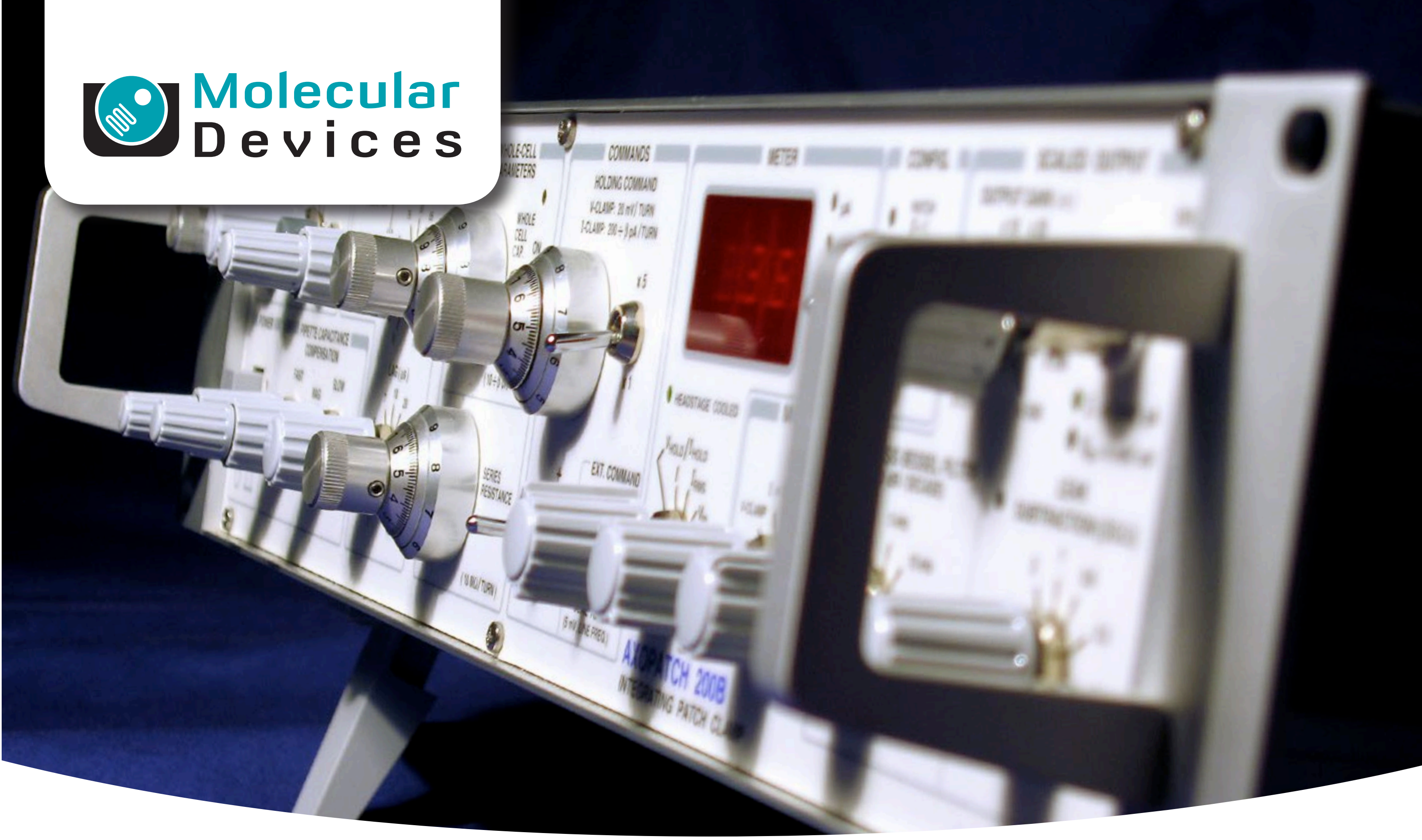
Molecular Devices



Axon Axopatch 200B Microelectrode Amplifier

Key Features

- Ultra low-noise current and voltage patch clamp amplifier
- Integrates with any data acquisition system
- Optimized for whole-cell and single-channel recordings
- Three recording modes from sub-pA to hundreds of nA currents

The Axon™ Axopatch™ 200B is the latest version of our premier patch-clamp amplifier incorporating innovative capacitor-feedback technology that provides the lowest-noise single-channel recording available. We have improved the integrating patch clamp amplifier with our proprietary technology, which includes cooling of the active elements in the amplifier to achieve the lowest possible electrical noise. No other amplifier offers such low noise. Positioning an electrode will also be easier with our, slim headstage design that improves access to the preparation.

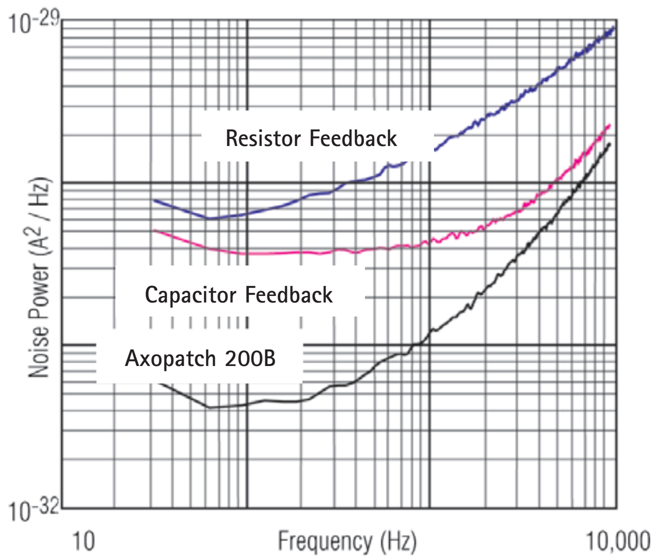
Other enhancements include three recording configurations in a single headstage (one patch and two whole cell ranges, with capacitance compensation ranges of 100 pF and 1000 pF), increased voltage and current command ranges for electrochemical measurements, built-in capacitance dithering capability for capacitance measurements, and addition of series resistance compensation to the current clamp circuitry to improve performance. The Seal Test now provides current steps in current clamp mode as well as voltage steps in voltage clamp mode. Leak Subtraction is now more sensitive in the most important resistance range. The, slim headstage design improves electrode access to the preparation, and the recording bandwidth has been doubled to up to 100 kHz.

The amazingly low open-circuit noise of 0.13 pA rms (10 kHz) increases to only 0.145 pA RMS when a patch-pipette holder is attached to the headstage input and the pipette capacitance is fully compensated (to eliminate capacitance charging transients). The power of capacitor-feedback technology is shown in Figure 1—capacitor feedback is clearly superior to resistive feedback; cooled capacitor-feedback technology is even better!

Like its predecessors, the Axopatch 200B Amplifier incorporates capacitive and resistive feedback elements in its headstage, providing the best possible performance for single-channel and whole-cell patch clamping. Convenient features include: ZAP (to rupture patches when going whole cell), dual-speed current clamp (to allow faster current clamping in small cells), Holding Command to set voltage commands in voltage clamp mode and current commands in current clamp mode, and a choice of three gain settings on the dedicated current output (for patch, whole-cell and loose-patch modes).

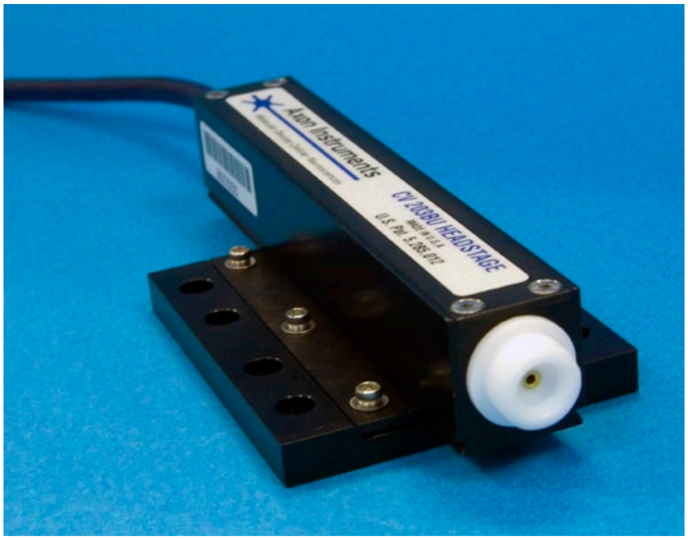
Noise reduction technology: capacitor feedback and cooling system

Noise spectra of patch-clamp amplifiers



The introduction of capacitor-feedback technology significantly reduced amplifier noise (Upper trace: resistive feedback; middle trace: capacitor feedback). With active cooling, the Axopatch 200B Amplifier dramatically reduces noise to the lowest levels ever, over the entire bandwidth range (bottom trace: Axopatch 200B Amplifier).

Axopatch 200B Headstage with Active Cooling



The actively cooled CV 203BU capacitor feedback headstage used for the Axopatch 200B Microelectrode Amplifier provides ultra-low noise performance in a slim package.

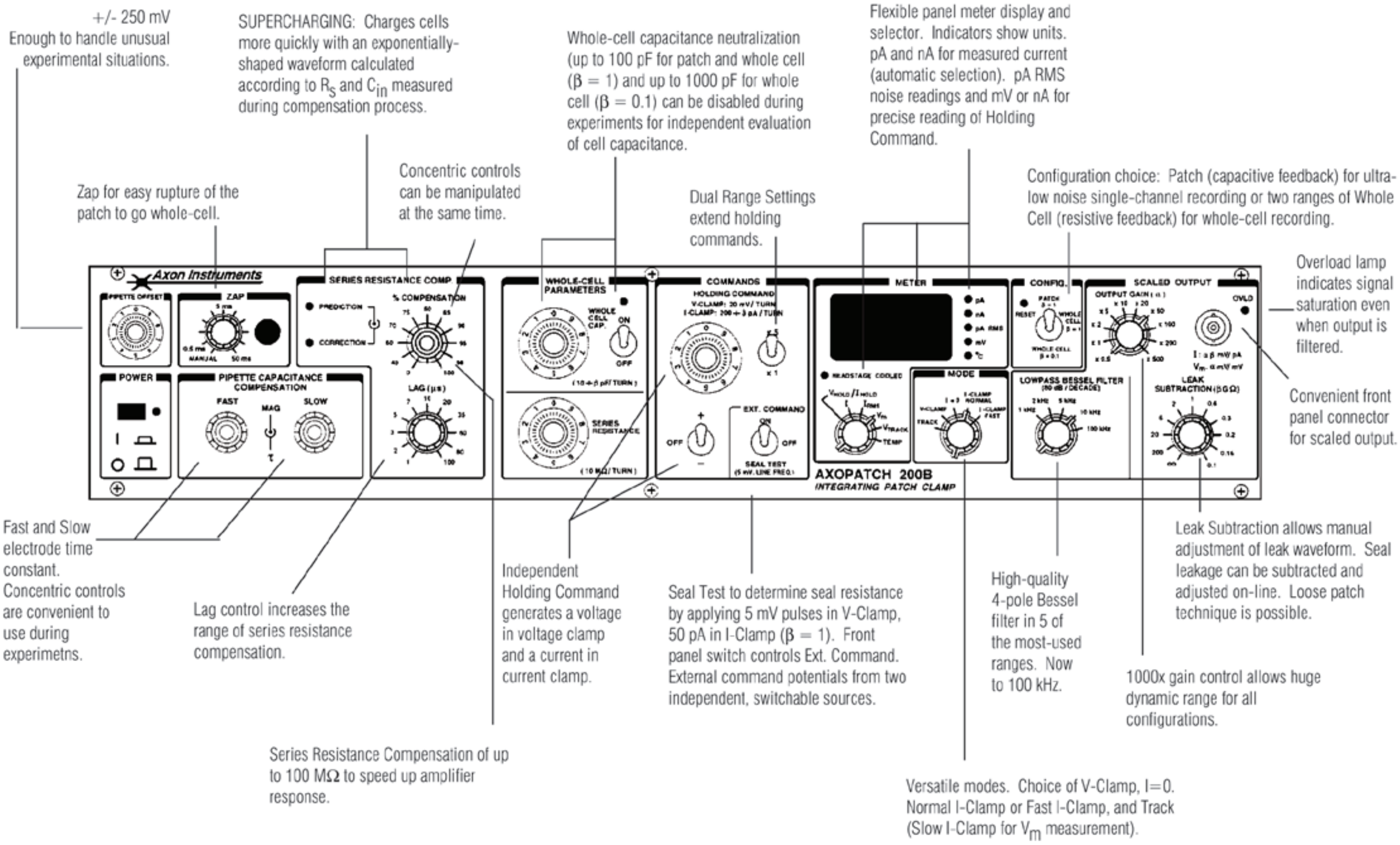
Unparalleled performance, utility, and ease of use

Included: Efficient controls for whole-cell capacitance compensation, a unique "super-charging" form of series-resistance compensation that complements the conventional "correction" form, and a variable LAG control; output gain with 1000-fold dynamic range; 4-pole lowpass Bessel filter; built-in leak subtraction; dual external-command inputs; versatile panel meter displaying Holding Command, rms current noise, membrane potential, tracking potential, current at the headstage input, and cooled circuitry temperature; telegraphic output of values for output gain, filter frequency, headstage mode (gain) and measured cell capacitance; ZAP; and dual-speed current clamp. Also, the bath is grounded for convenience of use and straightforward addition of command and compensation potentials.

Integrating headstage mode for quiet single-channel recording

With its unprecedented low noise, the capacitor-feedback integrating headstage for the Axopatch 200B Amplifier is ideal for measuring sub-picoamp current signals. The capacitor-feedback circuitry measures current as the rate of voltage increase across the capacitor; the voltage across the capacitor is the integral of the current. In contrast, resistor-feedback circuitry measures current as a voltage drop across a feedback resistor. This has the drawback of requiring extremely high-value resistors that become less ideal as they become larger in value, with accompanying increases in their inherent noise. Noiseless capacitors, on the other hand, are easily manufactured. Thus, capacitor-feedback technology offers the lowest possible noise for single-channel recording.

Through the use of this technology, the electronic circuit noise has been reduced to such a level that the noise inherent in the components themselves has become significant. The Axopatch 200B Amplifier actively cools the critical circuit components to about -15°C in order to reduce the thermal noise and so lowers the noise contribution of the amplifier itself to the lowest levels possible. The Axopatch 200B Amplifier is the ultimate low-noise amplifier.



In the design of the integrating patch clamp we addressed two additional technological challenges that are encountered in the pursuit of ultra-low noise. First and foremost, the voltage across the capacitor cannot ramp forever in one direction. Eventually, the supply limits are reached and the electronics must reset to the starting point to continue ramping. During this reset, the system freezes the output at the last measured value. For the best performance, this reset must be kept brief and must occur as infrequently as possible. The reset time of the Axopatch 200B Amplifier is so short (50 µs) that users may never see a reset under most normal recording conditions. Second, to minimize the frequency of resets, the voltage range across the capacitor must be as large as possible. By using unique compensation circuitry, the Axopatch 200B Amplifier manages to use the entire ±10 V range of the power supply to charge the capacitor. This reduces the frequency of resets without incurring the penalty of longer reset times.

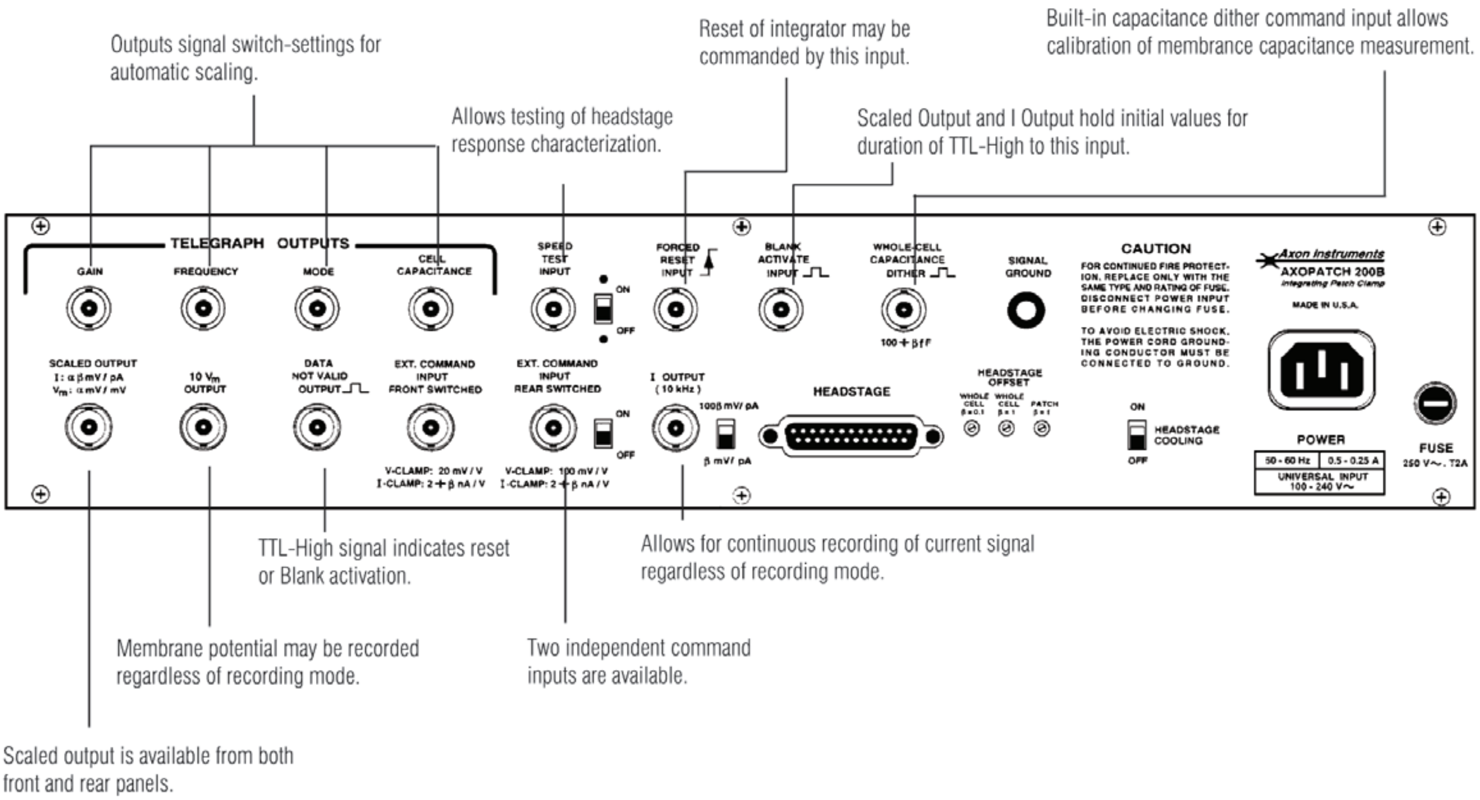
Bilayers

Headstages useful in artificial bilayer experiments must be stable with large input-capacitance loads. The Axopatch 200B Amplifier is rock solid with an input capacitance of 1000 pF. Furthermore, the integrating technology in the Axopatch 200B Amplifier enables the bilayer voltage to be stepped very quickly. There are two reasons for this. First, the integrator has an inherently large dynamic range that allows it to transiently pass currents of several microamperes. Second, during large command voltage steps the integrator enters the reset state. In this state, the headstage continues to operate as a voltage-clamp amplifier but with a very low feedback resistance. For the few milliseconds that the integrator is in the reset state it can pass up to 1 mA to rapidly charge the bilayer capacitance.

Resistive headstage mode for superb whole-cell performance

In whole-cell recording, more current noise is produced by the cell and the environment than by the patch clamp amplifier. Hence, the benefits of a low-noise capacitor-feedback headstage cannot be effectively utilized in whole-cell mode. For this reason, the Axopatch 200B Amplifier uses traditional resistor feedback headstage electronics

Schematic: Back



for the whole-cell mode of patch clamp recording. The CV 203BU Headstage includes two feedback resistors to provide a wide range of current-passing capacity in the whole-cell mode. The 500 MΩ feedback resistor (β = 1) provides both low noise and a large current passing ability (20 nA). For larger currents, one can switch to the 50 MΩ feedback-resistor (β = 0.1) to pass up to 200 nA.

Series resistance prediction

There are two goals of series resistance compensation. The first is to step the membrane potential to an assigned value as rapidly as possible. One way to speed up this process is to transiently increase the size of the command voltage step (applying a method known as "supercharging"). This causes the charging curve to briefly assume the steeper rate appropriate for a larger step. This transient, high-charging rate is terminated when the membrane potential approaches the intended value. On the Axopatch 200B Amplifier, supercharging is available through the Series Resistance Prediction control. The supercharging transient is automatically and conveniently determined by the user when the conventional whole-cell capacitance controls are set. Prediction refers to our unique algorithm for calculating the added supercharging waveform. Note that this technique does not require the command to be a voltage step; other commands, such as a sine wave, will also be supercharged.

Series resistance correction

The second goal of series resistance compensation is to measure the ionic currents. To eliminate error due to the voltage drop across the electrode and to improve the bandwidth of the recording, conventional Series Resistance Correction is required. This technique employs positive feedback to increase the command potential by adding a signal proportional to the measured current to the command input of the headstage.

Series Resistance Prediction and Correction may be used together or separately on the Axopatch 200B Amplifier. The controls are concentric and can be manipulated at the same time. Turning the controls together is quite similar to the series resistance percentage compensation found on other patch clamps. In experiments with real cells, we have found that both the Series Resistance Prediction and Correction on the Axopatch 200B Amplifier can be routinely set to levels exceeding 90%, enabling fast and accurate whole-cell voltage clamping. A variable LAG control permits an even greater degree of series resistance compensation to be achieved, although not at the highest frequencies.

Dual-speed current clamp

The Axopatch 200B Amplifier employs a dual-speed current clamp to optimize speed and stability. The choice of speeds depends on pipette resistance. For pipette resistances above 10 MΩ, the I-Clamp Fast mode can be employed to obtain a rise time of 10 µs under many experimental conditions. The I-Clamp Normal mode guarantees stability for any pipette resistance above 1 MΩ. In addition, current clamp to zero current (I=0 mode) is available, as is a slower clamp to zero current (Track mode) useful for following slow changes in pipette offset while approaching a cell before seal formation. The Holding Command can be used to set a holding current in I-Clamp. Two external command inputs are provided to permit multiple command sources (for cell capacitance experiments, current clamp, etc.). In addition, the Axopatch 200B Amplifier includes series resistance compensation in current clamp mode that allows for correction (similar to the Bridge Balance control of other amplifiers) of voltage errors due to the pipette resistance.

Pipette offset

Researchers are putting ever more unusual solutions into patch pipettes, producing large offset potentials. The Axopatch 200B Amplifier provides ±250 mV offset potential to handle even the most adverse situations.

Dual command potentials

Two separate command potential inputs allow you to sum command input signals from two different sources. For instance, you may wish to constantly supply a low-level sine wave command for evaluation of membrane capacitance. Large voltage steps may be mixed with this signal to construct a C_m versus V_m relationship. One of these command potentials may be switched on from the front panel to access the external source. The other is switched separately on the back panel. The back panel command is scaled to afford greater range (up to ±1 V), and so is quite useful for electrochemical measurements.

Seal test

A convenient Seal Test is built into the External Command potential front panel switch. The oscillator frequency is set to the line frequency for automatic synchronous triggering on any oscilloscope. Seal Test may be used in voltage clamp mode (5 mV pulse) or in current clamp mode (50 pA (β = 1) or 500 pA (β = 0.1)) pulses.

Holding command

The Holding Potential potentiometer can be used to manually establish the cell holding potential for voltage clamp or a holding current for current clamp. The Holding Command of the Axopatch 200B Amplifier has been enhanced over that of its predecessors with the addition of a x1 and x5 switch that allows you to choose either 0±200 mV or 0±1 V ranges. (In current clamp, the command response at β = 1 is 0±2 nA or 0±10 nA, and at β = 0.1 it is 0±20 nA or 0±100 nA.) An ON/OFF switch can disable this control when an external command from a computer is used to establish the holding potential.

Pipette capacitance compensation

Pipette Capacitance Compensation is in operation in both voltage- or current-clamp modes. There are controls to establish the Magnitude and τ of two time constants, Fast and Slow, allowing complete compensation of the pipette capacitance waveform. Magnitude and τ are controlled by concentric knobs allowing easy and convenient adjustment of parameters for each time constant.

Cell capacitance compensation

The Whole-Cell Capacitance control can compensate up to 100 pF (β = 1) or 1000 pF (β = 0.1) to allow recording from a large range of cell sizes. The control may be disabled by an ON/OFF switch to allow evaluation of the cell capacitance charging waveform at any time during an experiment.

Capacitance dithering

Useful for cell membrane capacitance measurements, Capacitance Dithering may be enabled during a TTL-High level signal to Whole Cell Capacitance Dither input to effectively increase the observed cell capacitance by 100 fF (β = 1) or 1 pF (β = 0.1). It may be used in conjunction with the DR-1 Resistance Dither unit (supplied with the Axopatch 200B Amplifier) which normally provides a short-circuit link between preparation and ground. The DR-1 unit inserts a 500 kΩ resistor in series with bath ground during a TTL-High signal and is suitable for finding the phase tracking angle in capacitance measurement experiments.

Output gain

Ten gain settings spanning a 1000-fold range may be selected to scale the output to the most desirable level. Axopatch 200B output swing is ±10 V, providing the greatest compatibility to the vast range of recording devices. However, the dynamic range of the instrument at unity gain is greater than the output swing. Thus a gain value of 0.5 is available to take advantage of the full dynamic range of Axopatch 200B headstage. (Note: The full range is also faithfully reported by the front panel meter.)

Low-pass filters

The scaled output passes through a 4-pole Bessel filter. The five settings from 1 kHz up to 100 kHz allow you to set the lowpass filter appropriate to your application over a range double that previously available.

Panel meter

The panel meter can report values for current and voltage while in any operational mode. Steady-state current is reported to monitor voltage-clamp output. To evaluate noise, current is displayed as an rms value. The V_m setting is used under current clamp to evaluate membrane potential. In I=0 mode, V_m is the resting membrane potential of the cell. V_{HOLD}/I_{HOLD} reports the setting of the Holding Command. The value is reported even when this command is switched off, allowing you to precisely set a desired holding command in advance. The temperature of the cooled headstage circuitry may be displayed when TEMP is selected.

Leak subtraction

It is often convenient to subtract leak errors during an experiment. The Axopatch 200B Amplifier allows you to correct leak errors as they appear without adjusting your data-acquisition software settings. This is also useful when a large seal leakage is expected, as in loose-patch experiments. Leak Subtraction has been improved in the Axopatch 200B Amplifier by increasing sensitivity in the resistance range most likely to be encountered by researchers.

Zap

To go whole cell it is necessary to rupture the cell-attached patch. As an alternative to carefully controlled suction, the Axopatch 200B Amplifier allows the patch to be ruptured by applying a single +1.3 V pulse for a chosen duration.

Slim headstage design

The re-engineered headstage has only one third the cross-sectional area of other headstages, thereby greatly improving ease of access to the preparation.

Excellent manual

Written by scientific consultants, with the assistance of Molecular Devices staff, the Axopatch 200B Amplifier manual will serve as a useful guide to the operation of the Axopatch 200B Amplifier as well as an informative reference for many aspects of patch clamping.

Pipette holders

The HL-U pipette holder is custom constructed to ensure low-noise mechanically stable recording. Two different barrel lengths are provided. The HL-U holder accepts pipettes of 1.0–1.7 mm OD. It includes a silver wire assembly, and has a 1.0 mm OD post for suction. The Axopatch 200B Amplifier is shipped with one pipette holder.

Technical Specifications

Unless otherwise noted: T_A = 20°C, 1 hour warm-up time.

CV 203BU Headstage

Construction: All critical components are in a sealed hybrid and cooled with a solid state cooling element.

Configuration: High-speed, low-noise current-to-voltage converter

Cooling: Input circuitry -15°C typical. Headstage cooling should be kept on at all times to ensure proper calibration of offset voltages.

Gain (β): 1 mV/pA (β = 1) Patch or Whole-Cell modes

0.1 mV/pA (β = 0.1) Whole-Cell mode

Feedback element:

Patch	1 pF
Whole Cell	β = 1, 500 MΩ in parallel with 1 pF
Whole Cell	β = 0.1, 50 MΩ in parallel with 1 pF

Tuning (Whole Cell mode only): Tuning circuit to idealize response of the feedback resistor is contained in the main instrument. Tuning is automatically bypassed when the capacitive feedback is selected.

Pipette-capacitance-compensation injection capacitor: 1 pF

Whole-cell-capacitance-compensation injection capacitor:

Patch	none
Whole Cell	β = 1: 5 pF
Whole Cell	β = 0.1: 50 pF

Case: Connected to ground. Case jack mates to 2 mm plugs.

Bandwidth: Test signal applied via Speed Test input

Internal: 140 kHz patch mode
70 kHz whole-cell mode

Max. external: 100 kHz (limited to output filter)

Capacitative load stability: 1000 pF, 0 Ω in series

Maximum instrument noise: Measured with minimal external noise sources (*i.e.,* radiated line-frequency noise, mechanical vibration) 8-pole Bessel filter

Max. Instrument Noise: Without Holder			
	Patch	Whole Cell	Whole Cell
Line Frequency & Harmonics	β = 1 0.005 pA_{p-p}	β = 1 0.005 pA_{p-p}	β = 0.1 0.005 pA_{p-p}
0.1–100 Hz	0.030 pA_{p-p}	0.50 pA_{p-p}	1.6 pA_{p-p}
0.1–1 kHz	0.015 pA_{rms}	0.25 pA_{rms}	0.75 pA_{rms}
0.1–5 kHz	0.060 pA_{rms}	0.65 pA_{rms}	1.65 pA_{rms}
0.1–10 kHz	0.130 pA_{rms}	1.10 pA_{rms}	3.0 pA_{rms}
Max. Instrument Noise: With Holder			
0.1–10 kHz	0.145 pA_{rms}	1.10 pA_{rms}	3.0 pA_{rms}

Reset Characteristics (Patch mode only)

Total reset time: 50 µs ±10%

Time between resets (T_{BR}):

For DC currents: $T_{BR} = 10 / (I_{DC} - I_{BIAS})$ where I_{DC} and I_{BIAS} are in pA and T_{BR} is in seconds.

I_{BIAS} is typically 0.3–1.0 pA.

For transient currents: A reset will occur if the headstage must deliver more than 10 pC of charge to the membrane.

Reset transients in current waveform at Scaled Output (typical):

100 Hz	±0.25 pA
1 kHz	±0.5 pA
10 kHz	±2 pA

Current Clamp

The speed in I=0 mode is the same as in I-Clamp Normal. In addition, Track mode is a slow clamp to zero current. Note that series resistance compensation remains active in current clamp mode, allowing measurement of pipette resistance and (when R_s is compensated) accurate monitoring of cell membrane potential, but the speed setting is still determined by the actual electrode resistance and not only the remaining uncompensated resistance.

The speed of the current clamp depends on the Mode setting (Normal or Fast), the time constant of the cell and the pipette resistance.

			10–90% rise time (overshoot)	10–90% rise time (overshoot)
R_p	R_m	C_m	I-Clamp Normal	I-Clamp Fast
1 MΩ	0 MΩ	0 pF	15 µs (10%)	N/A
1 MΩ	500 MΩ	33 pF	350 µs (0%)	N/A
10 MΩ	0 MΩ	0 pF	200 µs (20%)	20 µs (< 1%)
10 MΩ	500 MΩ	33 pF	250 µs (10%)	10 µs (< 1%)
50 MΩ	500 MΩ	33 pF	500 µs (30%)	150 µs (< 1%)

Capacitance Compensation

Pipette Capacitance	
Fast τ	0.2–2 µs
Fast Magnitude	0–10 pF
Slow τ	0.1–10 ms
Slow Magnitude	0–1 pF

These controls are used to charge pipette capacitance. In I-Clamp modes they act as a negative capacitance.

	β = 1	β = 0.1
Whole-Cell Capacitance	0.3–100 pF	3–1000 pF
Series Resistance	0–100 MΩ	0–100 MΩ

These controls are used to charge membrane capacitance in whole-cell V-Clamp. For Patch mode, whole-cell capacitance is not operative. In I-Clamp modes only the Series Resistance control is operative. The whole-cell capacitance control places an analog voltage proportional to setting on Cell Capacitance Telegraph Output.

Series Resistance Compensation

% Prediction: OFF, 0-100%. Acts with Whole-Cell Parameters to speed up charging of the membrane. Maximum achievable % Prediction is limited by the magnitude of the voltage step.

% Correction: OFF, 0-100%. Acts with Series Resistance setting to reduce series resistance errors and to speed up response to ionic currents.

Lag: 1–100 µs. Cuts high-frequency response of series-resistance correction circuit to enable a higher Correction setting.

Capacitance Dithering

Enabled during a TTL High level signal to Whole Cell Capacitance Dither input.

Effectively increases the observed cell capacitance by 100 fF (β = 1) or 1 pF (β = 0.1). Useful for cell membrane capacitance measurements. May be used in conjunction with the DR-1 Resistance Dither unit.

DR-1 Resistance Dither unit (supplied with the Axopatch 200B Amplifier) normally provides a short-circuit link between preparation and ground. Inserts a 500 kΩ resistor in series with bath ground during TTL High signal. Suitable for finding the phase tracking angle in capacitance measurement experiments.

Mode

V-Clamp: Pipette voltage is clamped.

I-Clamp normal or fast: Pipette current is clamped to command current from Holding Command knob or external input. Normal mode is stable for electrode resistances greater than 1 MΩ. Fast mode is stable for electrode resistances greater than 10 MΩ. Series Resistance control is active.

Track: Slow I-Clamp to zero current used to correct pipette offset.

(I=0): I-Clamp to zero current.

Selected mode sets analog voltage on Mode Telegraph Output.

Command Potentials

Seal test: 5 mV (V-Clamp mode), 50 pA (I-Clamp, β = 1) or 500 pA (I-Clamp, β = 0.1) command at line frequency.

External commands: Two separate BNC inputs, one front-switched, one rear-switched

Sensitivity:

		β = 1	β = 0.1		
Front input	20 mV/V	2 nA/V	20 nA/V	disabled	disabled
Rear input	100 mV/V	2 nA/V	20 nA/V	disabled	disabled

Input impedance: 10 kΩ. Inputs may be connected in parallel to increase sensitivity.

Holding command: Ten-turn potentiometer with dial. Polarity switch. Value can be previewed on meter.

V-Clamp mode:

	V-Clamp	I-Clamp		Track	I = 0
		β = 1	β = 0.1		
Toggle x1	±200 mV	±2 nA	±20 nA	disabled	disabled
Toggle x5	±1 V	±10 nA	±100 nA	disabled	disabled

Pipette offset:

Manual: ±250 mV. Ten-turn control with uncalibrated dial.

Track, I=0: ±200 mV. Nulling potential automatically adjusts to maintain zero pipette current.

Zap

Amplitude: +1.3 V_{DC} at pipette for chosen duration.

Duration: 0.5–50 ms or Manual. Triggered by front-panel pushbutton. In Manual position Zap amplitude is maintained as long as pushbutton is depressed.

RMS Noise

A 3.5 digit meter displays RMS current noise in pA. Measurement bandwidth is 30 Hz to 5 kHz. Upper -3 dB frequency is set by 4-pole Butterworth filter.

Inputs

Forced resets: Positive edge triggered. Initiates a reset of the integrator; has no control over the duration of reset.

Blank activate: Causes Scaled Output and I Output to hold their initial value for the duration of the blanking pulse. Does not affect 10 V_m output.

Speed test: Injects current into headstage input through a 1 pF capacitor. Injected current waveform is the derivative of the voltage waveform applied at Speed Test input. For example, a 100 Hz 10 V_{p-p} triangle wave will inject a 1 nA_{p-p} square wave into the headstage input.

Signal Outputs

Scaled output: Scaled and filtered by output control settings. Sample and hold pedestal compensation. Output is I (αβ mV/pA) when in V-Clamp or Track modes. Output is V_m (α mV/mV) when in I-Clamp mode. BNCs on front and rear panels are identical.

Specifications

I: Pipette current. Rear-panel switched gain of either β mV/pA or 100 β mV/pA; fixed filter: 10 kHz 3-pole Bessel. Output does not benefit from sample and hold pedestal compensation.

10 V_m: Membrane potential at x10 gain. Junction potentials removed.

Output Controls

Output gain: 10 values from 0.5-500. Affects Scaled Output only. Selected value sets analog voltage on Gain Telegraph Output for reading by computer.

Lowpass Bessel filter: 4-pole lowpass Bessel filter with five settings; 1, 2, 5, 10 and 100 kHz. Selected value sets an analog voltage on Frequency Telegraph Output.

Leak Subtraction: Causes a signal proportional to the command to be subtracted from current record. Range: 100 β MΩ to ∞.

Telegraph Outputs

Gain: Takes α and β gain factors into account.

I (mV/pA)	0.05‡	0.1‡	0.2‡	0.5	1	2	5	10	20	50	100†	200†	500†
V_m (mV/mV)				0.5	1	2	5	10	20	50	100	200	500
Telegraph Output (V)	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5

‡ Applicable for β = 0.1 only. † Applicable for β = 1 only.

Frequency:

Filter Setting (kHz)	1	2	5	10	100
Telegraph Output (V)	2	4	6	8	10

Mode:

	Track	V-Clamp	I=0	I-Clamp Normal	I-Clamp Fast
Scaled Output	I	I	V_m	V_m	V_m
Telegraph (V)	4	6	3	2	1

Cell capacitance (Telegraph output): 0 to +10 V, proportional to setting 0-100 pF (for β = 1; 0-1000 pF for β = 0.1) when WHOLE CELL CAP switch is in the ON position. 0 to -10 V, when WHOLE CELL CAP switch is in the OFF position

Data Not Valid: Output goes High during a reset in Patch mode or for the duration of a Blank Activate pulse in either Patch or Whole Cell mode.

Panel Meter

3.5 digit meter displays Track potential (V_{TRACK}) in mV, membrane potential (V_m) in mV, current noise (I_{RMS}) in pA RMS, membrane current (I) in pA or nA, Holding Command (V_{HOLD}/I_{HOLD}) in mV or nA or input circuitry temperature in degrees Celsius (TEMP). Meter has autoranging feature for all settings except TEMP.

Grounding

Signal ground is isolated from chassis and power ground. Signal ground is available on rear panel.

Control Inputs

Above 3 V accepted as logic High. Below 2 V accepted as logic Low. Inputs protected to ±15 V.

Model Cells

Unit is supplied with two model cell assemblies, the PATCH-1U and the MCB-1U model cells.

PATCH-1U model cell emulates three experimental conditions:

BATH: 10 MΩ electrode resistor to ground. 4 pF pipette capacitance.

CELL: 10 MΩ electrode resistor connected to a 500 MΩ//33 pF cell. 4 pF pipette capacitance.

PATCH: 10 GΩ resistor to ground. 5 pF pipette capacitance.

MCB-1U model cell emulates a bilayer membrane. 10 kΩ resistor in series with a 100 pF capacitor.

Pipette Holders

HL-U holders mate to threaded Teflon input connector of the CV headstage. Post for suction tubing is 1 mm OD. HL-U holder accepts glass 1.0–1.7 mm OD. Supplied with silver wire. Optional HLR-U right-angle adapter and HLB-U BNC adapter are available.

General Specifications

Dimensions (in.):	3.5 (H) x 19 (W) x 12.5 (D)
Dimensions (cm):	8.9 (H) x 48.3 (W) x 31.7 (D)
Weight (lbs.):	11.5 (5.1 kg)
Headstage (in.):	0.75 (H) x 0.70 (W) x 4.2 (D)
Headstage (cm):	1.8 (H) x 1.9 (W) x 10.5 (D)
Mounting plate (in.):	0.25 (H) x 2.0 (W) x 2.5 (D)
Mounting plate (cm):	0.6 (H) x 5.0 (W) x 6.2 (D)
Communications:	Analog and digital BNC
Rack use:	Standard 19" rack-mount (2U) with handles
Benchtop use:	Bayonet feet
Power:	85–264 VAC (110–340 VDC) 50–60 Hz, 30 watts (max.)
Fuse:	0.5 A slow (5 x 20 mm)
Line filter:	RFI filter included
Line cord:	Shielded line cord provided
Safety:	CE marking (Conformité Européan)

Ordering information

Axopatch 200B Microelectrode Amplifier

Part Number: AXOPATCH 200B-2

- Axopatch 200B instrument
- (1) CV 203BU headstage
- (1) Headstage mounting plate
- (1) HL-U pipette holder
- (1) Patch-1U model cell
- 1) MCB-1U bilayer model cell
- (1) DR-1 series resistance dither unit
- (1) Spare fuse
- Theory and Operation user guide (printed)

Optional accessories

- Single headstage unit

Contact Us

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Email: info@moldev.com

Check our website for a current listing of worldwide distributors.

Regional Offices

USA and Canada	+1-800-635-5577
Brazil	+55-11-3616-6607
China (Beijing)	+86-10-6410-8669
China (Shanghai)	+86-21-3372-1088
Germany	00800-665-32860
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