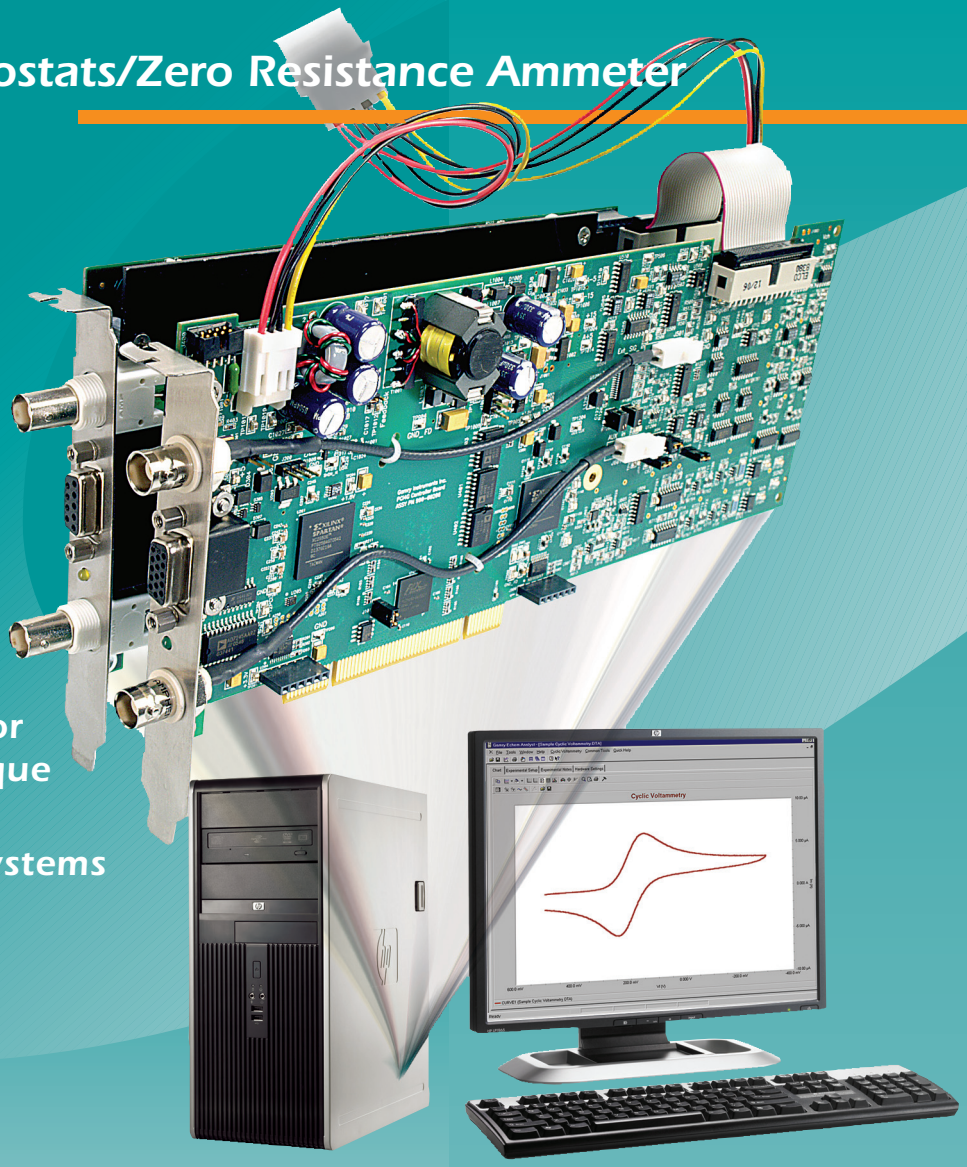
Defining High Value Electrochemistry...

Series G

Potentiostats/Galvanostats/Zero Resistance Ammeter

- Nine Current Ranges
- Low Noise
- Portability
- Floating Operation
- Software for Every Major Electrochemical Technique
- Multiple Potentiostat Systems



GAMRY

The Gamry Series G Potentiostats

The Series G 300™ and Series G 750™ Potentiostat/Galvanostat/ZRAs are high-precision research-grade electrochemical instruments. The G 750 and the G 300 have similar specifications, but differ in their current and compliance voltage limits.

	Series G 750	Series G 300
Current Ranges	9	9
Highest Current Range	750 mA	300 mA
Lowest Current Range	7.5 nA	3 nA
Compliance Voltage	± 12 V	± 20 V

A Different Approach to Potentiostat Design

The Series G is compact. It consists of two printed circuit boards that are installed in a standard Windows-compatible computer. There's no costly cabinet or front-panel. Modern electronic components and design techniques result in a full-featured instrument in a very compact package. Technology has decreased the size and increased the performance of electronics in your personal life, and the same is true in your electrochemical life. With the electronic advances of the last 15 years, a Potentiostat need *not* be a large, heavy instrument!

Built for Maximum Value

The Series G is designed for high value. The specifications are carefully selected to achieve a realistic balance between performance and cost. The Series G can be used with confidence in the majority of electrochemical applications.

Quiet! Potentiostat at Work

Noise is one of the most important specifications of a potentiostat, since it determines the lower limit of the current that can be measured. Nothing is more indicative of potentiostat quality than the noise level. Gamry applies over twenty years of potentiostat design experience to noise reduction via component selection, grounding, and shielding. The result is a specification for Noise and Ripple in the Series G of <20 μV rms. If you can find a quieter potentiostat, buy it!

Small Footprint

Is space in your lab at a premium? Since the Series G is inside your computer, it consumes zero space on your lab bench!

Easy Startup

Thanks to Plug and Play and our detailed Quick-Start Guide, installation is fast and easy. You do *not* have to be a Windows expert to install a Series G Potentiostat.

Easy Operation with Grounded Electrodes

The Series G is designed for electrical isolation from earth ground. This allows the Series G to function normally with either floating or grounded samples such as autoclaves or pipelines. Operation with a grounded sample is possible because the analog portion of the Potentiostat is isolated from ground. A bank of high-speed transformer isolators transfers digital information from the Potentiostat to the computer.

Communicates Easily with the Outside World

The Series G has analog outputs for the cell voltage and current, analog inputs for External Signal Input and an Auxiliary A/D Input for thermocouples, QCMs, etc. There's also a Miscellaneous I/O Connector that provides a number of inputs and outputs to customize your experiment, including a software-controlled analog output voltage to control the RDE710 Rotating Electrode.

Accuracy Contour Plot

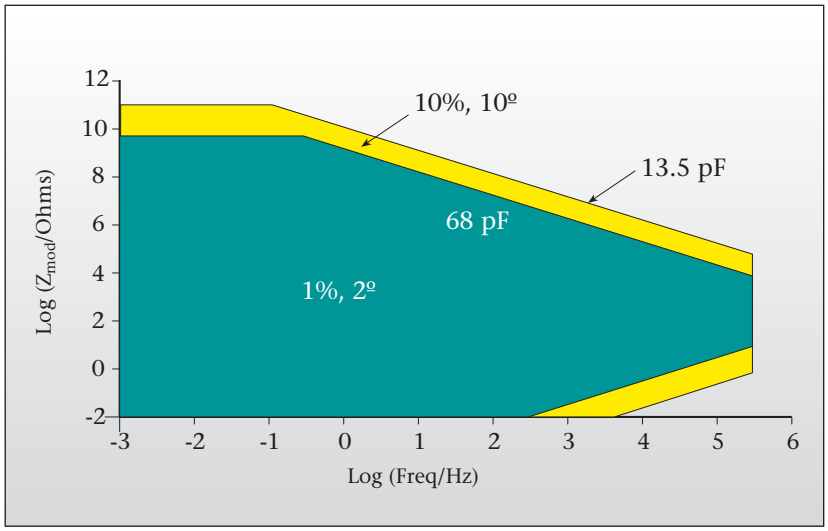
EIS for the Civilized Electrochemist

Every Series G is ready to perform EIS. The built-in Direct Digital Synthesis circuitry generates a pure sine wave that is ideal for electrochemical applications. Use the EIS300 Electrochemical Impedance Spectroscopy Software to enable our Sub-Harmonic Sampling technique. Measure impedances from 10^{10} ohms to 10^{-2} ohms at frequencies from 10 μHz to 300kHz.

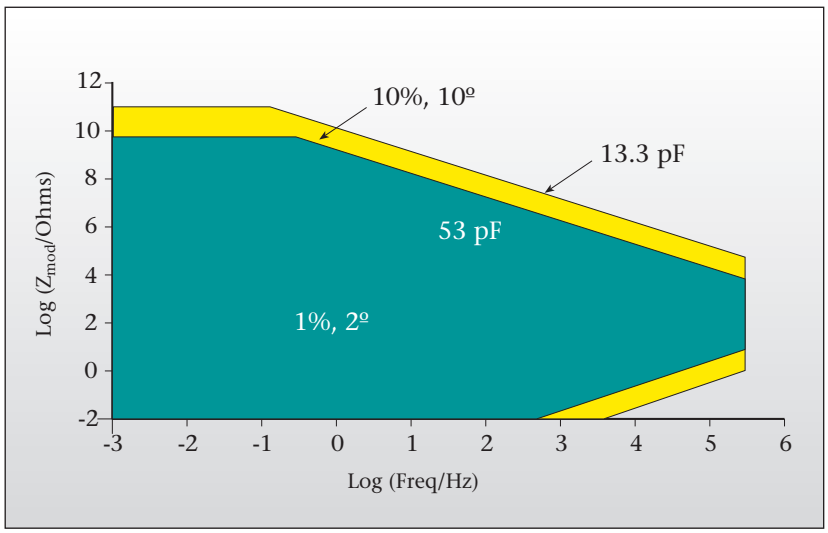
When performing techniques such as EIS or cyclic voltammetry, the ability of the potentiostat to control a rapidly changing potential while accurately measuring the current becomes critical. EIS may be performed at high frequencies and CV may employ fast scan rates and it is important to understand the capabilities of your potentiostat under these conditions.

The Accuracy Contour Plot maps the Potentiostat's response to the impedance of your sample as a function of frequency. For complete details, see our Technical Note on "Accuracy Contour Plots" in the App Note section of our website.

Accuracy Contour Plot for Series G 300



Accuracy Contour Plot for Series G 750



G for Green.

The Series G was designed using electronic components that do not contain lead; it conforms to the RoHS requirements of the European Union.

Portability

If your electrochemical experiments take you outside your laboratory, you'll appreciate the convenience of a Series G Potentiostat installed in an ***eStation Portable Electrochemistry System.*** The eStation is a PCI-expansion chassis that interfaces the Series G to the CardBus Interface of a Notebook Computer. Down the hall or around the world, you can take world-class electrochemical performance to the sample.

Bipotentiostat

Two Series G Potentiostats in a computer can be easily configured as a Bipotentiostat. A timing cable synchronizes the internal clocks of the Potentiostats. The Potentiostats can be used as single instruments as well.

Multiple Potentiostat Systems

A ***MultEchem System*** is designed for the intensive testing environment. It consists of up-to-eight Series G Potentiostats installed in an industrial computer. All of the Gamry Potentiostats in a MultEchem System can be operated simultaneously and independently. With special pricing, the MultEchem System offers a remarkably low price-per-potentiostat. Plus – the software in a Gamry MultEchem is the standard Gamry software, so it's flexible, it's robust, and you already know how to use it.

Multiple Samples

The ***ECM8™ Electrochemical Multiplexer*** partners with a Series G to conduct experiments on up to 8 electrochemical cells. The ECM8 converts a single Potentiostat into a powerful instrument suitable for automating repetitive electrochemical experiments in a sequential fashion.

Electrochemical Software for the Series G

Software for the Series G is available to run every major electrochemical technique. Choose your software package for the electrochemical techniques you plan to use. You only buy the software you need, so it's less expensive than do-everything software. It's also easier to use.

PHE200™ Physical Electrochemistry Software

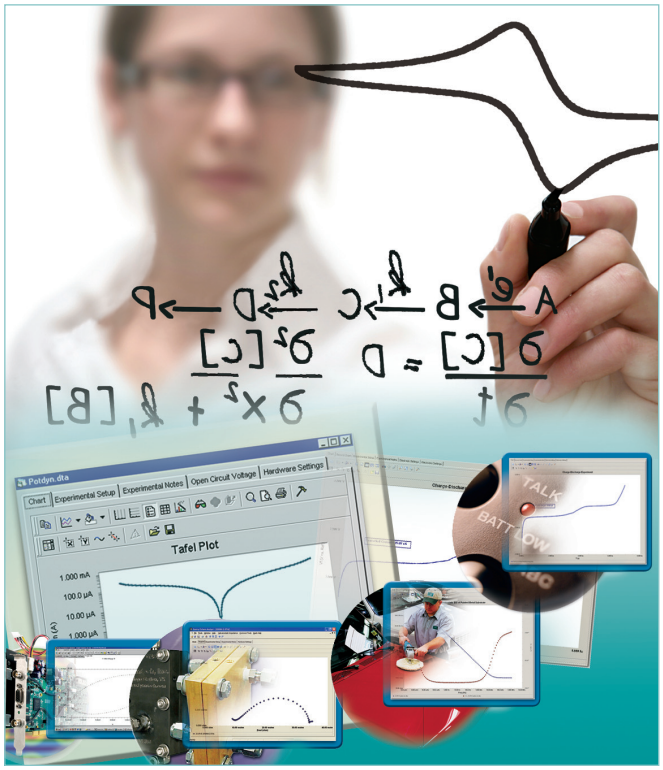
The PHE200 provides electrochemical techniques such as cyclic voltammetry and the chrono techniques for characterizing electrochemical reaction mechanisms and studying the electrode interface.

PV220™ Pulse Voltammetry Software

The PV220 Software is a companion to the PHE200. The extraordinary sensitivity of the pulse techniques allows electrochemical measurements to be made at very low concentrations.

EIS300™ Electrochemical Impedance Spectroscopy Software

EIS is a powerful tool for a variety of applications. Using our unique Sub-Harmonic Sampling, Gamry has civilized EIS – it's easy to use, it's compact, and it's very affordable.



DC105™ Corrosion Techniques Software

The DC105 software includes 14 electrochemical techniques for the study of corrosion. Corrosion rates can be measured using Polarization Resistance or Tafel Plots. Potentiodynamic Plots, Cyclic Polarization, and Critical Pitting Potential are available to evaluate passivity and pitting.

CPT110™ Critical Pitting Temperature Software

The CPT110 Software performs a completely automated measurement as specified in ASTM G 150.

VFP600™ Virtual Front Panel*

The low-cost VFP600 Virtual Front Panel simulates an old-fashioned analog potentiostat.

ESA400 ™ Electrochemical Signal Analyzer*

The ESA400 brings a high degree of sophistication to both data acquisition and analysis for electrochemical noise measurements.

Custom Scripting

The Series G enjoys the benefits of Open Source Scripting. For non-standard electrochemical experiments, Gamry software can be customized with Open Source Scripting. Call us to discuss your application.

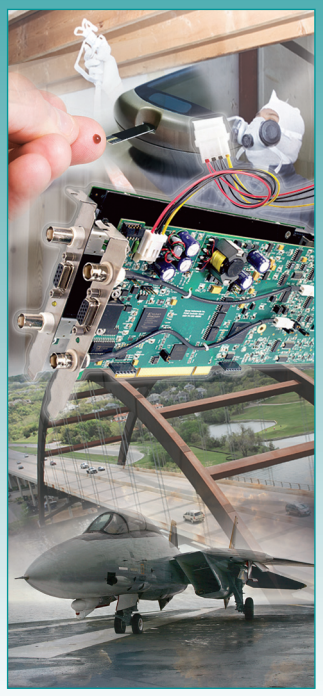
eChemBasic, eChemDC, and eChemAC Toolkit Software

eChemDC and eChemAC are powerful software applications to control your Gamry Potentiostat using the programming language of your choice, e.g., LabVIEW. eChemBasic is an entry-level product for less demanding applications.

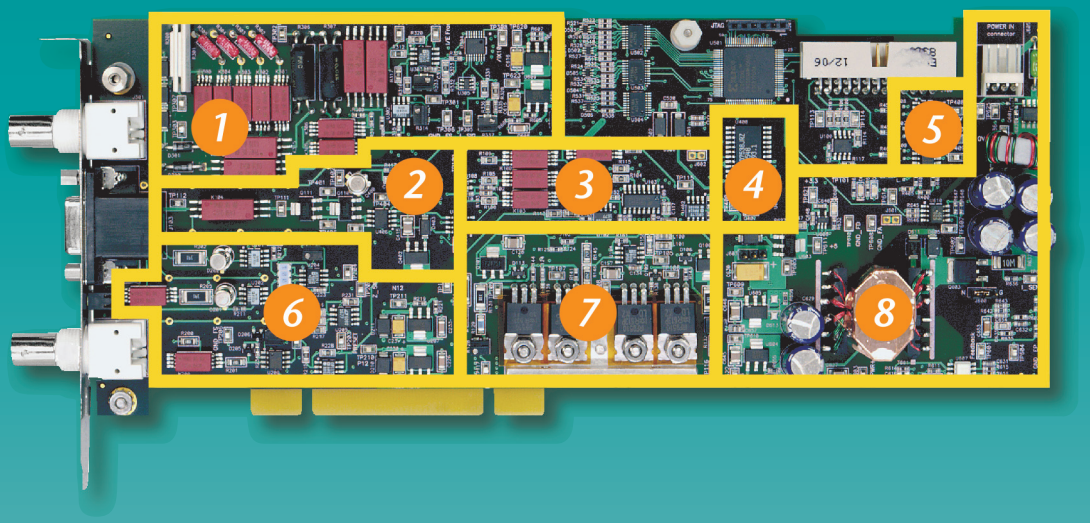
*The VFP600 and ESA400 are compiled LabVIEW™ applications.

Anatomy of a Series G Potentiostat

In principle, a potentiostat is relatively simple. In practice, it is quite complex. Why? The performance of the potentiostat is affected by the electrical characteristics of the sample. The potentiostat must have built-in flexibility to account for a wide range of sample types. Gamry Potentiostats are built for research and designed to accommodate a wide variety of sample types. Some of the components of the Series G Potentiostats and their function are highlighted and explained.



Series G Potentiostat Board



1 I/E CONVERTER

The Series G has nine decades of current ranges that autorange for convenience. Unlike our competitors, the nine current ranges do not require any options or any offset/gain. The I/E Converter also incorporates stability controls to balance bandwidth and noise.

2 CELL SWITCH

The cell is enabled through two switches. A relay is used for electrical isolation. An ultra-fast MOSFET switch with zero contact bounce applies the signal with virtually none of the spikes common with other instruments. The MOSFET switch is also used for current interrupt iR compensation.

3 CONTROL MODE

The Series G can function as a Potentiostat, a Galvanostat, or a Zero Resistance Ammeter. All of the relays and controls for changing modes are located here. Thanks to this and other features, you can be confident that your Series G can perform any new electrochemical technique you wish to employ in your lab.

4 iR COMPENSATION

For the most accurate potential control in resistive electrolytes, you may have to compensate for iR drop. The Series G allows you to compensate with either current interrupt or positive feedback. To set the level of positive feedback, the Series G measures the uncompensated resistance using the on-board EIS.

5 OVERLOAD DETECTION

The measured potential and current signals are matched against reference limits by a Voltage Comparator to insure the signals are within the range of the Series G. You always know if you take a questionable data point!

6 DIFFERENTIAL ELECTROMETER

High impedance (>10^{12} ohms) and low input current (<10 pA) for fast and accurate potential measurement. The Series G cleverly contains a second electrometer for the Zero Resistance Ammeter. Gamry Potentiostats are simply the best for electrochemical noise and galvanic corrosion measurement.

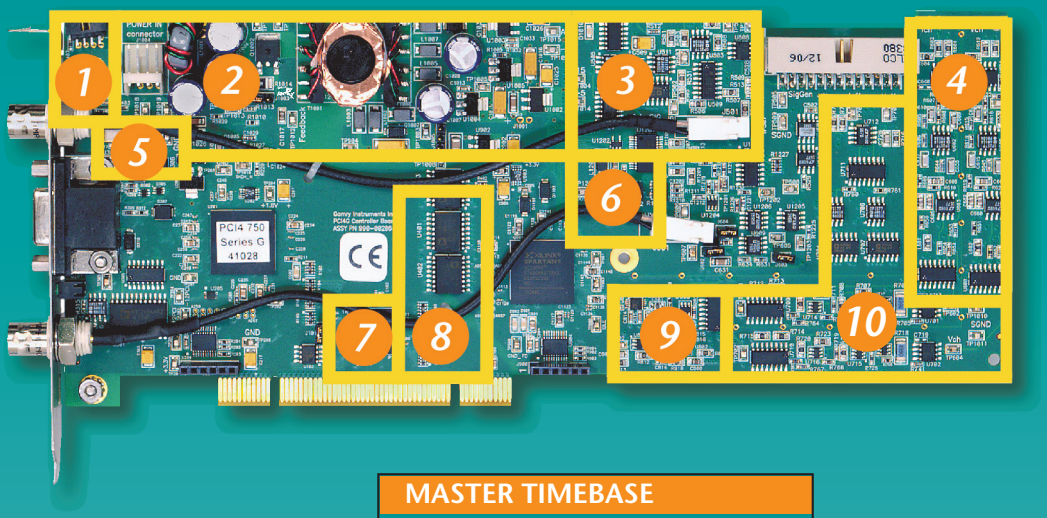
7 CONTROL AMPLIFIER

This is the muscle of the Series G. The Control Amp supplies current for fundamental potentiostat and galvanostatic operation. Set the bandwidth of the Control Amp to balance speed versus stability. The Control Amp is set automatically by the Gamry Software, but can be manually controlled for unique experiments.

8 DC-DC CONVERTER

The DC-DC Converter derives power for the Series G from the computer's power supply. It also provides transformer isolation from ground so the Series G floats. We use an efficient switching power supply. To eliminate switching noise, the data acquisition is synchronous with the switching frequency.

Series G Controller Board



MASTER-SERF CONNECTOR

The Master-Serf Connector is used in some multiple-potentiostat experiments (e.g., a Bipotentiostat) to synchronize the timing of one or more "Serf" Potentiostats to one "Master" Potentiostat.

1

DC-DC CONVERTER

Similar to the DC-DC Converter on the Potentiostat Board.

2

SIGNAL GENERATION

The output of a 16-bit Bias Digital-To-Analog Converter (DAC) and a 16-bit Scan DAC are summed to provide the applied potential or current waveform. Gamry uses 16-bit DACs, which have four times better resolution than a 14-bit DAC. That level of resolution is important for accurate generation of the applied signal.

3

FILTERS

Every signal contains some degree of noise. Intelligent filtering can suppress it to improve the quality of the data. Series G Potentiostats utilize three low-pass filters of 224 kHz, 1050 Hz, and 5 Hz. In addition, we employ sophisticated digital filtering for additional noise discrimination in specific electrochemical techniques.

4

MASTER TIMEBASE

All of the timing signals in the Series G are drawn from this single crystal oscillator. The Master Timebase controls the timing for the power supply, DDS, signal generation, and data acquisition.

5

SUB-HARMONIC SAMPLING

Every Series G includes a Direct Digital Synthesis subsystem to make the high-frequency EIS measurement by Sub-Harmonic Sampling. Gamry introduced Sub-Harmonic Sampling in 1996 and it has revolutionized EIS. Just add EIS300 software!

6

PCI INTERFACE

The Series G is installed in the PCI slots of your Windows computer. The PCI Bridge routes signals from the PCI bus to the internal bus of the Series G. It is the construction of the PCI bus that allows Plug and Play to work so well, making installation and operation of the Series G fast and easy.

7

DIGITAL ISOLATORS

The analog portion of the Series G is electrically floating so that you can perform electrochemical measurements on grounded samples. Electrochemical data and control signals are transferred across the boundary between the potentiostat and the computer by high-speed transformer-coupled digital isolators.

8

A/D CONVERTER

For the most accurate measurement of potential and current, the Series G is equipped with 16-bit Analog-To-Digital Converter (ADC). We measure *both* potential and current in your cell so you know exactly what's happening. For the most accurate potential measurement, the range of the ADC is variable from ±12 Volts to ±30 milliVolts!

9

OFFSET AND GAIN

For highest accuracy, it is best to make the measurement on the most sensitive potential and current range. That is not possible if a small AC signal is superimposed on a large DC signal. The offset and gain in a Series G allows the measurement of microvolt-level signals in the presence of a high DC background. This capability is important in EIS for potential measurement for low-impedance samples and current measurement for high-impedance samples.

10

System Information

The Series G™ requires electrochemical software for specific electrochemical applications. The Series G is shipped with the Gamry Framework™ Software, Gamry Echem Analyst Software, a Hardware Operator's Manual, a Quick-Start Guide, a Universal Dummy Cell 3, one 1.5 m cell cable, and a Gamry Mouse Pad. The Series G is protected by a 2-year factory service warranty.

Available Cell Cables

985-38	Standard Cell Cable, 1.5m	985-40	9 m Extended Cell Cable
985-39	4.5m Extended Cell Cable	985-13	ECM8 Multiplexer Interface Cable

Specifications

	G 750	G 300
Potentiostat	Yes	Yes
Galvanostat	Yes	Yes
Zero Resistance Ammeter	Yes	Yes
Cell Connections	2, 3, or 4	2, 3, or 4
Floating (Isolated from earth)	Yes	Yes
System		
Max. Current	±750 mA	±300 mA
Current Ranges	9 (7.5nA-750mA)	9 (3nA-300mA)
Current Ranges (inc. internal gain)	11(75 pA-750mA)	11(30 pA-300mA)
Min. Voltage Resolution	1 µV	1 µV
Min. Current Resolution	2.5 fA	1 fA
Max. Applied Potential	±8 V	±11 V
Rise Time	<2 µs	<2 µs
Noise and Ripple	<20 µV rms	<20 µV rms
*Noise and Ripple (typical)	<2 µV rms	<3 µV rms
Min. Time Base	50 µs	50 µs
Max. Time Base	600 s	600 s
Min. Potential Step	12.5 µV	12.5 µV
Analog/Digital Converters	16 bit	16 bit
Max. Data Points Per Experiment	262,143	262,143
EIS Measurement		
Frequency Range	10 µHz – 300 kHz	
Impedance Accuracy	See Accuracy Contour Plot	
Max AC Amplitude	3600 mV rms	3600 mV rms
Min AC Amplitude	55 µV rms	55 µV rms
Control Amp		
Compliance Voltage	>±12 V	>±20 V
Output Current	>±750 mA	>±300 mA
Speed Settings	4	4
Unity Gain Bandwidth (typical)	200, 100, 40, 6 kHz	
Electrometer		
Input Impedance	$>10^{12}$ Ω	$>10^{12}$ Ω
Input Current	<10 pA	<10 pA
*Input Current (typical)	<5 pA	<5 pA
Bandwidth (-3dB) (typical)	>4 MHz	>4 MHz
Common Mode Rejection Ratio	>80 dB (3 Hz),	>60 dB (1 MHz)

	G 750	G 300
Applied Potential		
Accuracy	±2 mV ± 0.2% of setting	
*Accuracy (typical)	±350 µV ± 0.05% of setting	
Resolution	12.5 µV, 50 µV, 200 µV/bit	
Drift	<30 µV/°C	<30 µV/°C
Potential Scan Range	±0.4 V, ±1.6 V, ±6.4 V	
Measured Potential		
Accuracy	±1 mV ± 0.3% of reading	
*Accuracy (typical)	±350 µV ± 0.03% of setting	
Full-Scale Ranges	30 V, 3 V, 300 mV, 30 mV	
Resolution	1 mV, 100 µV, 10 µV,1 µV/bit	
Offset Range	±12 V	±12 V
Applied Current		
Accuracy	±10 pA ± 0.3% of setting	
*Accuracy (typical)	±8 pA ± 0.07% of setting	
Resolution	0.0033% fullscale/bit	
Measured Current		
Accuracy	±10 pA ± 0.3% range	
*Accuracy (typical)	±8 pA ±0.08% range	
Resolution	0.0033% full-scale/bit	
Bandwidth (-3dB)	>500 kHz	>500 kHz
Note: Bandwidth is current range dependent	(750 µA-750 mA) >100 kHz (75 µA) >10 Hz (7.5 nA)	(300 µA-300 mA) >100 kHz (30 µA) >10 Hz (3 nA)
Stability Settings	3	3
Post Offset Gain	0.1, 1,10,100	0.1, 1,10,100
Offset Range	±2X full-scale	±2X full-scale
iR Compensation		
Mode	Current interrupt and positive feedback	
Minimum interrupt time	30 µs	30 µs
Maximum interrupt time	64 ms	64 ms
Auxiliary A/D Input		
Range	±3 V	±3 V
Resolution	0.1 mV	0.1 mV
Input Impedance	>25 kΩ	>25 kΩ
Auxiliary D/A Output		
Range	±5 V or 0-10 V	±5 V or 0-10 V
Resolution	2.5 mV	2.5 mV
Physical Dimensions		
Weight	1 kg	1 kg
Size	2 10x25 cm PCI Printed Circuit Boards	

* Typical specifications are representative of the actual performance of the Potentiostat, but are not guaranteed.
Specifications are for electrically isolated cells and are subject to change. Gamry products are CE and RoHS compliant.

GAMRY INSTRUMENTS
Redefining Electrochemical Measurement
+1.215.682.9330 • Fax: +1.215.682.9331 • www.gamry.com • info@gamry.com