Installation and Configuration Manual for SP300-based* Instruments

***SP300-based instruments are:**

- ✓ SP-200
- ✓ SP-240
- ✓ SP-300
- ✓ VSP-300
- ✓ VMP-300

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 11.

Model	**Serial number of the chassis**
☐ **SP-200**	
☐ **SP-240**	
☐ **SP-300**	
☐ **VSP-300**	
☐ **VMP-300**	

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 Amax) 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

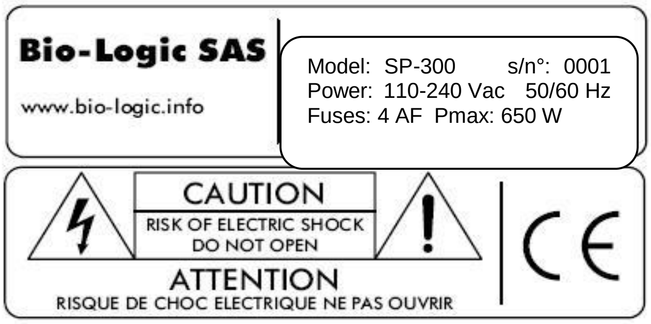
To avoid introducing safety hazards, never install non-standard parts in the equipment, or make any unauthorized modification. To maintain safety, always return the equipment to Bio-Logic SAS for service and repair.

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 on-screen of 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 safety 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).

The instrument has two different modes:

Ground: **connected via a 100 Ω - 0.1 W resistor to grounding earth. => Do not connect the ground lead to a power source from the Earth with a potential greater than 3 V_{dc}**

Float: **In this mode, ensure that the upper potential on the measurements leads do not exceed 100 V_{dc} from the Earth.**

Table of contents

1. An introduction to our product range

Historically, the first of our potentiostats was designed to study intercalated compounds with long experiment times due to slow diffusion coefficients. It was a multichannel instrument that worked in either galvanostatic mode or potentiostatic mode (each channel was devoted to one of either mode). Then the interest for multichannel potentiostats increased with battery testing, corrosion study & biosensors development. So, new versatile instruments have been developed to address all these applications. This was the first generation of the **Bio-Logic** instruments, based on the VMP3 technology.

Recently, a new generation of instrument has been introduced with the SP-300. This generation offers highest current & voltage sensitivity and also the best impedance specification of the market. This is the generation based on the SP-300 technology. This family of instrument includes SP-200, SP-240, SP-300, VSP-300 and VMP-300 instruments.
As the first instrument was the SP-300 and all the other derives from this one, this range of instruments is called **SP300-based** instruments.

The instruments consist of a single control and communication board associated with one or more potentiostat/galvanostat/ZRA channel board(s), depending on the configuration. For example, there is one or two channel(s) for the SP series, six channels for VSP-300, and sixteen channels for VMP-300...

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®

Additionally, all the instruments can be coupled with ultra low current option and have slots (except SP-200 and SP-240) which can accept other modules such as booster board or additional potentiostat/galvanostat/ZRA board.

Fig. 1: SP-300 instrument in bipot configuration with the 10 A booster board & the Ultra Low Current (ULC) electrometer.

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 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 the advanced features. Useful accessories are described in the eighth part. Finally calibration, maintenance and specifications are shown in the two last parts.

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

1.1 General instrument overview

Depending on the instrument selected, the number of channels and the option (low current/boosters) may be different.

Limit of instrument configuration:

- VSP-300 chassis accepts a maximum of 4 booster boards and these boosters have to be inserted in the slots #1 to #4 (not #5 and #6).
- Because of power limitation, VMP-300 chassis accepts a maximum of 12 booster boards if powered with 110Vac electrical network. They can be inserted in any slot.

The numbering of the slots is explained hereafter

A description of the instruments is as follows:

Tab. 1: General description of the instruments.

Type of instrument	Name	Communication board	Calibration board	Available slots in the instrument	Other Module (number of slot used by the module)
Single Channel	SP-200	√	√	1	ULC (0) and/or LSG (0)
	SP-240	√	√	2	4A/14V[a] (1) and ULC (0) and/or LSG (0)
	SP-300	√	√	2	1A/48V (1) and/or 2A/30V (1) and/or 4A/14V (1) and/or 10A/5V (1) and/or ULC (0) and/or LSG (0)
Multichannel	VSP-300	√	√	6	1A/48V (1) and/or 2A/30V (1) and/or 4A/14V (1) and/or 10A/5V (1) and/or ULC (0) and/or LSG (0)
	VMP-300	√	√	16	1A/48V (1) and/or 2A/30V (1) and/or 4A/14V (1) and/or 10A/5V (1) and/or ULC (0) and/or LSG (0)

a when provided by default
ULC: Ultra Low Current
LSG: Linear Scan Generator

1.1.1 SP-240/SP-300 slot numbering

It is from the left to right. The slot 1 is the slot the closest to the communication board. The other slot is dedicated to the booster board or the second potentiostat board.

1.1.2 VSP-300 slot numbering

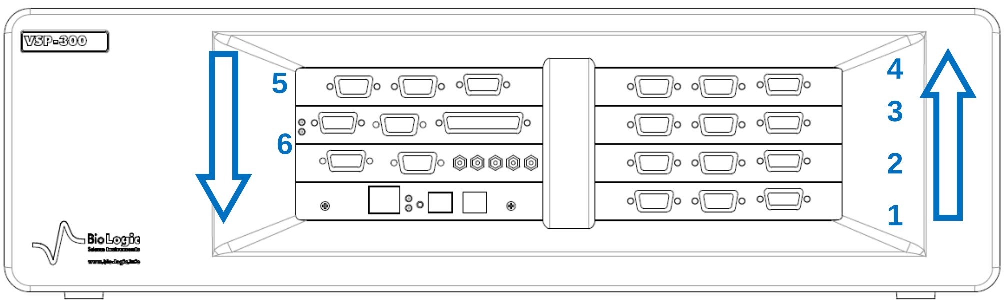


Fig. 2: VSP-300 numbering.

1.1.3 VMP-300 slot numbering

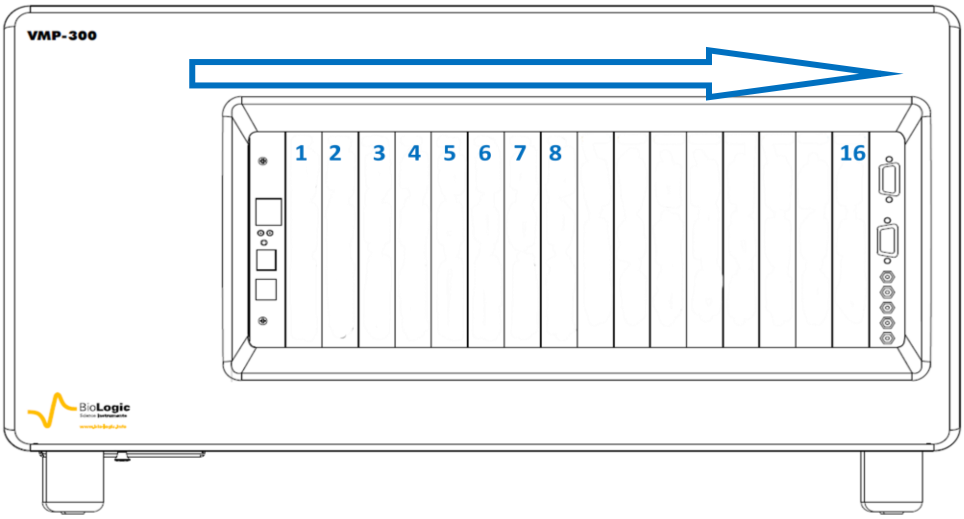


Fig. 3: VMP-300 numbering.

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

Before turning on the instrument, it is recommended to first install the EC-Lab® software and/or EC-Lab® express. For this operation, insert the CD-Rom in the computer. The installation is automatically launched with the "Autorun" function. The first software to be installed is EC-Lab®. 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. 4: EC-Lab® software installation. Step 1.

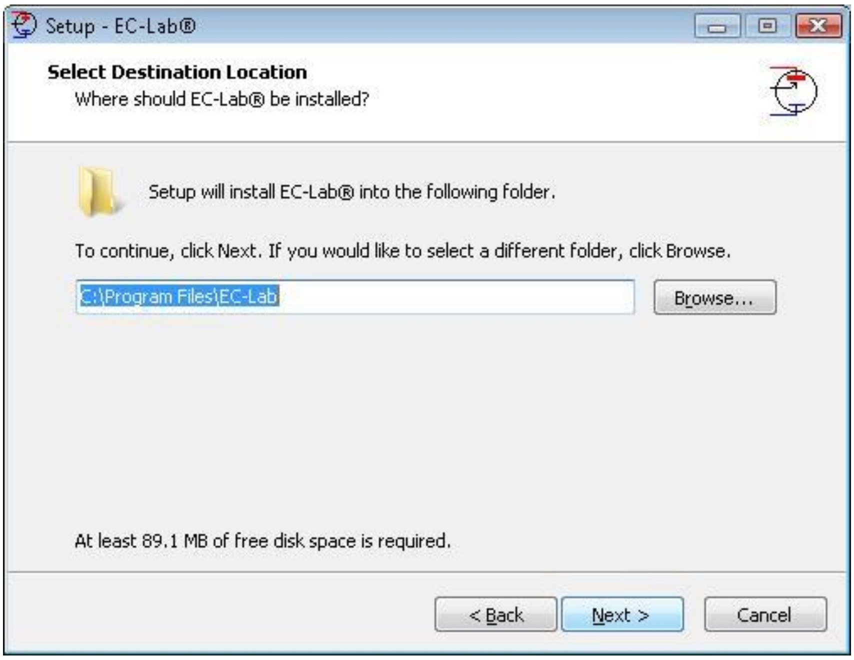


Fig. 5: EC-Lab® software installation. Step 2.

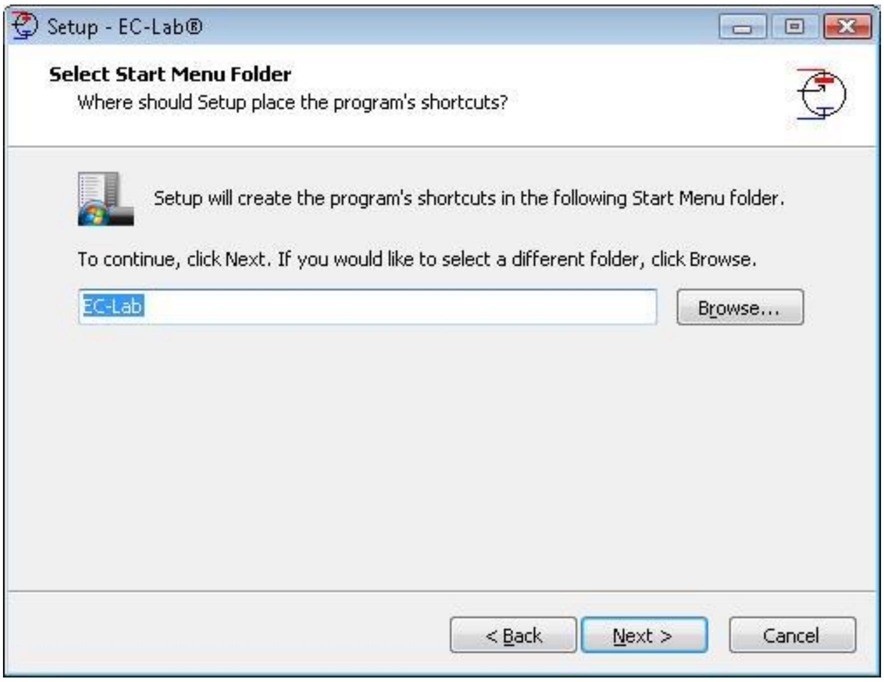


Fig. 6: EC-Lab® software installation. Step 3.

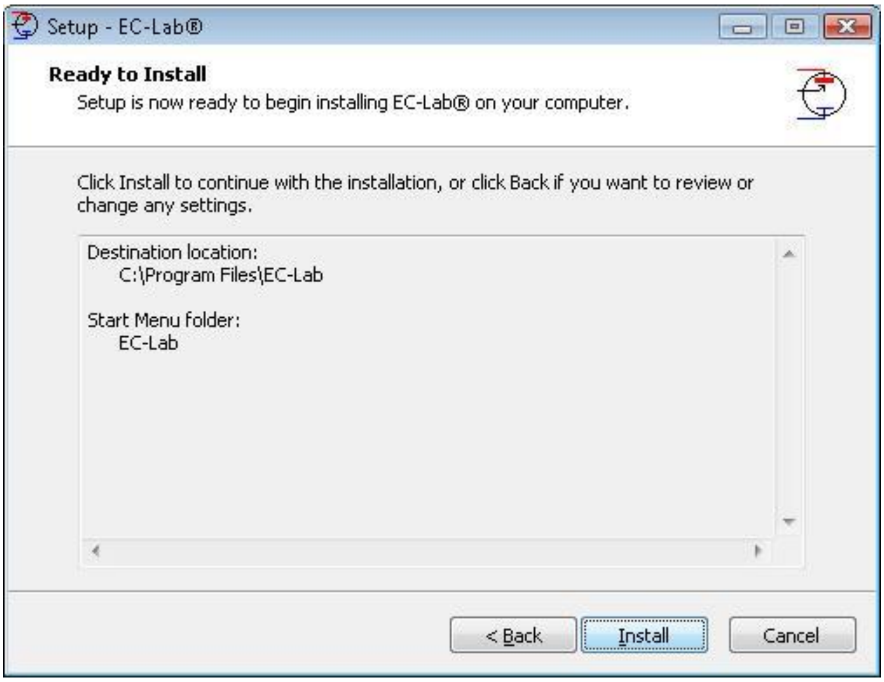
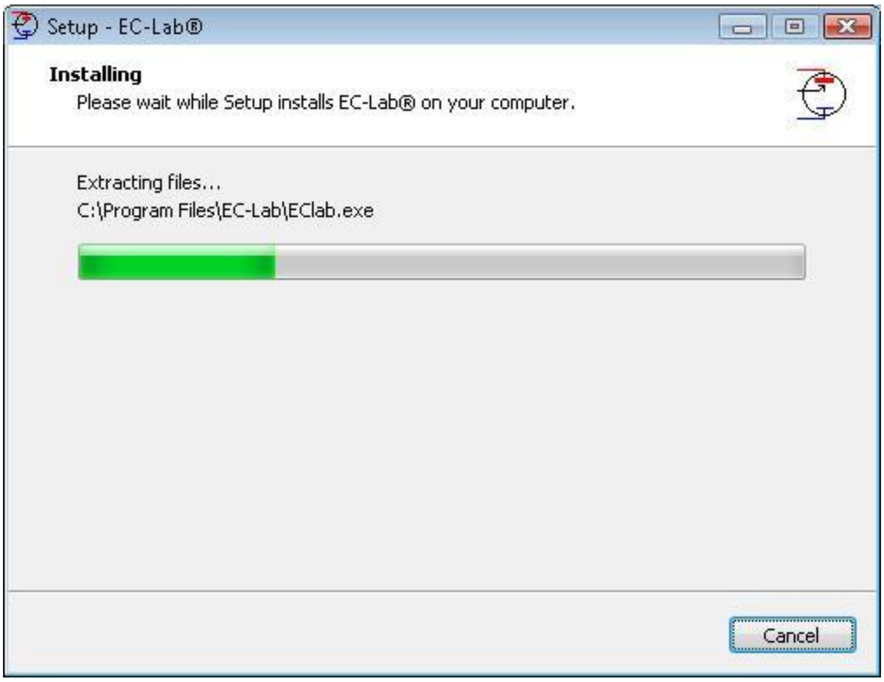


Fig. 7: EC-Lab® software installation. Step 4.

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. 8 top).
- "**Batch**", "**Data**" (include the data samples), "**Documents**" (include 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. 8 bottom).



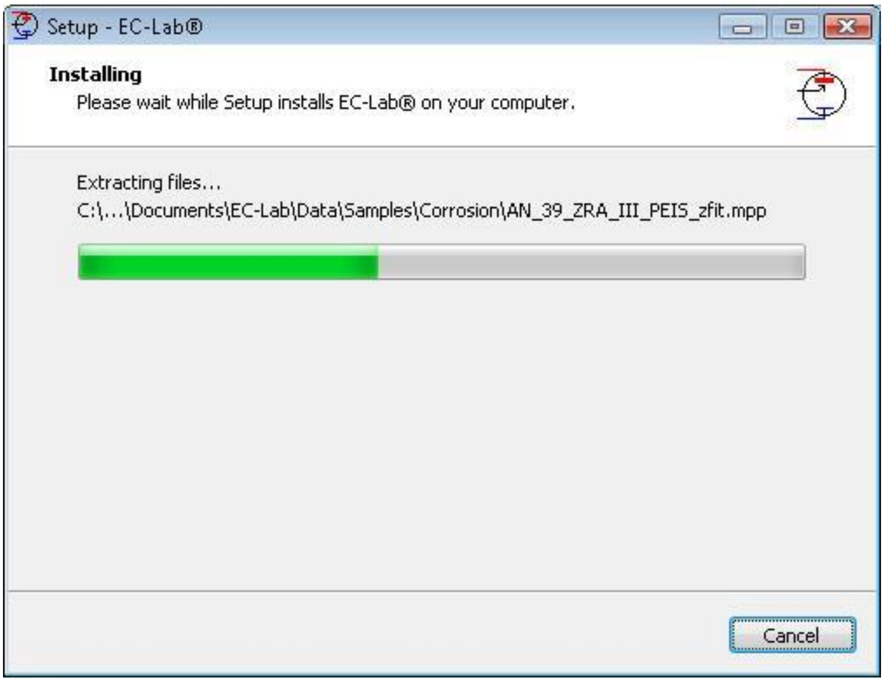


Fig. 8: EC-Lab® software installation. Step 5. (Top): Installation in the "Program Files" Directory. (bottom): Installation in the "Documents" Directory.

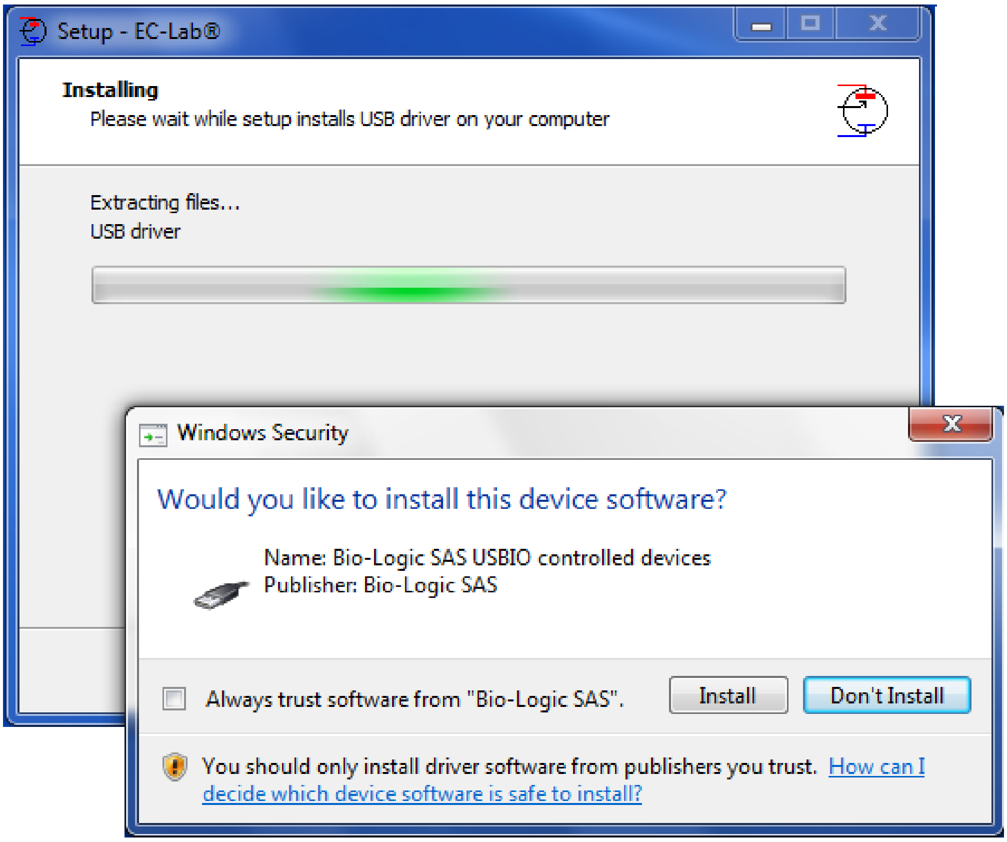


Fig. 9: EC-Lab® software installation. Step 6.

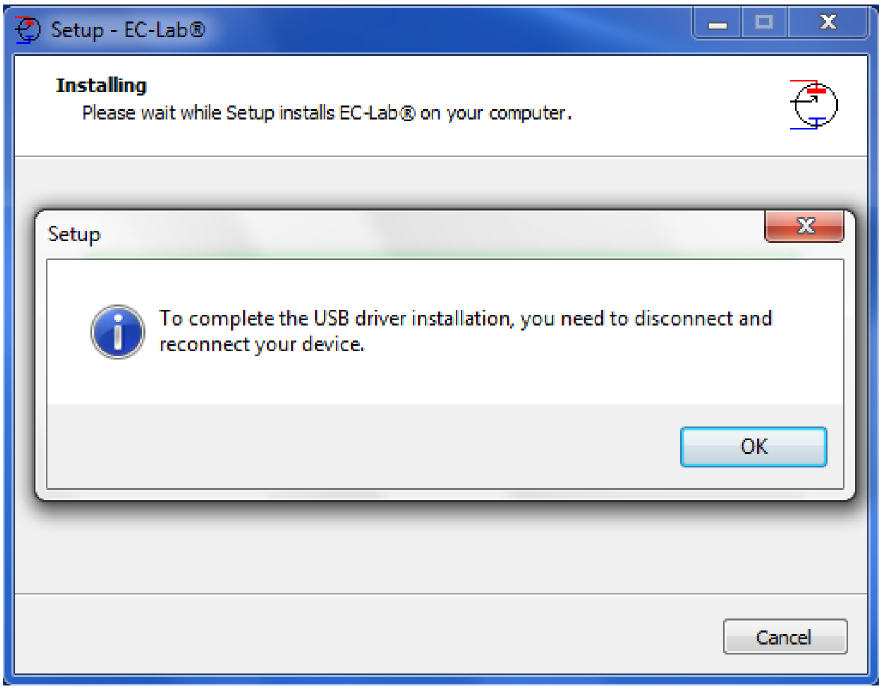


Fig. 10: EC-Lab® software installation. Step 7.

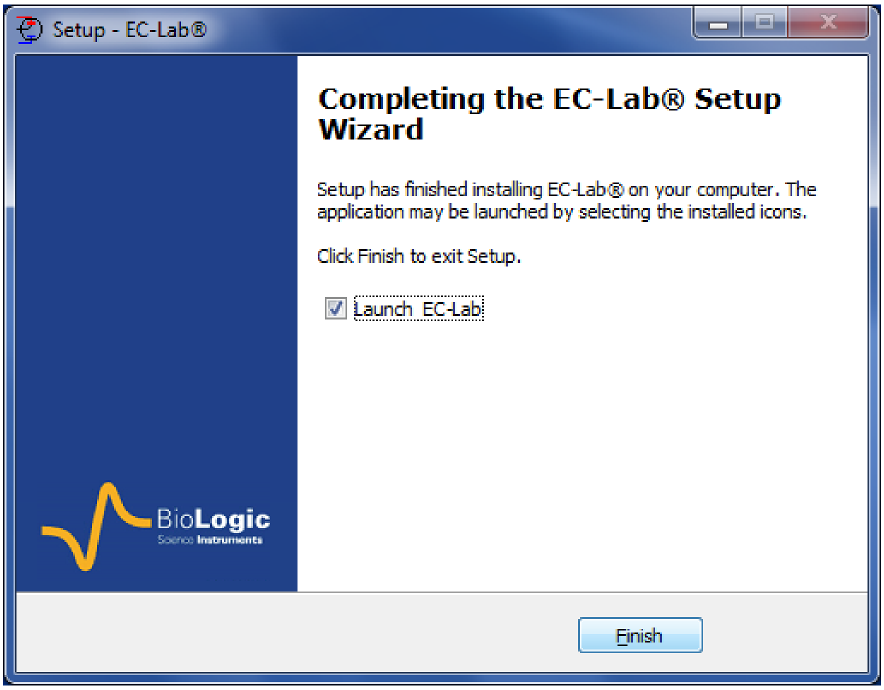


Fig. 11: EC-Lab® software installation. Step 8.

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 EC-Lab® Express software/OEM package installation

The EC-lab® Express software package is optional software which offers the user some enhanced features and control over the regular EC-Lab® software. Installation of EC-lab® Express is not required to operate the instrument provided that EC-Lab® is installed. The installation of EC-lab® Express software and the OEM package is done in exactly the same way as for EC-Lab®. Please see the above section for the installation.

NOTE: EC-lab® Express doesn't support the VMP-300.

2.3 Errors during the installation

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

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

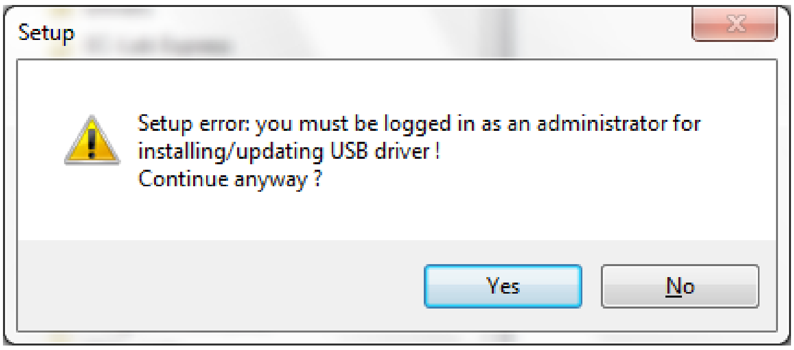


Fig. 12: Error during the installation.

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:

The procedure is show for Windows XP©, but the preocdure is similar for other windwos Operating System.

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. 13.

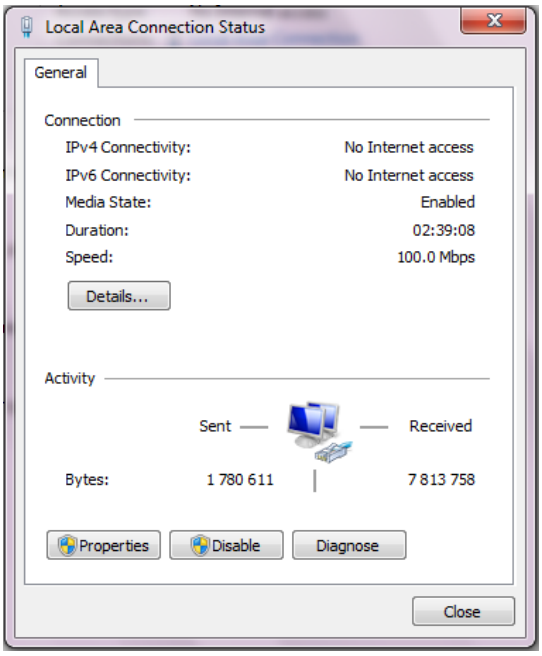


Fig. 13: Local Area connection status.

3- Select **Internet Protocol (TCP/IPv4 or TCP/IPv6)** and click on the **Properties** button. The window in Fig. 14.

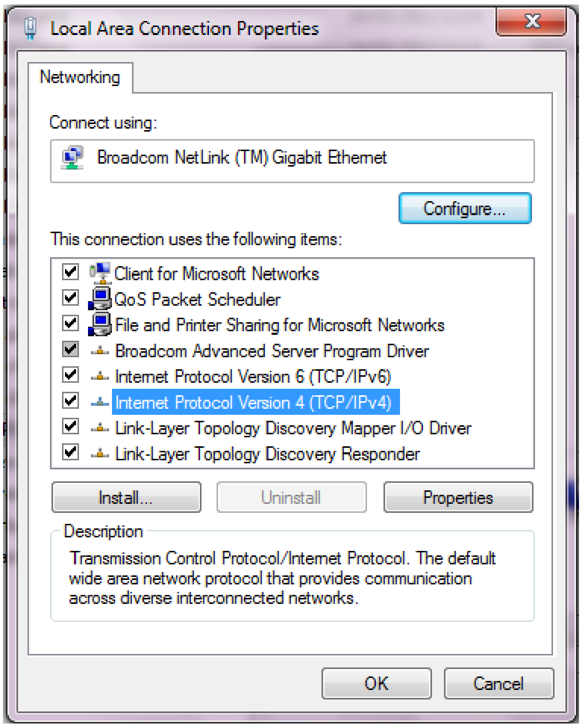


Fig. 14: Network window.

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.

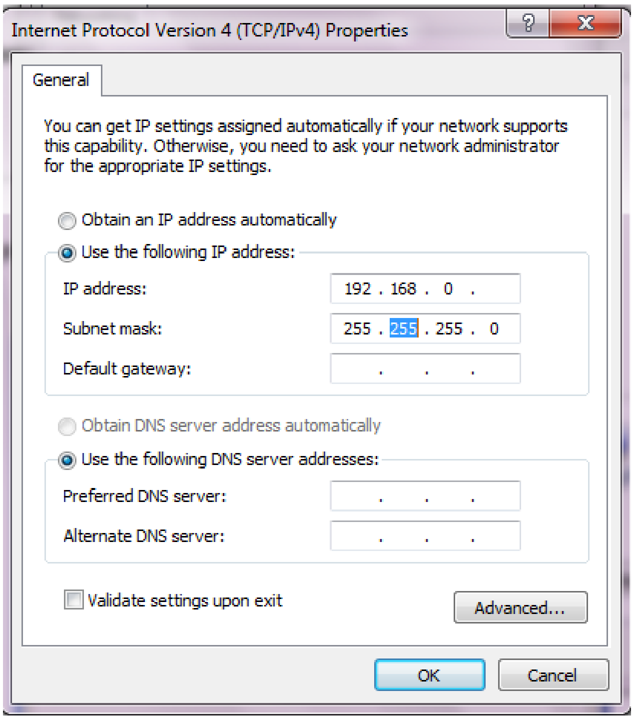


Fig. 15: TCP/IP properties window.

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. 16: USB device installation window. Step 1.

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

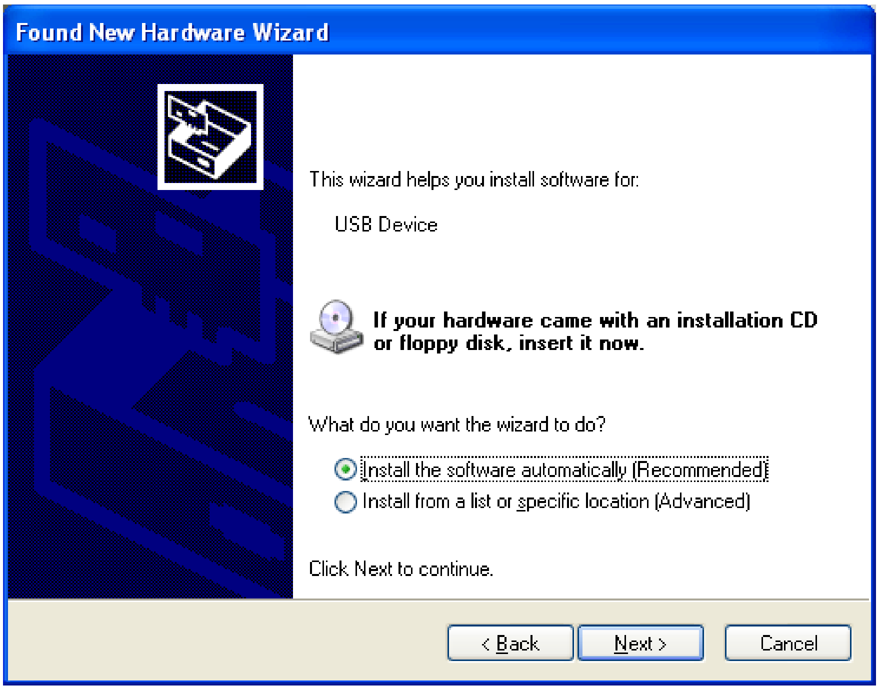


Fig. 17: USB device installation window. Step 2.

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.

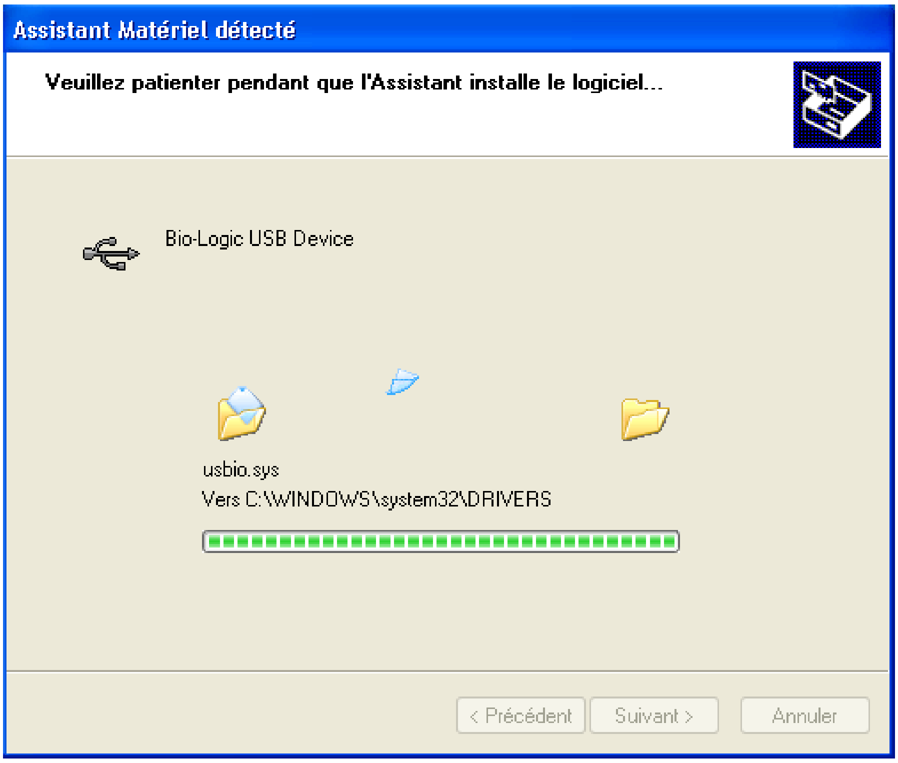


Fig. 18: USB device installation window. Step 3.

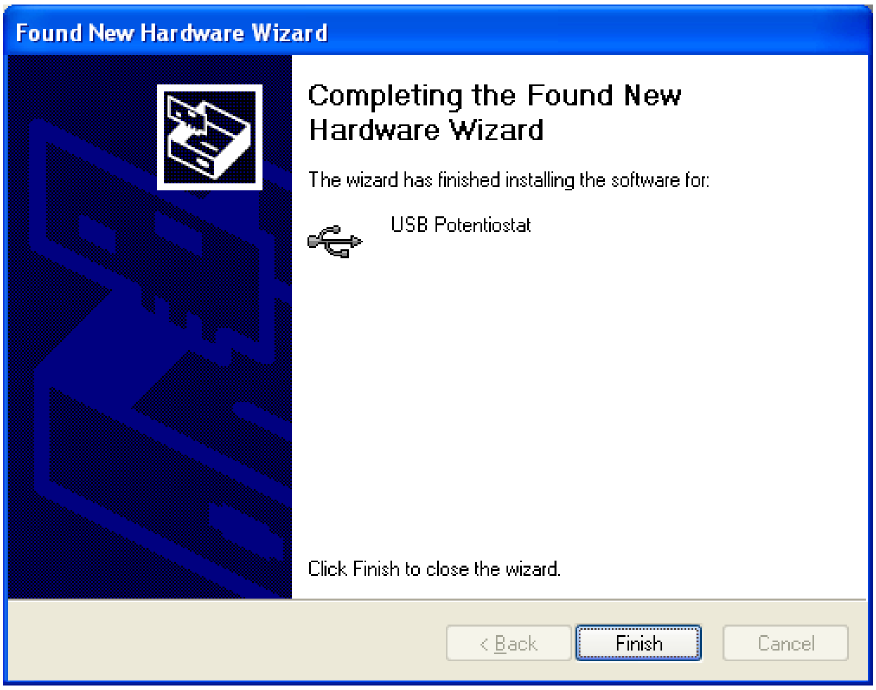


Fig. 19: USB device installation window. Step 4.

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 , eightand Vista systems, the USB driver is automatically installed when the instrument is detected. The following message is displayed at the end of the installation:

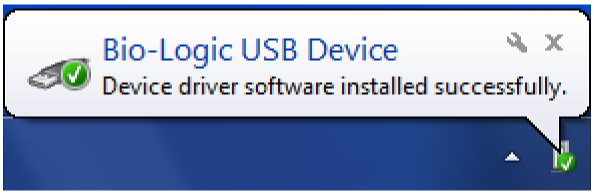


Fig. 20: USB device installation for Seven and Vista.

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.

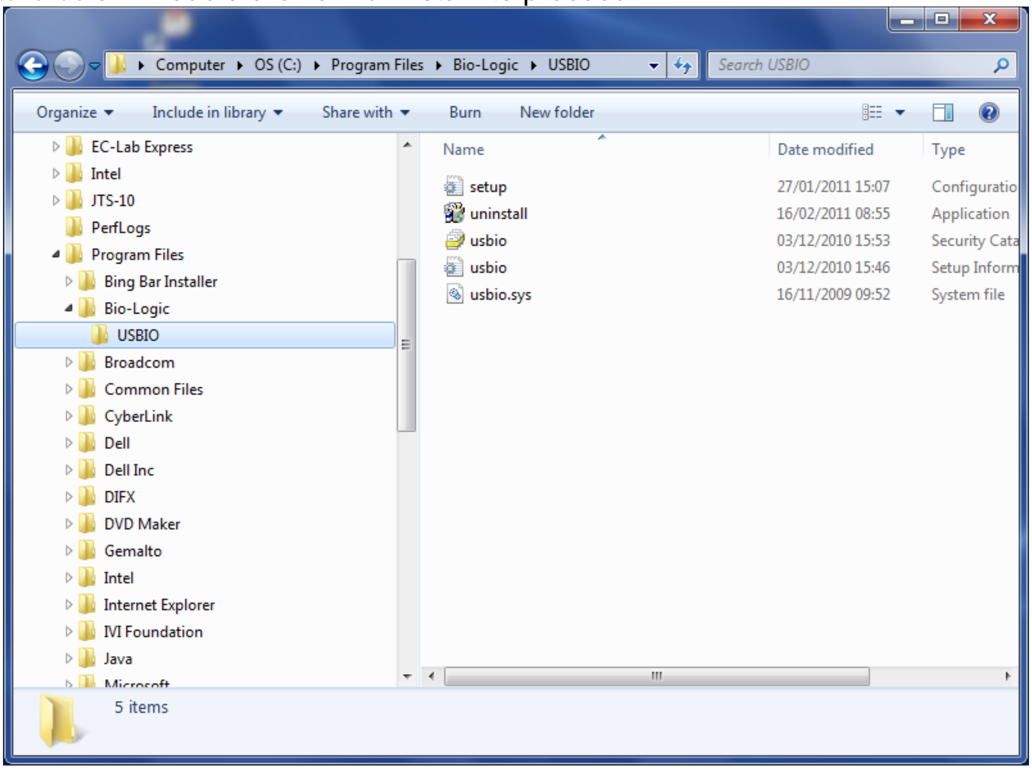


Fig. 21: Uninstall USB driver. Step 1.

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

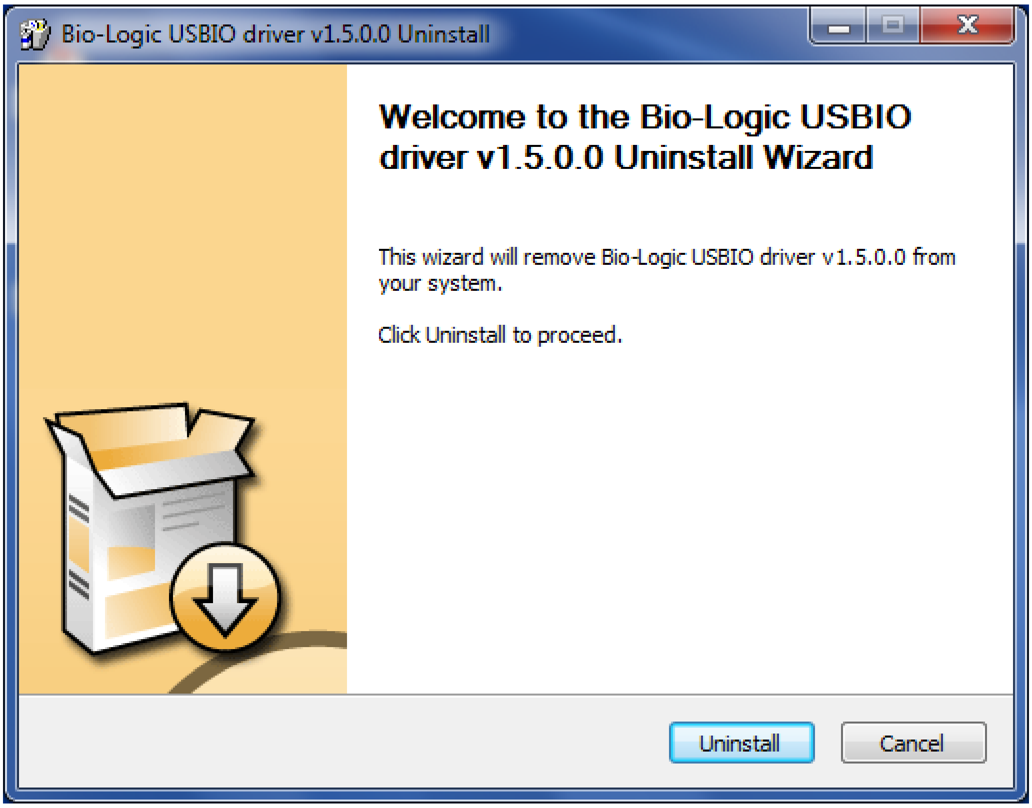


Fig. 22: Uninstall USB driver. Step 2.

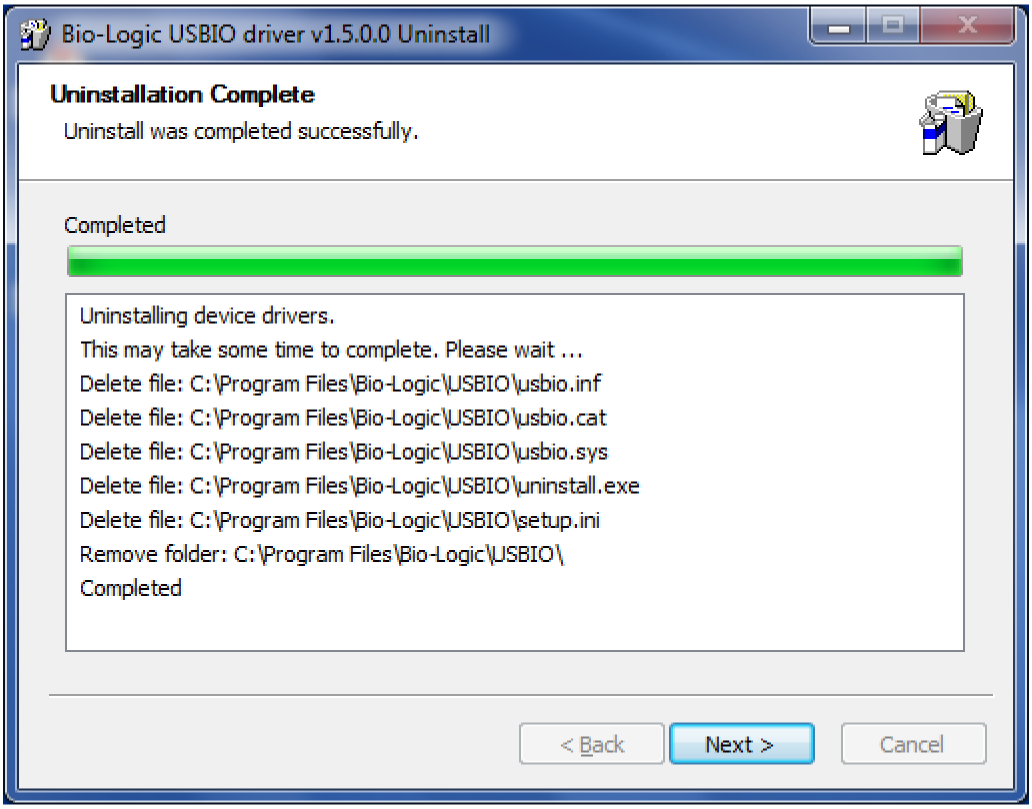


Fig. 23: Uninstall USB driver. Step 3.

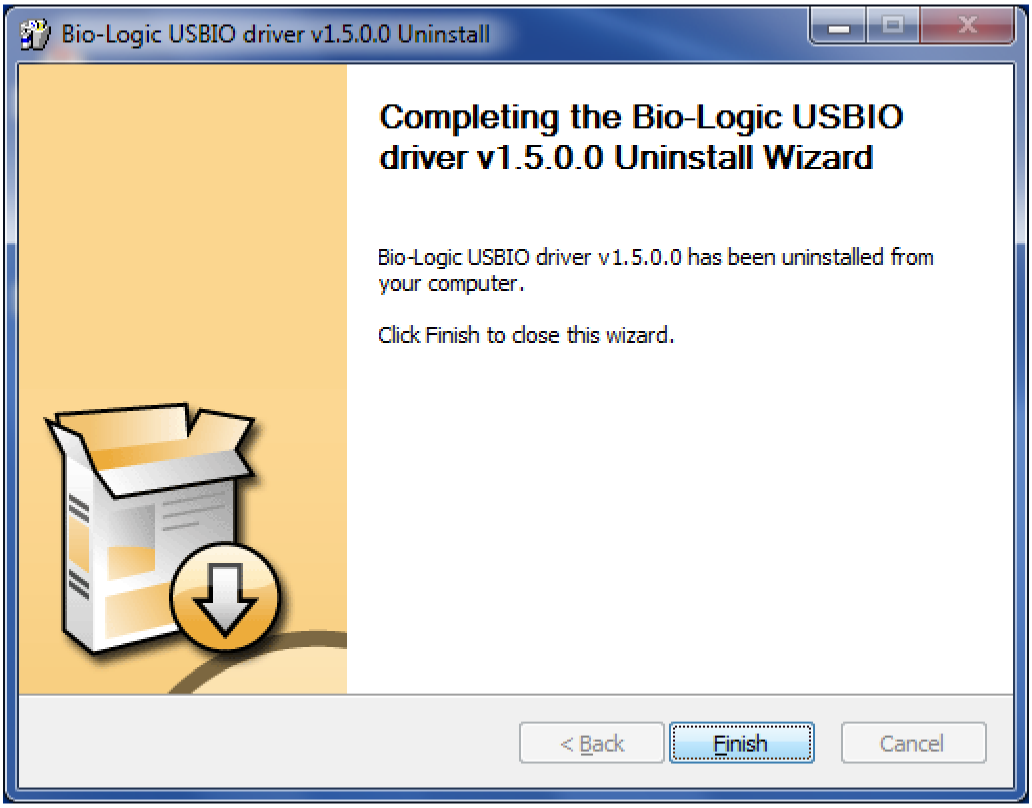


Fig. 24: Uninstall USB driver. Step 4.

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

4. Instrument installation

4.1 Connections

NOTE:
When multichannels instruments (SP-300, VSP-300 or VMP-300) and/are used 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 on the instrument communication board and the other one on 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 ans 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.

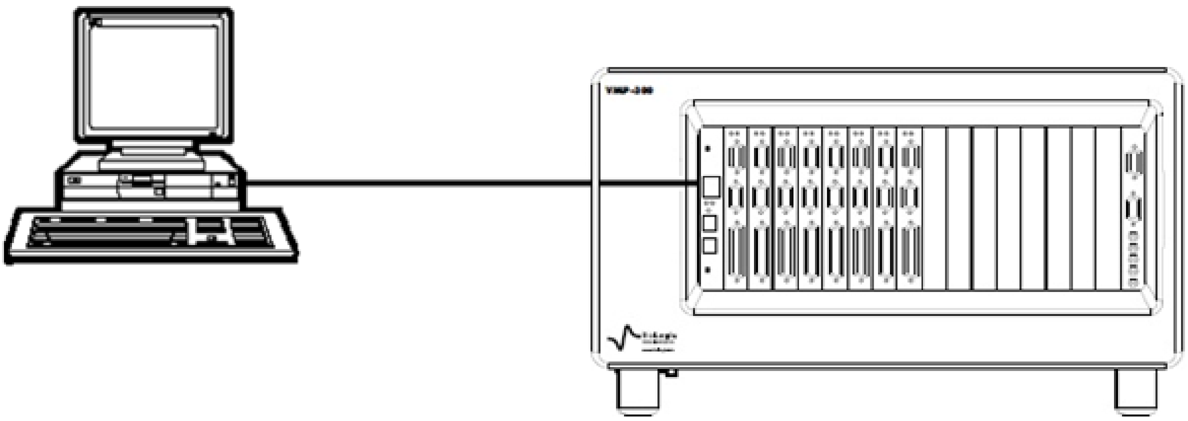


Fig. 25: Direct connection: one instrument to one PC.

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).

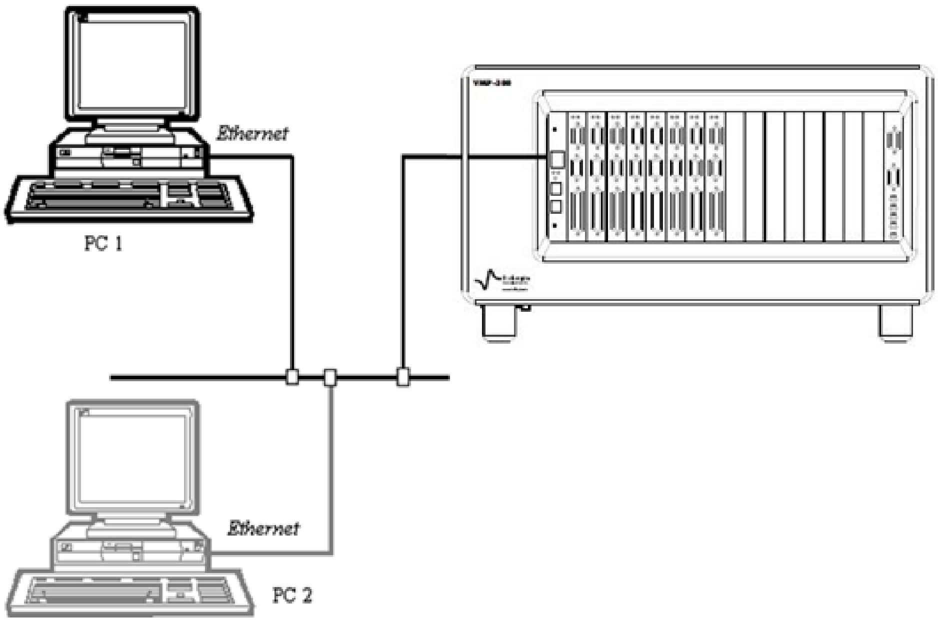


Fig. 26: Ethernet cable for network connection (1 INSTRUMENT, several PCs).

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

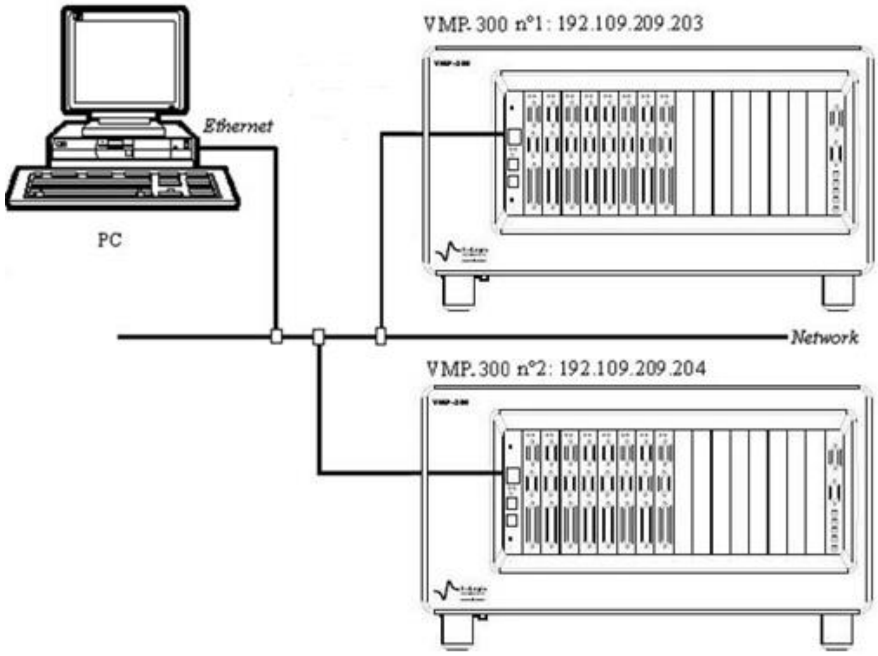


Fig. 27: Network connection: one PC to several instruments.

4.2 Power supply

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

5. Connection to the computer

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 commonly used as default: **192.109.209.128** or **192.168.0.1**. You can either manage your instrument directly with the computer (direct connection with the cable) 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.

Note: - to switch between EC-Lab® and EC-Lab® Express software, the instrument has to be switched off and restarted.

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 V10.30 or higher.

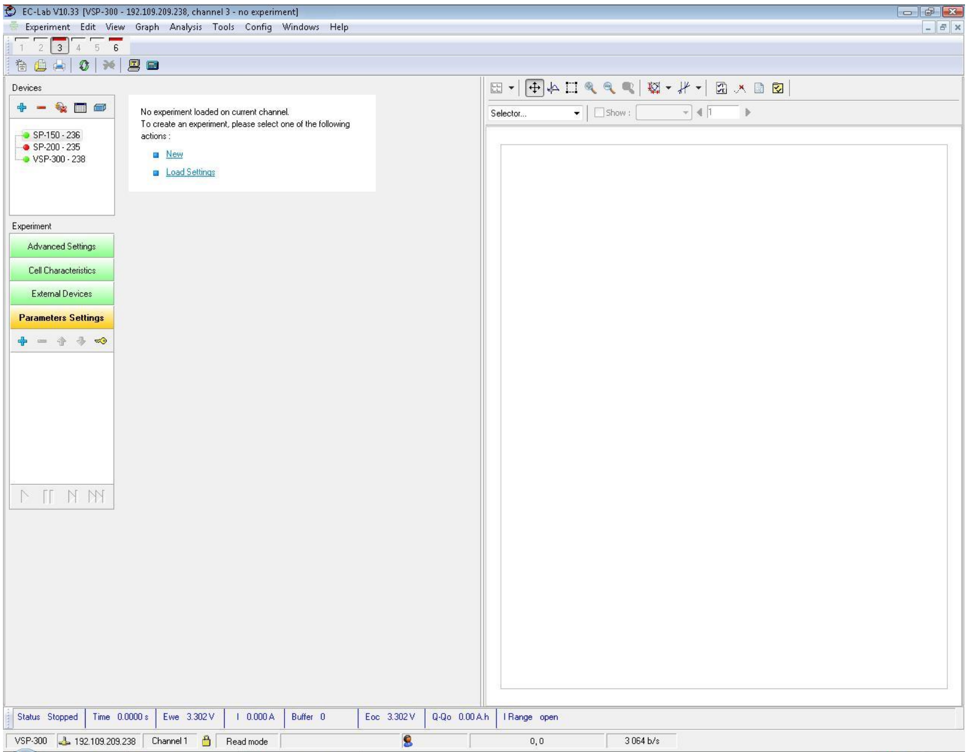


Fig. 28: Main window of EC-Lab®.

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.

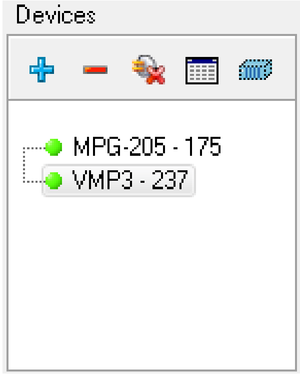


Fig. 29: “Devices” frame for connection.

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. 30 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.

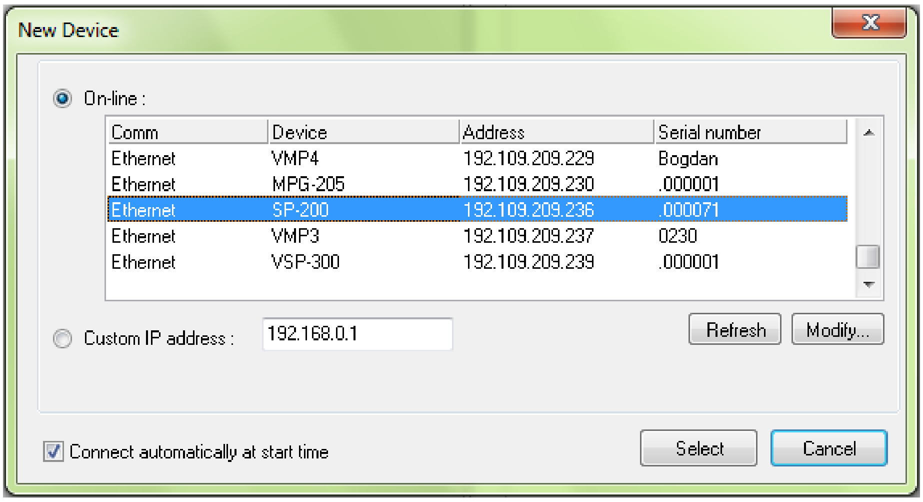


Fig. 30: “New Device” window to select and add an instrument to the current devices.

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) 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.

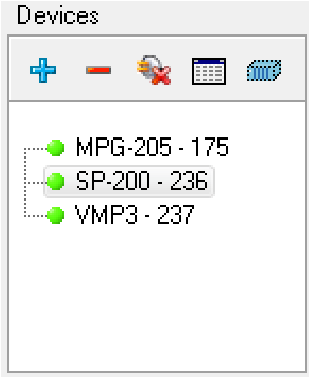


Fig. 31: "Devices" frame for connection with the new device.

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 IP address modification of the instrument

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:

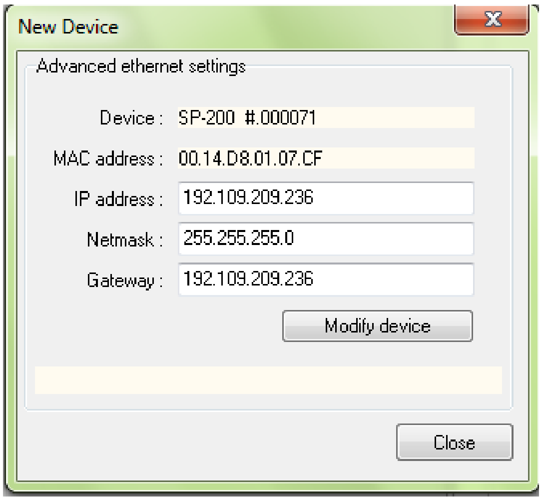


Fig. 32: "Advanced Ethernet settings" of the "New Device" window used to change the instrument IP Address.

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.

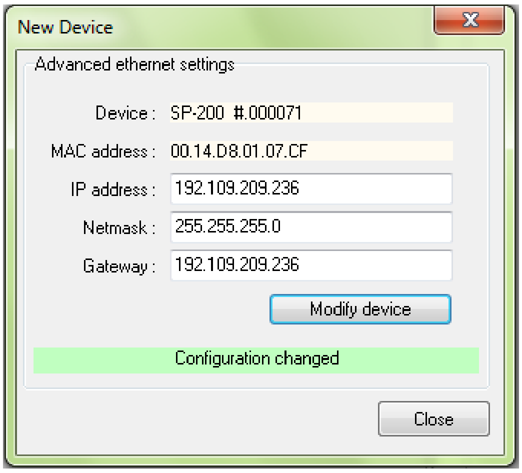


Fig. 33: New configuration.

Then click "**OK**" 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 Connection using EC-Lab® Express software

1) Launch EC-Lab® Express software.

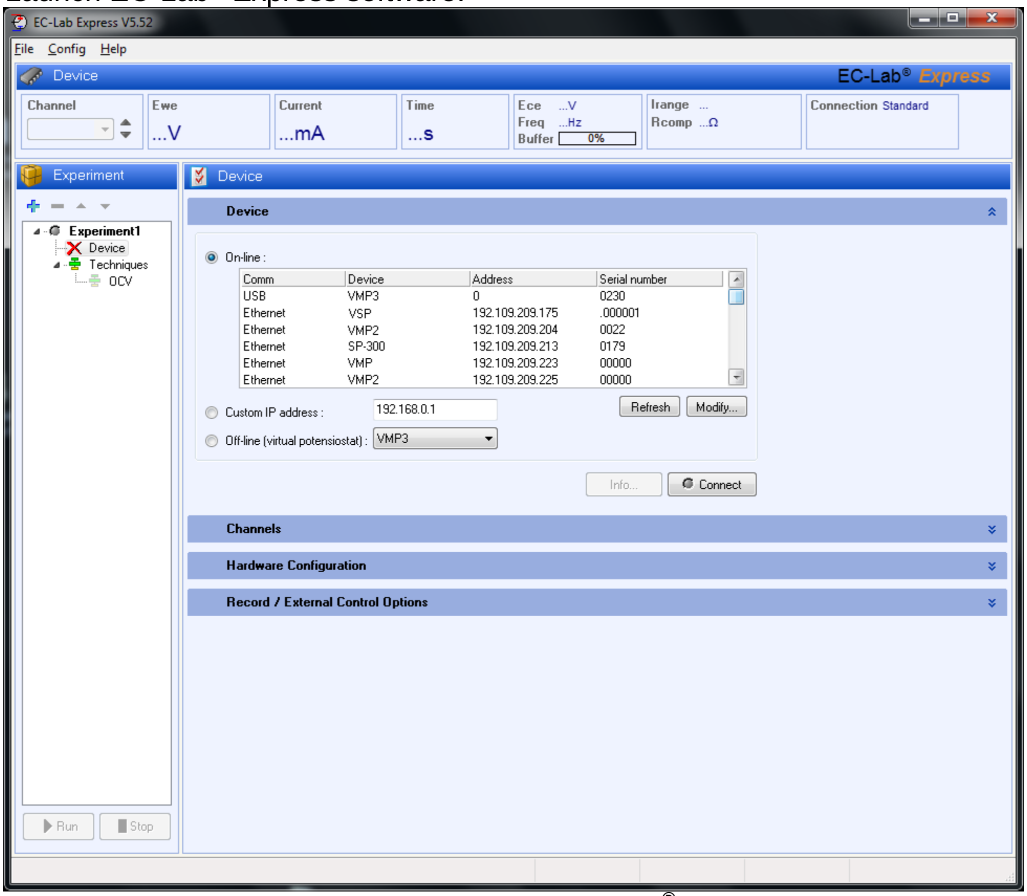


Fig. 34: Main window of EC-Lab® Express.

2) In the “device” frame, all the instruments available (connected by USB, direct Ethernet or through a LAN) are displayed.
The window shown in Fig. below appears. Click on “**Refresh**” to see the instruments present on your network.

<u>Note:</u> 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.

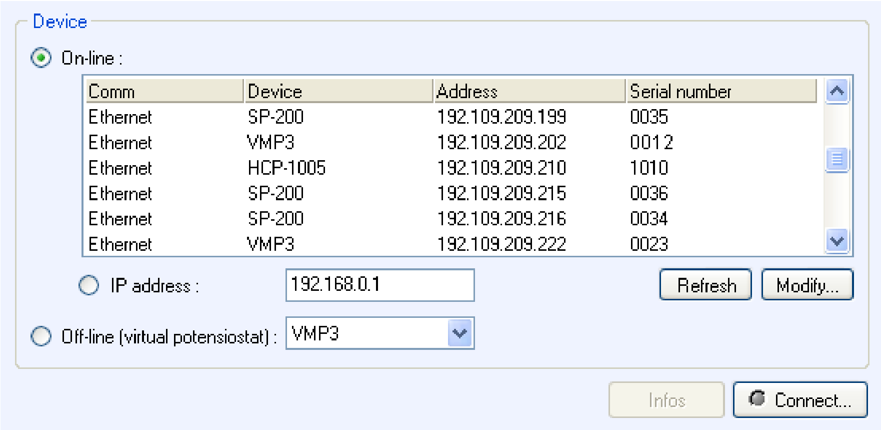


Fig. 35: Device connection window.

3) Select the instrument of interest and click on the “**Select**” button.

<u>Note</u>: If the IP address of the instrument is not valid, it has to be changed (see next section).

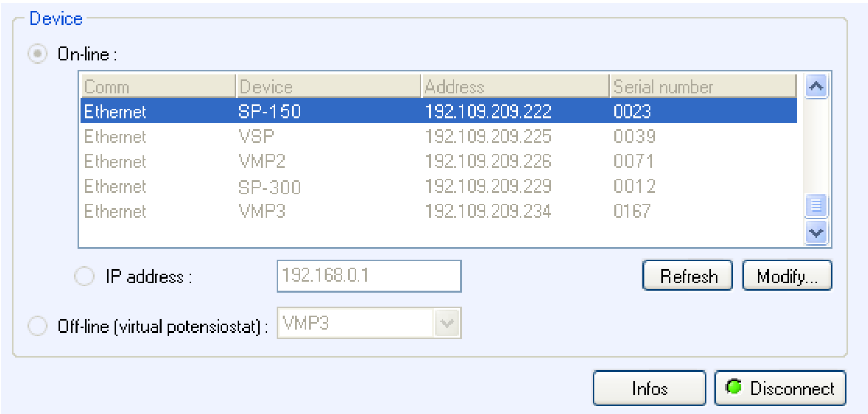


Fig. 36: Device connection window (selected instrument).

4) Click on “**Connect**”. The “**Connect**” button turns into a “**Disconnect**” button and becomes green to show the connection has been established.

5.3.1 IP address modification of the instrument

If the Ethernet connection requires changing the instrument's IP address, select the instrument and click on "**Modify**". The following window appears:

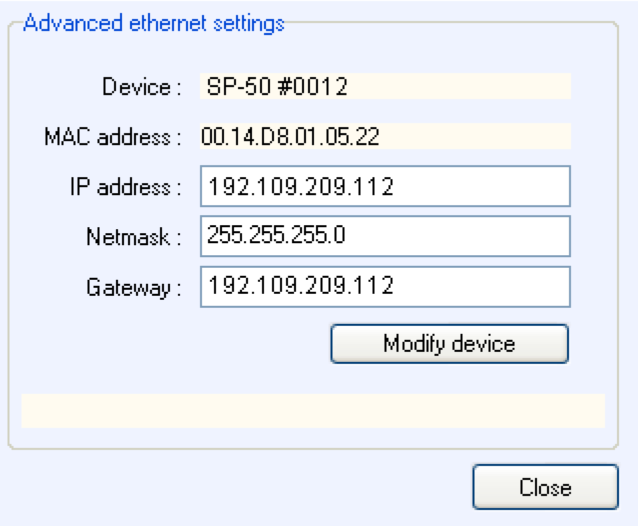


Fig. 37: "Advanced Ethernet settings" of the "New Device" window used to change the instrument IP Address.

Modify the IP Address to have a valid address in your network. Repeat this procedure with the Gateway and click on "**Modify device**". Then the new IP Address is sent to the instrument and a "configuration changed" message appears in green. 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.

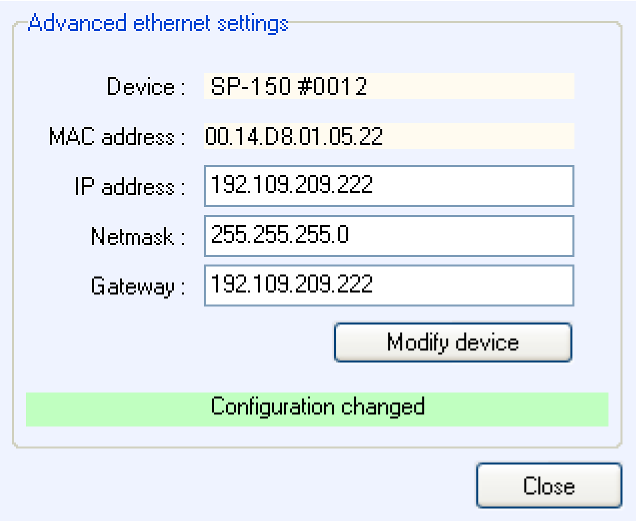


Fig. 38: New configuration.

Then click "**OK**" to display the "New Device" window and "**Refresh**" to refresh the window and select your instrument's IP address. Click on the "Select" button.
Now the instrument is connected and ready for use.

5.4 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:

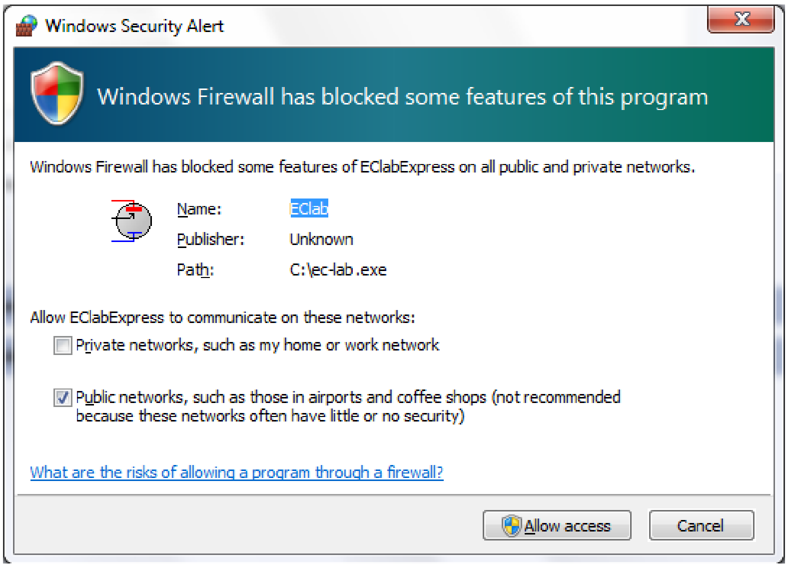


Fig. 39: “Windows security Alert” window.

5.5 Firmware Upgrading with EC-Lab® software

When the user receives a new unit from the factory, the software 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.

5.6 Firmware Downgrading 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 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
SP-200	V10.00
SP-240	V10.17
SP-300	V10.00
VSP-300	V10.17
VMP-300	V10.30

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).

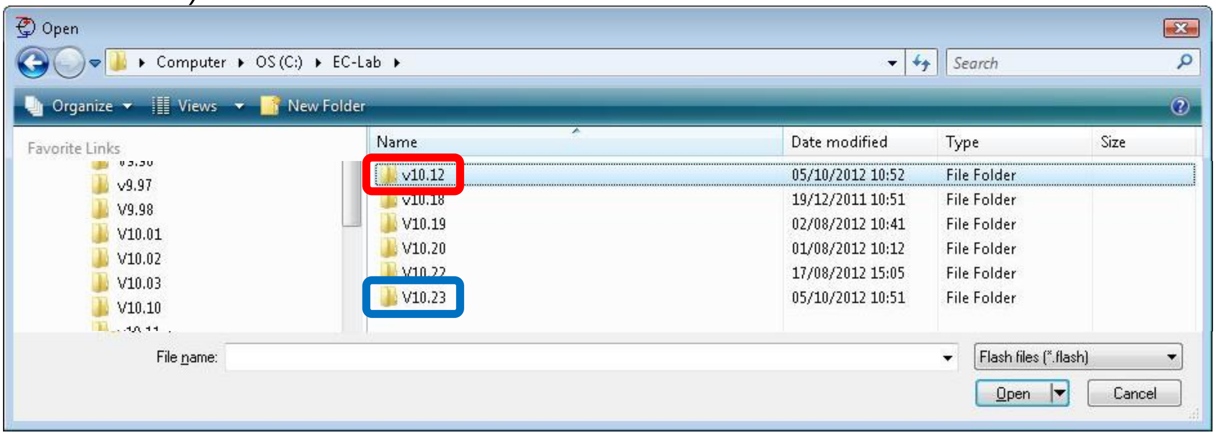


Fig. 40: Both versions on the computer.

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

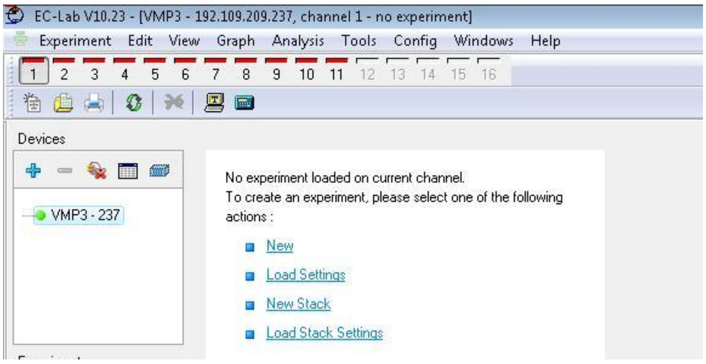


Fig. 41: connection under the latest version.

3) Open "Firmware Upgrade/Downgrade" tool in the **"Tools"** menu.

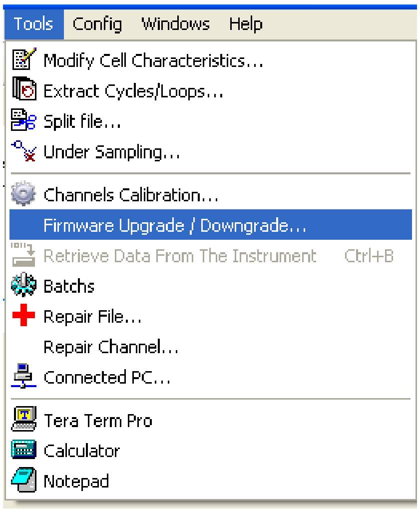


Fig. 42: Firmware Upgrade/Downgrade tool in the "Tools" menu.

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.

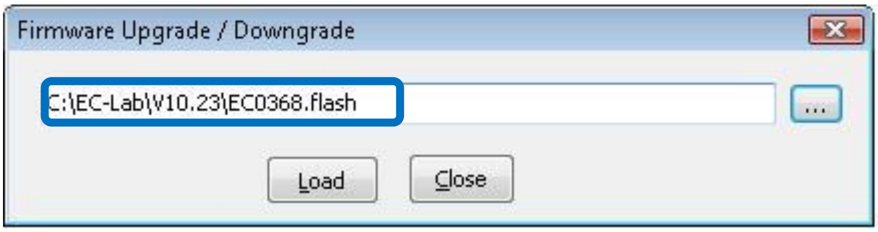


Fig. 43: Loading of the flash.

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.

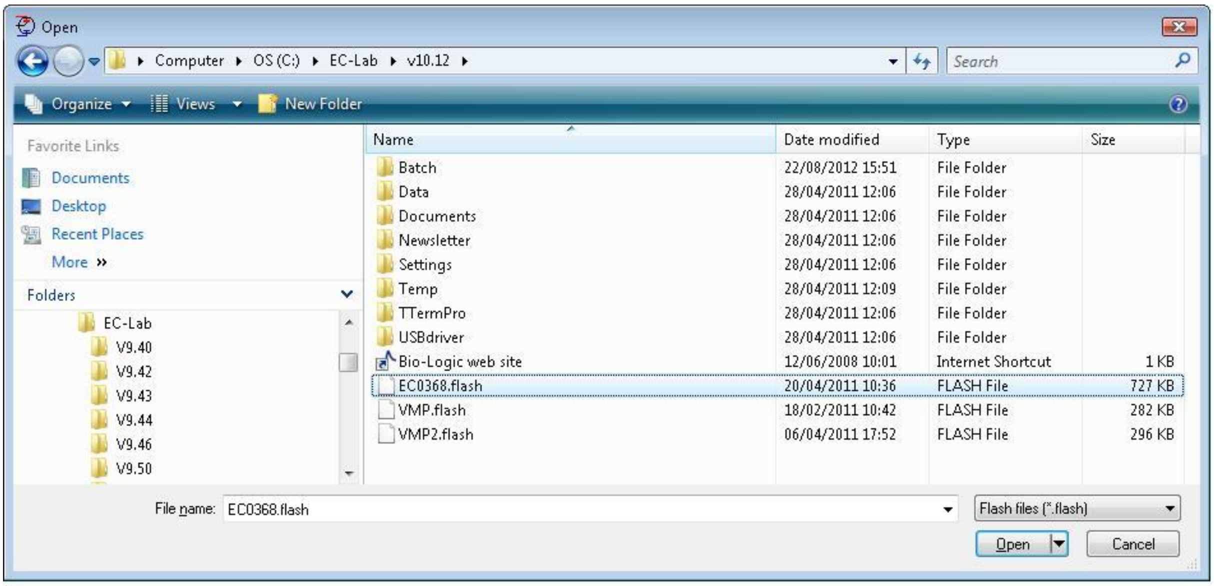


Fig. 44: Flash location in the EC-Lab folder.

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

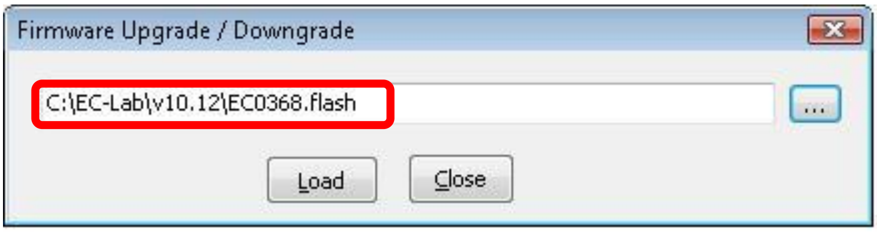


Fig. 45: “Firmware Upgrade/Downgrade” window.

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

Fig. 46: Warning message.

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

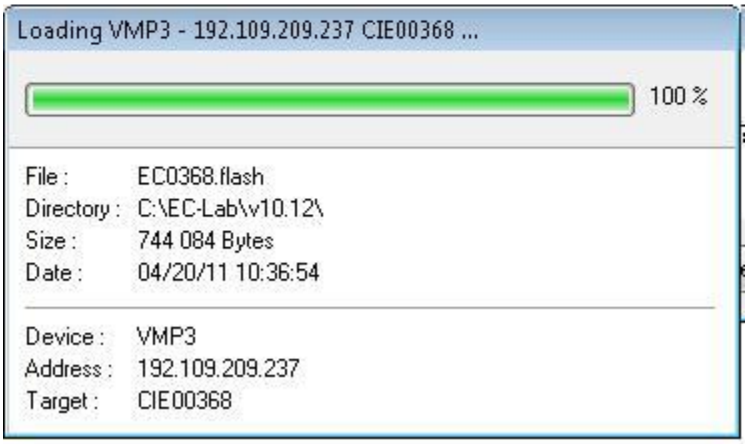


Fig. 47: Flash loading.

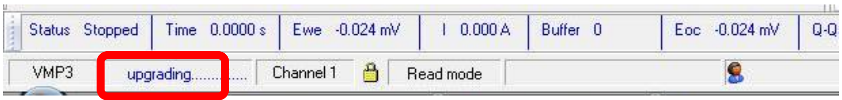


Fig. 48: Upgrading message on the status bar.

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 of EC-Lab V10.12 and connect to the instrument.

6. Connecting the instrument to the experiment

To connect the instrument to your experiment (the “cell”) a cell cable is used. The connection of the cell cable to the instrument varies depending on whether or not a current booster or low current option is to be used. Section 6.1 describes the various ways in which the cell cable can be connected to the *instrument*. Section 6.2 describes the various ways in which the cell cable can be connected to the *experiment*, depending on the type of system you have (e.g., battery, 3-electrode electrochemical cell, etc.) and the information you wish to obtain.

6.1 Cell cable to the instrument

6.1.1 Cell cable and potentiostat/galvanostat board association

To keep the high end specifications especially for EIS measurement, the cable and board are calibrated together, so user has to use the boards with the associated cable (same serial number).
When potentiostat/galavanostat board(s) is(are) purchased with the chassis, each cable has a label indicating the channel number *i.e.* the number of the slot where the potentiostat/galavanostat board is inserted.

If additional boards are purchased afterwards, user has to plug the appropriate cable to board. The serial number indicated on the electrometer (blue box) are the same as the serial number indicated on the label stick on the board. Note for ULC cable, the boards, the cable and the electrometer have to have the same serial number.

<u>NOTE:</u>
When the board is plugged into the chassis, it is possible to get the serial number of the board by using the calibration tool (more info on the calibration routine at the end of the manual).

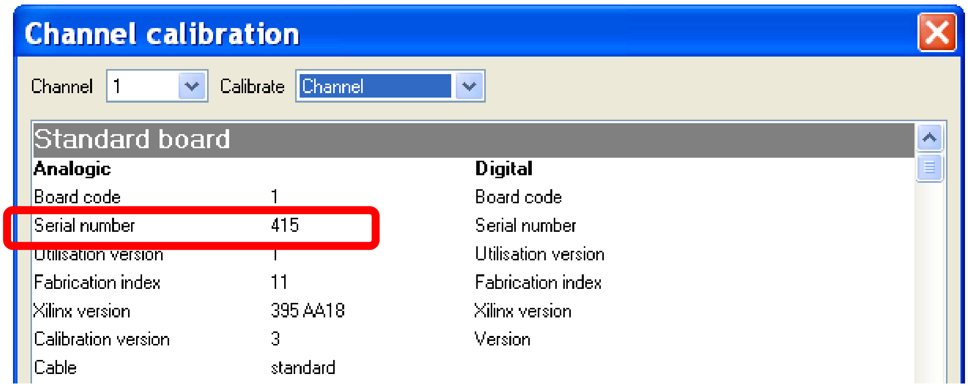


Fig. 49: Serial number information via the “Channel calibration” procedure.

6.1.2 Boards description

Each board has several connectors on the front panel but each board has been designed to avoid any confusion (different types and different genders for each connector).

6.1.2.1 Potentiostat/galvanostat/ZRA board

Three connectors are available on the front panel of the potentiostat/galvanostat/ZRA board:

- DB-9 connector for auxiliary analog/digital signals and to connect to the calibration board,
- DB-15 connector for the connection to the calibration board,
- Sub mixed DB-25 connector to be connected to the cell cable (standard cable or ULC cable).

Note that when the channel board is running, the green LED blinks.

6.1.2.2 Booster boards

There are two kinds of booster boards. The booster boards which needn't any additional cable to carry the current (1A/48V) and the boosters which need a cable to carry the current (2A/30V; 4A/14V; 10A/5V). The 2A/30V; 4A/14V; 10A/5V boosters can be connected in parallel to increase the maximum current.
NOTE: It is possible to connect in parallel only the same boosters, not possible to mix 4A and 10 A booster for example.

Fig. 50: Booster boards.

6.1.2.2.1 1A/48V booster board

- DB-15 female connector for connection to the calibration board,
- DB-15 male connector for connection to the potentiostat board.

The 1A/48V booster increases the unit's compliance and the cell polarization to +/- 48 V.
This option is compatible with the Ultra-Low current option. This combination of options allows user to get a current autoranging from 1 pA to 1 A. This option can be used both with EIS (maximum value 2 MHz) and standard channel boards. Once the booster is connected to the potentiostat board, connection to the cell is the same as without the booster 1A/48V connected.

6.1.2.2.2 2A/30V; 4A/14V; 10A/5V booster board

- DB-15 female connector for connection to the calibration board,
- DB-15 male connector for connecting the potentiostat/galvanostat board to the booster board,
- DB-9 connector for connecting the power cable P1 and P2 leads.

The 2A/30V, 4A/14V and 10A/5V boosters have similar boards with one DB-15 female connector, one DB-15 male connector and one DB-9 male connector. These boosters are connected to channel board and to calibration board in the same way.

The booster connection is as follows:

- Connect it to the standard channel with the DB15 male – DB15 female cable
- The power cable with P1 and P2 leads of the kit has to be connected to the booster board *via* DB9 connector.

Note that the connection to the cell is the following:

- P1 lead of the standard or ultra-low current (ULC) board cable has to be connected to the P1 lead of the booster option.
- P2 lead of the standard or ultra-low current (ULC) board cable has to be connected to the P2 lead of the booster option.

Then, connection to the cell with the booster option is the same as the standard or ULC board connection.

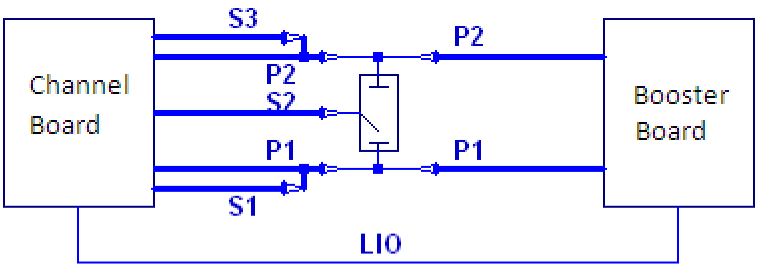


Fig. 51: Cell connection with 2A, 4A or 10A boosters

NOTE: It is possible to use the ULC cable presented in the next paragraph. Note that if the potentiostat board is connected to 2 A, 4 A or 10 A booster and to a ULC cable, the lowest Irange is 1 µA. The lowest Irange of the ULC cable is not reachable.

6.2 Connecting the cell cable to your cell.

6.2.1 Cables description

Two types of cable, standard and Ultra Low Current (ULC) can be connected to the DB25 connector of the potentiostat/galvanostat/ZRA boards. The difference between the two cables is their specifications. The current ranges available for the standard board is 10 nA to 500 mA (10 nA and 100 nA range are gains) and for the ULC, it is from 1 pA to 500 mA (1 pA and 10 pA are gains).

WARNING:
This probe with its cable, such as the standard cable, can only be plugged or unplugged on the channel board when the instrument is powered OFF.

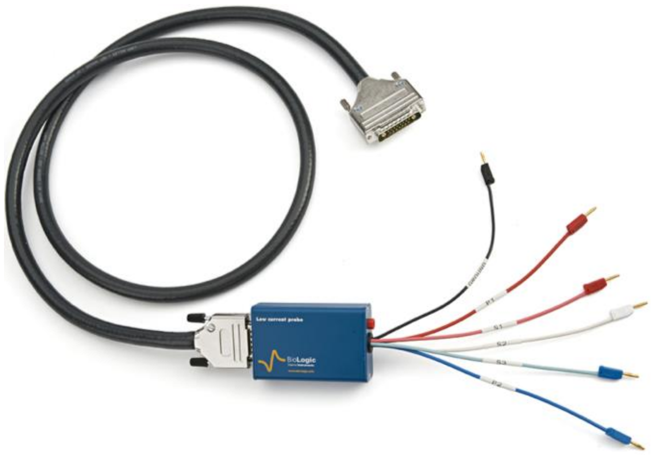


Fig. 52: Ultra Low current cable

The Ultra-Low Current option is composed of a cable associated with a very sensitive low current probe. This option uses no slot in the instrument chassis and the low current cable replaces the standard cable.
This option includes current ranges from 100 nA down to 100 pA with additional gains extending the current ranges to 10 pA and 1 pA. The resolution on the lowest range is 76 aA.
This option is compatible with another option the 1 A/48 V booster providing then current autoranging from 1 pA to 1 A. This option can be used both with EIS (maximum value 3 MHz) and standard channel boards.
The Ultra low current option can also be used 2A, 4A and 10A boosters. The lowest Irange is 1µA.
This option can be calibrated using EC-Lab® software for DC measurements. For AC measurements, and in order to keep very good specifications at high frequencies (up to 3 MHz), it is necessary to calibrate the AC part at the factory with its associated channel board.

Both cables offer 6 terminals after the electrometer. Each of this lead is ended with stackable 2 mm bananas for the connection to the electrochemical cell. The ULC electrometer offers also a Guard connector (red socket of 2 mm) which allows user to protect the cell from external perturbations.

A channel has 6 leads connections plus the 2 leads coming from the booster board to the electrochemical cell. Four are used in the cell control loop (2 for the current and 2 for the potential) while the 5th lead permits simultaneous recording of a supplementary cell potential. Additionally, a 6th "ground" lead is provided for cell shielding purposes or particular cell arrangements. To be easily identified, each lead has an associated color and label as follows:

- S1: RED – Sense 1 for the control and measurement of the Working electrode potential.
- S2: WHITE – Sense 2 for the control and measurement of the Reference electrode potential.
- S3: BLUE – Sense 3 for the control and measurement of the Counter electrode potential.
- P1: RED – Power 1 for the control and measurement of current flowing through the Working electrode.
- P2: BLUE – Power 2 for the control and measurement of current flowing through the Counter electrode.
- GND: BLACK – Ground

The internal structure of the channel board offers two working modes: grounded and floating. To switch from one mode to the other, no connection change is required.
A channel has the ability to link up with 2, 3, or 4 electrodes in different configurations depending on the electrochemical cell. E_{we} and E_{ce} are measured as follows:

E_{we} = S1 - S2
E_{ce} = S3 - S2

<u>Note</u>:

- disconnection of the cell cable without switching off the instrument can damage the electrometer located on the cable (either on the standard cable or on the ultra low current option),

- for the standard cable, maximum potential between ground and terminals should not exceeds 50 V, and not exceeds 100 V between the earth and ground.

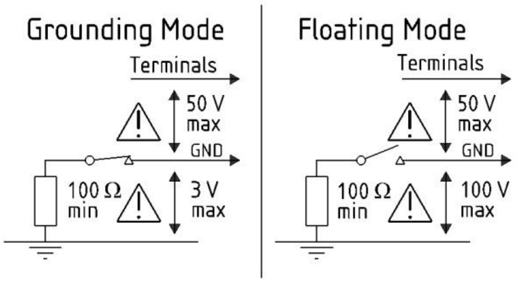


Fig. 53: Booster boards.

The current (defined in the positive direction) crosses the electrochemical cell from P1 to P2. Three typical standard configurations are explained below.

6.2.2 Standard connection

6.2.2.1 Standard three-electrode connection

In the standard three-electrode connection mode typically used in analytical electrochemistry or corrosion experiments, the working electrode is connected to S1+P1. The counter-electrode is connected to S3+P2, and the reference electrode is connected to S2.

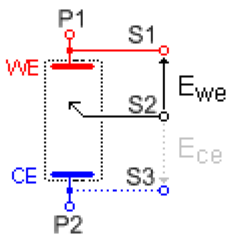


Fig. 54: Standard three-electrode connection for a classical metal-solution interface.

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

- Connection of the positive electrode (WE) to S1+P1,
- Connection of the negative electrode (CE) to S2+P2,
- Connection of the reference electrode (REF) to S3.

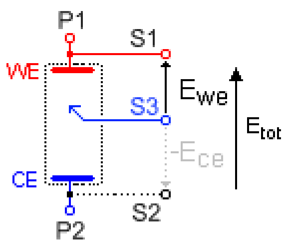


Fig. 55: Three-electrode connection with a reference electrode.

In the instrument, potential regulation is done between S1 and S2. 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 E_{ce} and E_{we}-E_{ce} in the "**Cell Characteristics**" window.
In the data file, the following rows will be displayed:

- E_{we} related to S1-S2 *i.e*. total potential of the battery,
- E_{ce} related to S3-S2 *i.e*. – negative electrode potential vs. Reference,
- E_{we} - E_{ce} related to S1-S3 *i.e*. positive electrode potential vs. Reference electrode.

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

6.2.2.2 Two-electrode connection

In the two-electrode connection mode, the positive electrode of the device of interest (battery, fuel cell, supercapacitor, ….etc) is connected to S1+P1. The potential control or measurement is performed between S1 and S2, and the controlled or measured current crosses the cell from P1 to P2. So the negative electrode has to be connected to S2+S3+P2. In order to study the positive battery and negative electrode materials, the user inserts a reference electrode. Then a three-electrode assembly is required (refer to the previous part).

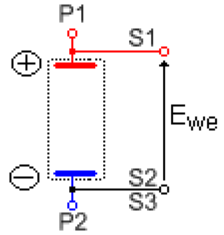


Fig. 56: Two-electrode connection to a battery cell.

6.2.2.3 Four-electrode connection

In the four-electrode connection mode, the user has the ability to record the liquid-liquid interface potential (E_{ce}), also called Kelvin probe connection.

In this connection mode, S1 should always be connected to WE (or to the positive electrode) for proper cell isolation. However, to avoid an IR drop in connections, it is recommended to connect S1 directly to the cell electrode and not to the P1 cable.

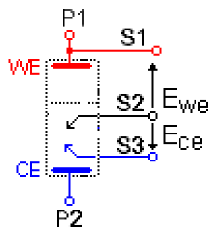


Fig. 57: Four-electrode connection for a liquid – liquid interface.

6.2.3 CE to Ground connection mode

This connection mode is chosen in the software "Advanced settings" window. Then the connections must be done in a special way, in connecting the ground cable to the CE electrode of the cell, as shown below:

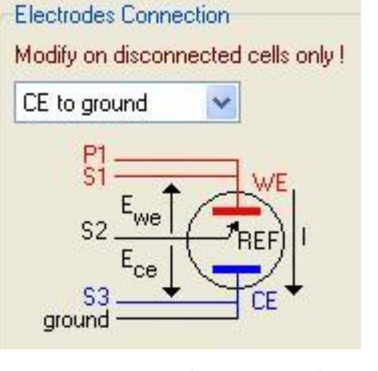


Fig. 58: CE to Ground connection mode.

6.2.4 WE to Ground connection mode

This connection mode is chosen in the software “Advanced settings” window. Then the connections must be done in a special way, in connecting the S1 and the Ground cable to the WE of the cell and S3 and P1 to the CE electrode of the cell, as shown below:

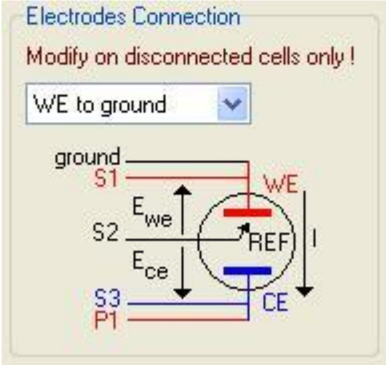


Fig. 59: CE to Ground connection mode.

6.2.5 High voltage control connection mode

This connection mode is chosen in the software “Advanced settings” window. Then the connections must be done in a special way, in connecting the S2 and the P3 cable to the WE of the cell and S1 and P1 to the CE electrode of the cell, S2 is connected to RE. Connection is shown below:

NOTE: when this mode is selected the impedance techniques are no more available.

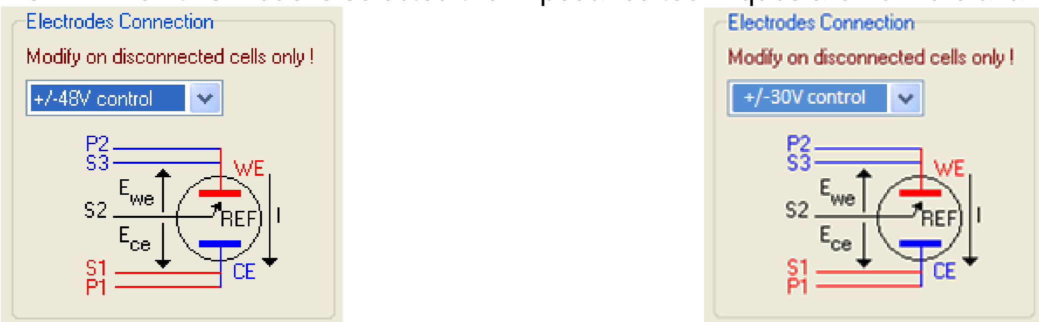


Fig. 60: High voltage control connection mode. Left: +/- 48V for the 1A/48V booster. Right: +/- 30V for the 2A/30V booster.

6.2.6 Floating mode

The instrument’s floating mode is selected in the advanced settings window of the EC-Lab® software. Both the standard mode and the floating mode can be used without modifying the cell connection.

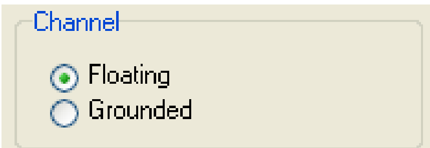


Fig. 61: Floating or Grounded mode selection.

The floating mode allows the user to work with grounded cells, autoclaves, pipelines, glove boxes, etc.
When the channel board is in floating mode, the red LED is not bright as it is when the channel board is in Grounded mode.
Note that some specifications of the instrument can be modified using the floating mode.
Using the floating mode for measurements will require taking some measurement precautions. Indeed, the cell connections should be isolated from the ground such as other apparatus that can be connected to the cell (multi-tester, voltmeter …).

6.3 Specific connection for high current boosters.

6.3.1 Connection to the cell with 1A/48V booster

The connection is similar to the connection described in the previous paragraph. The only difference is that the potentiostat/galvanostat (with/without EIS) board has to be connected to the 1A/48 V booster with the DB15 connection cable.

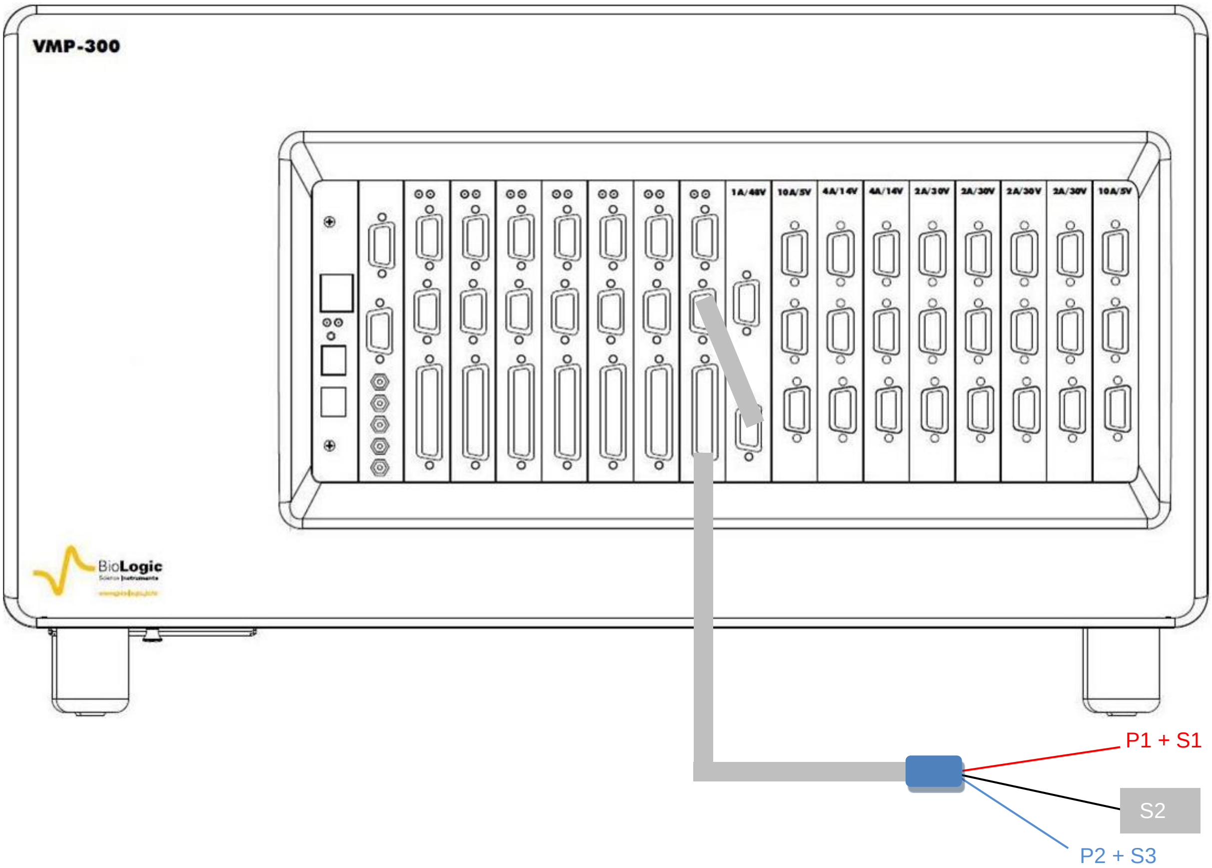


Fig. 62: Channel board connection to the cell with the 1A/48V booster.

6.3.2 Connection to the cell with 2A/30V, 4A/14V and with 10A/5V boosters

With the 2A/30V, 4 A/14 V and 10A/5V boosters, the connection with the cell cable of the potentiostat/galvanostat board remains the same, but the P1 and P2 (4 mm) leads coming from the booster board have also to be connected to the cell. The booster board needs to be connected to the channel board using the DB15 connection cable.
The 2A/30V, 4A/14V and 10A/5V boosters can be connected in parallel, so it is possible to increase the current ability of the channel board by using in parallel numerous 2 A, 4 A or 10A boosters. For example, if 12 boosters of 10A are connected to one potentiostat/galvanostat board, user can reach a current of 120 A.

Limit of instrument configuration:

- VSP-300 chassis accepts a maximum of 4 booster boards and these boosters have to be inserted in the slots #1 to #4 (not #5 and #6).
- Because of power limitation, VMP-300 chassis accepts a maximum of 12 booster boards if powered with 110Vac electrical network. They can be inserted in any slot.

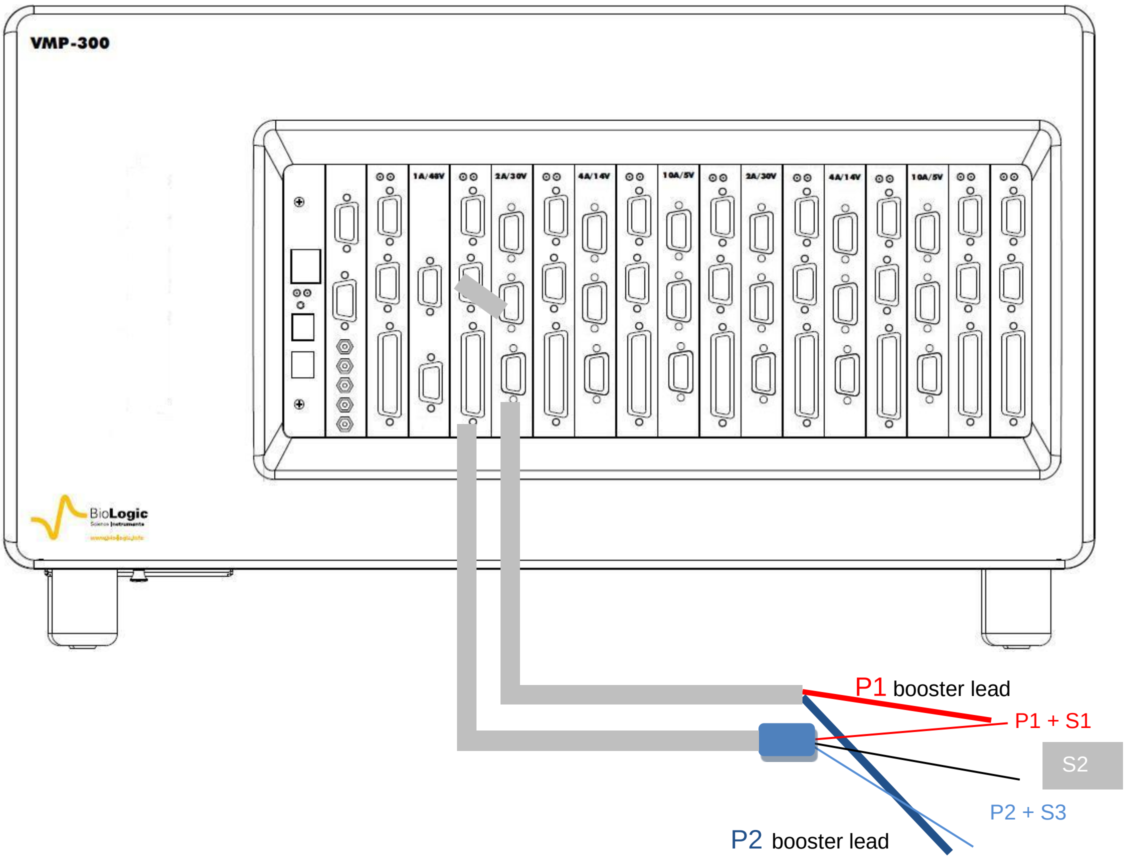


Fig. 63: Channel board connection to the cell with one 2A/30V booster

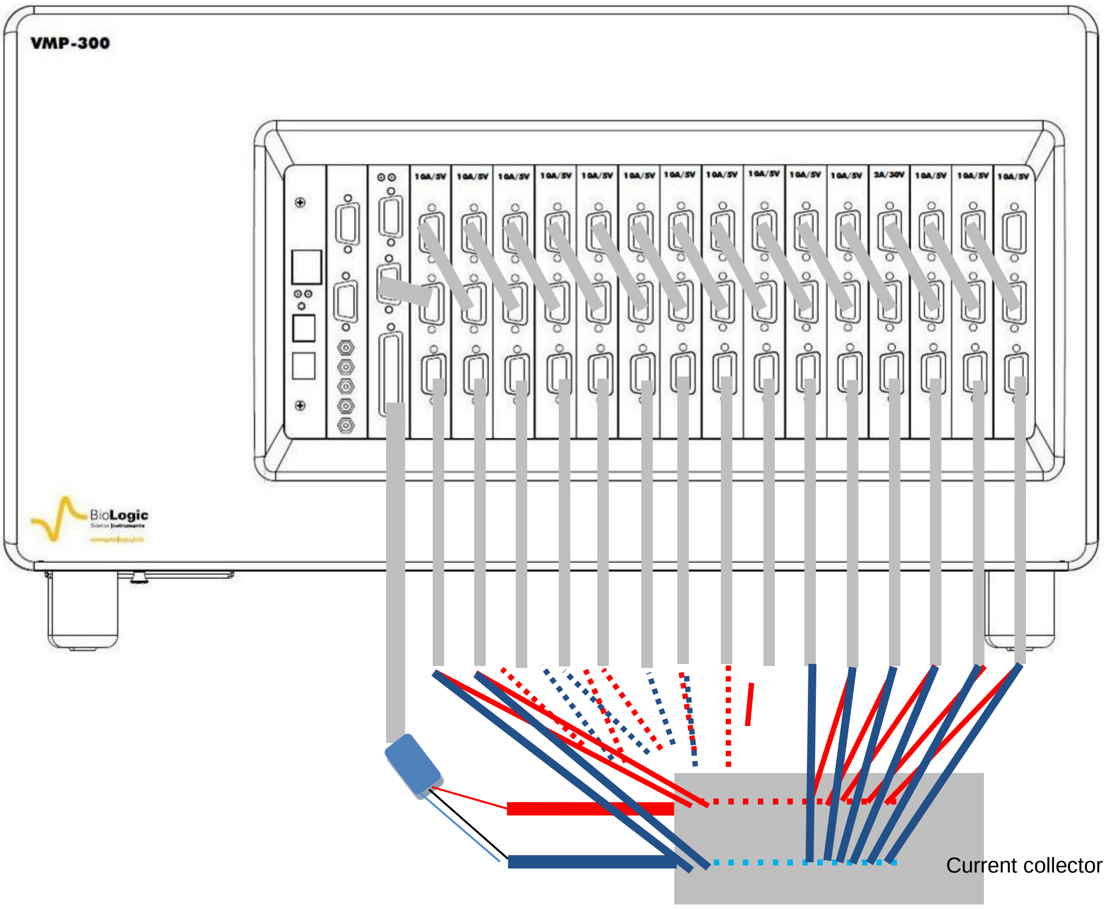


Fig. 64: Channel board connection to the cell with fifteen boosters.

Note: for clarity the P1 and P2 leads coming from the 10A booster cables are not displayed in the scheme but all the P1 and P2 leads of 10A boosters have to be connected to the cell trough the current collector.

6.4 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

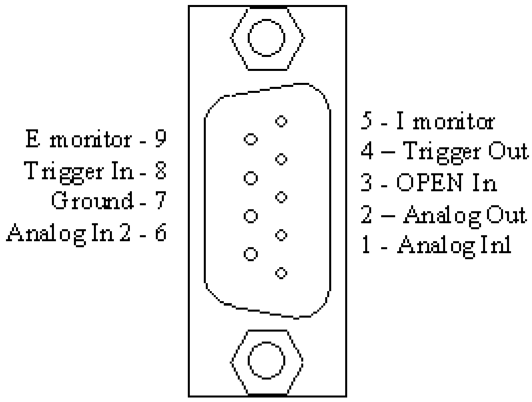


Fig. 65: Structure of the DB9 connector.

- ***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 inpolarity 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.

Another cable is also available, it is the IS-1 option. This cable is described in detail in the paragraph 8.

Fig. 66: DB9-8BNC cable.

7. Advanced features

7.1 Bandwidth

7.1.1 Bandwidth selection of a standard channel

Nine bandwidth possibilities are available for the instrument. These bandwidths represent the stability factors (SF) for a good measurement; if the bandwidth value is not well adjusted, the potentiostat will oscillate. Selection of the bandwidth well adapted to the cell is mainly done considering the response time of the studied cell and its capacity.
Table 1 gives information to help the user select the bandwidth most adapted to the studied cell in the required experimental conditions. Note that the values of capacity are given for a cell purely capacitive. The time constant (TC) is calculated considering the capacity of the cell and the resistance of the current range used for the measurement, i.e. TC = RC. Cells located in the green part of the table can be studied with all the bandwidths (1 to 9). Note however that the most suitable bandwidth is underlined in the table. For the cells located in the white part of the table, fewer bandwidth choices are available, whereas for the cells located in the red part, selection of the bandwidth has to be done by the trial and error method depending on the cell's particulars.

Table 1: Help for bandwidth selection for a standard board considering the capacity and the time constant (TC) of the studied cell, but also the experimental conditions. Considering these factors the most appropriate bandwidth (SF) is given.

	1 µA/ 1 MΩ		10 µA/ 100 kΩ		100 µA/ 10 kΩ		1 mA/ 1 kΩ		10 mA/ 100 Ω		100 mA/ 10 Ω		1 A/ 1 Ω	
	TC	SF	TC	SF	TC	SF	TC	SF	TC	SF	TC	SF	TC	SF
10 pF	10 µs	6/7	1 µs	7/8	100 ns	1-9	10 ns	1-9	1 ns	1-9	100 ps	1-9	10 ps	1-9
100 pF	100 µs	5	10 µs	6/7	1 µs	7/8	100 ns	1-9	10 ns	1-9	1 ns	1-9	100 ps	1-9
1 nF	1 ms	4	100 µs	5	10 µs	6/7	1 µs	7/8	100 ns	1-9	10 ns	1-9	1 ns	1-9
10 nF	10 ms	3	1 ms	4	100 µs	5	10 µs	6/7	1 µs	7/8	100 ns	1-9	10 ns	1-9
100 nF	100 ms	2	10 ms	3	1 ms	4	100 µs	5	10 µs	6/7	1 µs	7/8	100 ns	1-9
1 µF	1 s	1	100 ms	2	10 ms	3	1 ms	4	100 µs	5	10 µs	6/7	1 µs	7/8
10 µF	10 s		1 s	1	100 ms	2	10 ms	3	1 ms	4	100 µs	5	10 µs	6/7
100 µF	100 s		10 s		1 s	1	100 ms	2	10 ms	3	1 ms	4	100 µs	5
1 mF	1 ks		100 s		10 s		1 s	1	100 ms	2	10 ms	3	1 ms	4
10 mF	10 ks		1 ks		100 s		10 s		1 s	1	100 ms	2	10 ms	3
100 mF	100 ks		10 ks		1 ks		100 s		10 s		1 s	1	100 ms	2
1 F	1 Ms		100 ks		10 ks		1 ks		100 s		10 s		1 s	1

Example: for a cell with a capacity of 100 nF with a time constant of 1 ms, studied with a current range of 100 µA, the recommended bandwidth is the bandwidth number 4.

7.1.2 Bandwidth selection of a channel connected to ULC and/or one booster

The same kind of table can be proposed to help the user select the correct bandwidth when the channel board is connected with the booster. The selection of the bandwidth can be done as previously, considering the cell capacity and time constant of the cell.

Table 2: Help for bandwidth selection for a standard board with a booster considering the capacity and the time constant (TC) of the studied cell, but also the experimental conditions. Considering these factors the most appropriate bandwidth (SF) is given.

	1 µA/ 1 MΩ		10 µA/ 100 KΩ		100 µA/ 10 KΩ		1 mA/ 1 KΩ		10 mA/ 100 Ω		100 mA/ 10 Ω		1 A/ 1 Ω	
	TC	SF	TC	SF	TC	SF	TC	SF	TC	SF	TC	SF	TC	SF
10 pF	10 µs	7/8	1 µs	1-9	100 ns	1-9	10 ns	1-9	1 ns	1-9	100 ps	1-9	10 ps	1-9
100 pF	100 µs	7	10 µs	7/8	1 µs	1-9	100 ns	1-9	10 ns	1-9	1 ns	1-9	100 ps	1-9
1 nF	1 ms	6	100 µs	7	10 µs	7/8	1 µs	1-9	100 ns	1-9	10 ns	1-9	1 ns	1-9
10 nF	10 ms	5	1 ms	6	100 µs	7	10 µs	7/8	1 µs	1-9	100 ns	1-9	10 ns	1-9
100 nF	100 ms	4	10 ms	5	1 ms	6	100 µs	7	10 µs	7/8	1 µs	1-9	100 ns	1-9
1 µF	1 s	3	100 ms	4	10 ms	5	1 ms	6	100 µs	7	10 µs	7/8	1 µs	1-9
10 µF	10 s	2	1 s	3	100 ms	4	10 ms	5	1 ms	6	100 µs	7	10 µs	7/8
100 µF	100 s	1	10 s	2	1 s	3	100 ms	4	10 ms	5	1 ms	6	100 µs	7
1 mF	1 ks		100 s	1	10 s	2	1 s	3	100 ms	4	10 ms	5	1 ms	6
10 mF	10 ks		1 ks		100	1	10 s	2	1 s	3	100 ms	4	10 ms	5
100 mF	100 ks		10 ks		1 ks		100 s	1	10 s	2	1 s	3	100 ms	4
1 F	1 Ms		100 ks		10 ks		1 ks		100 s	1	10 s	2	1 s	3
10 F	10 Ms		1 Ms		100 ks		10 ks		1 ks		100 s	1	10 s	2
100 F	100 Ms		10 Ms		1 Ms		100 ks		10 ks		1 ks		100 s	1

7.2 Floating mode

By default, the instrument is configured in grounded mode. Changing this configuration can be done in the Advanced Settings window of EC-Lab® software. Both the standard and floating mode can be used without modifying the cell's connection.

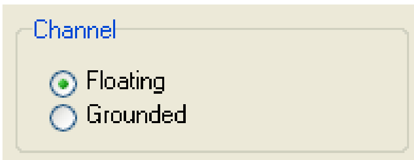


Fig. 67: Floating/Grounded mode selection frame.

Note: In EC-Lab, when the channel board is in floating mode, the red LED is not bright as it is when the channel board is in Grounded mode.

7.3 Filtering

In some experimental conditions, it would be useful to use a filter, then three possibilities of current and potential filter are available with the instrument. The filter configuration can be done in the Advanced settings window of EC-Lab® software.
Note the two gains are only available if the one of the filter is activated.

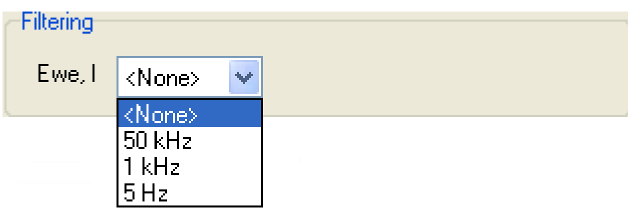


Fig. 68: filters selection frame.

7.4 External device control and recording

7.4.1 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.

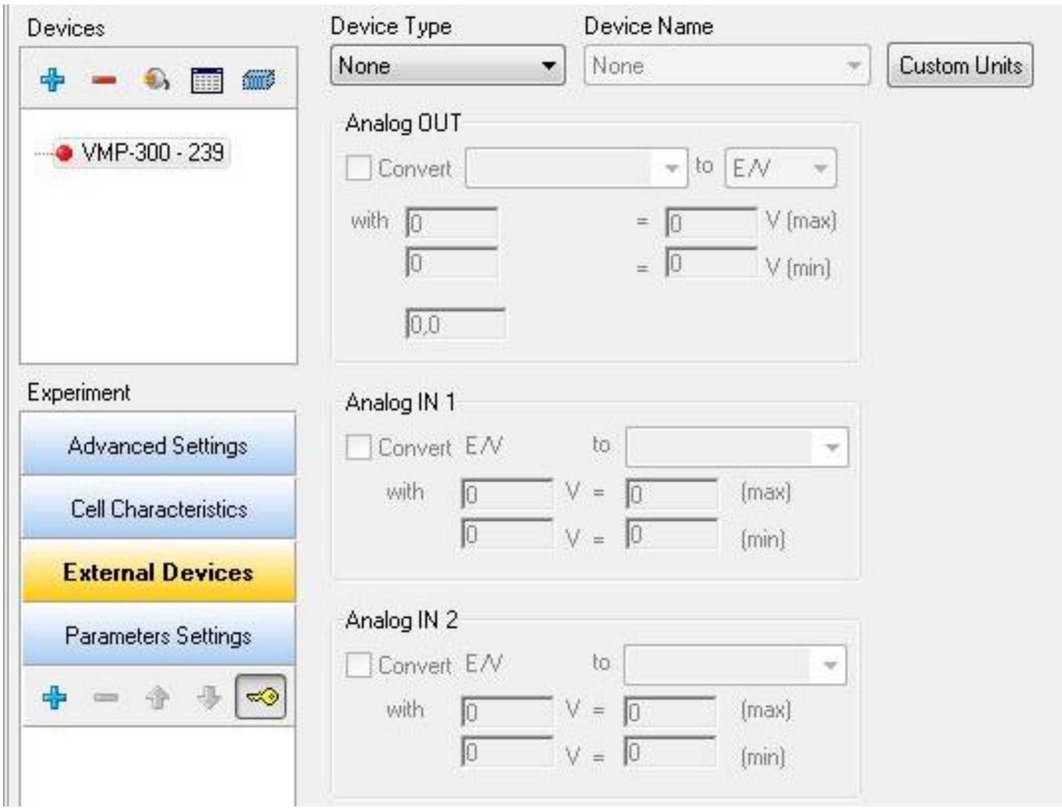


Fig. 69: "External Devices" frame.

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:

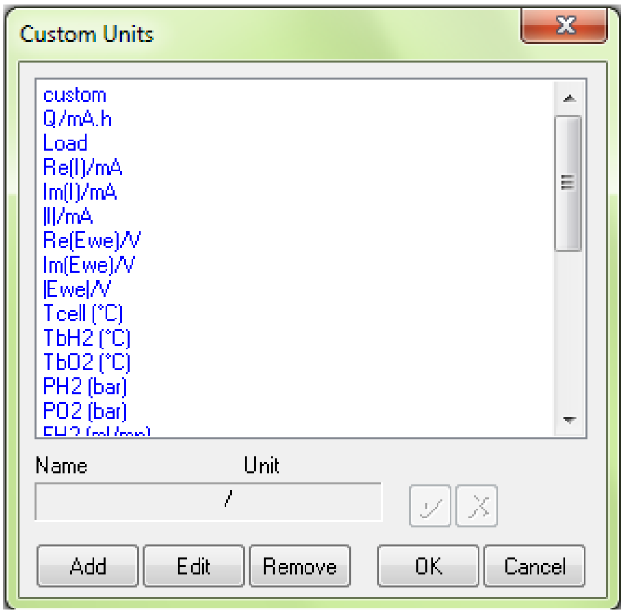


Fig. 70: Custom Units window to define new variables.

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.

7.4.2 Rotating electrodes control

The Bio-Logic instrument can control a rotating electrode such as a ALS-RRDE-3A Rotating Disk electrode model with the auxiliary input/output. A specific control panel has been designed to control the rotation speed.
Note that no measurement of the actual rotation speed is available with the ALS-RRDE-3A model.

Fig. 71: ALS-RRDE-3A Rotating Disk electrode

7.4.2.1 Connections

Two cables are necessary for connection of a rotating disc electrode, the cell cable and a special cable for RRDE with a DB-9 connector. This cable has a DB9 connector on one end and three wires named Analog Out, Trigger Out and 1 Ground on the other end (PN: 092-22/11).

The connection procedure is as follows:

- Connect the DB9 cable to the front of the channel board (Auxiliary Input/Output).
- Connect the “Analog Out” wire to the “Motor” plug on the rear panel of the RRDE-3A.
- Connect the “Ground” wire to the “GND” plug on the rear panel of the RRDE-3A.
- To control the purge of the RRDE-3A, connect the “Trigger Out” to the “Purge” plug on the rear panel of the RRDE-3A.
- Connect the REF1 and CA2 wires to the disk brush, REF3 and CA1 wires to the counter electrode, and REF2 wire to the reference electrode. For RRDE experiment, “CE to Ground” mode must be selected. In that case, use the appropriate connections for both the ring and the disc channels.

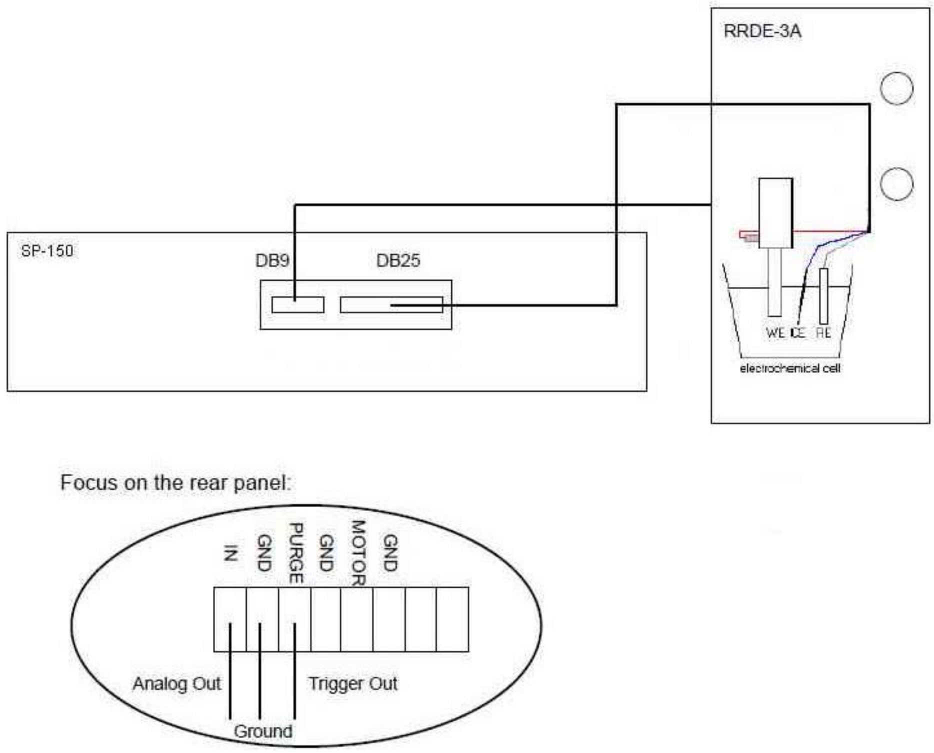


Fig. 72: ALS-RRDE-3A Rotating Disk electrode connection to the cell cable.

<u>Note:</u>
This menu is available only if channels designed to drive a RDE are currently connected to the RDE. If so, click on “External Devices” and the following window will be displayed:

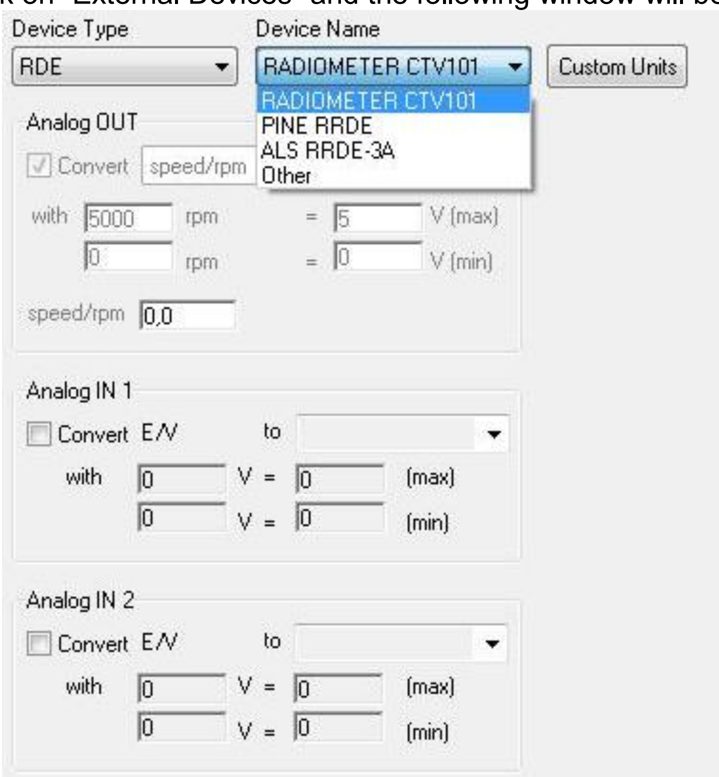


Fig. 73: Rotating electrode control configuration.

Under “**Device Name**” one can select the RDE type. Three standard rotators are included in the list; ALS-RRDE-3A, PINE RRDE or RADIOMETER CTV101. For these devices, the calibration parameters are factory set. Other external systems can be used but are not pre-configured in EC-Lab. If you would like another device to be pre-configured, please contact Bio-Logic and it will be added onto the device list upon request. Note that the calibration parameters for the pre-configured devices cannot be modified by the user .If you would like to configure a device not in the list, select “**Other**” in the Device Name and configure the “**Analog OUT**” window to define the control parameters. Click on the “**Apply**” button to validate the settings. Note that this menu can be activated without any rotating electrode unit, but it will only have effects on electrochemical instruments equipped with a rotating system.

7.4.3 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.

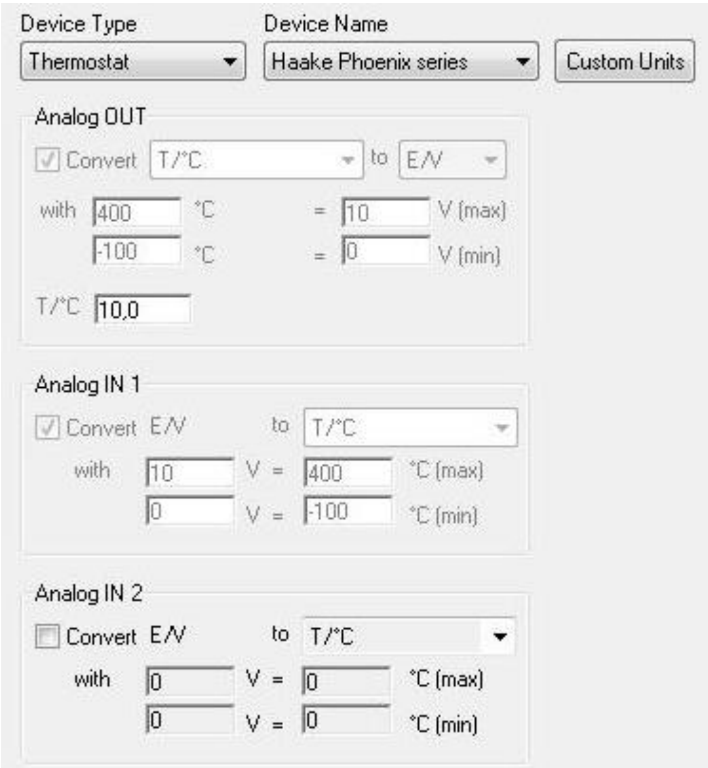


Fig. 74: Haake Phoenix series thermostat control configuration.

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

7.4.4 Electrochemical Quartz Crystal Microbalance coupling

The SEIKO EG&G QCM 922 quartz crystal microbalance can be coupled with our potentiostat / galvanostat to record both the frequency variation and the resistance variation. The configuration for the EQCM coupling is described in the following figure:

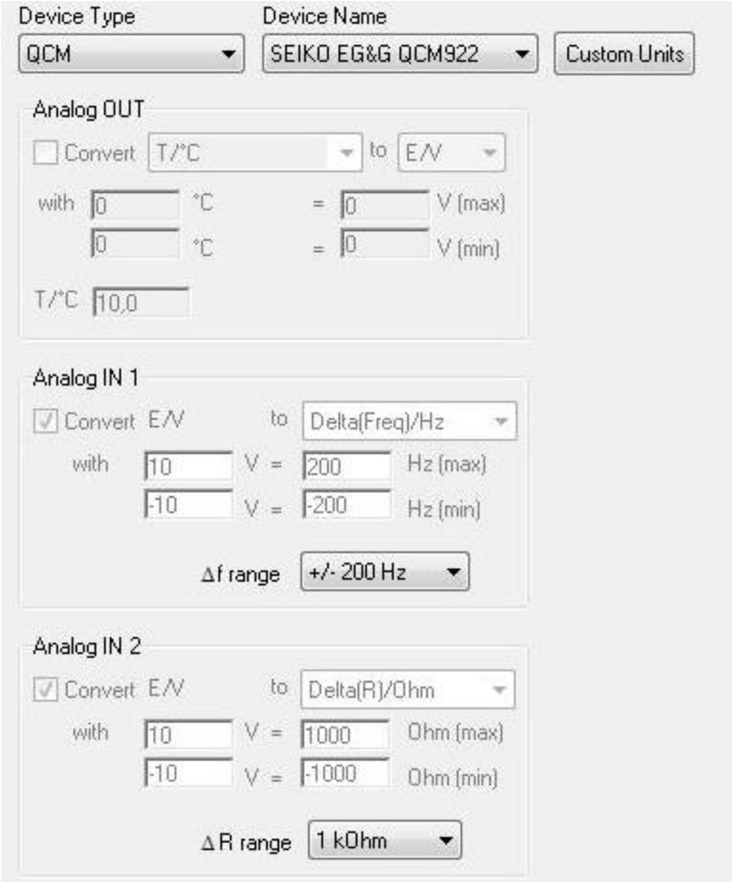


Fig. 75: SEIKO EG&G QCM-922 configuration window.

One can see that both frequency and resistance variations are recorded on the potentiostat analog inputs. The user has to define both the frequency range and the resistance range. The results of this experiment are displayed to the right.

A process is also available to calculate the amount of a species electro-disposed onto the QCM. To use this process, select the process data option in the Analysis menu.

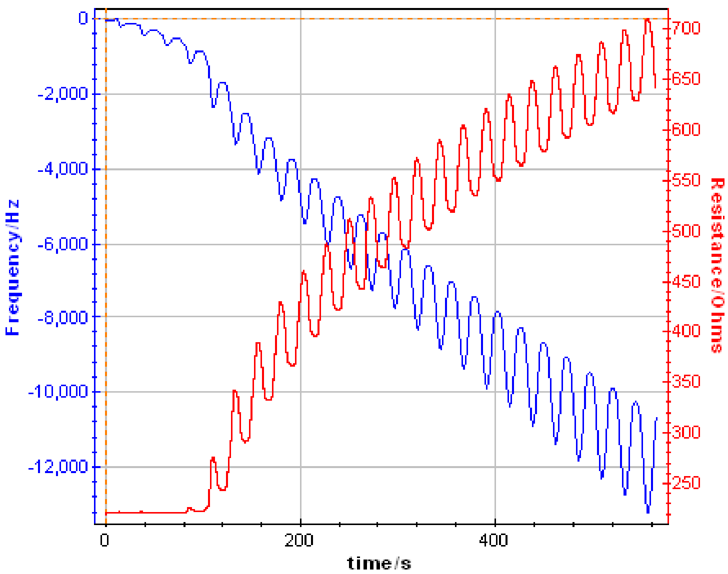
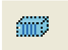


Fig. 76: Frequency and resistance variations recorded from the analog inputs for an instrument coupled with a SEIKO EG&G QCM 922.

7.5 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.

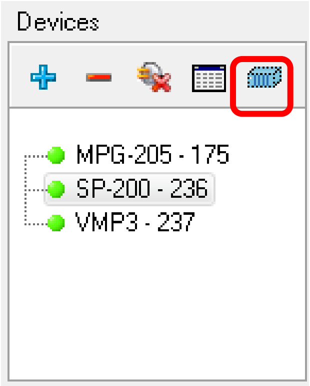


Fig. 77: Virtual potentiostat button (in the red rectangle).

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

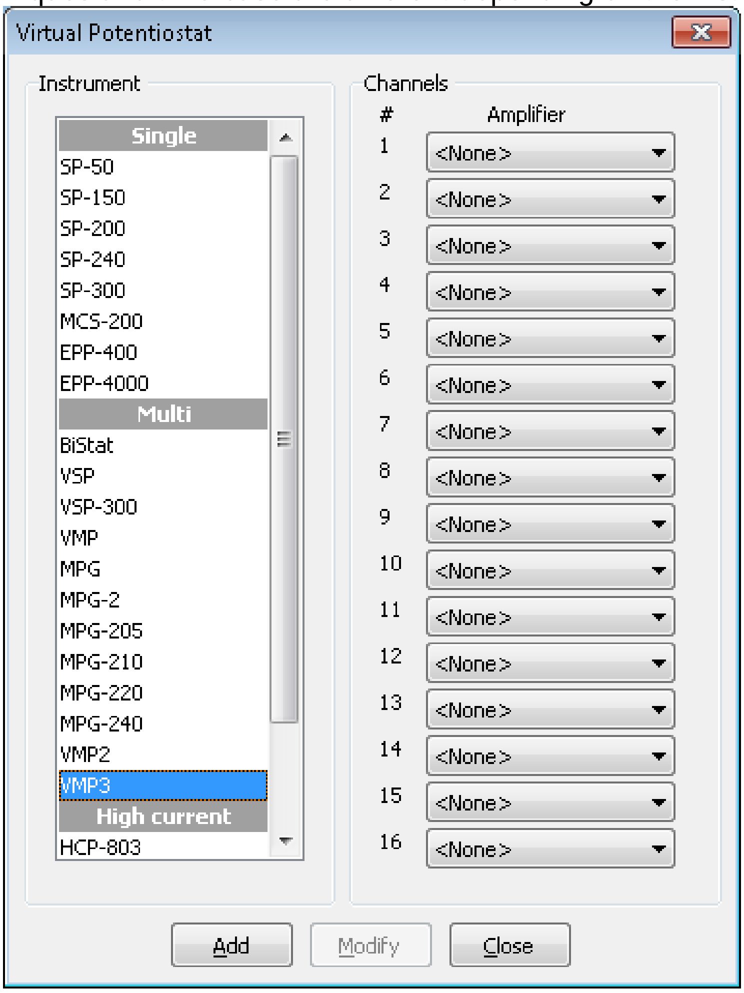


Fig. 78: Virtual potentiostat window.

8. Options & Accessories

The options and accessories of the SP300-based instruments are described in this section.

8.1 Linear Scan Generator (LSG)

This option is an electronic board which has to be plugged onto the potentiostat/galvanostat board. It allows users to apply a true linear voltage scan (analog and not digital) to the cell.
The analog nature of the scan is critical in several applications such as catalyst study for fuel cell development or for voltammetry requiring fast scan rate (to detect intermediate species with short lifetime).
As the linear scan generator allows fast scan investigation, hardware ohmic drop compensation is also implemented in the software. This correction is done continuously by the hardware which is much faster than the software compensation. For example, we can compare the standard and linear CV. Due to the feedback loop, the software compensation with the standard CV takes around 100 µs while the hardware compensation is about 100 times faster.

This option is compatible with ULC cable and booster boards.

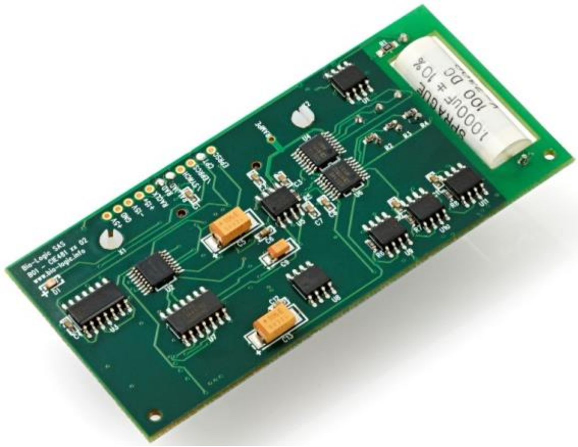


Fig. 79: LSG option.

LSG specifications:	
Scan ranges	1 MV/s, 10 kV/s, 100 V/s, 1 V/s.
Scan resolution	0.0015% FSR* (down to 15 µV/s).
Minimum voltage scan rate	0.1 mV/s
Sampling rate	down to 1 µs
Buffer size for Fast mode	40 000 data points
Voltage range	± 10 V. The voltage range can be adjusted.
Accuracy	< ±0.1% of range
Number of cycles	1 to 65535

8.2 Isolation System (IS1)

It is used to keep a potentiostat totally floating even when it is connected to a grounded external device via the auxiliary cable.
The auxiliary cable is connected to the potentiostat board using the DB9 (or SubD 9) connector. Thanks to this cable, an external device can communicate with the potentiostat either by sending/receiving digital triggers or sending/receiving analog signals. When the auxiliary cable is connected to an external device, the potentiostat board becomes grounded to the internal ground of the external device. Consequently, if the channel was initially used

in the floating mode, connecting it to the external device using the auxiliary cable makes it lose its floating character.

With the IS1, even if the channel is connected to an external device, it keeps its floating character.
The IS1 is powered by the potentiostat board using the LIO cable connected to the DB15 (or SubD 15) connector on the potentiostat or by an external 12V DC power supply. The auxiliary cable from the potentiostat board is connected to the DB9 connector on the IS1.
The external device is connected to the IS1 thanks to a simple BNC cable. All the available I/O were separated in the same manner as the DB9 to BNC adaptor.

Fig. 80: IS1 option.

IS1 specifications:

Analog I/O		**Digital I/O**	
Input (IN1, IN2) :		***Input (Trigger In, Open In):***	
Input impedance:	>10^{11}Ω / 15 pF	Input impedance	1 MΩ / 150 pF
Input voltage range:	+/- 10 V	Input voltage range	0 to 5 V
Bandwidth	50 kHz	Input frequency max	400 kHz
Signal noise:	10 mV_{pp} (peak to peak)	Low/high input threshold	[0; 0.8]V / [2 ; 5] V
		Maximum propagation time/Minimum pulse width	1 µs
Output (Out , I monitor, E monitor) :		***Output (Trigger Out):***	
Output impedance	100 Ω	Output impedance	100 Ω
Signal noise	10 mV_{pp}	Low/high input threshold	[0; 0.4] V / [4.6; 5] V
Output current max	10 mA	Maximum output frequency:	400 kHz
		Maximum propagation time/Minimum pulse width	1 µs

8.3 Current Collector (CC5)

Up to five current boosters can be connected in parallel, increasing the maximum current that can be passed through the cell. In order to simplify the connections, a current collector was designed (Fig. 82). A maximum current of 60 A can flow through the CC5 (Current Collector for 5 boosters).
This simple device collects the current coming from each booster in parallel and delivers it through two 60 cm power cables terminated by two sturdy crocodile copper clips, similar to automobile battery clips. The scheme below (Fig. 83) shows how to connect in parallel five boosters inserted in the VSP-300 chassis. All the boosters need to be connected to each other using the DB 15 connectors.

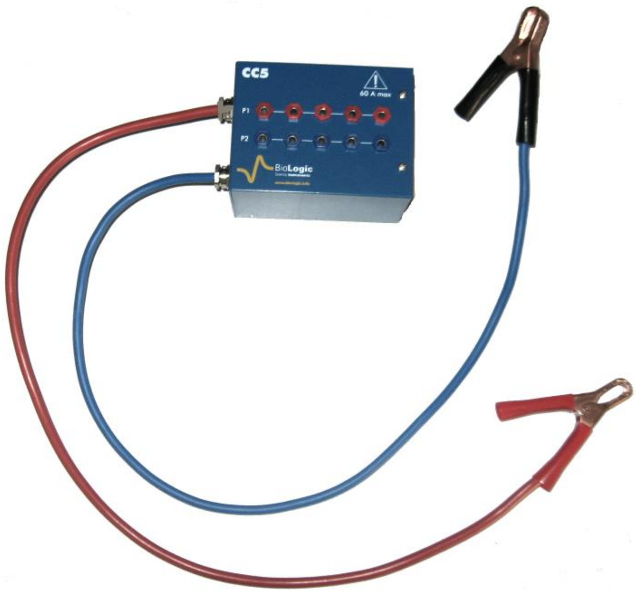


Fig. 81: CC5 option.

On each booster the power cables are connected to the CC5 as it is shown in Fig. below. The crocodile clips of the CC5 are then clipped to the battery or the cell of interest. The total current will flow through these cables. The connection leads from the potentiostat board coming from the DB 25 connector, are connected directly to the battery.

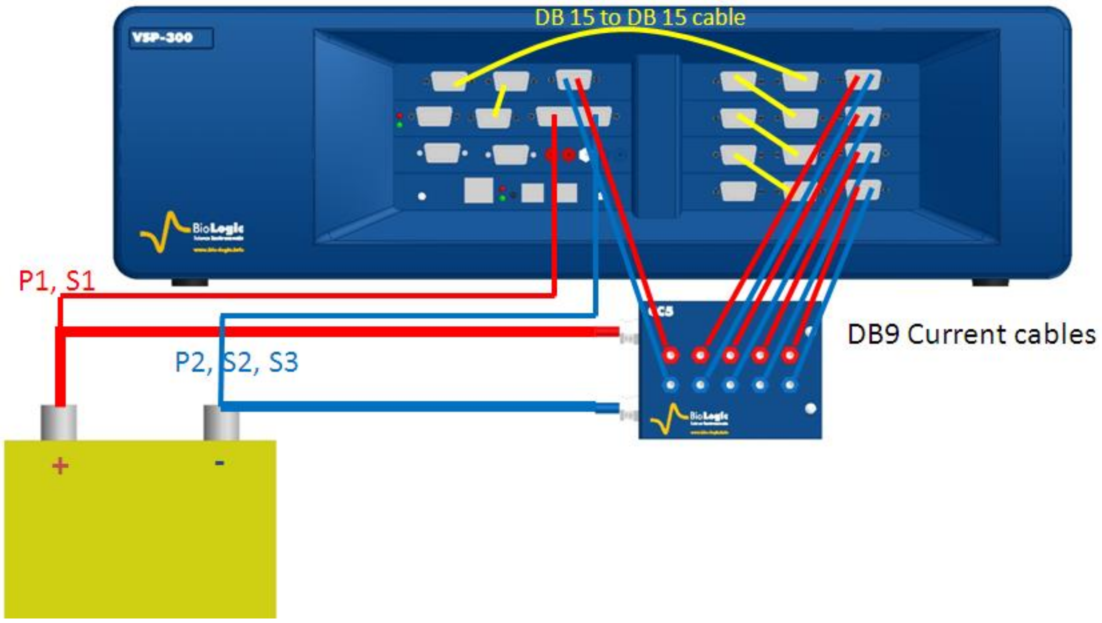


Fig. 82: connection with VSP-300 and CC5 to a battery.

NOTE: If more than 5 boosters are needed, it is possible to use several CC-5.

8.4 MP-MEA option

MP-MEA option is especially dedicated to applications using micro electrode array (MEA). Up to 256 electrodes can be handled with this multiplexer, the switching time is 8 ms between each electrode.

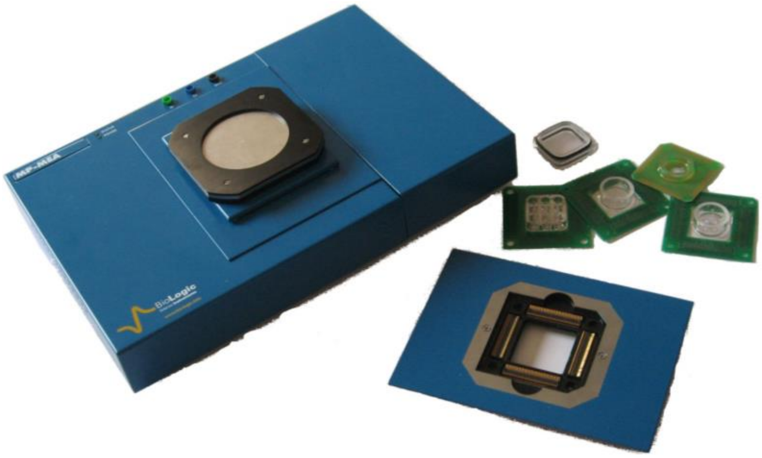


Fig. 83: MP-MEA option

8.4.1 Description

- At the top of the MP-MEA:

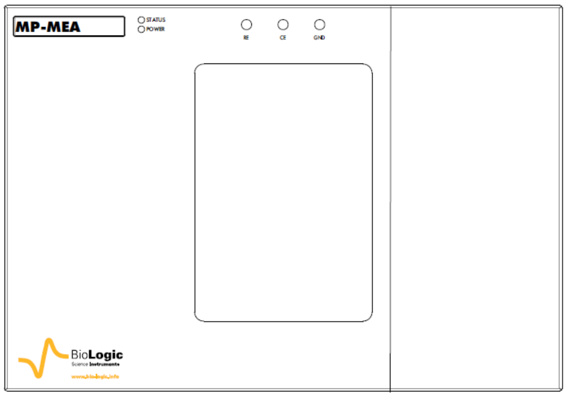
- The connector for the MEA (in the middle). To fit with most MEA, two types of adapters are available (connection from the top or from below)

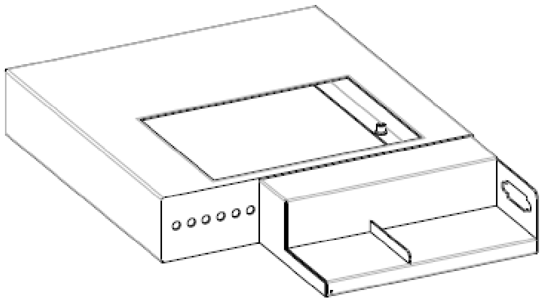
- Three 2mm-connectors (in the middle above the MEA connector). One to connect an external reference electrode, one to connect an external counter electrode and one to connect to ground of the instrument.

- Two LEDs. The LED “power” indicates if the MP-MEA is powered on and the “status” LED indicates experiments is running.

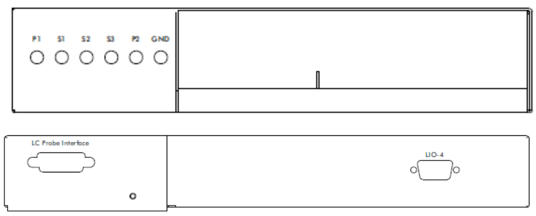
- At the right side:

- Connector for the Ultra Low current probe. P1, S1, S2, S3, P2 and GND 2mm-connectors of the Ultra Low current probe have to be connected to the appropriate connectors.





The Ultra low current probe to cable and DB-15 connector to connect MP-MEA to the board are available at the rear panel of the MP-MEA.



Two cables are needed to connect MP-MEA to instrument board. The DB-15 connectors of the instrument and of the one of the MP-MEA module has to be connected with DB-15/DB-15 cable AND the ultra low current probe connected to the DB-25 of the board has to be connected to the dedicated plug.

8.5 Test boxes for calibration check and user training

These accessories can be used to check the instrument or to help user optimize their setup..

8.5.1 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. 84: Dummy Cell-2

8.5.2 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	Tolerance	Temp. coeff.	Current Max	Power Max
5 mΩ	1%	+/- 50 ppm/°C	20 A	7 W

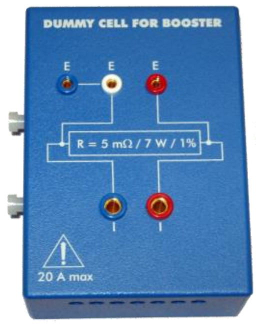


Fig. 85: Dummy Cell for Booster.

8.5.3 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.

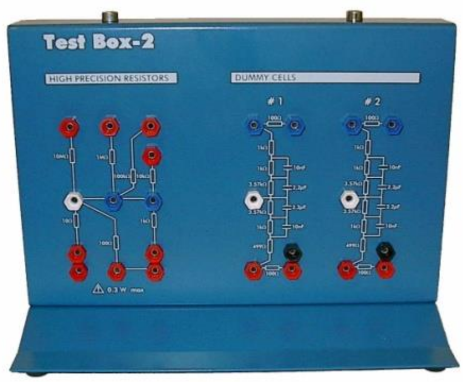


Fig. 86: TestBox-2.

High precision resistor characteristics:

High precision resistor	I range
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
10 MOhms +/- 0.04%	1 µA

8.5.4 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. 87: Test Box-3

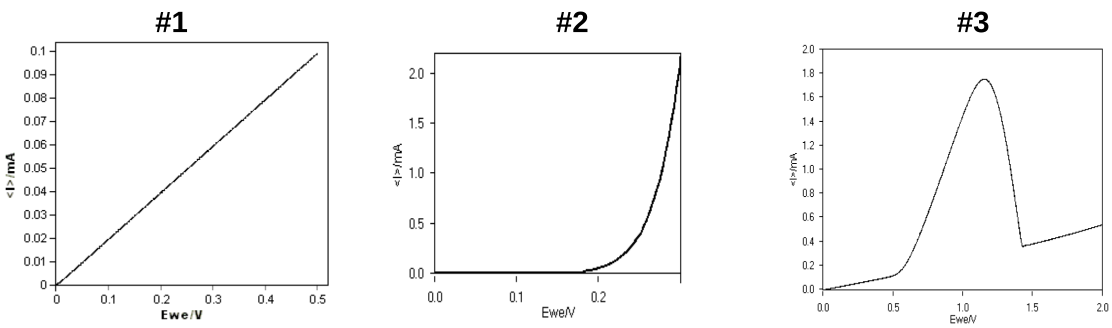


Fig. 88: stationary curve obtained with Test Box-3.

8.6 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.

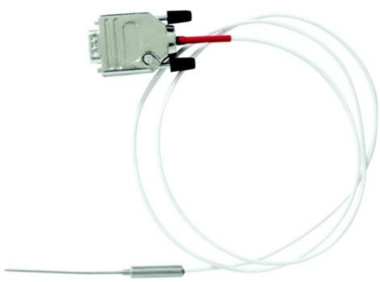


Fig. 89: Temperature probe.

8.7 Battery holders

8.7.1 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.

Fig. 90: Battery holder, BH-1.

It is possible to test many batteries simultaneously by linking multiple holders in series.

NOTE: Before starting a measurement check if the contact between the battery and the connector of the battery holder is efficient (stable voltage).

8.7.2 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. 91: Battery holder, BH-2.

8.8 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.

8.9 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/electrochemistry-ec-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 installed. 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®.

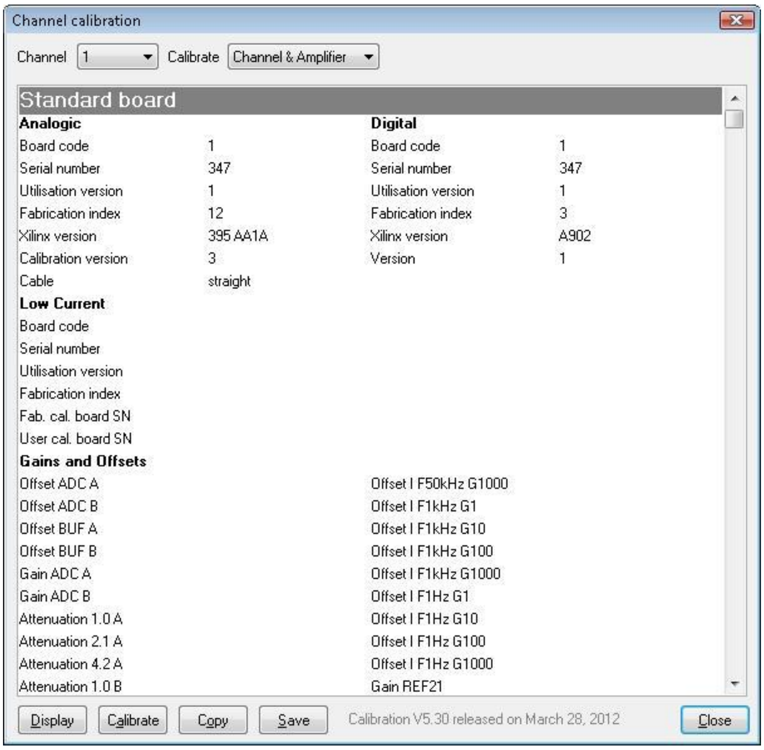
The low current boards are coupled with a channel board, so a low current board must **ALWAYS** be calibrated with the corresponding channel board.

9.2 Channel calibration with EC-Lab® software

To perform the calibration the user has to follow the procedure described in detail hereafter. The calibration procedure lasts a few minutes.

1) In EC-Lab® software Select "**Tools/channel calibration**". You will receive the following message.

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



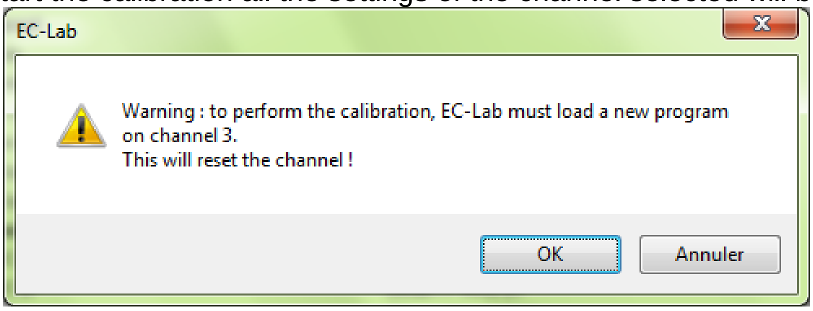
3) Select the channel you want to calibrate with the drop-down box 

4) Select the type of the calibration you want to run with the drop-down box: three different calibrations are offered *i.e.* only the "Channel", the "Channel & Amplifier", or only the "Amplifier" 

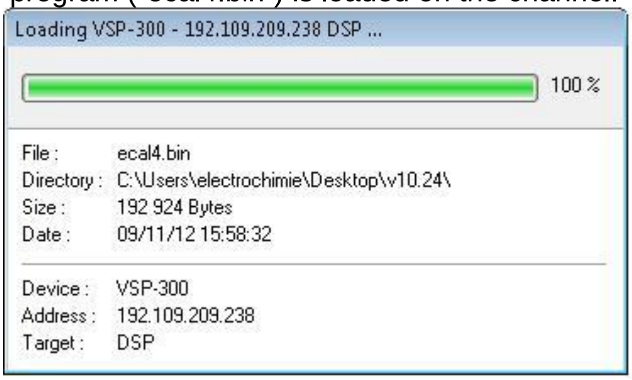
.

If you want to calibrate:
- the channel board alone, select "Channel"
- the booster and the channel board, select "Channel & Amplifier"
- the booster alone, select "Amplifier"

5) Click on the "Calibrate" button and this warning message appears which indicates that if you start the calibration all the settings of the channel selected will be reset.



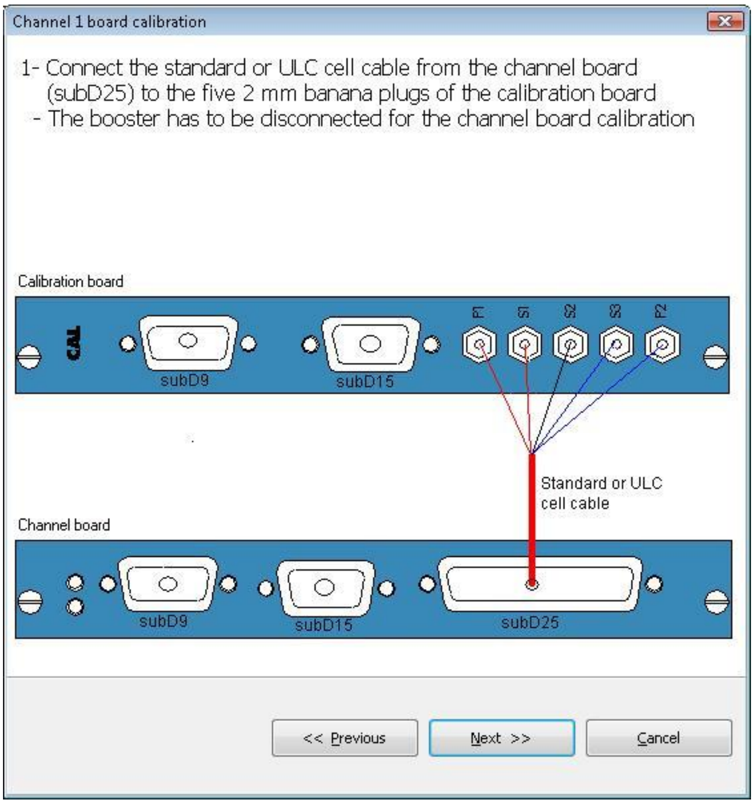
6) The calibration program ("ecal4.bin") is loaded on the channel.



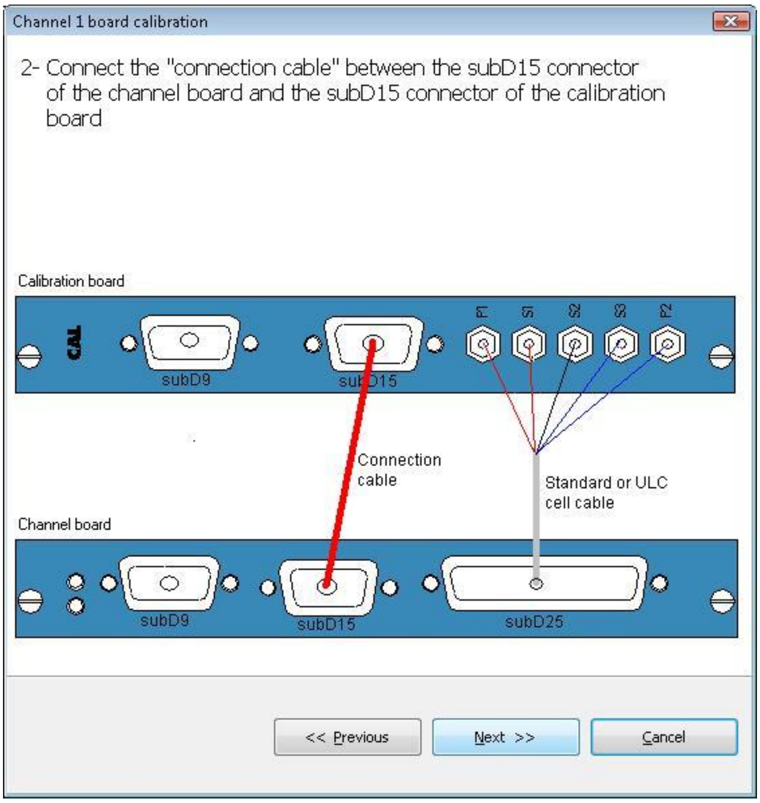
7) Specific connections have to be done between the calibration board and the channel and/or amplifier board(s) depending on the selected calibration. A wizard helps the user to use the appropriate connection.
NOTE: Hereafter, the "Channel & Amplifier" is selected. If user selects "Channel" (steps #8 to #16), only the first part will be done and if user selects "Amplifier" (steps #17 to #22), only the second part will be done.

8) Click on the “Next” button.

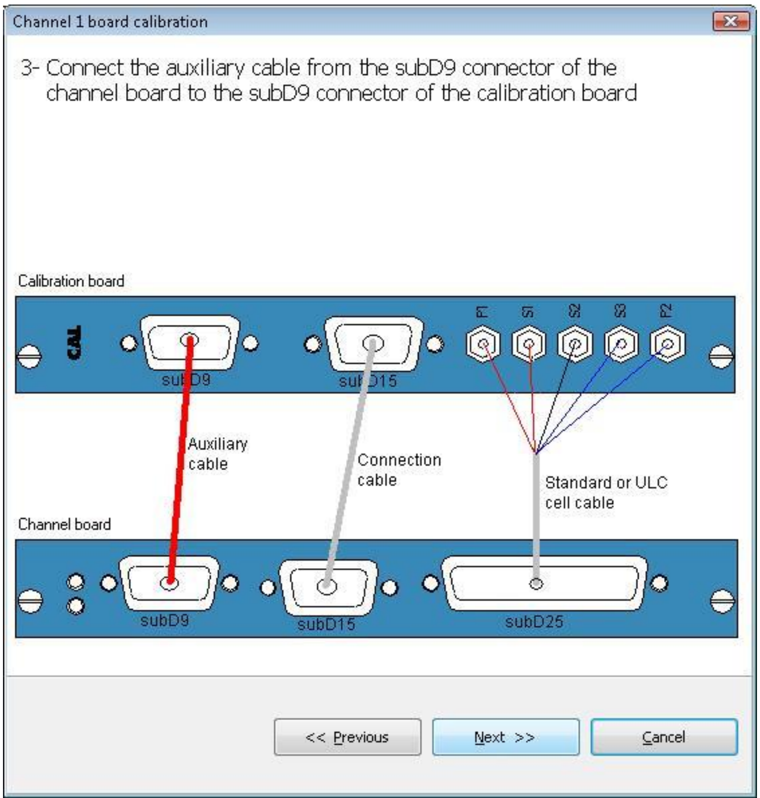
9) Connect the cell cable of the channel board to the calibration board and click on the “Next” button.



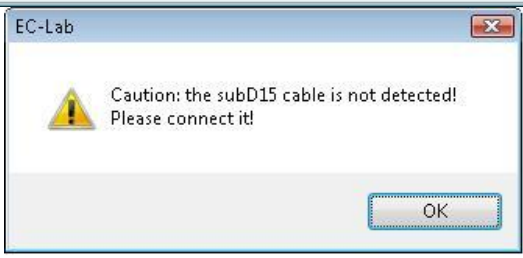
10) Connect the two DB15 connectors using DB15-BB15 cable and click on the “Next” button.



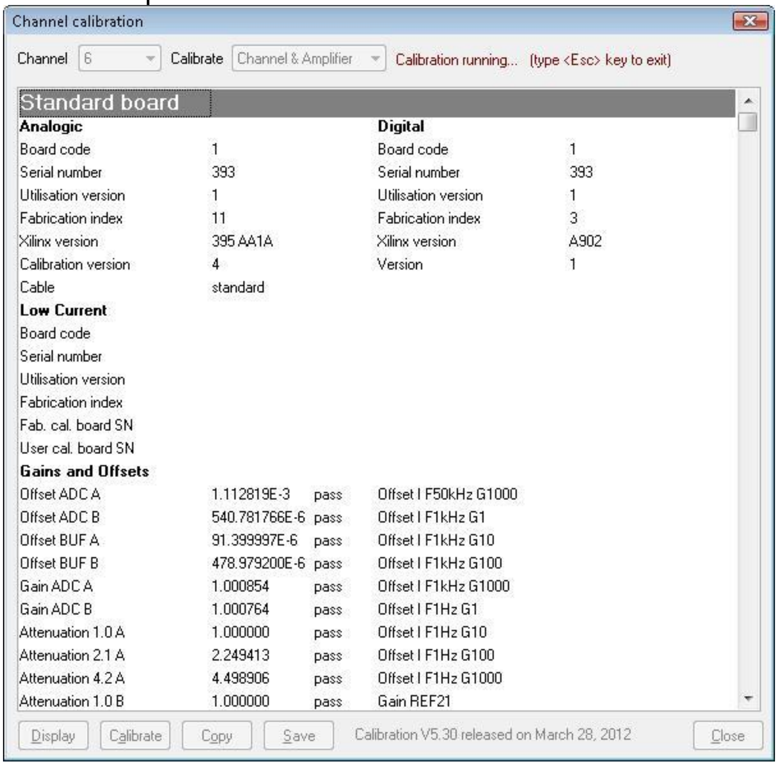
11) Connect the two DB9 connectors using DB9-DB9 cable and click on the “Next” button.



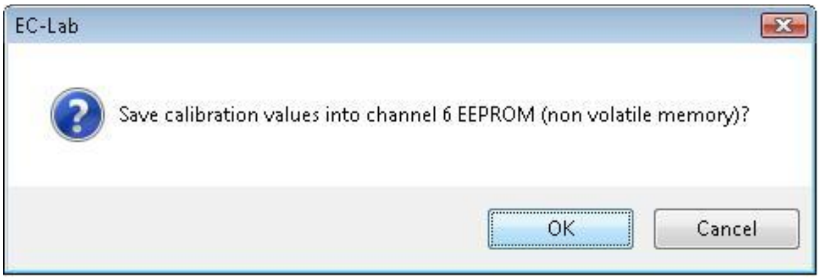
If the DB15-DB15 is not correctly connected a warning message appears.



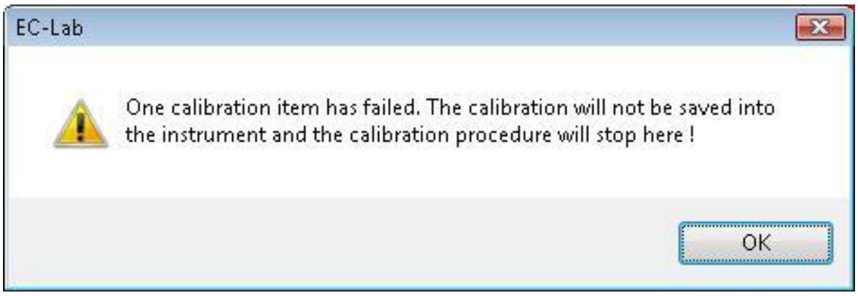
12) Then the calibration procedure starts.



13) If all the items pass, the value of the calibration is saved in the memory of the board and/or in the ULC electrometer. Click on the ”OK” button to complete the calibration process.

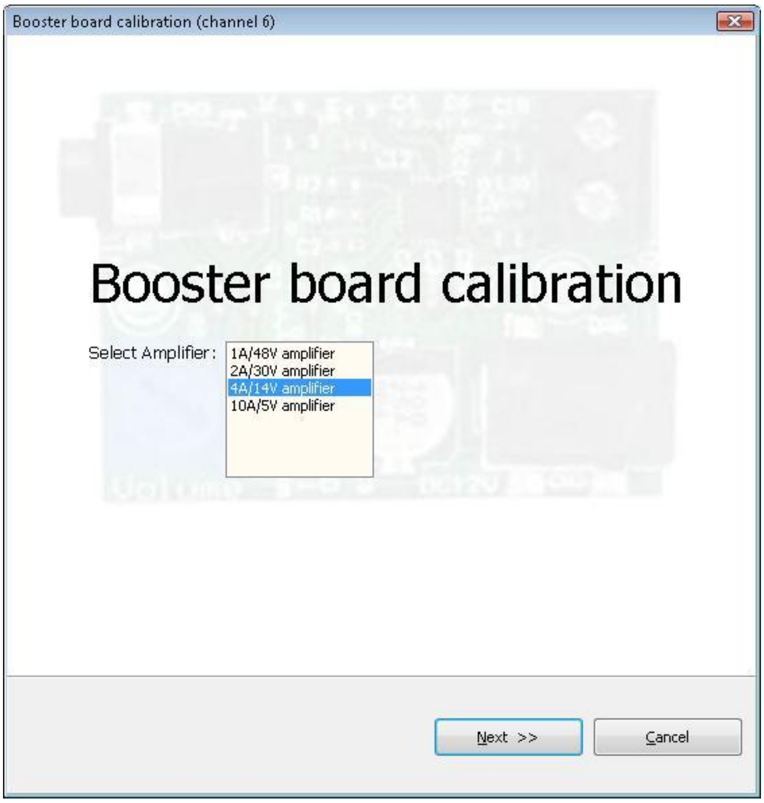


14) If one or more items failed, a warning message indicating that the value of the calibration will not be saved and the calibration process is not completed. Before contacting your local representative, please check again if all the cables were properly connected.

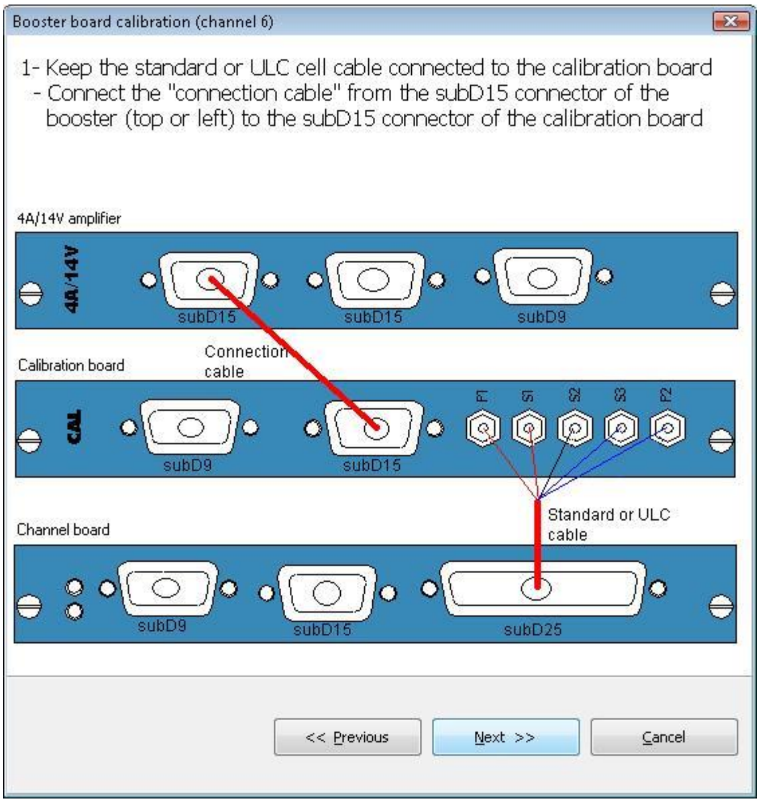


15) If you selected “Channel” calibration the calibration procedure is finished. If not, the calibration procedure continues with the calibration of the amplifier board. As this part calibrates only the amplifier board, so the amplifier board has to be connected as well.
If user select “Amplifier” calibration”, the calibration procedure starts from this step.

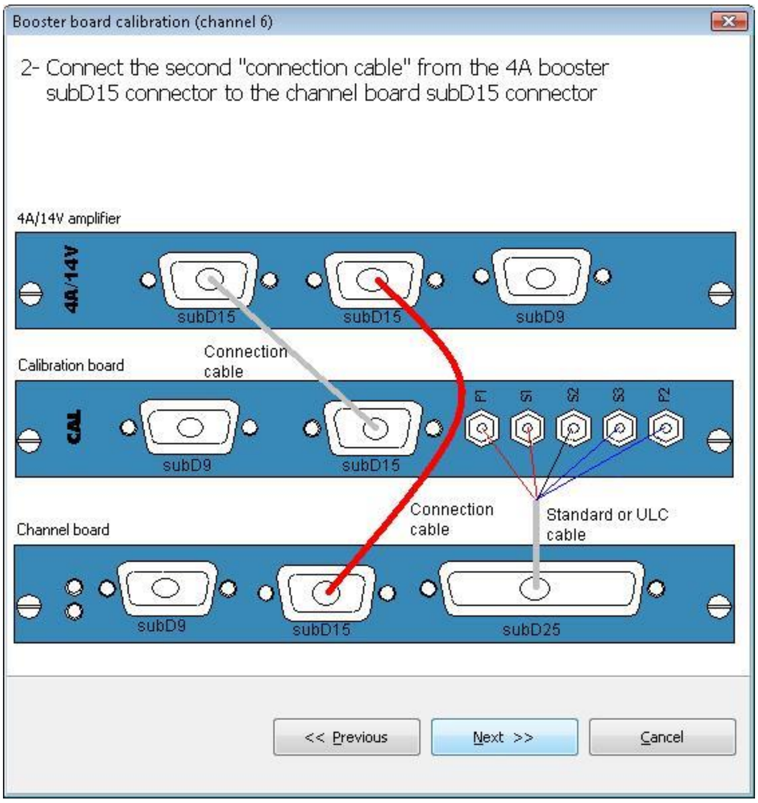
16) Select the appropriate amplifier with the drop-down box and click on the “Next” button. Hereafter, only the calibration procedure of the 4A amplifier is described but the procedure is the same for the other boosters.



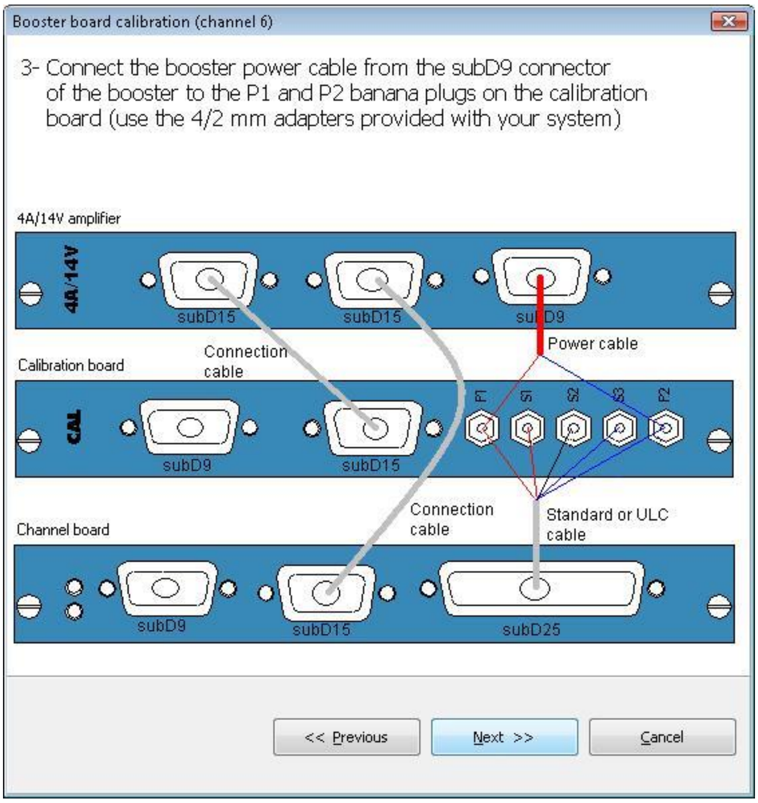
17) Connect the cell cable and the two DB15 connectors between amplifier and the calibration boards as described below and click on the “Next” button.



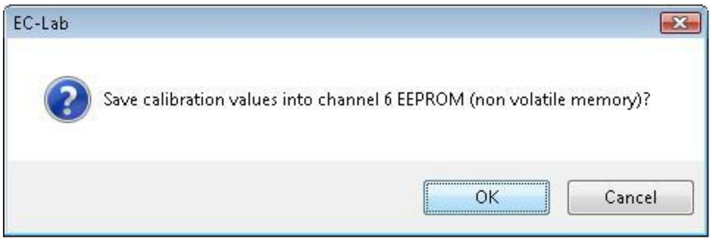
18) Connect the two DB15 connectors of the channel and the amplifier boards as described below and click on the “Next” button.



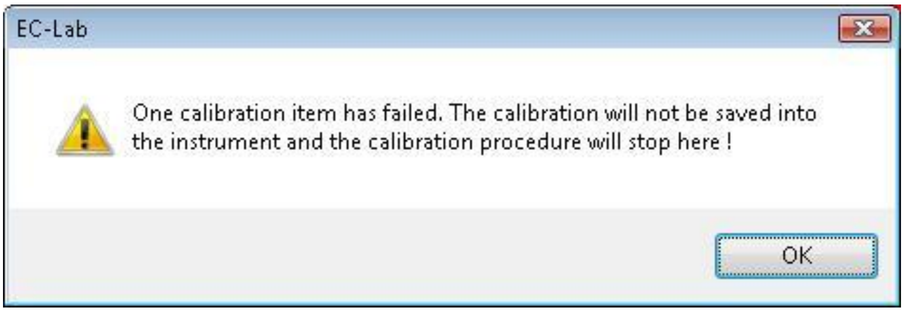
19) Connect the P1/P2 connector coming from the amplifier board to the P1/P2 of the cell cable coming from the channel (two 4mm to 2mm adapters are provided with the amplifier board) and click on the “Next” button.

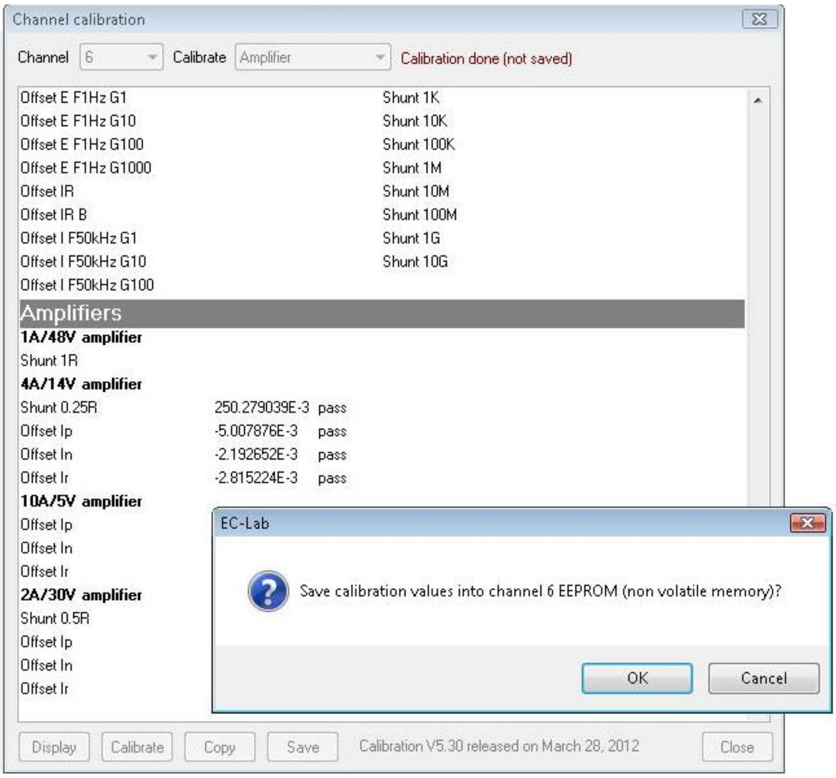


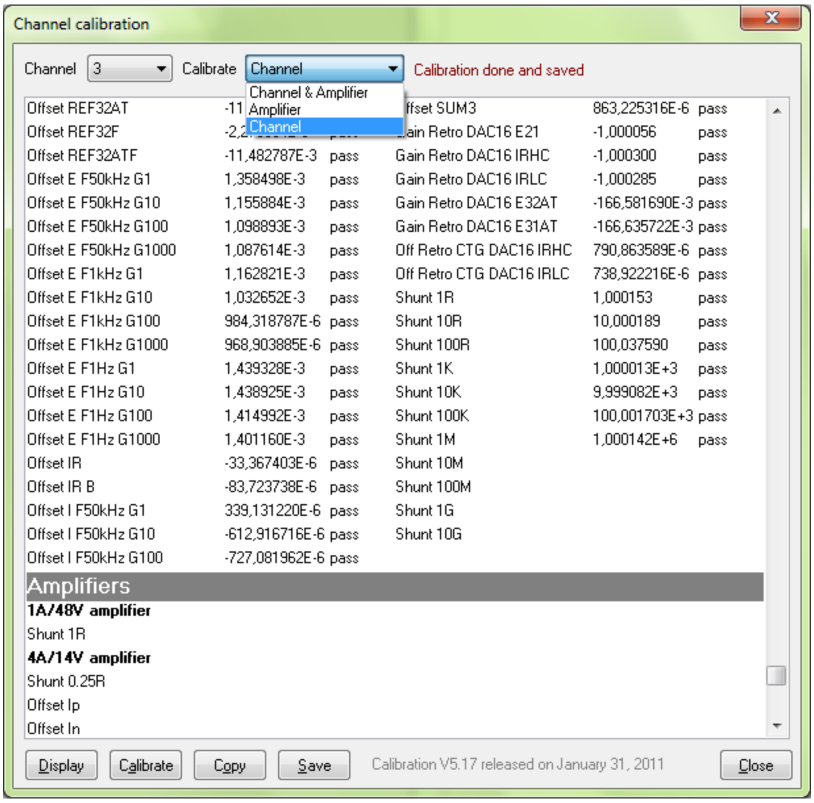
20) If all the items pass, the value of the calibration is saved in the memory of the board and/or in the ULC electrometer. Click on the "OK" button to complete the calibration process.



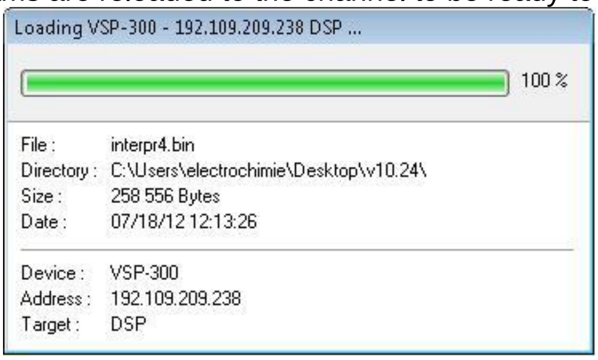
21) If one or more items failed, a warning message indicating that the value of the calibration will not be saved and the calibration process is not completed. Before contacting your local representative, please check again if all the cables were properly connected.







22) Standard programs are reloaded to the channel to be ready to be used.



9.3 Equipment maintenance

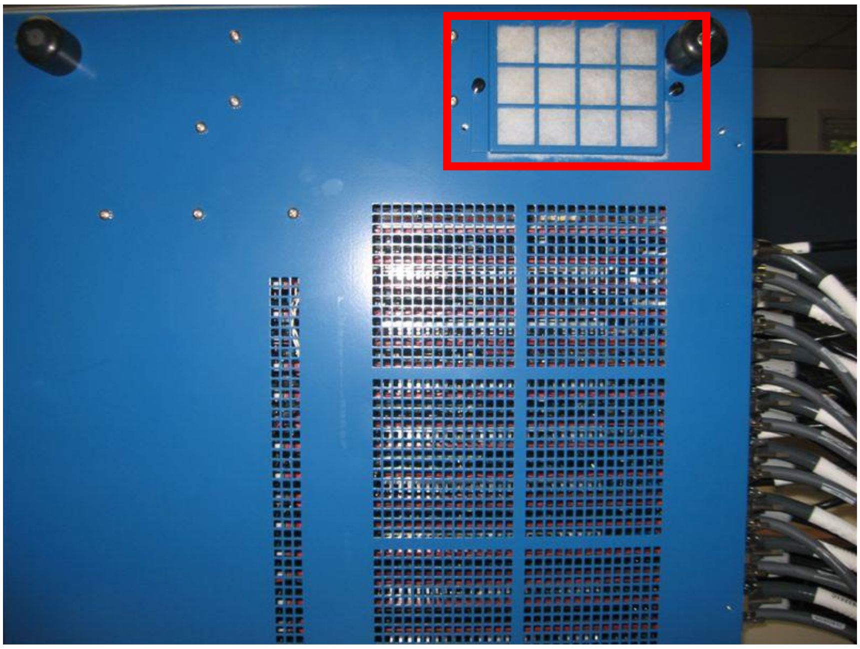
WARNING! Before performing any maintenance power down the unit then disconnect the power cord and all test cables.

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 on the right and left sides and under the chassis. An external cleaning can be made with a vacuum cleaner if necessary.

Cleaning:
Ventilation grids: 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.

NOTE for VMP-300:
It is recommended to clean periodically the filter. This filter is available on the underside of the instrument (see picture on the right).



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

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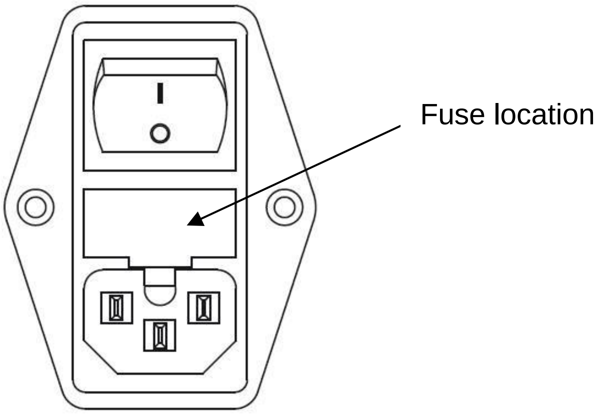


10. Technical Specifications

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/Current	Size (HxWxD)/mm	Weight without cable/kg
SP-200	[90;264]	[50; 60]	350	2 x 4 AF	10 Vdc / 500 mA	221x170x384	7.2
SP-240	[90;264]	[50; 60]	350	2 x 4 AF	10 Vdc / 500 mA or 14 Vdc / 4A (with 4A/14V booster)	225x205x 410	7.5
SP-300	[90;264]	[50; 60]	350	2 x 4 AF	10 Vdc / 500 mA or 48Vdc / 1A (with 1A/48V booster) or 30 Vdc/ 2A (with 2A/30V booster) or 14 Vdc / 4A (with 4A/14V booster) or 5 Vdc/ 10A (with 10A/5V booster)	225x205x 410	7.5
VSP-300	[90;264]	[50; 60]	650	2 x 5 AF		260x530x510	22
VMP-300	[90;264]	[50; 60]	1500	2 x 10 AF		533x315x 563	30

10.1.2 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
- **Warm-up:** 1 hour to rated accuracy
- **Cooling:** 7 Internal DC Fans
- **Vibration:** not specified
- **Choke:** not specified

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

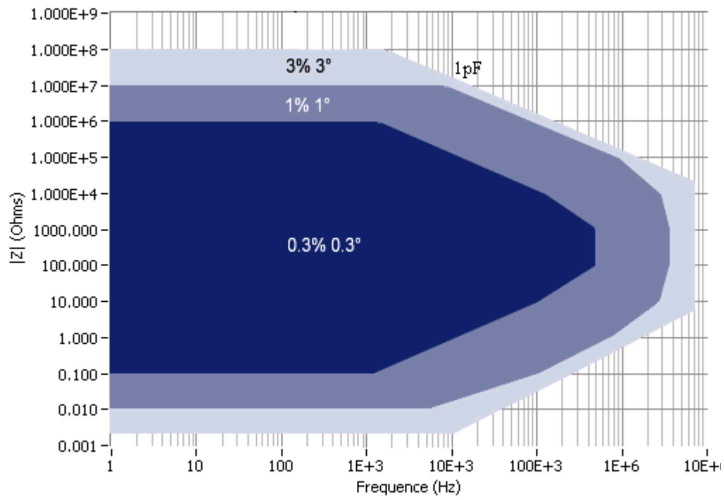
10.2 Channel specifications

10.2.1 Channel board

General Functions	
Potentiostat	Yes
Galvanostat	Yes
Impedance analyzer	Yes (option)
Coulometer	Yes
Linear scan generator	Yes (option)
Floating mode	Yes
IR compensation	Yes
Analog filtering	Yes
External input/outputs	Yes
Cell connection	2, 3, 4 or 5 terminal leads (+ ground)

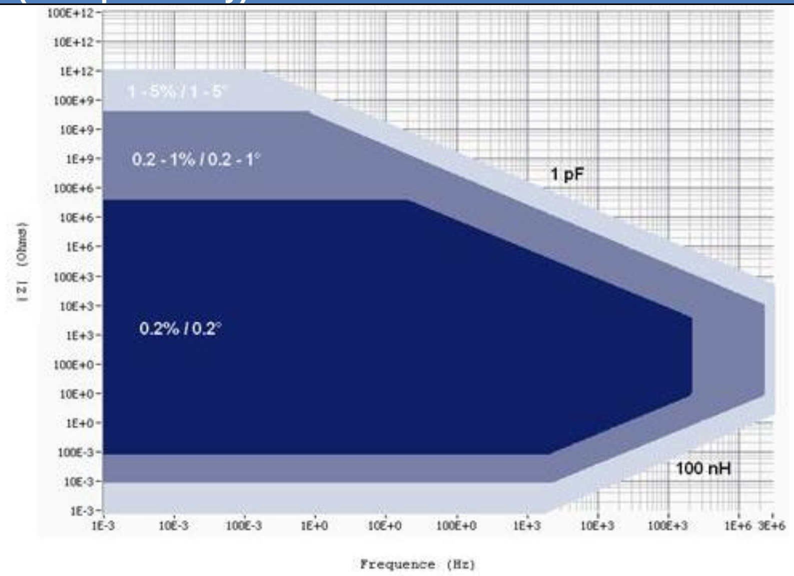
Control amplifier	
Compliance	12 V
Maximum current	± 500 mA continuous
Gain-Bandwidth compensation	9 programmable stability factors
Highest unity gain bandwidth	1.4 MHz
Slew rate (no load)	> 20 V/µs
Rise/Fall time (no load)	< 500 ns
Voltage control	
Ranges	Adjustable from ± 10 V down to ± 30 mV (1 mV resolution)
DC level shift	± 10 V, 300 µV resolution. For example: For an Erange of [0;20]V, the resolution is 333.33 µV. For [0;19.66]V, the resolution is 300 µV. For [0;13.1]V, the resolution is 200 µV. For [0; 6.55]V, the resolution is 100 µV. For [0; 3.27]V, the resolution is 50 µV. For [0; 1.31]V, the resolution is 20 µV. For [0; 0.65]V, the resolution is 10 µV. For [0; 0.32]V, the resolution is 5 µV. For [0; 0.13]V, the resolution is 2 µV. For [0; 0.06]V, the resolution is 1 µV.
Accuracy	< ± 1 mV ± 0.03% of setting
Lowest resolution	1 µV
Current control	
Ranges	± 1 A, ± 100 mA, ± 10 mA, ± 1 mA, ± 100 µA, ± 10 µA, ± 1 µA (7 ranges + Autorange)
Additional ranges	± 100 nA, 10 nA with gain
Accuracy	< ± 0.1 % of range ± 0.03 % of setting
Resolution	0.0033 % of range
Voltage measurement	
Ranges	± 10 V, ± 5 V, ± 2.5 V, ± 250 mV, ± 25 mV
DC level shift	± 10 V, 300 µV resolution
Accuracy (DC)	< ± 1 mV, ± 0.03 % of reading
Maximum resolution	< 0.0033 % of range
Bandwidth (-3 dB)	8 MHz
Filtering low-pass 4 poles Sallen-Key filters	50 kHz, 1 kHz and 5 Hz
Acquisition speed	1,000,000 samples/s
Current measurement	
Ranges	± 1 A, ± 100 mA, ± 10 mA, ± 1 mA, ± 100 µA, ± 10 µA, ± 1 µA
Additional ranges	± 100 nA, ± 10 nA
Accuracy (DC)	< ± 0.1 % of range ± 0.03 % of reading
Maximum resolution	0.0033 % of range
Bandwidth (-3 dB)	8 MHz
Filtering low-pass 4 poles Sallen-Key filters	50 kHz, 1 kHz and 5 Hz
Acquisition speed	1,000,000 samples/s
Electrometer	
Input impedance	1 TΩ II 25 pF typical
Input Bias current	< 10 pA
Bandwidth (-3 dB)	8 MHz
Common mode rejection ratio	> 60 dB at 100 kHz

Ground to chassis impedance	
Floating mode	1 MΩ II 25 pF typical
Grounded mode	< 100 Ω
IR compensation	
Resistance determination	EIS
Compensation mode	Hardware or software positive feedback
Compensation range	Programmable from 0 to 100 % of the current range resistor
Auxiliary Inputs/outputs	
External Input	Can be used to apply an external waveform directly to the control amplifier
2 Analog Inputs	Automatic ± 2.5 V, ± 5 V, ± 10 V ranges - 16 bits resolution
1 Analog Output	16 bits resolution on the ± 10 V range
2 Digital Inputs	TTL level Trigger input and Open input
1 Digital Output	TTL level Trigger output
2 Monitor Outputs	Cell current and compensated working electrode potential
Impedance specifications (EIS option only)	
Frequency range	10 µHz to 7 MHz
Frequency resolution	< 10 ppm of the setting
Sinus amplitude	0.5 mV to 5 V with 76 µV resolution 0.1 % to 100 % of the current range with resolution of 0.004 % of the range
Accuracy	See contour plot
Mode	Single sine, Multisine, FFT analysis
Contour plot	

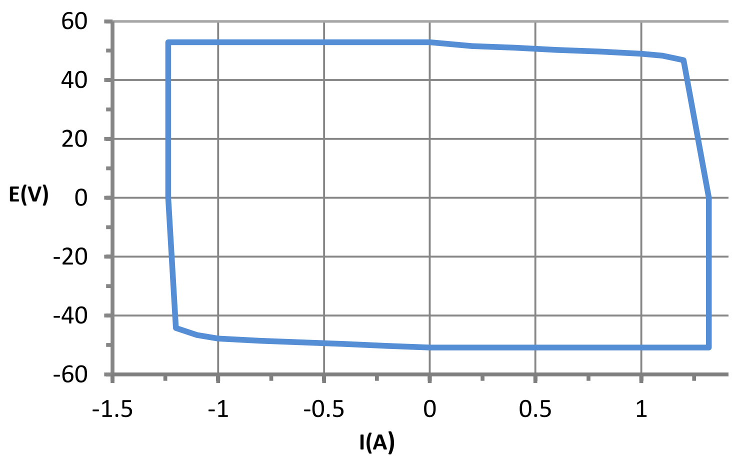


10.2.2 Ultra Low Current

Cell Control	
Maximum Current	± 500 mA (± 1 A continuous with 1 A/48 V)
Maximum Current resolution	0.004 % of the range (down to 76 aA on the ± 1 pA)
Applied Current Accuracy	< ±0.1% of range ±0.03% of setting for ±500 mA to ±100 nA ranges < ±0.1% of range ±1% of setting for ±10 nA range to ±1 nA ranges < ±0.2% of range ±2% of setting for ±100 pA range

Current Measurement	
Ranges	± 100 pA, ± 1 nA, ± 10 nA, ± 100 nA
Additional Ranges with gain	± 1 pA, ± 10 pA
Maximum Resolution	0.004 % of the range
Accuracy	< ±0.1% of range ±0.03% of setting for ±500 mA to ±100 nA ranges < ±0.1% of range ±1% of setting for ±10 nA range to ±1 nA ranges < ±0.2% of range ±2% of setting for ±100 pA range < ±1% of range ±2% of setting for ±10 pA range < ±10% of range ±2% of setting for ±1 pA range
Impedance specifications (EIS option only)	
Accuracy	

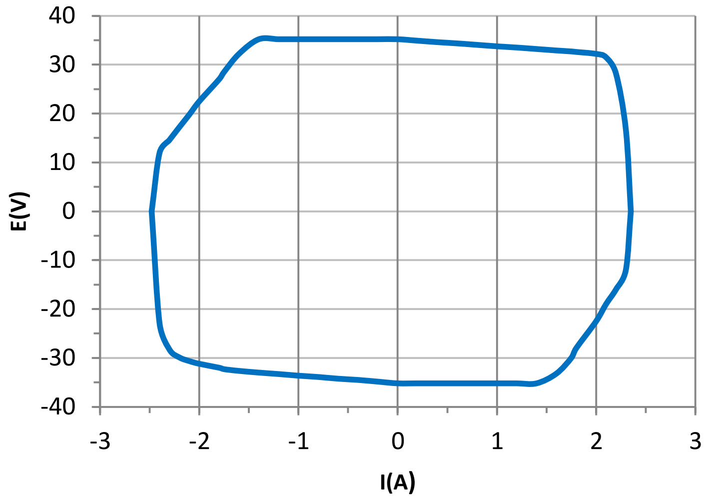
10.2.3 1A/48V booster

Control amplifier	
Compliance voltage	± 49V
Compliance current	± 1 A
Control voltage	± 48V
Bandwidth (-3dB)	>2MHz
Operating area	

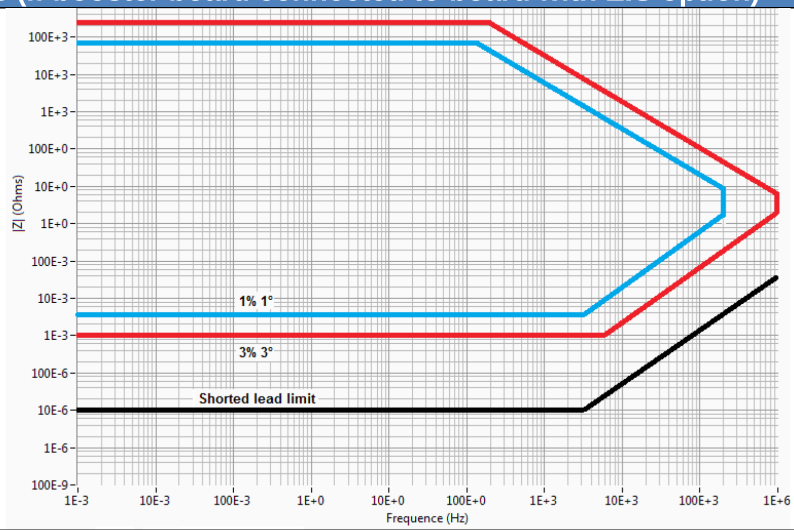
Slew rate (no load)	>15V/µs
Rise/Fall time (no load)	<250ns
Floating mode	Yes
Parallel ability	No
Current accuracy	0.1% range
Impedance specifications (if booster board connected to board with EIS option)	
Accuracy	Same as the potentiostat/galvanostat board but limited at 2 MHz

10.2.4 2A/30 V booster

Control amplifier	
Compliance voltage	± 30V
Compliance current	± 2 A
Control voltage	± 30V
Bandwidth (-3dB)	>3MHz
Operating area	Operating area was specified in the worst case



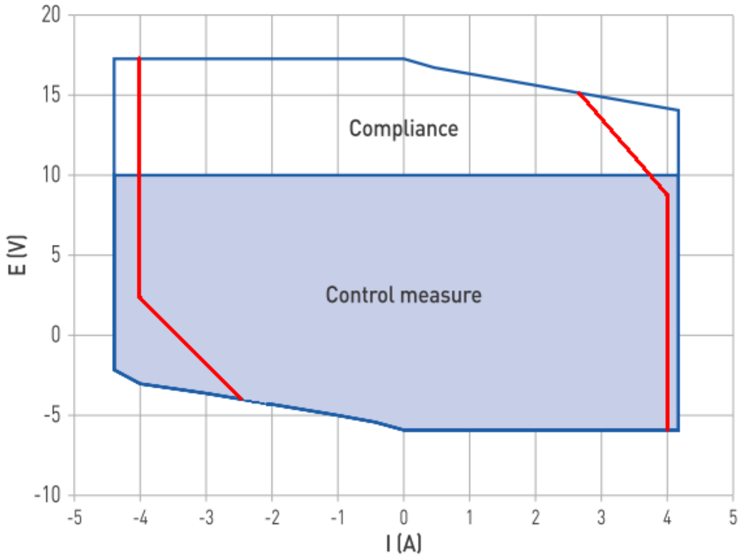
Impedance specifications (if booster board connected to board with EIS option)	
Accuracy	



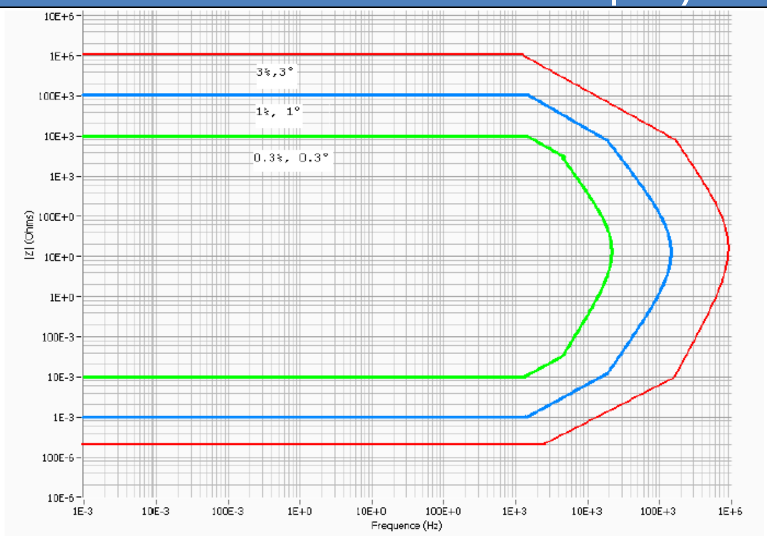
10.2.5 4A/14V booster

Control amplifier	
Compliance voltage	- 3 V ; +14 V
Compliance current	± 4 A
Control voltage	- 3 V ; +10 V
Operating area	

For VSP-300 chassis there is derating for the slot #5 and #6 (red curve). For all the other case, consider the blue curve.

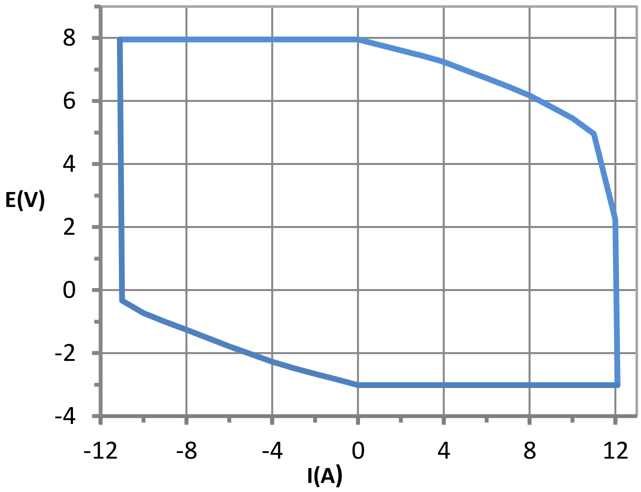


Bandwidth (-3 dB)	>4 MHz
Slew Rate (no load)	50 V/µs
Rise/Fall time (no load)	<200 nA
Floating mode	yes
Parallel ability	yes
Current accuracy	0.1% range
Slew rate (no load)	>50 V/µs
Rise/Fall time (no load)	<200 ns
Floating mode	yes
Parallel ability	Yes
Current accuracy	0.1% range
Impedance specifications (if booster board connected to board with EIS option)	
Accuracy	

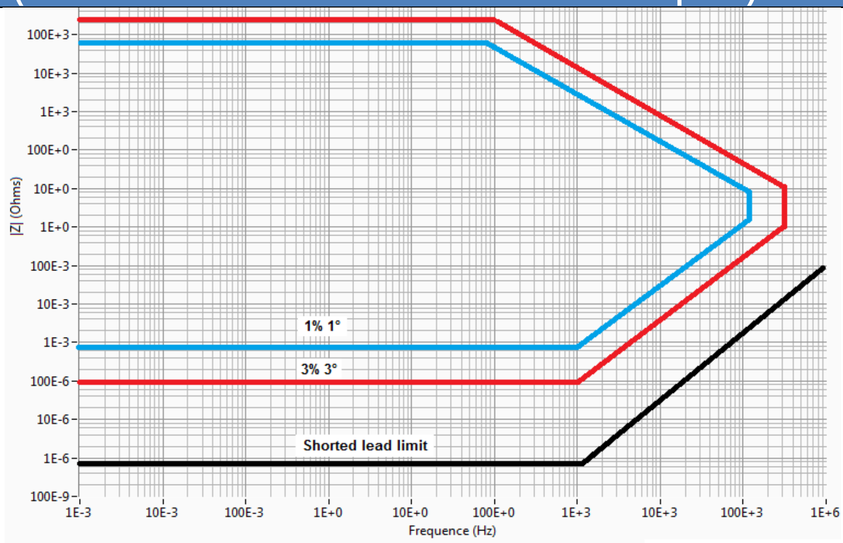


10.2.6 10 A/ 5V booster

Control amplifier	
Compliance voltage	0V; +5V
Compliance current	± 10 A
Control voltage	0V, 5V
Bandwidth (-3dB)	>8MHz
Operating area	

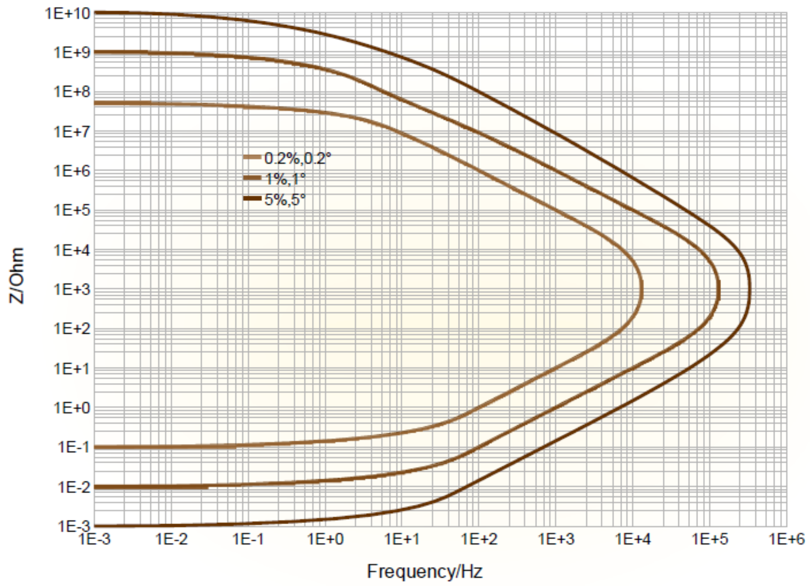


Slew rate (no load)	>50V/µs
Rise/Fall time (no load)	<200ns
Floating mode	yes
Parallel ability	Yes
Current accuracy	0.1% range
Impedance specifications (if booster board connected to board with EIS option)	
Accuracy	



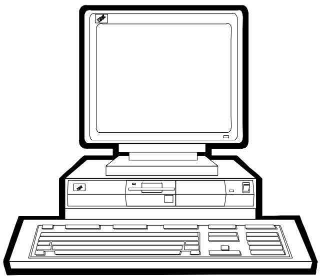
10.2.7 MP-MEA

General	
Number of channel	256
Swithching time	8 ms
Maximum Current	± 500 mA
Dimension	307 * 210 * 50 mm

Electrometer	
Impedance	<10^{10} Ohm//<3pF
Bias Current	<10 pA
Bandwidth	1 MHz
EIS accuracy with ULC	

10.3 PC requirements

Recommended:
- Pentium 2 GHz
- 512 Mo 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 amplifier 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.

12. EC declaration of conformity

12.1 SP-200

BioLogic
Science Instruments

Bio-Logic SAS
1, rue de l'Europe
F-38640 Claix
France

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_SP-200 Rev. A

We,

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

declare under our sole responsibility that the product,

SP-200 with cables

is 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: January 28, 2010

J-P Ourdouillie, Compliance Manager

François Goy, President

12.2 SP-240/SP-300

BioLogic
Science Instruments

Bio-Logic SAS
1 rue de l'Europe
F-38640 Claix
France

Tel.: +33 476 986 831
Fax: +33 476 986 909
Web : www.bio-logic.info

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

CE

DECLARATION OF CONFORMITY

N°: CETR_SP-240 Rev B

We,

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

declare under our sole responsibility that the products,

SP-240 with cables
SP-300 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: August 20, 2012

J-P Gurdouillie, Compliance Manager

François Goy, President

12.3 VSP-300

Bio-Logic SAS
1 rue de l'Europe
F-38640 Claix
France

Tel.: +33 476 986 831
Fax: +33 476 986 909
Web : www.bio-logic.info

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

CE

DECLARATION OF CONFORMITY

N°: CETR_VSP-300_Rev A

We,

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

declare under our sole responsibility that the products,

VSP-300 with cables
VSP-300 with 48V/1A & 14V/4A option

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: June 03, 2011

J-P Ourdouillie, Compliance Manager

François Goy, President

12.4 VMP-300

Bio-Logic SAS
1 rue de l'Europe
F-38640 Claix
France

Tel.: +33 476 986 831
Fax: +33 476 986 909
Web : www.bio-logic.info

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

CE

DECLARATION OF CONFORMITY

N°: CETR_VMP-300_Rev A

We,

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

declare under our sole responsibility that the products,

VMP-300 with cables

VMP-300 with Booster option

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: August 17, 2012

J-P Ourdouillie, Compliance Manager

François Goy, President

13. Glossary

This glossary is made for the user to understand most of the terms used in this instrument installation and configuration manual. The terms are classified in the alphabetical order.

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

Bandwidth: It depends on the electrochemical cell impedance. The bandwidths values are going from 1 to 9. Bandwidth selection is important for the stability of the potentiostat during measurement.

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 E_{we}).

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

Mixed DB-25: connector with 25 pins on the instrument front panel where the cable connecting the channel board and the electrochemical cell is set.

DB-9: connector with 9 pins on the instrument front panel used as auxiliary input/output.

DB-15: connector with 15 pins on the instrument front panel used to connect the channel board to the booster or to the calibration board.

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. With new improvements on the instrument, it is necessary to upgrade the firmware and the software to benefit of 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.

Low current: option providing a sub-aA resolution that can be added to each channel by the mean of a cable with an electrometer. This option extends the current range down to 1 pA with gain. This option can be added both to standard or Z option channel boards.

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

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.

14. Index