New Feature

*NEW*: THE FIRST ALL-IN-ONE SOLUTION FOR PERFORMING DYNAMIC CLAMP EXPERIMENTS

FULLY INTEGRATED SINGLE- OR DUAL- HEADSTAGE PATCH CLAMP AMPLIFIER AND DATA ACQUISITION SYSTEM ENSURES QUICK AND EASY SETUP

ULTRA-HIGH BANDWIDTH ENABLES CHARACTERIZATION OF THE FASTEST SIGNALS OPTIMIZED FOR LOW-NOISE SINGLE-CHANNEL WHOLE-CELL PATCH CLAMP

FULL COMPUTER CONTROL PROVIDES AUTOMATED COMPENSATION OF ELECTRODE AND WHOLE-CELL CAPACITANCE FOR UTMOST PRECISION AND SIGNAL FIDELITY

VOLTAGE AND FASTFOLLOWER™ CURRENT CLAMP CAPABILITY FOR COMPLETE CHARACTERIZATION OF CELLS' ELECTRICAL ACTIVITY


# dPATCH® LOW-NOISE ULTRA-FAST DIGITAL PATCH CLAMP AMPLIFIER SYSTEM

The **dPatch®** Digital Patch Clamp Amplifier System is the latest cutting-edge tool for electrophysiology research.. Using high-speed digital processing, matched with high-resolution data converters and paired with **SutterPatch®** software's intuitive user interface, this low-noise, high-bandwidth precision instrument provides capabilities previously unattainable to electrophysiologists.

Available in either a single- or dual-headstage configuration, the **dPatch** amplifier's architecture makes swapping headstages, or adding a second one to a single-headstage version, a plug-and-play operation. The two headstages are independently configurable for either voltage clamp or FastFollower™ current clamp. Data is streamed from each headstage in parallel and fully synchronized.

*5 MHz sampling rate, up to 22 bits of resolution*
One unique feature with **dPatch** is the headstage-based data sampling system. The signal from each headstage is continually digitized at 5 MHz. Output filtering has thirteen settings between 100 Hz and 1 MHz. A resolution of 18 bits is achieved at 1 MHz. For lower filter settings, automatic downsampling increases resolution while optimizing data rates. At a bandwidth setting of 1 kHz the **dPatch** system provides a signal resolution of better than 22 bits.

*Optimal noise performance in both the capacitive and resistive feedback ranges*
When other products remove thermal energy from the headstage circuitry, it in turn heats up the headstage housing. That leads to thermal drift of the pipette and other, cumbersome side effects. One of the development goals of the **dPatch** headstage was achieving a comparable noise performance at room temperature, without the need for a cooled headstage. In the two resistive feedback modes, the **dPatch** amplifier is even quieter than any of the competitor systems.

*Built-in data acquisition system means no third-party hardware*
Using a multiplexer-free design, the **dPatch** provides 8 fully differential analog input channels, 4 analog output channels, and 16 digital outputs (TTL). All I/O channels are sampled continuously (200 kHz for analog inputs, 250 kHz for analog and digital outputs) and available through the user interface.

***SutterPatch®** Software*
The **dPatch** amplifier, in combination with **SutterPatch** software, has been engineered to automatically capture and store all amplifier settings, stimulus information and external experiment parameters, and associate them in time with the raw data traces. This includes all amplifier and acquisition settings, as well as timing and progress of the experiment. Fully integrated computer control of the amplifier stages means that the acquisition software is aware of the internal state of the amplifier and digitizer at all times and can track any changes that may occur. This is independent of whether a change is triggered automatically or initiated by the user.

*Tracking of Other External Data*
In addition to status changes in connected hardware that are automatically tracked, the researcher can manually trigger tags to document events like stimulus application using instruments not connected to the amplifier.

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MADE IN USA

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Information about environmental parameters and a more detailed specification of sample properties can be recorded and stored with the raw data. A total of over 600 metadata attributes are supported. Examples include: animal species, genotype, date/time when a cell sample was prepared, recording solutions, pipette resistance, hardware properties, and detailed information about stimuli applied.

*Data Visualization and Analysis*

**SutterPatch®** software has been designed to simplify the navigation and analysis of complex datasets. The scope window supports multiple view modes in both two-dimensional and an innovative three-dimensional display. The 3D view is particularly useful during assay development. Built on top of the latest version of the proven Igor Pro platform, **SutterPatch** combines native Igor Pro functionality with a wealth of features that are tailored to electrophysiology applications. Both the newcomer and the experienced user of patch clamp programs will quickly feel comfortable using **SutterPatch** software.

Application modules provide focused functionality for particular applications.

*Currently Available:*

- Event Detection Module: A deconvolution algorithm that excels at detecting miniature synaptic events even on a noisy background.
- Action Potential Analysis Module: Phase plane plot, timing and waveform statistics.
- Camera Module: An easy way to document the identity and condition of the recorded cell.

*A Laboratory Workhorse*

While **dPatch®** system is ready for cutting-edge research, its feature set makes it immediately valuable in any lab setting.

- Three headstage feedback ranges for optimal whole-cell and single-channel recording
- Automated or manual compensation of electrode and whole-cell capacitance
- Series resistance compensation
- Simple cabling, quick and easy set-up
- High dynamic range of data acquisition module means no need for variable gain stages
- High speed of digitizer means no concern about sample rate

***Dynamic Clamp User Interface***

The dynamic clamp user interface provides a powerful mechanism for loading dynamic clamp models. No expertise with scripting is required. Gate equations or Markov model transitions are simply entered as text and are interpreted by **SutterPatch®**. Individual dynamic clamp routines are saved in a pool and can be easily transferred between users. In addition, a number of models are provided to get users started, ranging from a simple leak conductance to a 12-state sodium channel.

The **dPatch®** Integrated Digital Patch Clamp Amplifier is a computer-controlled single- or dual-headstage system for both single-channel and whole-cell recording applications.

***Amplifier***

- Hardware architecture enables all data conversion to be performed near the preparation, well away from known noise sources, such as power supplies and high-speed digital circuitry.
- Voltage clamp and FastFollower™ current clamp modes with smart switching between modes to avoid current artifacts
- Three choices of headstage feedback elements to optimize both single-channel and whole-cell recording

| Feedback Element | Range | Analog Bandwidth | Noise 10 kHz BW | Pipette Capacitance Compensation Range | Series Resistance Range | Cell Capacitance Range |
|---|---|---|---|---|---|---|
| Capacitive | ±20 nA | >500 kHz | <0.22 $pA_{RMS}$ | 20 pF | N/A * | N/A * |
| 500 MΩ | ±20 nA | >250 kHz | <0.75 $pA_{RMS}$ | 20 pF | 100 MΩ | 100 pF |
| 50 MΩ | ±200 nA | >250 kHz | <2.40 $pA_{RMS}$ | 20 pF | 10 MΩ | 1000 pF |

* Capacitive feedback range is optimized for single-channel voltage clamp recordings. Whole-cell compensation and current clamp mode are disabled with this range.

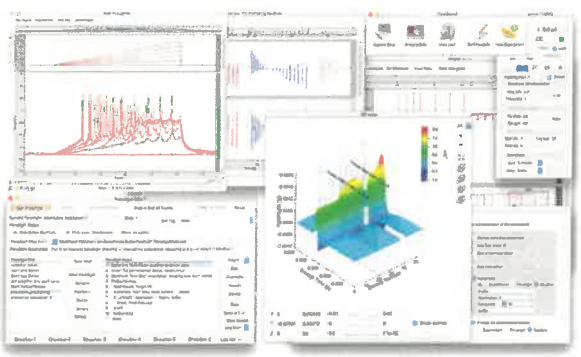
- Automatic compensation routines for pipette compensation and whole-cell compensation, and series resistance compensation
- Novel 2D matrix and triple-slider controls for manual compensation adjustment
- Series resistance prediction and correction independently programmable
- 8-pole Bessel filter 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 250, 500, 1000 kHz
- Signal processing of filter output to increase resolution and reduce data file size
- Resolution over 22 bits at 1 kHz filter setting
- High dynamic range of analog to digital converters eliminates need for variable output gain stages
- Holding potential ±1000 mV
- Current clamp bridge compensation and pipette capacitance compensation
- Software lock-in amplifier with up to 20 kHz base frequency for high-resolution capacitance measurements

***Data Acquisition***

- Embedded data acquisition system eliminates the need for an external data acquisition board
  - 5 MHz sampling rate per headstage, up to 22-bits resolution
  - 8 Auxiliary analog inputs, 16-bit fully differential, ±10 V input, each continuously sampled at 200 kHz
  - 4 Analog outputs, 16-bits, ±10 V output each continuously updated at 250 kHz
  - 16 Digital outputs (TTL) each running at 250 kHz
  - Independent Trigger IN / Trigger OUT for synchronization of external instrumentation
- Single high-speed USB 3.0 connection controls data acquisition and amplifier settings
- Complex command waveforms
- Data acquisition can be initiated by an onboard microsecond clock or external (TTL) trigger

***SutterPatch Software***

- Built on the foundation of Igor Pro (WaveMetrics, Inc.)
- Paradigms and Routines provide complete experimental control
- Waveform Editor for easy creation of even the most complex stimulus patterns or user-defined templates
- Associated Metadata stores all relevant information regarding your experiment
- Comprehensive data analysis routines and publication-quality graphics
- Rapid-response online line-frequency reduction
- Runs on Windows 10 (64-bit), or Macintosh OS X 10.11 (El Capitan), or newer versions



Screen shot of SutterPatch software