Quick Guide to the Front Panel of the AxoClamp

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Caltech, April 2011

Overview

The AxoClamp-2B amplifier contains two entirely independent circuits for injecting current into a pair of microelectrodes and measuring voltages from those microelectrodes. It can also be used for fancier techniques such as "voltage clamping", but we will not be doing that today. This guide provides a section-by-section overview of the AxoClamp's controls.

LED Displays

The leftmost display ($\mathbf{V_m}$) indicates the voltage read by the ME1 electrode, in millivolts. The middle display ($\mathbf{V_2}$) indicates the voltage read by the ME2 electrode. (It is unclear why the leftmost display is not labeled $\mathbf{V_1}$.) The function of the rightmost display can be set by the knob to its left: $\mathbf{I_m}$ displays the current through ME1 (in nA); $\mathbf{0.1\,x\,I_2}$ displays the current through ME2, but note the factor 10, so that a reading of "00.1" now means 1.0 nA. We will not use $\mathbf{I_B}$.

The three knobs below the rightmost display tell the amplifier what kind of head stage you have connected, and should not be touched.

Outputs

The 6 BNCs here are the outputs of the AxoClamp, and can be connected to any of the ACH*nn* inputs of the BNC-2090. The most important outputs are $\mathbf{10V_m}$, which is 10x the voltage of the ME1 electrode, and $\mathbf{V_2}$, which is (1x) the voltage of the ME2 electrode. The $\mathbf{I_m}$ and $\mathbf{0.1\,x\,I_2}$ outputs can be used to monitor the currents that you are driving into the electrodes. The last two are not important to us.

Power

You guessed it. Before turning the device on or off, make sure that both **Capacitance Neutralization** dials (see below) are turned all the way off (counter-clockwise).

Step Command

The main dial sets the amount of current that gets applied when either the small switch is pushed down to Cont., or when a 5 V pulse is applied to the **Step Command** BNC input on the back of the amplifier. (Unless the small switch is pushed up to Off, in which case the inputs to the BNC are ignored.) The black **Destination** knob determines to which electrode the current goes. The scale of the current depends on the head stage, such that for the "1x" head stage, a value of "+010.0" corresponds to 10 nA, while for the "0.1x" head stage, "+010.0" would only be 1.0 nA.

Mode

We will leave the mode set to **Bridge** for all our recordings. That is the mode in which you can directly send a current to an electrode and measure the voltage at the electrode. We will not be using **DCC** (discontinuous current clamp), **SEVC** (single-electrode voltage clamp), or **TEVC** (two-electrode voltage clamp).

(Note that the **Sample Rate** display and **Rate Adjust** knob are only used in DCC and SEVC modes, so we will not need those. The two outputs that I declared "not important" earlier pertain to those two modes as well.)

Voltage Clamp

This section is irrelevant in Bridge mode.

Microelectrode 1 (ME1)

The **DC Current Command** dial selects how much currents gets injected into the electrode when the little switch below it gets pushed up (for positive currents) or down (for negative currents). If the "0.1x" head stage is connected as ME1, a dial setting of $\left[\begin{smallmatrix}1\\0\end{smallmatrix}\right]$ means 1.0 nA. The **Input Offset** dial has no effect on the electrode itself, but only on the output of the amplifier. It is used to cancel any offset produced by electrochemistry at the electrode–electrolyte interface. A dial setting of $\left[\begin{smallmatrix}5\\0\end{smallmatrix}\right]$ nominally results in an offset of zero volts.

The **Bridge** knob is used to compensate for the series resistance of an electrode, so that the output of the amplifier more directly corresponds to the voltage of the neuron you are measuring from. (We will cover this in the tutorial.) If the "0.1x" head stage is connected as ME1, a dial setting of $\left[\begin{smallmatrix}0\\3\end{smallmatrix}\right]$ means 30 MΩ. The **Capacitance Neutralization** helps compensate for the shunt resistance of the electrode. (We will also cover this in the tutorial.) This knob should be used with care: if you overcompensate, you can set up oscillations that can easily kill a neuron.

The **Clear** button can be used to try to shake pieces of debris off an electrode tip. Never use it when you're inside a cell: you will kill it instantly. Lastly, the **Buzz** button can be used to temporarily overcompensate the Capacitance Neutralization, which can be used to penetrate a cell membrane. Again, don't do it when you're already inside: you may "fall out" of the cell, or damage it.

Microelectrode 2 (ME2)

This section controls the ME2 electrode in almost the same way that the previous section controls the ME1 electrode. The only difference is that the current gain of the two head stages is not the same, which means that the **DC Current Command** and **Bridge** dials (but not the **Input Offset** dial) scale differently: If the "1x" head stage is connected as ME2, a setting of $\left[\begin{smallmatrix}1\\0\end{smallmatrix}\right]$ on the **DC Current Command** dial means 10 nA, and a setting of $\left[\begin{smallmatrix}3\\0\end{smallmatrix}\right]$ on the **Bridge** dial means 30 MΩ.