

Instruction Manual

BMA-200

Single-Channel Bioamplifier



Read instructions carefully before operating this device.

- ❶ *This device is not to be used for Human Life Support applications.*
- ❷ *To avoid possible electrical shock, do not operate this device if it is wet or has had liquids spilled onto it.*
- ❸ *Service or calibration procedures should only be performed by qualified personnel familiar with the electrical hazards of line-powered devices.*



Ardmore PA 19003 U.S.A.
(610)642-7719
info@cwe-inc.com

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www.cwe-inc.com

STATEMENT OF WARRANTY

IF THIS INSTRUMENT FAILS WITHIN A PERIOD OF ONE YEAR FROM THE DATE OF DELIVERY OR INSTALLATION, CWE, INC. WILL, AT ITS OPTION, REPAIR OR REPLACE IT FREE OF CHARGE TO THE PURCHASER. THIS WARRANTY EXCLUDES DAMAGE INCURRED THROUGH ABUSE OR ACCIDENT AND CONSUMABLE ITEMS OR COMPONENTS SUCH AS BATTERIES. CWE, INC. DOES NOT ASSUME ANY LIABILITY FOR ANY CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OR MISUSE OF THIS INSTRUMENT. THIS WARRANTY IS APPLICABLE ONLY TO THE ORIGINAL PURCHASER OF THE INSTRUMENT AND IS NON-TRANSFERRABLE.

IF YOU HAVE A PROBLEM

Please call or write describing your problem. We can often identify what is wrong and suggest a solution without recourse to returning the device. Defective units under warranty should be returned to the factory along with a note describing the nature of the fault. Every effort will be made to ensure prompt repair or replacement of the device.

FACTORY SERVICE

Out of warranty or damaged instruments may be returned to the factory postage prepaid for service at prevailing rates. Upon request, a written or verbal quotation for such service will be issued after examination of the unit but prior to commencing repairs or service. Please contact us to obtain an RMA number before returning anything. Address requests for service or technical information to:

CWE, Incorporated
Technical Support Department
TEL (610)642-7719
info@cwe-inc.com

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1.0 INTRODUCTION

The BMA-200 Bioamplifier is a battery powered AC/DC differential preamplifier for the low-noise recording of muscle, nerve, or other biopotentials. Its portability, rugged design, and long battery life make it the ideal choice for use in the field or in the laboratory.

The wide gain range of the BMA-200 allows its use as a primary amplifier whose output can be fed directly to tape or chart recorders, or oscillographic displays. The six-position high and low pass filters have a sharp rolloff for effectively limiting the signal to the desired frequency bandwidth. The frequency response of the BMA-200 covers the range DC-50kHz.

A built-in audio monitor allows instant verification of the signals being recorded. The internal waterproof speaker can be used or headphones or an external amplifier/speaker may be connected to the headphone jack.



Model BMA-200 Bioamplifier front panel.



Model BMA-200 Bioamplifier rear panel.

2.0 SPECIFICATIONS

Input type	differential instrumentation amplifier
Input impedance	>10,000 Megohms
Input connector	7-pin Amphenol 703-91T-3475-001
Noise, wideband, referred to input.....	<7uV P-P, <3uV RMS
Common mode rejection	>100dB @ 60Hz
Input voltage range	± 1 V
Input offset adjustment ranges	± 2 , ± 20 , ± 200 mV
Bandpass filters	Butterworth, -12dB/octave
Low Frequency Filter	DC, 1, 3, 10, 30, 100Hz
High Frequency Filter	0.1, 1, 3, 10, 30, 50kHz
Output range	± 6 V @ 10mA
Output connector	BNC jack
Calibrator	1mV square wave, 10Hz
Stim/Record control input	TTL negative or switch closure
Headphone jack	3.5mm stereo mini-phone jack
Battery life	>30 hours between charges
Battery charger/adapter	24VDC @ 400mA
Dimensions	6W x 1.5H x 8D in. (15x3.8x20cm)
Weight	3.5 lbs. (1.6kg)

3.0 POWER ON/OFF SWITCH

Switch POWER ON by moving this toggle switch to the left. The centered position is POWER OFF. By momentarily moving the switch to the right, the BATTERY TEST function is activated. If the BAT light comes on during this test, approximately 70% or more of the battery capacity remains. If the BAT light does not light, the batteries should be charged before further amplifier use.

NOTE! Since there is no warm-up time needed, the amplifier should only be switched ON when actually being used. This will conserve battery life. If AC power is available, the amplifier can be operated indefinitely using the charger/adapter.

4.0 INPUT

The INPUT connector should be wired as described below. Note that the maximum usable input range is $\pm 1V$. Higher voltages up to 50V can be tolerated for brief periods.

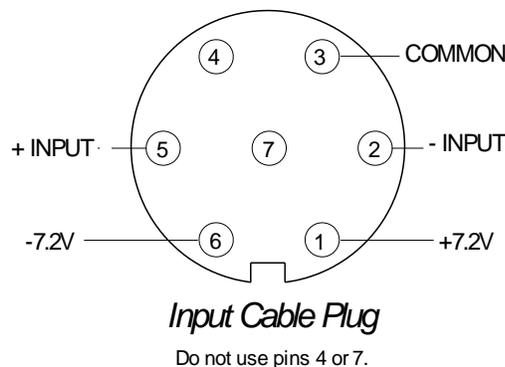
Whenever possible, the differential input configuration should be used. This permits the amplifier's common mode rejection to work, which will eliminate most extraneous noise pickup. If a single-ended configuration is used, be sure to provide proper shielding of the input leads.

4.1 INPUT CONNECTOR

For typical differential recording applications, two active leads and one common lead are used. The two active leads are connected to pin 5 (+) and pin 2 (-). Pin 3 is the COMMON connection. For single-ended applications, connect the active lead to the (+) input pin, and jumper the (-) input pin to COMMON.

For best results, keep the input cable as short as possible, and use fully shielded (preferably foil shield) cable. The cable shield should be connected to the shell terminal of the input connector.

NOTE! For proper amplifier operation, all three input pins **MUST** be connected!



4.2 AC/DC COUPLING

For most extracellular recording applications, AC COUPLING should be used. This permits the amplifier to ignore any small electrode potential differences that might otherwise cause amplifier saturation.

If DC amplifier response is required, set the AC/DC switch to DC, and the LOW FREQ filter switch to DC. The variable DC offset is activated by pulling out the OFFSET knob until it clicks. The DC input offset can then be adjusted as required. Three adjustment ranges are available: $\pm 2\text{mV}$, $\pm 20\text{mV}$, and $\pm 200\text{mV}$. As shipped, the range jumper is set for $\pm 20\text{mV}$.

5.0 OUTPUT

The amplified output signal is obtained from the OUTPUT BNC jack on the rear panel. This signal may be directly connected to most recording or monitoring devices, providing that their input impedance is 1000 ohms or greater. For best performance, use a shielded coaxial cable to connect the OUTPUT to your recording device. The output is short-circuit protected, but the output circuits can be damaged if a voltage is connected to this jack.

6.0 GAIN CONTROL

The gain of the BMA-200 amplifier is set using the 12-position GAIN knob. It is important to choose an appropriate gain setting for the input signal being amplified. For example, if an EMG signal is known to be about 1mV P-P (peak-to-peak), and an output signal of 1V P-P is desired, simply divide the output by the input to arrive at the proper gain setting (in this case $1\text{V}/.001\text{V}=1000$). If the gain is set too high, amplifier saturation and clipping will result. The signal-to-noise ratio of the amplifier is best when the output is in the $\pm 1\text{-}5\text{V}$ range.

7.0 CALIBRATION

Depressing the CAL switch causes both active amplifier inputs to be disconnected, and a 1mV P-P square wave at about 10Hz to be inserted at the input. This function is useful for calibrating recorders, or to provide a quick check of the amplifier and recording setup. Note that the shape of the amplified square-wave will depend on the band-pass filter settings.

8.0 FILTERS

The band-pass filters contained in the BMA-200 are of the Butterworth type, for flattest response and minimum peaking. The slope of the filters is -12dB/octave. This sharp cutoff enables the user to select the frequency band that contains the signal of interest. It is good practice to limit this band as much as possible, without attenuating the desired signal. This will dramatically improve the signal- to-noise ratio of the amplifier.

8.1 LOW FREQUENCY FILTER SWITCH (Inner Knob)

This switch selects the low frequency margin of the pass-band. Its range is DC-100Hz, in 6 positions. Note that if true DC response is required, the AC/DC switch must also be set to DC.

8.2 HIGH FREQUENCY FILTER SWITCH (Outer Knob)

This switch selects the upper frequency limit of the pass-band. Its range is from 100Hz-50kHz, in 6 positions.

9.0 AUDIO MONITOR

The built-in audio amplifier provides a convenient way of monitoring the signal being recorded. It is often possible to discriminate signals (and noise) with the ear that are difficult to see on an oscilloscope tracing. The built-in speaker is suitable for field use, but necessarily has a limited frequency response. A headphone jack is provided for connection of "Walkman-type" stereo headphones or an external speaker or amplifier/speaker combination for high-fidelity monitoring. Use stereo headphones only, with a 3.5mm mini-phone plug.

NOTE! Use of the audio monitor will shorten battery life. When not being used, be sure to switch the VOLUME CONTROL to its OFF position (fully counter-clockwise).

9.1 ON/OFF VOLUME CONTROL

This knob activates the internal audio amplifier, and sets the listening volume. To turn the audio monitor ON, rotate the knob clockwise out of its detented (OFF) position, and adjust the volume to a comfortable level. When not in use, be sure this knob is rotated fully-counterclockwise to the detented OFF position.

10.0 STIM/RECORD FUNCTION

The STIM/RECORD function allows the user to pass stimulating currents to the recording electrodes. When this function is active, the internal amplifier inputs are disconnected, and the (+) and (-) input connector pins are connected to the rear panel STIMULUS INPUT jacks. These jacks accept standard 2mm (0.080") diameter pin plugs.

While this function is most often used for passing a stimulus to the recording site, it can also be used as an input blanker. For example, if the recording electrodes are frequently repositioned, using this function will prevent amplifier saturation while the recording electrodes are moved.

The STIM/RECORD control input (BNC jack, rear panel) accepts TTL negative logic signals, or can simply be activated with a switch closure between the center contact and the shell of the BNC jack. A footswitch wired for this purpose is convenient for input blanking. This function operates via a reed relay. Response time is approximately 2.5mS.

11.0 BATTERIES

The BMA-200 operates from NiMH rechargeable batteries. Twelve AA-size cells are provided in two 6-cell packs. Battery life depends on a number of factors, but especially the extent to which the audio monitor is used. Typically, the amplifier can be used for more than 24 continuous hours between charges.

NOTE! *To conserve battery life, turn the instrument OFF when not actually being used. Turn OFF the audio monitor when it is not needed.*

11.1 BATTERY CHARGING

To recharge the optional NiCad batteries, simply connect the supplied charger to the rear panel jack. The CHG LED will be lighted, indicating that the batteries are being charged. From a fully discharged condition, allow about 15 hours for the batteries to charge. The supplied charger can also be used to power the amplifier if an AC outlet is available.

CAUTION! *Use only the battery charger supplied with the amplifier! Substituting a different charger will void your warranty and could result in permanent damage to the amplifier!*

11.2 BATTERY REPLACEMENT

To replace the batteries, follow the procedure outlined below:

- (1) Disassemble the case by removing the four screws securing the front and rear bezels. Remove the bezels.
- (2) Carefully lift up the top cover of the case. Lay the cover to one side of the case. Be careful not to dislodge the wires going to the speaker and battery packs.
- (3) Note the orientation of the battery wire connector where it plugs onto the main circuit board. Unplug this connector.
- (4) Carefully peel the battery packs from the inside surface of the top cover. Replace with a new set of battery packs by cementing in place with silicone glue or similar flexible adhesive. Let the glue cure before proceeding.
- (5) Re-connect the battery wire connector to the main circuit board, observing the orientation noted earlier. Before re-assembling the case, turn the amplifier ON and press the BATTERY TEST pushbutton to be certain all is well. If the LED's fail to light, check that the cable was installed correctly on the main circuit board.
- (6) Re-assemble the case. Finally, replace the front and rear bezels and bezel screws. Re-charge the batteries before use.

12.0 SETTING THE DC OFFSET RANGE

The range of the front-panel DC OFFSET control can be set to one of three ranges: $\pm 2\text{mV}$, $\pm 20\text{mV}$, or $\pm 200\text{mV}$. This is accomplished by placement of an internal jumper on the circuit board. The following procedure describes how the jumper is set.

- (1) Open the case to expose the circuit board as described in Section 11.2. Lay the top cover to one side, being careful not to disconnect the battery or speaker wires.
- (2) Locate the OFFSET RANGE jumper block near the left rear corner of the circuit board. Place the jumper across the appropriate pair of terminals using the silk-screened legend as a guide.
- (3) Replace the top cover and bezels. The range of the DC OFFSET control will now match the jumper setting.

13.0 OPTIONAL HEAD-STAGES

For special applications, the BMA-200 can be used with optional head-stages. Positive and negative supply voltages are present on the input connector for the purpose of powering external devices. For human subject recording demanding absolute patient safety, you should use the ISO-Z Isolation Amplifier head-stage. This device guarantees that no current will flow to the subject and complies with UL544 safe current limits. For very high-impedance microelectrode use, the HS-1 High-Impedance Head-stage is available.

14.0 USING TRANSDUCERS WITH THE BMA-200

The BMA-200 has its supply voltages present on the input connector. The primary purpose of this feature is to power the optional head-stages described earlier. These voltages remain fairly constant at about $\pm 7.2\text{V}$, but will naturally fall as the batteries are discharged. With care, it is possible to use these voltages for bridge excitation. A simple voltage regulator circuit can reduce the voltages to, say, $\pm 5\text{V}$, which will be unaffected by the state of battery charge. Since there is no current limiting provided, care must be exercised not to draw too much current from the batteries. A practical maximum would be about 20mA. Contact CWE if you are interested in designing or building such a device.

15.0 ORDERING INFORMATION

08-03000	BMA-200	AC/DC Bioamplifier, with adapter/charger & input connector
10-02020	ISO-Z	Isolation Amplifier Head-Stage
10-02030	HS-1	High-Impedance 1X Head-Stage
09-03112	ICA-400	Input cable, 9' (2.7m), with 1.5mm DIN TouchProof sockets
10-02040	BMA-931/CON	Spare unwired input connector
10-02066	D-482	Disposable pre-gelled ECG-type electrode, snap connect, pk of 150
10-02063	E-422	Snap-type electrode lead, 39" (1m) long, with 1.5mm DIN safety plug
10-02064	NEE-3	Needle electrode leads with 1.5mm DIN safety plug, pk of 3
10-02065	Alligator Lead	Alligator clip electrode lead, 1m long, color-coded, w/ 1/5mm DIN safety-plug, set of 3
08-03111	BMA-200-CHG	Replacement charger/adapter, 120/240V 50/60Hz
08-03110	BMA-200 /BAT	Replacement NiMH battery packs (2)