



**Princeton  
Applied  
Research**

**solartron**  
*analytical*

**MACCOR**<sup>TM</sup>



# Integrated Battery Test Systems

*The Most Advanced Battery Cyclers and Test System with Integrated Impedance Spectroscopy*

# Introducing...

## Are you getting the battery you are paying for?

Overcome the technical limitations, inaccuracies and long measurement times of traditional techniques. Use Electrochemical Impedance Spectroscopy (EIS) analysis for faster, repeatable and more accurate determination of critical parameters such as:

- State of Charge (SoC)
- State of Health (SoH)
- Equivalent Series Resistance Measurements (ESR)

## Do your competitors know more than you do?

Electrochemical Impedance Spectroscopy (EIS) is now the MUST HAVE tool for battery development, battery health diagnosis and battery management. Join the ever growing number of battery test engineers using EIS to deliver superior products to their customers.

## Partner with the BEST....

Repeatable, reliable and trustworthy EIS measurements for SoC and SoH are critical. With a MACCOR/Princeton Applied Research/Solartron Analytical solution, you are partnering with the best. MACCOR and Princeton Applied Research/Solartron Analytical represent:

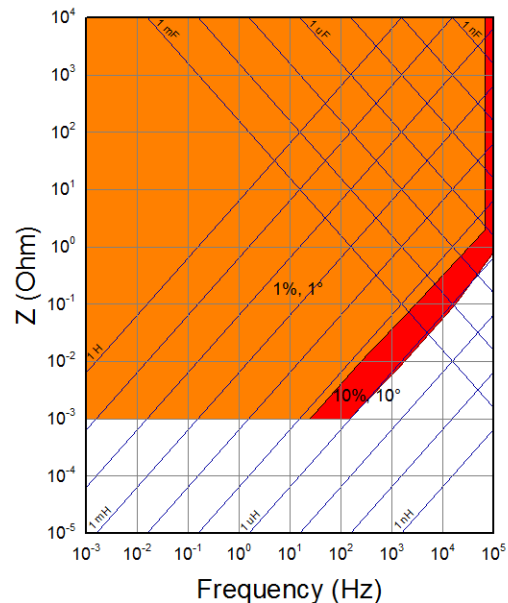
- Over 100 years of combined experience in battery test
- Largest global installed base
- Most cited systems in literature



## Integrated Cycler and Impedance System

The integration of Princeton Applied Research/Solartron Analytical impedance analyzers with MACCOR battery cyclers represents a step change in battery test and measurement solutions. Electrochemical Impedance Analysis (EIS) has never been easier with hardware and software control fully integrated into the MACCOR MIMS client software.

## System Impedance Accuracy



System accuracy map for PARSTAT 4000 with MACCOR 4300M

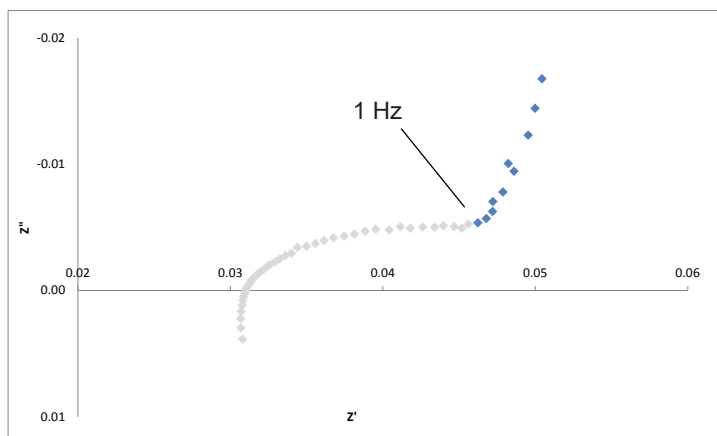
# Integrated MACCOR Battery Cyclers and Princeton Applied Research / Solartron Analytical Impedance Analyzers

## Why Aren't You Conducting EIS Analysis?

Disconnecting the battery from the cycler is often a deterrent to Impedance analysis. With the integration of the Princeton Applied Research / Solartron Analytical impedance systems into the MACCOR battery cycler, all EIS measurements are fully automated and require no user intervention.

## When Frequency Range Matters

SoC studies require measurements below 1Hz. Other integrated solutions do not offer this capability.



Typical cell data acquired by competitive solutions (grey) with additional data (blue) available through the MACCOR - Princeton Applied Research / Solartron Analytical integrated solutions.

## Features and Benefits

### Reliable, Repeatable Testing

Accuracy matters for EIS testing. Impedance system specifications are detailed in the inlaid Contour Map and available instrument specification sheets. System specifications cover all battery types. Configurable systems applicable for all battery analysis needs.

### Temperature Measurements

Enhanced EIS studies with temperature measurement control are controlled through MIMS client software. Temperature studies simulate the environmental conditions faced by real systems including:

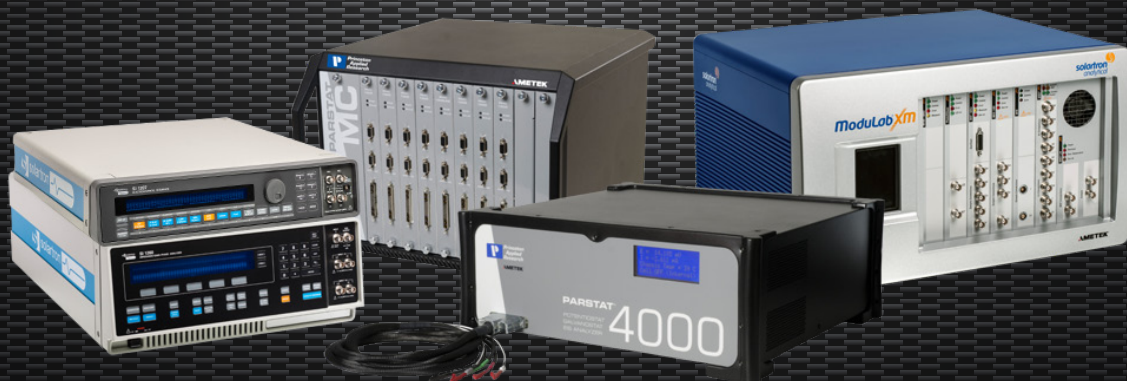
- Cold crank start for HEV's
- Portable device performance in different climates
- Kinetic vs. Temperature studies to determine anode/cathode performance during cycling

### Arbitrary Cycling Profiles and EIS

MACCOR's ability to read arbitrary waveforms allows tests using real load profiles. Impedance measurements further enhance these tests - data is used to compare performance degradation with EIS analysis in real time.

### Data Export to Third Party Analysis

Impedance data can be easily exported to third party software packages of the users choice.



## Product Selection Guide

Battery Type: Series Resistance	Number of Multiplexed EIS Channels Required	Recommended Princeton Applied Research/Solartron Analytical/ MACCOR EIS Solutions	
>10 mOhm	1 to 16	PARSTAT 4000	4200M/4300M
	>16	PARSTAT MC	4000 Series
10 mOhm to 1 mOhm	1 to 16	ModuLab XM ECS	4200M/4300M
	>16	CELLTEST	4000 Series
<1 mOhm	1 to 16	ModuLab XM ECS	4200M/4300M
	>16	CELLTEST	4000 Series

	MACCOR 4000	MACCOR 4200	MACCOR 4300M
MAX Number of Channels	192	16	18
Current Range	300 nA to 5 A*	300 nA to 5 A*	300 nA to 5 A*
Accuracy of Measurement	±0.02% FSR	±0.02% FSR	±0.02% FSR
Voltage Range	-2 V to 10 V*	-2 V to 10 V*	-2 V to 10 V*
Max. Number of steps in cycle experiment	127	127	127
Frequency Range	10µHz to 100kHz	10µHz to 100kHz	10µHz to 100kHz

\*Please note that MACCOR systems are highly customizable and configurable and therefore final system specifications will depend upon end user requirements



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