

## pH Electrode basics

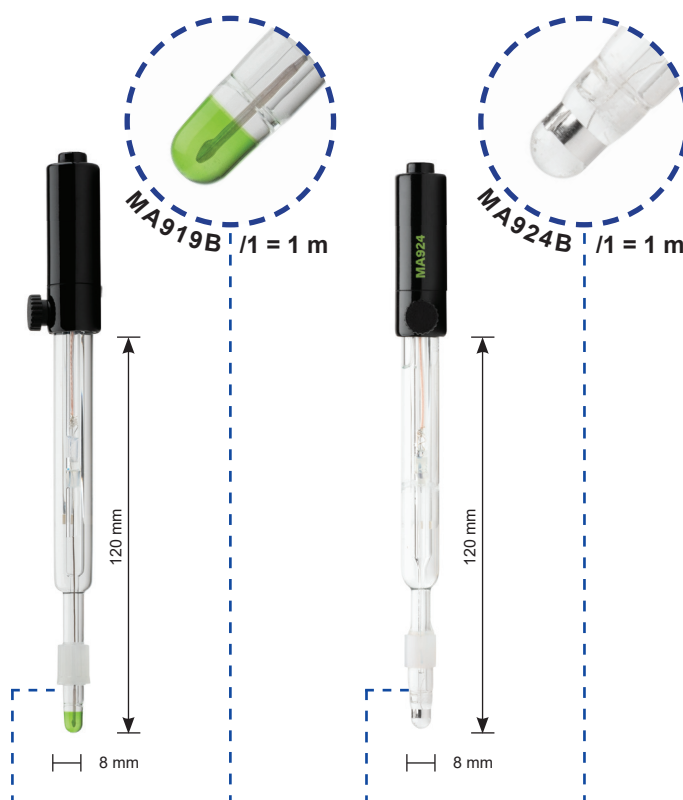


pH electrodes are constructed from a special composition glass which senses the hydrogen ion concentration. This glass is typically composed of alkali metal ions. The alkali metal ions of the glass and the hydrogen ions in solution undergo an ion exchange reaction, generating a potential difference. In a combination pH electrode, the most widely used variety, there are actually two electrodes in one body. One portion is called the measuring electrode, the other the reference electrode. The potential generated at the junction site of the measuring portion is due to the free hydrogen ions present in solution.

The potential of the reference portion is produced by the internal element in contact with the reference fill solution. This potential is always constant. In summary, the measuring electrode delivers a varying voltage and the reference electrode delivers a constant voltage to the meter. The voltage signal produced by the pH electrode is a very small, high impedance signal. The input impedance requires to be interfaced only with equipment with high impedance circuits.

Milwaukee has a wide assortment of pH and ORP electrodes to meet all your specific requirements. Finding the right electrode for a specific application is a very important task and in order to solve this selection problem it is important to consider the following:

- Glass body electrode versus Epoxy (plastic) body electrode:** Glass body electrodes stand higher temperatures (typically 100°C against 80°C for plastic) and are more resistant to corrosive chemicals and solvents. They are easier to clean and are available in different shapes depending on the application. On the other hand plastic body electrodes are more rugged and the glass bulb is better protected.
- Gel filled electrodes versus refillable electrodes:** refillable electrodes last longer since electrolyte can be changed for repeated usage. The response is faster due to a greater outflow of electrolyte into the sample and therefore less likely to clog. Gel filled electrodes require less maintenance and resist to higher pressure.
- Double reference junction versus Single junction reference:** Double junction reference electrodes have a longer life and protects the sample measured from silver contamination from the electrolyte. The Silver wire is more protected and therefore gets less contaminated. The single junction electrodes normally cost less and are ideal for general purpose applications
- Conic shaped versus Sphere shaped:** The conic-shaped electrode is easier to clean and to maintain (ideal for applications such as dairy). Has a more rugged tip and therefore ideal for penetration. The sphere-shaped has a faster response time due to the larger surface area on the bulb.



Model	MA919B/1	MA924B/1
Measuring Range	0 to 12 pH	±2000 mV
Temperature Range	-5 to 70 °C	0 to 70 °C
Shaft material	glass	glass
Reference Electrolyte	KCL 3.5M	KCL 3.5M
Reference Junction	open	open
Reference Type	double Ag/AgCl	double Ag/AgCl
Shape of membrane	spheric	Platinum ring
Max. Pressure	0,1 bar	0,1 bar
Connector type	BNC	BNC
Cable length	coaxial 1 meter	coaxial 1 meter
Shaft length	120 mm	120 mm
Diameter	8 mm	8 mm
Application	food laboratory	food laboratory



Glass Conic Tip Sensor

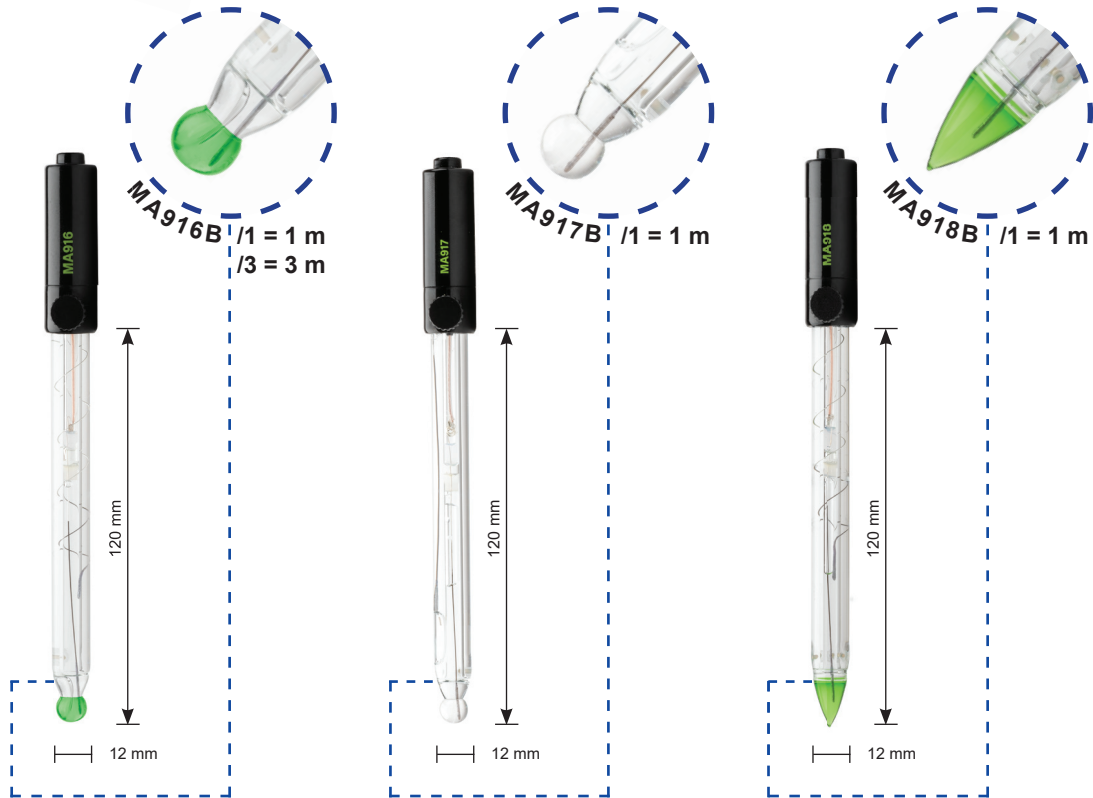
Glass Spheric Sensor

Dome-shaped

The pH electrode, due to the nature of its construction, needs to be kept moist at all times. In order to operate properly, glass needs to be hydrated. Hydration is required for the ion exchange process to occur. If an electrode should become dry, it is best to place it in some tap water for half an hour to condition the glass.

pH electrodes are like batteries; they run down with time and use. As an electrode ages, its glass changes resistance. This resistance change alters the electrode potential. For this reason, electrodes need to be calibrated on a regular basis. Calibration in pH buffer solution corrects for this change. Calibration of any pH equipment should always begin with buffer 7.0 as this is the "zero point." The pH scale has an equivalent mV scale. The mV scale ranges from +420 to -420 mV. At a pH of 7.0 the mV value is 0. Each pH change corresponds to a change of approx.  $\pm 60$  mV. As pH values become more acidic the mV values become greater.

pH electrodes have junctions which allow the internal electrolyte solution of the measuring electrode to leak out into the solution being measured.



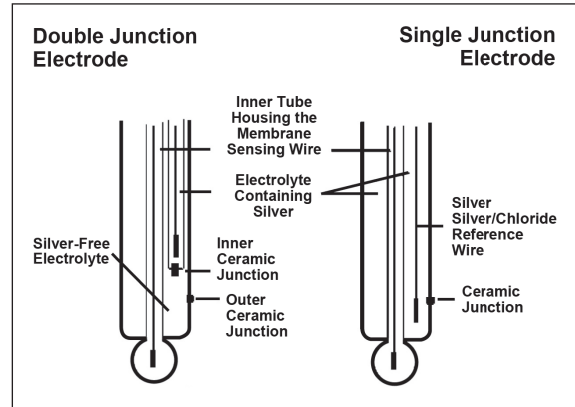
Model	MA916B/1 - MA916B/3	MA917B/1	MA918B/1
Measuring Range	0 to 12 pH	0 to 14 pH	0 to 12 pH
Temperature Range	0 to 60°C	0 to 70°C	-5 to 60°C
Shaft Material	glass	glass	glass
Reference Electrolyte	KCl 3.5M	KCl 3.5M	KCl 3.5M
Reference Junction	ceramic, single	ceramic, single	ceramic, triple
Reference Type	double, Ag/AgCl	double, Ag/AgCl	double, Ag/AgCl
Shape of membrane	spheric	spheric	conic
Max pressure	0.1 bar	0.1 bar	0.1 bar
Connector Type	BNC	BNC	BNC
Cable length	coaxial, 1 or 3 m	coaxial, 1 m	coaxial, 1 m
Shaft length	120 mm	120 mm	120 mm
Diameter	12 mm	12 mm	12 mm
Application	laboratory applications	laboratory applications	food-laboratory applications

# pH Electrode basics

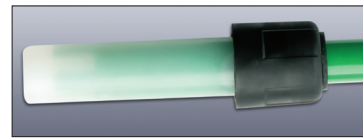
This junction can become clogged by particulates in the solution and can also facilitate poisoning by metal ions present in the solution. If a clogged junction is suspected it is best to soak the electrode in tap water to dissolve the material and clear the junction. When not in use it is best to store the electrode in either buffer 4.0 or buffer 7.0. Never store an electrode in distilled or deionized water as this will cause migration of the electrolyte solution from the electrode.

How long a pH electrode will last will depend on how it is cared for and the solutions it is used to measure. Typically, a gel-filled combination pH electrode will last six months to 1 year depending on the care and application.

How long an electrode will last is determined by how well the probe is maintained and the pH application. The harsher the system, the shorter the lifespan. For this reason it is always a good idea to have a back-up electrode on hand to avoid any system down time. Calibration is also an important part of electrode maintenance. This assures not only that the electrode is behaving properly but that the system is operating correctly.



**Electrode Storage Bottle Cap:** All our pH and ORP electrodes are supplied with a bottle storage cap which helps to keep the glass bulb always wet.



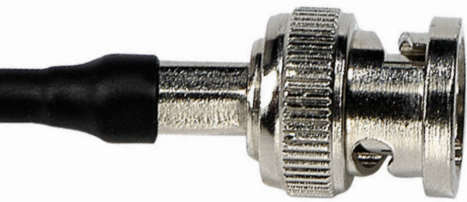
are supplied with a bottle storage cap which helps to keep the glass bulb always wet.



Model	MA920B/1	MA991B/1	MA905B/3	MA925B/3
Measuring Range	0 to 12 pH	0 to 13 pH	0 to 13 pH	±2000 mV
Temperature Range	-5 to 50°C	-5 to 70°C	-10 to 80°C	-5 to 100°C
Shaft Material	PVDF	glass	PVDF	PVDF
Reference Electrolyte	Viscolene	gel	polymer	polymer
Reference Junction	open	ceramic, single	double PTFE	PTFE
Reference Type	single, Ag/AgCl	single, Ag/AgCl	double Ag/AgCl	Ag/AgCl
Shape of membrane	conic	spheric	flat	flat Pt sensor
Max pressure	0.1 bar	0.1 bar	6 bar	6 bar
Connector Type	BNC	BNC	3/4" NPT - BNC	BNC
Cable length	coaxial, 1 m	coaxial, 1 m	3 m	3 meter
Shaft length	75 mm	120 mm	120 mm	135 mm
Diameter	6 mm	12 mm	22 mm	22 mm
Application	food-laboratory applications	laboratory applications	industrial applications	industrial applications



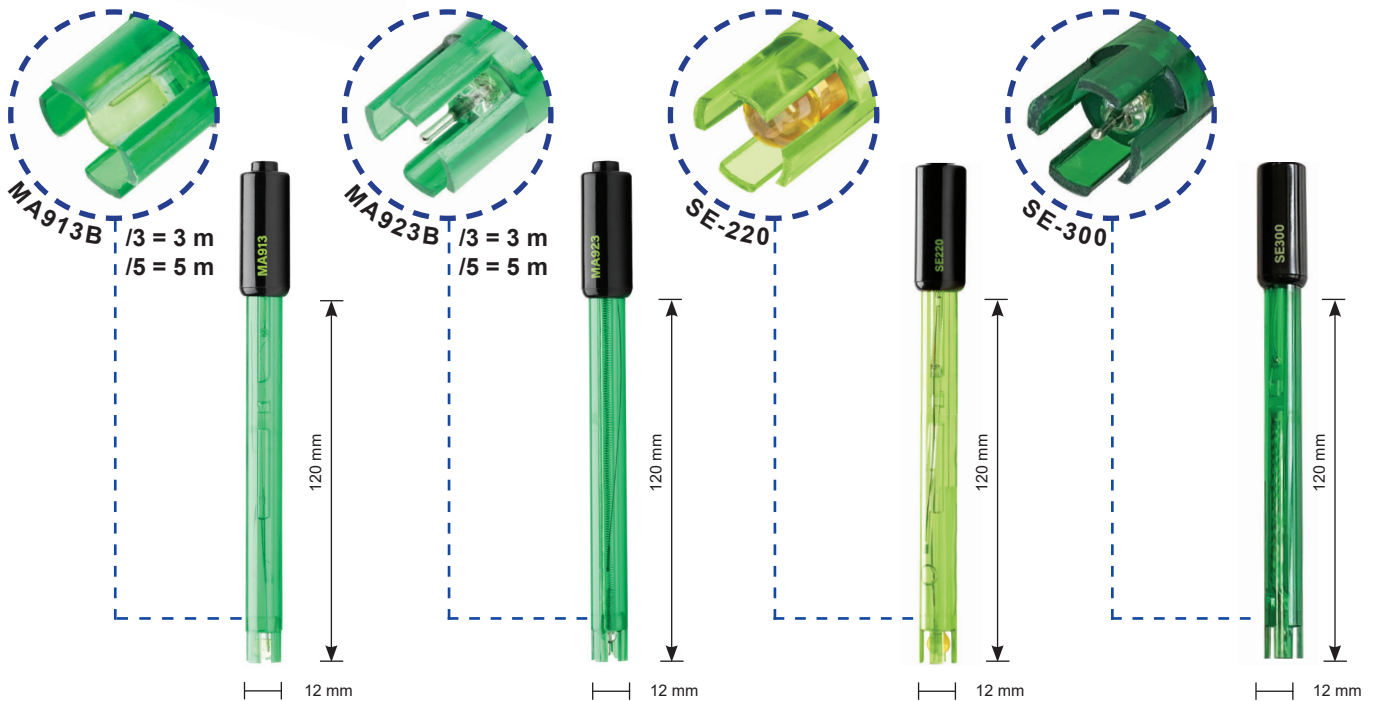
DIN Connector



BNC Connector

Temperature compensation: When measuring pH using a pH electrode the temperature error from the electrode varies based on the Nernst Equation as 0.03 pH/10C/unit of pH away from pH7. The error due to temperature is a function of both temperature and the pH being measured. Temperature compensation can be achieved manually or automatically. Manual temperature compensation is usually achieved by entering the temperature of the fluid being measured into the instruments menu and then the instrument will display a "Temperature Compensated" pH reading.

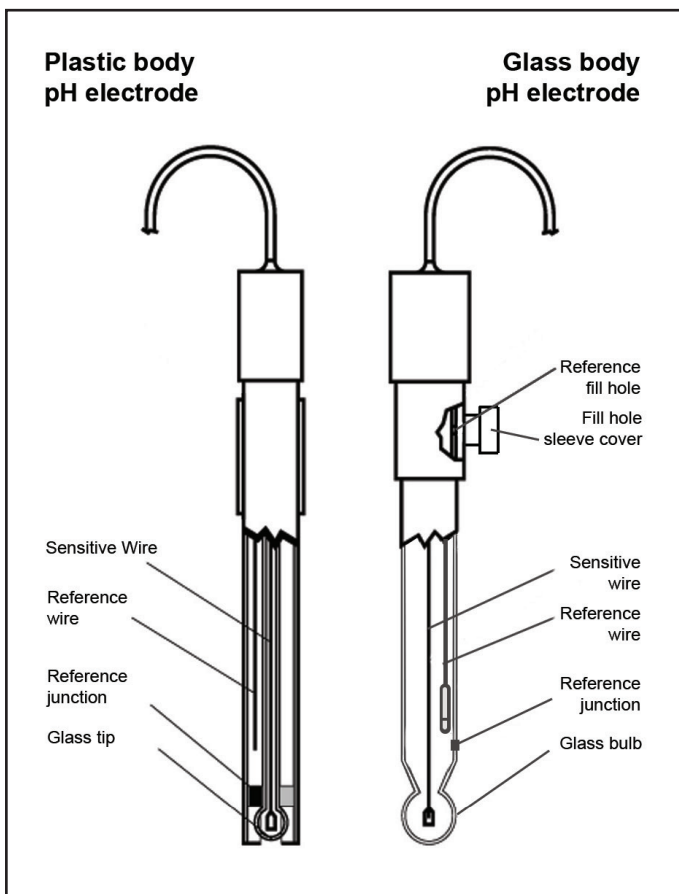
This means that the temperature is corrected to the value expected at 25 °C. Automatic temperature compensation requires input from a temperature sensor and constantly sends a compensated pH signal to the display. Automatic temperature compensation is useful for measuring pH in systems with wide variations in temperature.



Model	MA913B/3 - B/5	MA923B/3 - B/5	SE-220	SE-300
Measuring Range	0 to 13 pH	±1999 mV	0 to 13 pH	±1999 mV
Temperature Range	20 to 60°C	20 to 60°C	-5 to 70 °C	20 to 60°C
Shaft Material	PEI	PEI	PEI	PEI
Reference Electrolyte	gel	gel	gel	gel
Reference Junction	ceramic, single	cloth	cloth	cloth
Reference Type	single, Ag/AgCl	single, Ag/AgCl	double Ag/AgCl	double, Ag/AgCl
Shape of membrane	spheric	spheric, platinum sensor	spheric	spheric, platinum sensor
Max pressure	2 bar	2 bar	2 bar	2 bar
Connector Type	BNC	BNC	BNC	BNC
Cable length	coaxial, 3 m or 5 m	7-pole, 3 m or 5 m	coaxial 1 meter	7-pole, 3 m or 5 m
Shaft length	120 mm	120 mm	120 mm	120 mm
Diameter	12 mm	12 mm	12 mm	12 mm
Application	swimming pool	swimming pool	drinking water, waste water	drinking water, waste water

# pH Electrode

## Storage and Maintenance



### pH Electrode Storage and Maintenance

To ensure a quick response and free-flowing liquid junction, the sensing element and reference junction must not be allowed to dry out. For refillable electrodes make sure that the refill hole is open when measuring to ensure that the electrolyte solution flows properly through the reference junction

### Routine Storage

Soak electrode in a pH Electrode Storage Solution (MA9015). If a storage solution is unavailable, pH 4 buffer or pH7.01 may be used. When not in use, the fill hole should be covered to prohibit evaporation of reference fill solution.

### Maintenance & Cleaning

Cleaning your electrode between and after use will help extend the life of your electrode and avoid the cost of early replacement. Soak electrode in MA9016 cleaning solution for half an hour, followed by soaking it in storage solution (MA9015) for at least two hours. For long term storage, always keep the electrode in a bottle, filled with sufficient storage solution to cover the bulb and the junction.

### Weekly Maintenance

Inspect electrodes for scratches, cracks, salt crystal buildup, or membrane/junction deposits. Rinse off any salt buildup with distilled water, and remove any membrane/junction deposits.

### Normal aging

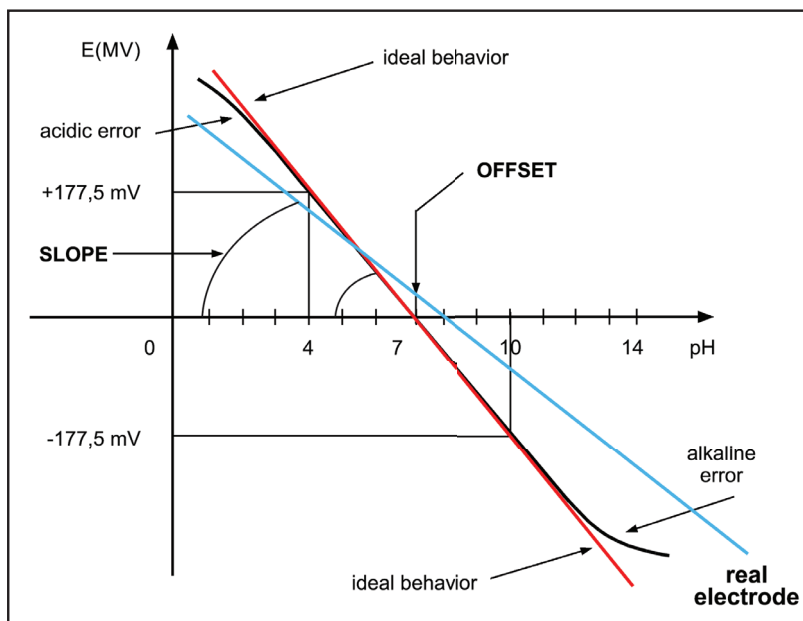
As pH electrodes age their efficiency is reduced. The aging is usually caused either by contamination of the glass membrane (which loses its sensitivity) or by blockage of the reference junction. The lifespan of the pH electrode is 6 months to 1 year (under normal conditions).

## Get accurate pH readings

The pH electrode is the most sensitive component of your pH instrument. Correct calibration procedures combined with proper maintenance will provide reliable measurements.

**Calibration:** The electrode must be calibrated regularly to ensure accurate, repeatable measurements. Although one-point calibration suffices for fairly reliable measurements, two or even three-point calibrations will give you more accurate results across the entire measurement range.

pH readings are only as accurate as the solution used for calibration. For high accuracy it is important to use uncontaminated buffers. Our 20 ml sachets always ensure a fresh solution and calibration can be performed directly in the sachet. Our 230 ml bottles are easy to use and reduce risk of contamination opposed to bigger bottles.



The calibration curve

# MW100 PRO/MW101 PRO/MW102 PRO+/MW500 PRO

## Budget pH/ORP/Temperature Portable Meters for fast and reliable results

- ATC
- MTC
- Points 2
- Self diagnostics
- CE







MW100 PRO, MW101 PRO, MW102 PRO+ and MW500 PRO are compact microprocessor-based pH, ORP and Temperature Portable Meters. These handy and ergonomically designed portable meters are ideal for anyone working on a low budget and still requires fast and reliable measurements.

These portable meters are suitable for a wide range of applications, such as Educational, Agriculture and Horticulture, as well as water and environmental analysis. These easy and fast to calibrate portable meters have a small, ergonomic and light case design. Other features include large and easy to read LCD and long battery life.

All meters are supplied with pH or ORP electrodes and calibration solutions in a carton box.

- **MW100 PRO** performs pH measurements with a 0.1 pH resolution.
- **MW101 PRO** performs pH measurements with a 0.01 pH resolution and with manual temperature compensation.
- **MW102 PRO+** is a microprocessor based pH/Temperature meter with extended range (-2.00 to 16.00 pH), Automatic Temperature Compensation, automatic calibration in 2 points and  $\pm 0.02$  pH accuracy.
- **MW500 PRO** performs ORP measurements with a range of  $\pm 1000$  mV.

Specifications	 <b>MW100 PRO pH Meter</b>	 <b>MW101 PRO pH Meter</b>	 <b>MW102 PRO+ pH/Temp Meter</b>	 <b>MW500 PRO ORP Meter</b>
Range	pH/ORP Temp. 0.0 to 14.0 pH	pH/ORP Temp. 0.00 to 14.00 pH	pH/ORP Temp. -2.00 to 16.00 pH -5 to 70°C	mV 0 to 1000 mV
Resolution	pH/ORP Temp. 0.1 pH	pH/ORP Temp. 0.01 pH	pH/ORP Temp. 0.01 pH 0.1°C	1 mV
Accuracy (@25°C)	pH/ORP Temp. $\pm 0.2$ pH	pH/ORP Temp. $\pm 0.02$ pH	pH/ORP Temp. $\pm 0.02$ pH $\pm 0.5^\circ\text{C}$	$\pm 5$ mV
Typical EMC Deviation	pH Temp.		pH Temp. $\pm 0.02$ pH $\pm 0.5^\circ\text{C}$	
Temperature Compensation	N.A.	manual, 0 to 50°C	automatic, 0 to 70°C	
Calibration	manual, 2-point through offset and slope trimmers	manual, 2-point through offset and slope trimmers	automatic at 1 or 2 points with memorized buffers (pH 4.01, 7.01, 10.01)	
pH Electrode	SE220 (included)	SE220 (included)	SE220 (included)	SE300 (included)
ORP Electrode				
Temperature Probe			MA831R (included)	
Environment	0 to 50°C, max RH 95%	0 to 50°C, max RH 95%	0 to 50°C, max RH 95%	0 to 50°C, max RH 95%
Battery Type	1 x 9V alkaline (included)	1 x 9V alkaline (included)	1 x 9V alkaline (included)	1 x 9V alkaline (included)
Battery Life	approx. 300 hours of use	approx. 300 hours of use	approx. 300 hours of use after 8 minutes of non-use	approx. 300 hours of use
Auto-off				
Packaging dimensions	212 x 145 x 67 mm	212 x 145 x 67 mm	212 x 145 x 67 mm	212 x 145 x 67 mm
Packaging weight	440 g	420 g	500 g	400 g

### Accessories

- M10004B** pH 4.01 buffer solution 20 mL sachet (25 pcs)
- M10007B** pH 7.01 buffer solution 20 mL sachet (25 pcs)
- M10010B** pH 10.01 buffer solution 20 mL sachet (25 pcs)
- MA9004** pH 4.01 buffer solution, 230 mL bottle
- MA9007** pH 7.01 buffer solution, 230 mL bottle

- MA9010** pH 10.01 buffer solution, 230 mL
- MA9015** Electrode storage solution, 230 mL
- MA9016** Electrode cleaning solution, 230 mL
- MA831R** Temperature probe
- MA9020** 200-275 mV ORP solution, 230 mL
- SE220** pH electrode with BNC connector and 1 m cable
- SE300** Platinum ORP electrode with 1 m cable



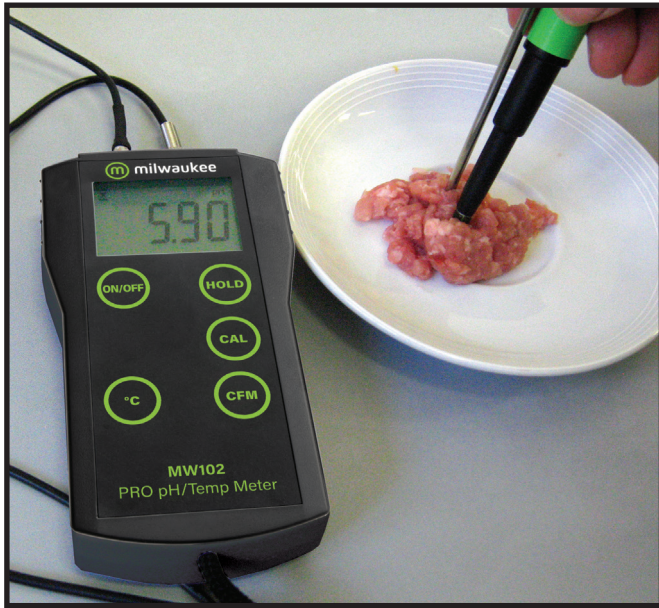
### Ordering Information

**MW100 PRO** and **MW101 PRO** are supplied complete with a SE220 pH electrode, pH 7.01 20 mL sachet of calibration solution, calibration screwdriver, 9V battery and instructions.

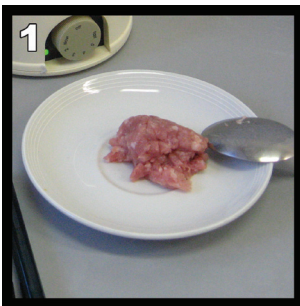
**MW102 PRO+** is supplied complete with a SE220 pH electrode, MA831R stainless steel temperature probe, pH 4.01 and pH 7.01 20 mL sachet of calibration solution, 9V battery and instructions.

**MW500 PRO** is supplied complete with a SE300 platinum electrode, 9V battery and instructions.

## Measuring pH in meat Using MW102 PRO+ pH portable meter with a MA920B/1 pH electrode



The pH changes occurring in a carcass during the first 24 hours after slaughter are important for the quality of the final meat or meat products. Protein denaturation will occur if pH falls to too low a level or if a relatively low pH sets in at a time after slaughter where the carcass temperature is still high. This will result in meat with poor water holding capacity and in extreme cases in meat that is PSE.



Calibrate the pH meter using pH 7 and pH 4 standardization buffers.

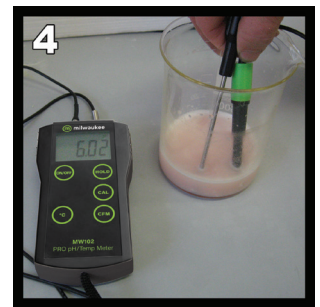
1. Cut meat sample into small pieces.



2. Weight approximately 10 grams into a blender cup. Run duplicates on each sample.



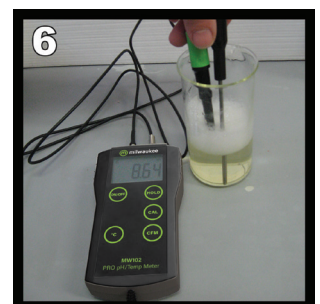
3. Add 100 ml of distilled deionized water and blend for 30 seconds on high speed.



4. Transfer sample to a beaker. Read the pH as soon as possible.



5. By pressing the HOLD key you can activate the hold function. The measured value is frozen on the display and the "HOLD" tag lights up. Release "HOLD" by pressing HOLD key again.



6. Blender cups, beakers and stir bars can be rinsed in distilled water between samples. The pH electrode should be rinsed with distilled water between each sample and periodically rinsed with acetone from a squeeze bottle to remove fat buildup.

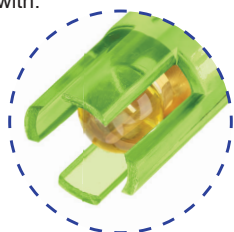
# Spare Electrodes & Probes


## pH, ORP, Conductivity, Dissolved Oxygen

Milwaukee has a wide assortment of pH, ORP, Conductivity and other specialty sensors to meet all your specific requirements.

Finding the right electrode for a specific application is a very important task and in order to solve this selection problem it is important to consider the following: electrode body, reference construction and junction.

Below you will find a list of Milwaukee electrodes and probes with corresponding instruments they are supplied with.



OTHER ELECTRODES & PROBES		
	<b>SE220</b>	Double junction pH electrode with 1 meter cable and gel filled electrolyte solution (MW100 / MW101 / MW102)
	<b>SE300</b>	Double junction orp platinum electrode with 1 meter cable and gel filled electrolyte solution (MW500)
	<b>SE510</b>	Conductivity/TDS probe with 1 meter cable (MW301 / MW401)
	<b>SE520</b>	Conductivity/TDS probe with 1 meter cable (MW302 / MW402)
	<b>SE600</b>	Combination probe for pH/EC/TDS with 1 meter cable (MW801 / MW802)
	<b>MA812/2</b>	Conductivity/TDS probe with 2 meter cable (MC310 / MC410)
	<b>MA814DB/1</b>	4-ring Conductivity/TDS/NaCl/Temperature probe with DIN connector and 1 meter cable (MW170)
	<b>MA815D/1</b>	4-ring Conductivity/TDS/NaCl/Temperature probe with DIN connector and 1 meter cable (MW306)
	<b>MA911B/2</b>	Double junction, gel filled pH electrode with BNC connector, 2 m cable
	<b>MA906BR/1</b>	pH/Temp amplified probe with 1 meter cable (MW105/MW106)
	<b>MA921B/2</b>	Double junction, gel filled ORP electrode with platinum sensor, BNC connector, 2 m cable
	<b>MA831R</b>	Stainless steel Temperature probe (MW150 / MW151 / MW160 / MW180)
	<b>MA840</b>	Polarographic D.O. probe with 4 meter cable (MW600)
	<b>MA845</b>	Dissolved Oxygen and Temperature polarographic probe (MW190)
	<b>MA860</b>	Dissolved Oxygen and Temperature galvanic probe (MW605)



## Electrode Selection Guide

### pH, ORP, Conductivity, Dissolved Oxygen



Milwaukee has a wide assortment of pH, ORP, Conductivity and other specialty sensors to meet all your specific requirements.

Before selecting an electrode, please consult the table below. The recommended electrodes are the ones best suited to each application, however we also ask you to verify the specifications on pages 9-12.

Special electrodes for specific applications can also be manufactured upon request.

Applications	pH	MA905B/3	MA911B/2	SE220	MA913B/3	MA906BR/1	MA916B/1	MA917B/1	MA918B/1	MA919B/1	MA920B/1	MA991B/1	ORP	MA921B/1	SE300	MA923B/3	MA924B/1	MA925B/3	Conductivity	SE510	D.O.	MA840	MA845	MA860
Agriculture / Soil testing																								
Aquarium																								
Brewing																								
Cheese																								
Dairy products																								
Emulsions																								
Environmental, Pollution																								
Fish farming																								
Food and beverage (general use)																								
Galvanizing waste solution																								
Hi purity water																								
Heavy duty applications																								
In-line applications																								
Laboratory (general use)																								
Meat																								
Paints																								
Paper																								
Photographic chemicals																								
Strong acid																								
Swimming pools																								
Water supply																								
Wine processing																								