

Introduction:

A biological potential (also known as a "biopotential") is a term used to describe small electrical signals produced by the body. The most commonly measured biopotentials include electroencephalogram/electrocorticogram (EEG/ ECoG), electrocardiogram (ECG/EKG), electromyogram (EMG) and electro-oculogram (EOG).

- EEG/ECoG: The electrical activity of the brain that occurs between pairs of electrodes in contact with the scalp and represents the sum of an immense amount of underlying neural activity.
- EMG: The electrical events associated with muscle activation.
- ECG: The electrical events associated with cardiac activity.
- EOG: Records eye movements because of a voltage difference between the cornea and retina. As the eye moves, the vector of this electric field changes with respect to the recording electrodes.

Biopotentials require significant amplification prior to recording as they are typically very small in amplitude (μV or mV). Depending on the signals, the hardware used for monitoring them will provide a variety of suitable amplification and filter settings.

ADInstruments Biological Amplifiers:

ADInstruments currently provide a number of biological amplifiers (Bio Amps) that are suitable for recording one to eight biopotentials in human or animal subjects. These include:

FE132 Bio Amp

Suitable for a single-channel measurement of ECG, EMG, EEG, sensory nerve action potentials, visual evoked response, cortical evoked potentials or slow wave (smooth muscle) studies.

FE135 Dual Bio Amp

Suitable for a dual-channel measurement of ECG, EMG, EEG, sensory nerve action potentials, visual evoked response, cortical evoked potentials or slow wave (smooth muscle) studies.

ML138 Octal Bio Amp

Suitable for measuring up to eight simultaneous biopotential recordings from a single subject. The unit is fully isolated and safe for connection to human subjects.

ML408 Dual Bio Amp/Stim

Suitable for dual-channel biopotential measurements as recorded by the Dual Bio Amp; however, this unit also includes an isolated stimulator that is suitable for human experiments involving mild electrical stimulation of nerves and muscles.

Note: The FE132, FE135, ML138 and ML408 are fully isolated, differential Bio Amps that are safe for

connection to human subjects when used with the patient cable (supplied standard with each unit). They may also be used with animal subjects but should not be alternated between human and animal subjects without adequate cleaning, particularly of the electrodes.

FE136 Animal Bio Amp

A galvanically isolated, differential amplifier that is suitable for measuring a wide variety of biological signals (incl. ECG, EEG and EMG) FOR ANIMAL USE ONLY. It is NOT suitable for connection to human subjects.

Advantages

ADInstruments range of Bio Amps are fully controlled by LabChart or Scope software, thereby allowing alteration of range and filter settings with a graphical user interface.

Please note that Scope v3.9.2, or later, must be used when using 35 Series PowerLabs and/or Bio Amps.

Intended Use

ADInstruments Bio Amps (FE132, FE135, FE136, ML408) are recommended ONLY for recording one or two biopotentials on a single subject. The use of more than one of these Bio Amps on a SINGLE subject IS NOT recommended as it may result in signal artifacts. These artifacts are particularly recognizable at the amplification settings required for EEG recordings. In circumstances where three or more biopotentials are being measured in a single subject, the ML138 Octal Bio Amp is recommended.

Recording biopotentials from different subjects with independent grounds using a single PowerLab unit, multiple ADInstruments' Bio Amps may be used. However, there is a limitation to how many can be powered by a single PowerLab (see Table 1 below).

	4e	8e	4SP, 4/30	4/35	8SP, 8/30	8/35	16SP, 16/30	16/35
Animal Bio Amp	4	4	4	4	8	8	8	16
Bio Amp	4	4	4	4	8	8	8	16
Dual Bio Amp	2	2	2	2	4	4	6	8
Dual Bio Amp/Stim	1	1	1	1	1	1	1	1

Table 1: ADInstruments' Bio Amps powered by a single PowerLab.

Multi-Channel Biological Amplifiers:

Octal Bio Amp

Purpose: The Octal Bio Amp is recommended when recording three or more biopotential signals on a single subject using a single PowerLab unit. The ML138 Octal Bio Amp can be used for recordings up to eight biopotential signals. For more than 8 signal recordings from a single subject, the GT201 16 Channel Bio Amp is recommended.

Certification: Any biological amplifier supplied by ADInstruments (except GT201 & GT205) for use on human subjects has been designed in accordance with, and independently certified as having met,

international safety standards IEC 60601-1 and its addenda. These products also carry the CE mark indicating that the products meet the European EMC directive. This latter standard is equivalent to the FCC Class B standard in the United States.

Advantages:

- Multi-channel amplifier for EEG, EMG, EOG and ECG recordings
- Safe for connection to human subjects
- 8 bipolar channels
- Range and filter settings using LabChart software
- Direct analog-outputs suitable for connection to PowerLab data acquisition systems



Figure 1: Octal Bio Amp



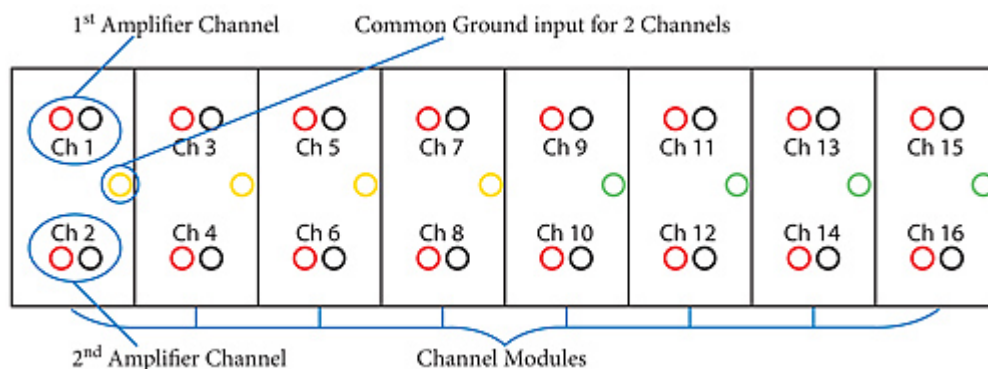
Figure 2: Front (left) and rear (right) view of the GT201 16 Channel Bio Amp

Channel Configurations

ADInstruments supply the g.BSamp in 8 or 16 channel configurations that consist of 4 or 8 modules, respectively. Each module contains two amplifier channels that share a common ground input. A total of 2 independent grounds are provided on both the 8 and 16 Channel Bio Amps for the measurement of various biopotentials or measurements from 2 different subjects.

Ground inputs that are internally (hardware) linked are indicated by the same color input connectors. If the user requires more channels of the same biopotential than are currently available with the internal ground linking (i.e. 16 channel EEG) then the independent grounds may be linked using an external jumper electrode. Below is a schematic diagram of the g.BSamp unit for a 16 Channel Bio Amp,

including 8 modules. Modules 1 to 4 share a common ground input whilst Modules 5 to 8 share a second common ground input. These ground inputs may be linked using an external electrode jumper cable at Module 4 and 5, thereby allowing one ground for a 16 channel recording of the same type of biopotential.



Electrodes

The ML138 Octal Bio Amp is supplied with four sets of MLAWBT9 EEG Flat Electrodes. The MLAC29 Bio Amp linking cable can be used to link common signals when using ML138 to record 12 lead ECG.

EEG/EOG/EMG

The MLAWBT9 EEG Flat Electrodes that are supplied by ADInstruments are suitable for use with all ADInstruments Bio Amps FE132, FE135, ML138 and ML408. These electrodes include the appropriate safety socket connections that are required for use in patient-isolated systems. The double-pin shielded electrodes (MLA2503/2505) supplied by ADInstruments for the 3- and 5-Lead Shielded Bio Amp Cables are NOT suitable for use with the Octal Bio Amp as they do not have suitable connectors.

ADInstruments also supply the EEG Electro-cap Systems that are suitable for use with the Octal Bio Amp. The MLAEC1 EEG Electro-cap System 1 includes a medium cap, electrode adapter, body harness, quick insert electrode, ear electrodes, disposable sponge disks, needle/syringe kit, electro-gel, head measuring tape, ivory cleaning liquid and a manual. The MLAEC2 Electro-cap System 2 includes all of the same components as the MLAEC1 but provides an additional large-sized cap.

ECG

ADInstruments supply the unshielded lead wires with snap-on connectors (MLA0313/0315) that may be used with disposable ECG electrodes (MLA1010B) and connected directly to the Octal Bio Amp.

Frequently Asked Questions:

What is the difference between referenced and differential recordings?

Referenced recordings are those in which a biopotential at a single site is referenced to an essentially electrophysiologically silent point, thereby providing an absolute measure of this biopotential.

In contrast, differential recordings are used to investigate the difference between two biopotentials

recorded at separate physiological sites, thereby providing a measure of a channel of physiological activity. Each of these channels may also be referenced to minimize signal artifact common to both sites.

For example, some systems record the signals as absolute values relative to an electrophysiologically silent reference. Multiple channel configurations (differential measurements between 2 electrode sites) are then software-selected to investigate any desired channel configuration. In systems that record direct differential measurements, various channel configurations are only obtainable by interchanging the lead wires to the hardware inputs.

Can I use the multiple channel biological amplifier for clinical or diagnostic purposes?

No. The PowerLab and ML138 Octal Bio Amp have been designed for use in teaching and research applications. They are NOT intended for clinical or critical life-care use and should NEVER be used for these purposes, nor for the prevention, diagnosis, curing, treatment, or alleviation of disease, injury, or handicap.

Is it possible to measure different types of biopotentials at the same time?

Yes, the ML138 Octal Bio Amp can be used to measure different biopotentials on a single subject (EEG, EOG, EMG and/or ECG). To measure biopotentials in two subjects, the customer will need to use the GT205 or GT201 as these units have two independent grounds.

What are the most common fields of application for a multiple channel biological amplifier?

Any application in which the researcher wishes to record more than 2 biopotentials from a single subject will require the ML138 Octal Bio Amp. Common research applications include:

- Sleep Studies
- Multichannel EEG
- Psychophysiology
- Multichannel EMG
- Multichannel ECG

Tips for using the GT201/GT205 Bio Amp:

Impedance

Problems with bad signal quality and noise occur predominantly for high impedance recordings. Especially when disposal electrodes are used the impedance is normally between 20 and 50 kOhm (Z measured at 10 Hz) or even higher, regardless of type and manufacturer of the electrodes. Ideally you should have an impedance of 10 kOhm or below which is possible with abrasive skin preparation.

Cross-talk

A channel recording a high impedance signal is very sensitive to other sources. Other channels with open inputs (no electrodes connected) show a completely unpredictable behaviour (high noise, saturation, oscillations, etc). Whenever a common reference of an open channels is connected to the reference input of a high impedance recording channel, disturbances can interfere with the recorded signal.

TIP: NEVER CONNECT ANY FLOATING CHANNELS TO CHANNELS USED FOR HIGH IMPEDANCE RECORDING. INVERTED INPUTS (BLACK SOCKETS) CAN BE INTERCONNECTED TO BUILD A COMMON REFERENCE BUT ONLY IF ALL THESE CHANNELS ARE USED.

Inter-connecting grounds

The isolated grounds of the amplifier (yellow and green) have completely independent supplies. When interconnecting the two grounds the two supplies are connected to all channels. This may add a small amount of noise to the channels but is normally insignificant for any impedance below 10 kOhm.

TIP: INTERCONNECT GROUNDS ONLY IF ALL CHANNELS ARE NEEDED TO BE USED WITH THE SAME GROUND POTENTIAL.

Reducing noise

High impedance recording means extreme sensitivity to any electrostatic charging or other potential shifts or drifts. Such disturbing potentials may cause low frequency artefacts in the signals or even input saturation.

TIP: USE ANTISTATIC MATERIALS AND EQUIPMENT IN THE LAB. CONNECT THE POTENTIAL EQUALISATION BOLT (REAR SIDE OF THE AMP) TO THE LAB GROUNDING. CONNECT THE PATIENT CHAIR OR BED TO THE SAME GROUNDING. EVEN GROUNDING THE PATIENT MAY BE REQUIRED IN SOME CASES.

Use a separate reference for every bipolar channel preventing the introduction of noise to any other channel. This is not always the optimal solution, but short-cutting all black sockets reduces the input impedance of the amp.

Selecting a Bioamplifier for Single - Subject Recordings:

