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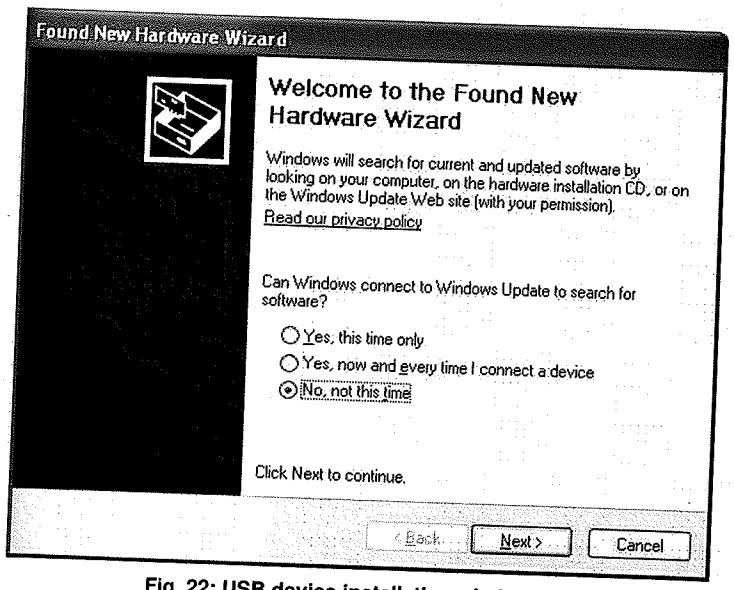


Fig. 22: USB device installation window (1).

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

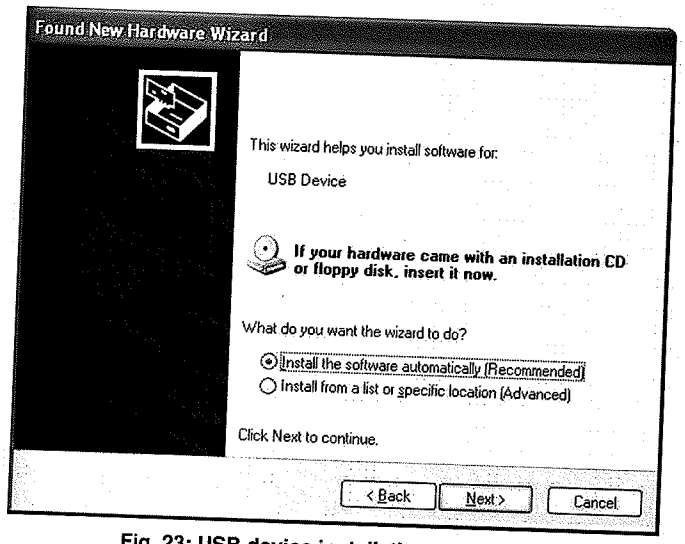


Fig. 23: USB device installation window (2).

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Check that EC-Lab® installation CD is in the CD drive. If yes Windows® XP will automatically search on the CD, find the USB driver and complete the installation. So go to the Fig. 25 for the end of the installation.

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

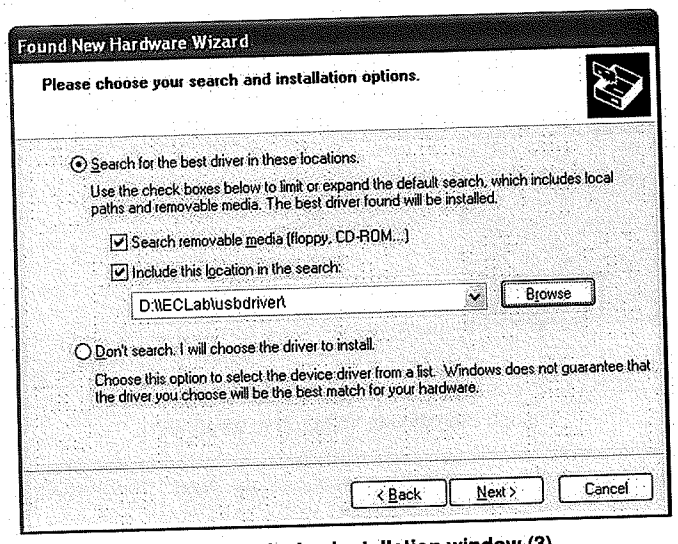


Fig. 24: USB device installation window (3).

Select "**Include this location in the search:**" and click on **Browse.** Select **D:\\ECLab\usbdriver\.** In that case Windows will go to search into the **usbdriver** folder. Click on next to proceed to the installation. Then the following window will be displayed.

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Fig. 25: 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.

3.4 USB driver update

With the new EC-Lab® version 9.50, a new USB driver is available. This new USB driver is included in the installation CD. Nevertheless, the new USB driver is not installed automatically with the new software version. The user has thus to update its computer operating system.
The way to proceed to update USB driver is described below for Windows© XP Pro. After the connection of the instrument to the computer with the USB cable, power on the instrument. Then the user has to follow the next steps.
In the Control Panel window, select the System menu. In this window choose the Hardware tab, as shown in the Fig. 26. In the device manager part, click on the Device Manager button and the window displayed is given in Fig. 27.
In the bottom of this window (Fig. 27), click on the "**USBIO controlled devices**", and the "**USB Potentiostat**" line will appear. Right click on the "**USB Potentiostat**" line and select to update the driver. Then the window displayed in Fig. 22 appears and the user has to follow the same procedure as those described for the USB driver installation.

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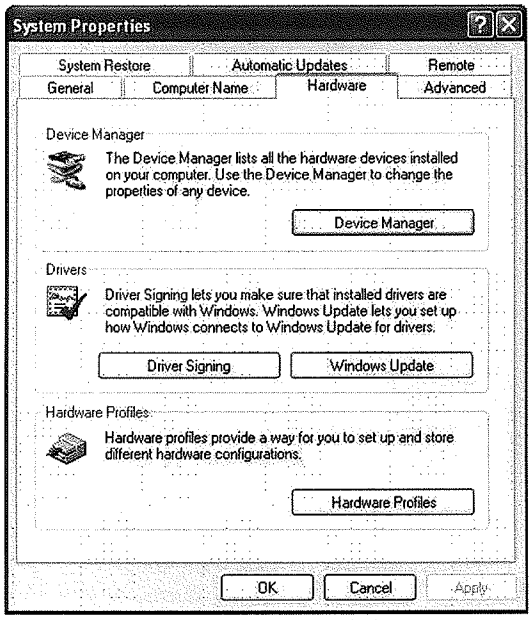


Fig. 26: Hardware menu in the System Properties window.

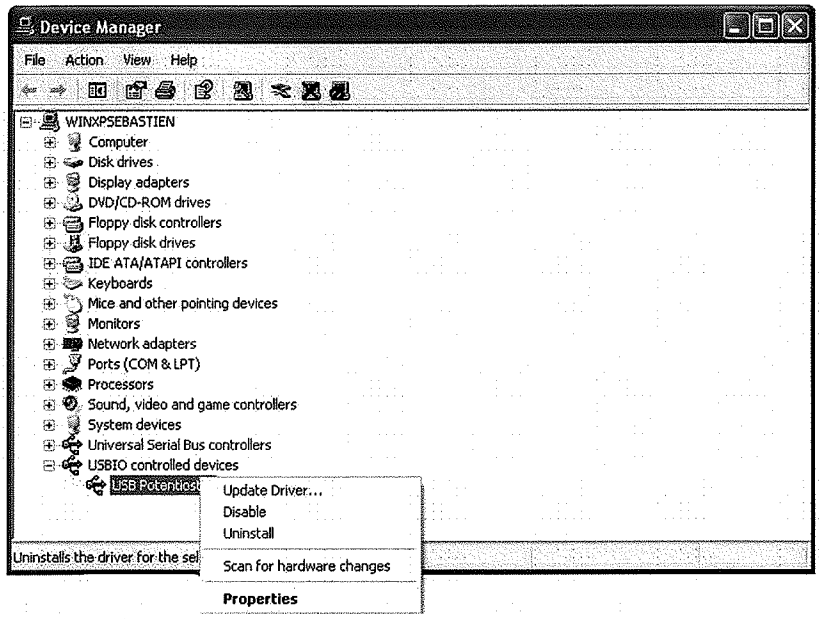


Fig. 27: Device Manager window.

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4. SP-150 connection to the computer

4.1 Connection using EC-Lab® software

4.1.1 Network parameter configuration with the Ethernet connection

When it is installed in a Local Area Network (via the Ethernet connection), the instrument is automatically detected by the computers of the network thank to its Mac Address. It becomes very easy to select an instrument in the network and modify its IP address via the Ethernet connection. The MAC Address is set at the factory on the communication board and the instrument can be detected even if it is not in the same network as the computer (before to be connected together). 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 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.

4.1.1.1 SP-150 Connection to the computer with EC-Lab® software: direct connection

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

1) Launch EC-Lab® software V9.00 or more. In the menu bar click on "**Config\Connection**". You will see the following window showing the connection status "Off line":

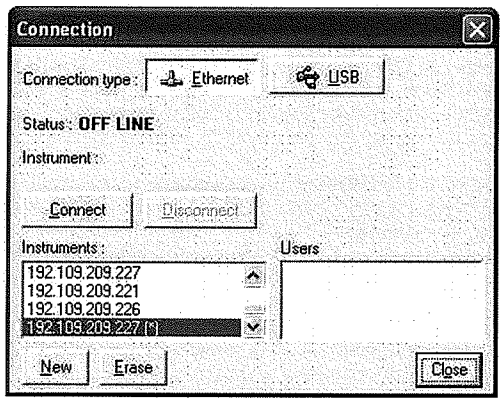


Fig. 28: "Connection" window for the connection between the computer and the instrument.

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Note: The user can work with EC-Lab© software off-line (without to be connected). The software will work as if it was connected to a virtual potentiostat. The user has just to define the device he wants to simulate.

2) Select the connection type (Ethernet in this case or USB)

3) Click on "New" to see the following window without any instrument found in your network. Click on "**Refresh**" to see the instruments present on your network. A new instrument has been detected with its IP Address (IP:192.168.0.1). The automatic search frame shows the Name of the instruments detected with their serial number (#). A Mac address is given to each instrument at the factory. The Mac address is used to detect the instrument in a LAN even if its IP Address is not valid in the network. It is also used for the detection of instruments connected by USB.

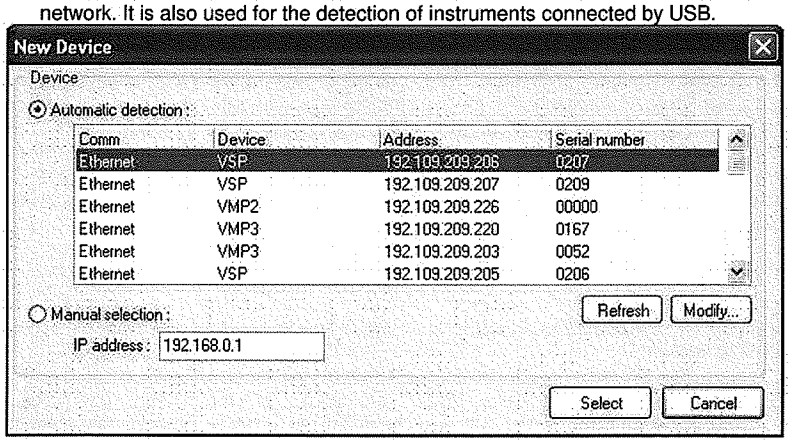


Fig. 29: "New Device" window to select and add an instrument to the current devices.

Only for the instruments provided with an ARM communication board (VMP3, VSP, HCP, EPP and last generation of VMP2), the automatic detection will give a list of instruments detected. If no device is found, the communication board is either a VM62 or a board VM42 (without a Mac address) or the communication is failed. In this case you have to select the Manual selection checkbox and set the instrument IP address into the frame.

4) At this time you have three different ways to proceed.
   a. The connection used is an USB connection: so select the device, click on "**Select**" and "**Connect**".
   b. The connection is an Ethernet connection that doesn't require changing the instrument IP address. Two cases are possible: direct connection with the crossed cable or IP address already valid in your network.
   c. Ethernet connection that requires changing the instrument IP address: either to add the instrument in your local network or to have an IP address compatible with the computer IP address.

5) Connection without to change the instrument IP Address:

Click on the IP Address to choose the instrument. Click on "**Select**" and "**Close**". The new IP Address appears in the "Device Configuration" window (Figure below). Click on "**Connect**" to make the direct connection.

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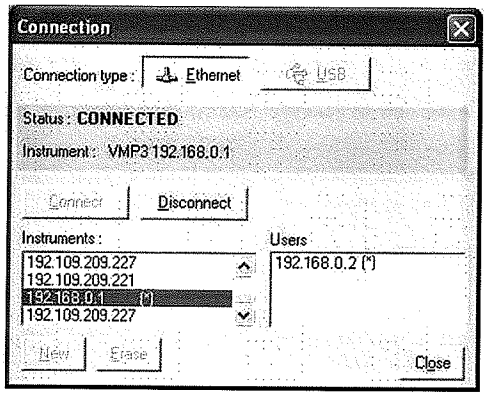


Fig. 30: "Connection" window with the instrument current IP Addresses added to the current devices.

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 IP Address.
Note: this connection without modifying the IP Address is possible only if the computer has a valid IP Address in the same network as the instrument (in this example: 192.168.0.2)

4.1.1.2 SP-150 IP address and gateways change: network connection

6) Connection changing the instrument IP Address:

Network connection: On the "**New device**" window (Fig. 29) select the desired instrument and click on "**Modify**". The following window is then displayed:

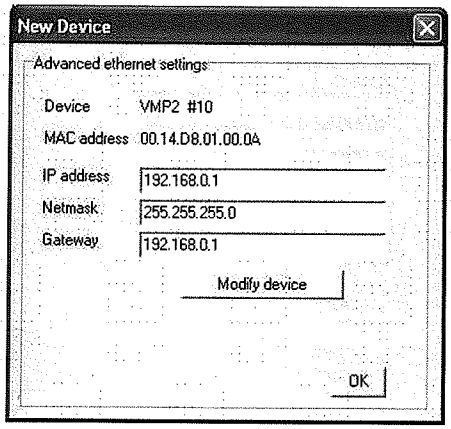


Fig. 31: "Advanced Ethernet settings" of the "New Device" window used to change the instrument IP Address.

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Launch EC-Lab® Express software. If only one instrument is detected by the software through the USB connection, the computer will automatically be connected to this unit. If more than one instrument is detected through several USB ports on the computer, the following window is displayed to offer the user to select the device he wants.

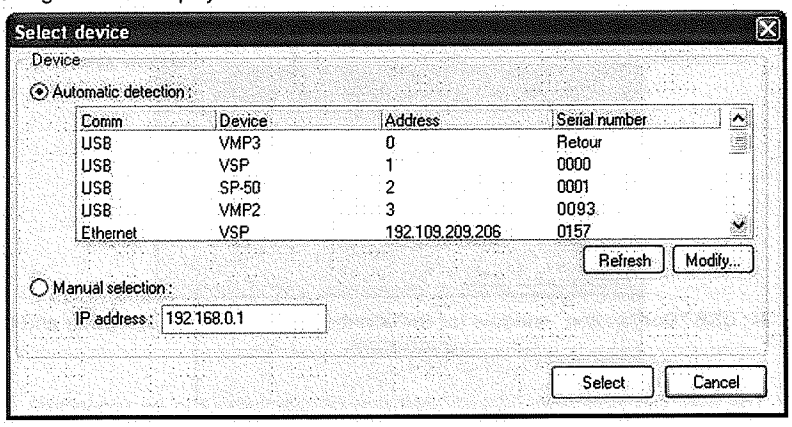


Fig. 36: "New Device" window to select an unit.

Click on "Select". The connection button is green lightened showing the effective connection.

4.2.2 Ethernet connection: Network parameter configuration

Let us consider now the Ethernet connection. If the computer IP address has been previously modified by the user to be in the same network as the instrument (default IP address 192.168.0.2) the connection will be made in the same way as the USB connection (so refer to the previous section in this case). If the instrument and the computer are in different networks, the way to proceed is the same in both the direct or the LAN connection. 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.

4.2.2.1 Ethernet connection requiring to change the instrument IP address

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

After launching EC-Lab® Express software, if the computer and the instrument are in different networks or if more than one instrument is detected through a multiple connection on the computer (both Ethernet and USB) or in your local area network, the "New Device" window is displayed to offer the user to select the device he wants.

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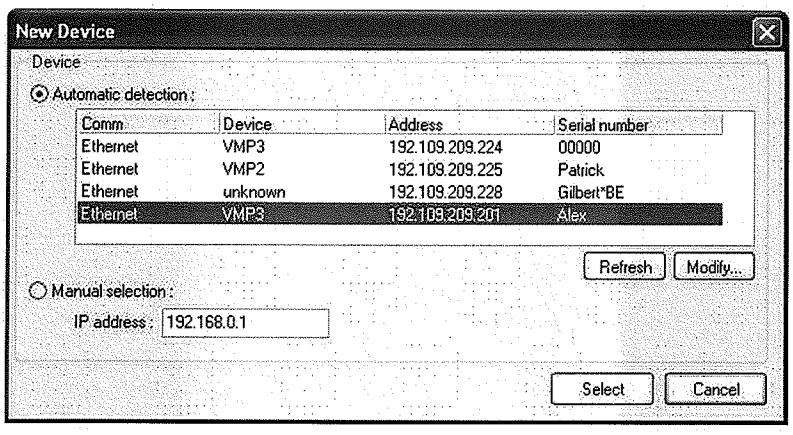


Fig. 37: "New Device" window to select an unit.

The case of the PC and the instrument in the same network has already been considered before. The automatic detection frame shows the communication mode, the Device type, the address of the instruments detected with their serial number (#). 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.

If the Ethernet connection requires to change the instrument IP address, click on "**Modify**". The following window is then displayed:

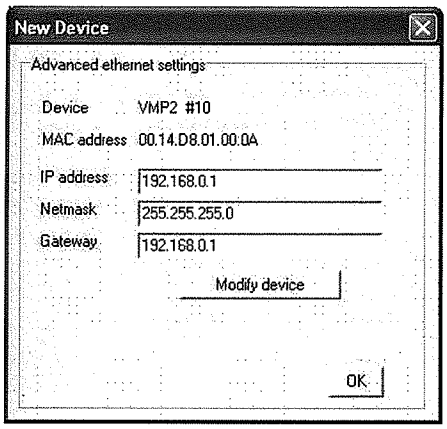


Fig. 38: "Advanced Ethernet settings" of the "New Device" window used to change the instrument IP Address.

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 will be sent to the instrument and a "configuration changed" message is displayed in green. Several "Bip"

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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.

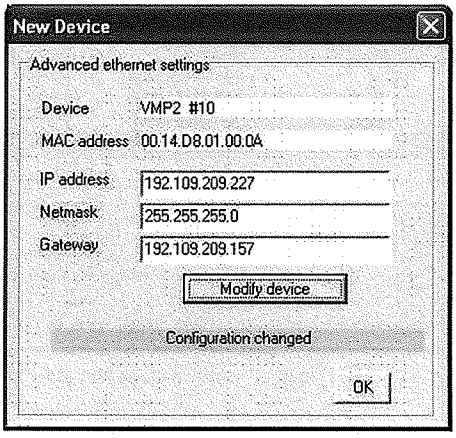


Fig. 39: SP-150 New configuration.

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

Note: to switch between EC-Lab® and EC-Lab® Express software, the SP-150 has to be switched off and restarted.

4.3 SP-150 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 to be used. It does not need to be upgraded. Nevertheless new EC-Lab® versions (with new protocols or improvement) are created and can be downloaded and installed by the user.
Since V8.00 the firmware is automatically upgraded (if necessary) when EC-Lab® is starting.

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5. Advanced features

5.1 External device control and recording

5.1.1 General description

EC-Lab® software offers the possibility to the user to control external devices such as rotating electrodes, thermostatic baths and to record external analog signals through the auxiliary DB9 connector. The user has to configure the output to control an external device and to configure 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 into a 0 to + 5 V range. The figure below shows the external device window where the user has to set parameters. Many instruments are already configured in the software to be controlled by our potentiostat. The list will be completed in the future versions of EC-Lab® software. To configure external devices select "**External Device**" in the "**Config**" menu. The following window is displayed:

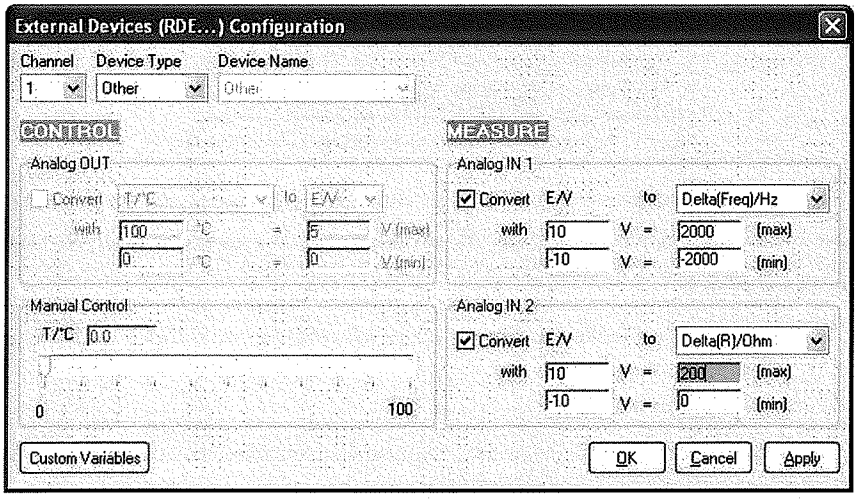


Fig. 40: External device configuration window.

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

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 with 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.

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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:

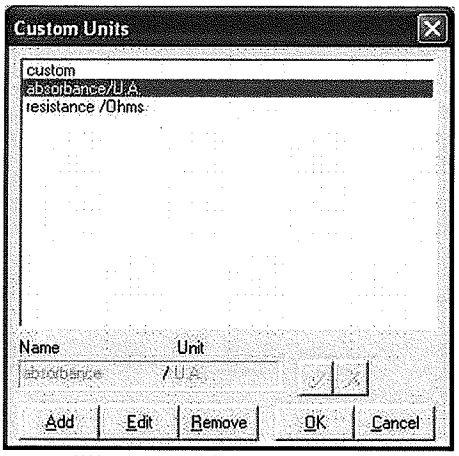


Fig. 41: Custom Units window to define new variables.

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 color (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 for 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 details 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.

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5.1.2 Rotating electrodes control

Available instruments with the rotating electrode control

Instrument	*MPG*	*VMP*	*VMP2/Z*	*BiStat/Z*	*VSP*	*VMP3/Z*	*HCP-803*	*EPP series*
Available			×	×	×	×	×	×

The standard SP-150 instrument, with or without boosters can control a rotating electrode such as PINE RRDE 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 (PINE RRDE Rotating Disk electrode) is designed to work either with one working electrode or with two working electrodes (ring-disk electrodes). A bipotentiostat is necessary for the measurement of the working electrode potential of both electrodes. The SP-150 (using two channels) or the BiStat are appropriated instruments for this kind of experiments.

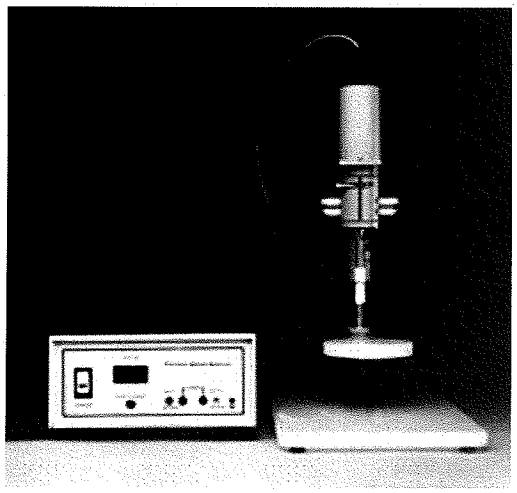
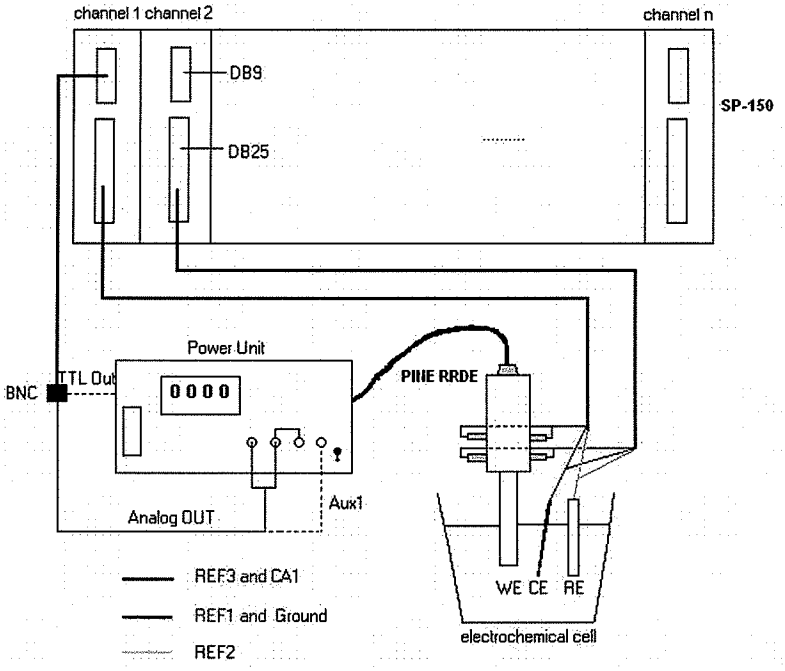


Fig. 42: Model PINE RRDE Rotating Disk electrode.

5.1.2.1 Connections

The instrument used to control a rotating electrode is provided with two cables. The first one is a cable with a DB9 connector on one side and eight BNC plugs on the other side. The other cable has a BNC plug on one side and two banana (4 mm) plugs on the other side. The connection of the electrochemical instrument with the electrode rotator depends on the working electrode. With only the disc electrode, one channel board is used and the connection is the standard one. With both ring and disc electrodes, two channels are used with only one counter and one reference electrode. The connection must be done according to the N'Stat mode. Please refer to the appropriate part of the manual for more information. In that case, the connection is described on the following picture:

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Model PINE RRDE connection to the VMP2 cell cable.

Fig. 43: PINE RRDE Rotating Disk electrode connection to the SP-150 cell cable.

The connection of the two channel boards with the rotating system is as follow:

- With the DB9 cable connect the auxiliary input/output of the channel board.
- Connect the "Analog out" BNC connector with the BNC plug of the second cable.
- Connect the two banana plugs to "input" and "common" on the power unit.
- Connect the REF 3 and CA1 wires of the first channel to the disk brush, the REF1 and Ground wires to the counter electrode and the REF2 wire to the reference electrode.
- Connect the REF 3 and CA1 wires of the second channel to the ring brush and the other wires as you did with the first cable.

NOTE: The user must not forget to choose the "CE to Ground" mode for the N'Stat connection in the "Advanced settings" window.
The user can also use the Trigger Out BNC to stop the motor with a trigger out at the end of the experiment.
It is also possible to measure and record the rotating speed of the electrode as the "Analog In1" potential when connected to output on the power unit.

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5.1.2.2 Control panel

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

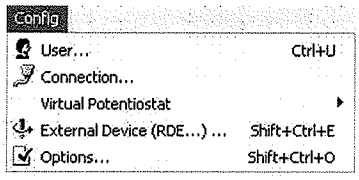


Fig. 44: Menu to choose for rotating electrode control.

Note: this menu is available only if channels designed to drive RDE (since 11/04) are connected with the RDE electrode rotator. Then the following window is displayed:

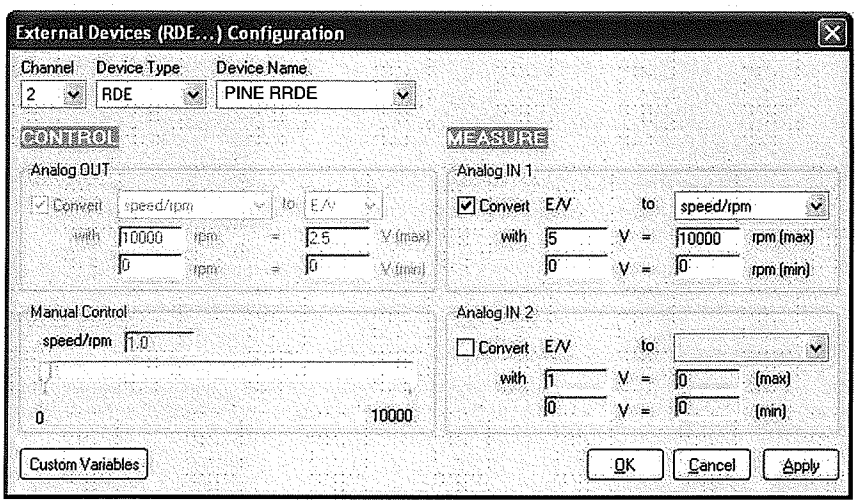


Fig. 45: Rotating electrode control configuration.

Under **Speed control unit**, one can select the standard supplied 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 into the list upon request. Note that calibration parameters for 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 for the electrochemical instruments equipped with a rotating system.

In order to use two potentiostat/galvanostat channels and some rotating ring-disk electrode (with two working electrodes) it could be useful for the user to synchronize both channels together in order to start the experiment on both channels at the same time. Report to the corresponding part in the manual for more information about the synchronize option.

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5.1.3 Temperature control

A temperature control is possible with the auxiliary output voltage of a SP-150. Several thermostats have already been configured on the VMP such as Julabo series and Haake Phoenix series.

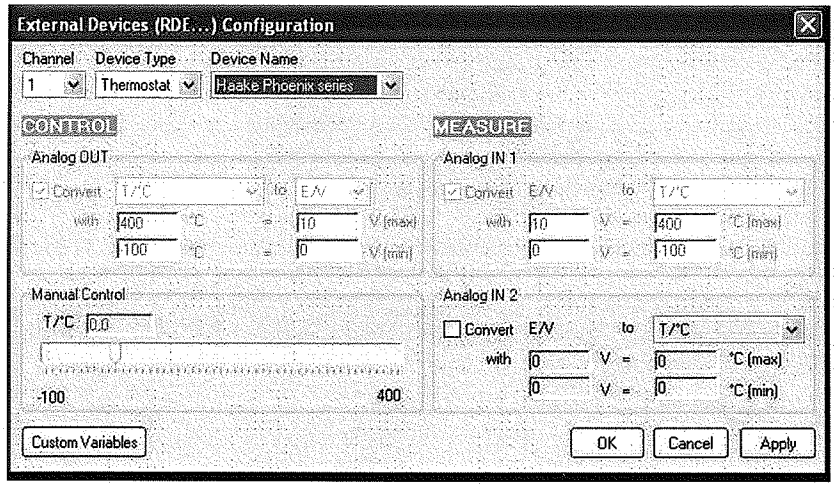


Fig. 46: Haake Phoenix series thermostat control configuration with a SP-150.

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

5.1.4 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 on the figure:

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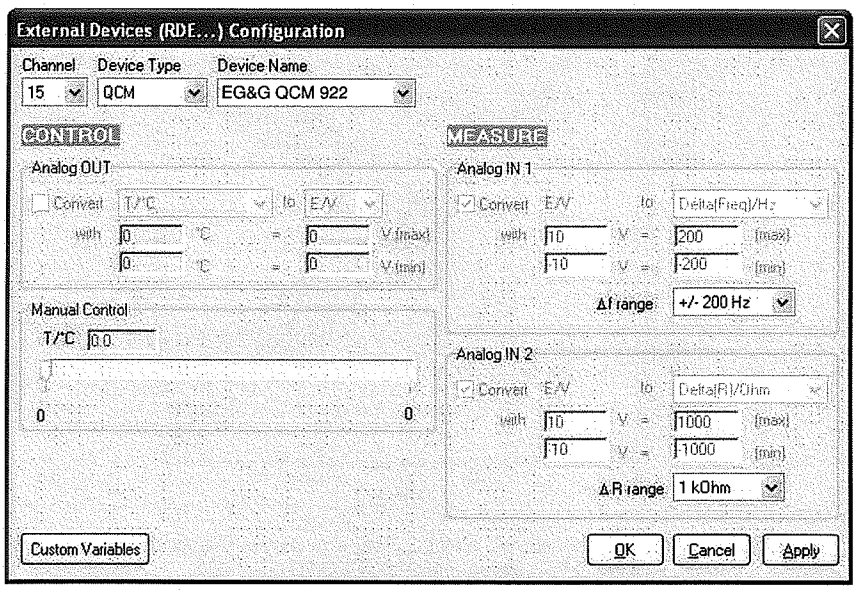


Fig. 47: SEIKO EG&G QCM-922 configuration window.

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:

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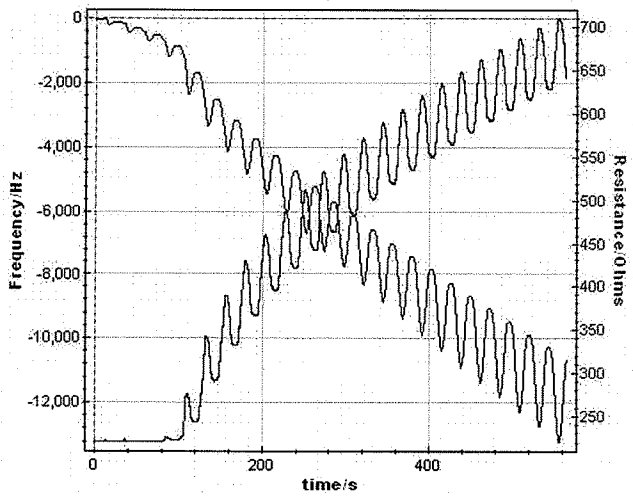


Fig. 48: Frequency and resistance variations recorded from the analog inputs for a SP-150 coupled with a SEIKO EG&G QCM 922.

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.

5.2 Virtual potentiostat

The user can work with EC-Lab® software without to be connected to an instrument. In that case the software sees a virtual potentiostat not available for experiments but that can be used as a user's interface. The user can select his virtual instrument in the "Config menu" and the corresponding software interface will be displayed. According to the instrument selected the available techniques and the time base are different.

5.3 Switching the SP-150 and the boosters between 110 V and 240 V

The SP-150 instruments and the SP-150 boosters can be connected directly to the 110-120 V or 220-240 V without any action is required.

The table below summarizes the fuses values for the next instruments:

SP-150	SP-150 booster
4 A	10 A

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6. Maintenance and calibration

6.1 Maintenance

Our instruments do not require a specific maintenance. Each channel board is calibrated at the factory (at 25°C) before to be delivered to the customer. According to the temperature differences between winter and summer, we recommend to adjust 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 EC-Lab® software channel calibration in the "**Tool**" menu. We also recommend a full check-up of the instrument (at the factory) every two years. 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.

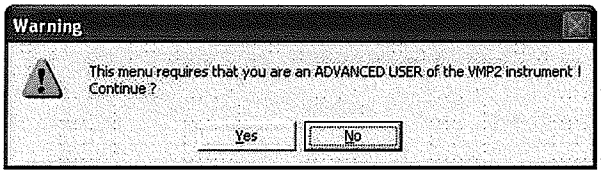
6.2 Software channel calibration

Available instruments with the calibration procedure

Instrument	*MPG*	*VMP*	*VMP2/Z*	*BiStat/Z*	*VSP*	*VMP3/Z*	*HCP-803*	*EPP series*
Available			×	×	×	×	×	×

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

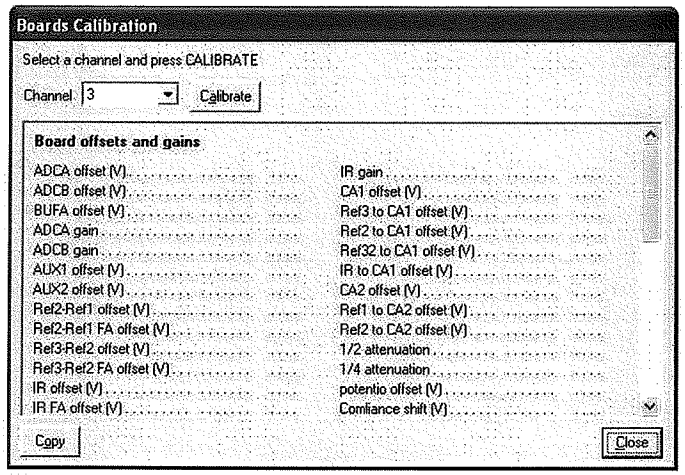
1) In EC-Lab® software Select "**Tools/channel calibration**" and follow the instructions. You will receive the following message:



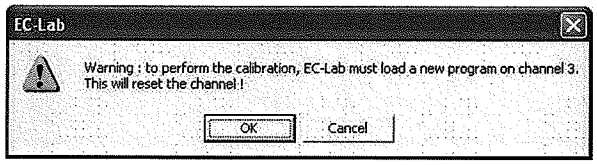
Answer "**Yes**" to the warning message. Then the board calibration window appears.

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

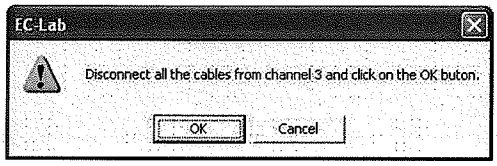
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3) A warning message will follow:



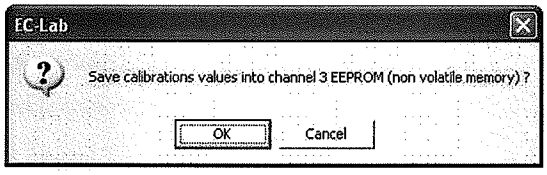
4) Click on Ok.



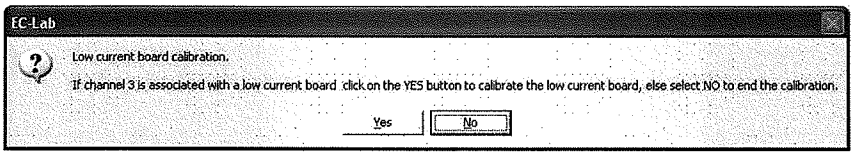
5) Disconnect all the cables from the channels to calibrate as called in the message. Then the calibration of the channel board will begin. For each variable, the numerical value corresponds to the compensated offset or gain and "pass" signify that the calibration is made. If "failed" appears instead of "pass" then the calibration cannot be done. The channel board is probably damaged and must come back at Bio-Logic 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.

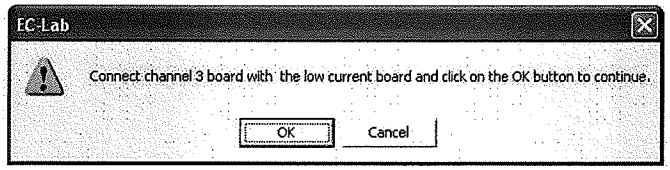
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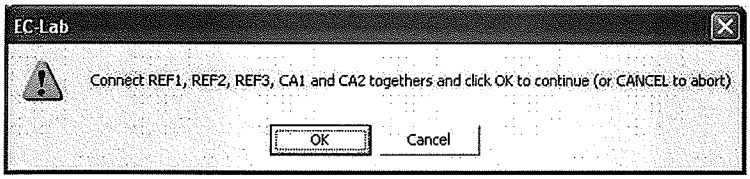
6) Click on "Ok" to save the calibration parameters on the channel board. On the board calibration window the message "calibration saved on channel X" is displayed. After the calibration of the channel board, a message will ask the user if a "p" low current board is associated to the standard channel. If a "p" low current board is connected to the channel the user must calibrate the low current board as follow.



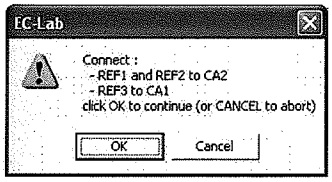
Click on "Yes" to calibrate the low current board. The connection message between the standard and the low current board appears:



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"

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10) A last message will ask you to save calibration values into 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 be reloaded on the channel board.

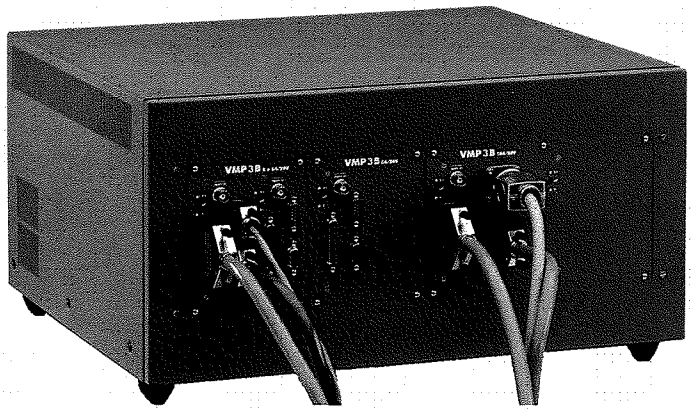
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7. The SP-150's accessories

The SP-150 potentiostat is designed for all fields of electrochemistry. The specification of the instrument must allow the user to work with very small currents (with the low current board option) and also to apply and measure very high currents (with current power booster option). The modularity of the SP-150 potentiostat allows all kind of experiments especially in general electrochemistry, battery study and corrosion. The SP-150 can be used for EIS measurements.

7.1 External current power boosters

The SP-150 is designed to accept 800 mA maximum continuous current for each of the channel boards at a room temperature of 25°C. The user can apply currents up to 80 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 and 80 A). A chassis can contain mixed amplification 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.



7.2 Z option for EIS measurement

The option for EIS measurement is available on the SP-150. This option is included on the channel board when mentioned. Each of the channel boards can be provided with EIS option. EIS measurements can be led simultaneously on all channels.

7.3 "p" Low current option

On the opposite of 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 or microelectrodes. The low current board is always coupled with a channel board (standard or Z).

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When added to a channel board, both low current board and channel board have to be calibrated together. The way to do the calibration is described in the manual.

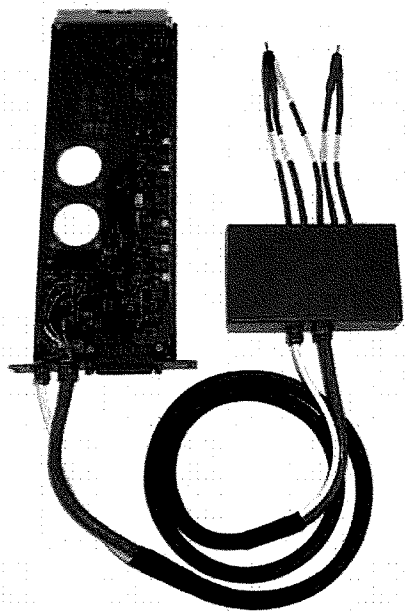
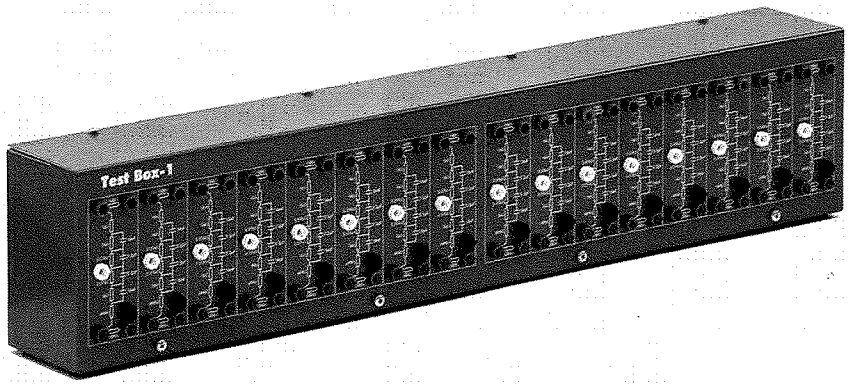


Fig. 49: "p" low current board.

7.4 Test boxes for calibration check and user's training

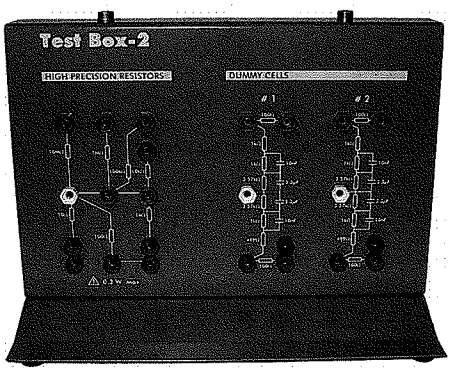
7.4.1 Test Box 1 and Test Box 4 for user's training



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The Test Box 1 is a tool provided with all the instruments. It is made with dummy cells circuits (one for each channel). The electrical circuits of the dummy cells can be used to simulate the behaviour of linear electrochemical systems. With this box the user will have the ability to test the electrochemical impedance spectroscopy or electrochemical protocols like Cyclic Voltammetry or Linear Polarization. The resistance values are given with 1% accuracy.
The Test Box 4 is the same as the Test Box 1 but with only two dummy cells instead of 16 for the Test Box 1.

7.4.2 Test Box 2



The Test Box 2 is a tool to check the calibration of our multichannel potentiostats / galvanostats. 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 calibration of the standard channel boards of our instruments. The high precision resistor circuit is made with 7 resistors in order to check each current range of the board.
Combined with EC-Lab® software channel calibration described in the technical note #16, the Test Box 2 can allow the user to keep an always well-calibrated instrument.

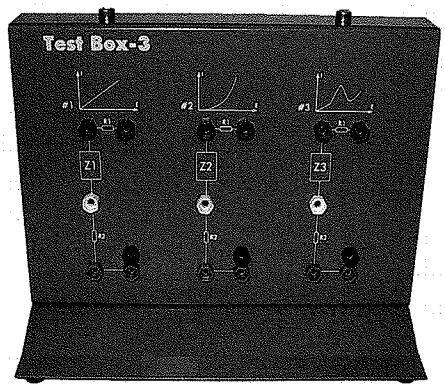
Ref: Technical note #16 is available on the support section of our web site.

High precision resistor Characteristics:

High precision resistor	*I range*	*VMP2/BiStat/VSP/VMP3/EPP*	*VMP*	*MPG*
10 Ohms +/- 0.01%	1 A	×		
100 Ohms +/- 0.005%	100 mA	×		
1 kOhms +/- 0.005%	10 mA	×	×	×
10 kOhms +/- 0.005%	1 mA	×		×
100 kOhms +/- 0.005%	100 µA	×	×	×
1 MOhms +/- 0.005%	10µA	×		
10 MOhms +/- 0.01%	1 µA	**for the "p" low current option**	×	

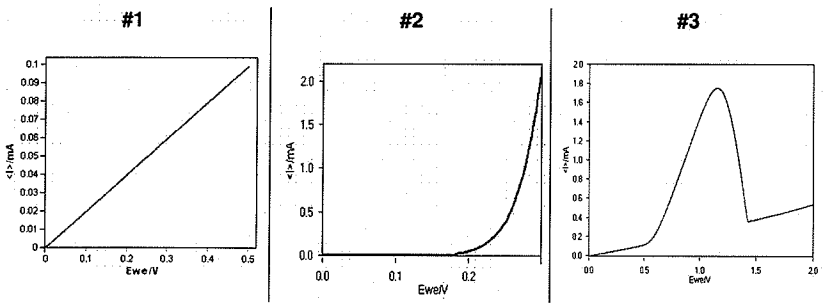
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7.4.3 Test Box 3



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 usual overlooked items about the electrochemical impedance spectroscopy. By the means of the Test Box 3 some general electrochemistry protocols like Cyclic Voltammetry, or corrosion protocols such as Linear Polarization or Generalized Corrosion can also be studied.

Stationary curves :



Ref: Application notes #8 and #9 are available on our web site.

7.5 Rotating disk electrode control with PINE Rotating Disk electrode

The auxiliary input/output of the SP-150 can be used to record and control external signal such as a rotating disk electrode (for example PINE RRDE Rotating Disk Electrode), a temperature control unit. A SP-150 DB9 cable is used for this connection. The available signals are E_{we} monitor, I monitor, TTL input, TTL output, External input 1, External input 2. See part **5.1** page 33 for more details.

7.6 Labview VIs

The SP-150 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

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potentiostats/galvanostats/EIS in an 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:
    - voltage scan (cyclic voltammetry),
    - current scan,
    - potentio impedance,
    - galvano impedance,
    - chronoamperometry,
    - chronopotentiometry,
    - open circuit voltage,
    - galvanostatic pulses,
    - potentiostatic pulses,
    - staircase potentio EIS,
    - staircase galvano EIS,
    - constant power,
    - constant load,
    - loop.
- start/stop the selected channel(s),
- retrieving data.

Note that the time base is 10 or 20 µs with these LabVIEW® Vis depending on the considered protocol.

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8. Technical Specifications

8.1 SP-150 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
Maximum current	± 800 mA continuous
Maximum potential resolution:	300 µV on 20 V dynamic range programmable down to 5 µV on 200 mV dynamic range
Maximum current resolution	0.004 % of the dynamic range programmable down to 0.760 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

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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 500 kHz
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

Current measurement noise (rms/Bandwidth):

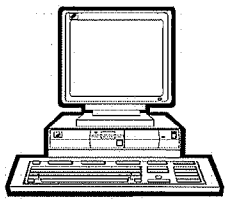
Noise is always present since all materials produce noise at a power level proportional to the material temperature. The shunt resistor is the first noise source in a current measurement path. A resistor noise is generally referred to as thermal noise or white noise. Just as the white light contains 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 carefully selected circuits with low noise specifications have been selected.

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

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8.2 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).



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8.3 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 SP-150 to the cells (or amplifier to cells) must be connected either to an electrochemical cell or to the testing box.

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9. Troubleshooting

9.1 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). Else see your network authorizations…
- into EC-Lab®, select **File, Repair...** Then select the saved file and click on the **Repair** button.
- if the problem persists, contact us.
- ensure that the computer IP Address has not been modified since the beginning of the experiment.

9.2 PC Disconnection

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

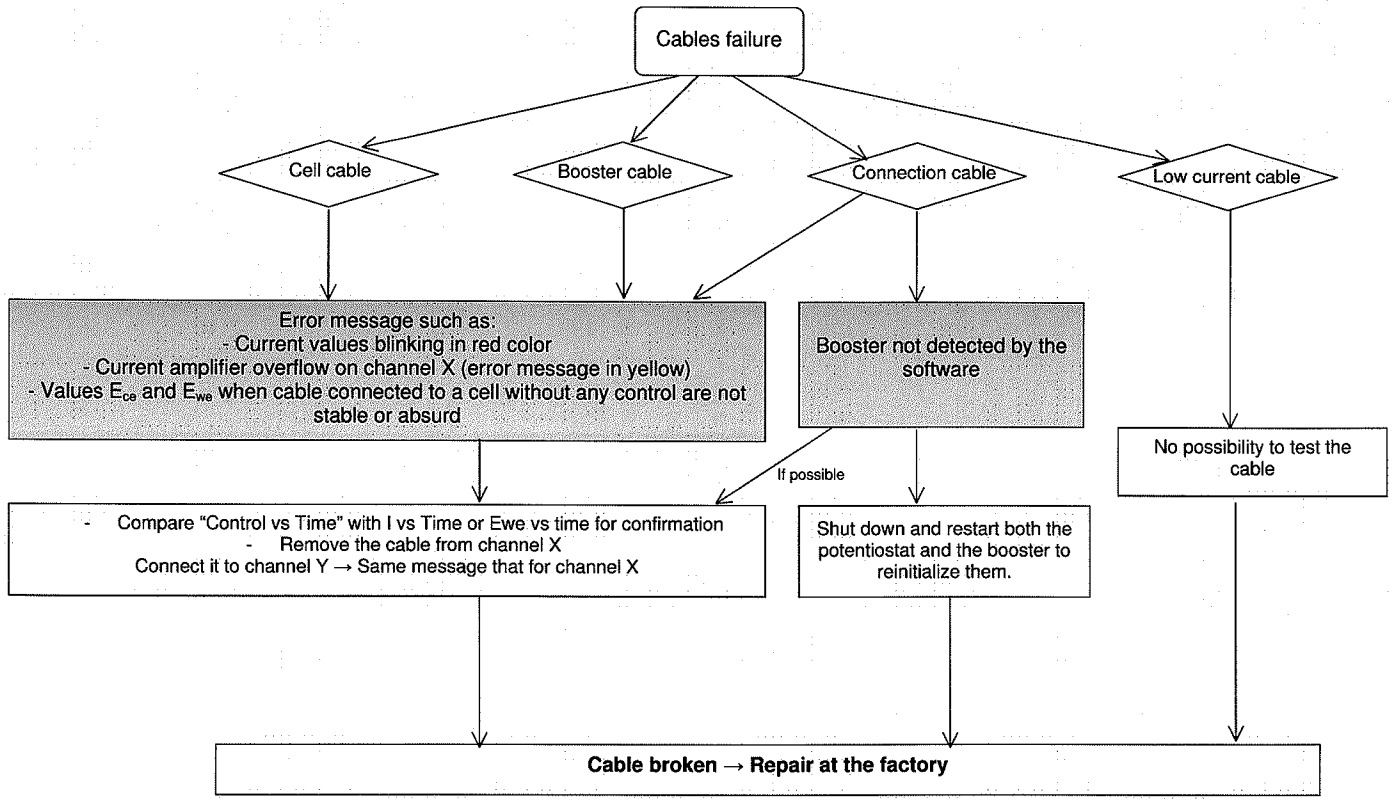
- check the PC – instrument connection.
  - direct connection: verify that the crossed Ethernet cable is plugged from both ends.
  - network connection: verify that the yellow led is blinking on the instrument front panel and that you can access to your network directories from the PC.
- check that the 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.

9.3 Effect of computer save options on data recording

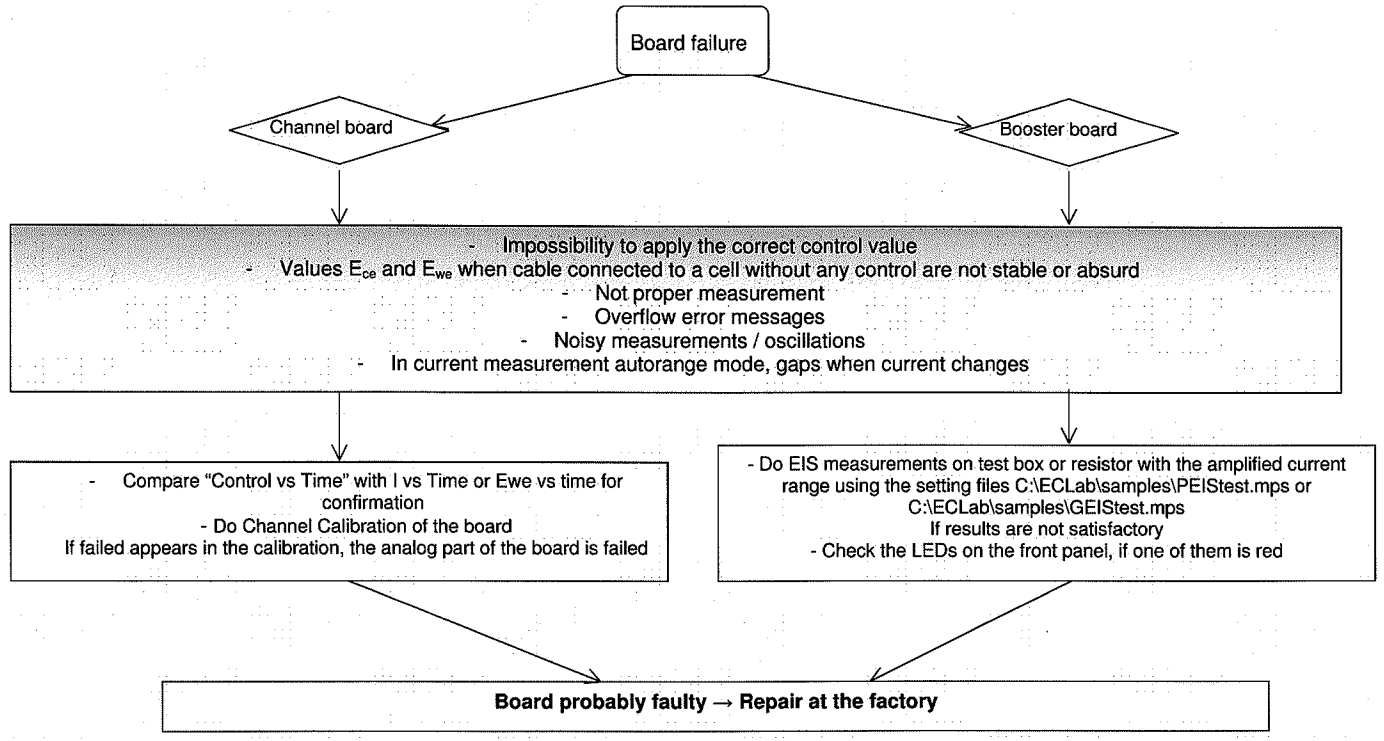
Electrochemical experiments can often have a long duration (more than 24 hours). During the experiment, the computer should always be able to record the data points. But the survey options, especially for the computer hard disk, risk to unable data points recording. In order to avoid that, we advise the user to remove the power save option of his computer in the setting panel.

9.4 Preliminary check

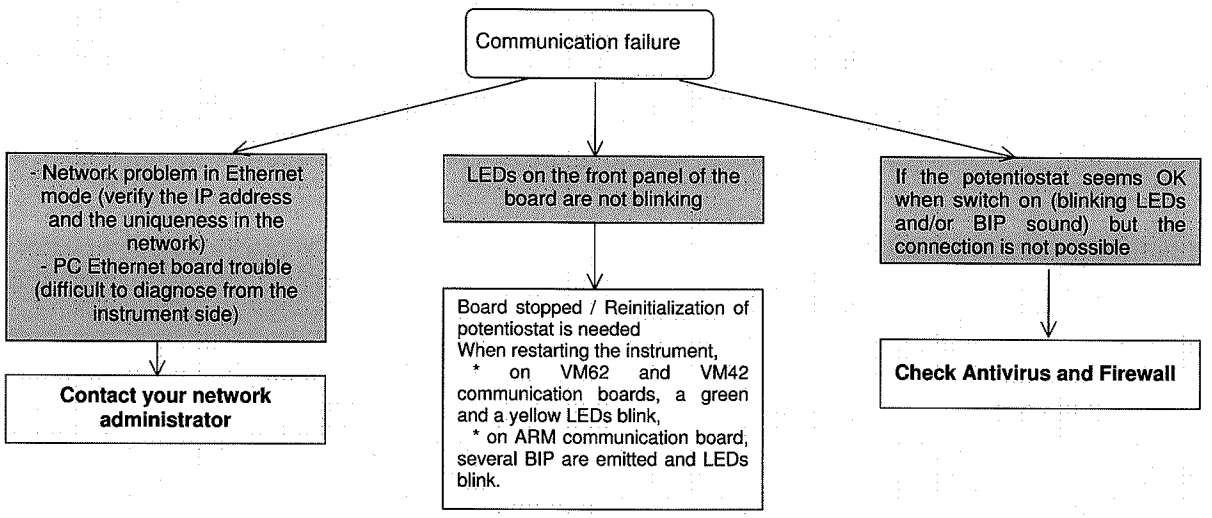
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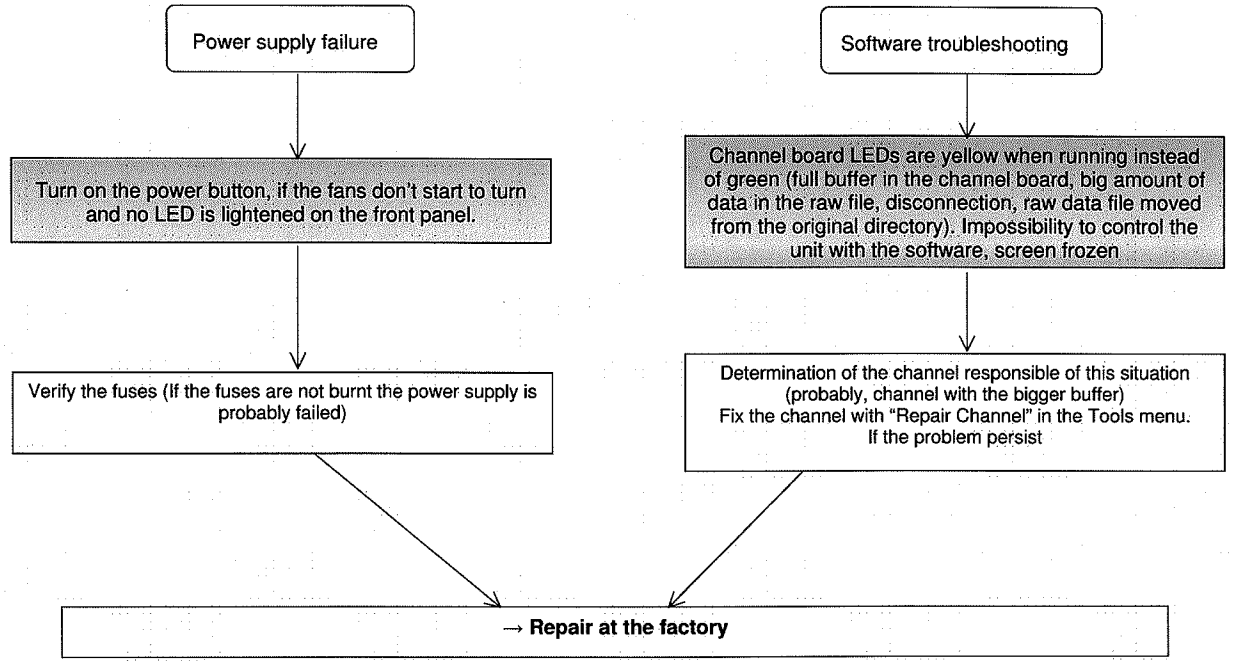


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Note: Two series of communication boards are available in our instrument range:
- VM42 and VM62 communication boards (without USB connection) for the VMP1, MPG, VMP2 and first generation of BiStat
- ARM communication board (Ethernet and USB connection) for the VMP3, VSP, HCP-803, EPP series, SP150, SP-50, VSP and last generation of BiStat.

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10. 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: represents the frequency of the regulation loop of the potentiostat. It depends on the electrochemical cell impedance. The bandwidths values are going 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 front panel used as auxiliary input/output.

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

Firmware upgrading: the firmware is the operating system of the instrument. 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-pA resolution that can be added to each channel.
This option extends the current range down to 1 nA. 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.

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.

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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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