

Signal

Sweep-based data acquisition & analysis system

Patch Clamp electrophysiology

Signal for Windows incorporates many powerful features for whole cell and single channel experiments that make it ideal for electrophysiological recording. Familiar terms, and easily set up protocols for standard requirements enable the user to get started quickly using Signal and a CED 1401 data acquisition interface. Signal also incorporates an import function allowing you to analyse data from other recording systems.

Stimulus generation

- Generate stimuli on up to 8 DACs and 8 TTL lines
- Define as many as 256 sets of up to 500 pulses
- Set stimuli at a fixed level or relative to an adjustable holding potential or current
- Output multiple sets of arbitrary waveforms per sweep. Waveforms are held in 1401 data acquisition interface memory for very accurate timing
- Sequence through sets of pulses manually, cyclically, randomly or by user-defined protocol
- Interactively edit, add and remove stimuli while recording
- Define pulses with fixed or stepping amplitudes and durations
- Pulse types include square wave, ramp, sinusoid, pulse trains and pre-recorded or user-generated waveforms, e.g. recorded action potentials

Clamp specific sampling support

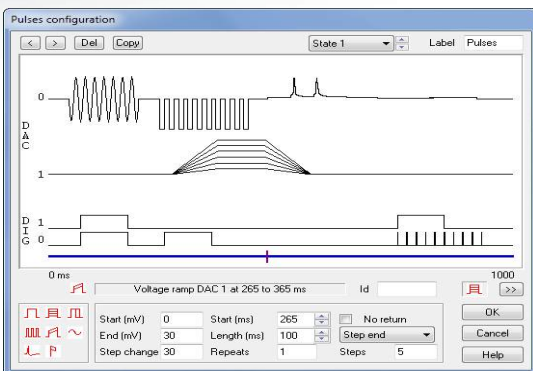
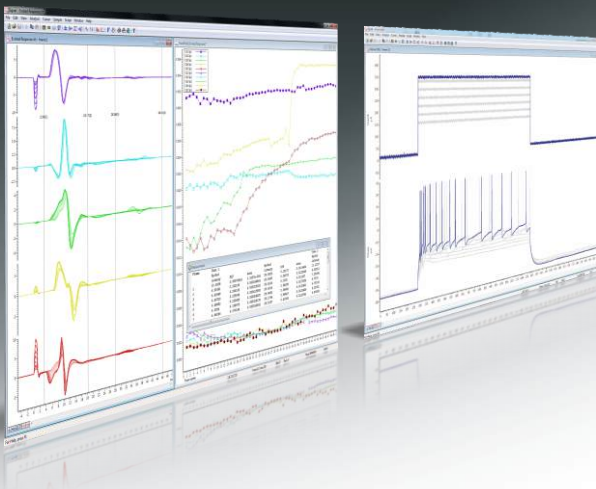
- Nominate a particular recording state to be used for seal and membrane resistance measurements
- Easy adjustment of holding potentials
- Dynamic readout of seal resistance
- Support for dynamic clamp studies with up to 15 selectable conductance models. Update rates of over 300 kHz* without timing jitter (see dynamic clamping data sheet for details)
- Membrane analysis option displays measurements of total resistance, access and membrane conductance, capacitive transient decay time constant and membrane capacitance
- Display selected measurements as a graph against time

Amplifier communication

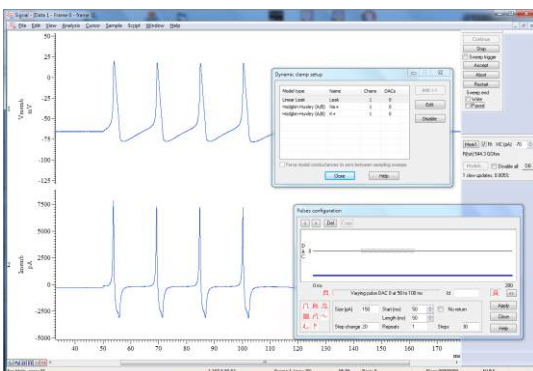
- Telegraph communication to set channel scales based on voltages supplied from a wide range of patch clamp amplifiers
- Direct software communication with Molecular Devices MultiClamp 700 and Axoclamp 900 amplifiers. Reads values for gains, filter settings, membrane capacitance, series resistance and external command sensitivity. These values are stored in the Signal data file

Leak subtraction

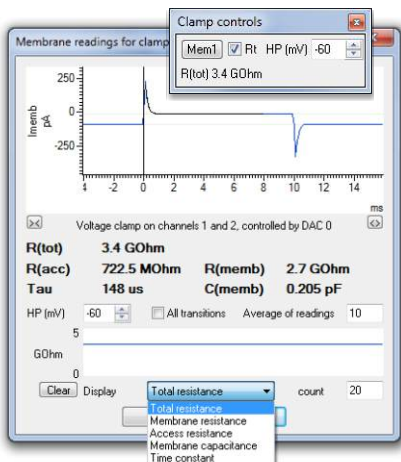
- Three methods of defining leak data on-line and off-line
- On- or off-line subtraction of scaled leak trace, including capacitive transients
- Subtract specific leaks on-line in current clamp using a selection of dynamic clamp models



Pulse configuration dialog



Action potentials simulated by dynamic clamp

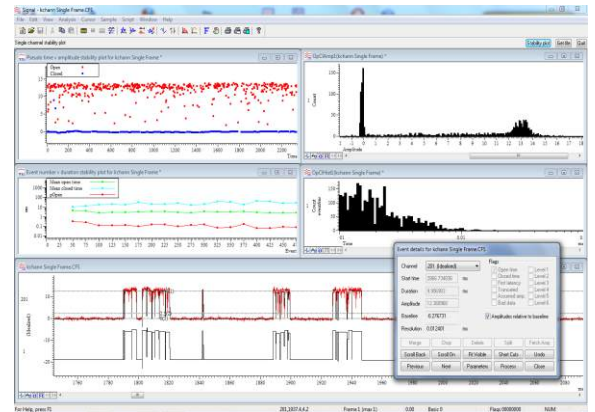


Membrane test during sampling

Single channel analysis

Idealised trace generation converts the waveform to a set of events describing the state of the channel(s) at the time of each transition point. Details include time, duration, mean amplitude and flags for open/closed, first latency and level.

- View details of individual events. Edit events by dragging times and amplitudes or setting values in a dialog
- Detect short events using SCAN analysis for improved accuracy
- Insert and remove events interactively
- Produce amplitude histograms from original data
- Generate open/closed time histograms, amplitude histograms and burst duration histograms from idealised traces
- Select events to include/exclude based on associated flags
- Generate idealised traces on-line as well as off-line



Single channel patch clamp analysis

Curve fits

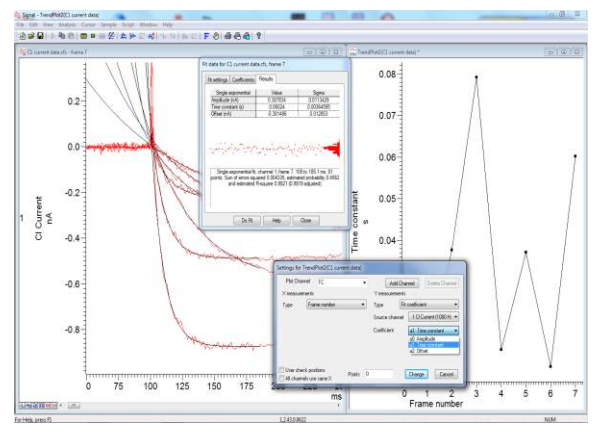
Fit mathematical functions to original or leak subtracted data and trend plots.

- Fit types include: Exponential - first or second order, Gaussian - one or two, Polynomials from first to fifth order and Sigmoid (Boltzmann) curve
- Gives best fit coefficients and an estimate of confidence
- Display fit coefficients in trend plots

Measurement plots

The trend and measurement plot functions in Signal generate graphs of measurements taken from the recorded data both on-line and off-line. For each frame selected, measurements are taken from individual or multiple events and plotted as X and Y coordinates. Typical examples would be the generation of an I/V curve or measurements from multiple action potentials.

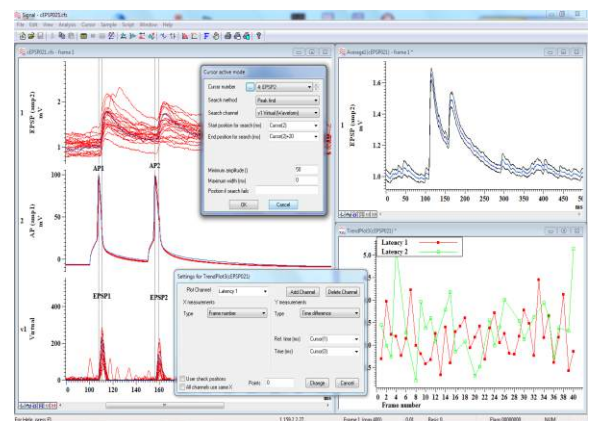
- Identify positions for measurements either manually or by setting 'active cursors' to seek for data features
- Extensive range of available measurements including peak heights, times, fit coefficients, areas, means, slopes, RMS amplitudes and standard deviations
- Plot up to 32 independent sets of measurements with optional log axes
- Easy export of results to spreadsheet



Exponential curve fitting on multiple traces

Advanced features

- Signal's output sequencer provides advanced control functions including fast access to incoming data. This can be used in many ways, for example, to generate a stimulus ramp and halt ramping immediately upon detection of an action potential.
- Signal's built-in script language provides the user with the ability to customise the system for particular requirements. This is used for automation and to add specific functions not available through the menus, for example non-standard leak subtraction routines. Script control can also enhance standard functions including the option of higher-order curve fits.



Analysis of paired recording from a pyramidal cell connected with a fast spiking interneurone in the cortex †

CED

Cambridge Electronic Design Limited

Technical Centre, 139 Cambridge Road, Milton, Cambridge CB24 6AZ, UK. Tel: (01223) 420186

Email: info@ced.co.uk Europe & International Tel: [44] (0)1223 420186 USA and Canada Toll free: 1-800-345-7794

Distributors in: Australia, Austria, China, France, Germany, Israel, Italy, Japan, Switzerland & Turkey

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* Dynamic clamping requires a Power1401mkII or later. 300 kHz update rate tested using a CED Power1401-3 running one Hodgkin-Huxley model. Maximum rates using a Power1401mkII circa. 100 kHz.