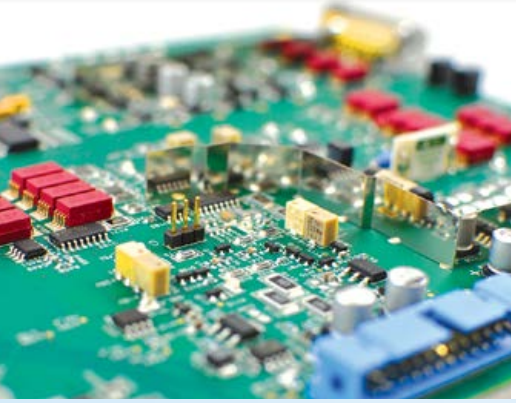
GAMRY INSTRUMENTS

Helping You Achieve Your Potential

More than 20 years of *Redefining Electrochemical Measurements*



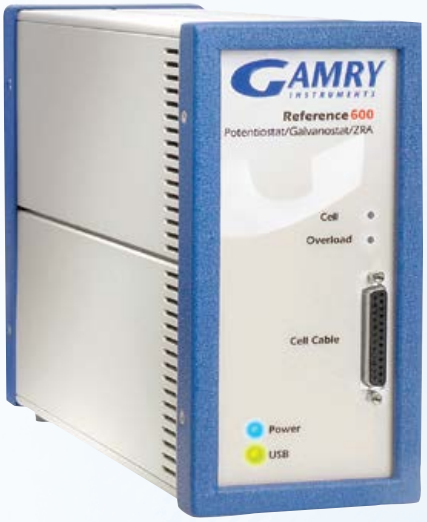
Innovation from Day One

Gamry Instruments designs, manufactures, and sells a variety of electrochemical instrumentation and accessories that are designed to fit your needs and budget. From our Reference 3000 with Auxiliary Electrometer to our Interface 1000, Gamry has always designed innovative instruments to meet your needs. Our first potentiostat, the PC3, was so innovative that we put it inside a computer! Gamry was also a leader in electrically isolating potentiostats from earth ground – any measurement with a grounded cell, grounded working electrode, or multiple working electrodes requires a floating potentisotat.

EIS at a Fraction of the Cost

Shortly after the PC3's introduction, Gamry implemented sub-harmonic sampling for electrochemical impedance spectroscopy. Electrical engineers and physicists had long been using sub-harmonic sampling, but Gamry led the way for instituting it on a potentiostat. The result – EIS at a fraction of the cost of the competition. Since this implementation, all Gamry potentiostats come equipped to perform EIS.

Several years after the implementation of sub-harmonic sampling, Gamry introduced the Femtostat. At the time of its introduction and for years afterward, the Femtostat was the leading low-current potentiostat. Gamry's forward thinking didn't stop with the Femtostat. In 1997, Gamry's Electrochemical Signal Analyzer (ESA) software brought forth biased-ZRA. This patented technique accentuated localized corrosion at the working electrode, which improved sensitivity and permitted more accurate evaluation of electrochemical noise signals.



Continually Innovating the Potentiostat

Gamry introduced the Reference 600 in 2005, showing the world that it was possible to make a high-performance potentiostat/galvanostat/ZRA in a compact package. Weighing only 3 kg and only a little bit bigger than a textbook the Reference 600 was a revolution in instrument design. The Reference 600 was so surprising to people that several called and asked where the instrument was…not believing that you could pack such performance into a device so small.

Shortly thereafter Gamry unveiled the next iterations of the Reference family – the Reference 3000, and the Reference 3000 Auxiliary Elecrometer, with eight additional sense channels. The Reference family of instruments defines high-performance electrochemistry. Everything has been designed to give you the absolute best measurement possible - from the printed-circuit board layout, to electrical isolation, to smart cables, to DSP and filtering. Nothing has been spared in pursuit of performance.

Since 1989, Gamry Instruments has been making high-performance, high-value instruments. From the first PC3 to the latest Interface 1000, Gamry has always been driven by a desire to solve the needs of our customers. By continually stressing innovation, performance, and reliability, we insure that our instruments have met your needs in the past and will continue to do so in the future.

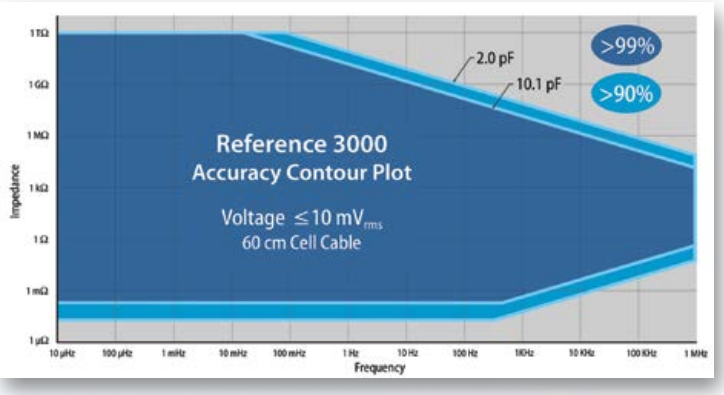
Gamry's latest innovative potentiostat is the Interface 1000. Available in both single and multichannel versions, these are value-oriented instruments that still cover the same wide-range of techniques that the Reference line does. These are the ideal instruments for labs on a budget doing basic DC corrosion, charging/discharging, physical electrochemistry or basic impedance spectroscopy.

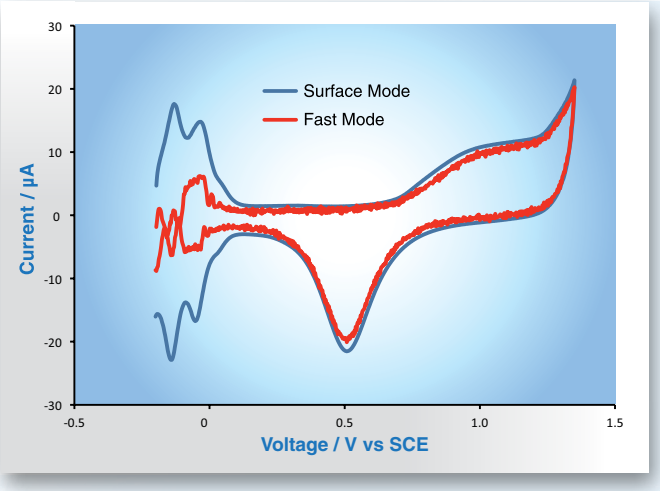
More Than Just Potentiostats

Gamry's innovations have not been limited to just potentiostats. Gamry also introduced the world's first commercial, rapid impedance-scanning QCM – the eQCM 10M. Its unique design allows it to accommodate any crystal frequency from 1-10 MHz mounted in any cell.

Innovating EIS

Gamry publishes Accuracy Contour Plots for every one of our instruments. The Accuracy Contour Plot describes the electrochemical impedance spectroscopy accuracy over a given frequency and magnitude range. These plots are generated through a series of experiments using real-world conditions and applied signals. We do not use inflated signal amplitudes or remove the cabling from our instrument in order to generate these plots. We publish real numbers you can achieve in your lab!





Digital Signal Processing

Gamry potentiostats incorporate digital signal processing (DSP) technology. This allows us to oversample and average in order to improve signal-to-noise ratios and provide accurate capacitance measurements. Our instruments have three sampling modes – Fast, Noise Reject, and Surface. Fast corresponds to signal acquisition much like a normal digital potentiostat – sampling at the end of each step. Noise reject oversamples and averages during the last 20% of a step. Surface mode oversamples and averages during the entire step to ensure accurate capacitance measurements by cyclic voltammetry.

Sequence Experimental Techniques

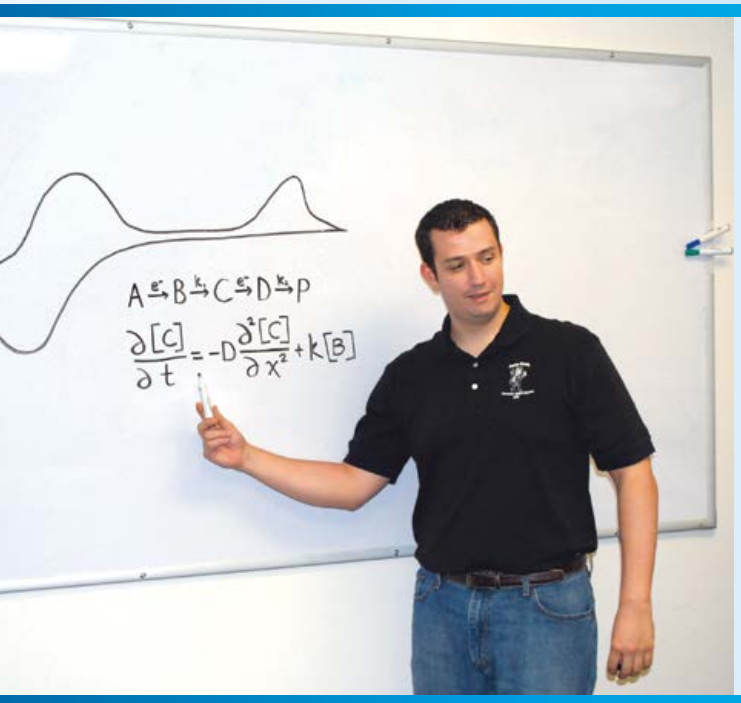
Gamry's software includes a Sequence Wizard for stringing together a series of experiments. The Sequence Wizard contains options for looping based on time, cycle number, or a variable. Run cyclic voltammograms with increasing vertex potentials or a series of chronoamperometry experiments with increasing step sizes. Imagine cyclic charging and discharging with increasing or decreasing current, load, or power levels. Throw in a delay into your loop and you can now tell the software to obtain an EIS spectrum once an hour for the next 24 hours. This powerful tool is limited only by your imagination and can also be customized just like the standard experimental scripts.

Applications

Gamry's flexible hardware and software covers a wide range of applications – corrosion, physical electrochemistry, sensors, bioelectrochemistry, energy storage and conversion devices, coatings, semi-conductors, photovoltaics, and more. Here are some highlights.

Corrosion Measurement

Gamry offers the world's most complete selection of electrochemical tools for the material scientist and corrosion engineer. Every Gamry potentiostat can run the complete repertoire of DC techniques, EIS, Electrochemical Noise, and EFM. Gamry has long been the electrochemical corrosion leader.



Physical Electrochemistry/ Bioelectrochemistry/Sensor Development

Research on amperometric, potentiometric and electrochemical biosensors continues to accelerate. A Gamry potentiostat running physical and electroanalytical techniques, coupled with EIS is the perfect tool for characterizing new sensor materials, membranes, and protocols. Gamry's QCM can also be used as a tool to help characterize interfaces or improve sensor design.

Academic and industrial electrochemists can also use their Gamry potentiostat combined with the physical electrochemistry software to measure the kinetics and study the mechanisms of electrochemical reactions. Add in our spectroelectrochemistry system to provide even more insight. Finally, complete your research by modeling reactions and mechanisms using the DigiElch Electrochemical Simulation Software.

Coatings Evaluation

Coatings evaluation demands a high-performance potentiostat. The Gamry Reference family instruments are designed for high impedance systems like coatings. When coupled with the EIS300 software and the PTC1 Paint Test Cell, they generate rapid, quantitative data to assess the quality of your coatings. Visit the Gamry website and download our three papers on evaluating paints with EIS.

Energy Devices

Gamry's suite of instruments and techniques allow you to characterize any number of energy devices – batteries, supercaps, fuel cells, electrolyzers, and photovoltaics. Whether you're testing full cells, half cells, or stacks, Gamry has what you need. Perform cyclic charge/discharge with a few simple clicks. Drop an EIS measurement into the middle of a charging step. We even give you the option to charge under constant current, constant load, or constant power.

Impedance is an integral part of analyzing energy devices. Besides the standard potentiostatic and galvanostatic techniques, we have a hybrid EIS technique where you perform a potentiostatic EIS experiment under galvanostatic control. Speed up those EIS measurements using our unique OptiEIS™ multisine technique. Our power-leveling algorithm maximizes signal-to-noise ratio while ensuring that you don't damage your sample. Anyone performing EIS on porous electrodes will benefit from our Transmission Line circuit elements. Gamry's EIS software also includes our exclusive Autofit™ routine that takes the guesswork out of estimating initial parameters for EIS circuit elements.

Custom Applications and Open-Source Scripting

Gamry's software includes all of the traditional available techniques and then some. Our software includes over 85 standard techniques and numerous custom techniques. The experimental scripts are open source, allowing users to create, modify, and share scripts with anyone. Software development kits are also available for languages such as LabVIEW, C, C++, C#, and Visual Basic. Examples are included with the development kits to get you started. Any language that can communicate with a Microsoft COM object can be used to control a Gamry potentiostat.

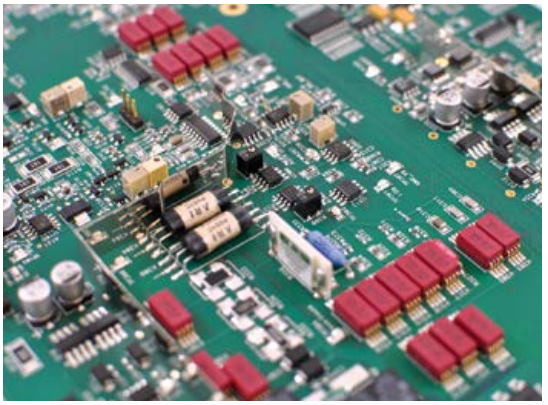
```
; Run a controlled potential IV curve from VInit to VFinal
function Cpiv (Pstat, VInit, VFinal, ScanRate, SampleTime, IRToggle)

    InitializePstat (Pstat, IRToggle)

    Pstat.PrintHardwareSettings ()

    ; Create a ramp generator for this pstat
    Signal = VRAMP.New ("SIGNAL", Pstat, VInit, VFinal, ScanRate, SampleTime)
    Signal.SetAcquisitionControl(NIL, NIL, NIL, SAMPLINGMODE_NR)

    Pstat.SetSignal (Signal)

    Curve = CPIV.New ("CURVE",Pstat)
    Curve.SetPlot (CPIV_LOGIV, 1.0e-12, 0.050, 1.0)

    Pstat.InitSignal ()         ; Initialize the signal generator via the Pstat
    Pstat.SetCell (CellOn)

    Notify ("Autoranging")
    Pstat.FindIERange ()
    Notify ("Running Potentiodynamic Curve")
    Curve.Activate ()
    Curve.Run ()                ; Actually run the curve here
    Pstat.SetCell (CellOff)
```

Writing the experimental techniques in an open-source scripting language means that Gamry can easily modify any experiment to your needs. Perhaps you're only interested in acquiring data for the last 100 seconds of a 10 hour potentiostatic hold. Maybe you want to automatically calculate a corrosion rate and tabulate the results for a series of repetitive experiments. Maybe you want to automatically write the results to a database. Gamry's flexibility allows you to do all of these and more.

Reference 3000
Potentiostat/Galvanostat/ZRA

HIGHLIGHTS

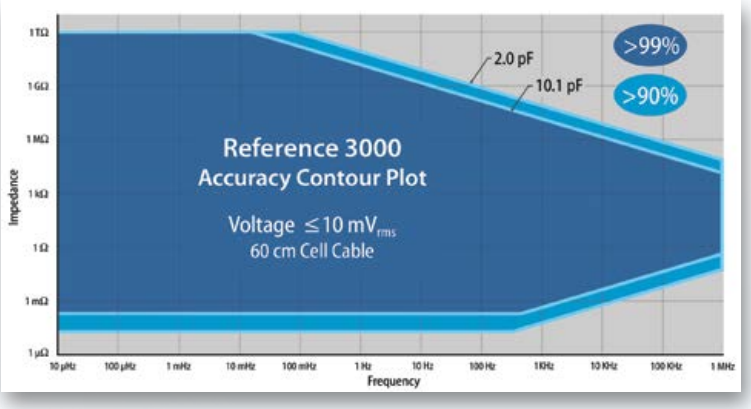
- 3 A Maximum
- Up to +/- 32V
- EIS from 10 µHz to 1 MHz
- Electrically isolated
- 11 current ranges
- 3 µs timing



Top of the Line Performance

The Reference 3000 is a high-current, high-performance potentiostat with 11 current ranges from 3 amps to 300 picoamps. This instrument also includes a switchable compliance mode for either high-current or high-voltage operations – ± 3A at ± 15V or ± 1.5A at ± 32V. A special stack mode, enabled with a high-voltage electrometer allows you to apply and measure right up to the compliance limit.

Built in EIS



With on-board electronics for electrochemical impedance spectroscopy, the Reference 3000 can make accurate measurements over a frequency range from 10 µHz to 1 MHz. Modes include potentiostatic, galvanostatic, and a unique hybrid mode where potentiostatic EIS is run galvanostatically to ensure you don't accidentally damage your sample.

Our combination of DSP and signal filtering ensure the best possible measurement. Compare our Accuracy Contour Plot with any of our competitors and you'll quickly see why the Reference 3000 delivers best-in-class performance.

Portable

Weighing only 5 kg means the Reference 3000 is small enough to move to wherever your experiment takes you. Combine that with the fact that the instrument is electrically isolated from ground and you get a perfect corrosion measurement system. Whether you're working with autoclaves, salt spray chambers, pipelines, rebar in concrete, or any other type of grounded cell, you can be sure the Reference 3000 will deliver the results you need.

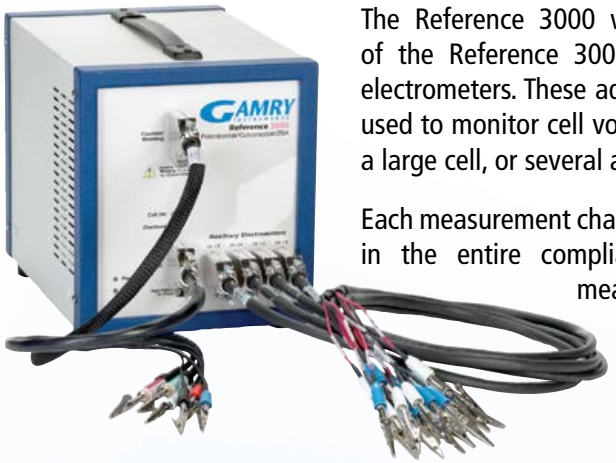
The Reference 3000 includes both current interrupt and positive feedback iR compensation. Our control loop algorithms accurately measure and correct for uncompensated resistance - this way you can be sure you're getting the signal you requested.

Optional Signals

A variety of inputs and outputs are available through the rear of the instrument. Monitor E or I, input an external signal, control a rotator, monitor an external signal, temperature, or even the potential of your counter electrode. Our miscellaneous I/O connector even includes four digital inputs and four digital outputs. Finally, the miscellaneous I/O connector also provides for syncing capabilities between any number of Reference family instruments for bipotentiostat or n-potentiostat configurations.

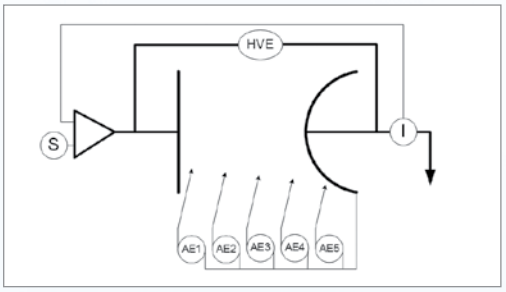
Reference 3000 Auxiliary Electrometer & Reference 30k Booster

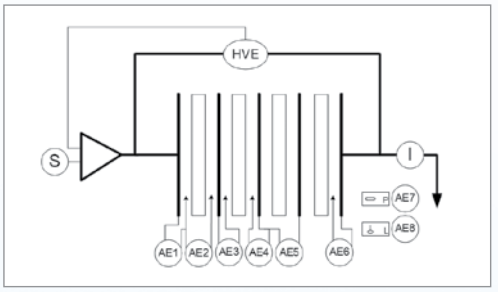
Eight Additional Electrometers



The Reference 3000 with Auxiliary Electrometer is a variant of the Reference 3000 that has eight additional differential electrometers. These additional measurement channels could be used to monitor cell voltages in a stack, potential distribution in a large cell, or several auxiliary processes all at once.

Each measurement channel can measure a ± 5 V signal anywhere in the entire compliance voltage range. Stack impedance measurements up to 100 kHz are also possible. Imagine characterizing eight cells in a stack simultaneously.





HIGHLIGHTS

- Stack impedance up to 100 kHz
- Multiple reference electrodes
- Monitor additional voltages

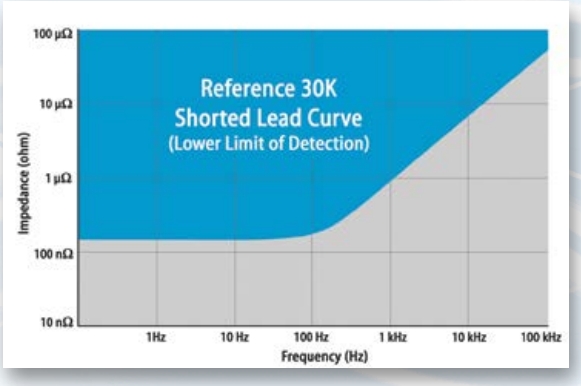
Higher Currents

The Reference 30k Booster for the Reference 3000 is an external hardware option which increases the current limit of the Reference 3000 by a factor of 10 to ± 30 Amps. The Booster will only operate with the Reference 3000 and will work with all Reference 3000 functions including the Auxiliary Electrometer option. The Reference 30k Booster replaces the current leads (Counter and Working) from the Reference 3000 while the Reference 3000 voltage sense leads (including those of the AE) keep their original function.

HIGHLIGHTS

- 30 A Maximum
- EIS to 300 kHz
- Pass-through mode
- Floating

Ultra Low Impedance



The Reference 3000 plus the Reference 30k Booster is an ideal system for the evaluation of new technologies for batteries, fuel cells, and next generation supercapacitors. The compliance limits of the Reference 30k allow complete discharge (through zero volts) and can accurately measure impedance values below 100 µΩ.

Reference 600
Potentiostat/Galvanostat/ZRA

HIGHLIGHTS

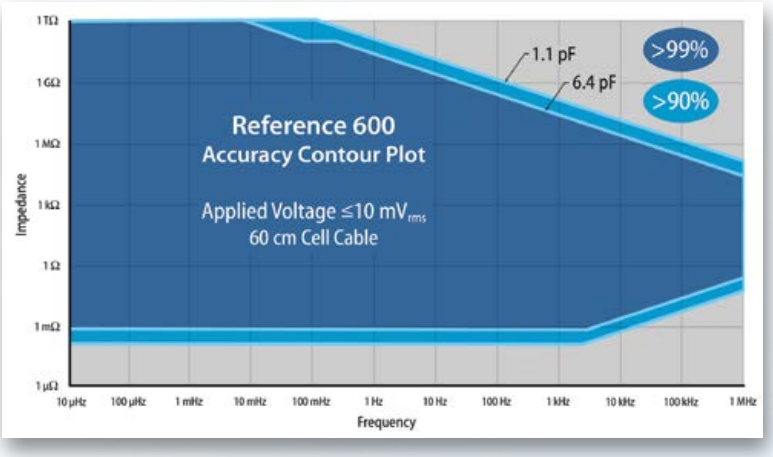
- 600 mA Maximum
- EIS from 10 µHz to 1 MHz
- Field deployable
- Floating
- 3 µs timing

Premium Performance

The Reference 600 is the lower-current instrument in the Reference family and is best for low-current applications demanding the lowest noise levels. It has 11 current ranges from 600 mA to 60 pA, a compliance voltage limit of ± 22V, and an applied voltage limit of ± 11V.

Like the Reference 3000, the Reference 600 is a compact, portable instrument. Weighing only 3 kg and roughly the size of the Bard and Faulkner electrochemistry book, the Reference 600 is easily transported from the lab to the field.

With noise levels of ≤ 2 µV rms, the Reference 600 is possibly the quietest potentiostat on the market. Combine this with the 3 µs timebase and you get a combination that is perfect for fast-scan experiments at UMEs, nanoelectrodes, and scanning applications.



Accurate EIS

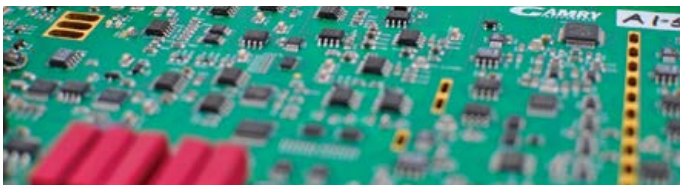
The Reference 600 includes the same DSP and filtering that the Reference 3000 does and therefore delivers the same accurate impedance. The lowest current range on the Reference 600 though allows for the measurement of higher impedance samples such as paints and coatings.

The Reference 600 includes both current interrupt and positive feedback iR compensation. Our control loop algorithms accurately measure and correct for uncompensated resistance - this way you can be sure you're getting the signal you requested.

Options

A variety of inputs and outputs are available through the rear of the instrument. Monitor E or I, input an external signal, control a rotator, monitor an external signal, temperature, or even the potential of your counter electrode. Our miscellaneous I/O connector even includes four digital inputs and four digital outputs. Finally, the miscellaneous I/O connector also provides for syncing capabilities between any number of Reference family instruments for bipotentiostat or n-potentiostat configurations.

Interface 1000
Potentiostat/Galvanostat/ZRA



Versatile

The Interface 1000 is a research-grade potentiostat/galvanostat/ZRA for use in general electrochemistry applications. It is the ideal instrument for labs on a budget doing corrosion measurements, single-cell battery testing, sensor development, and physical electrochemistry.

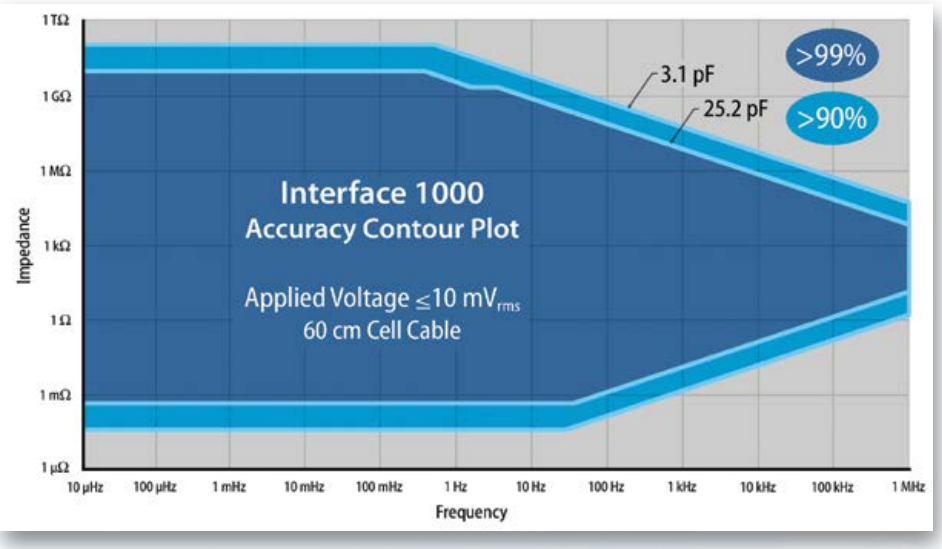
The Interface 1000 has nine current ranges from 10 nA to 1 A, a compliance limit of ± 20V, and a maximum applied potential of ± 12V. Like all Gamry potentiostats, the Interface 1000 comes equipped to perform EIS.

HIGHLIGHTS

- 1 A Maximum current
- EIS from 10 µHz to 1 MHz
- Floating

Low Noise

Ten active filters on the voltage and current channels reject external signal and noise that adversely impact your measurements. The Interface 1000 automatically selects the best filter for the acquisition mode, while still offering expert users the choice for manual adjustments.



The Interface 1000 acquires data at 60 kHz, using digital signal processing (DSP), in order to oversample for the best signal-to-noise ratio possible. Combine DSP acquisition with the low intrinsic noise level of the instrument to see why Gamry brings new meaning to low noise. A sophisticated two-stage cell switch is utilized in the design of the instrument. The first stage is a relay which insures pure electrical isolation. The second stage consists of an ultra-fast MOSFET switch with zero contact bounce. This second stage allows for better signal application with minimal spikes, as well as the ability to perform current interrupt.

Options

Monitor points as well as digital I/O and syncing capabilities expand the Interface 1000's experimental features. The monitor connector on the front allows you to monitor E and I on an additional device if necessary, while the User I/O on the back allows you to set or read four digital inputs and four digital outputs. Finally, the Sync on the rear allows for bipotentiostat and n-stat configurations.

Multichannel Potentiostat/Galvanostat/ZRA

HIGHLIGHTS

- Up to eight Interface 1000s in one chassis
- Multichannel value, single channel capability

Throughput

Time is money. When you want to increase throughput for any number of experiments you need multiple channels. Whether it's cycling batteries or running multiple long-term potentiostatic experiments, you need a multichannel potentiostat.

Gamry has changed the way people think about multichannel potentiostats with the introduction of the Interface Power Hub (IPH). No longer do you have to overpay for a multichannel chassis and fill it with powered-down potentiostats. The IPH holds up to eight Interface 1000s that can be controlled individually, in groups, or all as one.

Flexibility

When the need arises to move a channel closer to your cell, you can easily remove a single channel and place it right next to your experiment. No other manufacturer gives you this flexibility. Other manufacturers would send you a long cell cable which is going to pick up environmental noise and also suffer from voltage drop over long distances. Additionally, the increased cable length brings increased capacitance and decreased AC performance.

Other multichannel configurations are available. Contact Gamry or your local distributor for full details.

eQCM 10M
Electrochemical Quartz Crystal Microbalance

HIGHLIGHTS

- 1-10 MHz
- Any cell
- Adjustable driving amplitude

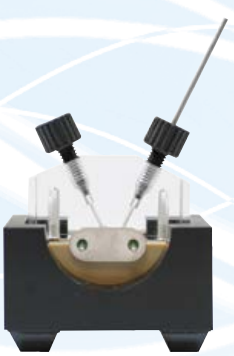
A Valuable Tool

The eQCM 10M™ is a rapid, impedance-scanning electrochemical quartz crystal microbalance (EQCM). An EQCM adds a valuable tool in the analytical toolbox of anyone investigating interfacial processes. Corrosion, ion intercalation, ion adsorption, polymer growth, and sensor binding events are all interfacial processes that produce mass changes. These mass changes can be measured by monitoring the resonant frequencies of an oscillating quartz crystal.

The eQCM 10M is a versatile instrument that accommodates any crystal from 1-10 MHz in any cell or holder. Its resolution allows you to detect mass changes on the ng/cm^2 scale. This is less than a monolayer of material. Gamry's Resonator software controls both the eQCM 10M and a Gamry Potentiostat.

The eQCM 10M rapidly scans a frequency window around the two resonant frequencies. The advantage of scanning through the two resonant frequencies is that you no longer need to cancel the parasitic capacitance in order to maintain oscillation. Additionally, the relative impedance spectrum is displayed each time a data point is acquired, giving you insight into bubble formation on your electrode or improper cell setup. Having the two resonant frequencies also allows you to do basic dissipation monitoring. When f_s and f_p respond similarly your film is rigid, however, when f_s and f_p respond differently the film is not rigid.

Resonator also allows you to adjust the driving amplitude of the crystal. This is especially important when working in an ionic liquid (IL) or a viscous solution where damping is especially high. The ability to manually increase the driving amplitude for heavily-loaded crystals offers a significant advantage over straight dissipation or time-resolved techniques. Data analysis is done in our flexible and customizable Echem Analyst™. We give you a variety of plotting options to allow you to display the data as you want. You can plot straight mass change versus time, mass versus charge, mass versus potential, or a basic form of dissipation versus time.



Spectroelectrochemistry

HIGHLIGHTS

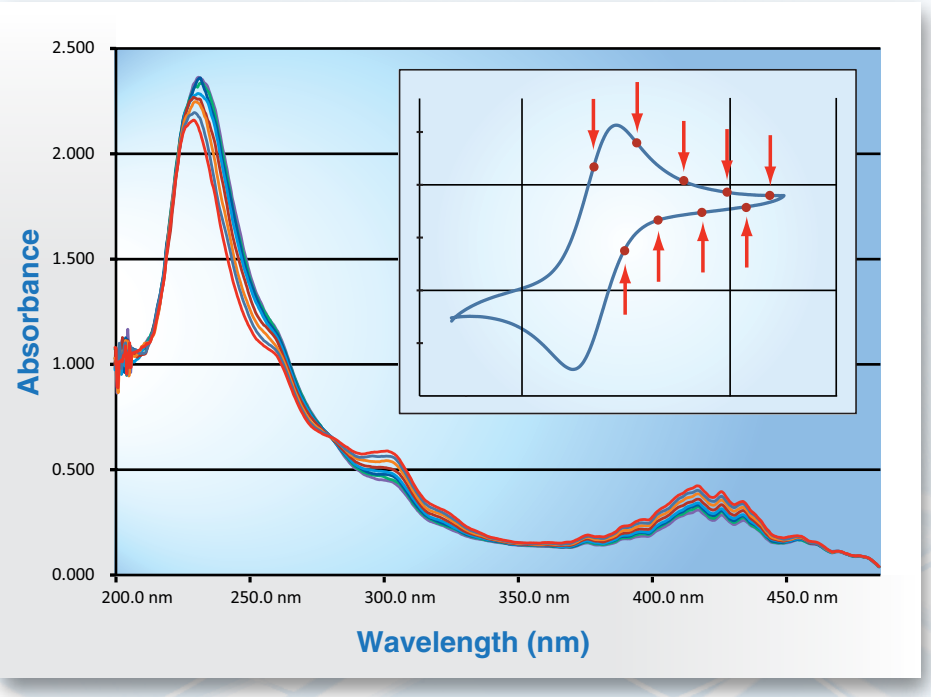
- Simultaneous data acquisition
- Ultra-low thermal drift
- Fiber-based spectrometers

Spectro-115E/115U

Spectroelectrochemistry is a coupled technique combining electrochemistry and spectroscopy. Gamry's two systems, the Spectro-115E™ (UV/Vis/NIR) and Spectro-115U™ (UV/Vis) can be combined with a Gamry potentiostat (PCI4 and newer).

Each system utilizes a miniature CCD spectrometer, USB 3.0 communication, and temperature compensation. These fiber-based spectrometers can be easily configured for absorption/transmission, fluorescence/phosphorescence, and Raman. The deuterium/tungsten light source, with a spectral output of 200 - >1100 nm can be configured to provide both D_2 and W. The light source also includes a safety shutter.

Other spectrometer configurations are available along with the ability to analyze data from other spectroscopy systems.



ECM8 Electrochemical Multiplexer
VistaShield Faraday Cage

Turn One Channel Into Many

The ECM8™ Electrochemical Multiplexer is an affordable way to expand the throughput of your lab. The ECM8 is ideal for corrosion inhibitor testing, EIS studies, monitoring of field probes for corrosion tests, chemical sensor development, and microbial fuel cells (MFCs).

The ECM8 partners with a Gamry Potentiostat to convert a single potentiostat into a powerful instrument suitable for sequential multichannel operations. Each multiplexer allows you to sequentially take measurements on up to eight electrochemical cells. The ECM8 is great for automating repetitive experiments, and for increasing throughput on long-term experiments where data can be taken periodically. You can even stack ECM8s to a single potentiostat to get more than eight channels.

Many MFC studies involve long-term potentiostatic tests with periodic sampling of current in order to calculate the energy output. Each of the eight multiplexer channels also incorporates a local potentiostat to polarize the same when not actively participating in a measurement. Each local potentiostat in the multiplexer can output a current of 30 mA at ± 5V that could be used to drive the MFC. Periodic cycling to monitor current is then all that is needed to calculate the energy output of each device – all this with only one potentiostat and one ECM8.

Shield Those Experiments

Low current experiments ranging from microelectrodes to EIS of coatings can be susceptible to picking up electromagnetic (EM) noise from the surrounding environment. A Faraday cage is the ideal solution for shielding your experiment from the harmful EM noise. Gamry's VistaShield Faraday Cage is made from powder-coated 304 Stainless Steel and is designed to stand up to a wide variety of laboratory environments. The Faraday cage's conductive glass window allows experimenters to visually observe the cell during an experiment without breaking the shielding.

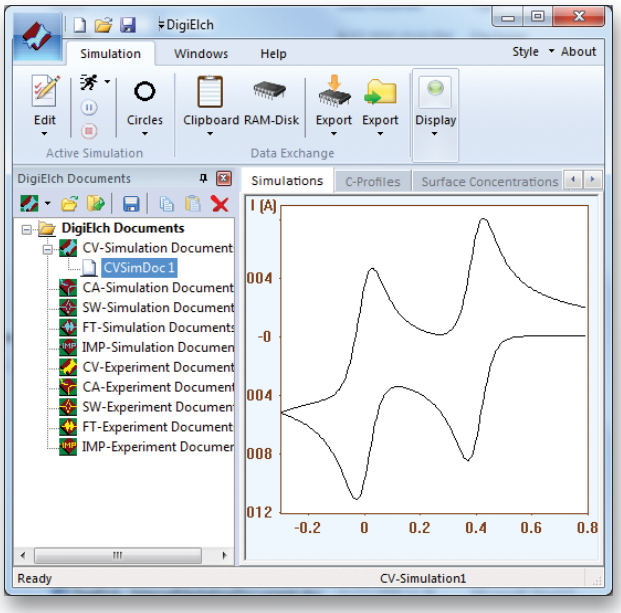
The VistaShield includes two ports on one side for cell cables and a number of ports on the back for gas and water flow. Inside there is a grounding lug for connection to a suitable ground. There is also a mounting post for holding a cell.

Stir/Purge

Any number of experiments will require replenishment of the double-layer or purging of oxygen from solution. The VistaShield can be connected with Gamry's Stir/Purge. Made of the same power-coated stainless steel as the Faraday cage, the Stir/Purge provides magnetic stirring and gas purging/blanketing. The stirrer speed and the gas flow rate are controlled by knobs on the front panel. The stirrer switches between on, off, and remote, while the gas flow switches between purge, blanket, and remote. The rear of the Stir/Purge has one gas line in and two gas lines out, a 15 pin D connector, a USB, and switched DC power in.

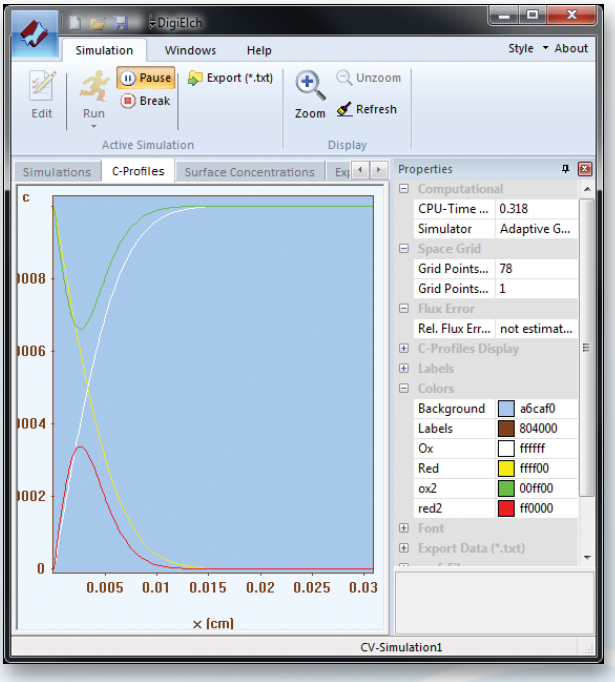
DigiElch Electrochemical Simulation Software

Simulate More Than Just CV



DigiElch is an electrochemical simulation software program that does much more than just cyclic voltammetry. Other experiments include chronoamperometry, square wave voltammetry, electrochemical impedance spectroscopy, and Fourier Transform voltammetry. DigiElch was originally developed by Manfred Rudolf and now Gamry is the exclusive worldwide provider of this program. The most common electrode geometries can be simulated including thin layer cells and the exact (two-dimensional) simulation of band and disk microelectrodes. Effects such as IR-drop and double layer charging can be included in all these simulations.

Get fast and accurate simulation of the current response for any user-defined mechanism consisting of charge-transfer steps and first- or second-order chemical reactions. 1D simulation of finite and semi-infinite diffusion. Two different simulation methods are available - a fast "fixed grid simulator" and a slower "Adaptive Grid Simulator".



Charge-Coupled Transfers

DigiElch allows for modeling of termolecular charge transfer reactions such as the proton coupled electron transfer (PCET). You also have the ability to model surface adsorption and redox catalysis reactions on electrode surfaces with unprecedented detail. Import experimental (or re-import of simulated) curves for data fitting. DigiElch even has improved computational efficiency via parallel processing.

A Professional option exists which includes all the features of DigiElch Standard, plus a non-linear regression strategy applied to multiple data files simultaneously to determine thermodynamic and kinetic parameters from your experimental data.

Control a Potentiostat

DigiElch can be optionally paired up with a Reference 600 to run actual experiments. The experimental setup with DigiElch includes hardware settings for the Reference 600 such as current range, filters and control amplifier bandwidth in addition to experimental details like electrode type, diffusion geometry and chemical species. The files collected in this way are immediately ready for fitting in DigiElch 7.

FlexCell

The FlexCell, used to determine the Critical Pitting Temperature according to the ASTM G150 standard, is designed to counteract a problem that plagues most other flat sample designs – crevice corrosion around the specimen seal. First popularized by Avesta Steel, the cell utilizes a flooded gasket seal design to inhibit crevice corrosion between the sample and its holder. This simple, yet elegant, design results in an easy to use, reliable, crevice-free system.

The FlexCell is a two-piece, 1 L cell with a flooded gasket, made up of a Teflon® base with three ports and two o-ring seals, and a glass bell top with 7 ports (four #7 Ace-Thread, 2 24/40 standard taper, 1 SJ 35 ball joint).

The flat specimen is mounted under the flooded gasket beneath the Teflon base. The three ports are for the flooded gasket DI water source, a temperature probe, and the reference electrode Luggin all positioned near the specimen.

The ports of the glass bell top accommodate a graphite counter (Ace #7), a gas dispersion tube (ST 24/40), an available wand stirrer (center ST 24/40) and an internal, Teflon coated copper coil (2x Ace #7). The copper coil is used to provide chilling while heating is provided by a wrap-around heating mantle. The remaining two ports (1 Ace #7 and the ball joint) are available to accommodate additional needs a researcher may have.

A stirrer is highly recommended. In the absence of convection, the flooded gasket can produce a barrier, corrosion free zone over the entire surface of the electrode. Only very slight stirring is necessary to disrupt this and keep the electrolyte/electrode interface constant for the duration of the experiment.

The wrap-around heating mantle is most often controlled with a TDC4 Temperature Controller. The TDC4 interfaces with a Gamry potentiostat to control both heating and cooling processes. Temperature limits, step sizes, delay periods, etc. are all under user control. The TDC4 is based on an Omega Temperature Controller which offers an impressive array of features. The TDC4 itself is controlled by your computer and the CPT110 Critical Pitting Temperature Software. Heating and cooling sources connected to your cell are turned on and off by the TDC4 to maintain the desired temperature. The TDC4 is a closed loop system, meaning it measures the temperature of the cell using a platinum RTD, and uses feedback to control the heater and/or cooler. The TDC4 can be used in an on/off mode or a PID (Proportional, Integral, Derivative) mode. The on/off mode uses hysteresis parameters to control its switching, while the PID mode uses tuning parameters.

Cells & Accessories

MultiPort

The MultiPort Corrosion Cell is the workhorse of a corrosion lab, accommodating 1 L standards testing for ASTM G5, G59, and G61. The two-piece design allows you to insert oversized samples in the cell, and makes it compatible with the Flat Specimen Holder. The MultiPort top has 7 variable use ports. In the normal cell configuration these ports are used as follows: one central 24/40 ground glass joint for a working, one SJ 28/15 ball joint paired with an adapter for a Luggin capillary/bridge tube for use with Gamry's SCE, Ag/AgCl, and Hg/Hg_2SO_4 reference electrodes (electrodes ordered separately), one or two Ace-Thread port(s) for counter electrode(s), one 24/40 ground glass joint for gas purging/blanketing (an adapter is supplied). The additional ports are: one 24/40 ground glass joint and two #7 Ace-Thread port(s) usable for temperature sensing, reagent addition, gas venting, etc.

The Ace-Threads allow for vertical adjustment to accommodate a wide range of sample volumes. Vertical adjustment combines with the ball joint to make sure your reference electrode bridge Tube is placed close to the surface of your corrosion sample. The bubbler has one position for deaeration and another for blanketing. The cell kit includes one 30 cm (12 in.) graphite counter electrode. However a second, optional, graphite counter electrode can be geometrically opposed on the opposite side of the sample at 180° for those ASTM standards calling for a second counter. This optional setup normalizes current density on the working electrode and is important for higher currents or more resistive electrolytes.

The standard working electrode assembly used in the MultiPort is described in ASTM G5 – a cylindrical sample that is drilled-and-tapped with a 3-48 UNF thread. The working electrode is screwed onto the support rod. A Teflon compression gasket insures a leak-free seal. The depth of the working electrode in the MultiPort is adjustable, allowing easy orientation of the working electrode and the reference electrode bridge tube.

ParaCell Kit for Flat Specimens

The ParaCell Electrochemical Cell Kit is designed for convenient mounting of a wide variety of flat samples. The design of the ParaCell places the working electrode and either a graphite counter electrode or a second working electrode in an opposed geometry. The cell is designed so that large and bulky samples (e.g., a 30 cm. wafer) can be accommodated on either end for experiments involving two electrodes such as galvanic corrosion or electrochemical noise.

The cell body is chemically-resistant polycarbonate and all metal is 304 Stainless Steel. The two end brackets are isolated from each other with plastic bushings so that contact with the samples will not short the electrodes mounted in the ParaCell.

The central hole on each end plate exposes a nominal area of 2.6 cm^2 where the working electrode and counter or second working are exposed. The ParaCell employs a Teflon-encapculated silicone o-ring to define the sample area. To discourage crevice corrosion, a potential problem with any flat sample, the 1 cm^2 Portholes™ Electrochemical Sample Masks can be used with the ParaCell.

EuroCell

The EuroCell is a general purpose electrochemical cell with an operational volume of 50-200 mL. It is equipped with 5 multi-purpose ports. In the normal cell configuration, these ports are used as follows: one central 24/40 ground glass joint for a working electrode, one Ace-Thread port for a Luggin capillary/bridge tube for use with Gamry's SCE, Ag/AgCl, and Hg/Hg_2SO_4 reference electrodes (electrodes ordered separately), one Ace-Thread port for a counter electrode, one 14/20 ground glass port for inert gas purging/blanketing (an adapter is supplied), one 14/20 ground glass port usable for temperature sensing, reagent addition, gas venting, etc.

The Ace-Threads allow for vertical adjustment to accommodate a wide range of sample volumes. The vertical adjustment is also handy to make sure your reference electrode bridge tube is placed close to the surface of your sample. The bubbler has one position for deaeration and another for blanketing.

The EuroCell is available in a jacketed version for temperature control. The temperature can be controlled by pumping thermostatted water from a water bath through the jacket. Rates of (electro)chemical reactions exhibit strong dependence on temperature.

The standard working electrode assembly used in the EuroCell is a shorter version of the one in the MultiPort and is described in ASTM G5 – a cylindrical sample that is drilled-and-tapped with a 3-48 UNF thread. The working electrode is screwed onto the support rod. A Teflon compression gasket insures a leak-free seal. Working electrodes for the EuroCell can be fabricated in your lab, or purchased in virtually any material from a variety of suppliers.

Dr. Bob's Cell

Dr. Bob's Cell is our smallest electrochemical cell kit, with operational volumes of 1-30 mL. Enzyme and catalysis studies, development of electrochemical sensors, basic research into battery mechanisms, and determination of redox potentials of inorganic complexes represent a few of its many applications. Designed for flexibility and convenience, this cell kit can hold any of Gamry's available working electrodes. Dr. Bob's Cell utilizes a pear-shaped flask which permits handling low volumes (down to 1-2 mL).

It is equipped with 5 multi-purpose ports. In the normal cell configuration, these ports are used as follows: one central Ace-Thread port for a working electrode (ordered separately), one Ace-Thread port for a Luggin capillary/bridge tube for use with Gamry's SCE, Ag/AgCl, and Hg/Hg_2SO_4 reference electrodes (electrodes ordered separately), one Ace-Thread port for a glass frit isolated platinum wire counter electrode (supplied), one 14/20 ground glass port for inert gas purging/blanketing (an adapter is supplied), one 14/20 ground glass port usable for temperature sensing, reagent addition, gas venting, etc.

The Ace-Threads allow for vertical adjustment to accommodate a wide range of sample volumes. Because the Dr. Bob's Cell uses standard joints and fittings, you can easily customize it for specific applications. The bubbler has one position for deaeration and another for blanketing. We include a 2 x 6 mm Teflon magnetic stir bar with all kits. A jacketed model is available for temperature control and will stand on its own while the non-jacketed model includes a stand.

Working electrodes are available in Platinum, Carbon (Glassy or Fiber), and Gold. They may be obtained in either a macro version with a 3 mm diameter or as a microelectrode with a 10 micron diameter.

RDE710 Rotating Electrode

The RDE710 Rotating Electrode is a research-grade rotator and features the ability to use rotating ring-disk, disk, and cylinder electrodes. The rotation rate is adjustable from 50 – 10,000 rpm (revolutions per minute). The controller has a Liquid Crystal Display (LCD) which indicates the rotation rate and is controlled by a rotation rate knob. The electrode assembly of the rotator has a versatile design that allows for the use of diverse electrode types. Different shaft and electrode tips can be selected depending on your desired use.

Rotating ring-disk electrodes are used where products generated at the disk electrode are monitored at the ring electrode. A number of ring-disk electrode configurations are available including platinum-platinum, gold-gold, glassy carbon-glassy carbon, and platinum-glassy carbon. Rotating disk experiments are performed where defined mass transport to the sample electrode is desired. An example of this type of experiment would be catalyst evaluation.

Rotating cylinder experiments are important in the oil industry to simulate the corrosion environment inside a pipeline, thus avoiding the need to assemble expensive flow loop setups. The rotator is an ideal tool because flow conditions at the rotating cylinder are generally turbulent even at low rotation rates. Cylinders can be made from a variety of different metals to evaluate their performance including 1018 carbon steel, 316 stainless steel and 430 stainless steel. Users can also machine cylinder samples using their own material.

POTENTIOSTAT/GALVANOSTAT/ZRA SPECIFICATIONS*

	Reference 3000	Reference 600	Interface 1000
SYSTEM			
Cell Connections	2, 3, or 4	2, 3, or 4	2, 3, or 4
Maximum Current	± 3 A	± 600 mA	± 1 A
Current Ranges	11 (300 pA – 3 A)	11 (60 pA – 600 mA)	9 (10 nA to 1 A)
Current Ranges (including internal gain)	13	13	11
Minimum Voltage Resolution	1 µV	1 µV	1 µV
Minimum Current Resolution	100 aA	20 aA	3.3 fA
Maximum Applied Potential	± 32 V	± 11 V	± 12 V
Rise Time	< 250 ns	< 250 ns	< 1 µs
Minimum Timebase	3.333 µs	3.333 µs	10 µs
Maximum Timebase	715 s	715 s	715 s
Noise and Ripple (typical)	< 2 µV rms	< 2 µV rms	< 20 µV rms
CONTROL AMPLIFIER			
Compliance	± 32 V	± 22 V	± 20 V
Output Current	> ±3 A	> ± 600 mA	> ± 1 A
Speed Settings	5	5	5
Unity Gain Bandwidth	980, 260, 40, 4, 0.4 kHz	980, 260, 40, 4, 0.4 kHz	980, 260, 40, 4, 0.4 kHz
EIS MEASUREMENT			
EIS	10 µHz - 1MHz	10 µHz - 1MHz	10 µHz - 1MHz
V AC amplitude	2.11 V max/ 4.03 µV min	2.11 V max/ 4.03 µV min	2.33 V max/17.8 µV min
ELECTROMETER			
Input Impedance	> 10^{14} Ω	> 10^{14} Ω	> 10^{12} Ω
Input Current (typical)	< 10 pA	< 2 pA	< 20 pA
Bandwidth	> 15 MHz at -3 dB	> 15 MHz at -3 dB	> 10 MHz at -3 dB
CMR	> 80 dB (3 Hz), > 60 dB (1 MHz)	> 80 dB (3 Hz), > 60 dB (1 MHz)	> 80 dB (10 Hz), > 60 dB (1 MHz)
APPLIED POTENTIAL			
Accuracy	± 1 mV ± 0.2% of setting	± 1 mV ± 0.2% of setting	± 1 mV ± 0.2% of setting
Resolution	12.5 µV, 50 µV, 200 µV/bit	12.5 µV, 50 µV, 200 µV/bit	12.5 µV, 50 µV, 200 µV/bit
Drift	< 20 µV/°C	< 20 µV/°C	< 20 µV/°C
Potential Scan Range	± 0.4, ± 1.6 V, ± 6.4 V	± 0.4, ± 1.6 V, ± 6.4 V	± 0.4, ± 1.6 V, ± 6.4 V
MEASURED POTENTIAL			
Accuracy	High Resolution Electrometer: ± 1 mV ± 0.3% of reading High Voltage Electrometer: ± 4 mV ± 0.3% of reading	± 1 mV ± 0.3% of reading	± 1 mV ± 0.3% of reading
Full scale ranges	High Resolution Electrometer: ± 12 V, ± 3V, ± 300 mV, ± 30 mV High Voltage Electrometer: ± 48 V, ± 12 V, ± 1.2 V, ± 120 mV	± 12 V, ± 3V, ± 300 mV, ± 30 mV	± 12 V, ± 3V, ± 300 mV, ± 30 mV
Resolution	High Resolution Electrometer: 400 µV, 100 µV, 10 µV, 1 µV/bit High Voltage Electrometer: 1.6 mV, 400 µV, 40 µV, 4 µV	400 µV, 100 µV, 10 µV, 1 µV/bit	400 µV, 100 µV, 10 µV, 1 µV/bit
Offset Range	High Resolution Electrometer: ± 12 V High Voltage Electrometer: ± 48 V	± 10 V	± 12 V, ± 3V
APPLIED CURRENT			
Accuracy	± 10 pA ± 0.3% of setting	± 10 pA ± 0.3% of setting	± 5 pA ± 0.3% of setting
Resolution	0.0033% full-scale/bit	0.0033% full-scale/bit	0.0033% of full-scale/bit
MEASURED CURRENT			
Accuracy	± 0.3% range ± 10 pA	± 0.3% range ± 10 pA	± 0.3% range ± 5 pA
Resolution	0.0033% full-scale/bit	0.0033% full-scale/bit	0.0033% of full-scale/bit
Bandwidth	> 10 MHz (3A – 600 µA), >1.5 MHz (60 µA), >0.15 MHz (6 µA)	> 10 MHz (600 mA – 600 µA), >1.5 MHz (60 µA), >0.15 MHz (6 µA)	> 10 MHz (1 A – 100 µA), >1.5 MHz (10 µA), >0.15 MHz (1 µA)
Stability settings	4	4	3
Post Offset Gain	1, 10, 100	1, 10, 100	1, 10, 100
Offset Range	± 1X full-scale	± 1X full-scale	± 1X full-scale

Selected Specifications* Specifications subject to change.

Gamry covers the world over with more than 40 international distributors and representatives available to assist you. Countries without representation can deal with Gamry directly.

GAMRY INSTRUMENTS

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