Aqueous reference electrodes must be stored properly to prevent damage when not in use. The ceramic frit should never be allowed to dry out. Follow these steps to properly store this reference electrode:

1. Slide the access door up to close the filling port.
2. Rinse the reference electrode with distilled water (aqueous) or clean solvent (non-aqueous).
3. Remove the cap and O-ring from the storage container. Slide the white cap onto the glass end followed by the O-ring (at least half-full with filling solution). Insert the reference electrode into the storage container so that the frit is safely in contact with the wetted sponge inside. Tighten the threaded cap of the storage container.
4. Always store the reference electrode upright and never in direct sunlight.

### Reference Electrode Impedance

Reference electrode input impedance should be less than 10 kΩ. 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 electrode must be replaced.

### Checking the Reference Potential

The standard potential of a reference electrode can be checked relative to another of the same reference electrode. Pine recommends that all users keep a “master” reference electrode that is never used in experiments and is always properly stored.

### Reference Electrode Conversions

<table>
<thead>
<tr>
<th>From</th>
<th>NHE</th>
<th>MOE</th>
<th>Ag/AgCl</th>
<th>SCE</th>
<th>MSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>To</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NHE</td>
<td>0</td>
<td>98</td>
<td>199</td>
<td>241</td>
<td>650</td>
</tr>
<tr>
<td>MOE</td>
<td>-98</td>
<td>0</td>
<td>101</td>
<td>143</td>
<td>552</td>
</tr>
<tr>
<td>Ag/AgCl</td>
<td>-199</td>
<td>-101</td>
<td>0</td>
<td>42</td>
<td>451</td>
</tr>
<tr>
<td>SCE</td>
<td>-241</td>
<td>-143</td>
<td>-42</td>
<td>0</td>
<td>409</td>
</tr>
<tr>
<td>MSE</td>
<td>-650</td>
<td>-442</td>
<td>-451</td>
<td>-409</td>
<td>0</td>
</tr>
</tbody>
</table>

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, non-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.

### Parts List

- Double junction Ag/AgCl reference electrode
- 3 oz. bottle of external filling solution
- 9.5 mm OD to 14/20 port PTFE adapter
- Reorder Part #: ACP1420A3
- Plastic storage container

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**Part #: RREF0024**

**Standard Size (9.5 mm) Double Junction Ag/AgCl Reference Electrode (saturated KCl)**

**Quick Facts**

- **Reaction**: $\text{AgCl}_\text{sat} + e \leftrightarrow \text{Ag} + \text{Cl}^-$
- **Standard Potential ($E^\circ$)**: +199 mV vs. NHE*
- **Internal Filling Solution**: 4M KCl with AgCl
- **External Filling Solution**: 10% KNO₃
- **Filling Solution Part #:** RRSLN0004-250 (250 mL)
- **Temperature Tolerance**: 10°C to 80°C
- **Avoid Use With**: $\text{NH}_4$ buffers, sulfides, [base] > 0.1M 0H⁻, perchlorates, non-aqueous/organic solvents
- **Typical Variance** ±3 – 5 mV
- **Typical Input Impedance**: < 10 kΩ

*Internal Filling Solution Inaccessible.*
To unpack the electrode (refer to diagram on adjacent page): Remove the Parafilm around the filling port (C) in the cap (B). Slide the access door (D) up to close the filling port (C). See the diagram below. Rinse the reference electrode with distilled water to remove any solution that may have leaked during shipment (white solid).

**Refresh Reference Electrode Tips**

Most often, the ceramic frit becoming blocked or partially blocked (by precipitates or crystals) is the cause of increased reference electrode impedance that results in potentiostat instability. Thermal cycling may also result in crystallization.

To refresh the electrode frit, try the following:

1. Replace the internal filling solution with distilled water (or 1M HCl) and store the electrode in distilled water (or 1M HCl) instead of filling solution for up to 24 hours.
2. Replace the internal filling solution with distilled water, and soak the frit portion of the electrode in 80°C distilled water for up to 1 hour. Apply an aspirator to the frit to pull a slight vacuum in addition if desired.
3. Dip the frit in distilled water and sonicate for several minutes.

**Filling Port Use**

The electrode cap (B) is permanently sealed to the glass body (I). Do not attempt to disassemble this reference electrode as permanent, irreversible damage may occur. Access to the filling solution is only possible through the filling port (C) in the cap.

**Reference Electrode Diagram**

- Brass Contact Pin A
- Electrode Cap B
- Filling Port C
- Sliding Access Door D
- Silver Wire E
- Inner Glass Body F
- Inner Ceramic Frit G
- 14/20 PTFE Adapter H
- 9.5 mm Glass Body I
- Outer Ceramic Frit J

**Electrode Usage Tips**

For optimal use, review the following tips for proper reference electrode use:

1. During an experiment, ensure the ceramic frit (H) is fully submerged in solution.
2. Ensure the clip connected to the brass contact pin (A) is not corroded and is firmly attached.
3. Ensure reference electrodes are always connected properly to the potentiostat. Current should never pass through a reference electrode.
4. The 14/20 PTFE Adapter (H) can carefully be moved along the length of the glass body (I) for optimal solution immersion depth.

**Other Reference Electrodes**

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

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

- **Mercury Sulfate Single Junction (saturated K₂SO₄)**
  - Part #: RREF0025
  - $E^\circ = 650$ mV vs. NHE
  - Filling Solution: saturated K₂SO₄
  - Temperature Range: 10°C to 60°C

- **Mercury Sulfate Double Junction (saturated K₂SO₄)**
  - Part #: RREF0026
  - $E^\circ = 650$ mV vs. NHE
  - Internal Filling Solution: saturated K₂SO₄
  - External Filling Solution: saturated K₂SO₄
  - Temperature Range: 10°C to 60°C

- **Mercury Oxide Single Junction (4.24M KOH)**
  - Part #: RREF0038
  - $E^\circ = 98$ mV vs. NHE
  - Filling Solution: 4.24M KOH
  - Temperature Range: 10°C to 80°C
  - Ideal for use in alkaline solutions

**Ag/Ag+ Pseudo Reference Electrode Kit**

- Part #: AKREF0033
- Ideal for use in non-aqueous solvents
- Unstable reference potential unless made into a Ag/AgNO₃ reference

**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.*