

PARSTAT[®] MC Family

multichannel potentiostat and galvanostat

MORE

MORE... potentiostat models
MORE... dynamic current range
MORE... polarization voltage
MORE... **capability** in one chassis



Isn't it time your potentiostat did MORE?

Designed by engineers with 50+ years of potentiostat design and development experience, the PARSTAT MC gives you MORE...

- MORE... potentiostat models
- MORE... dynamic current range
- MORE... polarization voltage
- MORE... capability in one chassis



When a chassis isn't just a box...

The foundation of the PARSTAT MC is the smart-design of the chassis which does more than house potentiostats and boosters. The chassis utilizes user-replaceable modules with industry-leading robustness and serviceability.

- Provides power, communication and thermal dissipation to different potentiostat, galvanostat and booster models
- Constructed completely of user-replaceable functional blocks: power supply, backplane, and fans
- Designed with footprint in mind, maximizes valuable bench space and fits within a standard rack
- Uses on-board buffering for intelligent data transfer; protects against communication interruptions while allowing for high-speed data acquisition experiments
- Maintains electrical isolation of each channel, allowing control of multiple working electrodes; asynchronous experiments will not impact each other
- Manages installation and removal of channels without interrupting ongoing experiments
- Houses up to 20 potentiostats, offering more throughput than any multichannel potentiostat on the market

PARSTAT MC 200

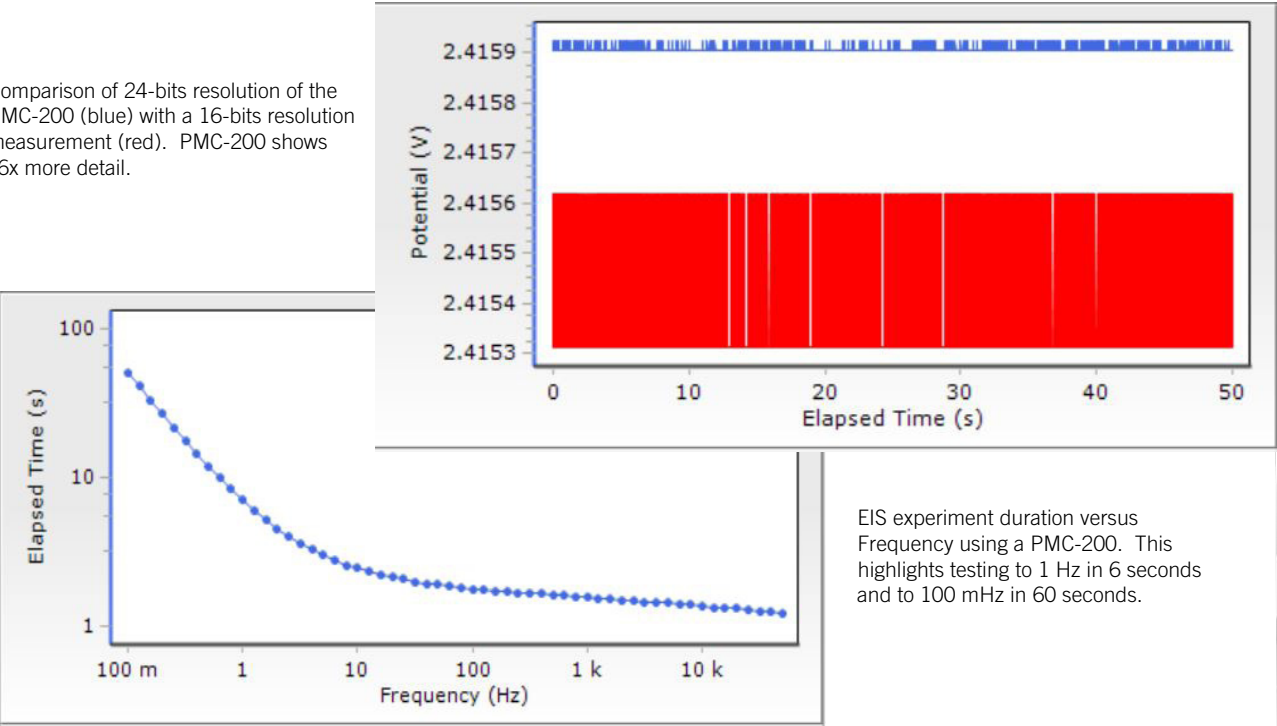
more... potentiostats per module

The PARSTAT MC 200 (PMC-200) provides core electrochemical test functionality in dual channel format. The PMC-200 was designed to excel at the most common tests on energy devices.

PMC-200 uses advanced concepts to reduce the number of discrete components, allowing double the capacity per module, while remaining a top-performer in resolution. Each channel runs high-speed Electrochemical Impedance Spectroscopy (EIS) experiments, dramatically improving experiment duration at low frequencies.

| | |
|-------------------------------|--------------------|
| Compliance Voltage | ± 10 V |
| Polarization Voltage | ± 10 V |
| Standard Maximum Current | 1 A, continuous |
| Standard Lowest Current Range | 2 µA (238 fA res.) |
| Voltage, Current Resolution | 24-bits |
| EIS Frequency Range | 100 kHz to 1 mHz |
| Data Acquisition Rate | 250 kS/sec (4 µs) |
| PMC-200 PSTAT Card | AC/DC |
| PMC-200 PSTAT Card | Dual Channel |

Comparison of 24-bits resolution of the PMC-200 (blue) with a 16-bits resolution measurement (red). PMC-200 shows 16x more detail.



EIS experiment duration versus Frequency using a PMC-200. This highlights testing to 1 Hz in 6 seconds and to 100 mHz in 60 seconds.

feature

allows for

Dual-Channel per Card

Electrochemical Impedance Spectroscopy (EIS)

24-Bits ADC Converter

1-Amp current per channel

Energy

Up to 20 channels of testing per chassis, double the testing capacity

EIS fast, accurate, included

Highest quality voltage and current resolution for measured responses

Allows analysis of larger batteries at higher rates

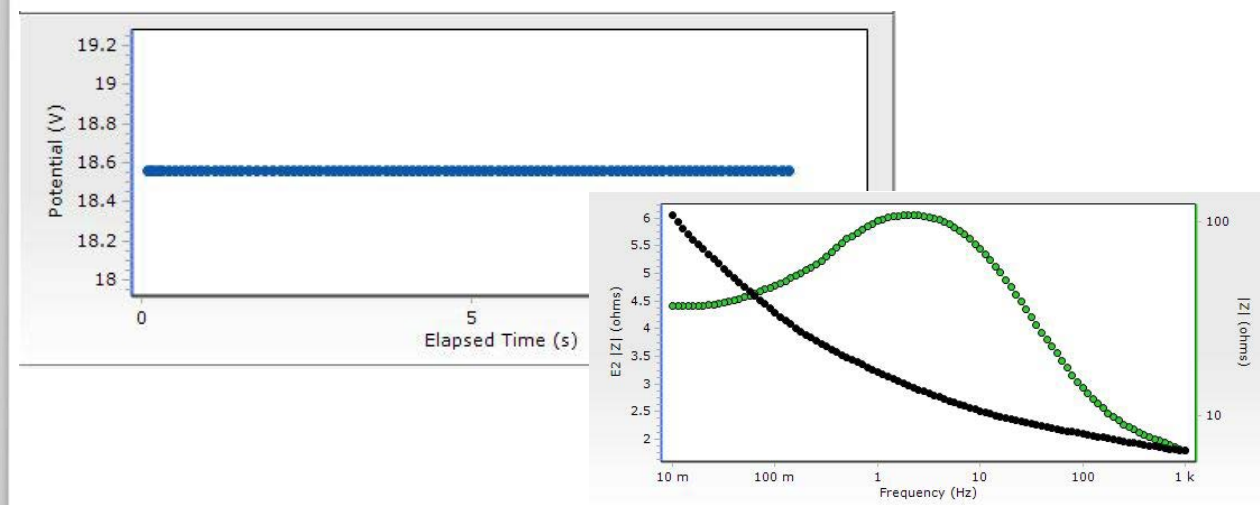


PARSTAT MC 2000A

more... polarization voltage and frequency range

The PARSTAT MC potentiostat family has reset expectations with the unparalleled research grade PMC-2000A potentiostat and galvanostat. With market leading specifications in current range, input impedance, applied voltage range and frequency range, all as standard features of the PMC-2000A, it sits atop our potentiostat family and the multichannel potentiostat marketplace.

| | |
|-------------------------------|-------------------------|
| Compliance Voltage | ± 30 V |
| Polarization Voltage | ± 30 V, ±6 V |
| Standard Maximum Current | 1 A |
| Standard Lowest Current Range | 4 nA |
| Number of Current Ranges | 10 ranges |
| EIS Frequency Range | 7 MHz to 10 μ Hz |
| Data Acquisition Rate | 1000 kS/sec (1 μ s) |
| PMC-2000A PSTAT Card | AC/DC |
| Auxiliary Voltage (6-WIRE) | Standard |



Using the 6-WIRE function of the PMC-2000A, a single Potentiostatic EIS experiment simultaneously measures the impedance of a single battery (black, 2-6 Ohms) and 2-battery stack (green, 10-100 Ohms) of 9 Volt commercial batteries. Even without a booster or option, the PMC-2000A determines one of these batteries dominates the impedance of the stack, while still producing 18 V DC.

feature

allows for

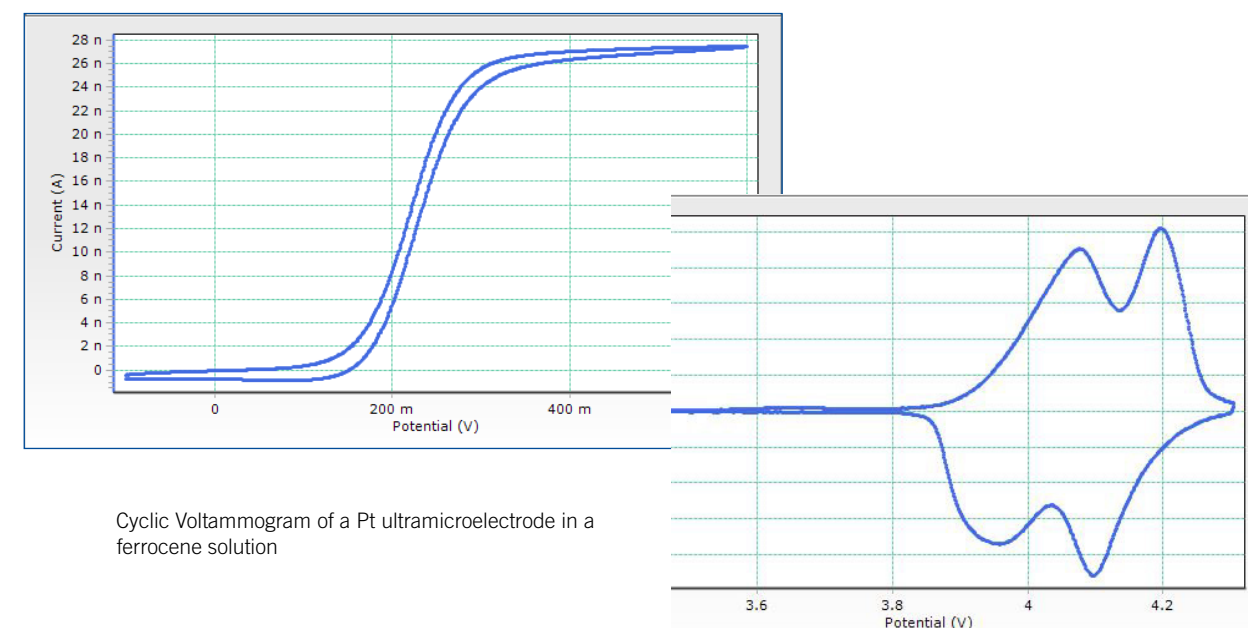
| | Energy | Physical Echem | Corrosion |
|---|---|--|--|
| High Frequency EIS 7 MHz | Solid-state energy materials analysis | Kinetics and mechanism investigations | Determination of uncompensated resistance for iR compensation |
| Data Acquisition Rate 1000 kS/Sec | Fast transients in electrochemical capacitors | Fast scan rate CVs for detection of biological species and rapid kinetics | Oversampling and averaging for noise reduction |
| Compliance Voltage 30 V | Studying stacks up to: 6 Li-ion batteries or 20 NiMH batteries | Tolerates the use of smaller counter electrodes (CE), frits on CE and nonaqueous electrolyte | Studies in low conductivity environments such as rebar in concrete |
| Polarization Voltage 30 V Range | Allows the study of Pb-Acid batteries | Large voltage fields for electrophoretic deposition | Anodization of Titanium or materials that form robust oxides |
| 6 V Range | Accuracy for single cell tests | Resolution for aqueous testing | Resolution for LPR and ZRA tests |
| 6-WIRE | Simultaneous DC and EIS measurements of Anode and Cathode or a single cell during stack testing | Additional sensor measurements and multiple cell impedances | Measurements of a pH probe or compliance voltage |

PARSTAT MC 1000

more... dynamic current range

The PMC-1000 potentiostat was designed with an extensive range of applications in mind. The wide native current range of the PMC-1000 allows for the complete characterization of low current nano devices, as well as high current batteries, with a single potentiostat card. This broad current range is not available from any other manufacturer without the addition of low current amplifiers or boosters. The PMC-1000 cards are configured with ten (10) current ranges, allowing a number of applications and techniques from corrosion to energy storage.

| | |
|-------------------------------|------------------------|
| Compliance Voltage | ± 12 V |
| Polarization Voltage | ± 10 V |
| Standard Maximum Current | 2 A |
| Standard Lowest Current Range | 4 nA |
| Number of Current Ranges | 10 ranges |
| EIS Frequency Range | 1 MHz to 10 μ Hz |
| Data Acquisition Rate | 500 kS/sec (2 μ s) |
| PMC-1000 PSTAT Card | AC/DC |
| PMC-1000/DC PSTAT Card | DC only |



Cyclic Voltammogram of a Pt ultramicroelectrode in a ferrocene solution

Cyclic Voltammogram of a Coin Cell (CR2032) Li-ion battery.

feature

allows for

| | Energy | Physical Echem | Corrosion |
|-------------------------------------|--|---|--|
| High Current 2 A Standard | Market leading high current bandwidth and accuracy | Application of large pulses and use of high surface area electrodes | Study of large samples |
| Low Current 4 nA Standard | Development of nanobatteries | Analysis of ultramicro and nanoelectrodes | Determination of low corrosion rates; EIS measurements on coatings |



VersaStudio

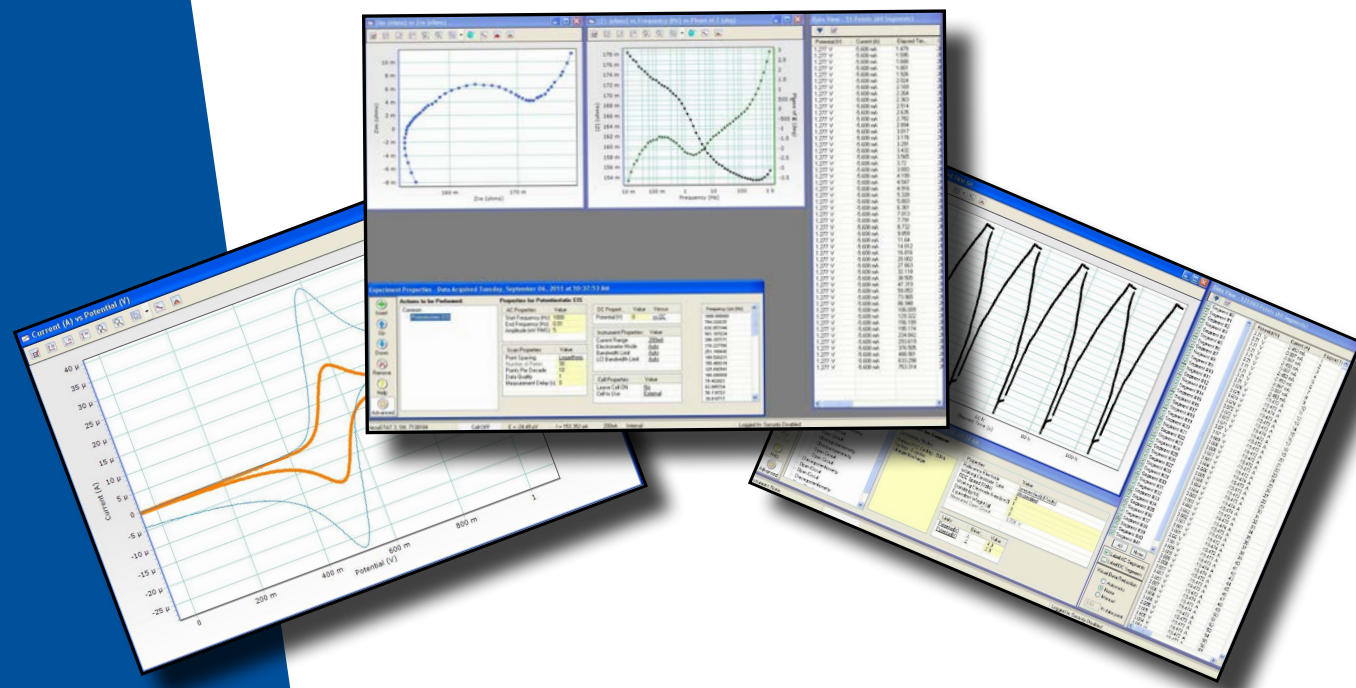
more...versatile software and research capabilities

The PARSTAT MC operates with VersaStudio software, providing access to a full suite of electrochemical tests. This range of experiments is specifically designed and continually evolving to assist researchers in Energy, Corrosion, and Physical Electrochemistry. These tests can be run individually or combined with available Advanced Actions to execute powerful, flexible sequences.

VersaStudio software provides full access to all capabilities of the PARSTAT MC, including the ultra low current option and high current boosters when present. An impressive list of electrochemical experiment types are provided that can be combined to run as powerful experimental sequences.

- Single software package with flexible experiment setup that drives the entire portfolio of instruments from Princeton Applied Research
- Data and testing parameters for the sequence are saved by default in a single file
- Cut, copy, paste actions for more convenient multi-step experiment setup
- Advanced actions such as message prompts, external applications prompts, and email notification are available to add even more flexibility and functionality to VersaStudio
- Powerful export capabilities for custom data analysis and presentation outside of VersaStudio
- Display data in tabbed single or multiple graph windows with a wide variety of graphing options for both DC and EIS experiments
- Special graphing options for Capacity vs. Cycle Number, Coulombic efficiency, and Corrosion Rate vs. Time
- Comprehensive EIS analysis and fitting techniques are available by importing data into the optional ZSimpWin software package

Our Global Support Team provides insight from our thousands of users to create an easy-to-use platform, making VersaStudio the ideal software for all. Instrument Properities give advanced users control over many aspects of the measurement chain, such as filters and acquisition modes, to maximize data quality.



Energy



The energy package provides techniques designed for testing and research of energy devices such as batteries, supercapacitors, and fuel cells. These techniques include:

Capacity-vs-Cycle, Coulombic Efficiency: Charge-Discharge, CC-CV
Diffusion evaluation: GITT, PITT

Device characterization: Constant Power and Constant Resistance control

Data acquisition variables to control the volume of data acquired, and stop limits for actions that include Potential (V), Current (A), and Capacity (Ah)

Physical Electrochemistry



The advanced voltammetry package provides a range of scan, step and pulse techniques that are important in analytical electrochemistry, microelectrode studies, sensor research, electrodeposition and battery, fuel cell analysis.

Determine voltage-windows, concentration, rate constants: Cyclic Voltammetry in different modes for smooth, fast scans

Electroplating and electrodeposition: Fast and Recurrent Pulse techniques

Improving the sensitivity of analytical measurements: Differential Pulse Voltammetry, Square Wave Voltammetry

Corrosion



The corrosion package provides a range of DC electrochemical measurement techniques that are of particular importance for the corrosion scientist investigating coatings, rebar corrosion, inhibitors, biomedical implants etc. These techniques include:

Coatings and inhibitor evaluation: EIS, Rp-versus-Time, Loop functions

Uniform corrosion: Linear Polarization (LPR), Split LPR, Tafel

Non-uniform corrosion: Cyclic Polarization, Potentiodynamic

Galvanic couples: Galvanic Corrosion, Electrochemical Noise in ZRA mode

Disbondment: Potentiostatic, Galvanostatic

Impedance



Electrochemical Impedance Spectroscopy (EIS) capabilities are standard on PARSTAT MC channels. This provides a range of fully integrated techniques for studying the impedance of electrochemical cells, sensors, batteries, fuel cells, corrosion and coatings.

Characterizing batteries and fuel cells under DC current load conditions, including State-of-Charge: Galvanostatic EIS

Analysis of electrochemical and corrosion cells providing information on electrode kinetics, diffusion and mass transfer: Potentiostatic EIS

Failure analysis: sequencing of loop, EIS and delay steps to investigate trends of impedance over time

Semiconductor analysis: Mott-Schottky

Voltammetry, Pulse

Corrosion

Energy

EIS

Sequence

Pre-experiment

- Open Circuit
- Linear Scan Voltammetry
- Cyclic Voltammetry (single)
- Cyclic Voltammetry (multiple cycles)
- Staircase Linear Scan Voltammetry
- Staircase Cyclic Voltammetry (single)
- Staircase Cyclic Voltammetry (multiple cycles)
- Multi-Vertex Scan
- Chronoamperometry
- Chronopotentiometry
- Chronocoulometry
- Fast Potential Pulses
- Fast Galvanic Pulses
- Recurrent Potential Pulses
- Recurrent Galvanic Pulses
- Square Wave Voltammetry
- Differential Pulse Voltammetry
- Normal Pulse Voltammetry
- Reverse Normal Pulse Voltammetry
- Zero Resistance Ammeter (ZRA)
- Electrochemical Noise (EN)
- Galvanic Corrosion
- Cyclic Polarization
- Linear Polarization
- Tafel
- Potentiostatic
- Potentiodynamic
- Galvanostatic
- Galvanodynamic
- Split LPR
- Galvanic Control LPR
- Constant Current
- Constant Potential
- Constant Resistance
- Constant Power
- Current CCDPL
- Charge-Discharge
- CC-CV
- GITT
- PITT
- Power CCD
- Resistance CCD
- Potentiostatic EIS
- Galvanostatic EIS
- Mott-Schottky
- Loop
- Time Delay
- Message Prompt
- Measure OC
- Auxiliary Interface
- Run External Application
- DAC Output Control
- Email
- Auto Current Range Setup
- Condition
- Deposition
- Equilibration
- Purge
- iR Determination

PARSTAT MC BOOSTERS

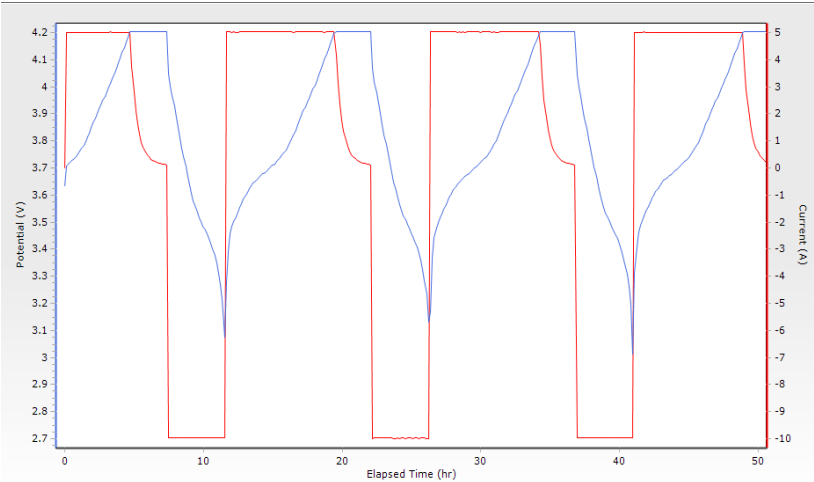
more... DC and AC current

The PARSTAT MC Booster extends the already industry-leading current capability of the PMC series of potentiostats up to 10-Amps. Two of these boosters can connect in parallel to increase to 20-Amps. The voltage range tests single cells, cells stacked in parallel, or many plating experiments.

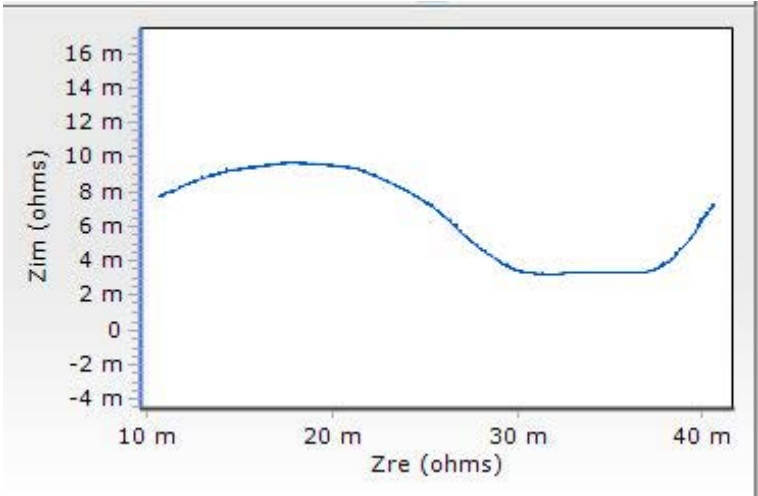
Using the same chassis as the potentiostat reduces both space and cost. Boosters can be ordered at the original purchase or easily installed at any time.

| | |
|--------------------------|------------------|
| Compliance Voltage | -1 to +6 V |
| Polarization Voltage | -1 to +6 V |
| Standard Maximum Current | 10 A per |
| | Combines to 20A |
| EIS Frequency Range | Defined by PSTAT |
| Data Acquisition Rate | Defined by PSTAT |
| Compatibility | PMC-1000 |
| | PMC-1000/DC |
| | PMC-2000A |

| Model Number | Option |
|-----------------|-------------------------------------|
| BOOSTER P10A/6V | In Chassis Booster -1 to +6 V, 10 A |
| 234625 | PMC-2000A to PMC Booster |
| 234626 | PMC-1000 to PMC Booster |



PMC-1000 with PMC Booster for charge-discharge (CC-CV action) tests on a commercial Li-ion battery pack. Charge at +5 Amps followed by Voltage Hold (until current decays to 100 mA); followed by discharge at -10 Amps.



Galvanostatic EIS test at 7 Amps (RMS) signal on same commercial Li-ion battery pack. Data represented as Nyquist plot.

PARSTAT MC ACCESSORIES

more... system options

Glassware

Flat Cell Kit K0235

This cell kit's construction is optimally designed for flat specimens with a range of sizes and geometries. The exposed sample area is 1 cm² with an option for a larger exposed area. A platinum mesh counter electrode and an Ag/AgCl reference electrode is included.



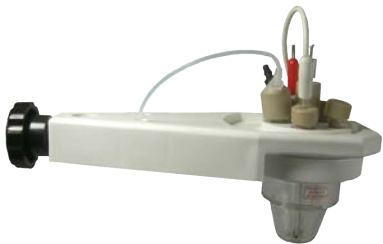
Corrosion Cell Kit K0047

The Corrosion Cell Kit's configuration is modeled after a design commonly found in many ASTM standards. This 1-Liter cell is supplied with graphite counter electrodes, a saturated calomel reference electrode (SCE) and a stainless steel test sample.



Micro-Cell Kit K0264

The Micro-Cell Kit is intended to be used for any application where solution volume is limited, requiring volumes ranging from 3 to 15 mL. A purge tube assembly is provided for bubbling or blanketing the solution with inert gas. This kit includes a platinum wire counter electrode and an Ag/AgCl reference electrode.



Battery Holders

Battery holders designed specifically for the PARSTAT MC connect directly to PMC-1000 or PMC-2000A completely replacing the cell cable. This clean design provides for a cleaner lab area, cleaner applied signal and ultimately a cleaner measured response. These holders are designed in a slim form factor to allow installation on adjacent PMC channels and are available in common/standard form factors including - 18650, AA, AAA, coin cell (2032) and a flexible screw-based design for custom cell geometries.

| Model Number | Option for PMC-1000 |
|--------------|----------------------------|
| BUTTONCELL1 | Button Cell Battery Holder |
| 18650BATT1 | 18650 Battery Holder |
| AABATT1 | AA Battery Holder |
| AAABATT1 | AAA Battery Holder |
| 2032BATT1 | Coin Cell Battery Holder |

| Model Number | Option for PMC-2000A |
|--------------|----------------------------|
| BUTTONCELL2 | Button Cell Battery Holder |
| 18650BATT2 | 18650 Battery Holder |
| AABATT2 | AA Battery Holder |
| AAABATT2 | AAA Battery Holder |
| 2032BATT2 | Coin Cell Battery Holder |



LOW CURRENT INTERFACE

more... low current range and resolution

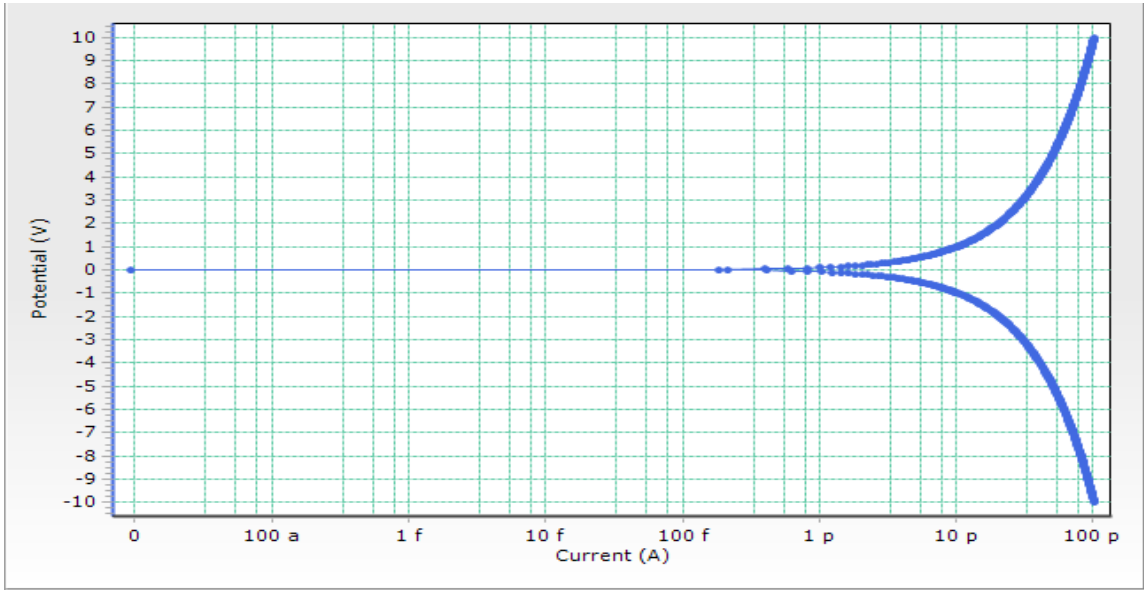
The Low Current Interface (LCI) is an external option compatible with many of the Princeton Applied Research potentiostats and galvanostats. This designed measures ultra-low currents with greater accuracy and resolution than the potentiostat alone. When added, there is a 1000x improvement of current range to 4 pA and of current resolution to 122 aA.



Applications involving ultramicroelectrodes, nanotechnology, coatings research, corrosion testing of bio-implants and sensor development are all areas where increased current sensitivity may be needed.

The LCI consists of an interface cable to connect to the potentiostat, a main body (including the high input impedance electrometer and additional current ranges) and the cell leads.

| | |
|---------------------------------|---|
| Current Measurement Ranges | 12 decades, 200 mA to 4 pA |
| DC Current Measurement Accuracy | 2 µA to 200 mA <0.2% full scale |
| | 20 nA and 200 nA ranges <0.5% full scale |
| | 200 pA to 4 pA ranges <1.0% full scale ±500 fA full scale |
| Applied Current Range | ± full scale per range |
| Applied Current Resolution | ± 1/32,000 x full scale |
| Applied Current Accuracy | ± 0.5% of range, ± 0.5% of reading |
| Max. Current Range, Resolution | ± 200 mA, 10 µA |
| Min. Current Range, Resolution | ± 4 pA, 122 aA |
| Part Number | VersaSTAT-LC |



TAFEL plot using VersaSTAT-LC demonstrating low current measurment on a 100 GOhm (1E11) resistor

PARSTAT MC FAMILY SUMMARY

more... details

Specifications

- Each PARSTAT MC chassis can be configured with up to ten (10) potentiostat modules of any PARSTAT MC family variety, up to 20 channels. Each potentiostat card provides a wide range of functionality as standard and installs in the same chassis. Configure your system to meet your specific requirements.
- Channels can operate simultaneously for high-throughput routine testing, individually for different experiments on distinct cells or in a complex matrix of multiple electrodes in a single test environment. Additional channels can be added on-site by the user, even while other channels are in operation.
- Running on Princeton Applied Research's popular VersaStudio software, the PARSTAT MC provides a platform to expand as research needs grow and evolve.

Ordering Information

| Configurable Modules: | |
|-----------------------|----------------------------------|
| PMC CHS08A | Chassis |
| PMC-200 | Dual PSTAT Channel AC/DC |
| PMC-1000 | PSTAT Channel AC/DC |
| PMC-2000A | PSTAT Channel AC/DC |
| PMC AUX01 | Digital AUX cable (1 m) |
| PMC ALG01 | Analog AUX cable (1 m) PMC-1000 |
| PMC ALG02 | Analog AUX cable (1 m) PMC-2000A |

| Booster Options: | |
|------------------|--------------------------------------|
| BOOSTER P10A/6V | In Chassis Booster -1 to +6 V, ±10 A |
| 234625 | PMC-2000A to Booster Analog Cable |
| 234626 | PMC-1000 to Booster Analog Cable |

| User Replaceable Modules: | |
|---------------------------|----------------------------|
| PMC FAN01 | Fan module |
| PMC BPLN01 | Backplane module |
| PMC PWR01 | Power supply module |
| 223945 | PMC-1000 Cell cable (2 m) |
| 234272 | PMC-2000A Cell Cable (2 m) |
| 1108584 | PMC-200 Cell Cable (1 m) |

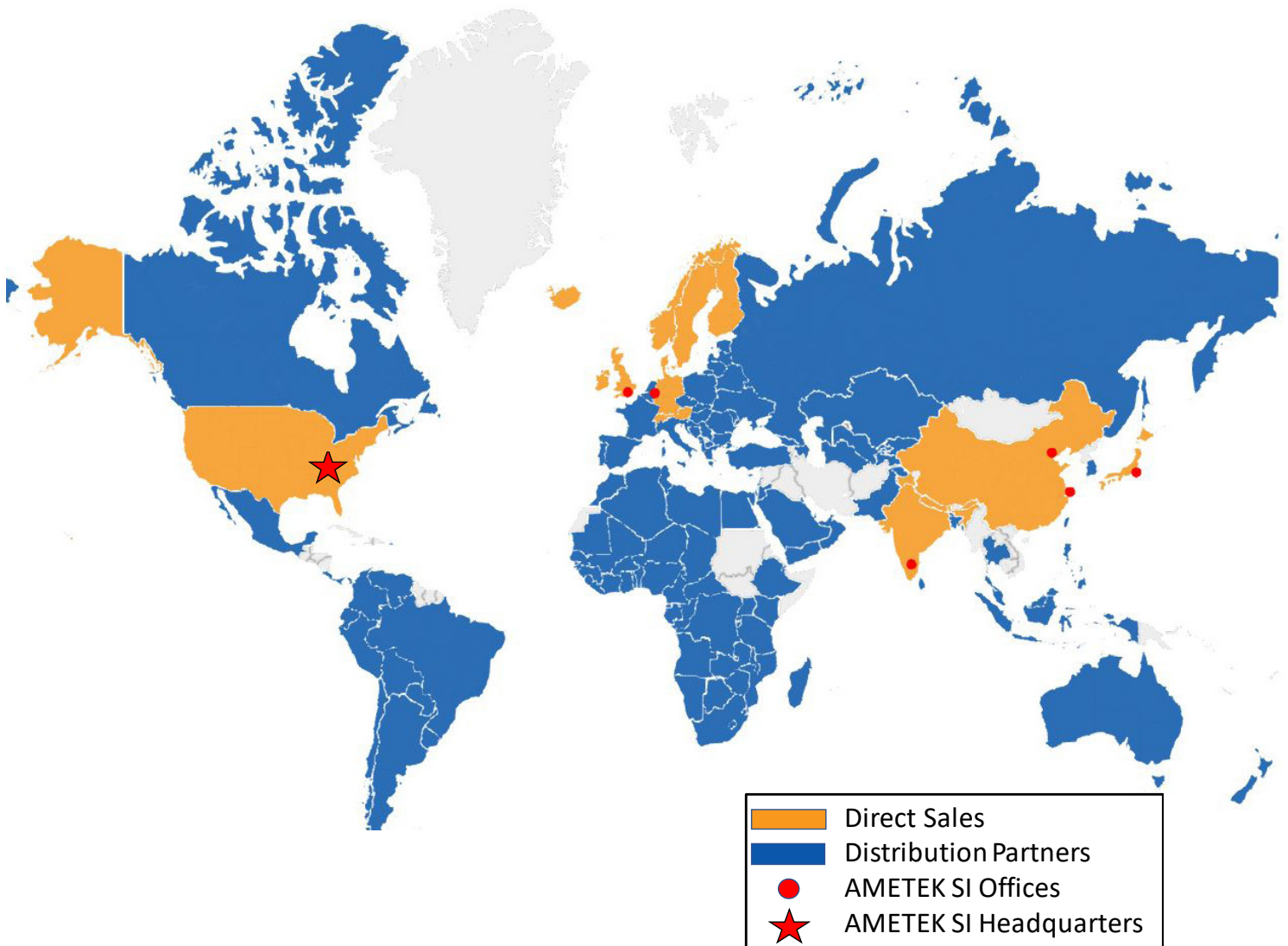
Comparison

| Specifications | PARSTAT MC PMC-200 | PARSTAT MC PMC-1000 | PARSTAT MC PMC-2000A |
|------------------------|--|---|---------------------------------|
| Max Current Output | ±1 A, per channel | ±2 A | ±1 A |
| Compliance Voltage | ±10 V | ±12 V | ±30 V |
| Min Current Range | ±2 µA (238 fA resolution) | ±4 nA down to ± 4 pA (122 fA down to 122 aA) | ±4 nA (122 fA resolution) |
| Communication Protocol | USB | | |
| Software | VersaStudio, VDK* | | |
| Advanced Features | 2-Channels per Module 24-bit Resolution | Low Current Interface Compatibility | 6-WIRE Standard EIS to 7 MHz |

VDK* = VersaStudio Developers Kit for LabView, etc.

SALES MAP

more... regional support



www.ameteksi.com

Please see our website for a complete list of our global offices and authorized agents.

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The contents of this brochure contain a brief summary of the PARSTAT MC Family of products offered by Princeton Applied Research and AMETEK. For further detailed specifications, please view our complete listing of product brochures online at www.ameteksi.com or contact your local sales representative.

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