Princeton Applied Research

AMETEK®

VersaSTAT-A Series

potentiostat and galvanostat

Introducing...

The **VersaSTAT-A** Series

The VersaSTAT-A series combines over fifty years of Princeton Applied Research knowledge and expertise with advanced performance from the latest measurement technology. This, together with VersaStudio software, makes the VersaSTAT-A series the best value system for electrochemical tests on the market.

Performance, Versatility, and Value...

- **The most popular, easy to use VersaStudio software**
- **Floating capability as standard for fuel-cell, electrolyzer, and corrosion tests**
- **2-Amp capability standard**
- **Exceptional performance at low-current**
- **EIS option may be added at any time without return to service**

The impressive combination of the performance and versatility makes the VersaSTAT-A series a tremendous value.

VersaSTAT3A and VersaSTAT4A

The VersaSTAT3A and VersaSTAT4A are option-based platforms that provide both standard core functionality and the ability to expand the range of measurements.

This versatile potentiostat / galvanostat platform addresses many different applications including Corrosion, Energy Storage, Sensors, Nanotechnology, and Physical Electrochemistry.

The VersaStudio software is included with all VersaSTAT instruments. Techniques are provided for a range of energy and corrosion applications.
The following groups of techniques are available:

Energy providing charge-discharge curves for Capacity-vs-Cycle Number or Coulombic Efficiency, as well as dedicated techniques such as Constant Power, Constant Resistance

Corrosion providing multiple corrosion analysis techniques, including the most common ASTM standards: LPR, Tafel, Cyclic Polarization

Voltammetry providing fundamental electrochemical techniques such as Cyclic Voltammetry (CV), Chrono-techniques. Pulse Voltammetry methods also available

Impedance may be added to any system to provide electrochemical impedance spectroscopy techniques

VersaSTAT3A and VersaSTAT4A:

- ± 2 A / ± 10 V polarization range as standard, ideal for many electrochemical applications including corrosion, sensors and biomedical
- Floating capability for testing ground connected cells
- Excellent current measurement resolution for corrosion, coatings and micro-electrode analysis
- An internal frequency response analyzer option that provides impedance analysis over the frequency range 1 MHz to 10 µHz

VersaSTAT4A additional features:

- Improved low current performance with fA resolution and pA accuracy
- 2 µs time base for faster data acquisition and faster scan rates

VersaSTAT3A & VersaSTAT4A specifications

Configuration	
Cell connections	2, 3 or 4 terminal plus ground
Isolation	User-selectable: Floating (Isolation) or Grounded

Data acquisition	
Data acquisition	3 x 16-bit ADCs synchronized - voltage / current / auxiliary
Time base resolution	**VersaSTAT3A:** 10 µs (100 k samples / second) **VersaSTAT4A:** 2 µs (500 k samples / second)
Automatic noise filters	Enabled / disabled

Power amplifier (CE)	
Voltage compliance	± 12 V
Current compliance	± 2 A
Potentiostat bandwidth	1 MHz
Stability settings	six settings; high stability, 1 MHz-100 Hz
Slew rate	≥ 8 V per µs typical (no load)
Rise time (-1.0V to +1.0V)	<350 ns (no load)

Voltage control (potentiostat mode)	
Applied voltage range	± 10 V
Applied voltage resolution	for ±10 mV signal = 300 nV for ±100 mV signal = 3 µV for ±1 V signal = 30 µV for ±10 V signal = 300 µV
Applied voltage accuracy	± 0.2% of value ± 2mV
Maximum scan rate	5000 Vs^{-1} (10 mV step)
Maximum scan range	± 10 V / 300 µV

Current control (galvanostat mode)	
Applied current range	± full scale (depends on range selected) ± 2A
Applied current resolution	±1/32,000 x full scale
Applied current accuracy	±0.2% of reading, ±0.2% of range, ±200 pA
Maximum current range / resolution	± 2 A / 60 µA
Minimum current range / resolution	**VersaSTAT3A:** ± 200 nA / 6 pA **VersaSTAT4A:** ± 4 nA / 120 fA

Electrometer	
Max input range	±10 V
Bandwidth	≥ 10 MHz (-3dB)
Input impedance	≥ 10^{12} Ω in parallel with ≤ 5 pF (typical)
Leakage current	≤ 5 pA at less than 25°C
CMRR	60 dB at 100 kHz (typical)

Voltage Measurement	
Voltage range	± 10 V
Minimum resolution	6 µV
Voltage accuracy	±0.2% of reading, ±2 mV

Current measurement	
Current ranges	**VersaSTAT3A:** Auto-ranging 2 A to 200 nA (8 ranges) **VersaSTAT4A:** Auto-ranging 2 A to 4 nA (10 ranges)
Current resolution	**VersaSTAT3A:** 6pA (200 nA range) **VersaSTAT4A:** 120 fA (4 nA range)
Current accuracy (DC)	**V3A & V4A:** 2A to 200nA: ±0.2% of reading, ±0.2% of range **VersaSTAT4A (only):** 20 nA: ±0.2% of reading, ±0.2%of range **VersaSTAT4A (only):** 4 nA: <0.5% ±20 pA
Low current interface	Both models add range to 4 pA
Bandwidth	1 MHz (signal ≥2 mA range typical)
Bandwidth limit filter	Yes, five total

IR Compensation	
Positive feedback	Yes
Dynamic IR	Yes

Impedance (EIS) option	
Mode	Potentiostatic / Galvanostatic
Frequency range	1 MHz to 10 µHz
Minimum AC voltage amplitude	0.1 mV RMS
Sweep	Linear or Logarithmic

Interfaces (included as standard)	
Digital inputs / outputs	5 TTL logic outputs, 2 TTL logic inputs
Auxiliary voltage input	Measurement synchronized to V and I ±10 V range, input impedance 10 kΩ Filter: off, 1 kHz, 200 kHz BNC connector
DAC voltage output (standard)	±10V range, output impedance 1 kΩ BNC connector (for stirrers, rotating disk electrode etc.)

PC / Software	
Communications interface	Universal Serial Bus (USB)
Operating system	Windows 11 / 10 / 8 / 7 (64-bit & 32-bit) Windows XP
PC specification (minimum)	Pentium 4 (1 GHz) / 1 GB memory High data rates may require additional memory
Software	VersaStudio

General	
Power	250 V A Max. Voltage range 90 V AC to 250 V AC, 50–60 Hz
Dimensions (w x d x h)	16.25" x 15.25" x 3.5" 421 x 387 x 89 mm
Weight	10 lbs, 4.5 kgs
Operating temperature range	10°C to 50°C

The **VersaSTAT** Series

Low Current Interface

The VersaSTAT LC Low Current Interface is a plug-in, research grade option for the VersaSTAT Series of potentiostats/galvanostat, designed for the measurement of ultra-low currents with greater accuracy and resolution than the base system. With the addition of a VersaSTAT LC option, any VersaSTAT Series system will acquire a lowest current range of 4pA and current resolution as small as 122 aA.

The VersaSTAT LC is ideal for applications requiring low current accuracy and resolution. Applications such as ultra micro electrodes, coatings research, corrosion testing of bio-implants, and sensor research are all areas where greater current sensitivity may be necessary.

The VersaSTAT LC option can be purchased at any time as a plug-in option. It consists of an interface cable to connect to the VersaSTAT, a main body containing the high input impedance electrometer and additional current ranges, and the cell leads. Once attached to the VersaSTAT system and calibrated with the built-in DC Calibration routine, additional bandwidth stabilization filters are provided with the VersaSTAT LC option to provide maximum stability over a wide range of experimental conditions and applications.

- Femtoampere accuracy and attoampere resolution for both DC and AC (EIS) measurements
- Zero Resistance Ammeter capability for EC noise experiments
- Expands E and I filter selection for VersaSTAT 3
- Plug-in add-on for VersaSTAT Series potentiostats galvanostats
- Auto-current ranging capability from 200mA - 4pA

VersaSTAT LC

Low Current Interface

Specifications

System Performance	
Minimum Current Range	4 pA (4 x 10^{-12} A)
Minimum Current Resolution	122 aA (122 x 10^{-18} A)

Power Amplifier	
Maximum Current	± 200 mA

Differential Electrometer	
Input Bias Current	<200 fA at 25°C
Maximum Voltage Range	± 10 V maximum
Input Voltage Differential	± 10 V
Bandwidth	700 kHz (-3 dB)
Common Mode Rejection	>60 dB @ 100 Hz, >50 dB @ 100 kHz
Input Impedance	>10^{14} Ω in parallel with <200 fF, typical

Current Measurement	
Ranges	12 decades, 200 mA to 4 pA
Accuracy (DC)	2 µ to 200 mA < 0.2% full scale
	20 nA and 200 nA ranges < 0.5% full scale
	200 pA - 4 pA ranges < 1.0% full scale ±500 fA full scale

Current Control	
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

Specifications not listed default to the connected potentiostat. Improved resolution when combined with PARSTAT 4000 Family. Compatible with VersaSCAN for ultimate high-resolution scanning electrochemical microscope (SECM) experiments.

Specifications subject to change.

Applications

Corrosion Research

The worldwide cost of corrosion is estimated at billions of dollars per year and represents several percent of GDP for most industrial countries. Corrosion affects our lives in many ways, causing safety and maintenance problems in bridges, buildings, pipelines, aircraft, automobiles and household goods. Investigation into improved coatings, inhibitors and alloys continues to combat the devastating cost of corrosion, but more research is needed.

Salt spray / coupon tests continue to be widely used in the investigation of corrosion phenomena. However, these tests typically take months to obtain information and are useless for investigating time-varying effects. By comparison, electrochemical test instrumentation (using potentiodynamic and galvanodynamic techniques) is able to obtain accurate results in a very short time period, allowing, for example, real-time monitoring of the performance of coatings and corrosion inhibitors.

Electrochemical techniques provided by our instruments that are widely used in corrosion applications include:

- Linear polarization resistance (LPR) and Tafel analysis – providing measurement of corrosion current (Icorr), polarization resistance (Rp) and corrosion rate
- Cyclic Polarization - providing a way to study localized, pitting corrosion
- Electrochemical impedance spectroscopy (EIS) - providing fast, non-destructive characterization of corrosion phenomena and verification of Rp and corrosion rate data obtained by LPR
- EIS at various polarization levels - providing impedance information relating to different corrosion regimes, such as passivation and pitting

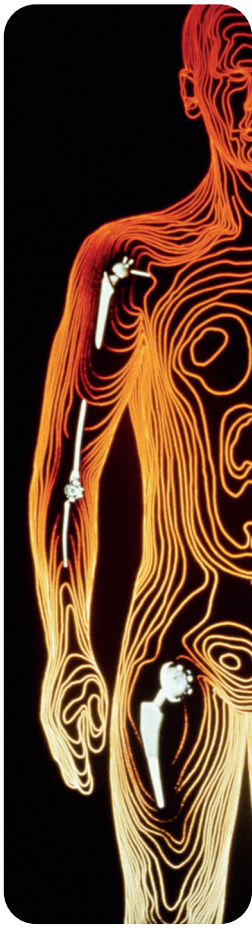
Battery, Fuel Cell and Supercapacitor Research

Fuel cells offer the prospect of cleaner, more environmentally friendly energy sources for the future, and research continues to be a priority for these devices. The development of micro fuel cells for mobile communications and PC applications is an exciting new application of this technology. Supercapacitors continue to be developed for instantaneous high power applications.

Research Electrochemistry

Research electrochemistry is a broad subject that covers many areas of investigation and depends on flexible test equipment that can be easily adapted to the requirements.

High current options may be added as the requirement grows, so whether the application involves electrodeposition or pulse-plating Princeton Applied Research instruments remain the ideal choice. With our wide selection of measurement techniques provides versatility to the VersaSTATs.



Sensors

Sensors are an integral part of our daily lives, and Princeton Applied Research systems have been used in research bringing many of these sensors to market. Sensors for glucose measurement to assist diabetics in controlling their blood glucose levels are just one of the many sensor applications that have been advanced by research utilizing our potentiostats/galvanostats. As the development of these transducers continues, you can count on our systems to provide the capabilities and performance that researchers need to refine these life-enhancing devices.

Biomedical Applications

DC corrosion analysis techniques are used to investigate the corrosion susceptibility of metallic biomedical implant devices such as artificial hips, orthopedic screws / rods and prosthetics. New alloys and implant techniques are continually being developed but corrosion still causes cracks and fractures in load bearing implants and inflammation due to corrosion products being deposited in the surrounding tissue.

Our instruments are ideal for running test standards such as the ASTM F2129 “Standard Test Method for Conducting Cyclic Potentiodynamic Polarization Measurements to Determine the Corrosion Susceptibility of Small Implant Devices” that are widely used in this application.

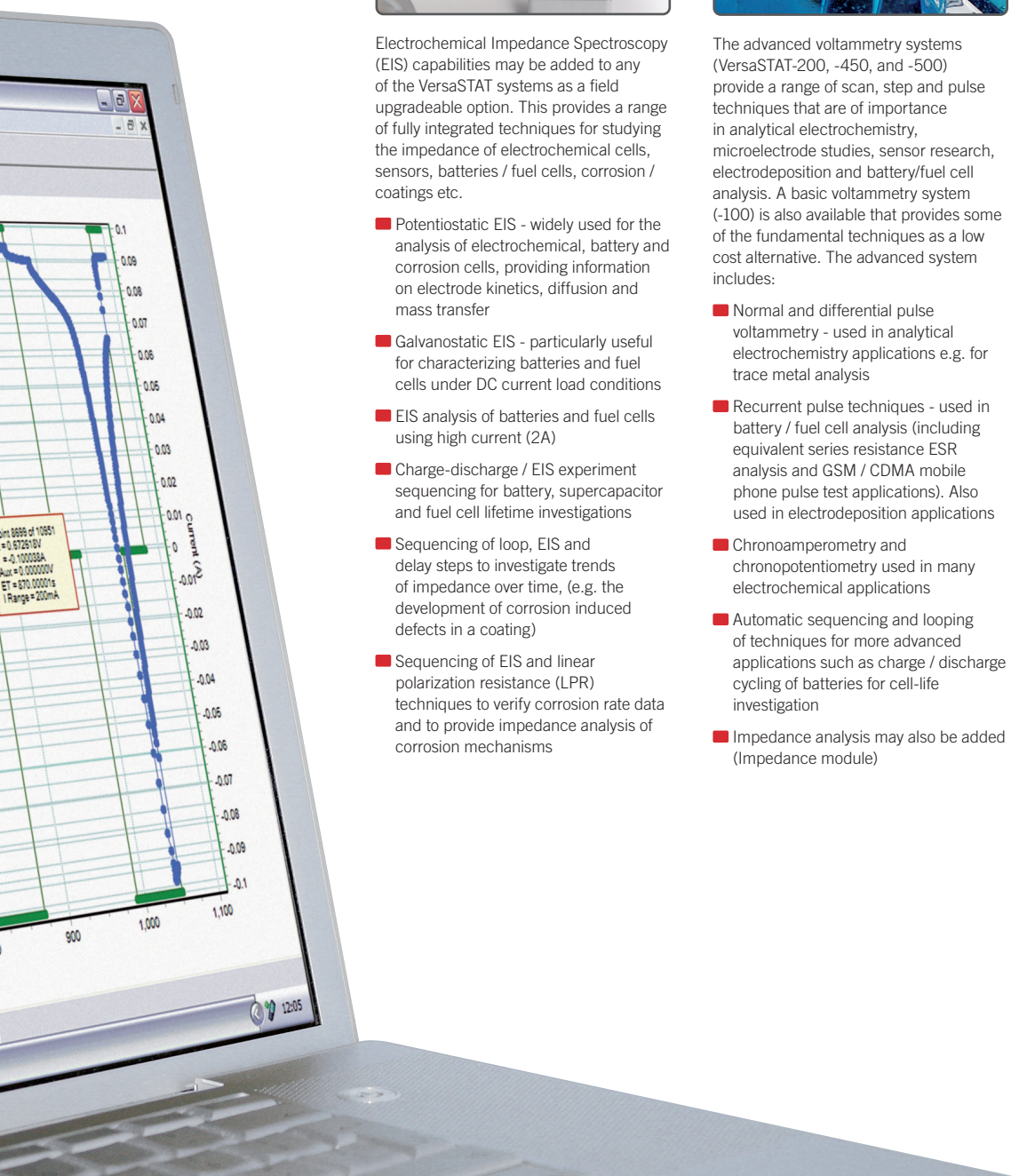
VersaStudio software

The complete VersaStudio software package provides full access to the capabilities of the instrument. Various systems combining hardware and the VersaStudio software are provided to focus on particular application areas and to minimize cost. Systems may be upgraded at any time as budget becomes available or as requirements change. An impressive list of energy, corrosion and voltammetry electrochemical experiment types are provided that can be run individually or combined in powerful experiment sequences.

There are six VersaSTAT systems available, each of which include VersaStudio software:

- **VersaSTAT**100 basic DC voltammetry techniques
- **VersaSTAT**200 advanced DC voltammetry techniques
- **VersaSTAT**300 DC corrosion techniques
- **VersaSTAT**400 advanced DC voltammetry and corrosion techniques
- **VersaSTAT**450 energy and advanced voltammetry system
- **VersaSTAT**500 energy, advanced voltammetry, and corrosion energy system

Impedance facilities may be added to any of these systems as a field upgraded option



Impedance

Electrochemical Impedance Spectroscopy (EIS) capabilities may be added to any of the VersaSTAT systems as a field upgradeable option. This provides a range of fully integrated techniques for studying the impedance of electrochemical cells, sensors, batteries / fuel cells, corrosion / coatings etc.

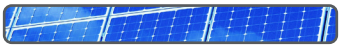
- Potentiostatic EIS - widely used for the analysis of electrochemical, battery and corrosion cells, providing information on electrode kinetics, diffusion and mass transfer
- Galvanostatic EIS - particularly useful for characterizing batteries and fuel cells under DC current load conditions
- EIS analysis of batteries and fuel cells using high current (2A)
- Charge-discharge / EIS experiment sequencing for battery, supercapacitor and fuel cell lifetime investigations
- Sequencing of loop, EIS and delay steps to investigate trends of impedance over time, (e.g. the development of corrosion induced defects in a coating)
- Sequencing of EIS and linear polarization resistance (LPR) techniques to verify corrosion rate data and to provide impedance analysis of corrosion mechanisms

Voltammetry

The advanced voltammetry systems (VersaSTAT-200, -450, and -500) provide a range of scan, step and pulse techniques that are of importance in analytical electrochemistry, microelectrode studies, sensor research, electrodeposition and battery/fuel cell analysis. A basic voltammetry system (-100) is also available that provides some of the fundamental techniques as a low cost alternative. The advanced system includes:

- Normal and differential pulse voltammetry - used in analytical electrochemistry applications e.g. for trace metal analysis
- Recurrent pulse techniques - used in battery / fuel cell analysis (including equivalent series resistance ESR analysis and GSM / CDMA mobile phone pulse test applications). Also used in electrodeposition applications
- Chronoamperometry and chronopotentiometry used in many electrochemical applications
- Automatic sequencing and looping of techniques for more advanced applications such as charge / discharge cycling of batteries for cell-life investigation
- Impedance analysis may also be added (Impedance module)

Energy



The energy systems (VersaSTAT-450 and -500) provide techniques designed for testing and research of energy devices such as batteries, super capacitors, and fuel cells. These techniques include:

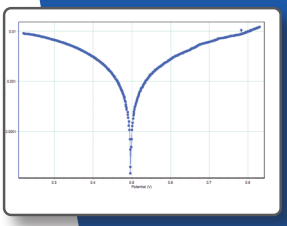
- Static (constant) applied techniques for current, potential, power, and resistance aimed at charging/ discharging energy devices
- Cyclic Charge/Discharge (CCD) techniques which can be easily modified for addition or subtraction of different actions including EIS if VersaSTAT is properly equipped
- Data acquisition variables to control the volume of data acquired, and stop limits for actions that include Potential (V), Current (A), and Capacity (Ah)

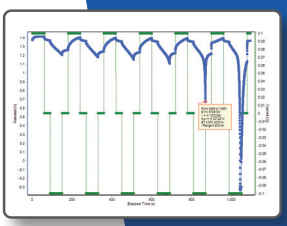
Corrosion

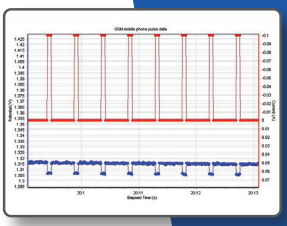
The corrosion system (VersaSTAT-300 and -500) provides a range of DC electrochemical measurement techniques that are of particular importance for the corrosion scientist investigating coatings, rebar corrosion, inhibitors, biomedical implants etc. These techniques include:

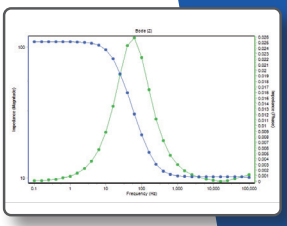
- Potentiostatic, galvanostatic, potentiodynamic and galvanodynamic techniques
- Tafel and Rp fitting analysis – providing the determination of corrosion current (Icorr), polarization resistance (Rp), data interpretation and corrosion rate calculations
- IR compensation for minimizing experimental errors due to solution resistance (Rs)
- Impedance analysis may also be added (Impedance module)

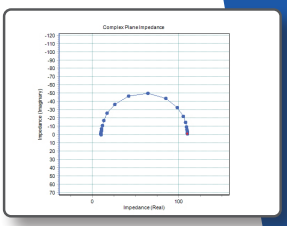
General software facilities











The VersaSTAT software modules make use of core facilities that provide everything you would expect from a high quality electrochemical test system:

- Flexible experiment setup that can automatically sequence the potentiostatic, galvanostatic and impedance capabilities of the VersaSTAT hardware
- Result displays and overlays in a wide variety of axis formats for DC and EIS experiments
- Voltage and current-vs-time strip chart display
- Default ASCII text format for ease of import to 3rd Party graphing programs. Optional Binary file format for management of large files.
- DC data analysis and fitting routines including Potential-vs-Capacity, Capacity-vs-Cycle Number, Coulombic Efficiency, line, Tafel and polarization resistance (Rp)
- Line and circle fitting for basic EIS data analysis, for estimation of cell parameters such as solution resistance and polarization resistance
- Comprehensive EIS analysis and fitting techniques are available by importing data into the popular ZSimpWin option package. A range of equivalent circuits are pre-programmed in ZSimpWin and additional circuits may easily be added as required

The software provides a comprehensive range of facilities, yet is incredibly easy to use. Basic experiments such as cyclic voltammetry are up and running with surprisingly few menu entries. This makes the system very easy for novice users.

Using the carefully designed menus, even complicated experimental sequences, (e.g. battery charge / pulse discharge / EIS or multi-step electrochemical applications), are simple and logical to set up.

	-100	-200	-300	-400	-450	-500
Voltammetry						
Open Circuit	■	■	■	■	■	■
Linear Scan Voltammetry	■	■		■	■	■
Cyclic Voltammetry (single cycle)	■	■		■	■	■
Cyclic Voltammetry (multiple cycles)	■	■		■	■	■
Staircase Linear Scan Voltammetry		■		■	■	■
Staircase Cyclic Voltammetry (single cycle)		■		■	■	■
Staircase Cyclic Voltammetry (multiple cycles)		■		■	■	■
Chronoamperometry	■	■		■	■	■
Multi-Vertex Scan		■		■	■	■
Chronopotentiometry		■		■	■	■
Chronocoulometry		■		■	■	■
Fast Potential Pulses or Galvanic Pulses		■		■	■	■
Recurrent Potential Pulses		■		■	■	■
Recurrent Galvanic Pulses		■		■	■	■
Square Wave Voltammetry		■		■	■	■
Differential Pulse Voltammetry		■		■	■	■
Normal Pulse Voltammetry		■		■	■	■
Reverse Normal Pulse Voltammetry		■		■	■	■
Corrosion						
Zero Resistance Ammeter (ZRA)			■	■		■
Galvanic Corrosion			■	■		■
Cyclic Polarization			■	■		■
Linear Polarization Resistance (LPR)			■	■		■
Tafel			■	■		■
Potentiostatic			■	■		■
Potentiodynamic			■	■		■
Galvanostatic			■	■		■
Galvanodynamic			■	■		■
Electrochemical Noise (EN)			■	■		■
Split LPR			■	■		■
Galvanic Control LPR			■	■		■
Dynamic IR			■	■		■
Energy						
Constant Current					■	■
Constant Potential					■	■
Constant Resistance					■	■
Constant Power					■	■
Charge-Discharge, CC-CV					■	■
Current CCDPL					■	■
Power CCD					■	■
Resistance CCD					■	■
GITT					■	■
PITT					■	■
EIS						
Potentiostatic or Galvanostatic EIS	*	*	*	*	*	*
Mott-Schottky	*	*	*	*	*	*
Sequence						
Loop		■	■	■	■	■
Time Delay		■	■	■	■	■
Message Prompt		■	■	■	■	■
Measure Open Circuit		■	■	■	■	■
Auto Current Range Setup		■	■	■	■	■
Run External Application		■	■	■	■	■
DAC Output Control		■	■	■	■	■
Pre-experiment						
Condition		■	■	■	■	■
Deposition		■	■	■	■	■
Equilibration		■	■	■	■	■
Purge		■	■	■	■	■
iR Determination		■	■	■	■	■

*EIS capability (Impedance) is optionally available with any of these systems

VersaSTAT ordering information

Hardware

Options	Model Number for VersaSTAT3A	Model Number for VersaSTAT4A
FRA option	FRA/VersaSTAT3	FRA/VersaSTAT4
Low Current Interface	VersaSTAT-LC	VersaSTAT-LC
Cell Accessories		
K0235	Flat Cell Kit	
K0047	Corrosion Cell Kit	
K0264	Micro-Cell Kit	
RDE0018	Analytical Cell Kit	
K0269B	Faraday Cage	
Ancillary Equipment		
QCM922A	Quartz Crystal Microbalance	
616A/B	Rotating Disk Electrode system (A for 110 V / B for 220 V)	
636A	Rotating Ring-Disk Electrode System	

Systems

The following systems all include **VersaStudio** software:

VersaSTATx 100 Basic DC Voltammetry system

VersaSTATx 200 Advanced DC Voltammetry system

VersaSTATx 300 Corrosion system

VersaSTATx 400 Advanced Voltammetry and Corrosion system

VersaSTATx 450 Energy and Advanced Voltammetry system

VersaSTATx 500 Complete DC Energy, Advanced Voltammetry and Corrosion system

x= model of potentiostat

Impedance capability may be added to any of the above systems by ordering the FRA option

Princeton Applied Research

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AMT-C00005-0224A