S,330)-(S,40),1,,&HAAAA
1300       S=170+INT((I-SP)*10/INSEC *3)
1305       SP3=(I/SP-1)/3-INT((I/SP-1)/3)
1310       IF SP3=0 THEN LOCATE INT(S/8),22:PRINT INT(SP/2)*CNT1:CNT1=CNT1+1
1320     NEXT I
1330     LOCATE 40,23:PRINT "TIME            [MIN]":COLOR 7
1340 RETURN
1350 '-------------- TIME --------------
1360 *TIME
1365     TM$=TIME$
1370     HT=VAL(LEFT$(TM$,2))
1380     MT=VAL(MID$(TM$,4,2))
1390     ST=VAL(RIGHT$(TM$,2))
1400     SECT=HT*60*60+MT*60+ST
1410     IF SECT=TNOW THEN GOTO 1365
1420     IF SECT<0    THEN GOTO 1365
1430     IF TNOW=863*100+99  THEN SSTART=SSTART-864*100
1440     TNOW=SECT
1450     SNOW=SECT-SSTART
1460     INTVAL=SNOW-INT(SNOW/INSEC)*INSEC
1470 RETURN
1480 '------------ MEASURE ------------
1490 *MEASURE
1500     OPEN "COM:E83NN" AS #1
1510      FOR P=1 TO 10
1520        PRINT #1,"C,MM"
1530        FOR K=1 TO 500
1540          IF LOC(#1)>37 THEN GOTO 1580
1550        NEXT K
1560      NEXT P
1570      CLOSE #1:GOSUB *ONLINE:GOTO 1600
1580      INPUT #1,CH$,MOU$,DAY$,HR$,MIN$,SEC$,RNG$,COEF$,PH$(NUM),TEMP$(NUM)
1590     CLOSE #1
1600 RETURN
1610 '------------ POINT DOT ------------
1620 *PDOT
1630     PH(NUM)=VAL(PH$(NUM))
1640     PHDOT=340-INT(300/(PHH-PHL)*(PH(NUM)-PHL))
1650     TMDOT=180+(SNOW/INSEC*3)
1655     IF TMDOTT>TMDOT THEN TMDOTT=TMDOT
1657     IF TMDOTT=0 AND PHDOTT=0 THEN TMDOTT=TMDOT:PHDOTT=PHDOT
1659      LINE(TMDOTT,PHDOTT)-(TMDOT,PHDOT),7
1660      CIRCLE(TMDOT,PHDOT),1,5
1665     TMDOTT=TMDOT:PHDOTT=PHDOT
1670 RETURN
1680 '------------ OFFLINE -------------
1690 *OFLINE
1700     OPEN "COM:E83NN" AS #1
1710      PRINT #1,"C,OL,0"
1720     CLOSE #1
1730 RETURN
```

Alterations in transmission protocol are made by changing the "COM:E83NN" specification in lines 810, 960, 1500, and 1700. The specification "COM:E88NN" contains the following information:

Parity Check: Even
Data Length: 8 bits
Stop Bit Length: 2 bits

Specifications

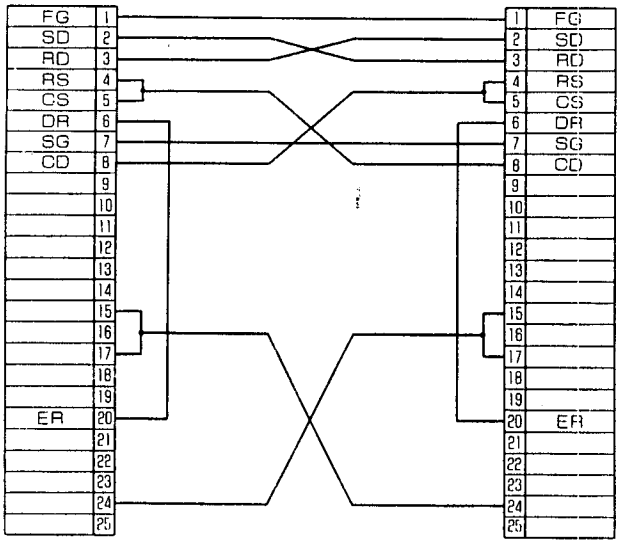
Conforms to JIS C6361 specifications.

1. Transmission system: half duplex

2. Transmission speed(dip switch setting):9600, 4800, 2400, 1200, 600, 300 (BPS)

3. Character composition (dip switch setting)
   - Start bit: 1 bit (fixed)
   - Character length: 7 or 8 bits
   - Parity check: Odd, Even or None
   - Stop bit: 1 or 2 bits

4. Connector pin arrangement (25-pin D-Sub connector)



Use the NEC PC9896 RS-232C (reverse) cable, for use with PC9801 computer.

APPENDIX:

CONCERNING pH MEASUREMENTS
PHB-90 Series Specifications
PHB-90 Series Accessories

CONCERNING pH MEASUREMENTS

Liquid Junction Potential

Liquid junction potential refers to the difference in potential which occurs around a liquid junction. The size of the potential varies according to the solution, the temperature, and the shape of the liquid junction.
When solutions of differing compositions come in contact, ion diffusion occurs at the place of contact, and since size and other factors of the ions concerned differ between solutions, the rate of diffusion also differs.
Due to the ion diffusion, a separation of electric charge occurs where the solutions come in contact, and this is thought to bring about a difference in potential. This potential slows down quick-moving ions, and speeds up slow-moving ions, the end result being that both positive and negative ions are moving at the same speed where the liquids come in contact. It is the electric potential in this balanced state which is referred to as liquid junction potential. When the liquid junction potential is great, measured values vary markedly from the true values.

Asymmetry Potential

Inside the glass electrode is an internal electrode which contains an internal solution of pH 7. When the electrode is placed in a solution of pH 7, the pH value on both sides of the glass membrane will be identical, so no potential should be produced. In fact, however, an electrode potential is produced, and this potential is known as asymmetry potential.
The size of the asymmetry potential varies according to such factors as the shape and composition of the glass, any distortion of the glass incurred during manufacture, and also by impurities in the internal solution, and changes in the glass membrane. In addition, when the glass membrane is dry, asymmetry potential increases, and can cause measurement errors.

Temperature Compensation

The electromotive force which is generated in the glass electrode varies according to the temperature of the solution. As its name implies, temperature compensation compensates for the variation in electromotive force due to temperature change. It is important to realize here that changes in the pH value of a solution due to temperature changes, and temperature compensation, are completely unrelated phenomena. For this reason, when measuring pH values, even with a pH meter having an automatic temperature compensator, it is necessary to record the temperature of the solution together with the pH value, or the measured results may turn out to be completely meaningless.

Temperature Conversion

Differences between Temperature Compensation and pH Conversion

When conducting measurements of pH using a glass electrode, the electromotive force generated in the electrode with every 1 pH varies according to the temperature of the sample (see table). The process of compensating for this electrically is defined as *Temperature Compensation*, and a pH meter equipped with this function can determine the pH value of a sample at the temperature at which it is measured.

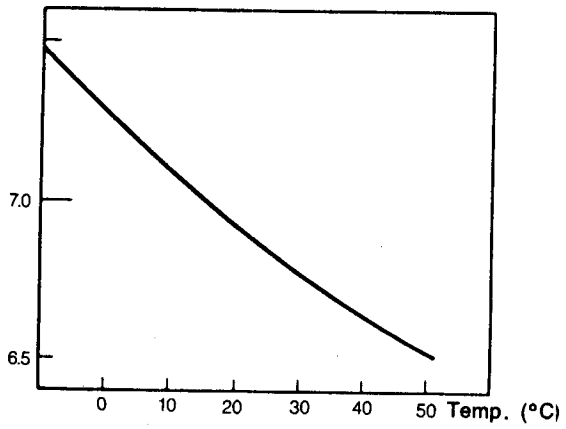
Table Electrode Potential (Electromotive Force) with Every 1 pH

Temp.(°C)	2.3026RT/F (mV)	Temp.(°C)	3.3026RT/F (mV)
0	54.20	35	61.15
5	55.19	40	62.14
10	56.19	45	63.13
15	57.18	50	64.12
20	58.17	55	65.11
25	59.16	60	66.11
30	60.15	65	67.10

Though it is possible with temperature compensation to find the pH of a sample of a given temperature, since the pH varies according to the temperature, it is not possible to find the pH of the same sample at a different temperature. The conversion of the pH of a sample at a given temperature to the pH at another temperature is called Temperature Conversion, and is distinguished from Temperature Compensation.

pH Conversion of Sample Solution

The pH of a sample possesses particular characteristics at different temperatures. This is because the physical properties of the sample vary according to the temperature. The next figure shows one example of the temperature-related characteristics of the pH of pure water. As the temperature of the water rises, the pH value shifts toward acidity. When using a pH meter, this shift in electromotive force is what is measured by the meter. By correcting the pH change due to temperature change, it is possible to determine the pH value of a sample at particular temperature. The PHB-90 Series converts the pH value of a sample to the value at 25°C.



Relation Between pH and Temperature in Pure Water

Calculating the Conversion Coefficient

The temperature coefficient of the sample is determined by the following formula:

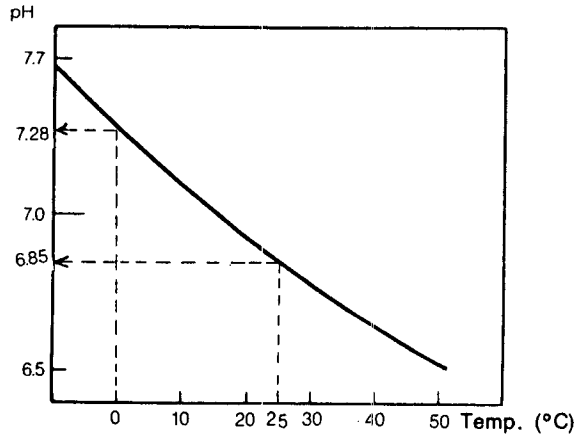
$$\alpha = (pH_{25} - pH_t)/(t - 25) \text{ (pH/°C)}$$

where: pH_{25}: pH value at 25°C
pH_t: pH value at t°C
α: temperature conversion value (pH/°C)

Note that erroneous measurements may be obtained when the pH-temperature relationship of the sample is not linear, or the temperature conversion coefficient is not constant (such as when the pH varies even at the same temperature).

As an example, the temperature conversion value will be calculated for the pure water shown in the graph.

$$\alpha = (6.85 - 7.28)/(0 - 25)$$
$$= \frac{-0.43}{-25}$$
$$= 0.0172$$



pH and Temperature

The temperature of a solution is an important factor to be considered when making accurate pH measurements. Possible causes of error in pH measurements include liquid junction potential, asymmetry potential, and the pH value of the internal reference solution, and each of these causes may be influenced by the temperature of the solution being measured. The best way to minimize these error-producing factors is to make sure the temperature of the buffer used in calibration, and the temperature of the solution being measured, are the same.

pH Values of Standard Buffers at Various Temperatures

Temperature (11°C)	pH 4	pH 7	pH 10
	4.003	7.119	10.318
5	3.999	7.086	10.245
10	3.998	7.058	10.178
15	3.999	7.035	10.117
20	4.002	7.015	10.61
25	4.008	7.000	10.011
30	4.015	6.988	9.965
35	4.024	6.979	9.925
40	4.035	6.973	9.888
45	4.047	6.969	9.856
50	4.060	6.968	9.828
55	4.075	6.970	9.807
60	4.091	6.980	9.787
70	4.126	6.990	9.757
80	4.164	7.000	9.737
90	4.205	7.020	9.727
95	4.227	7.030	9.737

SPECIFICATIONS

Model	PHB-92	PHB-93	PHB-94	PHB-95	PHB-96
Measurable Range					
pH	0-14	0-14			0-14
mV	—	0-±1999			0-±1999(.9)
Temp.(°C)	0-100	0-100			0-100
Resolution					
pH	0.01	0.01			0.01(0.001)
mV	—	1			1 (0.1)
Temp.(°C)		0.1			
Repeatability	±0.01 pH ± 1 digit				±0.005±1 digit
Temperature Compensation Range					
ATC (Automatic)	0-100°C		0-100°C		
MTC (Manual)	—		0-100°C		
Displayed Parameters	pH and t°C	pH or mV, and t°C		pH or mV or Time and t°C	
Calibration	Automatic 1-to 3-point calibration selecting from pH 2, 4, 7, 10, or 12 buffers.		1- to 3-point calibration selecting from pH2, 4, 7, 10, or 12 buffers, and one user-specified buffer.		
Auto-Hold Function	Yes (also possible in manual mode)				
Data Memory Function	—	Yes		—	
Temperature Conversion Function	—		Yes		
Time Function	—		Yes		
Expanded Display	—				Yes
Self-Check Function	—				Yes
Printer	—			Yes	
RS-232C Input/Output	—		Option (can be attached when pH meter leaves factory		Yes
Analog Output					
pH	±700mV DC	±700mV DC			
mV	—	±1V			
Temp (°C)	0-1V	0-1V			
Power Source	9V DC (AC line ±10 V, 50/60 Hz power supply also possible with Ac adaptor)				
Ambient Temperature	0-40°C				
Dimensions	W9.4 x H2.8 x D9.9 inch (W240 x H71 x D251 mm)		W9.4 x H2.8 x D10.1 inch (W240 x H71 x D256 mm)		
Weight	3.3 lbs. Approx (1.5 kg.)				

ACCESSORIES

Part No.	Description
PHE-9820	Combination glass-bodied pH electrode
PHE-9821	Sleeve junction pH electrode
PHA-4	pH buffer, pH 4.004
PHA-7	pH buffer, pH 7.000
PHA-10	pH buffer, pH 10.012
PHFS-H250	Reference cell filling solution
PHAD-90	9 volt, AC adaptor

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