

DC Circuits - Building a Potentiostat

Chemistry 243 - Experiment 4

Winter 2017

Pre-lab requirements and skills

- 1) Reading circuit diagrams; construction and use of electronic circuits.
- 2) General recollection of cyclic voltammetry.

In-lab objectives

- 1) Learn how to build a three-op-amp potentiometer circuit;
- 2) Set up a three-electrode cyclic voltammetry measurement;
- 3) Detect the current from the reduction of the ferricyanide anion.

In this lab, you will build a simple three-op-amp potentiostat circuit that will allow you to apply a voltage to an electrochemical cell and detect the current produced as the result of a redox process. You will use a LabView program (already written for you) to apply a series of triangular waveforms to the counter electrode of the cell and to read the current coming from the working electrode.

Part 1: Construction of the Potentiostat Circuit

The circuit diagram for the potentiostat is given below in Figure 1. You should notice the familiar technique being used to convert the current from the working electrode (WE): the transimpedance amplifier, or current-to-voltage amplifier, that we used with the photodiode last week. Also notice the buffer amplifier that keeps the reference electrode (RE) from drawing current. The other op amp “drives” the counter electrode (CE) by applying a voltage from the NI USB-6002 data acquisition device. The feedback capacitor on this op amp helps prevent unstable operation.

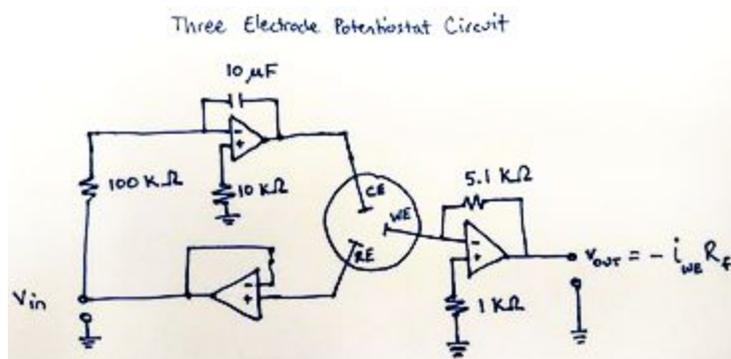


Figure 1. The three-op-amp potentiostat setup that you'll build on the solderless breadboard. Power supplies for the op amps should be 20V (to give $\pm 10V$ when the voltage divider is used).

Part 2: Cyclic Voltammetry

A solution of 5 mM $\text{K}_3[\text{Fe}(\text{CN})_6]$ (potassium ferricyanide) in 0.5 M K_2SO_4 (as a background electrolyte) has been prepared for you. Fill a beaker up about a third of the way with the solution and arrange your three electrodes (Pt wire for working and counter electrodes, Ag/AgCl reference electrode) so that they are not touching each other.

Open the LabView program "Cyclic Voltammetry USB-6002" and run it using the default settings (scanning from 0 to -600 mV and back, scan rate of 300 mV/s). You should see a peak in the positive direction from the reduction of ferricyanide ion. You may see a downward peak as the scan sweeps back the other way, but if it's there it will be very small. You can do multiple scans, but you should gently stir the solution before each one to restore equilibrium conditions.

Change the second switching potential so that it's something greater than zero, say 100 mV. The small, sloping current you see is called *capacitive current*, and it's due to the background electrolyte. Current due to oxidation or reduction of an analyte, by contrast, is called *Faradaic current*.