

## pH/mV (ORP) Meter

### 1. Specifications

<b>Ranges:</b>	<b>pH:</b> 0.00 to 14.00 <b>mV:</b> ± 1400
<b>Relative Accuracy:</b>	<b>pH:</b> ± 0.01 <b>mV:</b> ± 1
<b>Repeatability:</b>	<b>pH:</b> ± 0.01 <b>mV:</b> ± 1
<b>Input Impedance:</b>	>10 <sup>12</sup> Ω
<b>Calibration Control Range:</b>	<b>pH:</b> ± 1 pH @ 25° C <b>mV:</b> ± 60
<b>Temperature ° C Control Range:</b>	Manual from 0° C to 100° C
<b>Low Battery Indicator:</b>	<b>Lo Bat-</b> display on the readout
<b>Readout:</b>	LC-Display 3.5 digits 0.5"
<b>Battery Life:</b>	> 200 hours continuous
<b>Power Requirements:</b>	One 9 Volt alkaline battery
<b>Dimensions:</b>	5.7"L x 3.15"W x 1.5"H
<b>Weight:</b>	12.5 ounces

### 2. Introduction

This pH/ORP Meter is a highly accurate reliable portable Instrument and can perform a wide range of measurements such as pH or ion selective determinations and mV readings of oxidation-reduction potentials (ORP).

The meter uses a digital readout with resolution to 0.01pH units and to 1mV. The meter covers the range of **0** to **14** pH or **0** to ± **1400** mV. Temperature compensation is performed manually over the range of 0° C to 100° C.

This meter employs highly reliable CMOS amplifiers for low drift and extremely stable performance. The input impedance of better than 10<sup>12</sup> ohms allows the meter to be used with all types of electrodes currently available, including ion selective electrodes.

The purpose of this manual is to provide simple and direct instruction for the operation of this meter. **The operator is urged to read this entire manual** carefully to become familiar with all components and controls before attempting a measurement.

### 3. Principles of pH Measurements

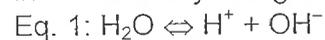
The pH of a solution is a measure of its acidity or alkalinity, expressed in quantitative terms on a scale of 0 to 14 pH. A pH of 7 corresponds to a neutral solution.

Solutions having pH less than 7 are referred to as being acidic. Vinegar and lemon juice are good examples of acids, which generally impart a "sour" taste. Alkaline solutions, referred to as being basic, have pH values greater than 7 and usually have a "soapy feeling". Baking soda dissolved in water forms an alkaline solution of about pH 9.

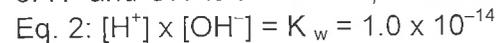
The extent of either acidity or alkalinity is related to the concentration of hydrogen ions or hydroxyl ions. The greater the concentration of hydrogen ions, the lower the pH of the solution will be. However, hydrogen ions are also found in alkaline solutions, although at a lesser concentration. In fact, all acid solutions have some hydroxyl ions and all alkaline solutions have some hydrogen ions. The product of the concentrations of these ions in any solution is a constant, equal to  $1.0 \times 10^{-14}$ . Therefore, to measure the degree of acidity or alkalinity of a solution, it is only necessary to measure the concentration of hydrogen ions, which can be done with a pH meter.

#### Dissociation of Water

Water chemically designated as  $H_2O$ , slightly dissociates into electrically charged particles, called ions:



At any given temperature, the product of the concentrations of  $H^+$  and  $OH^-$  is a constant, denoted by  $K_w$ :



Where  $[H^+]$  and  $[OH^-]$  refer to the concentration of hydrogen ions and hydroxyl ions.

Water, at  $25^\circ C$ , contains  $1.0 \times 10^{-7}$  moles per liter of  $H^+$  ions. Since there is one  $OH^-$  for every  $H^+$  ion, as shown by equation 1, the concentration of  $OH^-$  ions must be  $1.0 \times 10^{-7}$  moles per liter.

While the concentration of hydrogen ions in water is very low, the actual number of ions is large and is expressed in a unit known as "mole" (1 mole of ions =  $6.0 \times 10^{23}$ ). Since  $[H^+]$  ions in water at  $25^\circ C$  is then :  $(6.0 \times 10^{23}) \times (1.0 \times 10^{-7})$ , or 60,000,000,000,000,000 ions/liter. For convenience, the pH scale is frequently used instead of the hydrogen or hydroxyl ion concentration. pH is defined as  $pH = -\log(aH^+)$ , where  $aH^+$  refers to the activity of hydrogen ions. For practical purposes,  $[H^+]$  is substituted for  $(aH^+)$ , so that  $pH = -\log H^+$ .

A pH measuring system differentiates between strong and weak bases by comparing the  $[H^+]$  of each, although the alkalinity is due to  $[OH^-]$ . For example, the  $[H^+]$  of a strong alkaline solution might be  $1.0 \times 10^{-12}$  moles per liter – a pH of 12. A weak alkaline solution might have  $[H^+] = 1.0 \times 10^{-8}$  moles per liter – a pH of 8. The higher the pH value, the lower the  $[H^+]$  and the higher the  $[OH^-]$ , the more alkaline is the solution.

Electrochemical pH determination utilizes the difference in potential occurring between two solutions of different pH, separated by a special glass membrane build into a glass pH electrode.

A complete pH measuring system consist of a glass pH electrode, a sample solution, reference electrode and a pH meter.

This type of electrode system was discovered and initially developed for pH measurement during the early twentieth century. Considerable refinement of the technique has occurred since then. The glass electrode has been used extensively for measuring pH, and today represents the only practical method in use for this purpose.

## 4. Instrumentation

### Controls and Indicators

**Function Button:** The **pH** and **mV** push buttons allows the selection of **pH** or **mV** and turns the unit on. The **off** button turns the unit off when not in use to conserve power.

**Calibrate Control:** This control provides a wide range of offset potentials to standardize the instrument in the pH and mV mode.

**Temp. ° C Control:** This control compensates for the change with temperature for the pH electrode and operates in the pH mode only.

**Mode Indicator:** LED indicators display the operational mode which has been selected by the Function Buttons.

**Polarity Indicator:** In the mV mode, a minus (-) sign automatically is displayed to the left of the reading and shows the polarity of the input signal being measured. When the minus sign is not displayed the polarity is plus.

**Decimal Point Indicator:** The decimal point is automatically positioned in the pH mode.

**Off-scale display:** The readout flashes a "1" when an over voltage or open circuit condition is sensed at the input. When a minus (-) polarity is displayed in the pH mode, an under voltage is sensed at the input (i.e. pH below 0.00).

**Low Battery Indicator:** When the **LO BAT** sign is displayed on the upper left hand corner on the readout, then the battery needs replacing.

## 5. Operating Instructions

### Precaution

For best accuracy, fresh buffer solution should be used. Buffer bottles should be capped when not in use to prevent evaporation and contamination. Never pour decanted buffer solution back into the bottle.

The electrodes and the samples should be maintained at the same constant temperature during measurements. Temperature cycling of the electrodes will result in small drifts that may make readings of small changes in pH difficult.

### 5.1 One Point Calibration

1. Connect the electrode to the BNC input connector.
2. Immerse the electrode into the pH buffer 7.00 buffer and press the **pH**-button. Measure the temperature of the buffer solution and set the **Temp. ° C** control to this value.
3. Adjust the **Calibrate** control until the readout displays pH 7.00.
4. Remove the electrode from the pH 7.00 buffer. Rinse the electrode with tap water to prevent carryover of the buffer.
5. Assure that the temperature of the sample solution is the same as that of the buffer solution used for calibration. If it is not, adjust the **Temp. ° C** control to the temperature of the sample.
6. Lower the electrode into the sample solution. The display now indicates the pH of the sample. If the pH of the sample is not between pH 7.00 and pH 10.00 (pH 4.00), a two point calibration should be performed.

## 5.2 Two Point Calibration

In this procedure, two buffer solutions of different pH values are utilized.

The first calibration is performed at pH 7.00 as outlined in Section 4.1, a second calibration is performed at a different pH.

1. Perform the one point calibration, Section 4.1, through Step 4.
2. Immerse the electrode into the second buffer solution pH 10.00 (pH 4.00). The temperature of the second buffer must be identical to that of the first buffer.
3. Adjust the **Temp. ° C** control (ignore numbers on **Temp. ° C** scale) until the meter reads the pH value of the second buffer solution.
4. Raise the electrode, rinse with tap water and immerse the electrode into the sample solution. The display now indicates the pH of the sample.

## 5.3 Relative Millivolt Measurements

1. Connect the electrode to the BNC input connector and press the **mV**-button.
2. Immerse the electrode into a pH 7.00 buffer or into the first calibration standard if using ORP or ion selective electrodes, and adjust the **Calibrate** control until the meter reads 000 mV. The **Temp. ° C** control is inactive in this mode.
3. Remove the electrodes from the buffer (standard) and rinse with tap water. Relative mV measurements may now be made.

## 5.4 Absolute Millivolt Measurements

If absolute measurements of millivolt output of the electrode is desired, the following procedure should be used.

1. Insert a shorting plug into the BNC connector and press the **mV**-button.
2. Adjust the **Calibrate** control until the meter reads 000 mV.
3. Remove the shorting plug and plug the electrode to the BNC connector.
4. Rinse the electrode with tap water. The meter is now ready to make absolute millivolt measurements.

## 6. Problem Solving

(For specific electrode precaution and maintenance, refer to the appropriate electrode instruction sheet.)

### 6.1 Instrument Check

1. Short the input using a shorting plug and depress the **pH** button.
2. Adjust **Calibrate** control from 6 pH to 8 pH and observe that the reading is steady when set to any pH value.

## 6.2 Electrode Check

If the reading drifts or is noisy:

1. Assure that the electrode is plugged into the BNC terminal and seated firmly.
2. See that the proper standardizing solution is being used.
3. Check for a cracked or broken electrode by substituting an electrode known to be working properly.
4. Less stable readings will usually be obtained from unbuffered solutions, such as distilled water. Use only a calibrating buffer to check for drift.
5. Check for clogged reference junction.

If the agreement between a different buffer is poor:

6. Check for a faulty electrode by substituting known good electrodes.
7. Check for improper setting of the **Temp. ° C** control.
8. Check for aged or contaminated buffers by substituting fresh buffers.

If the response is sluggish:

Check for a faulty electrodes by substituting known good electrodes, or by performing an electrode cleaning procedure as described in the electrode instruction literature.