

One of the very nice features of Version 4 of the Gamry Software is the capability to plot currents and voltages following different conventions. These conventions vary according to geography, the material being studied, and personal taste. No matter what default convention is used for just-installed software, the chances are that *you* will want to change it!

The plotting convention must be established in two different environments: It must be defined in the Gamry Framework™ software, so that the CVs will meet the user's expectation in real time, while they are being run. It must also be defined in the Gamry Echem Analyst™ application so that it is presented correctly when the data is being viewed later or a report is being generated. To some extent, these two environments are separated.

## Changing the Real Time Plots in the Gamry Framework™ Software.

The experiments in the Gamry Framework™ are written in a scripting language called Explain™. This note assumes you know how to write an Explain script. Information on the Explain scripting language is available on the Gamry web site (<http://www.Gamry.com>) or by contacting us by phone at 215-682-9330, or by email at [support@Gamry.com](mailto:support@Gamry.com).

### The Voltage Axis

Some people, particularly those that are interested primarily in reductions, prefer to have a negative voltage plotted to the right. This is the so-called "American Polarographer's Convention" because of the large negative voltage window on a mercury electrode.

The normal plotting can be reversed with an Explain™ function designed for this purpose. It simply swaps left and right, or up and down. The following snippet of code from the script "Cyclic Voltammetry.exp" shows the function's usage. This is the code "as installed" originally. The voltage (x) axis is reversed, and follows the "American Polarographer's Convention."

```
function IvseEPlot (Cv)
    Cv.SetPlotView (VIEW_SINGLE)
;   Cv.SetPlotView (VIEW_DOUBLE)
    Cv.SetAxis(X_AXIS, RCV_Vf, LIN_AXIS, 1.0E-15, "E", "V")
    Cv.SetAxis(Y_AXIS, RCV_Im, LIN_AXIS, 1.0E-15, "I", "A")
;   Cv.SetAxis(Z_AXIS, RCV_T, LIN_AXIS, 1.0E-4, "T", "s")
    Cv.FlipAxis(X_AXIS, TRUE)
;   Cv.FlipAxis(Y_AXIS, TRUE)
;   Cv.FlipAxis(Z_AXIS, TRUE)
    return
```

**Figure 1.** The Explain™ function that formats the real-time plots for Cyclic Voltammetry.

The highlighted line is the line responsible for flipping the x-axis. The similar lines that refer to the Y- and Z-axes are commented out. The semicolon ( ; ) at the start of the line causes that line to be ignored and treated only as a comment. If you wish to plot the X-axis "normally", or positive to the right, simply edit the file (Click File, then Open in the Gamry Framework) and place a semicolon ( ; ) at the

start of the highlighted line as well. The voltage axis (X\_AXIS) will then be displayed "normally", with positive to the right.

### The Current Axis

Formatting the current axis is a bit trickier because there are two ways to do it! You should follow the instructions for only one of them. If you make both changes, then you will be right back where you started!

You may have guessed the first way: Simply remove the semicolon from the line that references the Y\_AXIS ( "Cv.FlipAxis(Y\_AXIS, TRUE)" ), thereby activating the line! Positive currents will now be plotted downwards, and negative currents will be plotted upwards.

A simpler way would be to change the sign convention used for currents. This is also a simple scripting change. As installed, the scripts use the "American Polarographer's Convention" for current as well. Cathodic (reduction) currents are given a positive sign. Anodic (oxidation) currents are given a negative sign. Changing this convention flips the sign of the current values stored in the Gamry Framework data file.

Up to Version 4.05, the script "Cyclic Voltammetry.exp" set the convention in a function called "InitializePstat" near the bottom of the script. The start of that function is shown in Figure 2. All that is required is to change the line which reads "Pstat.SetConvention(**Cathodic**)" to read "Pstat.SetConvention(**Anodic**)".

```
function InitializePstat (Pstat, IMode, IRange, IRComp, PFCor, AcqFreq)
    Pstat.SetCtrlMode (PstatMode)
    Pstat.SetCell (CellOff)
    Pstat.SetStability (StabilityNorm)
    Pstat.SetCASpeed (CASpeedSlow)
    Pstat.SetConvention (Cathodic)
    Pstat.SetGround (Float)
```

**Figure 2.** The function "Initialize Pstat" in "Cyclic Voltammetry.exp" (Versions 4.00 to 4.05)

Things became more civilized in Version 4.10. To change the current convention for all of the techniques included with the PHE200™ Physical Electrochemistry Software, you must only change one line! Figure 3 shows the line that is found near the top of the script "PHE200.exp". Changing "IConvention = 0" to "IConvention = 1" will use the "anodic currents are positive" convention.

```
; Current Convention: Cathodic = 0, Anodic = 1
global IConvention = 0
```

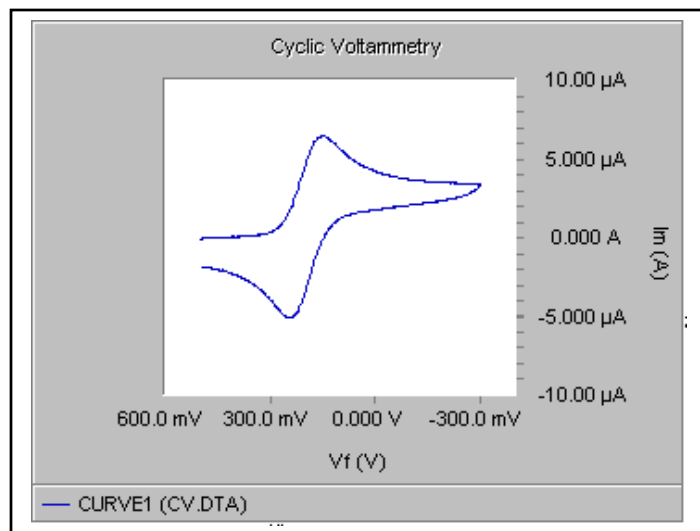
**Figure 3.** Setting the current convention in Version 4.1. Script "PHE200.exp"

## Changing the Display Convention in the Gamry Echem Analyst™ Software.

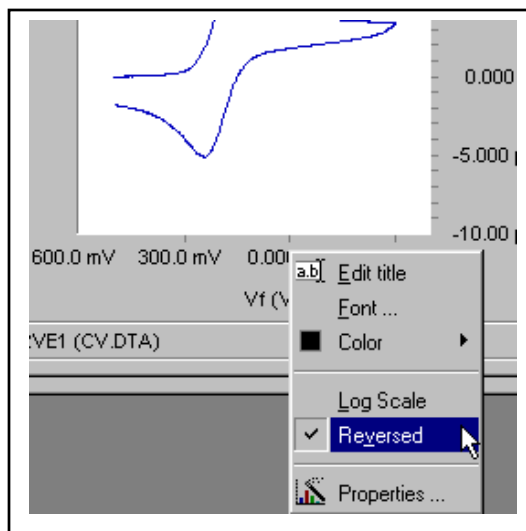
### The Voltage Axis

The default convention for the Echem Analyst™ (as installed) is the "American Polarographer's" convention. A cyclic voltammogram of ferricyanide is shown in Figure 4. Negative voltages are plotted to the right. This "reversed" axis can be returned to normal by "right clicking" on an X-axis label and unchecking "reversed". This is shown in Figure 5. This method is most useful for "unreversing" an

occasional plot. An unfortunate side effect of reversing the axis is that the label position is also reversed. They now appear on the right hand side of the plot.



**Figure 4.** A CV of ferricyanide shown with the default plotting convention

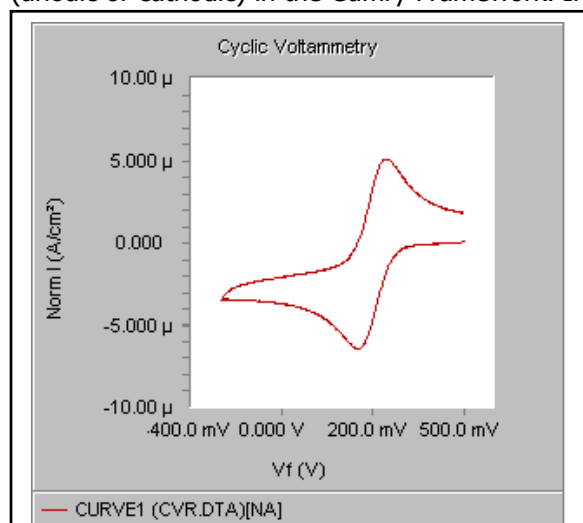


**Figure 5.** "Right clicking" on the X-axis brings up the Axis Menu.

If you wish to disable this capability, click **T**ools/**O**ptions/**C**hart and uncheck "Allow Reversing." This will cause all graphs to be drawn in the more common, positive-to-the-right mode. The "Reversed" option on the Axis Menu will no longer function.

### The Current Axis

The preferred way to control the direction in which currents are plotted is to set the desired convention (anodic or cathodic) in the Gamry Framework. In this way, the Echem Analyst can plot the currents in the conventional manner (positive currents plotted upwards) without having to "reverse" the current axis. This avoids the unfortunate side effect of having the x-axis on the top of the graph rather than the bottom!



**Figure 6.** The ferricyanide CV after the X-axis has been "unreversed" and the current has been normalized by an area of -1.

This action must be taken before the experiment is run. Once the experiment has been run, the current is stored in the data file according to the indicated convention. However, a trick can be used to force the CV to be plotted in the desired manner. If a negative area is entered on the Experimental Setup tab, the curve can be Normalized-by-Area and plotted. Figure 6 shows the data of Figure 4 once it has been "Normalized" by a negative area, and the x-axis has been "un-Reversed." If desired, the Y-axis label can be edited to remove traces of the "normalization."

### Summary

With a little work, and with the flexibility of the Gamry Framework and the Echem Analyst, you can present your CV data following your favorite plotting convention.