



## The BC-535 *Bilayer Clamp Amplifier*

- Resistive feedback headstage
- 75 kHz bandwidth
- **High current capability** – up to 2 nA!
- Gains to 1000 mV/pA
- Hold potentials to 1400 mV
- Digital hold controls
- AutoZero function
- Digital readout of membrane capacitance
- Capacitance compensation
- Compatible with all data acquisition systems

### *Resistive Feedback Headstage*

BC-535 has an advanced, dual-resistive feedback headstage which provides high bandwidth and low noise recording. The switching headstage resistance is automatically selected based on the gain setting. A low current mode provides up to 100 pA of current carrying capability, while the high current mode provides up to 2 nA of current capacity!

### *Digital Hold Control*

The hold control for the BC-535 has been designed to function entirely within the digital domain. This unique approach allows the user to make holding potential adjustments in highly reproducible and discrete steps of 1 and 10 mV, up to  $\pm 400$  mV. Hold potentials up to  $\pm 1000$  mV or step sizes greater than 10 mV can be applied at the Command Input BNC's located on the front and rear panels of the instrument.

### *AutoZero*

The large currents flowing through the low resistance aperture prior to membrane formation saturates the amplifier input. Under these conditions, junction potential offsets can be easily nullified by using the AutoZero function. Once armed, the AutoZero cycle measures and compensates for any offset potentials in the conducting pathway. Traditional manual controls remain for making small corrections or for resetting the offset potential without reactivating the AutoZero cycle.

### *Audio Output*

The BC-535 sports a VCO circuit providing auditory feedback during membrane formation. An internal speaker is included and an external speaker output is provided on the instrument rear panel.

## Capacitance Test

This test circuit has been completely redesigned and is used to monitor the formation and stability of the bilayer membrane. A triangle waveform is applied to the command input and the amplitude of the resulting square wave is proportional to the membrane capacitance. When selected, the membrane capacitance is read directly from the meter.

## Bessel Filter

The filtering capacity if the instrument has been expanded to include a low pass, 4-pole Bessel filter ranging from 0.05 to 20 kHz in 1-2-5 steps. The internal filter can be bypassed for use with external filtering apparatus and allows realization of the instrument's full 75 kHz bandwidth.

## Capacitance Compensation

Large capacitance transients are cancelled using both fast (0.-10  $\mu$ s) and slow (0.2 ms) controls. Each control provides separate adjustment of both amplitude and time constant. Maximum capacitance compensation is 500 pF.

## I/O

Input and output BNC's have been duplicated or moved to the instrument rear panel except for those requiring user interaction. Front panel BNC's include Command Input,  $V_c \times 10$  and  $I_m$  Output. Rear panel BNC's include the headstage connector,  $I_m$  Output, Cap Sync, Cap Out, Command In, and Gain and Filter telegraphs. A speaker output is also available on the rear panel.

BC-535 Specifications	
<b>Noise</b>	Measured with 8-pole Bessel filter at specified cutoff frequency
	Frequency range      Open input      100 pF at input
	DC to 1 kHz            0.060 pA RMS      0.82 pA RMS
	DC to 100 Hz          0.009 pA RMS      0.28 pA RMS
<b>Bandwidth</b>	75 kHz
<b>Input commands</b>	Internal Hold            Digital; 1 or 10 mV steps to $\pm 400$ mV maximum
	Command In             Front and rear external input, 10 V/V (applied voltage is attenuated by 10/100/1000 at the command electrode)
<b>Junction zero</b>	AutoZero or manual adjust. AutoZero lockout feature. Cycle time 1.5 s. Correction to $\pm 120$ mV.
<b>Audio</b>	VCO with off switch and volume control. Internal speaker and external speaker output.
<b>Capacitance test</b>	Triangle wave applied to command electrode. Derived membrane capacitance read from meter up to 1000 pF. Calibrated (1 mV/pF) square wave available at $I_m$ output. Cap Sync (rear panel) synchronized with input triangle wave.
<b>Gain</b>	Membrane current gain selectable from 0.5 to 1000 mV/pA in 1-2-5 steps
<b>Filter</b>	4-pole Bessel selectable from 0.05 to 20 kHz in 1-2-5 steps, or bypassed for full amplifier bandwidth
<b>Capacity compensation</b>	Fast (0-10 $\mu$ s) and slow (0-2 ms) with adjustment of amplitude and time constant for each range. Maximum compensation 500 pF.
<b>Headstage</b>	Switching
	Low Current Mode      50 gigohm feedback, 100 pA maximum current High Current Mode     500 megohm feedback, 2 nA maximum current
<b>I/O</b>	Front panel:
	Command Input        BNC input up to 10 V. Attenuated by 10, 100 or 1000
	$I_m$ Output                Membrane current scaled by amplifier gain setting
	$V_c \times 10$ Output        Applied command voltage x 10
	Rear panel:
	$I_m$ Output                Membrane current scaled by amplifier gain setting
	Cap Sync                TTL compatible
	Cap Out                  Reports calculated membrane capacitance scaled to 1 mV/pF
	Command Input        BNC input up to 10 V. Attenuated by 10, 100 or 1000
	Gain Telegraph        Stepped DC voltage 0.5 to 5.5 V in 0.5 V steps for gain settings of 0.5 to 1000 mV/pA. Telegraphed value of 0.0 V for bypass.
Filter Telegraph        Stepped DC voltage 0.5 to 4.5 V in 0.5 V steps for filter settings of 0.05 to 20 kHz. Telegraph value of 5.0 V for full bypass.	
External Speaker        Standard RCA jack	
<b>Digital meter</b>	3.5 digit LED $\pm 1999$ mV full scale
	Junction offset $\pm 120$ mV full scale
	Cap Test                 0 to 1999 pF
	$V_c$ $\pm 1999$ mV full scale
	$I_m$ $\pm 1999$ pA full scale
<b>Power</b>	100-125 or 220-240 VAC, 50/60 Hz
<b>Dimensions</b>	H x W x D
	Case                      9 x 42 x 25 cm (3.5" x 16.5" x 10")
	Headstage               2.3 x 2.8 x 5.8 cm (0.9" x 1.1" x 2.25") 1.8 m connecting cable