Warner Instruments
4 Channel Differential Amplifier
with Active Headstages

Model DP-314

Warner Instruments
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The **DP-314** 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} Ω 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-314** is powered by AC line power and contains no batteries. The line voltage covers a range of 90-120 and 220-250 V AC at 50 or 60 Hz. Switch selectable, via rear panel mounted switch located in the power entry module.

Principal features of the **DP-314** include:

- ✓ Low noise
- ✓ Gains to x10,000
- ✓ 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 our goal is to provide clarity rather than complexity, we welcome your feedback on this manual.

CONTROL DESCRIPTION

The front panel of the **DP-314** houses a TEST circuit (common to all channels), and INPUT OFFSET, HIGH PASS and LOW PASS filters, GAIN control, and OUTPUT BNC'S for each channel.

The CIRCUIT and CHASSIS GROUNDS are located on the instrument rear panel along with the power cord attachment, fuse, and line voltage selector switch.

Front panel

Test Circuit

The TEST circuit is used for evaluation of all amplifier channels and provides a 1 mV test signal for system evaluation.

An LED indicates operation of the internal signal generator which is *on* when the small button between the TEST JACKS is depressed by the headstage.

Offset Control

Each camplifier channel has a separate OFFSET CONTROL. This control provides DC offset to the amplifier inputs and is used to zero the amplifier output.

The **DP-314** is capable of applying offsets up to ±600 mV in either AC or DC modes.

Clipping Lights and Output BNC

CLIPPING LIGHTS are provided for each channel in the **DP-314** and indicate clipping of the amplifier's output. Two LEDs are provided to indicate clipping *high* or clipping *low*. Clipping offsets can be adjusted using the OFFSET CONTROL.

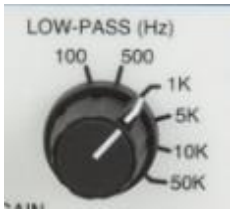
A channel specific OUTPUT BNC is also located in this section and provides connection to a data acquisition system, oscilloscope, or chart recorder.

High-pass Bessel filter

Each channel as a HIGH-PASS BESSEL FILTER. This 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



Each channel has a LOW-PASS BESSEL FILTER. This 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

Each channel's gain control sets the channel 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.

Rear Panel

The rear panel of the **DP-314** houses the fuse/power entry module, as well as the circuit and chassis grounding jacks.

SETUP AND TEST

Setup

Setup of the **DP-314** is simple. Place the amplifier near your experiment and connect the power cable to the rear of the instrument.

NOTE: Be sure the POWER SWITCH is *off* before connecting the amplifier to your power circuit.

Run BNCs from the OUTPUT of each channel on the **DP-314** to your data acquisition system. Place your headstages into position within your experimental setup and connect them to their respective channels on the amplifier. Headstages are numbered to facilitate channel assignment.

Setup is complete.

WARNING: DO NOT leave *unused headstages* connected to the amp !

Headstages have a high input impedance that will cause the associated channel to clip if it's connected and not used. This leads to overheating which will further lead to failures within the DP-314.

Under a clipping condition, a channel specific LED will light to indicate the problem. This should be taken as a warning to disconnect the unused headstage from that channel.

Headstages are numbered to facilitate proper channel re-assignment.

Test

Before beginning an experiment, it's good practice to perform a simple test to verify that the **DP-314** is functioning properly.

1. With the power *off,* set the front panel controls for each channel as follows:

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

2. Connect the **DP-314** OUTPUT BNC for the channel being tested to an oscilloscope or your data acquisition system.

3. Connect a headstage to the HEADSTAGE INPUT of each channel and turn the power *on*.

4. Plug the headstage for your first channel 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 headstage input pins.

9. Once the test button is depressed, the test indicator LED will light 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. Observe that both CLIPPING INDICATORS are *off*.

11. Connect the output BNC from the next channel to to test to your oscilloscope and repeat steps 4-10.

OPERATION

The amplifier can be placed into either *AC* or *DC mode,* and can be used for either differential or single-ended readings. Therefore, four configurations are possible for each channel. Also, each channel can be configured independently.

AC mode (per channel)

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 high-pass 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 (per channel)

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 manufactures a complete line of microelectrode holders useful for connecting microelectrodes to the **DP-314** headstages.

The following electrode holders are recommended:

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 (per channel)

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 (per channel)

The OUTPUT BNC are used to tie the **DP-314** to a data acquisition (DAQ) system. The DAQ must be capable of resolving a ± 10 V signal.

Similar to the headstage, the shell of the OUTPUT BNC is connected to the system ground. When the OUTPUT BNC of the **DP-314** is connected to a DAQ (or recording device), the ground of the DAQ will be carried through to the headstage case via the amplifier channel's common ground.

Consequently, any part of the experiment that is tied to the headstage ground will also 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.

NOTE: Do not leave unused headstages connected to the amp – *Headstages have a high input impedance that will cause the associated channel to clip if it's connected and not used. This leads to overheating which will further lead to failures within the DP-314. Under a clipping condition, a channel specific LED will light to indicate the problem. This should be taken as a warning to disconnect the unused headstage from that channel. Headstages are numbered to facilitate proper channel re-assignment.*

Appendix

Specifications

per channel unless otherwise stated

Voltage Gain:	x10, x100, x1000, x10,000	
Input resistance:	10^{12} Ω typical	
Output resistance:	50 Ω	
Input Leakage Current:	1.0 pA typical	
Common-mode Rejection:	120 dB minimum(1,000,000 to 1) @ 60 Hz	
Maximum common-mode signal:	± 10 V	
Noise, input shorted:	10 μV p-p, 1 Hz to 10 kHz typical	
Front-panel test signal:	1.0 mV p-p @ 100 Hz square wave	
2-Pole Bessel filters		
Low-frequency (high pass):	DC, 0.1, 1.0, 10, 100, 300 Hz	
High-frequency (low pass):	100, 300, 1k, 3k, 10k, 50k Hz	
Output voltage swing (10k load):	± 10 V	
Offset control range:	± 600 mV at output (DC mode) at any gain	
Input connectors:	two 2 mm pins, 0.5 inches (12.7 mm) apart	
Output connectors:	1 BNC per channel	
Power Requirements (general):	92 - 250 VAC, 50/60 Hz (switch selectable), 20 VA	
Physical (general)		
Dimensions	9.0 x 42.5 x 19.0 cm (H x W x D)	
Shipping weight	5.05 kg	
Operating Conditions:	Equipment is intended to be operated in a controlled laboratory environment.	Temperature: 0-40 °C Altitude: sea level to 2000 m Relative humidity: 0-95%

Warranty

The **DP-314** 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 shipping will be paid by the company.

Service

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

Our contact numbers are:

Customer Service: 800-232-2380
Sales: 833-668-8632
Orders: 800-232-2380
Tech Support: 800-547-6766

Our support department can be reached attechsupport@harvardapparatus.com or through the contact section of our website at http://www.warneronline.com