Getting Started with EC-Lab®:
EIS: **E**lectrochemical **I**mpedance **S**pectroscopy

AIM

The aim of this presentation is to guide the user to set the appropriate parameters to perform an EIS measurement.

Only PEIS technique will be discussed hereafter but the information given in the presentation can be adapted to GEIS, SPEIS, SGEIS, PEISW techniques.

PROCEDURE

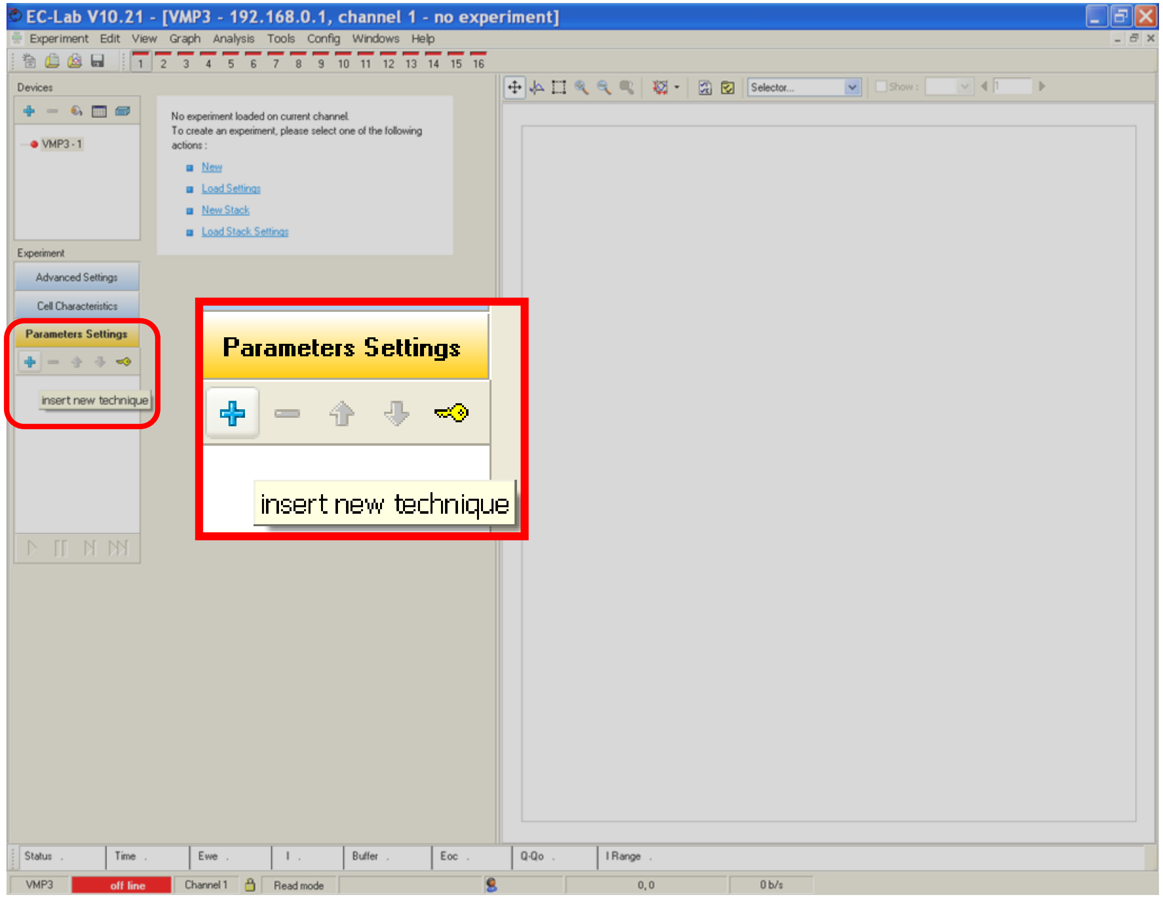
1. Insert the EIS technique
2. Insert other(s) technique(s) if needed
3. Set the « Advanced Setting » tab
4. Set the « Cell Characteristics » tab
5. Set EIS technique
6. Start the experiment

NOTE:
It is assumed that the computer and the instruments are connected. This is explained in the Getting Started named "EC-Lab®: Connection to the instrument(s) & Channel(s) selection".

Tutorials on impedance theory are available on request. No theoretical background will be discussed in this getting started.

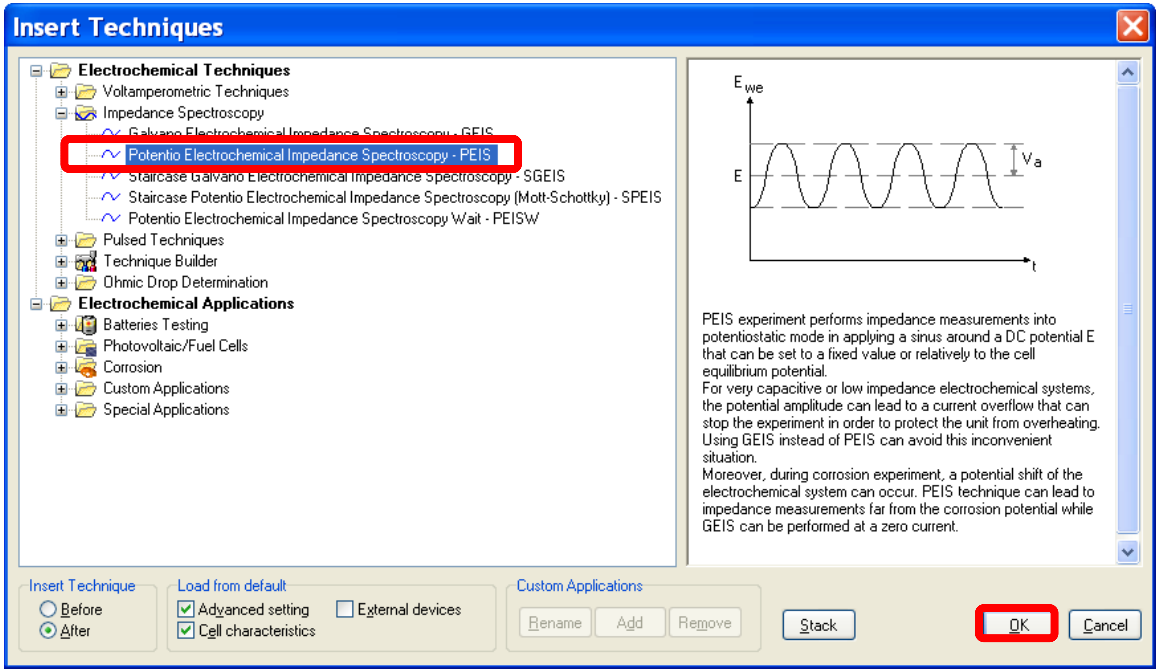
1- Insert the EIS technique

- In the experiment frame, click on the button to insert the new technique



- Select "Potentio Electrochemical Impedance Spectroscopy – PEIS" technique available in the "Impedance Spectroscopy" folder. The technique is highlighted in blue when selected

- Click on the "OK" button

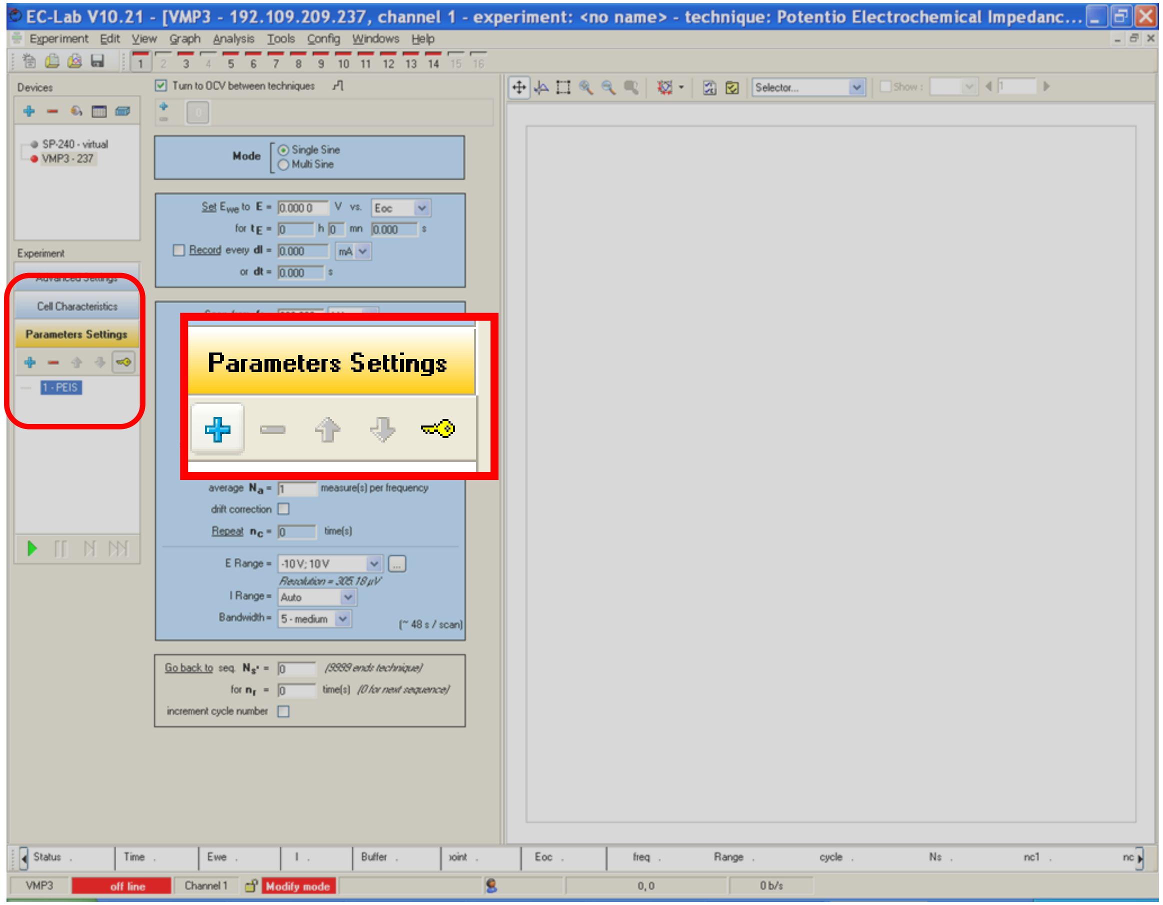


2- Insert other(s) technique(s)

- Click on the ✚ button to insert any additional technique(s).

Note: it is possible to remove technique or to move technique before or after. First select the technique that you want to remove/move (the technique will be highlighted in blue) and then by clicking on the appropriate button.

- To add
- To remove
- To move before
- To move after



3- Set the « Advanced Setting » tab

- Click on the **Advanced Settings** tab.

  Then the « Advanced Settings » window is displayed.

  For EIS measurements, the default parameters of the « Advanced Settings » are suitable for most of application.

NOTE:

This window is different for the VMP3 family and for the SP-300 family.

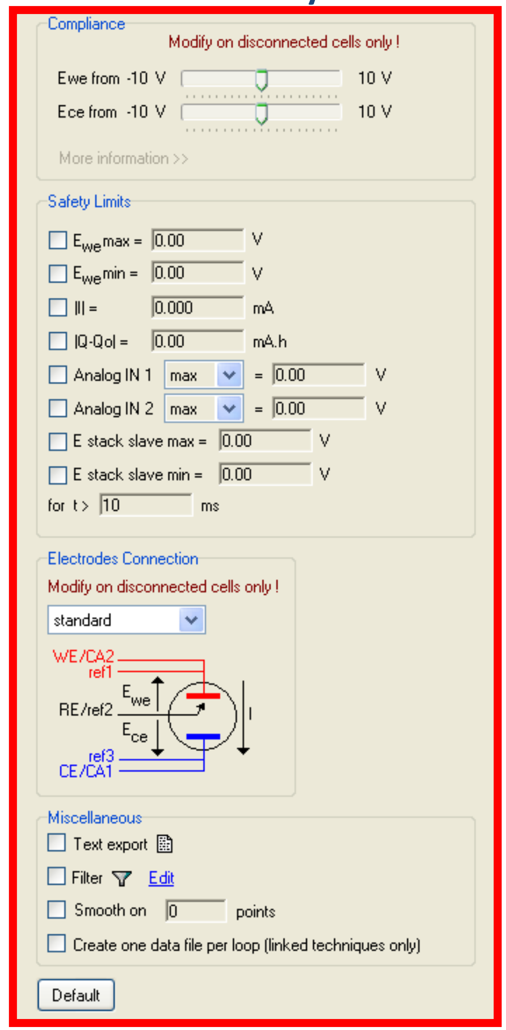
VMP3 family:

SP-50, SP-150, VSP, VMP3, CLB-500, CLB-2000, HCP-803; HCP-1005

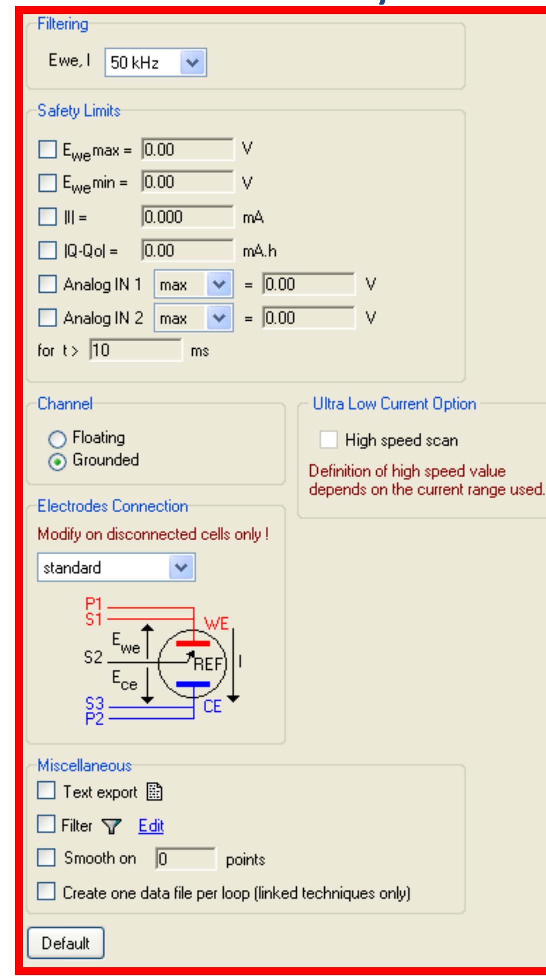
SP-300 family:

SP-200, SP-240, SP-300, VSP-300

VMP3 family



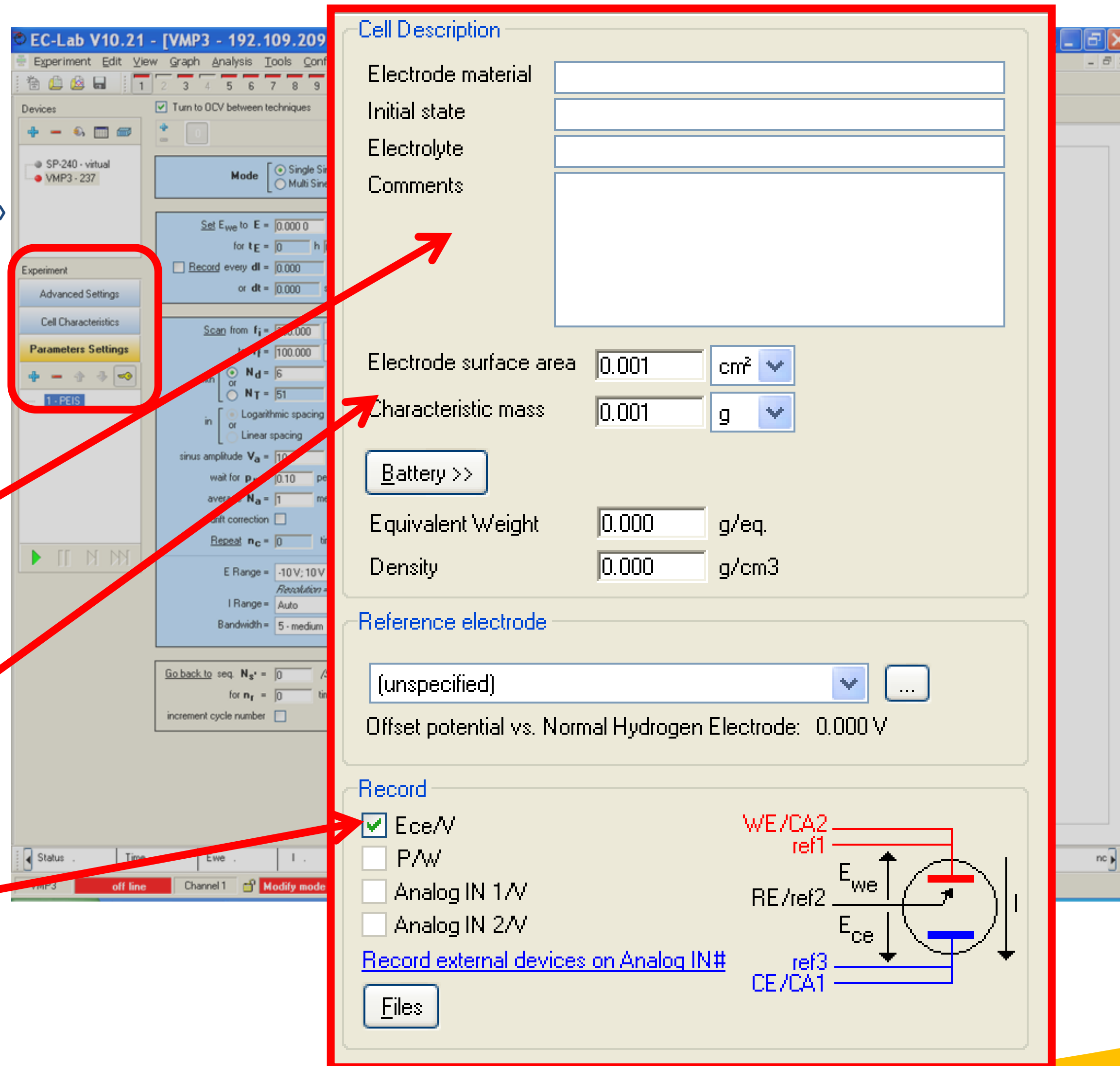
SP-300 family



4- Set the « Cell Characteristics » tab

- Click on the **Cell Characteristics** tab.

  then the « Cell Characteristics » window is displayed.



Information about the cell and some comments.

Electrode surface area has to be set if the user want to work with volumic/surfacic resistance (Ω/ cm³ or cm²) instead of resistance (Ω).

TIP:
Possible to record the impedance of the WE but also the **impedance of the CE**.

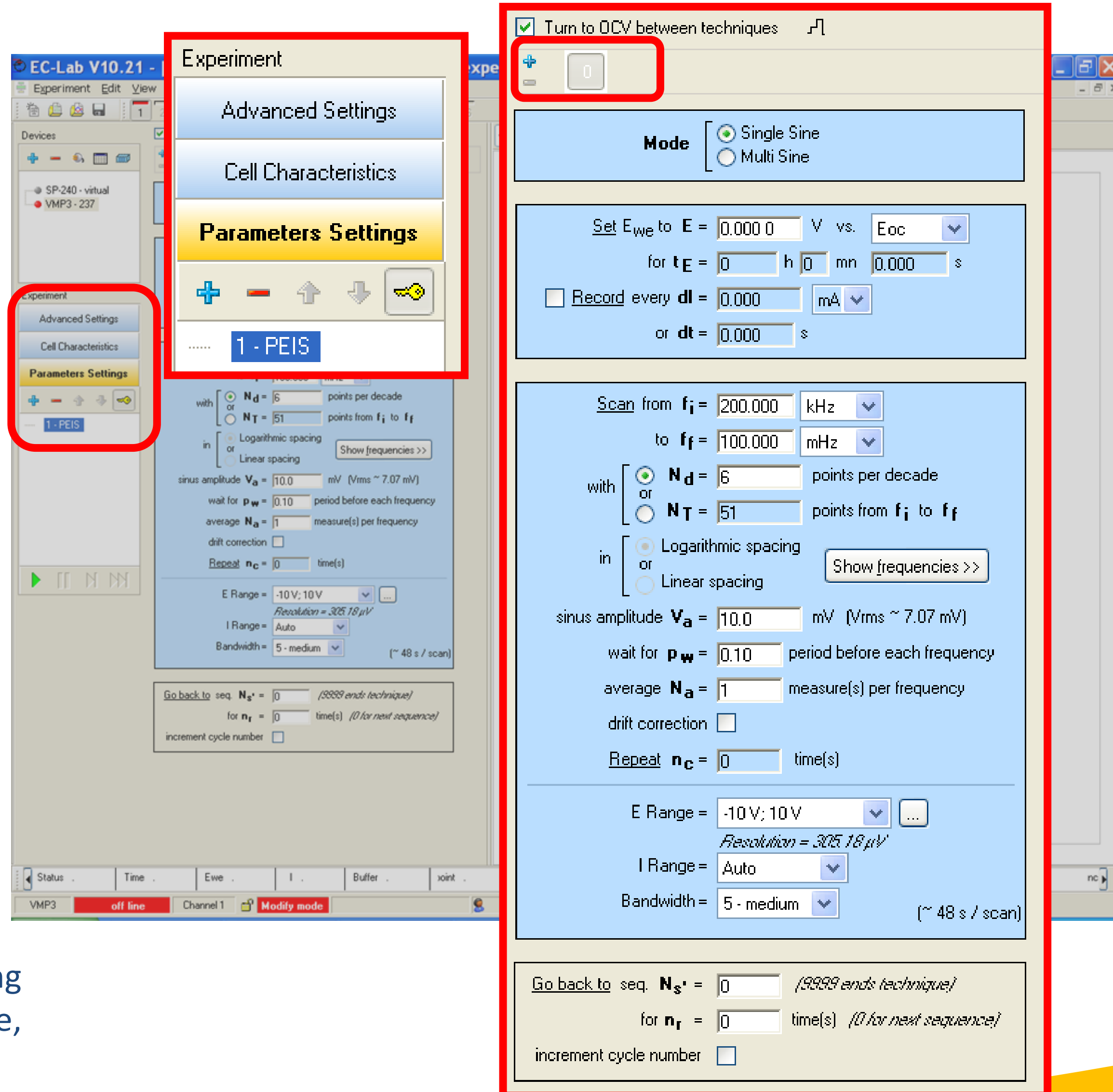
NOTE:
All these infomation are stored in the data file

5- Set the EIS technique

- Click on the **Parameters Settings** tab or directly on the EIS technique in the list of techniques. The technique is highlighted in blue.

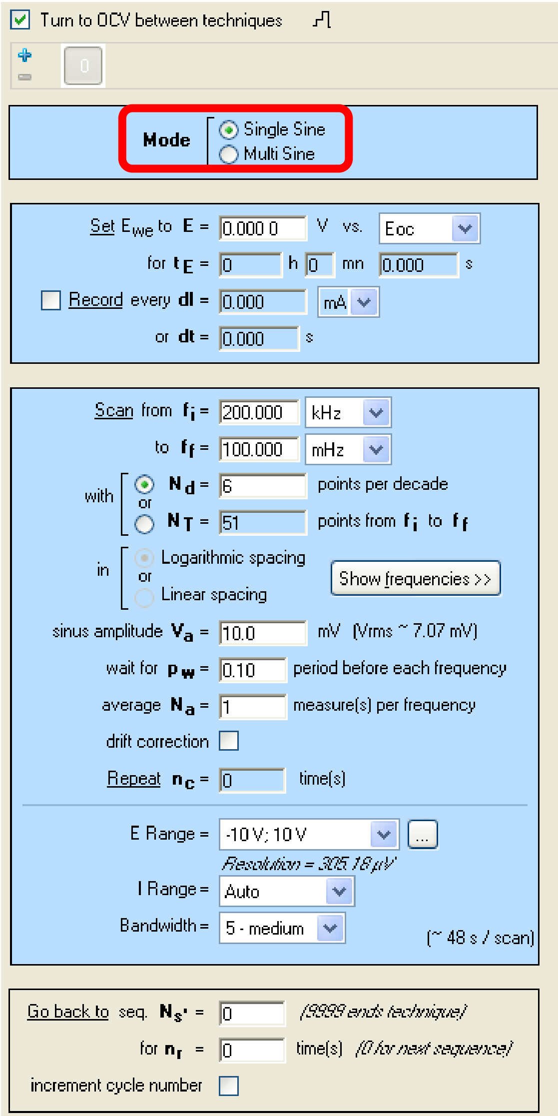
- Three different blocks composed the EIS technique (described in the next slide):
- First, select single or multisine mode
- Second, conditioning and initial period
- Third, EIS measurement (amplitude, frequency, sampling rate)

- It is possible to add or remove sequence by clicking on the  buttons

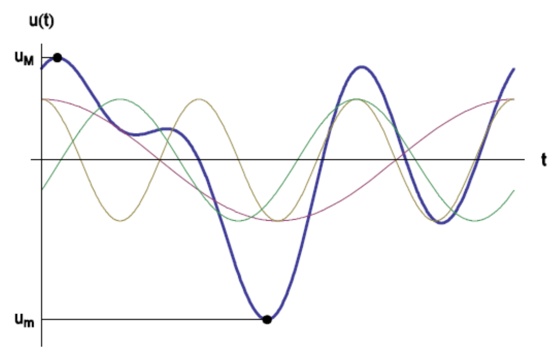


NOTE:

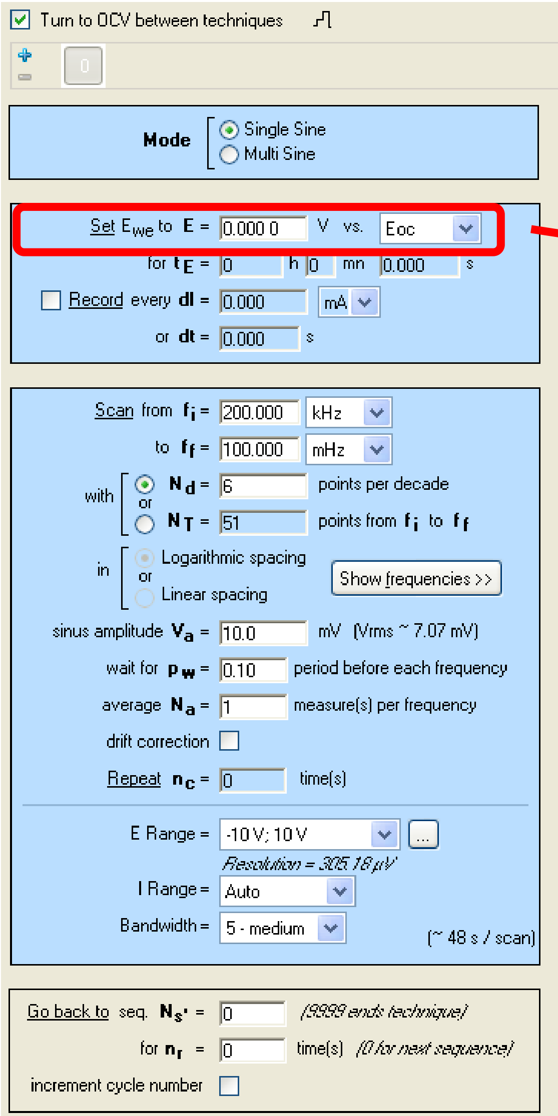
All the settings may be changed during the experiment (except Irange, Erange, bandwidth, single/multisine mode).



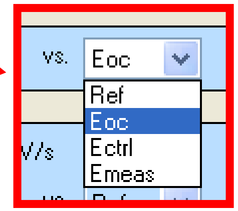
To reduce the duration of the experiment, the multisine mode is available. Several frequencies are applied in the meantime. This mode is active only for frequencies below 10 Hz.



5- Set the EIS technique



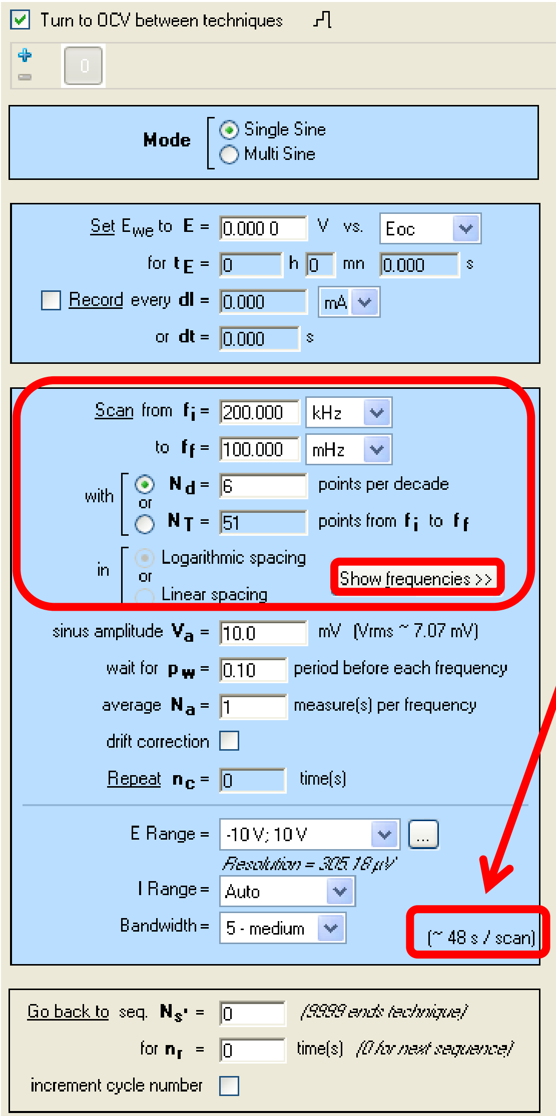
- Defines the potential at which the EIS measurement will be performed. This can be defined *versus* several voltage reference.



Ref (the potential of the reference electrode)
Eoc (Open circuit voltage)
Ectrl (potential of the previous controlled voltage, if a technique is set before the EIS)
Emeas (potential of the previous measured voltage, if a technique is set before the EIS)

It is possible to hold this potential during a certain time (t_E) before starting the experiment (conditioning period).

5- Set the EIS technique

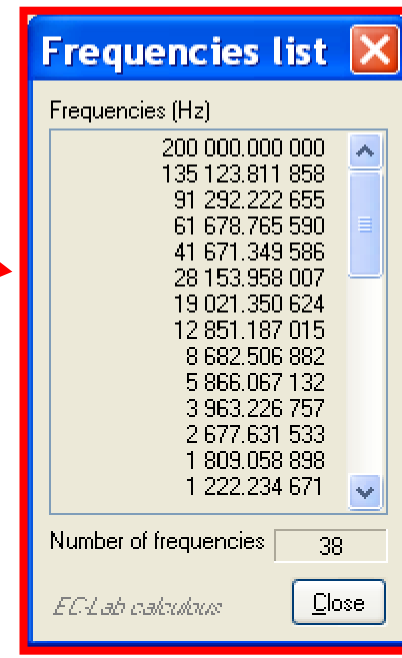


Defines the frequency sweep:

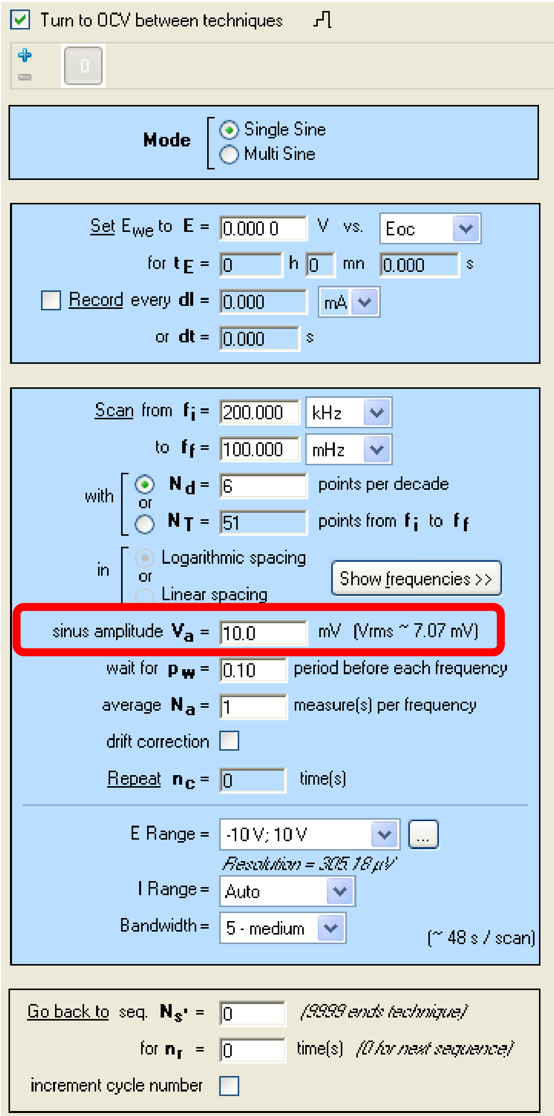
- min and max frequencies
- data point sampling (log or linear spacing, points per decade, or total point between min and max frequencies).

NOTE:
To check the frequencies at which the EIS are performed, click on the Show frequencies >> button.

The duration of the experiment is indicated at the bottom of the block in *italics*. It depends on the range of frequencies, the chosen sampling and also on the N_a parameters (shown in a next slide).

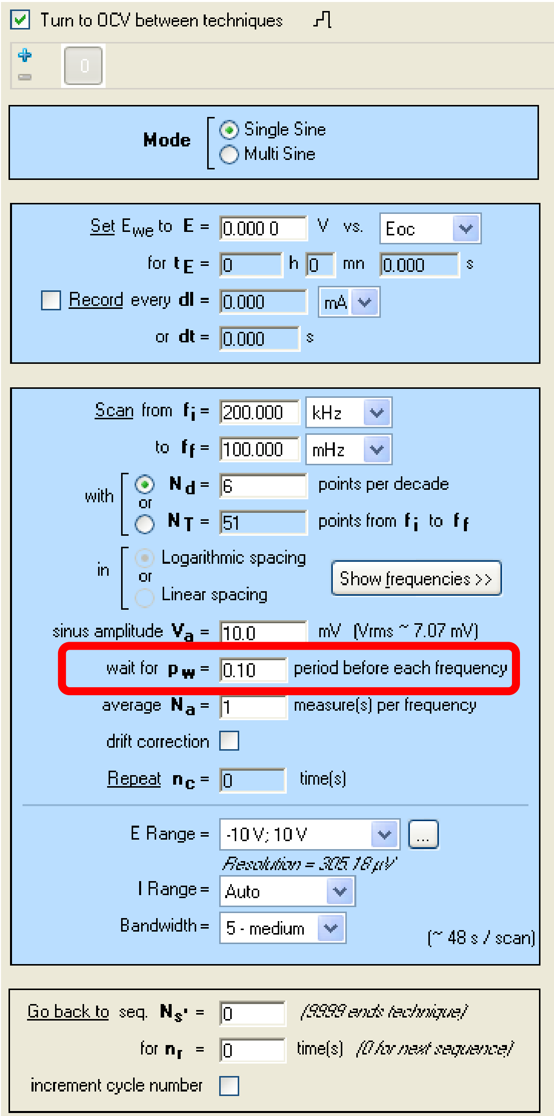


5- Set the EIS technique



Amplitude of the perturbation. The corresponding RMS value is indicated between brackets on the right.

5- Set the EIS technique

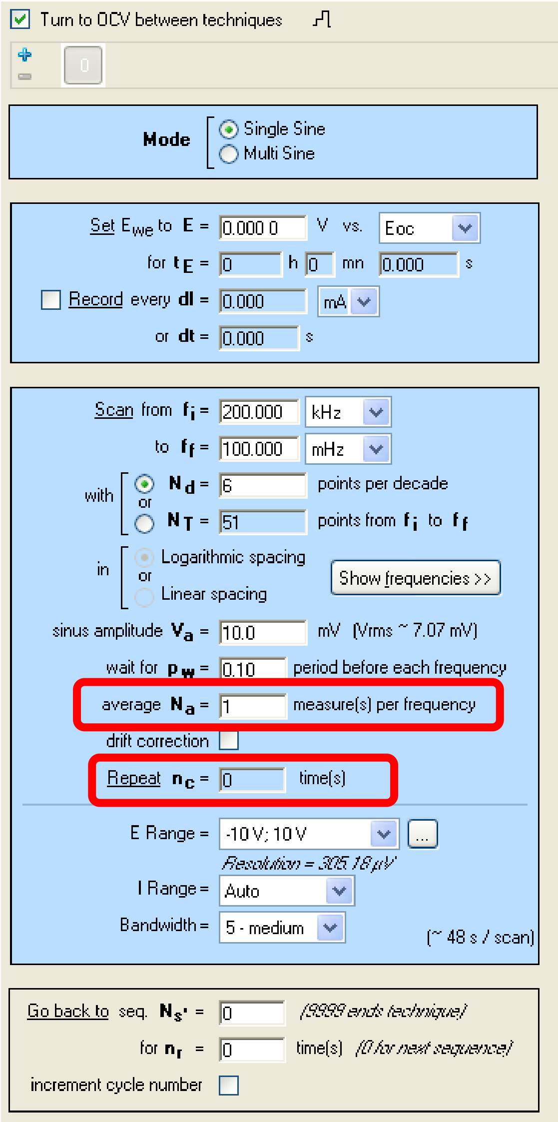


- Period of rest before a new frequency.

TIP:

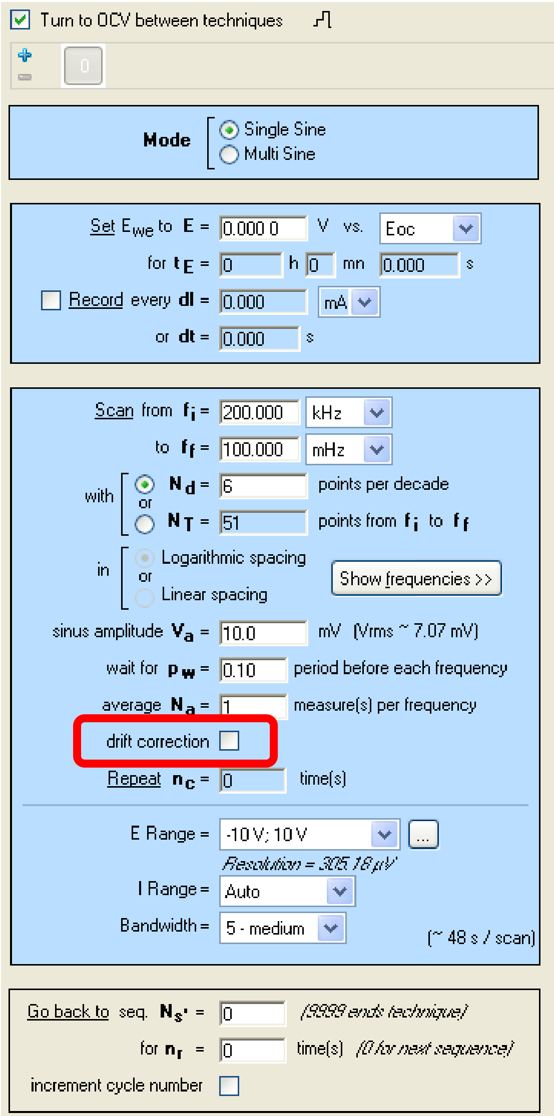
Important to activate when there is a big gap between two frequencies. For example, if one measurement is performed at 1 kHz and the following one is performed at 1 Hz

5- Set the EIS technique



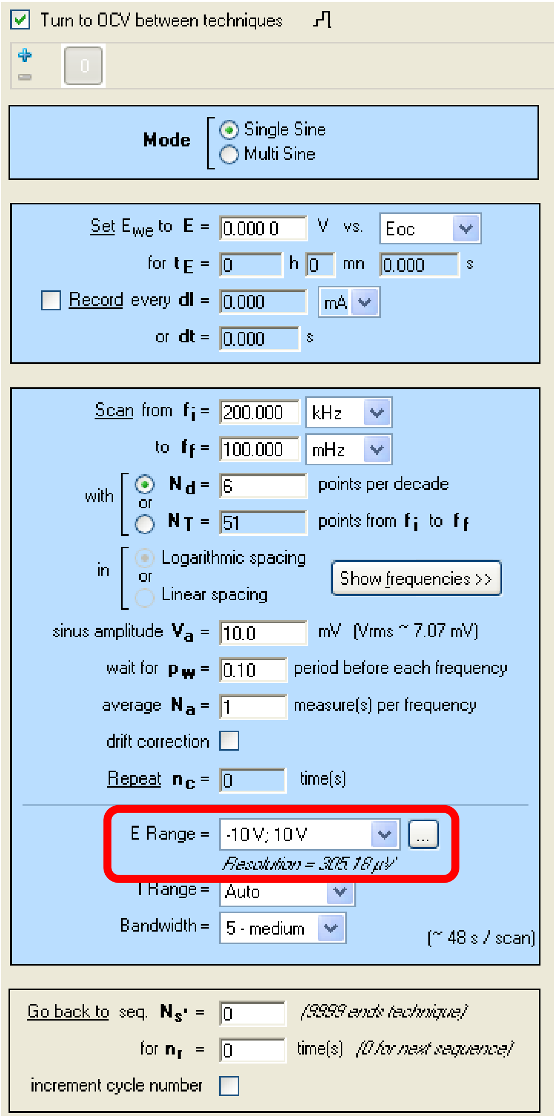
- Number of measurements performed at the same frequency.
- repeat the sweep of frequencies.

5- Set the EIS technique



- Patented drift correction. Must be activated for measurements on slow systems which is not yet in his steady state conditions.

5- Set the EIS technique

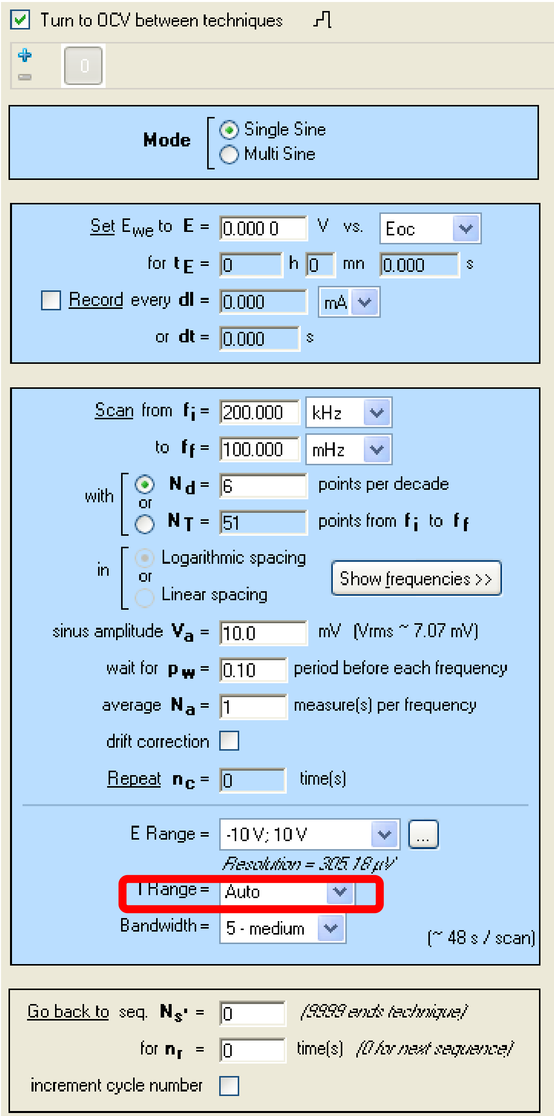


The Erange has to be wide enough to be in the range of the operating voltage of the battery but narrow enough to get an optimized resolution in voltage measurement/control.

It can be modified by clicking on or .

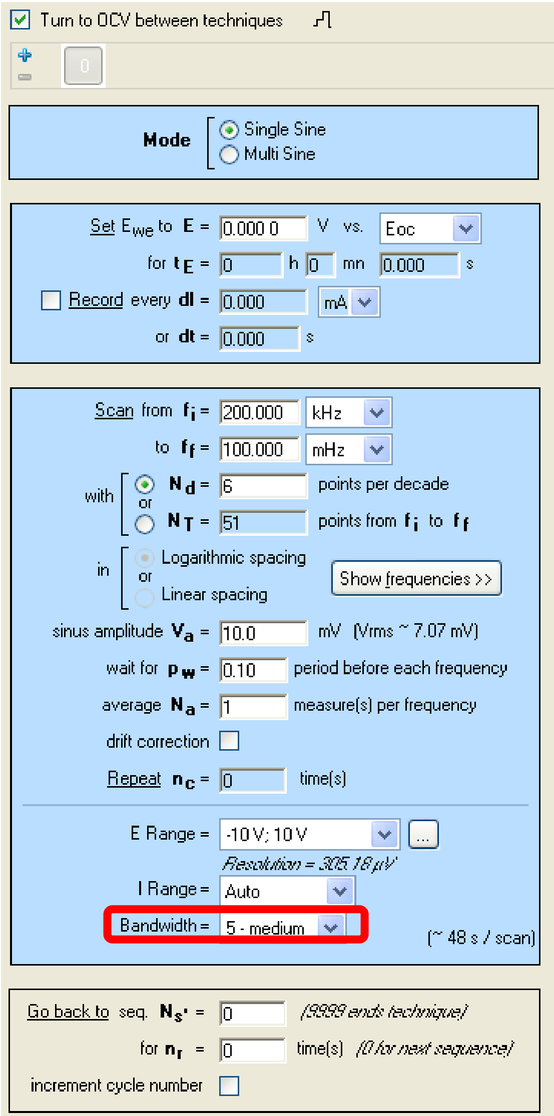
The resolution is given in *italics* below the box.

5- Set the EIS technique



- Current range for EIS experiment.

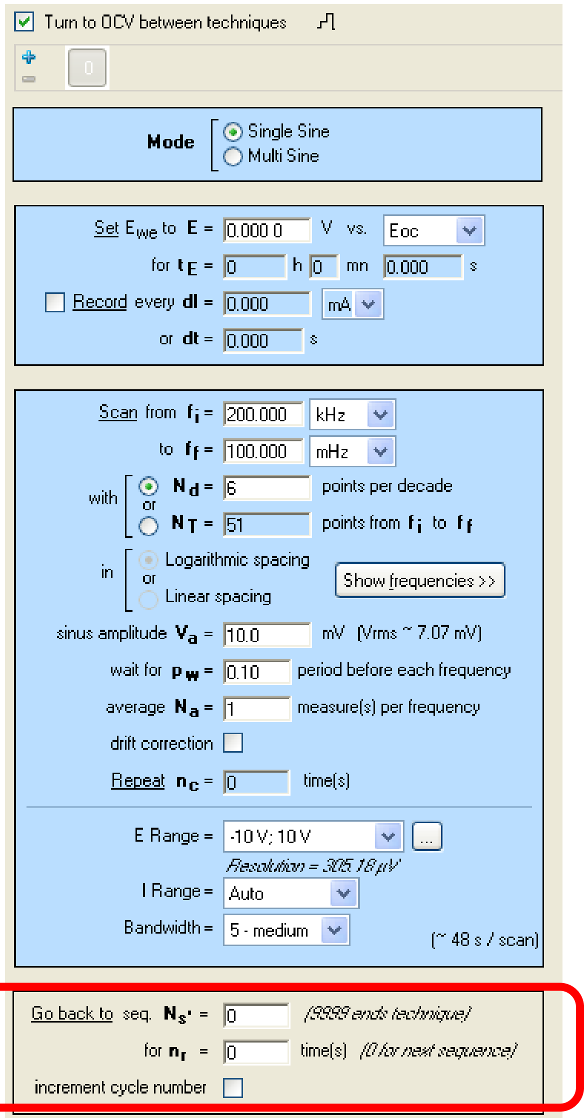
TIP:
Select auto as the level of current at low and high frequency may be very different.



- This parameter defines the stability/speed of the instrument. For high frequency measurement, set fast bandwidth. For example, Bd 7 for VMP3 family and 9 for SP-300 family.
(See manuals and application note for more information bandwidth).

Note:
The bandwidths of the VMP3 family and the bandwidth of SP-300 family are not identical. Bandwidth 7 of VMP3 is different from the bandwidth 7 of the SP-300.

5- Set the EIS technique



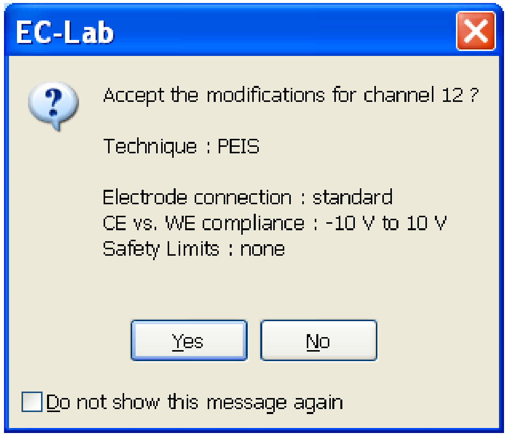
- This allows you to perform several cycles or sequences of EIS measurement.

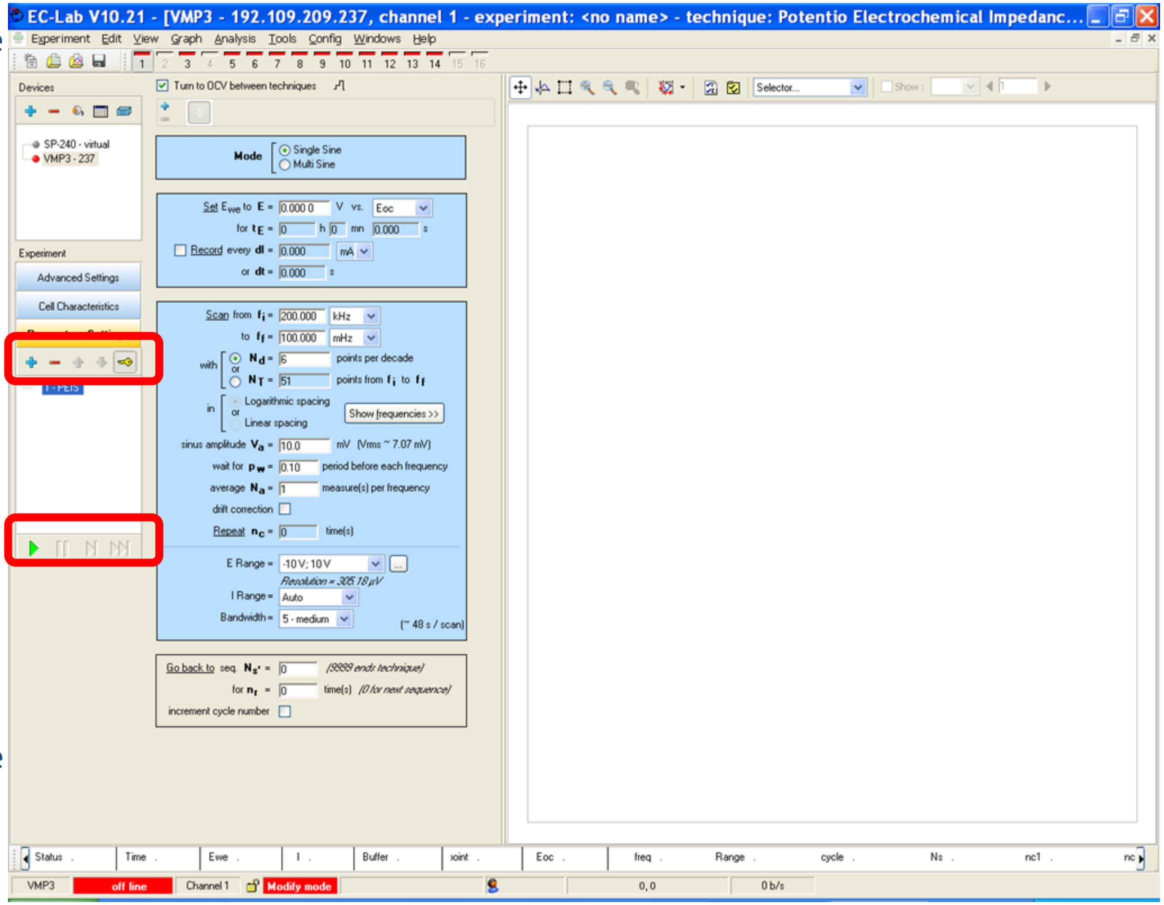
The user defines at which sequence he/she would like to go back and for how many times.

6- Start the experiment

- Click on [key button] button to check if the settings are accepted

- Some warning messages may show up.



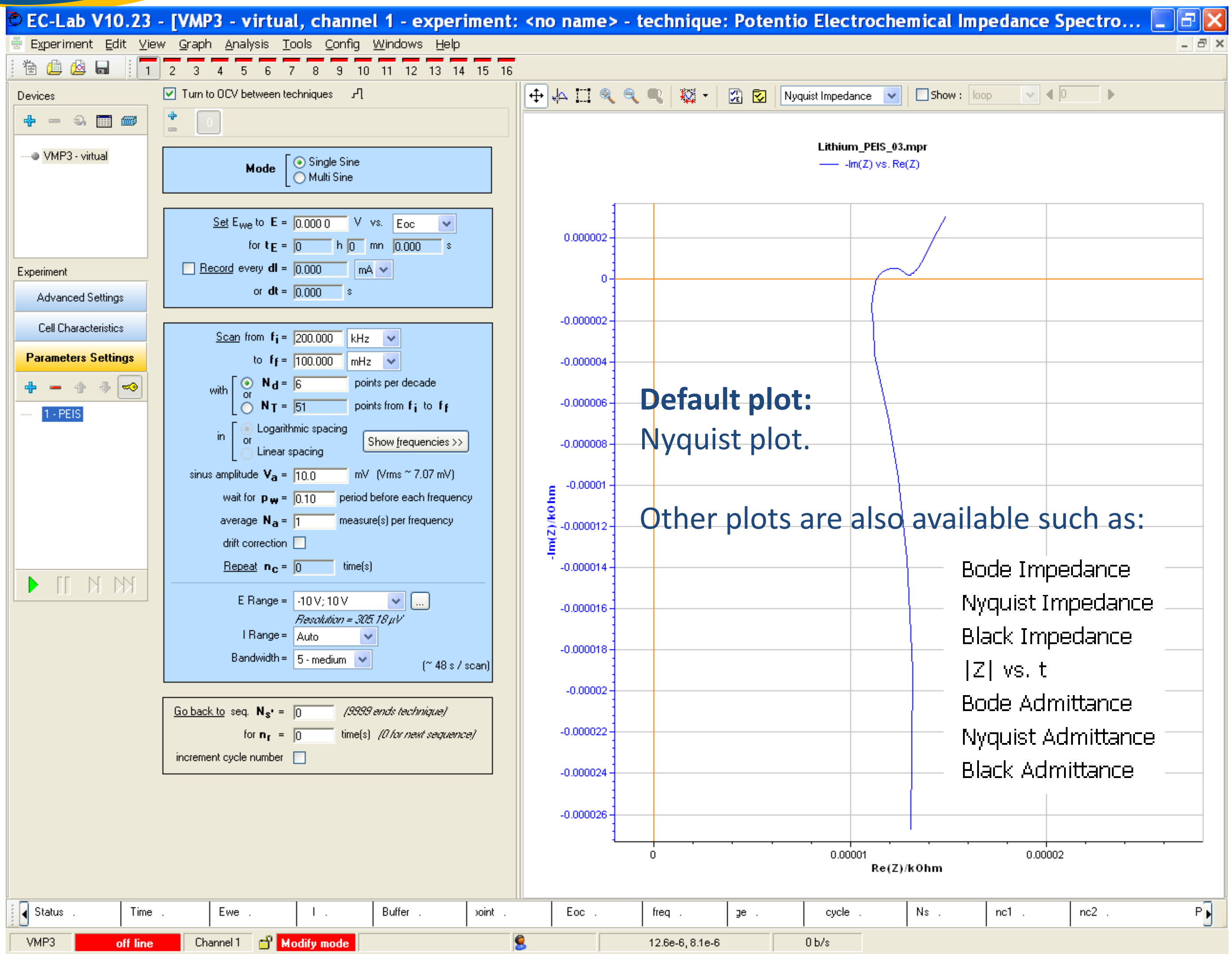


- Click on the [start button] button to start the experiment.

- It is possible to stop, pause, go to next sequence, go to next technique by clicking on the buttons [stop, pause, next sequence, next technique buttons] .

![BioLogic Science Instruments logo]

Example of resulting data



Default plot:
Nyquist plot.

Other plots are also available such as:

- Bode Impedance
- Nyquist Impedance
- Black Impedance
- |Z| vs. t
- Bode Admittance
- Nyquist Admittance
- Black Admittance

Few additional tips

• Check the value of the AC and DC current and potential.

DC values are <I> and <E> for current and potential, respectively.

AC values are III and IEI for current and potential, respectively.
To get AC values, the box « Hide Additional Variables » has to be unchecked.