TechnicalNOTE

GAMRY INSTRUMENTS

Battery-Testing with an Interface™ 5000

Introduction

This Technical Note will assist you in connecting your batteries to an Interface™ 5000 potentiostat and running experiments.

On the Terms *Cathode* and *Anode*

Terminology for electrochemical cells can be complicated. From an electrochemical perspective, a **cathode** is the electrode where reduction occurs, and an **anode** is the electrode where oxidation occurs. The actual potential of the electrode is not included in this definition.

For batteries, when they discharge, the cathode has a positive potential relative to the anode. When a battery gets charged, the cathode and anode switch (that is, the cathode is now the terminal which is positive relative to the anode). Most researchers in the fields of batteries and materials science call the positive terminal the cathode, for batteries under discharge are most relevant to their function.

For researchers dealing with fuel cells, signs are often reversed to call the cathode the positive electrode. In hydrogen fuel cells, for example, the cathode is where oxygen gets reduced, and the anode is where hydrogen is oxidized. Under conventional standards for electrochemistry the cathode in this case would be negative, but historically some researchers have labeled it the positive terminal.

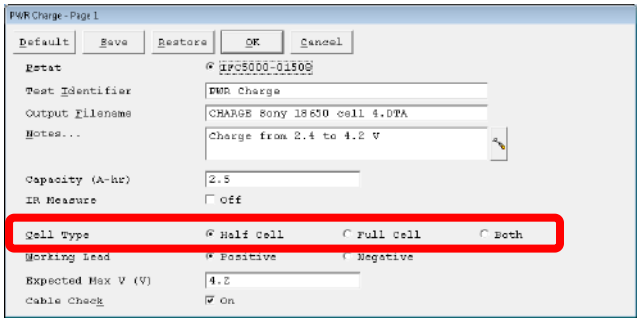

Figure 1. Example of an Electrochemical Energy dialog box with the **Cell Type** field, in Framework™ software.

For the purposes of this Technical Note, we use the convention of calling the electrodes the positive and negative terminals, because that is more consistent and easier to determine than what is the anode and cathode.

Half Cell, Full Cell, or Both?

When you set up your experiment using the Electrochemical Energy scripts in the Framework software (see an example in Fig. 1), use a section of the setup window called **Cell Type**. For **Cell Type**, choose a radio button for the desired type of cell:

Half Cell This is a 3-electrode experiment, meaning that a reference electrode is included. The instrument measures the voltage between the working sense lead (blue) and the reference lead (white). The system under test is usually in a beaker or a test cell.

Full Cell **Full Cell** mode is a 2-electrode experiment. It is generally used to test a single-cell electrochemical device, such as a commercial battery. The positive terminal of the cell is connected to the potentiostat's working (green) and working sense (blue) leads. The negative terminal of the device is connected to the potentiostat's counter (red) and reference (white) leads. Connect the potentiostat's counter sense (orange) lead to the cell cable's ground (black) lead.

Both **Both** mode is a 3-electrode experiment, and thus includes a reference electrode. It measures the voltage difference between the reference lead (white) and both sense leads (blue and orange). The cathode and anode are measured under the same conditions. (Only Gamry's Interface™ 5000 can perform **Both** mode.)

Because we discuss commercial batteries in this Technical Note, we concern ourselves herein only with **Full-cell** mode, which is for systems (e.g., batteries) with only two electrodes.

If the working lead is connected to battery's positive terminal, then choose the **Positive** radio button in the **Working Lead** field.

Connections

How to connect your two-terminal battery and the Interface 5000 (see Figure 2):

- Attach the white cell and red cell leads to one side of the device.
- Attach the blue and green cell leads to the other side. Try to connect the white and blue leads as close to the device as possible.

Figure 2. Coin cell with terminal tabs connected to Interface 5000 cell cables. Black and orange leads are connected together near the top of the photograph.

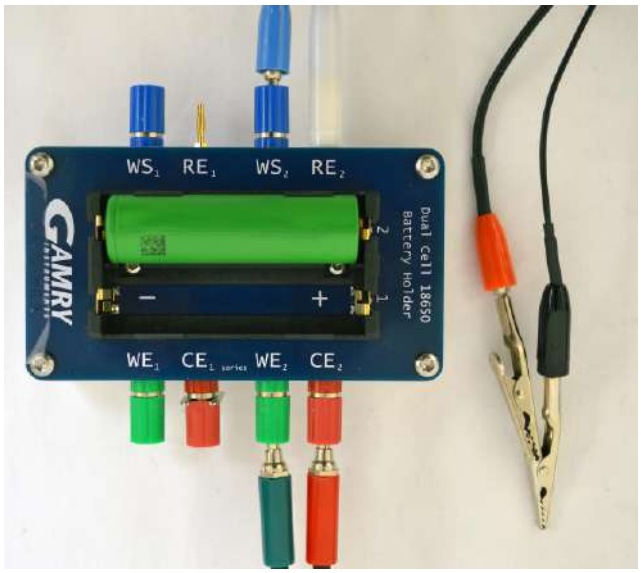

Figure 3. Dual Cell 18650 Battery Holder with a battery in position 2, and connections made with cell cable.

If you are using Gamry battery holders, you can connect them as shown in Figures 3 (18650 holder) and 4 (coin-cell holder). The black (ground) and orange (countersense) leads can be clipped together, isolated from the other leads.

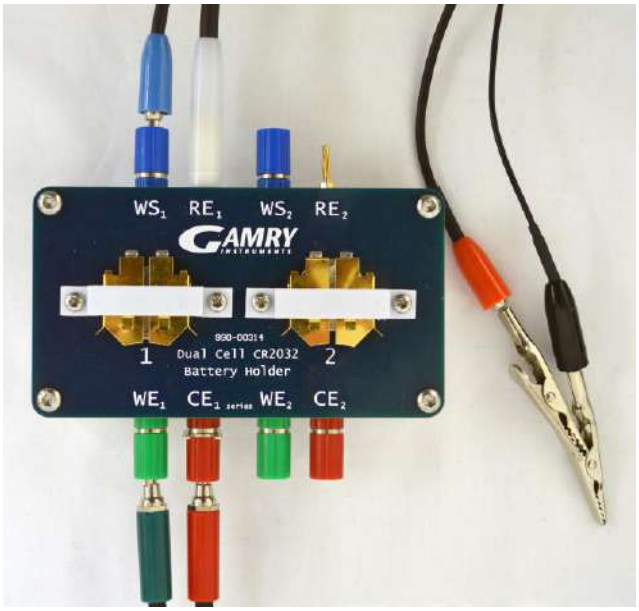

Figure 4. Dual Cell CR2032 Battery Holder with coin cells in both positions, and connections made to position 1 with cell cable.

Summary

This Technical Note explains the connections to a two-electrode battery, tested in **Half Cell** mode, in Gamry's Framework software. Connect the green and blue cables to the positive electrode of the battery, the red and white cables to the negative electrode of the battery, and black and orange cables to each other while isolated from the other cables.

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