

EPOCS HARDWARE AND SOFTWARE MANUAL



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Disclaimer: *This hardware and software manual relates to the installation, setup and use of EPOCS and operant conditioning. It is not meant as a substitute for training of operant conditioning.*



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1.1 EPOCS HARDWARE RECOMMENDATIONS

The hardware consists mainly of amplifiers that measure electrical signals from muscles, a data acquisition board, and a stimulator that delivers a brief electrical pulse to elicit a reflex. The amplifier and stimulator both use electrodes that are stuck temporarily to the skin surface. The system can also be configured to use a mechanical stimulator (for conditioning natural stretch reflexes) or a transcranial magnetic stimulator (for investigating the role of responses generated by the brain rather than reflexes from the spinal cord).

This section outlines the hardware that operant conditioning has been tested on. These are the recommended hardware components to be used.

1.1.1 Amplification

Amplifiers that measure electrical signals from muscles

The amplifier must meet the following specifications:

- A gain setting of x200 to x500
- Analog output ports with a range of +/- 5V
- A recording latency of less than 2ms from signal to analog output. *Please note, most wireless systems do not meet this latency specification.*

The following amplifiers have been tested with the EPOCS software:

- **Bortec AMT-8 EMG Amplifier**
http://www.bortec.ca/pages/amt_8.htm



- **Motion Labs MA300-XII**
https://www.motion-labs.com/prod_emg_systems.html



- **Grass P511** (no longer manufactured)



1.1.2 Digitization

The system has only been tested and will only run using *National Instruments Data Acquisition* boards. It is required that they have at least two Analog Inputs and at least one Digital Output. Note: EPOCS has been designed for the PCIe board listed below. Any other devices will require a custom update to the software which can be supplied if requested.

- **PCIe 6321** - This PCI express board requires a computer with a free PCI express slot. The BNC Panel (**NI BNC-2090A**) and a [Shielded Cable](http://sine.ni.com/nips/cds/view/p/lang/en/nid/207405) are required to connect this via BNC cables to the amplifier.
(<http://sine.ni.com/nips/cds/view/p/lang/en/nid/207405>)
- **NI USB 6343** – BNC version
(<http://sine.ni.com/nips/cds/view/p/lang/en/nid/209070>)
- **NI USB 6218** – BNC version
(<http://sine.ni.com/nips/cds/view/p/lang/en/nid/207098>)

1.1.3 Stimulation

The stimulator requires a trigger input, and must be able to stimulate with a pulsewidth of 0.5-1ms, and a maximum current of 50mA with voltage limit of 100V. The following stimulators have been used:

- **Digitimer DS5** – A custom update is available to use this via EPOCS, otherwise the Digitimer DS5 control software can be used (<https://digitimer.com/products/clinical-neurophysiology/peripheral-stimulators-2/ds5-isolated-bipolar-constant-current-stimulator-clinical-product/>)
- **Grass S48, S88** + CCU1 and SIU5 isolation unit – No longer manufactured.
- **Digitimer DS7** – *This is the recommended replacement for the Grass s48*

1.1.4 Processing (Computer)

- **Lenovo Thinkpad P50S** (Core i7-6500U, 2.5GHz/16GB/512GB, Quadro M500M graphics, Windows 7)
- **Lenovo ThinkCentre M83** 10AL (Core i7 4770, 3.4Ghz/8GB/1TB, GT630 graphics card, Windows 7)
- **Lenovo Thinkpad E series, HP Probook 440**

1.1.5 Accessories

- PowerVar 2.0 Power Conditioner (ABC200-11MED) or any appropriate medical grade power conditioner
- Second Screen – It is appropriate to have a second screen primarily for the subject. Cables and graphics card that allows multiple screens would be needed.
- BNC Cables for connecting the amplifier to the NI devices

If any other equipment is to be used, please let support know, so that we can advise you.

1.2 INSTALLING EPOCS

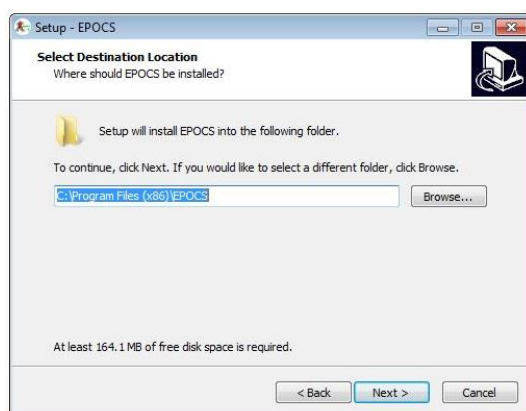
The first step is to run *install-EPOCS.exe*. This will take you through several steps shown below. If there are any errors with this portion of the installation, please contact technical support.



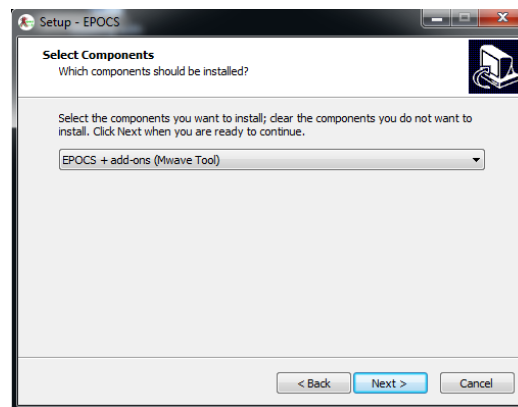
1. Windows Security Warning:
This may occur, press *Run* to continue.



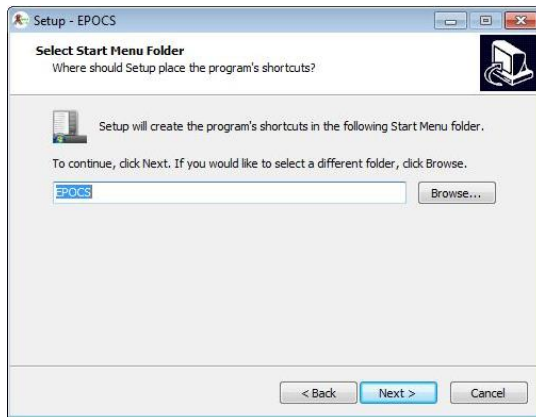
2. EPOCS Installation
Press *Next >* to continue



3. EPOCS Directory
Choose installation directory, default is
C:\\Program Files (x86)\\EPOCS

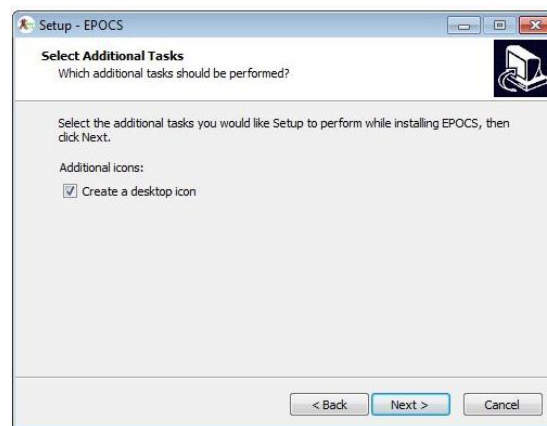


4. EPOCS Tools
Here you can choose to install just EPOCS or an additional M-wave Analysis tool (described in section 1.4.10.3)



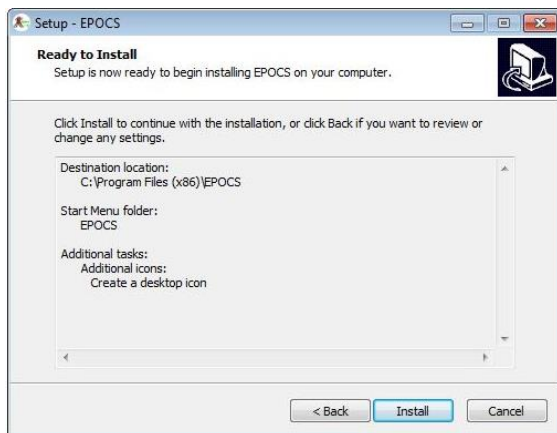
5. EPOCS Start Menu

EPOCS will be added to the Start Menu, here you can select the name to display



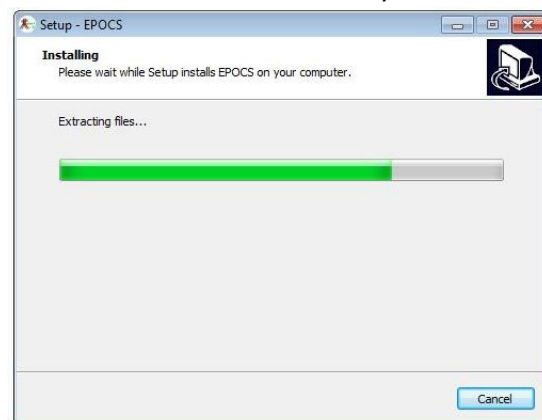
6. Desktop Shortcut

This is recommended. It will add EPOCS, EPOCS-Offline and a Data directory shortcut



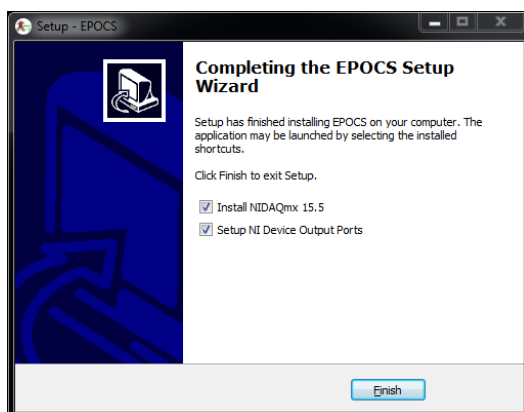
7. Installation Summary

If all is correct press continue, otherwise go back to change any settings



8. Installation Progress

EPOCS will then install, this can take 1-2 minutes

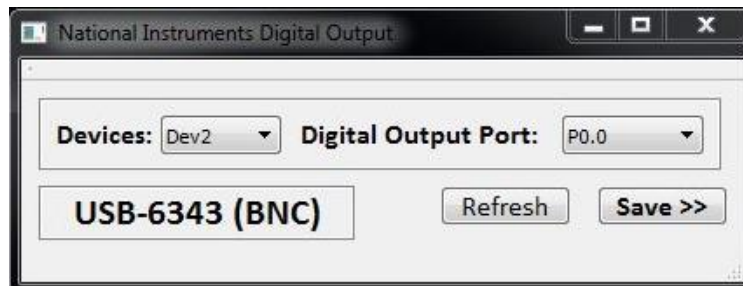


9. Post Installation programs NIDAQmx and NI Device Setup

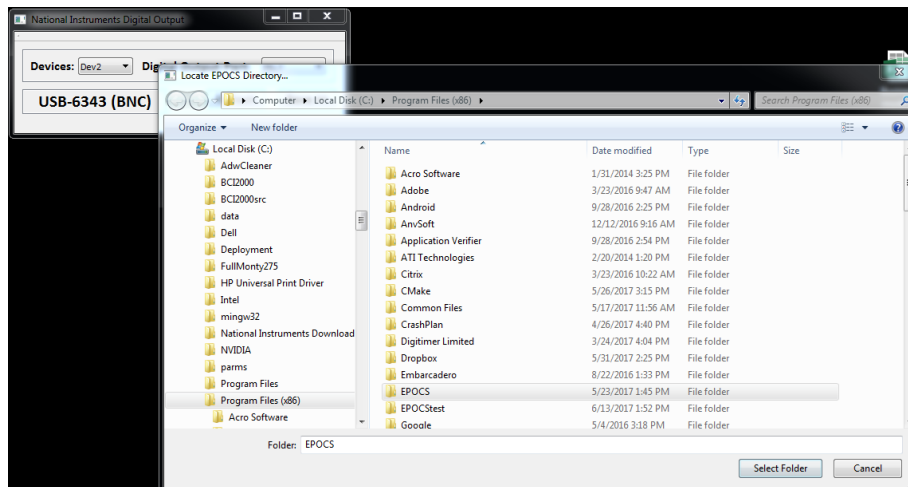
1.2.1 Post-Installation Programs

NIDAQmx drivers: After completing the installation (step 9), you have the option to install the *NIDAQmx drivers*. These will be downloaded and may take several minutes to complete. EPOCS is currently tested on NIDAmx 15.5. You can choose to install this at a later date from the NI website directly.

NI Device Setup: The final post-installation program is designed to setup the Digital Output port (used as the stimulus trigger) of your National Instruments Device. **This is essential to getting EPOCS to work.** If you choose to install this at a later time please go to your install directory, **EPOCS\app** and run **NIDevicesDO.bat**. This calibrates your NI device and sets up EPOCS to use it. Follow the onscreen instructions:



- First make sure you NI device is powered on and connected to your PC (either via USB, or PCI card installed)
- The software will automatically detect any NI devices present. If not, check your connections and power, then press refresh.
- NI devices have multiple ports and lines. These ports can be analog or digital outputs/inputs. Use *Port0/Line7* as the digital output trigger signal, where possible. The NI 6218 uses Port1 as digital outputs, so it will be Port1/Line7.
- Once you press Save >> you will be asked to locate and select your EPOCS installation folder (i.e. C:\Program Files (x86)\EPOCS):



Assuming this is completed correctly, you will find a file in *EPOCS\app\parms* called **NIDigitalOutputPort.prm**. If the file does not exist, then please try to re-connect the NI device and remove any connections to any Analog Outputs on your board (labeled AO0, AO1 etc.). If a problem persists please try removing any digital outputs, then analog and digital inputs.

Hardware setup for each of the three recommended NI devices are shown in Section 1.3.

Once EPOCS is installed you will find in your install directory a list of folders:

Name	Date modified	Type	Size
.hg	3/10/2017 2:44 PM	File folder	
.idea	11/28/2016 9:42 AM	File folder	
app	3/10/2017 2:19 PM	File folder	
data	11/28/2016 9:38 AM	File folder	
doc	3/10/2017 2:20 PM	File folder	
system-logs	11/28/2016 9:37 AM	File folder	
.hg_archival.txt	11/20/2015 5:21 PM	Text Document	1 KB
.hgignore	11/19/2015 12:27 ...	HGIGNORE File	1 KB
MakeDesktopShortcuts.bat	1/22/2015 4:28 PM	Windows Batch File	2 KB
README.md	1/22/2015 4:28 PM	MD File	3 KB
README.txt	10/7/2016 3:53 PM	Text Document	1 KB
unins000.dat	3/10/2017 2:20 PM	DAT File	886 KB
unins000.exe	3/10/2017 2:17 PM	Application	730 KB
UpdateEPOCS.bat	11/20/2015 5:07 PM	Windows Batch File	1 KB

app: this folder contains all the code for running EPOCS. This is mainly for developers and should only be accessed for what is described in this document

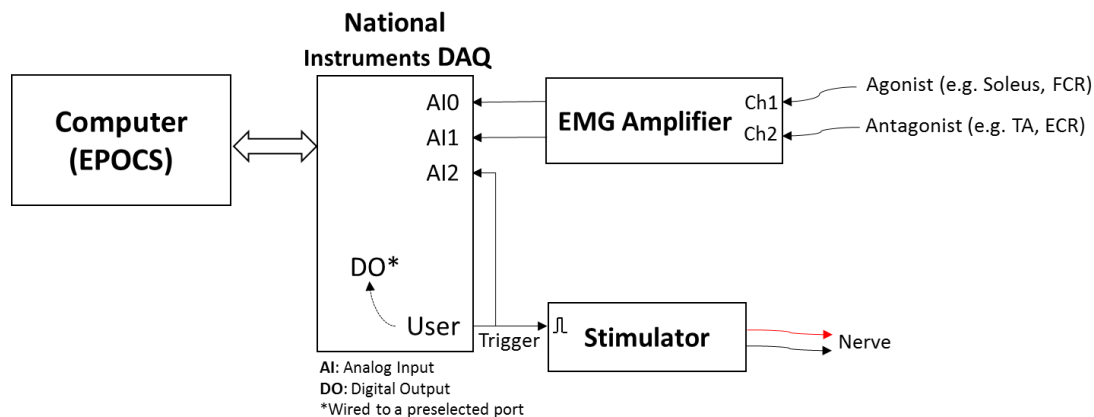
data: All subject data is stored here (see Section for details)

doc: This directory contains a static copy of the EPOCS documentation

If you had not previously made any shortcuts, then use **MakeDesktopShortcuts.bat** to do this.

1.3 NATIONAL INSTRUMENTS DEVICE HARDWARE SETUP

The NI DAQ will act as a bridge between EMG amplifiers and EPOCS, and from EPOCS to your isolated stimulator; It records the amplified analog signals and will send the digital stimulus trigger to the stimulator:

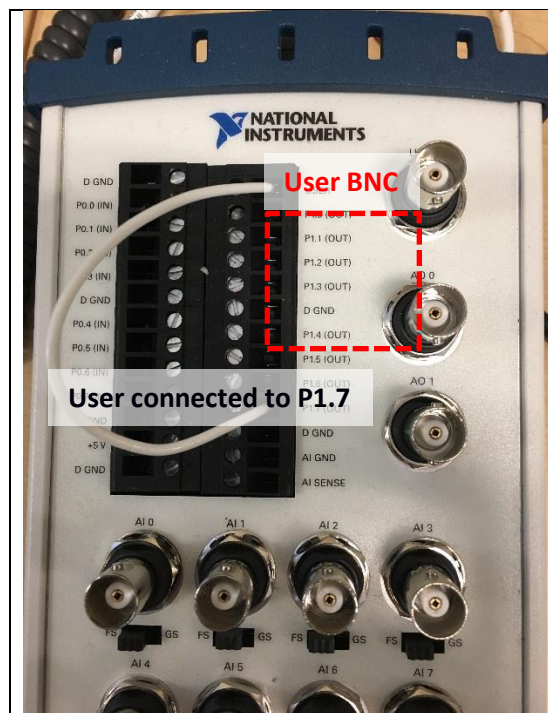


The NI DAQ has multiple Analog Inputs (AI0, AI1 etc.). AI0 and AI1 will be connected to the agonist and antagonist muscles respectively via BNC or other shielded cables appropriate for your device. The stimulus trigger (generated by EPOCS) is done through a Digital Output (DO) port. NI devices have several input and output ports each with several lines (i.e. Port0, Lines 0-7). In the following sections, we select which line of which port will be used as the digital stimulus trigger and how to wire this to the USER BNC output. The USER BNC output is a general purpose output that can be linked to any port/line.

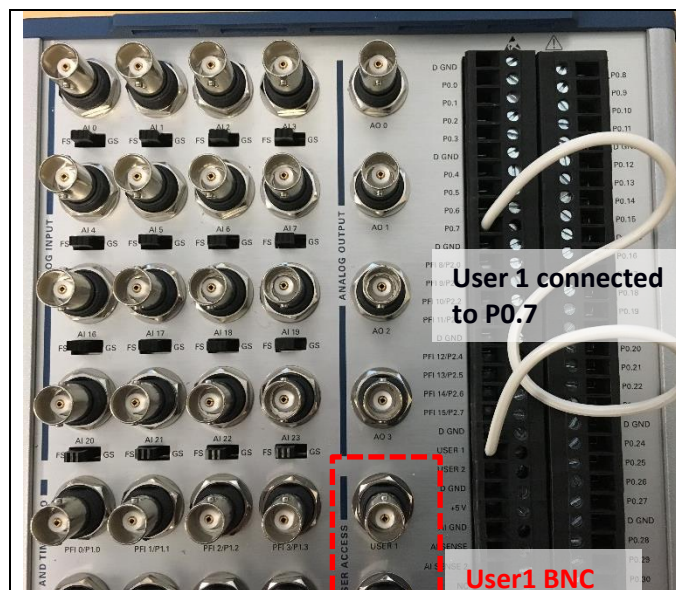
1.3.1 Stimulation Trigger

Setup the Digital Output trigger for your stimulator

It is important to understand that not all NI devices are the same. Some have limited number, if any, BNC connectors for Digital and Analog Outputs. This is the case with the 6218, 6434 and PCIe 6321. These have an extra output called "User". We have to manually connect this User output to whichever Port and Line was selected in the software setup. Examples of how to connect this in the NI 6218, 6434 and PCIe6321 are shown below.



NI USB 6218 (BNC): The User BNC is located on the top right (highlighted here). Using a piece of wire connect P1.7 (or whichever Digital Output port was connected) to the USER.



NI USB 6434 (BNC): This device has 2 USER outputs. User 1 BNC is located near the bottom right (highlighted here). Using a piece of wire connect P0.7 (or whichever Digital Output port was connected) to the USER 1.



NI PCIe 6321: To connect to this PCI card we use the **SHC68-68-EPM** cable to connect between the card and a **BNC2090A** rack mountable connector block (depicted here). This has two user outputs. Using a piece of wire connect P0.7 (or whichever Digital Output port was connected) to the USER 2. (You may need to use a screwdriver to open the pin that allows you to insert the wire).

This has now setup the Digital Output trigger for your stimulator.

Connect your stimulator (new task?)

Connect this User output to the stimulator trigger input. For example, for the Digitimer DS7A the Trigger input is located on the back of the device, where the TRIGGER in is BNC is located:



1.3.2 EMG Analog Inputs

Analog output from the EMG amplifier is required for use with EPOCS. Connect the channel representing the agonist (e.g. Soleus/FCR) muscle to AI0 of the NI device, and the antagonist to AI1. AI2 needs to be connected to the trigger signal. To do this, use a BNC T-connector to connect the USER signal to AI2 and to your Stimulator. These connections are depicted for NI USB 6218:



This forms the basis for your setup. Everything should now be ready for you to test EPOCS.

1.4 USING EPOCS

1.4.1 Running EPOCS

If you selected to place shortcuts on the desktop during the installation, you will have four new icons on the desktop:

- **EPOCS:** This is the primary software shortcut to run EPOCS
- **EPOCS Offline:** This tool can be used to analyze any previously recorded data offline
- **EPOCS Data:** A link to the directory where EPOCS data is stored
- **EPOCS Documentation:** A link to EPOCS' documentation

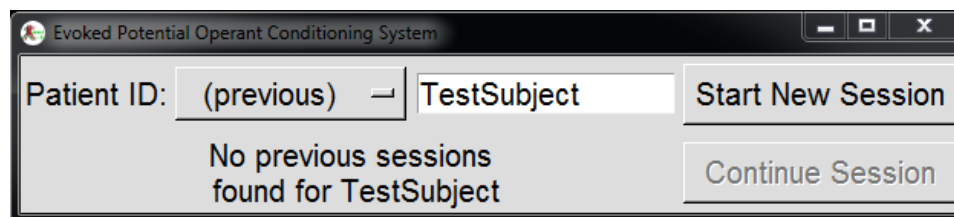
If you do not have these and would like to generate them go to: *C:\Program Files (x86)\EPOCS* and double-click on *MakeDesktopShortcuts.bat*



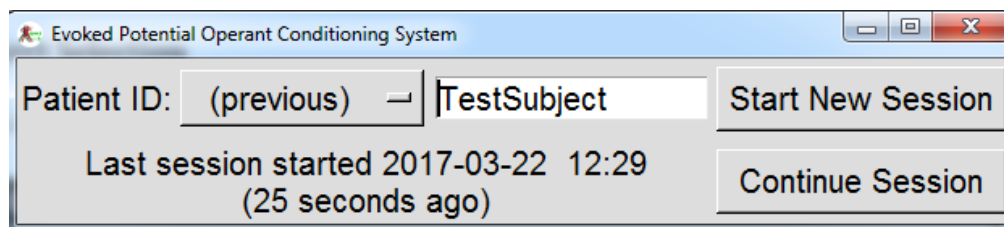
To run EPOCS double click the EPOCS icon.

1.4.2 Patient ID

When EPOCS is first loaded you will be presented with the following window:



At this stage, there will be no previous subject IDs. As subjects are run, they can be found in the drop-down box. If a session was recently run (within an hour), the subject ID will be displayed, the time since the session was closed and a Continue Session will be available:



Note: Previously recorded data in this continued session will not be accessible here, please use the offline tool instead. The Continue Session allows all the data to be saved within the same folder in a subject's data directory.

1.4.3 EPOCS Overview

Once a session is started or continued there are **five phases** in the H-reflex operant conditioning software. Each phase has a corresponding tab in EPOCS that displays, stores, and records the evoked potentials (see next image). Some phases also analyze data, display reflex waveforms for the researcher or therapist, and provide feedback to the subject/patient about EMG activity level. Table 1 briefly describes the purpose of each phase and the associated EPOCS module.

Note: It is important to note how EPOCS works! It uses the trigger signal to capture a window around the stimulus (default: 100ms pre- and 500ms post-stimulus). This window is then displayed in EPOCS. EPOCS does not display real-time EMG activity.

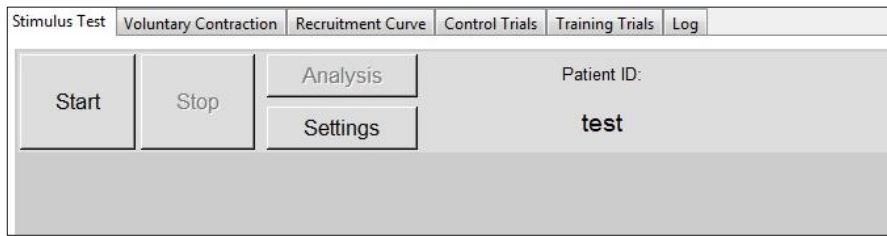


Figure 1 Partial screen shot of EPOCS modules (Stimulus Test is active). Phases of H-reflex training are visible in the module tabs at the top of the page.

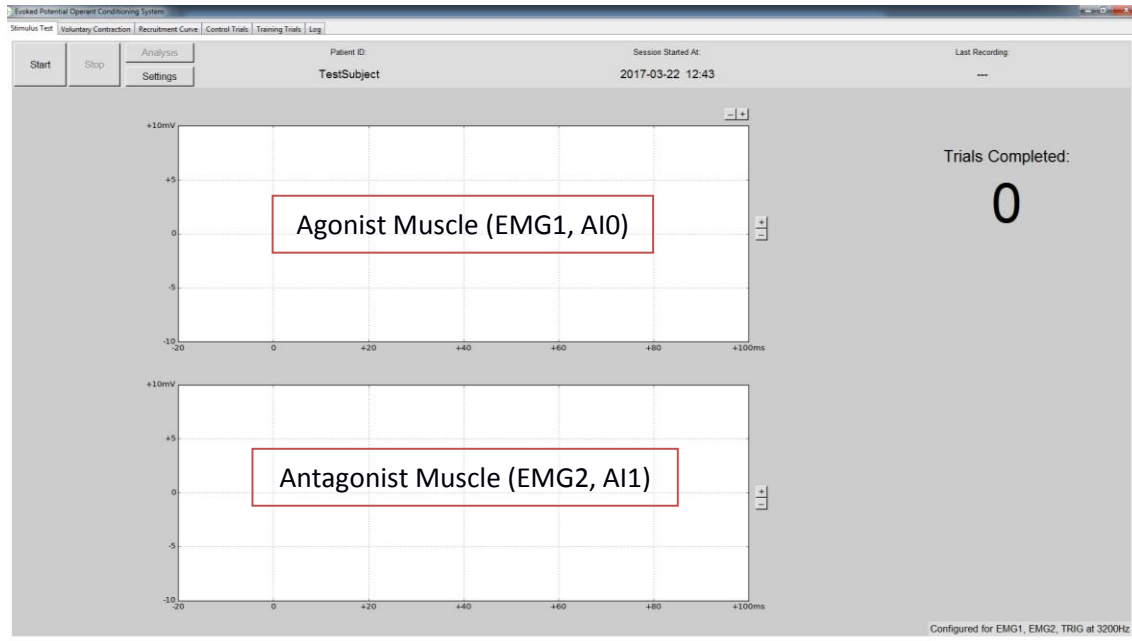
Phase	Purpose	EPOCS Module
I	<ul style="list-style-type: none"> ○ Verify good quality electrical connections ○ Locate the ideal location for stimulating the nerve pathway of interest ○ Locate the ideal location for recording EMG ○ Establish baseline EMG levels, and the range and morphology of individual's response 	Stimulus Test
II	<ul style="list-style-type: none"> ○ Record maximum voluntary contraction of muscle for background EMG reference. (optional) 	Voluntary Contraction
III	<ul style="list-style-type: none"> ○ Determine standing background EMG level ○ Determine best stimulation level by incremental tibialis nerve stimulation (first session) or verify stim electrode placed correctly ○ Verify location of nerve stimulation ○ Determine response windows for H-reflex and M-wave 	Recruitment Curve
IV	<ul style="list-style-type: none"> ○ Patient/subject learns to control background EMG during uniform level of nerve stimulation ○ Establish H-reflex baseline ○ Monitor M wave for consistent amplitude ○ Monitor H-reflex during training 	Control Trials
V	<ul style="list-style-type: none"> ○ Patient/subject learns to change H-reflex response with visual feedback from EPOCS about reflex size after each stimulus 	Training Trials

Table 1 A brief description of the five phases of H-reflex operant conditioning in humans, the associated EPOCS module, and recommended number of sessions for each type.

1.4.4 Stimulus Test

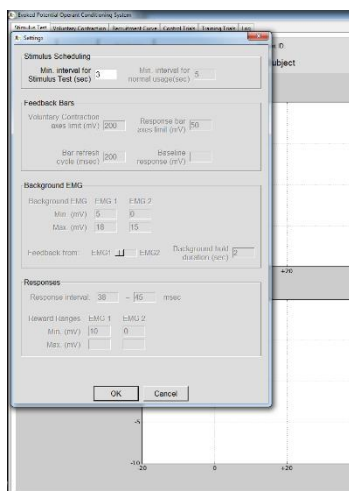
The Stimulus Test mode is a general-purpose mode used primarily to identify the stimulation location and testing that the connections to the agonist and antagonist are working correctly. Please note, there is no analysis mode in this version.

- As shown below, the top **graph** will show you the captured EMG signal from EMG1/AI0 (e.g. agonist) and the bottom graph EMG2/AI1 (e.g. antagonist). You can zoom in and out of these in both the x and y axis, using the + and – buttons.



- On the **bottom right**, is displayed the channels being recorded, which by default should be EMG1, EMG2, TRIG at 3200Hz. If these need to be changed please contact support.
- The top right shows the **Trials Completed**, i.e. how many stimuli have been given.
- At the very top, you can see the list of modes and below this several buttons:
 - Start/Stop**: This will start or stop the recording and stimulation process

Note: As soon as Start is pressed, if the subject is connected and their EMG meets the criteria, and the stimulator output is on, the **subject will be stimulated!!** Make sure they are ready and start the current very low.

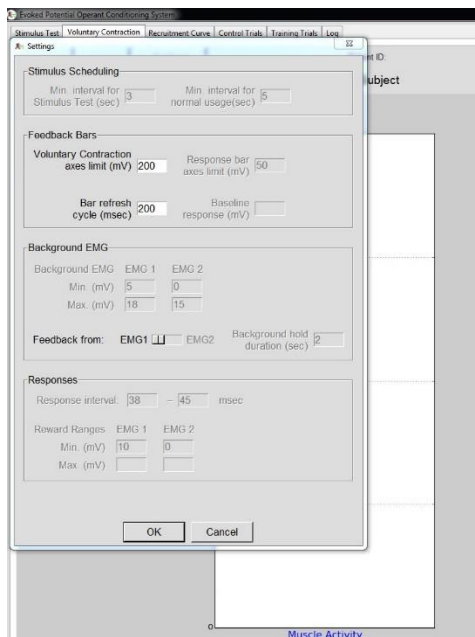
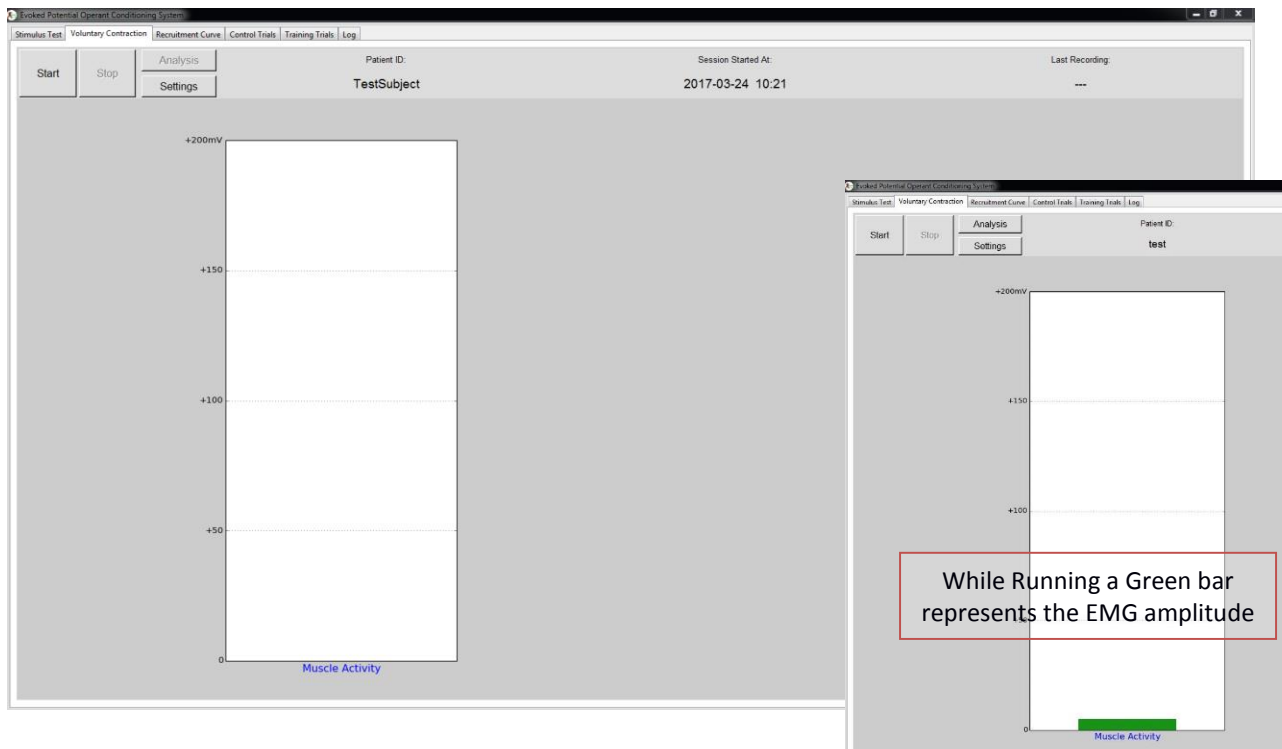


The **settings** window is specific for each mode (Stimulus test, Voluntary Contraction etc.). In Stimulus test you can only change the inter-stimulus duration (default: 3s).

1.4.5 Voluntary Contraction

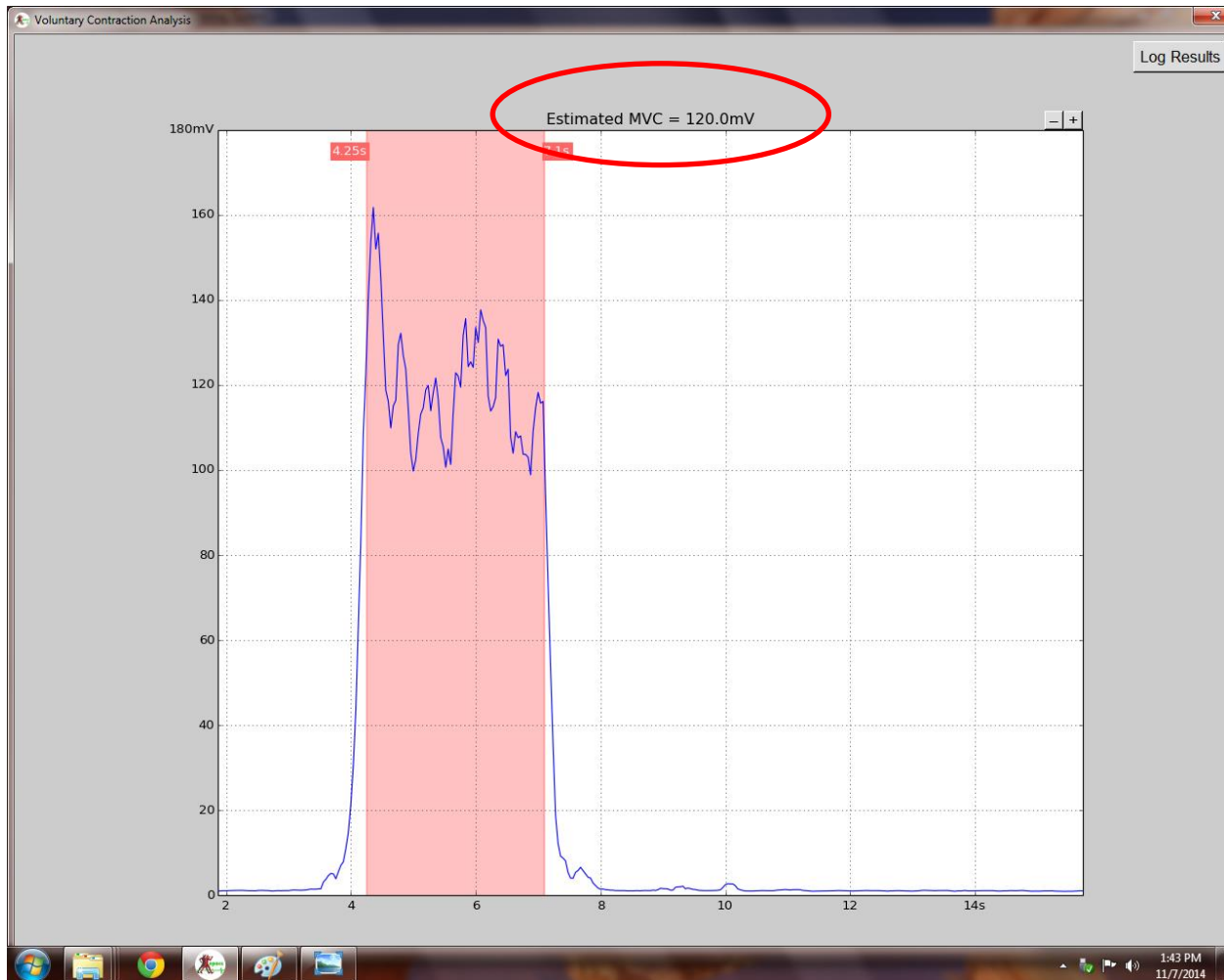
This mode is for recording the maximum voluntary contraction (MVC). When you press start no stimulation will occur and you will be able to see real-time feedback of a subject's mean rectified EMG activity (default is over 200ms overlapping windows).

- The bar graph here represents the current EMG mean rectified amplitude over a 200ms window (updated every 40ms)



The **settings** can be used to change the maximum value of the graph (default +200mV). The 200ms mean rectified value can be changed (minimum is 50ms). In addition, you can alter which muscle (EMG1 or EMG2) is displayed and analyzed.

The Voluntary Contraction **analysis window** allows you to post-analyze the MVC and log the results. Please **note** that once another Voluntary Contraction is recorded, you will not be able to access to previous recordings. When you press **Analysis** you will be presented with the following window:



You can manually click and drag either side of the overlay window to adjust the estimated area of the MVC. The mean of the overlay is shown above the graph (e.g. Estimated MVC = 183.0mV). Make sure to **Log Results**. The resulting log will look like this:

```

Evoked Potential Operant Conditioning System
Stimulus Test | Voluntary Contraction | Recruitment Curve | Control Trials | Training Trials | Log
Patient Code: test
Session Code: 2017-03-24-13-32

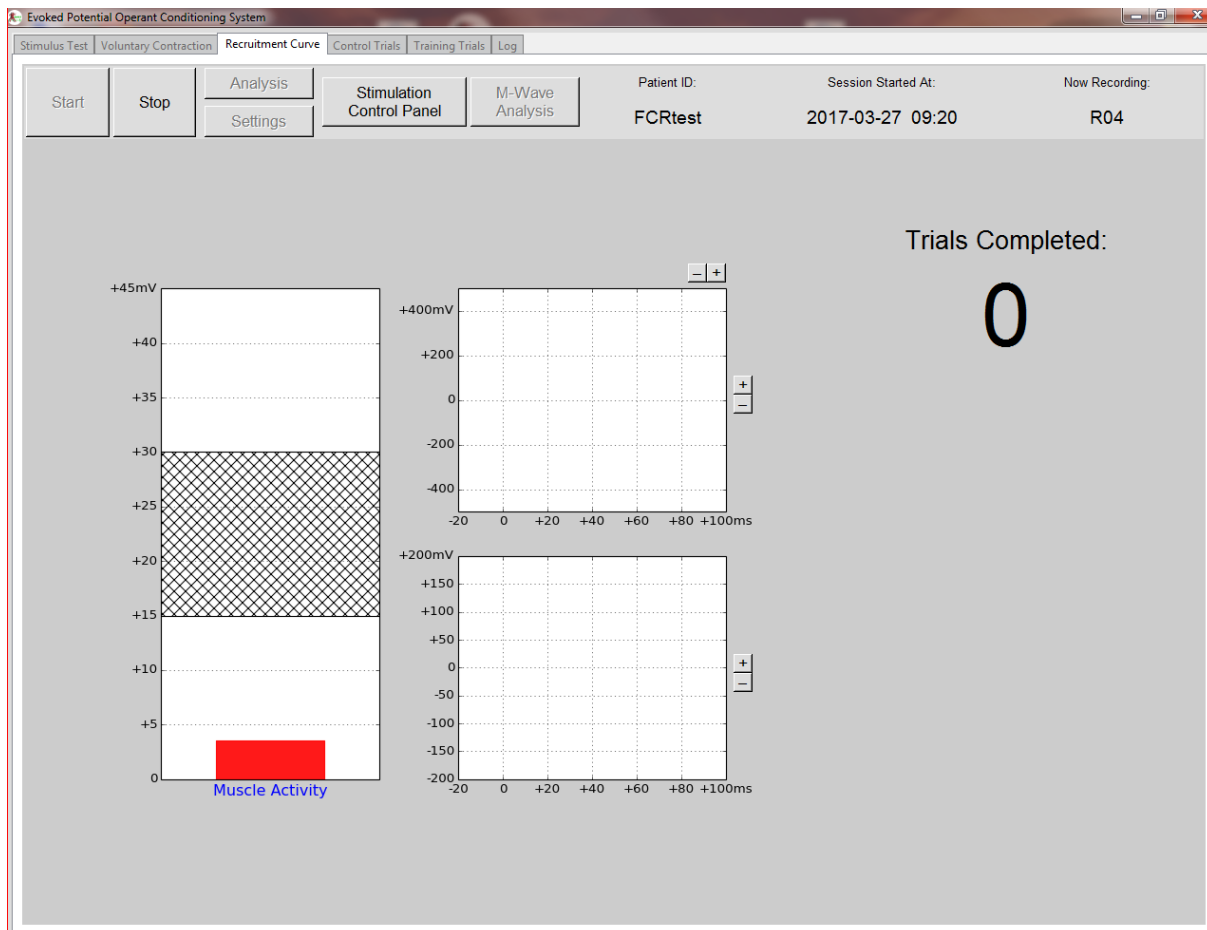
2017-03-24 13:32      Started run R01 (Voluntary Contraction)
2017-03-24 13:32      Stopped run R01
2017-03-24 13:33      ===== Voluntary Contraction Analysis (R01) =====
2017-03-24 13:33      MVC estimated at 183.0mV over a 200-msec window
  
```


1.4.6 Recruitment Curve

The recruitment curve is used to build the current to H-reflex and M-wave amplitude profile that will be used in subsequent modes (see Table 1). It is comprised of 3 graphs:

- **Left Graph:** This depicts continuous background EMG (mean-rectified) for channel 1 (EMG1/AI0 default) updated every 200ms (default). The bar is either red or green depending on whether it is within a certain background limit (shaded bar area). This can be changed in settings (Section 1.4.10). Stimulation will only occur when the subject's muscular tone sets it within these limits.
 - **Note:** To determine the limits run the recruitment curve for a few trials while subject is relaxed standing (for soleus). Observe where the bar sits on average and set a range around this that is comfortable to be kept in.
- **Top Right Graph:** As in Stimulus Test this will be the captured EMG signal from EMG1/AI0 (e.g. agonist)
- **Bottom graph** depicts EMG2/AI1 (e.g. antagonist).
 - You can zoom in and out of these in both the x and y axis, using the + and – buttons.

Subject EMG is in not in the shaded area so no stimulation will occur:



This next figure depicts a typical response shown in all plots when a subject is stimulated:

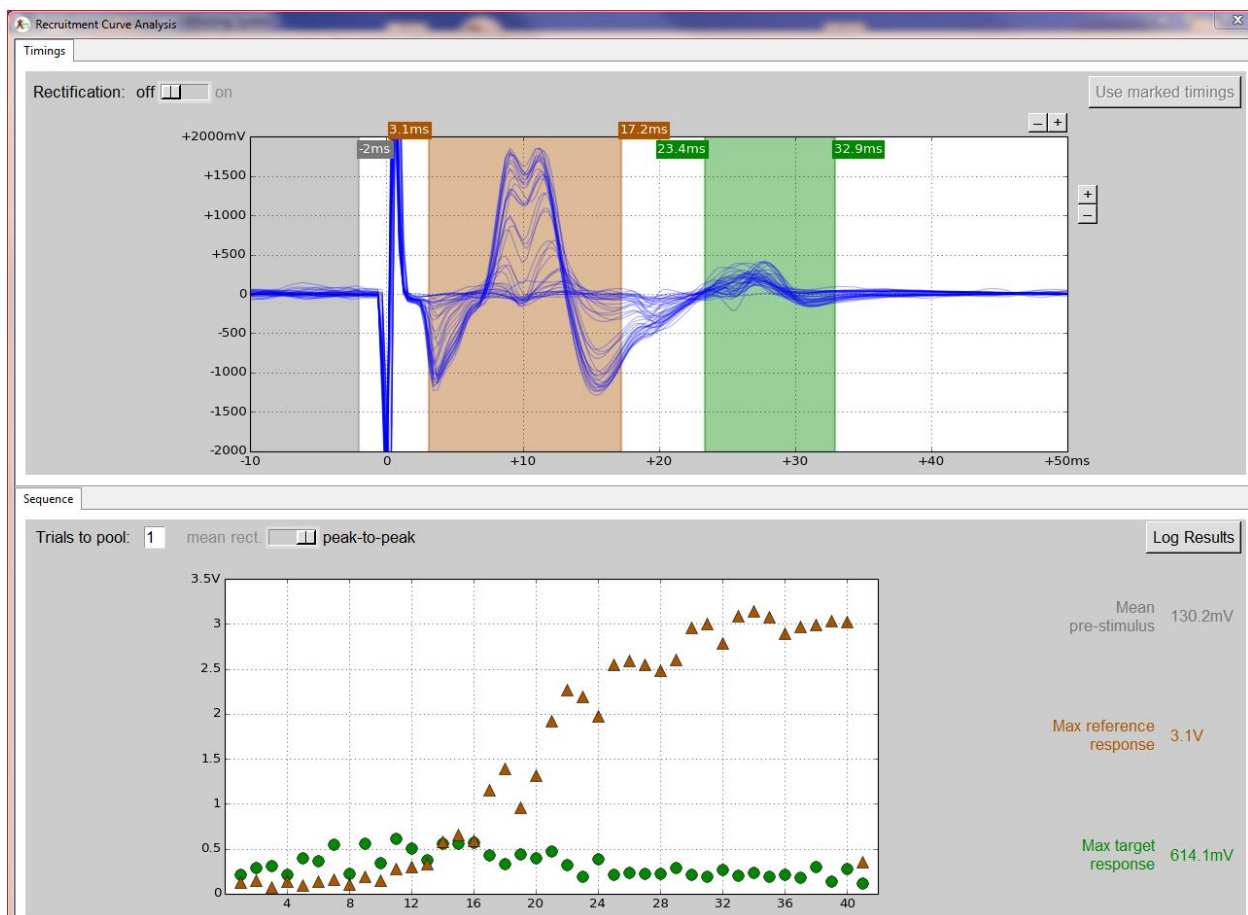


1.4.6.1 Recruitment Curve Analysis

Once completed we then can analyze the generated recruitment curve by pressing the *Analysis* button. This will display two graphs.

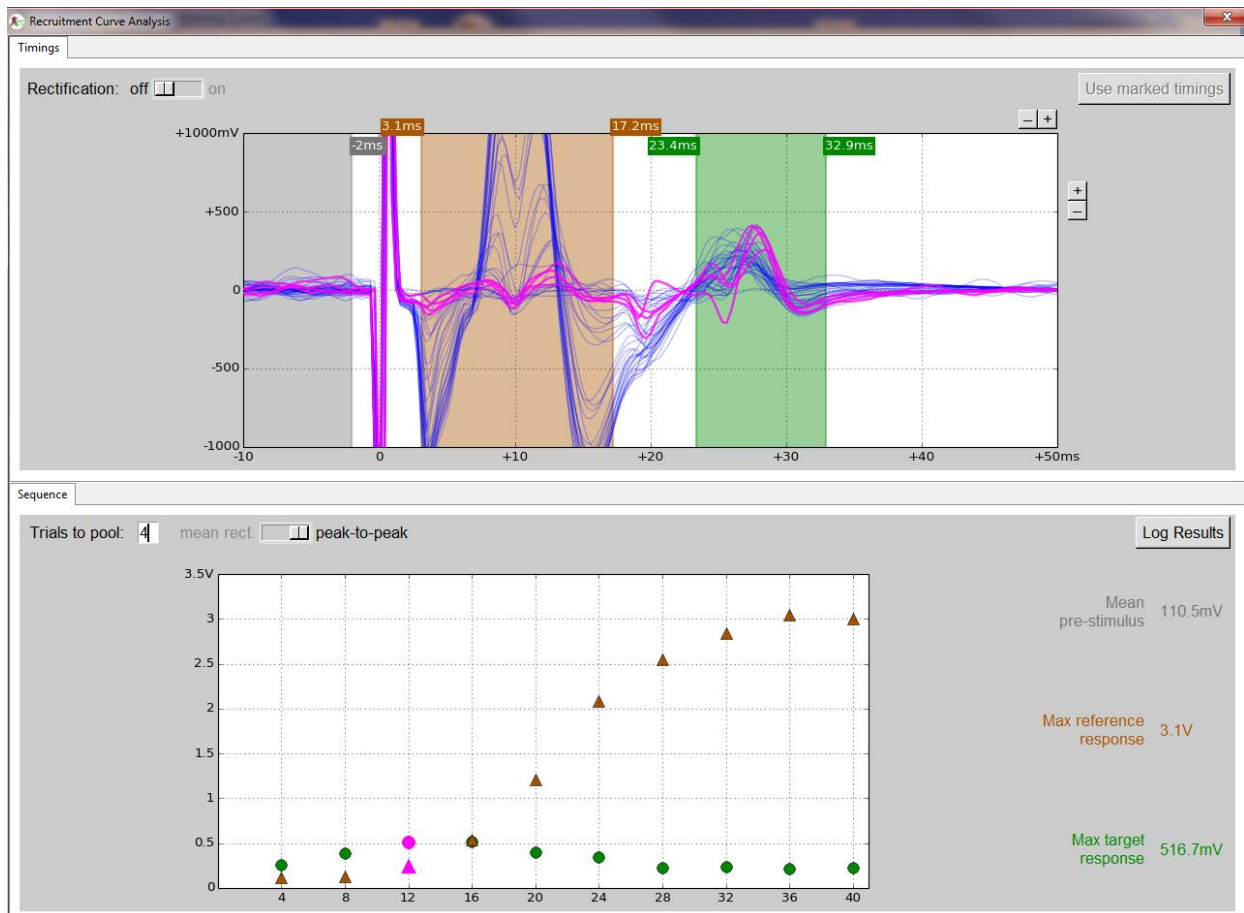
The top graph (time-domain response capture) depicts all captured EMG1 trials for this run and the windows for measurement. It also displays overlays for the Background EMG, M-wave and H-reflex. These overlays can be manually changed (just click and drag the edges). The “**Use marked timings**” button will go red when overlays have been modified. To save the new windows click the red “**Use marked timings**” button.

The bottom plot (sequence plot) shows the trials in the order they were collected. Each point represents a trial at the voltage value within the selected windows; green circles are the H-reflex and red triangles the M-wave trials. Values can be displayed peak-to-peak or mean rectified by changing the position of the switch above this plot. The mean background (pre-stimulus, grey shaded area on the top graph), reference response (M-wave) and target response (H-reflex) are shown.



“Trials to pool” averages the number of data trials entered into the white box in sequential order (a “1” in the box indicates no averaging as in the example above). We currently recommend collecting 4 stimuli at each current level. Thus, trials 1-4, collected at the same stimulus level, are averaged, then, 5 through 8 at the next stimulus level are averaged, and so on. This is depicted in Figure X.

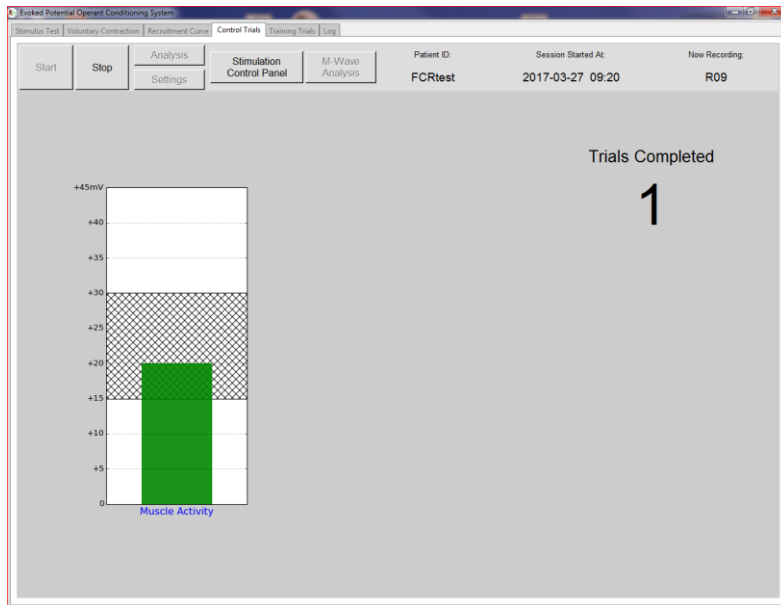
You can select a data point on the “name of plot bottom access” and the corresponding EMG trace or (traces if they are averaged values) will be displayed in the “top graph”.



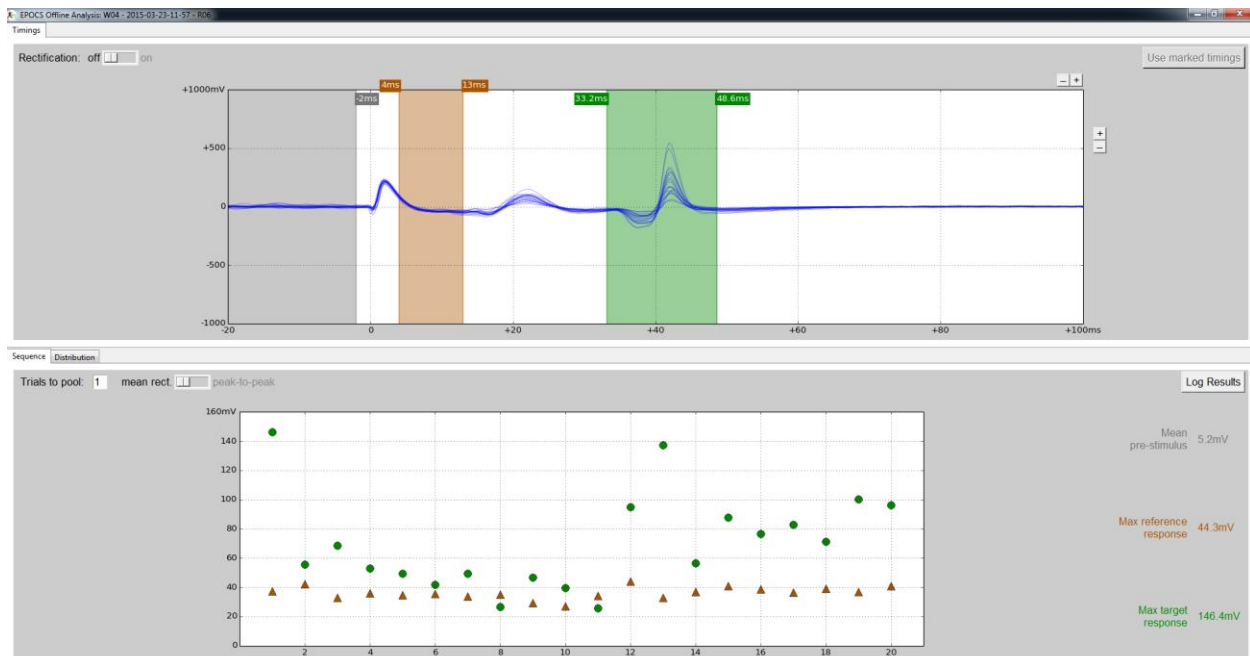
Log Results before closing.

1.4.7 Control Trials

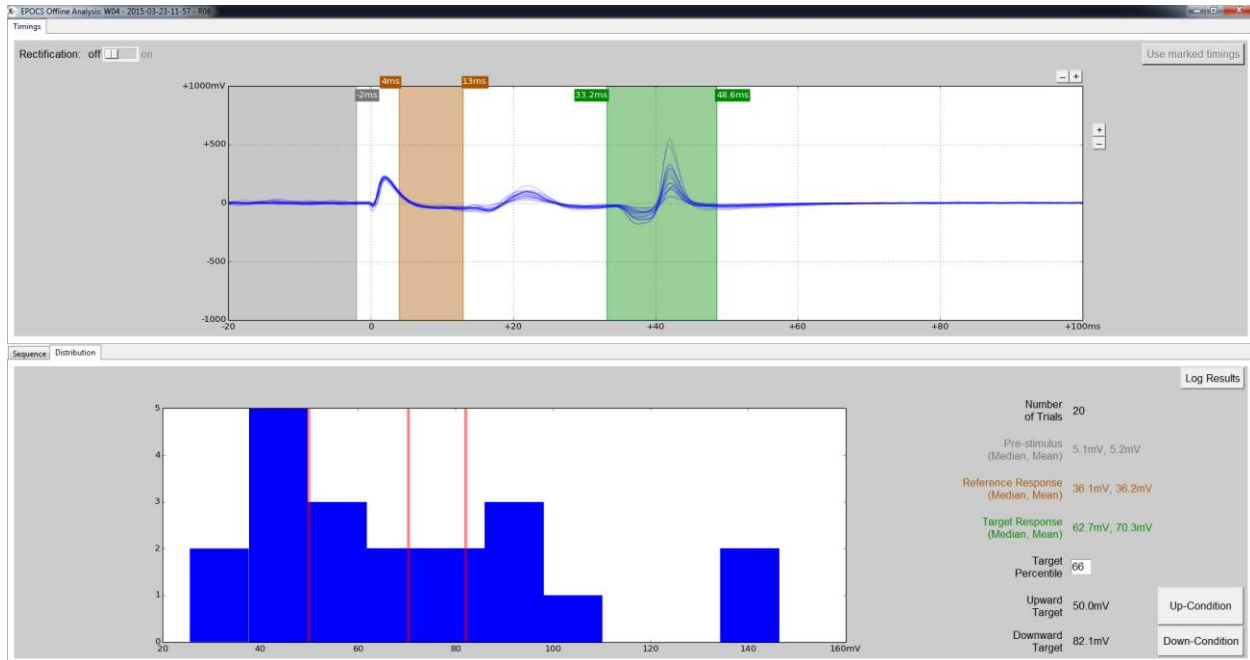
Control Trials, where the current is kept as to maintain a stable M-wave, do not show the subject the H and M waves, only the background EMG. The operator should use either an oscilloscope or M-wave analysis tool (Section 1.4.10.3) to real-time track the M-wave amplitude and adjust the current accordingly.



After completion, click on the **Analysis** button. In Control Trials, the bottom plot now has two tabs. The first ("Sequence") is the exactly the same as the Recruitment Curve.



The second tab ("Distribution") displays a histogram of the M-wave Amplitude plus several statistics about the trials (mean, median):



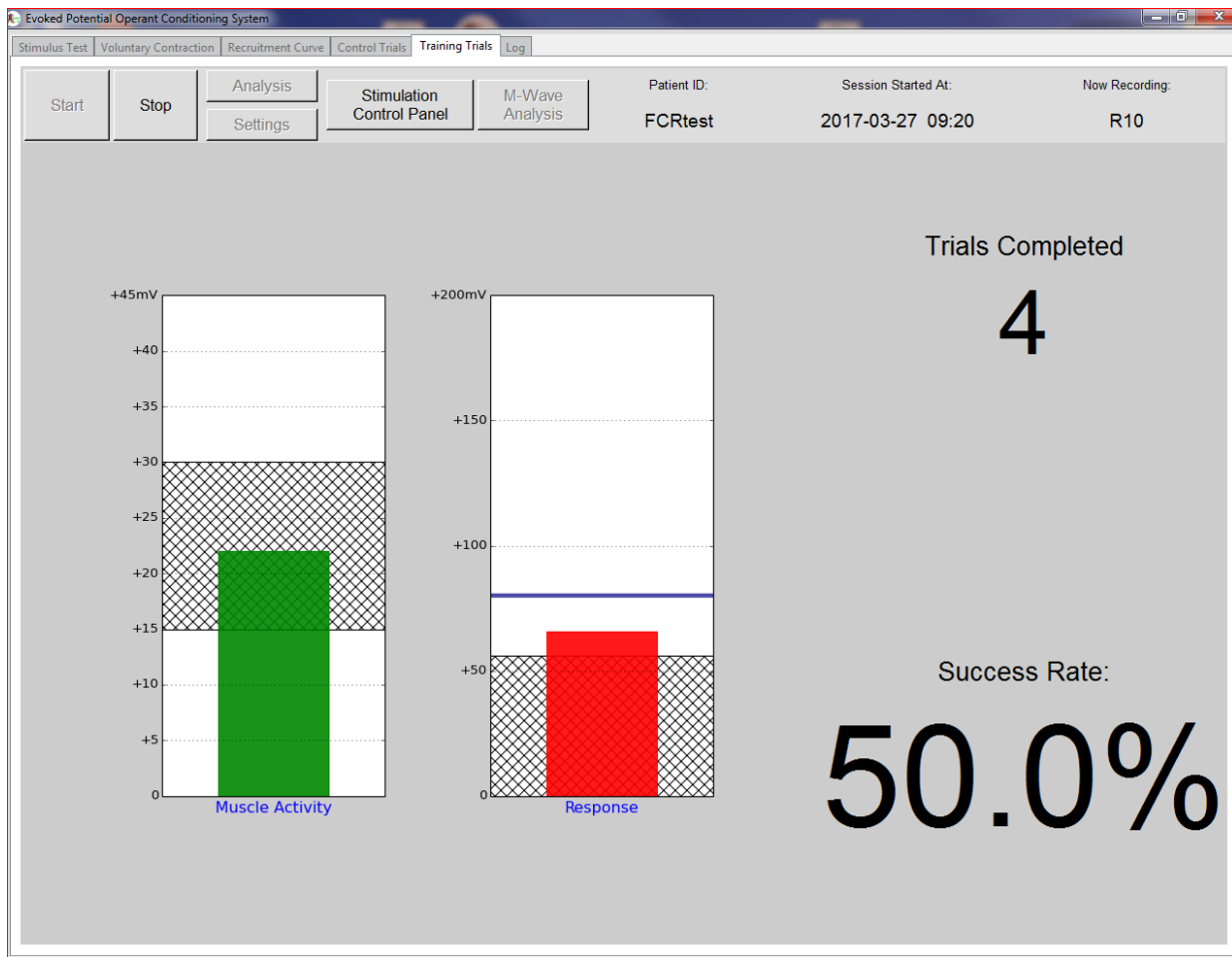
Remember to **Log Results** here.

If this is a Training Trial then to set the correct target for the H-reflex (or target response) press **Down-Condition** or **Up-Condition** before continuing. The target up/down condition is set by a **Target Percentile** box (default 66%). This can be made more or less difficult by changing this value.

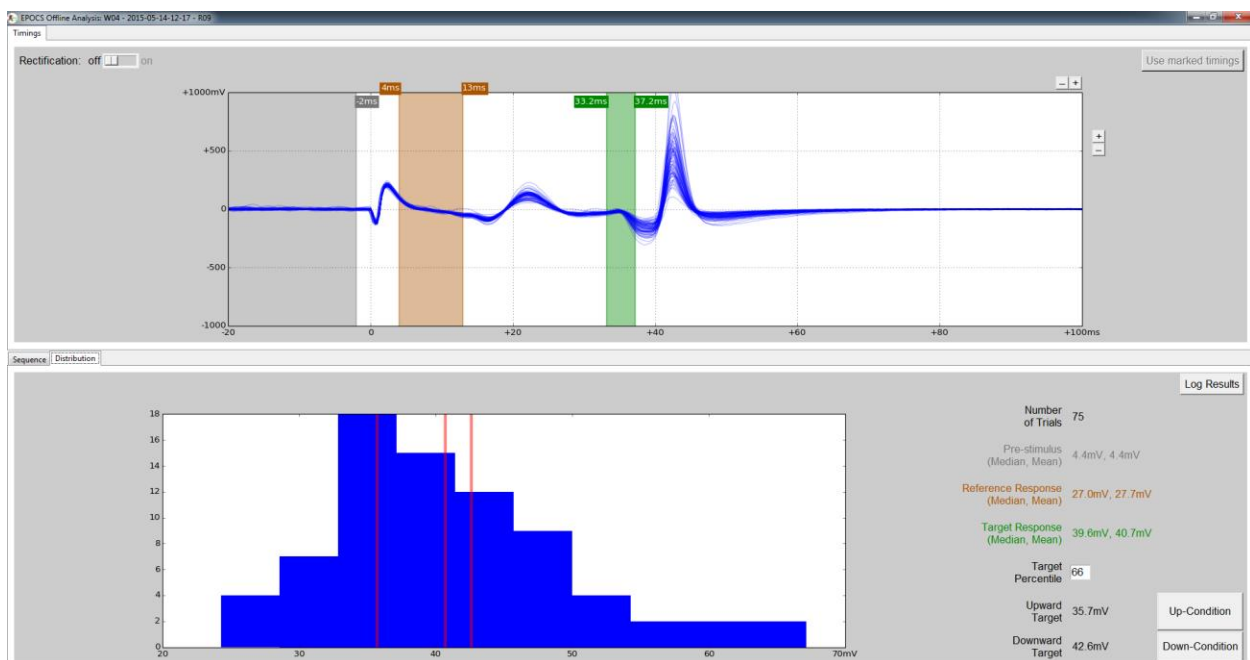
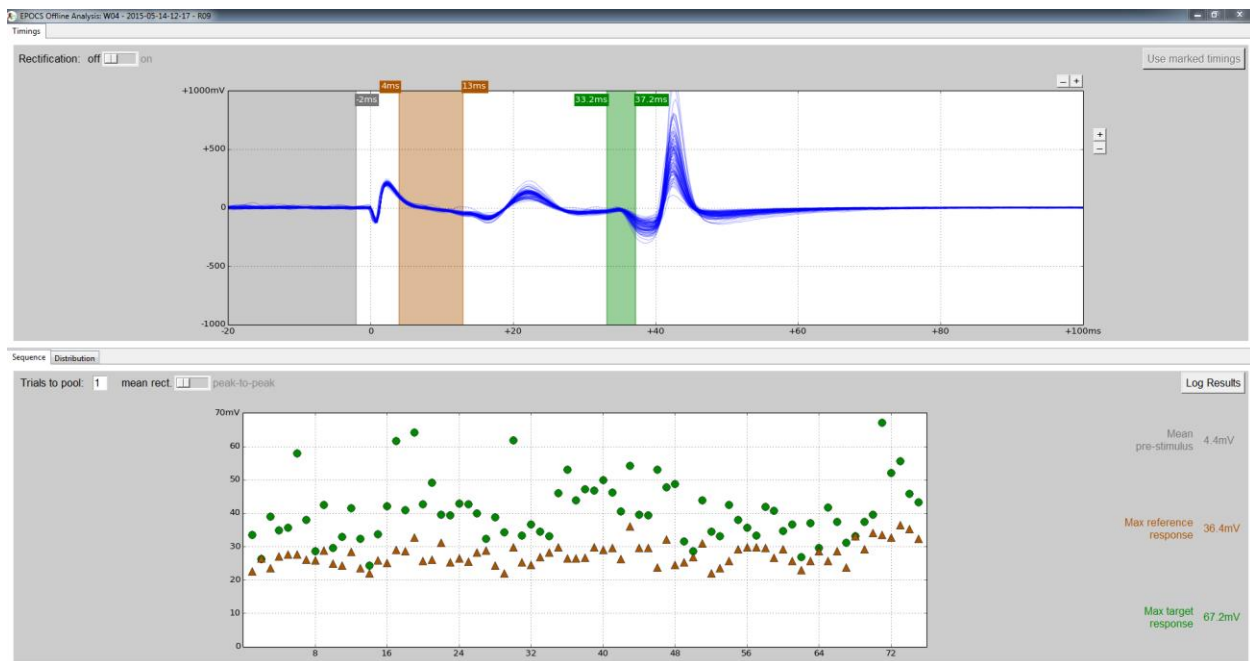
1.4.8 Training Trials

The Training Trial window is equivalent to the Control Trials but now we also have a second bar graph. This bar depicts the H-reflex (or target response) mean-rectified amplitude#200ms after the stimulus is delivered. This has several features:

- The shaded area is the within-session target that is set by the preceding Control or Training Trial analysis (when up-condition or down-condition is set).
- The solid horizontal line represents the mean H-reflex amplitude for control trials across all sessions thus far.
- When the H-reflex amplitude is not within the shaded area, then it is red, otherwise it will be green.
- A continuously updated percentage success rate is depicted.



Once completed select analysis and you will be presented with the same layout as is described in the Control Trials (Section 1.4.7). Examples are shown next.



Remember to **Log Results** and select **Up-Condition** or **Down-Condition** if a Training Trial is to follow. You can re-return to this screen if you forget to do so.

1.4.9 Log

As you progress through various modes, make sure to Log Results. Below is an example Log for a Stimulus Test, Recruitment Curve, 2 Control Trials and 2 Training Trials (Down-conditioning). Analysis was performed at each stage, and logged accordingly. The first Control Trial was stopped early. This will also be saved as a text file in the Subject data folder for that date/session.

```

Patient Code:
Session Code: 2015-04-30-12-07

2015-04-30 12:19   Started run R01 (Stimulus Test)
2015-04-30 12:20   Stopped run R01 after 20 trials

2015-04-30 12:20   Started run R02 (Recruitment Curve)
2015-04-30 12:24   Stopped run R02 after 48 trials
2015-04-30 12:25   ===== Recruitment Curve Analysis (R02) =====
2015-04-30 12:25   From 48 measurements, pooled in groups of 1:
2015-04-30 12:25       Mean pre-stimulus activity (-52 to -2 msec) = 4.7mV (average rectified signal)
2015-04-30 12:25       Maximum reference response (7.2 to 26.5 msec) = 330.6mV (average rectified signal)
2015-04-30 12:25       Maximum target response (33.2 to 48.6 msec) = 273.5mV (average rectified signal)

2015-04-30 12:25   ===== Recruitment Curve Analysis (R02) =====
2015-04-30 12:25   From 48 measurements, pooled in groups of 4:
2015-04-30 12:25       Mean pre-stimulus activity (-52 to -2 msec) = 27.0mV (peak-to-peak)
2015-04-30 12:25       Maximum reference response (7.2 to 26.5 msec) = 1857.8mV (peak-to-peak)
2015-04-30 12:25       Maximum target response (33.2 to 48.6 msec) = 1199.3mV (peak-to-peak)

2015-04-30 12:26   Started run R03 (Control Trials)
2015-04-30 12:27   Stopped run R03 after 2 trials

2015-04-30 12:28   Started run R04 (Control Trials)
2015-04-30 12:31   Stopped run R04 after 20 trials
2015-04-30 12:32   ===== Control Trials Analysis (R04) =====
2015-04-30 12:32   From 20 trials using target response interval from 33.2 to 48.6msec and aiming at percentile 66:
2015-04-30 12:32       pre-stimulus activity (median, mean) = 4.4mV, 4.5mV
2015-04-30 12:32       reference response (median, mean) = 60.4mV, 59.6mV
2015-04-30 12:32       target response (median, mean) = 175.8mV, 167.4mV
2015-04-30 12:32       upward target = 170.9mV
2015-04-30 12:32       downward target = 184.6mV

2015-04-30 12:32   Downward conditioning target set: 33.2-48.6 msec response will be rewarded below 184.6mV

2015-04-30 12:32   Started run R05 (Training Trials)
2015-04-30 12:39   Stopped run R05 after 75 trials
2015-04-30 12:41   ===== Training Trials Analysis (R05) =====
2015-04-30 12:41   From 75 trials using target response interval from 33.2 to 48.6msec and aiming at percentile 66:
2015-04-30 12:41       pre-stimulus activity (median, mean) = 4.5mV, 4.6mV
2015-04-30 12:41       reference response (median, mean) = 67.1mV, 66.8mV
2015-04-30 12:41       target response (median, mean) = 182.6mV, 183.3mV
2015-04-30 12:41       upward target = 177.2mV
2015-04-30 12:41       downward target = 189.8mV

2015-04-30 12:41   Downward conditioning target set: 33.2-48.6 msec response will be rewarded below 189.8mV

2015-04-30 12:42   Started run R06 (Training Trials)
2015-04-30 12:48   Stopped run R06 after 75 trials
2015-04-30 12:50   ===== Training Trials Analysis (R06) =====
2015-04-30 12:50   From 75 trials using target response interval from 33.2 to 48.6msec and aiming at percentile 66:
2015-04-30 12:50       pre-stimulus activity (median, mean) = 4.4mV, 4.5mV
2015-04-30 12:50       reference response (median, mean) = 76.1mV, 76.1mV
2015-04-30 12:50       target response (median, mean) = 178.9mV, 180.4mV
2015-04-30 12:50       upward target = 174.9mV
2015-04-30 12:50       downward target = 186.1mV

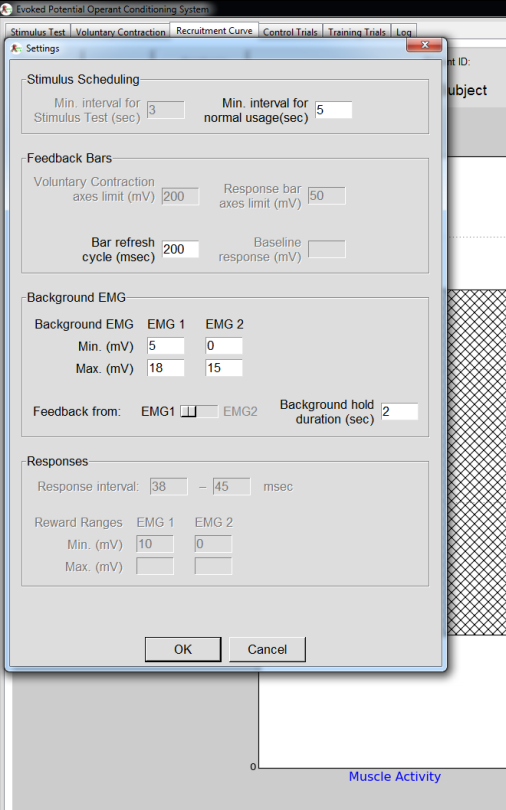
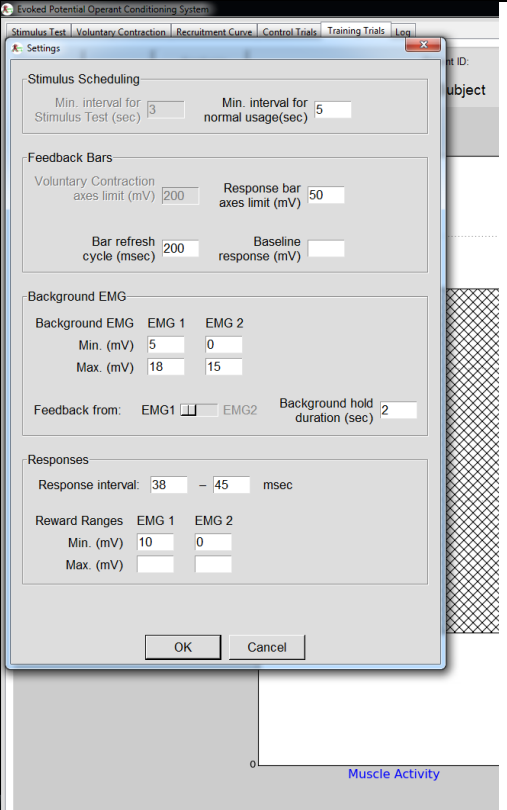
```

1.4.10 Settings

As previously mentioned, in different modes, certain settings will be grayed out as they are not relevant to that mode. There are two versions of EPOCS, the original, and a beta version. Both are described here. Please note some parameters can only be changes in the modes that they are relevant to.

1.4.10.1 Working Version

<p>Stimulus Test: The inter-stimulus is 3 seconds (minimum 2)</p>	<p>Voluntary Contraction: The axes limit (default 200mV) and the time window in which to calculate the mean rectified value (default 200ms) are set.</p>

	
<p>Recruitment Curve / Control Trials:</p> <ul style="list-style-type: none"> • Minimum inter-stimulus interval: default 5 seconds • Time window in which to calculate the mean-rectified EMG (default 200ms) • The <i>Background EMG</i> limits for EMG1 (agonist) and EMG2 (antagonist). Stimulation will not occur unless the EMG values remain in these limits for a default of 2 seconds (<i>Background Hold Duration</i>). 	<p>Training Trials:</p> <ul style="list-style-type: none"> • Response bar limit can be set here (default 50mV). Note this will be need to be set the first time. • Response settings: <ul style="list-style-type: none"> ○ Response interval – H window, set elsewhere but can be changed here. ○ The Reward Ranges are set in the Control/Training Trial analysis when setting up/down conditioning.

1.4.10.2 *Beta Version*

The beta version has further settings relating to future add-ons. The only difference is that there are now two tabs (EMG, Stimulation) in the Settings Window. The newly added setting “Stimulation Current Step Control” can be ignored.

Up/Down Counter

In later versions of EPOCS you will also can up or down count trials:

Trial Numbers

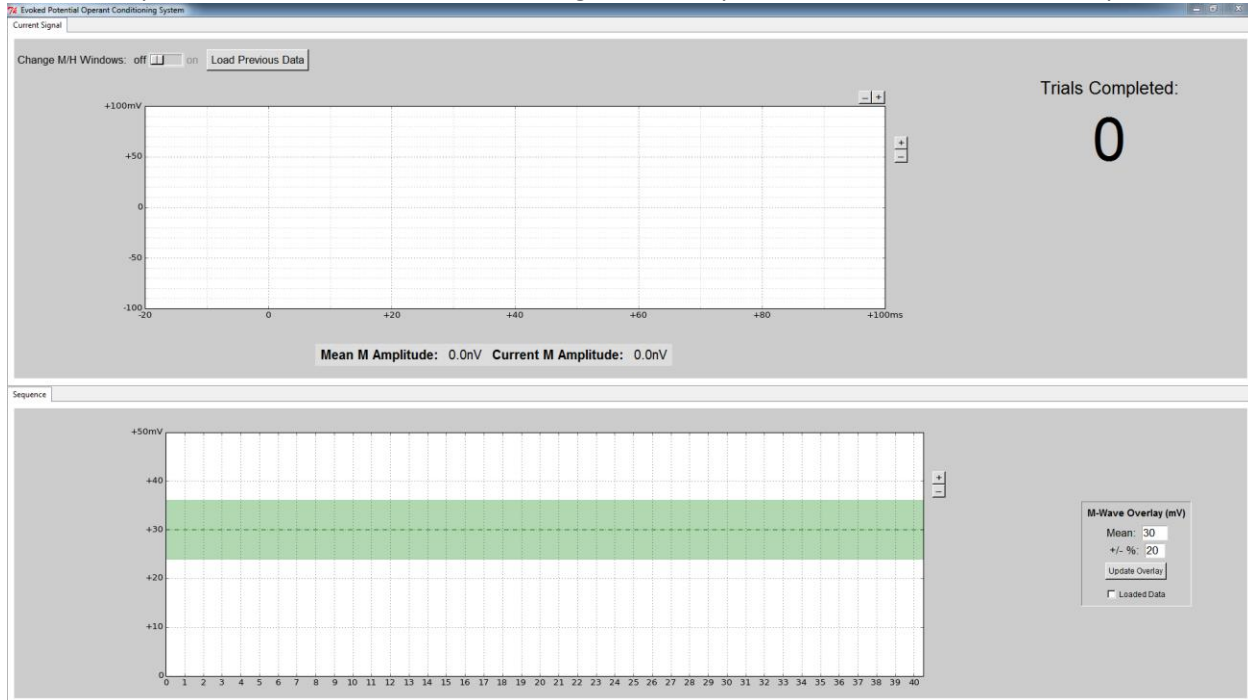
Count up/down: UP ☐ DOWN ☐ Control Trials: Training Trials:

When down counting, after the set number of trials (e.g.75) EPOCS will automatically stop.

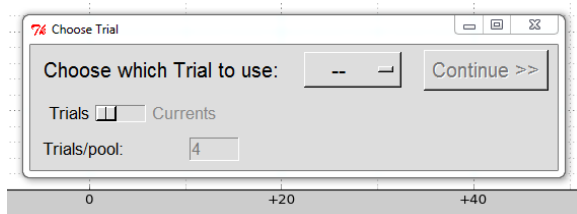
1.4.10.3 M-Wave Analysis Window (add-on)

The M-wave analysis window is an additional tool that may or may not be present in your current version. For details please contact support.

This tool is presented in the Control and Training Trials. It represents an advanced Oscilloscope:



- The **Top graph** represents the same graph you see for the Agonist muscle (EMG1) in the Stimulus Test and Recruitment Curve. While running, it will show the current EMG1 signal and the mean of all signals for this Run. The M-wave value (mean rectified) for the current and average of all signals is displayed below this graph.
- As with the Analysis Windows in Recruitment Curve, Control and Training Trials, you have the option to view and adjust the M and H windows (and save these), but this is only available when the not running.
- You also have the option to load and view a previously recorded signal from any of a Recruitment Curve, Control or Training Trial by clicking "Load Previous Data".
 - When clicked, this will ask you to locate the file to load.
 - For Control and Training Trials, this will load the mean template of response for the run loaded.
 - *Note: If you try to load a different subject's data a warning will come up.*
 - For a Recruitment Curve you may load a specific current or trial (i.e. point on the recruitment curve). The following dialog will appear:



You may choose a specific trial, or current. For the current, it is necessary to know how many trials to pool (i.e. how many repetitions of each current were made).

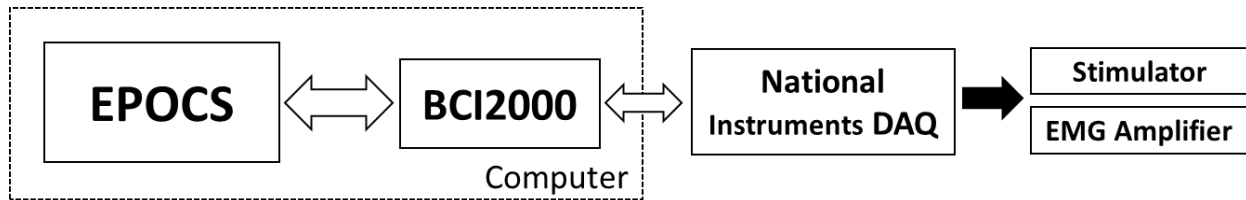
- The bottom graph is the equivalent of the bottom graph in the Analysis Windows for each mode. It uses a red circle to represent the M-wave, and green triangle the H-reflex mean rectified amplitude. This will update every trial/stimulation.

- The green overlay allows the user to set the target M-wave amplitude and a \pm % deviation (default 20%). This is to aid visualization of the M-wave variability and to improve control.
 - You may also check the *Loaded Data* checkbox. This will derive the overlay values from any loaded data. For example, if you choose to load a previous Control Trial then the average plot will be displayed in the top graph and the green overlay will have a center corresponding to the average M-wave mean rectified amplitude for that loaded trial (\pm 20%)

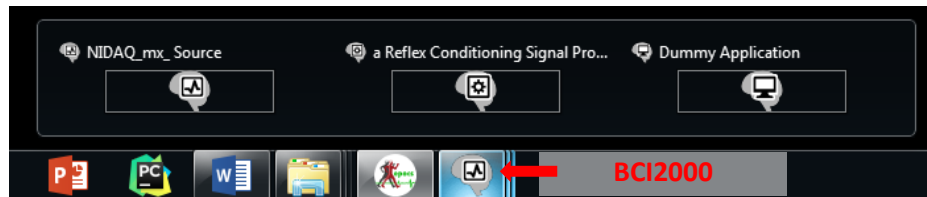
1.5 TROUBLESHOOTING

1.5.1 BCI2000 error log

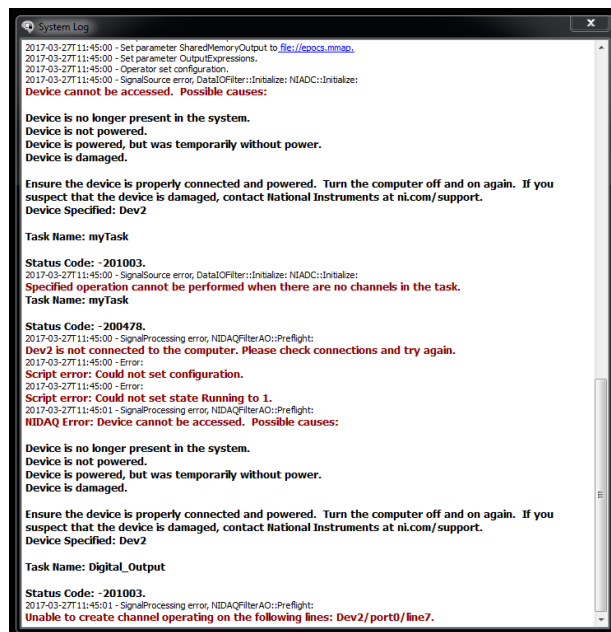
EPOCS uses an open source platform called BCI2000. This runs underneath EPOCS and continually interacts with it. BCI2000 is the primary communicator to the NI DAQ:



You will see BCI2000 loaded when EPOCS is run:



If EPOCS is not running an error window may come up that is from BCI2000 (Errors are depicted in red):



In this error, the NI device is not connected and can be identified from the first line: “Device cannot be accessed. Possible causes:”. If an error depicted is not covered here, please contact support.

BCI2000 Error	Reason
<p>Device cannot be accessed. Possible causes:</p> <p>Device is no longer present in the system. Device is not powered. Device is powered, but was temporarily without power. Device is damaged.</p> <p>Ensure the device is properly connected and powered. Turn the computer off and on again. If you suspect that the device is damaged, contact National Instruments at ni.com/support. Device Specified: Dev2</p> <p>Task Name: myTask</p> <p>Status Code: -201003.</p>	<ol style="list-style-type: none"> 1. National Instruments device is not connected to the computer. If in doubt use NI MAX software to determine if your device is connected. 2. The steps depicted in Section 1.3.1 were not setup correctly. It may be possible that the wrong device was selected (e.g. Dev1 instead of Dev2).
<p>Script error: ../batch/run-nidaqmx.bat, line 49: Could not load "C:\Program Files (x86)\EPOCSm\app\prog\../parms/NIDigitalOutputPort.prm" as a parameter file.</p>	<p>The steps depicted in Section 1.3.1 were not setup correctly. An error may have occurred during this setup. Contact support if repeating this setup does not resolve the issue.</p>

Any other issues with EPOCS are related to connections with the amplifier and stimulator.

A flat line signal that does not vary with muscular contraction	<ol style="list-style-type: none"> 1. Zoom into the signal to make sure this is the case. EPOCS does not take into consideration the gain of your amplifiers. 2. If this is not the case, then there is an issue with the connection between the amplifier and NI inputs (Section 1.3.1)
Large square-wave artefacts that lasts several 100 miliseconds	<p>There is an issue with the connection between the amplifier and NI inputs (Section 1.3.1), i.e. there is none. What you are seeing is the trigger signal shadowed on AI0 and AI1.</p>
System runs without error but no signal is captured and appears in Stimulus Test or Recruitment Curve	<p>The trigger signal (USER BNC) is not split and fed back into AI2 (Section 1.3.1).</p>