Load/Power Supply Interface (LPI1010)

High Voltage EIS Test System

Operator's Manual



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If You Have Problems

Please visit our service and support page at https://www.gamry.com/support-2/. This page contains information on installation, software updates, and training. It also contains links to the latest available documentation. If you are unable to locate the information you need from our website, you can contact us via email using the link provided on our website. Alternatively, you can contact us one of the following ways:

Internet	https://www.gamry.com/support-2/
Telephone	(215) 682-9330 9:00 AM–5:00 PM US Eastern Standard Time
	(877) 367-4267 Toll-free US & Canada Only

Please have your instrument model and serial numbers available, as well as any applicable software and firmware revisions.

If you have problems in installation or use of a system containing a Load/Power Supply Interface (LPI1010) High Voltage EIS Test System, please try to call from a phone next to your computer, where you can type and read the screen while talking to us.

We will be happy to provide a reasonable level of free support for registered users of the LPI1010 system. Reasonable support includes telephone assistance covering the normal installation, use, and simple customization of a computerized system containing an LPI1010 system connected to a Windows®-compatible computer.

A service contract that extends both the hardware warranty and software update period is available at an additional charge. Software updates **do not** include software enhancements offered to our customers at additional cost.

Enhancements to the LPI1010 system and Gamry's standard applications software that require significant engineering time on our part can be performed on a contract basis. Contact us with your requirements.

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The information in this manual has been carefully checked and is believed to be accurate as of the time of release. However, Gamry Instruments, Inc. assumes no responsibility for errors that might appear.

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Chapter 1: Safety Considerations

Your Load/Power Supply Interface (LPI1010) High Voltage EIS Test System has been supplied in a safe condition. This chapter of the Load/Power Supply Interface (LPI1010) High Voltage EIS Test System Operator's Manual contains information and warnings that you must follow to ensure continued safe operation of the Load/Power Supply Interface (LPI1010) High Voltage EIS Test System.



Caution: The safety of any system incorporating the LPI1010 is the responsibility of the assembler of the system.



Warning: If the LPI1010 is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Inspection

When you receive your Load/Power Supply Interface (LPI1010) High Voltage EIS Test System, inspect it for evidence of shipping damage. If you observe any damage, please notify Gamry Instruments Inc. and the shipping carrier immediately. Save the shipping container for possible inspection by the carrier.



Warning: An LPI1010 damaged in shipment can be a safety hazard. Do not operate damaged apparatus until a qualified service technician has verified its safety. Tag a damaged EIS Box to indicate that it could be a safety hazard.

Product Safety

The LPI1010 has been designed, tested, and certified to meet the requirements of EN 61010, *Safety requirements for electrical equipment for measurement, control, and laboratory use*. As defined in this standard, it is a Category II apparatus, with any "hazardous live voltages" protected by "reinforced insulation".



Warning: Never connect a Device Under Test which outputs a voltage higher than the full-scale voltage rating of the LPI1010. Doing so could pose an electric shock hazard to the user and may damage the equipment.

Connect only **shrouded** banana plugs into the Cable End banana receptacles. Gamry Instruments, Inc. recommends using the supplied LPI DUT Cables (985-00211 and 985-00212) rated at 1 kV, under Cat IV conditions.

If you build your own Device Under Test cables, always connect the shrouded banana plugs to a wire rated for at least 1 times the full-scale voltage rating of the LPI1010.



Warning: Never operate the LPI1010 with any cover or panel on the chassis open. Dangerous voltages may be present at several points within the LPI1010 chassis, including PC board traces. Always remove the power connections before opening the LPI1010 case.



Caution: For user safety, before connecting either terminal of the DUT to the system:

1. Connect the LPI D-sub Module to the cell connector on the front panel of the Interface 1010 and secure the jack screws
2. Connect the current control and current monitor cables from the LPI D-sub Module to the Electronic Load or programmable power supply in your setup
3. Connect the LPI Power Cable
4. Connect the USB cable between the Interface 1010E and the host computer

Temperature and Ventilation

Your LPI1010 was designed for indoor use at ambient temperatures between 0°C and 45°C.

Generally, the LPI1010 does not generate a lot of heat by itself during operation. Passive cooling is generally sufficient to keep the LPI1010 components within their operating temperature range.

Be careful when operating the LPI1010 in an enclosed space (such as an enclosed relay rack or NEMA enclosure). The temperature within the enclosure must not exceed 45°C. You may need to provide ventilation holes or even forced air-cooling for the enclosed space if excessive temperature rise occurs.

Defects and Abnormal Stresses

Treat your LPI1010 as potentially hazardous if any of the following is true of the unit:

- It shows visible damage,
- It does not operate properly,
- It has been stored for a long period of time under unfavorable conditions,
- It has been dropped or subjected to severe transport stress,
- It has been subjected to environmental stress (corrosive atmosphere, fire, etc.).

Do not use your LPI1010 or any other apparatus if you think it could be hazardous. Have it checked by qualified service personnel.



Caution: If any part of the wiring, connectors, or enclosures on the LPI 1010 appears physically damaged, do not use the LPI cable.

Environmental Limits

Note that there are environmental limit conditions on the storage, shipping, and operation of this equipment. The LPI1010 has **not** been designed for outdoor use.

Storage	Ambient temperature	–40°C to 75°C
	Relative humidity	Maximum 90% non-condensing
Shipping	Same as storage plus	
	Acceleration	Maximum 30 G
Operation	Ambient temperature	0°C to 45°C
	Relative humidity	Maximum 90% non-condensing
Altitude	Storage and operation	Mean sea level to 10 000 ft. (3050 m)



Warning: The LPI 1010 is not designed for operation in conditions where liquid water may enter the chassis, or water vapor may condense within the chassis. Operation of an LPI1010 that has water within the chassis can create a safety hazard, which could result in personal injury or death. Never submerse any parts of the LPI cable in liquid.

Cleaning

Clean the external chassis only when necessary.

Disconnect the LPI1010 from all power sources prior to cleaning.

Use a cloth **lightly** dampened with either clean water or water containing a mild detergent, to clean the outside of the LPI1010 enclosure. Alternatively, you may use isopropyl alcohol. Do not use a wet rag or allow fluid to enter the LPI1010 enclosure. Do not immerse the LPI1010 in any type of cleaning fluid (including water). Do not use any abrasive cleaners.

Service

Your LPI1010 instrument has no user-serviceable parts inside. Refer all service to a qualified service technician.



Caution: Never open the plastic housing of the LPI D-sub Module or Cable End Module. There are no user-serviceable parts inside of these modules.

RF Warning

The LPI1010 has been tested for both radiated and conducted RF interference and for immunity to RF fields, and has been found to be in compliance with FCC Part 18 and EU Council Directive 2014/30/EU, the EMC Directive EN 61326:2013—*Electrical equipment for measurement, control, and laboratory use—EMC Requirements*. Testing was performed in accordance with the Basic Immunity Requirements.

However, your LPI1010 system still does generate some radio-frequency energy. The radiated levels are low enough that the LPI1010 should not create an interference problem in most industrial laboratory environments.

Your LPI1010 system may also respond to environmental radio-frequency energy. We recommend you avoid using mobile phones and other radio-frequency equipment in the same room as an LPI1010. The LPI1010 circuitry has been tested for operation in high-intensity RF fields and has demonstrated little response to those fields. However, there is no guarantee that the electrochemical cell and its connections will not respond to RF fields. This response most often appears as DC shifts in a cell's response caused by rectification of the RF signal.

A Faraday cage surrounding your cell may be used to minimize the effect of environmental RF fields. If your cell is isolated from earth ground, Gamry recommends connecting the **System Ground** to a Faraday cage.

Electrical Transient Sensitivity

Your LPI1010 system was designed to offer reasonable immunity from electrical transients, including transients on the incoming AC mains supply and electrostatic discharge. It has been tested for compliance with EN 61326-1:2013—*Electrical equipment for measurement, control, and laboratory use—EMC Requirements* describing acceptable limits for electrical transient susceptibility in laboratory test equipment. It should continue to operate when subject to the standard ESD and power-line events defined in EN 61326-1:2013.

In severe cases involving transients beyond the limits tested in EN 61326-1:2013, the LPI1010 could still malfunction as a result of electrical transients. If you are having problems in this regard, the following steps may help:

If the problem is static electricity (sparks are apparent when you touch the LPI1010 or its cables):

- Try placing your LPI1010 on a static-control work surface. Static-control work surfaces are now generally available from computer-supply houses and electronics-tool suppliers. An antistatic floor mat may also help, particularly if a carpet is involved in generating the static electricity.
- Air-ionizers or even simple air-humidifiers can reduce the voltage available in static discharges.

If the problem is AC power-line transients (often from large electrical motors near the LPI1010):

- Try plugging your LPI1010 into a different AC power branch circuit.
- Plug your LPI1010 into a power-line surge-suppressor. Inexpensive surge-suppressors are now generally available because of their use with computer equipment.

Contact Gamry Instruments, Inc. if these measures do not solve the problem.

CE Compliance

The European Community has instituted standards limiting radio-frequency interference emitted by electronic devices, setting limits for susceptibility of apparatus to RF energy and transient events, and mandating safety requirements. Gamry Instruments, Inc. has designed and tested the LPI1010 to comply with these standards.

The relevant CE regulations include EN 61010-1:2010 as well as IEC 61000-4-2 and IEC 61000-4-3.

RoHS Compliance

The LPI1010 is built using lead-free components and lead-free solder. It complies with the European RoHS initiative.

Chapter 2: Introduction

About this Manual

This manual covers the installation, safety, and use of the Gamry Instruments LPI1010 system with Revision 7 (and later revisions) of the Gamry Framework software. It is equally useful when setting up a newly-purchased instrument or modifying the setup of an older instrument for use with new software. Technical material such as specifications, block diagrams, or optional parts can be found in the Appendices.

This manual discusses software installation and software operation in some detail. The installation is written assuming installation using Revision 7 of Gamry's Framework software. Installation is also described in Gamry Instruments' Quick-Start Installation Guide.

Software support for the LPI1010 system is described in the Gamry Help system.

About the LPI1010

The LPI1010 system is a research-grade electrochemical instrument. It is designed for testing energy storage or power-conversion devices such as batteries, fuel cells, or capacitors. For brevity, this manual shall refer to these devices as Device Under Test (DUT).

The LPI1010 system enables monitoring and testing of DUTs as single cells or as stacks with voltages of up to 1000 V. Depending on model of the LPI1010, voltages of up to 10 V, 100 V, and 1000 V can be operated with the help of an electronic load or programmable power supply. The current is limited by the potentiostat programmed for the LPI. The LPI1010 is designed to be used with a Gamry Instruments Interface 1010 potentiostat.

Typical experiments include but are not limited to voltage monitoring, charging and discharging, leakage tests, or electrochemical impedance spectroscopy (EIS). All LPI tests are performed in Galvanostatic mode. In this mode, the current through the DUT is modulated by the LPI1010 system and the voltage at the DUT terminals is measured by the LPI1010 system. Two different setups are commonly used to accomplish this testing:

- A **Programmable Power Supply** is placed across the terminals of the DUT. The power supply must be capable of both sinking and sourcing current (often referred to as a 2-quadrant power supply). The programmable power supply is placed in Current-Control mode. The output current is defined by a ±10 V control signal fed to the programmable power supply control input from the LPI D-sub Module. The programmable power supply allows for both charging and discharging of the DUT. The AC current may be applied along with a DC bias current, but this is not mandatory.
- An **Electronic Load** functions in the same manner as the programmable power supply except that it is only capable of discharging the DUT. Electronic loads are commonly used on Fuel Cells, for the charging capability is not required. Typically, the current control signal has a large DC bias and a modulated AC signal with a maximum amplitude of about 10% of the DC bias. The DC bias must be larger than the peak AC current.

Software and Applications

The LPI1010 supports Gamry Instruments' electrochemical energy software as well as specialized LPI scripts under the Framework system.

Typical applications for the LPI1010 include:

- Research in electrochemical storage and conversion,
- Battery and electrochemical capacitor evaluation, and
- Fuel cell testing

Notational Conventions

In order to make this manual more readable we have adopted some notational conventions. These are used throughout this manual and all other Gamry Instruments manuals:

- Numbered lists. A numbered list is reserved for step-by-step procedures, with the steps always performed sequentially.
- Bulleted list. The items in a bulleted list, such as this one, are grouped together because they represent similar items. The order of items in the list is not critical.
- File names and folders. Inside paragraphs, references to computer files and Windows® folders are capitalized and placed within quotes, for example: “C:\MYGAMRYDATA\CV.DTA” and “GAMRY.INI”.

Chapter 3: Installation

This chapter of the Gamry Instruments Inc. Load/Power Supply Interface (LPI1010) High Voltage EIS Test System covers normal installation of the LPI1010. We assume the LPI1010 system is installed as part of a Gamry Instruments' Framework-based electrochemical measurement system containing a Microsoft Windows®-compatible computer.

Initial Visual Inspection

After you remove your LPI1010 from its shipping carton, check it for any signs of shipping damage. If you observe any damage, please notify Gamry Instruments, Inc. and the shipping carrier immediately. Save the shipping container for possible inspection by the carrier.

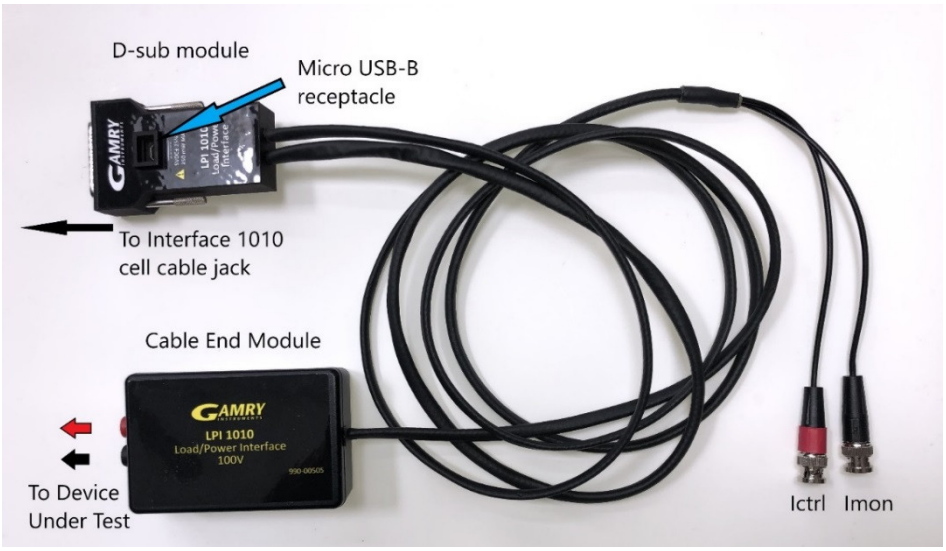


Warning: If the LPI1010 is taken from a cold location (for example outdoors in winter conditions) to a warm, humid location, water vapor may condense on the cold surfaces inside the LPI1010, possibly creating a hazardous condition. Before connecting power to a "cold" LPI1010, allow at least one hour to warm at room temperature.

Verify that all parts listed on the packing list are included. Be sure you have the correct version of your LPI1010. Compare the packing list with the label on the D-sub Module and Cable End Module. Below are the variants of the LPI1010, each with a different input voltage range:

Part #	Name	Voltage Range
992-00155	LPI1010 Load/Power Supply Interface 10V	10 V full-scale
992-00156	LPI1010 Load/Power Supply Interface 100V	100 V full-scale
992-00157	LPI1010 Load/Power Supply Interface 1kV	1 kV full-scale

Figure 3-1
Overview of the LPI1010 Top-Level Assembly



Physical Location

Normally users place their LPI1010 on a flat workbench surface next to the potentiostat and electronic load or programmable power supply. Keep enough space for the instrument to easily access and reach all cable connections and to avoid over-bending the cables.

The LPI1010 does not have active cooling. If you place your LPI1010 within an enclosed space, make sure that the internal temperature within that space does not exceed 45°C, the maximum ambient temperature for the LPI1010. Be particularly careful if a computer or other heat-dissipating equipment is mounted in the same enclosure as the LPI1010.

The LPI1010 is not designed for outdoor use.

Computer Requirements

Before you connect the potentiostat connected to your LPI1010 to a computer, you must make sure that your computer meets these requirements:

- A computer based on one of the x86 family of Intel™ microprocessors or a 100%-compatible processor from another vendor.
- Microsoft Windows® 10 or newer is required with Gamry Framework™ software version 7.9.1 and above. Only the 64-bit version of these operating systems is supported.

Quick-Start Guide for System Installation

Your shipment should have included a document entitled **Quick-Start Installation Guide**. It contains the latest instructions for installing Gamry Instruments' hardware and software onto a computer system. If this document is missing, you can find it on www.gamry.com. The Quick-start Guide found at www.gamry.com contains the latest information concerning system installation, so the information provided below is always subject to change.

Software Installation

The LPI1010 is compatible with the Windows® Plug & Play configuration system. Like most Plug & Play hardware, it is best if you install the software for the LPI1010 **before** you install the instrument hardware.

The latest Gamry software is not provided on a DVD anymore but is now available for download as `*.exe` or `*.iso` file on Gamry Instruments' Client Portal after creating an account and registering your instrument:

https://www.gamry.com/client-portal/my-account/

An internet download of Gamry Instruments' software will download a self-extracting file. Running this file will extract the software and begin the installation.

Reboot Your Computer after Software Installation

Reboot your computer when the Gamry Setup program is done. The Setup program normally offers you the opportunity to do so. Following Setup, you may not be able to use your LPI1010 until the drivers are loaded.



Device driver installation may not occur until a while after the Windows® Desktop appears. On a slow computer, or a busy computer with lots of active applications, the delay before driver installation can be a minute or more.

Running the Framework

Many newer electrochemical applications do not run as an application within Gamry Instruments' Framework software. This is true of all applications that use Gamry Instruments' Toolkit for instrument control. Gamry Instruments' Framework software is the main application software for performing routine analysis associated for electrochemical measurements. There are other software programs such as Resonator that are stand-alone programs. Programs that you develop using our toolkits will fall into the stand-alone software category.

The Framework Instrument Manager is useful in organizing the instruments in the system. The Framework also has a Calibration program that is used to calibrate instruments connected to the system.

Framework Device Status Bar

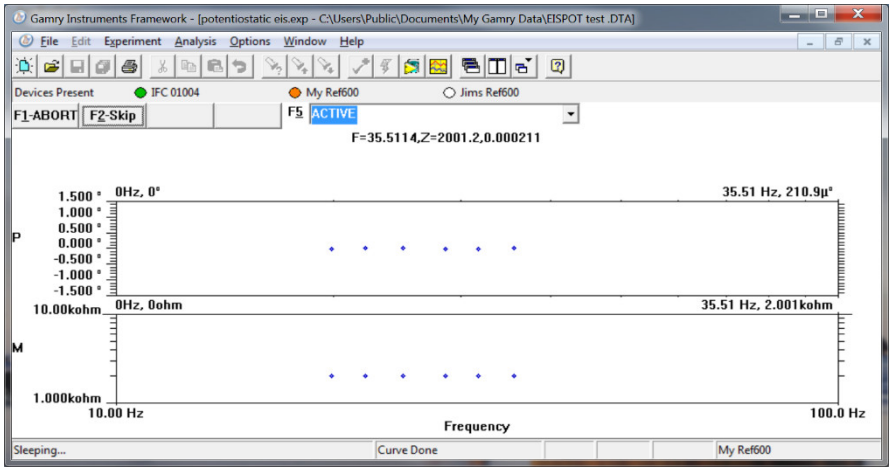
By default, the Gamry Framework shows a Device Status Bar under its main menu (see Figure 3-2). If you do not see the Device Status Bar when you run the Gamry Framework, it has been disabled in the Framework **Options** menu.

Instruments that are connected to the computer appear on this bar. The round indicator associated with each device shows its status:

Green	The device is available to run experiments
Orange	The device is currently running an experiment
White	The device is connected to the system but is not usable. This is generally the result of a mismatch between the Framework software and the device's firmware. You can use the Gamry Instrument Manager to fix the mismatch.

The screen capture below shows a Framework screen with three USB instruments connected.

Figure 3-2
Framework with Three Potentiostats and One Running Test



The Interface 1000 (IFC 01004) in this system is shown with a green indicator because it is installed and ready to run. The Reference 600 labeled My Ref600 has an orange indicator because it is recording the EIS spectrum shown on the screen. The Reference 600 labeled Jims Ref600 has a white indicator, showing it is plugged in but cannot be used. This is an indication of a version mismatch between Gamry Instruments Framework software and the instrument's firmware.

Firmware Update

Before using your LPI1010 system, verify that you have the latest firmware installed. The LPI1010 itself does not have a firmware but the Interface 1010 potentiostat used with it does. From time to time, Gamry

Instruments makes changes to the instrument's firmware code and a firmware update is required to make use of the new or improved code.

You can update the firmware with the LPI1010 connected to the potentiostat or with the potentiostat as standalone instrument. There are three separate firmware images that can be updated in the field on your Interface 1010. The first is the Instrument Firmware. This is the program that handles most of the functions of the Interface 1010. The second is the Communications Firmware. This program handles the communications between your Interface 1010 potentiostat and the host computer. The third is the PLD firmware, which you should only change if a Gamry Instruments representative instructs you to.

Initiate the Firmware Update process using the Framework **Options, Instrument Manager...** command.

Appropriate update files can be obtained from the Gamry Instruments website at www.gamry.com. If you encounter a problem updating the firmware of your Interface 1010 potentiostat, please contact Gamry Instruments for assistance.



Caution: Interrupting a firmware update can cause a catastrophic failure of your system. Do not turn off the Interface 1010 potentiostat, do not unplug any the communications cable, and do not stop the operation of the host computer when the USB LED of the potentiostat is a continuous red color.

Do not interrupt a firmware update that is in progress. An incomplete update can render an Interface 1010 potentiostat inoperable until it is returned to Gamry for reprogramming.

Should the firmware update be interrupted, contact Gamry before starting the return process.

Chapter 4: Hardware Installation

The LPI1010 was developed to measure single cells and stacks of energy storage or energy conversion devices with voltages of up to 1000 V. Galvanostatic signal control is hereby conducted by the Gamry Instruments Interface 1010 potentiostat. Due to the potentiostat's voltage limitations, an external electronic load or programmable power supply is required to control the larger voltage signals of the DUT.

The LPI1010 serves as active link between potentiostat, electronic load, and DUT. It is under control of an external computer which runs the applications of Gamry Instruments' Framework software.

Setup Overview

An LPI1010 experimental setup requires the following Gamry Instruments components:

- Interface 1010E Potentiostat/Galvanostat/ZRA
- LPI1010 Load/Power Supply Interface – 10 V, 100V, or 1 kV
    - LPI D-sub Module
    - LPI Cable End Module
    - LPI Power Cable
    - LPI Voltage Sense Cables
- Electronic load or programmable power supply

Figure 4-1 shows a schematic outline of an electrochemical test setup using the LPI1010.

The LPI D-sub Module is plugged in to an Interface 1010 potentiostat using the 25-pin D-sub connector at the front panel where typically the cell cable is connected. The D-sub Module needs to be powered separately by using an LPI Power Cable. It is connected between its micro USB port and the User I/O connector (15-pin HD D-sub) at the potentiostat's rear panel.

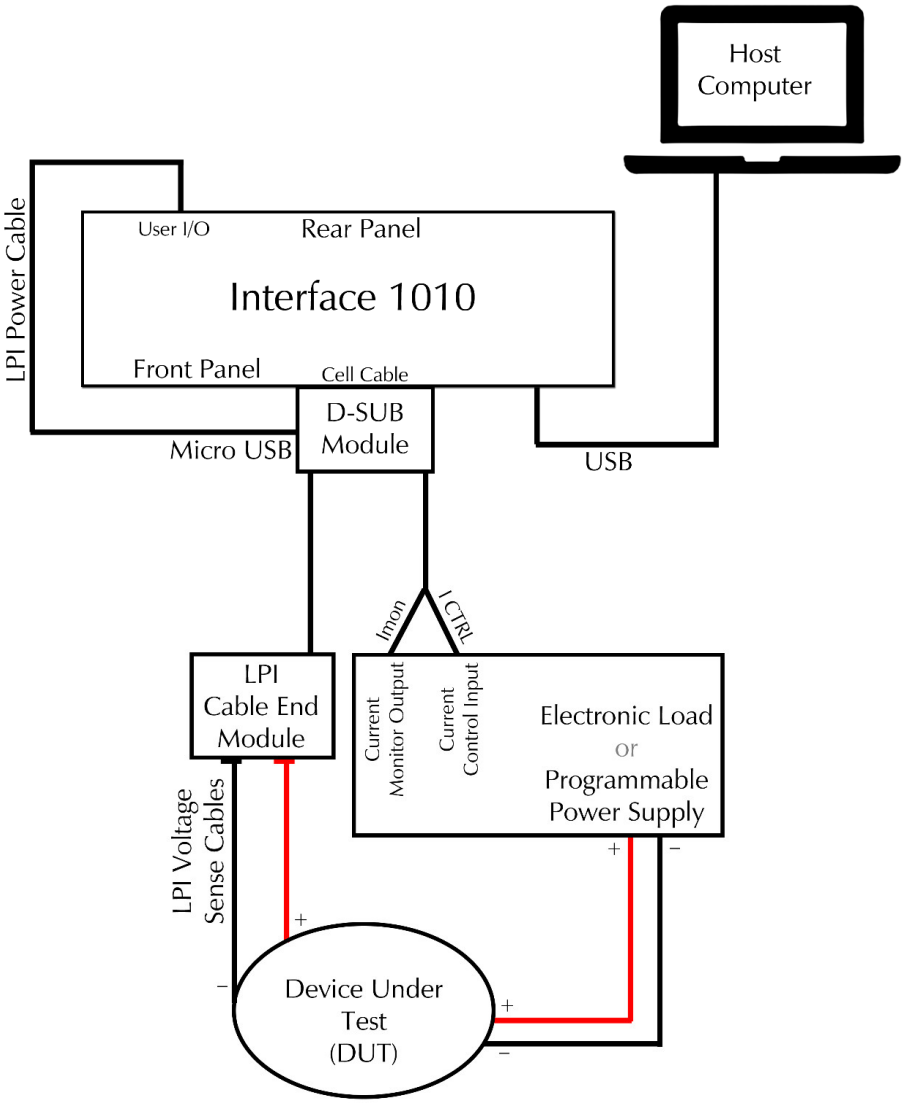
The D-sub Module has two longer cables attached whereas one cable feeds directly in the Cable End Module. The Cable End Module has two additional protected 4 mm banana connectors which interface with the provided LPI Voltage Sense Cables. The other end of the LPI Voltage Sense Cables is connected to the DUT.

The second cable of the D-sub Module has two BNC connectors for current control (I_CRTL) and current monitor (I_MON) which feed the electronic load or programmable power supply. The power output connectors of the electronic load are connected to the DUT.

The Interface 1010 potentiostat does not plug directly into the AC mains supply. Instead, the mains are connected to an external power supply, which supplies a regulated 48 V DC output. This regulated DC is then connected to the DC power input jack on the rear of the Interface 1010.

The Interface 1010 connects to a computer using a filtered High Speed USB A/B cable. A suitable cable is always shipped with your Interface 1010. The replacement cable is Gamry Part Number 985-00131. The computer controls the potentiostat using Gamry Instruments' Framework software. The computer software and instrument are responsible for taking the measurement and storing it.

Figure 4-1
Typical Electrochemical Test Setup using the LPI1010



Signal Processing

Both the Electronic Load and Programmable Power Supply must have inputs for controlling the DUT current and outputs proportional to the actual DUT current. As mentioned in the system description, the Cable End Module accepts the raw DUT voltage and divides it down before feeding that signal to the LPI D-sub Module. A detailed description of the signals is discussed below:

- **Current Control:** The current control signal originates in the Interface 1010 and is multiplied by 3.3333 in the LPI D-sub module. It is then output to the electronic load or programmable power supply. This signal, shown as "Sout" in the block diagram of Appendix C, is produced by the Counter Electrode pin of the Interface 1010 cell connector and fed into the LPI D-sub Module. The modulated current control signal has a bandwidth of zero to 100 kHz. Inside the D-sub Module, the "Sout" signal is multiplied by 3.333 to obtain a 0 to ±10 V signal (full-scale). This signal is then fed by a coax cable to the control input of the electronic load or programmable power supply.
- **Current Monitoring:** The typical 0 to ±10 V (full-scale) current sense signal output by the electronic load or programmable power supply is shown as "Imon" in the block diagram of Appendix C. "Imon"

is fed by a coax cable to the LPI D-sub Module where it is divided down to 0 ±0.100 V (full-scale). This signal is then fed into the Work Electrode pin of the Interface 1010 cell connector.

- **Voltage Monitoring:** The DUT terminal voltage is divided down in the LPI Cable End Module using resistor-capacitor networks. The dividers ensure that the voltage out of the LPI Cable End module equals ±10 V at the full-scale rating of the LPI cable. For example, the 1 kV LPI cable divides the DUT voltage by 100 and the 10 V LPI cable divides it by 1. This 0 to ±10 V signal (full-scale), shown as "LV" in the block diagram of Appendix C, is fed by a coax cable to the LPI1010 D-sub Module. The "LV" signal is buffered by unity-gain amplifiers in the LPI D-sub Module and fed differentially into the Reference Electrode and Work Sense Electrode of the Interface 1010 cell connector.

Install the Interface 1010 potentiostat

The LPI1010 is used with the Gamry Instruments Interface 1010E Potentiostat/Galvanostat/ZRA. Follow the installation instructions in the Interface 1010 Operator's Manual (988-00063). The current version of this manual can be downloaded on Gamry's website at https://www.gamry.com/support/documentation-downloads/.



Please refer to the Interface 1010 Operator's Manual for detailed information about connections, specifications, and general usage.

Install the LPI1010

1) Ensure that the DUT is not connected to anything
2) Verify that both the Interface 1010's Power switch is turned OFF and the electronic load or programmable power supply is turned OFF
3) Connect the LPI1010 D-sub Module to the Cell Cable connector on the Interface 1010's front panel, as shown in Figure 4-2

Figure 4-2
Installation of the LPI1010 D-sub Module at the front of an Interface 1010 potentiostat



4) Hand-tighten the jackscrews of the LPI1010 D-sub Module until they are snug.

LPI Power Cable and Power Connection

The LPI1010 is indirectly powered using the potentiostat's User I/O connector. It supplies 5 V to the female micro USB-B connector on the D-sub Module. Gamry Instruments guarantees proper performance only using its supplied power cable (P/N 985-00197), see Figure 4-3.

Figure 4-3
LPI Power Cable



The LPI Power Cable has a 15-pin HD D-sub connector on one end which mates with the User I/O connector on the back of the Interface 1010. Hand-tighten the jackscrews on the LPI Power Cable until snug. The other end of the cable terminates in a male micro USB-B connector and plugs into the female micro USB-B connector on the top side of the LPI1010 D-sub Module as shown in Figure 4-4.

Figure 4-4
Installation of the LPI Power Cable at the rear of an Interface 1010 potentiostat (left) and micro USB connector of the LPI1010 D-sub Module (right)



The Interface 1010 supplies a regulated 5 V output and Earth ground via the User I/O connector. Inside the LPI D-sub Module, the 5 V power is stepped up to an isolated ±15 V power supply by way of a transformer. Thus, all circuitry connected to the cell-connector pins are isolated from Earth ground.

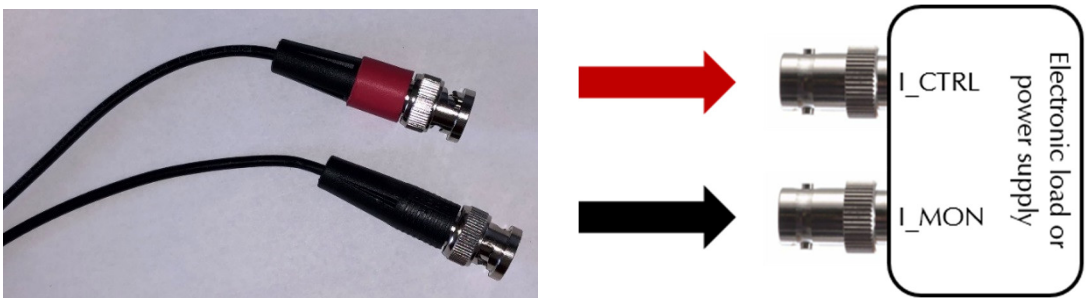


Gamry Instruments does **not** recommend commercially available wall chargers and USB cables to power the LPI Top Assembly.

Connect Current Monitor and Current Control Cables

The LPI D-sub module has to cables connections with one directly leading to the LPI Cable End Module. The second cable has two male BNC connectors which mate with the appropriate connectors on the electronic load or programmable power supply as shown in Figure 4-5.

Figure 4-5
Schematic overview of current control (I_CTRL) and current monitor (I_MON) cable installation



The red-marked BNC connector lead is the current control (I_CTRL) output of the LPI1010 and goes to the mating current control input of the electronic load or programmable power supply. The black-marked BNC connector lead serves as current monitor (I_MON) of the LPI1010 and connects to the current monitor output of the electronic load or programmable power supply.



If one or both connectors on the electronic load or programmable power supply is not a female BNC, use an appropriate adapter such as those shown in Appendix B of this manual.

Connect Voltage Sense Cables

The LPI1010 system includes two additional LPI Voltage Sense Cables (P/N 985-00211 and 985-00212) with protected male banana connectors on each cable end, see Figure 4-6.

Figure 4-6
LPI Voltage Sense Cables



Connect both supplied LPI Voltage Sense Cables to the matching connectors of the LPI as shown in Figure 4-7. The red cable is for the positive (+) contact and the black cable is for the negative (-) contact.

Figure 4-7
LPI Voltage Sense Cables connected to the LPI Cable End Module

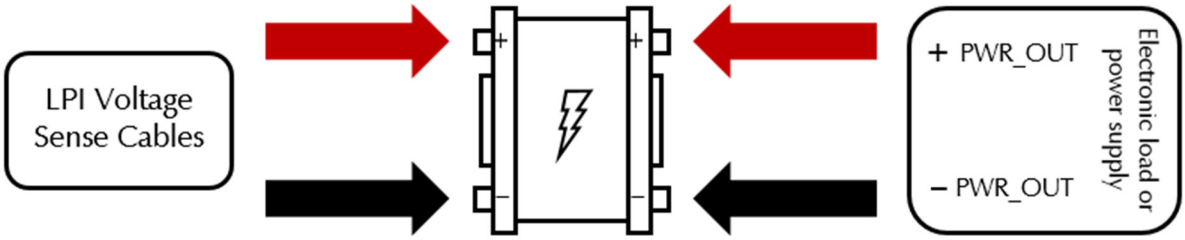


The other end of the LPI Voltage Sense Cable is connected to the DUT.

Connect Cell Cables to DUT

After installing the LPI1010 to the potentiostat and all other cables to the LPI1010 and the electronic load or power supply, the DUT can be connected to the setup as shown in Figure 4-8.

Figure 4-8
Schematic overview of cell cable connection between DUT and electronic load or power supply



Connect the free ends of the LPI Voltage Sense Cables to the DUT. If the DUT does not connect directly to the male banana plugs on the LPI Voltage Sense Cables, use an adapter appropriately rated for the voltage of the DUT. The red cable connects to the positive (+) contact, the black cable connects to the negative (-) contact of the DUT.

Connect the electronic load or programmable power supply to the DUT. Depending on the system, the power output connections of the electronic load or programmable power supply may vary. Due to the large variety of available systems and DUT connections, Gamry Instruments cannot supply appropriate cables and recommend user-supplied cables.

When building cables for the connection between DUT and electronic load or programmable power supply, verify that the cable have the appropriate current and voltage rating for the application. Use appropriate cable connectors depending on your DUT and electronic load or programmable power supply to guarantee a stable and rigid connection.

Configure Electronic Load or Programmable Power Supply settings

After finishing the installation of the LPI1010 and Interface 1010 and before running any actual experiments with a DUT, the hardware settings of the electronic load or programmable power supply need to be checked. Due to the large variety of electronic loads and programmable power supplies on the market, this section discusses the configuration only in a general terms.

1) Ensure that the DUT is not connected to anything
2) Verify that the output of your electronic load or programmable power supply is set to zero
3) Turn on your electronic load or programmable power supply
4) Set the operation mode to **External Current Control**
5) Set the full-scale current on your electronic load or programmable power supply to accommodate the maximum desired test current



In most cases the full-scale setting applies to both the current control and current monitoring features, however this is not always the case. Consult the user manual of your Electronic Load or Programmable Power Supply when setting these parameters.

Configure Electronic Load or Programmable Power Supply settings in Framework

The LPI1010 was designed to be a general-purpose analyzer capable of operation with many different loads and power supplies. Gamry Instruments attempts to address their unique characteristics for correct operation.

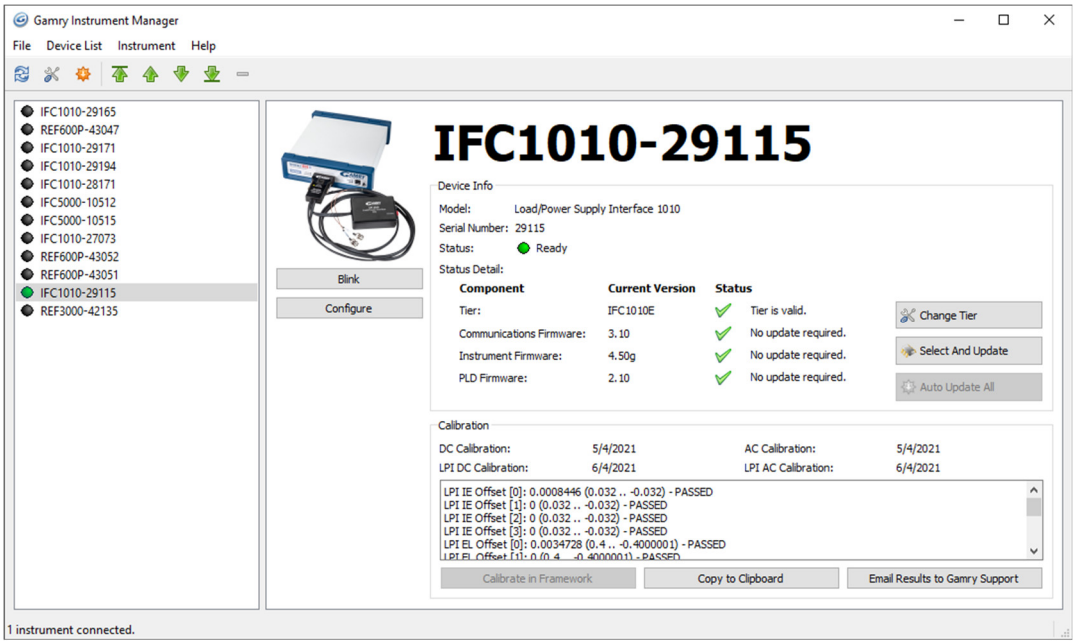
Use the Gamry Instrument Manager to enter the characteristics of the load or power supply. These settings are then used in the LPI1010 control and measurement algorithms.



The setup configuration of the electronic load or programmable power supply **MUST** be entered in Framework before the first use of your LPI1010 system.

1) Ensure that your LPI1010 is plugged into the Interface 1010 instrument, and the LPI1010 has its power cable connected to the back of the Interface 1010
2) Power on your Interface 1010 and ensure that its USB port is connected to your computer
3) Start the Gamry Instrument Manager from either the Start menu or from within the Framework™ software by selecting **Option/Instrument Manager…** on the Framework Menu. From the Start menu navigate to the Gamry program group and then select the Gamry Instrument Manager from the list

Figure 4-9
Gamry Instrument Manager window



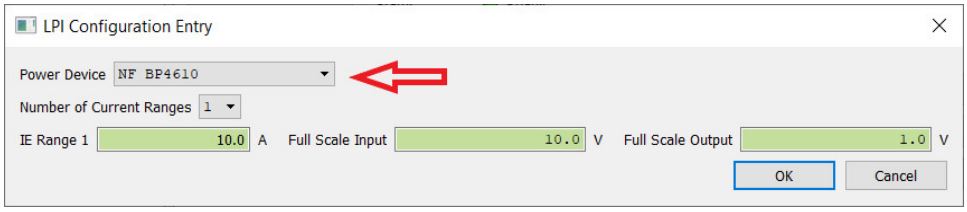
4) The left pane of the Instrument Manager shows a complete list of applied potentiostats. The status indicator should turn green after a potentiostat fully powered up.

5) Click on the potentiostat that is connected to the LPI1010. Detailed information about the potentiostat is then shown in the right window. Check if any software updates are required, see also chapter ***Error! Reference source not found.*** for more information.

6) If the LPI1010 is correctly connected to the selected potentiostat and powered, the device is listed with the **Model** name *Load/Power Supply Interface 1010*.

7) Press the **Configure** button to open the LPI Configuration Entry dialog box as shown in Figure 4-10.

Figure 4-10
LPI Configuration Entry setup window



Power Device	The dropdown box allows selecting the electronic load or programmable power supply in use. The remaining fields in the setup window populate automatically after selecting a load or power supply. If your load or power supply is not in the list, you need a Power Device configuration file. Please contact your Gamry representative to discuss your options.
Number of Current Ranges	Specifies how many ranges the load or power supply has. Many power supplies or loads may only have one range as shown in the image. Please select the appropriate number of ranges.
IE Range	Specifies the maximum current for each available IE Range. Depending on the entered number of current ranges, one separate entry is added to the IE Range setup.

	Enter the current ranges in ascending order. Enter the maximum current of your load or power supply if only a single range is available. It is important to enter these number accurately. The LPI1010 uses these values in combination with the Full Scale Output value. Setting a voltage on the output results in a current at the cell proportional to the IE Range values entered here.
Full Scale Input / Full Scale Output	The value of the measurement full-scale voltage is entered in the Full Scale Input field. The value of the control full scale is entered in the Full Scale Output. The LPI1010 can use voltages between +1 V and +10 V for either of these fields. The first two entries in the LPI Configuration Entry dialog box are used to scale the current measurement and control signals. Most commercial loads and power supplies apply full-scale current when +10 volts is applied to their remote programming input. Likewise, most commercial loads and power supplies report full-scale current when +10 volts is set on the current monitor signal. The specifications of the Load/Power Supply should tell you these values.



Caution: An incorrect Load/Power Supply configuration can lead to hazardous conditions. You must verify the configuration before starting any experiment.

8) After all parameters in the LPI Configuration Entry configuration are entered, all settings are stored in the non-volatile memory within the LPI1010 itself. If the load/power supply is not changed, you can run experiments without re-entering the configuration every time. However, if you want to use a different load/power supply, you must re-enter the configuration for the new load/power supply or you risk applying an incorrect current to your cell. Contact your local Gamry Representative if you want to add a new load or power supply to the dropdown box.

Chapter 5: Calibration

Introduction

When purchasing an LPI1010 system, it already comes fully calibrated and ready to use. However, there might be circumstances to re-do the calibration, for example when using different cables or the quality of your data is in question. It is recommended calibrating your instrument at least once a year.

Before calibrating the LPI1010, please make sure that your Interface 1010 is fully calibrated or calibrate it first if required.

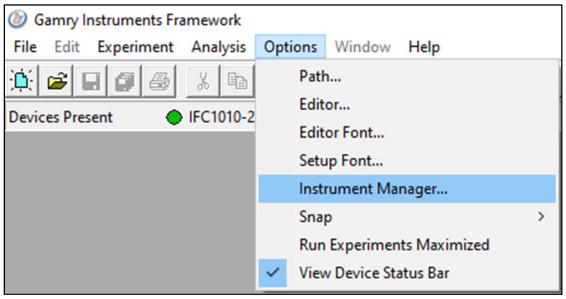
Calibration can be initiated through Framework™ software, or directly through the Gamry Instrument Manager (GIM) . To initiate calibration, use one of the following steps:

- Click the **Calibrate in Framework** button, located in the Calibration area of GIM. This launches the appropriate calibration routine for the instrument selected in GIM. Follow the instructions given in Framework. See the relevant Calibration Quick Start Guide for additional details.

  If there are any failures during calibration, click the **Email Results to Gamry Support** button in GIM. One of our support engineers will review the results and provide appropriate advice.

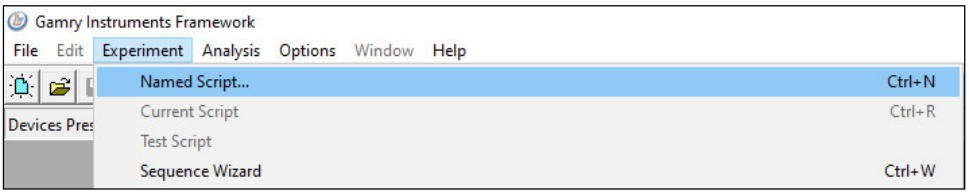
  You run the Instrument Manager by selecting **Options/Instrument Manager...** on the Framework Menu.

Figure 5-1
Menu path to the Gamry Instrument Manager



- Open LPI calibration via the LPI selection on the **Framework's Experiment drop-down menu**.
- Access the LPI calibration script by selecting **Experiment/Named Script…** on the Framework Menu. The name of the LPI calibration script is `CALIBLPI.EXP`.

Figure 5-2
Menu path to the script directory



This standard user calibration uses an external resistive dummy cell, see Figure 5-3.

Caution: The standard LPI1010 calibration calls for an external resistive dumm cell. Your LPI1010 system was shipped with two Calibration Cells, which include a 200 mΩ (5% accuracy) and 2 Ω (5% accuracy) resistor. After calibration, please place this dummy cell in a safe place where you can find it if your unit requires recalibration.

If you do need to recalibrate and you cannot find your calibration cell, contact Gamry Support. For safety reasons, it is not recommended using a cell that is not specified to calibrate your LPI.

Caution: Depending on the LPI model, different calibration cells are required. The 1 kV LPI1010 model for example requires a special 20 Ω cell. Please contact Gamry Support to discuss your options.

Figure 5-3
LPI1010 200 mΩ Calibration Cell with cover



LPI calibration is only required infrequently. Recalibrate your LPI1010 under the following circumstances:

- It is at least one year since your last calibration.
- Your LPI has been serviced.
- You notice breaks or discontinuities in the data curves recorded with your system.
- The system is being run in an environment that is very different from the previous operating environment. For example, if the LPI1010 was calibrated at 15°C and you are now operating it at 30°C, you should recalibrate.

LPI calibration is also described in Gamry's Quick-Start Calibration Guide for the LPI1010.

Procedure to Calibrate the LPI1010

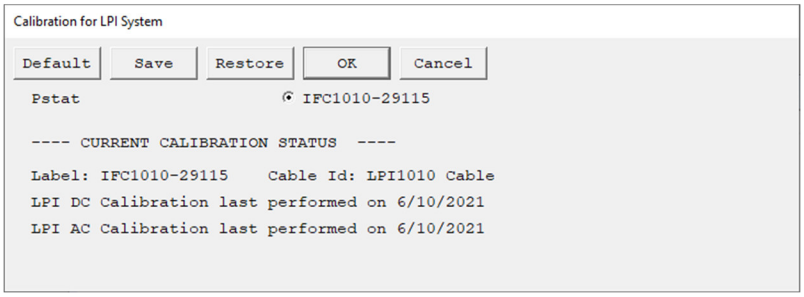
1) Verify that the electronic load or programmable **power supply is turned OFF**.
2) Ensure that the LPI1010 is correctly installed and powered. Verify that the **Interface 1010's Power switch is turned ON**.

3) Verify that all settings for the electronic load or programmable power supply in the LPI Configuration Entry setup window are correct.

4) Open Gamry Framework™ software and open the LPI calibration experiment using one of the methods discussed in the previous section

5) The **LPI Calibration** window appears, see Figure 5-4. Click the **OK** button and exactly follow each setup instruction before continuing with the next step

Figure 5-4
LPI Calibration setup window

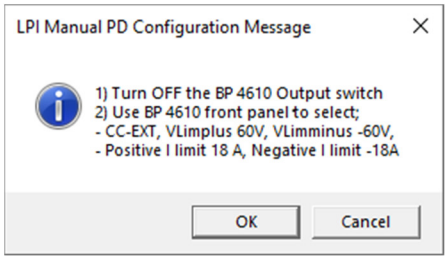


The setup window shows the potentiostat used for calibration. Select the correct device for the LPI calibration. Further below in the setup window are the previous LPI calibration results listed included the date. If a calibration was not successful, an error message is shown instead.

Caution: The LPI calibration is a semi-automatic procedure which requires the user to change the calibration cell at least once during the process. The electronic load or programmable power supply needs to be operated individually, requiring user interaction.

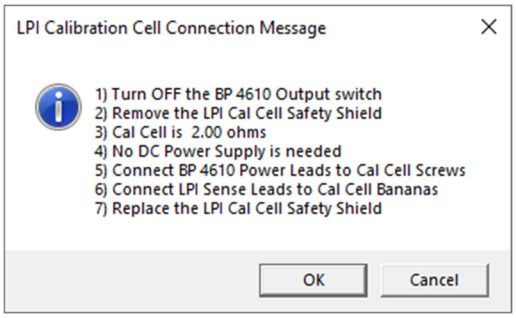
6) A safety message appears followed by an instruction to configure your electronic load or programmable power supply settings, see Figure 5-5. These settings can vary depending on the instrument you are using. Press **OK** after setting all parameters.

Figure 5-5
LPI Manual PD Configuration window



7) An instruction window appears to install your first calibration cell, see Figure 5-6. Note that LPI calibration requires at least two different calibration cells with different resistors. In this case, the 2 Ω cell is the first.

Figure 5-6
LPI Calibration Cell Connection message



Follow the instructions and connect all cables. Always verify that the output switch of the electronic power supply or programmable power supply is turned **OFF** before installing the calibration cell. Remove the safety enclosure by removing both thumb screw to access the PCB of the calibration cell. Connect the power cables of the electronic load or programmable power supply to the studs. Slide the safety enclosure back on and secure again. Connect the LPI Voltage Sense Cables to the banana connectors. Click the **OK** button to continue.

Figure 5-7
LPI1010 200 mΩ Calibration Cell with connected cell leads

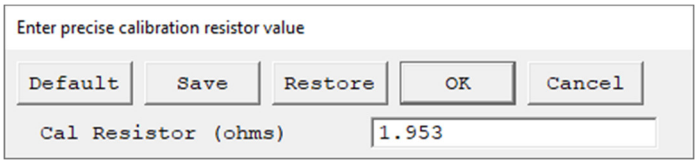




Caution: After attaching all cables to the calibration cell and before continuing with the calibration, put the safety cover back on and secure it. Continuing without a cover and leaving the contacts open is a severe safety hazard.

8) In order to start the first calibration, the precise resistor value of the calibration cell needs to be entered. You can find the resistor value on the side of your calibration cell. Press **OK** to continue.

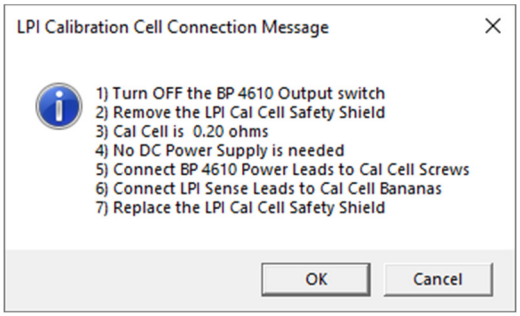
Figure 5-8
Entering Resistor value of the Calibration Cell



9) The following steps require to turn the output switch of your electronic load or programmable power supply ON and OFF several times. Follow these instructions to continue the calibration procedure.

10) During the LPI calibration, you are required to switch the calibration cell. A new window appears with installation instructions and the required calibration cell, see. In this case, a 0.2 Ω cell is required. Always verify that the output switch of the electronic power supply or programmable power supply is turned **OFF** before installing the calibration cell. Press **OK** after installing the cell.

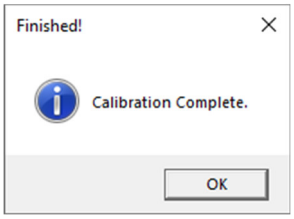
Figure 5-9
Entering Resistor value of the Calibration Cell



11) Again, the calibration procedure asks you several times to turn the output switch of your electronic load or programmable power supply ON and OFF. Follow these instructions to continue the calibration procedure.

12) After the calibration is done, a window appears to confirm its completion. Click the **OK** button to acknowledge completion.

Figure 5-10
Completed Calibration



The LPI1010 D-sub Module contains an EEPROM memory chip. All cell cables with EEPROM memory are known as **dynamic cables**. After performing a calibration, the calibration results are stored in the cable. You can also see all calibration results in the Calibration pane at the bottom of the Gamry Instrument Manager, see Figure 4-9.

Chapter 6: Adding a new Load/Power Supply to Framework

Introduction

When purchasing an LPI1010 system, the device already includes pre-programmed values for various power supplies and electronic loads. The values for each power supply or electronic load are stored in the non-volatile memory of the LPI1010 itself. It lets you then choose the settings for various electronic loads and power supplies from the **Power Device** drop-down box within the LPI Configuration Entry dialog box as shown in Figure 4-10.

If the load/power supply is not changed, you can run experiments without re-entering the configuration every time. However, if you want to use a different load/power supply, you must re-enter the configuration for the new load/power supply or you risk applying an incorrect current to your cell.

Additionally, you can permanently add your own, custom electronic load/power supply settings to the Power Device drop-down list. In order to do so, a so-called **PD Info File** needs to be added to the Gamry Instruments directory. This chapter explains in detail how to create such a file. Please contact your local Gamry Representative if you need additional support.



Caution: An incorrect Load/Power Supply configuration can lead to hazardous conditions. You must verify the configuration before starting any experiment.

File Format

The PD Info file is a settings file that describes the ranges and workings of an electronic load or programmable power supply. This file is used in the configuration of a Gamry LPI1010 instrument. The PD Info file is an ASCII text file that is formatted in the fashion of an `*.INI` file. These files contain both so-called *Sections* and *Keys*.

Sections

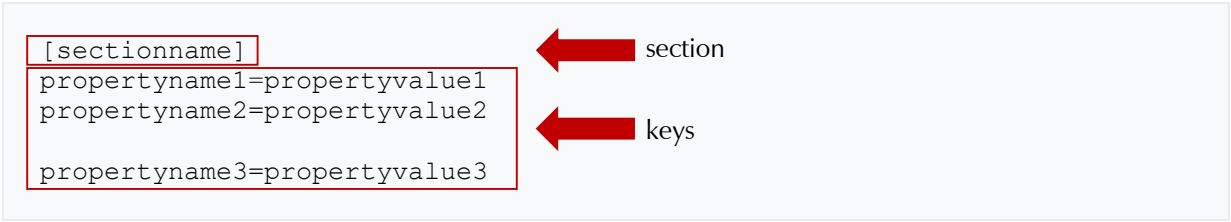
A sections is a named **region** within the PD Info file which are put in brackets as shown below. Each section may contain one or more keys which follow the section description.

- Section names should not contain a space.
- Section names are not case-sensitive.
- Section names are unique.

Keys

Keys are the basic element in the file and are named properties that exist within a section. Each **key name** has a **key property** value assigned. Key properties can be of the type *String*, *Float*, or *Integer*.

- Key names should not have a space.
- Key names are not case sensitive.
- Key names are unique.



File Name

PD Info files must have a properly formatted **file name** in order to be recognized by the Gamry Software. All files must have a name that start with '`LPI1010 PDxxxx Setting File`' where the '`xxxx`' is a unique four- digit number. The file name for one of Gamry's default installed settings files is shown below. Note the '`xxxx`' is '`0001`' in this example.

```
LPI1010 PD0001 Setting File for NF BP4610.INI
```

Gamry Reserved ID Numbers

Gamry installed PD Info files will have four-digit identifiers ranging from `0001` to `1000`. You should not make any custom setting file using an identifier in this range. If you use a number in this range, you risk having your file overwritten during an update of the Gamry software.

Custom ID Numbers

Customers may make their own PD Info files using an identifier in the range from `1001` to `9999`. These numbers will not be overwritten by Gamry software updates. It is up to the customer to make sure they use a number that they have not previously used, or the software will not be able to properly identify the PD Info file.

File Name Descriptive Text

Each PD Info file can have descriptive text **AFTER** the required '`LPI1010 PDxxxx Setting File`' text. In the example below, the descriptive text helps identify that this is a PD Info file for a NF BP 4610 power supply ('`for NF BP4610`').

```
LPI1010 PD0001 Setting File for NF BP4610.ini
```

File Name Extension

The file name must have a `*.INI` extension. Any other extension will not allow the Gamry software to recognize the file.

File Location

All PD Info files are required to be in a specific folder. The location of this folder may be different based upon varying locale and installation settings. The normal location for the folder is shown below:

```
C:\ProgramData\Gamry Instruments\Framework\PDInfo
```

For different locales you can locate the **ProgramData folder** by entering '`%PROGRAMDATA%`' into the search field on Windows. From there you can navigate to **Gamry Instruments > Framework > PDInfo**.

Required Sections

In order for a PD Info file to be properly interpreted by the Gamry software, specific section are required within the file. If the file is missing one of these sections or a section is missing required information, the software will be unable to load the file and not be able to be used by the system.

[DeviceInfo]

The `[DeviceInfo]` section gives the basic information about the electronic load or power supply. The example depicts the information for a BP4610 power supply from NF Corporation described as '`DeviceName=NF BP4610`'. Each of the keys for this section will be discussed below:

```
[DeviceInfo]
DeviceName=NF BP4610
DeviceID= 0001
Type = PS
NumIRanges= 1
MaxVoltage= 110.0
MaxCurrent= 10.0
MaxFreq= 30000.0
ClassName = NFBP4610
```

Key Name	Type	Required	Description
DeviceName	String	YES	This is the name that is shown by the software when referencing the device.
DeviceID	Integer	YES	This is the unique four-digit ID that is in the file name. These two numbers **must** match. Custom devices should have an ID in the range of 1001 to 9999. IDs from 0001 to 1000 are reserved for Gamry defined power devices.
Type	Integer	YES	0 = Power Supply 1 = Electronic Load
NumIRanges	Integer	YES	Number of current ranges (IE Range) that the power device contains. Valid values are 1 to 4.
MaxVoltage	Float	YES	This is the maximum voltage, in V, that can be created by the power device. If the device has multiple voltage ranges, the maximum value on the highest range is used.
MaxCurrent	Float	YES	This is the maximum current, in A, that can be sourced or sunk by the power device. If the device has multiple current ranges, the maximum value on the highest range is used.
MaxFreq	Float	YES	This is the highest frequency, in Hz, that the power device is capable of response. This is for reference; specific current ranges may have a lower response.
ClassName	String	NO	This is the class name used for programmatic control of the power device. Most devices require manual interaction.

[DeviceStrings]

The `[DeviceStrings]` section contains informational strings used to display messages to the user. Each message can contain a variable number of lines of information to be displayed. The number of lines is specified by the `NameStringCount` entry, where `Name` is the string identifier. The example below depicts the section for a BP4610 power supply from NF Corporation. Each of the keys for this section will be discussed below:

```
[DeviceStrings]
SafetyStringCount= 4
SafetyString0= CAUTION! Cell Terminals could be at 110 V
SafetyString1 = This voltage can cause injury or death
SafetyString2 = Obey all Warnings in the LPI 1010 Operator's Manual
SafetyString3 = Follow HV Safety Rules when making cell connections

ConnectCellStringCount=5
ConnectCellString0= 1) Turn OFF the BP 4610 Output switch
ConnectCellString1= 2) Assume High Voltages are on Cell Terminals
ConnectCellString2= 3) Follow HV Safety Rules when making cell
connections
ConnectCellString3= 4) Connect BP 4610 Power Leads to Device Under Test
ConnectCellString4= 5) Connect LPI Sense Leads to the Device Under Test

CellOnStringCount = 2
CellOnString0 = 1) Double check your Cell connections then
CellOnString1 = 2) Turn ON the BP 4610 Output Switch

CellOffStringCount = 1
CellOffString0 = Turn OFF the BP 4610 Output Switch

ManualConfigStringCount = 4
ManualConfigString0 = 1) Turn OFF the BP 4610 Output switch
ManualConfigString1 = 2) Use BP 4610 front panel to select;
ManualConfigString2 = - CC-EXT, VLimplus 60V, VLimminus -60V,
ManualConfigString3 = - Positive I limit 18 A, Negative I limit -18A

CalConnectStringCount = 7
CalConnectString0= 1) Turn OFF the BP 4610 Output switch
CalConnectString1= 2) Remove the LPI Cal Cell Safety Shield
CalConnectString2= 3) Cal Cell is %5.2f ohms
CalConnectString3= 4) No DC Power Supply is needed
CalConnectString4= 5) Connect BP 4610 Power Leads to Cal Cell Screws
CalConnectString5= 6) Connect LPI Sense Leads to Cal Cell Bananas
CalConnectString6= 7) Replace the LPI Cal Cell Safety Shield
```

Key Name	Type	Required	Description
SafetyStringCount	Integer	YES	This is the count for the number of lines of `Safety` strings.
SafetyStringX	String	YES	One or more safety strings. The safety strings are shown every time the device is used. It should contain cautionary information about voltages and safety. `X` is the counter for the Safety string, starting with `0`.
ConnectCellStringCount	Integer	YES	This is the count for the number of lines of `ConnectCell` strings.
ConnectCellStringX	String	YES	One or more strings used to inform the user to connect a cell to the power device. It may contain some safety information as well to remind the user of any dangers. `X` is the counter for the ConnectCell string, starting with `0`.
CellOnStringCount	Integer	YES	This is the count for the number of lines for the `CellOn` strings.
CellOnStringX	String	YES	One or more strings used to tell the user to turn on the cell (output) for the power device. `X` is the counter for the CellOn string, starting with `0`.
CellOffStringCount	Integer	YES	This is the count for the number of lines for the `CellOff` strings.
CellOffStringX	String	YES	One or more strings used to tell the user to turn off the cell (output) for the power device. `X` is the counter for the CellOff string, starting with `0`.
ManualConfigStringCount	Integer	YES	This is the count for the number of lines for the `ManualConfig` strings.
ManualConfigStringX	String	YES	One or more strings used to specify the configuration of the power device for use during calibration. `X` is the counter for the ManualConfig string, starting with `0`.
CalConnectStringCount	Integer	YES	This is the count for the number of lines for the `CalConnect` strings.
CalConnectStringX	String	YES	One or more strings used to specify the cell and how to connect it for calibration. Each calibration routine may specify a different cell. The calibration cell value will be filled into the format specifier as shown in the example `CalConnectString2`, where `%5.2f` is the format specifier for a floating point number. `X` is the counter for the CalConnect string, starting with `0`.

[IRangeX]

The `[IRangeX]` section provides information about the current ranges for the power device in use. Depending on the number of available current ranges, one or more IRange sections for the power device are required. The number of sections has to match the number of current ranges for the power device. The range number `X` starts at 0 and can go up to a maximum of 3. Hence a maximum of 4 current ranges is possible. The ranges should be entered in ascending order, so the smallest and first range is `IRange0`. The example below depicts the information for a BP4610 power supply from NF Corporation which has a single 10 A current range. Each of the keys for this section will be discussed below.

```
[IRange0]
RangeMaxI= 10.0
RangeMaxVin= 10.0
RangeMaxVout = 1.0
RangeMaxFreq= 30000.0
```

Key Name	Type	Required	Description
RangeMaxI	Float	YES	This is the maximum current, in Amps, for the current range.
RangeMaxVin	Float	YES	This is the voltage, in Volts, that is output from the current monitor when the power device is at maximum current. The LPI has a maximum of 10.0 V input.
RangeMaxVout	Float	YES	This is the control voltage, in Volts, that must be applied to the power device to achieve the maximum current. The LPI has a maximum of 10.0 V output.
RangeMaxFreq	Float	NO	This is the maximum bandwidth, in Hz, of the current range. This parameter is optional.

Optional Sections

[CalFrontEndOfst]

This section is used during calibration for the Front End channel offsets. The cell is not turned on, so the value of the resistor is not extremely important. The example depicts the information for a BP4610 power supply from NF Corporation. Each of the keys for this section will be discussed below.

```
[CalFrontEndOfst]
CalCellValue = 2.0
CalCell = 2 Ohm Cal Cell
VchRange = 0.02
IchRange = 0.02
```

Key Name	Type	Required	Description
CalCellValue	Float	YES	This is the calibration cell value, in ohms.
CalCell	String	YES	This is the description of the calibration cell which is used to tell the user what connection to make.
VchRange	Float	YES	This is the voltage, in volts, used to set the Vch range on the IFC1010 instrument. For the calibration, the range is usually set to the x100 gain or the 30 mV range.
IchRange	Float	YES	This is the voltage, in volts, used to set the Ich range on the IFC1010 instrument. For the calibration, the range is usually set to the x100 gain or the 30 mV range.

[CalELGerr]

This section is used during calibration of the Electrometer gain. The cell should be selected to produce a mid-range voltage for the power device. Normally, the LPI is selected to have a similar voltage range to the power device. Make sure the voltage produced is within the capability of both the power device and the LPI. Ohm's law, V=IR, dictates the voltage that will be produced for a given IApplied. The example depicts the information for a BP4610 power supply from NF Corporation. Each of the keys for this section will be discussed below.

```
[CalELGerr]
CalCellValue = 20.0
CalCell = 20 Ohm Cal Cell
VchRange = 2.0
IchRange = 3.0
IApplied1 = -1.0
IApplied2 = 1.0
TApplied = 5.0
TRest = 20.0
Enabled = 1
```

Key Name	Type	Required	Description
CalCellValue	Float	YES	This is the calibration cell value, in ohms.
CalCell	String	YES	This is the description of the calibration cell which is used to tell the user what connection to make.
VchRange	Float	YES	This is the voltage, in volts, used to set the Vch range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.
IchRange	Float	YES	This is the voltage, in volts, used to set the Ich range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.
IApplied1	Float	YES	This is the first current, in Amps, applied to the cell. In the case of a bipolar power supply, this should be a negative current. In the case of an electronic load, this will be a positive current, selected to be less than `IApplied2`.
IApplied2	Float	YES	This is the second current, in Amps, applied to the cell. In the case of a bipolar power supply, this should be a positive current. In the case of an electronic load, this will be a positive current, selected to be higher than `IApplied1`.
TApplied	Float	YES	This is the time, in seconds, that each IApplied is applied to the cell.
TRest	Float	YES	This is the time, in seconds, that the calibration routine waits between `IApplied1` and `IApplied2`. This is to help alleviate any temperature buildup in the calibration resistor.

Enabled	Integer	YES	The enabled field is used to tell the calibration routine if this calibration is active for the power device. If the calibration is disabled, the previous values are not used. 0 = Disabled 1 = Enabled

[CalIEGerrIRangeX]

There are one or more sections used during calibration of the IERange gain. The number of sections has to be equal to the number of current ranges on the power device. The cell should be selected to produce a mid-range voltage for the power device. Normally, the LPI is selected to have a similar voltage range to the power device. Make sure the voltage produced is within the capability of both the power device and the LPI. Ohm's law, V=IR, dictates the voltage that will be produced for a given IApplied. The example below depicts the information for a BP4610 power supply from NF Corporation which has a single 10 A current range. Each of the keys for this section will be discussed below.

```
[CalIEGerrIRange0]
CalCellValue = 2.0
CalCell = 2 Ohm Cal Cell
VchRange = 2.0
IchRange = 3.0
IApplied1 = -4.0
IApplied2 = 4.0
TApplied = 5.0
TRest = 20.0
Enabled = 1
PreciseCalCellValue=1.98721
```

Key Name	Type	Required	Description
CalCellValue	Float	YES	This is the calibration cell value, in ohms.
CalCell	String	YES	This is the description of the calibration cell which is used to tell the user what connection to make.
VchRange	Float	YES	This is the voltage, in volts, used to set the Vch range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.
IchRange	Float	YES	This is the voltage, in volts, used to set the Ich range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.
IApplied1	Float	YES	This is the first current, in Amps, applied to the cell. In the case of a bipolar power supply, this should be a negative current. In the case of an electronic load, this will be a positive current, selected to be less than `IApplied2`.
IApplied2	Float	YES	This is the second current, in Amps, applied to the cell. In the case of a bipolar power supply, this should be a positive current. In the case of an electronic load, this will be a positive current, selected to be higher than `IApplied1`.

TApplied	Float	YES	This is the time, in seconds, that each IApplied is applied to the cell.
TRest	Float	YES	This is the time, in seconds, that the calibration routine waits between `IApplied1` and `IApplied2`. This is to help alleviate any temperature buildup in the calibration resistor.
Enabled	Integer	YES	The enabled field is used to tell the calibration routine if this calibration is active for the power device. If the calibration is disabled, the previous values are not used. 0 = Disabled 1 = Enabled
PreciseCalCellValue	Float	NO	This is the precise value for the calibration resistor to be used. This value will be printed on the resistor. The user will have a chance to enter this value during calibration. It is stored in the file once entered to simplify future calibrations.

[CalSignalOffsetIRangeX]

There are one or more sections used during calibration of the Signal offset. The number of sections has to be equal the number of current ranges on the power device. The example below depicts the information for a BP4610 power supply from NF Corporation which has a single 10 A current range. Each of the keys for this section will be discussed below.

```
[CalSignalOffsetIRange0]
CalCellValue = 0.2
CalCell = 200 mOhm Cal Cell
VchRange = 0.2
IchRange = 0.2
IAppliedScan0 =0.3
IAppliedScan1 =0.3
IAppliedScan2 =0.5
TApplied = 1.0
TRest = 0.1
Enabled = 1
```

Key Name	**Type**	**Required**	**Description**
CalCellValue	Float	YES	This is the calibration cell value, in ohms.
CalCell	String	YES	This is the description of the calibration cell which is used to tell the user what connection to make.
VchRange	Float	YES	This is the voltage, in volts, used to set the Vch range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.
IchRange	Float	YES	This is the voltage, in volts, used to set the Ich range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.

IAppliedScan0	Float	YES	This is the current, in Amps, applied using the 0.4 V Scan DAC range. Note that the voltage to achieve a specified current varies with each power device. In the case of the NF BP4610 power supply, 1.0 V gives 10 Amps of current. The request of 0.3 V will give 3 Amps of current, well within the capability of the power device and the dummy cell.
IAppliedScan1	Float	YES	This is the current, in Amps, applied using the 1.6 V Scan DAC range. Note that the voltage to achieve a specified current varies with each power device. In the case of the NF BP4610 power supply, 1.0 V gives 10 Amps of current. The request of 0.3 V will give 3 Amps of current, well within the capability of the power device and the dummy cell.
IAppliedScan2	Float	YES	This is the current, in Amps, applied using the 6.4 V Scan DAC range. Note that the voltage to achieve a specified current varies with each power device. In the case of the NF BP4610 power supple, 1.0 V gives 10 Amps of current. The request of 0.5 V will give 5 Amps of current, well within the capability of the power device and the dummy cell.
TApplied	Float	YES	This is the time, in seconds, that each IApplied is applied to the cell.
TRest	Float	YES	This is the time, in seconds, that the calibration routine waits between each IApplied. This is to help alleviate any temperature buildup in the calibration resistor.
Enabled	Integer	YES	The enabled field is used to tell the calibration routine if this calibration is active for the power device. If the calibration is disabled, the previous values are not used. 0 = Disabled 1 = Enabled

[CalDDSOffset]

This section is used during calibration of the DDS offset. The cell should be selected to produce a mid-range voltage for the power device. Normally, the LPI is selected to have a similar voltage range to the power device. Make sure the voltage produced is within the capability of both the power device and the LPI. Ohm's law, V=IR, dictates the voltage that will be produced for a given IApplied. The example below depicts the information for a BP4610 power supply from NF Corporation. Each of the keys for this section will be discussed below.

```
[CalDDSOffset]
CalCellValue = 0.2
CalCell = 200 mOhm Cal Cell
VchRange = 3.0
IchRange = 0.2
IAppliedDCI = 0.3
TApplied = 10.0
TRest = 2.0
Enabled = 1
```

Key Name	Type	Required	Description
CalCellValue	Float	YES	This is the calibration cell value, in ohms.
CalCell	String	YES	This is the description of the calibration cell which is used to tell the user what connection to make.
VchRange	Float	YES	This is the voltage, in volts, used to set the Vch range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.
IchRange	Float	YES	This is the voltage, in volts, used to set the Ich range on the IFC1010 instrument. For the calibration, the range is usually set to the x10 gain or the 300 mV range.
IAppliedDCI	Float	YES	This is the current, in Amps, applied to the cell. This value should be set to 3% of the current range, but not to exceed 3 Amps.
TApplied	Float	YES	This is the time, in seconds, that `IAppliedDCI` is applied to the cell.
TRest	Float	YES	This is the time, in seconds, that the calibration routine waits before moving on to the next step. This is to help alleviate any temperature buildup in the calibration resistor.
Enabled	Integer	YES	The enabled field is used to tell the calibration routine if this calibration is active for the power device. If the calibration is disabled, the previous values are not used. 0 = Disabled 1 = Enabled

[AppliedDCTest]

This section is used during calibration to confirm the application of DC values to the cell. Nothing is calibrated during this step, rather it is just a check to confirm expected DC levels. Make sure the voltage produced is within the capability of both the power device and the LPI. Ohm's law, V=IR, dictates the voltage that will be produced for a given IApplied. The example below depicts the information for a BP4610 power supply from NF Corporation. Each of the keys for this section will be discussed below.

```
[AppliedDCTest]
CalCellValue = 0.2
CalCell = 200 mOhm Cal Cell
VchRange = 0.2
IchRange = 3.0
IAppliedDCI = 8.0
TApplied = 5.0
TRest = 20
Enabled = 1
```

Key Name	Type	Required	Description
CalCellValue	Float	YES	This is the calibration cell value, in ohms.
CalCell	String	YES	This is the description of the calibration cell which is used to tell the user what connection to make.
VchRange	Float	YES	This is the voltage, in volts, used to set the Vch range on the IFC1010 instrument. For this step, the range is usually set to the to a gain which matches the voltage expected at the cell. A x1 gain or the 3 V range will give full scale for the LPI. A x10 gain or the 300 mV range will give 1/10 full scale. A x100 gain or the 30 mV range will give 1/100 full scale.
IchRange	Float	YES	This is the voltage, in volts, used to set the Ich range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.
IAppliedDCI	Float	YES	This is the current, in Amps, applied to the cell.
TApplied	Float	YES	This is the time, in seconds, that `IAppliedDCI` is applied to the cell.
TRest	Float	YES	This is the time, in seconds, that the calibration routine waits before moving to the next step. This is to help alleviate any temperature buildup in the calibration resistor.
Enabled	Integer	YES	The enabled field is used to tell the calibration routine if this calibration is active for the power device. If the calibration is disabled, the previous values are not used. 0 = Disabled 1 = Enabled

[CalSysACCorIRangeX]

There are one or more sections used during calibration based on the number of ranges for the power device. This section is used during calibration to measure the AC response of the entire system and to correct the system for a neutral response as much as possible. Make sure the voltage produced is within the capability of both the power device and the LPI. Make sure that the total DC and AC amplitudes do not exceed the capability of the power device. In the case of an electronic load, the DC amplitude must be at least 2 times the AC amplitude to ensure that the current never drops below 0. Electronic loads also require a power source to be able to source the current. The total AC + DC amplitudes cannot exceed the maximum current capability of the power source. Ohm's law, V=IR, dictates the voltage that will be produced for a given IApplied. The

example below depicts the information for a BP4610 power supply from NF Corporation. Each of the keys for this section will be discussed below.

```
[CalSysACCorIRange0]
CalCellValue = 0.2
CalCell = 200 mOhm Cal Cell
VchRange = 0.2
IchRange = 3.0
ACAmpl = 3.0
DCAmpl = 0.0
FreqLow = 1.0
FreqHigh = 30000.0
PointDensityLow = 4
PointDensityHigh = 40
Enabled = 1
```

Key Name	Type	Required	Description
CalCellValue	Float	YES	This is the calibration cell value, in ohms.
CalCell	String	YES	This is the description of the calibration cell which is used to tell the user what connection to make.
VchRange	Float	YES	This is the voltage, in volts, used to set the Vch range on the IFC1010 instrument. For this step, the range is usually set to the to a gain which matches the voltage expected at the cell. A x1 gain or the 3 V range will give full scale for the LPI. A x10 gain or the 300 mV range will give 1/10 full scale. A x100 gain or the 30 mV range will give 1/100 full scale.
IchRange	Float	YES	This is the voltage, in volts, used to set the Ich range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.
ACAmpl	Float	YES	This is the current, in Amps, applied to the cell.
DCAmpl	Float	YES	This is the DC current, in Amps, applied to the cell. In the case of a power supply, this should be 0.0 Amps. In the case of an electronic load, this should be a positive number that is 2x greater than the `ACAmpl` but does not exceed 1/2 the maximum DC level of the device used for sourcing the current.
FreqLow	Float	YES	This is the lower frequency limit, in Hz, for the spectrum. A normal limit for this is 1.0 Hz. For large power devices with lower bandwidth this limit may be lower.
FreqHigh	Float	YES	This is the upper frequency limit, in Hz, for the given current range. This limit will be based on the power device. Normally this limit will be about 1/2 of the bandwidth listed on the specification sheet of the power device.

PointDensityLow	Integer	YES	This is the number of points acquired per decade in frequency for frequencies below 100 Hz. A suitable number here is 4.
PointDensityHigh	Integer	YES	This is the number of points acquired per decade in frequency for frequencies above 100 Hz. A suitable number here is 40.
Enabled	Integer	YES	The enabled field is used to tell the calibration routine if this calibration is active for the power device. If the calibration is disabled, the previous values are not used. 0 = Disabled 1 = Enabled

[CalSGGerrIRangeX]

There are one or more sections used during calibration of the Signal Generator gain. The number of sections has to be equal the number of current ranges on the power device. The cell should be selected to produce a mid-range voltage for the power device. Normally, the LPI is selected to have a similar voltage range to the power device. Make sure the voltage produced is within the capability of both the power device and the LPI. Ohm's law, V=IR, dictates the voltage that will be produced for a given IApplied. The power, Power=IR^2, dissipated in the calibration cell should be kept low – below 80 W – to prevent any thermal impact. The example below depicts the information for a BP4610 power supply from NF Corporation which has a single 10 A current range. Each of the keys for this section will be discussed below.

```
[CalSGGerrIRange0]
CalCellValue = 2.0
CalCell = 2 Ohm Cal Cell
VchRange = 2.0
IchRange = 3.0
IApplied1 = -4.0
IApplied2 = 4.0
TApplied = 5.0
TRest = 20.0
Enabled = 1
PreciseCalCellValue=1.98721
```

Key Name	**Type**	**Required**	**Description**
CalCellValue	Float	YES	This is the calibration cell value, in ohms.
CalCell	String	YES	This is the description of the calibration cell which is used to tell the user what connection to make.
VchRange	Float	YES	This is the voltage, in volts, used to set the Vch range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.
IchRange	Float	YES	This is the voltage, in volts, used to set the Ich range on the IFC1010 instrument. For the calibration, the range is usually set to the x1 gain or the 3 V range.

IApplied1	Float	YES	This is the first current, in Amps, applied to the cell. In the case of a bipolar power supply, this should be a negative current. In the case of an electronic load, this will be a positive current, selected to be less than `IApplied2`.
IApplied2	Float	YES	This is the second current, in Amps, applied to the cell. In the case of a bipolar power supply, this should be a positive current. In the case of an electronic load, this will be a positive current, selected to be higher than `IApplied1`.
TApplied	Float	YES	This is the time, in seconds, that each IApplied is applied to the cell.
TRest	Float	YES	This is the time, in seconds, that the calibration routine waits between `IApplied1` and `IApplied2`. This is to help alleviate any temperature buildup in the calibration resistor.
Enabled	Integer	YES	The enabled field is used to tell the calibration routine if this calibration is active for the power device. If the calibration is disabled, the previous values are not used. 0 = Disabled 1 = Enabled
PreciseCalCellValue	Float	NO	This is the precise value for the calibration resistor to be used. This value will be printed on the resistor. The user will have a chance to enter this value during calibration. It is stored in the file once entered to simplify future calibrations.

Appendix A: LPI1010 Specifications

All specifications are at an ambient temperature of 22°C, with the LPI1010 powered using an Interface 1010 potentiostat and in loopback mode. Errors caused by the electronic load or programmable power supply are not included. All specifications were obtained after software calibration.

A numbered note qualifies many of the specifications. Many of these notes describe the method used to measure a specification. The notes are found at the end of this appendix.

All specifications are subject to change without notice.

General

	LPI1010 10 V	**LPI1010 Std 100 V**	**LPI1010 NF 100 V**	**LPI1010 1kV**		
Gamry P/N	990-00502	990-00505	990-00511	990-00506	%	
Voltage Sense Input Range	±10	±100	±100	±1000	V	
Current Control Output Range	0 to ±10	0 to ±10	0 to ±1	0 to ±10	V	
Current Monitor Input Range	0 to ±10	0 to ±10	0 to ±1	0 to ±10	V	
Voltage Sense Input Resistance	100	3.33	3.33	3.03	MΩ	Note 1
Voltage Sense DC CMRR	n/a	70	70	70	dB	
Voltage Sense AC CMRR	n/a	65	65	65	dB	Note 2
Current Monitor Input Differential Resistance	200	200	20	200	kΩ	Note 3
Bandwidth for 0.5% FS Magnitude Accuracy	100	100	80	40	kHz	Note 4
Control Voltage DC Accuracy (10 V FS)	±2 ±0.07 setpoint	±2 ±0.07 setpoint	±2 ±0.07 setpoint	±2 ±0.07 setpoint	mV %	

Environmental

Operating Temperature Range		0 to +45	°C	
Relative Humidity	Max	90 (non-condensing)	%	
Storage and Shipping Temperature		–40 to +75	°C	
Maximum Shipping Acceleration		30	G	

NOTES:

1. Measured between ground and each leg.
2. AC CMRR measured at 20 kHz for 100V Std and 100 V NF LPI1010 system. AC CMRR measured at 10 kHz for 1KV LPI1010 system.
3. Measured between BNC shell and center pin.
4. 0.5° phase accuracy

Appendix B: Optional Adapters

Due to the large variety of electronic loads and programmable power supplies on the market, the BNC connectors at the current monitor and current control cables of the LPI Cable End Module might not be suitable. For this, Gamry Instruments offers various adapter cables.

Female BNC-to-Banana-Plug Adapter Cable

A Female BNC-to-Banana Plug adapter cable is available as an option as shown below. The cable with part number 721-00018 mates with the Male BNC connectors on the LPI cable. The length of the cable is length 14 cm (5.4″).

Figure B-1
Female BNC-to-Banana Plug adapter cable (P/N 721-00018)



Female BNC-to-Stripped-Wire Adapter

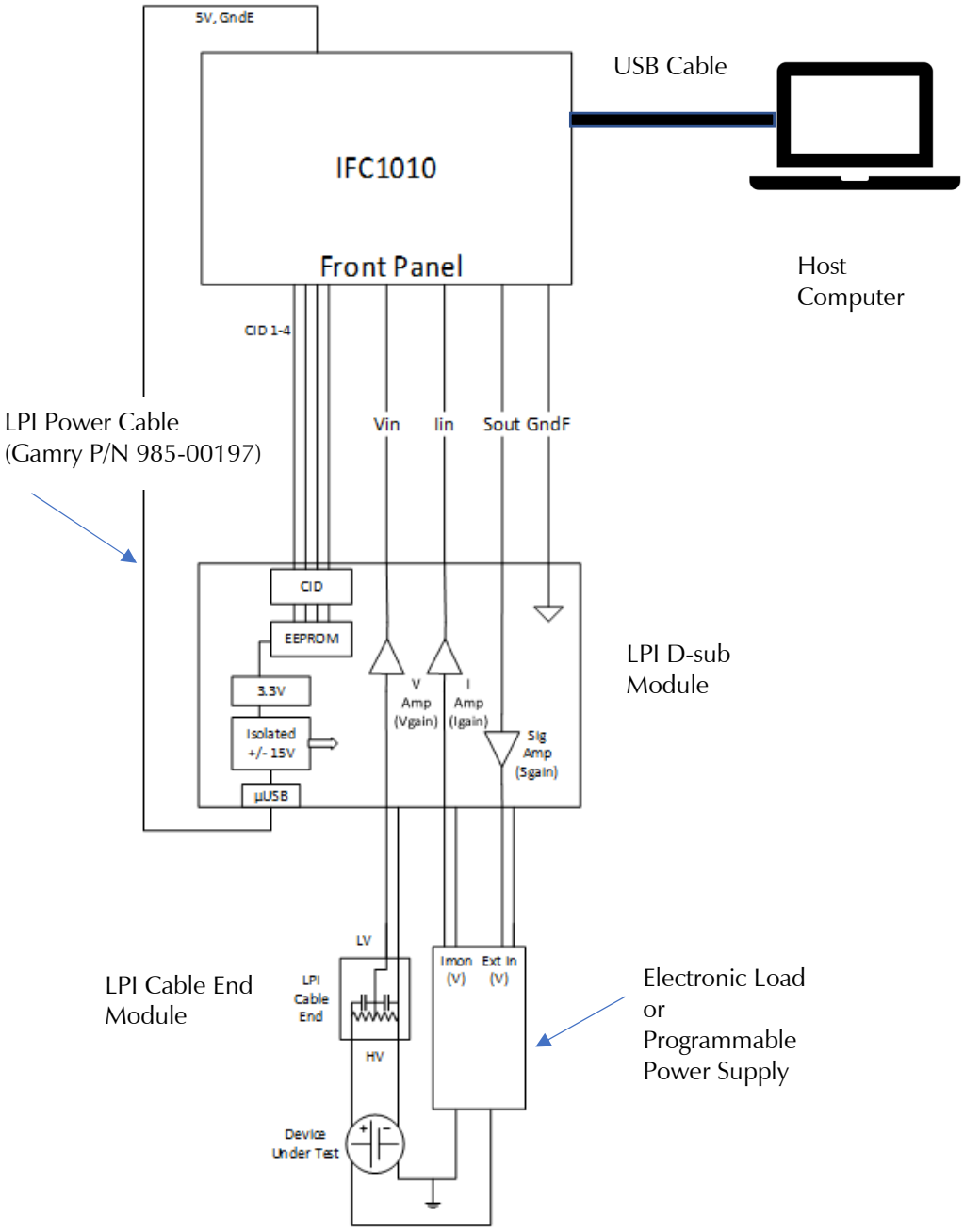
A Female BNC-to- Stripped Wire adapter cable is available as an option as shown below. The cable with part number 721-00018 mates with the Male BNC connectors on the LPI cable. The open ends of the cable can be fully customized. The length of the cable is length 15 cm (5.9″).

Figure B-2
Female BNC-to-Stripped Wire adapter cable (P/N 721-00019)



Appendix C: Block diagram

Figure C-1
Female BNC-to-Stripped Wire adapter cable (P/N 721-00019)



Appendix D: Certifications

GAMRY INSTRUMENTS
Redefining Electrochemical Measurement

Declaration of Conformity: No. DOC-2020-CE-LPI1010

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name and Location:
Gamry Instruments
734 Louis Drive
Warminster, PA 18974
USA

This declaration is for the Gamry Instruments product model: Load/Power Supply Interface (LPI1010)
The declaration is based upon compliance with the following directives:

- EMC Directive 2014/30/EU
- Low Voltage Safety Directive 2014/35/EU

The declaration is based upon product compliance with the following standards as defined in report number R-3173P from Retlif Testing Laboratories for EMC test and analysis and report number R-3173P-2 from Retlif Testing Laboratories for safety analysis.

EMC Standards	Title	Class/ Criteria
EN 61326-1:2013	Electrical equipment for measurement, control, and laboratory use – EMC requirements - Part 1: General Requirements	
IEC 61000-4-2	Electrostatic Discharge	B
EN 61326-1:2013	Electrical equipment for measurement, control, and laboratory use – EMC requirements - Part 1: General Requirements	
IEC 61000-4-3	Radiated Immunity	A

Low Voltage Directive Safety Standards	Title
EN 61326-1:2013	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General Requirements



Signature

September 18, 2020
Date

Dr. Gregory A. Martinchek, PhD
Title: President

Formal signed declaration is on file at Gamry, Inc.

Certificate of Conformance



January 31, 2020

Mr. Jay Stolzenberg
Gamry Instruments Inc.
734 Louis Drive
Warminster, PA 18974

Dear Mr. Stolzenberg,

Enclosed you will find Retlif Testing Laboratories Test Report Number R-3173P, which covers the EMC testing of your Load Power Interface, Model Number: 990-00505, Serial Number: EUT 1. This testing was performed and test report generated in accordance with your Purchase Order Number: 2019-1037.

The following table is a brief description of the test methods performed and results obtained on the Load Power Interface. Please refer to the Test Program Summary page for an overview of all testing performed.

Test Method	Test Results
CISPR 11, Conducted Emissions, Class A	Complied
CISPR 11, Radiated Emissions, Class A	Complied
IEC 61000-4-2, Electrostatic Discharge	Complied
IEC 61000-4-3, Radiated Immunity	Complied*

*Modifications were performed in order to demonstrate compliance.

Thank you for the opportunity to be of service to you. Should you have any questions regarding the enclosed report, please feel free to contact me.

Sincerely,

Retlif Testing Laboratories

Patricia Harris

Patricia Harris
Publications Administrator
pharris@retlif.com
Enc. (as stated)

40 YEARS OF TESTING EXCELLENCE

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September 18, 2020

Mr. Jay Stolzenberg
Gamry Instruments, Inc.
734 Louis Drive
Warminster, PA 18974

Dear Mr. Stolzenberg,

Enclosed you will find Retlif Testing Laboratories Report Number R-3173P-2 covering the safety testing and evaluation which was performed on your Load Power Interface (LPI) Cable, Model Number: 990-00505, Serial Number: EUT 1. This testing was performed and test report generated against your Purchase Order Number: 2019-1037.

The following table is a brief description of the clauses in EN 61010-1 and the applicability/results obtained on the Load Power Interface (LPI) Cable. Please refer to the Test Program Summary page for an overview of all testing performed.

EN 61010-1	Results
4 Tests	Pass
5 Marking and Documentation	Pass
6 Protection Against Electric Shock	Pass
7 Protection Against Mechanical Hazards	Pass
8 Resistance to Mechanical Stresses	Pass
9 Protection Against the Spread of Fire	Pass
10 Equipment Temperature Limits and Resistance to Heat	Pass
11 Protection Against Hazards from Fluids	N/A
12 Protection Against Radiation, Including Laser Sources, and Against Sonic And Ultrasonic Pressure	N/A
13 Protection Against Liberated Gases and Substances, Explosion And Implosion	N/A
14 Components and Subassemblies	N/A
15 Protection by Interlocks	N/A
16 Hazards Resulting from Application	N/A
17 Risk Assessment	N/A
ANNEX F Routine Tests	N/A
ANNEX H Qualification Of Conformal Coatings For Protection Against Pollution	N/A
ANNEX K Insulation Requirements Not Covered By Clause 6.7	N/A

Thank you for the opportunity to be of service to you. Should you have any questions regarding the enclosed report or the actual testing of your sample, please do not hesitate to contact me.

Sincerely,

Retlif Testing Laboratories
Patricia Fiore
Patricia Fiore
Engineering Assistant
pfiore@retlif.com

Enc. (as stated)

40 YEARS OF TESTING EXCELLENCE

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GAMRY INSTRUMENTS
Redefining Electrochemical Measurement

Declaration of Conformity: No. DOC-2022-UKCA-LPI1010

According to ISO/IEC Guide 22 and CEN/CENELEC EN 45014

Manufacturer's Name and Location:
Gamry Instruments
734 Louis Drive
Warminster, PA 18974
USA

This declaration is for the Gamry Instruments product model: Load/Power Supply Interface (LPI1010)
The declaration is based upon compliance with the following directives:

- EMC Directive 2014/30/EU
- Low Voltage Safety Directive 2014/35/EU

The declaration is based upon product compliance with the following standards as defined in report number R-3173P from Retlif Testing Laboratories for EMC test and analysis and report number R-3173P-2 from Retlif Testing Laboratories for safety analysis.

EMC Standards	Title	Class/ Criteria
EN 61326-1:2013	Electrical equipment for measurement, control, and laboratory use – EMC requirements - Part 1: General Requirements	
IEC 61000-4-2	Electrostatic Discharge	B
EN 61326-1:2013	Electrical equipment for measurement, control, and laboratory use – EMC requirements - Part 1: General Requirements	
IEC 61000-4-3	Radiated Immunity	A

Low Voltage Directive Safety Standards	Title
EN 61326-1:2013	Safety requirements for electrical equipment for measurement, control, and laboratory use – Part 1: General Requirements



Signature

August 31, 2022
Date

Dr. Gregory A. Martinchek, PhD
Title: President

Formal signed declaration is on file at Gamry, Inc.

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