Installation and Configuration Manual for MPG-2XX* Instruments

***MPG-2XX instruments are:**

- ✓ **MPG-2**
- ✓ **MPG-205**
- ✓ **MPG-210**
- ✓ **MPG-220**
- ✓ **MPG-240**

BioLogic
Science Instruments

Certificate of Conformity

We certify that all goods detailed below have been inspected and tested, and unless otherwise stated conform with the order of the customer, the drawings and specifications of **Bio-Logic Science Instruments SAS**.

Instruments used to calibrate this equipment is traceable to NIST Standards.

CE certificates available in paragraph 12.

Model	Serial number of the chassis
☐ **MPG-2**	
☐ **MPG-205**	
☐ **MPG-210**	
☐ **MPG-220**	
☐ **MPG-240**	

Firmware of EC-Lab®: ....

Signed, for and on behalf of Bio-Logic Science Instruments SAS:

Date:

Equipment installation

WARNING!: The instrument is safely grounded to the Earth through the protective conductor of the AC power cable.

Use only the power cord supplied with the instrument which is designed for the appropriate current rating (10 A max) and be sure to connect it to a power source provided with protective Earth contact.

Any interruption of the protective Earth (grounding) conductor outside the instrument could result in personal injury.

General description

The equipment described in this manual has been designed in accordance with EN61010 and EN61326 and has been supplied in a safe condition. The equipment is intended for electrical measurements only. It should be used for no other purpose.

Intended use of the equipment

The instrument is an electrical laboratory device intended for professional use in laboratory, commercial and light-industrial environments. Instrumentation and accessories shall not be connected to humans.

Instructions for use

To avoid injury to an operator the safety precautions given below, and throughout the manual, must be strictly adhered to, whenever the equipment is operated. Only advanced users may use the instrument.
Bio-Logic SAS accepts no responsibility for accidents or damage resulting from any failure to comply with these precautions.

Grounding

To minimize the hazard of electrical shock, it is essential that the equipment be connected to a protective ground through the AC supply cable. The continuity of the ground connection should be checked periodically.

Atmosphere

You must never operate the equipment in corrosive atmosphere. Moreover if the equipment is exposed to a highly corrosive atmosphere, the components and the metallic parts can be corroded which may result in a malfunction of the instrument.
The user must also be careful that the ventilation grids are not obstructed on the right and left sides, below or behind the chassis. External cleaning can be done with a vacuum cleaner if necessary.
Please consult our specialists to discuss the best location in your lab for the instrument (avoid glove box, hood, chemicals …).

Avoid Unsafe Equipment

The equipment may be unsafe if any of the following statements apply:

- Equipment shows visible damage,
- Equipment has failed to perform an intended operation,
- Equipment has been stored in unfavourable conditions,
- Equipment has been subjected to physical stress.

In case of doubt as to the serviceability of the equipment, don't use it. Get it properly checked out by a qualified service technician.

Live Conductors

When the equipment is connected to its measurement inputs or supply, the opening of covers or removal of parts could expose live conductors. Only qualified personnel, who should refer to the relevant maintenance documentation, may perform adjustments, maintenance or repair.

Equipment Modification

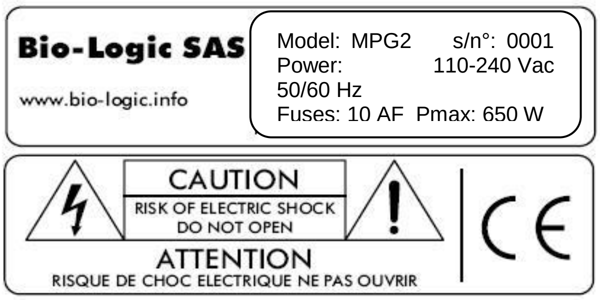
To avoid introducing safety hazards, never install non-standard parts in the equipment, or make any unauthorized modification. To maintain safety, always return the equipment to Bio-Logic SAS for service and repair.

In Case Of Problems

Information about your hardware and software configuration is necessary for Bio-Logic to analyze and solve any problems you may encounter.

If you have any questions or if any problems occur that are not mentioned in this document, please contact your local retailer. The highly qualified staff will be glad to help you.
Please keep information on the following at hand:

- Description of the error (the error message, .mpr file, picture of on-screen settings or any other useful information) and of the context in which the error occurred. Try to remember all steps you had performed immediately before the error occurred. The more information on the actual situation you can provide, the easier it is to track the problem.
- The serial number of the device located on the rear panel device.



- The software and hardware version you are currently using. On the Help menu, click About. The displayed dialog box shows the version numbers.
- The operating system on the connected computer.
- The connection mode (Ethernet, LAN, USB) between computer and instrument.

General safety considerations

Class I

The instrument is safely grounded to the Earth through the protective conductor of the AC power cable.

Use only the power cord supplied with the instrument which is designed for the appropriate current rating (10 A max) and be sure to connect it to a power source provided with protective Earth contact.

Any interruption of the protective Earth (grounding) conductor outside the instrument could result in personal injury.

Warranty and liability claims in the event of injury or material damage are excluded when they are the result of one of the following.

- Improper use of the device,
- Improper installation, operation or maintenance of the device,
- Operating the device when the safety and protective devices are defective and/or inoperable,
- Non-observance of the instructions in the manual with regard to transport, storage, installation,
- Unauthorized structural alterations to the device,
- Unauthorized modifications to the system settings,
- Inadequate monitoring of device components subject to wear,
- Improperly executed and unauthorized repairs,
- Unauthorised opening of the device or its components,
- Catastrophic events due to the effect of foreign bodies.

ONLY QUALIFIED PERSONNEL should operate (or service) this equipment.

WARNING!

- **Do not connect the ground lead to a power source from the Earth with a potential greater than ± 10 V_{dc}.**
- **Operate on a non-flammable support.**
- ***Heavy* instrument: lift with *caution.***

To prevent exposure to the magnetic field created around the cell cable during experiments drawing high currents (higher than 10 A), it is recommended to maintain a distance of 20 cm between user and cable while the experiment is running (ICNIRP Guidelines).

Table of contents

1 Introduction of the product range

Historically, the first potentiostat built by **BioLogic** was a multi-channel instrument. It was designed to study intercalated ion compounds with long experiment times due to slow diffusion coefficients. It worked either in galvanostatic or in potentiostatic mode (each channel was devoted to one mode). Since this time, many improvements have been made and currently, every instrument in the product range is a potentiostats/galvanostats/ZRA (ZRA: Zero Resistance Ammeter). Electrochemical Impedance Spectroscopy (EIS) can also be added as an option on each potentiostat/galvanostat/ZRA board.

The first instrument was the VMP3, are derived from the VMP3. The MPG-2XX instruments are dedicated to battery testing.

The first instrument was the VMP3, the MPG-2XX instruments initially being derived from it. The **MPG-2XX-based** instruments are dedicated to battery testing. This series is composed of five different instruments.

MPG-2

MPG-205

MPG-210

MPG-220

MPG-240

Fig. 1: MPG-2XX series.

The instruments consist of a single control and communication board associated with several potentiostat/galvanostat channel boards, depending on the configuration.

Each instrument has its own operating system included into the computer board. Once started, the on-board computer fully controls the entire experiment. Therefore, if the host computer (PC, Mac, etc.) fails, or the connection to the Bio-Logic instrument is interrupted, the experiment will continue to be performed and data collected by the instrument. Data can be retrieved from the instrument when connection to the host computer is re-established.

All units are designed to be multi-user instrument. Several users may simultaneously connect to the same instrument, offering great flexibility for our multichannel devices. These computers can be connected to the instrument through an Ethernet or USB connection. All the instruments are controlled by EC-Lab® software.

Through the EC-Lab software the instrument can control auxiliary equipment (rotating electrodes or thermostatic baths) and record external signals such as absorbance, rotation speed, temperature, and quartz microbalance variables (resistance and frequency).

The aim of this manual is to guide the user through the instrument's installation and configuration. This manual is composed of several chapters. The first part is a general description of the instruments. The second and third parts describe how to install the software and how to configure the computer. The fourth and the fifth parts concern the installation and configuration of the instrument and how to connect the instrument to the computer. The sixth chapter is dedicated to the cell connection in different configurations. The seventh chapter deals with some of our advanced features. Useful experimental accessories are described in the eighth part. Finally, calibration, maintenance and specifications are shown in the two last parts.

NOTE: WHEN A USER RECEIVES A NEW UNIT FROM THE FACTORY, THE SOFTWARE AND FIRMWARE ARE INSTALLED AND UP TO DATE. THE INSTRUMENT IS READY TO BE USED. IT DOES NOT NEED TO BE UPGRADED.

1.1 General description

Depending on the selected instrument, the number of channels and the options (low current/boosters) may be different. A description of the instrument specifications is summarized below:

Tab: 1: General description of the MPG-2XX instruments.

	Number of channel	Maximum current
MPG-2	16	100 mA
MPG-205	8	5 A
MPG-210	4	10 A
MPG-220	2	20 A
MPG-240	1	40 A

The numbering of the slots is from the left to right (channel 1 is the closest to the communication board) (Fig. 2).

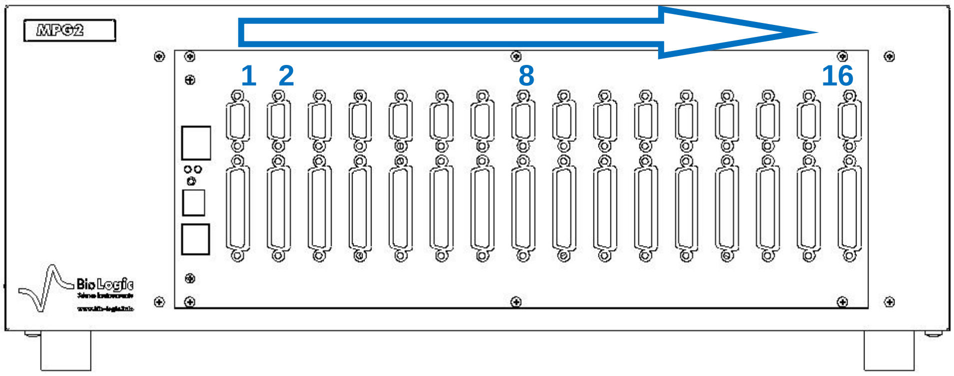


Fig. 2: Slot numbering.

Each channel can be set, run, paused or stopped, independently of the others, using identical or different experimental protocols. Any settings of any channel can be modified during a run, without interrupting the experiment.

The channels can be interconnected and run simultaneously, for example to perform multi-pitting experiments using a common counter-electrode in a single bath.
Simultaneous measurements of the current and potential of the working electrode are performed continuously using two 16-bit Analog to Digital Converters. This allows the user to make true power or noise measurements.

Once the protocols have been loaded and started from the PC, the experiments are entirely under the control of the instrument’s on-board computer. The instrument temporarily buffers data and regularly transfers it to the PC, which is used for data storage, on-line visualization, on-line and off-line data processing and display.

This architecture ensures a very safe operation since a shutdown of the monitoring PC does not affect the experiments in progress on the instrument.

1.2 Software features

In general, any electrochemical experiment is composed of open circuit sequences and/or galvanic sequences performed while measuring the potential, and/or imposed potential sequences performed while measuring the current.

Common electrochemical techniques, such as Cyclic Voltammetry (CV), Chronopotentiometry (CP), etc. are obtained by combination of these elementary sequences. These combinations appear in EC-Lab as flow-diagrams for easy visual description for the user.

At various points within any experimental sequence, conditional tests can be performed on the working electrode potential or current, the counter electrode potential, or the external parameters. These conditional tests force the experiment to go to the next step, to loop to a previous sequence, or end the sequence or experiment.

The application software package provides useful protocols for general electrochemistry, corrosion, batteries, super-capacitors and custom applications. Standard graphic functions such as re-scaling, zoom, linear and log scales are available. Standard processed files can be created at the user's convenience upon running an experiment for the purpose of real time display of the experiments in progress. Post processing is also possible using built-in options to create variables at the user's convenience, such as derivative or integral values, etc. Raw data and processed data can be exported as standard ASCII text files.

The user can find more information about EC-Lab® software in the software manuals, available in the "**help**" menu of the software.
It is assumed that the user is familiar with Microsoft Windows© and knows how to use the mouse and keyboard to access the drop-down menus.

2 Installing EC-Lab software on the computer

For this operation, insert the CD-Rom in the computer. The installation is automatically launched with the "Autorun" function. If your computer does not have a CD-Rom drive, all software can be downloaded from the Bio-Logic website at:

http://www.bio-logic.info/electrochemistry-ec-lab/downloads/

2.1 EC-Lab® software installation

Fig. 3: EC-Lab® software installation. Step 1.

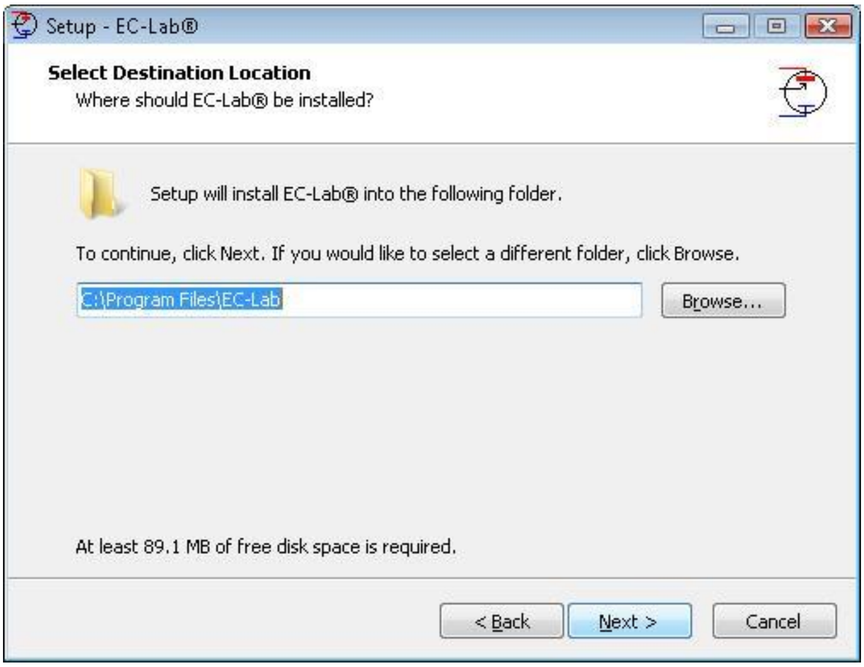


Fig. 4: EC-Lab® software installation. Step 2.

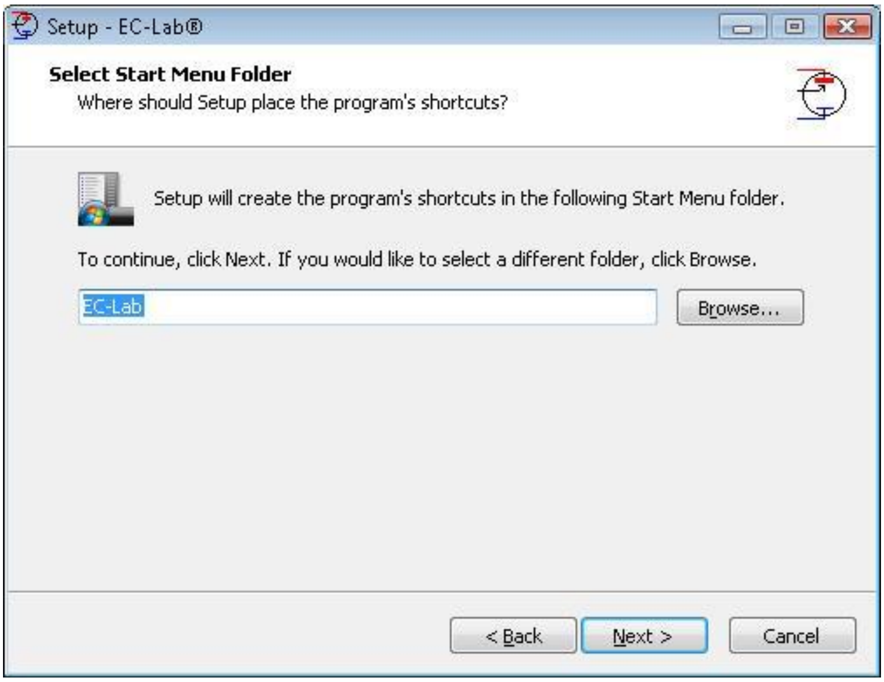


Fig. 5: EC-Lab® software installation. Step 3.

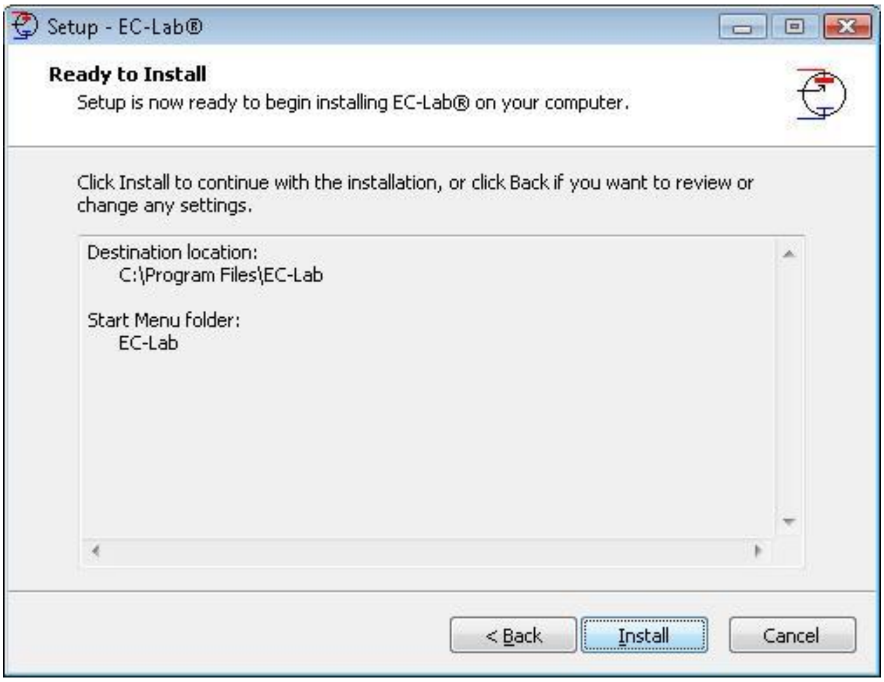
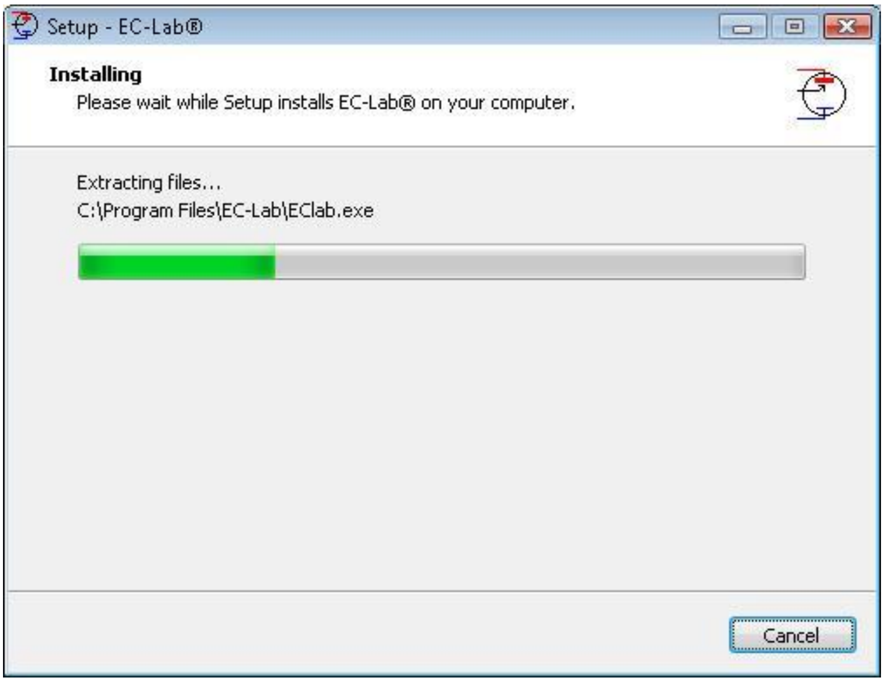


Fig. 6: EC-Lab® software installation. Step 4.

During the installation, two main folders are created.

- "**EC-Lab.exe**", the **USB drivers**, **TeraTermPro** and other files are located in the in the "**Program Files**" directory (Fig. 7 top).
- "**Batch**", "**Data**" (include the data samples), "**Documents**" (includes manuals and getting started document), "**Newsletter**", "**Settings**" (includes the default settings files), "**Temp**" folders and also the "**EC-Lab.ini**" & "**VMPerr.txt**" files (includes the initial settings) are installed in the "Documents" directory (Fig. 7 bottom).



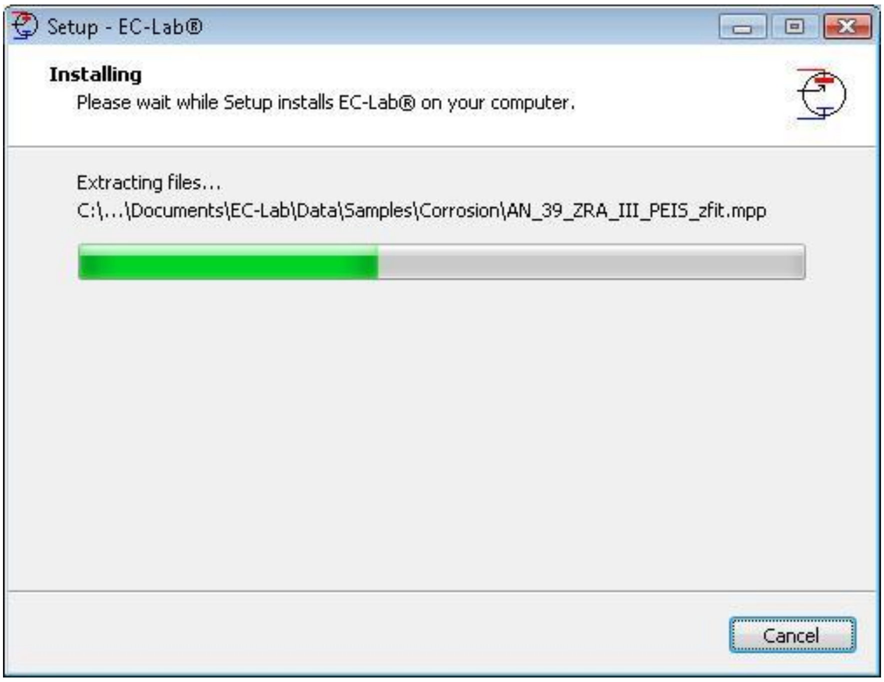


Fig. 7: EC-Lab® software installation. Step 5. (Top): Installation in the "Program Files" Directory. (bottom): Installation in the "Documents" Directory.

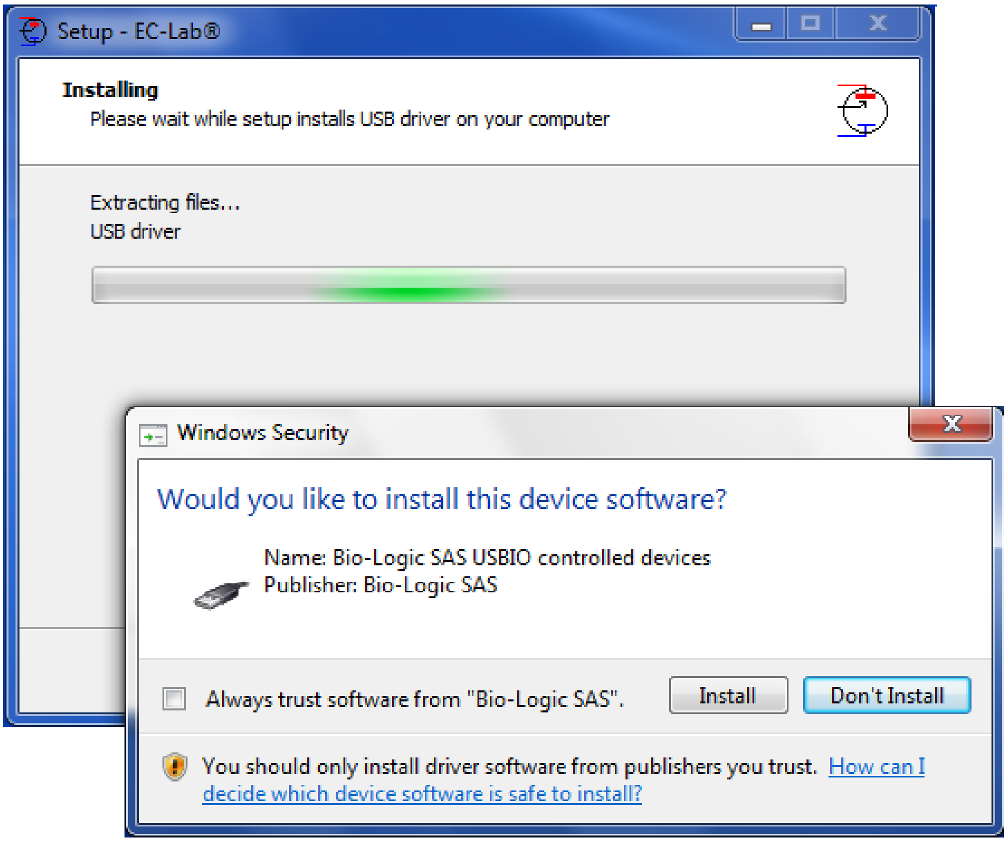


Fig. 8: EC-Lab® software installation. Step 6.

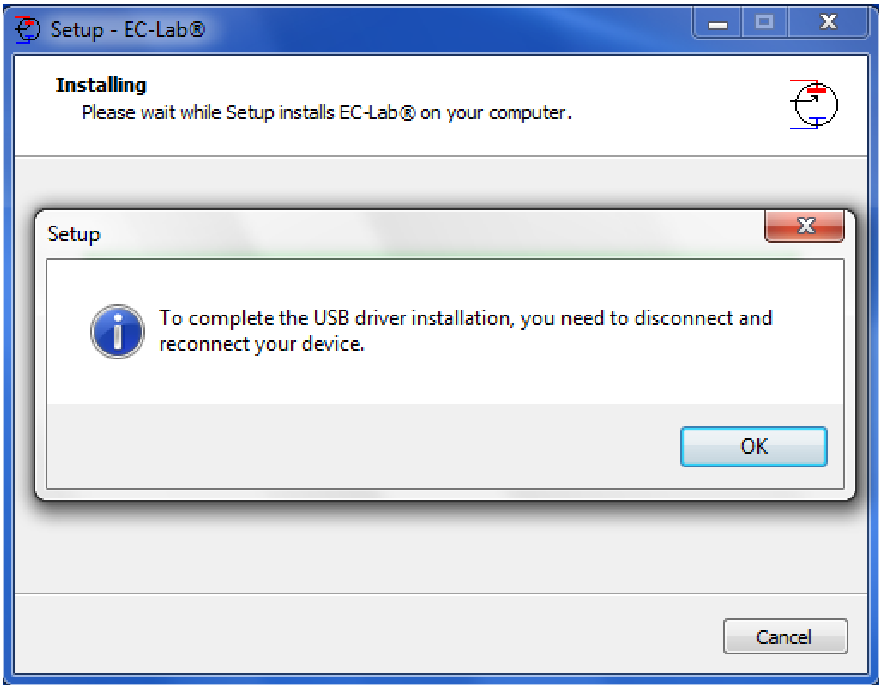


Fig. 9: EC-Lab® software installation. Step 7.

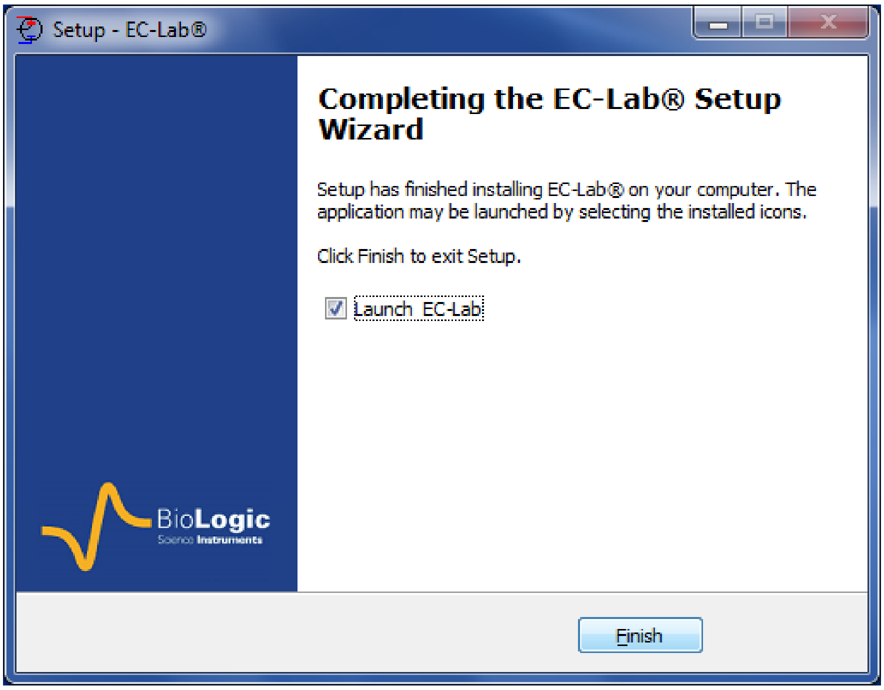


Fig. 10: EC-Lab® software installation. Step 8.

At the end of the installation, the instrument will be detected via USB is and ready to be connected and used. See “Section 4: Connections” to connect the instrument in the software.

2.2 OEM package installation

The installation of the OEM package is done in exactly the same way as for EC-Lab®. Please see the above section for the installation.

2.3 Errors during the installation

During the installation an error may occur if you are not the administrator of the computer.

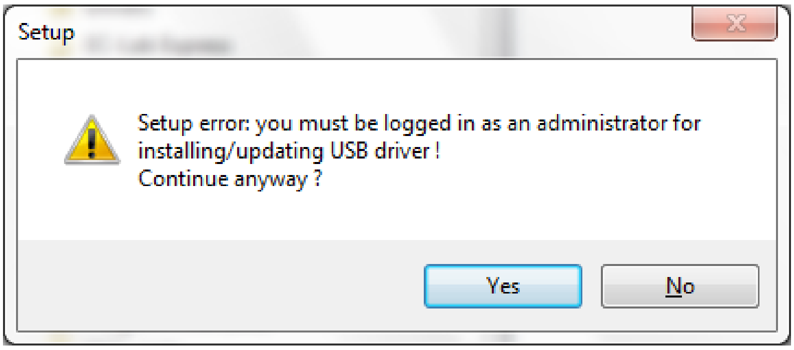


Fig. 11: Error during the installation.

In this case it is necessary to contact your network administrator for the installation.

3 PC installation and configuration

IT IS HIGHLY RECOMMENDED TO ASK FOR ASSISTANCE FROM YOUR NETWORK ADMINISTRATOR.

NOTE:
IP ADDRESSES OF THE INSTRUMENT(S) AND THE COMPUTER(S) MUST REMAIN THE SAME THROUGHOUT AN ENTIRE EXPERIMENT OR COMMUNICATION BETWEEN INSTRUMENT AND PC WILL NOT BE MAINTAINED. THE AUTOMATIC WINDOWS UPDATE BE MUST DISABLED IN ORDER TO AVOID ANY IP ADDRESS CHANGE WHILE RUNNING AN EXPERIMENT. THIS IS ESPECIALLY CRITICAL FOR PROLONGED EXPERIMENTS.

3.1 TCP/IP installation and configuration

The instrument uses the TCP/IP (Transfer Control Protocol / Internet Protocol) to exchange data with the PC. This protocol uses IP addresses to identify hosts on a network, so you will need 2 IP numbers, one for the instrument and one for the PC. For a direct connection between the instrument and the PC, you can use the following numbers (default factory settings):

192.109.209.127 or 192.168.0.2	(PC)
192.109.209.128 or 192.168.0.1	(INSTRUMENT)

If you connect the PC and the instrument to your local network, you need to ask your system administrator for 2 VALID IP NUMBERS FOR YOUR INTRANET (and the sub-net mask and the gateway numbers if necessary).

Note:
1- Before the installation of the TCP/IP protocol, your Ethernet board must be properly installed on your computer.
2- With Windows© Vista, it is recommended to replace the default IP addresses with new ones even if the instrument is directly connected to the computer. Windows Vista does not accept universal IP addresses. You can use the following ones: **192.109.209.127** for the PC and **192.109.209.128** for the instrument.

The TCP/IP protocol must be installed on the PC computer to establish the connection with the instrument.
If your computer is connected to a network, the TCP/IP protocol may already be installed. In that case the computer already has an IP address (obtained automatically). When the computer is connected directly to the instrument, it is necessary to give a static IP address to the computer. The following section describes how to give a static IP address to the computer:

1- In the **Control Panel**, double click on the **Network Connections** icon. Then the **Local Area Connection window** appears. Right click on the name and choose “**Status**” to see the computer IP address in the network.

2- On the "**General**" tab click on **Properties**. This will load the window in Fig. 12:

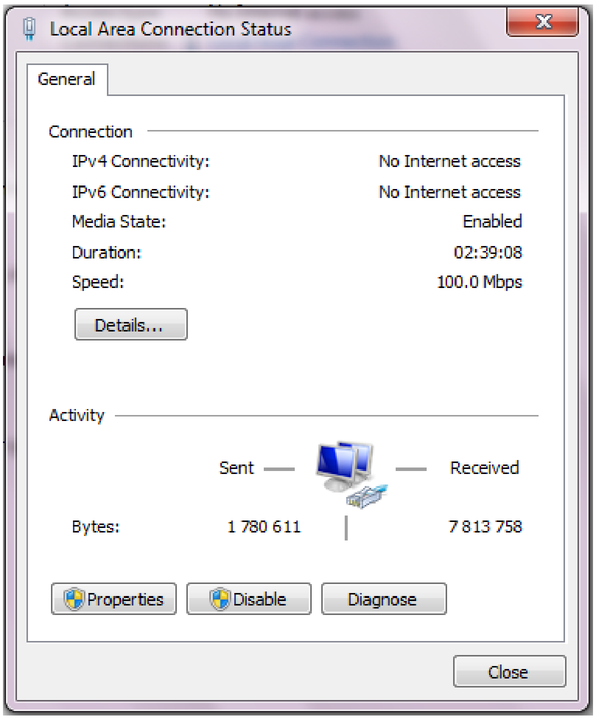


Fig. 12: Local Area connection status.

3- Select **Internet Protocol (TCP/IPv4 or TCP/IPv6)** and click on the **Properties** button. The window in Fig. 13 appears.

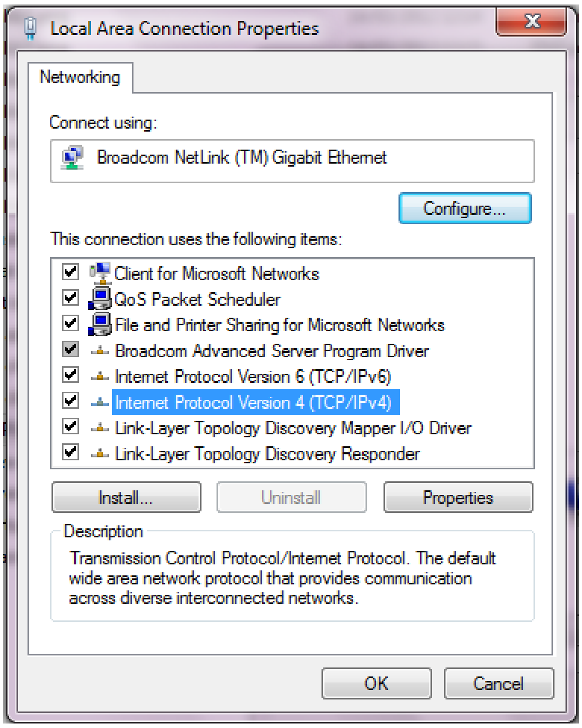


Fig. 13: Network window.

4- At this point in the installation (Fig. 14), the user has to activate the "**Use the following IP address**" box.

WARNING: THERE MIGHT BE ANOTHER TCP/IP PROTOCOL INSTALLED CALLED "TCP/IP DISTANT ACCESS", DO NOT CLICK ON THIS LINE!

5- Enter the PC **IP address**, DO NOT ENTER A NETWORK MASK (it will automatically be added) and click on the OK button.

WARNING: IP ADDRESSES MUST BE UNIQUE IN A NETWORK

6- Restart the PC. Now the PC and the INSTRUMENT are in the same network.

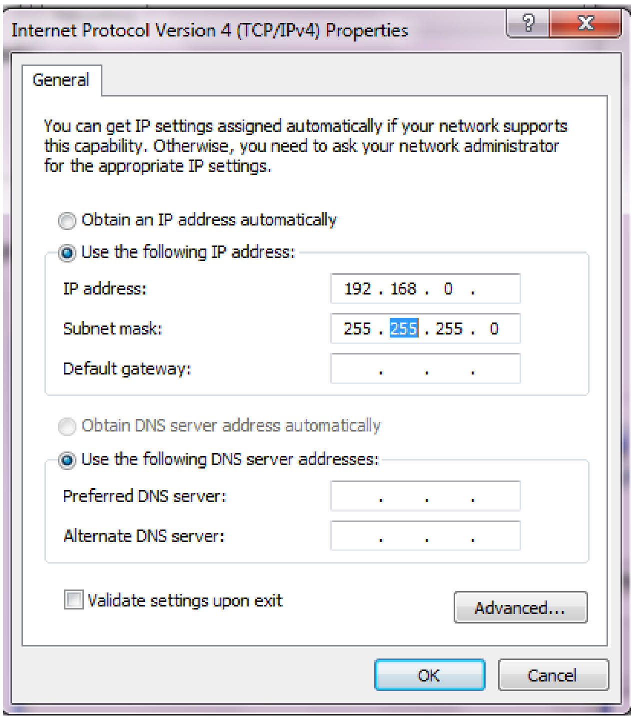


Fig. 14: TCP/IP properties window.

3.2 USB driver installation

The instrument can use a USB connection to exchange data with the PC. This connection requires USB drivers to be installed in the computer operating system. Installation of the drivers will vary depending upon the operating system of the computer.

We highly recommend that the user works with **at least** Windows© 2000 to control the potentiostat through a USB connection.

For other Windows® versions, the user will probably have to specify where to find the driver on the CD-Rom. In this window, select the automatic installation of the software.

3.2.1 Windows XP installation

The way to proceed to install USB drivers is described below for Windows© XP Pro. After connecting the instrument to the computer with the USB cable power on the instrument. When the user powers on the instrument, Windows automatically detects a new USB device. Then the following installation window appears:

Fig. 15: USB device installation window. Step 1.

In this window, select "**No, not this time**" and click on "**Next**". The following window is displayed:

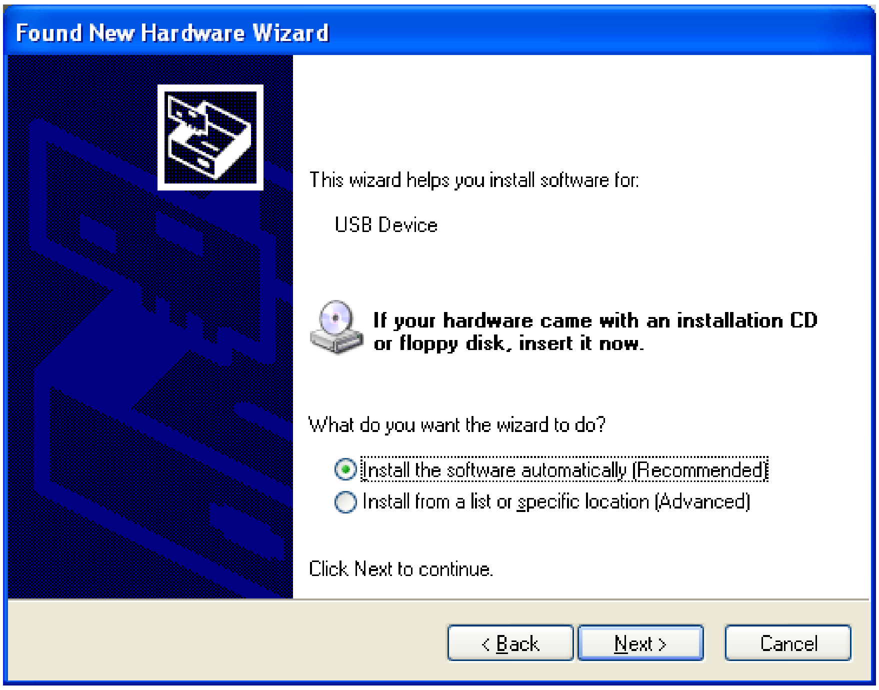


Fig. 16: USB device installation window. Step 2.

Check that the EC-Lab® installation CD is in the CD drive. If it is, Windows® XP will automatically search on the CD, find the USB driver and complete the installation.

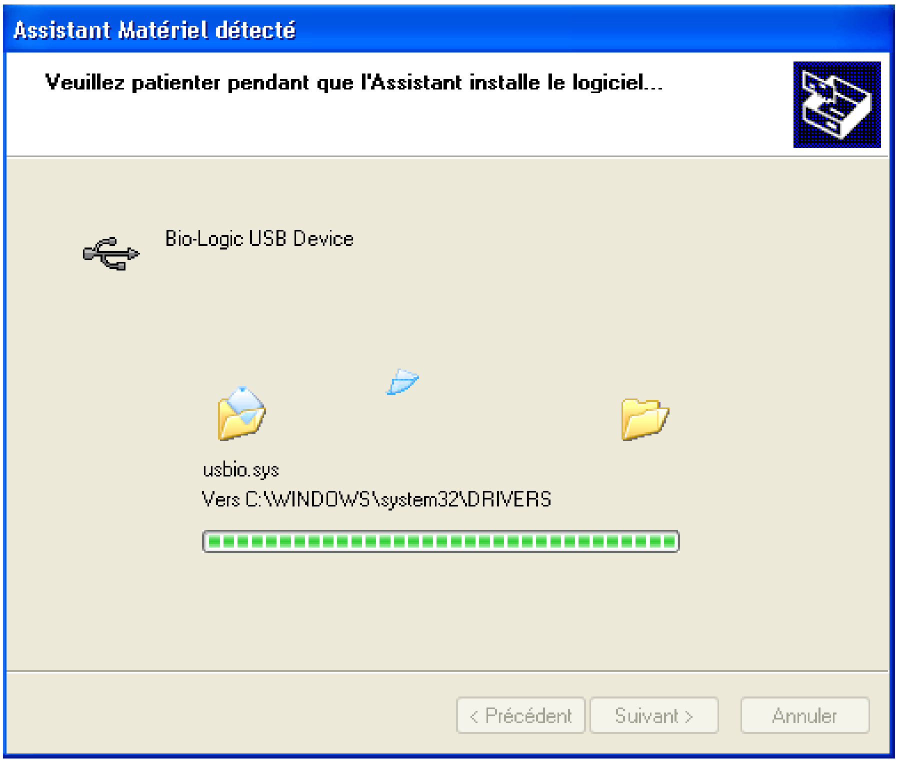


Fig. 17: USB device installation window. Step 3.

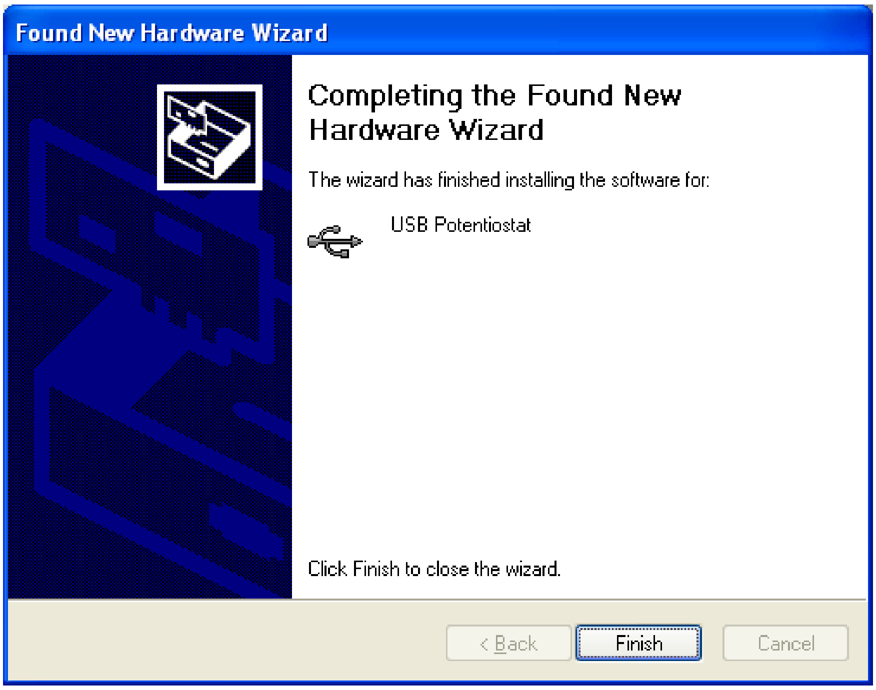


Fig. 18: USB device installation window. Step 4.

Click on Finish. The potentiostat can now be connected to the computer through the USB connection. It is not necessary to restart the computer after this installation.

3.2.2 Windows Seven, Eight & Vista installation

With Windows seven, eight and Vista systems, the USB driver is automatically installed when the instrument is detected. The following message is displayed at the end of the installation:

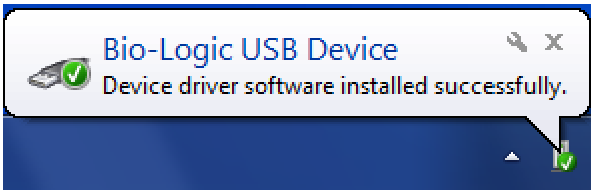


Fig. 19: USB device installation for Seven and Vista.

3.2.3 Uninstall USB drivers

For this operation, please open the folder: C:\Progrm Files\Bio-Logic\USBIO as described in the picture below. Double click on “uninstall” to proceed.

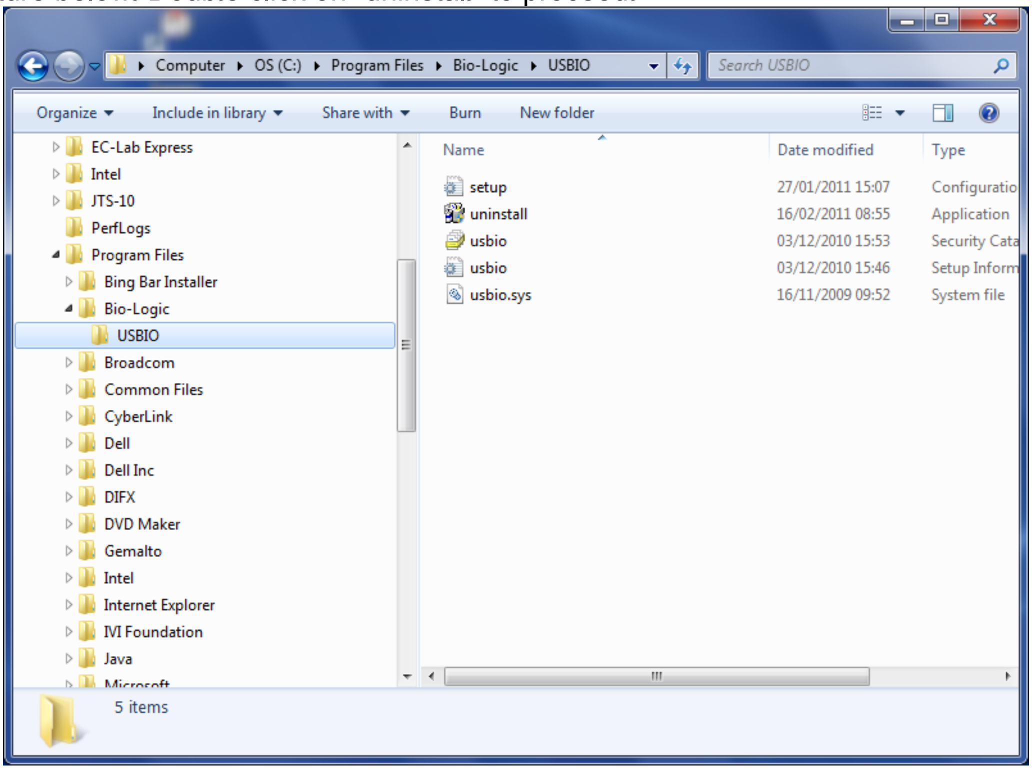


Fig. 20: Uninstall USB driver. Step 1.

The uninstall wizard is launched. Click on the “Uninstall” button to proceed.

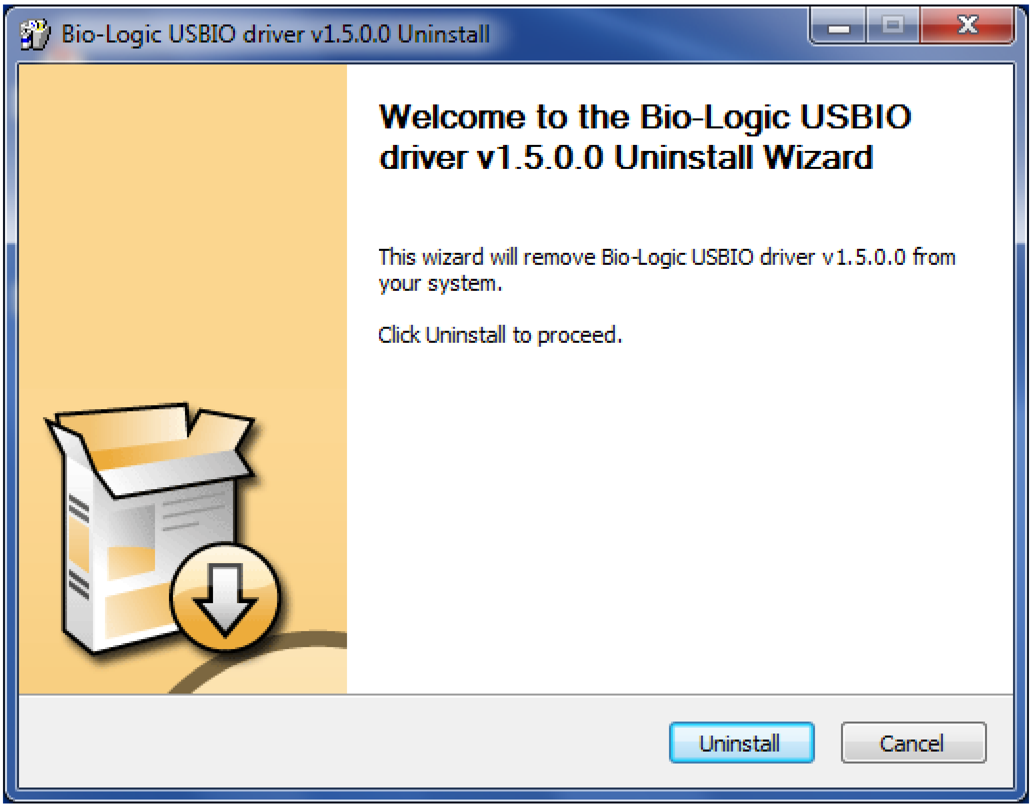


Fig. 21: Uninstall USB driver. Step 2.

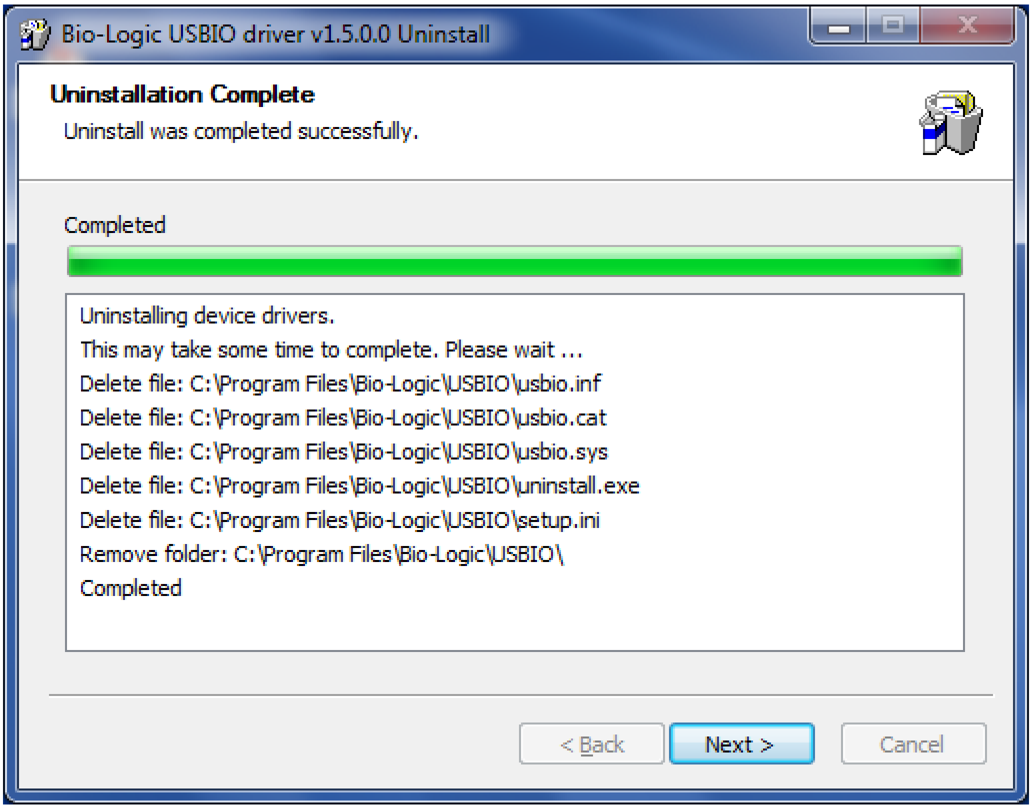


Fig. 22: Uninstall USB driver. Step 3.

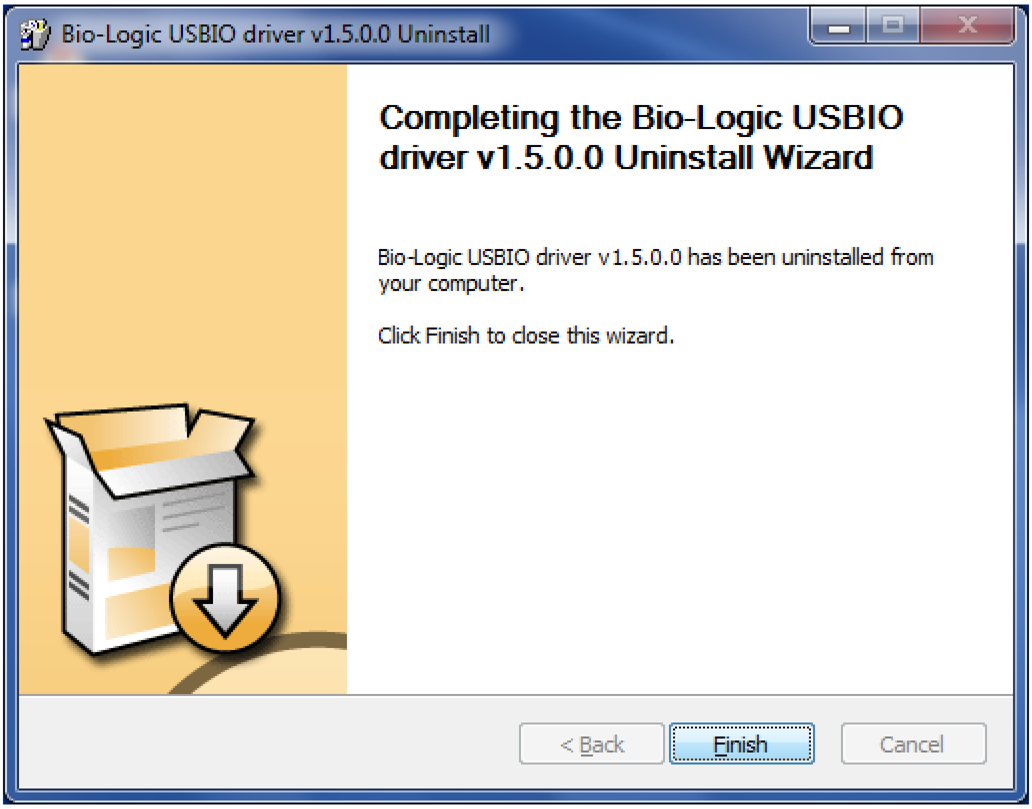


Fig. 23: Uninstall USB driver. Step 4.

When you click on the “Finish” button the USB driver is completely uninstalled.

4 Instrument installation

4.1 Connections

NOTE:
When multi-channels instruments are used and/or when measurements require fast sampling rates, use of the Ethernet connection is highly recommended.

Depending on your local installation, you can use a direct connection (one PC to one instrument) or a network connection (one or several PCs to one or several instruments).
By default; the IP address of the instrument is 192.109.209.128 or 192.168.0.1.

4.1.1 Direct USB connection

This connection can be done easily using the USB connection cable. One end must be connected to the instrument communication board and the other one to the control unit of the computer.

4.1.2 Direct Ethernet connection

Connect the computer directly to the instrument can be done with the Ethernet cable. The Ethernet cable is provided with the instrument and should have either green or black plugs on its ends. The IP addresses of both devices must be in the same network. This means that the first three groups of numbers in the IP address must be the same. For example, 192.109.209.128 or 192.168.0.1 for the instrument and 192.109.209.127 or 192.168.0.2 for the computer, respectively.

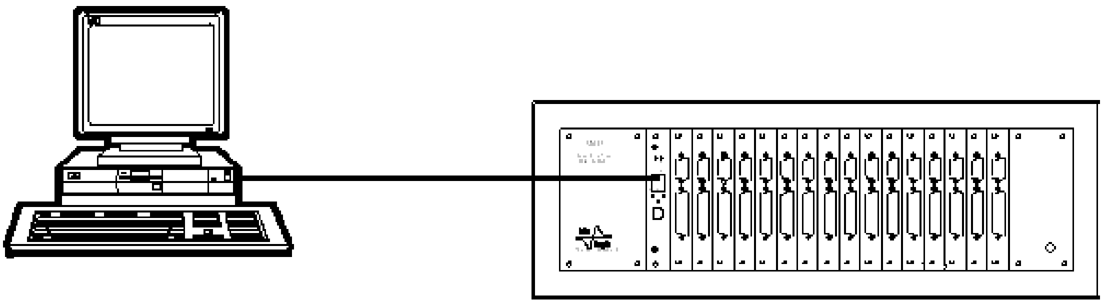


Fig. 24: Direct connection: one instrument to one PC.

4.1.3 Network connections

Several PCs can be connected to the same instrument through the network.
WARNING: check IP addresses before connection to avoid any IP conflicts (see TCP/IP configuration chapter).

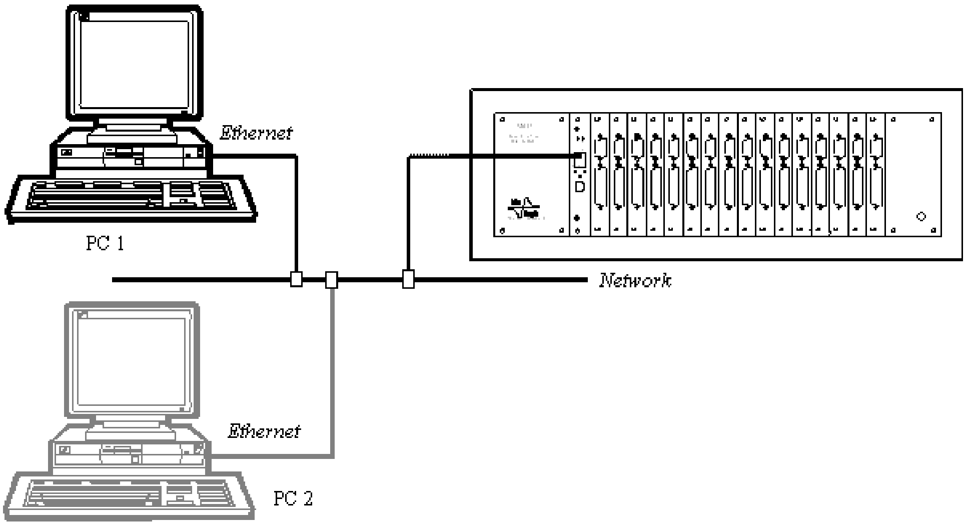


Fig. 25: Network connection: one instrument to several PCs.

Alternatively, a single PC can control several instruments through the network.

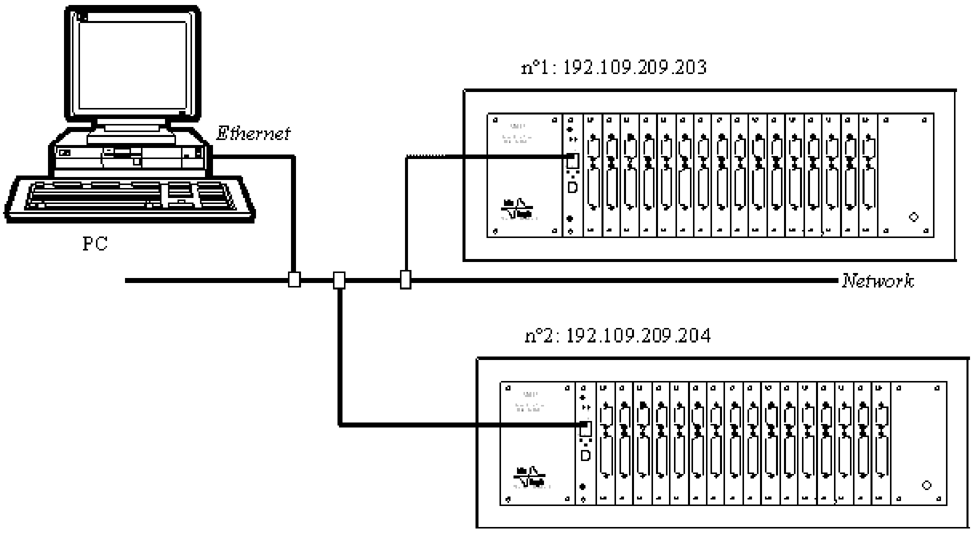


Fig. 26: Network connection: one PC to several instruments.

4.2 Power supply

Power supply connections are on the rear panel of the instrument and current booster units.

5 PC connection to the instrument

5.1 Network parameter configuration with the Ethernet connection

The Ethernet connection on the communication board is a 10/100 baseT compatible with every network. The **USB** connection is also integrated on this board. When it is installed on a Local Area Network (via the Ethernet connection), the instrument is automatically detected by the computers of the network. It becomes very easy to select an instrument in the network and modify its IP address via the Ethernet connection. This is possible with a MAC Address (set at the factory on the communication board) even if the instrument is not in the same network as the computer (before being connected together). All new instruments are delivered with the following IP address used as default: **192.109.209.128** or **192.168.0.1**. You can either manage your instrument directly with the computer or change the instrument's IP address to add the instrument in your local network. The way to proceed is the same in both cases. The first step is the detection of the new instrument by a computer (directly or via the network). The second step is the IP address change before the connection, either to have both the instrument and the computer in the same LAN or to make a small network consisting of only the instrument and the PC.

5.2 Connecting to the instrument using EC-Lab® software

The procedure to connect your computer directly or via the network to the instrument is as follows.

1) Launch EC-Lab® software V10.20 higher.

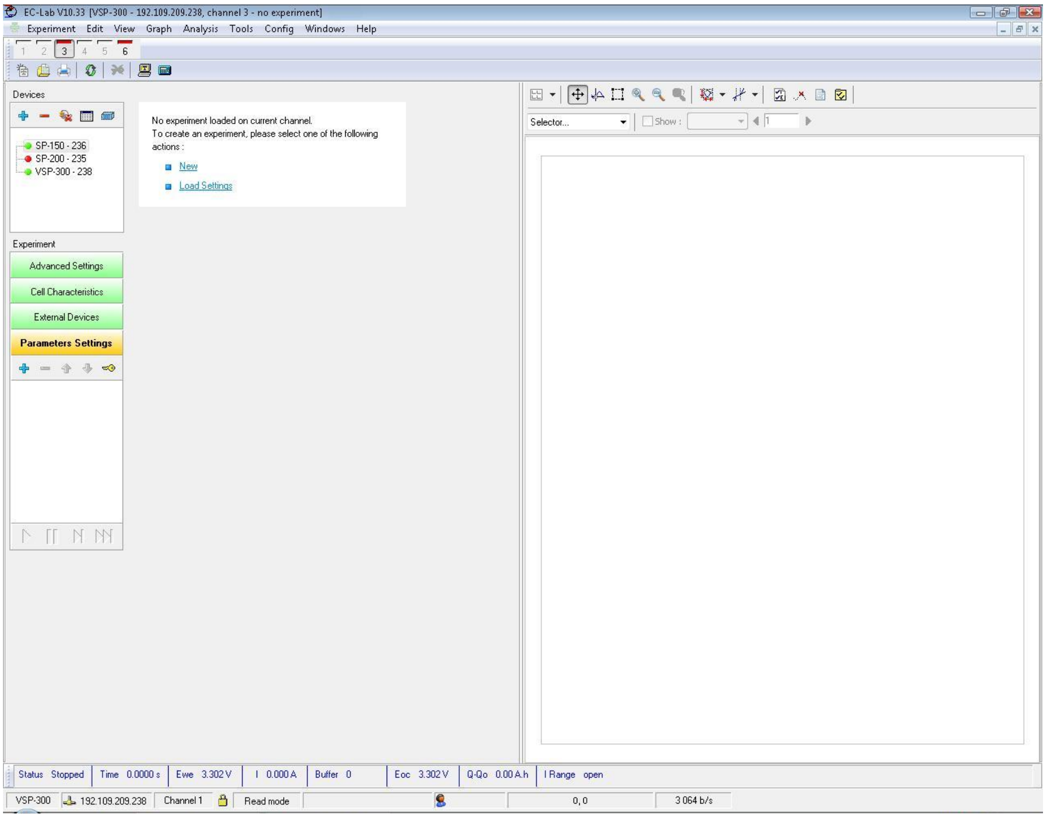


Fig. 27: Main window of EC-Lab®.

2) In the **“Devices”** frame, click on the **“+”** button to add the instrument of interest to the list.
   Only one session of EC-Lab® is needed to control several instruments.

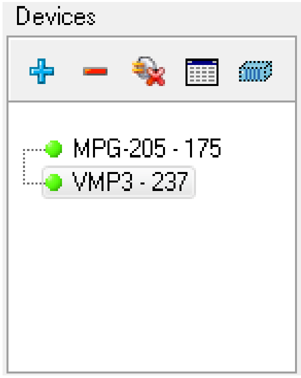


Fig. 28: “Devices” frame for connection.

Note: This step is only required the first time. The instruments configured previously are saved and will be displayed in the list of device each time EC-Lab® is opened. In that case, go directly to step 6.

3) The window shown in Fig. 29 below appears. Click on “**Refresh**” to see the instruments present on your network.

   Note: The automatic search frame shows the name of the instruments detected with their serial numbers (#). A MAC address is given to each instrument at the factory. The MAC address is used to detect the instrument in a LAN even if its IP Address is not valid in the network. It is also used for the detection of instruments connected by USB.

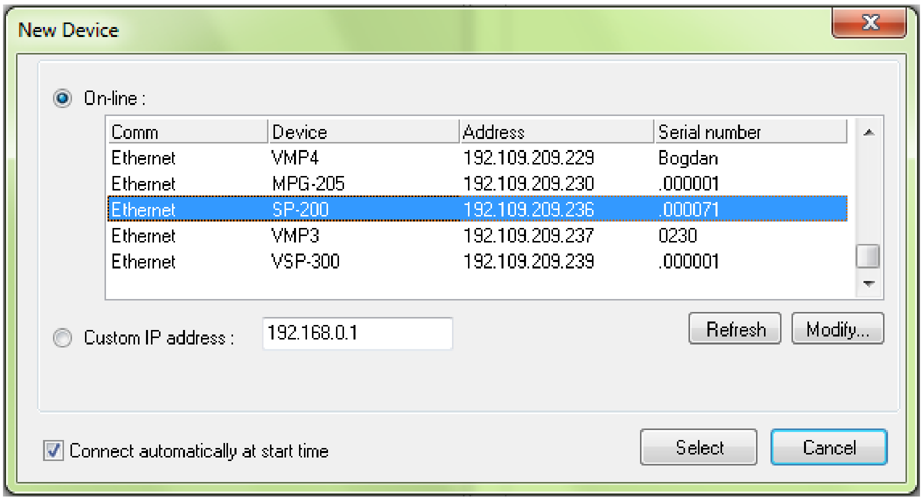


Fig. 29: “New Device” window to select and add an instrument to the current devices.

4) Select the instrument and click on the “**Select**” button.
   Note: If the IP address of the instrument is not valid, it has to be changed (see next section 5.2.1).

5) The instrument selected appears in the list displayed in the "**Device**" frame. Then, the connection is established automatically and the circle to the left of the device name will turn green.

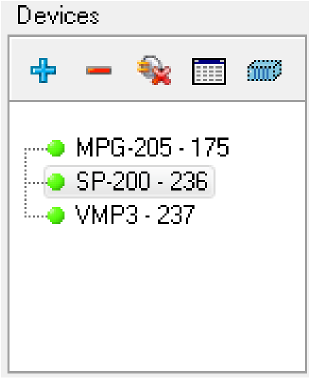


Fig. 30: "Devices" frame for connection with the new device.

6) Note if the instrument is already in the list, the user has to select the instrument in the "**Device**" frame and then click on the "**connect**" button .

It is possible to remove a device by clicking on the **"-"** button.

When the connection is established "**Connected**" is displayed in the connection status of the "Connection" window. One can see the "Connection status" with the device type and the instrument's IP Address.

5.2.1 Modification of the instrument IP address

If the IP address of the instrument is not valid i.e. two IP addresses are the same or not in the appropriate network, the IP address has to be changed.
In the **"Devices"** frame, click on the **"+"** button to open the "**New Device**" window. On the "**New Device**" window select the desired instrument and click on "**Modify**". The following window then appears:

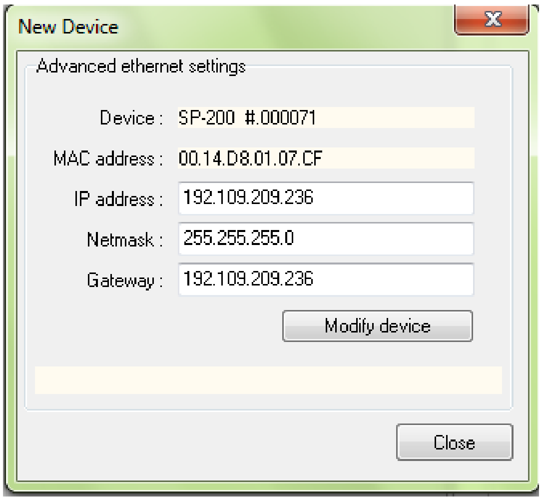


Fig. 31: "Advanced Ethernet settings" of the "New Device" window used to change the instrument IP Address.

Modify the IP Address to have a valid address in your network. Repeat this procedure with the Gateway and click on "**Modify device**". A "configuration changed" message is displayed in green when the instrument receives the new IP address. Several "Bip" sounds are emitted by the instrument indicating that the communication board is reinitialized with the new IP Address. "Configuration changed" appears at the bottom of this window.

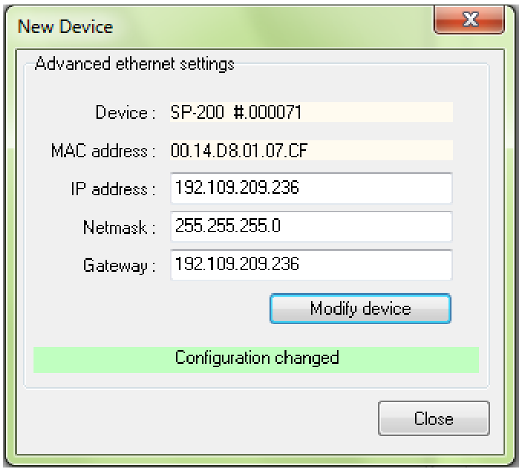


Fig. 32: New configuration.

Then click “Close” to display the “New Device” window where you have to click “Refresh” to refresh the window and select your instrument IP address.

Now the instrument is ready for use.

Note that it is possible to communicate with the instrument from another subnet with the following ports 23455 (broadcast), 23456, 23457 and 23458.

5.3 Windows Security Alert

When the user tries to find an instrument in the network or by USB, the software will use a broadcast that may be stopped by windows firewall. In this case click on the “Allow access” button:

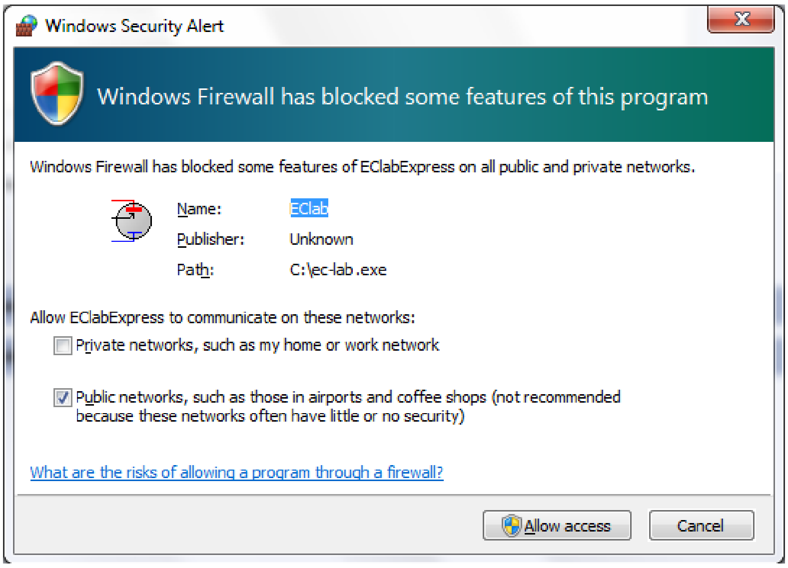


Fig. 33: “Windows security Alert” window.

5.4 Firmware Upgrade with EC-Lab® software

When the user receives a new unit from the factory, the software (in the computer, if purchased from Bio-Logic) and firmware (in the instrument) are installed and upgraded. The instrument is ready for use. It does not need to be upgraded. However, when a new EC-Lab® version is released (with new protocols or improvements) the firmware has to be updated and installed by the user.

5.5 Firmware Downgrade with EC-Lab® software

It is possible to downgrade the firmware of the instrument in an advanced tool available in EC-Lab®. This procedure should only be done by an advanced user and in very special cases. Please contact technical support for assistance.

WARNING:

- If the user downgrades the firmware of the instrument, corresponding version of EC-Lab® must also be used. For example, if the firmware of the instrument is the V10.20, the user must control the instrument with EC-Lab® V10.20.
- Make sure that the older version supports the particular instrument.

Instruments	Lowest compatible version
MPG-2	V10.00
MPG-2XX series	V10.20

The firmware downgrade procedure is as follows:

NOTE:

- The example shows a downgrade from V10.23 to V10.12 but the procedure will be the same for other versions.

1) Make sure that both versions are installed on the computer (here it is V10.12 and V10.23).

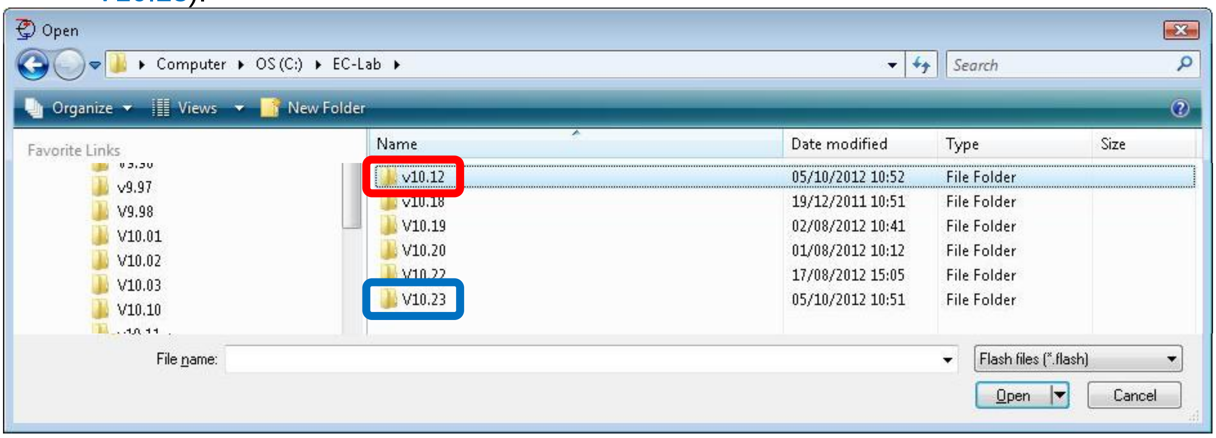


Fig. 34: Both versions on the computer.

2) Connect the instrument with the latest software version (here: V10.23). The version # is listed in the header of the EC-Lab window.

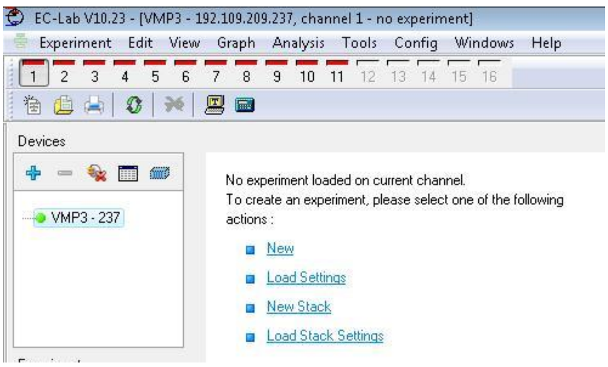


Fig. 35: connection under the latest version.

3) Open “Firmware Upgrade/Downgrade” tool in the **“Tools”** menu

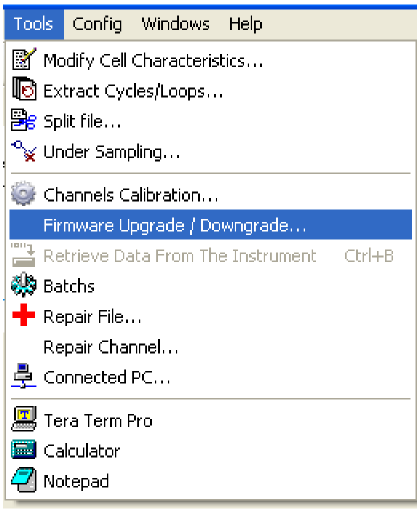


Fig. 36: Firmware Upgrade/Downgrade tool in the “Tools” menu.

4) The window displays the pathway of the current firmware flash (here: V10.23).

NOTE:
For V10.33 and later, the flash file is located in the “Program files” directory.

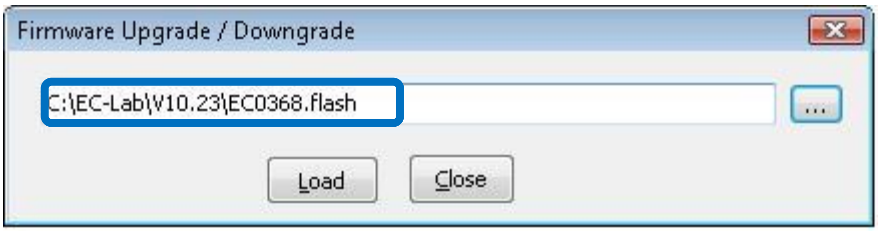


Fig. 37: Loading the flash.

5) Click on the “Browse”  button to select to the flash file (EC0368.flash) of the older version (here: V10.12). Click on “Open” when the flash file is selected.

NOTE: If the wrong file is selected, the communication board may be damaged.

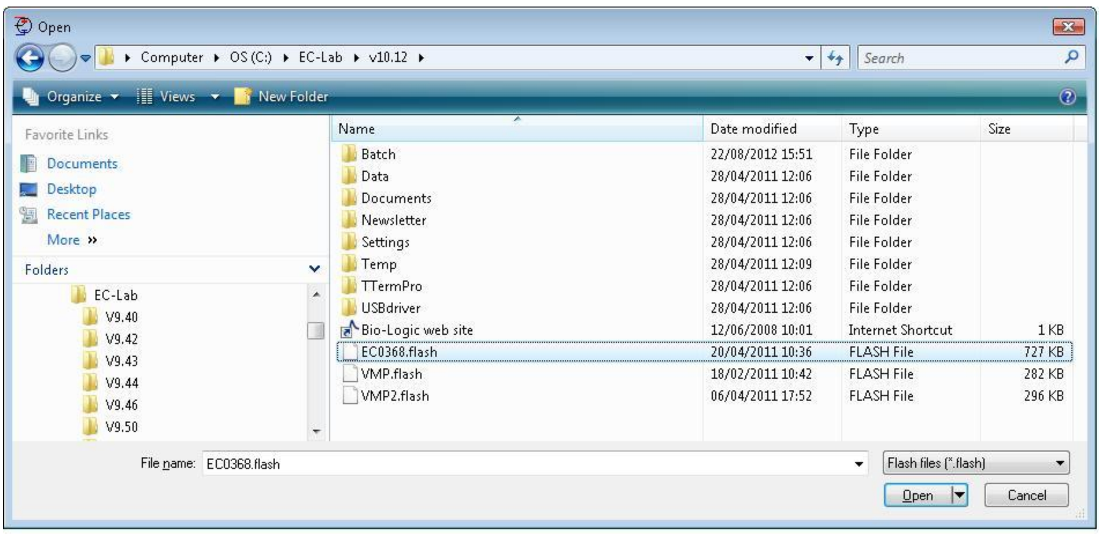


Fig. 38: Flash location in the EC-Lab folder.

6) The pathway of the flash of the old version (V10.12) is shown in the "**Firmware Upgrade/Downgrade**" window.

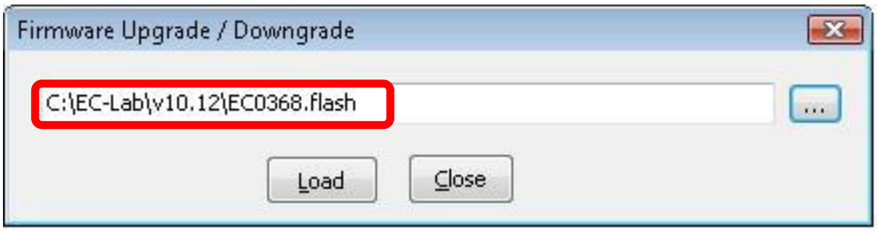


Fig. 39: "Firmware Upgrade/Downgrade" window.

7) Click on the "Load" button. A warning message shows up. Click on "OK" to continue the downgrade.

Fig. 40: Warning message.

8) The downgrade process starts and "Upgrading..." appears on the bottom of the window (but the firmware is really downgraded).

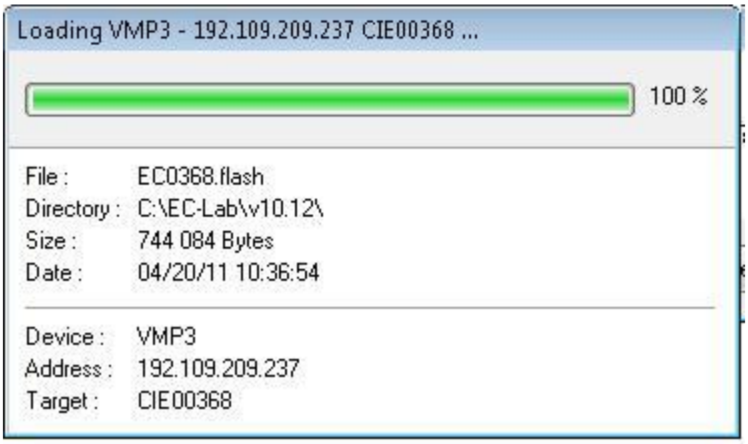


Fig. 41: Flash loading.

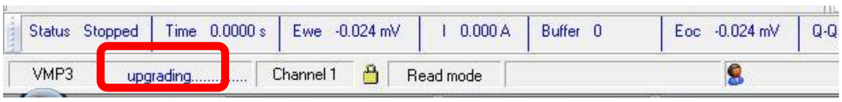


Fig. 42: Upgrading message on the status bar.

9) Close the "firmware downgrading/upgrading" window and EC-Lab® V10.23. The downgrading procedure is now completed and you can connect the older version to the instrument.

10) Open the older version EC-Lab® V10.12 and connect to the instrument.

6 Connecting to the cell

6.1 Front panel description

The cell cables have to be connected to the front panel of the MPG-2XX instrument. So in the first part, the front panel are described. Then the different ways to connect the cell cable to the cell is explained.

6.1.1 MPG-2

The cell cable with a DB25 connector has to be connected on the channel board side and 5 terminals (2 mm plugs) to connect to the cell.

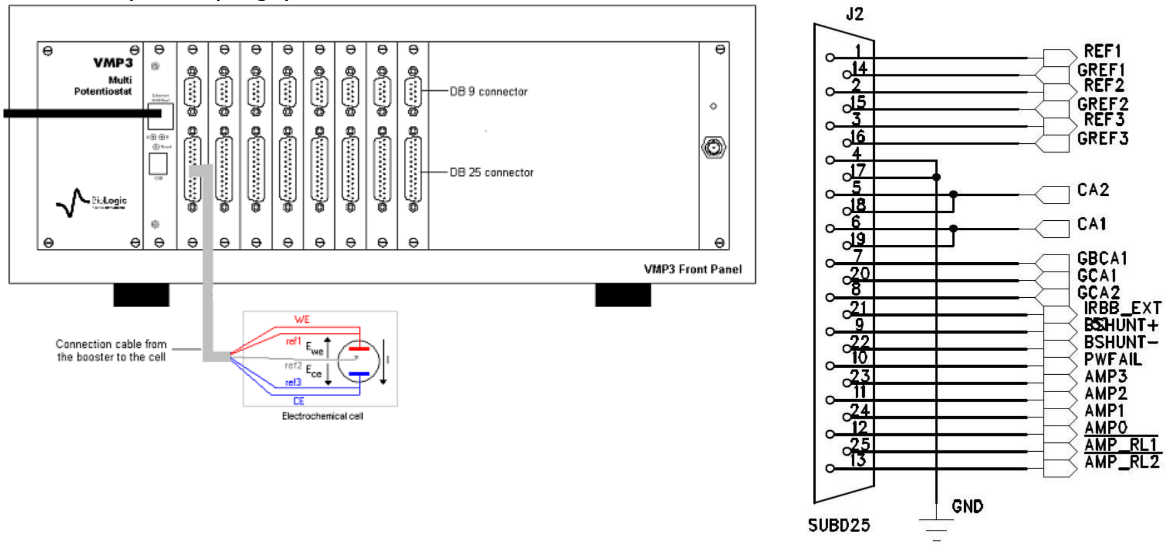


Fig. 43: MPG-2 front panel and structure of the connector.

6.1.2 MPG-2XX

The instruments of the MPG-2XX (except the MPG-2) have LED on the front panel. The functions of the LED are the following:

- Led "R": Run light yellow when on;
- Led "P": Power, light green when ok, light red when fail (overheat, power failure, Open In)
- Open in: BNC contact close to GND open the relays and active a failure (can be used for safety)

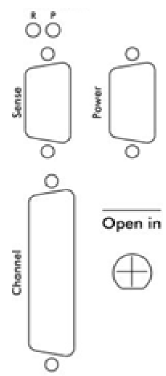


Fig. 44: LEDs of the MPG-2XX front panel.

6.1.2.1 MPG-205

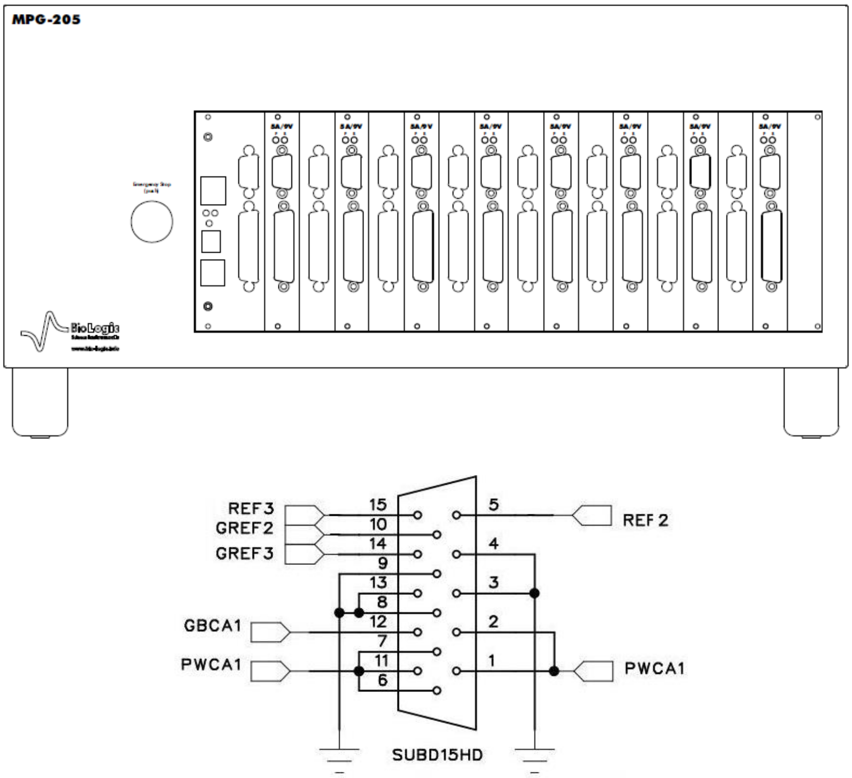


Fig. 45: MPG-205 front panel and structure of the connector.

6.1.2.2 MPG-210

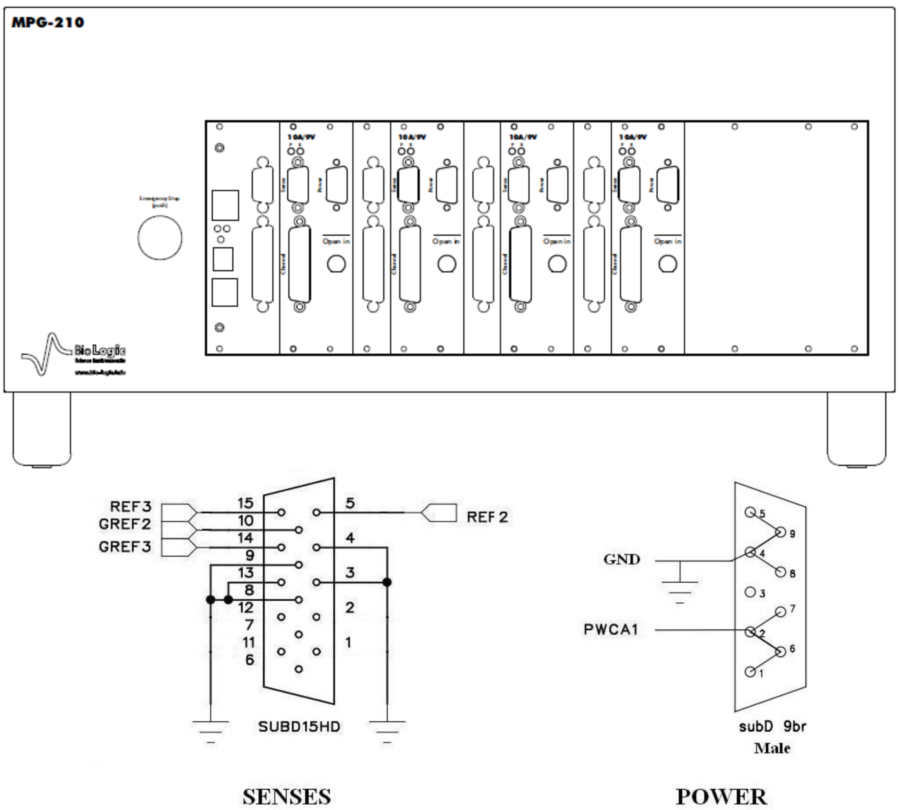


Fig. 46: MPG-210 front panel and structure of the connector.

6.1.2.3 MPG-220/MPG-240

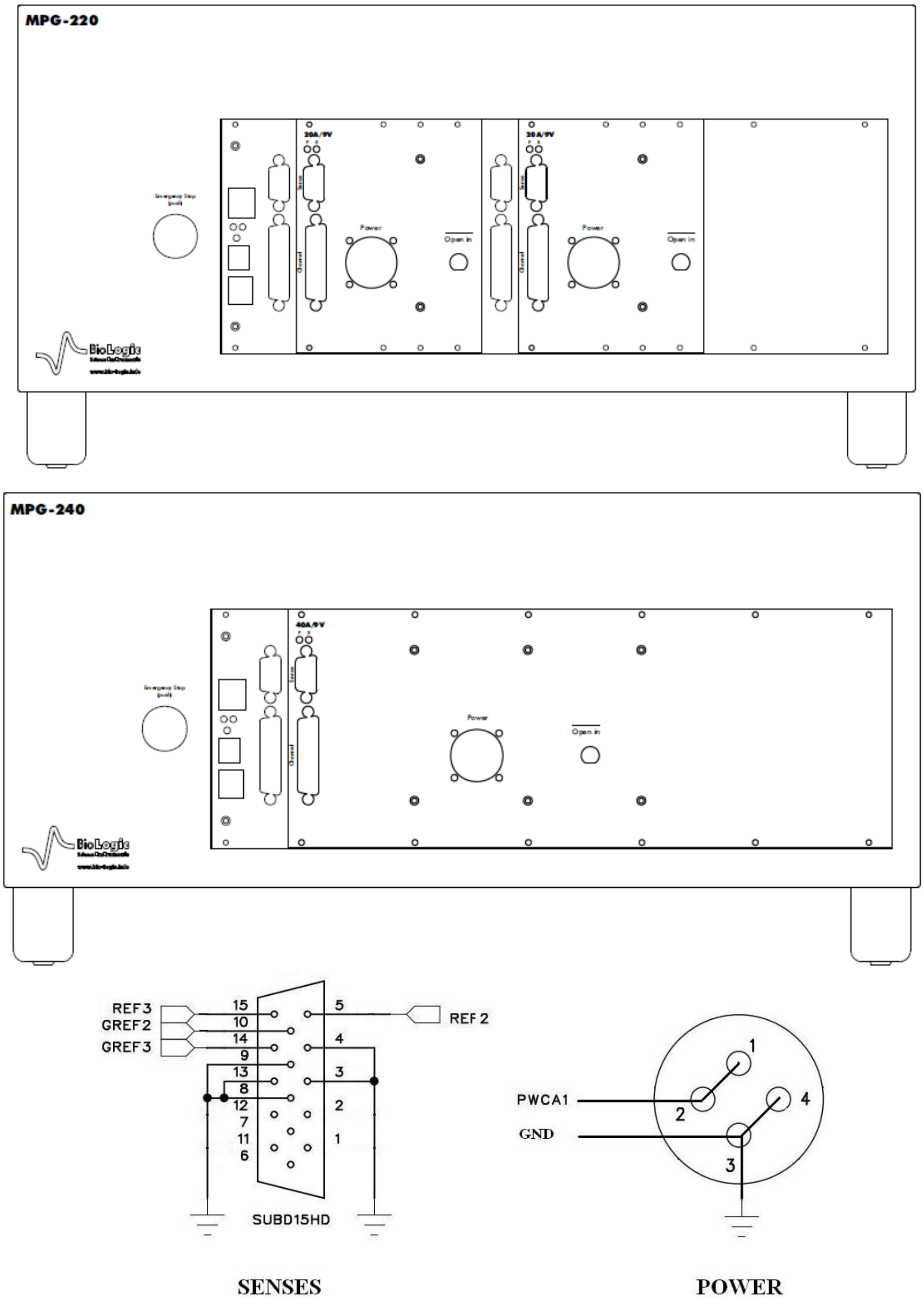


Fig. 47: MPG-220 (top)/MPG-240 (bottom) front panel and structure of the connector.

6.2 Connecting the cell cable to your cell.

This paragraph explains how to connect a channel to a cell using the standard 2.5 m or 25 DB25 cables provided with the instrument.

6.2.1 MPG-2

In the standard configuration, a cell cable has 6 leads for connection to the electrochemical cell: 4 are used in the cell control loop (2 for the current and 2 for the potential) while the 5th lead permits simultaneous recording of an additional voltage. Additionally a 6th ground lead is provided for cell shielding purposes or for particular cell arrangements such as multi-pitting protocols. This lead is especially used in the CE to ground mode. To be easily identified, each lead has an associated color and label as follows:

- Ref1: RED – Reference 1 for the control and measurement of the Working electrode potential.
- Ref2: WHITE – Reference 2 for the control and measurement of the Reference electrode potential.
- Ref3: BLUE – Reference 3 for the control and measurement of the Counter electrode potential.
- CA2: RED – Control Booster for the control and measurement of current flowing through the working electrode (in standard mode).
- CA1: BLUE – Control Booster for the control and measurement of current flowing through the counter electrode (in standard mode).
- GND: BLACK – Ground connected to REF1 in the CE to Ground mode.

The internal structure of the instrument has led to the building of two different connection modes: “Standard” and “CE to Ground”.
A channel has the possibility to link up with 2, 3 or 4 electrodes in different configurations depending on the electrochemical cell. In the standard mode E_{we} and E_{ce} are measured as follow:

E_{we} = Ref1 - Ref2

E_{ce} = Ref3 - Ref2

The current (defined in the positive direction) crosses the electrochemical cell from CA2 to CA1. Typical standard configurations are explained hereafter.

6.2.1.1 Standard three-electrode connection

In the standard three-electrode connection mode, the working electrode (positive electrode) is connected to REF1+CA2. The counter-electrode (negative electrode) is connected to REF3+CA1 and the reference electrode is connected to REF2.

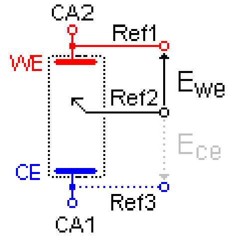


Fig. 48: Standard three-electrode connection for a classical metal-solution interface.

Another three-electrode connection with a reference electrode can be done, for example in battery applications. This connection allows the user to record/control simultaneously the positive and the negative electrodes of the battery. For this, the following connection has to be done:

- Connection of the positive electrode (WE) to REF1+CA2,
- Connection of the negative electrode (CE) to REF2+CA1,
- Connection of the reference electrode (REF) to REF3.

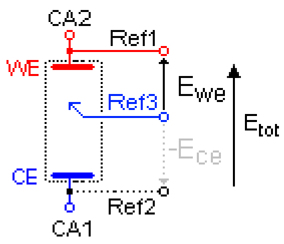


Fig. 49: Three-electrode connection with a reference electrode.

In the instrument, potential regulation is done between REF1 and REF2. Therefore, the total potential of the battery will be displayed by default. The other parameters, such as the potential of the positive and the negative electrodes *versus* the reference electrode, can be displayed by ticking the boxes Ece and Ewe-Ece in the "**Cell Characteristics**" window.
By this way, in the data file, the following rows will be displayed:

- Ewe related to REF1-REF2 *i.e*. total potential of the battery,
- Ece related to REF3-REF2 *i.e*. – negative electrode potential *vs*. Reference,
- Ewe - Ece related to REF1-REF3 *i.e*. positive electrode potential *vs*. Reference electrode.

It is then possible to plot change of potential (positive, negative, total) as a function of time or state of charge (SOC).

6.2.1.2 Two-electrode connection to a battery cell

In the two-electrode connection mode the positive electrode of the battery is connected to REF1+CA2. The potential control or measurement is performed between REF1 and REF2, and the controlled or measured current crosses the cell from CA2 to CA1. So the negative electrode has to be connected to REF2+REF3+CA1. In certain cases, to study either the positive or negative electrode materials for batteries, the user inserts a reference electrode. Then a three-electrode assembly is required (refer to the previous part).

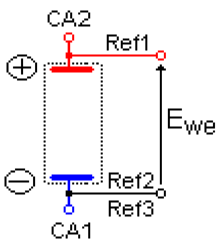


Fig. 50: Two-electrode connection to a battery cell.

<u>Note:</u> Connecting REF3 to CA1 adds parallel impedance. It is better to avoid it for accurate impedance measurements. So for impedance measurement, it could be better to disconnect REF3 from the cell if E_{ce} measurement is not required. Notice that in that case, it is recommended to connect REF3 to the ground cable.

6.2.2 Other MPG-2XX

The MPG-2XX (except MPG-2) channel has 4 lead connections to the electrochemical cell: 4 are used in the cell control loop *i.e.* 2 for the current (power leads) and 2 for the potential (sense leads). To be easily identified, each lead has an associated color and label as follows:

- Sense: RED – for the control and measurement of the working electrode potential.
- Sense BLUE – for the control and measurement of the Counter electrode potential.
- Power: RED – for the current control and measurement flowing through the working electrode.
- Power: BLUE or BLACK – for the current control and measurement flowing through the counter electrode.

6.2.2.1.1 Two electrode connection to a battery cell

In the two-electrode connection mode the positive electrode of the battery is connected to the red Power + Sense. The potential control or measurement is performed between the blue Sense and the red Sense and the controlled or measured current crosses the cell from the red Power to the black Power. So the negative electrode must be connected to the blue Sense + Power.

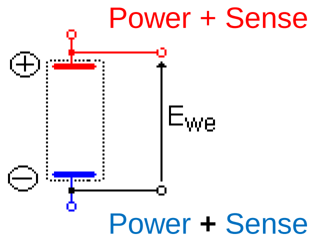


Fig. 51: Two-electrode connection to a battery cell.

6.3 Auxiliary inputs/outputs (DB9)

The following figure shows the structure of the DB9F connector and the different pins that can be used as auxiliary inputs/outputs.

- ***Trigger In*** and ***Trigger Out*** are techniques programmed into the experiment protocol. Trigger In can be used to start or stop an electrochemistry technique. For this, another instrument must send a trigger to the instrument. Trigger Out can be sent at the beginning or the end of the experiment. It is used to start or stop an experiment on another instrument.
  The Trigger signals have high and low levels:
  + 3.5 V < Trigger high level < + 5 V
  0 V < Trigger low level < 0.8 V

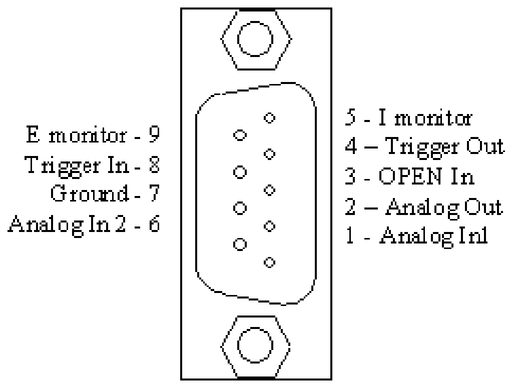


Fig. 52: Structure of the DB9 connector.

- ***Analog Out*** is used to control an external device (1 mA max).
- ***Analog In1*** and ***Analog In2*** are general analog inputs used for auxiliary signal (voltage) recording. Activate Record Aux1 and Record Aux2 in the cell characteristics window to record these variables in the data file.
- ***E monitor*** (not available, HCP & CLB series) and ***I monitor*** are outputs that visualize I and E on a scope. The output variables are opposite in polarity to the real measured values. I.e., if the analog output say -2V, it's actually +2V at the cell.
- ***OPEN In*** is an external Trigger signal (active high) that can open the relays providing an "open circuit" condition (0.0 Amps of current through the cell). This may be used as an emergency stop of the experiment that is triggered by an external monitor/event.
- ***Ground*** is tied to the earth

For convenience we have designed a 50 cm cable that connects to the DB9 connector of a channel on one end with 8 BNCs on the other end.
The available signals are: E monitor, I monitor, Trigger In, Trigger Out, Analog In1, Analog In2 and Analog Out as described above.

Fig. 53: DB9-8BNC cable.

7 Advanced features

7.1 External device control and recording

7.1.1 General description

The EC-Lab® software offers the user the ability to control external devices such as rotating electrodes and thermostatic baths and to record external analog signals through the auxiliary DB9 connector. The user has to configure the analog output to control an external device and configure the Analog In1 and Analog In2 inputs to record external signals. Our instruments can control and record analog signals from – 10 to + 10 V. Most external devices work in a 0 to + 5 V range. The figure below shows the external device window where the user sets parameters. Many instruments are already configured in the software to be controlled by our potentiostat. This list continues to be expanded in new versions of EC-Lab® software. To configure external devices select "**External Device**" frame.

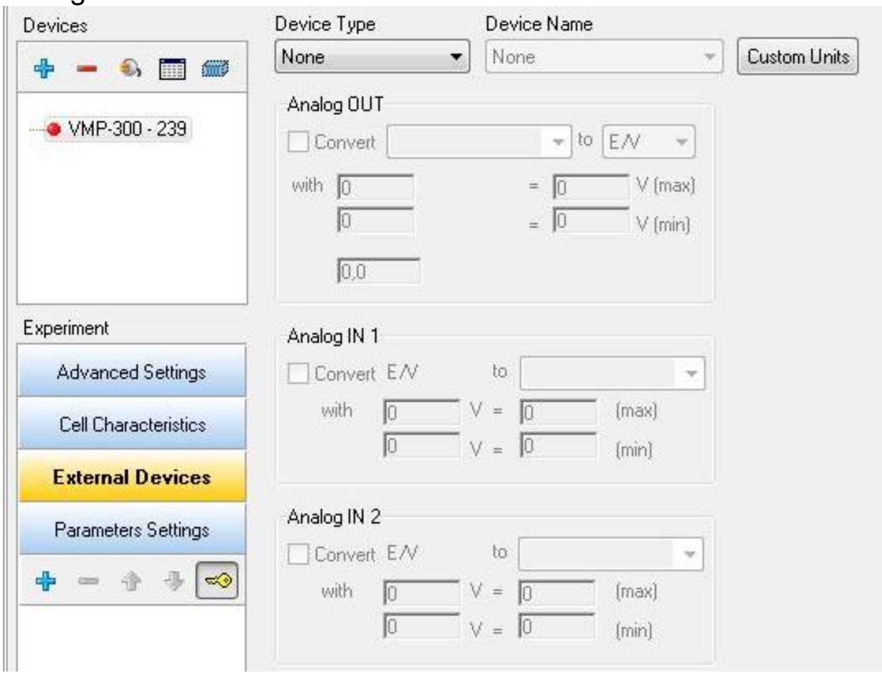


Fig. 54: External device configuration window.

The user must define several parameters to configure the external device to either be controlled via the analog output (left column) or record/measure data via analog input 1 and 2 (right column). The procedure for the configuration of the auxiliary inputs/outputs is described is as follows:

1- Choose the channel to configure. Each channel can be configured for a specific device. One channel can control one device and the other one another device.
2- Select the Device Type in the list between None, Thermostat, RDE, QCM and other. According to the selected device type one or several device names are available.
3- Among the available devices some can be controlled by the analog output and some of them can only be used to record values with analog inputs 1 and 2. The user must tick the box to activate the input/output.
4- In the activated frame, the user must define the conversion between the input voltage and the variable to plot. This is a direct linear conversion in the range defined by the user between the min and the max value.
5- The user can also define the name and the unit of the variable they want to display. Click on "**Custom Variables**". The figure below is displayed:

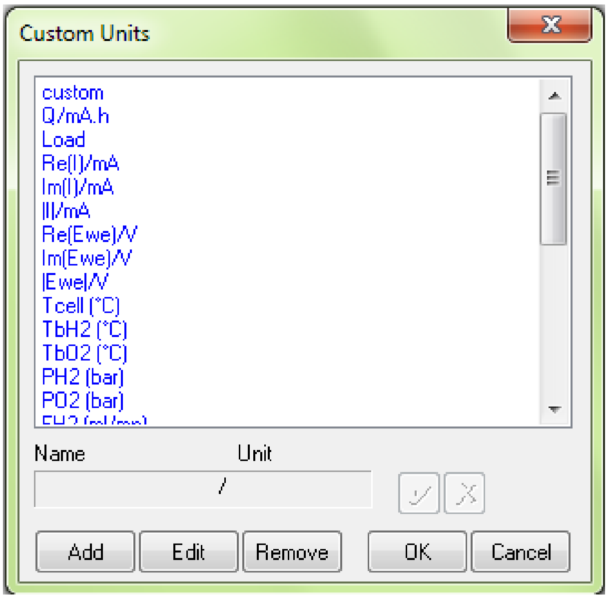


Fig. 55: Custom Units window to define new variables.

To create a new variable with its unit, click on "**Add**" and put the name and the unit of the new variable in the frame. Then click on  to validate. The new variable is displayed in the list in blue (as a custom variable) and can now be selected as the recorded variable for the analog inputs.

6- Finally click on "**OK**" to configure the selected channel to record the auxiliary input signal

The new selected variables for Analog In1 and Analog In2 are automatically displayed on the "Cell characteristics" window and activated for recording. In the "**Selector**" the created variables are displayed and can be plotted. These auxiliary variables can be used in several protocols as conditional limits of an experiment.

Note: - The parameters set in Analog In1 and Analog In2 to define the linear slope can be inverted to display an inverse relationship between the recorded value and the plotted value.
- The configuration of external devices that can be controlled by the potentiostat (analog output) are described in detail in the corresponding sections of the manual.
- A manual control of external devices is also available on the left of the panel.
- When a channel has been configured to control an external device, this device can be seen in the global view.

7.1.2 Temperature control

Temperature control is possible with the auxiliary output voltage of the instrument. Several thermostats have already been configured such as the Julabo series and the Haake Phoenix series.

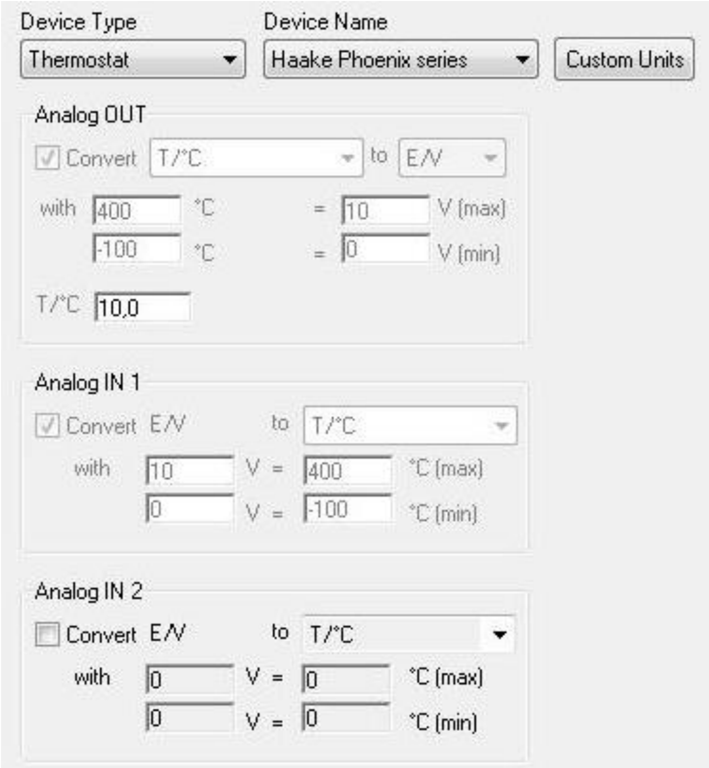
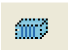


Fig. 56: Haake Phoenix series thermostat control configuration.

The user can configure other thermostats to only record temperatures (Analog In) or to both control (Analog Out) and record (Analog In) temperature.

7.2 Virtual potentiostat

The user can work with the EC-Lab® software without being connected to an instrument. In that case, the software sees a virtual potentiostat that is not available for experiments but can be used as a user's interface. The user can select his virtual instrument in the "**Devices"** frame, click on the "**Virtual potentiostat**" button  then, the corresponding software interface will be displayed.

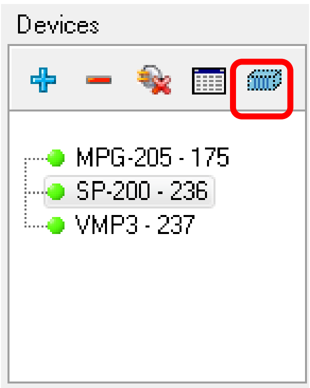


Fig. 57: Virtual potentiostat button (in the red rectangle).

The available techniques and time base are different depending on the instrument selected.

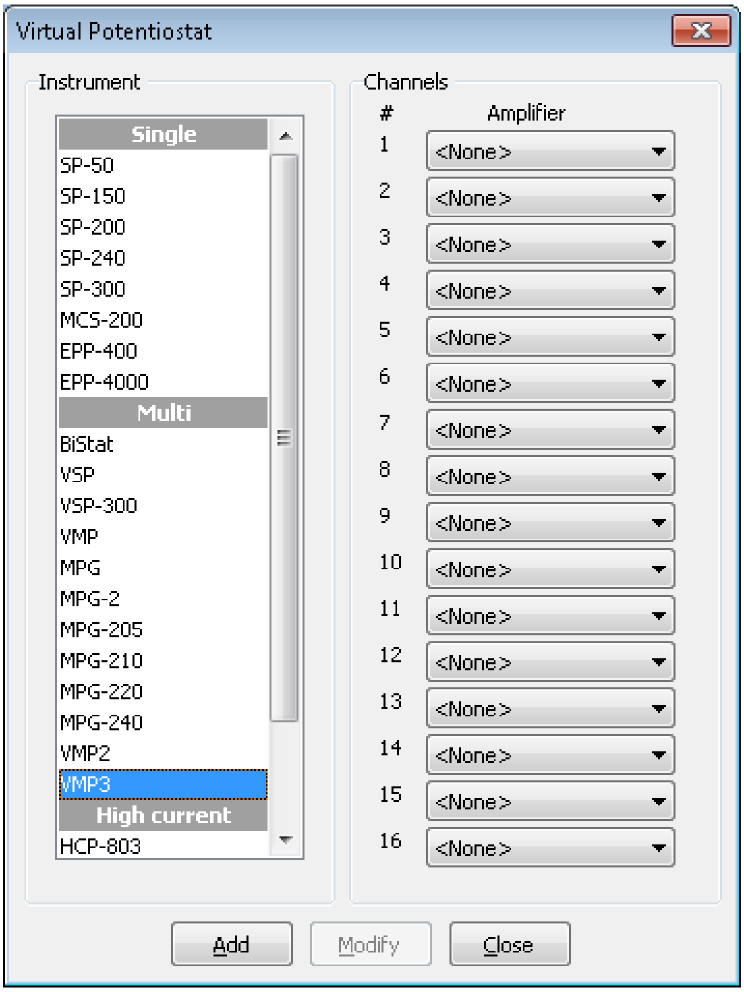


Fig. 58: Virtual potentiostat window.

8 Accessories

Some of our available accessories are described in this section. These accessories can be used to check the instrument or to help the user optimize their setup .

8.1 Test boxes for calibration check and user training

8.1.1 Dummy Cell 2 (DC2)

The Dummy Cell 2 is provided with each channel board. The circuitry is made of resistors (accuracy 1%) and capacitors.
On the left side there are two lugs, on the right side two holes. This allows several DC-2s to be bound together.

The dummy cells for boosters and DC2s can be bound together as well.

Fig. 59: Dummy Cell-2

8.1.2 Dummy cell for booster

The Dummy cell for booster is specifically dedicated to periodically check a booster. The dummy cell for booster is provided with each booster chassis.

Dummy cell for booster and DC2 can be bound together as well.

Characteristics of the dummy cell are given in the following table:

Resistance/mΩ	Standard tolerance	Temperature coefficient
5	1%	+/- 50 ppm/°C

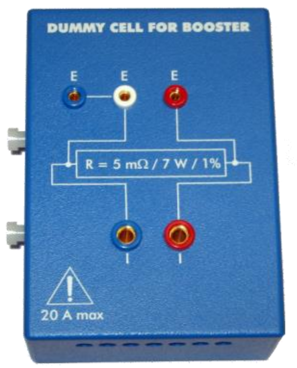


Fig. 60: Dummy Cell for Booster.

8.1.3 Test Box 2

The Test Box 2 is a tool specifically designed for checking the calibration of the standard channel boards of our instruments. This test box is made of one electrical circuit with high precision resistors for calibration check and two dummy cell circuits for user training. The high precision resistor circuit is made with 7 resistors, one to check each current range of the board.

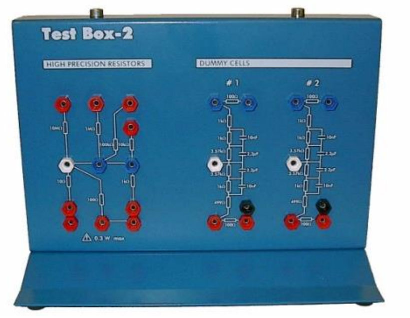


Fig. 61: TestBox-2.

High precision resistor characteristics:

High precision resistor	I range	INSTRUMENT
10 Ohms +/- 0.04%	1 A	×
100 Ohms +/- 0.02%	100 mA	×
1 kOhms +/- 0.02%	10 mA	×
10 kOhms +/- 0.02%	1 mA	×
100 kOhms +/- 0.02%	100 µA	×
1 MOhms +/- 0.02%	10µA	×

8.1.4 Test Box 3

Test Box 3 is a tool for teaching and practice on linear and non-linear electrochemical systems. This testing box is made of three electrical circuits simulating real electrochemical systems. Along with application notes #8 and #9 Test Box 3 can be used to highlight some commonly overlooked points about electrochemical impedance spectroscopy. Additionally, with Test Box 3 some general electrochemistry protocols like Cyclic Voltammetry and, corrosion techniques such as Linear Polarization or Generalized Corrosion can also be practiced.

Fig. 62: Test Box-3

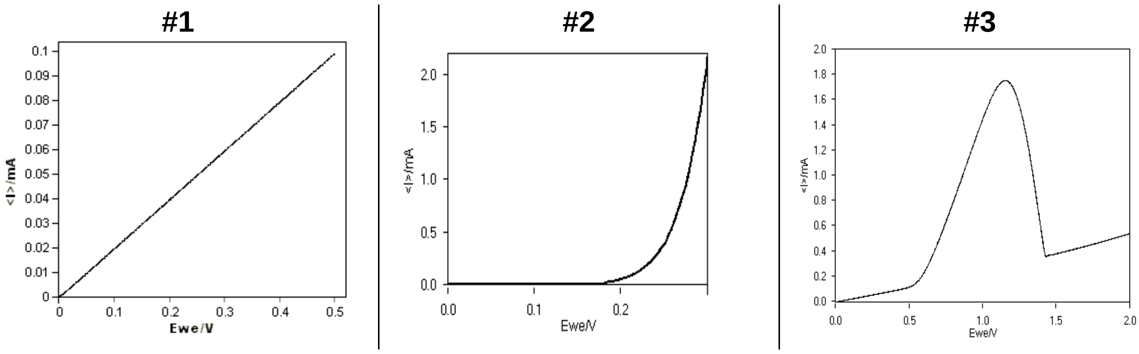


Fig. 63: stationary curve obtained with Test Box-3.

8.2 Temperature probe

To allow the user to measure temperature, temperature probe (PN: 092-22/13) can be connected to the auxiliary input/output of the potentiostat board. The temperature probe is fully controlled in EC-Lab® software.

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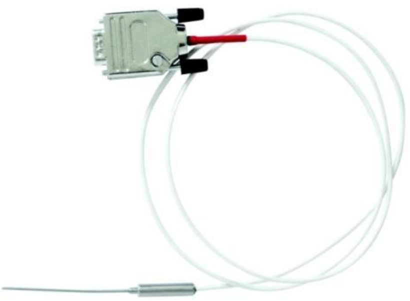


Fig. 64: Temperature probe.

8.3 Battery holders

8.3.1 Battery Holder: BH-1

This accessory is designed to make battery testing easier. The holder is modular and compatible with a wide variety of battery types (coin cells, 18650 and 26650 cells). The BH-1 can accommodate up to 4 batteries in pairs of two. Perfect contact of the BH-1 connectors with the battery poles is ensured with spring-loaded connection points. Each of the batteries is secured in place by isolating separators specifically designed for each battery type.
It is possible to test many batteries simultaneously by linking multiple holders in series.

Fig. 65: Battery holder, BH-1.

8.3.2 Battery Holder: BH-2

This battery holder is designed to accommodate eight individual batteries, all of the same length. A maximum of 15 A can be passed through the connectors.

Fig. 66: Battery holder, BH-2.

8.3.3 Coin Cell Holder: CCH-1

This coin cell holder eliminates the need for cumbersome cell cables. It is plugged directly into DB-25 connectors on the front panel of the VMP3, VMP-300 or MPG2 series instruments. It allows the user to test four coin cells in parallel (on four individual channels). Four CCH-1 holders can be connected across the front panel of a 16 channel instrument.

Fig. 67: Coin Cell Holder, CCH-1.

8.4 Rack

To get a vertically integrated, compact setup, it is possible to put five units in a rack with lateral tablet for the control computer. It is possible to use this rack for the VMP3, Booster chassis, HCP and CLB only if the sliding option is not purchased.

Rack specifications:		
Maximum unit		5 units
Rack Dimension/mm (H x W x D)	**Rack**	1850x600x710
	Shelf with the sliding tablet	257x495x450
	Shelf without the sliding tablet	295x495x450
Temperature Range/°C		10 – 40

Fig. 68: Rack with five units.

8.5 Sensor Adapter Module

The Sensor Adapter Module (SAM-50) is necessary to perform measurements of up to 50 V on each channel. This high voltage may be necessary to test stacks of energy devices (fuel cells, photovoltaic cells). This accessory must be connected to the VMP3 channels. It enlarges the voltage range to 50 V on each channel. Practically, SAM-50 acts as a level shifter. It is able to measure a difference of potential within the normal range of a channel board which is [-10; +10] V. One channel is capable of measuring 2 cells of one stack, so with a SAM-50 connected to 5 channels, the user can measure 10 cells.
With this accessory, each element of the stack can be tested simultaneously while the master channel controls the whole stack. The master channel can be connected to any booster of our range. See Technical Note #27, page 2, found on the Bio-Logic website. (http://www.bio-logic.info/electrochemistry-ec-lab/apps-literature/technical-notes/)

Fig. 69: SAM-50

SAM50 specifications:	
Input voltage	0 – 50 V
Output voltage	± 10 V
Common rejection mode	70 dB
Accuracy (Full Scale Range)	0.3 %
Bandwith	220 kHz
Slew Rate	2 V/µs
Rise/Fall Time	1 µs
Input impedance	400 kΩ

8.6 Labview VIs

The potentiostat can be controlled with the free EC-Lab® development package. This package is devoted to software developers who need to integrate the control of the Bio-Logic potentiostats/galvanostats/EIS with OEM software. The EC-Lab® development package includes a LLB LabVIEW® library where the functions of the DLL are implemented (Requirements: LabVIEW® V8.5 or higher). This development package includes a DLL with specific functions for:

- connection/disconnection to a selected instrument (Ethernet or USB),
- initialization of the channels by loading the firmware,
- loading protocols on the channels:
  - all techniques available in EC-Lab® Express
- starting/stopping the selected channel(s),
- retrieving data.
- Note that the time base with these LabVIEW® Vis depends on the selected protocol.

8.7 Electrochemistry accessories

Bio-Logic can provide accessories for many fields of electrochemistry and battery chemistry. Please consult the Bio-Logic website for more details:
http://www.bio-logic.info/battery-testing-bt-lab/accessories/

9 Calibration and Maintenance

9.1 New board installation in an existing instrument

When a user orders new boards (channel board or low current board), they can install them themselves. The procedure for this operation is described in the corresponding service note. With the newly provided boards, the latest software version must always install. This can be downloaded from our website. The board installation procedure consists of 4 steps:

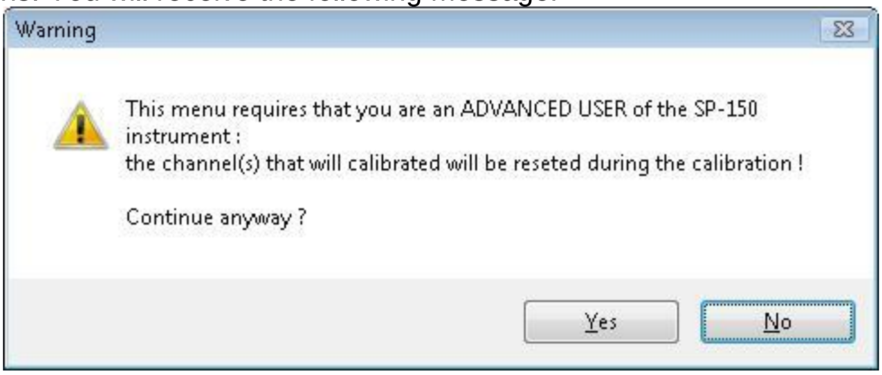
1- Install the new software version on the computer and on the instrument firmware in order to have the old unit and the new boards in the same software version.
2- Power off the unit and unplug it.
3- Install the new boards in the chassis, plug in the unit and power it on.
4- Calibrate the new boards with EC-Lab®.

The low current boards are coupled with a channel board, so a low current board must **ALWAYS** be calibrated with the corresponding channel board.

9.2 Channel calibration with EC-Lab® Software

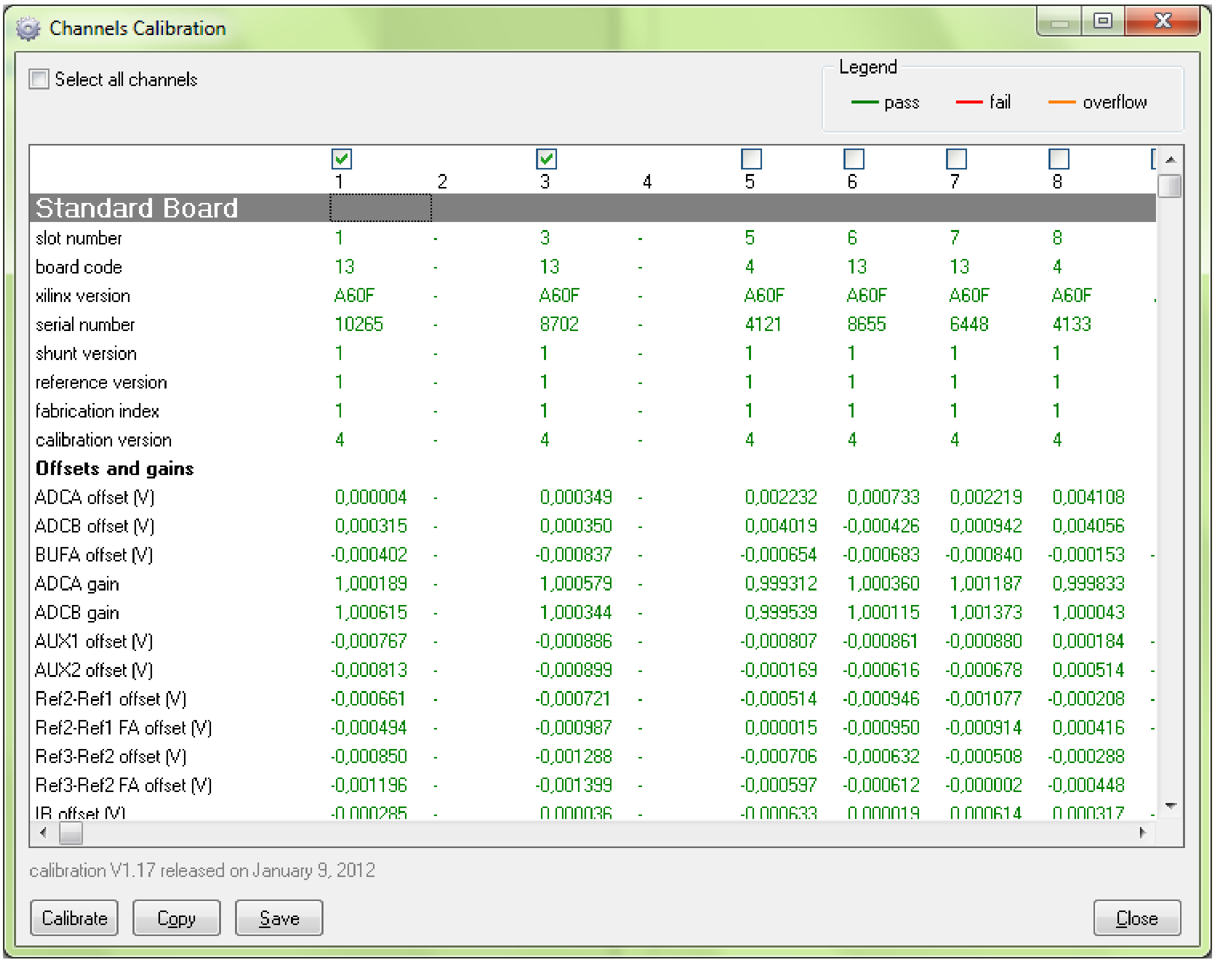
CAUTION !!!: Before calibrating remove all cell cables from the channel boards.

1) In the EC-Lab® software, select "**Tools/channels calibration**" and follow the instructions. You will receive the following message:

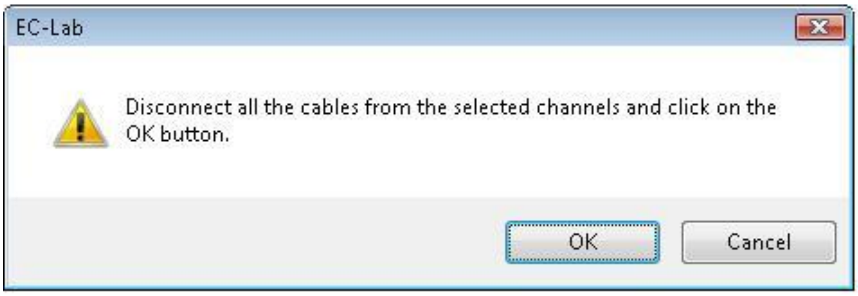


Answer "**Yes**" to the warning message. Then the board calibration window appears.

2) Select a channel (in our example channel 1 and 3) and click on the calibrate button.



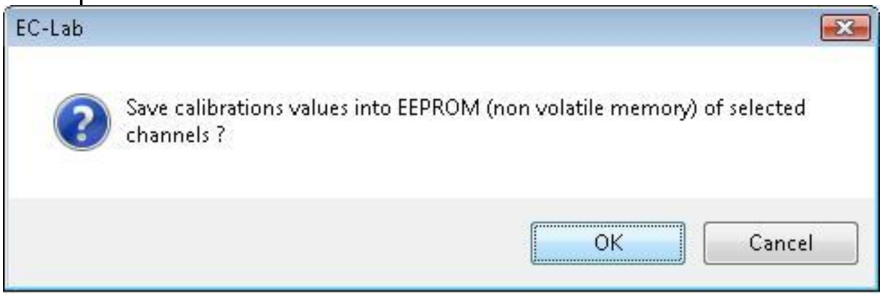
3) Click on Ok.



4) Disconnect all the cables from the channels to be calibrated as called for in the message, including the DB25-DB25 ribbon cable.

Then the calibration of the channel board will begin. For each variable, the numerical value corresponds to the compensated offset or gain and “pass” signifies that the calibration is made. If “failed” appears instead of “pass” then the calibration cannot be done. The channel board is probably damaged and must be sent back to the factory to be repaired.

When this calibration is finished, click on copy and paste the results in Word. Then save the file and print the report.



5) Click on “Ok” to save the calibration parameters on the channel board. On the board calibration window the message “calibration saved on channel X” appears.

Now the standard channel board is calibrated and the calibration parameters have been saved in the channel board memory. If a low current board is connected to this channel board, it has been calibrated too.
Then **close** the calibration window. The standard program will reload on the channel board.

9.3 Equipment maintenance

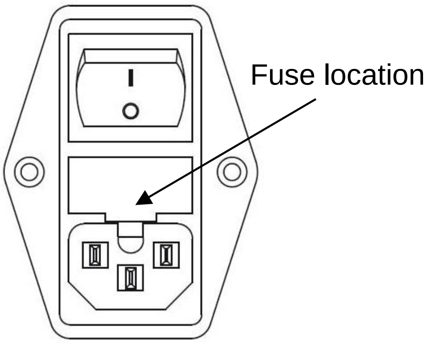
WARNING!: Before performing any maintenance power down the unit then disconnect the power cord and all test cables.

Our instruments do not require specific maintenance. Each channel board is calibrated at the factory before it is delivered to the customer. Due to the temperature differences between winter and summer, we recommend adjustment of the gains and offsets of the channel boards twice a year, especially if the instrument is not in an air-conditioned room. This adjustment is performed using the EC-Lab® software “**Channel Calibration**” in the “**Tools**” menu. We also recommend a full check-up of the instrument (at the factory) every two years.

Ventilation:
The user must carefully check that the ventilation grids are not obstructed under the chassis. An external cleaning can be made with a vacuum cleaner if necessary.

Cleaning:
<u>Ventilation grids:</u> external cleaning can be made with a vacuum cleaner if necessary.
Use a damp cloth or mild, water-based cleaner to clean the instrument. *Clean* the exterior of the box only, never the circuit board. *Do not apply cleaner directly* to the box or *allow liquids to enter or spill* on the box.

Fuses:
WARNING !: To maintain protection from electric shock and fire, replace fuses, with the same rating and type.



10 Technical Specifications

10.1 Equipment Ratings

10.1.1 Electrical & Mechanical specifications

Instrument type	Input				Output		Mechanical	
	Voltage Range/ Vac	Frequency range/Hz	Power max/ W	Fuses[a]	Voltage range/ Vdc	Current	Size (HxWxD)/mm	Weight without cable/kg
MPG-2	[90;264]	[50; 60]	350	2 x 6.3 AF	± 10	100 mA	182x470x504.5	19
MPG-205	[90;264]	[50; 60]	860	2 x 10 AF	[-2; +9]	5 A	254x494 x454	25
MPG-210	[90;264]	[50; 60]	860	2 x 10 AF	[-2; +9]	10 A	254x494x454	24
MPG-220	[90;264]	[50; 60]	860	2 x 10 AF	[-2; +9]	20 A	254x494x454	24
MPG-240	[90;264]	[50; 60]	860	2 x 10 AF	[-2; +9]	40 A	254x494x454	24

a: cold start-250 VAC (5x20 mm) (Neutral+phase)

Environmental

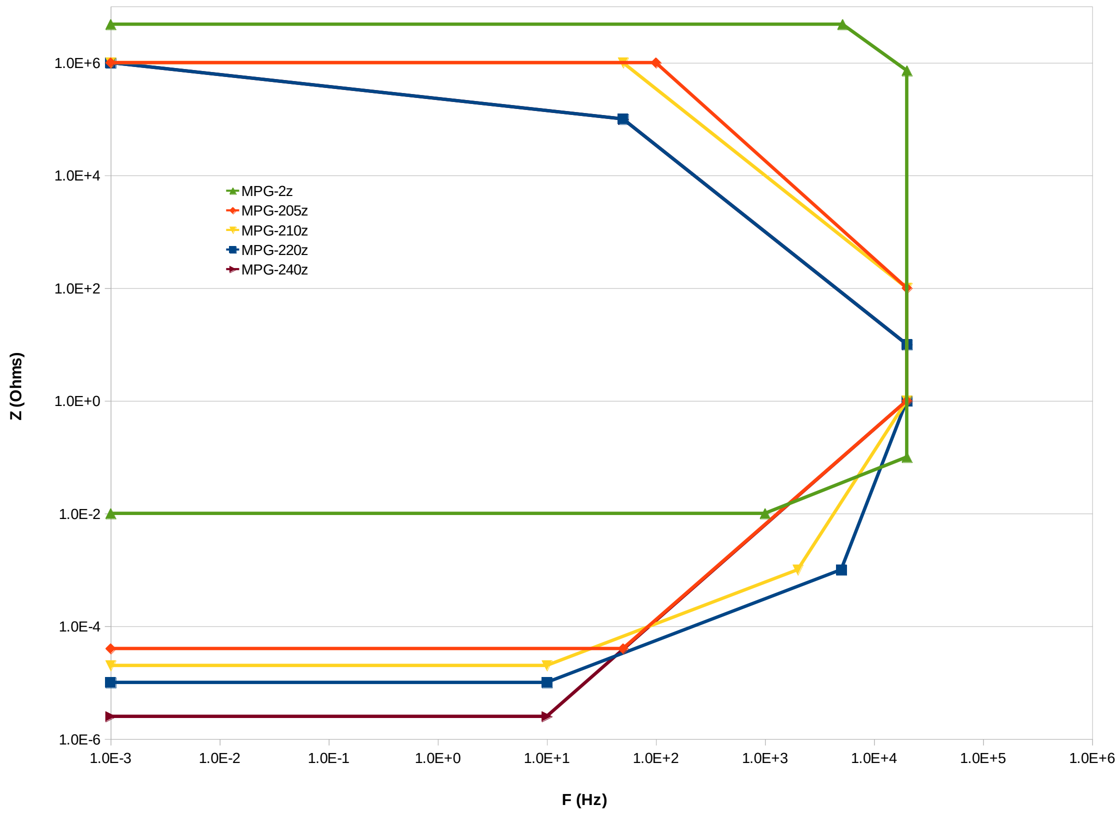
- **Indoor use**
- **Operating Temperature:** 10°C to +40°C Indoor use
- **Storage Temperature:** 0°C to +50°C
- **Pollution degree:** 1 (no pollution or only dry)
- **Altitude:** <2000 m above sea level
- **Humidity:** 10% to 80% non-condensing
- **Case protection:** IP20 or better
- **Warm-up:** 1 hour to rated accuracy
- **Cooling:** Internal DC Fans
- **Vibration:** not specified
- **Choke:** not specified

Safety complies with EN61010-1.
EMC complies with EN61326.

10.2 Specifications

General Functions	MPG-2	MPG-205	MPG-210	MPG-220	MPG-240
Number of channel	16	8	4	2	1
IR compensation	Yes				
Cell connection	2, 3, 4 or 5 terminal leads	2 or 4 terminal leads			
Cell Control					
Compliance	±10 V	[-2; 9] V @ 5A	[-2; 9] V @ 10A	[-2; 9] V @ 20A	[-2; 9] V @ 40A
Maximum current	± 100 mA continuous	± 5 A continuous	± 10 A continuous	± 20 A continuous	± 40 A continuous
Maximum potential	10 V à 100 mA	9 V @ 5A	9 V @ 10A	9 V @ 20A	9 V @ 40A
Potential resolution	200 µV down to 5 µV For example: For an Erange of [0;20]V, the resolution is 305 µV. For [0;19.64]V, the resolution is 300 µV. For [0;13.09]V, the resolution is 200 µV. For [0; 6.53]V, the resolution is 100 µV. For [0; 3.26]V, the resolution is 50 µV. For [0; 1.29]V, the resolution is 20 µV. For [0; 0.64]V, the resolution is 10 µV. For [0; 0.31]V, the resolution is 5 µV.				
Current resolution	0,004% of FSR				
Accuracy	±0.1% of control ±0.01% of FSR				
Bandwidth control:	7 stability factors, loop compensation poles at: 680kHz, 217kHz, 62kHz, 21kHz, 3.2kHz, 318Hz, 32Hz				

Voltage measurement					
Ranges	±10 V; ±5 V; ±2.5 V	[0; 5] V ; [0; 10] V			
Accuracy (DC)	±0.1% of control ±0.01% of FSR				
Resolution	0.0033% of FSR				
Acquisition speed	200 µs				
Noise (peak to peak 0-100 kHz)	500uV				
Current measurement					
Ranges	±100 mA, ±10 mA, ±1 mA, ±100 µA, ±10 µA	±5 A, ±1 A, ±100 mA, ±10 mA, ±1 mA, ±100 µA, ±10 µA	±10 A, ±1 A, ±100 mA, ±10 mA, ±1 mA, ±100 µA, ±10 µA	±20 A, ±1 A, ±100 mA, ±10 mA, ±1 mA, ±100 µA, ±10 µA	±40 A, ±1 A, ±100 mA, ±10 mA, ±1 mA, ±100 µA, ±10 µA
Accuracy (DC)	±0.1% of control ±0.01% of FSR				
Resolution/Noise (peak to peak 0-100 kHz)	0.0033% of FSR/0.02% of FSR				
Electrometer					
Input Impedance (1)	100 GΩ || 25 pF typical	100 GΩ || 100 pF typical			
Input Bias Current	< 10 pA				
Bandwidth (-3 dB)	8 MHz	3 MHz			
CMRR	> 85dB				
Auxiliary Inputs / Outputs					
2 analog inputs (2)	automatic ± 2.5 V, ± 5 V, ± 10 V ranges – 16 bits resolution				
1 analog output (2)	± 10 V range 16 bits resolution				
2 Digital inputs	TTL level Trigger input and Open Input				
1 Digital output	TTL level Trigger output				
2 Monitor Outputs	E and I monitor	I monitor			
Safety	1 digital security input (open in)				
Emergency stop button	No	Yes			
Contour plot (1%; 1°)					
Same contour plot for 2.5 m or 25 cm cable.					

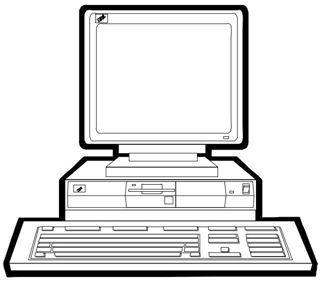


Current measurement noise (rms/Bandwidth):

Noise is always present since all materials produce noise at a power level proportional to the material temperature. The shunt resistor is the first noise source in a current measurement path. Resistor noise is generally referred to as thermal noise or white noise. Just as white light contains all the colors, white noise includes uniformly distributed power at all frequencies. Thus, total power noise is proportional to the bandwidth. To minimize noise measurement, select circuits with low noise specifications.

I range	Boost OFF
100 uA	16 nA/100 kHz
10 uA	1.6 nA/26 kHz
1 uA	0.16 nA/3.5 kHz
100 nA	17 pA/520 Hz
10 nA	1.7 pA/100 Hz
1 nA	0.18 pA/28 Hz

10.3 PC requirements



Recommended:
- Pentium 2 GHz
- 2 Go RAM
- 80 GB Hard Drive
- Screen resolution 1280*1024
- Ethernet board with 10/100 base T or USB port
- Windows XP© (SP2), Seven, Eight (32 or 64 bits).

10.4 Safety precautions

To avoid electrical shocks:
- The equipment must be connected to a protective ground.
- The equipment must be disconnected from the power source before it is opened.

To avoid electrostatic shocks:
- Every lead from the instrument to the cells (or booster to cells) must be connected either to an electrochemical cell or to the testing box.

11 Troubleshooting

11.1 Data saving

Problem: Data cannot be saved from a given channel (this channel appears in yellow in EC-Lab®, and the program displays an error message while attempting to save data):
Solution(s):

- ensure that the file being saved to has not been moved or destroyed, or opened by another application,
- if the saved file is on a network drive, ensure that you have the right to write data into the same directory (create and destroy a text file). Otherwise see your network authorizations…,
- in EC-Lab®, select **File, Repair...** Then select the saved file and click on the **Repair** button,
- ensure that the computer's IP Address has not been modified since the beginning of the experiment,
- if the problem persists, please contact Bio-Logic.

11.2 PC Disconnection

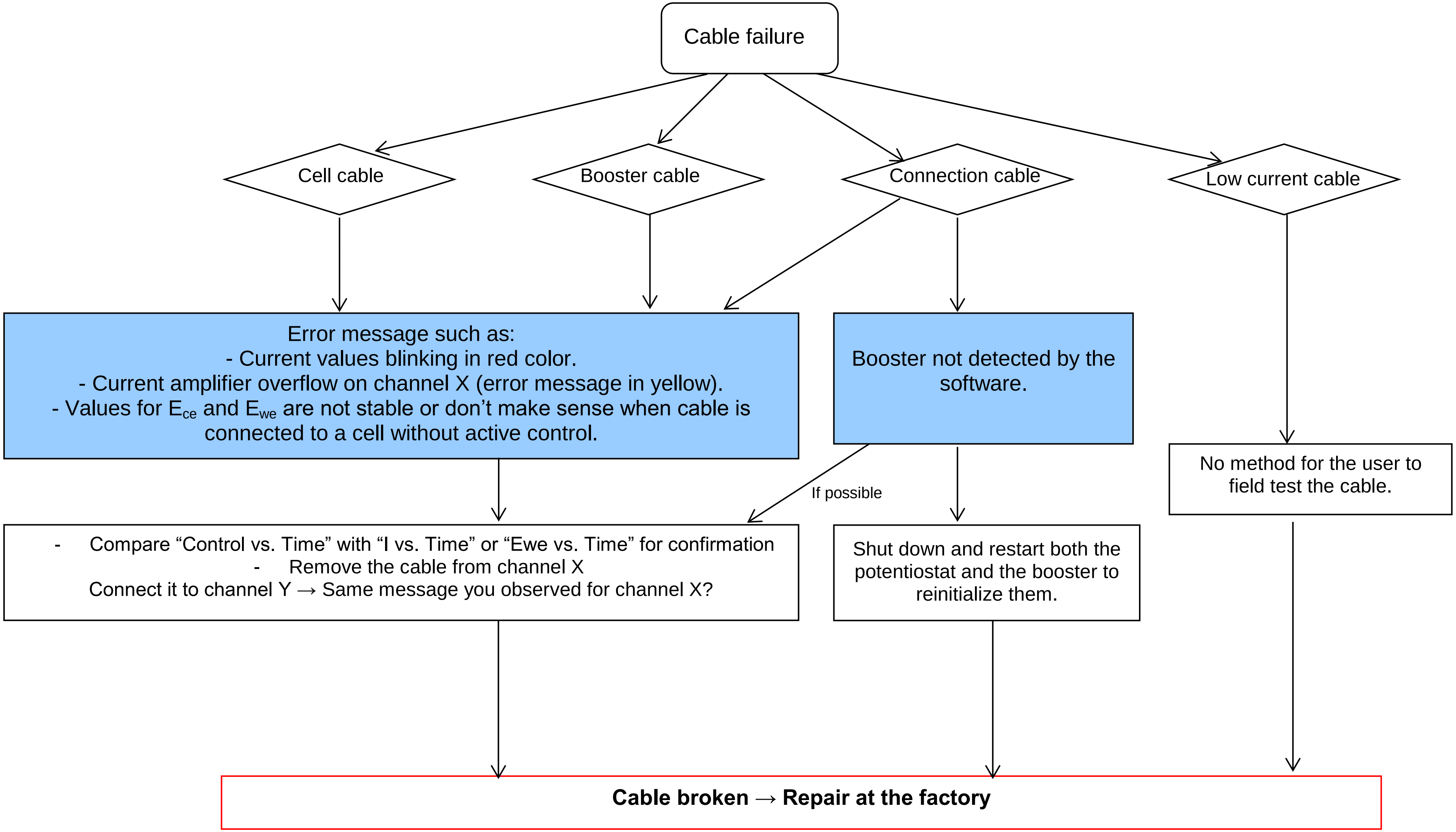
Problem: The PC is disconnected from the instrument ("Disconnected" is displayed in red on the EC-Lab® status bar):
Solution(s):

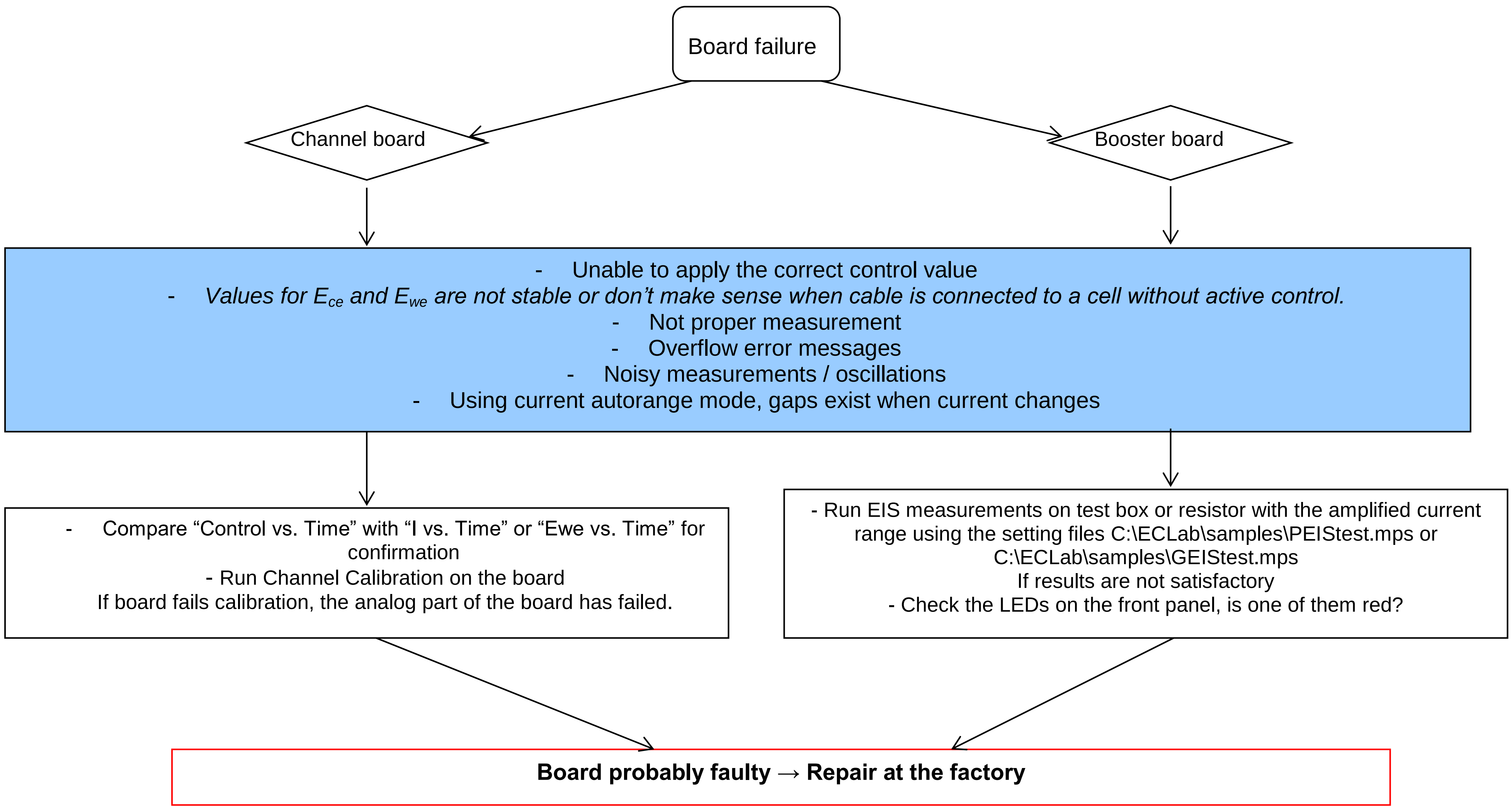
- check the PC – instrument connection,
  - direct connection: verify that the Ethernet cable is plugged in at both ends,
  - network connection: verify that the yellow LED is blinking on the instrument front panel and that you have access to your network directories from the PC,
- check that the green led is blinking (this ensures that the multichannel potentiostat is running properly),
- in the Tera Term Pro window type "r" or "R": this will restart the Ethernet connection program that is a part of the instrument firmware,
  WARNING: this operation is not a simple task, proceed with this only in extreme circumstances.
- if the problem persists, please contact Bio-Logic

11.3 Effects of computer save options on data recording

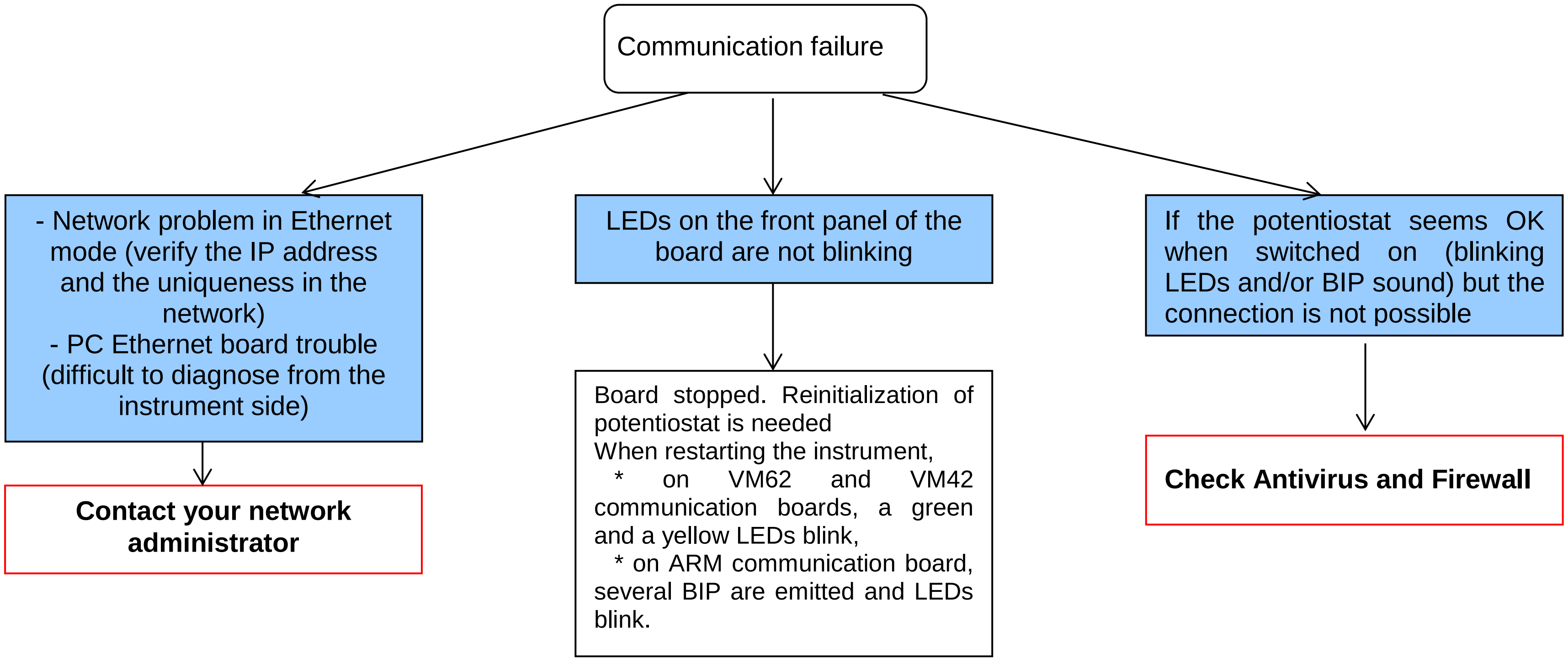
Electrochemical experiments often have a long duration (hours to days or longer). During the experiment, the user must ensure that the computer is always ready and able to record the data. If the power saving options for the hard disk are activated, there is a risk of the computer not being able to continuously record data from the instrument. In order to avoid this, we advise the user to turn off all of the power save option for the computer in the settings panel.

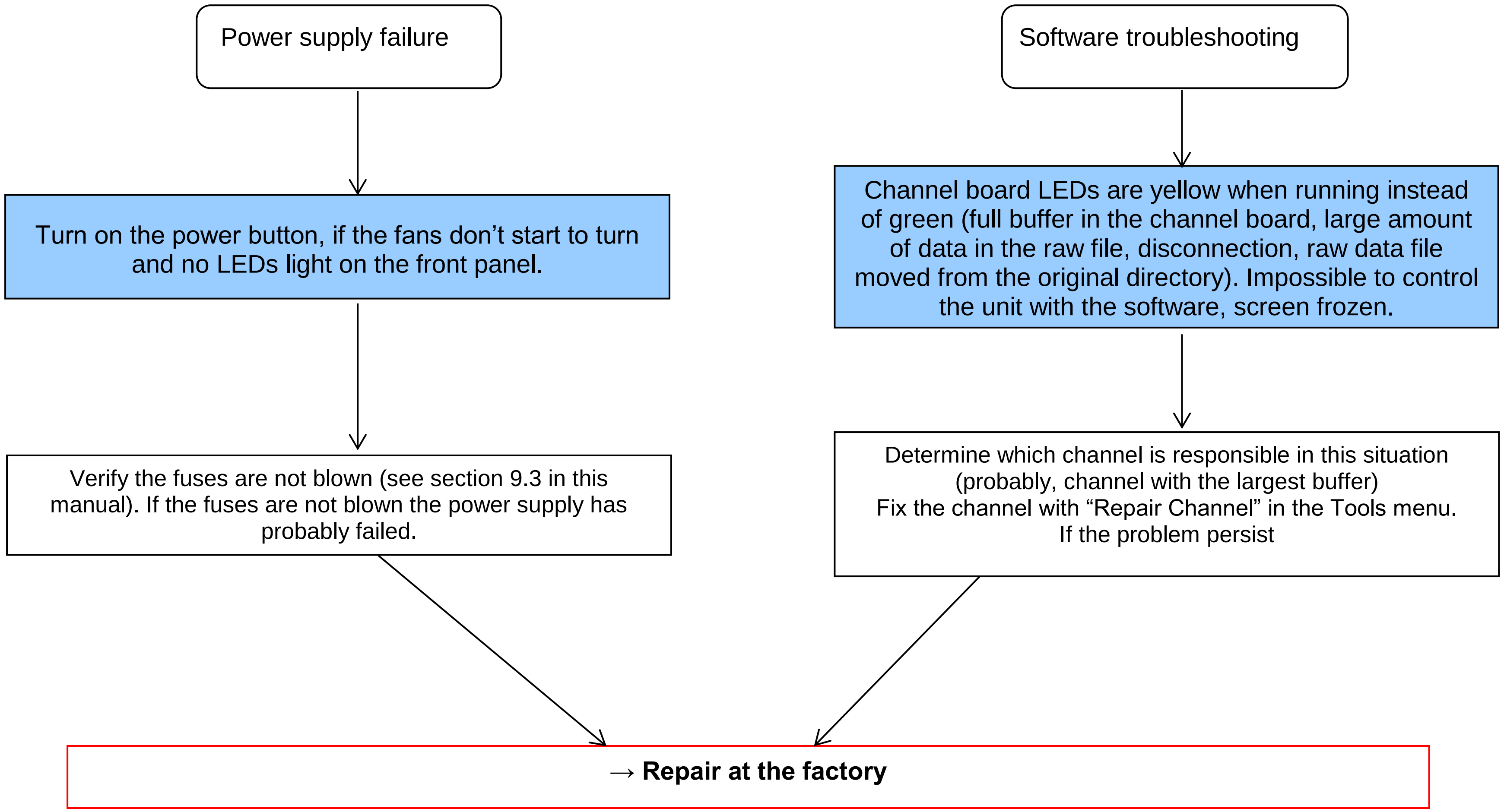
11.4 Preliminary checks


Cable failure
Cell cable
Booster cable
Connection cable
Low current cable
Error message such as:
- Current values blinking in red color.
- Current amplifier overflow on channel X (error message in yellow).
- Values for E_{ce} and E_{we} are not stable or don't make sense when cable is connected to a cell without active control.
Booster not detected by the software.
No method for the user to field test the cable.
If possible
- Compare "Control vs. Time" with "I vs. Time" or "Ewe vs. Time" for confirmation
- Remove the cable from channel X
Connect it to channel Y → Same message you observed for channel X?
Shut down and restart both the potentiostat and the booster to reinitialize them.
Cable broken → Repair at the factory



Note: if you send a board back to the factory, be sure to always send the cell cable associated with this board as well.


Communication failure
- Network problem in Ethernet mode (verify the IP address and the uniqueness in the network)
- PC Ethernet board trouble (difficult to diagnose from the instrument side)
Contact your network administrator
LEDs on the front panel of the board are not blinking
Board stopped. Reinitialization of potentiostat is needed
When restarting the instrument,
* on VM62 and VM42 communication boards, a green and a yellow LEDs blink,
* on ARM communication board, several BIP are emitted and LEDs blink.
If the potentiostat seems OK when switched on (blinking LEDs and/or BIP sound) but the connection is not possible
Check Antivirus and Firewall


Power supply failure
Turn on the power button, if the fans don't start to turn and no LEDs light on the front panel.
Verify the fuses are not blown (see section 9.3 in this manual). If the fuses are not blown the power supply has probably failed.
Software troubleshooting
Channel board LEDs are yellow when running instead of green (full buffer in the channel board, large amount of data in the raw file, disconnection, raw data file moved from the original directory). Impossible to control the unit with the software, screen frozen.
Determine which channel is responsible in this situation (probably, channel with the largest buffer)
Fix the channel with "Repair Channel" in the Tools menu.
If the problem persist
→ Repair at the factory

12 EC declaration of conformity

12.1 MPG-2

BioLogic
Science Instruments

Bio-Logic SAS
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F-38640 Claix
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Tel: +33 476 98 68 31
Fax: +33 476 98 69 09
Web: www.bio-logic.info

SAS capital 337 000 €
SIRET 328 685 284 000 31
APE 2651B

EC DECLARATION OF CONFORMITY

N°: CETR_MPG2_Rev. A

We,

Bio-Logic SAS
1, Rue de l'Europe
38840 Claix France

declare under our sole responsibility that the products,

MPG2 with cables

are in conformity with the following standard(s) in accordance with the provisions of the Electromagnetic Compatibility Directive 2004/108/CE and the Low Voltage Directive 2006/95/CE.

Security: IEC 61010-1
EMC: IEC 61326

Emissions

EN 55022: Conducted Class B
EN 55022: Radiated Class A
EN 61000-3-2: Harmonic Current

Immunity

IEC 61000-4-2: ESD
IEC 61000-4-3: EM field
IEC 61000-4-4: Burst
IEC 61000-4-5: Surge
IEC 61000-4-6: Conducted RF
IEC 61000-4-8: Magnetic Field
IEC 61000-4-11: Voltage Dip/Short Interruptions

Date: March 24, 2010

J-P Ourdouillie, Compliance Manager

François Goy, President

12.2 MPG-2XX

Bio Logic
Science Instruments

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Web : www.bio-logic.info

SAS capital 337 000 €
SIRET 328 685 284 000 31
APE 2651B

EC DECLARATION OF CONFORMITY

N°: CETR_MPG2-xx_Rev. A

We,

Bio-Logic SAS
1, Rue de l'Europe
38840 Claix France

declare under our sole responsibility that the products,

MPG2-8x5A with cables
MPG2-4x10A with cables
MPG2-2x20A with cables
MPG2-1x40A with cables

are in conformity with the following standard(s) in accordance with the provisions of the Electromagnetic Compatibility Directive 2004/108/CE and the Low Voltage Directive 2006/95/CE.

Security: IEC 61010-1
EMC: IEC 61326

Emissions
- EN 55022: Conducted Class B
- EN 55022: Radiated Class A

Immunity
- IEC 61000-4-2: ESD
- IEC 61000-4-3: EM field
- IEC 61000-4-4: Burst
- IEC 61000-4-5: Surge
- IEC 61000-4-6: Conducted RF
- IEC 61000-4-8: Magnetic Field
- IEC 61000-4-11: Voltage Dip/Short Interruptions

Date: September 19, 2010

J-P Ourdouillie, Compliance Manager

François Goy, President

13 Glossary

This glossary is made to help the user understand many of the terms used in this instrument installation and configuration manual. The terms are defined in alphabetical order.

Booster: current power booster that can be added to each channel individually.

Bandwidth: represents the frequency of the regulation loop of the potentiostat. It depends on the electrochemical cell impedance. The bandwidth's values go from 1 to 7 with increasing frequency.

Calibration: operation that has to be done for each channel in order to reduce the difference between a controlled value (for example E_{ctrl}) and the corresponding measured value (for example Ewe).

Cell connection: connection of the instrument's channel board to the electrochemical cell with five leads.

DB25: connector with 25 pins on the instrument's front panel where the cable connecting the channel board and the electrochemical cell is set.

DB9: connector with 9 pins on the instrument's front panel used as auxiliary input/output.

Default settings: settings defined and saved as default by the user and automatically opened when the corresponding protocol is selected.

Firmware upgrading: the firmware is the operating system of the instrument. It is necessary to upgrade both the firmware and software to benefit from the most recent version.

Gateway: IP address allowing the connection of computers from different networks onto an instrument.

Impedance: defined by the ratio E/I.

Network: group of computers connected together to which the multichannel potentiostat can be added. Several users with different computers can lead experiments on one or more channels of the potentiostat.

N'Stat: connection mode used to work with several working electrodes, one counter and one reference electrode in the same electrochemical cell. This mode must be used with special connections (see the user manual).

Specifications: Characteristics of the instrument such as cell control or current and potential measurement.

Subnet mask: IP number used when the instrument is not in the same network as the computer.

TCP/IP: Transfer Control Protocol/Internet Protocol using IP addresses to identify hosts on a network

Triggers: option that allows the instrument to set a trigger out (TTL signal) at experiment start/stop or to wait for an external trigger in to start or stop the run.

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Manual Rev_D (March 2014)