Princeton Applied Research

VersaSTAT Series

potentiostat/galvanostat

Now Includes 2-Amp

AMETEK

Introducing...

The **VersaSTAT** Series

The VersaSTAT 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 series the best value system for electrochemical tests on the market.

Performance, Versatility, and Value...

- **The most popular, easy to use VersaStudio software**
- **2-Amp capability now standard as well other power booster options available**
- **Exceptional performance at low-current**
- **EIS function available initially or after through upgrade**

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

VersaSTAT 3

The VersaSTAT 3 is an option-based platform that provides both standard core functionality and the ability to expand the range of measurements.

This versatile potentiostat / galvanostat 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

- ± 2 A (as of August 1st, 2018) / ± 10 V polarization range as standard, ideal for many electrochemical applications including corrosion, sensors and biomedical
- Boosters, up to 20 A 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 1 MHz to 10 µHz

VersaSTAT 3 specifications

Configuration	
Cell connections	2, 3 or 4 terminal plus ground

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

Power amplifier (CE)	
Voltage compliance	± 12 V
Current compliance	± 2A (as of August 1st, 2018) ± 650 mA (prior to this date 2A option available)
Potentiostat bandwidth	1 MHz
Stability settings	high-speed, high-stability
Slew rate	≥ 8 V per µs typical (no load)
Rise time (-1.0 V to +1.0 V)	<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 ± 2 mV
Maximum scan rate	5000 Vs^{-1} (50 mV step)
Maximum scan range / resolution	± 10 V / 300 µV

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

Electrometer	
Max input range	±10 V
Bandwidth	≥ 10 MHz (-3 dB)
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	Auto-ranging (8 ranges) 2A to 200nA (8 ranges) - standard Down to 4 pA with low current option
Current resolution	6 pA (200 nA range)
Current accuracy (DC)	±0.2% of reading, ±0.2% of range
Bandwidth	1 MHz (signal ≥2 mA range typical)
Bandwidth limit filter	Yes

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)	±10 V range, output impedance 1 kΩ BNC connector (for stirrers, rotating disk electrode etc.)

PC / Software	
Communications interface	Universal Serial Bus (USB)
Operating system	Windows 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 VA Max. Voltage range 90 Vac to 250 Vac, 50-60 Hz
Dimensions (w x d x h)	16¼" x 15¼" x 3½" 421 x 387 x 89 mm
Weight	10 lbs, 4.5 kgs
Operating temperature range	10°C to 50°C
Humidity	Maximum 80% non-condensing
Temperature (specified)	25°C
Dummy Cell	Internal and external Supplied
CE approved	Yes

The **VersaSTAT** Series

Hardware

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

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

The VersaSTAT series uses high-speed digital to analog converter circuitry, providing instantaneous step changes and pulses to generate the most complex potentiostatic / galvanostatic waveforms. Three high-speed, (500 ksamples / second) analog to digital converters provide fully synchronized measurements of 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 provides 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 design of the VersaSTAT 3 delivering improved speed and low-current measurement required for a range of electrochemical applications.

VersaSTAT 4 will 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 applications such as sensors, corrosion, nanotechnology. Additional analog filtering makes the VersaSTAT 4 the superior choice for these applications and the additional bandwidth filtering adds extra stability for capacitive cells. The VersaSTAT 4 with these settings is attractive alternative to the VersaSTAT 3 for low-current applications.

- Improved low current performance with fA resolution and pA accuracy
- 2 µs time base for faster data acquisition and faster scan rates
- Analog filter selections on current and voltage channels for superior signal/noise measurements (NONE, 200 kHz, 1 kHz, **100 Hz, 10 Hz, 1 Hz**)
- Additional bandwidth filtering options for greater stability on capacitive cells
- Maximum current to 2 A with additional booster options to 20 A
- An internal frequency response analyzer option that provides impedance analysis over the frequency range 1 MHz to 10 µHz

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

Power amplifier (CE)	
Voltage compliance	± 12 V
Current compliance	± 2 A (standard as of August 1st, 2018) ± 1 A (prior to this date 2A option available)
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) ± 2 A
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	± 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

Windows is a registered trade mark of Microsoft Corporation.
Specifications subject to change.

Superior to the VersaSTAT 3

Current measurement	
Current ranges	Auto-ranging (10 ranges) 2 A to 4 nA (10 ranges) Up to 20 A (with booster option) Down to 4 pA with low current option
Current resolution	120 fA (4 nA range)
Current accuracy (DC)	20 nA to 2 A: ±0.2% of reading, ±0.2% of range 4 nA: <0.5% ±20 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 / Gavanostatic
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 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 VA Max. Voltage range 90Vac to 250Vac, 50-60 Hz
Dimensions (w x d x h)	16¼" x 15¼" x 3½" 421 x 387 x 89 mm
Weight	10 lbs, 4.5 kgs
Operating temperature range	10°C to 50°C
Humidity	Maximum 80% non-condensing
Temperature (specified)	25°C
Dummy Cell	Internal and External supplied
CE approved	Yes

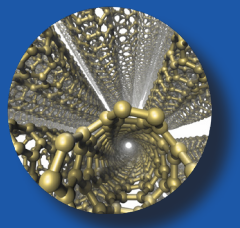
The **VersaSTAT** Series

Our Markets

Energy Storage

Corrosion

Sensors



Electrodeposition

Research Electrochemistry

VersaSTAT 3F

The VersaSTAT 3F shares similar specifications to the VersaSTAT 3 (10µs data acquisition) and the VersaSTAT 4 (4nA lower current range, enhanced filtering options). The VersaSTAT 3F was designed specifically to operate with other potentiostats or earth-grounded cells.

The "F" in the VersaSTAT 3F name indicates a "Floating" option, a term used to describe the electrical isolation of the systems electrode leads and rear panel connectors from the 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 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 provides additional filters that could be required in order to enhance the signal to noise ratio. A special "Notch Filter" for those frequencies associated with line power (50/60Hz) 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 at 50/60 Hz
- Analog filter selections on current and voltage channels for superior signal/noise measurements (NONE, 200 kHz, 1 kHz, **100 Hz, 10 Hz, 1 Hz**)
- An internal frequency response analyzer option that provides impedance analysis over the frequency range 1 MHz to 10 µHz
- Additional bandwidth filtering options for greater stability on capacitive cells

VersaSTAT 3F specifications

Configuration	
Cell connections	2, 3 or 4 terminal plus ground

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

Power amplifier (CE)	
Voltage compliance	± 12 V
Current compliance	± 2 A (standard as of August 1st, 2018) ± 650 mA (prior to this date 2A option available)
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} (50 mV step)
Maximum scan range / resolution	±10 V / 300 µV

Current control (galvanostat mode)	
Applied current range	± full scale (depends on range selected) ± 2 A
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	± 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	60dB at 100kHz (typical)

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

Superior to the VersaSTAT 3

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

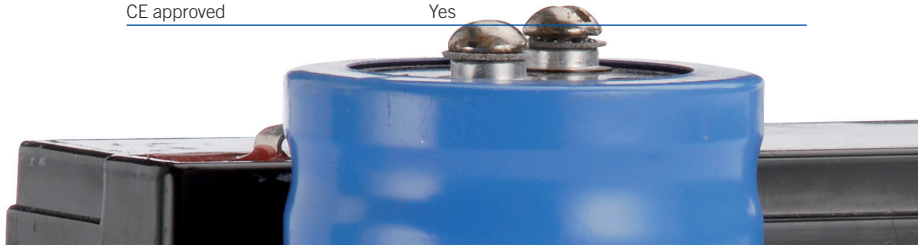
IR Compensation	
Positive feedback	Yes
Dynamic IR	Yes

Impedance (EIS) option	
Mode	Potentiostatic / Gavanostatic
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)	±10 V range, output impedance 1 kΩ BNC connector (for stirrers, rotating disk electrode etc.)

PC / Software	
Communications interface	Universal Serial Bus (USB)
Operating system	Windows 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	
Isolation	Floating (Isolation) or Grounded; user-selectable
Power	250 VA Max. Voltage range 90 Vac to 250 Vac, 50-60 Hz
Dimensions (w x d x h)	16¼" x 15¼" x 3½" 421 x 387 x 89 mm
Weight	10lbs, 4.5 kgs
Operating temperature range	10°C to 50°C
Humidity	Maximum 80% non-condensing
Temperature (specified)	25°C
Dummy Cell	Internal and External supplied
CE approved	Yes



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
- 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

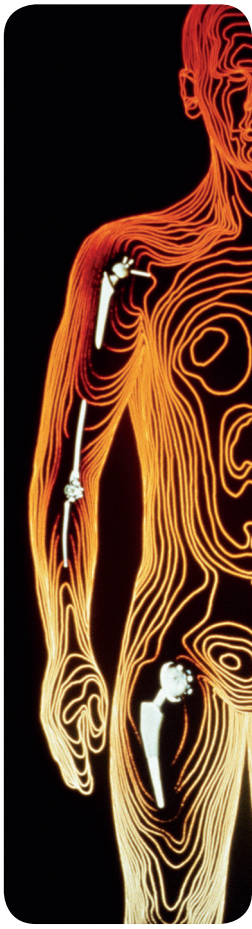
Battery, Fuel Cell and Supercapacitor Research

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 PAR 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.

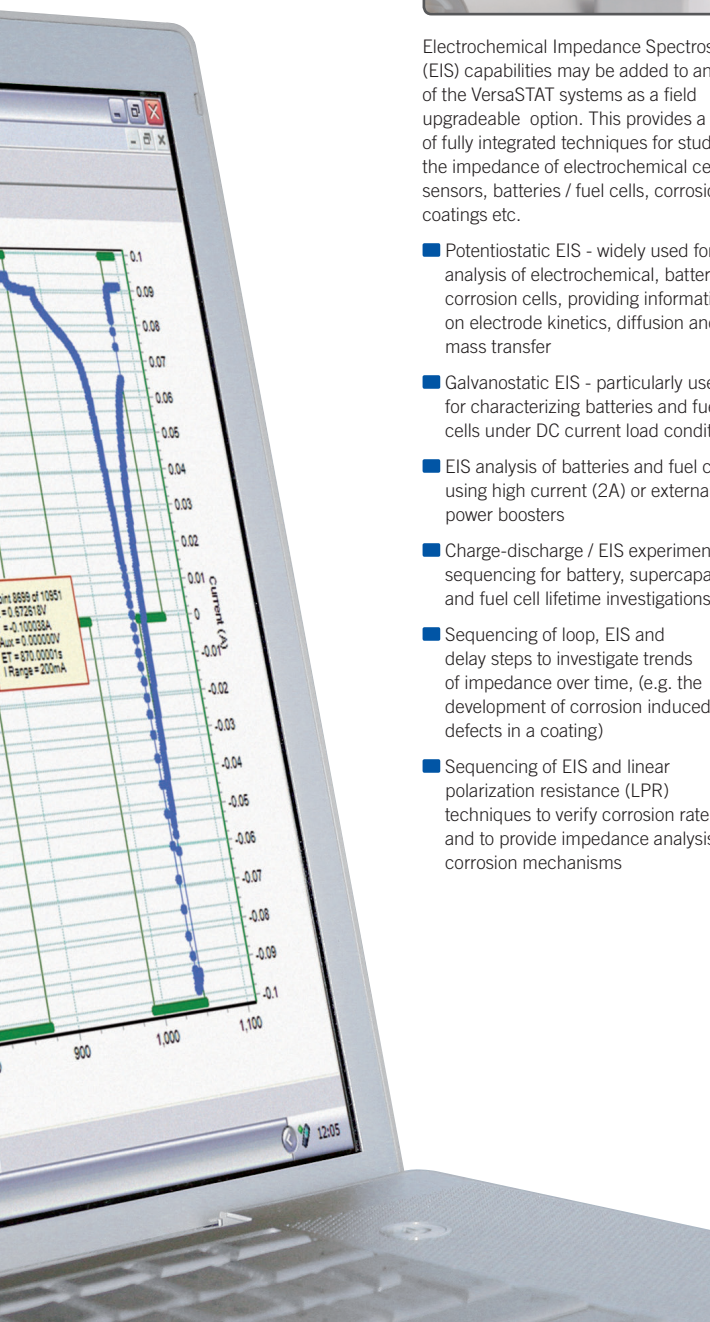
VersaStudio software

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.

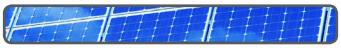
- Potentiostatic EIS - widely used for the analysis of electrochemical, battery and corrosion cells, providing information on electrode kinetics, diffusion and mass transfer
- Galvanostatic EIS - particularly useful for characterizing batteries and fuel cells under DC current load conditions
- EIS analysis of batteries and fuel cells using high current (2A) or external power boosters
- 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, & –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
- 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
- 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

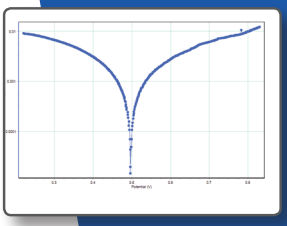
The corrosion system (VersaSTAT-300 and -500) provides a range of DC electrochemical measurement techniques that are of particular importance for the corrosion scientist investigating coatings, rebar corrosion, inhibitors, biomedical implants etc. These techniques include:

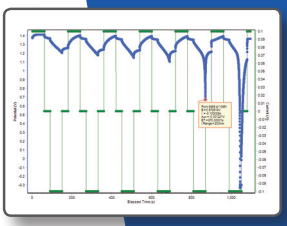
- Potentiostatic, galvanostatic, potentiodynamic and galvanodynamic techniques
- Tafel and Rp fitting analysis – providing the determination of corrosion current (Icorr), polarization resistance (Rp), data interpretation and corrosion rate calculations
- IR compensation for minimizing experimental errors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

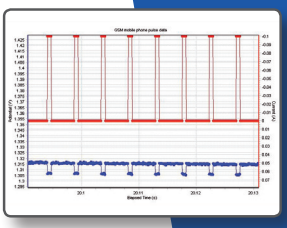
General software facilities

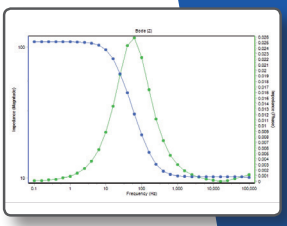
	-100	-200	-300	-400	-450	-500
Voltammetry						
Open Circuit	■	■	■	■	■	■
Linear Scan Voltammetry	■	■		■	■	■
Cyclic Voltammetry (single cycle)	■	■		■	■	■
Cyclic Voltammetry (multiple cycles)	■	■		■	■	■
Staircase Linear Scan Voltammetry		■		■	■	■
Staircase Cyclic Voltammetry (single cycle)		■		■	■	■
Staircase 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			■	■		■
Dynamic IR			■	■		■
Energy						
Constant Current					■	■
Constant Potential					■	■
Constant Resistance					■	■
Constant Power					■	■
Charge-Discharge, CC-CV					■	■
Current CCDPL					■	■
Power CCD					■	■
Resistance CCD					■	■
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		■	■	■	■	■

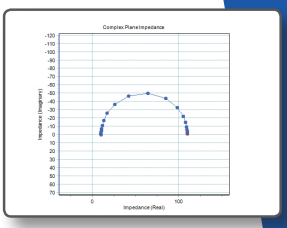
*EIS capability (Impedance) is optionally available with any of these systems











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.

VersaSTAT ordering information

Hardware

Options	Model Number for VersaSTAT3	Model Number for VersaSTAT4	Model Number for VersaSTAT3F
2A high current upgrade (standard after August 1st, 2018)	2A/VersaSTAT3/UP	2A/VersaSTAT4/UP	2A/VersaSTAT3F/UP
FRA option	FRA/VersaSTAT3	FRA/VersaSTAT4	FRA/VersaSTAT3F
Low Current Interface	VersaSTAT-LC	VersaSTAT-LC	VersaSTAT-LC
Advanced auxiliary interface	AAI/VersaSTAT3	AAI/VersaSTAT4	AAI/VersaSTAT3F

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

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

*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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