TechnicalNOTE

On Calibration of Your Potentiostat

Introduction

All scientific instruments must be calibrated in order to ensure proper function and accurate results, including potentiostats. This Technical Note explains the general principles behind various kinds of calibration for a potentiostat done at our factory and in your laboratory.

Why Calibrate?

Calibration of your potentiostat is necessary. Because of drifts of internal components over time, placement of the instrument in various environments, and slight differences in cable and cell geometry, your potentiostat's measurements may change slightly. Calibration "resets" the potentiostat's response to a signal.

Types of Errors in Measurement

DC performance

DC performance is an offset error. That is, the error is created by a slight, constant DC bias in the electronics. DC performance tends to drift over time and with temperature shifts. For example, if you place your instrument in a laboratory that is significantly warmer or cooler than the factory where it was calibrated, a small amount of DC bias may appear. In addition, certain electronic components may change their values over time, or get a fine coating of dirt or dust that can shift their values. Users of Gamry Instruments' potentiostats can correct for this type of error with the DC Calibration function. For reproducibility with very low currents, users can calibrate their potentiostat using the Low-current DC Calibration function.

Gain performance

Gain error is an error in slope or amplification of a signal. This type of error is dealt with in our engineering and design of potentiostats. We use precision components when we build potentiostats, and correct for residual gain error with the initial factory calibration. There is no calibration available for users to correct for this type of error.

With all new potentiostats, Gamry Instruments offers the System Assurance program, including one complete factory calibration for two years after purchase. Additional System Assurance is available for further time periods. Contact Gamry Instruments or your local representative for more details.

AC performance

AC error is a variation across a frequency range in response to a signal. Usually this error appears when different cables or cells are used with one potentiostat. If you change a cable, slight differences in construction or equipment set-up can create a small amount of AC error. Even placement of cables in the laboratory can change the AC performance of your system measurably. The initial factory calibration compensates for a certain amount of AC error, but a change in placement or size of cell cable can shift the cable's capacitance.

The cell cables used with Gamry Instruments' potentiostats are made up of coaxial cables. The outer conductor in a coaxial cable shields the signal of interest, which is carried by the central conductor. Cable capacitance arises in coaxial cables because of the insulation between the conductors. The application of a voltage signal through the cable takes a certain amount of time based partly upon this capacitance, meaning that it takes a certain amount of time for the cable to reach its charged level. This lag in charging time slows down the signal being transmitted, and even interferes with that signal. This effect is particularly pronounced for high-frequency signals like those that occur in Electrochemical Impedance Spectroscopy (EIS) measurements.

If we consider the example of digital data pulses represented by a square wave with near-vertical rises and falls entering one end of a coaxial cable, a cable with a high capacitance slows these voltage transitions so that they come out of the cable's opposite end looking more like saw-teeth (see Fig. 1). The end result is a distortion of the signal—and your data. You can correct for this type of error with the AC Calibration function in Reference™ family instruments. For Interface™ family instruments, all the AC calibration is done at the factory.

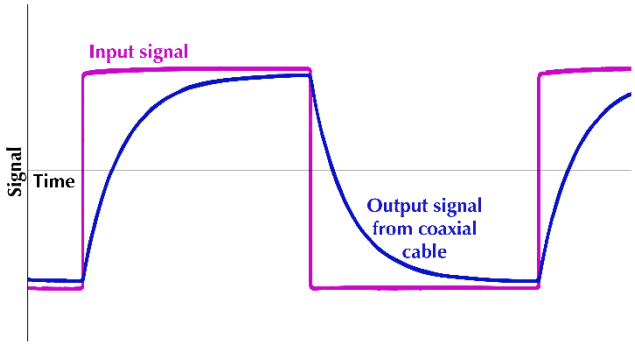

Figure 1. Example of what happens to the signal when a square wave (purple) is passed through a coaxial cable (blue).

If you are doing high-impedance measurements (for example, on insulating coatings), you can also correct for minor variations in cables' capacitances caused by slight differences in manufacturing. For more information on cable-capacitance correction, see our Technical Note.

Summary

This Technical Note explains the types of measurement errors that may appear in your Potentiostat, and how you can correct for them.

When is it useful to calibrate your instrument?

(1) When you receive your new potentiostat.

(2) After a period of one year, or if you change the laboratory environment significantly.

If you are having trouble with your instrument, run a calibration check first.

Interface instruments can run only DC and Cable Capacitance Correction functions, while Reference family instruments can run DC, AC, Cable Capacitance Correction, and Low I DC calibration functions.

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