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LabSen[®]

pH Electrode Handbook

Built with Swiss sensor technologies and materials



LabSen®

Preface

pH electrodes are analytical sensors for measuring potential of hydrogen (pH), the negative logarithm of the hydrogen ion activity in solution. Without a reliable pH electrode that is suitable for your specific application, measurement accuracy and precision would be impossible to achieve no matter how good the instrument is.

Since 1991, Apera Instruments has been dedicated on the development of electrochemical sensors. More than 2 million pieces of pH electrodes are serving our customers in over 50 countries. Adopting state-of-the-art sensor technologies and premium materials from Switzerland, we developed LabSen® series laboratory pH electrodes and IndSen® series industrial pH electrodes, providing extraordinary products and services to help you succeed in pH measurement.

This handbook divides Apera LabSen® pH electrodes into 6 categories of applications, illustrating the electrode requirements for each application from the perspective of technology and engineering, introducing the industry-leading pH electrode technologies and help you choose the right pH electrode.

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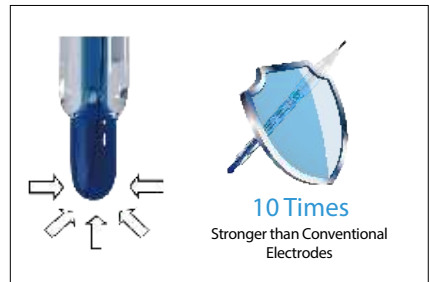
Main Features of LabSen® pH Electrode

Having high-quality pH electrode that is proper for the application is critical to the reliability of pH measurement. Built with state-of-the-art sensor technologies and premium materials from Switzerland, LabSen® pH electrodes have three major features that stand out from conventional ones in the market.

01 Sturdy Glass Membrane

The sensitive glass membrane of pH electrode is the most fragile part. The easy breakage of glass membranes has been a disturbing problem for conventional pH electrodes.

LabSen® pH glass membrane is made with a thickening layer technology. The glass membrane is 10 times stronger than that of conventional pH electrodes. There's no worry about membrane breakage with regular collision. In the meantime, the sturdy membrane has a low resistance, which ensures a fast response time.



02 Blue Gel Inner Solution

The inner reference solution of conventional pH electrode is in liquid form. Air bubbles tend to be generated in it. Users have to spend effort to shake-off the air bubble before they can take a stable measurement.

LabSen's unique blue gel inner solution does not flow at all, meaning it will never generate air bubbles. The electrode can work well even when being held upside-down. It is not only more convenient to use, but also improves the measurement accuracy by eliminating heat convection in the inner glass membrane.

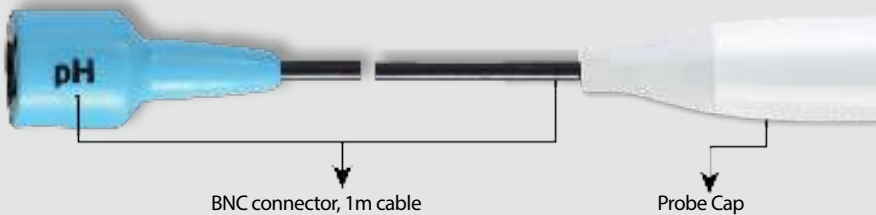


03 Full Range of Selections

There are more than 30 models of LabSen® series pH electrodes, covering a wide variety of applications. We divide them into 6 categories, in which you will be able to find the most suitable model for your very specific testing requirement.

01	General Water Solutions in Lab and Field
02	Low Ionic Strength Low Temperature Solutions
03	Micro-Volume Solutions
04	Solid Spear Test Surface Test
05	Strong Acidic Strong Alkaline High Temperature Solutions
06	Viscous Protein-Containing Solutions





Composed of glass membrane, junction, inner solution, reference system and reference electrolyte, etc, each part of LabSen® pH electrode is handmade with specialized technology and craftsmanship spirit.

Glass Membrane

As the essential part of pH electrode, glass membrane is a sensitive membrane that responds to the hydrogen ion activity in solutions. Its quality depends on the type (formula) and shape of the membrane.

Type	Remarks
S	Standard glass membrane for general applications, 0-100°C, membrane resistance < 150 MΩ
HA	Suitable for strong alkaline and high temperature solutions, low alkaline error, 0 – 130°C, membrane resistance < 500MΩ
L	Low resistance membrane for low ionic strength and low temperature solutions, 0 – 80°C, membrane resistance < 50MΩ
HF	Made for solutions with HF concentration < 1wt% (approx. 10g/L or 0.5mol/L), and other strong acid solutions like sulfuric acid and hydrochloric acid, 0-100°C, membrane resistance < 400MΩ
PHY	Our toughest membrane, resistant to chemical corrosion and high temperature, 0 – 130°C, membrane resistance < 600 MΩ



Glass Lathe Processing

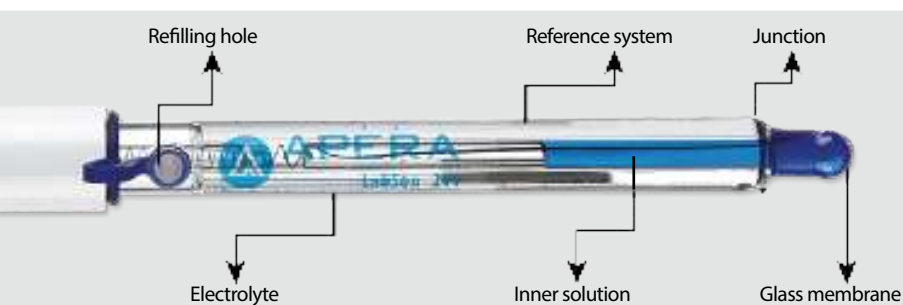
LabSen pH electrode glass membrane is processed by glass lathe, which can form various shapes of glass membranes, including cylindrical, conical and olive shapes that generate faster response, as well as spear, flat and slim shapes that fulfill functional requirements.



Reference Electrolyte

In addition to the conventional 3M KCl solution and gel KCl, LabSen pH electrode adopts the following special electrolytes.

- Polymer Reference Electrolyte — With open junction, polymer electrolyte directly contacts with test samples. The anti-pressure capacity can reach 6 bars. It is suitable for almost all applications, including samples containing oil, low ionic strength, protein and suspension.
- Protelyte Reference Electrolyte — Suitable for protein-containing, low temperature and viscous samples.
- Pre-pressurized Reference Electrolyte — With prefilled pressure in the gel electrolyte, the electrolyte can still infiltrate well even in viscous samples.



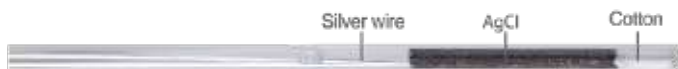
Junction

The reference system connects to solutions through the junction. LabSen® pH electrodes adopt the following types of junctions for different applications.

Name	Picture	Diagram	Remarks
Ceramic			Made with porous ceramic material, slow electrolyte outflow, vulnerable to contamination and clogging.
Open			Solid polymer electrolyte, open junction allows direct contact with solution completely, no clogging and maintenance free.
Movable glass sleeve			The flow rate of the electrolyte depends on the tightness of the sleeve, easy to clean, suitable for suspensions, emulsions, and low ionic strength solutions.
PTFE			Porous PTFE ring, water repellant, and resistant to chemical corrosions and high temp.; low risk of contamination or clogging.

Reference System

Long-life reference system — composed of a glass tube, AgCl particles, and a silver wire. The top end of the slim glass tube is stuffed with cotton and AgCl particles, ensuring the long-term stability of the reference electrode. The reference electrolyte does not contain Ag⁺, which prevents the reaction between the electrolyte and sulfides or proteins in the solutions that leads to junction clogging.



Silver ion trap reference system — The combination of Long-life reference system and a silver ion trap. The silver ion trap will absorb all the exuded Ag⁺, ensuring that there's no Ag⁺ in the reference electrolyte, and avoiding clogging of the junction caused by samples containing sulfides, proteins or TRIS buffer solutions.





LabSen®

General Water Solutions in Lab & Field

General water solutions refer to aqueous solutions that are within the range of 2 – 12 pH, at the temperature of 10 – 60°C, not including strong acids or strong alkalis, nor solutions with low ionic strength or micro volume.



Application Requirements for Laboratory and Field Measurement



Fast

&



Accurate

LabSen 211



General purpose pH electrode, providing fast, stable and low-drifting pH measurement. Compatible with TRIS buffers.

LabSen 213



With the patented fast-response temperature sensor for ATC. Other features are the same as LabSen 211.

LabSen 221



With a moveable sleeve junction, good for lower ionic strength samples, fast response and stable reading.

LabSen 223



With a patented fast-response temperature sensor for ATC. Other features are the same as LabSen 221.

LabSen 231



Open junction, no clogging, no refilling, maintenance free, suitable for wastewater, emulsion, suspension, etc.

LabSen 331



POM body, anti-corrosion, open junction, no clogging, no refilling and maintenance free, suitable for wastewater, emulsion, suspension, etc.

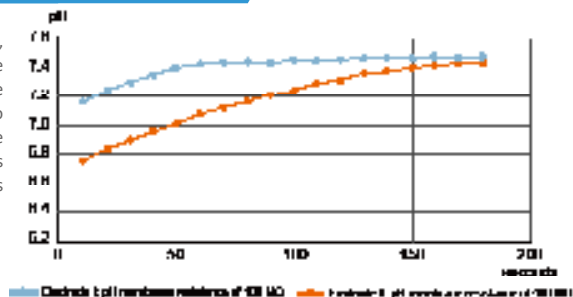
LabSen 333



With a built-in temperature sensor for ATC. Other features are the same as LabSen 331.

Membrane Resistance and Electrode Response

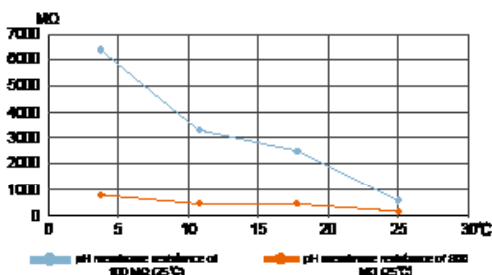
pH electrode is featured with high membrane resistance, ranging from tens to thousands of MΩ. The higher the membrane resistance is, the slower the electrode response will be. The data shown in the right figure shows two electrodes testing tap water. The membrane resistance of electrode I is 100MΩ, and the measurement stabilizes in 60 seconds; The membrane resistance of electrode II is 400MΩ. It is not stabilized even after 3 minutes.



The resistance of the glass membrane increases exponentially as the temperature drops. It doubles when the temperatures drops by every 7°C. The membrane resistance of the two electrodes shown in the right figure is 100 MΩ and 800 MΩ at 25°C. When the temperature decreases to 4°C, the membrane resistance became 800 MΩ and 6400 MΩ. Obviously, the latter electrode can hardly get stabilized any more.

Proprietary membrane formulation and the thickening layer technology of LabSen electrodes lead to premium quality, impact resistant glass membrane, meeting test requirements of fast and accurate measurement.

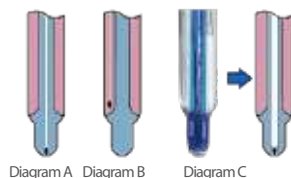
The impact of pH membrane resistance to the electrode



The impact of the electrode to pH membrane resistance

Fast Response ATC Electrodes

The conventional way to make the glass pH/Temp. combination electrode is to place the temperature sensor inside the bulb or the electrode (see Diagram A and B). As the bulb and the electrode are filled with solution, the temperature sensing is very slow. Adopting the patented structure, the temperature sensor of LabSen pH electrode (see Diagram C) is placed in an independent cavity under the pH glass membrane. With a built-in heat conducting medium, the temperature sensing speed is increased by 40%, greatly improving the response and stability of the pH electrode.



LabSen®	211	213	221	223	231	331	333
pH Range	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH
Temperature Range	-5 – 100 °C	-5 – 100 °C	-5 – 100 °C	-5 – 100 °C	-5 – 80 °C	0 – 80 °C	0 – 80 °C
Temperature Sensor	N/A	NTC 30 KΩ	N/A	NTC 30 KΩ	N/A	N/A	NTC 30KΩ
Type of Glass Membrane	S	S	S	S	S	S	S
Membrane Resistance	< 150 MΩ	< 150 MΩ	< 150 MΩ	< 150 MΩ	< 200 MΩ	< 100 MΩ	< 250 MΩ
Junction	Ceramic	Ceramic	Moveable Sleeve	Moveable Sleeve	Open	Open	Open
Reference System	Long-life	Long-life	Long-life	Long-life	Long-life	Long-life	Long-life
Reference Electrolyte	3M KCl	3M KCl	3M KCl	3M KCl	Polymer	Polymer	Polymer
Housing Material	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	POM	POM
Dimension	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm
Connector/Cable	BNC/1m	BNC-RCA/1m	BNC/1m	BNC-RCA/1m	BNC/1m	BNC/1m	BNC-RCA/1m

- 
- Low Ionic Strength Solutions
 - Low Temperature Solutions
-

Low ionic strength solutions refer to pure water of various purity levels, including tap water, drinking water, distilled water, RO water, stormwater, boiler water, surface water, deionized water, ultrapure water, etc., as well as non-aqueous solutions. When the ionic strength is low (conductivity < 100 $\mu\text{S}/\text{cm}$), stable pH reading will be hard to achieve.

Low-temperature solutions will cause a high glass membrane resistance, which will also cause measuring difficulty.

LabSen®





Application Requirement for Low Ionic Strength Solutions



LabSen 801



Glass moveable sleeve junction, fast and accurate reading, for general low ionic strength solutions, e.g. drinking water, RO water, distilled water, etc.

LabSen 803



Built-in patented fast-response temperature sensor for ATC. Other features and functions are the same as LabSen 801.

LabSen 811



Glass moveable sleeve, double junction, suitable for ultrapure water and de-ionized water (conductivity $< 10 \mu\text{S}/\text{cm}$), fast response and stable reading.

LabSen 813



Built-in patented fast-response temperature sensor for ATC. Other features and functions are the same as LabSen 811.

LabSen 881



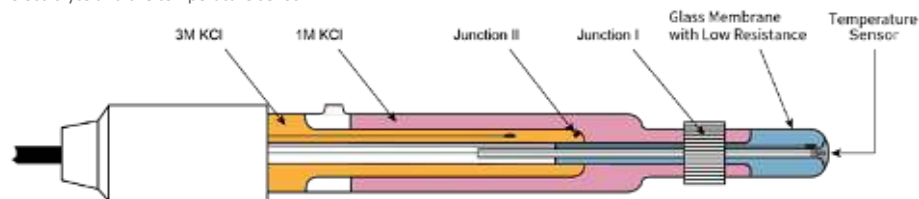
For solutions with low temperature. Low membrane resistance, 3 ceramic junctions and Protelyte electrolyte, preventing junction clogs and contamination.

The Difficulties and Solutions for Pure Water pH Measurement

	Measurement Difficulties	Solutions
Glass Membrane	The low conductivity of the solution results in high solution resistivity, which causes interference with the glass membrane's high impedance, generating drifting readings.	Adopting LabSen L-type low resistance glass membrane ($< 50 \text{ M}\Omega$), which is determined by the membrane formula and large surface area in the shape of cylindrical or olive.
Junction	The low ion concentration causes a rapid change in the KCl concentration at the junction area, resulting unstable potential of the junction.	Adopting the moveable sleeve junction with a large-area structure and quick electrolyte infiltration.
Polarization Effect	High concentration reference electrolyte (3M KCl) and low ion concentration sample solution cause significant density gradient, generating electrode polarization.	With double junction structure, the moveable sleeve adopts 1M KCl solution, reducing density gradient and polarization effect
Measuring Method	Theoretically, the pH of pure water should be 7.00. However, the reaction of pure water with carbon dioxide in the air will cause the pH to decrease to as low as pH 5.5	Using a flow cell to measure flowing water without contacting air.

Structure of Ultrapure Water pH Electrode

The following diagram shows the structure of LabSen ultrapure water pH electrodes, the Swiss-patented 4-layer glass tube includes all the structural elements for ultrapure water measurement: low resistance glass membrane, double junction structure; Junction I adopts glass moveable sleeves and reference solution of 1M KCl, while junction II adopts 3M KCl electrolyte and the temperature sensor.



LabSen®	801	803	811	813	881
pH Range	0 – 11 pH	0 – 11 pH	0 – 11 pH	0 – 11 pH	0 – 11 pH
Temperature Range	0 – 80 °C	0 – 80 °C	0 – 80 °C	0 – 80 °C	-30 – 80 °C
Temperature Sensor	N/A	NTC 30 K Ω	N/A	NTC 30 K Ω	N/A
Type of Membrane Glass	L	L	L	L	L
Membrane Resistance	$< 50 \text{ M}\Omega$	$< 50 \text{ M}\Omega$	$< 50 \text{ M}\Omega$	$< 50 \text{ M}\Omega$	$< 50 \text{ M}\Omega$
Junction	Moveable Sleeve	Moveable Sleeve	Moveable Sleeve	Moveable Sleeve	Ceramic $\times 3$
Reference System	Silver ion trap	Silver ion trap	Silver ion trap	Silver ion trap	Silver ion trap
Reference Electrolyte	3M KCl	3M KCl	3M KCl	3M KCl	Protelyte
Electrolyte	/	/	1M KCl	1M KCl	/
Housing Material	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass
Size	$\varnothing 12 \times 130 \text{ mm}$	$\varnothing 12 \times 130 \text{ mm}$	$\varnothing 12 \times 130 \text{ mm}$	$\varnothing 12 \times 130 \text{ mm}$	$\varnothing 12 \times 120 \text{ mm}$
Connection/Cable	BNC/1 m	BNC-RCA/1 m	BNC/1 m	BNC-RCA/1 m	BNC/1 m



LabSen®

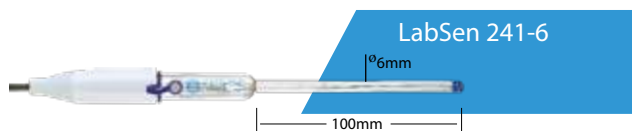
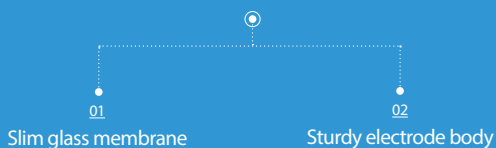


Micro-Volume Samples

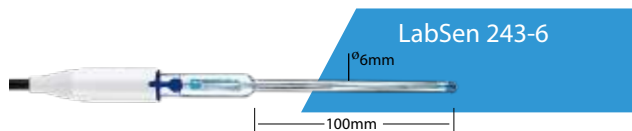
When the sample volume is very small (e.g. 20 μ L), or the sample container is slim and deep (test tubes, centrifuge tubes, cuvettes, microplates, NMR tubes, etc.), using micro-volume pH electrodes would be necessary to take reliable measurements.



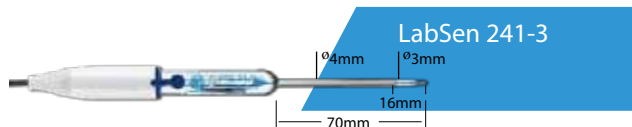
Application Requirement for Micro-Volume Measurements



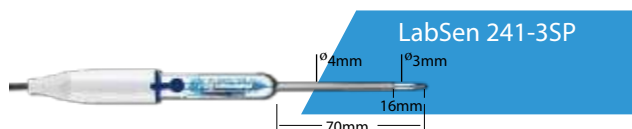
Semi-Micro pH electrode suitable for test tubes and small-volume sample solutions (>0.2 mL). Smallest test volume is 60µL with the use of Apera's semi-micro container.



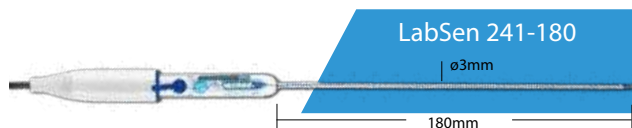
Built-in temperature sensor for ATC. Other features are the same as LabSen 241-6.



Micro pH electrode with stainless steel sheath protects the slim electrode from breakage, suitable for very small containers e.g. microplates and centrifuge tubes, etc (>30µL). Smallest test volume is 15µL with the use of Apera's micro container.



Micro pH electrode with Protelyte electrolyte, suitable for protein-containing solutions such as serum and microbiological samples. Other features and functions are the same as LabSen 241-3.



The 180mm/ø3mm electrode is suitable for the pH measurement in slim and deep containers such as NMR tubes. Minimum sample volume is 50 µL.

Glass Membrane Requirement

Electrode size & sample volume

LabSen®	241-6	243-6	241-3	241-3S	241-3S
Measuring tip diameter	Ø6 mm	Ø6 mm	Ø3 mm	Ø3-Ø4	Ø3 mm
Measuring tip length	100 mm	100 mm	70 mm	16-70 mm	180 mm
Minimum sample volume	0.2 mL	0.2 mL	General: 30 µL Special: 15 µL*	General: 30 µL Special: 15 µL*	50 µL

*With Apera's micro container, the electrode can test as low as 15µL (see figure below)



Microplate measurement



NMR tube measurement



Measuring 15 µL sample with the micro container

Requirement for the Glass Membrane Resistance

The small size of the micro glass membrane could lead to high glass membrane resistance. Some micro electrodes in the market have very high resistance (some even up to 1000 MΩ at 25 °C), causing very slow electrode response. When the test sample is at low temperature, the membrane resistance could reach as high as 8000 MΩ, which makes the measurement impossible. However, the membrane formulation and the thick glass membrane of LabSen slim electrodes is not only resistant to impact and chemicals, but also has a lower membrane resistance, ensuring fast response and stable readings in micro-volume samples.

Strength Requirement for the Electrode

Ø3 micro electrode is highly easy to break at the joint area between the wide and the slim glass tubes (See the right figure). LabSen 241-3 is built with a Ø4 stainless steel sheath, which greatly enhanced the durability of the slim glass tube.



LabSen®	241-6	243-6	241-3	241-3SP	241-180
pH Range	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH
Temperature Range	0 – 100 °C	0 – 100 °C	0 – 100 °C	0 – 100 °C	0 – 100 °C
Temperature Probe	N/A	NTC 30 KΩ	N/A	N/A	N/A
Type of Membrane Glass	S	S	S	S	S
Membrane Resistance	< 350 MΩ	< 350 MΩ	< 450 MΩ	< 450 MΩ	< 450 MΩ
Junction	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic
Reference System	Long-life	Long-life	Long-life	Long-life	Long-life
Reference Electrolyte	3M KCl	3M KCl	3M KCl	Protelyte	3M KCl
Housing Material	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass
Size	Ø12 - Ø6x150 mm	Ø12 - Ø6x150 mm	Ø12 - Ø3x150 mm	Ø12 - Ø3x150 mm	Ø12 - Ø3x240 mm
Connection/Cable	BNC / 1 m	BNC-RCA / 1 m	BNC / 1 m	BNC / 1 m	BNC / 1 m

- 
- Solid Samples Spear Test
 - Surface Test
-

General standard glass membrane is only suitable for water solutions; A spear glass membrane can stick into solid or semi-solid samples for direct pH measurement, e.g. fruit, meat, cheese, dough, soil, etc.;

A flat glass membrane can measure the pH on flat surfaces, e.g. skin, paper, textiles, etc.



LabSen®



Application Requirement for Solid Samples



LabSen 251

Glass body, suitable for soft solid or semi-solid samples, e.g. cheese, fruit, vegetable and sushi etc.



LabSen 551

The PVC body effectively protects the glass rod. In addition to soft solid and semi-solid samples, it is more suitable for harder samples, such as direct soil testing.



LabSen 751

The food-grade titanium alloy body effectively protects the glass rod, no corrosion, more suitable for solid and semi-solid food testing, e.g. cheese, dough, meat product, fruit, etc.



LabSen 761

The titanium blade easily cuts into frozen/raw meat and fish to measure pH directly.



LabSen 371

POM body, flat glass membrane, PTFE junction, suitable for flat surface measurement, e.g. paper, skin, textiles, leather, and etc.

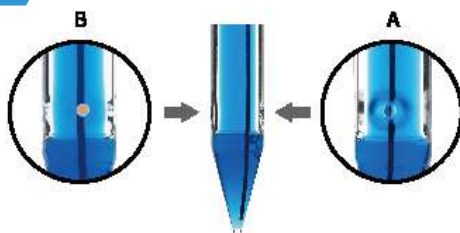
Glass Membrane Requirement for Spear Electrodes

Sturdy glass membrane: Spear pH electrode has to stick into the sample for measurements. For example, LabSen 761 blade electrode is often used to test frozen meat. If the glass membrane is not strong enough, the probe could easily be damaged. LabSen spear membrane adopts thickening layer technology, making it strong enough for sticking-in measurements.

Low membrane resistance: When sticking into the sample, friction will be generated between the glass membrane and the sample. For example, when we measure pH of soil samples, if the membrane resistance is too high, the electric charge generated by the friction between the glass membrane and the soil will greatly affect the stability of the measurement.

Double-protected Junction Structure

The junction of the spear electrode is perpendicular to the spearing direction of the electrode, and the junction can be easily blocked by small particles. LabSen spear electrode has two junctions — open junction (A) + ceramic junction (B) — with different features and hard to be blocked, greatly extending the service life of the electrode.



LabSen®	251	551	751	761	371
pH Range	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH
Temperature Range	0 – 80 °C	0 – 80 °C	0 – 80 °C	0 – 80 °C	0 – 80 °C
Temperature Probe	N/A	N/A	N/A	N/A	N/A
Type of Membrane Glass	S	S	S	S	S
Membrane Resistance	< 250MΩ	< 250MΩ	< 250MΩ	< 250MΩ	< 500MΩ
Junction	Open+Ceramic	Open+Ceramic	Open+Ceramic	Open+Ceramic	PTFE
Reference System	Long-life	Long-life	Long-life	Long-life	Long-life
Reference Electrolyte	Polymer	Polymer	Polymer	Polymer	3M gel KCl
Housing Material	Lead-free glass	PVC	Titanium alloy	Titanium alloy blade	POM
Size	Ø6 - Ø12x100 mm	Ø5 - Ø15x130 mm	Ø5 - Ø12x115 mm	Ø12x115 mm	Ø12x105 mm
Connection/Cable	BNC/1 m	BNC/1 m	BNC/1 m	BNC/1 m	BNC/1 m

** All the above electrodes can be installed with an NTC 30KΩ temperature sensor to achieve ATC. The corresponding models are LabSen 253, 553, 753, 763, and 373 with BNC/RCA connectors.*



LabSen®

- 
- A person wearing a dark shirt is using a pH electrode to measure the pH of water in a large tank. The electrode is submerged in the water, and a copper-colored metal rod is also visible in the water. The background shows the interior of the tank and some structural elements.
- Strong Acidic
 - Strong Alkaline
 - High Temperature
-

At low pH values ($< \text{pH } 2$), acid error will occur. Regular pH electrodes will give a falsely higher pH value than the real result.

At high pH values ($> \text{pH } 11$), alkaline error will occur. Regular pH electrodes will give a falsely lower pH value than the real result.

Not only the measurement errors, strong acid and strong alkali will also corrode the glass membrane, and the electrode will be damaged quickly, which could be more severe at high temperature.



Application Requirement for Strong Acid / Strong Alkaline / High Temp. Solutions



LabSen 831

HF corrosion resistance, suitable for the measurement of HF solution with less than 0.1M concentration, or other strong acidic solutions, high durability.



LabSen 833

Built-in temperature sensor for ATC. Other features are the same as LabSen 831.



LabSen 841

Special HA glass membrane, suitable for strong alkaline/high salinity/high temperature solutions, extremely low alkaline error and 5 times service life than regular electrodes.



LabSen 843

Built-in temperature sensor for ATC. Other features are the same as LabSen 841.



LabSen 861

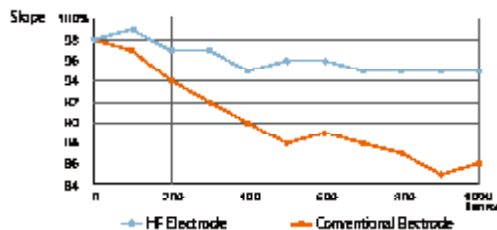
Special PHY glass membrane, with anti-fouling PTFE junction, suitable for high temperature and caustic solutions e.g. electroplating solutions, etc.



LabSen 863

Built-in temperature sensor for ATC. Other features are the same as LabSen 861.

Acid error, strong acid solutions, and HF-containing solutions



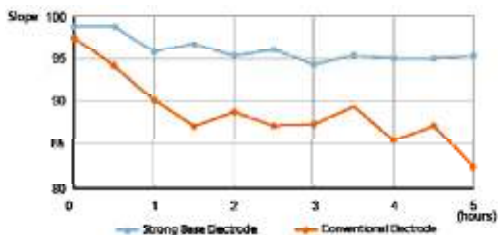
Acid Error occurs in strong acid solutions where the decrease of H^+ activity leads to a higher pH reading than the real value (usually happens when pH is less than 2). Strong acidic solutions also corrode pH glass membranes. Hydrofluoric acid solution is extremely corrosive and could directly dissolve conventional pH glass membranes. HF resistant pH electrode is suitable for measurement of HF acid with concentration $< 0.5\text{mol/L}$ or 10g/L .

LabSen's HF glass membrane is corrosion resistant and can measure HF acid solutions for up to 1000 times ($< 0.5\text{mol/L}$ or 10g/L , 25°C , 1 minute per measurement), and is also suitable for solutions containing HCl and H_2SO_4 . Compared with conventional electrodes, the service life of LabSen HF electrodes is significantly increased.

Alkaline error and strong alkaline solutions

Alkaline error occurs in strong alkaline solutions (usually $> \text{pH } 11$) where the relatively lower H^+ ions in the gel layer of the glass membrane is replaced by sodium ions. The electrode may eventually respond to Sodium ions instead of H^+ ions, giving a falsely lower pH value than the real result. Alkaline error is much higher than acid error. For strong alkaline solution (e.g. NaOH and KOH) measurements, in addition to the alkaline error, it also corrodes pH glass membrane, shortening the electrode's service life.

LabSen HA membrane can endure high temperatures and strong alkaline solutions. Compared with conventional electrodes, the service life is increased by about 5 times.



LabSen®	831	833	841	843	861	863
pH Range	0 – 12 pH	0 – 12 pH	1 – 14 pH	1 – 14 pH	1 – 13 pH	1 – 13 pH
Temperature Range	0 – 100 °C	0 – 100 °C	0 – 130 °C	0 – 130 °C	0 – 130 °C	0 – 130 °C
Temperature Probe	N/A	NTC 30 KΩ	N/A	NTC 30KΩ	N/A	NTC 30 KΩ
Type of Membrane Glass	HF	HF	HA	HA	PHY	PHY
Membrane Resistance	$< 400 \text{ M}\Omega$	$< 400 \text{ M}\Omega$	$< 500 \text{ M}\Omega$	$< 500 \text{ M}\Omega$	$< 500 \text{ M}\Omega$	$< 500 \text{ M}\Omega$
Junction	Ceramic	Ceramic	Ceramic	Ceramic	Multi-pore PTFE	Multi-pore PTFE
Reference System	Silver ion trap	Silver ion trap	Silver ion trap	Silver ion trap	Silver ion trap	Silver ion trap
Reference Electrolyte	3M KCl	3M KCl	3M KCl	3M KCl	3M Gel KCl	3M Gel KCl
Housing Material	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass
Size	$\varnothing 12 \times 120 \text{ mm}$	$\varnothing 12 \times 120 \text{ mm}$	$\varnothing 12 \times 120 \text{ mm}$	$\varnothing 12 \times 120 \text{ mm}$	$\varnothing 12 \times 120 \text{ mm}$	$\varnothing 12 \times 120 \text{ mm}$
Connection/Cable	BNC/1 m	BNC-RCA/1 m	BNC/1 m	BNC-RCA/1 m	BNC/1 m	BNC-RCA/1 m

- Viscous Samples
 - Protein-containing Solutions
-

The difficulty for measuring viscous and dairy samples is that the junction could easily be blocked. The former is because the sample's viscosity makes electrolyte very difficult to infiltrate; the latter is because the proteins in dairy samples react with the reference solution to precipitate and block the junction.

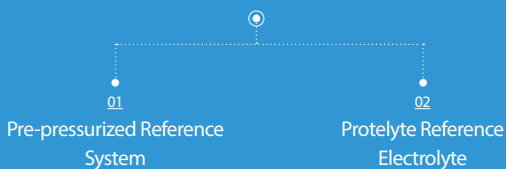


LabSen®





Application Requirement for Viscous and Protein-containing Samples



LabSen 851-S

S glass membrane, suitable for viscous sample measurement, e.g. cosmetics, paint, resin, etc. The pre-pressurized reference system ensures smooth flow of electrolyte, preventing junction clogs.

LabSen 853-S

Built-in temperature sensor for ATC. Other features are the same as LabSen 851-S.

LabSen 851-H

HA glass membrane, suitable for viscous samples with strong alkaline or high temperature, resistant to high pressure disinfection. The pre-pressurized reference system ensures smooth flow of electrolyte, preventing junction clogs.

LabSen 853-H

Built-in temperature sensor for ATC. Other features are the same as LabSen 851-H.

LabSen 821

Suitable for protein samples, e.g. dairy product, milk, cream, etc. With three ceramic junctions and the Protelyte reference electrolyte, preventing the junctions from being blocked by proteins.

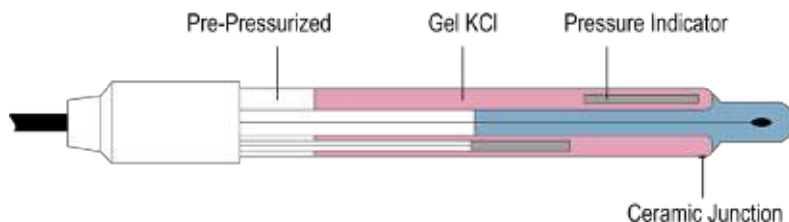
LabSen 823

Built-in temperature sensor for ATC. Other features are the same as LabSen 821.

Pre-pressurized Reference System

There are many viscous samples such as lotions and hair dyes in cosmetics industry; jams and creams in the food industry; paints, glues, and resins in the chemical industry, etc. It is difficult to measure their pH with conventional pH electrodes. Slow response, unstable readings, and poor repeatability are the common problems. Because the viscous solution will clog the ceramic junction and hinder the infiltration of the reference solution.

Another situation is to test samples under high temperature and high pressure in which the sample solution will infiltrate into the electrode in the reverse direction. Pre-pressurized electrodes can effectively solve this problems. Pre-pressurization is a special electrode processing technology that pre-fills a certain pressure inside the electrode to ensure that the electrolyte can slowly pass through the junction even in a very viscous solution and also prevents the sample solution from entering the electrode, ensuring good stability and repeatability of measurement. The figure below is a diagram of the pre-pressurized electrode. The pressure indicator tube in the figure is used to indicate the pressure inside electrode.



Dairy Product Testing

When using a conventional pH electrode to test dairy products and other protein-containing liquid food, the protein in the sample will react with KCl solution, precipitating and blocking the ceramic junction. Protelyte is an oily electrolyte, which does not react with protein. Moreover, LabSen 821/823 are equipped with 3 ceramic junctions, minimizing the chance of a clogged junction.



LabSen®	851-S	853-S	851-H	853-H	821	823
pH Range	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH
Temperature Range	-5 – 100 °C	-5 – 100 °C	0 – 130 °C	0 – 130 °C	-5 – 100 °C	-5 – 100 °C
Temperature Probe	N/A	NTC 30 KΩ	N/A	NTC 30 KΩ	N/A	NTC 30 KΩ
Type of Membrane Glass	S	S	HA	HA	S	S
Membrane Resistance	< 150 MΩ	< 150 MΩ	< 500 MΩ	< 500 MΩ	< 200 MΩ	< 200 MΩ
Junction	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic×3	Ceramic×3
Reference System	Pre-pressurized	Pre-pressurized	Pre-pressurized	Pre-pressurized	Silver ion trap	Silver ion trap
Reference Electrolyte	Gel KCl	Gel KCl	Gel KCl	Gel KCl	Protelyte	Protelyte
Housing Material	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass
Size	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm
Connection/Cable	BNC/1 m	BNC-RCA/1 m	BNC/1 m	BNC-RCA/1 m	BNC/1 m	BNC-RCA/1 m



IndSen®

IndSen® Industrial pH Electrodes

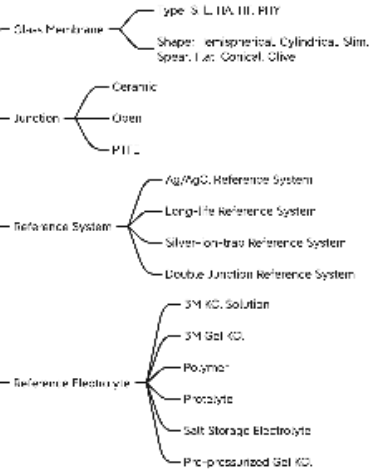
In addition to the requirements for electrode installation, pH electrodes used for industrial process control have more requirements for electrode performance. The design of each structure and element all reflects the complex requirement of the specific application. For example, for the same glass membrane, 3 types of junctions can be used; for the same type of junction, 4 types of reference systems and 6 types of electrolytes can be installed. Some of them are fixed structural combinations while most of them are related to the application requirements. An unreasonable combination will affect the measurement accuracy and electrode service life.

We are showing 7 models of the most common IndSen® industrial pH electrodes on the next page. The main purpose is to introduce the application of the latest technologies in industrial pH electrodes. If you have difficulties in process monitoring or have any other specific requirements, feel free to contact us. We are happy to customize the most suitable industrial pH electrode for you.

Application Requirements for Industrial pH Electrodes

IndSen pH Electrode Application Requirement

Electrode Performance



Electrode Installment

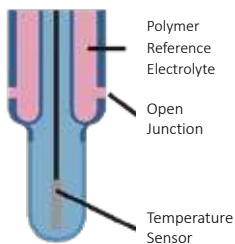
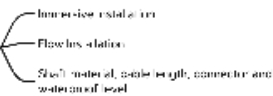
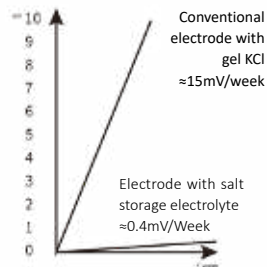


Diagram of the industrial pH electrode with open junction, polymer electrolyte, and temperature sensor



The drift of the pH electrode with salt storage electrolyte in low conductivity solutions



(a) Silicone rubber electrode head (applicable with temperature sensor)

(b) With PG13.5 screw threads electrode head (applicable with temperature sensor)

(c) With PG13.5 screw threads S7 connector (non-applicable with temperature sensor)



9316



9156



9256



9326



9336



9346



9416

IndSen®	9316	9156	9256	9326	9336	9346	9416
Suitable Application	Waste-water measurement	Pure-water Measurement	Pure-water Measurement	Strong alkalis measurement	Measurement of Solution with HF	High temperature or caustic solution measurement, e.g. electroplating solution	Measurement of viscous solution
pH Range	0 – 14 pH	0 – 11 pH	0 – 11 pH	0 – 14 pH	0 – 12 pH	1 – 13 pH	0 – 14 pH
Temperature Range	0 – 100 °C	0 – 80 °C	0 – 80 °C	0 – 130 °C	0 – 100 °C	0 – 130 °C	0 – 100 °C
Temperature Probe	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Glass Membrane	S	L	L	HA	HF	PHY	S
Membrane Resistance	< 150 MΩ	< 50 MΩ	< 50 MΩ	< 500 MΩ	< 400 MΩ	< 500 MΩ	< 150 MΩ
Junction	Open×2	Ceramic×3	Multi-pore PTFE	Open×2	Open×2	Open×2	Ceramic
Reference System	Silver ion trap	Silver ion trap	Silver ion trap	Silver ion trap	Silver ion trap	Silver ion trap	Pre-pressurized
Reference Electrolyte	Polymer	Gel KCl	Salt Storage Gel	Polymer	Polymer	Polymer	Gel KCl
Pressure	6 bar	6 bar	6 bar	6 bar	6 bar	6 bar	6 bar
Housing Material	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass	Lead-free glass
Electrode Size	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm	Ø12×120 mm

Calibration and Maintenance Solutions

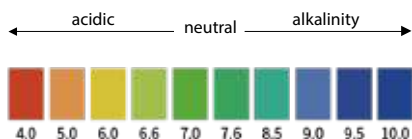
The measurement principle of electrochemical instruments is to compare and measure an unknown solution with the standard solution of known values. Therefore, as the standard solution, the quality of pH calibration buffers is fundamental to the measurement accuracy. Having fresh and clean calibration buffers made with quality raw materials and standard procedures is essential.



LabSen®

Solutions

- Apera calibration buffers are produced in an ISO 9001:2015 facility with ISO 17025:2017 accreditation using high-purity reagents, deionized water and certified analytical balances in a temperature controlled environment. Reported values are accurate to ± 0.01 pH @ 25°C and are traceable to NIST Standard Reference Materials (SRMs).
- Color-coded buffers for quick identification
- 2-year expiration from manufacture for an unopened bottle.








SKU	Maintenance Solutions
AI1107	3M KCl Soaking/Refill Solution
AI1190	Protelyte Soaking/Refill Solution
AI1166	Cleaning solution

pH Buffer Solutions	Accuracy (@25°C)
pH 1.68	± 0.01 pH
pH 4.00	± 0.01 pH
pH 7.00	± 0.01 pH
pH 10.01	± 0.01 pH
pH 12.45	± 0.01 pH




**CalPod Solution Holder
for easy calibration**

Connectors

Connector	Picture	Remarks
Waterproof BNC		Standard BNC
S7		For pH, ORP and conductivity electrodes
S7-BNC cable		Use with S7 connectors
BNC+RCA		For pH electrodes with temperature sensor
S type multi pin		For pH and conductivity electrodes with temperature sensor

Recommended Replaceable Models

Apera LabSen	Mettler Toledo	Hanna
LabSen 211	InLab Routine /LE409	HI 1131B
LabSen 221	InLab Science/LE420	HI1048B/HI1049B
LabSen 331	InLab Expert / InLab Easy / LE407	HI 1210B
LabSen 851-H	InLab Power / InLab Viscous	N/A
LabSen 241-3/LabSen 241-3SP	InLab Micro/LE422	HI1083B/FC240B/HI1093B
LabSen 241-6	InLab Semi-Micro	HI1330B
LabSen 241-180	InLab NMR	HI1093P
LabSen 251	InLab Solids	FC210B/HI2031B
LabSen 551	LE427	FC200B/FC400B
LabSen 821	InLab Dairy	FC220B
LabSen 371	InLab Surface	HI1413B
LabSen 801	InLab Pure	N/A
LabSen 881	InLab Cool	FI1053B
LabSen 831	InLab Hydrofluoric	N/A
LabSen 841	N/A	HI1043B
LabSen 761	N/A	FC230B+FC098



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