

## 1 – Cutoffs

Cutoffs are convenient tools that can be used to control the experimental conditions, in order to prevent or to react on specific situations, for example when the cell temperature surpasses a threshold value, or when the current exceeds user defined limits.

Cutoffs are available in NOVA and can be used in combination with any electrochemical signal that can be sampled and with all the measurement commands, except the Chrono methods and the measurement commands that involve the use of a fast sampling ADC (high speed linear scan and chrono methods high speed).



### Warning

Cutoffs can only work if the electrochemical signal to test is sampled during the measurement. A cutoff condition defined on the pH value for example, can only be triggered if the pH is sampled during the measurement.

### 1.1 – How cutoffs work

For all the commands that provide access to cutoffs in NOVA, cutoff conditions are defined in the options. The options are checked after a data point has been recorded. This means that, in order to trigger a cutoff condition, at least one data point must be recorded.

The *Record signals (> 1 ms)* command also provides the possibility to decouple the options from the sampling, using the fast options. Specific information about the fast options is provided in Section 1 of this tutorial.

The cutoff framework in NOVA provides three degrees of freedom:

- It is possible to define the number of detections required to trigger the cutoff condition.
- It is possible to combine two or more cutoff conditions using OR / AND logical operators.
- It is possible to define the consequence of a triggered cutoff, for each condition.

In order to define one or more cutoffs, open the **Options** window by clicking the  button in the procedure editor. Figure 1 illustrates this for the Autolab Cyclic voltammetry potentiostatic procedure.

## NOVA Cutoff tutorial

Commands	Parameters	Links
Cyclic voltammetry potentiostatic		
Remarks	Cyclic voltammetry potentiostatic	...
End status Autolab		...
Signal sampler	Time, WE(1).Potential, WE(1).Current	...
Options	1 Options	...
Instrument		
Instrument description		
⊕ Autolab control		...
⊕ Set potential	0.000	
⊕ Set cell	On	...
⊕ Wait time (s)	5	
Optimize current range	5	
⊕ CV staircase	[0.000, 1.000, -1.000, 0.000, 2, 0.1000000]	-
⊕ Set cell	Off	...

Figure 1 – Opening the options window in the Cyclic voltammetry potentiostatic procedure



### Note

It is also possible to edit the Options by selecting the procedure header and clicking the  button in the quick access toolbar (see Figure 2).

Commands	Parameters	Links
Cyclic voltammetry potentiostatic		
Remarks	Cyclic voltammetry potentiostatic	...
End status Autolab		...
Signal sampler	Time, WE(1).Potential, WE(1).Current	...
Options	1 Options	...
Instrument		
Instrument description		
⊕ Autolab control		...
⊕ Set potential	0.000	
⊕ Set cell	On	...
⊕ Wait time (s)	5	
Optimize current range	5	
⊕ CV staircase	[0.000, 1.000, -1.000, 0.000, 2, 0.1000000]	-
⊕ Set cell	Off	...

Figure 2 – Click the procedure header and select the  button from the quick access toolbar to open the Edit Options window

The Edit options window, shown in Figure 3 can be used to define all the options to be used during the measurement.

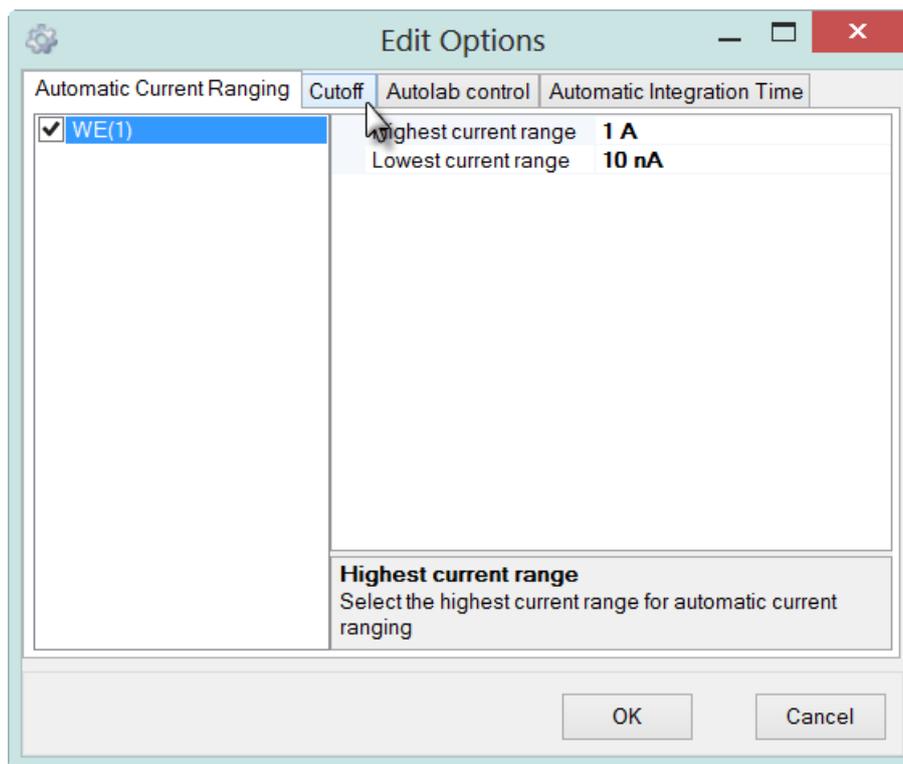


Figure 3 – The Edit Options window

There are four tabs in the Edit Options window.

- **Automatic Current Ranging:** used to set the automatic current ranging (ACR) options for the available working electrodes. ACR can be switched on or off and a highest and lowest current can be specified.
- **Cutoff:** used to define the cutoff condition(s) to be tested during the measurement. More information is provided in this tutorial.
- **Autolab control:** this is a special tab that can be used to specify specific actions to be taken during a measurement. These actions are executed at the end of each sampling stage<sup>1</sup>.
- **Automatic Integration Time:** used to set the automatic integration time (AIT) options for measurements involving the analog integrator module<sup>2</sup> (FI20 module or on-board integrator).

Click the Cutoff tab in the Edit Options window to reveal the Cutoff interface (see Figure 4).

<sup>1</sup> Polarographic experiments require a new Hg drop to be formed at the end of each step. This action is specified in the Autolab control option. Please refer to the Voltammetric analysis tutorial for a practical example.

<sup>2</sup> Please refer to the Filter and Integrator tutorial for more information.

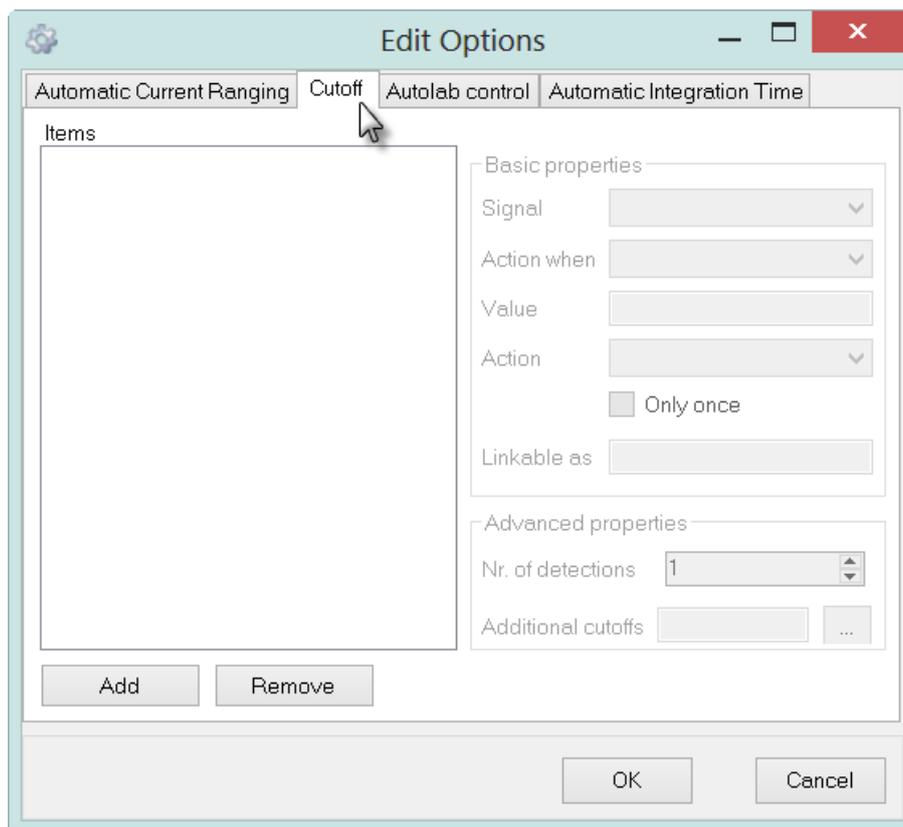


Figure 4 – The Cutoff interface of the Edit Options window

If no cutoff conditions have been defined (which is the case for the Autolab Cyclic voltammetry potentiostatic procedure), the cutoff interface will be empty.

To define a cutoff condition, press the  button (see Figure 5).

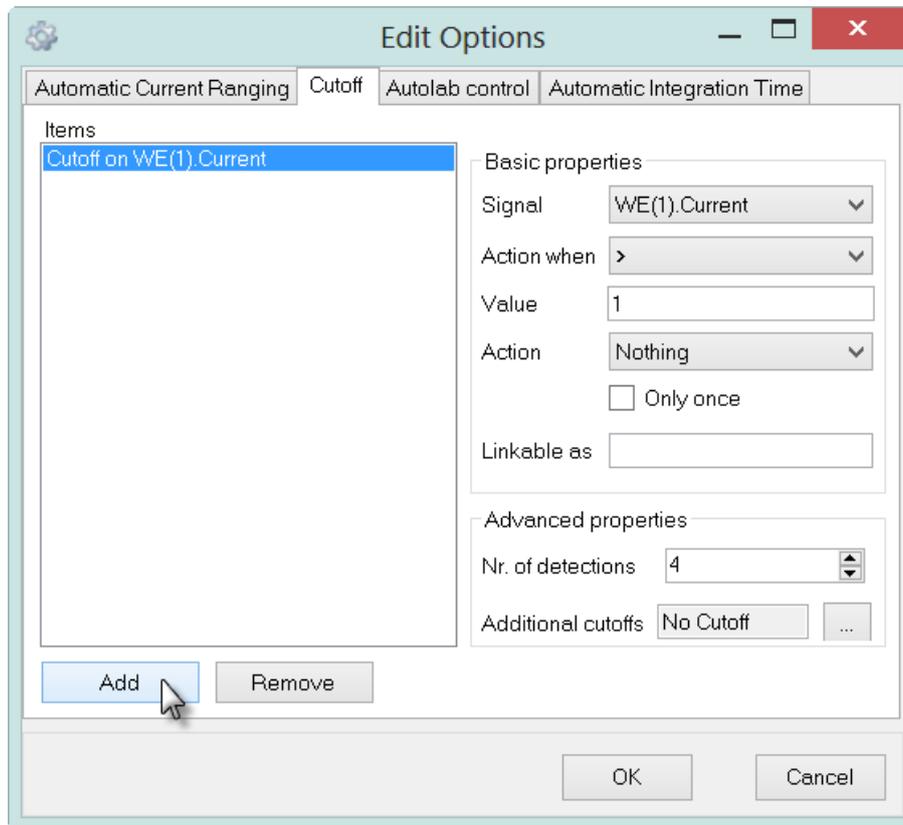


Figure 5 – Pressing the Add button creates an editable cutoff condition

Once a cutoff has been added to the Edit Options window, it is possible to set the properties.

Two areas are provided on the right-hand side of the window:

**Basic properties (see Figure 6):**

Basic properties	
Signal	WE(1).Current
Action when	>
Value	1
Action	Nothing
	<input type="checkbox"/> Only once
Linkable as	

Figure 6 – The Basic properties of the cutoff editor

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## NOVA Cutoff tutorial

- **Signal** – defines the signal on which the cutoff condition is used.
- **Action when (< or >)** – defines the inequality needed to trigger the cutoff.
- **Value** – defines the threshold value of the signal.
- **Action** – defines what should happen when the cutoff condition is met. Four actions are available:
  - **Nothing:** proceeds with the measurement.
  - **Stop command:** skips to the next command.
  - **Stop measurement:** stops the whole measurement sequence located within the timing guide and continues to the next timing guide.
  - **Stop complete procedure:** stops the complete procedure and applies the End status Autolab settings.
- **Only once:** specifies if the cutoff action should be executed only once.
- **Linkable as** – defines a unique parameter name for the cutoff **Value** that can be used to link to other command parameters in the procedure editor.



### Note

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When the cutoff is used in combination with specific measurement commands, additional actions can be used. Please refer to the final section of this tutorial for more information.

### Advanced properties (see Figure 7):

The image shows a dialog box titled "Advanced properties". It contains two main sections. The first section is labeled "Nr. of detections" and features a numeric input field with the value "4" and a small up/down arrow control to its right. The second section is labeled "Additional cutoffs" and contains a button labeled "No Cutoff" and a button with three dots "...".

Figure 7 - The Advanced properties of the cutoff editor

- **Nr. of detections** – defines the number of consecutive inequality detections required to trigger the cutoff. The maximum value is 100.
- **Additional cutoffs** – defines additional cutoff conditions.

Figure 8 shows how to define a cutoff condition that stops the complete procedure when the WE(1).Current signal exceeds 0.6 mA, five consecutive times.

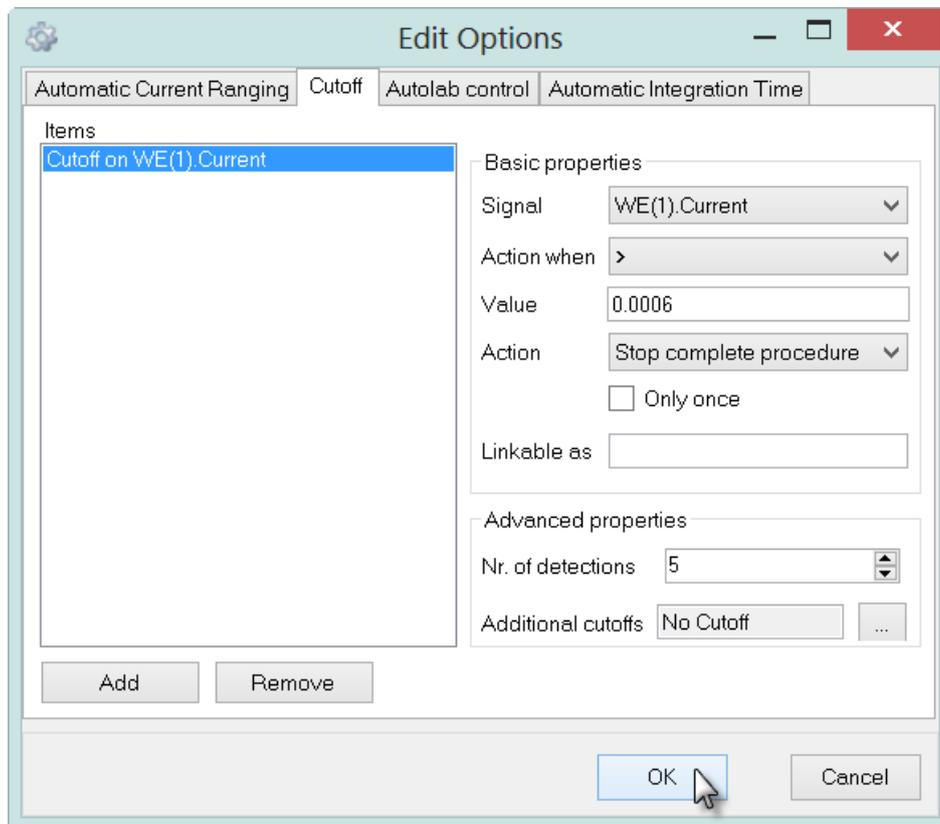


Figure 8 – Setting up a cutoff condition on WE(1).Current

Clicking the  button validates the defined cutoff. A preview window will be displayed, allowing you to define for which measurement commands in the procedure this cutoff should be used (see Figure 9). The Autolab Cyclic voltammetry potentiostatic procedure contains two measurement commands: *Optimize current range* and *CV staircase*.

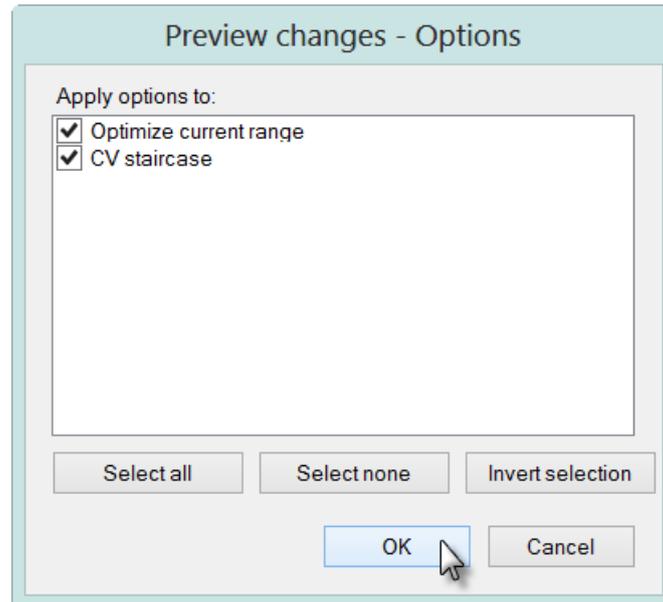


Figure 9 – Using the cutoff condition on the CV staircase command

After defining the cutoff conditions, the procedure editor, shown in Figure 10, will be updated, displaying the number of options used during the CV staircase command, which is now two (automatic current ranging and cutoff).

Commands	Parameters	Links
Cyclic voltammetry potentiostatic		
Remarks	Cyclic voltammetry potentiostatic	...
End status Autolab		...
Signal sampler	Time, WE(1).Potential, WE(1).Current	...
Options	2 Options	...
Instrument		
Instrument description		
Autolab control		
Set potential	0.000	
Set cell	On	...
Wait time (s)	5	
Optimize current range	5	
CV staircase	[0.000, 1.000, -1.000, 0.000, 2, 0.1000000]	--
Set cell	Off	...

Options :

- WE(1)[1 mA..100 nA]
- Cutoff WE(1).Current > 0.0006

Figure 10 – The updated procedure editor



### Note

A tooltip displays the information about the cutoff option and the automatic current ranging option defined in the procedure (see Figure 10).

## 1.2 – Performing the measurement on the dummy cell<sup>3</sup>

If the modified Cyclic voltammetry potentiostatic is performed on the Autolab dummy cell (c), the cutoff condition will be triggered during the measurement and the measurement will stop (see Figure 11).

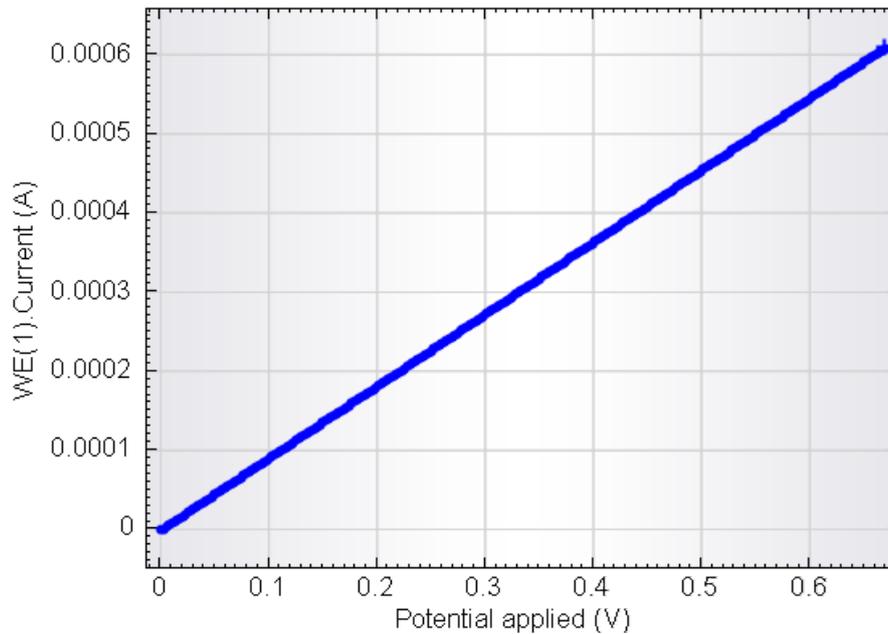


Figure 11 – The cyclic voltammogram recorded on dummy cell (c)

Close inspection of the measured data points shows that the number of data points exceeding 0.6 mA is five, as defined in the cutoff conditions (see Figure 12).

<sup>3</sup> The PGSTAT101 is not equipped with the Autolab dummy cell. An optional external dummy cell can be obtained. Contact your Autolab distributor for more information.

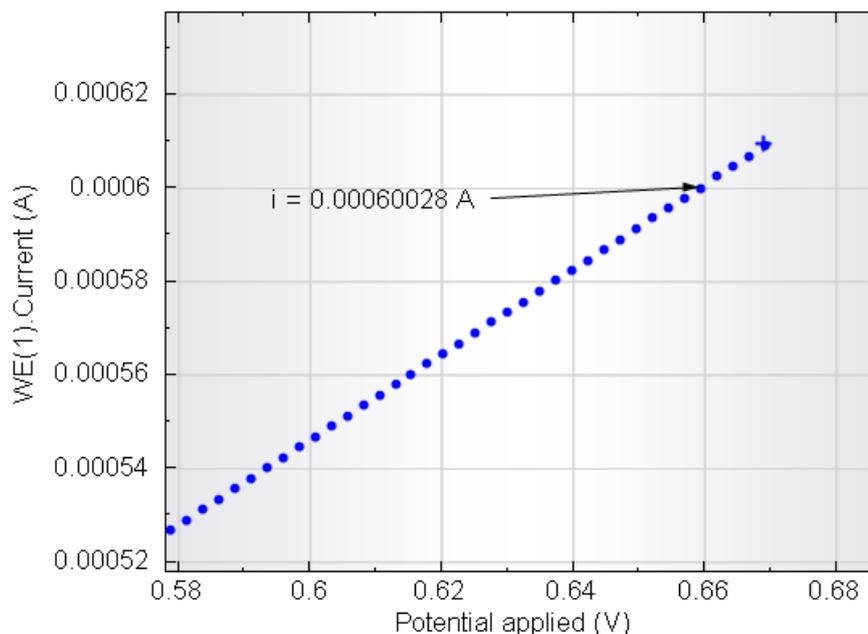


Figure 12 – Detailed view of the cyclic voltammogram recorded on dummy cell (c)



### Note

The user log displays a message when the cutoff condition is met during a measurement (see Figure 13).

User log message	Time	Date	Command
Autolab/USB connected ( $\mu$ 3AUT70530)	9:18:16 AM	11/11/2010	-
Cutoff on WE(1).Current occurred	9:22:22 AM	11/11/2010	CV staircase

Figure 13 – The log displays a 'Cutoff occurred in CV staircase' message

## 2 – Combining two cutoffs with an OR operator

It is possible to add more than one cutoff condition to the options. To do this, open the Edit Options window again and press the **Add** button to add a second cutoff condition. For this example, set the additional cutoff in order to stop the complete procedure when the value of the WE(1).Potential electrochemical signal exceeds 0.4 V ten times (see Figure 14).

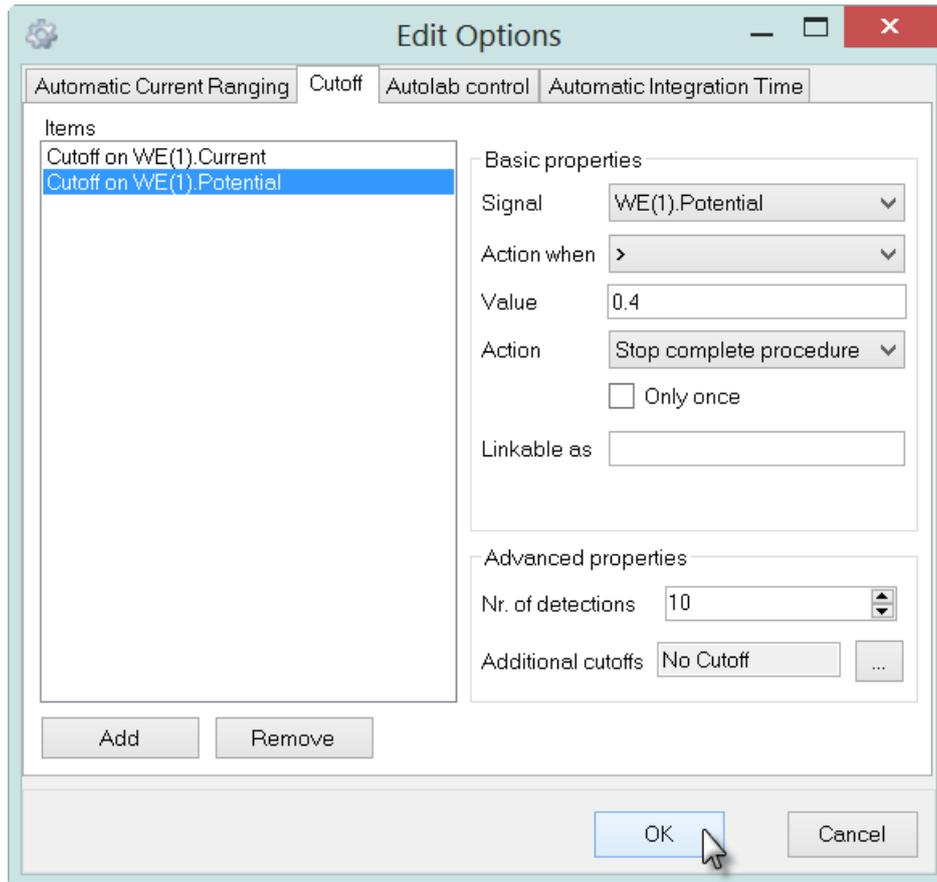


Figure 14 – Setting up an additional cutoff condition on WE(1).Potential

Press the **OK** button and choose the CV staircase command from the preview menu in order to update the options. The procedure setup will be updated, showing that the number of options used in the CV staircase command is three (see Figure 15).

Commands	Parameters	Links
Cyclic voltammetry potentiostatic		
Remarks	Cyclic voltammetry potentiostatic	...
End status Autolab		...
Signal sampler	Time, WE(1).Potential, WE(1).Current	...
Options	3 Options	...
Instrument		
Instrument description		
⊕ Autolab control		
⊕ Set potential	0.000	
⊕ Set cell	On	
⊕ Wait time (s)	5	
Optimize current range	5	
⊕ CV staircase	[0.000, 1.000, -1.000, 0.000, 2, 0.1000000]	--
⊕ Set cell	Off	...
<..>		

Options :

- WE(1)[1 mA..100 nA]
- Cutoff WE(1).Current > 0.0006
- Cutoff WE(1).Potential > 0.4

Figure 15 – The updated procedure editor

**Note**

A tooltip displays information on the two cutoffs and the automatic current ranging in the procedure editor (see Figure 15).

Depending on the experimental conditions either one of the two cutoff will be triggered first. This means that the cutoff conditions are set up in an **OR** combination.

**2.1 – Performing the measurement on the dummy cell<sup>4</sup>**

If the modified Cyclic voltammetry potentiostatic is performed again on the Autolab dummy cell (c), the cutoff condition will be triggered by the condition on the WE(1).Potential and the measurement will stop (see Figure 16).

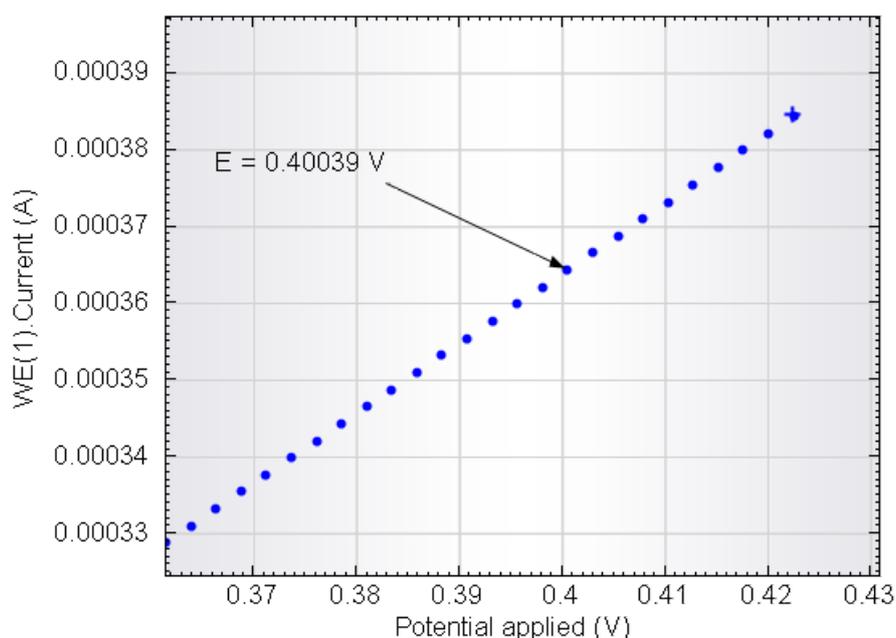


Figure 16 – Detailed view of the cyclic voltammogram recorded on dummy cell (c)

The experimental data shows that the first cutoff condition that was triggered during the measurement is the second one, on WE(1).Potential. Ten data points were recorded after the potential exceeded 0.4 V, as required.

<sup>4</sup> The PGSTAT101 is not equipped with the Autolab dummy cell. An optional external dummy cell can be obtained. Contact your Autolab distributor for more information.

### 3 – Combining two cutoffs with an AND operator

It is possible to add more than one cutoff condition to the options, in such a way that **both** cutoff conditions must be met before the cutoff is triggered. Starting from the first cutoff example, click the  button located on the additional cutoffs line (see Figure 17).

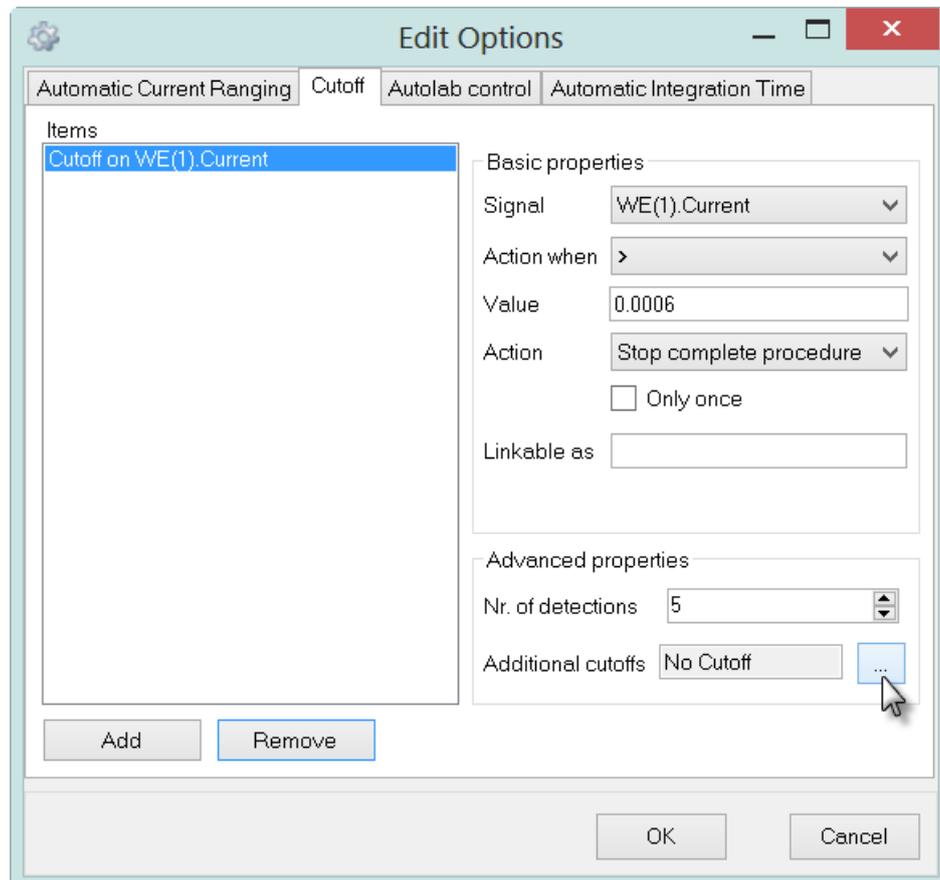


Figure 17 – Adding another cutoff to the initial cutoff (1/4)

Clicking the additional cutoffs button opens a new window. Press the Add button in the new window and set the additional cutoff conditions in order to stop the complete procedure when the WE(1).Potential signal exceeds 0.7 V ten times (see Figure 18).

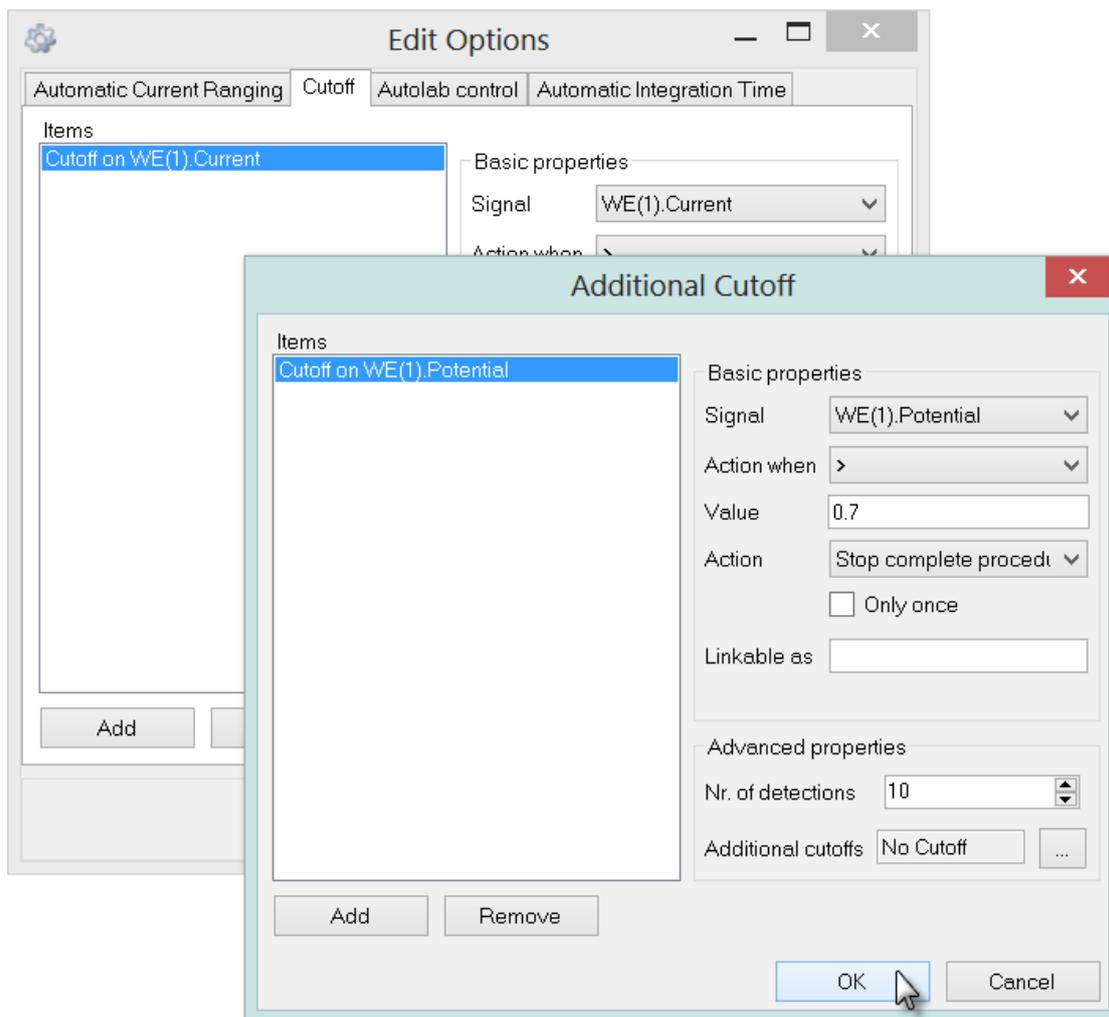


Figure 18 – Adding another cutoff on the initial cutoff (2/4)

Click the  button to close the window. The Edit Options window will be updated (see Figure 19).

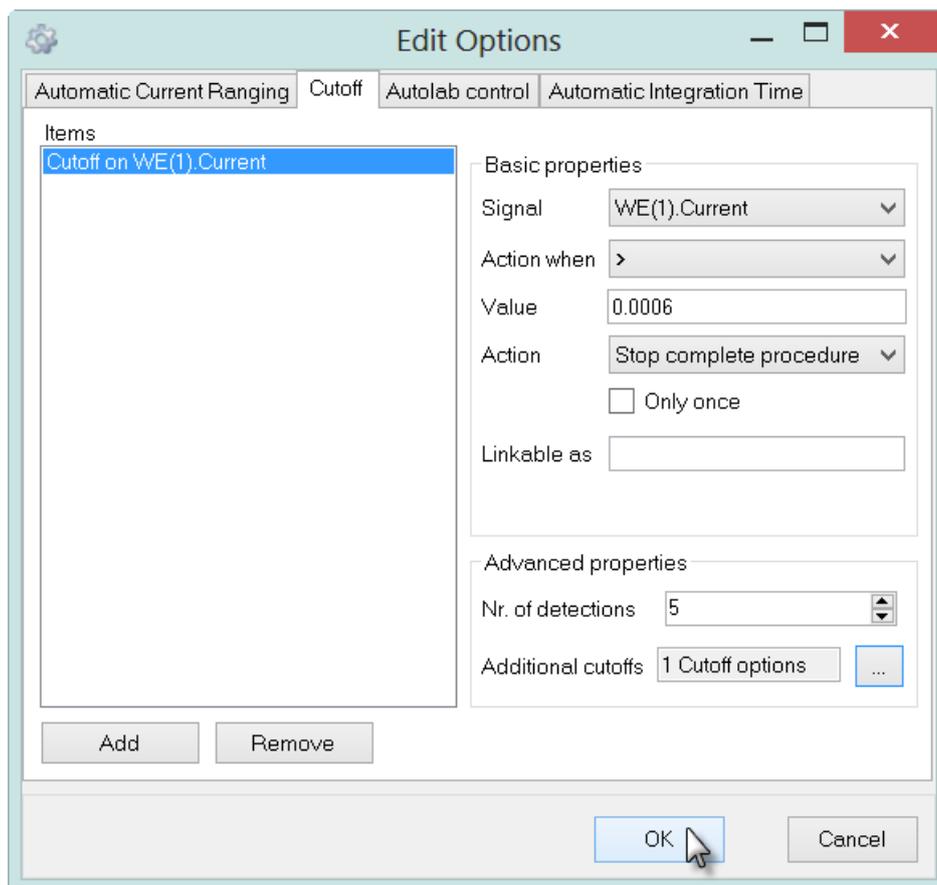


Figure 19 – Adding another cutoff to the initial cutoff (3/4)

Set the Action to Nothing for the first Cutoff condition (see Figure 20).

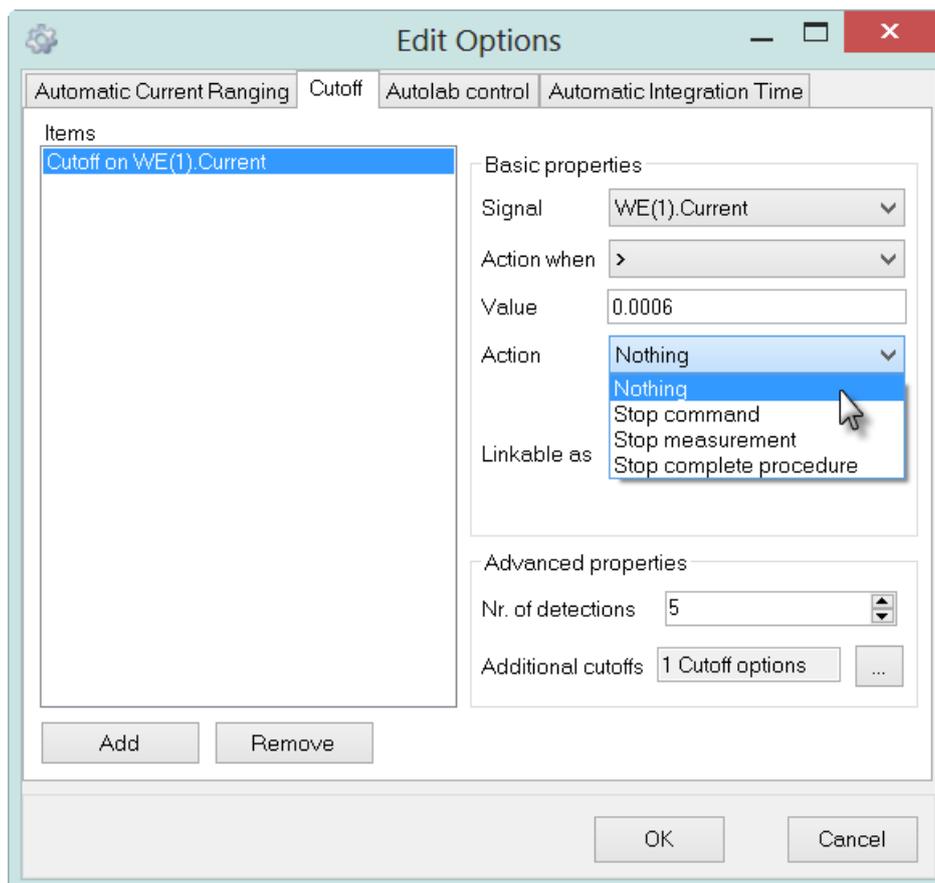


Figure 20 – Adding another cutoff to the initial cutoff (4/4)

Using this cutoff combination will monitor the two conditions at the same time. However, when the condition on the WE(1).Current signal is met, nothing will happen until the second condition, on the WE(1).Potential signal is met.

### 3.1 – Performing the measurement on the dummy cell<sup>5</sup>

If the modified Cyclic voltammetry potentiostatic is performed again on the Autolab dummy cell (c), the first cutoff condition will be triggered when the WE(1).Current exceeds 0.6 mA. However, this cutoff condition does not stop the measurement (Action → Nothing) until the second cutoff condition is triggered when the WE(1).Potential exceeds 0.7 V (see Figure 21).

<sup>5</sup> The PGSTAT101 is not equipped with the Autolab dummy cell. An optional external dummy cell can be obtained. Contact your Autolab distributor for more information.

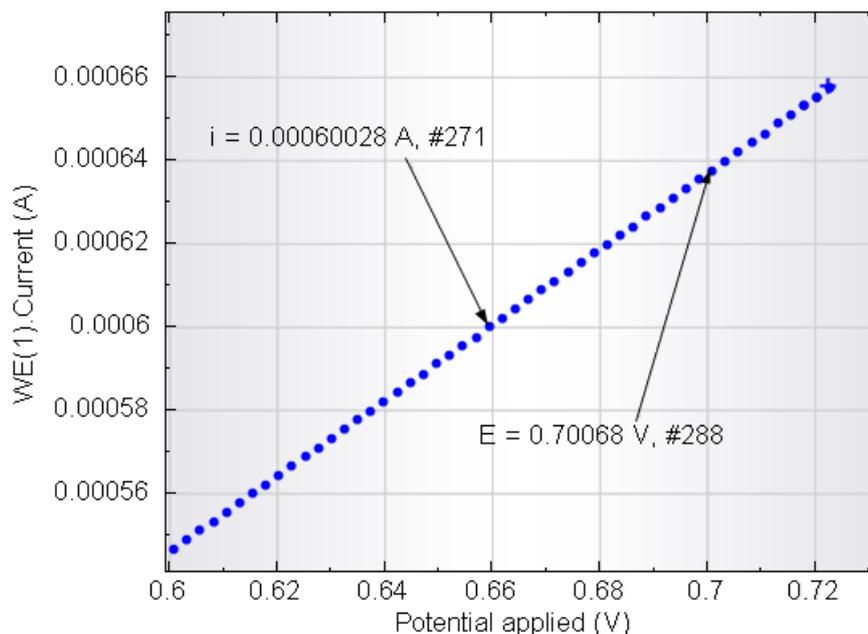


Figure 21 – Combining two cutoff condition with a AND operator

The first cutoff is triggered at a current value of 600.28  $\mu\text{A}$  (data point #217) but the measurement continues. At a potential value of 0.70068 V (data point #288), the second cutoff condition is triggered and ten detections are required to stop the measurement.

This means that the cutoff conditions are set up in an **AND** combination.

#### 4 – Reverse scan direction (LSV and CV staircase only)

Like all the Options, it is possible to specify a global cutoff condition or a specific cutoff condition in the procedure editor. In this tutorial, only the global cutoff condition has been used so far. This condition is specified for the whole procedure, by modifying the Options in the header of the procedure editor (see Figure 22).

## NOVA Cutoff tutorial

Commands	Parameters	Links
Cyclic voltammetry potentiostatic		
Remarks	Cyclic voltammetry potentiostatic	...
End status Autolab		...
Signal sampler	Time, WE(1).Potential, WE(1).Current	...
Options	1 Options	...
Instrument		
Instrument description		
⊕ Autolab control		...
⊕ Set potential	0.000	
⊕ Set cell	On	...
⊕ Wait time (s)	5	
Optimize current range	5	
⊕ CV staircase	[0.000, 1.000, -1.000, 0.000, 2, 0.1000000]	-
⊕ Set cell	Off	...

Figure 22 – Global options are specified at the top most level of the procedure editor

It is possible to specify local options directly, for a single measurement command in the procedure editor, by expanding this command and clicking the  button in the procedure editor in order to edit its options directly (see Figure 23).

Commands	Parameters	Links	
Cyclic voltammetry potentiostatic			
Remarks	Cyclic voltammetry potentiostatic	...	
End status Autolab		...	
Signal sampler	Time, WE(1).Potential, WE(1).Current	...	
Options	1 Options	...	
Instrument			
Instrument description			
⊕ Autolab control		...	
⊕ Set potential	0.000	}	
⊕ Set cell	On		
⊕ Wait time (s)	5		
Optimize current range	5		
⊖ CV staircase	[0.000, 1.000, -1.000, 0.000, 2, 0.1000000]		
Start potential (V)	0.000	}	
Upper vertex potential (V)	1.000		
Lower vertex potential (V)	-1.000		
Stop potential (V)	0.000		
Number of stop crossings	2		
Step potential (V)	0.00244	}	
Scan rate (V/s)	0.1000000		
Estimated number of points	1650		
Interval time (s)	0.024400		
Signal sampler	Time, WE(1).Potential, WE(1).Current		
Options	1 Options		...
Potential applied	<..array..> (V)		}
Time	<..array..> (s)		
WE(1).Current	<..array..> (A)		
Scan	<..array..>		
WE(1).Potential	<..array..> (V)		
Index	<..array..>	}	
⊕ i vs E			...
⊕ Set cell	Off	...	
<..>			

Figure 23 – Editing the local options for the CV staircase command



**Note**

It is also possible to edit the Options by clicking the  button in the quick access toolbar (see Figure 24).

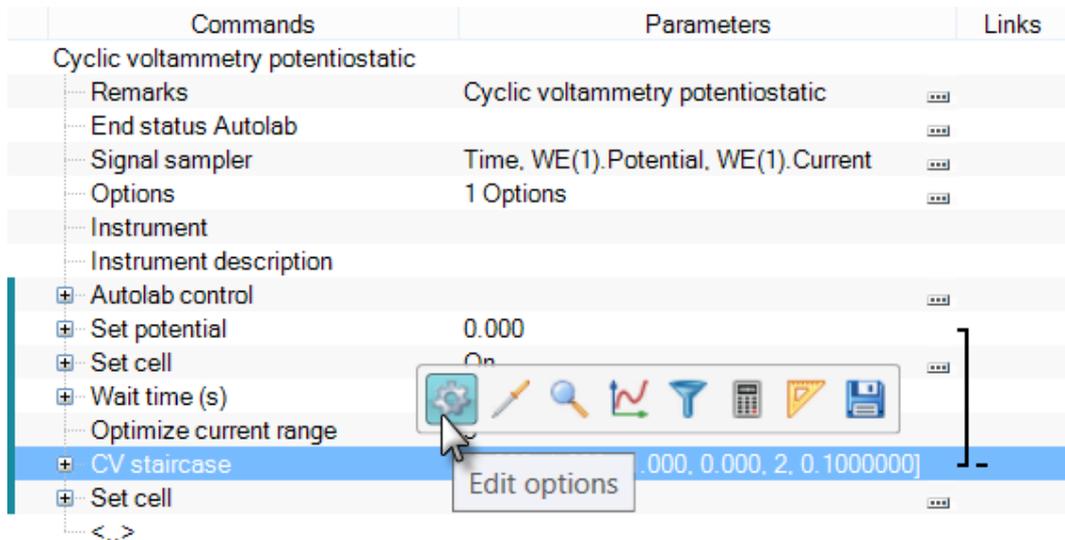


Figure 24 – Clicking the  button in the quick access toolbar opens the Edit Options window

When local options are edited directly, depending on the command, custom actions can be selected in the Action drop-down list. For the *CV staircase* and the *LSV staircase* commands, the **Reverse scan direction** custom action is available (see Figure 25).

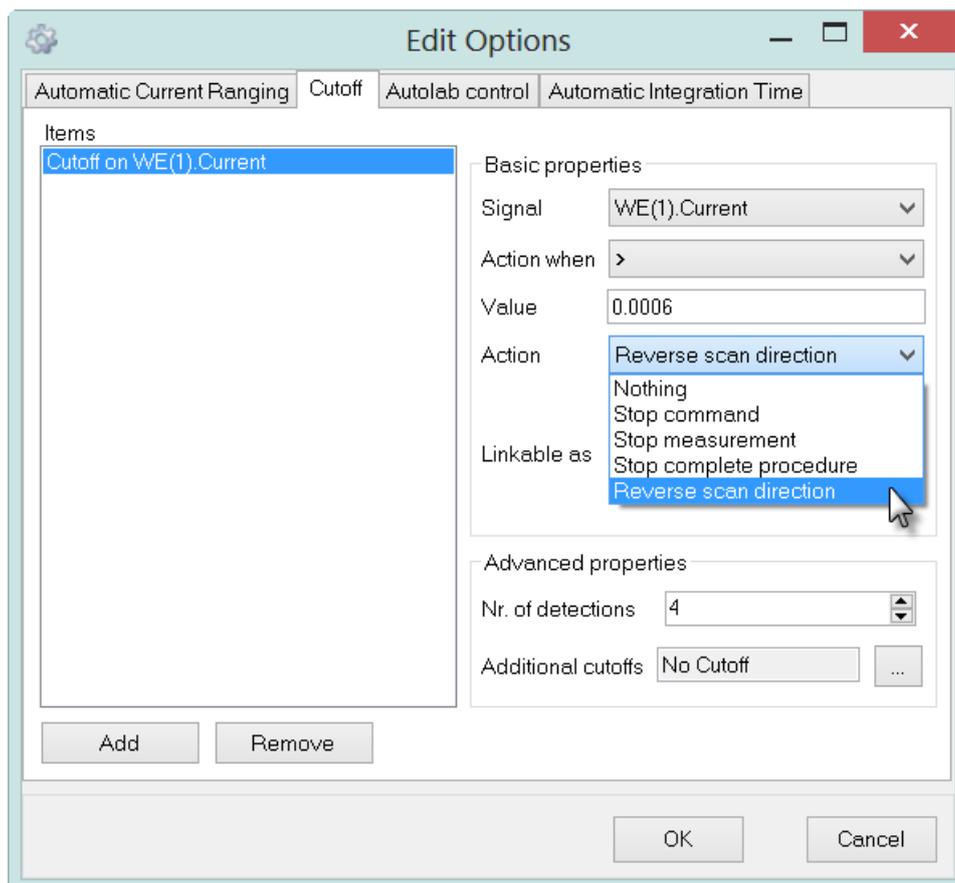


Figure 25 – The custom action Reverse scan direction can be selected in the local options for the *CV staircase* and *LSV staircase* commands

The Reverse scan direction custom action can be used to automatically reverse the scan direction whenever the cutoff condition is met.



### Warning

When the reverse scan direction action is used on a *LSV staircase* command, the scan is reversed back to the start potential or current. Once this point is reached the *LSV staircase* will start the scan again towards the stop potential or current. If the cutoff condition is met again in the new scan, the direction will be reversed once more. The *LSV staircase* will only stop completely when the stop potential or current is reached.



### Note

Custom actions can only be defined as local options. These actions are not listed in the drop-down list provided in the global options dialog.

Using the settings specified in Figure 25 will force the scan direction to be reversed each time the cutoff condition is met. To force the scan reversal to be executed only once, it is possible to check the *Only once* checkbox provided in the cutoff editor (see Figure 26).

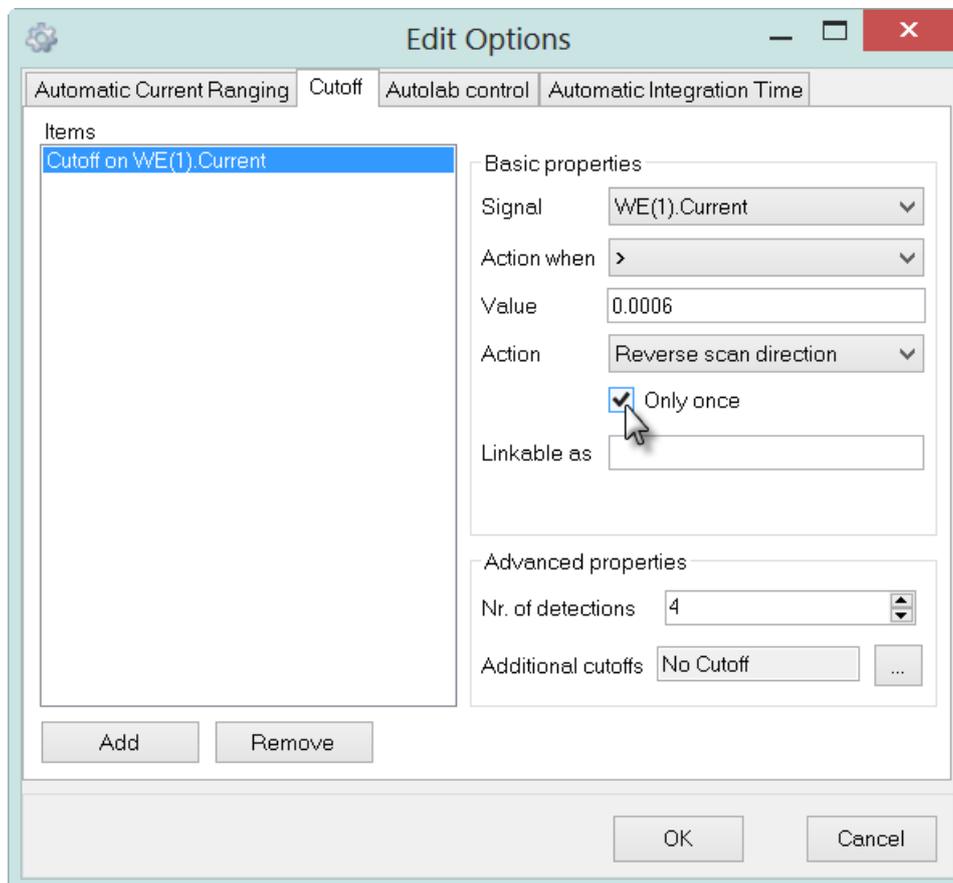


Figure 26 – Checking the *Only once* checkbox forces the cutoff action to be executed only once

### 4.1 – Performing the measurement on the dummy cell<sup>6</sup>

If the Cyclic voltammetry potentiostatic procedure is performed on the Autolab dummy cell (c), using the local options as defined in Figure 25, the scan direction will be reversed when the WE(1).Current exceeds 0.6 mA. The cutoff condition is triggered after 5 consecutive detections. This will result in the  $i$  vs  $t$  plot shown in Figure 27.

<sup>6</sup> The PGSTAT101 is not equipped with the Autolab dummy cell. An optional external dummy cell can be obtained. Contact your Autolab distributor for more information.

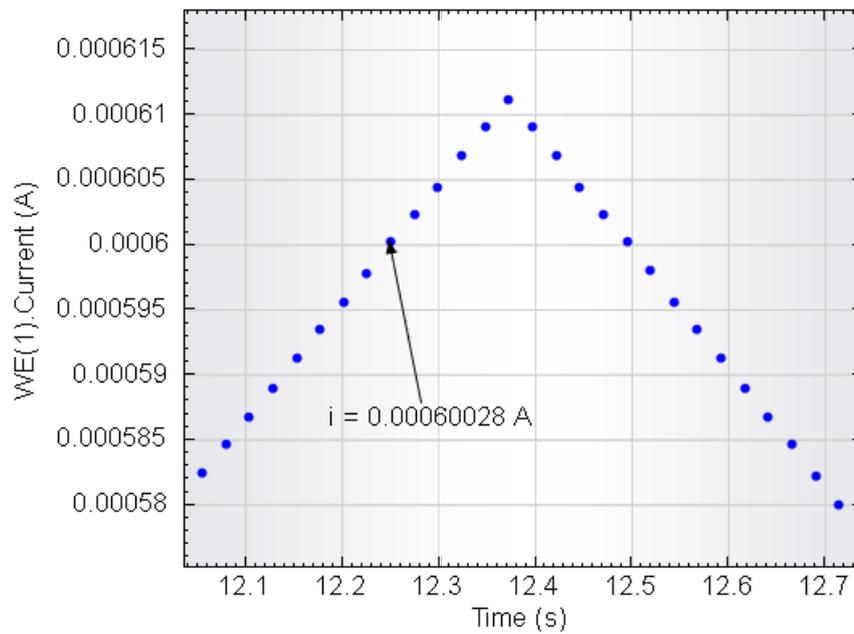


Figure 27 – The scan direction is reversed when the cutoff on current is triggered



#### Note

The reversal of the scan direction requires one additional data point to be measured. In the example provided in Figure 27, the number of detections is set to 5, but the scan direction is effectively reversed after 6 data points.

## 5 – Linking parameters to cutoff conditions

The *Linkable as* field located in the Basic parameters of the edit cutoff interface can be used to provide a unique identifying name to identify the cutoff value in the procedure editor. This allows the cutoff value to be linked to other parameters in the procedure editor (see Figure 28).

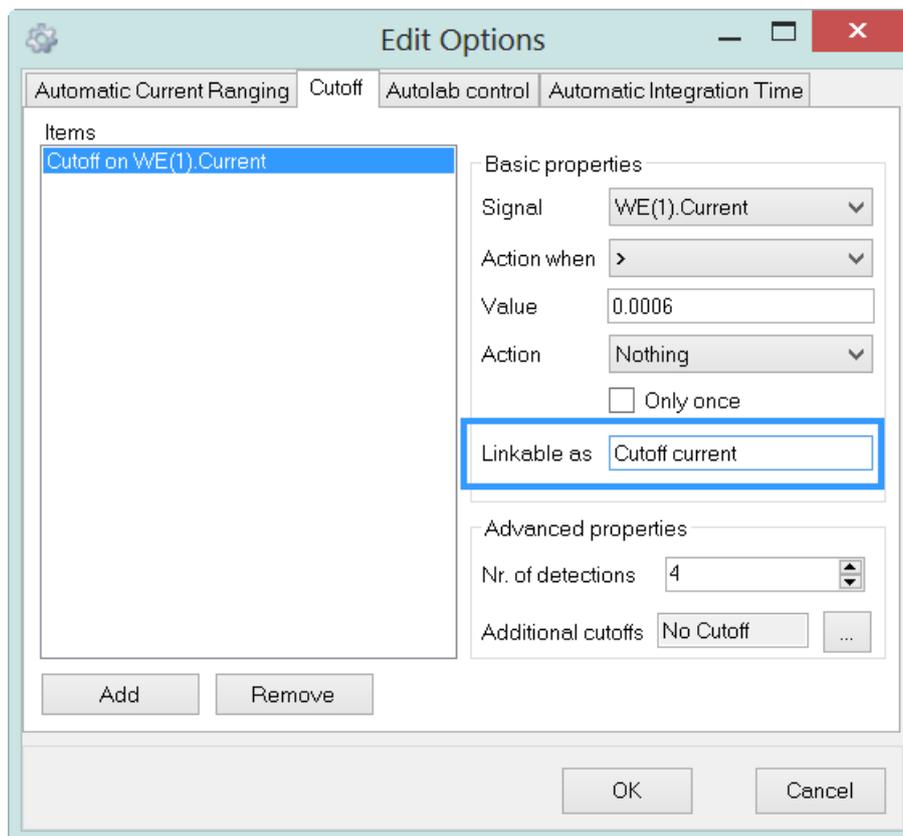


Figure 28 – The *Linkable as* field can be used to add the cutoff value to the procedure editor

The name specified in the editor will be displayed in the procedure editor when the editor is closed (see Figure 29).

Commands	Parameters	Links
Cyclic voltammetry potentiostatic		
Remarks	Cyclic voltammetry potentiostatic	...
End status Autolab		...
Signal sampler	Time, WE(1).Potential, WE(1).Current	...
Options	1 Options	...
Instrument		
Instrument description		
⊕ Autolab control		...
⊕ Set potential	0.000	}
⊕ Set cell	On	
⊕ Wait time (s)	5	
Optimize current range	5	
⊖ CV staircase	[0.000, 1.000, -1.000, 0.000, 2, 0.1000000]	
Start potential (V)	0.000	}
Upper vertex potential (V)	1.000	
Lower vertex potential (V)	-1.000	
Stop potential (V)	0.000	
Number of stop crossings	2	
Step potential (V)	0.00244	}
Scan rate (V/s)	0.1000000	
Estimated number of points	1650	
Interval time (s)	0.024400	
Signal sampler	Time, WE(1).Potential, WE(1).Current	
⊖ Options	2 Options	
Cutoff current	0.0006	
Potential applied	<..array..> (V)	
Time	<..array..> (s)	
WE(1).Current	<..array..> (A)	
Scan	<..array..>	
WE(1).Potential	<..array..> (V)	
Index	<..array..>	
⊕ i vs E		...
⊕ Set cell	Off	...
<.>		

Figure 29 – The name specified in the *Linkable as* field is displayed in the procedure editor

Once it is displayed in the procedure editor, it can be linked to other parameters, like an *Input box* command, as shown in Figure 30.

## NOVA Cutoff tutorial

Commands	Parameters	Links	
Cyclic voltammetry potentiostatic			
Remarks	Cyclic voltammetry potentiostatic	...	
End status Autolab		...	
Signal sampler	Time, WE(1).Potential, WE(1).Current	...	
Options	1 Options	...	
Instrument		]	
Instrument description			
[-] Input box		]	
Title of box			
Message	Message		
Value	0.0007	]	
Time limit (s)	30		
Use time limit	No		...
[-] Autolab control			...
[-] Set potential	0.000	]	
[-] Set cell	On		...
[-] Wait time (s)	5		
Optimize current range	5		
[-] CV staircase	[0.000, 1.000, -1.000, 0.000, 2, 0.1000000]	]	
Start potential (V)	0.000		
Upper vertex potential (V)	1.000		
Lower vertex potential (V)	-1.000		
Stop potential (V)	0.000		
Number of stop crossings	2		
Step potential (V)	0.00244		
Scan rate (V/s)	0.1000000		
Estimated number of points	1650		
Interval time (s)	0.024400		
Signal sampler	Time, WE(1).Potential, WE(1).Current		...
[-] Options	2 Options		...
Cutoff current	0.0007	]	
Potential applied	<..array..> (V)		
Time	<..array..> (s)		
WE(1).Current	<..array..> (A)		
Scan	<..array..>		
WE(1).Potential	<..array..> (V)	]	
Index	<..array..>		
[-] i vs E		...	
[-] Set cell	Off	...	
<.>			

Figure 30 – Linking the cutoff value to an *Input box* command

Using this option, it is possible to define the cutoff value during the measurement, based on measured values, specified or calculated values.

## 6 – Fast options (Record signals (> 1 ms) only)

The *Record signals (> 1 ms)* command offers the possibility to define two different interval times:

- The **interval time**, which corresponds to the time between two consecutive data points. This value must be  $\geq 1.33$  ms.
- The **fast interval time**, which correspond to an interval time that can be used to run the Options specified in the procedure. This fast interval time must be  $\geq 1.33$  ms **and** must be an integral fraction of the interval time.

Each *Record signals (> 1 ms)* command offers the possibility to use the fast options, through the *Use fast options* toggle (see Figure 31). When the fast options are not used, the fast interval time parameter is not shown in the procedure editor.

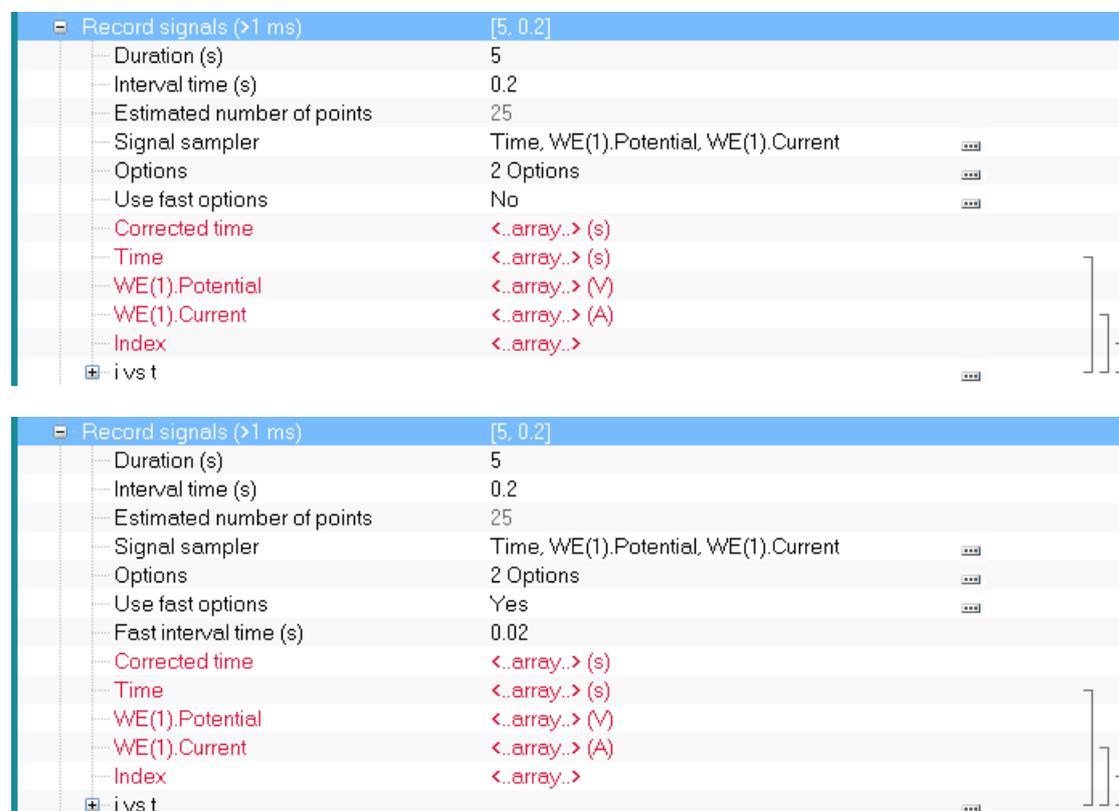


Figure 31 – The *Use fast options* toggles the fast interval time off (top) or on (bottom)

Using the fast interval time does not increase the number of data points recorded. This only changes the behavior of the Options (Automatic current ranging, Cutoffs, etc...).

- If the fast options are not used, the Options specified in the command will be executed at the end of each interval time.
- If the fast options are used, the Options specified in the command will be executed at the end of each fast interval time.

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## NOVA Cutoff tutorial

The fast options therefore allows a complete decoupling of the sampling of the data and the execution of the options. This is particularly useful for experiments during which data points need to be recorded for a long time, with a large interval time while the properties of the cell need to be controlled with a short interval time.



### Note

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When the fast options are used in combination with one or more cutoff options, the number of consecutive detections specified for each cutoff no longer relates to the interval time. The fast interval time is used instead. This means that the number of consecutive detections will no longer match the number of data points recorded after the cutoff condition is met.



### Note

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More information on the Record signals (> 1 ms) and the fast options framework provided by this command is available in the Chrono methods tutorial, available from the Help menu in NOVA.

## 7 – Tutorial procedures on the Autolab dummy cell<sup>7</sup>

A Cutoff tutorial folder is located in the **Program Files\Metrohm Autolab\Nova 1.11\Shared DataBases\Tutorials** folder (see Figure 32). Using the database manager, set this folder as the Standard database.

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<sup>7</sup> The PGSTAT101 is not equipped with the Autolab dummy cell. An optional external dummy cell can be obtained. Contact your Autolab distributor for more information.

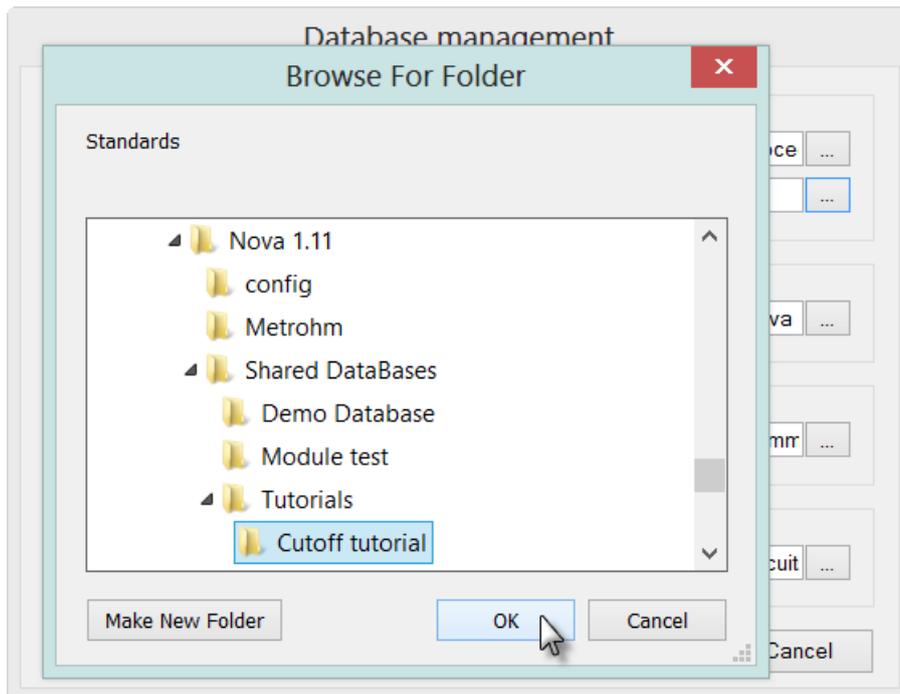


Figure 32 – Loading the Cutoff tutorial database

Seven procedures are included in this tutorial procedure. All the procedures are intended to be used with the Autolab dummy cell. The first four procedures correspond to the four examples discussed in the first part of this tutorial. The final three procedures illustrate the use of the different Action options that can be used when a cutoff condition is met (see Figure 33).

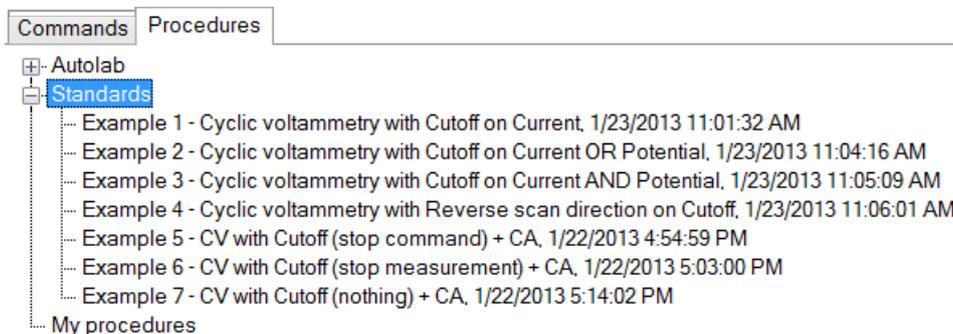


Figure 33 – The seven cutoff tutorial procedures

This section will provide some description regarding the last three cutoff procedures. These procedures are identical and are designed to perform a CV staircase measurement followed by a chrono amperometry measurement (using the *Record signals (>1 ms)* command). Finally, at the end of the measurement, a Message box is displayed (see Figure 34).

## NOVA Cutoff tutorial

Commands	Parameters	Links
Example 5 - CV with Cutoff (stop command) + CA		
Remarks	Cutoff tutorial	...
End status Autolab		...
Signal sampler	Time, WE(1).Potential, WE(1).Current	...
Options	2 Options	...
Instrument	AUT40034	
Instrument description		
Message box		
Autolab control		...
Set potential	0.000	
Set cell	On	...
Wait time (s)	5	
Optimize current range	5	
CV staircase	[0.000, 1.000, -1.000, 0.000, 2, 0.1000000]	-
Record signals (>1 ms)	[10, 0.1]	-
Message box		
Set cell	Off	...
<..>		

Figure 34 – Overview of the procedure used in the last three examples

A cutoff condition is defined on the WE(1).Current signal and this condition is triggered when this value exceeds 0.6 mA five consecutive times. These procedures illustrate the different Action options that can be used for this cutoff (see Figure 35).

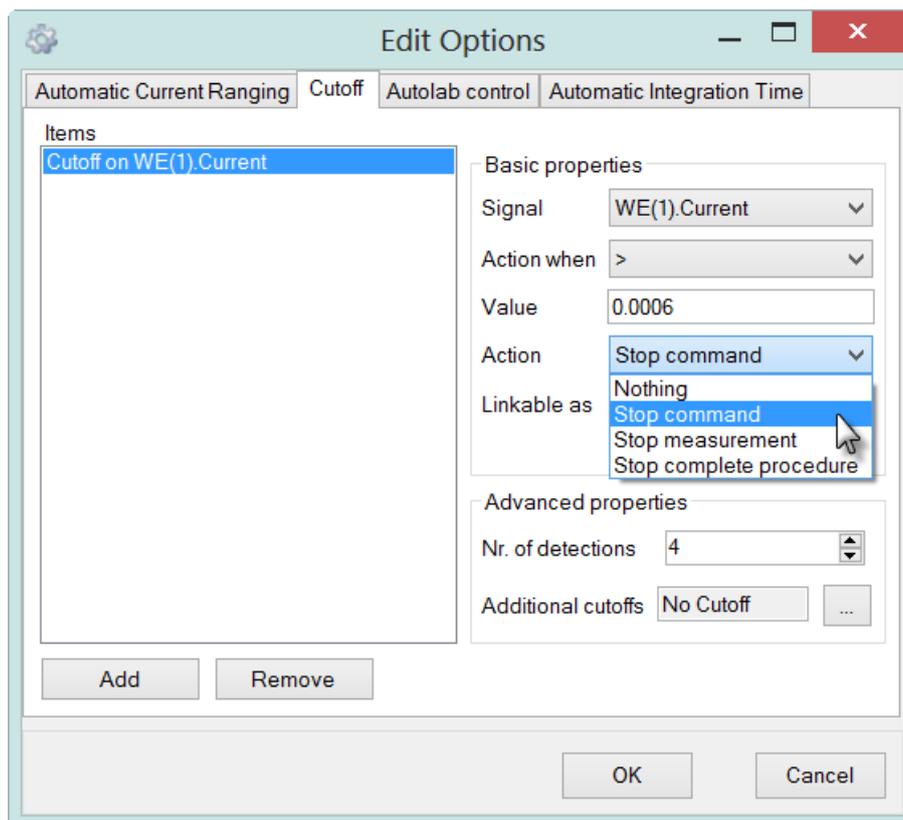


Figure 35 – The different action settings for the cutoff used in the tutorial procedures



### Note

The Stop complete procedure action is used in the first tutorial procedure.

## 7.1 – Example 5 – CV with Cutoff (stop command) + Chrono amperometry

Select the *Example 5 – CV with Cutoff (stop command) + CA* procedure from the Standards group. Connect WE(1) to the dummy cell (c) and start the measurement.

A message box will be displayed at the beginning of the measurement, as a reminder (see Figure 36).

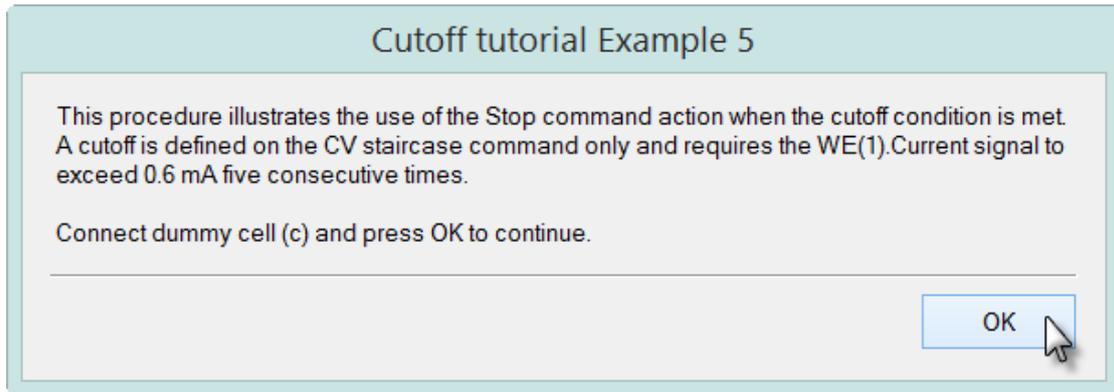


Figure 36 – The message box shown at the beginning of Example 5

Two plots are generated during this experiment. Plot #1 shows the data recorded during the cyclic voltammetry measurement and plot #2 shows the data provided by the Record signals command.

 **Note**

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Switch the measurement view to *Two plots vertically tiled* mode by pressing the  button in the toolbar.

Click the  button to continue. First the CV staircase command will be executed until the cutoff condition is met. Immediately after this event, the Record signals command will start, recording the current during 10 seconds. At the end of the measurement, a message box is displayed (see Figure 37).

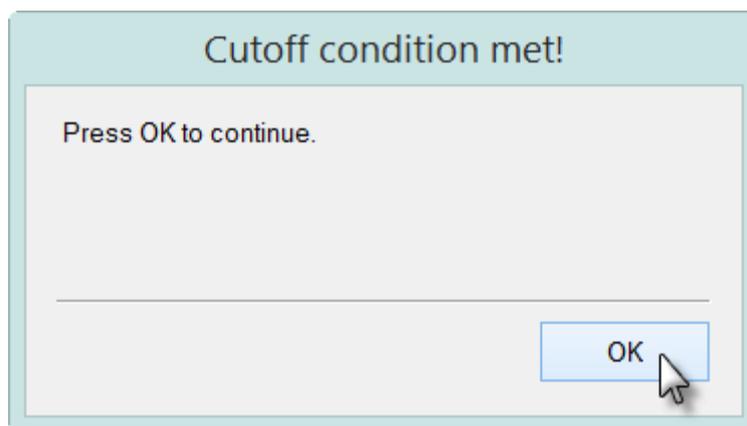
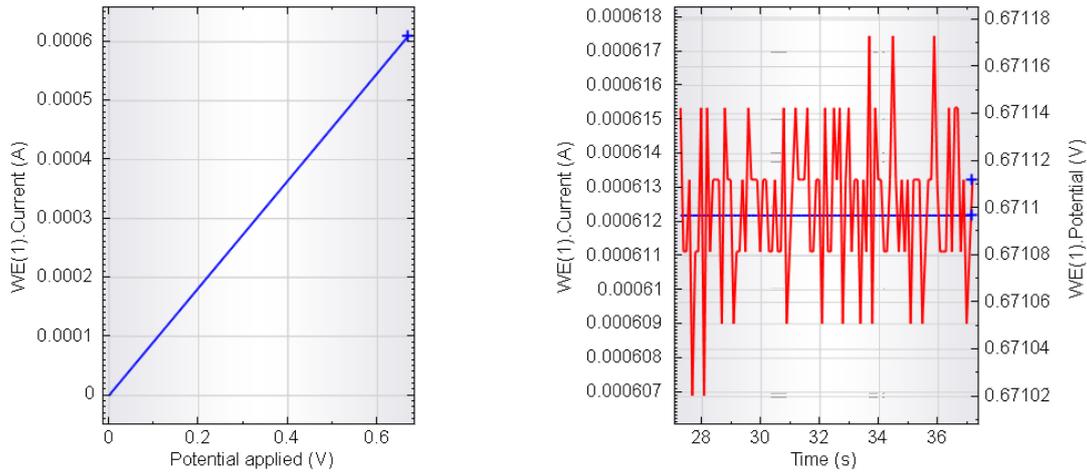


Figure 37 – Cutoff condition met message

Figure 38 shows the expected data displayed in the measurement view at the end of the measurement.



**Figure 38 – The experimental data recorded during Example 5 (plot #1, left – cyclic voltammetry data, plot #2, right – Record signals data: blue curve corresponds to WE(1).Potential, the red curve corresponds to WE(1).Current)**

The CV staircase command was interrupted after the cutoff condition was met. However, since the cutoff action was set to Stop command, only the CV staircase command was stopped. The next command, Record signals, continues immediately after the interruption. Finally, at the end of the measurement, the message box is displayed.

**7.2 – Example 6 – CV with Cutoff (stop measurement) + Chrono amperometry**

Select the *Example 6 – CV with Cutoff (stop measurement) + CA* procedure from the Standards group (see Figure 39). The procedure contains two measurement guides interrupted by a Message box command.

Commands	Parameters	Links
<b>Example 6 - CV with Cutoff (stop Measurement) + CA</b>		
Remarks	Cutoff tutorial	...
End status Autolab		...
Signal sampler	Time, WE(1).Potential, WE(1).Current	...
Options	2 Options	...
Instrument	AUT40034	
Instrument description		
Message box		
Autolab control		...
Set potential	0.000	
Set cell	On	...
Wait time (s)	5	
Optimize current range	5	
CV staircase	[0.000, 1.000, -1.000, 0.000, 2, 0.1000000]	-
Record signals (>1 ms)	[10, 0.1]	-
Message box		
Set cell	Off	...
< . >		

**Figure 39 – The procedure used in Example 6**

Connect WE(1) to the dummy cell (c) and start the measurement. Again, a message box will be displayed at the beginning of the experiment. The measurement will

start with the CV staircase command until the cutoff condition is met. The whole measurement sequence indicated by the first timing guide will be stopped and therefore, the *Record signals* command will be skipped. The final message box is displayed at the end of the measurement and then the next measurement sequence is executed. Only one command is present in this second sequence (*Set cell Off*).

Figure 40 shows the expected plot in the measurement view.

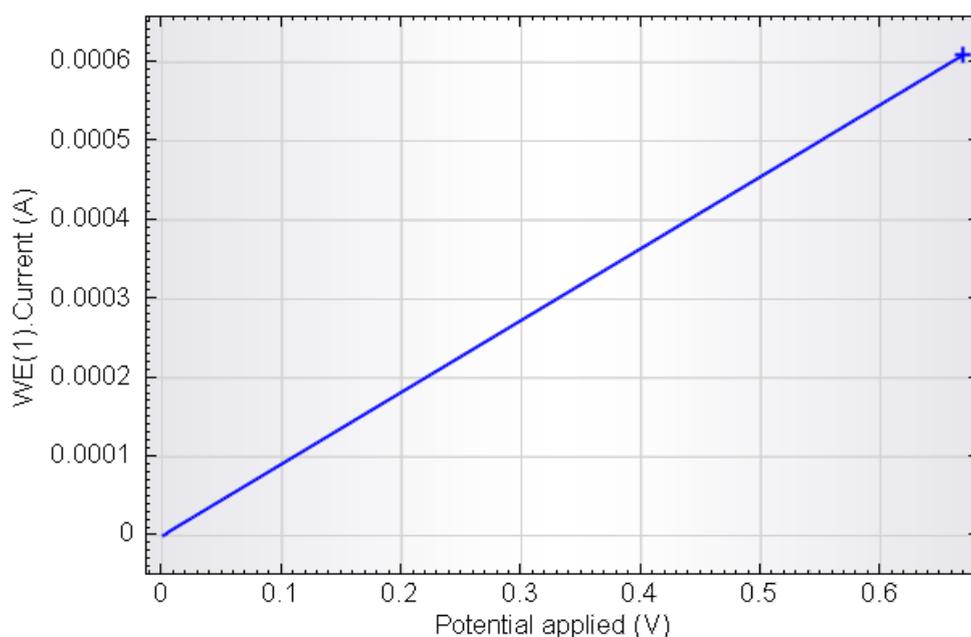


Figure 40 – The WE(1).Current (blue curve) recorded during Example 6, plotted against the applied potential

### 7.3 – Example 7 – CV with Cutoff (Nothing) + Chrono amperometry

Select the *Example 7 – CV with Cutoff (Nothing) + CA* procedure from the Standards group. Connect WE(1) to the dummy cell (c) and start the measurement.

Two plots are generated during this experiment. Plot #1 shows the data recorded during the cyclic voltammetry measurement and plot #2 shows the data provided by the Record signals command.



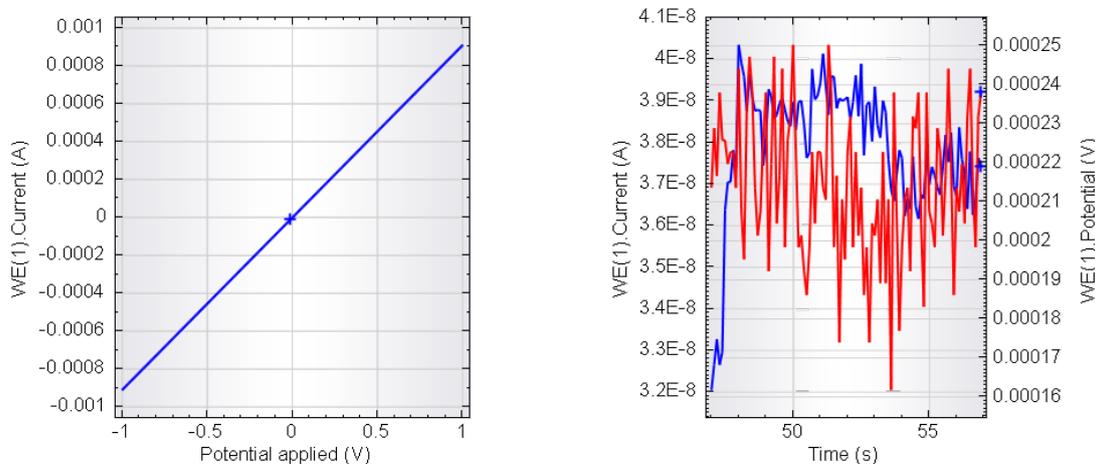
#### Note

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Switch the measurement view to *Two plots vertically tiled* mode by pressing the  button in the toolbar.

A message box will be displayed at the beginning of the experiment. The measurement will start with the CV staircase command until the cutoff condition is met. The CV staircase will not be interrupted and, when the scan is finished, the record signal command will be executed and the final message box will be displayed.

Figure 41 shows the expected data displayed in the measurement view at the end of the measurement.



**Figure 41 – The experimental data recorded during Example 7 (plot #1, left – cyclic voltammetry data, plot #2, right – Record signals data: blue curve corresponds to WE(1).Potential, the red curve corresponds to WE(1).Current)**

This procedure does exactly what was defined in the cutoff Action field: nothing. The CV staircase is allowed to continue even though the cutoff condition was met during the measurement. Since the cyclic voltammogram stops at 0 V, the record signals command that follows measures the response of the cell at 0 V.



**Note**

The user log displays that the cutoff did occur in the CV staircase command during the measurement (see Figure 39).

User log message	Time	Date	Command
Autolab/USB connected (μ3AUT70530)	9:18:16 AM	11/11/2010	-
Cutoff on WE(1).Current occurred	9:22:22 AM	11/11/2010	CV staircase

**Figure 42 – The Cutoff occurred message is displayed in the user log even if the cutoff action is set to *nothing***