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LabSen[®]

pH Electrode Handbook

Precision pH Measurement, Simplified for Excellence



LabSen®

Preface

pH electrodes are analytical sensors for measuring potential of hydrogen (pH), which is the negative logarithm of the hydrogen ion activity. Without a reliable pH electrode that is suitable for your specific application, measurement accuracy and precision would be impossible to obtain.

Since 1991, Apera Instruments has been unwavering in its commitment to the advancement of electrochemical sensors. Our pH electrodes, numbering over 2 million, are serving a diverse customer base spanning over 60 countries. By harnessing cutting-edge sensor technologies and incorporating premium materials sourced from Switzerland, we have engineered the LabSen® series of laboratory pH electrodes. Our extraordinary products and services are designed to empower you to excel in pH measurement.

This comprehensive handbook categorizes Apera LabSen® pH electrodes into six distinct application types. It elucidates the electrode requirements for each application, viewed through the lens of technology and engineering. By introducing the vanguard of pH electrode technologies, we aspire to assist you in selecting the optimal pH electrode for your needs.



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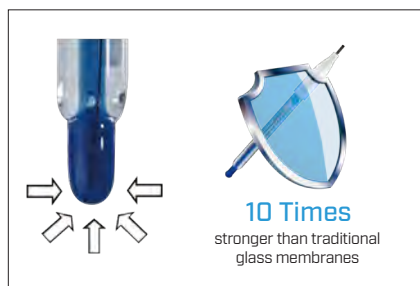
Main Features of LabSen® pH Electrode

Having superior-quality pH electrodes that are suited for your applications is the key to the reliability of pH measurement. Built with state-of-the-art sensor technologies and top-tier materials from Switzerland, LabSen® pH electrodes boast three distinctive features that set them apart from traditional products in the market.

01 Robust Glass Membrane

The delicate glass membrane of a pH electrode is often its most vulnerable component. The possibility of easy breakage of these glass membranes has long been a vexing issue for traditional pH electrodes.

LabSen® pH electrodes, however, are designed with a sturdy layer technology. This results in a glass membrane that is tenfold stronger than those found in traditional pH electrodes, effectively eliminating concerns about membrane breakage due to regular collisions. Simultaneously, this robust membrane maintains a low impedance, guaranteeing a swift response time. This innovative approach ensures both durability and efficiency in pH measurement.



02 Blue Gel Inner Solution

Traditional pH electrodes have a liquid inner solution that can create air bubbles, resulting in jumping readings. Users often need to rigorously shake the electrode to remove these bubbles.

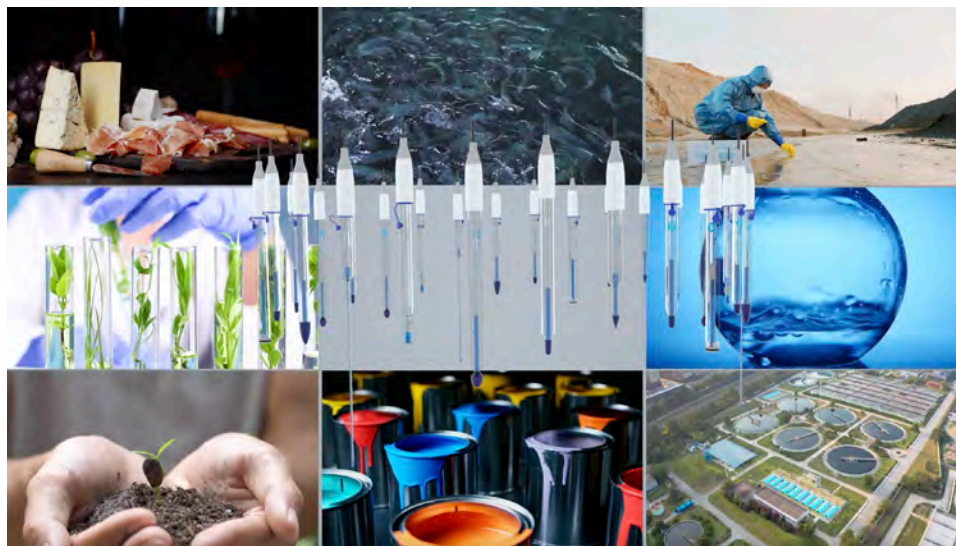
LabSen's electrodes, however, use a unique blue gel-like solution. This prevents air bubbles and allows the electrode to work in any position, even upside-down. This design makes the electrode easier to use and improves measurement accuracy by preventing heat changes inside the electrode. It's a user-friendly solution for more accurate pH measurements.

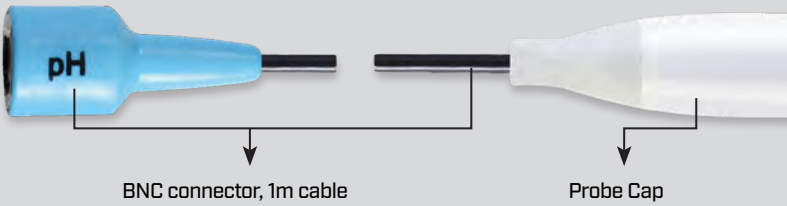


03 Full Range of Selections

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 application.

01	General Water Solutions Dirty Liquids
02	Pure water Organic Solvents Low Temperature Solutions
03	Micro-Volume Water Solutions
04	Direct Test in Solid Samples Surface Test
05	Strong Acidic Strong Alkaline High Temperature Solutions
06	Viscous Liquids Protein-Containing Liquids





Experience the unparalleled precision of LabSen® pH electrodes, where each component – from the glass membrane to the junction, inner solution, reference system, and reference electrolyte – is crafted by hand. Our electrodes are a testament to exceptional technology blended with the spirit of craftsmanship. Every LabSen® pH electrode is not just a product but a masterpiece, meticulously assembled to ensure the highest standards of quality and performance.

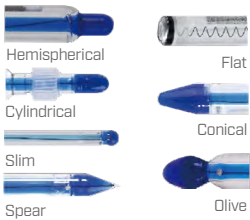
Glass Membrane

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 impedance < 150 MΩ
HA	Suitable for strong alkaline and high temperature solutions, low alkaline error, 0 – 130°C, membrane impedance < 500MΩ
L	Low impedance membrane for low ionic strength and low temperature solutions, 0 – 80°C, membrane impedance < 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 impedance < 400MΩ
PHY	The strongest membrane, resistant to chemical corrosion and high temperature, 0 – 130°C, membrane impedance < 600 MΩ



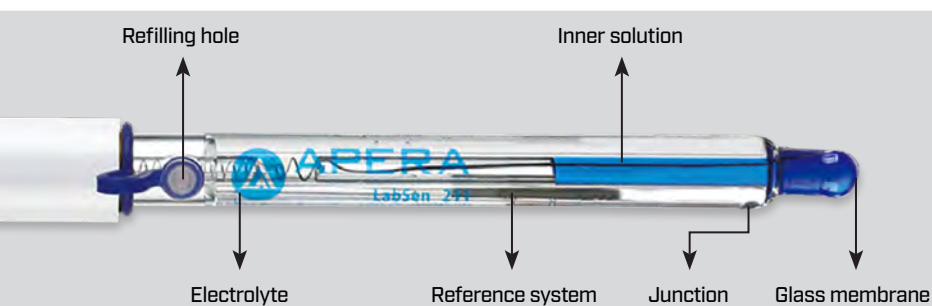
Glass Lathe Processing
LabSen pH electrode glass membrane is processed by glass lathe, which can form various shapes of glass membranes, including cylindrical, conical and olive shapes that generate faster response, as well as spear, flat and slim shapes that fulfill functional requirements.



Reference Electrolyte

In addition to the conventional 3M KCl electrolytes, LabSen pH electrode adopts the following special electrolytes for different purposes and applications.

- 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 pre-filled 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-repellent, 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
 - Dirty Liquids
-

General water solutions refer to the aqueous solutions that are within the range of 2 – 12 pH, at the temperature of 10 – 60°C, and do not have low ionic strength (conductivity < 100 μ S) or high salinity (> 5 ppt/0.5%)

Dirty liquids refer to general water solutions that contain complex substances such as wastewater, emulsion, suspensions, and slurries. The combination of an open junction and polymer electrolyte is the perfect solution to prevent junction clogs in these liquids.



Application Requirements for Laboratory and Field Measurement



Fast

&



Accurate

LabSen 211



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

LabSen 221



Refillable, movable sleeve junction, good for general purpose and lower ionic strength samples, fast response and stable reading.

LabSen 231



Non-refillable, open junction, no clogging, 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.

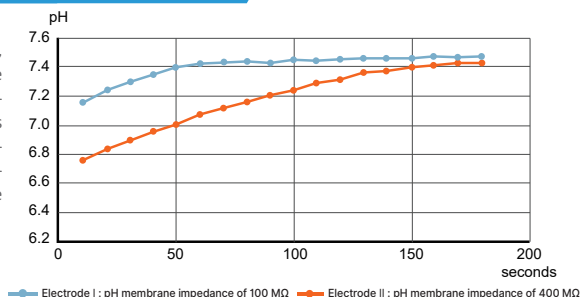
LabSen 335



Non-refillable, POM body, anti-corrosion, open junction, built-in temp. sensor, suitable for suspensions, emulsions, and other dirty liquid with 8-pin connector for pocket and portable meters

Membrane Impedance and Electrode Response

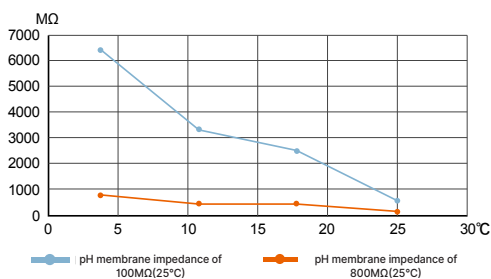
pH electrode is featured with high membrane impedance, ranging from tens to thousands of MΩ. The higher the membrane impedance is, the slower the electrode response will be. The data shown in the right figure shows two electrodes testing tap water. The membrane impedance of electrode I is 100MΩ, and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



The impedance of the glass membrane increases exponentially as the temperature drops. It doubles when the temperatures drops by every 7°C. The membrane impedance 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 impedance 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.

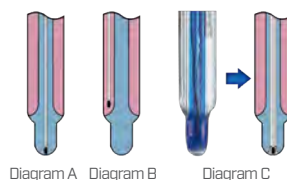
The impact of pH membrane impedance to the electrode



The impact of the electrode to pH membrane impedance

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	221	231	331	335
pH Range	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH	0 – 14 pH
Temperature Range	-5 – 100 °C	-5 – 100 °C	-5 – 80 °C	0 – 80 °C	0 – 80 °C
Temperature Sensor	N/A	N/A	N/A	N/A	NTC 30KΩ
Type of Glass Membrane	S	S	S	S	S
Membrane Impedance	< 150 MΩ	< 150 MΩ	< 200 MΩ	< 100 MΩ	< 250 MΩ
Junction	Ceramic	Moveable Sleeve	Open	Open	Open
Reference System	Long-life	Long-life	Long-life	Long-life	Long-life
Reference Electrolyte	3M KCl	3M KCl	Polymer	Polymer	Polymer
Housing Material	Lead-free glass			POM	
Dimension	Ø12×120 mm				
Connector/Cable	BNC/1m	BNC/1m	BNC/1m	BNC/1m	8-pin/1m

* All the above electrodes can be installed with an NTC 30KΩ temperature sensor to achieve ATC. The corresponding models are LabSen 213, 223, and 333 with BNC/RCA connectors.

- 
- Pure Water
 - Organic Solvents
 - Low Temperature Solutions
-

Pure water refers to aqueous solutions with low ionic strength such as drinking water, well water, distilled water, RO water, storm water, boiler water, surface water, deionized water, etc. The lower the ionic strength, the more challenging it is to get a stable pH reading.

It is highly difficult to use conventional glass electrodes to measure the pH in non-aqueous or organic solvents as they have very low conductivity levels and can dehydrate and damage the glass membrane quickly.

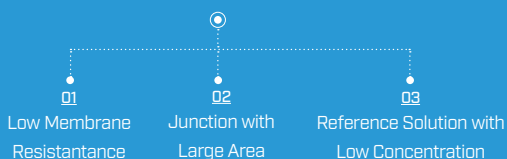
Low-temperature solutions will significantly raise glass membrane impedance, which leads to greater measuring difficulty.

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Application Requirements for Low Ionic Strength Solutions



LabSen 801



Refillable, movable sleeve junction, fast and accurate reading, for pure water, e.g. drinking water, RO water, distilled water, storm water, boiler water, etc.

LabSen 805



Non-refillable, low membrane impedance and 3 ceramic junctions, built-in temp. sensor, suitable for pure water, with 8-pin connector for pocket and portable meters

LabSen 811



Refillable, movable sleeve, double junction, suitable for ultra-pure water (conductivity < 10 μ S/cm), fast response and stable reading.

LabSen 871



Refillable, PHY membrane, double junction with glass movable sleeve, made for quick and stable measurement in organic solvents and non-aqueous solutions.

LabSen 881



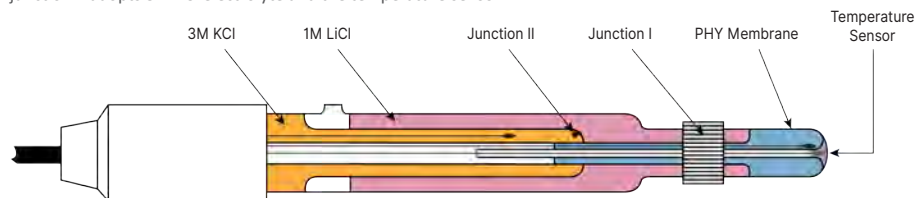
Refillable, for solutions with low temperature. Low membrane impedance, 3 ceramic junctions and Protelyte electrolyte, preventing junction clogs.

The Difficulties and Solutions for Pure Water pH Measurement

	Measurement Challenge	Solution
Glass Membrane	The low conductivity of the solution results in high solution resistivity, which causes interference with the glass membrane's high impedance, and generates drifting readings.	Adopts L-type low impedance glass membrane (< 50 MΩ), which is determined by the membrane formula and large surface area in cylindrical or olive shape.
Junction	The low ion concentration causes a rapid change in the KCl concentration at the junction area, resulting unstable potential of the junction.	Adopts the movable sleeve junction with a large-area structure and quick electrolyte infiltration.
Organic Solvents	Non-aqueous organic solvents could dehydrate and damage conventional glass membranes quickly, and have poor solubility with KCl electrolyte.	Adopts PHY-type membrane and double-junction with 1M LiCl solution as the outer-bridge electrolyte.
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	Use a sealed container for the sample testing or a flow cell to measure flowing water without contacting air.

Structure of Organic Solvents pH Electrode

The following diagram shows the structure of LabSen pH electrodes for organic solvents, the Swiss-patented 4-layer glass tube includes all the structural elements for quick and stable measurement in non-aqueous solutions: robust PHY glass membrane, double junction structure; Junction I adopts glass movable sleeves and reference solution of 1M LiCl, while junction II adopts 3M KCl electrolyte and the temperature sensor.



LabSen®	801	805	811	871	881
pH Range	0 – 11 pH	0 – 11 pH	0 – 11 pH	1 – 13 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 KΩ	N/A	NTC 30 KΩ	N/A
Type of Membrane Glass	L	L	L	PHY	L
Membrane Impedance	< 50 MΩ	< 50 MΩ	< 50 MΩ	< 600 MΩ	< 50 MΩ
Junction	Movable Sleeve	Ceramic×3	Movable Sleeve	Movable Sleeve	Ceramic×3
Reference System	Silver ion trap	Long-life	Ag/AgCl	Ag/AgCl	Silver ion trap
Reference Electrolyte	3M KCl	Gel I	3M KCl	3M KCl	Protelyte
Outer-bridge Electrolyte	/	/	1M KCl	1M LiCl	/
Housing Material	Lead-free glass				
Size	Ø12×130 mm	Ø12×120 mm	Ø12×130 mm	Ø12×130 mm	Ø12×120 mm
Connection/Cable	BNC/1 m	8-pin/1 m	BNC/1 m	BNC/1 m	BNC/1 m

** All the above electrodes without temp. sensor can be installed with an NTC 30KΩ thermistor to achieve ATC. The corresponding models are LabSen 803, 813, 873, 883 with a BNC/RCA connector.*



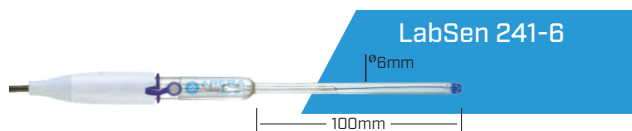
LabSen®



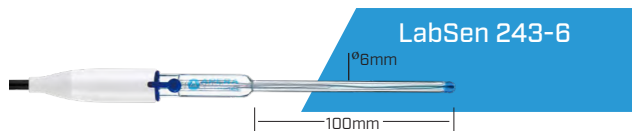
Micro-Volume Samples

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

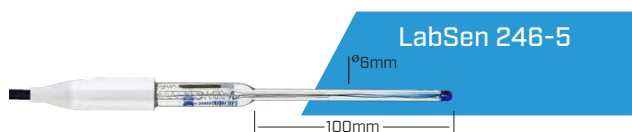
Application Requirements for Micro-Volume Measurements



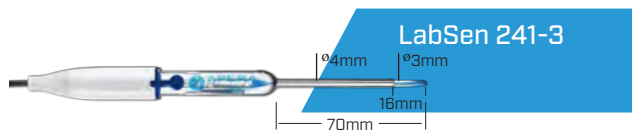
Refillable semi-Micro pH electrode suitable for test tubes and small-volume sample solutions (>0.2 mL). Minimum test volume is 60µL with the use of Apera's semi-micro container.



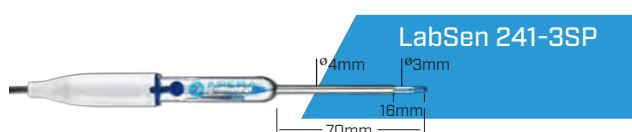
Built-in temperature sensor for ATC. Other features are the same as LabSen 241-6.



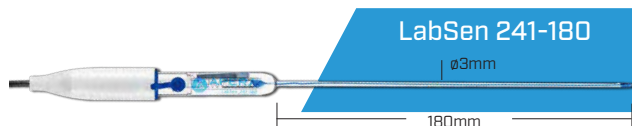
Non-refillable semi-micro pH/temp. electrode with 8-pin connector for pocket and portable meters. Minimum test volume is 60µL with the use of Apera's semi-micro container.



Refillable micro pH electrode with stainless steel sheath, suitable for very small containers e.g. micro plates and centrifuge tubes, etc (>30µL). Minimum test volume is 15µL with the use of Apera's micro container.



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



Refillable, the 180mm/3mm electrode is suitable for 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	241-180
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 a micro container

Requirement for the Glass Membrane Impedance

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

Strength Requirement for the Electrode

Ø3 micro electrode is fragile 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	246-5	241-3	241-3SP	241-180
pH Range	0 – 14 pH	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	0 – 100 °C
Temperature Probe	N/A	NTC 30 KΩ	NTC 30 KΩ	N/A	N/A	N/A
Type of Membrane Glass	S	S	S	S	S	S
Membrane Impedance	< 350 MΩ	< 350 MΩ	< 350 MΩ	< 450 MΩ	< 450 MΩ	< 450 MΩ
Junction	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic
Reference System	Long-life	Long-life	Long-life	Long-life	Long-life	Long-life
Reference Electrolyte	3M KCl	3M KCl	3M KCl	3M KCl	Protelyte	3M KCl
Housing Material	Lead-free glass					
Size	Ø12 - Ø6x150 mm			Ø12 - Ø3x150 mm		Ø12 - Ø3x240 mm
Connection/Cable	BNC / 1 m	BNC-RCA / 1 m	8-pin / 1 m	BNC / 1 m	BNC / 1 m	BNC / 1 m

- 
- Solid Sample Direct 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. fruits, meats, cheese, dough, soil, etc.

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



LabSen®



Application Requirements for Solid Samples



LabSen 251



Glass body, suitable for soft solid or semi-solid samples, e.g. cheese, fruits, dough, vegetables, and sushi etc.

LabSen 551



The PVC body effectively protects the glass tube. In addition to soft solid samples, it is more suitable for in-field measurement, 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, fish, and other solid samples to measure pH directly.

LabSen 765



The titanium blade sheath easily cuts into frozen/raw meat, fish, and other solid samples to measure pH/temp. directly. With 8-pin connector for pocket and portable meters

LabSen 371



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

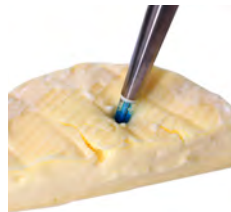
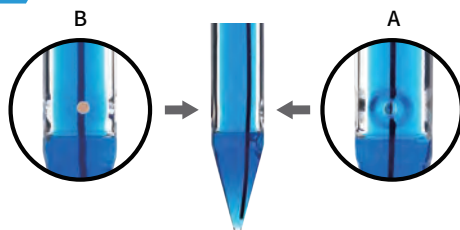
Glass Membrane Requirement for Spear Electrodes

Sturdy glass membrane: Spear pH electrode sticks into solid sample for direct pH measurements. For example, LabSen 761 blade electrode is often used to test frozen meat. If the glass membrane is not strong enough, the electrode could easily get damaged. Lab-Sen spear membrane adopts Sturdy-Layer technology, making it strong enough for sticking-in measurements.

Low membrane impedance: 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 impedance 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.

Special Double 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	765	371
pH Range	0 – 14 pH	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	0 – 80 °C
Temperature Probe	N/A	N/A	N/A	N/A	NTC 30 KΩ	N/A
Type of Membrane Glass	S	S	S	S	S	S
Membrane Impedance	< 250MΩ	< 250MΩ	< 250MΩ	< 250MΩ	< 250MΩ	< 500MΩ
Junction	Open+Ceramic	Open+Ceramic	Open+Ceramic	Open+Ceramic	Open+Ceramic	PTFE
Reference System	Long-life	Long-life	Long-life	Long-life	Long-life	Long-life
Reference Electrolyte	Polymer	Polymer	Polymer	Polymer	Polymer	3M gel KCl
Housing Material	Lead-free glass	PVC	Titanium alloy	Titanium alloy blade	Titanium alloy blade	PVC
Size	Ø6 - Ø12x100 mm	Ø5 - Ø15x130 mm	Ø5 - Ø12x115 mm	Ø12x115 mm	Ø12x115 mm	Ø12x105 mm
Connection/Cable	BNC/1 m	BNC/1 m	BNC/1 m	BNC/1 m	8-pin/1 m	BNC/1 m

**All the above electrodes without temp. sensor can be installed with an NTC 30KΩ thermistor to achieve ATC. The corresponding models are LabSen 253, 553, 873, 753, 763, 373 with a BNC/RCA connector.*



LabSen[®]

- 
- 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 ($> \text{pH } 12$), 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 more quickly, which could be even more severe at high temperature.



Application Requirements for Strong Acidic / Strong Alkaline / High Temp. Solutions



LabSen 831

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



LabSen 835

Non-refillable, resistant to HF corrosion, open junction, suitable for strong acidic solutions and HF-containing solutions with 8-pin connector for pocket and portable meters



LabSen 841

Refillable, special HA glass membrane, suitable for strong alkaline/high salinity solutions, extremely low alkaline error and long service life with silver ion trap reference system



LabSen 845

Non-refillable special HA glass membrane, open junction, suitable for strong alkaline/high salinity solutions with 8-pin connector for pocket and portable meters



LabSen 861

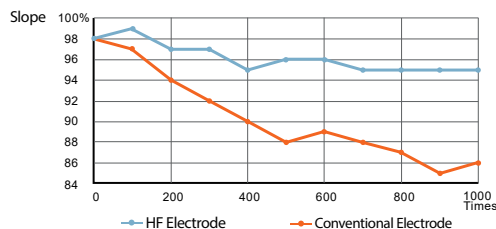
Non-refillable, PHY glass membrane, with anti-fouling PTFE junction, suitable for high temperature and caustic solutions e.g. electroplating solutions, etc.



LabSen 865

Non-refillable, PHY glass membrane, anti-contamination PTFE junction, suitable for high temperature and caustic solutions with 8-pin connector for pocket and portable meters

Strong acidic solutions, and HF-containing solutions



Comparison of the lifespan of a conventional electrode and a HF acid resistant electrode tested with 0.1M HF acid solution

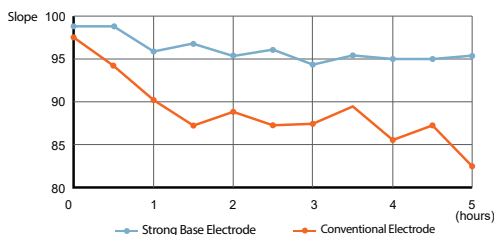
Acidic error occurs in strong acid solutions where the decrease of H^+ activity leads to a higher pH reading than the real value (usually happens when pH is less than 1). Strong acidic solutions also corrode pH glass membranes. Hydrofluoric acid solution is extremely corrosive and could directly dissolve conventional pH glass membranes.

LabSen's HF glass membrane is corrosion-resistant and can measure solutions containing HF acid for up to 1000 times (measurement time < 60 seconds and HF concentration < 2000 ppm or 0.1mol/L), 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 > 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.



Comparison of the lifespan of conventional electrode and strong base electrode tested with 1M NaOH (60°C solution)

LabSen®	831	835	841	845	861	865
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 – 140 °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 Impedance	< 400 MΩ	< 400 MΩ	< 500 MΩ	< 500 MΩ	< 500 MΩ	< 500 MΩ
Junction	Ceramic	Open	Ceramic	Open	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	Polymer	3M KCl	Polymer	3M Gel KCl	3M KCl
Housing Material	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	8-pin/1 m	BNC/1 m	8-pin/1 m	BNC/1 m	8-pin/1 m

* All the above electrodes can be installed with an NTC 30KΩ temperature sensor to achieve ATC. The corresponding models are LabSen 833, 843, and 863 with BNC/RCA connectors.

- Viscous Liquids
 - Protein-containing Liquids
-

The difficulty for measuring viscous and protein-containing samples is that the junction could easily get clogged. 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 electrolyte and clog the junction.



LabSen®





Application Requirements for Viscous and Protein-containing Liquids



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.

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. The pre-pressurized reference system ensures smooth flow of electrolyte.

LabSen 853-H

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

LabSen 855

HA glass membrane, pre-pressurized reference, suitable for highly viscous liquid samples, etc with 8-pin connector for pocket and portable meters.

LabSen 821

Suitable for protein samples, e.g. dairy product, milk, cream, etc. Three ceramic junctions and the Protelyte reference electrolyte prevent the junctions from being clogged by proteins.

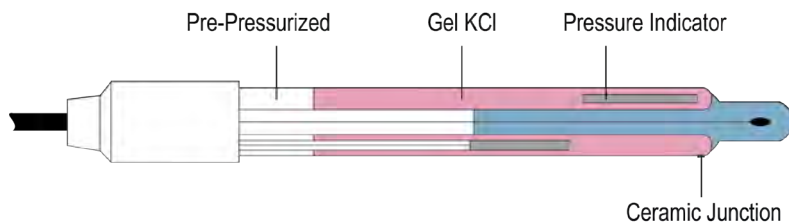
LabSen 823

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 electrolyte.

Another situation is to test samples under high pressure in which the sample solution will infiltrate into the electrode in the reversed direction. Pre-pressurized electrodes can effectively solve this problem. Pre-pressurization is a special electrode processing technology that pre-fills a certain pressure inside the electrode to ensure that the electrolyte can slowly exude through the junction even in a very viscous liquid and also prevents sample solution from entering the electrode, ensuring good measurement stability and repeatability. The figure below is a diagram of the pre-pressurized electrode. The pressure indicator tube in the figure is used to tell the remaining 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 electrolyte, clogging the ceramic junction. Protelyte is an oily electrolyte, which does not react with protein. Moreover, LabSen 821/823 are equipped with 3 ceramic junctions, further minimizing the chance of junction clogs.



LabSen®	851-S	853-S	851-H	853-H	855	821	823
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	0 – 130 °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	NTC 30 KΩ	N/A	NTC 30 KΩ
Type of Membrane Glass	S	S	HA	HA	HA	S	S
Membrane Impedance	< 150 MΩ	< 150 MΩ	< 500 MΩ	< 500 MΩ	< 500 MΩ	< 200 MΩ	< 200 MΩ
Junction	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic	Ceramic×3	Ceramic×3
Reference System	Silver ion trap				Silver ion trap	Silver ion trap	
Reference Electrolyte	Pre-pressurized gel KCl				Pre-pressurized Gel KCl	Protelyte	Protelyte
Housing Material	Lead-free glass						
Size	Ø12×120 mm						
Connection/Cable	BNC/1 m	BNC-RCA/1 m	BNC/1 m	BNC-RCA/1 m	8-pin/1 m	BNC/1 m	BNC-RCA/1 m

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. Consequently, the integrity and quality of pH calibration buffer solutions are pivotal to the measurement accuracy.

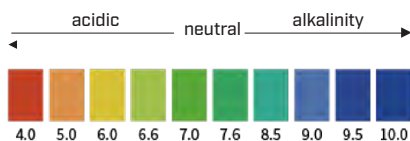
It is imperative to utilize calibration buffers that are freshly prepared, uncontaminated, and formulated with high-grade chemicals following stringent procedural guidelines. This ensures the reliability and precision of the electrochemical measurements.



LabSen®

Solutions

- Apera calibration buffers and maintenance solutions are produced with 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.








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

SKU	Maintenance Solutions
AI1107	3M KCl Soaking/Refill Solution
AI1190	Protelyte Soaking/Refill Solution
AI1166	Electrode Cleaning Solution
AI1170	pH Sensor Care Kit
AI1172	1 mol/L LiCl Reference Refill Solution



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 8-pin		For pH and conductivity electrodes with temperature sensor


Electrode Model Comparison Table

Apera LabSen	Mettler Toledo	Hanna
LabSen 211	InLab Routine /LE409	HI1131B
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
LabSen 871	InLab Science Pro	N/A

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pH Electrode Handbook

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