

## EIS cell analysis techniques

### Simultaneous multi-channel AC and DC measurements

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Application Guide: AGML07

#### Introduction

The Solartron ModuLab system, comprising of potentiostats and frequency response analyzers (FRAs), provides the most advanced electrochemical test system in use today. With the provision for connecting up to four high-performance potentiostats per chassis each with an FRA and other options, or up to eight potentiostats for DC tests only, scientists and engineers now have the capability to measure AC and DC characteristics of multiple cells using a single unit.

The ModuLab system allows the same, or completely different, tests to be run simultaneously on each channel. This allows battery or fuel cell engineers to test cells of similar construction under different sets of experimental conditions. With the ability to run different experiments simultaneously, the system will greatly accelerate the development of new energy storage devices and materials. Alternatively, experiments may be run on multiple corrosion coatings or electrochemical cells in exactly the same way.

This guide demonstrates the use of simultaneous AC and DC measurements on two channels of the ModuLab System and the same principles described below can be used to test more cells by adding further potentiostats to a chassis or by adding further chassis to the system.

#### Key system capabilities used in this demonstration

- Multiple potentiostat / FRA capability of the ModuLab system
- Integration of AC and DC testing on each potentiostat

#### Equipment required for this demonstration

- Solartron ModuLab with two potentiostats and two FRA options fitted and two demonstration batteries.

#### Connections

- Connect the ModuLab potentiostats to the batteries using the connection diagram shown in the following experiment.

#### Experiment setup

Select "AGML07 Multichannel AC and DC" in the "ModuLab Application Guide" project

Step #	Purpose
Step 1	Charge the cell while capturing data at low data rate
Step 2	Open circuit to allow the cell to rest after charging.
Step 3	Run an impedance test from 100 kHz to 1 Hz, note the speed of sweep
Step 4	Discharge the cell while capturing data at low data rate
Step 5	Open circuit to allow the cell to rest after charging.
Step 6	Run an impedance test from 100 kHz to 1 Hz, note the speed of sweep

#### Additional test possibilities:

- More ModuLab potentiostats may be added to the chassis, or more chassis added to the system to provide additional test channels without the expense of purchasing complete units
- Analyse anode / cathode performance using auxiliary channels (voltage drop and impedance)
- Higher current levels can be run by adding external boosters

## Notes on setup

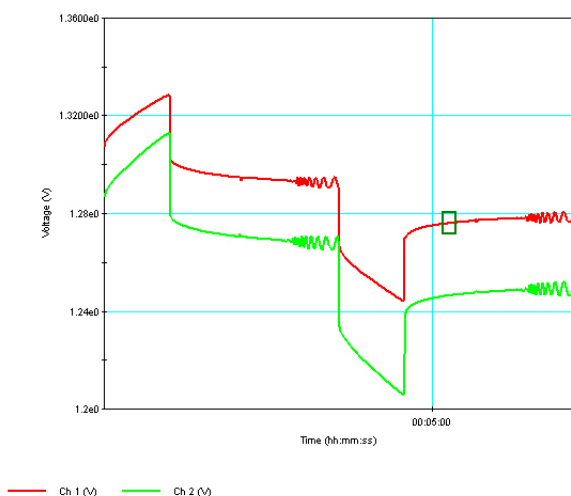
Both potentiostats are selected in the experiment run menu. The same experiment is then simultaneously applied to two test cells. The results from the channels are shown below overlaid on the same graphs allowing immediate comparisons to be made between the performance of different electrode materials etc. This test can be expanded to more channels, depending on how many potentiostats and FRAs are available.

Alternatively, different test schedules may be allocated to each channel by modifying the experiment setup, showing the flexibility of the system.

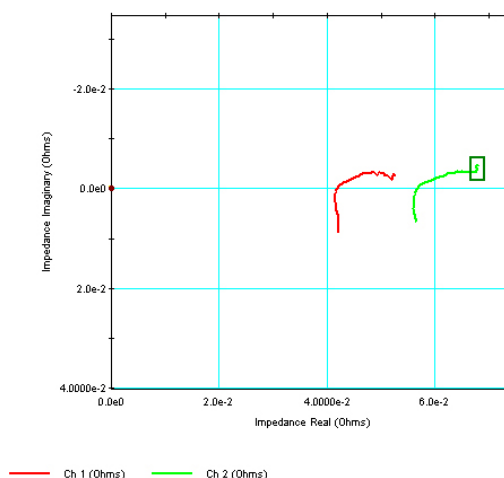
## Data presentation and analysis

The graphs below show the DC and impedance results from the two potentiostats allowing immediate comparison of the DC charge / discharge curves and EIS spectra of the cells.,

Simultaneous voltage measurements from channels 1 and 2



Impedance measurements after charge step



## Conclusions

The capability to run independent, simultaneous multi-channel experiments greatly increases productivity while reducing development time and costs compared to single channel or even multiplexed test systems where instrumentation is shared amongst the number of cells that need to be tested. The ModuLab system was designed to be a very cost effective system for multiple channels which, over a very short period of time easily recovers the initial cost by providing much higher test throughput leading to quicker introduction of new products to the market and greater profitability.

Multiple potentiostats with FRAs may be added “plug and play” to the system as and when required giving virtually no limit to the amount of cells that can be tested in parallel. This will prove to be an invaluable tool in the rapid screening and development of a wide range of devices.



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