AMETEK®

solartron analytical / Princeton Applied Research / Signal Recovery









Product Catalog

Battery Cyclers / Analyzers
Potentiostats / Galvanostats
Scanning Electrochemical Systems
Solar Test Systems
Materials Test Systems
Lock-In Amplifiers
Accessories

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Princeton Applied Research, Solartron Analytical and Signal Recovery are global leaders with well over 100 years combined experience in design, manufacture and support of research instrumentation for applications as diverse as electric vehicle, fuel cell/electrolysis, general electrochemistry, corrosion, dielectric materials, photovoltaics and applied physics.

>100 Years of Product Innovation

1948



Solartron was founded by two engineers in Kingston UK, E. R. Ponsford and L. B. Copestick.

1961

Princeton Applied Research was founded by a group of scientists from Princeton University and the Plasma Physics Laboratory.

1970s



Solartron Analytical launched 1170, the world's first digital FRA.

1980s

Solartron introduced the world's first digital frequency response analyzer (1250) and EIS enabled potentiostat (1286).

1990s



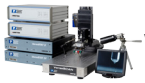
Solartron Analytical launched the 1260A Impedance/Gain-Phase Analyzer with its unique 12-decade frequency range.

2000s

PAR introduced VersaSTAT product series together with VersaStudio software platform.

Solartron Analytical released ModuLab XM, a modular platform for electrochemical and materials research.

2011



Princeton Applied Research launched VersaSCAN.

2013

PAR introduced the PARSTAT Multichannel series of potentiostats and boosters.

2016



Solartron Analytical launched the Apps-XM series of application specific products.

2020

Solartron Analytical introduced SI-9300R multichannel battery cycler / analyzers.

2022



Introduction of SI-6200 stand-alone and cabinet-based coin-cell / materials tester.

2024

Introduction of stand-alone SI-9300R desktop high-power battery cycler / analyzer.

Applications

Energy Storage

Both Energy Storage and Energy Conversion devices have roles associated with the need for portable power. Specific technologies include batteries, capacitors, fuel cells and solar cells. In commercial devices, these technologies are often used in combination as part of a power system. The power available from a device is the product of its voltage and current. The voltage of a single device is defined by its specific chemistry; whereas, the current of a single device is defined by its size (electrode area). Single devices are combined in stacks, in series or parallel, to meet the most demanding applications, such as electric vehicles.

The evolving need requires the improvement in capability to provide pulse-power, long run-time and cycle life. Power sources also have engineering constraints of volume and weight. New materials and advancements of engineering play a key role in meeting the market demand.

Electrochemical Impedance Spectroscopy (EIS) has become the go-to method to evaluate State-of-Charge, State-of-Health, and failure mechanisms of rechargeable batteries. Due to the high operating voltage and low-impedance of Li-ion batteries, the highest-levels of accuracy are required for both DC and AC measurements. Our portfolio offers a range of products to test from new materials as a half-cell to common commercial forms of coin cells, cylindrical and pouch cells.

Corrosion

AMETEK offers a range of electrochemical instruments and accessories to assist corrosion scientists in their research. Whether a potentiostat/galvanostat for corrosion rate measurements, a corrosion cell for experimenting with coupons, or a scanning system for both quantitative and qualitative measurements, all of our products are backed by Princeton Applied Research and Solartron Analytical's excellent reputation for design and support.



General and Research Electrochemistry

General and physical electrochemistry encompass many areas of investigation. These include fundamental physical electrochemistry, where the focus is on the kinetics and thermodynamics of electron transfer reactions, nanotechnology, or research conducted at the nanoscale, and electroanalysis, which involves the use of electrochemical processes to quantify an electroactive analyte.

Surface Imaging and Scanning

Scanning systems combine the functionality of electrochemical measurements with an advanced positioning system in order to map localized acitivity. A modular base provides flexibility to gain information on local events for various applications, ranging from pitting corrosion to sensor development to electrode kinetics. The spatial resolution of these scanning techniques provides complementary information to the traditional integrated response of bulk electrochemical methods.

The Princeton Applied Research VersaSCAN Electrochemical Scanning System is capable of performing the following techniques using a single scanning base:

- Scanning Electrochemical Microscope System (SECM)
- Constant Distance SECM (VS STYLUS)
- Scanning Vibrating Electrode Technique (SVET)
- Localized Electrochemical Impedance Spectroscopy (LEIS)
- Scanning Kelvin Probe (SKP)
- Scanning Droplet Cell (SDC)
- Optical Surface Profiling (OSP)

Materials Analysis

Solartron Analytical provides a range of integrated solutions that enable researchers to measure the combined electrical, thermal and mechanical properties of materials. Testing over a wide temperature range –268 to >1200°C is simplified using PC software with integrated temperature control facilities. Remote controlled furnaces and cryostats with purpose designed sample holders simplify testing of solids, liquids and powders. Materials can also be tested in specialized atmospheric conditions with use of single or dual gases for fuel cell, solid oxide and super ionic conductor applications.

Materials that can be tested include insulators, dielectrics, ionic conductors and electronic materials using a wide range of time domain and AC electrical techniques including I-V, fast pulse, C-V, Mott-Schottky, impedance, capacitance, and tan delta. Our systems provide full integration of time domain and AC techniques that provide charge carrier excitation and analysis without changing sample setup and connections.

Electrochemical Techniques



PARSTAT products:
- PARSTAT4000A
- PARSTAT3000A
- PARSTAT3000A-DX

XM products:
- ModuLab ECS XM
- EchemLab XM
- EnergyLab XM
- SolarLab XM

Solar cell techniques using ModuLab ECS XM / SolarLab XM:
- IMVS
- IMPS
- EIS
- Dark Charge Extraction
- Short Circuit Charge Extraction (Light)
- I-V
- IPCE (option)

PMC products:
- PMC-1000
- PMC-2000A
- PMC-200

VersaSTAT Products:
- VersaSTAT3A
- VersaSTAT4A
- VersaSTAT3
- VersaSTAT4
- VersaSTAT3F

*EIS capability (Impedance) is optionally available with any VersaSTAT system

Cycler Products:
- SI-9300R
- SI-9300R-SA
- SI-6200

Electrochemical Scanning techniques using VersaSTAT / PARSTAT plus VersaSCAN option:
- SECM
- SVET
- SKP
- LEIS
- SDC
- OSP

* EIS capability (impedance) is optionally available
** Not available for PMC-200

Battery Cyclers / Analyzers

Page	Product	Description
5	High-Power Cell Testers SI-9300R SI-9300R–SA	200 A per channel, cabinet-based and stand-alone cyclers
6	Coin-Cell / Materials SI-6200	200 mA per channel, cabinet-based and stand-alone cyclers
7	Aspire	PC software

Battery Cyclers / Analyzers

All Solartron cyclers include a full range of reference grade facilities that is applicable to cell development, quality control and production test. Systems are purpose designed for high efficiency, low running cost and high channel density.

- Modern, flexible PC software enables integration of cyclers and third-party equipment
- Single or multiple PC system control without limitations
- High accuracy EIS measurements per channel (not multiplexed)
- Fast time domain data acquisition on all channels without system limit
- Patented “direct to disk” data storage direct from cycler to network attached storage drives – removes PC interaction, maximizes data acquisition rates and increases system reliability
- 24-bit measurement resolution for differential capacity tests and high precision coulometry.
- 3rd Party System Integration via API (Python, Visual Studio, LabView…)

SI-9300R-XCH

SI-9300R-XCH is designed for high channel count cabinet-based systems for testing high-power cells in development, quality control and production test applications.

- Up to ±200 A continuous charge / discharge current per channel (±300 A pulse tests)
- Up to 40 channels per cabinet, no cabinet limit
- For testing cylindrical, pouch, or prismatic cells
- Power sharing between channels, modules and cabinets – high efficiency, low power usage, high channel density, no need for cooling systems

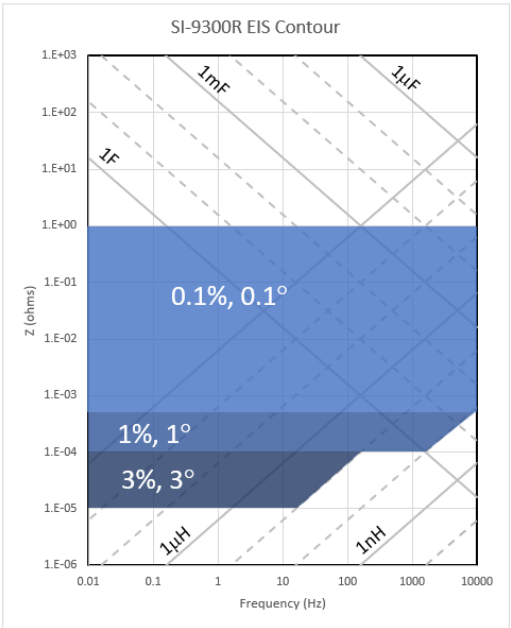


SI-9300R-SA-XCH

The SI-9300R-SA-XCH desktop stand-alone battery cycler provides unrivaled flexibility to place cyclers exactly where they are required without need for cabinets.

- Place modules next to climate chambers – shorter cable runs, lower power loss, improved accuracy
- Up to ±200 A continuous charge/discharge current per channel (±300 A pulse tests)
- Up to 4 channels per module, no module limit
- For testing cylindrical, pouch, or prismatic cells
- Power sharing between channels and modules – high efficiency, low power usage, high channel density, no need for cooling systems





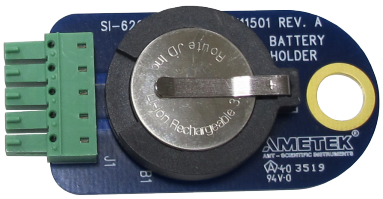
Battery Cyclers / Analyzers

SI-6200 Battery Cycler

The SI-6200 with its 10 V / 200 mA per channel capability is designed for cell material development. A range of coin-cell holders are available for various coin-cell formats. SI-6200 can be used either cabinet based or stand-alone as needed. For stand-alone operation simply plug into any available wall power socket and connect via network cable to PC and data storage device.

Each module has 10 channels, each capable of running independent tests, or they can operate in parallel groups for tests on higher current cells. Any number of PCs can be connected to control and monitor tests. All Solartron battery cyclers save data direct-to-disk (patented) to maximize data throughput and system reliability. PCs are not involved in data storage.



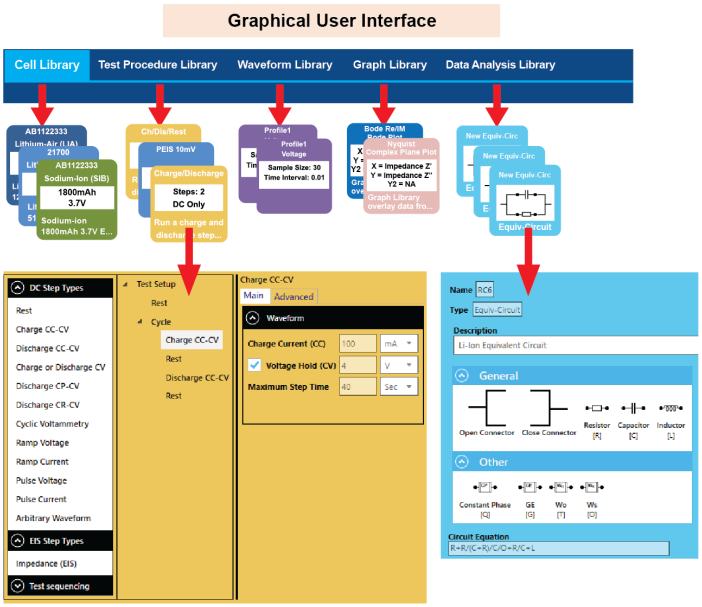




Specifications	SI-9300R-XCH	SI-9300R-SA-XCH	SI-6200
Architecture	Cabinet-based Up to 5 cha. / module Up to 8 modules / cabinet	Stand-alone distributed (cabinet not required) Up to 4 ch. / module	Cabinet-based or Stand-alone 10 ch. / module
Cell connections	4-wire main channel connections + 2 aux channels / main		4-wire + thermistor / main ch.
Max V polarization / (compliance)	+300 mV to +10 V / (+300 mV to +10 V)		-3 V to +10 V / (-3 V to +10 V)
Maximum current	±200 A (±300 A pulse) ±1000 A parallel connect	±200 A (±300 A pulse) ±800 A parallel connect	±200 mA per channel ±2 A parallel connect
Current resolution	2 µA (24-bit ADC)	2 µA (24-bit ADC)	40 pA (24-bit ADC)
Max DC sample rate	1 kS/s	1 kS/s	1 kS/s
EIS (per channel, not multiplexed)	10 kHz swept sine		20 kHz swept sine
Special features	Anode / cathode EIS Channel Share Power / Regenerative Power 24-bit measurement resolution		24-bit measurement resolution
Grounding	Floating, isolated		

Battery Cyclers - Aspire Energy Software

Aspire Energy Software provides a fully integrated test environment for management of cyclers, climate chambers, data loggers and ancillary equipment.

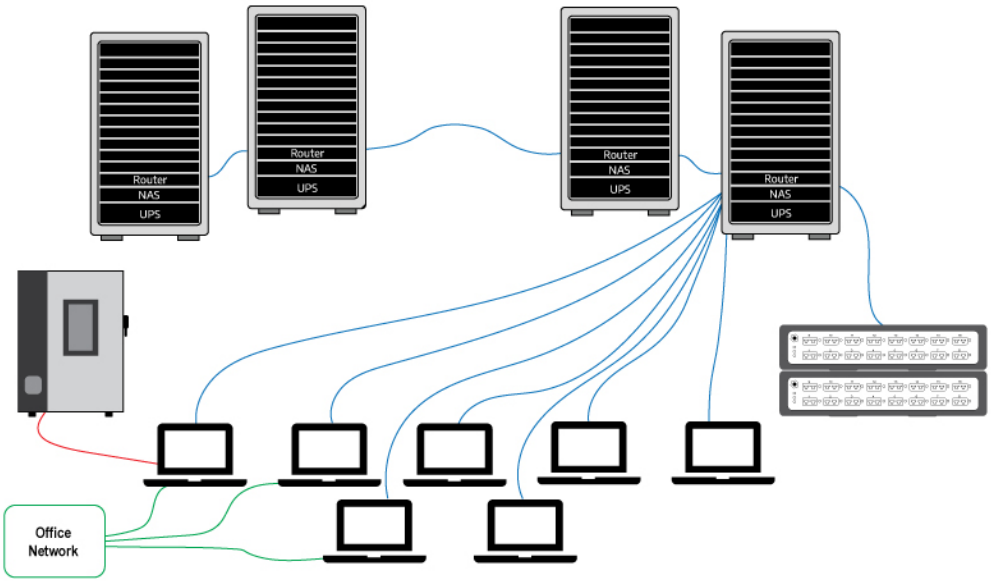


Multi-User Systems

The Aspire software can be installed on as many PCs as you wish. From a simple single PC system to a fully networked, multi operator solution – the software is fully scalable.

PCs, cyclers, data storage drives and ancillary equipment are networked to allow easy access from anywhere on the system.

Any PC / user can connect to any cycler channel to start/stop/ monitor test progress. Data analysis is available on all PCs.



Key Features and Functionality

- Single or Multi-PC user environment for control, monitoring and analysis
- Compatibility with growing range of instrumentation hardware
- Shared user libraries – minimize repetitive test / data entry
- Unique direct to disk data storage (patented) for system reliability
- Integrated test environment with location mapping – cyclers, climate chambers, data loggers
- EIS per channel
- Built-in live data analysis
- API access for 3rd party development

Supported Test Types:

- Charge / Discharge CC-CV, CP-CV, CR-CV
- Cyclic Voltammetry
- Voltage / Current Pulse
- EIS per channel
- Urban Profile
- Cycles/Loops/Variables
- Built-in Data Analysis (including EIS fitting)
- Loop Variables
- Ethernet control

Electrochemical Test Products

Energy, Electrochemistry and Corrosion Research

Page	Product	Description
9	How to choose a Potentiostat	
10	Single Channel Systems VersaSTAT3A VersaSTAT4A EnergyLab XM	 Versatile single channel potentiostat Extended current range Highest accuracy EIS
11	Single Channel Systems(cont.) EchemLab XM PARSTAT 3000A PARSTAT 3000A-DX PARSTAT 4000A	High accuracy and high voltage 100 V Single channel high voltage 30V 2 channel high voltage 30V 10 MHz EIS 48 V / 2 A
12	Multi Channel Systems PARSTAT MC PMC-1000 PMC-2000A PMC-200 PMC Booster CellTest System	 Up to 10 modules per chassis 1 MHz EIS 7 MHz EIS 10A (up to 30A with 3 in parallel) V Single channel high voltage 30V 8 channel system with high performance EIS
13	ModuLab XM	Modular high performance potentiostat / galvanostat – boosters, high voltage, femto ammeter – best EIS performance
14-15	VersaSCAN	Scanning electrochemical systems – SECM, Stylus, SVET, LEIS, SKP, SDC, OSP
16	Solar Test Systems	Photo-electrochemistry – IMPS, IMVS, I-V….
17-20	Electrochemical Accessories	Boosters, LCI, Cell Kits, RRDE etc.

Electrochemistry - How To Choose A Potentiostat

Princeton Applied Research and Solartron Analytical offer the widest portfolio of potentiostats in the industry. A primary purpose of this Product Catalog is to highlight the differentiation of these products and develop the strategy to guide you to the model that best fits your needs. Each product has further details available in its brochure and on our website.

Application

Our recommendation is to start with Application. By starting at your application, we have our first decision-point towards which Family of products and accessories are most well suited.

Simply stated: “What are you studying?”

- Energy: Batteries, Capacitors, Fuel Cells, Solar Technology
- Corrosion: Bare Metals (Oil and Gas, Defense), Coatings, Biomedical, Galvanic Couples
- Physical Electrochemistry: Electrochemical Sensors, Nanotechnology, Electrodeposition
- Materials: Dielectrics, Insulators, Piezoelectrics

Performance / Specifications

This is core in the decision-making process. The potentiostat must be able to control the cell, apply the signal and measure the response of the system. Translating application test needs into product specifications can be complicated. To make an informed decision, you should ensure that you understand each specification and how it impacts the system and your measurements.

Applications require different breath of measurements with different accuracy needs. Common specifications are:

- Maximum and Minimum Measurable Current
- Compliance and Polarization Voltage
- Impedance Capability
- Accuracy of Measured Values: Current, Voltage, Impedance
- Resolution of Applied Signals and Measured Values
- Communication Protocol
- Expandability, Options
- Software, Programmability



Technical, Applications Support

Princeton Applied Research and Solartron Analytical have a strong global support team. This provides support in many regional languages and time zones. We have decades of experience partnering with leaders of academic research, government labs, and commercial industry.

You may interface with this team during the product selection process to give you confidence that the proposed system will meet your needs.

Additionally, this global team generates key technical content such as Frequently Asked Questions, How-To Guides, and general knowledge on products, applications and techniques.

Citations, References

With our position as innovators of potentiostat and frequency response analyzer design, many of our models have more than 1,000 peer-reviewed publications. This creates a world-wide community of users across a range of applications sharing best practices.

Incumbency

Incumbency is a powerful force in the decision making process. The loyalty to a company, brand, or product is often driven by familiarity and compatibility from a software platform that is known, stable, and up-to-date.

Working in a single software package gives users access to existing test protocols, overlaying previous data files; even across varying models.

Accessories

Potentiostats often interface with accessories to become test systems. These may be ancillary equipment, cells, or cables. Specific Examples are:

- Power Boosters
- Low Current Interfaces
- Cell Kits
- Reference Electrodes
- Speciality Cables
- Integrated Systems, such as Cryostats, Furnaces, Rotators, Microbalances

Single Channel Potentiostats / Galvanostats

VersaSTAT 3A



The VersaSTAT Family combines our option-based hardware and software platforms to create the most popular line of instruments. These are USB-based communication. The VersaSTAT 3 provides sufficient function for most standard electrochemical experiments. This includes energy, physical electrochemistry, and corrosion experiments.

- Standard ±2 A current capability
- Standard ±200 nA current range with 6 pA resolution
- 2 different E and I Filters

VersaSTAT 4A



The VersaSTAT 4A improves on low-current measurement capabilities by extending the current range and providing access to lower cutoff frequency filters.

- Standard ±2 A current capability
- Standard ±4 nA current range with 122 fA resolution
- 5 different E and I Filters for improved Signal-to-Noise

EnergyLab XM



The EnergyLab XM uses the same XM based platform to deliver ModuLab performance to a focused application, the study of single-cell energy storage devices.

- Supplied internal capability to 2 A
- Range of external current boosters
- Supplied four (4) auxiliary differential voltage inputs for anode/cathode simultaneous impedance

Specifications	VersaSTAT 3A	VersaSTAT 4A	EnergyLab XM
Architecture	Single channel fixed configuration		
Cell connections	Pstat 4-wire		Pstat 4-wire + 4 aux ch (8-wire)
Max V polarization / (compliance)	±10 V / (±12 V)		±8 V / (±8 V)
Maximum current	±2 A		±300 mA (pstat) ±2 A (built-in booster)
Current resolution	6 pA 122 aA (LCI option)	122 fA 122 aA (LCI option)	1.5 pA
Max DC sample rate	100 kS/s	500 kS/s	1 MS/s
EIS	1 MHz swept sine		1 MHz swept sine, harmonic, multisine (main and aux channels)
External booster	Contact for information		Up to ±100 A or ±100V
Special features			Anode / cathode EIS
Grounding	Floating, isolated		

Single Channel Potentiostats / Galvanostats

EchemLab XM



The EchemLab XM, which also uses the XM based platform, is a wide application based instrument with sufficient voltage to study stacks of energy storage devices or complex physical electrochemistry techniques.

- Supplied internal capability to ±100 V polarization
- Supplied internal capability to ±100 V compliance
- Supplied four (4) auxiliary differential voltage inputs for DC or EIS analysis of cells within a stack

PARSTAT 3000A/3000A-DX



The PARSTAT 3000A and PARSTAT 3000A-DX offer dual voltage ranges for both high voltage and high resolution experiments. The PARSTAT3000A-DX is a hardware-synchronized bipotentiostat designed for sophisticated experiments like the RRDE analysis of Fuel Cell Catalysts.

- Auxiliary voltage input (6-WIRE) for simultaneous impedance
- ±30 V range for studying stacks or titanium corrosion
- ±6 V range to achieve high voltage resolution for standard experiments

PARSTAT 4000A



PARSTATs deliver high compliance and wide dynamic current range as standard to cover a diverse range of applications.

- High accuracy applied and measured voltage and current
- Wide-dynamic current range both standard and expandible
- User-selectable stability modes and high compliance to overcome the most complex cell requirements common to corrosion systems

Specifications	PARSTAT 3000A	PARSTAT 3000A-DX		PARSTAT 4000A	EchemLab XM
Architecture	Single chan. fixed config.	Dual chan. (Bistat) fixed config.		Single chan. fixed config.	Single chan. fixed config.
Cell connections	6 – wire pstat + 1Aux	4 – wire pstat	6 – wire pstat + 1 Aux	4 – wire pstat	4 – wire pstat + 4 aux ch(8 – wire)
Max V polarization (compliance)	±30 V / (±30 V)	±10 V / (±12 V)	±30 V / (±30 V)	10 V / (±48 V)	±8 V / (±8 V) pstat ±100 V / (±100 V) HV
Maximum current	±1 A	±2 A	±1 A	±4 A	±300 mA (pstat) ±100 mA (HV)
Current resolution	122 fA	122 fA / 122 aA (LCI)	122 fA	1.2 fA / 2 aA (LCI)	1.5 pA (pstat)
Max DC sample rate	1 MS/s	0.5 MS/s	1 MS/s	1 MS/s	1 MS/s
EIS	7 MHz (swept sine)	1 MHz (swept sine)	7 MHz (swept sine)	10 MHz, (swept sine)	1 MHz (swept sine, harmonic, multisine) Main + 4 aux channels
External booster	N/A	N/A	N/A	±20 A	Up to ±100 A "or" ±100 V*
Special features	Aux ch EIS		Aux ch EIS	E I monitor	Aux ch EIS
Grounding	Floating, isolated				

Multichannel Potentiostats / Galvanostats

PARSTAT MC



PARSTAT performance is available in a multichannel configuration in our PARSTAT MC series. The chassis is designed for robustness.

- Data Buffers
- User Replaceable Parts
- Hot-Swappable Function

This expandable platform is tailored through:

- Potentiostat Models: PMC-200, PMC-1000, PMC-2000A
- Channels: Up to 20 per chassis and 32 per system
- Current Range: Up to 30A and down to 4 pA (122 aA resolution)

CellTest System



The 1470E CellTest System is an 8 channel system providing cost-effective DC experiments and options for Solartron Analytical EIS performance. CellTest is designed for the energy researcher with application-driven software, high current per channel standard, and advanced EIS function and accuracy.

- 4 A per channel, able to be combined to 32 A
- Solartron Analytical EIS performance in simultaneous (1400/1455) mode or sequential mode (stand-alone FRA)
- Auxiliary measurement channels for multiple anode/cathode electrode investigation (AC/DC)
- Wide range of external boosters

Specifications	PMC-200	PARSTAT MC PMC-1000	PMC-2000A	CellTest 1470E*
Architecture	2 ch / board 20 ch / chassis	1 ch / board 10 ch / chassis		8 channels fixed config.
Cell connections	4 – wire	4 – wire	6 – wire	4 – wire + 8 x 2 – wire aux
Max V polarization /(compliance)	±10 V / (±10 V)	±10 V / (±12 V)	±30 V / (±30 V)	+10/ – 3V / (+10/ – 3V)
Maximum current	±1A	±2A	±1A	±4A
Current resolution	240 fA	122 fA 122 aA (LCI)	122 fA	1.5 nA
Max DC sample rate	0.25 MS/s	0.5 MS/s	1 MS/s	10 kS/s
EIS	100 kHz swept sine	1 MHz swept sine	7 MHz swept sine	1 MHz, swept sine, harmonics, multisine
External booster		Up to ±30 A	Up to ±30 A	Up to ±100 A
Special features			Aux ch EIS	Aux ch EIS
Grounding	Floating, Isolated			

* Not RoHs Compliant

ModuLab XM ECS



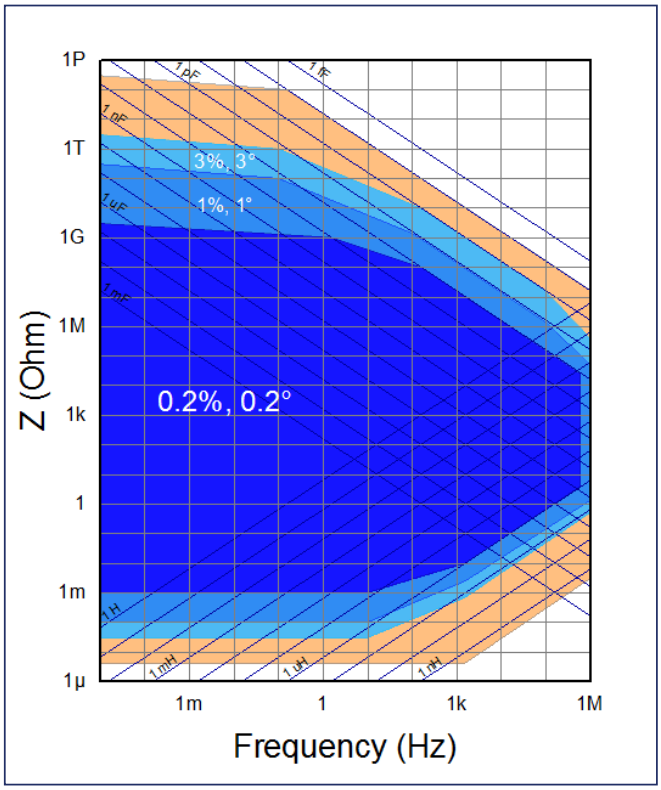
The Solartron Analytical XM based platform uses unique calibrations which provide best in world EIS accuracy. Accurate and repeatable sub 100 µΩ measurements with 3 µΩ of noise for State-of-Charge and State-of-Health determinations. Ethernet communication for wide-variety of control options.

- The ModuLab XM ECS system can be tailored for your different range of electrochemical experiments through boosters and option interfaces
- Can be expanded even beyond traditional electrochemistry including materials and photovoltaic measurements
- Exclusive Femto module for low current measurement

Specifications	ModuLab XM ECS
Architecture	User-configurable “plug & play” channels and options
Cell connections	4 - wire pstat +4 aux ch (option)
Max V polarization / (compliance)	±8 V / (±8 V) pstat ±30 V / (±30 V) HV30 ±100 V / (±100 V) HV100
Maximum current	±300 mA (pstat) ±2 A (int. booster)
Current resolution	1.5 pA (pstat) 0.15 fA (femto)
Max DC sample rate	1 MS/s
EIS	1 MHz (swept sine,harmonic, multisine) Main + 4aux channels
External booster	Up to ±100 A or ±100 V
Special features	Anode / Cathode EIS E and I monitor
Grounding	Floating, Isolated

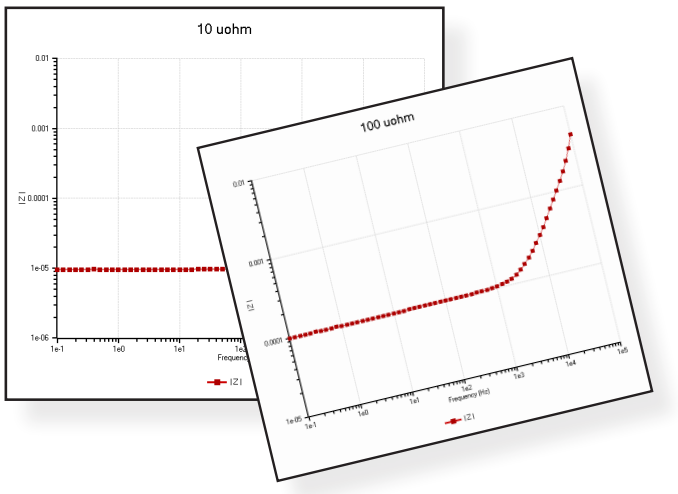
System Impedance Accuracy

Impedance accuracy specification for PSTAT, Femto Ammeter and 2A Booster combined.



Ultra Low Impedance

The ModuLab XM ECS is able to make very accurate, extreme low impedance measurements in the micro-ohm region using a wide range of internal and external power boosters. These example plots show the quality of 10 µΩ and 100 µΩ data that is available from the system.



Scanning Electrochemical Systems



VersaSCAN

The VersaSCAN is a single platform capable of providing spatial resolution to both electrochemical and materials-based measurements. Traditional electrochemical experiments measure an average response over the entire electrode/electrolyte interface. Samples often consist of local sites of passivate/active nature or sites of anodic/cathodic character. This need to investigate localized phenomenon led to the emergence of scanning probe electrochemistry.

By making the measurement at a probe placed just above the surface of the sample, the response is taken from a subset of the sample. A small measurement probe positioned very close to the surface, but non-contact, reduces the sampling volume and provides a high spatial resolution.

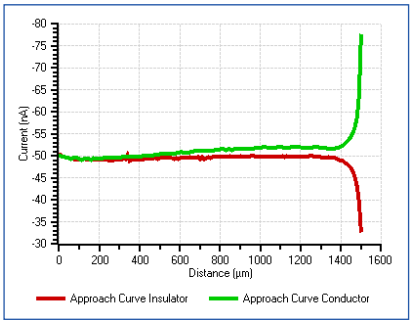
However, these small responses require superior measurement technology to record the measured parameter.

- Piezoelectric motors exclusively drive positioning. All axes give wide range (100-mm) and high resolution and repeatability. This overcomes a limitation of screw-based or hybrid-system designs
- On-Site Installation and Training provided by our Global Support Team
- Single platform capable of running several different scanning probe techniques of different resolution and application
- Leverages industry-leading measurement technology from Princeton Applied Research, Solartron Analytical and Signal Recovery products

SECM

Scanning Electrochemical Microscope System

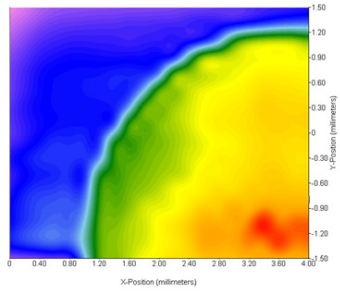
- SECM controls and monitors electrochemical reactions at the sample and ultramicroelectrode-tip using a 2-channel potentiostat
- Low Current Interface integration provides improved current measurement sensitivity for ultimate resolution and versatility
- Includes AC-SECM technique
- Common Applications include biological sensors, reaction kinetics, porous membranes, and corrosion mechanisms.

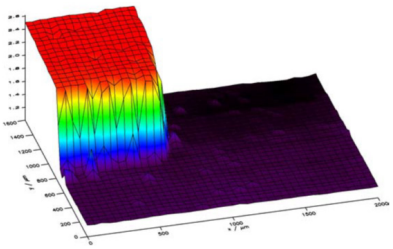


SOFT STYLUS PROBE

Constant Distance SECM

- VS-Stylus is constant distance SECM without major topographic artefacts. Ideal for tilted, corrugated and rough samples.
- Eliminates many of the experimental difficulties of Approach Curves and changing probe-to-sample distance that are associated with standard SECM techniques
- Common Applications include local electrochemical imaging, electrodeposition, surface science, and biological samples.

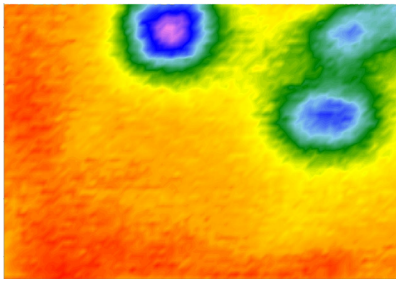




SVET

Scanning Vibrating Electrode Technique

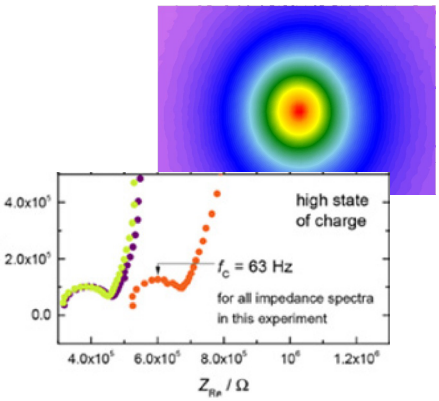
- SVET uses a Pt/Ir microelectrode to map the voltage-field in solution from local current events, such as corrosion pits or galvanic couples
- Our SR 7230 ensures superior signal measurement enabling high-resolution measurements
- Common Applications include bare metal corrosion, galvanic couples, and studies of pits or crevices.



Scanning Electrochemical Systems

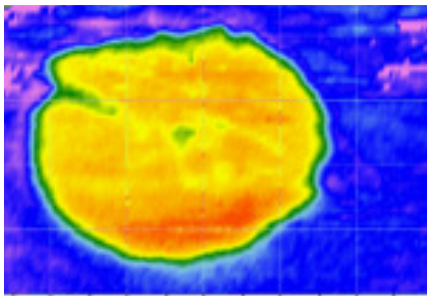
LEIS
Localized Electrochemical Impedance System

- LEIS provides spatial resolution to all of the applications that benefit from EIS measurements
- Wide measurement bandwidth and high measurement accuracy combine to benefit Local State-of-Charge (SoC) measurements and Coating failure analysis
- Common Applications include battery materials, coatings, and delamination testing.



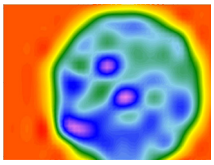
SKP
Scanning Kelvin Probe

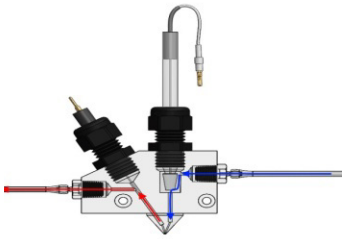
- SKP uses a relative work-function measurement, typically in atmospheric conditions, to map the anodic/cathodic nature of samples
- Superior probe design and signal measurement capability provide high-resolution measurements
- Common Applications include coatings and the study of variations in surface electrical properties.



SDC
Scanning Droplet Cell

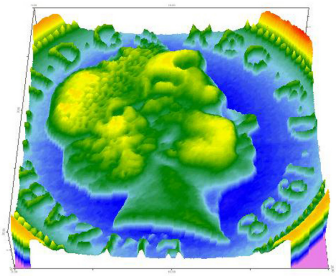
- SDC controls a flowing droplet at the surface of the sample. Users measure a subset of their sample using standard electrochemical methods
- Flowing the droplet ensures no impact of reaction products
- Common Applications include study of oxide layers, catalysis, and fuel cells.





OSP
Optical Surface Profiler

- OSP uses laser-based technology to accurately map topography of any sample
- When combined with otaher techniques, OSP data provides a mechanism for Constant-Distance measurements removing a key complication of data interpretation
- Common Applications include surface topography mapping and integration with other techniques for constant distance measurements.



VersaSCAN Options



VersaSCAN L-Cell

- Screws into optical table of VersaSCAN
- Approximately 1 Liter in volume
- Level adjustment mechanism
- Accepts large flat samples and 32 mm diameter mounted samples



VersaSCAN mL-Cell

- Screws into optical table of VersaSCAN
- Designed for small-volume experiments to maximize concentrations.



VersaCAM

- Imaging system useful for the initial positioning of probes
- Visualizes probe-to-sample distance

ModuLab XM PhotoEchem



The ModuLab XM PhotoEchem combines the powerful ModuLab Frequency Response Analyzer and Potentiostat technology. Existing systems can be upgraded to ModuLab XM PhotoEchem with an option card and optical bench.

SolarLab XM



SolarLab XM is an application specific XM product that is primarily focused on solar cell / photovoltaic research, developed in conjunction with Professor Laurie Peter of the University of Bath, UK.

Technique	Parameters
IMPS	Effective Diffusion Coefficient of Electrons
IMVS	Effective Lifetime of Electrons
Photo Voltage Decay	Effective Lifetime of Electrons
I-V	Fill Factor, Pmax, Voc, Isc, Efficiency
Charge extraction – Dark	Trapped Charge Density
Charge extraction – Short Circuit	Trapped Charge Density
IPCE Option	Quantum Efficiency
AC Measurement	Impedance / Capacitance

Common* LED Options (nm)	Maximum Power (mA)	Bandwidth, FWHM (nm)
420	500	12
455	1000	18
470	1600	29
505	1000	30
530	1600	31
590	1600	14
625	1000	16
660	1200	25
Cold White	1000	N/A
Warm White	1000	N/A

*More LED Options are available. Contact us for details.

Specification	
Wavelength Range	350 nm – 1100 nm
Intensity Range	6 Decades (With ND Filter)
Maximum Beam Divergence	4 degrees
Maximum Beam Diameter / Cell Size	1 cm
IMPS / IMVS Transfer Function	Reference Photodetector
Calibration	NIST Traceable
LED Driver Maximum Current	10 A
Typical LED Stability at Max Power	<2% Drift After 24 hours
LED Driver Maximum Frequency (IMPS and IMVS)	250 kHz

Electrochemical Accessories



LC Low Current Interface

- Femtoampere accuracy and attoampere resolution for both DC and AC (EIS) measurements
- Auto-current ranging capability from 200 mA – 4 pA (80 fA minimum range with PARSTAT 4000A)
- Users can add to existing systems without complicated tools or procedures
- Supported through VersaSCAN to provide industry-leading current resolution to localized, scanning techniques

Power Booster – Solartron Analytical

- Compatible with Solartron potentiostats including: ModuLab XM ECS, EnergyLab XM, EchemLab XM, SolarLab XM, 1280Z, 1285A, 1287A, 1470E, 1480A and 1470A
- Wide frequency bandwidth for impedance measurements. Accurate EIS measurement up to 700 kHz.
- Up to 100 V and up to 100 A





Power Booster – Princeton Applied Research MC

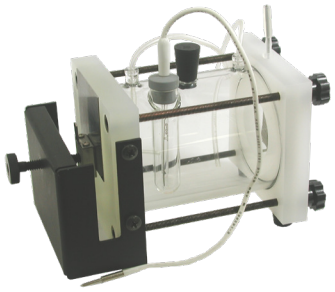
- 10 A boosters in-chassis boosters available and compatible with the PMC-2000A and PMC-1000
- Up to 30 A when operated in parallel
- Installs in PMC CHS08A chassis with PMC-2000A and PMC-1000

Power Booster – Princeton Applied Research

- 8 A / 50 V and 20 A / 20 V Options
- Operates in boosted or normal mode
- Calibrated with the potentiostat for optimal performance
- Increases both current and compliance voltage



Electrochemical Accessories



Flat Cell Kit

- Optimal construction for corrosion/coatings studies of flat specimens having a range of sizes and geometry
- Specially designed gasket to minimize crevice corrosion
- Platinum mesh counter electrode and Ag/AgCl reference electrode included
- Exposed sample area is 1 cm^2 with an option for a larger exposed area of 12.6 cm^2

Corrosion Cell Kit

- Cell configuration is modeled after a design commonly found in many ASTM standards
- Supplied with graphite counter electrodes and saturated calomel reference electrode (SCE)





Micro-Cell Kit

- Intended to be used for any application where solution volume is limited, requiring volumes ranging from 3 to 15 mL
- Purge tube assembly provided for bubbling or blanketing the solution with inert gas
- Platinum wire counter electrode and Ag/AgCl reference electrode included

Analytical Cell Kit

- Designed with two cell top configurations, one for general use and the other for accommodating a rotating electrode (RDE, RRDE, RCE) connected to the 616 or 636 A/B rotator
- Supplied with a platinum wire counter electrode and Ag/AgCl reference electrode
- Operates with solution volumes from 5 – 50 mL



Electrochemical Accessories



QCM922A Electrochemical Quartz Crystal Microbalance

- Front panel display of resonant frequency and resistance changes
- Frequency range up to 30 MHz
- Wide variety of resonators in both standard and mirror finishes
- Integrates with our potentiostats for EQCM measurements or can be operated in stand-alone mode.

636A RRDE Rotating Ring-Disk Electrode

- Rotating Disk Electrode (RDE), Rotating Cylinder Electrode (RCE) or Rotating Ring-Disk (RRDE) configuration
- Fixed shaft or interchangeable electrode assemblies available
- PTFE or PEEK shroud options





Faraday Cage

- Designed to reduce electromagnetic interference and other noise from interfering with the measurements of the potentiostat
- Standard K0269B Faraday Cage is 27 x 30 x 41 cm and is large enough to accommodate the VersaSTAT LC
- An oversized faraday cage designed for use with the VersaSCAN is also available

Battery Holders

- Replaces the standard cell cable by connecting directly to the potentiostat
- 5 options are available for the following form factors: 18650, AA, AAA, coin cell (2032) and a flexible screw-based design for custom cell geometries



Electrochemical Accessories



Reference Electrodes

- A variety of chemistries and form factors are available.
- The popular Saturated Calomel Electrode (SCE), with a standard 14/20 ground glass joint, is designed for use in the K0047 Corrosion Cell.
- Ag/AgCl reference electrodes with either a standard 14/20 ground glass joint or a smaller form factor suitable for use in the Flat Cell Kit.
- Non-aqueous and chloride free aqueous reference electrodes are offered.

Working Electrodes

- Physical electrochemistry applications benefit from our range of milli- and micro-electrodes
- Au, Pt, and Glassy Carbon (GC) milli-electrodes with 2 mm ±0.2 mm diameter are available
- Au, Pt, and GC micro-electrodes with 10 µm ±2 µm diameter are available
- These electrodes are ideally suited for the K0264 Micro-Cell Kit





Counter Electrodes

- Graphite rods for use in the K0047 Corrosion Cell Kit
- Pt coated mesh for use in the K0235 Flat Cell Kit
- Pt wire suitable for the K0264 Micro-Cell Kit

Materials Test Products

Dielectrics, Polymers, Ferroelectrics, Semiconductors, displays

Page	Product	Description
22	How to choose a Materials Test System	
23	ModuLab XM MTS MaterialsLab XM 1260A / 1296A	Time Domain and EIS modular materials test system Time Domain and EIS fixed configuration EIS test system 32 MHz
24	Accessories	Cryostats, Furnaces, Sample Holders

How To Choose A Materials Test System

Solartron Analytical offers a wide portfolio of material test systems. A primary purpose of this Product Catalog is to highlight the differentiation of these products and develop the strategy to guide you to the model that best fits your needs. Each product has further details available in its brochure and on our website.

Application

Our recommendation is to start with application and measurement needs. By starting with measurement needs, we can narrow down our product selection to a product family.

- DC voltage control: linear sweeps, pulses, staircase sweeps, triangular sweeps
- Electrochemical Impedance Spectroscopy (EIS): constant DC level or DC sweeps

Performance / Specifications

This is core in the decision-making process. The materials test system must be able to control the signal and measure the response of the system. Translating application test needs into product specifications can be complicated. To make an informed decision, you should ensure that you understand each specification and how it impacts the system and your measurements.

Applications require different breath of measurements with different accuracy needs. Common specifications are:

- Cell Impedance Range
- Minimum and Maximum AC Frequency
- Need for Synchronized Auxiliary Measurements
- Accuracy of Measurements
- Software, Programmability

Accessories

Materials test systems often interface with accessories or other instruments in order to test samples under different conditions. Automation and synchronization of these other instruments and accessories can often result in a system that is easier to use and can significantly reduce the total test time.

- Low Temperature Sample Testing
- High Temperature Sample Testing

Technical, Applications Support

You may interface with our knowledgeable support team during your product selection process to have confidence that the proposed system meets your needs. We can also refer you to various technical documents to assist your choice.

Citations, References

Due to product innovation, for example, in the fields of frequency response and impedance analysis, many of our models have more than 1,000 peer-reviewed publications. This creates a world-wide community of users across a range of applications sharing best practices.

Materials Test Techniques

		1260A	1260A / 1296A	Modulab XM MTS	Materials Lab XM
General	Open Circuit	▭	▭	■	■
	Run External Program	▭	▭	■	■
Voltage Waveforms	Constant Level	▭	▭	■	■
	Linear Sweep	▭	▭	■	■
	Triangular Sweep	▭	▭	■	■
	Staircase Linear Sweep	▭	▭	■	■
	Staircase Triangular Sweep	▭	▭	■	■
	Pulse	▭	▭	■	■
	Sweep Pulse	▭	▭	■	■
	Differential Pulse	▭	▭	■	■
	Square Wave	▭	▭	■	■
	Combinations of Above	▭	▭	■	■
EIS	Constant Level	■	■	■	■
	Linear Sweep	▭	▭	■	■
	Triangular Sweep	▭	▭	■	■
	Staircase Linear Sweep	■	■	■	■
	Staircase Triangular Sweep	■	■	■	■
	Mott-Schottky	■	■	■	■
Special	Sample / Ref Mode	▭	■	■	▭
	Femto Ammeter	▭	■	■	▭
	High Voltage (100V)	▭	▭	■	▭

Materials Test Systems

ModuLab XM MTS



ModuLab XM MTS is able perform time domain (DC) and frequency domain (AC) tests. Materials samples may be tested at low or high temperature using fully integrated cryostat and furnace accessories. Electrochemical or photoelectrochemical options may also be included in the ModuLab system.

- Widest impedance range - 10 µΩ to >100 TΩ
- Instantaneous switching between DC and AC experiments
- High voltage, Femto Ammeter and Sample/Reference options (for dielectric/insulators)
- Expandable for electrochemical and photoelectrochemical experiments

Materials Lab XM



The Materials Lab XM uses the same XM based platform to deliver ModuLab performance to a focused application, the study of Materials. This focused design allows this instrument to occupy a small footprint. ModuLab software includes integrated equivalent circuit analysis, MultiSine, and Harmonic Analysis for non-linear materials.

- Application-focused on dielectrics, insulators, and electronic materials
- Impedance Range from 1 mΩ to 1 TΩ (1E15 Range)
- Auxiliary measurement port for synchronized measurement of optical, mechanical or other transducers.

1260A / 1296A



The 1260A Impedance Analyzer is the cornerstone of FRA technology. The 1260A can be used as a stand-alone unit, but its applications to Materials is greatly expanded when combined with the 1296A Dielectric Interface. This solution measures at both high-frequency and high-impedance.

- 1260A provides a wide frequency range: 32 MHz to 10 µHz for solid state materials
- Most referenced, most cited, most popular Impedance Analyzer available
- 1296A increases impedance measurement range to 100 TΩ (1E14 Ω) for dielectrics

Specification	ModuLab XM MTS	Materials Lab XM	1260A* / 1296A*
Maximum Frequency EIS	1MHz	1Mhz	1260A SA - 32 MHz 1260A/1296A – 10 MHz
Minimum Frequency EIS	10 µHz	10 µHz	10 µHz
Test Type	DC ramp, pulse and EIS	DC ramp, pulse and EIS	EIS only
Maximum DC sample rate	1 MS/s	1 MS/s	N/A
Maximum AC Peak Voltage	8 V standard 100 V (HV100 option)	8 V	4.2 V (1260A) 10 V (1296A)
Maximum DC Voltage	±8 V standard ±100 V (HV100 option)	±8 V	±40.95 V
Current resolution	1.5 pA standard 0.15 fA (femto option)	1.5 pA	200 pA (1260A) 1 fA (1296A)
Maximum Impedance	100 TΩ	1 TΩ	100 TΩ
Minimum Impedance	10 µΩ (MBST)	1 mΩ	100 mΩ
Sample / Ref mode (10x phase accuracy)	MREF option	No	Requires 1296A
Combine with electrochemistry	Add XM Pstat plus options	No	Add 1287A
Special EIS Capabilities	Single and Multisine, Harmonics	Single and Multisine, Harmonics	

* Not RoHs Compliant



129610A LHe/LN_2 Cryostat System

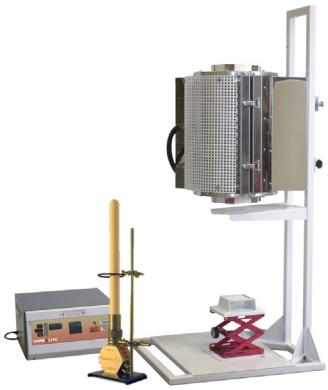
The 129610A cryostat may be used together with any Solartron materials test system to run I-V, Pulse, C-V, Impedance, Mott-Schottky and a wide range of other materials test techniques. It offers fully integrated temperature control.

- Cryogen not in contact with sample — prevents sample damage
- Temperature Range of 5 K to 600 K
- Compatible with liquid helium (LHe) and liquid nitrogen (LN_2)
- Low cryogen usage (low running cost) — capillary tube around sample space

129620A High Temperature Test System

An integrated system uses a split tube furnace design together with a lab jack that allows easy sample access and positioning. The sample is positioned in a purpose designed sample holder between platinum electrodes that allow testing at very high temperature. Key applications are development of solid-state materials, included SOFC and solid-state batteries.

- Operating range room temperature to 1200ºC using a precise temperature controller
- Various sample holder configurations are available depending on material requirements — 2 terminal/4 terminal/van der Pauw
- Dual gas configuration is available for SOFC type applications
- Controlled atmospheres





12962A Room Temperature Sample Holders

The 12962A sample holder allows accurate impedance tests of solid materials at room temperature. The sample holder consists of two parallel electrodes, one of which is fixed in position and the other which can be moved into contact with the sample by adjustment of a micrometer.

The sample holder makes use of guard ring and reference techniques in order to improve accuracy by reducing “fringing” effects at the edge of the sample.

- Electrode diameter of 20 mm standard. Options of 10 mm, 30 mm, and 40 mm.
- 2 terminal connections
- Sample types of solid, liquid, powder
- Sample thickness range of 0.2 mm to 25.4 mm

Signal Recovery

Page	Product	Description
26	Lock-in Amplifiers 7270 7230A	 DSP Lock-in amplifier with color display DSP Lock-in amplifier
26	Preamplifiers 5113A 5402A 7210DIF-P	 Voltage preamplifier Current preamplifier 4-channel voltage preamplifier

Signal Recovery

7270 DSP Lock-in Amplifier



The 7270 offers dual reference and dual harmonic detection, enabling signals at two different frequencies to be measured simultaneously. Tandem demodulation is also included. Its built-in spectral display mode shows power spectral density of the input signal, making it easy to avoid interfering signals when selecting a reference frequency.

7230A DSP Lock-in Amplifier



The 7230A offers similar high-level features to the 7270 lock-in amplifier, but without the built-in display. This model is ideal for anyone that plans to use their own software written in Python, C#, LabView or other software platforms. Full access is provided via USB, Ethernet and RS232 interfaces to all measurement facilities. Contact us for OEM discounts.

5113A Preamplifier



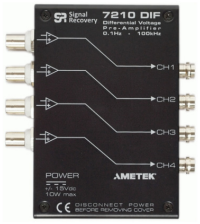
The 5113A is a high-performance, ultra low-noise (battery or line powered) voltage preamplifier with continuously adjustable gain and selectable high, low or bandpass filtering. It offers single-ended or true differential operation with DC or AC coupling,

5402A Preamplifier



The 5402A is an ultra low-noise (battery or line powered) current input preamplifier designed for use whenever the signal is a current source. Its 6 input gain settings enable detection of sub-pA current signals.

7210DIF-P Four Channel Differential Input Preamplifier



The 7210DIF-P is a four channel, medium input impedance, low-noise, AC-coupled voltage preamplifier which offers true differential inputs. It has a frequency response from 0.1 Hz to 1 MHz and gain setting of x100 with x1, ×10, and ×1000 available.

Specification	7270	7230A
Display	Large, easy-to-use built-in color display with comprehensive range of operating modes	Remote control only (no display)
Frequency Range	250 kHz to 1 mHz	250 kHz to 1 mHz
Sample Rate	Main ADC and analog outputs update rate of 1 MS/s	Main ADC and analog outputs update rate of 1 MS/s
Reference Modes	Dual Reference, Dual Harmonics and Virtual Reference	Dual Reference, Dual Harmonics and Virtual Reference
Connectivity	Ethernet, USB, RS232	Ethernet, USB, RS232
PC Software (included)	Acquire, LabView, SRInstComms	Acquire, LabView, SRInstComms

Specification	5113A Preamplifier	5402A Preamplifier	7210DIF-P Preamplifier
Number of channels	1	1	4
Type	Voltage	Current	Voltage
Inputs	Single / Differential	Single Ended	Differential
Frequency Response	DC to 1 MHz	DC to 4 MHz	0.1 Hz to 1 MHz
Gain	5 to 50,000	10 kV to 1 G V/A	1 to 1000

Notes

Notes

Notes



801 S Illinois Ave, Oak Ridge, TN 37830, USA

Unit 1, Spectrum House, 1, Millars Business Centre, Fishponds Close, Wokingham, Berkshire, RG41 2TZ.

Bhoruka Tech Park 3rd & 4th Floor Hoody Village, ITPL Main Rd, Mahadevapura, Bengaluru, Karnataka 560048.

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solartron analytical / Princeton Applied Research / Signal Recovery

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