Demonstration Guide

analytical measurement solutions

solartron analytical

AC / DC cell analysis techniques; Characterisation of individual cells within energy storage devices using auxiliary electrodes

John Harper and Brian Sayers
Solartron Analytical, Farnborough, UK.

Demonstration Expt: DG03

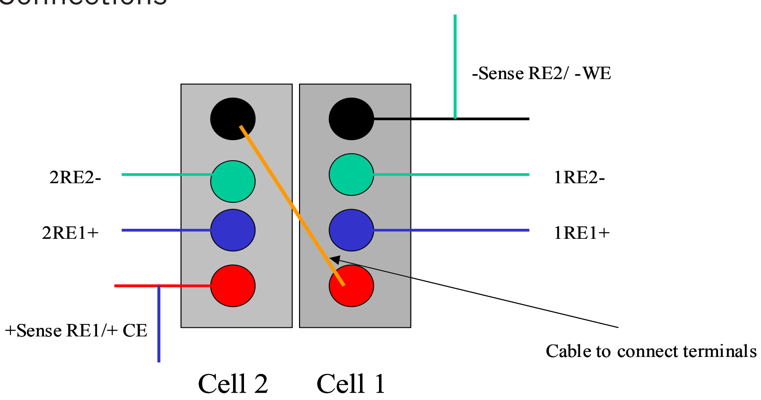
Introduction

Energy storage devices such as fuel cells and lead acid batteries are usually constructed from multiple cells to form a stack. The characterization of many processes within the cell can be determined using impedance spectroscopy and this is achieved by connecting the cables from an analyzer across the entire stack via the terminals on the cell. Unfortunately, this method cannot determine the impedance of individual anodes and cathodes or even individual cells within the structure since it measures the combined impedance of all cells. Furthermore, diagnosis of failure mechanisms is usually determined by disassembly of the cell; a time consuming and often unnecessary process. Indeed, visual inspection of the components cannot always help to deduce the mode of failure. Examples include poisoning of catalysts and hydration effects in fuel cell membranes.
With the addition of the auxiliary voltage option card, the Solartron CellTest System allows one to determine the individual impedance of anodes and cathodes which can identify the cause of a problem without the need to dismantle the cell. This demonstration guide shows how to configure the system to allow auxiliary impedance measurements across the battery test box supplied with each demonstration unit.

Equipment

- Solartron CellTest System (comprising of a 1470E multi-channel potentiostat and a 1455 FRA)
- two battery demonstration test boxes

Connections



i) Connect -Sense RE2 and -WE on channel one cable to the black connector on cell1
ii) Connect +Sense RE1 and +CE on channel one cable to the red connector on cell2
iii) connect red terminal from cell one to black terminal on cell two as shown
iv) connect auxiliary voltage cables to blue and green terminals on the battery modula as shown.
iv) connect auxiliary channels 1 and 2 on 1455 card to auxiliary channels 1 and 2 on the 1470E units

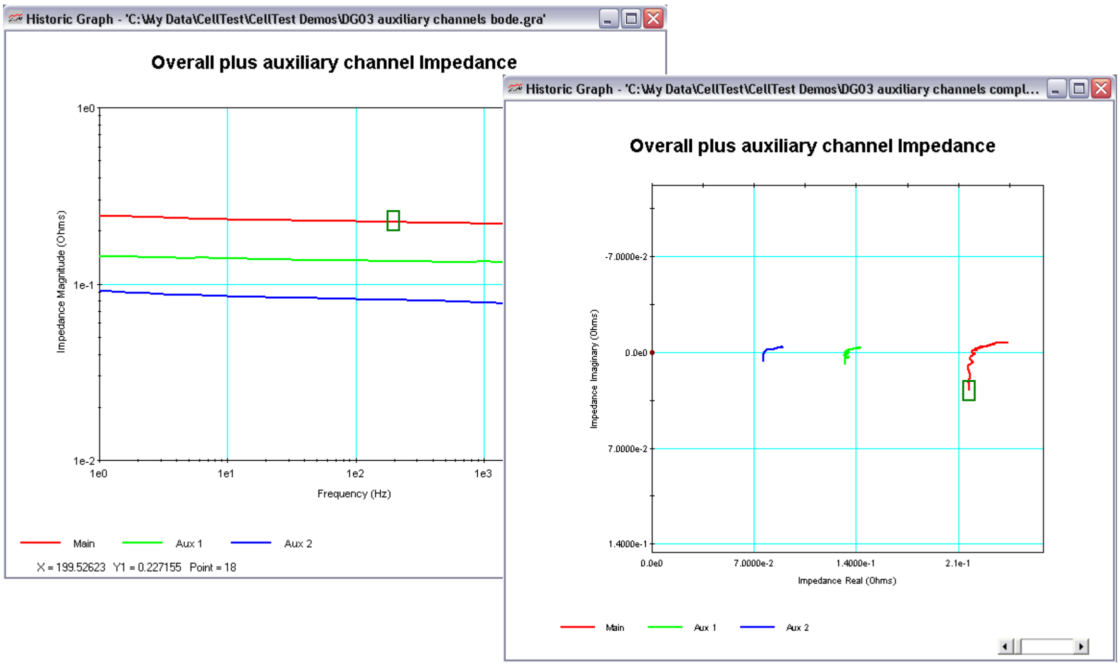
Software Setup

Using the experimental setups described in the tables below, it is relatively simple to demonstrate the use of auxiliary voltage channels to measure the impedance of individual anodes and cathodes in the stack arrangement.

Schedule

Step	Parameter	Setting	Comment
Step 1 Normal Step	i) Mode ii) Start (A) ii) Sample rate iii) Step duration	i) Current control ii) +0.5A iii) 1 sample / second iii) 60 s	charge battery - slow data capture
Step 2 Rest Step	i) Sample rate ii) Step duration	i) 1 sample / second ii) 20 seconds	allow cell to rest after charge - slow data capture
Step 3 Impedance	i) Mode ii) DC level iii) Channel selection iv) AC level v) Measurement mode vi) Frequency	i) Current control ii) 0A iii) Main + Aux channels iv) 30mA v) Sweep frequency vi) 10,000Hz to 1Hz Logarithmic sweep 10 pts / decade	Impedance sweep from 10kHz to 1Hz measuring main and auxiliary channels. Ensure that auxiliary channels 1 and 2 are assigned to main channel 1 in the hardware setup menu.

Results



The impedance of the individual cells (green and blue lines) and total impedance of the stack are shown above in Bode and complex plane format. The graph format can be selected by right clicking on the graph and changing the graph type.

Conclusions

The ability to measure the impedance of individual cells within a stack arrangement allows the engineer or scientist unparalled access to significant information of mechanisms that are critical toward the development and realization of emerging technologies.