SP-50 / SP-150 Installation and Configuration Manual

BioLogic
Science Instruments

EC declaration of conformity

BioLogic
Science **Instruments**

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CE

DECLARATION OF CONFORMITY

N°: CETR_SP-150 Rev. B

We,

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

declare under our sole responsibility that the products,

SP-50 with cables
SP-150 with cables
SP-150 with Low Current option and 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 B
- 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: February 15, 2010

J-P Ourdouillie, Compliance Manager

François Goy, President

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 and designed for the good 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 SP-50 / SP-150 is an electrical laboratory equipment intended for professional and intended to be used in laboratories, 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 user can 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 and can involve malfunction of the instrument.
The user must also be careful 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.
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, must do adjustments, maintenance or repair

EQUIPMENT MODIFICATION

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

GUARANTEE

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

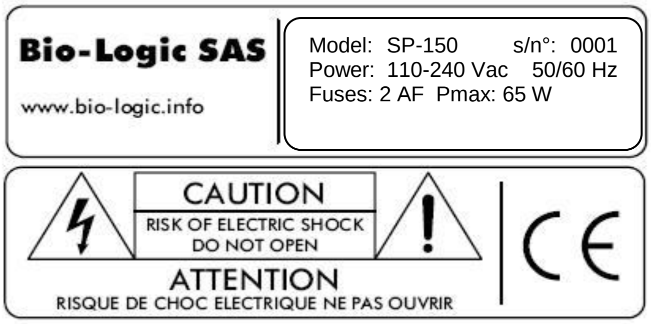
- Improper use of the device,
- Improper installation, operation or maintenance of the device,
- Operating the device when the safety and protective devices are defective and/or inoperable,
- Non-observance of the instructions in the manual with regard to transport, storage, installation,
- Unauthorized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

IN CASE OF PROBLEM

Information on your hardware and software configuration is necessary to analyze and finally solve the problem you encounter.

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

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



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

General safety considerations

Class I

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

Use only the power cord supplied with the instrument and designed for the good 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.

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

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- Improper installation, operation or maintenance of the device,
- Operating the device when the safety and protective devices are defective and/or inoperable,
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- Improperly executed and unauthorised 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 potential greater than +/- 10 Vdc

Operate on a non-flammable support

Table of contents

1. Introduction

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 either in galvanostatic mode or in potentiostatic mode (each channel was devoted to one of either mode). Then the interest for multichannel potentiostats increased with battery testing, corrosion study, and, recently, biosensors development. Now our multichannel product range has different modular Multichannel instruments that are both potentiostats and galvanostats: the VMP3, VSP, Bistat. Our range is completed with single channel potentiostat/galvanostats: the **SP-50** and **SP-150**. They can be used in most electrochemical applications from battery testing or intercalated compounds study to corrosion. We can also mention electrochromics, fuel cells, supercapacitors or biosensors study.

The **SP-50 / SP-150** consist of single computer board associated with one potentiostat channel board. The **SP-50** has its own operating system included on the computer board. When started, the on-board computer fully controls the experiment. One or more computers can perform full remote monitoring of the system. These computers are connected to the **SP-50 /SP-150** through an Ethernet connection or with an alternative USB connection (only one computer). With the Ethernet connection, different users are able to access the instrument, but the user remains locked when an experiment is running on the unit.

Note **SP-150** offer more options than **SP-50**. The main differences between both instruments are shown in the table below:

	SP-50	**SP-150**
Compliance adjustable	No	Yes
EIS option	No	Yes
LC option	No	Yes
External Current booster (2, 5, 10, 20, 80 or 100 A)	No	Yes

The **SP-50 / SP-150** potentiostat can control auxiliary instruments (such as rotating electrode or thermostatic bath) and record external signals such as absorbance, rotating speed, temperature and quartz microbalance variables (resistance and frequency).

The aim of this manual is to guide the user in the instrument installation and configuration. This manual is composed of several chapters. The first one is an introduction. It explains the abilities of the instrument. The four following parts concern the instrument’s installation and configuration and the configuration of the computer. The sixth chapter is dedicated to the explanation of advanced features. The accessories are described in the seventh part. Finally the last part describes the technical specifications.

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

Fig. 1: SP-50.

1.1 General description

The **SP-50 / SP-150** chassis can contain one potentiostat/galvanostat channel. For **SP-150** this board can have the EIS option and connect to a Low Current or High Current booster. The **SP-50** is a fixed configuration and supports only one standard potentiostat/galvanostat channel without EIS ability.

It can be set, run, paused or stopped at the user's convenience. Most of the settings of the channel can be modified during a run, without interrupting the experiment.

Simultaneous measurements of the current and potential of the working electrode are performed continuously, using two 16-bit Analog to Digital Converters. This allows the user to make true power or noise measurements.

Once the techniques have been loaded and started from the PC, the experiments are entirely under the control of the instrument's on-board computer. It temporarily buffers data and regularly transfers the data to the PC, which is used for data storage, on-line visualization, on-line and off-line data processing and fitting.
This architecture ensures a very safe operation since a shutdown of the monitoring PC does not affect the experiments in progress on the instrument.

1.2 Software features

The potentiostat/galvanostat is controlled either with EC-Lab® Express or EC-Lab® software. An electrochemical experiment is a set of open circuit sequences and galvanic sequences, measuring the potential in both cases, and applied potential sequences, measuring the current.
Typical electrochemical techniques, such as Cyclic Voltammetry, Chronopotentiometry, etc.., are obtained by associations of elementary sequences, and appear as flow-diagrams combining these sequences.

Conditional tests can be performed at various levels of any sequence 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, loop to a previous sequence, or end the sequence.

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 and 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® and EC-Lab® Express software in the software manuals.

Its design makes the SP-50 a recommended potentiostat/galvanostat for education and for new researchers learning their experience in electrochemistry. It can support most of the electrochemical applications from corrosion to general electrochemistry.

Its design makes the SP-150 a very versatile single potentiostat/galvanostat. It can support most of the electrochemical applications from corrosion experiments to research on batteries, super-capacitors or electrochromics. It is also a very well adapted tool for sensors and actuators applications.

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. Instrument installation

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 and designed for the good 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.

2.1 Connections

Depending on your local installation, you can use a direct connection (1 PC to 1 SP-50 / SP-150) or a network connection (1 or several PCs to 1 or several SP-50s / SP-150s).

2.1.1 Direct connection

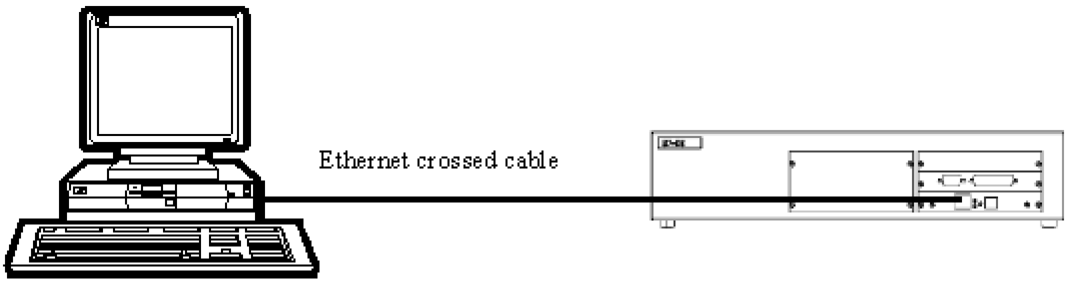


Fig. 2: Ethernet crossed cable for direct connection.

2.1.2 Network connections

Several PCs can be connected to the same SP-50 / SP-150 through the network.
WARNING: check IP addresses before connecting to avoid conflicts (see TCP/IP configuration chapter).

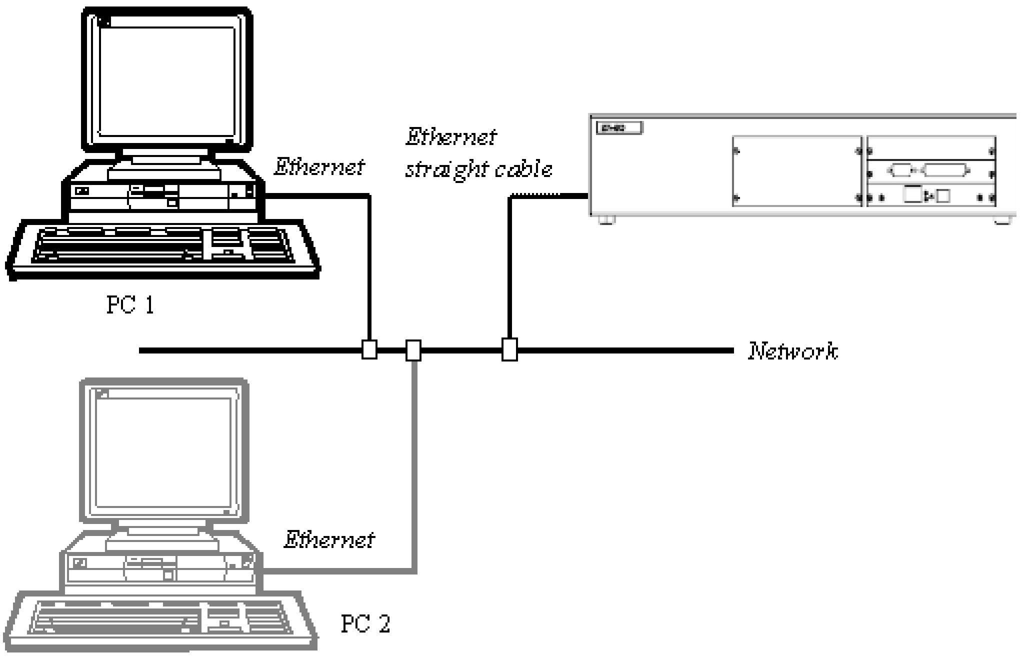


Fig. 3: Ethernet straight cable for network connection (1 SP-50 / SP-150, several PCs).

Alternatively, a single PC can control several SP-50s / SP-150s through the network.

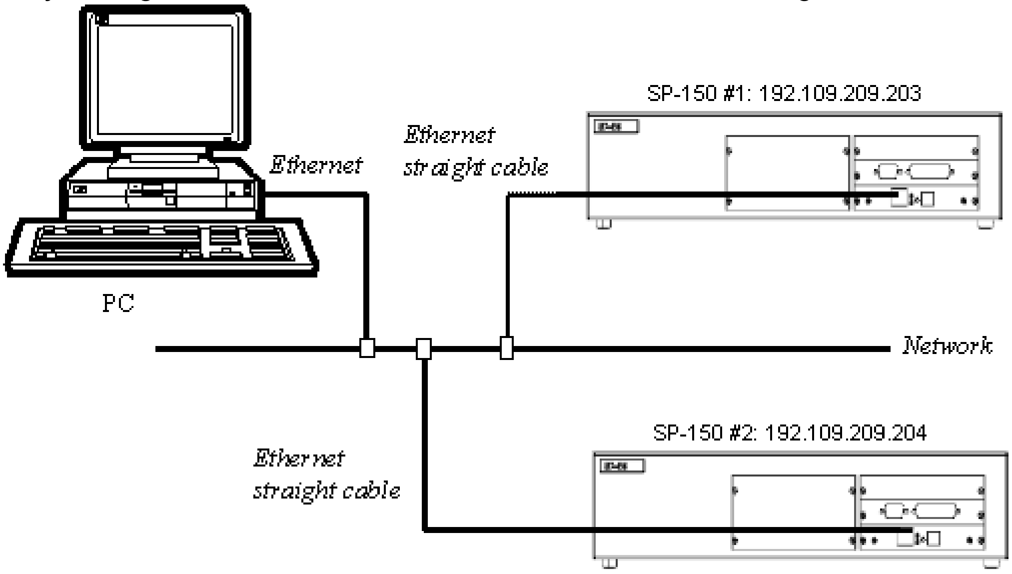


Fig. 4: Connection of 1 PC to several SP-50s / SP-150s.

2.2 Cell connections

2.2.1 Connection of the standard channel board to the electrochemical cell

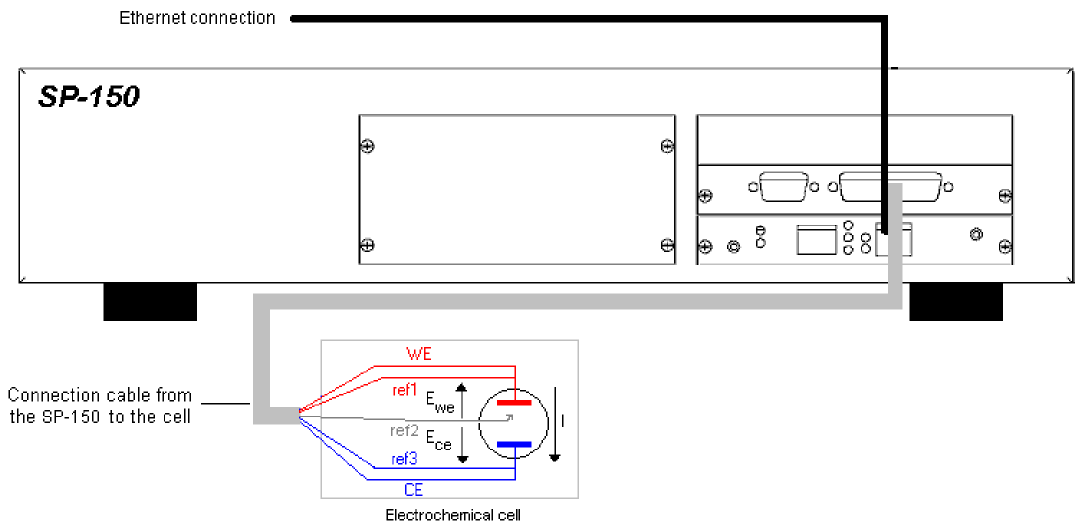


Fig. 5: SP-50 / SP-150 channel board connection to the cell.

The cell cable is 1.5 m long with a DB25 connector on the channel board side and 5 terminals (2 mm plugs) to connect to the cell.

2.3 Current booster

The channel of the SP-150 can be equipped with a current booster (2A to 100 A). One or two cables are used for the connections depending on the use of a booster.

2.3.1 Connection of the standard channel board to the cell through a booster

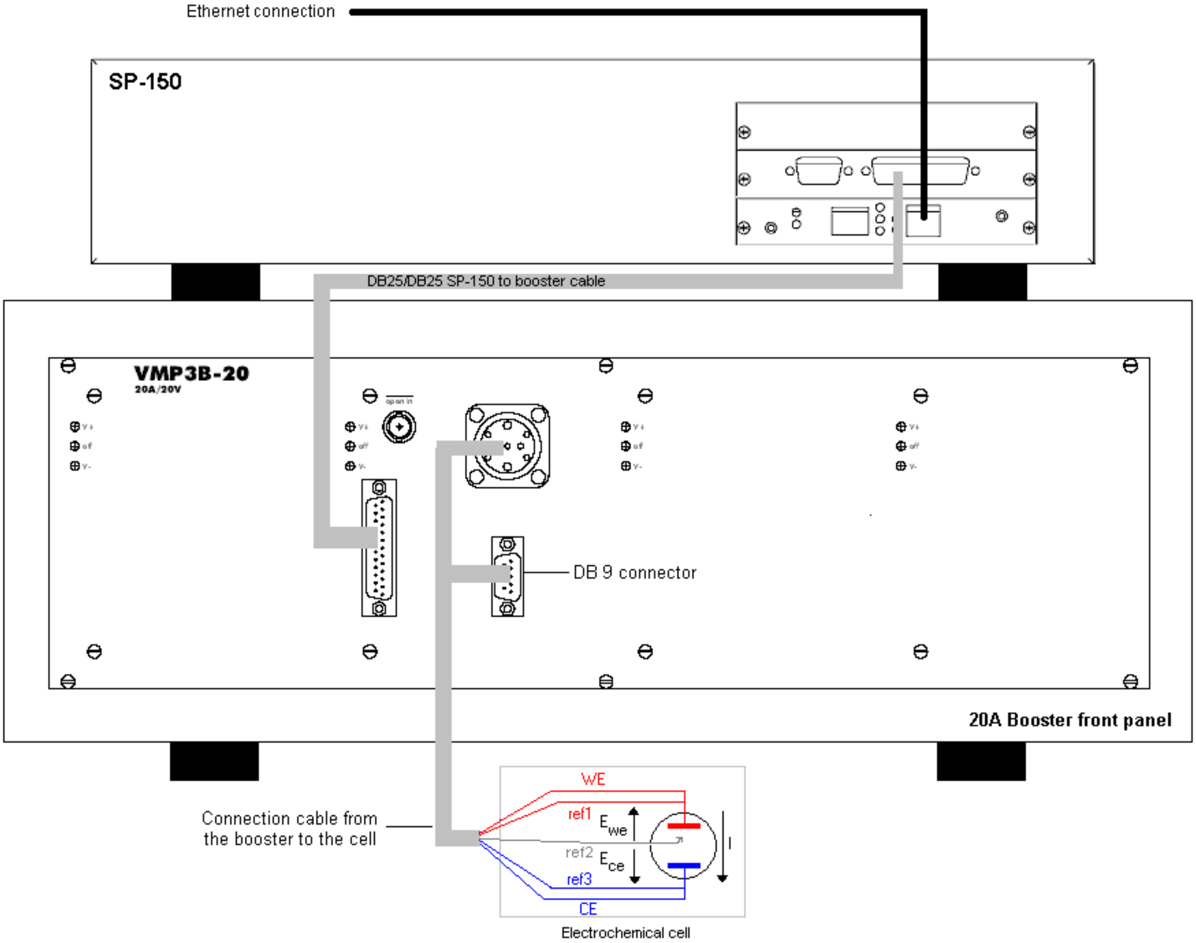


Fig. 6: SP-150 to booster and booster to cell connections.

The instrument to booster cable is 0.8 m long with a female DB25 connector on each side. The booster to cell cable is 1.5 m long. It is ended by 5 terminals to connect to the cell: 2 for the current (4 mm banana plugs) and 3 for the potential (2 mm banana plugs).

2.4 Low Current option

The channel of the SP-150 can be equipped with the "p" low current option providing a sub-pA resolution. This option extends the current ranges down to 1 nA with a resolution better than 0.1 pA.
A SP-150 standard channel with the "p" low current option features 10 current measurement ranges in fixed or auto-ranging mode. The "p" low current option inherits all the standard board benefits: impedance measurements (if standard channel is a Z version), 2 electrometers, simultaneous recording of the potential and current, high speed acquisition, DSP technology, 20 V adjustable control range, 2 auxiliary inputs per channel, and up to 5 terminal measurements.

Fig. 7: The 'p' low current option.

The "p" option improves some of the specifications like the electrometers input bias current which is typically less than 100 fA or the input impedance at least 10^{14} Ω in parallel with no more than 1 pF. All these performances make a SP-150 with the "p" low current option best suited for research on insulators, coatings, thin film electrodes, dielectric materials, microelectrodes, sensors, low conductive medium, and biological interfaces.

2.4.1 Installation

The "p" low current option physically consists of a board and a probe, a small box to be placed close to the cell and cables. The "p" low current option must be installed in series with a standard channel board (with EIS option or not). The connection between the standard channel and the "p" low current option is performed using a supplied ribbon cable.
Installing a "p" low current option in a SP-150 is a question of a few minutes and can be performed on site (preferably by an electronic technician) providing that minimum precautions are used.

Fig. 8: Standard channel installed.

Fig. 9: Standard channel connected to a 'p' low current board.

2.4.2 Calibration

Once installed and connected to its adjacent standard channel, the 'p' low current option must be calibrated using EC-Lab®. Calibration is necessary only once.
WHEN THE "P" LOW CURRENT BOARD IS PROVIDED WITH A NEW INSTRUMENT, IT IS NOT NECESSARY TO DO THE CALIBRATION. IT HAS BEEN ALREADY DONE AT THE FACTORY.

Note: 1) The supplier recommends calibrating the channel boards and the "p" low current boards two or three times an year, especially if the room where the instrument is located is sensitive to temperature variations.
2) A new instrument is delivered with calibrated channel board and calibrated "p" low current board.

Select the **Tools/Channel calibration…** menu in EC-Lab® (see paragraph 8).

As only one channel is available, select this channel and click on the **Calibrate** button and follow the instructions to calibrate the channel and the associated "p" option. You will be asked to perform some specific actions (cell cable connections and disconnections) during the calibration procedure. Note that new firmware is loaded on the channel during the calibration. The channel will be reinitialized after calibration.

2.5 Cable connection to the cell

This paragraph explains how to connect an instrument channel to a cell using the standard 1.5 m cable provided with the instrument.
In the standard configuration, a an instrument channel has 6 lead connections 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 an additional voltage. Additionally a 6th ground lead is provided for cell shielding purposes or for a particular cell arrangement like in multi-pitting protocols. This lead is especially used in the CE to ground mode. To be easily identified, each lead has an associated color and label as follows:

- REF1: RED – Reference 1 for the control and measurement of the working electrode potential.
- REF2: WHITE – Reference 2 for the control and measurement of the Reference electrode potential.
- REF3: BLUE – Reference 3 for the control and measurement of the Counter electrode potential.
- CA2: RED – Control Amplifier for the current control and measurement flowing through the working electrode (in standard mode).
- CA1: BLUE – Control Amplifier for the current control and measurement flowing through the counter electrode (in standard mode).
- GND: BLACK – Ground connected to REF1 in the CE to Ground mode.

The internal structure of the instrument has led to the building of two different connection modes: “Standard” and “CE to Ground”.

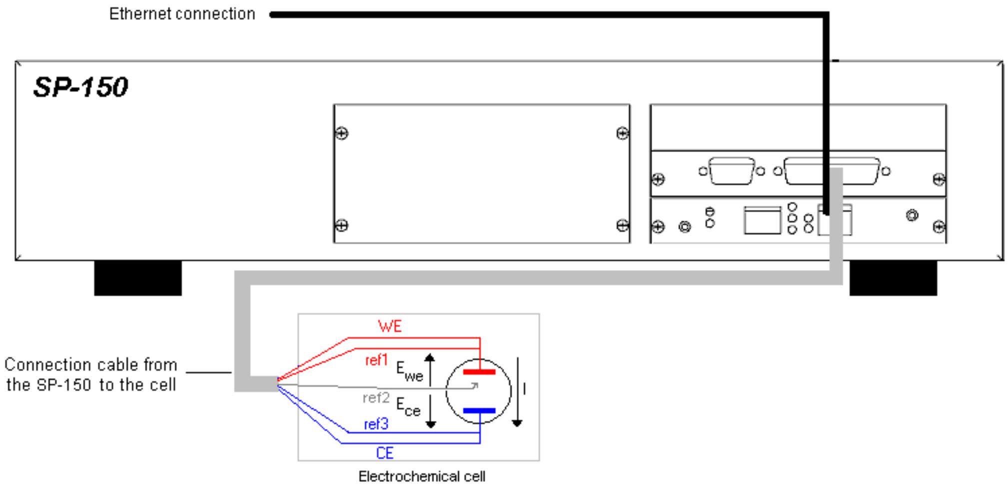


Fig. 10: Channel board connection to the cell.

2.5.1 Standard connection

A channel has the possibility to link up with 2, 3 or 4 electrodes in different configurations depending on the electrochemical cell. In the standard mode E_{we} and E_{ce} are measured as follows:

E_{we} = REF1 - REF2

E_{ce} = REF3 - REF2

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

2.5.1.1 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 REF1+CA2. The counter-electrode is connected to REF3+CA1 and the reference electrode is connected to REF2.

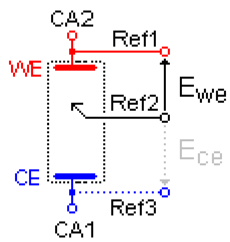


Fig. 11: Standard three-electrode connection for a classical metal-solution interface.

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

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

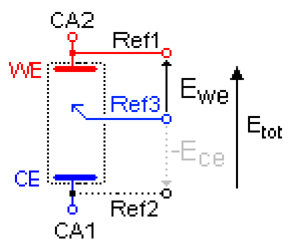


Fig. 12: Three-electrode connection with a reference electrode.

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

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

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

2.5.1.2 Two-electrode connection to a battery cell

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

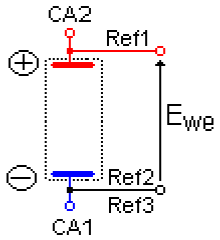


Fig. 13: Two-electrode connection to a battery cell.

2.5.1.3 Four-electrode connection for liquid-liquid interfaces

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

In the standard connection mode, REF1 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 REF1 directly on the cell electrode and not to the CA2 cable.

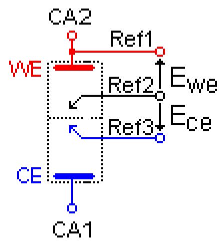


Fig. 14: Four-electrode connection for a liquid – liquid interface.

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

2.5.2 CE to Ground connection mode

This connection mode is chosen in the EC-Lab® software "Advanced settings" window. Then the connections must be done in a special way, in connecting the CA1 (CE) cable to the WE of the cell and the ground cable to the CE electrode of the cell, as shown below:

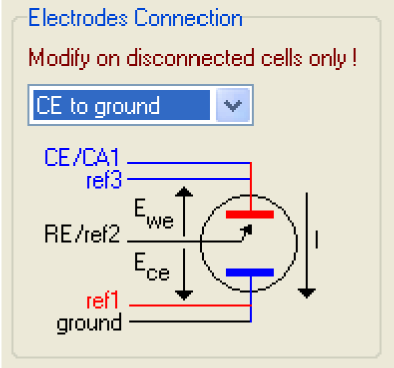


Fig. 15: CE to Ground connection mode.

2.6 Channel DB25 front panel connector

Front view

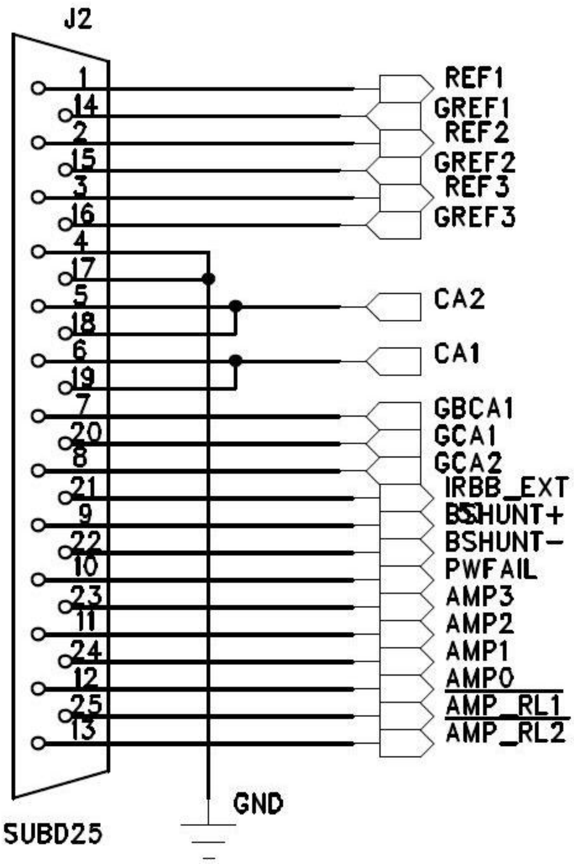


Fig. 16: Scheme of the DB25 connector

2.7 Power supply

Power supply connection is on the rear panel of the SP-50 / SP-150 chassis and current booster units.

2.8 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.

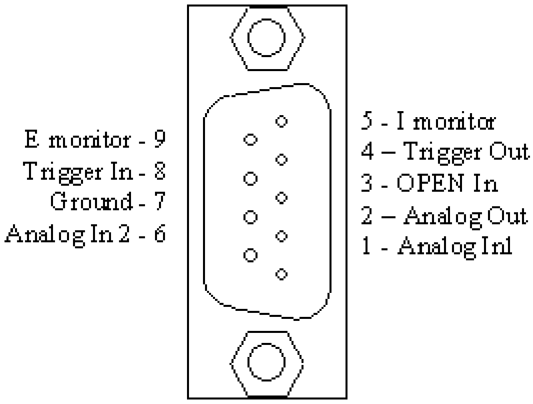


Fig. 17: Structure of a DB9F connector.

Trigger In and ***Trigger Out*** are programmed in the experiment protocol. Trigger In can be used to start or stop the experiment of electrochemistry. In that case another instrument sends a trigger to the instrument. Trigger Out can be sends at the beginning or 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

E monitor and ***I monitor*** are outputs that visualize I and E on a scope. The output variables are opposite to the real measured values.

OPEN In is an external Trigger signal (active high) that can open the relays providing 0 A current in the cell. For example, an emergency stop may come from an external event.

Ground is tied to the earth.

Analog Out is used to control external device.

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.

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

Fig. 18: DB9-8BNC cable.

3. Software installation on the computer

Before to turn on the instrument, it is recommended to install the software EC-Lab® 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®.

3.1 EC-Lab software installation

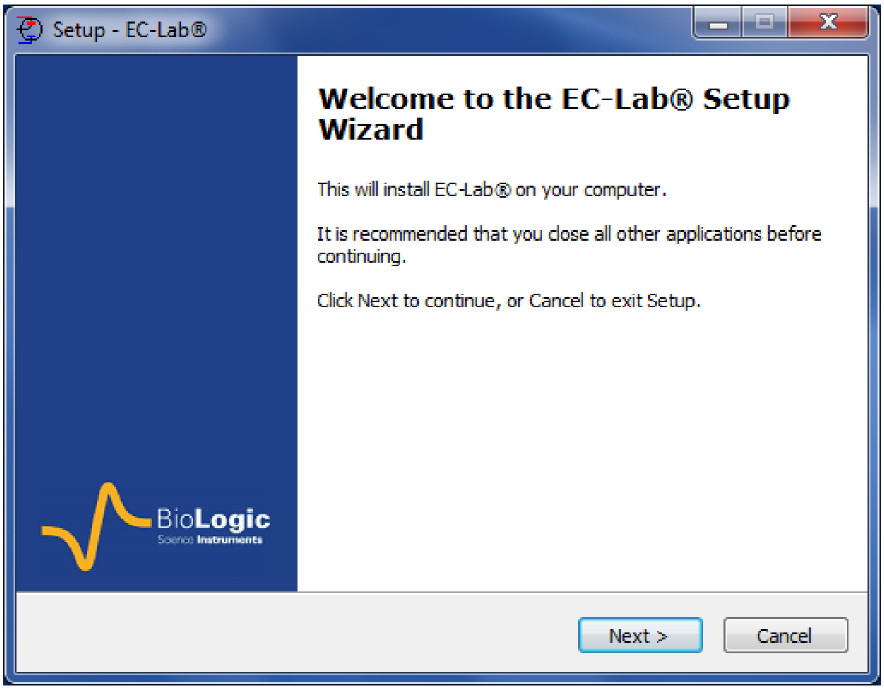


Fig. 19: EC-Lab® software installation (1).

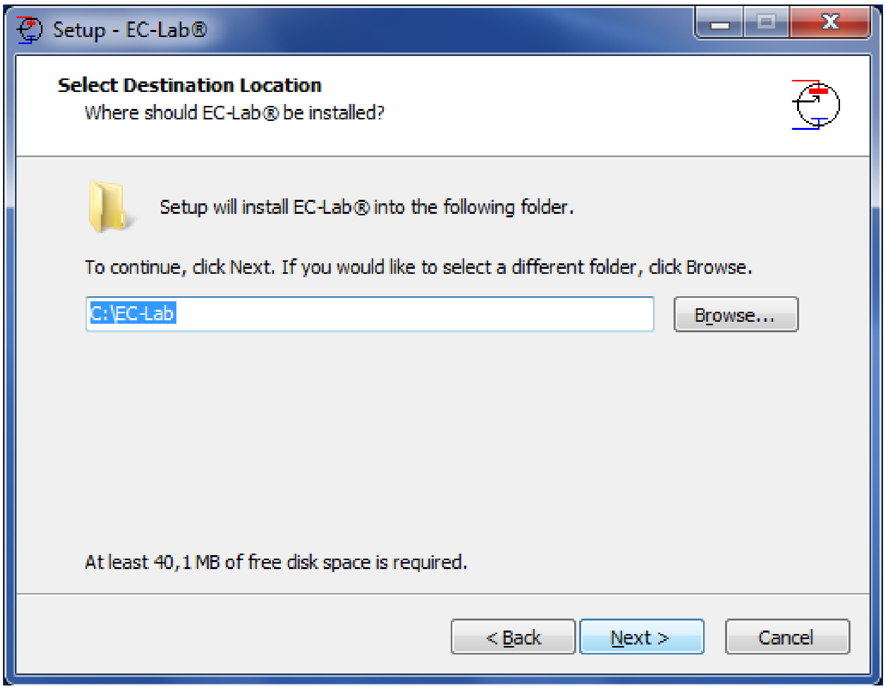


Fig. 20: EC-Lab® software installation (2).

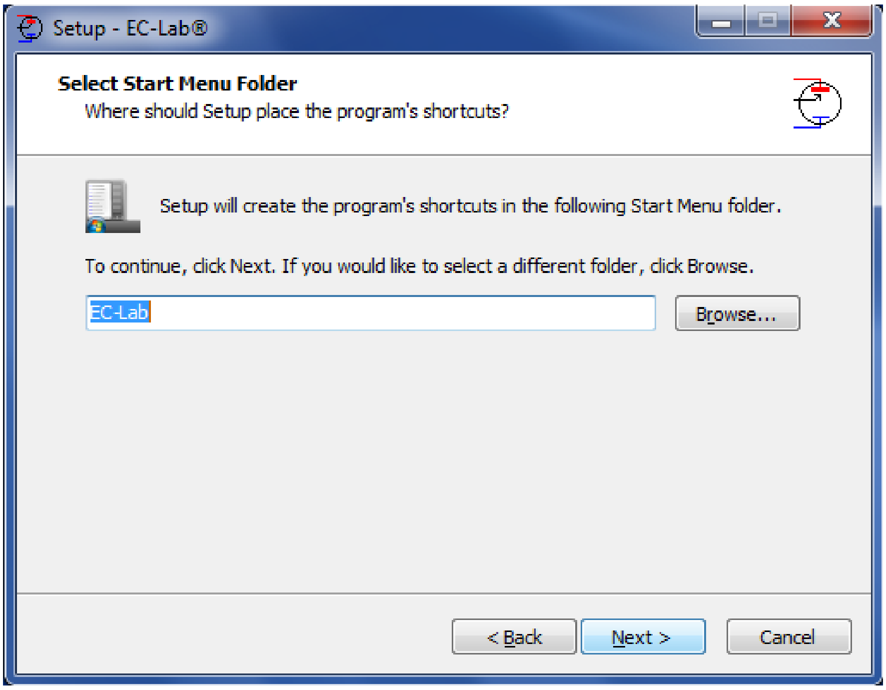


Fig. 21: EC-Lab® software installation (3).

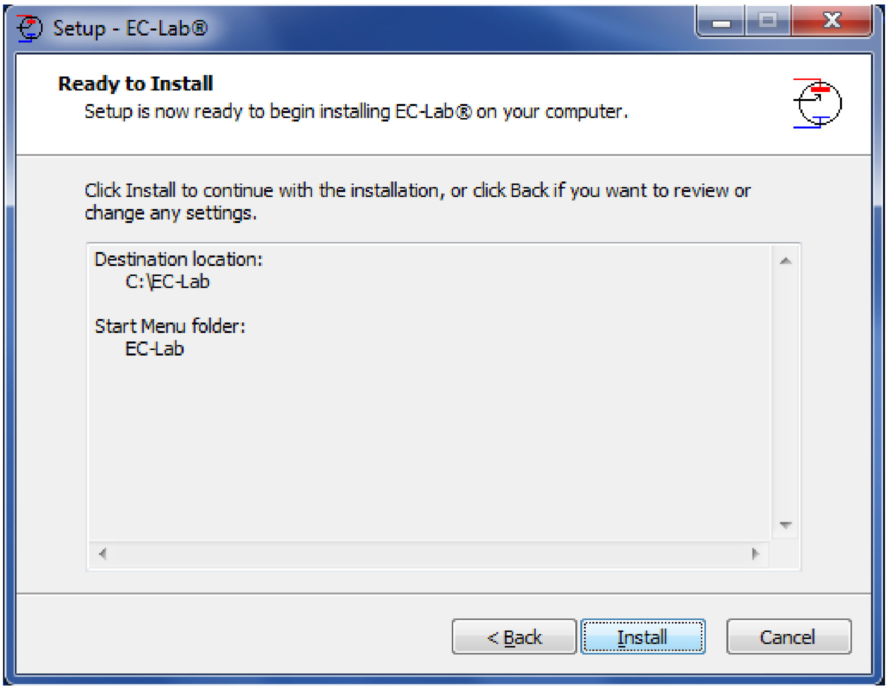


Fig. 22: EC-Lab® software installation (4).

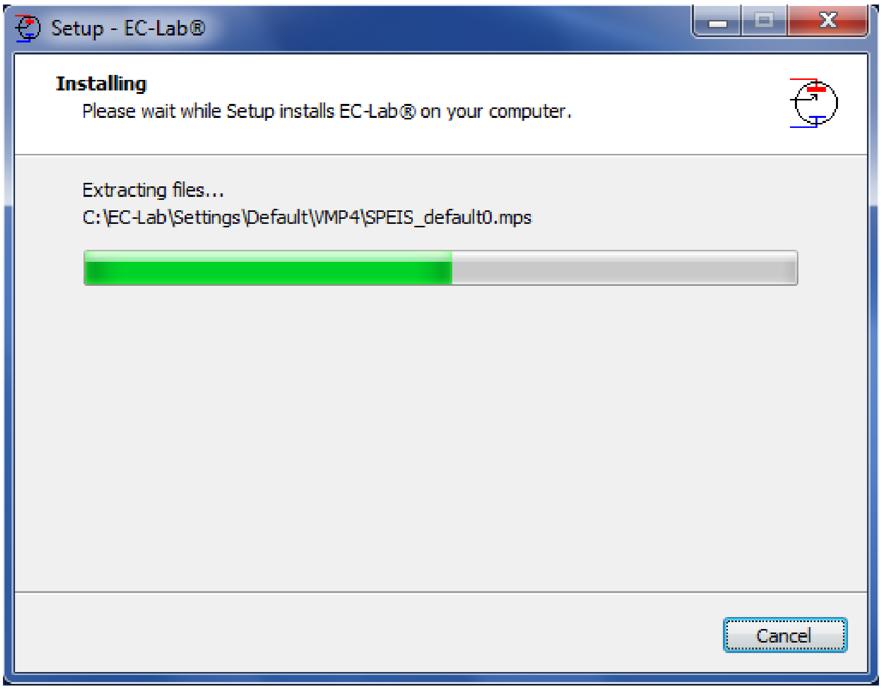


Fig. 23: EC-Lab® software installation (5).

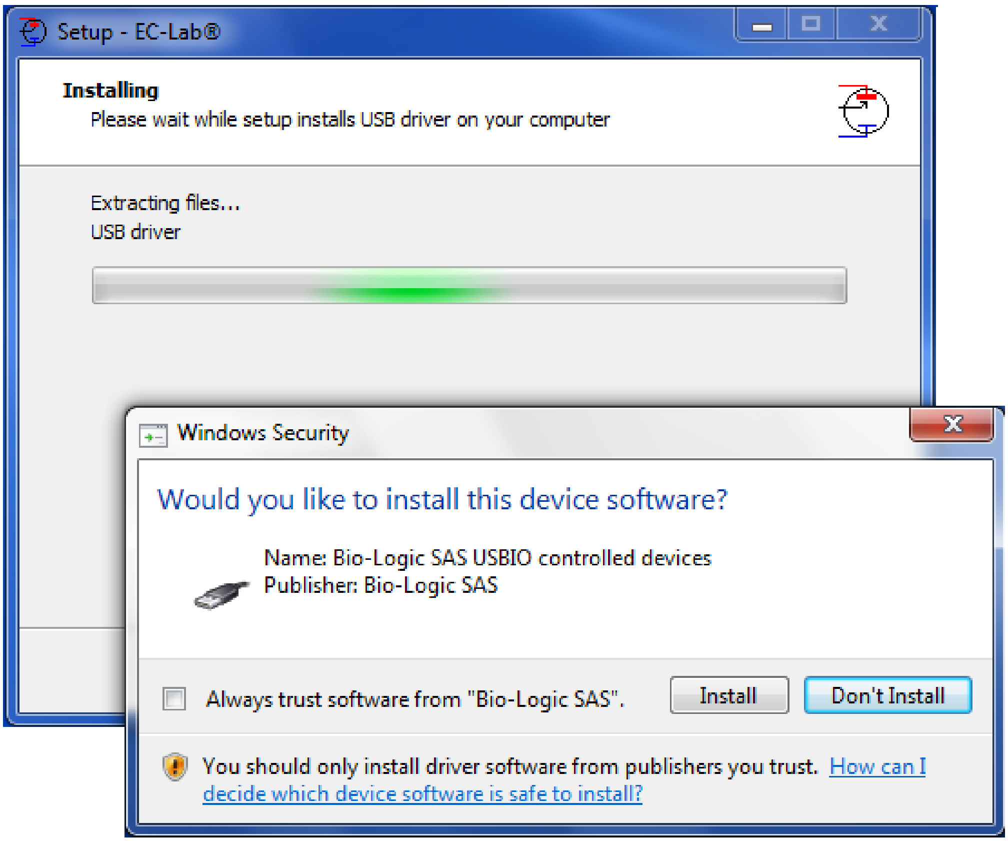


Fig. 24: EC-Lab® software installation (6).

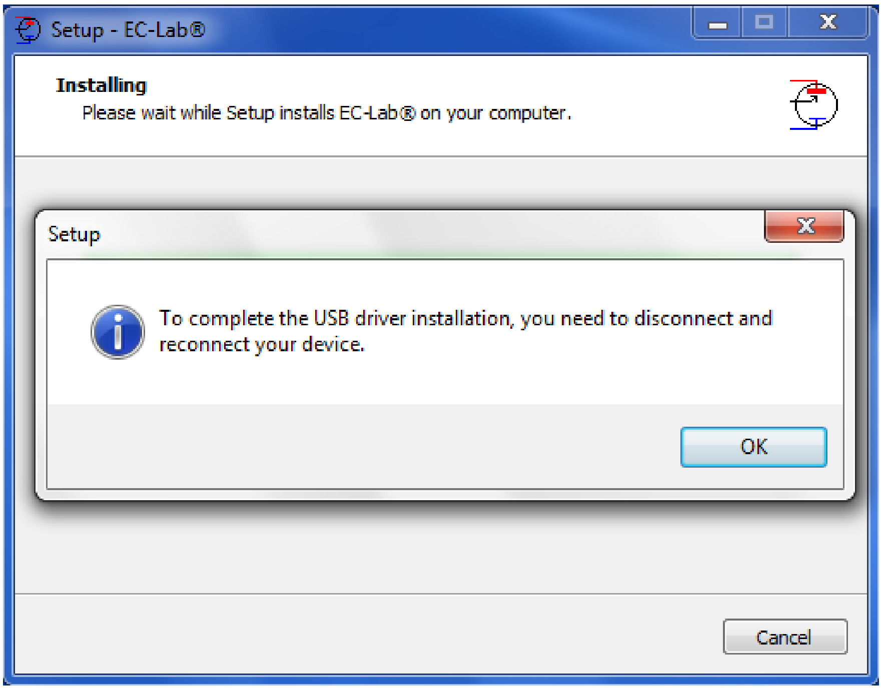


Fig. 25: EC-Lab® software installation (7).

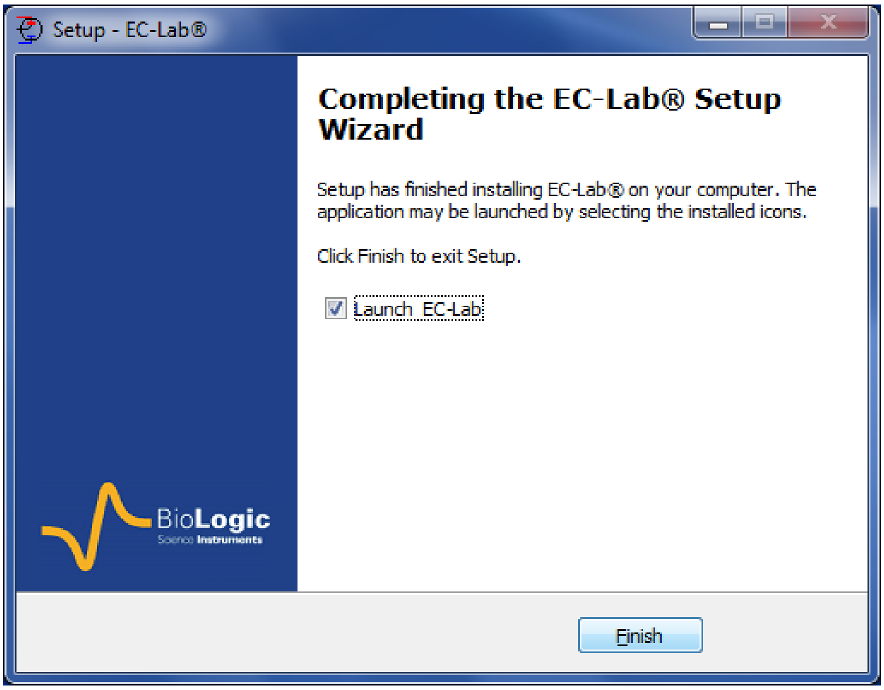


Fig. 26: EC-Lab® software installation (8).

At the end of the installation, the instrument connected by USB is detected and ready to get used.

3.2 EC-Lab® Express software/OEM package installation

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

3.3 Errors during the installation

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

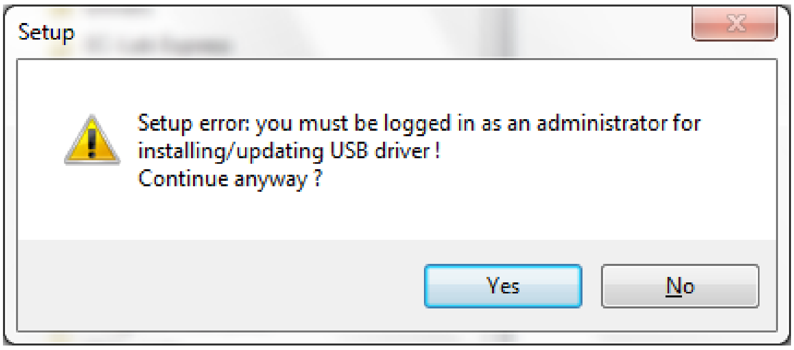


Fig. 27: EC-Lab® software installation (9).

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

4. PC installation and configuration

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

4.1 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):

192.168.0.2 (PC)

192.168.0.1 (SP-50/SP-150)

But, 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 by other 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:

192.109.209.202 (PC)

192.109.209.201 (SP-50/SP-150)

4.1.1 Windows configuration

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 the computer an IP address. The following part describes how to give an IP address to the computer:

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

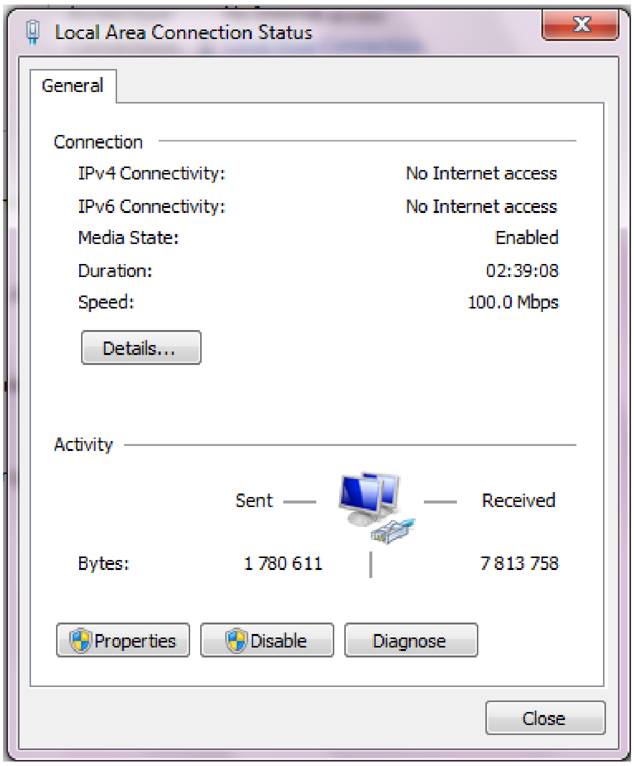


Fig. 28: Local Area connection status.

On the "**General**" tab, click on **Properties**. This will load the following window:

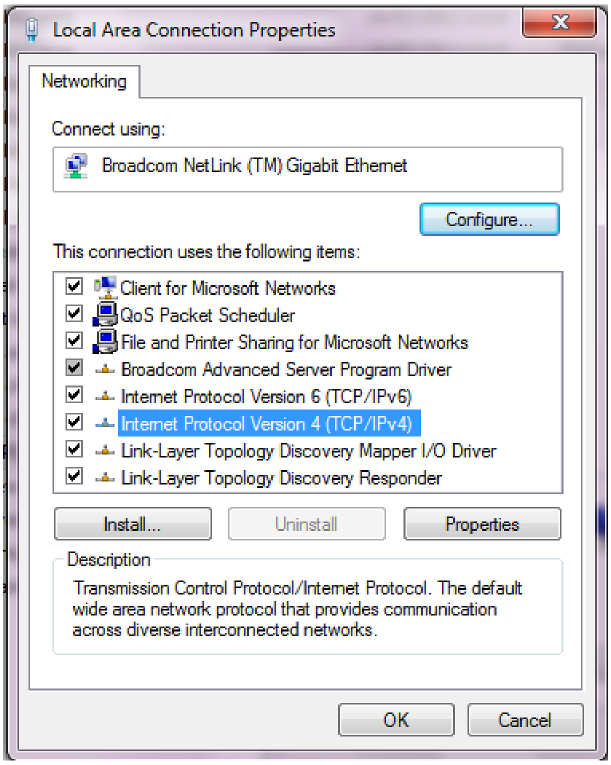


Fig. 29: Network window.

2- Select **Internet Protocol (TCP/IP)** and click on the **Properties** button. The following window appears:

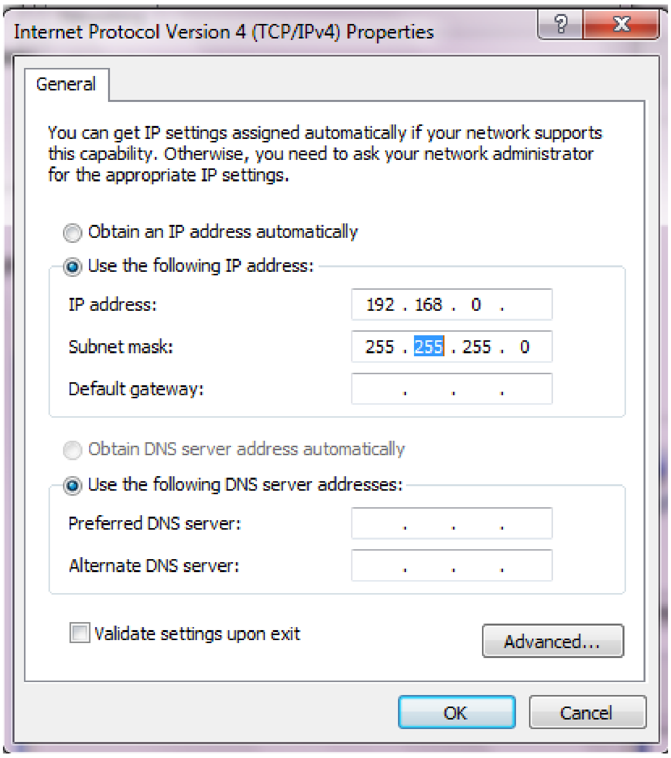


Fig. 30: TCP/IP properties window.

3- At this point of the installation, the user must activate the "**Use the following IP address"** box. The next step consists of entering the PC's IP address.
WARNING: THERE MIGHT BE ANOTHER TCP/IP PROTOCOL INSTALLED CALLED "TCP/IP DISTANT ACCESS", DO NOT CLICK ON THIS LINE!

4- Enter the PC's **IP address**, DO NOT ENTER A NETWORK MASK (it will automatically be added), and click on the OK button.
WARNING: IP ADDRESS MUST BE UNIQUE IN A NETWORK

5- Restart the PC. Now the PC and the SP-50/SP-150 are in the same network.

4.2 USB driver installation

The SP-50/SP-150 can use an 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 operation system of the computer.
We highly recommend that the user works with **at least** Windows© 2000 to control the potentiostat through an USB connection.

4.2.1 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:

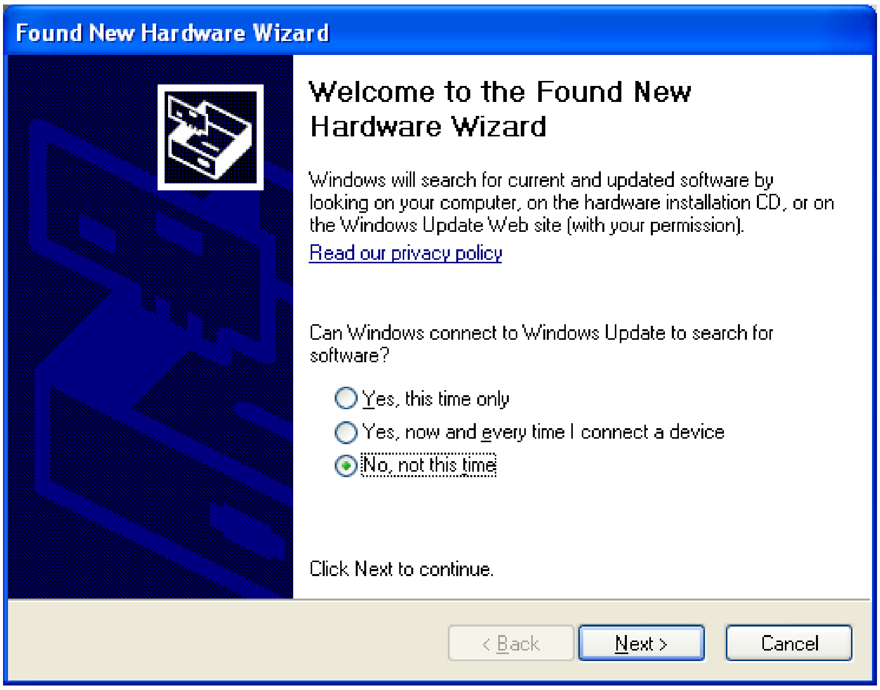


Fig. 31: USB device installation window (1).

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

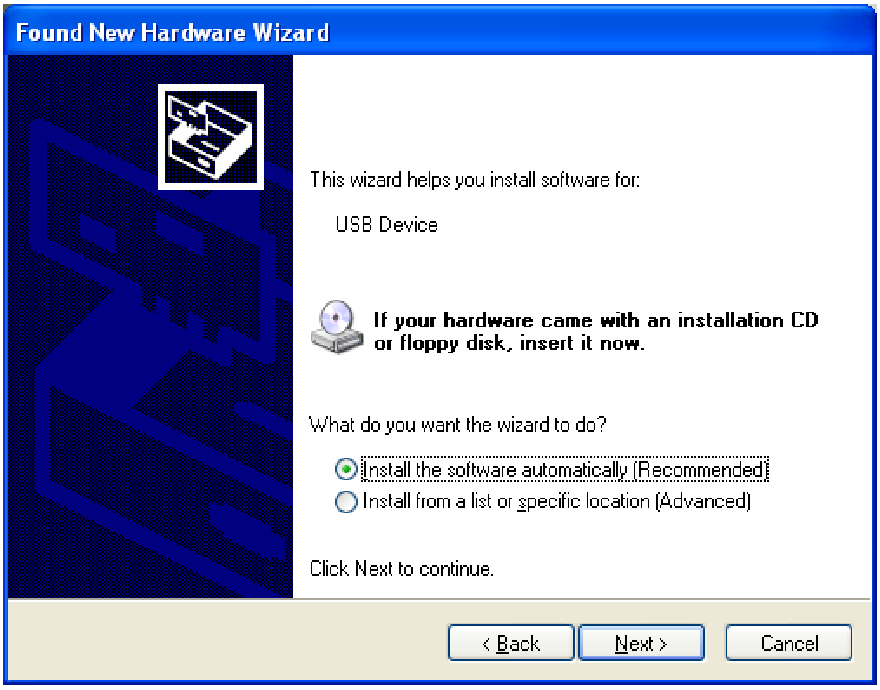


Fig. 32: USB device installation window (2).

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.

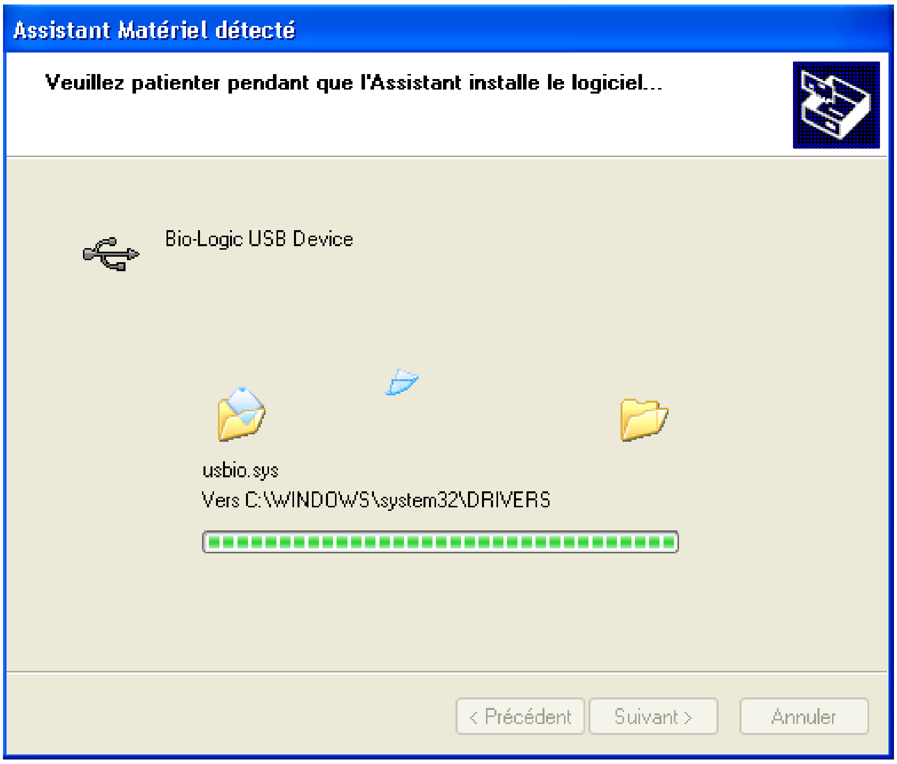


Fig. 33: USB device installation window (3).

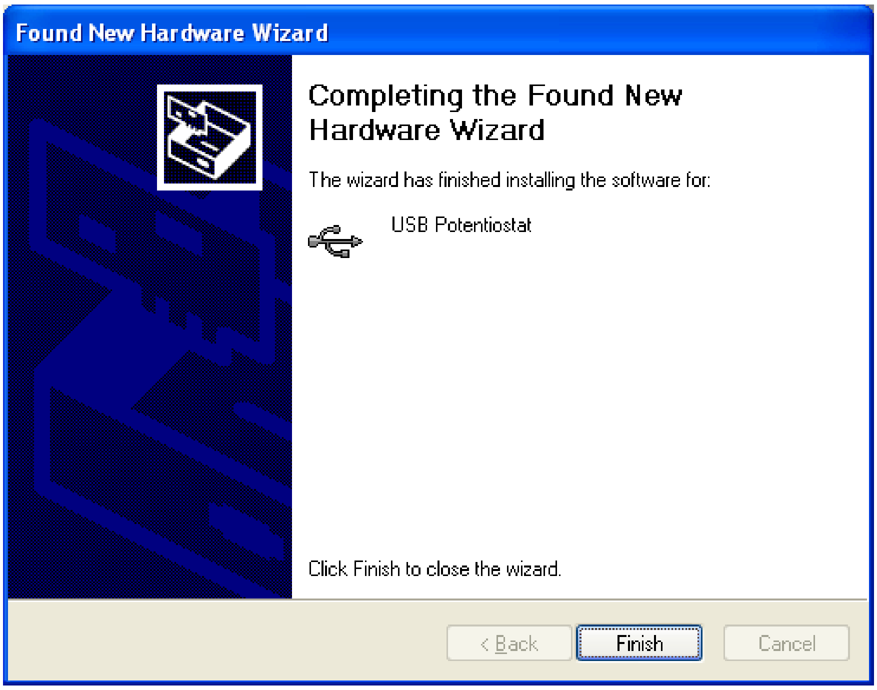


Fig. 34: USB device installation window (4).

Click on Finish. The potentiostat can now be connected to the computer through an USB connection.

Note: It is not necessary to restart the computer after this installation.

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

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.

4.2.2 Windows Seven and Vista installation

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

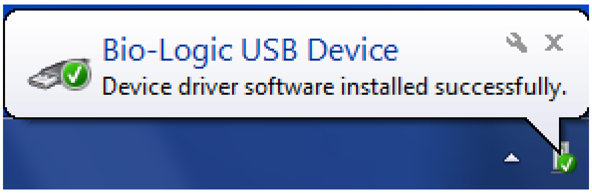


Fig. 35: USB device installation for Seven and Vista.

4.2.3 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.

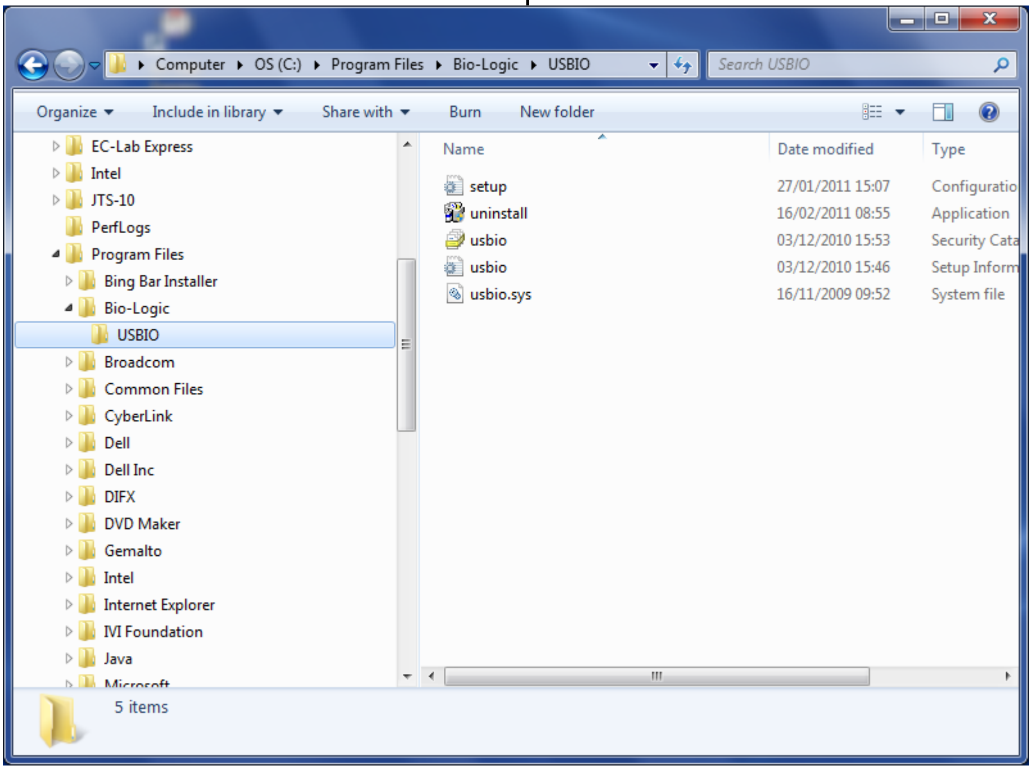


Fig. 36: Uninstall USB driver (1).

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

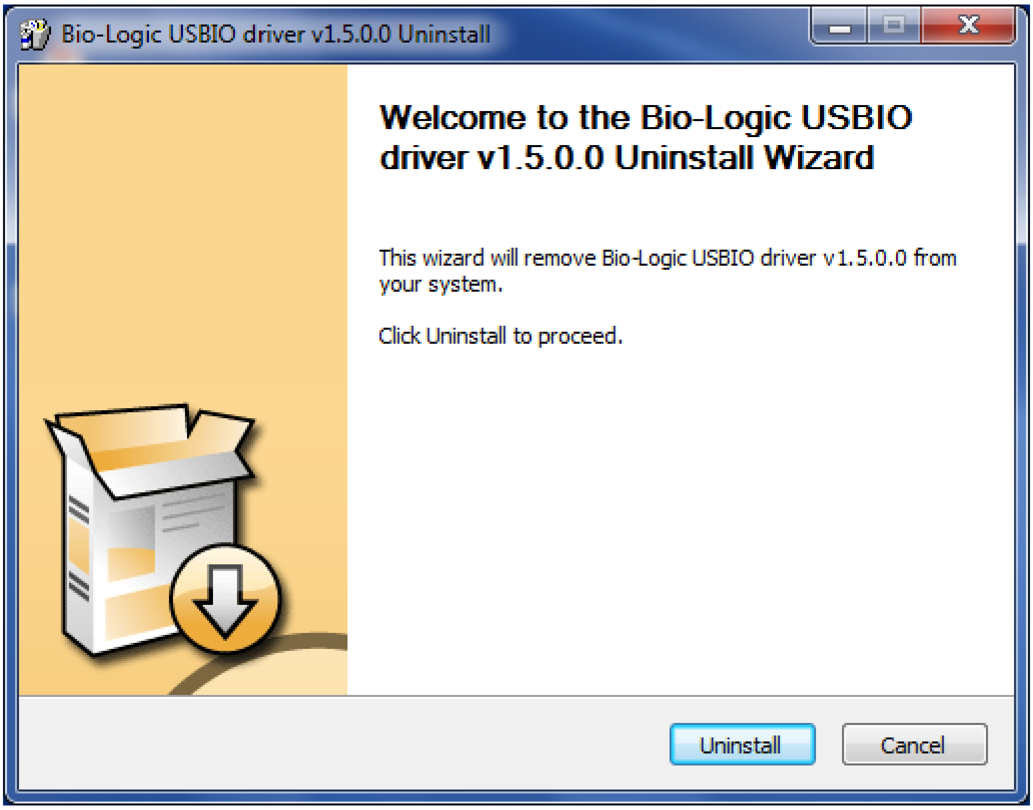


Fig. 37: Uninstall USB driver (2).

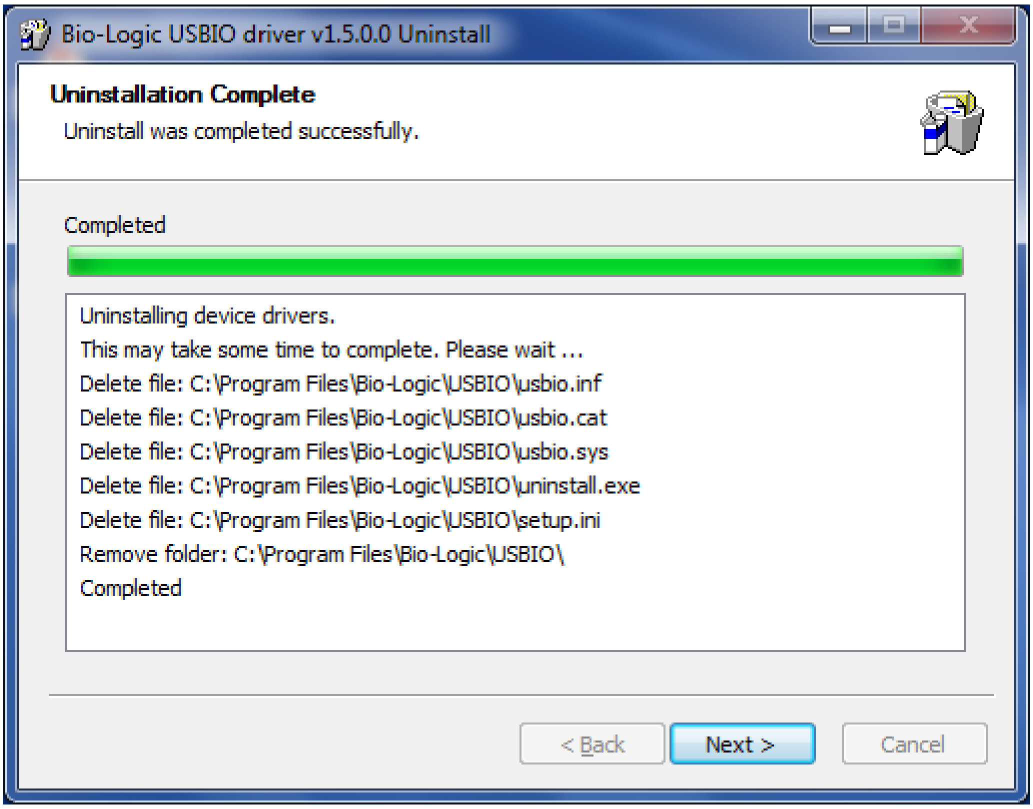


Fig. 38: Uninstall USB driver (3).

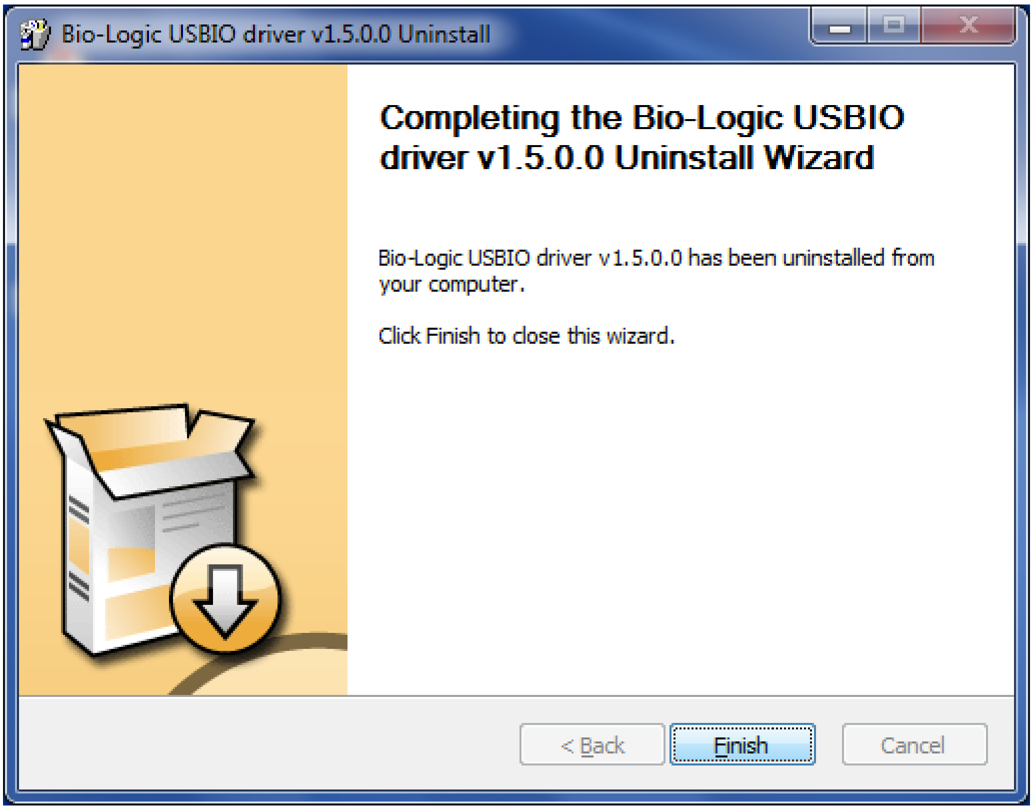


Fig. 39: Uninstall USB driver (4).

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

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 in 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). Now new instruments are delivered with the following IP address commonly used as default: **192.168.0.1**. You can either manage your instrument directly with the computer (direct connection with the crossed 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 including 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 Connection to the computer with EC-Lab® software

The procedure to connect your computer directly or via the network to the instrument is as follows. Use the crossed Ethernet cable or USB cable for a direct connection and a straight cable for the network connection.

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

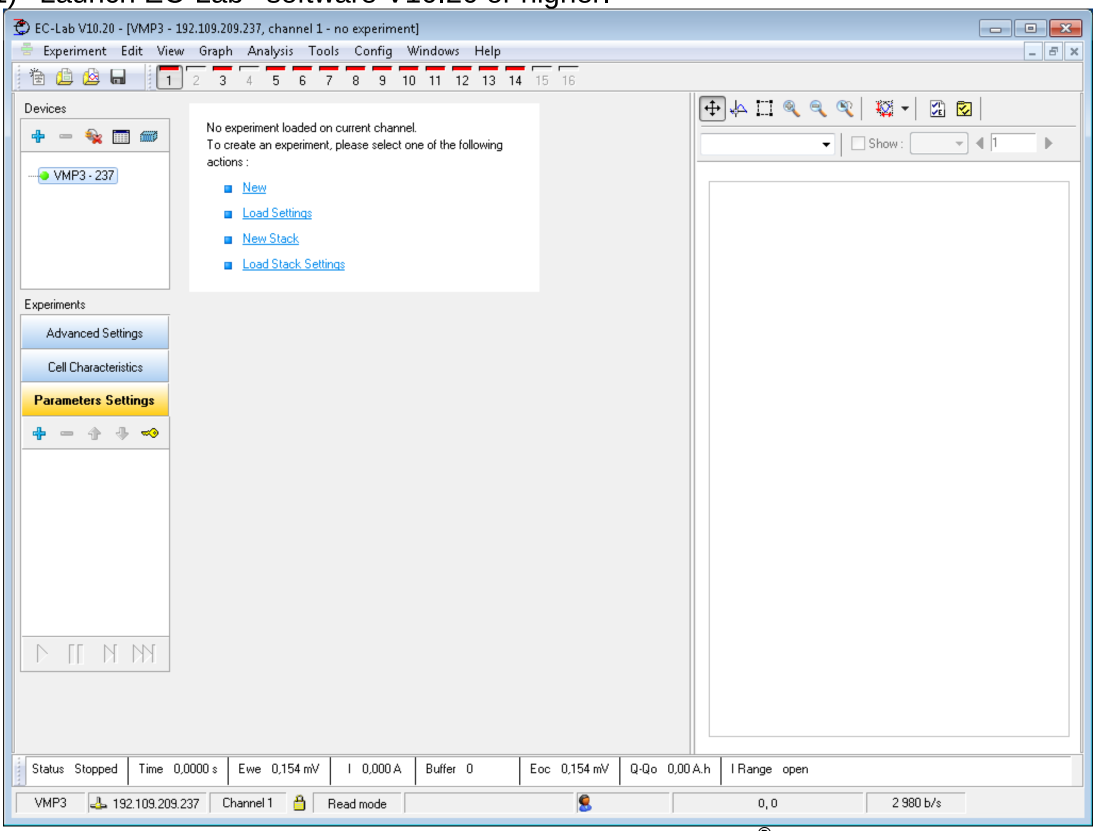


Fig. 40: Main window of EC-Lab®.

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

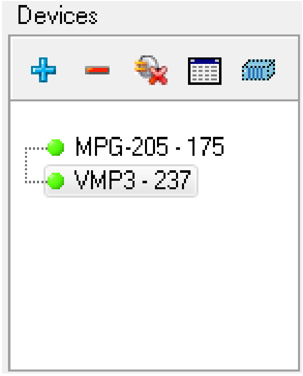


Fig. 41: “Devices” frame for connection.

Note: This step is required only for 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. below appears. Click on “**Refresh**” to see the instruments present on your network.

Note: The automatic search frame shows the name of the instruments detected with their serial numbers (#). A MAC address is given to each instrument at the factory. The MAC address is used to detect the instrument in a LAN even if its IP Address is not valid in the network. It is also used for the detection of instruments connected by USB.
Automatic detection will give a list of instruments detected (except VMP1 and firsts VMP2).

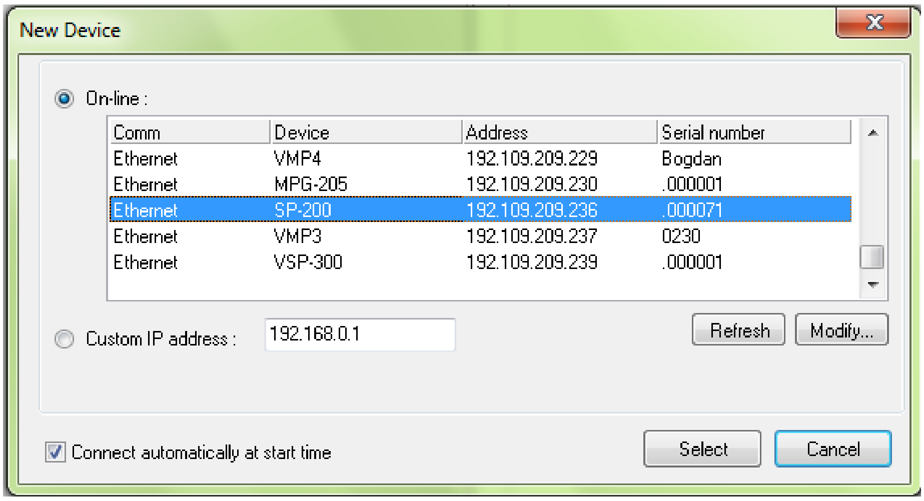


Fig. 42: “New Device” window to select and add an instrument to the current devices.

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 paragraph).

5) The instrument selected appears in the list displayed in the "**Device**" frame. Then, the connection is established automatically.

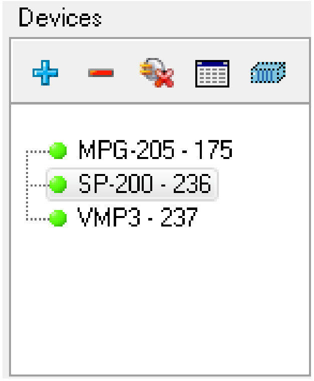


Fig. 43: "Devices" frame for connection with the new device.

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 same IP addresses or not in the appropriate network, IP address has to be changed.
On the "New device" window select the desired instrument and click on "**Modify**". The following window then appears:

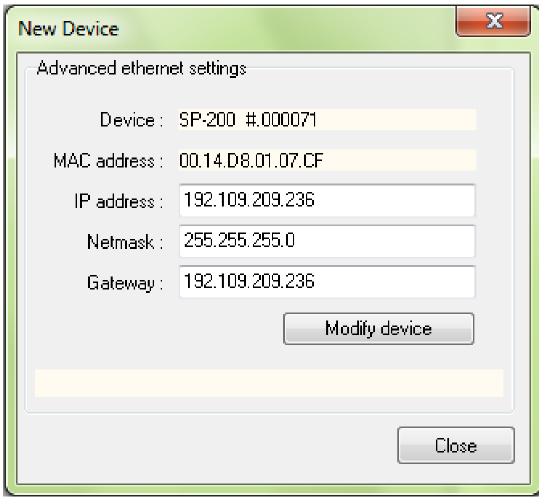


Fig. 44: "Advanced Ethernet settings" of the "New Device" window used to change the instrument IP Address.

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 indicating that the communication board is reinitialized with the new IP Address. "Configuration changed" appears at the bottom of this window.

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.

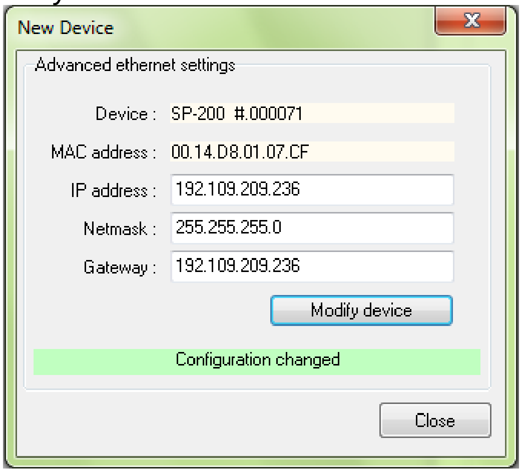


Fig. 45: New configuration.

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.

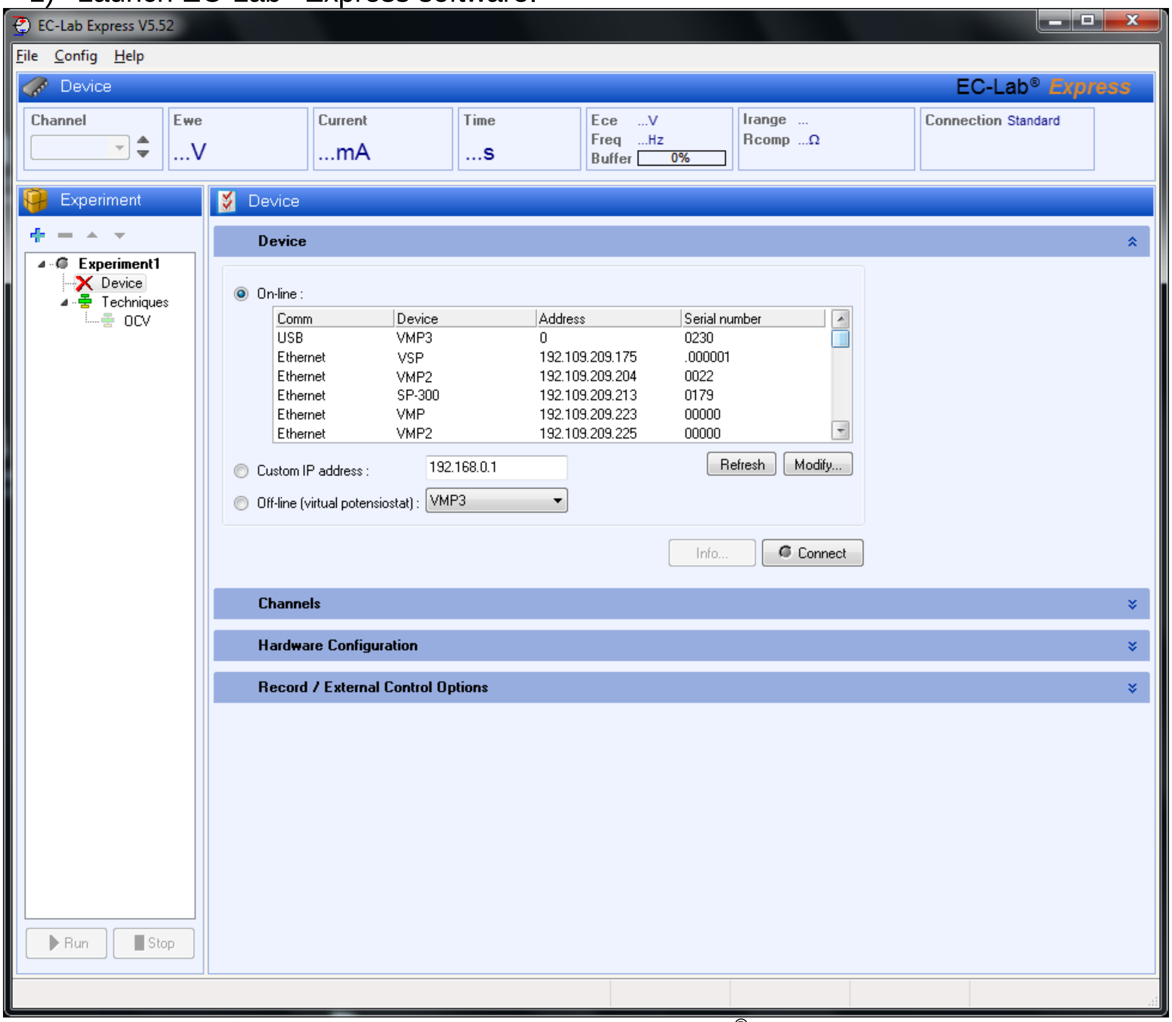


Fig. 46: Main window of EC-Lab® Express.

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.
Automatic detection will give a list of instruments detected (except VMP1 and firsts VMP2).

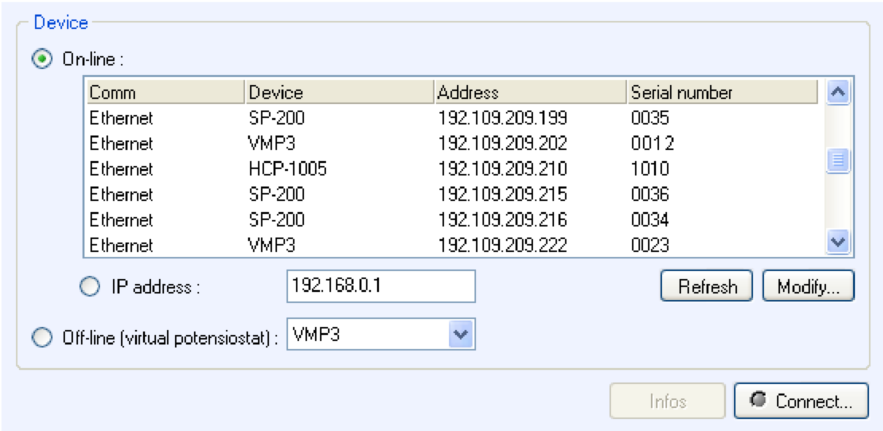


Fig. 47: Device connection window.

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 paragraph).

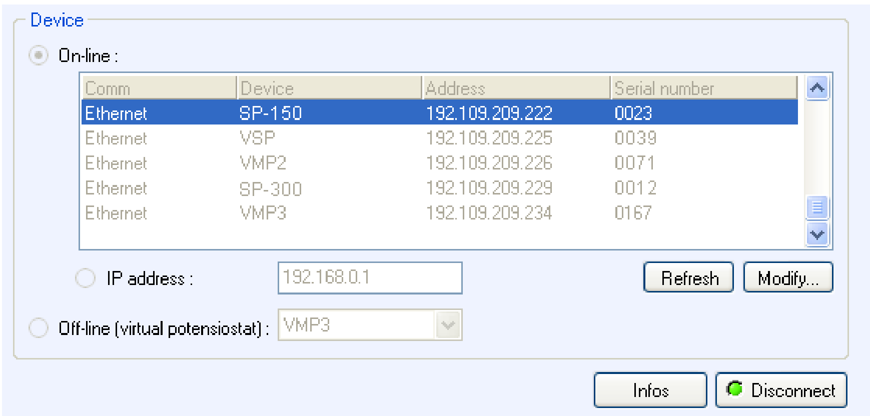


Fig. 48: Device connection window (selected instrument).

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

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:

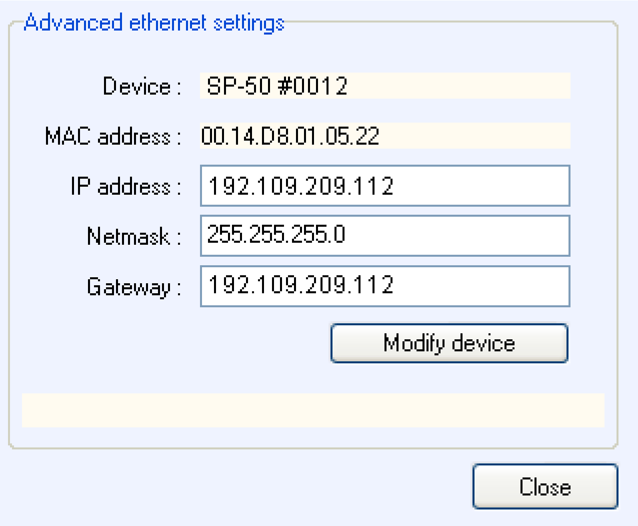


Fig. 49: "Advanced Ethernet settings" of the "New Device" window used to change the instrument IP Address.

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.

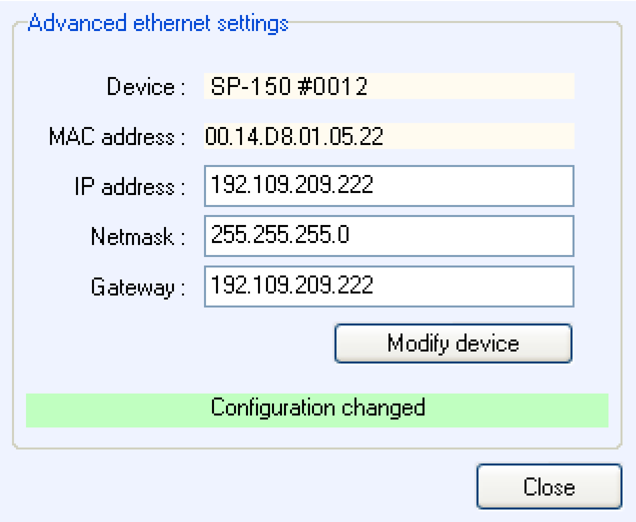


Fig. 50: New configuration.

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 Firmware Upgrading with EC-Lab® software

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

5.5 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:

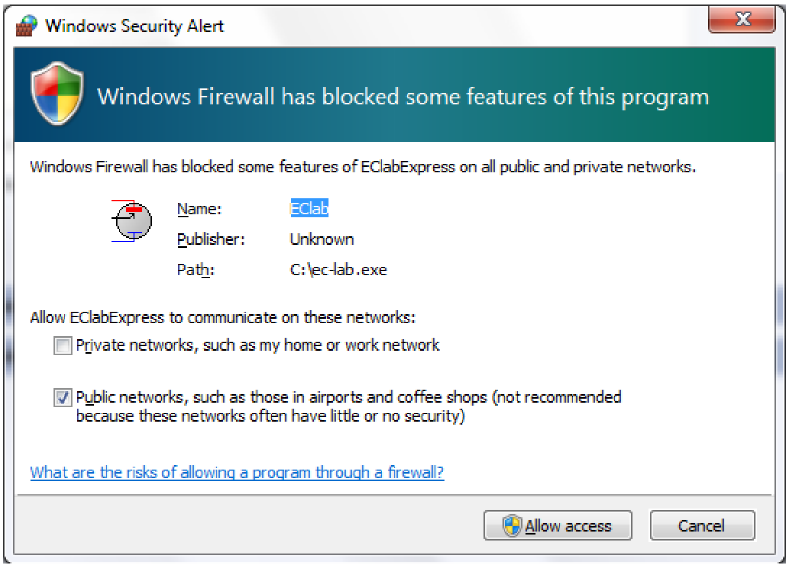


Fig. 51: "Windows security Alert" window.

6. Advanced features

6.1 External device control and recording

6.1.1 General description

The EC-Lab® software offers the user the ability to control external devices such as rotating electrodes and thermostatic baths and to record external analog signals through the auxiliary DB9 connector. The user has to configure the analog output to control an external device and configure the Analog In1 and Analog In2 inputs to record external signals. Our instruments can control and record analog signals from – 10 to + 10 V. Most of the 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. The list will be completed in future versions of EC-Lab® software. To configure external devices select "**External Device**" in the "**Config**" menu. The following window appears:

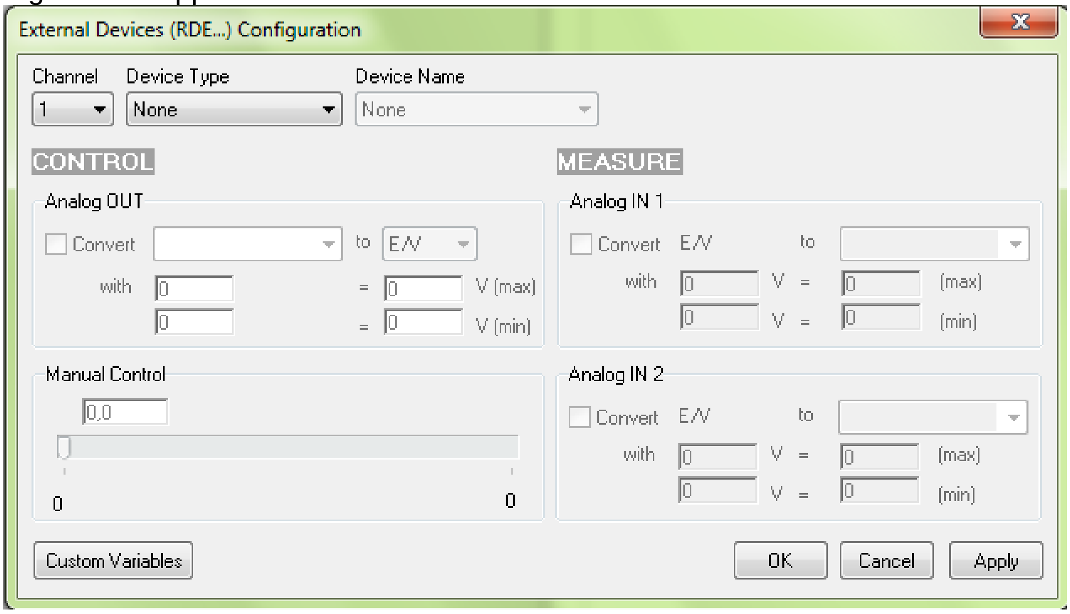


Fig. 52: External device configuration window.

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

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

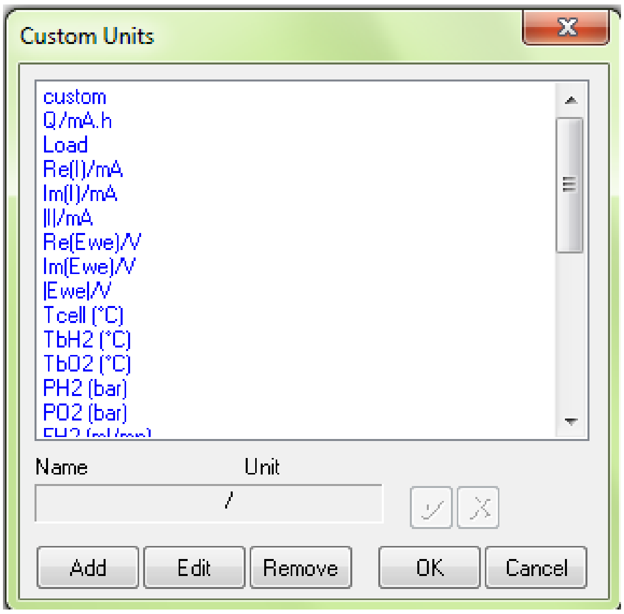


Fig. 53: Custom Units window to define new variables.

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 "**Configure**" 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 have an opposite variation of the recorded value with the plotted value.
- The configurations 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 right of the panel.
- When a channel has been configured to control an external device, this device can be seen in the global view.

6.1.2 Rotating electrodes control

The 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 rotating speed. Note that no measurement of the rotating speed is available. This model of rotating electrode (ALS-RRDE-3A Rotating Disk electrode model) is designed to work with either one.

Fig. 54: ALS-RRDE-3A Rotating Disk electrode

6.1.2.1 Connections

Two cables are necessary for the connection, the cell cable and a special cable for RRDE with DB-9 connector. This cable has a DB9 connector on one end and three wires called Analog OUT, Trigger Out and Ground on the other end (ref: 092-22/11). Only one channel board is used and the connection is the standard one.

The connecting procedure is the following:

1. Connect, with DB9 cable, the auxiliary input/output of the channel board.
2. Connect the "Analog out" wire to “IN” connector on the rear panel of the RRDE-3A.
3. Connect the "Ground" wire to one of the “GND” connector on the rear panel of the RRDE-3A.
4. If user wants to control the purge of the RRDE-3A, connect the “Trigger Out” to the “Purge” connector on the rear panel of the RRDE-3A.
5. Connect REF1 and CA2 wires to the disk brush, REF3 and CA1 wires to the counter electrode, and REF2 wire to reference electrode.

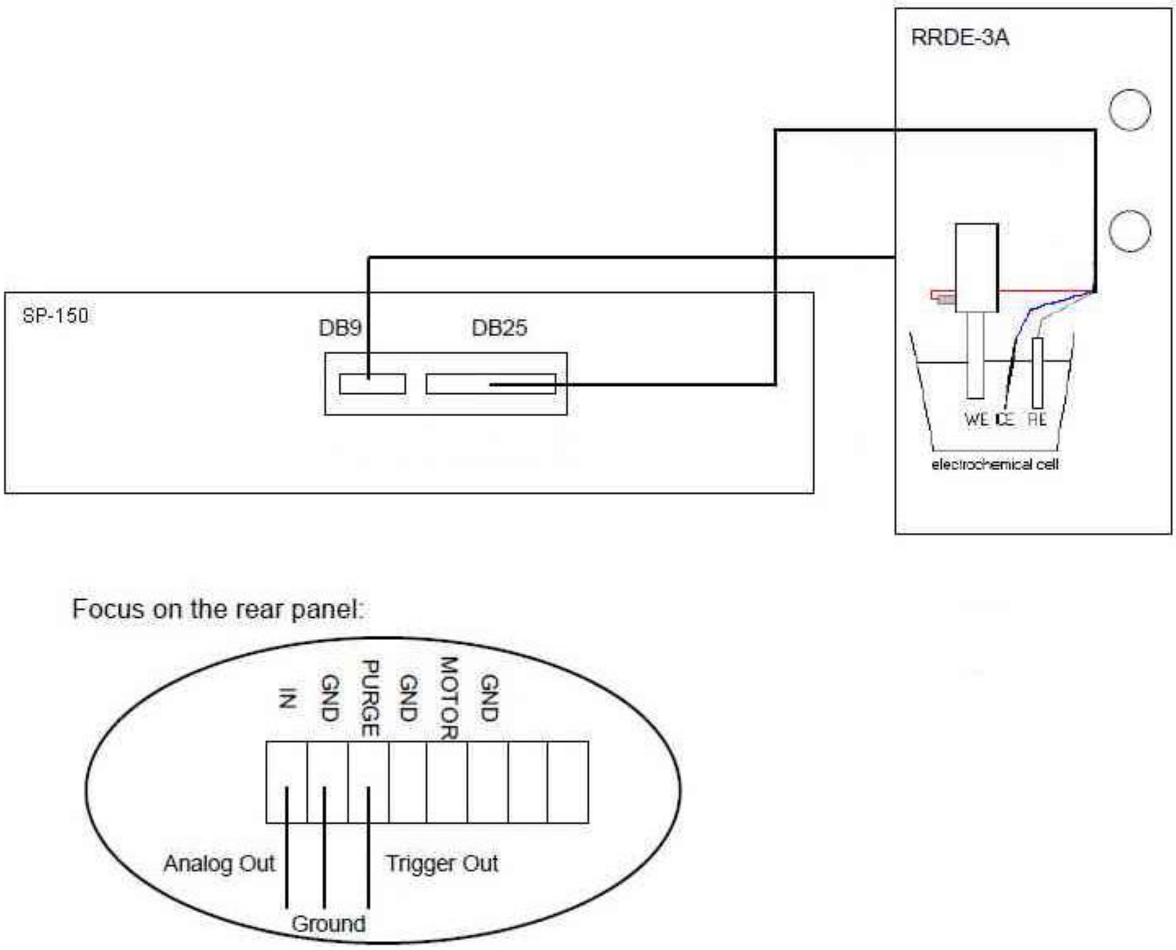


Fig. 55: ALS-RRDE-3A Rotating Disk electrode connection to the cell cable.

6.1.2.2 Control panel

Before running any experiment with a rotating electrode, one must first choose the rotating unit. Select **Config\External Device (RDE…)…** in the EC-Lab® main menu:

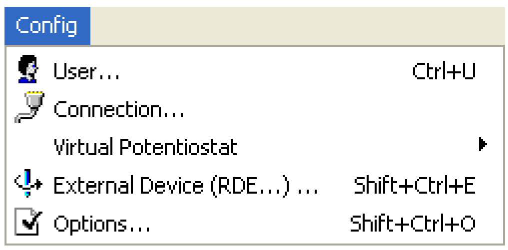


Fig. 56: Menu for external device selection.

Note: this menu is available only if channels designed to drive RDE are connected with the RDE electrode rotator. Then the following window is displayed:

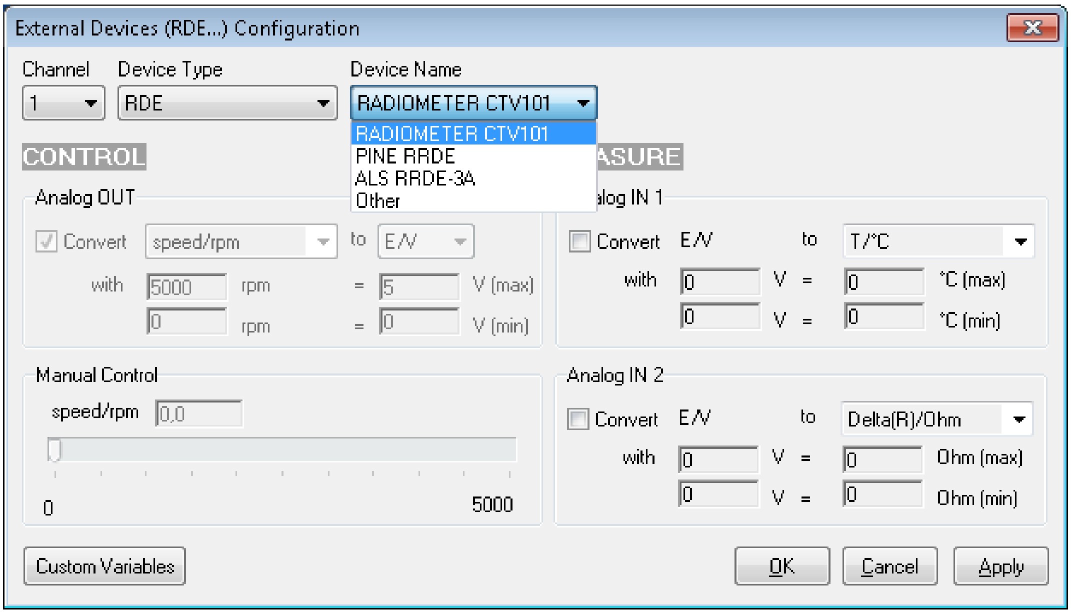


Fig. 57: Rotating electrode control configuration.

Under **RDE** device type, one can select the standard supplied ALS-RRDE-3A, PINE RRDE or RADIOMETER CTV101 electrodes rotator. For these devices, the calibration parameters are factory set. Other external systems can be used but are not available. They will be added onto the list upon request. Note that the calibration parameters for the already selected device are not available. Nevertheless if you select another device, it is possible in 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 will only have effects on the electrochemical instruments equipped with a rotating system.

6.1.3 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.

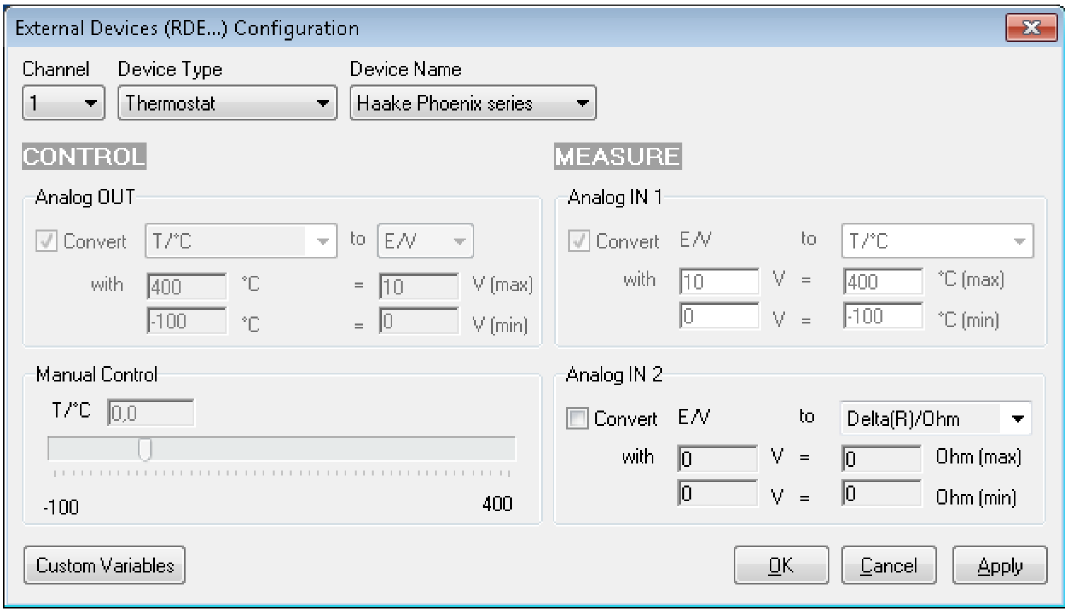


Fig. 58: Haake Phoenix series thermostat control configuration.

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

6.1.4 Electrochemical Quartz Crystal Microbalance coupling

The SEIKO EG&G QCM 922 quartz crystal microbalance has been 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:

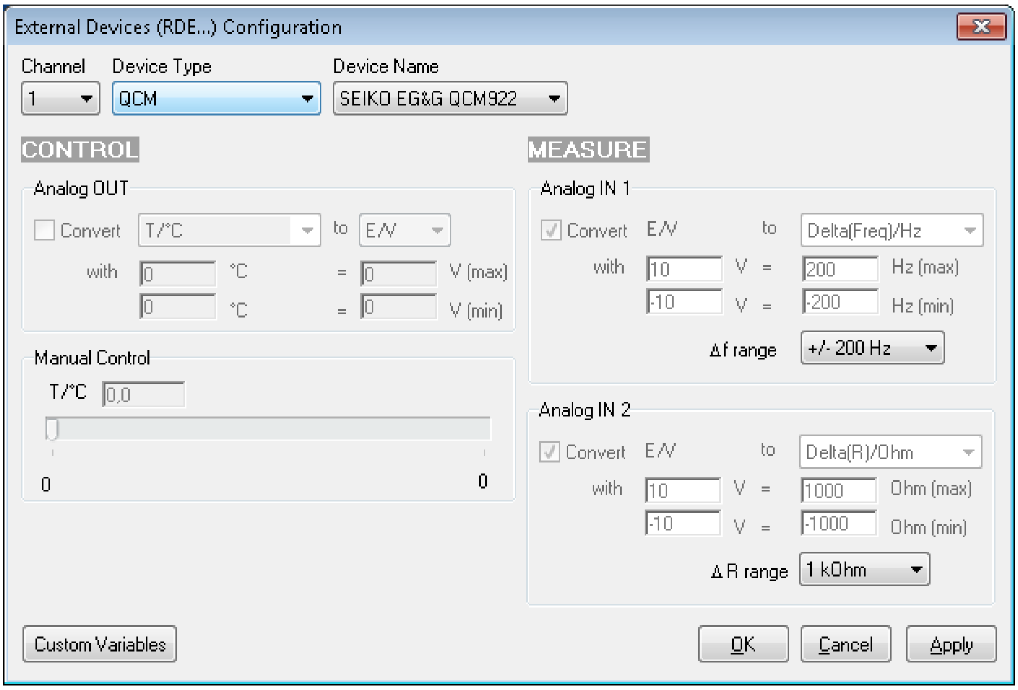


Fig. 59: SEIKO EG&G QCM-922 configuration window.

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 below:

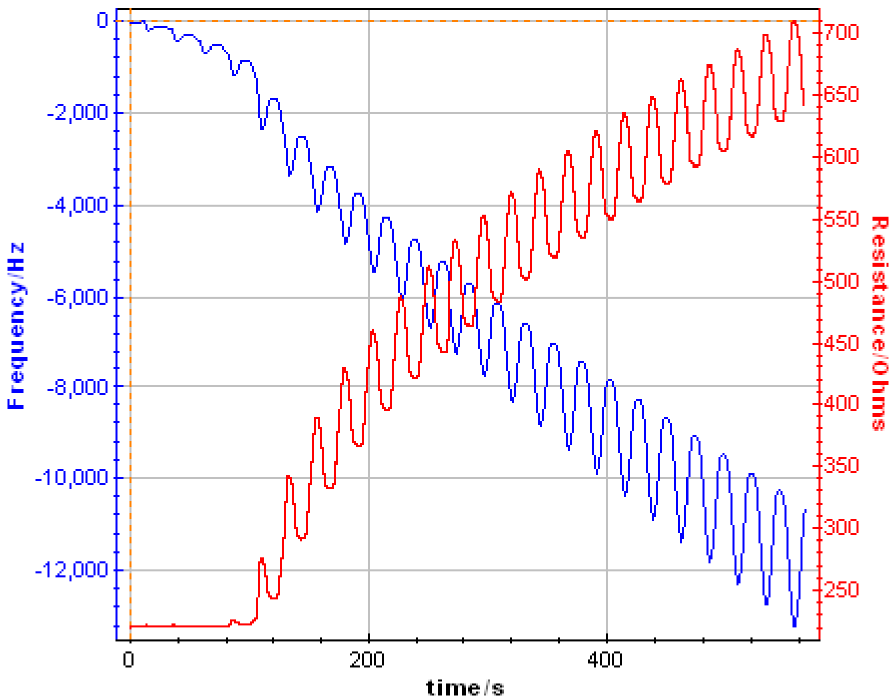
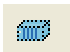


Fig. 60: Frequency and resistance variations recorded from the analog inputs for an instrument coupled with a SEIKO EG&G QCM 922.

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

6.2 Virtual potentiostat

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

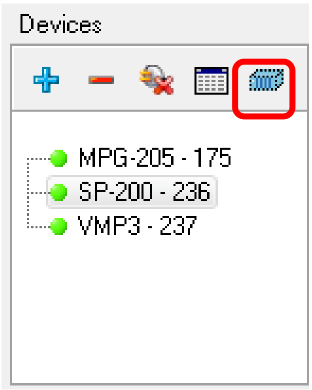


Fig. 61: Virtual potentiostat button (in the red rectangle).

The available techniques and time base are different according to the instrument selected.

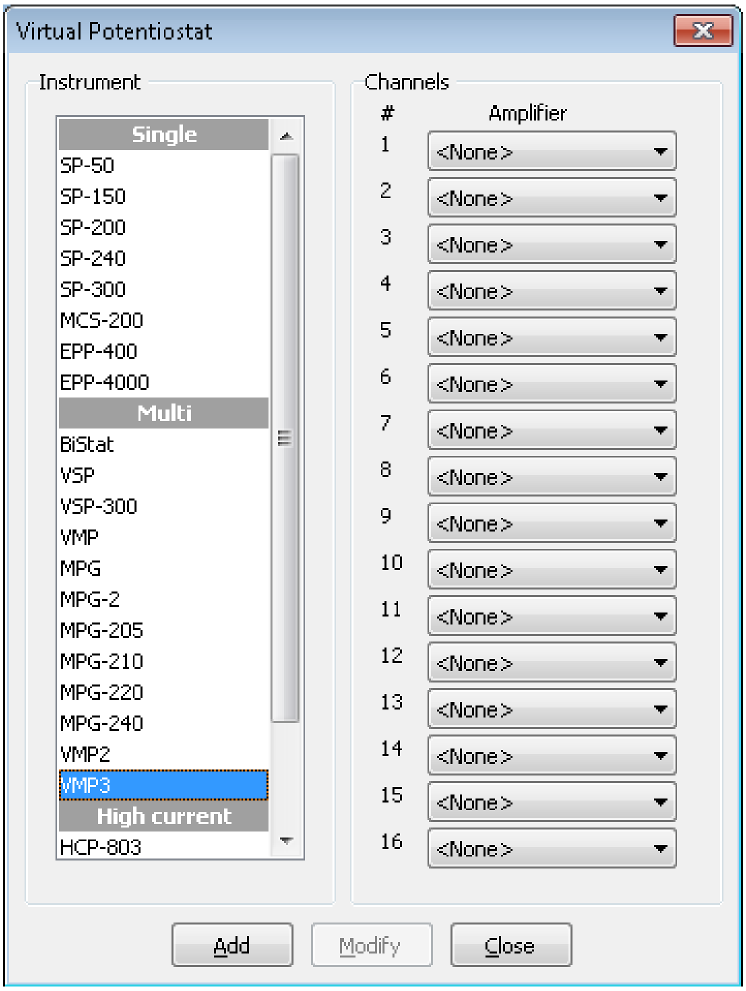


Fig. 62: Virtual potentiostat window.

7. The accessories

The SP-150 potentiostat is designed for all fields of electrochemistry. The specification of the instrument allows the user to work with very small currents (with the low current board option) and apply and measure very high currents (with current power booster option). The modularity of the SP-150 potentiostat allows for all kinds of experiments especially in general electrochemistry, battery study and corrosion. The SP-150 can also be used for EIS measurements. These options described in the paragraphs 7.1, 7.2 and 7.3 are not available on the SP-50.

7.1 External current power boosters

The instrument is designed to accept an 800 mA maximum continuous current at a room temperature of 25°C. The user can apply currents up to 100 A using a current power booster. A booster is made of a chassis with current booster channels. Different booster channels are available (2 A, 5 A, 10 A, 20 A, 80 A and 100 A). A chassis can contain mixed booster boards up to 20 A (example: 2*2 A + 1*5 A + 1*10 A). From 2 to 20 A, the power booster can work in a voltage range of ± 10 V. For the 80 A booster, the voltage range is limited to ± 3 V and for the 100 A booster the voltage range is limited to [0.6 – 5] V.

Fig. 63: External current booster

7.2 EIS option

The option for EIS measurement is available on the SP-150. This option is included on the channel board when mentioned.

7.3 Low current option

Unlike the current power booster, the "p" low current board can be added to the channel board in order to reach very low currents (sub-pA resolution on 1 nA range). This option is advised for measurements on biosensors, bioelectronics, biologic interfaces, and microelectrodes. The low current board is always coupled with a channel board (standard or Z).

When added to a channel board, both low current board and the channel board must be calibrated together. This procedure is described in the manual.

Fig. 64: Low current board.

7.4 Test boxes for calibration check and user's training

7.4.1 Dummy cell 01 for user's training

The Dummy cell 01 is a tool provided with all the instruments. It is made with dummy cell circuits. The electrical circuits of the dummy cell can be used to simulate the behaviour of linear electrochemical systems. With this box, the user has the ability to test the electrochemical impedance spectroscopy or electrochemical protocols like Cyclic Voltammetry and Linear Polarization. The resistance values are given with 1% accuracy.

Fig. 65: DC01

7.4.2 Test Box 2

The Test Box 2 is a tool that checks the calibration of our instruments. This testing box is made of one electrical circuit with high precision resistors for calibration check and two dummy cells circuits for user's training. It has been specially designed to check the calibration of the standard channel board of our instruments. The high precision resistor circuit is made with 7 resistors in order to check each current range of the board.

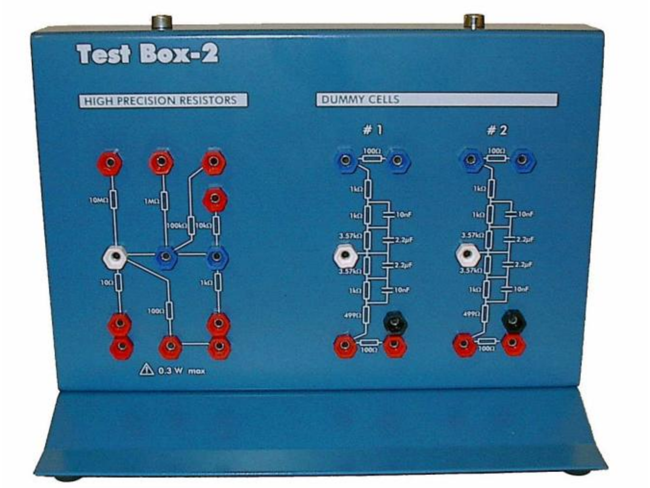


Fig. 66: TestBox-2.

High precision resistor Characteristics:

High precision resistor	***I range***	***SP-50/SP-150***
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	**for the "p" low current option**

7.4.3 Test Box 3

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

Fig. 67: Test Box-3

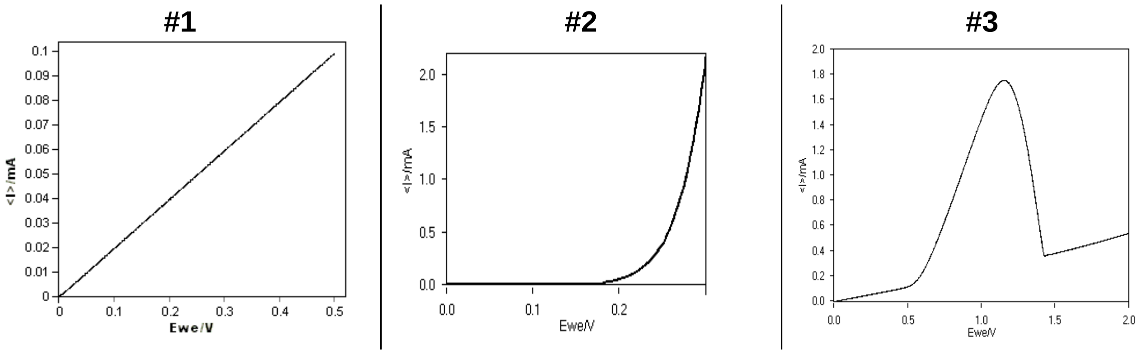


Fig. 68: stationary curve obtained with Test Box-3. ***Ref: Application notes #8 and #9 are available on our web site.***

7.5 Temperature probe

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

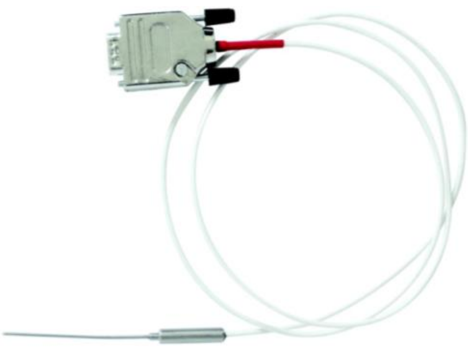


Fig. 69: Temperature probe.

7.6 Labview VIs

The potentiostat can be controlled with the free EC-Lab® development package. This package is devoted to software developers who need to integrate the control of the Bio-Logic potentiostats/galvanostats/EIS with OEM software. The EC-Lab® development package also includes a LLB LabVIEW® library where the functions of the DLL are implemented (Requirements: LabVIEW® V6.1 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 considered protocol.

7.7 Electrochemistry accessories

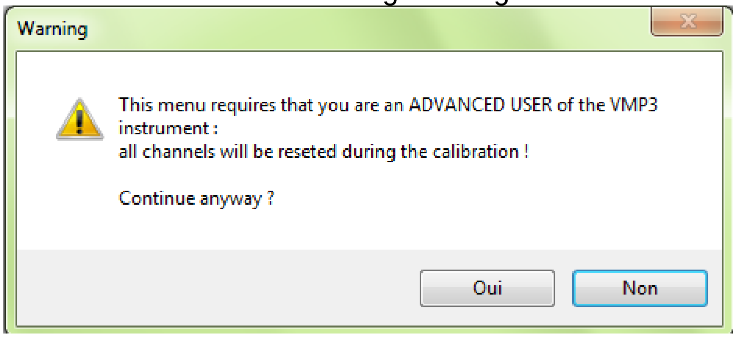
Bio-Logic can provide accessories for various fields of electrochemistry, please consult the Bio-Logic website for more details http://www.bio-logic.info/potentiostat/index.html.

8. Calibration and Maintenance

8.1 Software channel calibration

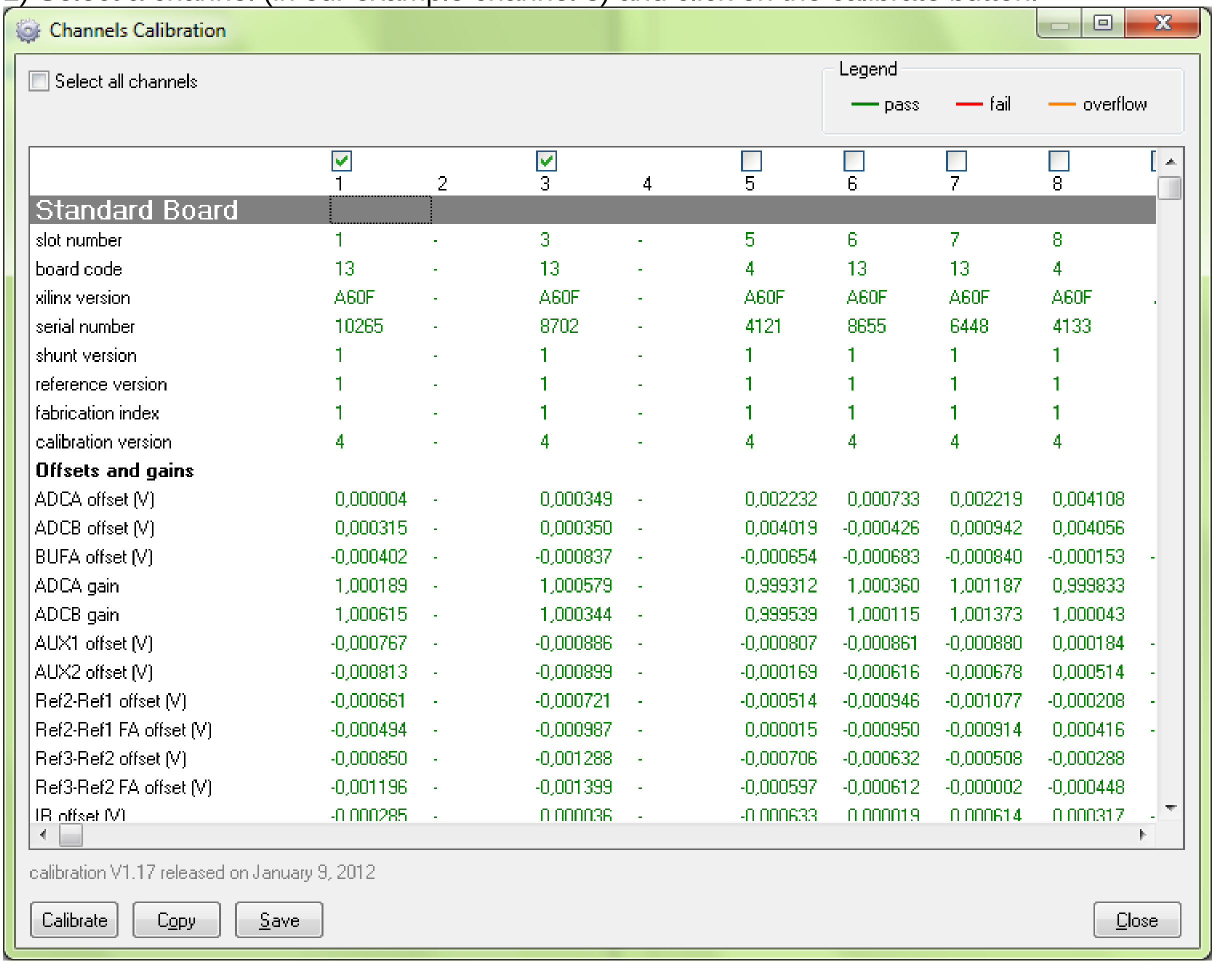
CAUTION !!!: Before operating remove all cell cables from the channel boards.

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

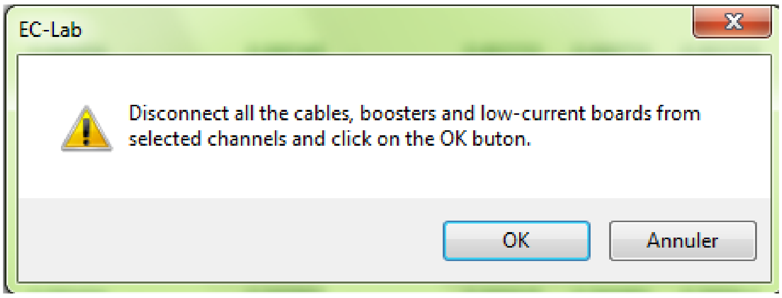


Answer "**Yes**" to the warning message. Then the board calibration window appears.

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



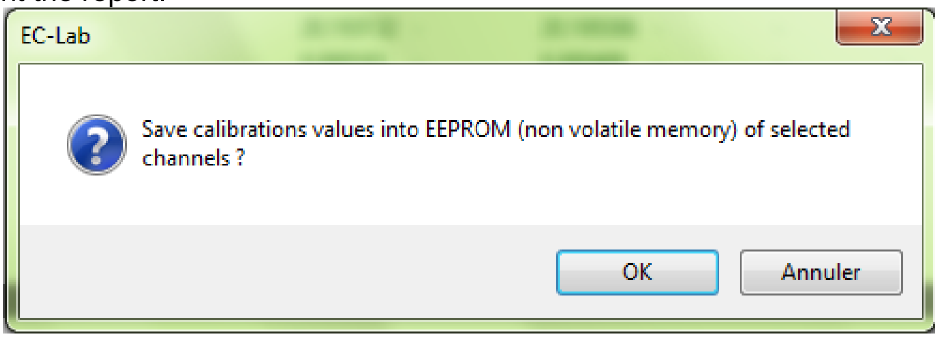
3) Click on Ok.



4) Disconnect all the cables from the channels to be calibrated as called for in the message.

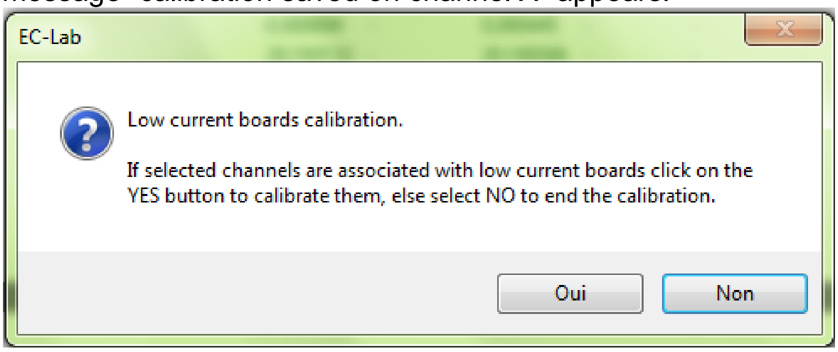
Then the calibration of the channel board will begin. For each variable, the numerical value corresponds to the compensated offset or gain and “pass” signifies that the calibration is made. If “failed” appears instead of “pass” then the calibration cannot be done. The channel board is probably damaged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

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

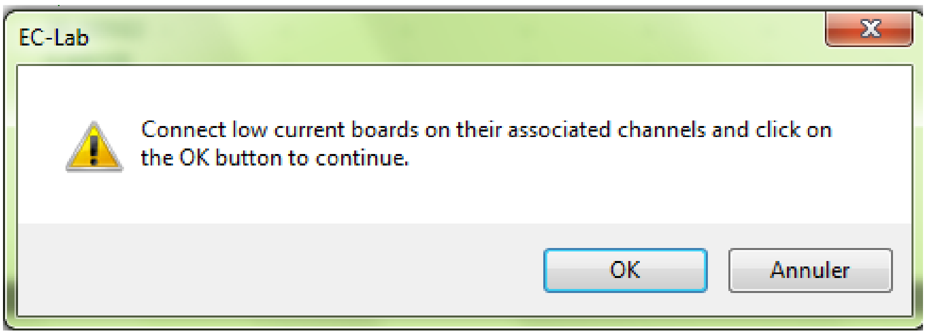


5) Click on “Ok” to save the calibration parameters on the channel board. On the board calibration window the message “calibration saved on channel X” appears.

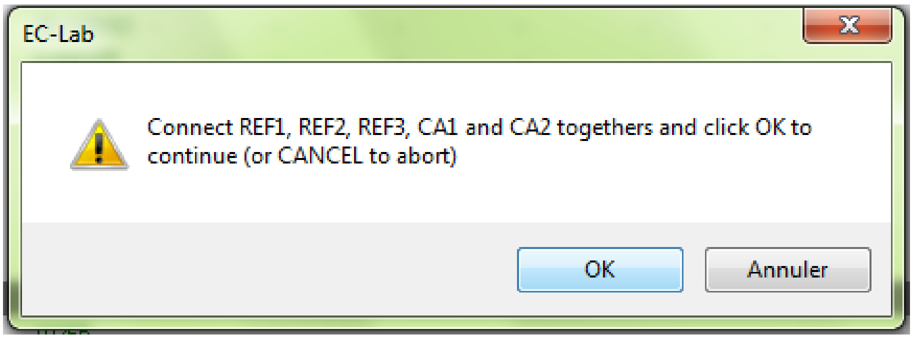
If a "p" low current board is connected to the channel, the user must calibrate the low current board as follows.



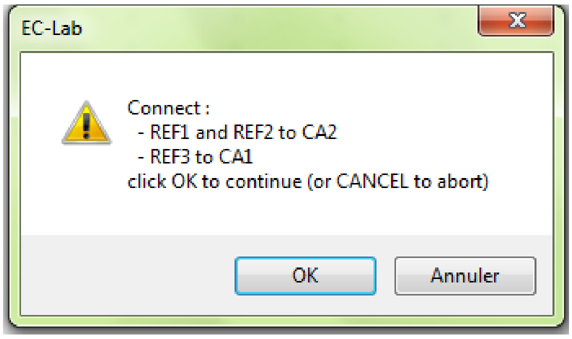
6) Click on “Yes” to calibrate the low current board. The connection message between the standard and the low current board appears:



7) Click on "Ok" to start the low current board calibration.



8) Connect all the banana terminal plugs of the low current board together to the same potential point and click on “Ok” to start the low current board calibration.



9) Disconnect Ref3 and CE/CA1 from the other cables and connect them together. Click "Ok"

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

8.2 Equipment maintenance

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

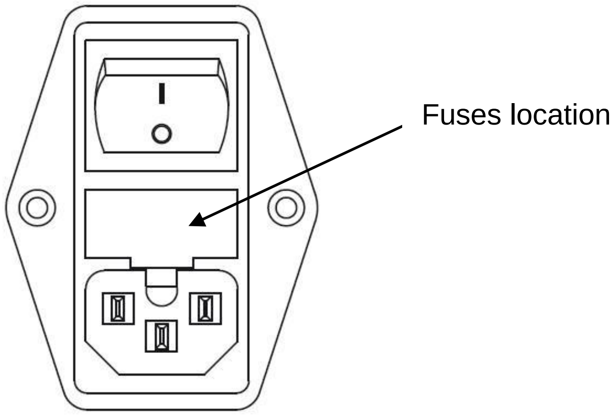
Our instruments do not require a specific maintenance. Each channel board is calibrated at the factory (at 25°C) before being delivered to the customer. We recommend adjusting the gains and offsets of the channel boards twice a year due to temperature differences between winter and summer, especially if the instrument is not in an air-conditioned room. This adjustment is performed using the EC-Lab® software’s channel calibration in the “**Tool**” menu. We also recommend a full check-up of the instrument at the factory every two years.

Ventilation:
The user must be careful 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.

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

Rating: 2 A Fast / 250 Vac
Size: 5x20 mm



9. Technical Specifications

9.1 Equipment Ratings

Electrical

- Input:
  Input voltage range: 90 to 264 Vac
  Power: 65 W max
  Frequency: 50 to 60 Hz
  Fuses (Neutral +Phase): 2 x 2 AF, cold start-250 VAC (5x20 mm)
- Output:
  ± 10 Vdc / 800 mA or ± 10 Vdc / 240 mA with Low-Current option

See "Channel specifications" chapter for detail Potentiostat/Galvanostat specifications

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:** IP30
- **Warm-up:** 1 hour to rated accuracy
- **Cooling:** Internal DC Fans
- **Vibration:** not specified
- **Choke:** not specified

Mechanical

- **Size**: 95(H) x 435(W) x 335(D) mm
- **Weight**: 7.2 kg without cable

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

9.2 Channel specifications

SPECIFICATIONS	
Cell control	
Connection	2, 3, 4 or 5 terminal leads (+ ground)
Converters	16 bits dynamic DAC 12 bits attenuation DAC - 12 bits DC shifts DACs
Compliance	± 10 V (adjustable for SP-150, for ex 0-20V)
Maximum current	± 800 mA continuous
Maximum potential resolution:	300 µV on 20 V dynamic range programmable down to 5 µV. For example: For an Erange of [0;20]V, the resolution is 305 µV. For [0;19.64]V, the resolution is 300 µV. For [0;13.09]V, the resolution is 200 µV. For [0; 6.53]V, the resolution is 100 µV. For [0; 3.26]V, the resolution is 50 µV. For [0; 1.29]V, the resolution is 20 µV. For [0; 0.64]V, the resolution is 10 µV. For [0; 0.31]V, the resolution is 5 µV.
Maximum current resolution	0.004 % of the dynamic range programmable down to 760 pA on the 10 µA range

Accuracy (DC):	< 0.1 % FSR*
Rise Time:	< 2 µS (no load)
Acquisition time	20 µs
Current measurement	
Ranges	± 10 µA to ± 800 mA (7 ranges)
Maximum resolution	0.004 % FSR*
Acquisition speed:	200,000 samples/s
Accuracy (DC)	< 0.1 % FSR*
Potential measurement	
Converters	16 bits ADC + 12 bits DC shift DAC's
Ranges	± 2.5 V, ± 5 V, ± 10 V ± 10 V adjustable
Maximum resolution	0.0015 % of the range, down to 75 µV
Acquisition speed	200,000 samples/s
Accuracy (DC)	< 0.1 % FSR*
Electrometer	
Inputs	3 potential measurements leads with 2 differential voltage measurements
Impedance	> 10^{12} ohms in parallel with 20 pF
Bias current	< 5 pA
Common mode rejection	> 60 dB at 50kHz
Auxiliary Inputs / Outputs	
2 general purpose analog inputs	16 bits resolution with automatic ± 2.5 V, ± 5 V, ± 10 V ranges
1 analog output	± 10 V
1 input trigger	TTL level
1 output trigger	TTL level
1 security input to Open Circuit	TTL level
General	
Dimensions, weight	435 x 335 x 95 (mm, H x W x D), 7.2 kg
Power	85-264 V, 47-440 Hz
EIS OPTION	
Impedance specifications	
Frequency range	10 µHz to 1 MHz
Amplitude	programmable from 1 mV to 1 V peak to peak (potentio mode) 0.1 % to 50 % of the current range (galvano mode)
Accuracy	< 1 %
LOW CURRENT OPTION (LC)	
Cell control	
Maximum current	± 100 mA continuous
Maximum current resolution	0.004 % of the dynamic range programmable 76 fA on the 1 nA range
Applied current resolution	< 1 % FSR* on the 1 nA range < 0.5 % FSR* on the 10 nA range < 0.1 % FSR* on the other ranges
Current measurement	
Ranges	± 1 nA, ± 10 nA, ± 100 nA, ± 1 µA
Maximum resolution	0.004 % FSR*
Accuracy	< 1 % FSR* on the 1 nA range < 0.5 % FSR* on the 10 nA range < 0.1 % FSR* on the other ranges

Electrometer	
Impedance	10^{14} ohms in parallel with 1 pF
Bias current	60 fA typical, 150 fA max at 25°C
Bandwith	1 MHz

*FSR: Full Scale Range
Specifications subject to change.

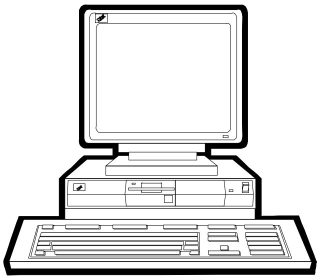
Current measurement noise (rms/Bandwidth):

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

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

9.3 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 (32 or 64 bits).



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9.4 Safety precautions

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

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

10. Troubleshooting

10.1 Data saving

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

- ensure that the saved file has not be 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, contact us.

10.2 PC Disconnection

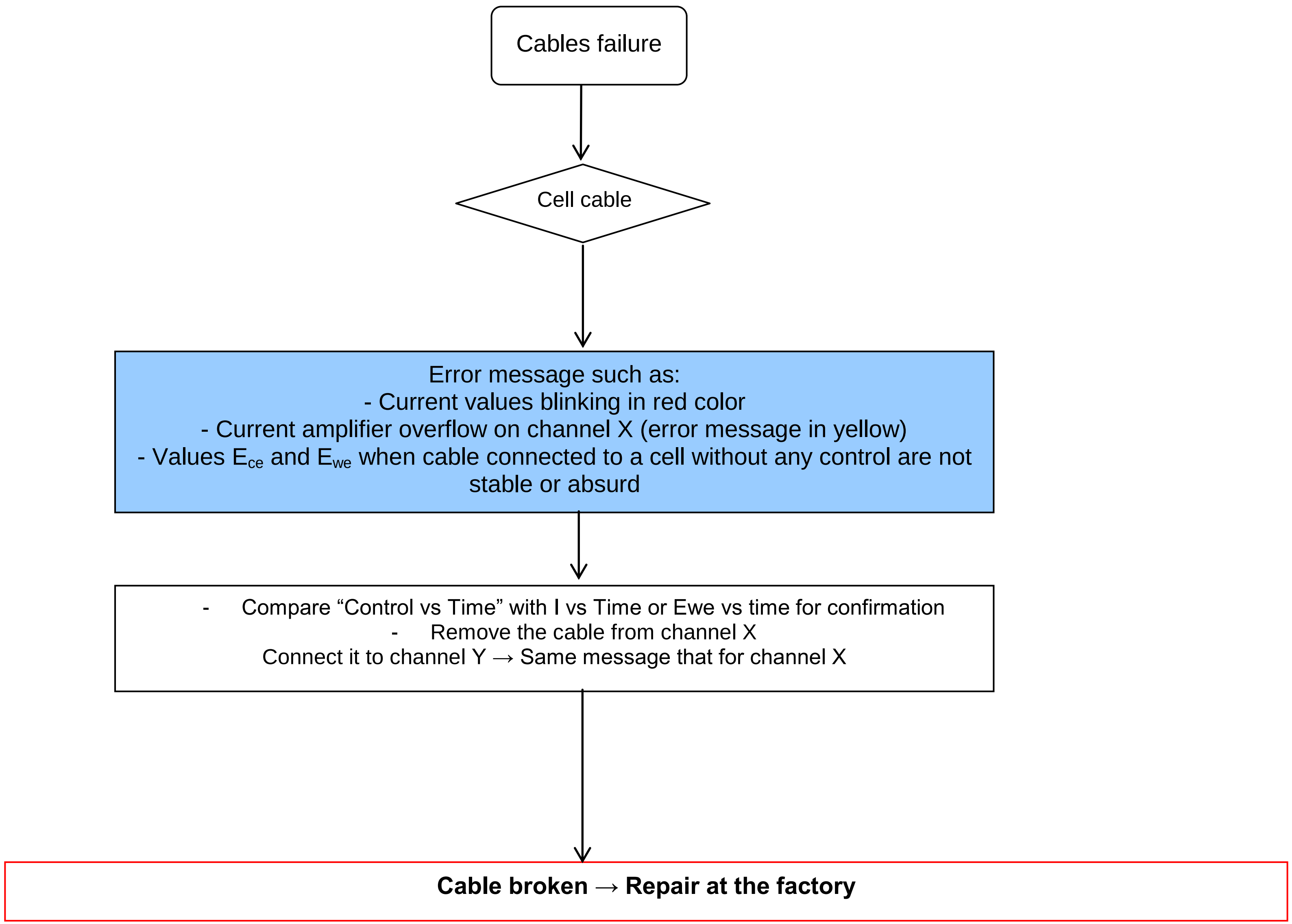
Problem: The PC is disconnected from the instrument ("Disconnected" is displayed in red in the EC-Lab® status bar):
Solution(s):

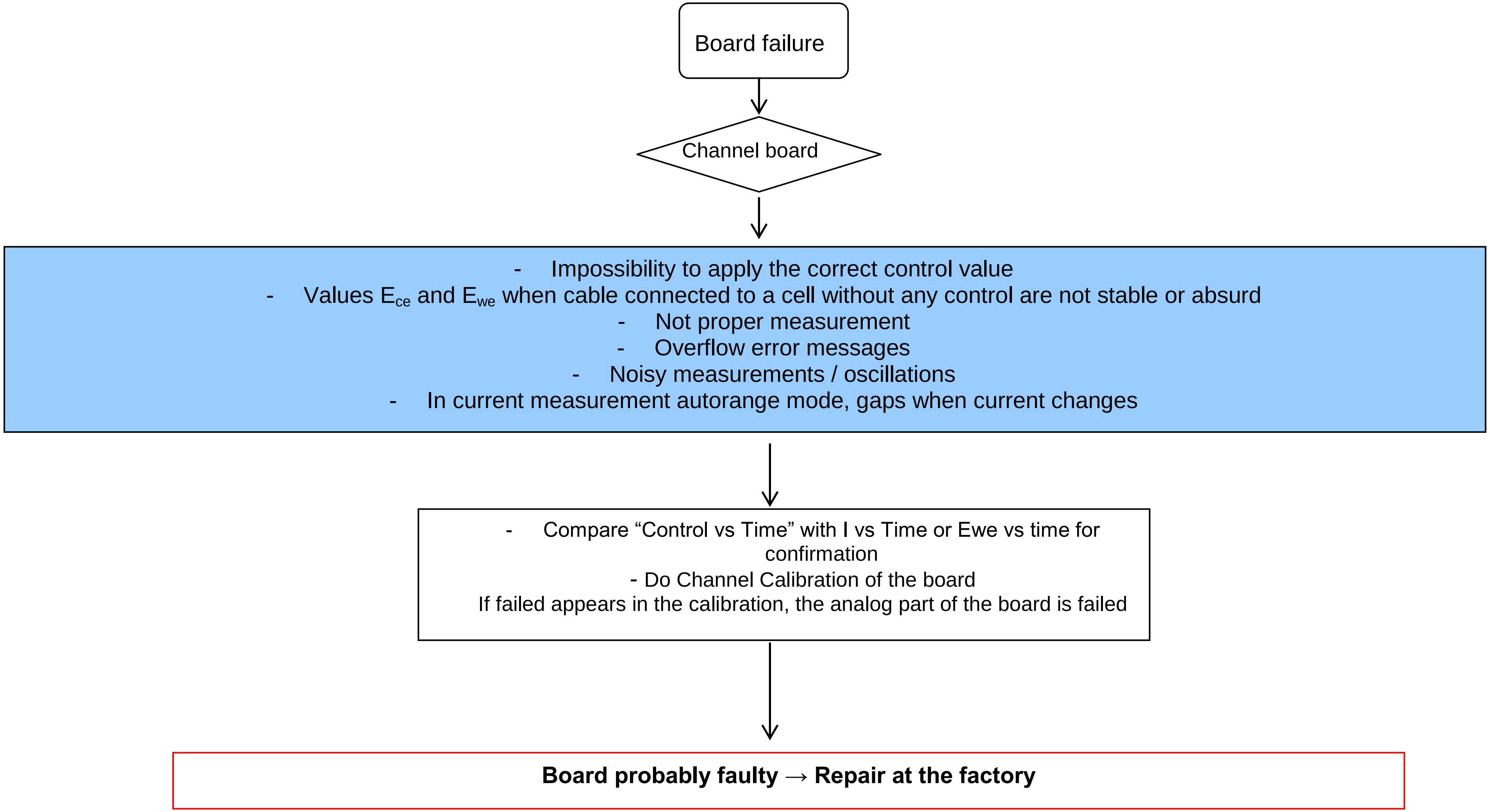
- check the PC – instrument connection.
    - direct connection: verify that the crossed Ethernet cable is plugged from both ends.
    - network connection: verify that the yellow led is blinking on the instrument front panel and that you can access to your network directories from the PC.
- check that the green led is blinking (this assumes that the multichannel potentiostat is always 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, so proceed like this only in case of trouble.
- if the problem persists, contact us.

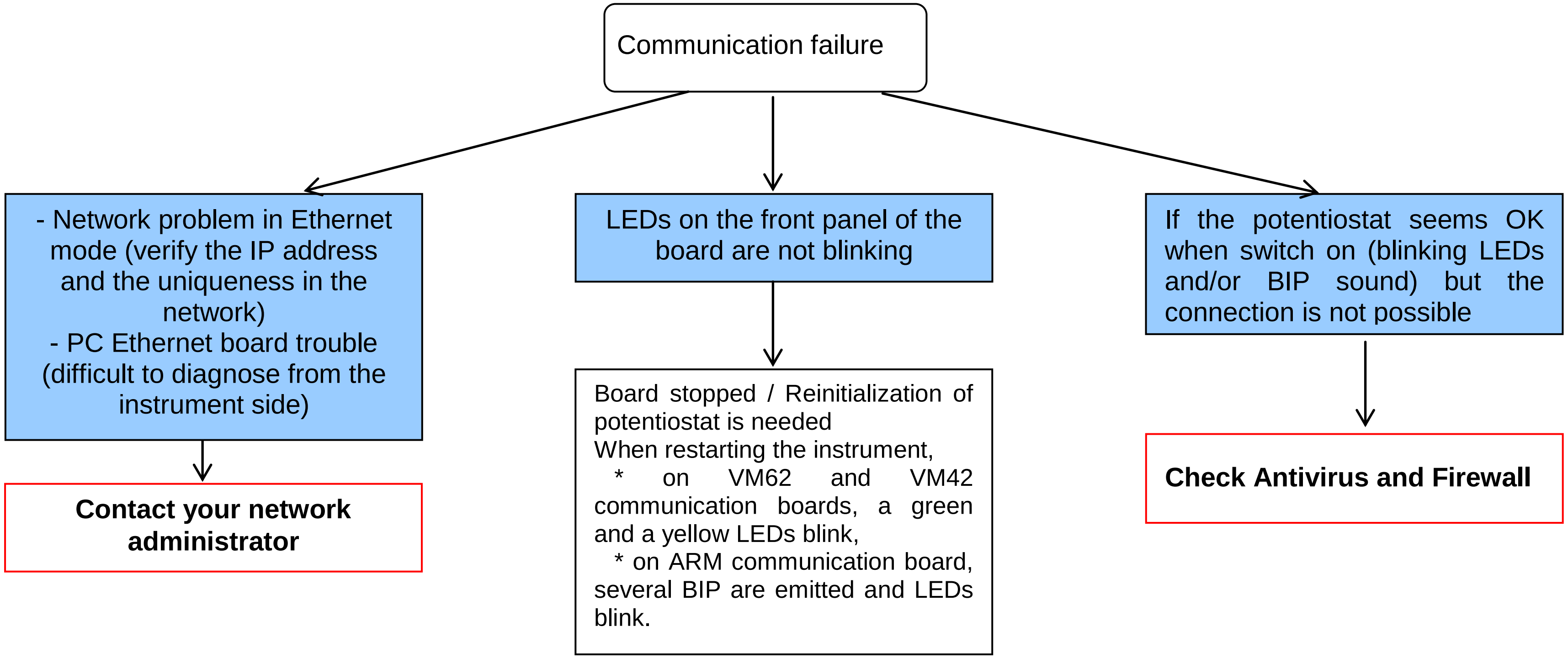
10.3 Effects of computer save options on data recording

Electrochemical experiments often have a long duration (more than 24 hours). During the experiment, the computer should always be able to record the data points. If the user has enabled the power save option for his hard disk, he risks being unable to record the data points. In order to avoid that, we advise the user to remove the power save option of his computer in the setting panel.

10.4 Preliminary check

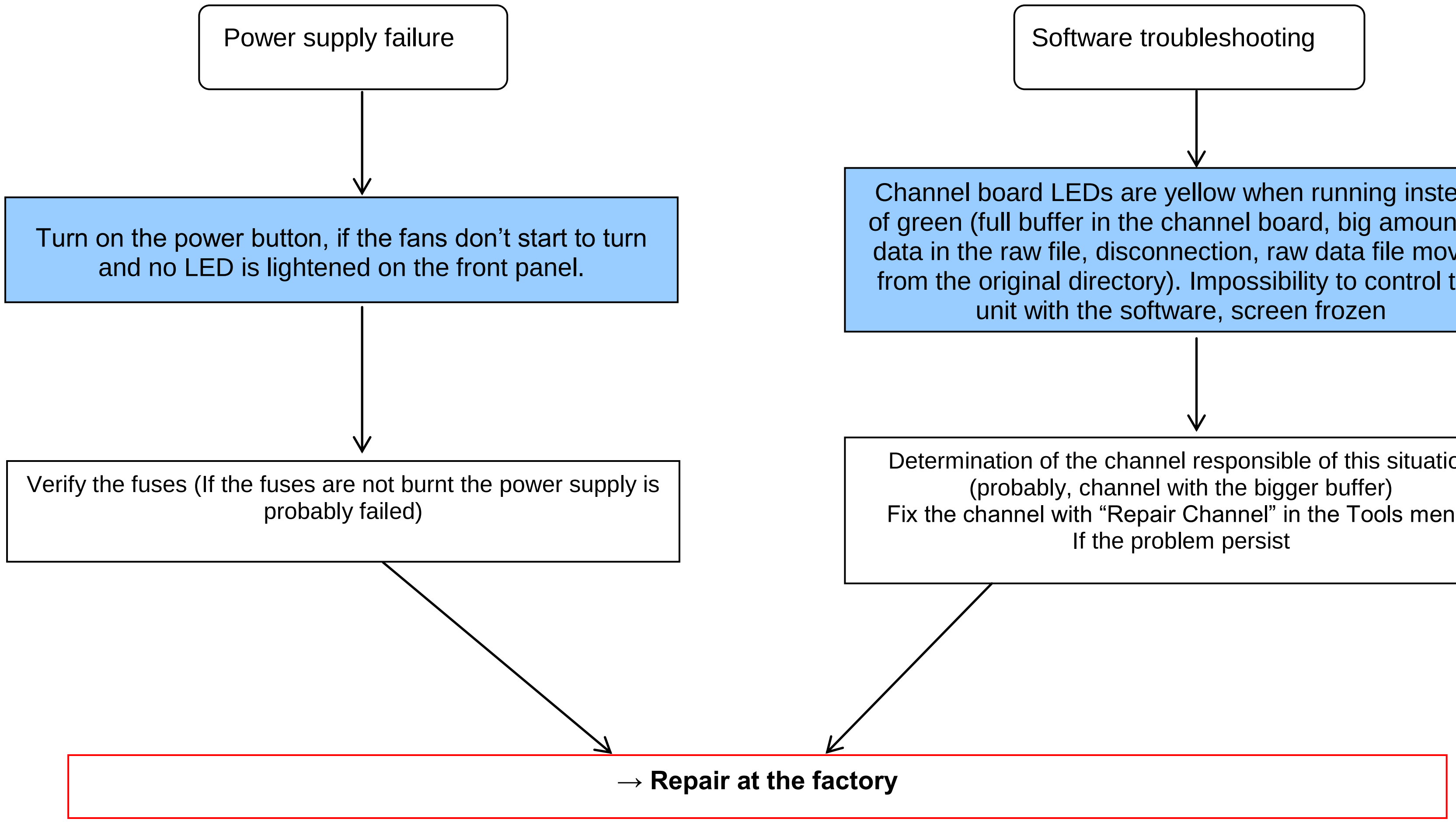

Cables failure
Cell cable
Error message such as:
- Current values blinking in red color
- Current amplifier overflow on channel X (error message in yellow)
- Values E_{ce} and E_{we} when cable connected to a cell without any control are not stable or absurd
- Compare “Control vs Time” with I vs Time or Ewe vs time for confirmation
- Remove the cable from channel X
Connect it to channel Y → Same message that for channel X
Cable broken → Repair at the factory


Board failure
Channel board
- Impossibility to apply the correct control value
- Values E_{ce} and E_{we} when cable connected to a cell without any control are not stable or absurd
- Not proper measurement
- Overflow error messages
- Noisy measurements / oscillations
- In current measurement autorange mode, gaps when current changes
- Compare “Control vs Time” with I vs Time or Ewe vs time for confirmation
- Do Channel Calibration of the board
If failed appears in the calibration, the analog part of the board is failed
Board probably faulty → Repair at the factory



Note: Two series of communication boards are available in our instrument range:

- VM42 and VM62 communication boards (without USB connection) for the VMP1, MPG, VMP2 and first generation of BiStat
- ARM communication board (Ethernet and USB connection) for the VMP3, VSP, HCP-803, EPP series, SP150, SP-50, VSP and last generation of BiStat.


Power supply failure
Turn on the power button, if the fans don't start to turn and no LED is lightened on the front panel.
Verify the fuses (If the fuses are not burnt the power supply is probably failed)
Software troubleshooting
Channel board LEDs are yellow when running instead of green (full buffer in the channel board, big amount of data in the raw file, disconnection, raw data file moved from the original directory). Impossibility to control the unit with the software, screen frozen
Determination of the channel responsible of this situation (probably, channel with the bigger buffer)
Fix the channel with "Repair Channel" in the Tools menu.
If the problem persist
→ Repair at the factory

11. Glossary

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

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

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

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

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

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

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

Firmware upgrading: the firmware is the operating system of the instrument. 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.

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

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

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

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

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

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

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