

## Application Note 102      Biopotential Amplifier Testing with CBLCALC

### Overview

This Application Note details how to use the CBLCALC to verify the calibration of BIOPAC biopotential amplifiers. It is intended for use with AcqKnowledge software versions 4 and higher using MP160 or MP150 data acquisition hardware. Contact [BIOPAC](http://www.biopac.com) for information about earlier hardware or software versions.

CBLCALC is a device used to check the accuracy of BIOPAC's 100C series biopotential amplifiers. CBLCALC stands for "**CaBLE CAL**ibration" and is used to calibrate EMG, EOG, EEG, ECG, and ERS amplifiers. It functions as an adapter that allows the MP160 or MP150 System to acquire a calibrated signal (through a biopotential amplifier) which is output simultaneously by the MP160/150 System. Using a known stimulus signal, output via the UIM100C (or HLT100C/AMI100D for MP160), the CBLCALC attenuates this signal (divides it by 1,000) and re-routes it back into the amplifier where it is amplified by the selected gain setting (for instance, 1,000).

Accordingly, a one-volt input signal maps to a one-volt signal acquired in the acquisition window. This information can then be used to check for proper calibration of the amplifier.



**Note:** to verify DA100C signal calibration or for earlier 100B series biopotential amplifiers, use [CBLCAL](http://www.biopac.com).

### Hardware Setup

Connect the MP150, UIM100C (or MP160, HLT100C/AMI100D) and biopotential amplifiers as normal.

1. Connect the CBLCALC between the selected amplifier and the UIM100C, inserting the single 3.5 mm plug into the Analog Output "0" port on the UIM100C. (For MP160/HLT100C/AMI100D, use a CBL122\* adapter to connect the CBLCALC to the Analog Output "0" port of the HLT100C/AMI100D.)

**\*IMPORTANT:** CBL122 is **unisolated** and must not be used with external equipment when a human subject is connected to the MP System unless the external equipment has its own built-in isolation.

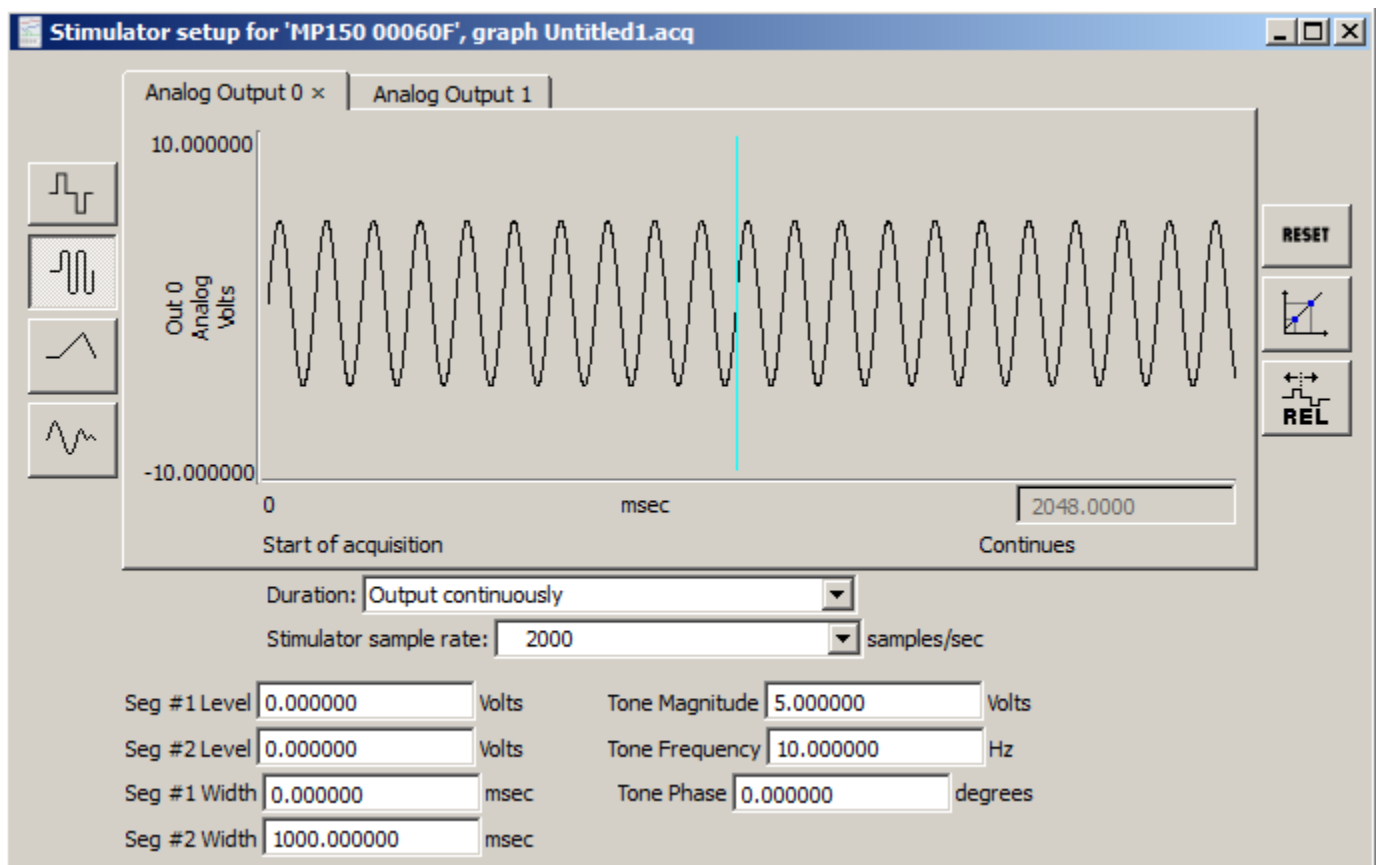
2. Connect the end containing several 2 mm pins into the corresponding holes on the face of the biopotential amplifier.
3. Select a gain setting of 1,000 for DA, EGG, EMG, EOG, and ECG or 5,000 for EEG and ERS.
4. Turn all filters to the desired position.
5. Select an appropriate channel on the top of the amplifier being tested (usually channel one, as this is the default setup in the software).

### Software Setup

1. Under MP150 > Set Up Data Acquisition > Channels, insure that the default is set to analog channel one (A1).
2. Under MP150 > Set Up Data Acquisition > Length/Rate, choose a sampling rate of 2000 Hz (or higher).
3. Choose an acquisition length of at least 5 seconds

4. Choose **Record Last** mode.
5. Under Set Up Data Acquisition > **Stimulator** (see figure below), select the sine wave for the shape of the output signal.
6. Set the "Seg. #1 Width" to zero. This means that the signal will be transmitted continuously starting at time-point zero.
7. Set "Seg. #2 Width" to 1,000 msec (one second). This is the length of the output signal.
8. Make sure that "Analog Output 0" is selected, and choose "output continuously" from the respective menu.
9. Set the signal magnitude.
  - o If the gain setting on the amplifier is set to 1,000, the magnitude should be set to 5 Volts (i.e. 10 V p-p). If the lowest gain setting available is 5,000, then choose 1 Volt.
10. Set the frequency.
  - o A sinusoidal signal with a frequency of 10 Hz can be used to check the gain calibration of most of biopotential amplifiers. For amplifiers supplied with a lower frequency response at or near 10 Hz (i.e. EMG100), increase the UIM100's output to a more appropriate frequency.

**The most important settings are the signal magnitude and frequency (see figure below).**



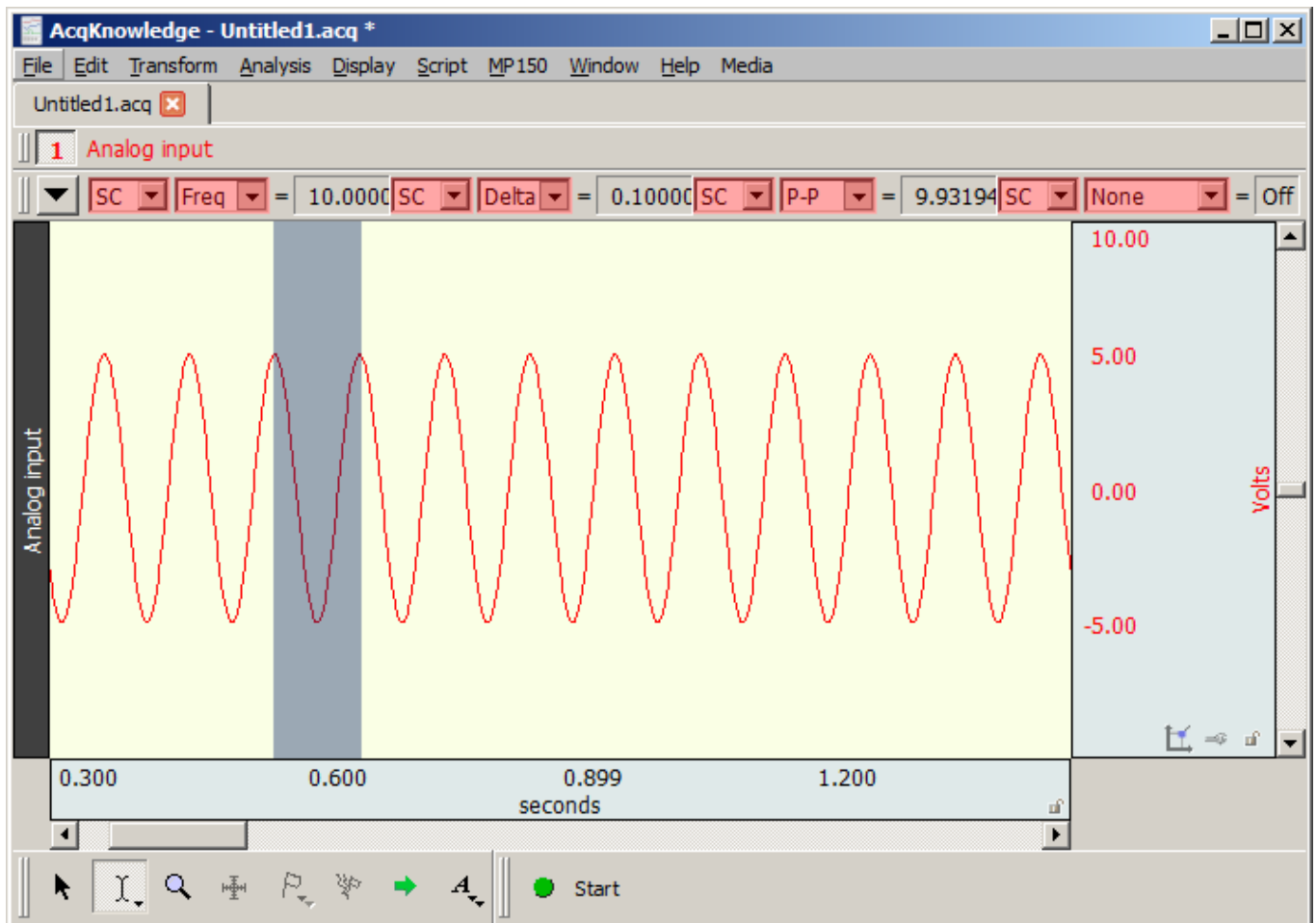
**Stimulator Setup for EOG and ECG**

### Acquisition and Measurement

*AcqKnowledge* is now set up to check for the proper calibration of biopotential amplifiers.

1. Start the acquisition.
  - Since you are in record last mode and are outputting a signal continuously, *AcqKnowledge* could theoretically acquire data forever. However, just collect data until the waveform has stabilized. Perform all your calibration measurements on the latter part of the collected record.
2. Scale the waveform to approximate the one in the figure below.
3. Measure its (peak to peak) amplitude.

- The measured voltage depends on the voltage input and the gain setting on the amplifier. Use the following formula to determine this number:  
**Measured Voltage = (Stimulator Input Voltage) \* (1/1,000) \* (Biopotential Amplifier Gain Setting)**
  - If the amplifier gain setting is 1,000, it will cancel the CBLCALC attenuation (1/1,000). Therefore, the measured voltage will equal the stimulator output voltage. In this example, assuming a gain setting of 1,000 and a stimulator output of 10 V (p-p), the expected signal will be 10 V (p-p) or very close to 10 V (p-p).
- Highlight several peaks with the "I-beam" editing tool.
  - Click the "peak detection" icon at the top of the acquisition window two times (selected with the arrow cursor as shown in the figure below).
  - You have now precisely highlighted one of the many peak-to-peak amplitudes. It is important to measure the amplitude of the acquired waveform correctly. If problems arise, check the section in the manual on peak detection.
  - To measure the amplitude of the waveform, open one of the pop-up measurement windows and select "p-p". This window menu now indicates the vertical distance of the waveform between the two peaks that you have selected (see figure below).
  - To verify the consistency of the difference in peak-to peak values, click the "peak detection" icon again.
    - This will move the cursor to the next available peak below. Repeat this several times to verify the subsequent peak heights.
    - If your measured peak-to-peak height is 10.04 Volts, then you can ascertain that your acquired signal is  $\pm 5.02$  Volts. If you output a 5 Volt magnitude signal with the stimulator, then measuring 5.02 Volts (0-pk) is considered accurate for any biopotential amplifier (the analog output stimulator is accurate to within  $\pm .5\%$ ).
- To best determine the accuracy of the amplifier, you should consider an average of measurements.



Peak detection of a biopotential waveform