Electrode Usage Modes

Ag/Ag⁺ Pseudo (Electrolyte)

$$Ag_{(s)} + e \rightleftharpoons Ag^{+}_{(aq)}$$

For this reaction, $E^{\circ} = 0.799\,V\ vs.\ NHE^{\ddagger}$, which is strongly dependent upon pH, condition of electrode materials, analyte solution, temperature, etc. This mode is the most simple and uncomplicated reference electrode used. It is ideal for measuring potential differences where an absolute, calibrated reference potential is not required, yet a three-electrode cell is used. Roughen/clean the surface of the silver wire using the enclosed 600-grit sandpaper. Either the fritted tube or the 2 mm OD tube can be used. Ensure if the fritted tube is used that cell electrolyte has diffused into the tube and is in contact with the silver wire.

Ag/Ag₂O Pseudo (Electrolyte)

$$Ag_2O_{(s)} + H_2O + 2e \rightleftharpoons 2Ag_{(s)} + 2OH^{-}$$

For this reaction, $E^{\circ} = 0.344\,V\ vs.\ NHE^{\ddagger}$, which is strongly dependent upon pH, condition of electrode materials, analyte solution, temperature, etc. This mode is ideal for measuring potential differences where an absolute, calibrated reference potential is not required, yet a three-electrode cell is used. Soak the silver wire in concentrated acid for 1-2 minutes to form a layer of silver oxide on the surface. Either the fritted tube or the 2 mm OD tube can be used. Ensure if the fritted tube is used that cell electrolyte has diffused into the tube and is in contact with the silver wire.

Ag/AgNO₃ ($10\ mM\ AgNO_3\ in\ MeCN$)

$$AgNO_3 + e \rightleftharpoons Ag_{(s)} + NO_3^{-}$$

For this reaction, , $E^{\circ} = 0.541\,V\ vs.\ NHE^{\ddagger}$. This mode requires the user to prepare $10\,mM\ AgNO_3 + 100\,mM\ TBAPF_6\ in\ MeCN$ filling solution. Polish the Ag wire with 600-grit sandpaper, rinse completely with water, then with ethanol and wipe dry. Fill the fritted glass tube with this solution, then place the silver wire/cap onto the tube. You may consider a salt bridge to minimize Ag^{+} leakage. This reference electrode should be calibrated on a daily basis vs. a well-behaved couple, such as ferrocene.

‡Approximate values, will differ based on environment.

Reference Electrode Conversions

From ▶ / To ▼	NHE	MOE 4.24M KOH	Ag/AgCl sat'd KCl	SCE sat'd KCl	MSE sat'd K_2SO_4
NHE	0	98	199	241	650
MOE 4.24M KOH	-98	0	101	143	552
Ag/AgCl sat'd KCl	-199	-101	0	42	451
SCE sat'd KCl	-241	-143	-42	0	409
MSE sat'd K_2SO_4	-650	-442	-451	-409	0

Add listed value (in mV) to convert.
NHE = Normal Hydrogen; MOE = Mercury Oxide; SCE = Calomel; MSE = Mercury Sulfate

Optional Accessories

Additional reference electrodes are available from Pine Research, including aqueous and LowProfile applications. Ensure proper operation and lifetime of the reference electrode with a storage system. Use an isolation tube or salt bridge when temperature or ion contamination are of concern.

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Search YouTube for "Pine Research Instrumentation" for instructional videos on this product.

YouTube

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Reference Electrode

Product Guide

This brief reference guide describes how to unpack, use, clean, store, and test the product. Please contact us with any additional questions.

Part #: AKREF0033

Standard Size (9.5 mm) Non-Aqueous Silver Pseudo Reference Electrode (Ag/Ag+)

Quick Facts

Reaction	$Ag^{+} + e \rightleftharpoons Ag_{(s)}$ (in general)
Standard Potential (E°)	N/A (depends on mode)
Temperature Tolerance	N/A (depends on mode)
Avoid	Storage in direct sunlight
Typical Input Impedance	$< 10\ k\Omega$ (with ceramic frit)

Ideal for use in non-aqueous solvent systems and when an absolute reference potential is not critical (e.g. for measuring potential *difference*). Several operation modes are recommended, based on the specific chemical system.

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Unpack the Electrode

Newly purchased reference electrodes are packed to ensure safe shipment. Refer to the diagram to identify the components discussed in this guide. For this reference electrode, no solution is present during shipping, so all that should be unpacked is any packaging material. The electrode is shipped assembled with the electrode/cap (**A**, **B**, **C**, **E**), fritted glass tube (**D**), and 14/20 PTFE adapter (**F**).

Electrode Storage

1. Following an experiment, fully rinse and then dry the silver wire and inner cap components.
2. Rinse the fritted glass tube with clean solvent, used in the experiment, and ensure the frit is not clogged. Then dry.
3. Prevent damage to the silver wire by attached a glass tube and storing in the included storage bottle. No solution is needed during storage.
4. Always store the reference electrode upright and never in direct sunlight.

Performance Verification

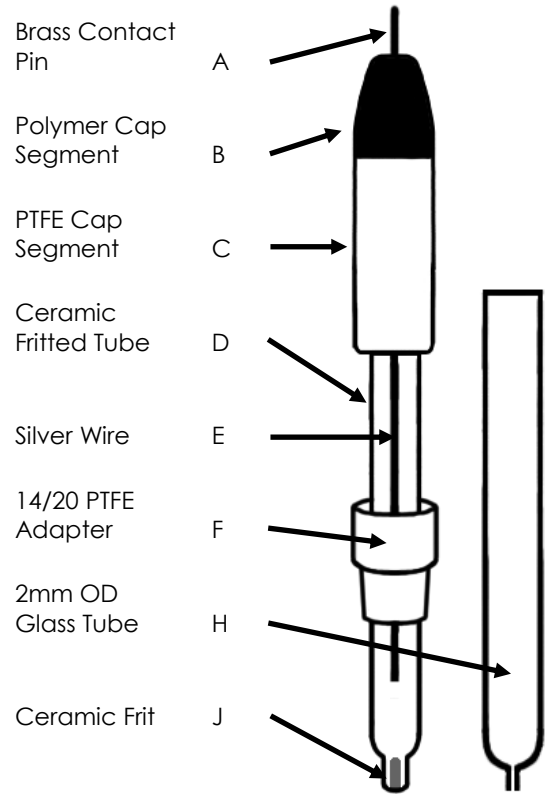
Reference electrode input impedance should be less than $10\ k\Omega$. The most likely cause of high reference electrode input impedance is a blocked or partially blocked ceramic frit (**J**). Ceramic frits can become blocked by precipitation of salts in the microporous structure. *In some cases*, the frit clog can be cleared *but often*, the frit cannot be cleared and the glass tube must be replaced.

Refresh Fritted Glass Tube

When the ceramic frit has been plugged (by precipitates or crystals), a higher than normal input impedance may cause problems such as potentiostat instability. Thermal cycling may also result in crystallization. To refresh the electrode:

1. Fill the fritted glass tube with distilled/deionized water and store the electrode in distilled/ deionized water for 24 – 48 hours. Soaking with hot (80°C) water, and/or adding sonication steps, can also be effective.
2. Drain the distilled/deionized water. Construct the electrode as desired (see: Electrode Usage Modes section) and test. Check E° vs. the lab master reference electrode before use.

Reference Electrode Diagram



Parts List

The following are included in the box:

- Non-Aqueous electrode cap/Ag Wire
- Ceramic fritted tube
- 14/20 PTFE Adapter
- $2\ mm$ OD glass tube
- 600 grit sandpaper
- Plastic storage container

All parts contained in the kit can be ordered individually should they need to be replaced.

Other Reference Electrodes

Ag/AgCl Single Junction (saturated KCl)
- Part #: RREF0021
- $E^{\circ} = 199\ \text{m}V\ vs.\ NHE$*
- Filling Solution: $4M\ KCl\ with\ AgCl$
- Temperature Range: 10°C to 80°C

Ag/AgCl Double Junction (saturated KCl)
- Part #: RREF0024
- $E^{\circ} = 199\ \text{m}V\ vs.\ NHE$*
- Internal Filling Solution: $4M\ KCl\ with\ AgCl$
- External Filling Solution: $10\%\ KNO_3$
- Temperature Range: 10°C to 80°C

Calomel/SCE Single Junction (saturated KCl)
- Part #: RREF0022
- $E^{\circ} = 241\ \text{m}V\ vs.\ NHE$*
- Filling Solution: $4M\ KCl$
- Temperature Range: 10°C to 50°C

Mercury Sulfate Single Junction (saturated K_2SO_4)
- Part #: RREF0025
- $E^{\circ} = 650\ \text{m}V\ vs.\ NHE$*
- Filling Solution: saturated K_2SO_4
- Temperature Range: 10°C to 60°C

Mercury Sulfate Double Junction (saturated K_2SO_4)
- Part #: RREF0026
- $E^{\circ} = 650\ \text{m}V\ vs.\ NHE$*
- Internal Filling Solution: saturated K_2SO_4
- External Filling Solution: saturated K_2SO_4
- Temperature Range: 10°C to 60°C

Mercury Oxide Single Junction ($4.24M\ KOH$)
- Part #: RREF0038
- $E^{\circ} = 98\ \text{m}V\ vs.\ NHE$*
- Filling Solution: $4.24M\ KOH$
- Temperature Range: 10°C to 125°C
- Ideal for use in alkaline solutions

LowProfile (3.5 mm) Reference Electrodes
- Ag/AgCl in 60 mm and 74 mm lengths
- Ag/Ag+ in 60 mm and 74 mm lengths

*Double junction electrodes are subject to additional potential drop across the second frit. Reference electrodes must be filled with proper filling solution to function correctly. Occasionally electrodes are shipped without filling solution inside chamber. Frit should be allowed to soak with filling solution overnight prior to use if electrode was dry for extended time.