Princeton Applied Research

VersaSTAT Series

potentiostat/galvanostat

AMETEK

Introducing...

The **VersaSTAT** Series

The VersaSTAT series is a completely new design of potentiostat / galvanostat, combining over forty years of Princeton Applied Research knowledge and expertise in the development of world leading electrochemical test products with advanced performance from the very latest measurement technology. This, together with easy to use, yet powerful PC software makes the VersaSTAT series of instruments the best value electrochemical test systems on the market.

Combining advanced measurement technology with user-friendly, yet powerful modular PC software, the VersaSTAT series potentiostat/galvanostat are a cut above for performance, versatility, and value...

- Versatile, easy to use VersaStudio software
- High Current and power booster options for electrodeposition, pulse-plating, and energy storage
- High speed DC measurement and experiment sequencing (e.g. for step/ pulse analysis)
- Optional built-in frequency response analyzer providing fully integrated DC and EIS analysis

The impressive combination of the performance and versatility makes the VersaSTAT series a tremendous value for researchers and scientists.

VersaSTAT 3

The more value oriented VersaSTAT 3 provides most of the capabilities you need in your laboratory. This versatile potentiostat / galvanostat is performance driven allowing for use in many different applications including Corrosion, Energy Storage, Sensors, Electrodeposition, and Research Electrochemistry.

Electrochemical techniques provided by the VersaSTAT 3 that are widely used in corrosion applications include Linear Polarization Resistance (LPR), Electrochemical Impedance Spectroscopy (EIS), and EIS at various polarization levels.

The new VersaStudio software is included with all VersaSTAT 3 systems. Systems are provided for a range of voltammetry and corrosion applications. The following groups of techniques are available:

Corrosion providing multiple corrosion analysis techniques such as LPR, Tafel etc

Voltammetry providing basic and advanced scan, step and pulse electrochemical techniques

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

- ±650mA / ±10V polarization range as standard - ideal for many electrochemical applications including corrosion, sensors and biomedical
- ±2A high current option and boosters up to 20A for battery, fuel cell or electroplating applications
- 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 10µHz to 1MHz

VersaSTAT 3 specifications

Configuration	
Cell connections	2, 3 or 4 terminal plus ground

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

Power amplifier (CE)	
Voltage compliance	± 12V
Current compliance	± 650mA (standard) ± 2A (with 2A option)
Potentiostat bandwidth	1 MHz
Stability settings	high-speed, high-stability
Slew rate	≥ 8V per µs typical (no load)
Rise time (-1.0V to +1.0V)	<350ns (no load)

Voltage control (potentiostat mode)	
Applied voltage range	± 10V
Applied voltage resolution	for ±10mV signal = 300nV for ±100mV signal = 3µV for ±1V signal = 30µV for ±10V signal = 300µV
Applied voltage accuracy	±0.2% of value ± 2mV
Maximum scan rate	5000Vs^{-1} (50mV step) (10Vs^{-1} VersaSTAT-100)
Maximum scan range / resolution	± 10V / 300µV

Current control (galvanostat mode)	
Applied current range	± full scale (depends on range selected) ± 650mA (standard), ± 2A (with option)
Applied current resolution	±1/32,000 x full scale
Applied current accuracy	±0.2% of reading, ±0.2 % of range
Maximum current range / resolution	± 650mA / 60µA
Minimum current range / resolution	± 200nA / 6pA

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

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

Current measurement	
Current ranges	Auto-ranging (8 ranges) 1A (650mA max.) to 200nA (8 ranges) 2A to 200nA (with option)
Current resolution	6pA (200nA range)
Current accuracy (DC)	±0.2% of reading, ±0.2% of range
Bandwidth	1MHz (signal ≥2mA range typical)
Bandwidth limit filter	Yes

IR Compensation	
Positive feedback	Yes
Dynamic IR	Yes

Impedance (EIS) option	
Mode	Potentiostatic / Gavanostatic
Frequency range	10µHz to 1MHz
Minimum AC voltage amplitude	0.1mV 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 ±10V range, input impedance 10kΩ Filter: off, 1kHz, 200kHz BNC connector
DAC voltage output (standard)	±10V range, output impedance 1kΩ BNC connector (for stirrers, rotating disk electrode etc.)

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

General	
Power	250VA Max. Voltage range 90Vac to 250Vac, 50-60Hz
Dimensions (w x d x h)	16¼" x 15¼" x 3½" 421 x 387 x 89mm
Weight	10lbs, 4.5kgs
Operating temperature range	10°C to 50°C
Humidity	Maximum 80% non-condensing
Temperature (specified)	25°C
Dummy Cell	Internal (DC only)
CE approved	Yes

The **VersaSTAT** Series

Hardware

The VersaStat series are not simply updates to previous VersaSTAT instruments, they are a completely new design that makes use of the latest generation of RISC processor devices to provide the speed, versatility and precision required for electrochemical applications, but at a lower cost.

The system requires the minimum of installation set-up, being controlled from a PC via its standard Universal Serial Bus USB connection and utilizing “plug and play” technology to get the system up and running, fast...

The VersaStat series utilize high-speed digital to analog converter circuitry, providing instantaneous step changes and pulses to generate the most complex potentiostatic / galvanostatic waveforms. Three high-speed, (500ksamples / second) analog to digital converters provide fully synchronized measurements of the cell voltage, cell current and auxiliary voltage input.

The units provide 4-terminal cell connections, which allows great flexibility for the analysis of both high and low impedance cells. In low impedance applications, errors due to cell connection cable impedance may adversely affect the accuracy of results. The use of 4-terminal connections, allows the cell voltage to be measured at the cell terminals, minimizing errors due to cable impedance. For high impedance cells (e.g. in corrosion applications) where the voltage drop in the CE / WE connections is small compared to the impedance of the cell, 3-terminal connections are also available.

An auxiliary voltage input is also provided for connection to external devices. The measurements taken from this input are synchronized to the cell voltage and current measurements, allowing the auxiliary input to be used in many applications, including measurements from pH meters, temperature sensors and optical sensors.

The VersaStat series provide an optional built-in frequency response analyzer (FRA) that is able to characterize a wide range of electrochemical cells. The FRA is fully integrated into the system allowing high speed switching between DC and EIS measurements.

VersaSTAT 4

The VersaSTAT 4 builds upon the already impressive new design of the VersaSTAT 3 giving you even more improved speed, versatility, and precision required for a range of electrochemical applications.

The increased maximum current of 1A standard, as well as optional current boosters up to 20 A, positions the VersaSTAT 4 to take you from the early stages of battery and fuel cell development to the charge/discharge experiments on the final product and the challenges that lie ahead for the next generation of batteries.

The improved low current performance with fA resolution and pA accuracy addresses current sensitive applications such as sensors, corrosion inhibitors, and combined with the optional FRA, coating technologies. The additional analog filtering makes the VersaSTAT 4 an even better choice for corrosion applications while the additional bandwidth filtering adds extra stability for capacitive cells. The VersaSTAT 4, with its added capabilities, makes an exciting addition to our VersaSTAT family making them even more of an exceptional value for all of your application needs.

- Improved low current performance with fA resolution and pA accuracy
- Maximum current up to 1A with additional booster options from 2A-20A
- 2 µs time base for faster data acquistion and faster scan rates
- Additional analog filter selections on current and voltage channels for superior signal/noise measurements
- Additional bandwidth filtering options for greater stability on capacitve cells
- An internal frequency response analyzer option that provides impedance analysis over the frequency range 10µHz to 1MHz
- Easy-to-use VersaStudio software included

The VersaSTAT 4 provides a lower cost, simple to use, yet powerful electrochemical test system that is equally capable for routine electrochemical research and for educational / teaching requirements. The software is fully featured to allow complex experiments to be set-up and run but is simple to operate for the novice user. The full range of support and technical help available from Princeton Applied Research makes this the ideal product for educational applications.

VersaSTAT 4 specifications

Configuration	
Cell connections	2, 3 or 4 terminal plus ground

Data acquisition	
Data acquisition	3 x 16-bit 500k samples per second ADCs synchronized - voltage / current / auxiliary
Time base resolution (minimum)	2µs (500k samples / second)
Automatic noise filters	Enabled / disabled

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

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

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

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

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

Current measurement	
Current ranges	Auto-ranging (10 ranges) 1A to 4nA (10 ranges) 2A to 4nA (with option)
Current resolution	120fA (4nA range)
Current accuracy (DC)	20nA to 2A: ±0.2% of reading, ±0.2% of range
4nA: <0.5% ±20pA	
Bandwidth	1MHz (signal ≥2mA range typical)
Bandwidth limit filter	Yes, five total

IR Compensation	
Positive feedback	Yes
Dynamic IR	Yes

Impedance (EIS) option	
Mode	Potentiostatic / Gavanostatic
Frequency range	10µHz to 1MHz
Minimum AC voltage amplitude	0.1mV 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 ±10V range, input impedance 10kΩ Filter: off, 1kHz, 200kHz BNC connector
DAC voltage output (standard)	±10V range, output impedance 1kΩ BNC connector (for stirrers, rotating disk electrode etc.)

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

General	
Power	250VA Max. Voltage range 90Vac to 250Vac, 50-60Hz
Dimensions (w x d x h)	16¼" x 15¼" x 3½" 421 x 387 x 89mm
Weight	10lbs, 4.5kgs
Operating temperature range	10°C to 50°C
Humidity	Maximum 80% non-condensing
Temperature (specified)	25°C
Dummy Cell	Internal (DC only)
CE approved	Yes

Superior to the VersaSTAT 3

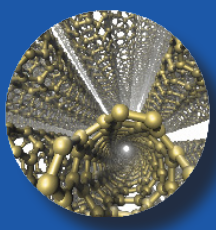
The **VersaSTAT** Series

Our Markets

Sensors

Corrosion

Energy Storage



Electrodeposition

Research Electrochemistry

VersaSTAT 3F

The VersaSTAT 3F is the latest addition to the VersaSTAT family. Although sharing similar specifications to the VersaSTAT 3 (10µs data acquisition, +/-650mA current range) and the VersaSTAT 4 (4nA lower current range, enhanced filtering options), the VersaSTAT 3F was designed specifically to operate with earth-grounded cells.

The “F” in the VersaSTAT 3F name is for “floating,” a term used to describe the electrical isolation of the systems electrode leads and rear panel connectors from earth ground. In floating mode, the internal ground of the VersaSTAT 3F (as well as the cell leads and external connections at the rear panel) is allowed to float with respect to earth ground which allows it to operate with these grounded cells. Examples of earth grounded cells include autoclaves, strain apparatus, storage tanks and pipelines, and additional electrodes connected to a separate potentiostat that is not floating

The VersaSTAT 3F was designed to operate in either a “normal” mode (same mode as V3 and V4 models) or a “floating” mode, selectable in the operating software. In addition to the mode selections, the VersaSTAT 3F also provides additional filters that could be required with some cells in order to enhance the signal to noise. A special “Notch Filter” for those frequencies associated with line power (50/60Hz), and “EIS Filters” (for those systems equipped with the FRA option) are available as needed.

- Capable of “floating” for operation with grounded cells and electrodes
- Specialized filters for float mode operation for enhanced signal/noise ratio
- ±650mA / ±10V polarization range as standard - ideal for many electrochemical applications including corrosion, sensors and biomedical
- An internal frequency response analyzer option that provides impedance analysis over the frequency range 10µHz to 1MHz
- Additional bandwidth filtering options for greater stability on capacitve cells
- Easy-to-use VersaStudio software included

VersaSTAT 3F specifications

Configuration	
Cell connections	2, 3 or 4 terminal plus ground

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

Power amplifier (CE)	
Voltage compliance	± 12V
Current compliance	± 650mA (standard) ± 2A (with 2A option)
Potentiostat bandwidth	1 MHz
Stability settings	six settings; high stability, 1MHz-100Hz
Slew rate	≥ 8V per µs typical (no load)
Rise time (-1.0V to +1.0V)	<350ns (no load)

Voltage control (potentiostat mode)	
Applied voltage range	± 10V
Applied voltage resolution	for ±10mV signal = 300nV for ±100mV signal = 3µV for ±1V signal = 30µV for ±10V signal = 300µV
Applied voltage accuracy	±0.2% of value ± 2mV
Maximum scan rate	5000Vs^{-1} (50mV step) (10Vs^{-1} VersaSTAT-100)
Maximum scan range / resolution	± 10V / 300µV

Current control (galvanostat mode)	
Applied current range	± full scale (depends on range selected) ± 650mA (standard), ± 2A (with option)
Applied current resolution	±1/32,000 x full scale
Applied current accuracy	±0.2% of reading, ±0.2 % of range, ±200pA
Maximum current range / resolution	± 650mA / 60µA
Minimum current range / resolution	± 4nA/120fA

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

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

Current measurement	
Current ranges	Auto-ranging (10 ranges) 1A (650mA max.) to 4nA (10 ranges) 2A to 4nA (with option)
Current resolution	120fA (4nA range)
Current accuracy (DC) 4nA: <0.5% ±20pA	20nA to 2A: ±0.2% of reading, ±0.2% or range
Bandwidth	1MHz (signal ≥2mA range typical)
Bandwidth limit filter	Yes, five total

IR Compensation	
Positive feedback	Yes
Dynamic IR	Yes

Impedance (EIS) option	
Mode	Potentiostatic / Gavanostatic
Frequency range	10µHz to 1MHz
Minimum AC voltage amplitude	0.1mV 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 ±10V range, input impedance 10kΩ Filter: off, 1kHz, 200kHz BNC connector
DAC voltage output (standard)	±10V range, output impedance 1kΩ BNC connector (for stirrers, rotating disk electrode etc.)

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

General	
Power	250VA Max. Voltage range 90Vac to 250Vac, 50-60Hz
Dimensions (w x d x h)	16¼" x 15¼" x 3½" 421 x 387 x 89mm
Weight	10lbs, 4.5kgs
Operating temperature range	10°C to 50°C
Humidity	Maximum 80% non-condensing
Temperature (specified)	25°C
Dummy Cell	Internal (DC only)
CE approved	Yes

Superior to the VersaSTAT 3

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 needed.

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
- Expands E and I filter selection for VersaSTAT 3 and VersaSTAT MC Systems
- 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	4pA (4 x 10^{-12} A)
Minimum Current Resolution	122 aA (122 x 10^{-18} A)

Power Amplifier	
Maximum Current	± 200mA

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

Current Measurement	
Ranges	12 decades, 200mA to 4pA
Accuracy (dc)	2µ to 200mA < 0.2% full scale
	20nA and 200nA ranges < 0.5% full scale
	200pA - 4pA ranges < 1.0% full scale ± 500fA 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	± 200mA / 10µA
Min. Current Range/Resolution	± 4pA / 122aA

All other specifications not listed default to the connected potentiostat. 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. New technology ultra-thin / ultra-flexible batteries are being developed for smart-card and intelligent paper applications.

Research electrochemistry

Research electrochemistry is a broad subject that covers many areas of investigation and therefore requires 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 our instruments remain the ideal choice. With our wide selection of measurement techniques, our instruments provide the range of capabilities that are needed to cover the diverse requirements of a modern research laboratory.

Sensors

Sensors are an integral part of our daily lives, and Princeton Applied Research systems have been utilized in research that brought 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. Be it potentiometric voltametric, gas, or biological sensors, the development and utilization of these as transducers continue to expand, and 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

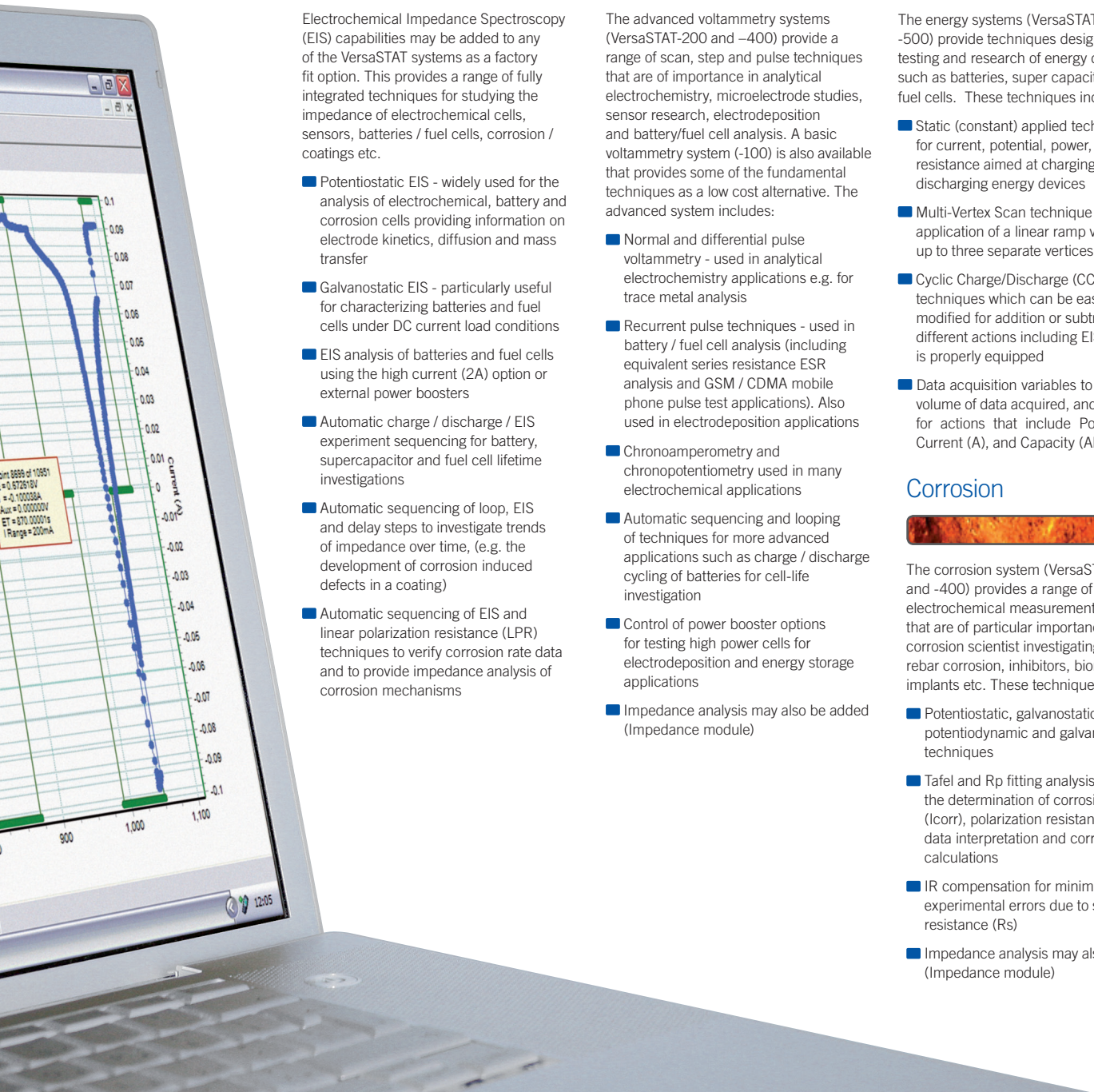
The complete VersaStudio software provides full access to the capabilities of the instrument, including the high current option and power booster when present. Various systems combining hardware and the VersaStudio software are provided to focus on particular application areas and to minimize cost.

Systems may be upgraded at any time as budget becomes available or as requirements change. An impressive list of corrosion and electrochemical experiment types are provided that can be run individually or combined in powerful experiment sequences.

There are four 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 complete DC voltammetry and corrosion techniques
- **VersaSTAT**450 energy and voltammetry system
- **VersaSTAT**500 voltammetry, corrosion, and energy system

Impedance facilities may be added to any of these systems as a factory fit option



Impedance

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

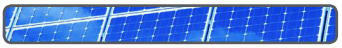
- Potentiostatic EIS - widely used for the analysis of electrochemical, battery and corrosion cells providing information on electrode kinetics, diffusion and mass transfer
- Galvanostatic EIS - particularly useful for characterizing batteries and fuel cells under DC current load conditions
- EIS analysis of batteries and fuel cells using the high current (2A) option or external power boosters
- Automatic charge / discharge / EIS experiment sequencing for battery, supercapacitor and fuel cell lifetime investigations
- Automatic 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)
- Automatic 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 and –400) 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
- Control of power booster options for testing high power cells for electrodeposition and energy storage applications
- 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
- Multi-Vertex Scan technique for application of a linear ramp voltage with up to three separate vertices
- Cyclic Charge/Discharge (CCD) techniques which can be easily modified for addition or subtraction of different actions including EIS if system 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

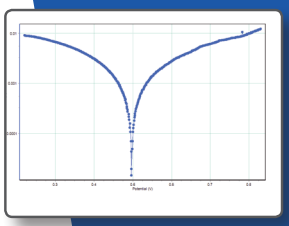
The corrosion system (VersaSTAT-300 and -400) provides a range of DC electrochemical measurement techniques that are of particular importance for the corrosion scientist investigating coatings, rebar corrosion, inhibitors, biomedical implants etc. These techniques include:

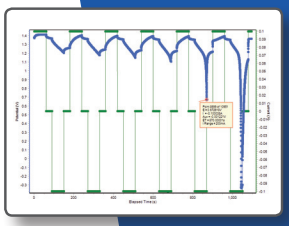
- Potentiostatic, galvanostatic, potentiodynamic and galvanodynamic techniques
- Tafel and Rp fitting analysis – providing the determination of corrosion current (Icorr), polarization resistance (Rp), data interpretation and corrosion rate calculations
- IR compensation for minimizing experimental errors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

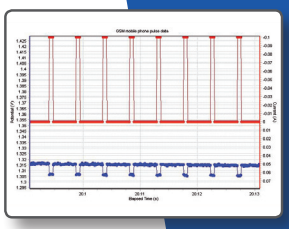
General software facilities

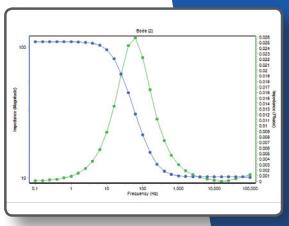
	-100	-200	-300	-400	-450	-500
Voltammetry						
Open Circuit	■	■	■	■	■	■
Linear scan voltammetry	■	■		■	■	■
Cyclic voltammetry (single)	■	■		■	■	■
Cyclic voltammetry (multiple cycles)	■	■		■	■	■
Staircase linear scan voltammetry		■		■	■	■
Staircase cyclic voltammetry (single)		■		■	■	■
Staircase cyclic voltammetry (multiple cycles)		■		■	■	■
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		■		■	■	■
Corrosion						
Zero resistance ammeter (ZRA)			■	■		■
Galvanic Corrosion			■	■		■
Cyclic Polarization			■	■		■
Linear Polarization			■	■		■
Tafel			■	■		■
Potentiostatic			■	■		■
Potentiodynamic			■	■		■
Galvanostatic			■	■		■
Galvanodynamic			■	■		■
Dynamic IR			■	■		■
Energy						
Constant Current					■	■
Constant Potential					■	■
Constant Resistance					■	■
Constant Power					■	■
Multi-Vertex Scan					■	■
Current CCDPL					■	■
Power CCD					■	■
Resistance CCD					■	■
EIS						
Potentiostatic EIS	*	*	*	*	*	*
Galvanostatic EIS	*	*	*	*	*	*
Sequence						
Loop		■	■	■	■	■
Time Delay		■	■	■	■	■
Message Prompt		■	■	■	■	■
Measure OC		■	■	■	■	■
Auxiliary Interface		■	■	■	■	■
Run External Application		■	■	■	■	■
DAC Output Control		■	■	■	■	■
Pre-experiment						
Condition		■	■	■	■	■
Deposition		■	■	■	■	■
Equilibration		■	■	■	■	■
Purge		■	■	■	■	■
iR Determination		■	■	■	■	■

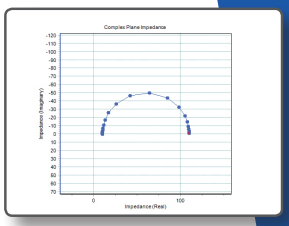
*EIS capability (Impedance) is optionally available with any of these systems











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
- Full storage and retrieval facilities allow straight-forward comparison of current and stored data
- DC data analysis and fitting routines including line, Tafel and polarization resistance (Rp)
- Data output in text format into other applications for further analysis and report generation
- 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.

VersaSTAT ordering information

Hardware

Options	Model Number	Model Number	Model Number
2A high current option	2A / VersaSTAT3	2A / VersaSTAT4	2A / VersaSTAT3F
FRA option	FRA / VersaSTAT3	FRA / VersaSTAT4	FRA/VersaSTAT3F
Advanced auxiliary interface	AAI / VersaSTAT3	AAI / VersaSTAT4	AAI/VersaSTAT3F
Low Current Interface	VersaSTAT-LC	VersaSTAT-LC	VersaSTAT-LC

Power Boosters compatible with the VersaSTAT Series

8A / 50V*	8A / VersaSTAT3	8A / VersaSTAT4	8A / VersaSTAT3F
10A / 20V*	10A / VersaSTAT3	10A / VersaSTAT4	10A / VersaSTAT3F
20A / 20V*	20A / VersaSTAT3	20A / VersaSTAT4	20A / VersaSTAT3F

Cell Accessories

K0047	Corrosion Cell Kit
K0235	Corrosion Flat Cell
K0264	Micro-Cell Kit
RDE0018	Analytical Cell Kit
K0269B	Faraday Cage

Ancillary Equipment

QCM922	Quartz Crystal Microbalance
616A	Rotating Disk Electrode system
636A	Rotating Ring-Disk Electrode System (requires 2 VersaSTATs, one with floating capability

Systems

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

VersaSTATx 100 Basic DC electrochemistry system

VersaSTATx 200 DC electrochemistry system

VersaSTATx 300 DC corrosion system

VersaSTATx 400 Full capability DC system

VersaSTATx 450 Energy and Voltammetry system

VersaSTATx 500 Voltammetry, Corrosion, and Energy system

x= model of potentiostat

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

*Bandwidth reduced with addition of current boosters

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

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