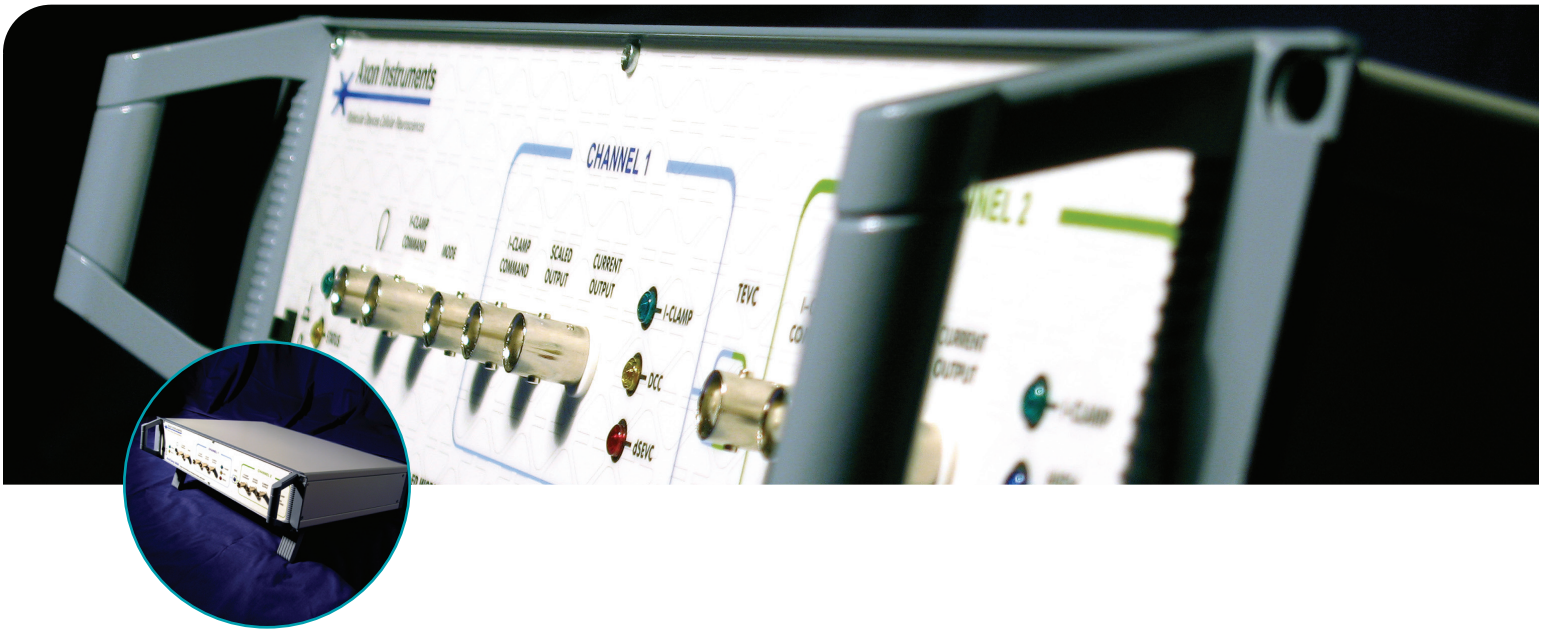
Molecular Devices

Axoclamp 900A Microelectrode Amplifier

A COMPUTER-CONTROLLED AMPLIFIER FOR CURRENT-CLAMP AND VOLTAGE-CLAMP APPLICATIONS



- NEXT-GENERATION COMPUTER CONTROL
- EASY USB CONNECTION
- SUPERIOR QUALITY: LOW NOISE, HIGH BANDWIDTH
- MULTIPLE MODES OF OPERATION
- BUILT-IN OUTPUT GAIN AND FILTER OPTIONS
- AUTOMATIC OSCILLATION CORRECTION

The Axoclamp™ 900A Amplifier is the newest microelectrode amplifier from Molecular Devices. Like the Axoclamp 2B amplifier, the Axoclamp 900A amplifier offers several modes of operation that measure signals from single cells, tissue slices and whole animal preparations. The advanced signal conditioning included in the Axoclamp 900A Amplifier saves the expense of buying additional hardware and frees up valuable space in an electrophysiology setup.

By making the Axoclamp 900A Amplifier computer-controlled, several powerful new features have been added to make it simpler to set up and run experiments. This exciting new instrument is designed to meet researchers' needs today, as well as offer flexibility for future experiments.

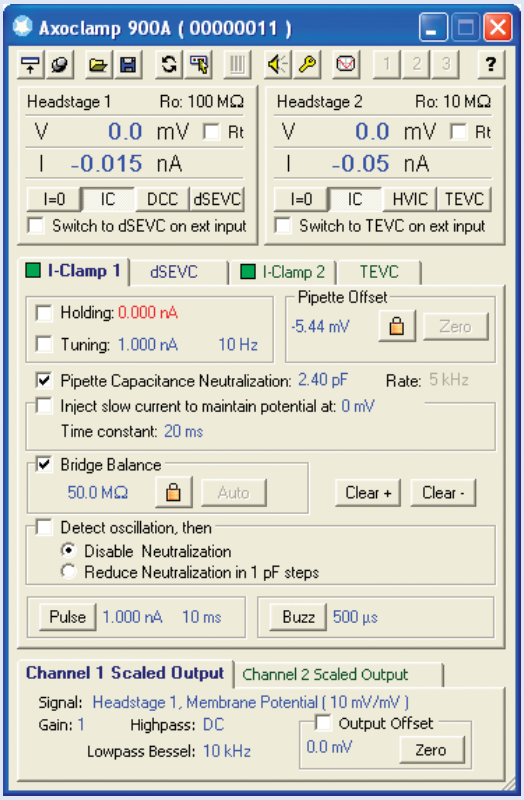
SEVERAL MODES OF OPERATION

This versatile amplifier offers several modes of operation. Current clamp (I-Clamp), for measuring voltage responses, is available in two channels with independent Bridge Balance and I=0 options. Discontinuous current clamp (DCC) is especially useful when small changes in electrode resistance occur during an experiment. Two-electrode voltage clamp (TEVC) uses two microelectrodes, one for continuous recording of electrode voltage and the other for injection of current.

The high-output compliance of TEVC makes it possible to voltage clamp large rapid currents. Discontinuous single-electrode voltage clamp (dSEVC) is used to voltage clamp small cells that cannot tolerate impalement by a second electrode and eliminates problems due to the large series resistance inherent with many preparations. High-voltage current clamp (HVIC) is used primarily for extracellular iontophoresis applications.

Computer or Conventional Controls

Axoclamp Commander Software Interface



The Axoclamp 900A amplifier is fully integrated with Axoclamp Commander Software. The figure to the left shows many of the features of the software interface, including the different modes available, controls for I-Clamp mode in Channel 1 and output signal conditioning controls. Although controlled by software, the Axoclamp 900A Amplifier uses customary analog inputs and outputs instead of a built-in digitizer. Thus, the amplifier can be used with any external digitizer and acquisition software package, including Molecular Devices' Digidata® Digitizers and pCLAMP® Data Acquisition and Analysis Software. Using the Axoclamp 900A Amplifier with the Digidata 1440A Digitizer and pCLAMP 10 Software enables full telegraphing of the Axoclamp 900A amplifier parameters.

Conventional Interface with SoftPanel Controller

To offer a more conventional method of amplifier control, the optional SoftPanel Controller was designed as a hardware extension of the Axoclamp Commander Software. The SoftPanel controller communicates with the computer via an easy-to-set-up USB 2.0 connection. Using the SoftPanel Controller does not negate the many benefits afforded by computer control of the amplifier.

ADVANTAGES OF COMPUTER CONTROL

Through computer control, the traditional knobs, dials and buttons are no longer needed and are replaced by an intuitive software interface. Computer control provides several advantages over conventional amplifiers. It enables automation of several standard tasks such as adjustment of Pipette Offset, Bridge Balance and Pipette Capacitance Neutralization.

Other added benefits include automatic oscillation detection and correction (in less than 2 ms), automatic mode-switching between I-Clamp and voltage clamp modes (TEVC, dSEVC), computer display of monitor signals used for tuning DCC and dSEVC modes, slow current injection in I-Clamp mode to prevent small, slow drifts in the membrane voltage, the ability to save personalized settings, multiple signal selections for output from the two channels and automated resistance measurement.

Full communication between third-party software and the Axoclamp 900A Amplifier is possible. For those who prefer more conventional amplifier control, the optional SoftPanel™ Controller can be used as a hardware extension of the Axoclamp 900A Amplifier, without the loss of the benefits of computer control.

EXCELLENT AMPLIFIER PERFORMANCE

The ±180 V output compliance used for TEVC and HVIC modes makes it possible to pass larger currents and ensures faster clamp speeds. TEVC and dSEVC modes both have wide AC voltage-clamp gain ranges for excellent voltage control. When DC Restore is enabled, the DC voltage-clamp gain is greater than 1,000,000, ensuring optimal voltage control for constant-voltage measurements. The new dSEVC design is more stable and twice as fast as the Axoclamp 2B Amplifier, providing an excellent alternative to standard continuous single-electrode voltage clamping.

Specifications

Technical Specifications

Scaled output:

Gain: 1–2000 in 1:2:5 sequence

Highpass filter: Single-pole; DC-300 Hz

Lowpass filter: 4-pole Bessel, 2 Hz to 30 kHz; Butterworth, 3 Hz to 45 kHz

Output (DC) offset: ±3 V

Current output: 1 per channel Gain 10, 100, or 1000 nA/V†

Auxiliary headstage: 1 per channel, gain 10 V/V

Maximum Current*						
		I-Clamp	HVIC	TEVC	dSEVC	DCC
Headstage	Ro	(Ch 1&2)	(Ch 2)	(Ch2)	(Ch1)	(Ch1)
HS-9A x0.1U	100 M	0.12 µA	1.8 µA	1.8 µA	0.036 µA	0.036 µA
HS-9A x1U	10 M	1.20 µA	18.0 µA	18.0 µA	0.360 µA	0.360 µA
HS-9A x10U	1 M	12.00 µA	180.0 µA	180.0 µA	3.600 µA	3.600 µA

*Maximum current specifications assume negligible electrode resistance.

Pipette Offset: ±250 mV

Pipette Capacitance Neutralization: -10 to 35.5 pF (I-Clamp 1&2, DCC, dSEVC, TEVC Ch1 only)

Buzz: Increases capacitance 4 pF for duration of 0.1–500 ms to break through tough cell membranes, activate within the software or remotely with a hand-held remote

Clear (±): Maximum positive or negative current—duration up to 0.5 sec. to clear debris from electrodes, decrease tip resistance before impaling cell

Bridge Balance: 0 to maximum of 8, 80, or 800 MΩ†

Output compliance: ±180 V for TEVC and HVIC, ±12 V for I-Clamp 1 & 2, DCC, dSEVC

DC Restore: DC voltage-clamp gain, selectable ~1,000,000, TEVC & dSEVC

Step activate: Independent on channels 1 & 2, internal or external timing up to 50 kHz pulse amplitude/duration programmable

Blank activate: Used for blanking response to external stimuli, channel 1 only

Audio monitor: Direct Signal Monitoring or VCO mode to monitor voltage or current in either channel

Two jacks for headphones or powered speakers (not included)

Performance Specifications

I-CLAMP (Ch 1 & 2)

Internal holding level max.: ±10 nA, ±100 nA, or ±1000 nA†

External command sensitivity: 1, 10, or 100 nA/V†

DCC (Ch 1)

Internal holding level max.: ±10 nA, ±100 nA, or ±1000 nA†

External command sensitivity: 1, 10, or 100 nA/V†

HVIC (Ch 2)

Internal holding level max.: ±0.13, +1.3, or 13.0 µA†

External command sensitivity: 10, 100, or 1000 nA/V†

dSEVC (Ch 1)

Internal holding level: ±200 mV

AC voltage-clamp gain: 0.003–30 nA/mV, 0.03–300 nA/mV, or 0.3–3000 nA/mV†

External command sensitivity: 20 mV/V

Voltage rise time[a]: 250 µs

Current settling time[a]: 500 µs to 10% of peak value

Voltage noise[a]: 180 µV rms

Current noise[a]: 0.30 nA rms

a: Model cell with two 50 MΩ resistors to simulate electrode resistances and a 50 MΩ resistor and 470 pF capacitor in parallel to simulate the cell membrane. 10 mV step. Lowpass filter, 10 kHz. voltage-clamp gain, 2.2 nA/mV; Lag, minimum. Sample rate, 20 kHz. Pipette Capacitance Neutralization, 1.5 pF. Set for flattest membrane step response. HS-9A x0.1U headstage.

TEVC (Ch 1 & 2 together)

Internal holding level: ±200 mV

AC voltage-clamp gain: 20 to 50,000

Voltage-clamp lag: 5.4 µs–52 ms

External command sensitivity: 20 mV/V

Voltage rise time[b]: 60 µs

Current settling time[b]: 80 µs to 10% of peak value

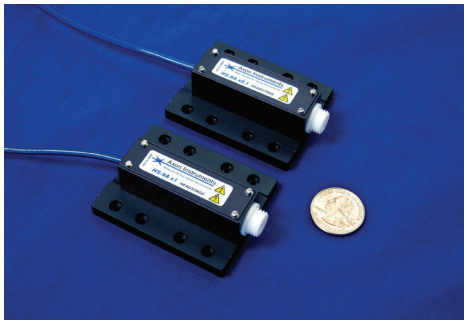
Voltage noise[b]: 23 µV rms

Current noise[b]: 70 nA rms

b: Model cell with two 1 MΩ resistors to simulate electrode resistances and a 1 MΩ resistor and 220 nF capacitor in parallel to simulate the oocyte membrane. Lowpass filter, 10 kHz. voltage-clamp gain, 9300. Lag, 0.019 ms Adjusted for fastest rise time. HS-9A x1U headstage for voltage electrode and HS-9A x10U for current electrode.

† Depending on headstage.

Headstage with Baseplate



The small profile of the miniaturized HS-9A and VG-9A headstages makes it easy to incorporate them into an electrophysiology set up. The dovetail design integrates with a baseplate for easy attachment to micromanipulators.

General Specifications

Dimensions (in.):	4.3 (H) x 19 (W) x 14.3 (D)
Dimensions (cm):	10.9 (H) x 48.3 (W) x 36.3 (D)
Weight (lbs.):	9.5 (4.3 kg)
Headstage (in.):	0.75 (H) x 0.70 (W) x 2.25 (D)
Headstage (cm):	1.9 (H) x 1.8 (W) x 5.7 (D)
Communications:	(3) USB 2.0 Type B female ports → One for amplifier control → One for monitor signal computer display for discontinuous modes → One for optional SoftPanel Controller
Rack use:	Standard 19" rack-mount (2U) with handles
Benchtop use:	Bayonet feet
Power:	100–240 VAC 50–60 Hz, 30 watts (max.)
Safety:	CE marking (Conformité Européan)
Computer:	1 GHz or better processor, Windows 2000/XP, CD-ROM drive 512 MB RAM, 500 MB HD space
Software:	Axoclamp 900A Commander Software (included)

ORDERING INFORMATION

Axoclamp 900A Microelectrode Amplifier*
Part Number: AXOCLAMP 900A

- → Axoclamp 900A Instrument
- → (1) Remote BUZZ box
- → (1) Clamp-1U model cell
- → (2) HL-U electrode holders
- → (1) Axoclamp 900A Commander Software CD
- → (2) USB cables
- → (2) Headstage baseplates
- → Theory and Operation user guide (printed)

* Two HS-9A headstages must be ordered with the Axoclamp 900A Instrument.

OPTIONAL ACCESSORIES

SoftPanel Controller
Part Number: 1-SOFTPANEL

MCO-2U Model Cell
Part Number: 1-MCO-2U

Headstage options:

- → HS-9A x0.1U
- → HS-9A x1U
- → HS-9A x10U
- → VG-9A x10
- → VG-9A x100