VC-CC ePatch

The new tiny amplifier designed by Elements for high quality patch clamp recordings in both voltage clamp and current clamp modes.

The low-noise amplifier, pulse generator and digitizer are included within the small headstage (only 42 x 18 x 78 mm) that can be directly installed to the micromanipulator mounting plate and powered by the USB port of any laptop.

Technical specifications (voltage-clamp):

- Open input noise (rms): 300fA @ 625Hz; 1.5pA @ 10 kHz; 12pA @ 100 kHz
- Current ranges: ±200pA (Gain 2.25GΩ), ±2nA (Gain 225MΩ), ±20nA (Gain 22.5MΩ), ±200nA (Gain 2.25MΩ)
- Voltage pulse generator range of ± 500 mV
- Digital filters: cutoff frequencies in the range between 625 Hz and 100 kHz
- Max sampling rate: 200 kS/s
- C-fast – C-slow – R-series – P/N compensations
- C-fast compensation range: 0-11 pF
- C Slow compensation ranges: C in 0 - 250 pF, τ in 0 - 2500µs
- R series correction ranges: R in 0 - 25 MΩ

Technical specifications (current-clamp):

- Noise (rms): 11µV @ 625Hz; 22µV @ 10 kHz; 350µV @ 100 kHz
- Current stimulus ranges: ±2.5nA (res. 0.2pA); ±100nA (res. 10pA)
- Voltage range: ±700 mV
- Pipette neutralization (0-31 pF range) and Bridge Balance compensation (0-40 MΩ range)
- True-zero current mode

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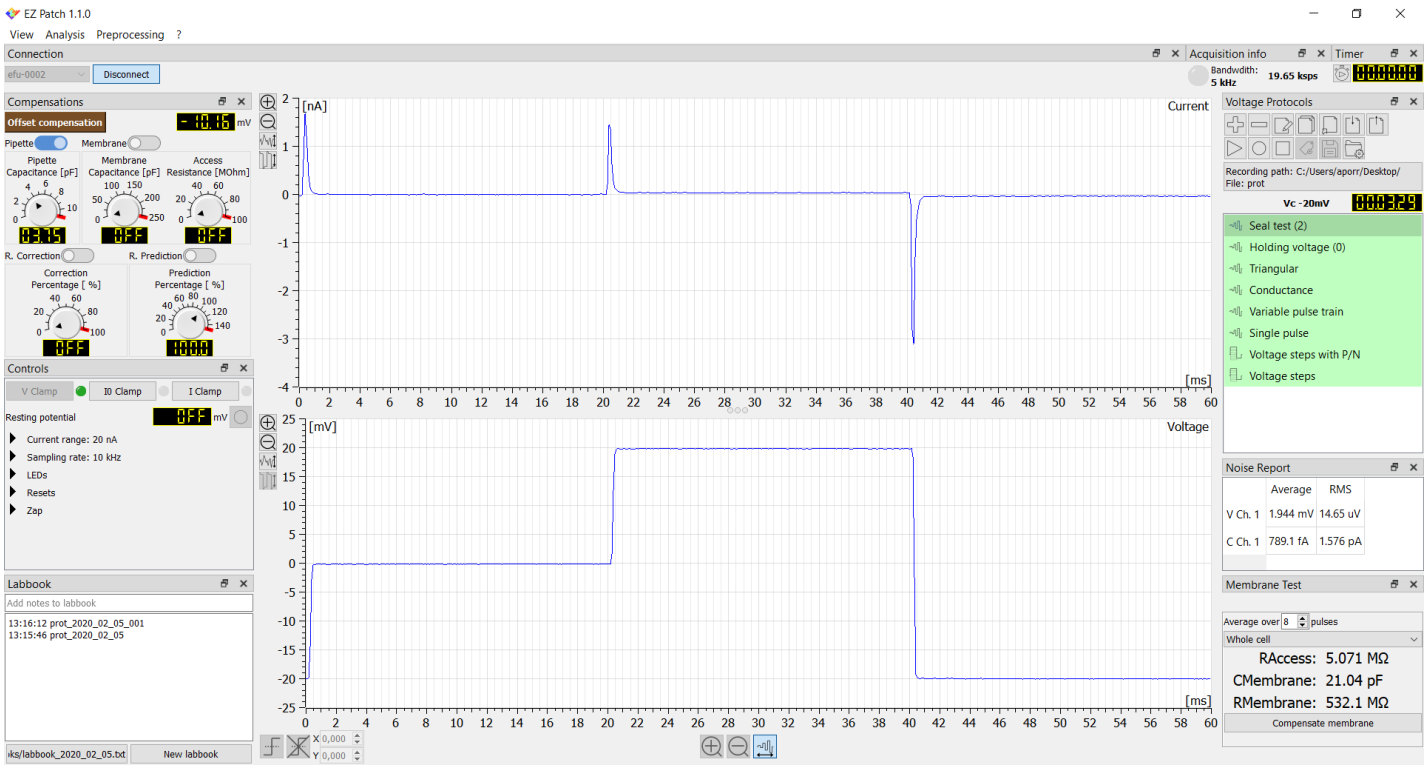
EZ Patch software interface

VC-CC ePatch is operated through the EZ Patch software, a user-friendly interface developed and released by Elements for an easy and fast control of the amplifier unit.

Features:

- Customizable user-friendly Windows-format interface
- Real-time display of voltage and current digitized data
- V-clamp, I_0-clamp and I-clamp modes
- Parametric voltage and current protocols editor
- Automatic or manual control of compensation settings
- Membrane parameters estimation to keep track of cell health
- Resting potential recording in true-zero current mode
- Real-time data analysis in voltage-clamp mode (I/V graph, histograms, FFT, etc.)
- Real-time action potential waveform analysis (AP treshold detection, AP frequency, AP slope, etc.)
- “Store sweep” tool to easily compare data during the recording
- Digital LabBook
- Data output saving format: .abf, with more coming soon
- Programmable Digital-Output to external devices
- Available for Windows and Mac OS



The figure shows the EZ Patch software interface. The oscilloscope window displays a triggered view of a defined continuous square wave applied to monitor the cell parameters. The real time analysis of the current response provides a range of measurements (Cm, Rm and Ra) shown within the membrane test widget (bottom, right of the GUI).

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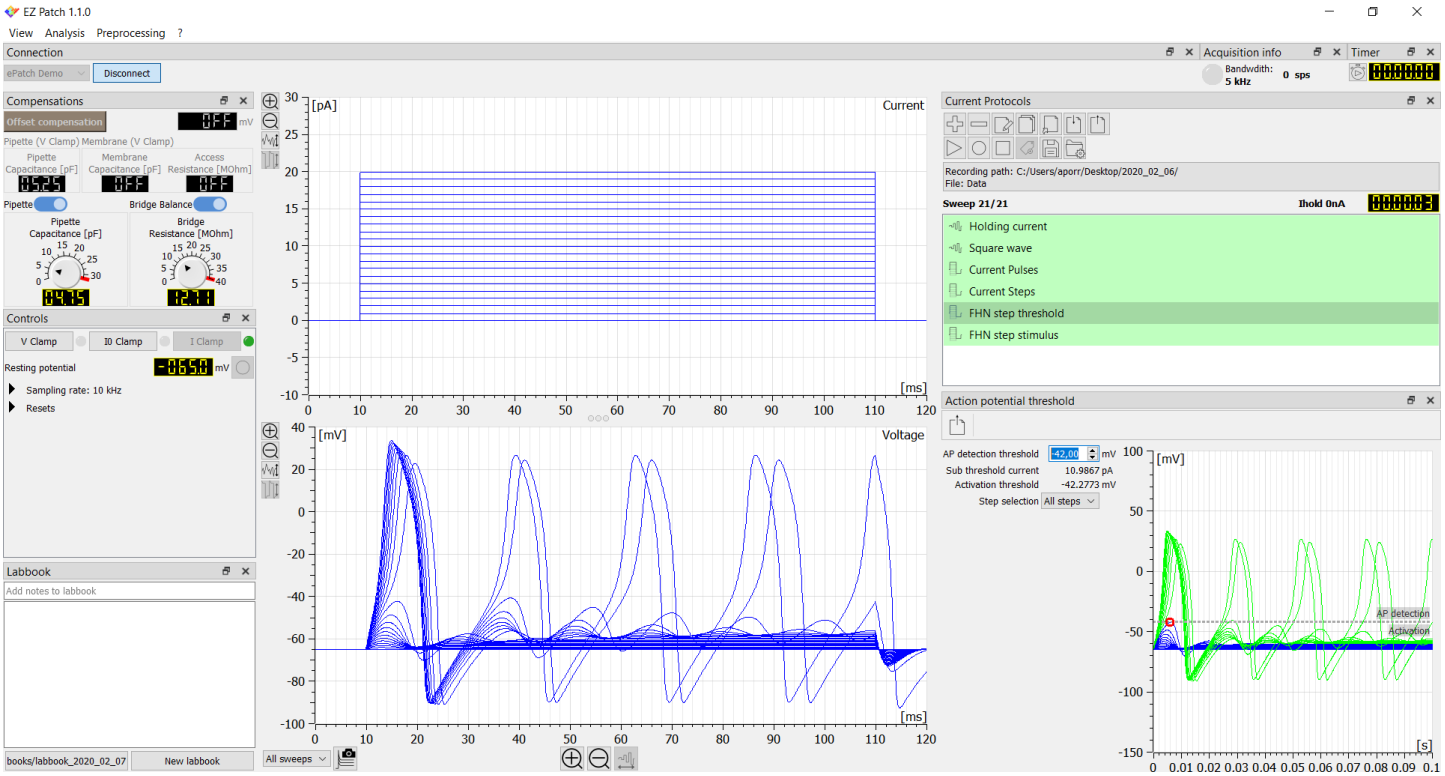
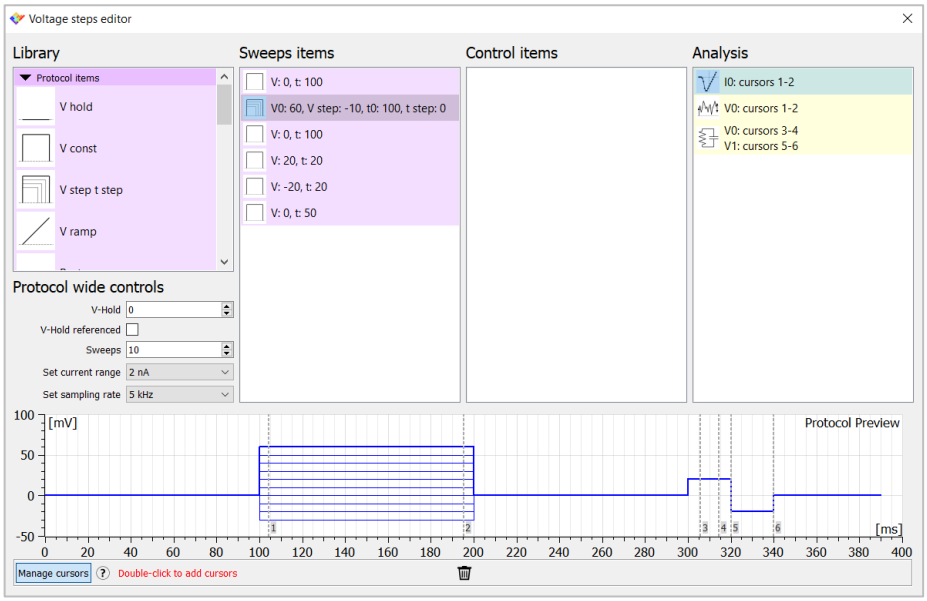
EZ Patch software interface



Snapshot of the EZ patch interface demo mode during the application of a series of current-steps to the single cell FitzHugh-Nagumo (FHN) model. The action potential threshold analysis tool automatically calculates both the AP threshold and the sub threshold current values. The analysis can be exported as row data within a .csv file.



The voltage protocol editor is designed to easily set up all the various aspects of data acquisition, ranging from the acquisition mode, the sampling rate, the gain, the shape of the command waveform and much more…

Real time analyses within a defined region of the waveform can be easily configured adjusting the settings of the cursors in the waveform preview.

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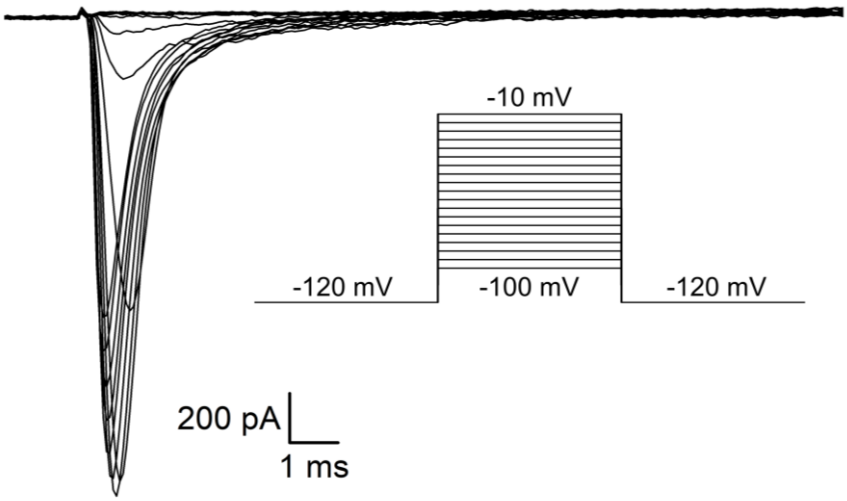
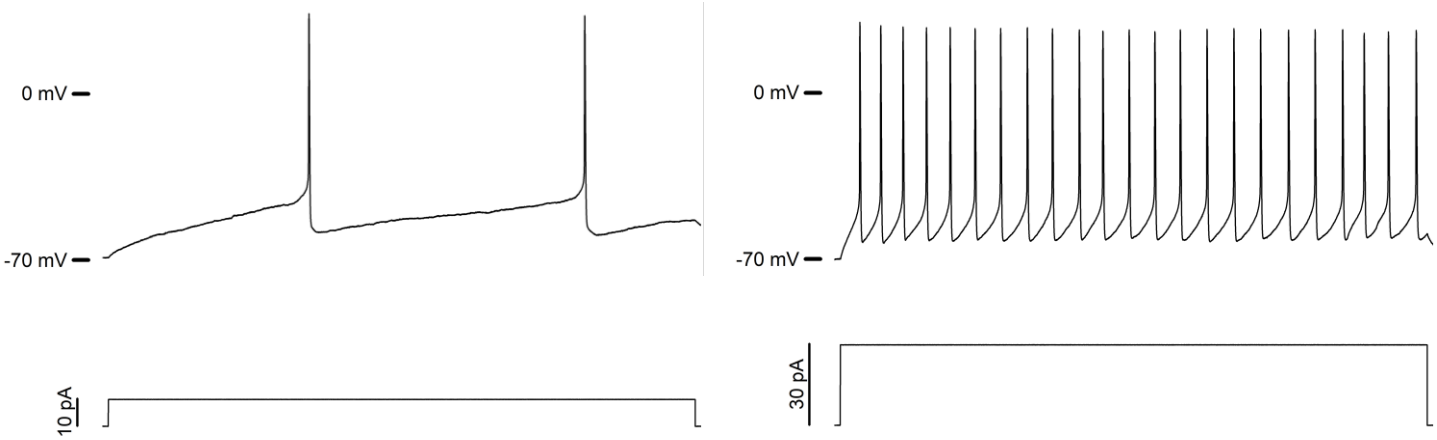
Case Studies

Na_v 1.5 channel current in voltage-clamp mode



Representative whole-cell current traces recorded from an HEK cell overexpressing $Na_v1.5$ channel, using the indicated pulse protocol. Data were recorded at 10 kHz sampling rate (5 kHz bandwidth). Both pipette and membrane capacitance were compensated. Voltage errors were minimized using 80% series resistance compensation. Pipette was filled with a solution containing (in mM): 135 NaCl, 4 KCl, 1 $CaCl_2$, 2 $MgCl_2$, 10 HEPES, 20 Glucose, PH 7.4. Bath solution contained (in mM): 5 NaCl, 140 CsCl, 4 Mg-ATP, 2 $MgCl_2$, 5 EGTA, 10 HEPES, PH 7.4.

Current-clamp recording of cortical neurons firing



Representative whole-cell current-clamp recordings of a cortical neuron isolated from neonatal rat brains. After achieving the whole-cell configuration in VC mode, the amplifier was switched to the “true zero current mode” to measure the resting potential value. Afterwards, both the pipette neutralization and the bridge balance compensation were applied. The action potentials were finally recorded by injecting currents of 10 and 30 pA for 1 s (left and right, respectively) from the same holding potential of -70 mV. Data were acquired at 10 kHz SR and saved in .abf format. Data courtesy of Dr. A. Binda and Prof. I. Rivolta, School of Medicine and Surgery, University of Milano-Bicocca, Italy.

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