info@biopac.com
support@biopac.com
www.biopac.com

PPG100C – PHOTOPLETHYSMOGRAM AMPLIFIER MODULE

The photoplethysmogram amplifier module (PPG100C) is a single channel amplifier designed for indirect measurement of blood pressure or density. The PPG100C is designed for use in the following applications:

- General pulse rate determination
- Blood pressure analysis
- Exercise physiology studies
- Psychophysiological investigations

The PPG100C couples to a photoplethysmogram (PPG) transducer (TSD200 or TSD200C) to record the Blood Volume Pulse (BVP) waveform via optical (photoplethysmogram) methods. The peak measurement recorded by the PPG100C indicates the point of maximal blood density in the respective location. Indications of blood pressure can be inferred by comparing the point of R-wave onset in the ECG to the point of maximum blood density recorded by the PPG100C.

The PPG100C includes lower frequency response selection switches, which permits either absolute (DC) or relative (via 0.05 or 0.5 Hz high pass filters) blood density measurements.

The PPG100C also has the capability to interface to a wide range of commercially available optical probes. Specifically, optical transducers for SpO_2 can easily be used with the PPG100C, via the TCIPPG3 snap on interface. The TCIPPG3 interface adapter plugs into the front of the PPG100C and allows it to work with SpO_2-type probes that terminate in a 9-pin D female connector (such as those from Nonin®). The visible light transmitter and receiver of the probe is employed to establish a very high quality, high S/N ratio, transmissive, photo-plethysmogram signal, suitable for evaluating PPG signal characteristics. Note that this configuration does not provide SpO_2 output, but rather a highly-detailed PPG waveform versus time. Probes are available for fingers, toes, earclip and universal attachment. BIOPAC probes compatible with the TCIPPG3 / PPG100C combination include the TSD124A, TSD124B and TSD124C. The TCIPPG3 also supports use of the OXY100E-200 extension cable.

FREQUENCY RESPONSE CHARACTERISTICS

The 0.05 Hz high pass and 0.5 Hz high pass lower frequency response settings are single pole roll-off filters.

See also: Sample frequency response plots. 10 Hz LP

PPG100C CALIBRATION

None required.

PPG100C SPECIFICATIONS

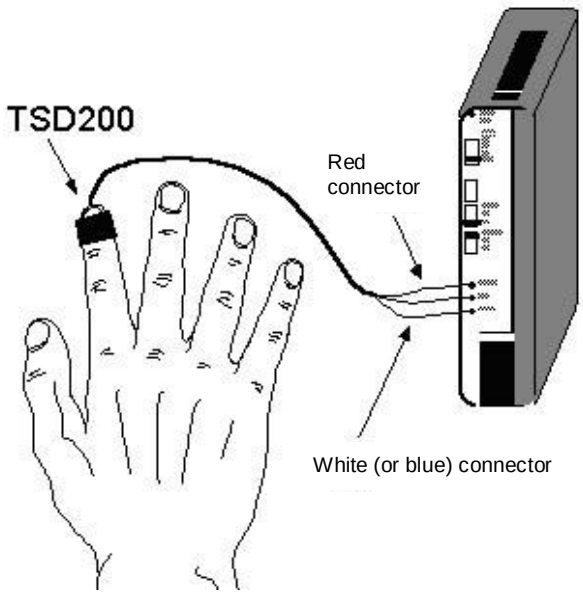
Gain:	10, 20, 50, 100
Output Range:	±10 V (analog)
Low Pass Filter:	3 Hz, 10 Hz
High Pass Filter:	DC, 0.05 Hz, 0.5 Hz
Noise Voltage:	0.5 µV rms ï amplifier contribution
Excitation:	6 V
Signal Source:	TSD200 Photoplethysmogram Transducer
Weight:	350 grams
Dimensions:	4 cm (wide) x 11 cm (deep) x 19 cm (high)
Upper Frequency Response:	10 Hz
Lower Frequency Response:	DC or 0.05 Hz or 0.5 Hz
Noise Voltage:	0.5 µV (rms) ï amplifier contribution

Gain Settings:	
Input Signal Range (pk-pk):	Gain:
2000 mV	x 10
1000 mV	x 20
400 mV	x 50
200 mV	x 100
Input Connectors:	Three 1.5 mm male Touchproof sockets (Vsup, Ground, Input)

This illustration shows the proper connections to use the TSD200 with the PPG100C. The TSD200 can be placed on other body locations by employing ADD208 adhesive disks to hold the TSD200 in place.
The TSD200 connects to the PPG100C as follows:

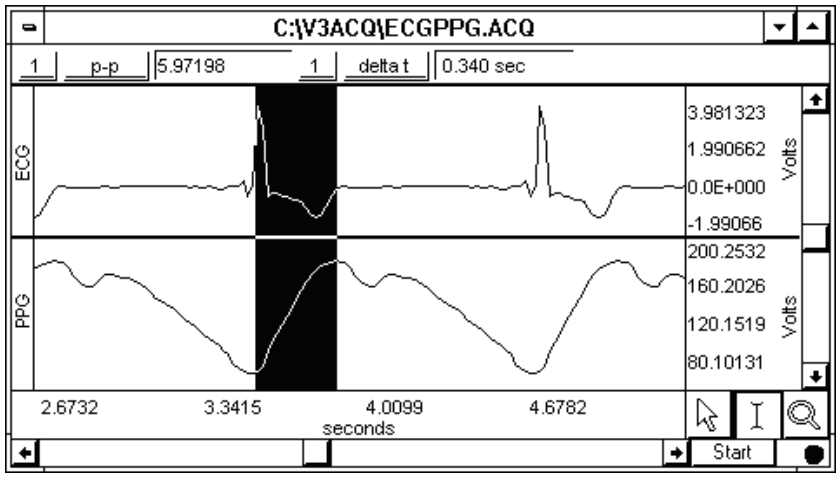
TSD200 Lead	PPG100C
Red connector	VIN+/+VSUP
Black connector	GND
White* connector	VIN-/INPUT

*may be blue shrink wrap instead of white connector



Finger pulse measurement using the PPG100C and TSD200

This graph illustrates photoplethysmogram data indicating blood density with respect to the acquired ECG. The distance between peaks on the two channels can provide indications of blood pressure, vascular resistance and compliance.



Photoplethysmogram data and ECG waveforms

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support@biopac.com
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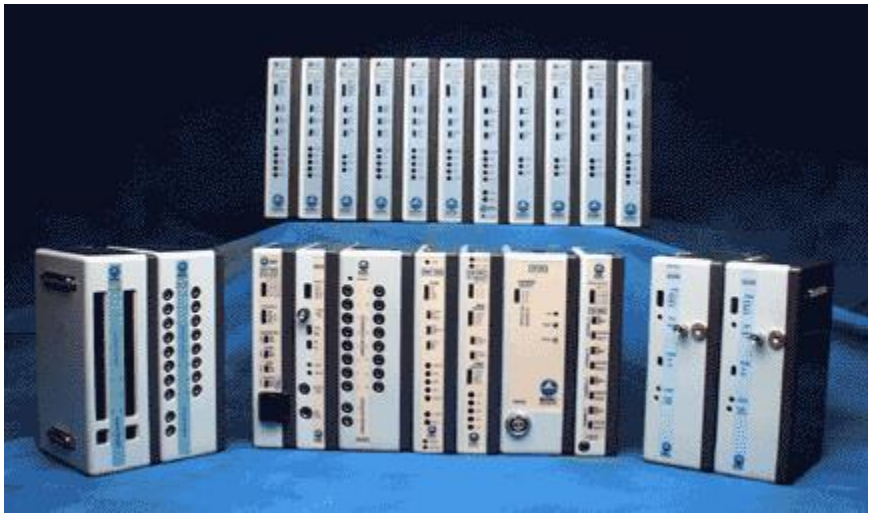
AMPLIFIER MODULES



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 ±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**ð 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 ñbaselineò 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 ñcroppedò 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 ï to +, measuring the flow of a signal requires that there be (at least) one ñ-ò electrode and (at least) one ñ+ò electrode. An additional electrode, a ñgroundò (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 ï 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 ñzeroed outò 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 ñzeroingò 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.