

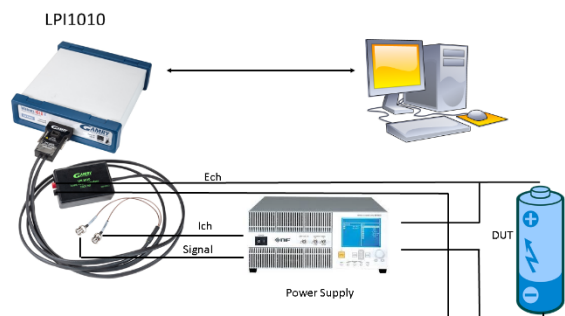
## ***LPI1010™ Load/Power Supply Interface For Batteries and Fuel Cells***

Alternative energy sources are becoming more prevalent as alternatives to fossil fuels become important in the electricity generation equation. Fuel cells and batteries both play their part in this arena for energy storage and conversion. Their success depends on continued improvement in performance. The LPI1010 Load/Power Supply Interface (LPI) was designed to help you make this improvement possible.

Electrochemical impedance spectroscopy (EIS) is a powerful electrochemical technique, which can be particularly useful for battery and fuel cell development. You can use EIS for materials selection and performance evaluation. Fundamental studies of new approaches and optimization of battery and fuel cell performance can both benefit from EIS testing and modeling.

Gamry's LPI1010 extends the range for voltage and current compared to standard EIS systems designed for the laboratory. Lab EIS systems also cannot handle the large voltages in battery packs and fuel cell stacks which can have voltages up to 1000V. The LPI has three different models to handle these voltage ranges; 10V, 100V and 1000V.

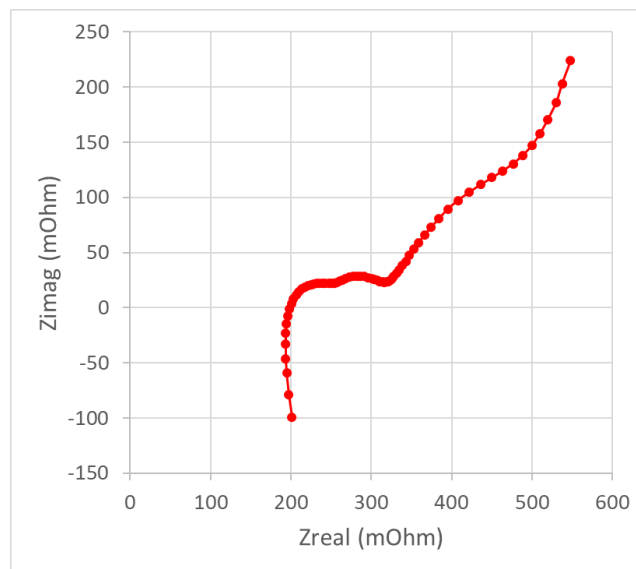
A typical system consists of an Interface 1010E potentiostat and an LPI1010 working in conjunction with a Bipolar Power Supply or Electronic Load (see Systems Information). A schematic of the system is shown below for impedance measurements on a battery. A similar arrangement can be used to measure a fuel cell.



**The LPI1010 with a Power Supply measures the impedance of the Battery.** The measurement of  $I$  and  $E$  at a given frequency allows the calculation of the impedance.

The system employs an Bipolar Power Supply to source and sink the current from the battery. The sinusoidal excitation signal from the LPI1010 is input to the Power Supply, which modulates the battery current. The current signal from the Power supply is output to the current input channel of the LPI1010. The voltage of the battery is measured directly by the LPI1010 at the voltage input channel. The system then calculates an impedance from these signals. The LPI1010 measures EIS in either galvanostatic mode or our proprietary hybrid mode.

The Gamry LPI1010 is designed to accommodate the low impedance of batteries and fuel cells. It can measure complex impedance over a frequency range of 10  $\mu$ Hz to 100 kHz (the upper limit is determined by the electronic load or power supply).



Galvanostatic EIS on a 60.9V battery. 10kHz to 1 mHz. 0.5 A rms.

### ***Using the LPI to Measure EIS of Fuel Cells***

The LPI1010 can also measure the impedance of fuel cells. It can help identify problems that limit a fuel cell's efficiency, it can help optimize cell design, and it can determine anodic and cathodic process mechanisms. EIS can be useful in the selection of membranes and the study

of membrane impact on performance. Clever placement of reference electrodes in a cell may allow an analyst to separately test subsections of the cell, such as the anode, the cathode, and the electrolyte.

### System Information

A full LPI1010 system will consist of an Interface 1010E, LPI1010 (10, 100, or 1000V model) and power supply or load. Gamry Instruments can supply complete systems including a Power Supply. Older Interface 1010Es will require an upgrade at the factory before they can operate an LPI1010. Customers using their own loads or power supplies may require a custom configuration file and calibration cells. Contact Gamry or your local distributor for further details on these systems and situations.



Representative image of Gamry Interface 1010E and LPI1010 100V NF.

General Specifications***	Value
Frequency Range	10 uHz – 100 kHz*
Weight	1 kg
Measurement modes	Galvanostatic or Hybrid EIS
Cable lengths	1 m
Signal output to load or power supply	10 V full scale, BNC connector**
Signal input from load or power supply	10 V full scale, BNC connector**

\*LPI1010 only. Measurement bandwidth is dependent upon your power supply or electronic load. \*\*LPI1010 100V NF is 1 V full scale

\*\*\* Specifications subject to change without notice.

Model	PN
LPI1010 Load/Power Supply Interface 10V	992-00155
LPI1010 Load/Power Supply Interface 100V	992-00156
LPI1010 Load/Power Supply Interface 100V NF	992-00163
LPI1010 Load/Power Supply Interface 1000V	992-00157