

The Value of Stack Mode Measurements

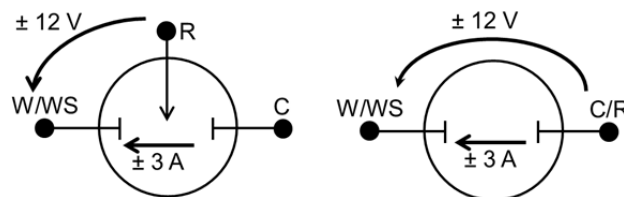
Introduction

Some researchers want to be able to apply or measure voltages larger than 12 V. One example of the need for larger potentials is battery testing, while another might be CV inside small microfluidic channels. Perhaps you want to perform certain types of electrodeposition experiments. In these instances you may need to look a little harder for a potentiostat that can operate at these higher voltages.

All Reference™ 3000 potentiostats are able to measure and apply voltages and currents up to the *compliance limit*. The compliance limit is the output limit of the *control amplifier*. What is the control amplifier? The control amplifier is an operational amplifier within the potentiostat used to drive the counter electrode in order to achieve the desired voltage between a reference electrode and a working electrode. Higher power means larger voltages and currents, but this comes at a cost though: more power means more heat dissipation, larger instruments, and additional cost.

For those that need higher voltages, the Reference 3000 has some unique advantages you should know and understand. The Reference 3000 has two compliance ranges: ± 15 V at ± 3 A, or ± 32 V at ± 1.5 A. Under normal circumstances, the Reference 3000 can apply and measure up to 12 V. This is done in the 15 V compliance range. Connections to the cell are standard and shown in Figure 1A.

Working/Working sense leads are connected to the Working electrode; the Counter lead attaches to the Counter electrode, and the Reference lead goes to the Reference electrode. In two-electrode mode, the Working and Working Sense are connected to the working electrode and the Reference and Counter are connected to the counter electrode as show in Figure 1B.



(A) Three-electrode setup (B) Two-electrode setup

Figure 1. Normal operation of a Reference™ 3000 in 3-electrode (A) or 2-electrode (B) modes. Voltages < ± 12 V. Reference lead is connected to Floating Ground.

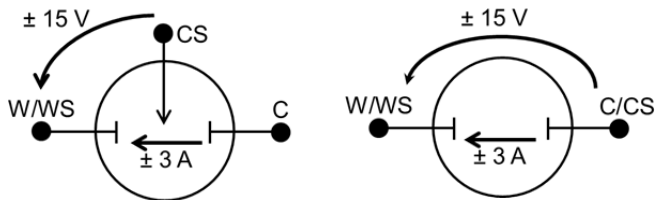
Software Version 6

In Version 6.x of Gamry Instruments' Framework™ software, when running experiments contained in the **Electrochemical Energy** submenu, there are three choices for cell type: **Half**, **Full**, and **Stack**. **Half** (3-electrode) and **Full** (2-electrode) cell types correspond to the situation described above where voltages can be applied or measured up to 12 V. Connections are as shown in Fig. 1. When selecting

Stack mode to reach higher voltages, follow the procedure as outlined below.

Voltages > 12 V but < 15 V: Low Compliance

To go beyond 12 V requires Stack Mode. In Stack Mode, the Reference 3000 is measuring the potential difference between the Counter Sense and the Working Sense. The Reference lead is not used in this setup; connect the Reference lead to the Floating Ground lead via a 2 mm pin adapter. For 3-electrode mode, connect the Working and Working Sense leads to the working electrode, Counter Sense lead to the reference electrode, and Counter lead to the counter electrode as shown in Figure 2A. For 2-electrode mode, connect the Working and Working Sense leads to the working electrode and the Counter and Counter Sense leads to the counter electrode as shown in Figure 2B.



(A) Three-electrode setup (B) Two-electrode setup

Figure 2. Stack mode operation (low compliance) of a Reference™ 3000 in 3-electrode (A) or 2-electrode (B) modes. Voltages > 12 V but < 15 V. Reference lead is connected to Floating Ground.

Voltages > 15 V: High Compliance

Applying and measuring voltages larger than 15 V requires switching to High Compliance. This is done through the **Utilities** submenu. In the Framework software, choose **Experiment > Utilities** and click **Compliance Voltage**. A **Compliance Voltage Setting** dialog box opens:

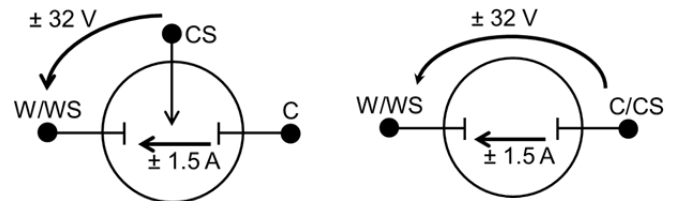


Select the radio button for the desired Reference 3000, and then click the **OK** button. A new window appears, which lets you select **Low** or **Hi**:



Click the **Hi** radio button, and then click **OK**. The instrument is now in high compliance mode.

For 3-electrode mode, connect the Working and Working Sense leads to the working electrode, Counter Sense lead to the reference electrode, and Counter lead to the counter electrode as shown in Figure 3A. For 2-electrode mode, connect the Working and Working Sense leads to the working electrode, and the Counter and Counter Sense leads to the counter electrode as shown in Figure 3B.



(A) Three-electrode setup (B) Two-electrode setup

Figure 3. Stack mode operation (low compliance) of a Reference™ 3000 in 3-electrode (A) or 2-electrode (B) modes. Voltages > 15 V. Reference lead is connected to Floating Ground.

Software Version 7

Version 7 of our Framework software changes the Cell Type selection to **Half** (3-electrode), **Full** (2-

electrode), and **Both** in the **Electrochemical Energy** experiments. The setup box explicitly asks you for your expected maximum voltage. The software automatically chooses Low Compliance or High Compliance based upon your input. If desired, the software can show a dialog box that describes the cable connections to your cell if you activate the **Cable Check** checkbox.

Selecting **Both** is only valid for the Interface 5000. Selecting **Both** for the Interface 1000 or a Reference family instrument will result in an error message.

High-voltage Experiments not in Electrochemical Energy

Some researchers may want higher voltages for experiments that are not part of the experiments in Electrochemical Energy submenu.

We at Gamry have gone ahead and modified the most commonly requested high-voltage experiments for you including:

Chronoamperometry, Chronopotentiometry, Cyclic Polarization, Cyclic Voltammetry, Potentiodynamic, and Potentiostatic.

Please submit your information using the form on the right to receive a zip file containing these scripts. Copy them into your Scripts folder and then run them using the Named Script option available under the Experiment menu.

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