Instruction Manual

BMA-400

4-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 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.*

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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
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TABLE OF CONTENTS

1.0 INTRODUCTION

The BMA-400 Bioamplifier is a four-channel AC/DC preamplifier for the low-noise recording of muscle, nerve, or other biopotentials. The wide gain range of the BMA-400 allows its use as a primary amplifier whose output can be fed directly to data acquisition systems or oscilloscope displays. The six-position high and low pass filters have a sharp roll off for limiting the signal to the desired frequency bandwidth. The frequency response of the BMA-400 covers the range DC-50kHz. Provision is made for passing external stimulus currents to the electrodes. A full range of head-stages and electrode connectors is available, including a medical-grade isolation amplifier head-stage suitable for safe human subject recording.

Figure 1: BMA-400 front panel

2.0 SPECIFICATIONS

Input type ..... differential instrumentation amplifier

Input impedance ..... >10,000 MΩ

Input connector ..... 7-pin Amphenol 703-91T-3475-001

Noise, wideband, referred to input..... <7μV P-P, <3μV RMS

Common mode rejection ..... >100dB @ 60Hz

Input voltage range ..... ±1V

Input offset adjustment ranges ..... ±2, ±20, ±200mV

Bandpass filters ..... 2-pole Butterworth, -12dB/octave

Low Frequency Filter ..... DC, 1, 3, 10, 30, 100Hz

High Frequency Filter 0.1, 1, 3, 10, 30, 50kHz

Output range ..... ±10V @ 10mA

Output connector ..... BNC jack

Stim/Record control input ..... TTL negative or switch closure

Data Port connector ..... 25-pin D-SUB

Dimensions ..... 12W x 4H x 9D in. (31x10x23cm)

Weight ..... 5 lbs. (2.3kg)

3.0 POWER SUPPLY CONNECTION

The POWER SUPPLY included with the BMA-400 is a universal input device that can be used with any mains voltage in the range 95 - 240VAC, 50 or 60Hz. It is only necessary to connect the appropriate power cord for your country. The mains cord should be plugged into a grounded, three-wire outlet.

The output cable from the power supply is terminated with a 5-pin DIN plug. This should be plugged into the mating connector on the rear panel of the BMA-400 mainframe.

With the power supply connected as described above, switch POWER ON via the front panel switch. One or more indicator lights will turn on for each channel. The purpose of these lights is described in later sections.

4.0 INPUTS

The INPUT connector should be wired as described below and shown in *Figure 2*. Note that the maximum usable input range is about ±0.5V. 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 by canceling noise signals present on both active inputs. If a single-ended configuration is used, be sure to provide proper shielding of the input leads.

4.1 INPUT CONNECTOR WIRING

For typical *differential* recording applications, two active leads and one common lead are used. The two active leads are connected to pins 5 and 2 (see diagram). 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 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!

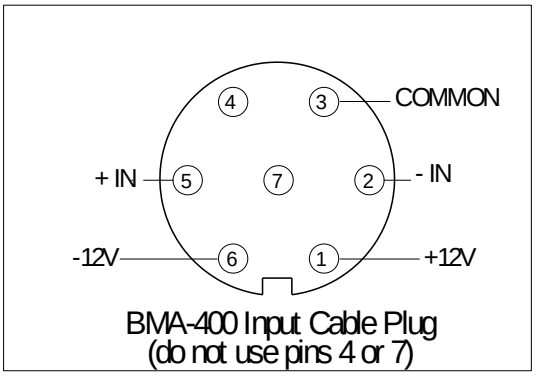

Figure 2: BMA-400 Input Connector Wiring

5.0 AMPLIFIER CONTROLS

For most applications, it is only necessary to select appropriate GAIN and BANDPASS FILTER settings. Other functions, such as stimulus passing through the recording electrodes, require use of the DATA PORT or other connections. AC coupling is normally used for extracellular recording and has the advantage of rejecting any small electrode voltage imbalances which would otherwise cause difficulties. The sections below describe the various controls available, and how and when to use them.

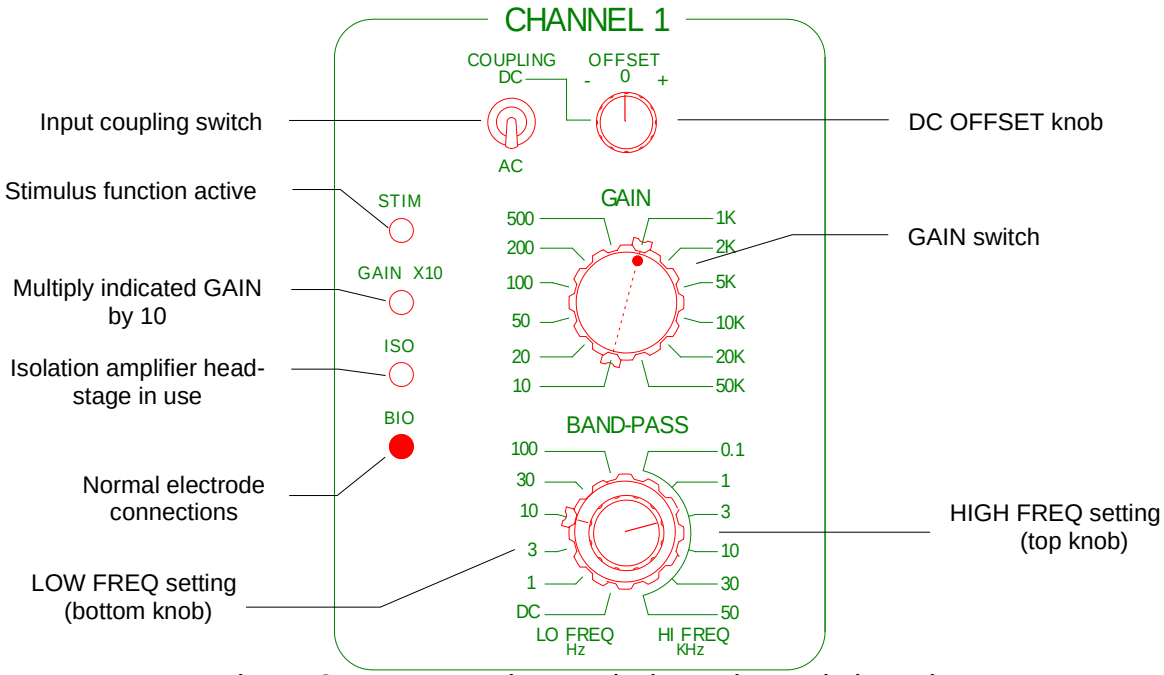

Figure 3: Front panel controls (one channel shown)

5.1 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. When AC coupling is selected, an effective low frequency (high-pass) filter of 0.1Hz is inserted.

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 knob is activated when the AC/DC switch is set to DC. The DC input offset can then be adjusted as required. Three adjustment ranges are available: ±2mV, ±20mV, and ±200mV. As shipped, the internal range jumper is set for ±20mV.

5.2 GAIN CONTROL

The gain of the BMA-400 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 voltage by the input voltage to arrive at the proper gain setting (in this case 1V / .001V = 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 ±1-5V range.

5.3 FILTERS

The band-pass filters contained in the BMA-400 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. *Table 1* shows some typical bandpass settings for various biopotential signals.

5.31 LOW FREQUENCY FILTER SWITCH (Outer 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.

5.32 HIGH FREQUENCY FILTER SWITCH (Inner Knob)

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

Table 1: Bandpass settings for typical applications

Application	**LO FREQ**	**HI FREQ**
EEG	0.1Hz	10 (or 100)Hz
ECG	0.1Hz	100Hz
EMG	10 (or 30)Hz	3KHz
single unit	100Hz	10 (or 50)KHz

5.4 INDICATOR LIGHTS

The indicator lights show important information about the configuration of each channel. In normal operation with standard electrode connections, only the BIO light will be lit. When head stages are in use, one or more of the other lights will indicate special functions. These are described below:

STIM – This light indicates that the stim function is active. That is, the input leads are temporarily disconnected from the amplifier, and connected to the corresponding stimulus inputs (see DATA PORT).

x10 – This light indicates that the front panel gain setting should be multiplied by ten to learn the true overall gain of the amplifier channel. When ISO-Z or SUPER-Z head-stages are used, they will automatically telegraph their gains to this light.

ISO – This light indicates that an isolation amplifier head-stage is in use.

BIO – This is the default indicator light. It indicates that standard, non-isolated inputs are in use.

6.0 OUTPUT (Rear Panel)

The amplified output signal for each channel is obtained from the corresponding 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. The channel output signals are also available on the DATA PORT connector.

7.0 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 routed to the rear panel STIMULUS INPUT CONNECTIONS (see DATA PORT).

While this function is most often used for passing a stimulus to the recording site, it can also be used 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 (see DATA PORT) accepts TTL negative logic signals, or can simply be activated with a switch closure between the control pin and ground. A footswitch wired for this purpose is convenient for input blanking. This function operates via a reed relay. Response time is approximately 2.5mS.

8.0 DATA PORT CONNECTOR (REAR PANEL)

The DATA PORT connector on the rear panel provides access to the following functions: stimulus inputs (two per channel); stimulus control inputs (one per channel), and; additional output signals (one per channel). The required connector is a standard 25-pin D-SUB male plug. *Figure 3* shows how these functions are accessed from the DATA PORT connector.

STIMULUS INPUTS – These inputs provide a means of temporarily connecting an external stimulus to the recording electrodes. When the STIMULUS function is active, the (+) and (-) stimulus inputs are connected to the corresponding input leads.

STIMULUS CONTROL INPUT – This input activates the STIMULUS function. The required signal is a logic low (approx. 0 - 0.4V). A simple switch closure to ground will also activate this function.

OUTPUT SIGNALS – These pins provide an additional means of accessing the individual amplifier output signals. They are identical to the signals present on the regular OUTPUT jacks.

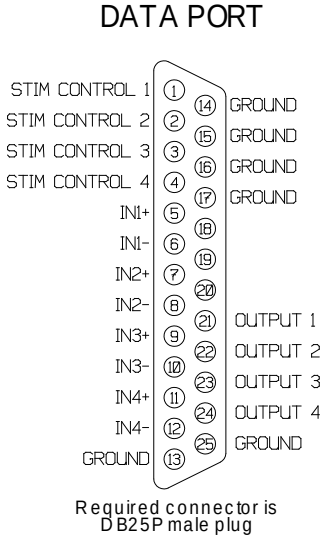

Figure 4: DATA PORT connections

9.0 SETTING THE DC OFFSET RANGE

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

❶ Remove the top cover of the case to expose the circuit boards.

❷ Locate the OFFSET RANGE jumper block near the top center of the circuit board. Place the jumper across the appropriate pair of terminals using the silk-screened legend as a guide.

❸ Replace the top cover. The range of the DC OFFSET control will now match the jumper setting.

10.0 OPTIONAL HEAD-STAGES

For special applications, the BMA-400 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 requiring 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 UL-544 safe current limits. For very high-impedance microelectrode use, the SUPER-Z High-Impedance Head-stage is available. This accessory preamplifier/buffer uses matched high-impedance buffers compatible with any electrode type, including ion-specific microelectrodes. In addition, the SUPER-Z includes switchable 10X gain, allowing an overall amplifier gain of 500,000X. All the accessory head-stages use standard 2mm (0.080") diameter pin jacks as input connectors, except the ISO-Z, which uses the required 1.5mm DIN safety socket connections.

11.0 USING TRANSDUCERS WITH THE BMA-400

The BMA-400 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 are ±12V. With care, it is possible to use these voltages as bridge excitation for pressure, force, or acceleration transducers. A simple voltage regulator circuit can reduce the voltages to, say, ±5V if required. Since there is no current limiting provided, care must be exercised not to draw too much current from this source. A practical maximum would be about 25mA. Contact CWE if you are interested in designing or building such a device.

12.0 ORDERING INFORMATION

PART NO.	MODEL	DESCRIPTION
09-03010	BMA-400	Four-channel AC/DC Bioamplifier, with international power supply and four input cables (order electrode leads separately)
09-04000	ISO-Z	Isolation Amplifier Head-Stage, 1.5mm safety socket connections
10-02030	HS-1	High-Impedance 1X Head-Stage, 2mm pin jack connections
09-03112	ICA-400	Pre-wired input cable, 9' (2.7m), with 1.5mm safety sockets
10-02040	BMA-931/CON	Spare unwired input connector
10-02064	D-482	Disposable pre-gelled ECG-type electrode, snap connect, pk of 300
10-02063	E-422	Snap-type electrode lead, 39" (1m) long, 1.5mm safety plug, pk of 3
10-02064	NEE-3	Needle electrode lead, 1.5mm safety plug, pk of 3
10-02065	Alligator Lead	Alligator clip electrode lead, 1m long, color-coded, set of 3
10-10010	BNC-3	BNC-BNC patch cable, 3’ long
10-10011	BNC-6	BNC-BNC patch cable, 6’ long
10-10012	BNC-20	BNC-BNC patch cable, 20’ long
10-02050	PIN-PLUGS	Set of 3 color-coded miniature pin plugs for custom cables, unwired
10-02051	PIN-DIN Adapter	2mm pin jack to 1.5mm DIN safety-socket plug, 5” (13cm) long (allows use of PIN-PLUGS with ICA-400 cable and ISO-Z head-stage, set of 3
09-03200	BMA-400 PS	110/220V international power supply
09-03011	RACK-MOUNT	Rack-mounting kit for BMA-400