



Getting Started with EC-Lab[®]:

Cyclic voltammetry

V1

Getting Started EC-Lab: CV

March 2024



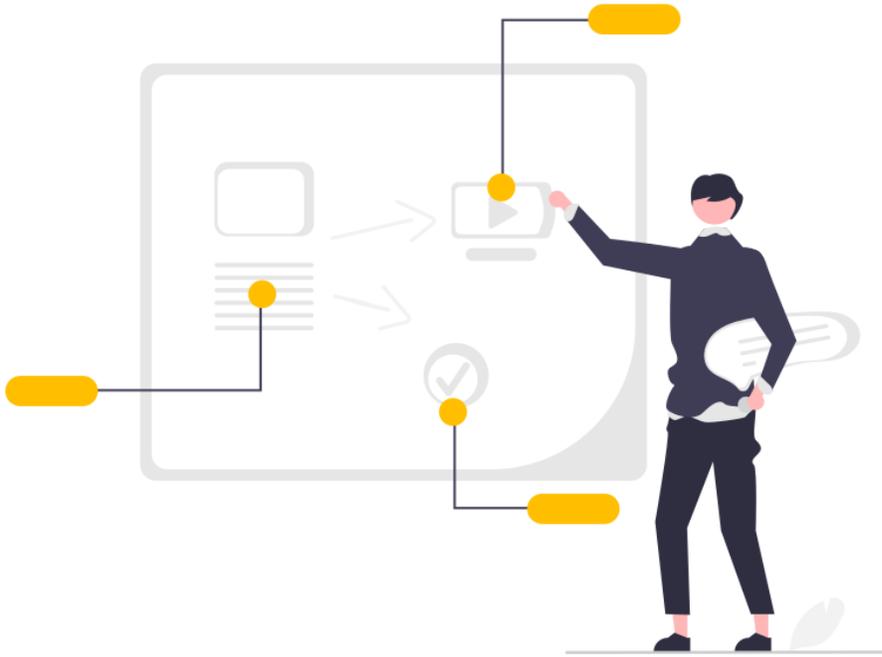
Overview and quick access

■ Procedure

- Launch the experiment
 - Step 0: Connect instrument and select channel
 - Step 1: Add CV technique
 - Step 2: Set CV parameters
 - Step 3: Optimize the measurement
 - Step 4: Set general parameters
 - Step 5: Launch the measurement
 - Step 6: Add additional experiments
- Investigate the results
 - Step 7: Read the graph
 - Step 8: Analyse the data

■ Find out more

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- Need help?
- FAQ



Procedure





Step 0: Connect instrument and select channel

- Connect instrument and select channel

EC-Lab - [VMP-3e - 10.11.1.106, channel 1 - no experiment]

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

1 2 3 5 6 7 8 9 10 11 12 15

Devices

VMP-3e - 106

No experiment loaded on current channel.
To create an experiment, please select one of the following actions:

- [New](#)
- [Load Settings](#)
- [New Stack](#)
- [Load Stack Settings](#)

Experiment

Safety/Adv. Settings

Cell Characteristics

External Devices

Parameters Settings

Status: stopped Time: 0:00:00 LVC: 0.403mV I: 0.0A Data: 0 LVC: 0.403mV I: 0.0A Channel: open

VMP-3e 10.11.1.106 Channel 1 Amplifier: None EIS Read mode 0, 0 Undersample: Off 21 523 b/s

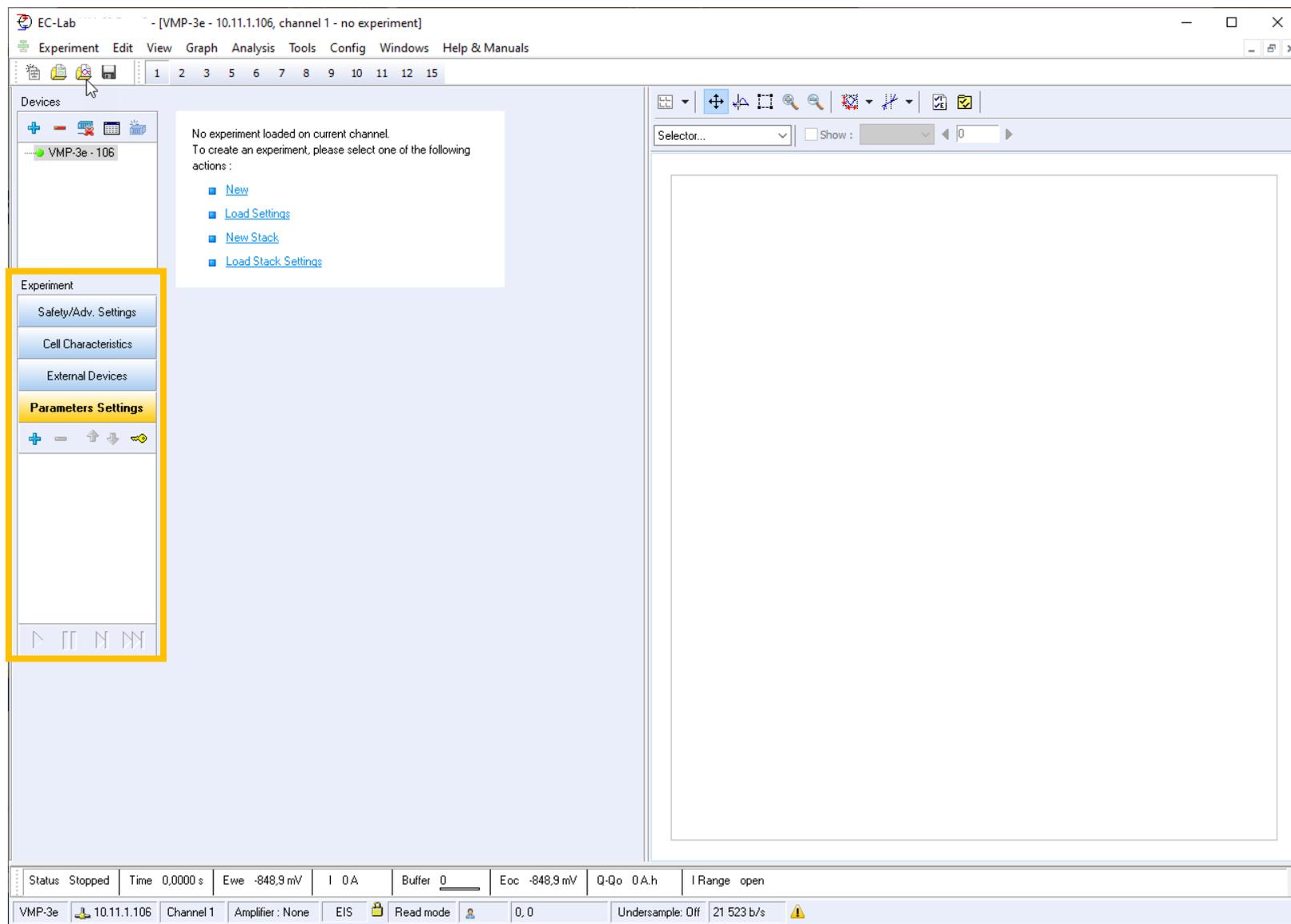


Check out our Getting Started with EC-Lab[®] tutorial dedicated to connecting the instrument and selecting channels.



Step 0: Connect instrument and select channel

- When the instrument and channel are selected, the user can set the experiment





Step 1: Add CV technique

- Click on + to add a technique to the list

The screenshot shows the EC-Lab software interface. The main window displays a message: "No experiment loaded on current channel. To create an experiment, please select one of the following actions: New, Load Settings, New Stack, Load Stack Settings". A "Parameters Settings" dialog box is open, showing a list of techniques. The "+" button in the dialog is highlighted with a yellow box. A callout box with the text "Add/remove a technique" points to this button. The status bar at the bottom shows: Status Stopped, Time 0,0000 s, Ewe -742,1 mV, I 0 A, Buffer 0, Eoc -742,1 mV, Q-Qo 0 A.h, I Range open. The bottom-most bar shows: VMP-3e, 10.11.1.106, Channel 1, Amplifier : None, EIS, Modify mode, 0,0, Undersample: Off, 21 793 b/s.



Step 1: Add CV technique

Empty window:
no technique loaded

EC-Lab - [VMP-3e - 10.11.1.106, channel 1 - no experiment]

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

1 2 3 5 6 7 8 9 10 11 12 15

Devices

VMP-3e - 106

No experiment loaded on current channel.
To create an experiment, please select one of the following actions:

- New
- Load Settings
- New Stack
- Load Stack Settings

Experiment

- Safety/Adv. Settings
- Cell Characteristics
- External Devices
- Parameters Settings**

Parameters Settings

Modify mode / Read mode

To move technique before/after

Status Stopped Time 0,0000 s Ewe -742,1 mV I 0 A Buffer 0 Eoc -742,1 mV Q-Qo 0 A.h I Range open

VMP-3e 10.11.1.106 Channel 1 Amplifier : None EIS Modify mode 0,0 Undersample: Off 21 793 b/s



Step 1: Add CV technique

- Select Cyclic Voltammetry – CV technique

It is in the Voltamperometric techniques folder

- Click on **OK** to validate

EC-Lab - [VMP-3e - 10.11.1.106, channel 1 - no experiment]

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

1 2 3 5 6 7 8 9 10 11 12 15

Devices

VMP-3e - 106

No experiment loaded on current channel.
To create an experiment, please select one of the following actions:

- New
- Load Settings
- New Stack
- Load Stack Settings

Experiment

Safety/Adv. Settings

Cell Characteristics

External Devices

Parameters Settings

Insert Techniques

Search

Recent Techniques

- Electrochemical Techniques
 - Voltamperometric Techniques
 - Open Circuit Voltage - DCV
 - Special Open Circuit Voltage - SOCV
 - Cyclic Voltammetry - CV
 - Cyclic Voltammetry Advanced - CVA
 - Linear Sweep Voltammetry - LSV
 - Chronoamperometry / Chronocoulometry - CA
 - Chronopotentiometry - CP
 - Staircase Voltammetry - SV
 - Large Amplitude Sinusoidal Voltammetry - LASV
 - AC Voltammetry - ACV
 - Levich plot
 - Impedance Spectroscopy
 - Pulsed Techniques
 - Technique Builder
 - Manual Control
 - Ohmic Drop Determination
 - Bipotentiostat
- Electrochemical Applications

Graph: E_{we} cycle, E_1 , E_2 , E_f

Cyclic voltammetry (CV) is the most widely used technique for acquiring qualitative informations about electrochemical reactions. CV provides informations on redox processes, heterogeneous electron-transfer reactions and adsorption processes. It offers a rapid location of redox potential of the electroactive species. CV consists of scanning linearly the potential of a stationary working electrode using a triangular potential waveform. During the potential sweep, the potentiostat measures the current resulting from electrochemical reactions (consecutive to the applied potential). The cyclic voltammogram is a current response as a function of the applied potential.

Insert Technique: Before Alter

Load from default: Safety/Adv. Settings External devices Cell characteristics

Custom Applications: Rename Add Remove Stack

OK Cancel

Status Stopped Time 0,0000 s Ewe -747,3 mV I 0 A Buffer 0 Eoc -747,3 mV Q-Qo 0 A.h I Range open

VMP-3e 10.11.1.106 Channel 1 Amplifier : None EIS Modify mode 0,0 Undersample: Off 21 774 b/s



Step 1: Add CV technique

Search bar to quickly find the desired technique

Description of the settings technique and associated graph

EC-Lab - [VMP-3e - 10.11.1.106, channel 1 - no experiment]

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

Devices

No experiment loaded on current channel.
To create an experiment, please select one of the following actions:

- New
- Load Settings
- New Stack
- Load Stack Settings

Experiment

Safety/Adv. Settings

Cell Characteristics

External Devices

Parameters Settings

Insert Techniques

Search

Recent Techniques

- Electrochemical Techniques
 - Voltamperometric Techniques
 - Open Circuit Voltage - DCV
 - Special Open Circuit Voltage - SOCV
 - Cyclic Voltammetry - CV
 - Cyclic Voltammetry Advanced - CVA
 - Linear Sweep Voltammetry - LSV
 - Chronoamperometry / Chronocoulometry - CA
 - Chronopotentiometry - CP
 - Staircase Voltammetry - SV
 - Large Amplitude Sinusoidal Voltammetry - LASV
 - AC Voltammetry - ACV
 - Levich plot
 - Impedance Spectroscopy
 - Pulsed Techniques
 - Technique Builder
 - Manual Control
 - Ohmic Drop Determination
 - Bipotentiostat
- Electrochemical Applications

Insert Technique

Load from default

Custom Applications

Before

Alter

Safety/Adv. Settings

External devices

Cell characteristics

Rename

Add

Remove

Stack

OK

Cancel

Status Stopped Time 0,0000 s Ewe -747,3 mV I 0 A Buffer 0 Eoc -747,3 mV Q-Qo 0 A.h I Range open

VMP-3e 10.11.1.106 Channel 1 Amplifier : None EIS Modify mode 0,0 Undersample: Off 21 774 b/s

Search bar to quickly find the desired technique

Description of the settings technique and associated graph

Cyclic voltammetry (CV) is the most widely used technique for acquiring qualitative information about electrochemical reactions. CV provides information on redox processes, heterogeneous electron-transfer reactions and adsorption processes. It offers a rapid location of redox potential of the electroactive species. CV consists of scanning linearly the potential of a stationary working electrode using a triangular potential waveform. During the potential sweep, the potentiostat measures the current resulting from electrochemical reactions (consecutive to the applied potential). The cyclic voltammogram is a current response as a function of the applied potential.



Step 1: Add CV technique

- CV technique is loaded in the technique list
- Corresponding CV parameter settings appear

The screenshot displays the EC-Lab software interface for configuring a Cyclic Voltammetry (CV) experiment. The window title is "[VMP-3e - 10.11.1.106, channel 1 - experiment: <no name> - technique: Cyclic Voltammetry]". The interface includes a menu bar (Experiment, Edit, View, Graph, Analysis, Tools, Config, Windows, Help & Manuals), a toolbar, and a main workspace. On the left, a "Devices" panel shows "VMP-3e - 106". Below it, the "Experiment" panel has buttons for "Safety/Adv. Settings", "Cell Characteristics", "External Devices", and "Parameters Settings". The "Parameters Settings" panel is active, showing a list of techniques with "1 - CV" selected. The main workspace contains a configuration panel for the CV technique, outlined in yellow, with the following settings:

- Set E_{we} to $E_i = 0,000$ V vs. Eoc
- Scan E_{we} with $dE/dt = 20,000$ mV/s
- to vertex potential $E_1 = 1,000$ V vs. Ref
- Reverse scan to vertex $E_2 = -1,000$ V vs. Ref
- Repeat $n_c = 0$ time(s)
- Measure <I> over the last 50 % of the step duration
- Record <I> averaged over $N = 10$ voltage steps
- E Range = -2,5 V; 2,5 V (Resolution = 100 μ V)
- I Range = Auto
- Bandwidth = 5 - medium
- End scan to $E_f = 0,000$ V vs. Eoc

Below the configuration panel, there is a "Force E1 / E2" button and a note: "(dE/dt ~ 100 μ V / 5 ms), (dEN ~ 1,0 mV), (4000 points per cycle)". The status bar at the bottom shows: Status Stopped, Time 0,0000 s, Ewe -707,1 mV, I 0 A, Buffer 0, Eoc -707,1 mV, Q-Qo 0 A.h, P 0 W, nc 0, I Range open, cycle 1. The bottom-most bar shows: VMP-3e, 10.11.1.106, Channel 1, Amplifier: None, EIS, Modify mode, 0,0, Undersample: Off, 21 558 b/s.



Step 1: Add CV technique

General parameters

Technique parameters



You can display the description of the settings by clicking on the  icon.

Step 2: Set CV parameters

- Set E_i , dE/dt , E_1 and E_2 to define voltage ramp and voltage sweep

- The final voltage E_f can be defined

The screenshot displays the EC-Lab software interface for setting Cyclic Voltammetry (CV) parameters. The main window is titled "[VMP-3e - 10.11.1.106, channel 1 - experiment: <no name> - technique: Cyclic Voltammetry]". The interface includes a menu bar (Experiment, Edit, View, Graph, Analysis, Tools, Config, Windows, Help & Manuals) and a toolbar with icons for file operations and analysis. The left sidebar shows the "Parameters Settings" section for "1 - CV".

The main parameter settings are as follows:

- Set E_{we} to E_i = 0,000 V vs. Eoc**
- Scan E_{we} with dE/dt = 20,000 mV/s**
- to vertex potential E_1 = 1,000 V vs. Ref**
- Reverse scan to vertex E_2 = -1,000 V vs. Ref**
- Repeat n_c = 0 time(s)**
- Measure <I> over the last 50 % of the step duration**
- Record <I> averaged over N = 10 voltage steps**
- E Range = -2,5 V; 2,5 V** (Resolution = 100 μ V)
- I Range = Auto**
- Bandwidth = 5 - medium**
- End scan to E_f = 0,000 V vs. Eoc**

A diagram on the right illustrates a typical CV cycle with labeled potentials: E_i (initial potential), E_1 (first vertex), E_2 (second vertex), and E_f (final potential). The diagram shows the potential E_{we} versus time t for one cycle.

At the bottom of the interface, there is a "Force E1 / E2" button and a status bar showing experimental parameters: Status Stopped, Time 0,000 s, Ewe -717,6 mV, I 0 A, Buffer 0, Eoc -717,6 mV, Q-Qo 0 A.h, P 0 W, nc 0, I Range open, cycle 1.

Step 2: Set CV parameters

Define E_i , E_1 , E_2 , E_f versus the voltage of:

- **Ref:** the reference electrode
- **Eoc:** open circuit voltage
- **Ectrl:** the previous controlled voltage, if a technique is set before the CV
- **Emeas:** the previous measured voltage, if a technique is set before the CV

The screenshot shows a software interface for setting CV parameters. The interface includes a graph of potential E_{we} versus time t showing a cyclic voltammogram with points E_i , E_1 , E_2 , and E_f . A dropdown menu is open, showing options: Eoc, Ref, Ectrl, and Emeas. Red boxes highlight the 'Eoc' and 'Ref' selections in the interface.

Parameters shown in the interface:

- Set E_{we} to E_i = 0,000 V vs. Eoc
- Scan E_{we} with dE/dt = 20,000 mV/s
- to vertex potential E_1 = 1,000 V vs. Ref
- Reverse scan to vertex E_2 = -1,000 V vs. Ref
- Repeat n_c = 0 time(s)
- Measure <I> over the last 50 % of the step duration
- Record <I> averaged over N = 10 voltage steps
- E Range = -2,5 V; 2,5 V Resolution = 100 μ V
- I Range = Auto
- Bandwidth = 5 - medium
- End scan to E_f = 0,000 V vs. Eoc



- Set $E_i = 0$ V vs. Eoc to avoid a current jump at the beginning of the CV.
- Set E_1 and E_2 vs. Ref as OCV may change. E_{Ref} is an absolute voltage value.



Step 2: Set CV parameters

- To perform several cycles, set Repeat n_c

The screenshot shows the EC-Lab software interface for setting Cyclic Voltammetry (CV) parameters. The main window displays the following settings:

- Turn to OCV between techniques
- Set E_{we} to E_i = 0,000 V vs. Eoc
- Scan E_{we} with dE/dt = 20,000 mV/s to vertex potential E_1 = 1,000 V vs. Ref
- Reverse scan to vertex E_2 = -1,000 V vs. Ref
- Repeat n_c = 0 time(s)** (highlighted with a yellow box)
- Measure <I> over the last 50 % of the step duration
- Record <I> averaged over N = 10 voltage steps
- E Range = -2,5 V; 2,5 V (Resolution = 100 μ V)
- I Range = Auto
- Bandwidth = 5 - medium
- End scan to E_f = 0,000 V vs. Eoc

A graph on the right shows the potential E_{we} versus time t for one cycle. The potential starts at E_i , rises to E_1 , falls to E_2 , and then rises to E_f . The area under the curve is labeled "cycle".

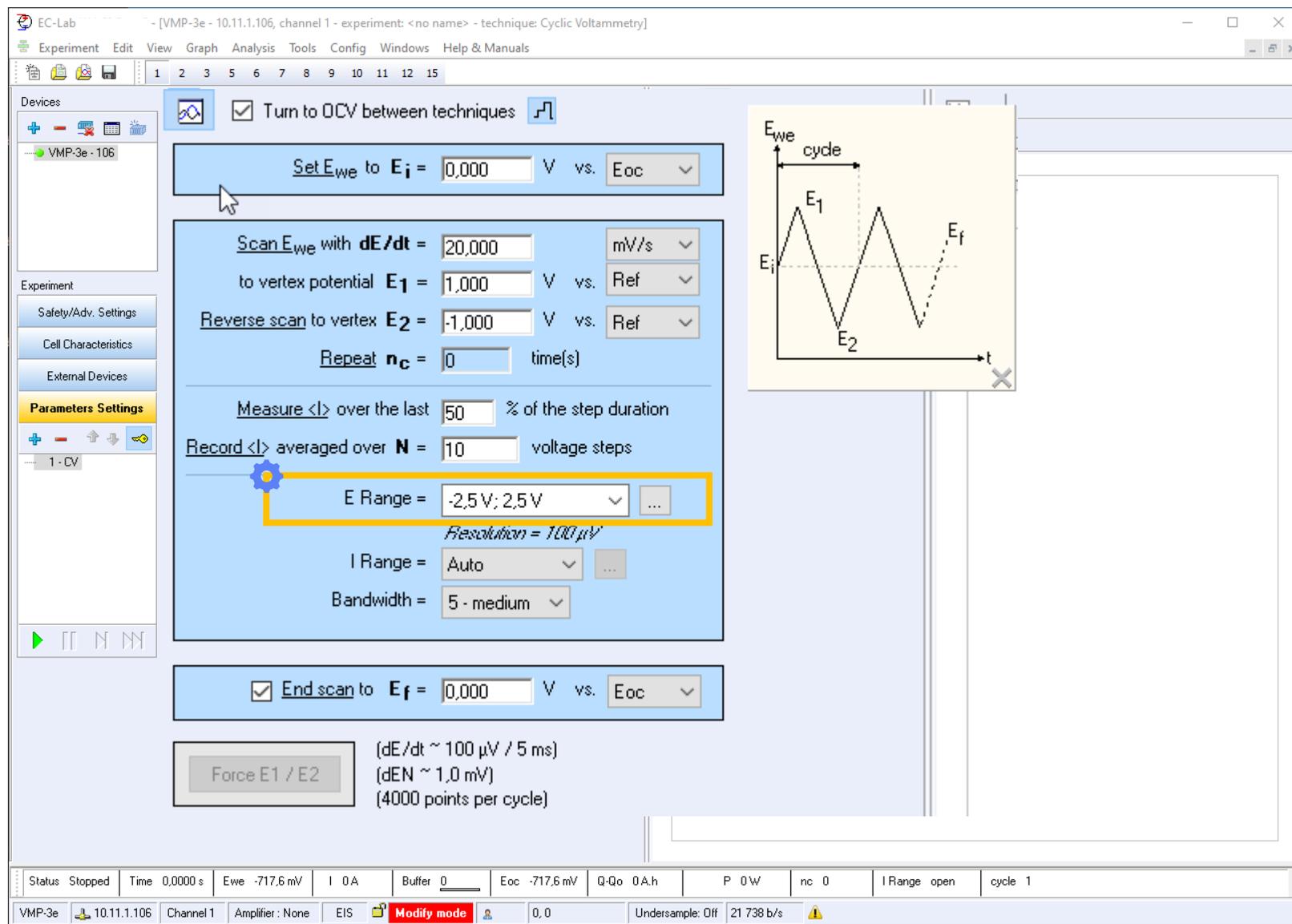
At the bottom, the status bar shows: Status Stopped, Time 0,000 s, Ewe -717,6 mV, I 0 A, Buffer 0, Eoc -717,6 mV, Q-Qo 0 A.h, P 0W, nc 0, IRange open, cycle 1.



Step 3: Optimize the measurement

- E Range is the range of expected voltage
- E_i , E_1 and E_2 must be in the E Range

 E Range has to be as narrow as possible, the resolution depends on it.



The screenshot shows the EC-Lab software interface for a Cyclic Voltammetry experiment. The main window displays various parameters for the scan:

- Set E_{we} to E_i = 0,000 V vs. Eoc**
- Scan E_{we} with dE/dt = 20,000 mV/s**
- to vertex potential E_1 = 1,000 V vs. Ref**
- Reverse scan to vertex E_2 = -1,000 V vs. Ref**
- Repeat n_c = 0 time(s)**
- Measure <I> over the last 50 % of the step duration**
- Record <I> averaged over N = 10 voltage steps**
- E Range = -2,5 V; 2,5 V** (Resolution = 100 μ V)
- I Range = Auto**
- Bandwidth = 5 - medium**
- End scan to E_f = 0,000 V vs. Eoc**

A graph on the right shows a cyclic voltammogram with potential E_{we} on the y-axis and time t on the x-axis. The scan starts at E_i , goes to E_1 , then to E_2 , and finally to E_f . A "cycle" is indicated between E_1 and E_2 .

At the bottom, a status bar shows: Status Stopped, Time 0,0000 s, Ewe -717,6 mV, I 0 A, Buffer 0, Eoc -717,6 mV, Q-Qo 0 A.h, P 0 W, nc 0, I Range open, cycle 1.



Step 3: Optimize the measurement

- I Range is the range of expected current
- Autorange is available

⚙ For high scan rates, it is recommended to set a fixed I Range because I Range shift duration may be no more negligible.

EC-Lab [VMP-3e - 10.11.1.106, channel 1 - experiment: <no name> - technique: Cyclic Voltammetry]

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

1 2 3 5 6 7 8 9 10 11 12 15

Devices: VMP-3e - 106

Experiment: Safety/Adv. Settings, Cell Characteristics, External Devices, Parameters Settings

1 - CV

Turn to OCV between techniques

Set E_{we} to E_i = 0,000 V vs. Eoc

Scan E_{we} with dE/dt = 20,000 mV/s to vertex potential E_1 = 1,000 V vs. Ref

Reverse scan to vertex E_2 = -1,000 V vs. Ref

Repeat n_c = 0 time(s)

Measure <I> over the last 50 % of the step duration

Record <I> averaged over N = 10 voltage steps

E Range = -2,5 V; 2,5 V Resolution = 100 μ V

I Range = Auto

Bandwidth = 5 - medium

End scan to E_f = 0,000 V vs. Eoc

Force E_1 / E_2 ($dE/dt \sim 100 \mu\text{V} / 5 \text{ms}$, $dEN \sim 1,0 \text{mV}$, 4000 points per cycle)

Status Stopped Time 0,0000 s Ewe -717,6 mV I 0 A Buffer 0 Eoc -717,6 mV Q-Qo 0 A.h P 0 W nc 0 I Range open cycle 1

VMP-3e 10.11.1.106 Channel 1 Amplifier: None EIS Modify mode 0.0 Undersample: Off 21 738 b/s



Step 3: Optimize the measurement

- Adjust bandwidth to make sure that the potentiostat controls the cell in stable and fast way

The screenshot shows the EC-Lab software interface for a Cyclic Voltammetry (CV) experiment. The main window displays various parameters for the scan:

- Set E_{we} to E_i = 0,000 V vs. Eoc**
- Scan E_{we} with dE/dt = 20,000 mV/s**
- to vertex potential E_1 = 1,000 V vs. Ref**
- Reverse scan to vertex E_2 = -1,000 V vs. Ref**
- Repeat n_c = 0 time(s)**
- Measure $\langle I \rangle$ over the last 50 % of the step duration**
- Record $\langle I \rangle$ averaged over N = 10 voltage steps**
- E Range = -2,5 V; 2,5 V** (Resolution = 100 μV)
- I Range = Auto**
- Bandwidth = 5 - medium** (highlighted with a yellow box and a gear icon)
- End scan to E_f = 0,000 V vs. Eoc**

A diagram on the right shows a CV cycle with potential E_{we} on the y-axis and time t on the x-axis. The cycle starts at E_i , goes up to E_1 , down to E_2 , and back up to E_f . A "cycle" label indicates the duration of one scan.

At the bottom, a status bar shows: Status Stopped, Time 0,000 s, Ewe -717,6 mV, I 0 A, Buffer 0, Eoc -717,6 mV, Q-Qo 0 A.h, P 0 W, nc 0, I Range open, cycle 1.

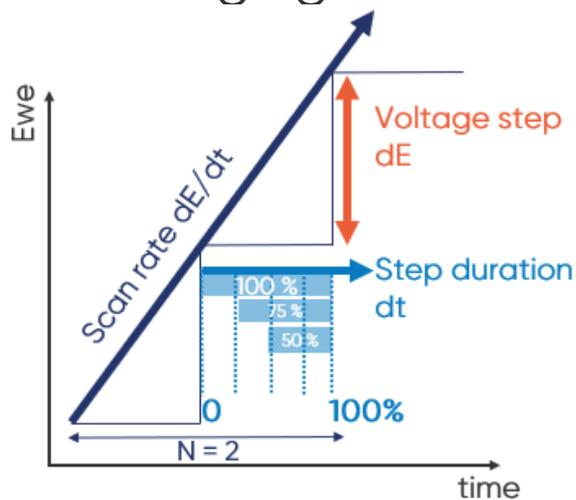
⚙️ Set fast bandwidth for high scan rate (200mV/s)

- 7-fast for essential
- 9-fast for premium



Step 3: Optimize the measurement

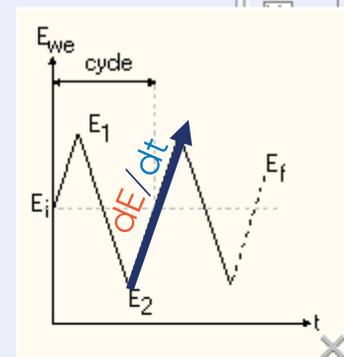
- Adjust current measurement and averaging



Note: dE is dependent on potential resolution

⚙️ Set to 50% to cut first current value points corresponding to undesired capacitive response of the cell

$N = 10$ voltage steps allows to get smoother data





Step 4: Set general parameters

- Add information and comments about the cell

The screenshot shows the EC-Lab software interface. The 'Cell Characteristics' tab is selected in the left sidebar. The 'Cell Description' section is highlighted with a yellow box and contains the following fields:

- Electrode material
- Initial state
- Electrolyte
- Comments

Below the 'Cell Description' section are the following fields:

- Electrode surface area (A): 0,001 cm²
- Characteristic mass: 0,001 g
- Volume (V): 0,001 cm³

The 'Battery' tab is selected, showing the following fields:

- Mass of active material: 0,001 mg at x = 0,000
- Molecular weight of active material (at x = 0): 0,001 g
- Atomic weight of intercalated ion: 0,001 g
- Acquisition started at: x₀ = 0,000
- Number of e- transferred per intercalated ions: 1
- for Δx = 1, theoretical capacity ΔQ = 26,802 mA.h
- Battery capacity C = 0,000 A.h

The Reference Electrode is set to SCE Saturated Calomel Electrode with an offset potential vs. Normal Hydrogen Electrode of 0.241 V.

Note: All this information are store in the data file



Step 4: Set general parameters

Electrode surface area must be set if the user want to work with current density (mA/cm²) instead of current (mA)

The screenshot shows the EC-Lab software interface. The title bar indicates the experiment is '[VMP-3e - 10.11.1.106, channel 1 - experiment: <no name> - technique: Cyclic Voltammetry]'. The main window is divided into several sections:

- Devices:** Shows a device named 'VMP-3e - 106'.
- Cell Description:** Contains fields for 'Electrode material', 'Initial state', 'Electrolyte', and 'Comments'.
- Parameters Settings:** This section is further divided into 'Battery', 'Corrosion', and 'Materials' tabs. The 'Materials' tab is active, showing fields for:
 - Electrode surface area (A): 0,001 cm² (highlighted with a red box and a red circle, with a red arrow pointing from the text on the left to it)
 - Characteristic mass: 0,001 g
 - Volume (V): 0,001 cm³
 - Mass of active material: 0,001 mg at x = 0,000
 - Molecular weight of active material (at x = 0): 0,001 g
 - Atomic weight of intercalated ion: 0,001 g
 - Acquisition started at: x₀ = 0,000
 - Number of e⁻ transferred per intercalated ions: 1
 - for Δx = 1, theoretical capacity ΔQ = 26,802 mA.h
 - Battery capacity C = 0,000 A.h
- Reference Electrode:** Set to 'SCE Saturated Calomel Electrode' with an 'Offset potential vs. Normal Hydrogen Electrode: 0.241 V'.

The status bar at the bottom shows: Status Stopped, Time 0,0000 s, Ewe -717,6 mV, I 0 A, Buffer 0, Eoc -717,6 mV, Q-Qo 0 A.h, P 0 W, nc 0, I Range open, cycle 1. The bottom-most bar shows: VMP-3e, 10.11.1.106, Channel 1, Amplifier: None, EIS, Read mode, 0, 0, Undersample: Off, 21 540 b/s.



Step 4: Set general parameters

- Safety and Advanced Settings are available here

Note: This window is different for the Essential and Premium instruments

The screenshot displays the EC-Lab software interface for a Cyclic Voltammetry experiment. The main window is titled "EC-Lab" and shows the "Safety/Adv. Settings" panel. This panel is highlighted with a yellow border and contains the following sections:

- Safety Limits:** For $t > 10,0$ ms. Includes checkboxes for Ewe max, Ewe min, III, IQ-QoI, Analog IN1, Analog IN2, Estack slave max, and Estack slave min. Values are set to 0,000 00 V or mA. A checkbox "Do not start on E overload" is checked.
- Compliance:** "Modify on disconnected cells only!". Includes sliders for Ewe from and Ece from, both set to -10 V to 10 V. A "More information >>" link is present.
- Potential control:** A dropdown menu is set to "Ewe". Below it, "Ecell = Ewe" is displayed.
- Record:** Checkboxes for Ece/V, Energy/W.h, Analog IN1/V, and Analog IN2/V. A link "Record external devices on Analog IN#" is provided.
- Electrode Connections:** "Modify on disconnected cells only!". A dropdown menu is set to "standard". A schematic diagram shows connections for WE/CA2/ref1, RE/ref2, and CE/CA1. Potentials E_{we} , E_{ce} and current I are indicated.
- Data Process:** Checkboxes for "Online text export" and "Filter". Includes a "Smooth on" field set to 0 points and a checkbox "Create one data file per loop (linked techniques only)". Radio buttons for "Charge/Discharge" and "Discharge/Charge" are present.

The status bar at the bottom of the window displays the following information: Status Stopped, Time 0,0000 s, Ewe -720,8 mV, I 0 A, Buffer 0, Eoc -720,8 mV, Q-Qo 0 A.h, P 0 W, nc 0, IRange open, cycle 1. The bottom-most bar shows: VMP-3e, 10.11.1.106, Channel 1, Amplifier: None, EIS, Read mode, 0, 0, Undersample: Off, 21 756 b/s.



Step 5: Launch the measurement

- Click on ▶ to launch experiment

EC-Lab [VMP-3e - 10.11.1.106, channel 1 - experiment: <no name> - technique: Cyclic Voltammetry]

Experiment Edit View Graph Analysis Tools Config Windows Help & Manuals

1 2 3 5 6 7 8 9 10 11 12 15

Devices

- VMP-3e - 106

Experiment

- Safety/Adv. Settings
- Cell Characteristics
- External Devices
- Parameters Settings**

1 - CV

Turn to OCV between techniques

Set E_{we} to $E_i = 0,000$ V vs. Eoc

Scan E_{we} with $dE/dt = 20,000$ mV/s

to vertex potential $E_1 = 1,000$ V vs. Ref

Reverse scan to vertex $E_2 = -1,000$ V vs. Ref

Repeat $n_c = 0$ time(s)

Measure <I> over the last 50 % of the step duration

Record <I> averaged over $N = 10$ voltage steps

E Range = -2,5 V; 2,5 V Resolution = 100 μ V

I Range = Auto

Bandwidth = 5 - medium

End scan to $E_f = 0,000$ V vs. Eoc

Force E_1 / E_2 (dE/dt ~ 100 μ V / 5 ms)
(dEN ~ 1,0 mV)
(4000 points per cycle)

Status Stopped Time 0,0000 s Ewe -707,1 mV I 0 A Buffer 0 Eoc -707,1 mV Q-Qo 0 A.h P 0 W nc 0 I Range open cycle 1

VMP-3e 10.11.1.106 Channel 1 Amplifier: None EIS Modify mode 0,0 Undersample: Off 21 558 b/s

Note: All the settings may be changed during the experiment (Modify on the fly) except I Range, E Range and bandwidth



Step 5: Launch the measurement

Load techniques with same settings using a .mps files created when launching the experiment

The screenshot displays the software interface for an electrochemical workstation. The main window is titled "[VMP-3e - 10.11.1.106, channel 1 - experiment: <no name> - technique: Cyclic Voltammetry]". The interface includes a menu bar (Experiment, Edit, View, Graph, Analysis, Tools, Config, Windows, Help & Manuals), a toolbar, and several panels. The "Parameters Settings" panel is active, showing various experimental parameters such as "Set E_{we} to E_i = 0,000 V vs. E_{oc}", "Scan E_{we} with dE/dt = 20,000 mV/s", "to vertex potential E₁ = 1,000 V vs. Ref", "Reverse scan to vertex E₂ = -1,000 V vs. Ref", "Repeat n_c = 0 time[s]", "Measure <I> over the last 50 % of the step duration", "Record <I> averaged over N = 10 voltage steps", "E Range = -2,5V; 2,5V", "I Range = Auto", "Bandwidth = 5 - medium", and "End scan to E_f = 0,000 V vs. E_{oc}". A "Force E1 / E2" button is also visible. The "Status Stopped" box is highlighted, and the control buttons (Stop, Pause, Relax, Next technique, Next sequence) are also highlighted. The status bar at the bottom shows "Status Stopped", "Time 0,0000 s", "Ewe -707,1 mV", "I 0 A", "Buffer 0", "Eoc -707,1 mV", "Q-Qo 0 A.h", "P 0 W", and "Modify mode".

Stop experiment

Pause experiment

Next technique

Next sequence

Status of experiment is displayed (Stopped, Paused, Relax...)



Step 6: Add additional experiments

- Click on + button to add more techniques
- Order of execution appears in the technique list

The screenshot displays the EC-Lab software interface. The main window shows the 'Experiment' configuration area with a 'Parameters Settings' section containing a list of techniques: 1 OCV, 2 ZIR, and 3 CV. A yellow box highlights this list. To the right, the 'Insert Techniques' dialog box is open, showing a tree view of available techniques under 'Electrochemical Techniques'. A yellow arrow points from the '+' button in the 'Parameters Settings' section to the 'Insert Techniques' dialog. The status bar at the bottom shows 'Status Stopped', 'Time 0,0000 s', 'Ewe -707,1 mV', 'I 0 A', 'Buffer 0', 'Eoc -707,1 mV', 'Q-Qo 0 A.h', 'P 0 W', 'nc 0', 'IRange open', 'cycle 1', and 'Modify mode'.



Step 6: Add additional experiments

Can be used as a waiting time for equilibration of the electrochemical cell

Note: CA or CVA technique can be used to set a conditioning period before starting voltage ramp

Can be used to determine and compensate ohmic drop

The screenshot shows the EC-Lab software interface. The main window displays experiment parameters for a Cyclic Voltammetry (CV) technique. The 'Parameters Settings' tab is active, showing various scan parameters such as scan rate, potential range, and resolution. A 'Recent Techniques' list is visible on the right, showing a hierarchy of techniques including 'My protocol - OCV + ZIR + CV'. A 'Save As Custom Application...' dialog box is open, showing the option to save the current protocol as a custom application. The status bar at the bottom indicates the current experiment status, including time, potential, current, and other parameters.

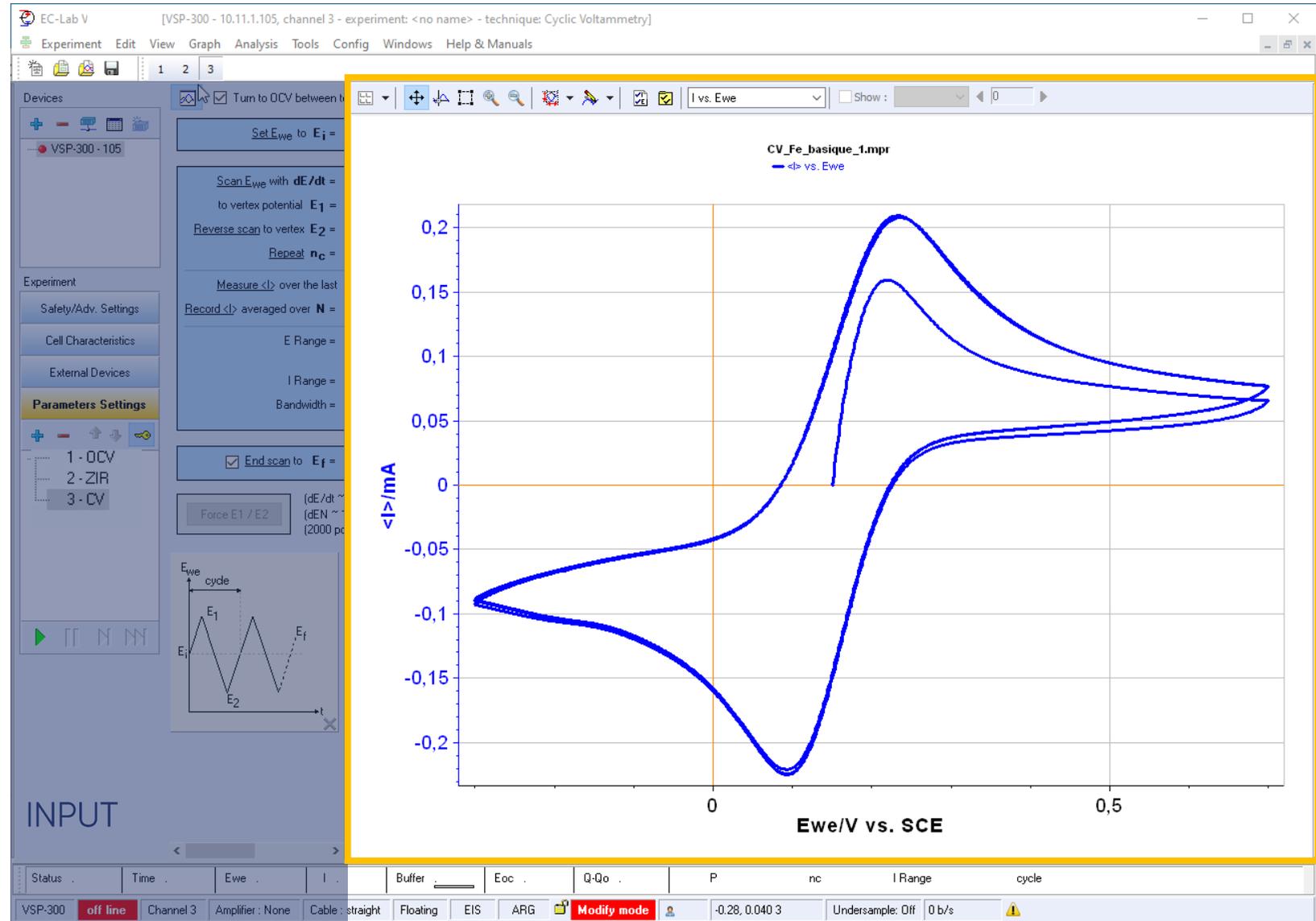


You can save personalized protocol to technique list with **Save As Custom Application...** (in the main bar menu Experiment) and find it under Electrochemical Application - Custom Applications **My protocol - OCV + ZIR + CV**



Step 7: Read the graph

- Graphic is displayed in real time
- Data are saved in .mpr file



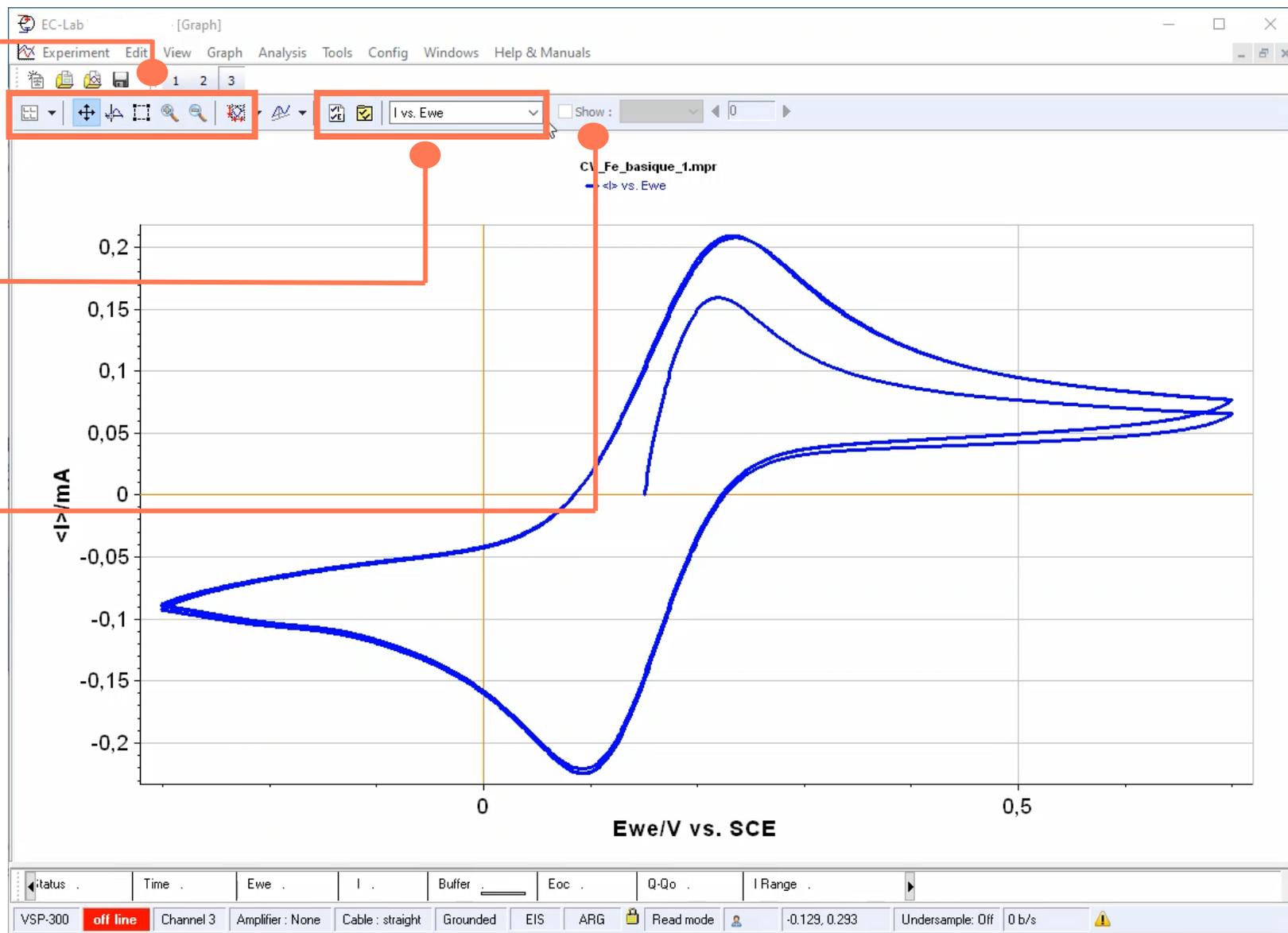


Step 7: Read the graph

Browse through the graph
(Filter, Scroll, Cursor, Selection,
Zoom +, Zoom -, Autoscale)

Modify the graph
(Selector, graphic properties,
representations)

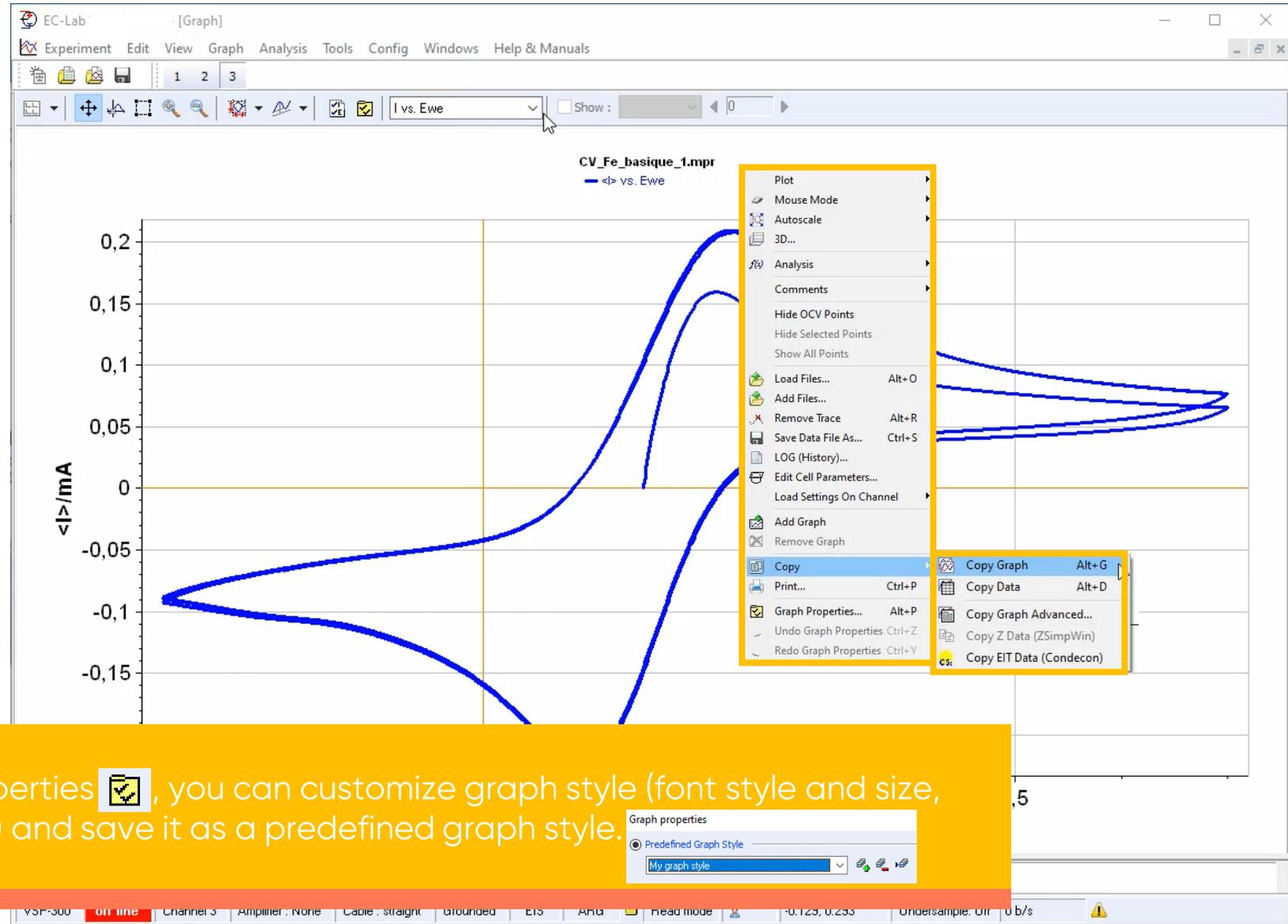
Show only selected
cycle



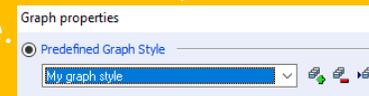


Step 7: Read the graph

- Copy graph as a picture with a right click on the graph



In graph properties , you can customize graph style (font style and size, traces, grid...) and save it as a predefined graph style.

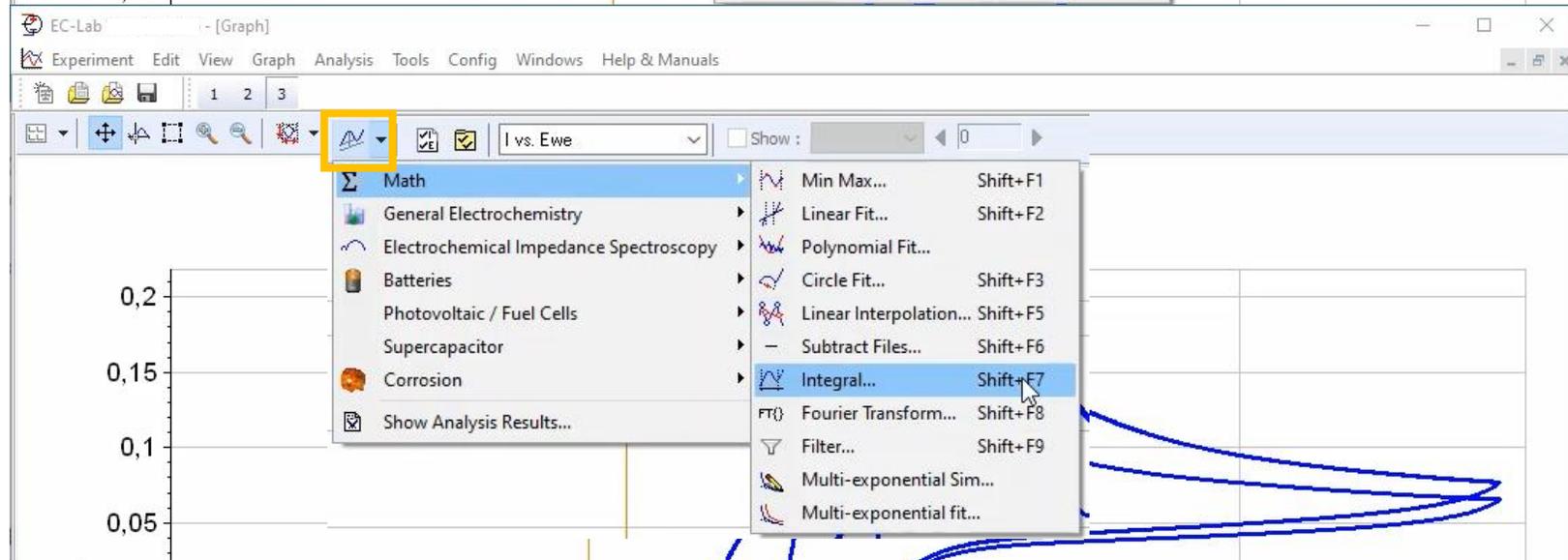
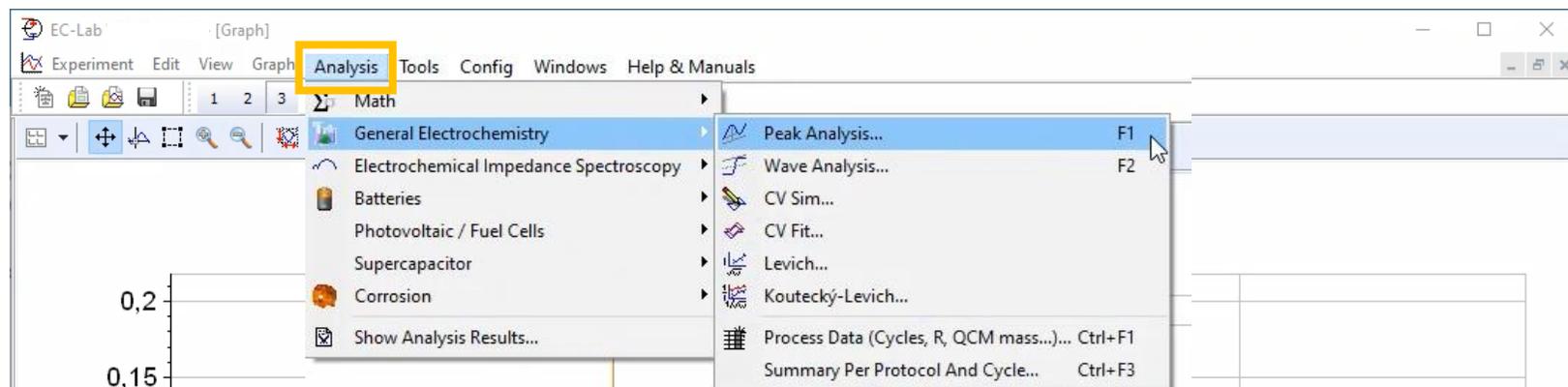




Step 8: Analyse the data

- Analyse the CV
 - Math
 - General Electrochemistry

Note: Analysis is available either in the main tool bar or as a shortcut in the graph bar or with F6



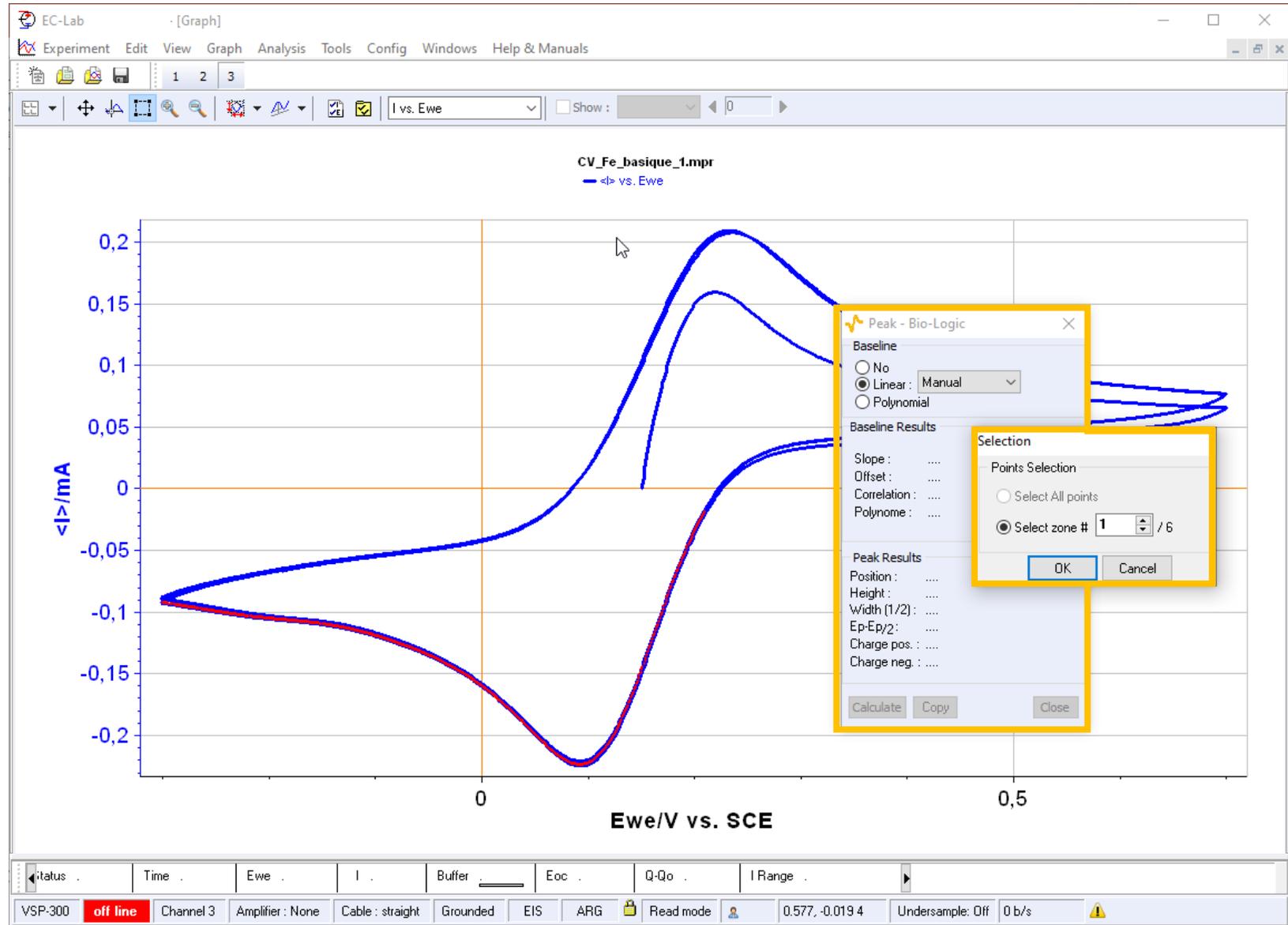
Did you know? CV Sim (available in Analysis - General Electrochemistry) is a powerful cyclic voltammetry simulation. It can be used as a learning tool.



Step 8: Analyse the data

- Peak analysis
 - Select the peak on the graph
 - Click on calculate
 - Select zone (if needed) and click on ok

Note: For details on baseline options, refer to EC-Lab Analysis and Data Process manual

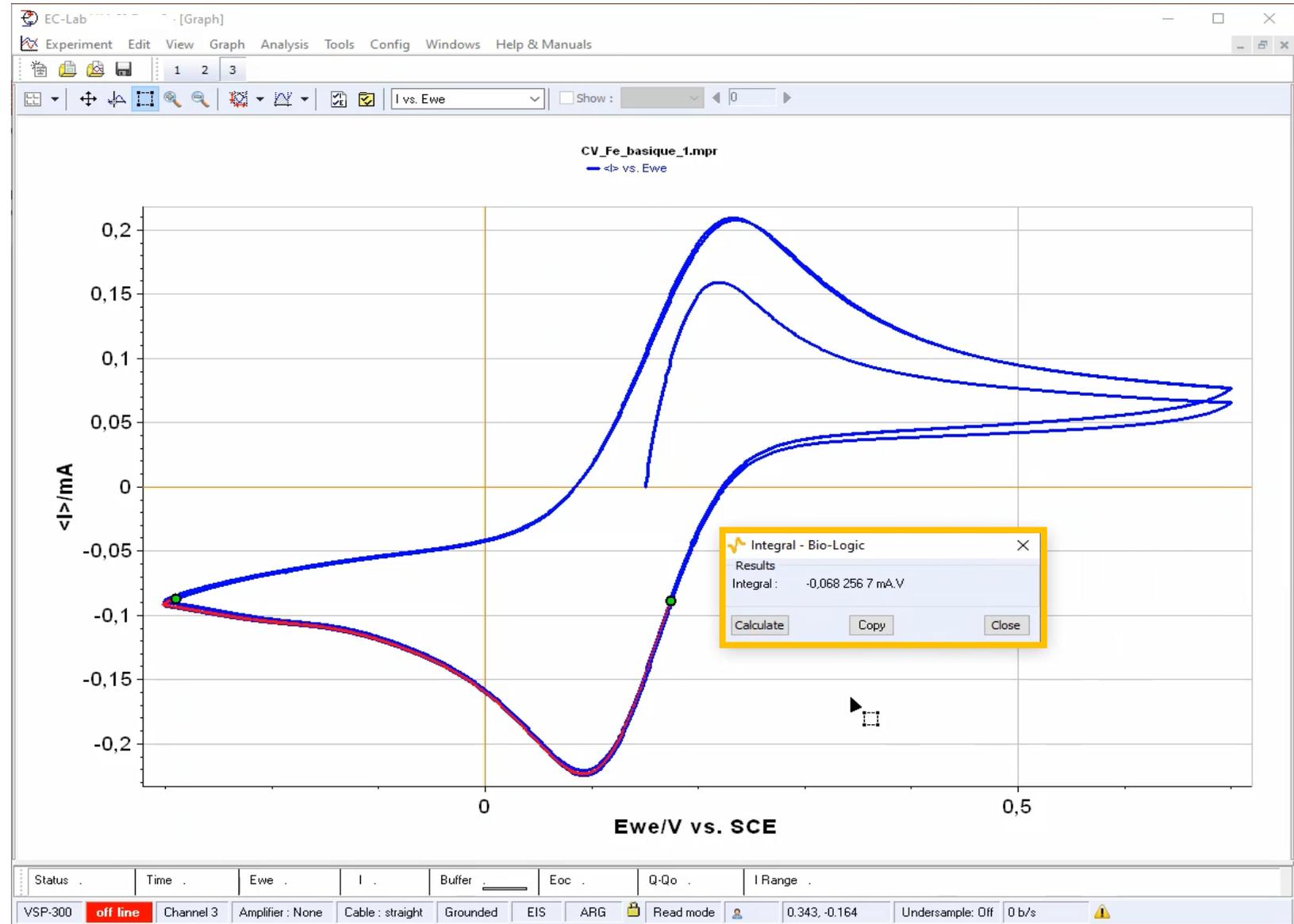




Step 8: Analyse the data

■ Integral

- Select the area of interest on the graph
- Click on calculate
- Select zone (if needed)



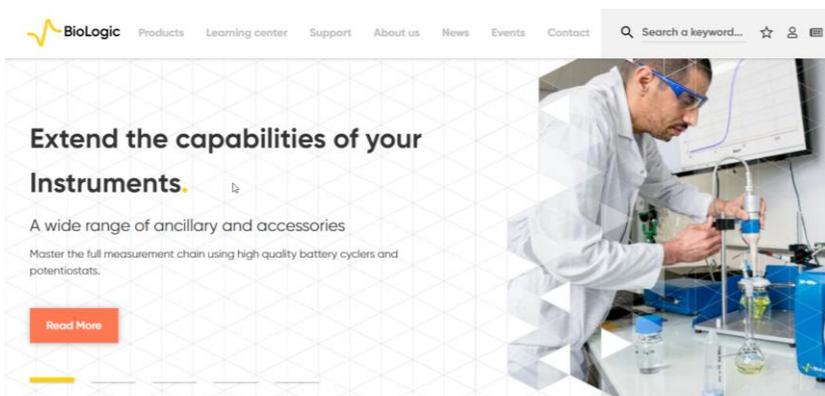


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■ Documentation list

- What is CV? A comprehensive guide to Cyclic Voltammetry (article)
- EC-Lab Techniques and Applications (manual)
- EC-Lab Analysis and Data Process (manual)



Did you know? Free update of EC-Lab® are available on our website.



Need help?

Contact us!



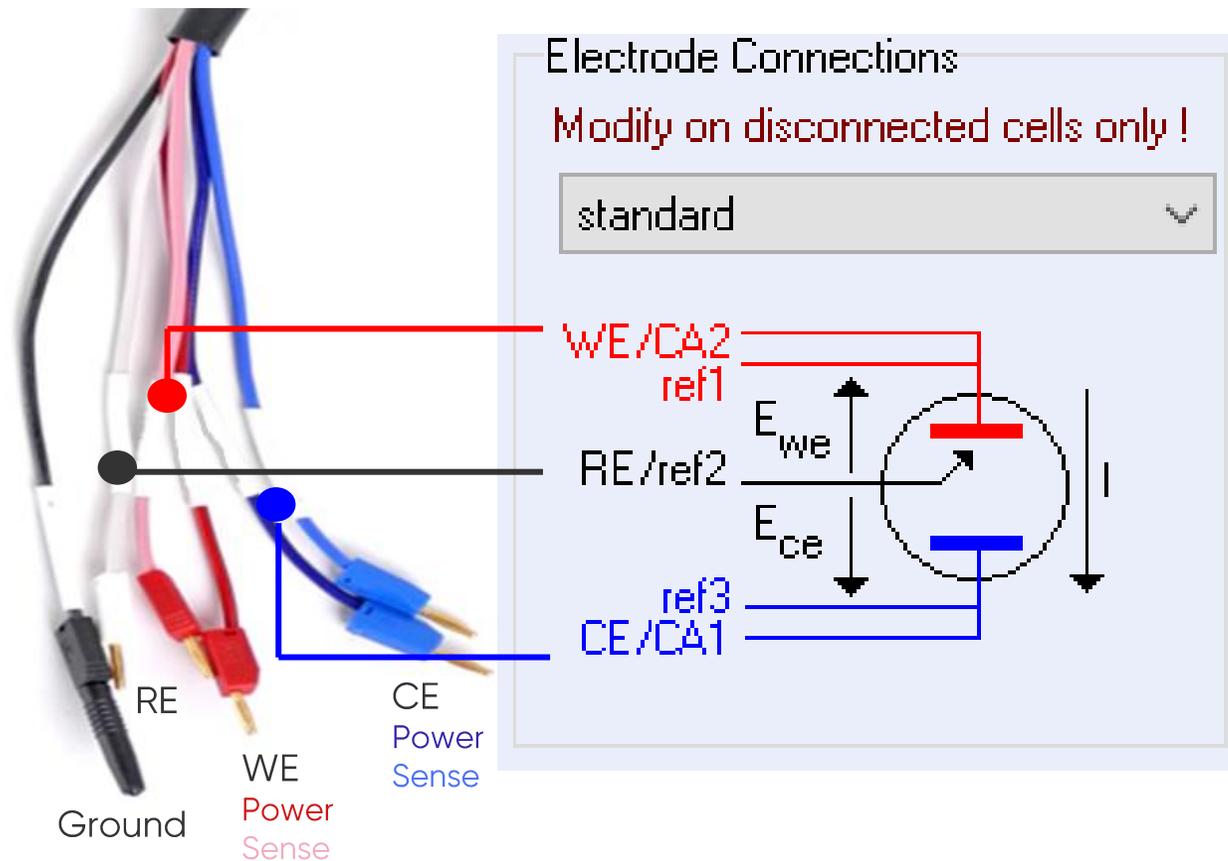
- Helpful information to provide when contacting support center:
 - Serial number of the instrument (located on the rear panel of the device)
 - Software and hardware version you are currently using (on the Help menu, About on EC-Lab)
 - Operating system on the connected computer
 - Connection mode (Ethernet, LAN, USB) between computer and instrument



FAQ

- How do I connect potentiostat to the cell?
- How do I select correct bandwidth?
- What is the difference between compliance and control voltage?
- If I do some modifications on the fly on the experiment parameters, how can I remember what I have done?

How do I connect potentiostat to the cell?



- In standard electrode connections mode:
 - Working Electrode (WE)
Connect power and sense
 - Reference Electrode (RE)
 - Counter Electrode (CE)
Connect power and sense

Note: For other connection modes, refer to Connection to the cell (article) or Technical Note #09 and #11, or the Installation and Configuration Manual.



How do I select correct bandwidth?

- To quickly verify if the correct bandwidth is selected (no oscillation and stable measurement), you can follow these steps:
 - Change the Bandwidth factor. Start with a lower value. If decreasing the bandwidth factor does not work, try to increase it. The faster, the better.
 - For potentiodynamic measurements carried out at high scan rates, fast bandwidths must be set.
 - The hardware ohmic drop compensation slows down the regulation loop, so in some cases, you may need to decrease the bandwidth.
 - For Premium range potentiostats, adjust bandwidths 7, 8, 9 first. Then, if the measurement still shows signs of oscillation try the advanced bandwidths 1 to 6.

Note: To go further, refer to Get more from your potentiostat, Understanding bandwidth & its effect on measurements (articles), Application Note #04, Technical Notes #35

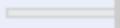
What is the difference between compliance and control voltage?

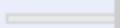
- Compliance is the voltage between WE and CE
- Control voltage is the voltage between WE and RE
- Verify the desired voltage to apply matches with the compliance.
 - For Premium: compliance = ± 12 V
 - For Essential: compliance = 20 V adjustable from ± 10 V, between $[-20 ; 20]$ V

Note: Compliance is adjustable only on essential instrument in Safety/Adv Settings.

Compliance

Modify on disconnected cells only !

Ewe from -10 V  10 V

Ece from -10 V  10 V

<< Less information

Ex: if Ewe = 1,00 V

then Ece must be between -9,000 V and 0 V.



Potential control

Ewe 

Ecell = Ewe

If I modify-on-the-fly the experiment parameters, how can I remember what I have done?

- Each experiment is associated with a LOG file (right click on the graph), which is the memory of an experiment
- This file contains the mark of all the change parameters happening during the experiment

2

3

1

File	cvtest_C06.mpr
I Range	Auto
I Range min	Unset
I Range max	Unset
I Range init	Unset
Bandwidth	8
E2 (V)	0,000
vs.	Ref
nc cycles	0
Reverse Scan	1
Ef (V)	0,000
vs.	Eoc
Modify on :	03/07/2024 09:21
dE/dt	25,000

Copy Print Close



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