

**EEG100C – ELECTROENCEPHALOGRAM AMPLIFIER MODULE**

The electroencephalogram amplifier module (EEG100C) is a single-channel, high-gain, differential input, biopotential amplifier designed specifically for monitoring the neuronal activity of the brain. The EEG100C is designed for use in the following applications:

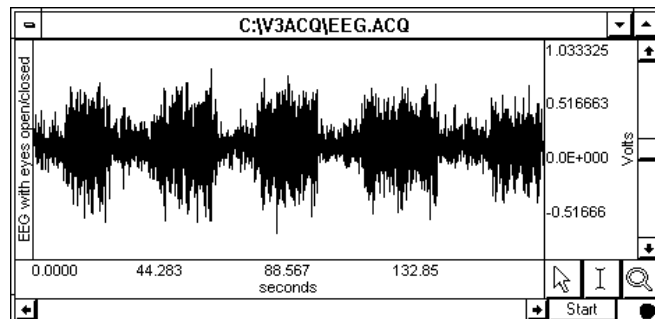
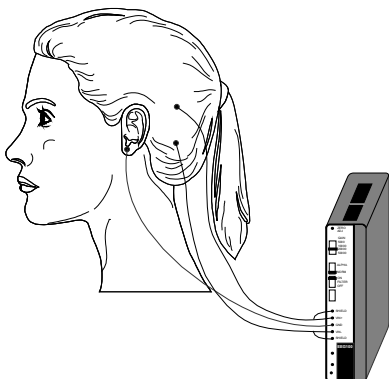
- |  |                   |
|--|-------------------|
| Conventional EEG (16 channel, unipolar or bipolar) | Sleep studies     |
| Epilepsy investigations                            | Evoked responses  |
| Tumor pathology studies                            | Cognition studies |

The EEG100C will connect directly to any of BIOPAC Systems, Inc.’s series of Ag-AgCl lead electrodes. Typically, EL503 electrodes are recommended for evoked response measurements. Use two shielded electrodes (LEAD110S) for the signal inputs and one unshielded electrode (LEAD110) for ground. If hair is present, disposable electrodes don’t work very well for scalp attachment—add electrode gel (GEL100) and tape the electrode lightly in place or use a conductive adhesive paste (like Ten20® or Collodion HV®).

The EEG100C has built-in drive capability for use with shielded electrode leads. If high bandwidth (resolution) EEG measurements are required, then shielded electrode leads are recommended. When the interference filter is switched on, shielded leads are typically not necessary.

This module is designed to pass the EEG signal ranges (Delta, Theta, Alpha, Beta, and Gamma) with minimal distortion. In addition, the EEG100C has a built-in Alpha wave detector. When enabled, the output signal will produce a smoothed wave with peaks that indicate points of maximum Alpha activity. The Alpha wave detector consists of a highly selective, six pole, 8-13 Hz bandpass filter, followed by a full wave rectifier, followed by a 6Hz, three pole, low pass filter. The EEG100C is capable of measuring Slow Cortical Potentials, down to 0.005 Hz in frequency (32 second time constant).

**BIPOLAR EEG ELECTRODE PLACEMENT**



*EEG waveform with eyes closed then opened*

***Bipolar connection to the occipital lobe***

The illustration above shows a bipolar connection to the occipital lobe; to make a unipolar connection, relocate the VIN- electrode to the earlobe (where GND is attached). The graph indicates the change in the occipital EEG when eyes are closed and opened. The data is shown compressed, but can easily be expanded to show waveform differences in greater detail.

**FREQUENCY RESPONSE CHARACTERISTICS**

The 0.005 Hz high pass and 0.5 Hz high pass lower frequency response settings are single pole, roll-off filters.

Modules can be set for 50 Hz or 60 Hz notch options to match the wall-power line frequency of the destination country. The proper setting reduces noise from interfering signals when the notch filter is engaged. Generally, wall-power line frequency is 60 Hz in the United States and 50 Hz in most of Europe and China; if necessary contact BIOPAC to determine the appropriate line frequency. To reset the line frequency setting, adjust the bank of switches on the left panel of the amplifier module (as shown on the next page).

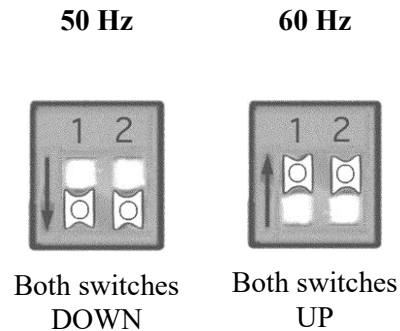
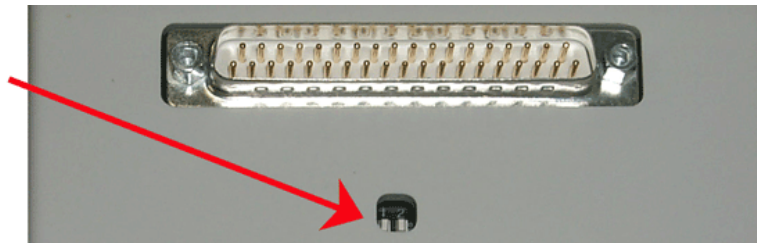
The 50/60 Hz notch is only engaged when the 35 Hz LPN filter switch on the EEG100C amplifier is set to ON.

FREQUENCY RESPONSE, CONT'D

See also: Frequency response Plots

- 35 Hz LPN (with 50 Hz notch enabled)
- 35 Hz LPN (with 60 Hz notch)
- 100 Hz LP option

Line Frequency switch bank is on the left panel of biopotential and transducer amplifiers



EEG100C CALIBRATION

The EEG100C is factory set and does not require calibration. To confirm the accuracy of the device, use the CBLCALC.

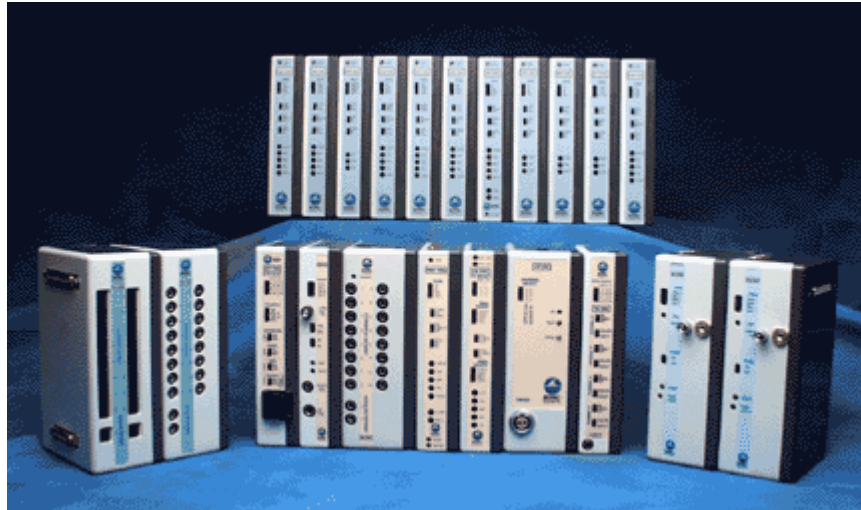
Hardware settings are based on line frequency, which varies by country. To confirm that line frequency is set correctly for the country, check the switches on the left panel of the amplifier.

EEG100C SPECIFICATIONS

Gain:	5000, 10000, 20000, 50000			
Output Selection:	Normal, Alpha Wave indicator			
Output Range:	±10 V (analog)			
Frequency Response	Maximum bandwidth (0.005 Hz – 100 Hz)			
Low Pass Filter:	35 Hz, 100 Hz			
High Pass Filter:	0.005 Hz, 0.5 Hz			
Notch Filter:	50 dB rejection @ 50 Hz or 60 Hz			
Noise Voltage:	0.1 µV rms – (0.005–35 Hz)			
Signal Source:	Electrodes (three electrode leads required)			
Z (input)	Differential: 2 MΩ		Common mode: 1000 MΩ	
CMRR:	110 dB min (50/60 Hz); see also: <a href="#">Shield Drive Operation</a>			
CMIV—referenced to	Amplifier ground: ±10 V		Mains ground: ±1500 VDC	
Input Voltage Range:	<u>Gain</u>	<u>V<sub>in</sub> (mV)</u>	<u>Gain</u>	<u>V<sub>in</sub> (mV)</u>
	5000	±2	20000	±0.5
	10000	±1	50000	±0.2
Maximum Over-Voltage for Differential Input:	±25 V			
Weight:	350 grams			
Dimensions:	4 cm (wide) x 11 cm (deep) x 19 cm (high)			
Input Connectors:	Five 1.5 mm male Touchproof sockets (Vin+, Ground, Vin-, 2 of shield)			

See also: JUMP100C and MEC series

## AMPLIFIER MODULES

*100C series modules*

The 100C series biopotential/transducer amplifier modules are single channel, differential input, linear amplifiers with adjustable offset and gain. These modules are used to amplify smaller voltage signals coming from raw electrodes and transducers (typically less than  $\pm 0.01$  volt). In addition to amplifying signals, most of the 100C series modules include selectable signal conditioning ability so that data may be filtered or transformed as it is being collected.

- **Biopotential modules:** ECG100C, EEG100C, EGG100C, EMG100C, EOG100C, ERS100C
- **Transducer modules:** EDA100C; PPG100C; RSP100C; SKT100C
- **MRI Smart modules**—advanced signal processing circuitry removes spurious MRI artifact from the source physiological data: ECG100C-MRI; EDA100C-MRI; EEG100C-MRI; EMG100C-MRI; PPG100C-MRI.

Modules can be cascaded by snapping the modules together. Up to sixteen 100C series modules can be connected to the MP System at any one time.

**IMPORTANT**

When cascading modules, it is important to remember that **no two amplifiers may be set to the same channel**. If two connected amplifier modules are left on the same channel, then contention will result and both amplifier outputs will give erroneous readings.

**Amplifier offset** Set by the zero adjust control trim potentiometer near the top of the module. The offset control can be used to adjust the zero point or “baseline” of a signal.

**Gain Switch** The four-position slide Gain switch controls sensitivity. Lower gain settings will amplify the signal to a lesser extent than higher gain settings. If the signal plotted on the screen appears to be very small for a given channel, increase the Gain for that particular channel. Conversely, if the signal seems to be “cropped” at +10 Volts or –10 Volts, decrease the Gain.

**Connections** Transducers and electrodes connect to the amplifiers using 1.5 mm female Touchproof connectors.

- Electrodes** The biopotential amplifier modules use a three-electrode arrangement (VIN+, GND, VIN-). Although certain applications may require different arrangements of electrodes and/or transducers, some generalizations about electrode and transducer connections can be made. Electrodes measure the electrical activity at the surface of the skin, and since electricity flows from – to +, measuring the flow of a signal requires that there be (at least) one “-” electrode and (at least) one “+” electrode. An additional electrode, a “ground” (or earth) electrode is used to control for the general level of electrical activity in the body.
- Leads** Typically, electrode leads are used to connect individual electrodes to the xxx100C amplifier. Most electrode leads are shielded, which means they introduce less noise than an unshielded lead. A shielded electrode lead has an extra jack on one end that plugs into the SHIELD input on the amplifier modules. A standard electrode lead configuration consists of two LEAD110S electrode leads (one connected to the VIN + input and one to the VIN – input on the amplifier) and a single LEAD110 (connected to the GND input on a biopotential amplifier).
- Transducers** Transducers, on the other hand, are not designed to measure electrical activity directly and usually involve simpler connections. The transducers discussed in this manual translate physical changes (in temperature, for instance) into electrical signals. Connections for individual transducers are discussed in each section.
- Channel** The active channel is selected using the channel select switch on the top of the module. The channel select switch can direct the amplifier output to one of sixteen possible MP System input channels. *Remember to make sure that each amplifier module is set to a unique channel.*
- Zero Adjust** On input signals, a limited range in baseline level (DC offset) can be “zeroed out” using the zero adjust potentiometer. Typically, the zero adjust will not have to be used (as it is preset at the factory). However, some of the 100C series modules can measure DC signals and, in certain circumstances, signal “zeroing” may be required.
- Setup** All 100C Series biopotential or transducer amplifiers incorporate specific gain, coupling and filtering options that are appropriate for the biopotential type or transducer signal that requires measurement. Generally, when an electrode or transducer is inserted into the corresponding 100C series module, the amplifier will immediately produce a useful output, with no user adjustments necessary.
- Certain functionality is added to each module to optimize its performance with its intended signal measurement. For example, all 100C series biopotential amplifiers incorporate a selectable interference filter. When the interference filter is on, 50/60 Hz interfering signals are suppressed.
- Filters** All 100C series amplifiers are constructed with filters that have a high degree of phase linearity. This means the 100C series modules will filter signals with as little distortion as possible. These modules also incorporate protection circuitry to limit input current in the event of input signal overload. Notch and bandstop filters have the potential to cause distortion, especially in the form of “ringing” in the data stream; biopotential hardware notch filters are implemented in conjunction with LP or HP functions to minimize distortion.
- Line Freq** Line Frequency is set using the recessed switch boxes on the left panel of the amplifier module (50 Hz = all switches down, 60 Hz = all switches up). It is important to select the correct line frequency for your geographical region. Typically, U.S. line frequency is 60 Hz; Europe and China 50 Hz. Contact BIOPAC for additional line frequency information. All MP biopotential amplifier modules which contain a 50/60 Hz notch filter only engage the filter when the pass filter is also ON:
- ECG100C, EEG100C, EOG100C amplifiers: the 50/60 Hz notch is only engaged when the 35 Hz LPN low pass notch filter switch is set to ON.
  - EMG100C, ERS100C amplifiers: the 50/60 Hz notch is only engaged when the 100 Hz HPN high pass notch filter switch is set to ON.

See individual module sections for details.