

Cardiac Action Potentials Analysis with LabScribe

Introduction

The **Cardiac Action Potentials Advanced Analysis Module** calculates physiologically relevant parameters from previously recorded intracellular cardiac action potential data.

This document includes a step by step tutorial for using the features of the *LabScribe* **Cardiac Action Potentials Advanced Analysis Module**. To use the step by step guide, you will need a recording of intracellularly recorded cardiac action potentials from any species.

Cardiac Action Potentials Analysis: Step by Step

Offline Calculations

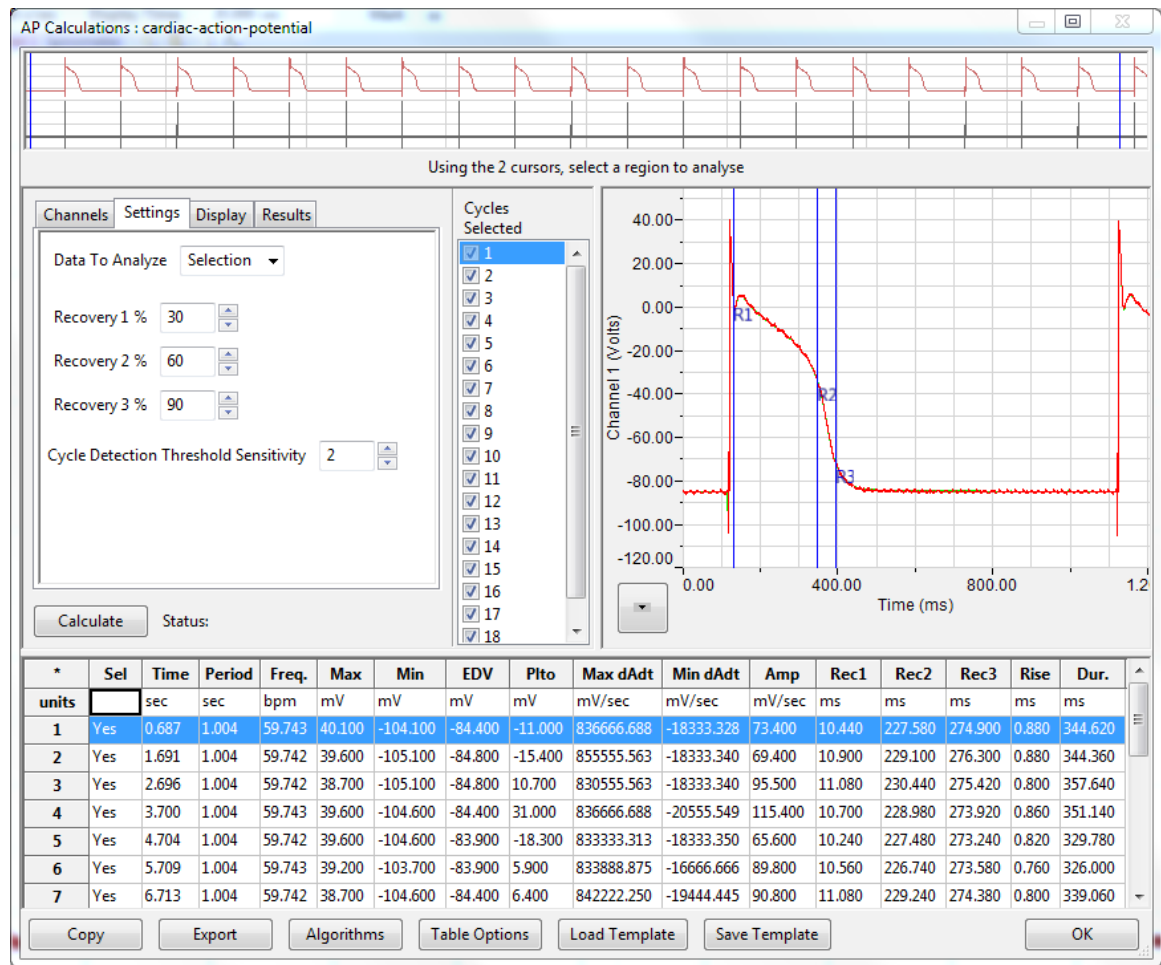
Sophisticated analysis can be done on a previously recorded cardiac action potentials data file using the **Offline Calculations** function of the **Cardiac Action Potentials Advanced Analysis Module**.

This analysis is performed using the offline **Cardiac Action Potentials Calculations** dialog, so you should first become familiar with this dialog.

The Offline Cardiac Action Potentials Calculations Dialog

To display the **Cardiac Action Potentials Calculations** dialog and familiarize yourself with its features:

- 1) If it is not already open, open a cardiac action potential recording.
- 2) Select **Offline Calculations** from the **Action Potentials** submenu of the **Advanced** menu. This will open the offline **Cardiac Action Potentials Calculations** dialog.
- 3) Familiarize yourself with the offline **Cardiac Action Potentials Calculations** dialog, pictured below.
 - Across the top of the dialog, in the channel display area, you will see a sample of the raw data channel to be analyzed, including the selection between the two cursors. By default **Channel 1** is displayed.
 - On the left of the middle row are the tabbed dialogs used to configure the analysis.
 - At the right is the XY graph window in which the **Cardiac Action Potentials Graph** is displayed.
 - Between the configuration dialogs and the graph are the editable lists of the **Cycles** to be analyzed and displayed.
 - Across the lower part of the dialog is the **Data Table** with the calculated average values for each of the analyzed groups of beats.

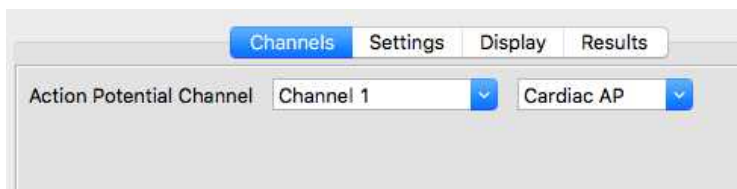


Cardiac Action Potentials Calculations dialog.

To configure the analysis, the tabbed configuration panels at the left side of the middle row of the dialog are used.

To configure **Channels**:

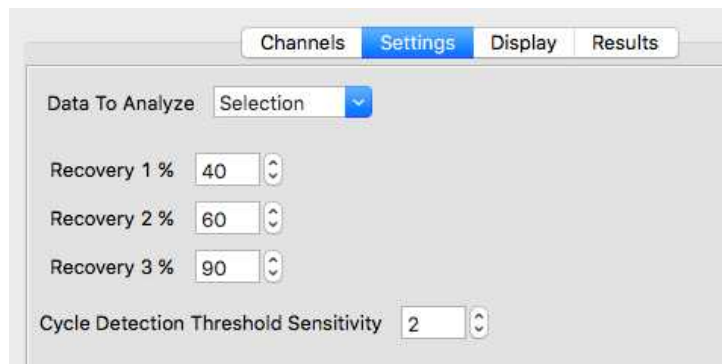
- 1) Click the leftmost tab of the configuration dialogs, the one labeled **Channels**.
- 2) From the **Action Potential Channel** menu, choose the desired channel. This is the channel on which the analysis will be performed.



Cardiac Action Potentials Channels configuration dialog.

To configure the **Settings**:

- 1) Click the **Settings** tab, which is the second tab from the left in the configuration dialogs. The **Cardiac Action Potentials Settings** configuration dialog will open.



Cardiac Action Potentials Settings configuration dialog.

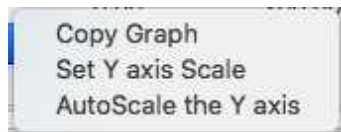
- 2) From the **Data to Analyze** menu, choose whether you want to analyze the entire channel, a block of data, or a selection of data defined by the two cursors.
- 3) From the **Recovery 1%**, **Recovery 2%**, and **Recovery 3%** menus, choose the % recovery you would like indicated on the graph and entered onto the **Data Table** for each of these points.
- 4) From the **Cycle Detection Threshold Sensitivity** menu, choose **2**. It is important that the cycle detection is set to the correct sensitivity. Adjusting the **Cycle Detection Threshold Sensitivity** number to higher numbers will lower the threshold at which a cycle is detected. Start at a low value; you will be able to adjust this later if you discover that cycles are being missed in the analysis.
- 5) Click the **Calculate** button just above the **Data Table** to start the analysis. The **Cardiac Action Potentials Graph** will appear in the graph window at the right, and the **Data Table** will be populated with values.

Important: After any configuration settings are changed, click **Calculate** again, to trigger the revised analysis.

Once the **Channels** and **Settings** configuration dialogs are completed, it is possible to view the **Cardiac Action Potentials Graph** and start the analysis.

To display the **Cardiac Action Potentials Graph**:

- 1) The Cardiac Action Potentials Graph should be automatically displayed in the XY Graph window, showing the selected cycle from the group of cycles specified in the **Cycles in Group** list to its left.
- 2) Use the menu indicated by the arrow at the lower left of the graph to **Copy Graph** to the clipboard, **Set the Y axis scale**, or **AutoScale the Y axis**.

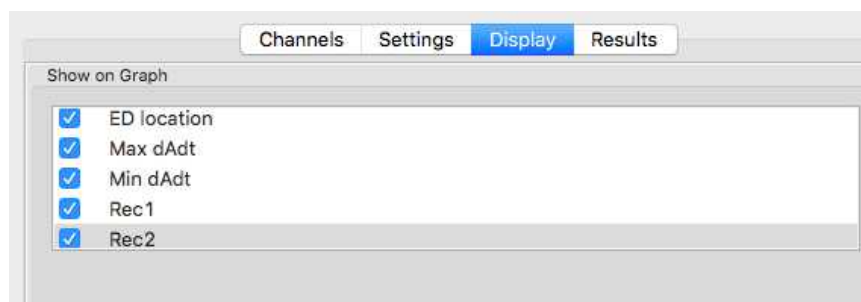


XY Graph menu.

- 3) Look at the **Cardiac Action Potentials Graph** and familiarize yourself with its features.
 - Cardiac Action Potentials parameters are indicated by the vertical blue Marks on the graph. The parameters that are shown are determined by the **Display** configuration dialog.
 - The specific cycle shown in the graph corresponds to the checked cycle in the **Cycles Selected** list to the left of the graph. The parameters and calculations from this cycle appear in the **Data Table**.
- 4) Change the cycle displayed by selecting a different cycle in the **Cycles Selected** list. The cycles are listed in order of their appearance in the data file.

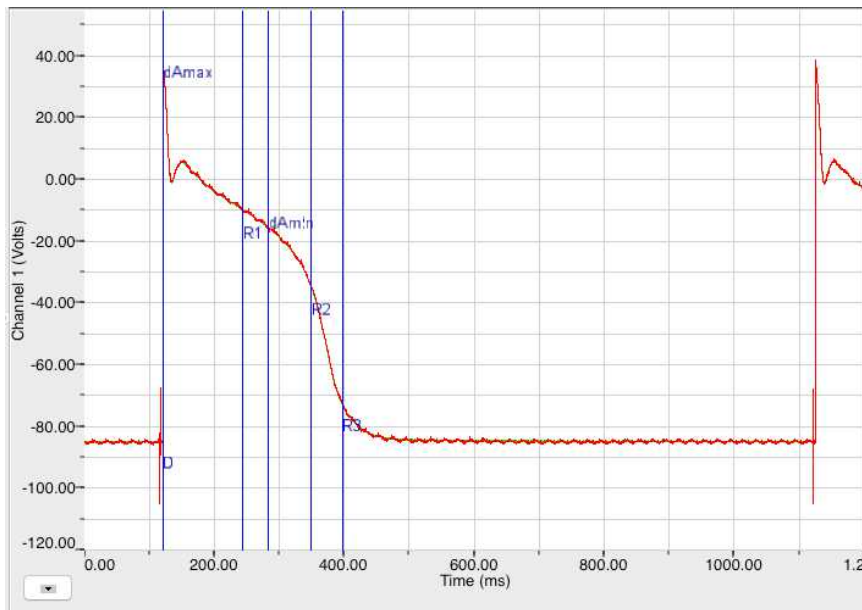
To configure the **Display** dialog:

- 1) Click on the **Display** tab to open the **Display** configuration dialog.



Cardiac Action Potentials Display configuration dialog.

- 2) From the **Show on Graph** menu, choose which parameters you would like indicated on the **Cardiac Action Potentials Graph**. Choose from the **ED location**, the **Maximum** and **Minimum** derivatives, and the three **Recovery** points specified in the **Settings** dialog. These parameters are defined in the Algorithms section below.



Parameters located on the Cardiac Action Potentials Graph.

The **Results** dialog includes basic information about the selection being analyzed, and can be edited by the user.

To configure the **Results** dialog:



Cardiac Action Potentials Results configuration dialog.

- 1) Click on the **Results** tab to open the **Results** configuration dialog.
- 2) The **Results** dialog includes basic information about the selection being analyzed. To edit the information included, add more text or paste the contents of the clipboard into the dialog.

Data Table

All the data for each cycle, as well as the averaged values for all the cycles, is included in the **Data Table**.

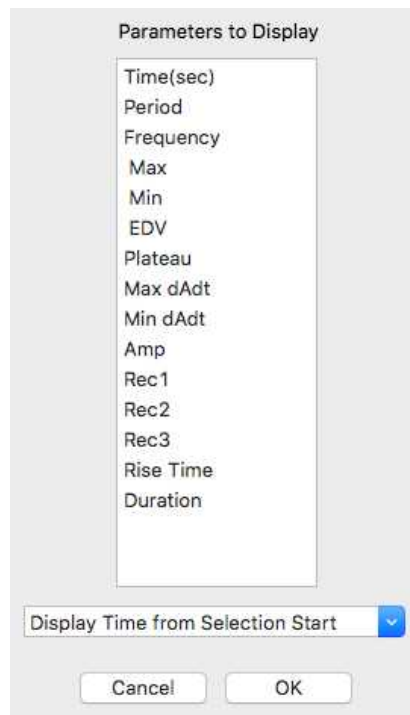
*	Sel	Time	Period	Freq.	Max	Min	EDV	Plto	Max dAdt	Min dAdt	Amp	Rec1	Rec2	Rec3	Rise	Dur.
units		sec	sec	bpm	mV	mV	mV	mV	mV/sec	mV/sec	mV/sec	ms	ms	ms	ms	ms
1	Yes	1.691	1.004	59.742	39.600	-105.100	-84.800	-15.400	855555.562	-18333.340	69.400	123.660	229.100	276.300	0.880	344.360
2	Yes	2.696	1.004	59.742	38.700	-105.100	-84.800	10.700	830555.562	-18333.340	95.500	131.980	230.440	275.420	0.800	357.640
3	Yes	3.700	1.004	59.743	39.600	-104.600	-84.400	31.000	836666.688	-20555.549	115.400	126.740	228.980	273.920	0.860	351.140
4	Yes	4.704	1.004	59.742	39.600	-104.600	-83.900	-18.300	833333.375	-18333.352	65.600	123.820	227.480	273.240	0.820	329.780
5	Yes	5.709	1.004	59.743	39.200	-103.700	-83.900	-13.900	833888.875	-16666.668	70.000	121.960	226.740	273.580	0.760	326.000
6	Yes	6.713	1.004	59.742	38.700	-104.600	-84.400	6.400	842222.250	-19444.445	90.800	132.960	229.240	274.380	0.800	339.060
7	Yes	7.717	1.004	59.743	39.600	-105.600	-84.400	-12.500	842222.250	-18333.330	71.900	117.280	229.080	273.860	0.840	336.560
8																
9	#		7	7	7	7	7	7	7	7	7	7	7	7	7	7
10	Mean		1.004	59.742	39.286	-104.757	-84.371	-1.714	839206.366	-18571.432	82.657	125.486	228.723	274.386	0.823	340.649
12	SD		0.000	0.001	0.394	0.553	0.341	16.976	7833.458	1105.425	17.096	5.148	1.136	1.013	0.038	10.451
13	Max		1.004	59.743	39.600	-103.700	-83.900	31.000	855555.562	-16666.668	115.400	132.960	230.440	276.300	0.880	357.640

Copy Export Algorithms Table Options Load Template Save Template

The Cardiac Action Potentials Data Table.

To use the **Data Table** and export values to the **Journal**:

- 1) Click **Table Options** at the bottom of the dialog to see a list of all the cardiac action potential parameters that can be displayed in the **Data Table**. These parameters and calculations are all defined in the **Algorithms** dialog, and are summarized below.



Cardiac Action Potentials Table Options dialog.

- 2) Choose the options you wish to include in the analysis and display in the **Data Table**. Choose whether you wish to display the **Time from the Start of the Selection** or the **Time of Day** of the recording. Click **OK**.
- 3) Click the asterisk in the upper left corner of the **Data Table**. The **Autosize** option adjusts the size of the cells for optimal display. The **Copy Selection** option will copy any selected cells to the clipboard.
- 4) Click **Algorithms** to see the definitions of the parameters and calculations. The definitions are also included below.
- 5) To copy all the calculated data in the **Data Table** to the clipboard, click the **Copy** button, or click the **Export** button to export the data. The data are exported in a tab (*.txt) or comma (*.csv) separated text file, and the graph can be exported as a Portable Network Graphics (*.png) or JPEG (*.jpg) image.
- 6) To load the analysis configuration for the current analysis, click **Save Template** to name and save the settings. Clicking **Load Template** when the module is reopened will display the list of previously saved templates.
- 7) Click **OK** to save the current configuration. The next time the offline **Cardiac Action Potentials Calculations** dialog is opened, it opens with these settings.

Offline Calculation Algorithms: The offline calculations include:

- **Period:** The time from the start of one action potential to the start of the next.
- **Rate:** Heart rate, measured in beats per minute.
- **Max:** Maximum amplitude voltage for the selected action potential.
- **EDV:** Voltage before the initial upswing of the action potential.
- **Max dAdt:** Maximum derivative of action potential.
- **Min dAdt:** Minimum derivative of action potential.
- **Plto:** Plateau voltage of action potential.
- **Amplitude:** Plto - EDV.
- **Recovery 1:** The time, in milliseconds, from EDV to the point where the signal drops below the level corresponding to the % Recovery 1 level.
- **Recovery 2:** The time, in milliseconds, from EDV to the point where the signal drops below the level corresponding to the % Recovery 1 level.
- **Recovery 3:** The time, in milliseconds, from EDV to the point where the signal drops below the level corresponding to the % Recovery 1 level..
- **Rise Time:** Time from EDV to Maximum.
- **Cycle Duration:** Time from EDV to the point where the signal recovers to baseline.