

Warner Instruments, Inc.
Differential Amplifier
Model DP-311



Warner Instruments, Inc.
1125 Dixwell Avenue, Hamden, CT 06514
(800) 599-4203 / (203) 776-0664
(203) 776-1278 - fax

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The model **DP-311** is a battery powered AC/DC amplifier offering very low noise, high gain and excellent common mode rejection.

The **DP-311** is designed for amplifying signals such as EEG, EKG and extracellular action potentials. With gain selections of x10, x100, x1000 and x10,000, μV level signals are sufficiently amplified for computer signal analysis. The input impedance is typically $10^{12} \Omega$ and the input leakage is typically 1 pA.

The unit features both high pass and low pass filters, plus a DC operation mode. An input-offset control nulls potentials present at the input, which can be seen at the output in DC mode. Front panel test pins apply 1 mV pulses to the headstage input to check operation of the entire system.

The **DP-311** is powered by AC line power and contains no batteries. The line voltage covers a range of 90-270 V AC at 50 or 60 Hz. Consequently there is no need to select the line voltage.

Principal features of the **DP-311** include:

- ✓ Low noise
- ✓ Gains to x 10,000
- ✓ Excellent common mode rejection
- ✓ Internal 2-pole low-pass Bessel filter
- ✓ Internal 2-pole high-pass Bessel filter
- ✓ Compact design

**THIS EQUIPMENT IS NOT DESIGNED NOR INTENDED
FOR USE ON HUMAN SUBJECTS**

NOMENCLATURE

Text conventions

This manual refers to amplifier controls at two functional levels; specific controls and the settings of these controls. To minimize the potential for confusion, we have employed the following text conventions.

- Product numbers are presented using **bold type**.
- References to a specific control is specified using SMALL CAPS.
- References to individual control settings are specified using *italic type*.
- Special comments and warnings are presented in highlighted text.
- Any other formatting should be apparent from context.

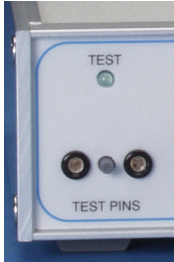
Since it is our goal to provide clarity rather than complexity, we welcome any feedback you may wish to provide.

CONTROL DESCRIPTION

The front panel of the **DP-311** houses the TEST JACKS, an OFFSET CONTROL, the HIGH PASS FILTER and LOW PASS FILTER controls, a GAIN CONTROL, and an OUTPUT BNC.

The POWER SWITCH, the HEADSTAGE INPUT, and the CIRCUIT and CHASSIS GROUNDS are located on the rear panel of the **DP-311**. The power cord attachment and fuse are also located on the rear panel.

Front panel



Test Jacks

The TEST JACKS provide a 1 mV test signal for the system. A light indicates operation of the internal generator which is *on* when the small button between the TEST JACKS is depressed by the headstage.

Offset Control

The OFFSET CONTROL provides DC offset to the amplifier inputs. The instrument is capable of providing offsets up to ± 600 mV in either AC or DC modes.

CLIPPING LIGHTS indicate clipping of the amplifier output. Two LEDs are provided to indicate clipping *high* or clipping *low*. Clipping offsets can be adjusted using the OFFSET CONTROL.



High-pass Bessel filter

The HIGH-PASS BESSEL FILTER sets the low frequency limit of the amplifier from DC to 300 Hz in 6 steps of *DC*, *0.1*, *1*, *10*, *100*, and *300 Hz*.

While placing the amplifier in *DC* mode disables the high-pass filter, all other controls remain active.

Low-pass Bessel filter

The LOW-PASS BESSEL FILTER sets the high frequency limit of the amplifier from 100 Hz to 50 kHz in 6 steps of *100*, *300*, *1000*, *3000*, *10,000*, and *50,000 Hz*.



Gain Control

The gain control sets the overall system gain from 10 to 10,000 in 4 steps.

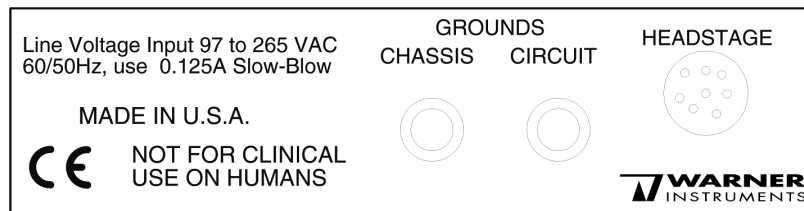
Power

The power section contains an LED which indicates when power is applied to the unit. (The POWER SWITCH is located on the rear-panel.) The OUTPUT BNC is also located in this section and provides connection to a chart recorder, oscilloscope or data acquisition system.



Rear Panel

The rear panel of the **DP-311** houses the POWER SWITCH, the FUSE/POWER ENTRY MODULE, CIRCUIT and CHASSIS GROUNDING JACKS and the HEADSTAGE CONNECTOR.



SETUP AND TEST

Setup

Setup of the **DP-311** is simple. Place the amplifier near your experiment and connect the power cable to the rear of the instrument. Run a BNC from the OUTPUT of the **DP-311** to your data collecting apparatus (e.g. data acquisition system). Place the headstage into position within your experimental setup and connect the headstage to the amplifier.) Setup is complete.

NOTE: Be sure the POWER SWITCH is *off* before plugging the amplifier in.

Test

Before beginning an experiment, it's a good practice to perform a simple test to verify that the **DP-311** is functioning properly.

1. With the power *off* set the front panel controls as follows:

HIGH-PASS (Hz)	DC
LOW-PASS (Hz)	10 kHz
GAIN	1000

2. Connect the **DP-311** OUTPUT BNC to an oscilloscope or your data acquisition system.
3. Connect the headstage to instrument and turn the power *on*.
4. Plug the headstage into the TEST JACKS, but not far enough to depress the TEST BUTTON between the pins.
5. Adjust the OFFSET CONTROL for a *zero-volt* baseline on the oscilloscope.
6. Set the HIGH-PASS FILTER control to *0.1 Hz*
7. Allow time for the baseline to return to zero.
8. Push the headstage fully into the TEST JACKS (i.e.: far enough to depress the test button).

NOTE: Take care to keep the headstage handle perpendicular to the TEST JACKS to avoid stressing the input pins of the headstage.

9. When the TEST BUTTON is depressed, the TEST INDICATOR LED will be *on* and the amplifier will enter test mode.
10. In test mode, the headstage input is connected to a 1 mV p-p square wave at 100 Hz. This signal will appear as a 1 V p-p square wave at the OUTPUT BNC when the instrument gain is at 1000. Note that both CLIPPING INDICATORS are *off*.

OPERATION

The amplifier can be placed in either *AC* or *DC modes* and can be used for either differential or single-ended readings. Therefore, four configurations are possible.

AC mode

In *AC mode*, the headstage inputs are capacitively coupled (AC coupled) to the amplifier through a DC blocking capacitor. This prevents pure DC from entering the amplifier. As a result, the amplifier output will return to baseline in the presence of a constant potential difference at the headstage inputs.

The amplifier is placed in *AC mode* by selecting a cut off frequency other than *DC* (e.g., 0.1, 1.0, 10, 100, or 300 Hz) using the HIGH PASS FILTER control. *AC mode* is useful for recording biopotential signals such as EEG, EMG, and ECG.

DC mode

In *DC mode*, the headstage inputs are direct coupled (DC coupled) to the amplifier through a resistance. As a result, a constant potential difference at the headstage inputs will be passed to the amplifier output.

DC mode is useful for making measurements through high impedance fluid filled microelectrodes. Warner Instruments manufactures a complete line of microelectrode holders useful in connecting microelectrodes to the **DP-311** headstage.

The following electrode holders are recommended for use with **DP-311**:

Holder	Model	Order #
for 1.0 mm OD glass	ESP-F10N	64-0980
for 1.2 mm OD glass	ESP-F12N	64-0981
for 1.5 mm OD glass	ESP-F15N	64-0982
for 2.0 mm OD glass	ESP-F20N	64-0983

Input Connections

The pins on the headstage represent the positive and negative inputs of a differential amplifier and the headstage case is connected to the system ground.

For differential readings, use both pins for inputs. A GROUND CLIP is provided to connect the headstage case (i.e.: system ground) to the experimental ground if so desired.

For single-ended readings, the GROUND CLIP can be tied to the negative input pin, allowing the positive pin to be used as the amplifier input.



NOTE: The negative and positive pins are labeled on the headstage.

Output Connection

The OUTPUT BNC connector on the front panel is the output of the amplifier. It is used to tie the **DP-311** to an oscilloscope or recording device. If a data acquisition system is used, it must be capable of resolving a ± 10 V signal.

Similar to the headstage, the shell of the OUTPUT BNC is also connected to the system ground. When the OUTPUT BNC of the **DP-311** is connected to an oscilloscope (or recording device), the ground of the oscilloscope will be carried through to the headstage case via the common ground. Consequently, any part of the experiment that is tied also to the headstage ground will be connected to the oscilloscope ground.

NOTE: Under these conditions, any additional grounds connected to the headstage case will create a ground loop in the system.

APPENDIX

Specifications

Voltage Gain:	x10, x100, x1000, x10,000
Input Resistance:	$10^{12} \Omega$ typical
Input Leakage Current:	1.0 pA typical
Common-mode Rejection:	120 dB minimum @ 60 Hz
Noise, input shorted:	< 10 μ V p-p, 1.0 Hz to 10 kHz
Front-panel test signal:	1.0 mV p-p @ 100 Hz square wave
2-Pole Bessel filters	
Low-frequency (high pass):	open circuit, 0.1, 1, 10, 100, 300 Hz
High-frequency (low pass):	100, 300, 1k, 3k, 10k, 50k Hz
Maximum Common-mode signal:	± 2 V
Output voltage swing (10k load):	± 10 V (± 5 V at gain = x10)
Offset control range:	± 600 mV at output (DC mode), any gain
Output Resistance:	50 Ω
Input connectors:	two 2 mm pins, 0.5 inches (12.7 mm) apart
Output connector:	BNC
Power Requirements:	90 - 270 VAC, 50/60 Hz (no selector switch)

Warranty

The **DP-311** is covered by our Warranty to be free from defects in materials and workmanship for a period of one year from the date of shipment. If a failure occurs within this period, we will either repair or replace the faulty component(s). This warranty does not cover failure or damage caused by physical abuse or electrical stress (e.g., inputs exceeding specified limits).

In the event that repairs are necessary, shipping charges to the factory are the customer's responsibility. Return charges will be paid by Warner Instruments.

Service

We recommend that all questions regarding service be referred to our Technical Support Department.

We are located at 1125 Dixwell Avenue, Hamden, CT 06514. Normal business hours are Monday through Friday, 8:30 AM to 5:00 PM (EST). We can be reached by phone at (800) 599-4203 or (203) 776-0664. Our fax number is (203) 776-1278.

E-mail us at support@warneronline.com or through the contact section of our website at <http://www.warneronline.com>.