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## ERS100C – EVOKED RESPONSE AMPLIFIER MODULE


The Evoked Response Amplifier Module (ERS100C) is a single channel, high gain, extremely low noise, differential input, biopotential amplifier designed to accurately amplify the very small potentials (< 200 nV) associated with evoked response measurement. The ERS100C is designed for use in the following applications:

- Auditory brainstem response (ABR) testing
- Visual evoked response testing
- Nerve conduction velocity and latency recording
- Somatosensory response testing

The ERS100C will connect directly to any of BIOPAC's C-series module extension cables (such as MEC110C) and then to 10 mm Gold-plated Cup electrodes (such as EL160 and EL160-EAR). Electrodes should be applied per standard practice, using ELPREP for skin prep and GEL102 conductive gel. After attachment and strain relief, check impedances with EL-CHECK.

To provide a linked ear connection, a CBL204 TouchProof "Y" Lead Adapter should be added to the $V^-$ side of the amp. Ground should be placed on the forehead or in another convenient location. The ERS amp can be used when other biopotentials are being recorded, though only one ground electrode need be applied to a participant.; if a second ground is needed, please use CBL205 AC-Coupled Lead Adapter and follow BIOPAC Grounding Guidelines.

The ERS100C has built-in drive capability for use with shielded electrode leads. Shielded leads are typically required, as the ERS100C has a frequency response that extends through the 50/60 Hz interference bands. Furthermore, the ERS100C is used to amplify extremely low-level signals that can be easily corrupted by interfering signals.

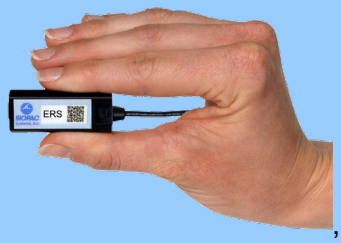
The ERS100C incorporates selectable gain and bandwidth options to perform a variety of evoked response testing. The ERS100C is typically used with two shielded electrodes for signal input and one unshielded electrode for ground. In nearly all cases of stimulus response testing, the ERS100C will be used in conjunction with the MP Data Acquisition System and the STM100C general-purpose stimulator that can be used to present auditory, visual, or mechanical stimulus signals.

For most types of evoked response testing, the MP System will be operating in averaging mode. Typically, the stimulus output (usually a pulse) will be output through one of the analog channels (Out 0 or Out 1) or I/0 15 just prior to the data collection pass. Stimuli output on analog channels typically consist of pulses or tones, and stimulus output waveforms can easily be created and modified using the Acq*Knowledge* Stimulator setup, described in the Software Guide.

### Auditory Evoked Potentials

The ERS100C can record auditory evoked potentials, like the ABR. Use the STM100C to present an auditory pulse or "click" to the auditory stimulator, such as the ER-3A Tubephone. Present the acoustical signal to the active ear using a calibrated auditory earphone like the OUT101 Tubephone.

*Alternative:* **ERS Smart Amp**




ERS100D Extremely low noise differential amplifier that accurately amplifies very small potentials.

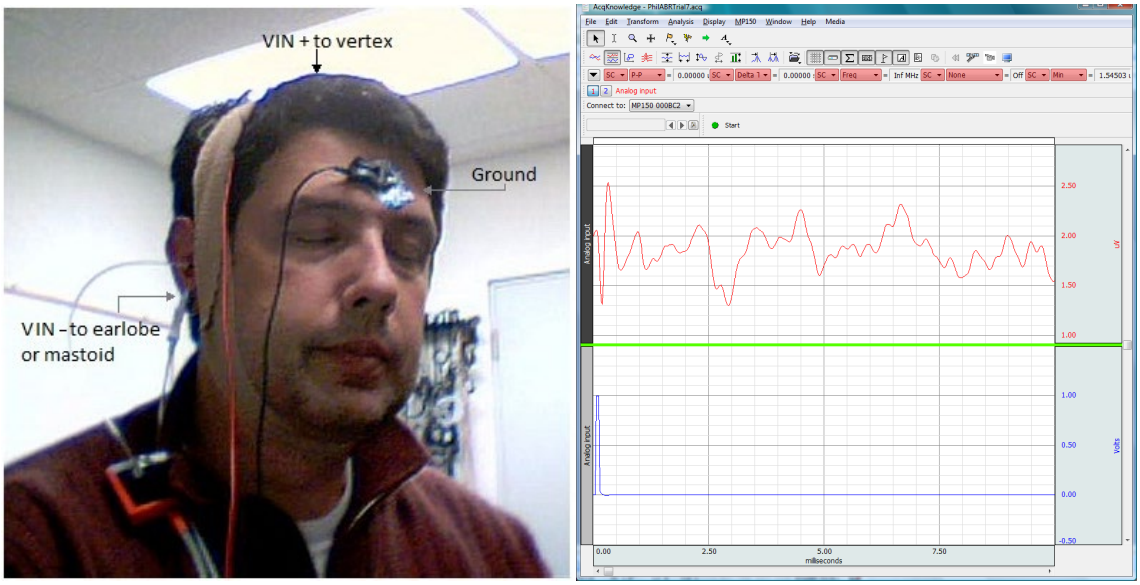
Smart Amplifiers are designed for great data. Smart Amplifiers improve performance by amplifying the physiological signal close to the subject, which allows a high-level voltage connection to the data acquisition system and reduces noise artifact.

## Auditory Brainstem Response

To record the ABR:

1) Place the active (VIN-) electrode at the earlobe or mastoid.
2) Place the reference (VIN+) electrode at the vertex.
3) Place the ground electrode at the forehead

The MP System collected the data in the "Averaging" mode.




*ABR electrode setup and 2000 trial ABR test performed using the ERS100C with the STM100C and OUT101 (Tubephone)*

## Somatosensory response

Somatosensory tests are used to characterize the perception of touch. Active electrodes are usually placed on an earlobe, and passive electrodes are placed on the contralateral earlobe. The ground electrode is placed on the forehead. In somatosensory response tests, the stimulation source is usually an electrical pulse or mechanical impulse applied at some point along the leg or arm

## General nerve conduction velocity

The ERS100C can also be used for general nerve conduction velocity tests, and will perform exceptionally well since the ultra low noise characteristics of the ERS100C are not required to obtain the best results and these tests don't require the extensive averaging required for auditory or visual evoked response measurements

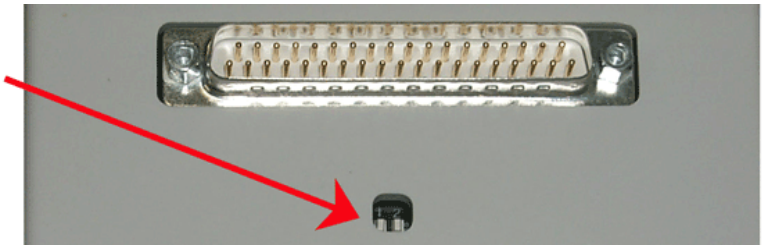
## FREQUENCY RESPONSE CHARACTERISTICS

The 1 Hz high pass or 20 Hz high pass lower frequency response settings are single pole roll-off filters.

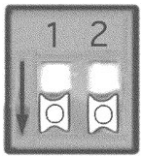
Modules can be set for 50 Hz or 60 Hz notch options to match the wall-power line frequency of the destination country. The proper setting reduces noise from interfering signals when the notch filter is engaged. Generally, wall-power line frequency is 60 Hz in the United States and 50 Hz in most of Europe 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.

The 50/60 Hz notch is only engaged when the 100 Hz HPN filter switch on the ERS100C amplifier is set to ON.

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

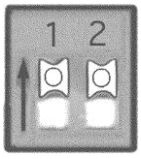


**50 Hz**




Both switches DOWN

**60 Hz**




Both switches UP

See also: Sample frequency response plots

100 Hz HPN (with 50 Hz notch)
100 Hz HPN (with 60 Hz notch)
3,000 Hz LP
10 kHz LP

## ERS100C CALIBRATION

The ERS100C is factory set and does not require calibration. To confirm the accuracy of the device, use the CBLCALC.

## ERS100C SPECIFICATIONS

| | |
|---|---|
| Gain: | 5000, 10000, 20000, 50000 |
| Output Range: | ±10 V (analog) |
| Frequency Response | Maximum bandwidth (1.0 Hz – 10 kHz) |
| Low Pass Filter: | 3 kHz, 10 kHz |
| High Pass Filter: | 1.0 Hz, 20 Hz, 100 Hz |
| Notch Filter: | 50 dB rejection @ 50 Hz or 60 Hz |
| Noise Voltage: | 0.5µV rms – (100-3000 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: Shield Drive Operation |
| CMIV–referenced to | |
| Amplifier ground: | ±10 V |
| Mains ground | ±1500 VDC |

Input Voltage Range

| Gain | Vin (mV) |
|---|---|
| 5000 | ±2 |
| 10000 | ±1 |
| 20000 | ±0.5 |
| 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) |

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## AMPLIFIER MODULES


***100C series biopotential; 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 ±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; NICO100C-MRI, and 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.

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**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 *xxx*100C 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.