

Getting Started with EC-Lab®: EIS: Electrochemical Impedance Spectroscopy



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:

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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

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1- Insert the EIS technique

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

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• Click on the "OK" button

Insert Techniques		×
Electrochemical Techniques Voltamperometric Techniques Impedance Spectroscopy Calvano Electrochemical Impedance Spectroscopy - SEIS V Potentic Electrochemical Impedance Spectroscopy - SGEIS V Staiccase Datentio Electrochemical Impedance Spectroscopy (Molt-Schottky) - SPEIS V Potentic Electrochemical Impedance Spectroscopy Wait - PEISW Pulsed Techniques Technique Builder Electrochemical Applications Electrochemical Applications Corrosion Custom Applications Special Applications Special Applications	E we E we	
Insert Technique Load from default Custom Applications ● <u>A</u> fter ✓ <u>A</u> dyanced setting ■ <u>E</u> xternal devices ● <u>A</u> fter ✓ <u>Cell</u> characteristics ■ <u>A</u> dd	Remove Stack Car	icel

2- Insert other(s) technique(s)

• Click on the 🔂 button to insert any additional technique(s).

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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

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+ - 6 🕅 📾	2											
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Cell Characteristics		(
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	average N drift correc <u>Repeat</u> m	la = 1 meas ction □ n c = 0 time(ure(s) per frequency s)									
	E Ran I Ran Bandwic	ge = -10 V; 10 V <i>Fietralution = 3</i> ge = Auto 3th = 5 - medium v	25.18μV • • • (~ 48 s /	scan)								
	Go back to seq. N ₃ for n ₁	r = 0 /335 r = 0 time(:	9 ends technique) s) (0 for next sequenc	2)								
Status . Time	Ewe .	1.1	Buffer .	soint .	Eoc	freq	. Ra	inge .	cycle .	Ns .	nc1 .	nc 🖡
VMP3 off line	Channel 1	Modify mode		2		0,0		0 b/s				

3- Set the « Advanced Setting » tab

VMP3 family

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

Compliance Modify on disconnected cells only! Ewe from -10 V 10 V Ece from -10 V 10 V More information >> Safety Limits E_{we} max = 0.00 V E_{we} min = 0.00 V $ =$ 0.000 $ 0.00 $ N $ 0.00 $ NA $ 0.00 $ V	Filtering Eve, I 50 kHz Safety Limits Eve max = 0.00 V Eve min = 0.00 V UII = 0.000 mA 10-Qol = 0.00 mA 10-Qol = 0.00 mA Analog IN 1 max = 0.00 V Analog IN 2 max = 0.00 V for t > 10 ms Channel Channel UItra Low Current Option High speed scan Definition of high speed value depends on the current range Electrodes Connected cells only! standard S1 S2 Eve Fice Filter Filter Filter Edit Smooth on 0 points Create one data file per loop (linked techniques only)
Miscellaneous Text export Filter Filter Edit Smooth on Create one data file per loop (linked techniques only)	 Filter ▼ Edit Smooth on 0 points Create one data file per loop (linked techniques only)
Default	

SP-300 family

pends on the current range used.

4- Set the « Cell Characteristics » tab

Cell Description EC-Lab V10.21 - [VMP3 - 192.109.209 ⊻iew Graph Analysis Tools Cor Electrode material 5 6 7 8 Turn to OCV between techniques Initial state Click on the **Cell Characteristics** tab. 🔶 🗕 🗞 🥅 📾 Electrolyte SP-240 · virtual Mode Single Single Single S VMP3 - 237 Comments then the « Cell Characteristics » Set Ewe to E = 0.000 0 window is displayed. for tE = 0 Record every dl = 0.000 or dt = 0.000 Advanced Settings **Cell Characteristics** arameters Settings Electrode surface area 0.001 cm² 🗸 Characteristic mass 0.001 g × Battery >> Equivalent Weight 0.000 g/eq. Information about the cell and some 0.000 Density g/cm3 E Range = -10 V; 10 V comments. Resoluti I Range = Auto Reference electrode Bandwidth = 5 - medium Electrode surface area has to be set if the Goback to seq. Ns' = 0 (unspecified) ¥ for nr = 0 user want to work with volumic/surfacic ncrement cycle number Offset potential vs. Normal Hydrogen Electrode: 0.000 V resistance (Ω / cm³ or cm²) instead of Record resistance (Ω). Ece/V WE/CA2 ref P/W Status nc 🖡 TIP: Channel 1 🚽 🖬 🖬 Analog IN 17V RE/ref2 Analog IN 2/V Possible to record the impedance of the WE Record external devices on Analog IN# ref3 but also the **impedance of the CE**. CE/CA1 Files NOTE:

All these infomation are stored in the data file

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5- Set the EIS technique

EC-Lab V10.2 Experiment Edit

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VMP3 - 237

Advanced Setting

Parameters Setting

Status VMP3

1 · PEIS

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

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- 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).

		Γ	I urn to OCV between techniques パ	
-	Experiment xp	e	* •	_ 7
	Advanced Settings			
	Cell Characteristics		Mode Multi Sine	
	Parameters Settings		<u>Set</u> E _{we} to E = 0.000 0 V vs. Eoc v	
	4 - 4 J -		for $\mathbf{t}_{\mathbf{E}} = 0$ h 0 mn 0.000 s	
	1 - PEIS		or dt = 0.000 s	
ľ	with $\begin{bmatrix} 0 & N_d + [5] \\ 0 & N_f + [5] \end{bmatrix}$ points per decade		Scan from fi = 200.000 kHz V	
	in Constraintic spacing in Constraintic spacing in Linear spacing sinus amplitude Va = [10.0] mV (Vms ~ 7.07 mV)		to $\mathbf{r}_{\mathbf{f}} = 100.000 \text{ mHz}$	
	wait for $\mathbf{p}_{w} = 0.10$ period before each frequency average $\mathbf{N}_{a} = 1$ measure(s) per frequency		or $N_T = 51$ points from f_i to f_f	
-	dift correction time(s)		in Or Show frequencies >>	
	E Range = -10 V; 10 V V <i>Recolution = 305.18 µV</i> I Range = Auto		sinus amplitude $V_a = 10.0$ mV (Vrms ~ 7.07 mV)	
	Bandwidth = 5 - medium 💉 (~ 48 s / scan)		wait for $\mathbf{p}_{\mathbf{W}} = 0.10$ period before each frequency	
<u>(</u>	20 back to seq. Ns* = 0 /9999 ends technique/ for n_f 0 time(s) /0 for nest sequence/		average N _a = 1 measure(s) per frequency	
L	ncrement cycle number		Repeat $\mathbf{n_c} = \mathbf{n}$ time(s)	
			E Range = .10 V; 10 V	
	Euro I Duffer Juint		Resolution = 305.18 μV I Range = Auto ✓	
0	Channel 1 D Modify mode		Bandwidth = 5 - medium 💉 (~ 48 s / scan)	nc J
			Go back to seq. Ns' = 0 /9999 ands technique/	
			for n _f = 0 time(s) <i>(0 har next sequence)</i>	
			Increment cycle number	



Science Instruments

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.



✓ Turn to OCV between techniques √1
Mode Single Sine
Set Ewe to E = 0.000 0 V vs. Eoc 💌
for t _E = 0 h 0 mn 0.000 s <u>Record</u> every dI = 0.000 mA → or dt = 0.000 s
Scan from $f_i = 200.000$ kHz \checkmark to $f_f = 100.000$ mHz \checkmark with $\bigcirc N_d = 6$ points per decade
in Cogarithmic spacing Show frequencies >>
sinus amplitude V a = 10.0 mV (Vrms ~ 7.07 mV) wait for p w = 0.10 period before each frequency
average N a = 1 measure(s) per frequency
$\frac{\text{Repeat}}{\text{Repeat}} \mathbf{n_{C}} = 0 \qquad \text{time(s)}$
E Range = .10 V; 10 V v <i>Resolution = 305 18 µV</i> I Range = Auto v Bandwidth = 5 - medium v (~ 48 s / scan)
Go back to seq. Ns* = 0 /9999 ends technique/ for nr = 0 time(s) /0 for next sequence/ increment cycle number

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• 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).



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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

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).

Frequencies list	×
Frequencies (Hz)	
200 000.000 000 135 123.811 858 91 292.222 655 61 678.765 590 41 671.349 586 28 153.958 007 19 021.350 624 12 851.187 015 8 682.506 882 5 866.067 132 3 963.226 757 2 677.631 533 1 809.058 898 1 222.234 671	
Number of frequencies 38	
EC-Lab calculous	se

☑ Turn to OCV between techniques ♪
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Mode Single Sine
Set E _{we} to E = 0.000 0 V vs. Eoc ∨ for t E = 0 h 0 mn 0.000 s Record every dI = 0.000 mA ∨ or dt = 0.000 s
$\frac{\text{Scan from } \mathbf{f}_{i} = 200.000}{\text{to } \mathbf{f}_{f} = 100.000} $
sinus amplitude $V_a = 10.0$ mV (Vrms ~ 7.07 mV) wait for $p_w = 0.10$ period before each frequency average $N_a = 1$ measure(s) per frequency drift correction <u>Repeat</u> $n_c = 0$ time(s) E Range = -10 V; 10 V \checkmark <i>Resolution = 305,18 µV</i> I Range = Auto \checkmark
Bandwidth = 5 - medium 💉 (~ 48 s / scan)
Go back to seq. Ns* = 0 /9999 ands technique/ for nr = 0 time(s) /0 for newl sequence/ increment cycle number

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

✓ Turn to OCV between techniques √1
* 1
Mode Single Sine
Set E _{we} to E = 0.000 0 V vs. Eoc ♥ for t _E = 0 h 0 mn 0.000 s Record every dI = 0.000 mA ♥ or dt = 0.000 s
Scan from $f_i = 200.000$ kHz to $f_f = 100.000$ mHz with \bigcirc Nd = 6 points per decade or NT = 51 points from f_i to f_f in \bigcirc Logarithmic spacing or Linear spacing Show frequencies >> Linear spacing mV (Vrms ~ 7.07 mV) wait for $p_w = 0.10$ period before each frequency
$\frac{\text{average } \mathbf{n_{d}} = 1 \text{measure(s) per inequency}}{\text{drift correction } \mathbf{n_{c}} = 0 \text{time(s)}}$ $E \text{ Range = } \frac{-10 \text{ V}; 10 \text{ V}}{Resolution = 305.18 \mu V} \dots Resolution = 305.18 \mu V$ $I \text{ Range = } \text{ Auto } \mathbf{v}$ $Bandwidth = 5 \cdot \text{medium } \mathbf{v} (\sim 48.6 \text{ Locars})$
$\frac{Go \text{ back to seq. } N_{S'} = 0 \qquad (3339 \text{ ends technique})}{\text{for } n_{\Gamma} = 0 \qquad \text{time(s) } (0 \text{ for next sequence})}$

Period of rest before a new frequency.

TIP:

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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

☑ Turn to OCV between techniques ฦ
*
Mode Single Sine
Set Ewe to E = 0.000 0 V vs. Eoc for t E = 0 h 0 mn 0.000 s Record every dI = 0.000 mA ∨ or dt = 0.000 s
$\label{eq:scalar} \begin{array}{c c} \underline{Scan} \mbox{ from } f_i = 200.000 \mbox{ kHz } \\ \mbox{to } f_f = 100.000 \mbox{ mHz } \\ \mbox{to } f_f = 100.000 \mbox{ mHz } \\ \hline \mbox{with } \hline \begin{array}{c} & \mathbf{N_d} = 6 \\ \mbox{or } \mathbf{N_T} = 51 \\ \mbox{points from } f_i \mbox{ to } f_f \\ \mbox{in } \hline \mbox{ Logarithmic spacing } \\ \mbox{or } \mathbf{N_T} = 51 \\ \mbox{points from } f_i \mbox{ to } f_f \\ \mbox{in } \hline \mbox{Linear spacing } \\ \mbox{sinus amplitude } \mathbf{V_a} = 10.0 \\ \mbox{ wait for } \mathbf{p_w} = 0.10 \\ \mbox{ period before each frequency } \\ \mbox{average } \mathbf{N_a} = 1 \\ \mbox{ measure(s) per frequency } \\ \mbox{ drift correction } \\ \mbox{ Hepeat } \mathbf{n_c} = 0 \\ \mbox{ time(s) } \end{array}$
E Range = .10 V; 10 V <i>Resolution = 305 18 µV</i> I Range = Auto Bandwidth = 5 - medium (~ 48 s / scan)
Go back to seq. Ns' = 0 /9999 ands technique/ for nr = 0 time(s) /0 har next sequence/ increment cycle number

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

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✓ Turn to OCV between techniques √1
*
Mode Single Sine
Set E _{we} to E = 0.0000 V vs. Eoc for t E = 0 h 0 mn 0.000 s Record every dI = 0.000 mA ✓ or dt = 0.000 s
$\label{eq:scalar} \begin{array}{ c c c c c } \hline Scan & from f_i = 200.000 & kHz & \checkmark \\ \hline to & f_f = 100.000 & mHz & \checkmark \\ \hline to & f_f = 100.000 & mHz & \checkmark \\ \hline with & \bigcirc & N_d = 6 & points per decade \\ \hline or & N_T = 51 & points from f_i to f_f \\ \hline in & \bigcirc & Logarithmic spacing \\ \hline or & Linear spacing & Show frequencies >> \\ \hline Linear spacing & Show frequencies >> \\ \hline unit & State & V_a = 10.0 & mV & (Vrms ~ 7.07 mV) \\ \hline wait for & p_w = 0.10 & period before each frequency \\ \hline average & N_a = 1 & measure(s) per frequency \\ \hline drift correction & \hline \end{array}$
$\frac{\text{Repeat } \mathbf{n_{c}} = 0 \qquad \text{time(s)}}{\text{E Range} = \frac{.10 \forall; 10 \forall \qquad \checkmark \qquad \cdots \qquad}{\text{Resolution} = .325 18 \mu \forall}$ $\text{I Range} = \boxed{\text{Auto}}$ $\text{Bandwidth} = \boxed{5 \cdot \text{medium}} \checkmark \qquad (~ 48 \text{s / scan})$
Goback to seq. Ns' = 0 (9999 ands technique) for nr = 0 time(s) (0 for next sequence) increment cycle number

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

✓ Turn to OCV between techniques √1
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Mode Single Sine
Set Ewe to E = 0.000 0 V vs. Eoc ✓ for t = 0 h mn 0.000 s Record every dl = 0.000 mA ✓ or dt = 0.000 s
$\begin{array}{c c} \underline{Scan} \mbox{ from } f_i = 200,000 \mbox{ kHz } \\ \mbox{to } f_f = 100,000 \mbox{ mHz } \\ \mbox{with } \boxed{\bigcirc \mbox{ N_f = } 6 \mbox{ points per decade } \\ \mbox{or } \mbox{ N_T = } 51 \mbox{ points from } f_i \mbox{ to } f_f \\ \mbox{in } \boxed{\bigcirc \mbox{ N_T = } 51 \mbox{ points from } f_i \mbox{ to } f_f \\ \mbox{ in } \boxed{\bigcirc \mbox{ Linear spacing } \mbox{ Show frequencies } > \\ \mbox{ clinear spacing } \mbox{ Show frequencies } > \\ \mbox{ sinus amplitude } \mbox{ V_a = } 10.0 \mbox{ mV } \mbox{ (Vrms } 7.07 \mbox{ mV) } \\ \mbox{ wait for } \mbox{ p_w = } 0.10 \mbox{ period before each frequency } \\ \mbox{ average } \mbox{ N_a = } 1 \mbox{ measure(s) per frequency } \\ \mbox{ drift correction } \mbox{ line(s) } \end{array}$
E Range = .10 V; 10 V V Resolution = 305.18 µV Hange = Auto Bandwidth = 5 · medium V (~ 48 s / scan)
Go back to seq. Ns' = 0 /9999 ands technique/ for nr = 0 time(s) /0 for newt sequence/ increment cycle number

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 voltage or .

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

✓ Turn to OCV between techniques √1
* I
Mode Single Sine
Set Ewe to E = 0.000 0 V vs. Eoc for t E = 0 h 0 mn 0.000 s Record every dI = 0.000 mA ∨ or dt = 0.000 s
<u>Scan</u> from fi = 200.000 kHz ↓ to ff = 100.000 mHz ↓
with \bigcirc Nd = 6 points per decade or NT = 51 points from fi to ff in \bigcirc Logarithmic spacing or Linear spacing Show frequencies >>
sinus amplitude $V_a = 10.0$ mV (Vrms ~ 7.07 mV) wait for $p_w = 0.10$ period before each frequency
average N _a = 1 measure(s) per frequency
Repeat n_c = 0 time(s)
E Range = -10 V; 10 V · · · · · · · · · · · · · · · · · ·
I Range = Auto Bandwidth = 5 - medium ♥ (~ 48 s / scan)
Go back to seq. Ns* = 0 /9999 ands technique; for nr = 0 time(s) /0 for next sequence; increment cycle number

Current range for EIS experiment.

TIP:

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

✓ Turn to OCV between techniques √1							
-							
Mode Single Sine							
<u>Set</u> E _{we} to E = 0.000 V vs. Eoc v for t E = 0 h 0 mn 0.000 s <u>Record</u> every dl = 0.000 mA v or dt = 0.000 s							
Scan from fi = 200.000 kHz ✓ to ff = 100.000 mHz ✓							
with $\begin{bmatrix} \odot & N_d = 6 \\ or \\ O & N_T = 51 \end{bmatrix}$ points from f_i to f_f							
in Cogarithmic spacing or Chinear spacing Show frequencies >>							
sinus amplitude V a = 10.0 mV (Vrms ~ 7.07 mV)							
wait for $\mathbf{p}_{\mathbf{W}} = 0.10$ period before each frequency							
average N a = 1 measure(s) per frequency							
drift correction							
Repeat n _c = 0 time(s)							
E Range = -10 V; 10 V 💉 <i>Revolution = 305 18 µV</i>							
I Range = Auto 🗸							
Bandwidth = 5 - medium 🗸 (~ 48 s / scan)							
Go back to seq. Ns' = 0 (3399 ands technique)							
for n _f = 0 time(s) /0 for next sequence/							
increment cycle number							

• 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.

✓ Turn to OCV between techniques
* I
Mode Single Sine
Set Ewe to E = 0.000 0 V vs. Eoc 🗸
for t E = 0 h 0 mn 0.000 s
Record every dl = 0.000 mA 🗸
or dt = 0.000 s
<u>Scan</u> from fi = 200.000 kHz →
to f _f = 100.000 mHz 🗸
with $\begin{bmatrix} \odot & \mathbf{N}_{\mathbf{d}} = \begin{bmatrix} 6 & \\ 0 & \\ 0 & \\ \end{bmatrix}$ points per decade
\bigcirc NT = 51 points from f _i to f _f
in Or Show frequencies >>
L Linear spacing
sinus amplitude $\mathbf{V}_{\mathbf{a}} = [10.0 \text{ mV} (\text{Vrms}^{-7}.07 \text{ mV})]$
wait for $\mathbf{p}_{\mathbf{W}} = [0.10]$ period before each frequency
drift correction
Beneat $\mathbf{n}_{-} = 0_{-}$ time(s)
E Range = 10V;10V 💌
Resolution = 305.18 µV I Range = Auto ❤
Bandwidth = 5 - medium 💉 (~ 40 - 4
(* 48 s / scan)
Goback to seg. Net = 0 /9999 ands (achnique)
for n _r = 0 time(s) /0 for next sequence/
increment cycle number

• 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

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Experiment Edit ⊻iew Graph Analysis Tools Config Windows Help

✓ Turn to OCV between techniques x¹

5 6 7 8 9 10 11 12 13 14 15 16

Click on button to check if the • settings are accepted

Bio**Logic**

Science Instruments

So •

Some warning messages may show up.	 SP-240 - virtual VMP3 - 237 	Mode Single Sine								
EC-Lab	Experiment Advanced Settings	Set Evento E E ≈ 10.0000 V Vs. Ecc v for t E ≈ 10 mm 10.000 s Pecced every dl ≈ 10.000 mA v or dt ≈ 10.000 s								
Accept the modifications for channel 12 ? Technique : PEIS Electrode connection : standard CE vs. WE compliance : -10 V to 10 V Safety Limits : none	Cel Characteristics	$\begin{array}{c c} \hline Scan \mbox{ from } f_i = 200.000 & \mbox{ iHz } \checkmark \\ to \ f_f = 100.000 & \mbox{ mHz } \checkmark \\ \hline \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$								
Yes No		drift correction Escent nc = 0 time(s) E Range = 10V; 10V Recoldrive = 325 l/g/V I Range = Auto Bandwidth = 5 - medium Go back to seg. Not = 0 (**48 s / scen)								
Click on the button to start the experiment.		for n ₁ = 0 time(s) /// Air new requence/								
	VMP3 off line	Channel 1 Modify mode	x . 8	LOC .	0,0	Hange . 0 b/s	cycle .	N\$.	nc1 .	nc 🕨

EC-Lab V10.21 - [VMP3 - 192.109.209.237, channel 1 - experiment: <no name> - technique: Potentio Electrochemical Impedanc...

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Show :

V 4 1

It is possible to stop, pause, go to next sequence, go to next technique by clicking on the • buttons · M N ·

Example of resulting data

© EC-Lab V10.23	- [VMP3 - virtua	al, channel 1 - (experimer	it: <no nam<="" th=""><th>e> - te</th><th>chnique</th><th>Pote</th><th>ntio Elect</th><th>rochen</th><th>nical Im</th><th>pedance</th><th>Spectro</th><th>. ð X</th></no>	e> - te	chnique	Pote	ntio Elect	rochen	nical Im	pedance	Spectro	. ð X
Experiment Edit View	w Graph Analysis I	ools <u>C</u> onfig <u>W</u> indow	rs <u>H</u> elp	10									_ @ ×
Devices	J 2 3 4 5 6	7 8 9 10 11 12 echniques 과	: 13 14 15	™		R 🗱 -	S) 🖸	Nyguist Impeda	nce 🔽	Show : la	00p 🔽 🗸		
+ - 0 🔳 📾	2												
• VMP3 - virtual	Mode	⊙ Single Sine ○ Multi Sine		Lithium_PEIS_03.mpr — -Im(Z) vs. Re(Z)									
Experiment Advanced Settings Cell Characteristics Parameters Settings TIPEIS	Set Ewe to E = for t _E = for t _E = or dt = or dt = Scan from f _i = to ff with Or N = or N = in Or Cagait or N = with Or N = with Or N = with or pw average Na = drift correction Repeat nc = E Range = I Range = I Range = Bandwidth = So back to seq. Ns' = for nr = increment cycle number Increment cycle number	0.000 V vs. Ecc 0 h 0 mn 0.00 0.000 s 200.000 kHz v 100.000 mHz v 5 points per der 5 points per der 5 points per der 5 points from f hnic spacing Show freq 10.0 mV (Vins ~ 0.10 period before ear 1 measure(s) per fin 0 time(s) 10V: 10V v 4.400 v 5 - medium v 0 (2029 ends fect 0 time(s) (20 km rec 0 time(s) (20	ade is to ff uencies >> 7.07 mV) ch frequency equency (~ 48 s / scan) wit sequence/	00000 0000 0- 0000 0- 0000 0- 1000 0- 1000 0- 0000 0- 000 0- 0000 0- 000 000	02 0 02 04 06 08 N 01 12 14 16 18 02 22 22 24 26)efaul Iyquis)ther	i t pl st pl	ot: ot.	also	availa Bo N ¹ Bl Bo N Bl Bo	able_s ode Imp yquist I lack Imp Z vs. t ode Adr yquist A lack Adr	uch as: bedance mpedance bedance mittance admittance mittance	
					C)		0.000	01 Re(Z)/k	0hm	0.000	102	
Status . Time	. Ewe .	I. Buffer	. point	. Eoc		freq .	je .	cycle		Ns.	nc1 .	nc2 .	P
VMP3 off line	Channel 1 📑 M	lodify mode			1	2.6e-6, 8.1e-6		0 b/s					

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

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

BioLogic Science Instruments

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

File Selection							
File Selection Files : C\EC-Lab\V10.21\Data\Samples\EIS\PEIS_at_7MHz.mpr	Variables Representation : Custom X Y1 Y2 freq/Hz Image: Arrow of the second						
	Same selection for all files <u>H</u> ide Additional Variables						
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