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 that it 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 live 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 costs less and are ideal for general purpose applications

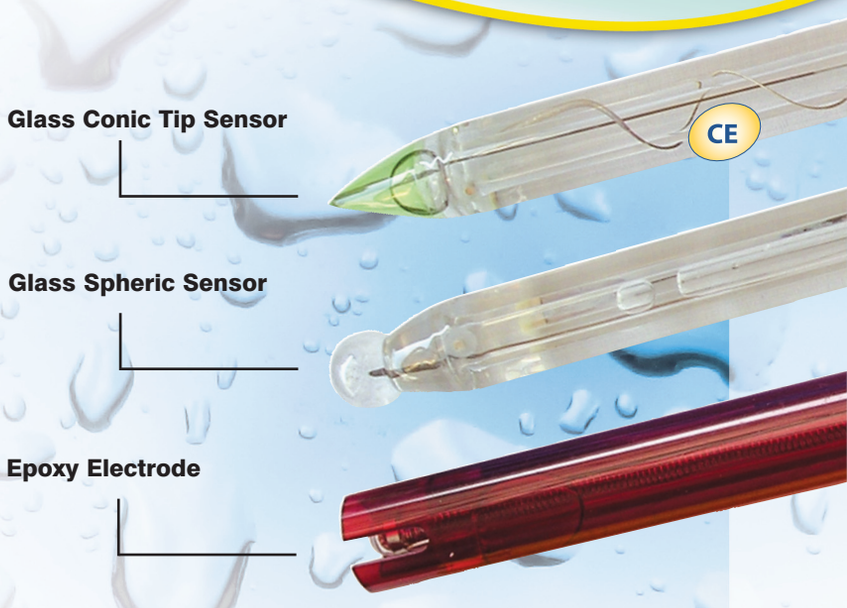
- **Conic shaped versus Sphere shaped**: The conic-shaped electrode is easier to clean and to maintain (ideal for applications such as dairy). Has a more rugged tip and therefore ideal for penetration. The sphere-shaped has a faster response time due to the larger surface area on the bulb.

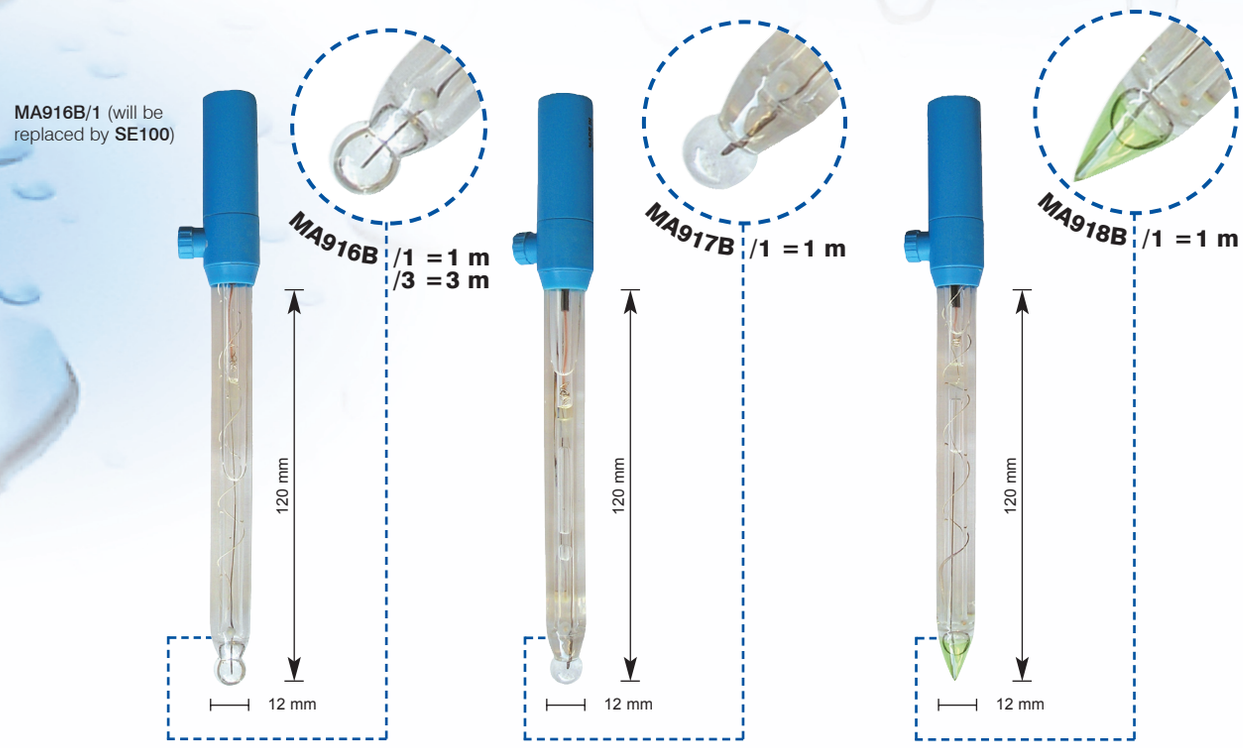
Model	MA919B/1	MA924B/1
Measuring Range	0 to 13 pH	±2000 mV
Temperature Range	-5 to 80 °C	-5 to 80 °C
Shaft material	glass	glass
Reference Electrolyte	KCL 3.5M	KCL 3.5M
Reference Type	double Ag/AgCl	double Ag/AgCl
Reference Junction	open	open
Shape of membrane	spheric	Platinum ring
Max. Pressure	0,1 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

pH Electrode
basics

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 a half hour to condition the glass.

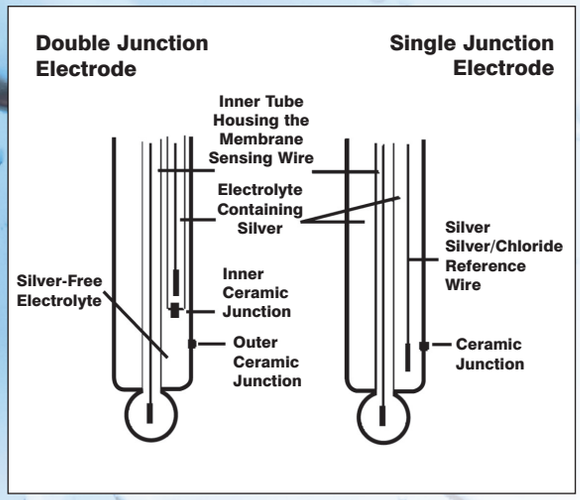
pH electrodes are like batteries; they run down with time and use. As an electrode ages, its glass changes resistance. This resistance change alters the electrode potential. For this reason, electrodes need to be calibrated on a regular basis. Calibration in pH buffer solution corrects for this change. 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. ±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 13 pH	0 to 14 pH	0 to 12 pH
Temperature Range	-5 to 100°C (23 to 212°F)	0 to 100°C (32 to 212°F)	-5 to 100°C (23 to 212°F)
Shaft Material	glass	glass	glass
Reference Electrolyte	KCl 3.5M + AgCl	KCl 3.5M	KCl 3.5M + AgCl
Reference Junction	ceramic, single	ceramic, single	ceramic, triple
Reference Type	single, Ag/AgCl	double, Ag/AgCl	single, 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	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.

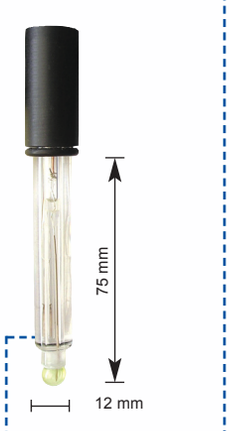
How long a pH electrode will last will depend on how it is cared for and the solutions it is used to measure. Typically, a gel-filled combination pH electrode will last six months to 1 year depending on the care and application.
How long an electrode will last is determined by how well the probe is maintained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

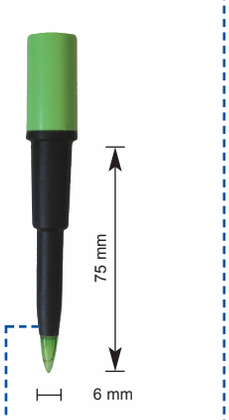
MA915B /2 =2 m
/3 =3 m

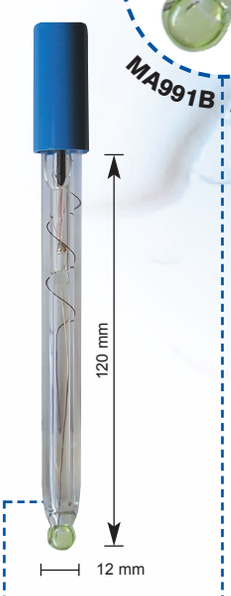
MA920B /1 =1 m

MA991B /1 =1 m

MA991B/1 (will be replaced by **SE120**)







Model	MA915B/2 - MA915B/3	MA920B/1	MA991B/1
Measuring Range	0 to 13 pH	0 to 12 pH	0 to 13 pH
Temperature Range	-5 to 95°C	0 to 50°C (32 to 122°F)	-5 to 100°C (23 to 212°F)
Shaft Material	glass	PVDF	glass
Reference Electrolyte	polymer	Viscolene	KCl 3.5M
Reference Junction	ground glass	open	ceramic, single
Reference Type	double, ground glass	single, Ag/AgCl	single, Ag/AgCl
Shape of membrane	spheric	conic	spheric
Max pressure	3 bar	0.1 bar	0.1 bar
Connector Type	BNC	BNC	BNC
Cable length	2 or 3 m	coaxial, 1 m	coaxial, 1 m
Shaft length	75 mm	75 mm	più di 120 mm
Diameter	12 mm	6 mm	12 mm
Application	industrial applications	laboratory applications	laboratory applications

pH Electrode
basics

Temperature compensation: When measuring pH using a pH electrode the temperature error from the electrode varies based on the Nernst Equation as 0.03pH/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 Deg 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	MA905B/3	MA913B/3	MA923B/3
Measuring Range	0 to 13 pH	0 to 13 pH	±1999 mV
Temperature Range	-5 to 95°C	0 to 60°C (32 to 140°F)	0 to 80°C (32 to 176°F)
Shaft Material		Epoxy	Epoxy
Reference Electrolyte	polymer	gel	gel
Reference Junction	double, Teflon	ceramic, single	cloth
Reference Type		single, Ag/AgCl	single, Ag/AgCl
Shape of membrane		spheric	spheric pH: conic / ORP: Platinum sensor
Max pressure	6 bar	2 bar	3 bar
Connector Type	3/4" NPT - BNC	BNC	DIN
Cable length	3 m	coaxial, 3 m	7-pole, 1 m
Shaft length	120 mm	120 mm	120 mm
Diameter	22 mm	12 mm	14 mm
Application	industrial applications	water, waste water	water, waste water

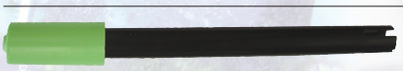
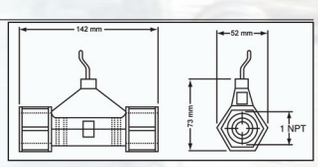
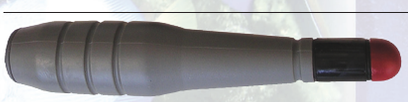
Electrodes & Probes

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.

OTHERS ELECTRODES & PROBES

	MA811D/1	Conductivity/TDS probe with DIN connector and 1 meter cable (for SM301 & SM401)
	MA811/2	Conductivity/TDS probe with 2 meter cable (for SMS310)
	MA812D/1	Conductivity/TDS probe with DIN connector and 1 meter cable (for SM302 & SM402)
	MA812/2	Conductivity/TDS probe with 2 meter cable (for SMS410)
	MA814DB/1	4-ring Conductivity/TDS/NaCl/Temperature probe with DIN connector and 1 meter cable (for Mi170 & Mi180)
	MA814D/1	4-ring Conductivity/TDS/NaCl/Temperature probe with DIN connector and 1 meter cable (for Mi306)
	MA815/2	Conductivity probe with 2 meter cable (for SMS315)
	MA816/2	TDS probe with 2 meter cable (for SMS415)
	MA818/5	In line 4-pin Conductivity probe with pipe threads at both end with NTC sensor and 5 meter cable 
	MA831R	Stainless steel Temperature probe
	MA840	Polarographic D.O. probe with 3 meter cable (for SMS600 & Mi605)
	MA850	Combination spare probe for pH/Conductivity/TDS with 1 meter cable (for SM801 & SM802)
	MA851D/1	pH/Conductivity/TDS/Temperature amplified probe with DIN connector and 1 meter cable (for Mi805 & Mi806)
	SE230 (*) SE230/2 (*)	Double junction, gel filled pH electrode with BNC connector, with 1 or 2 meter cable
	SE240 (*)	pH/Temperature amplified probe with BNC & RCA connectors with 1 meter cable
	SE310 (*) SE310/2 (*)	Double junction, gel filled ORP electrode with platinum sensor, with BNC connector and 1 or 2 meter cable
	SE260	pH/ORP/Temperature amplified probe with DIN connector and 1 meter cable (for Mi106)

(*) Available from the 1st of September 2010

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 6-7-8-9

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

Applications	pH	MA905B/3	MA911B/1	SE230	MA913B/3	MA914BR/1	SE240	MA915B/2	MA916B/1	SE100	MA916B/3	MA917B/1	MA918B/1	MA919B/1	MA920B/1	MA923D/1	SE260	MA991B/1	SE120	ORP	MA921B/1	SE310	MA923B/3	MA924B/1	Conductivity	MA818/5	MA813D/1	D.O.	MA840
Agriculture / Soil testing					■			■					■																
Aquarium			■	■	■						■										■	■	■				■		■
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													■	■	■									■					■