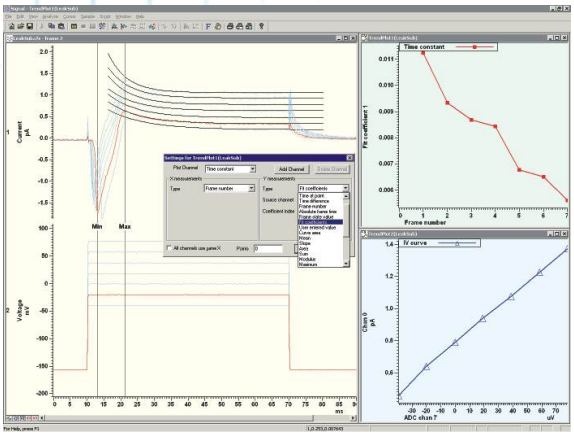
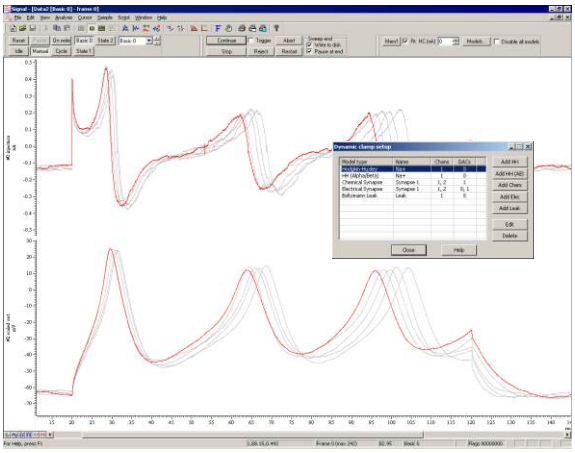
Signal

Version 5

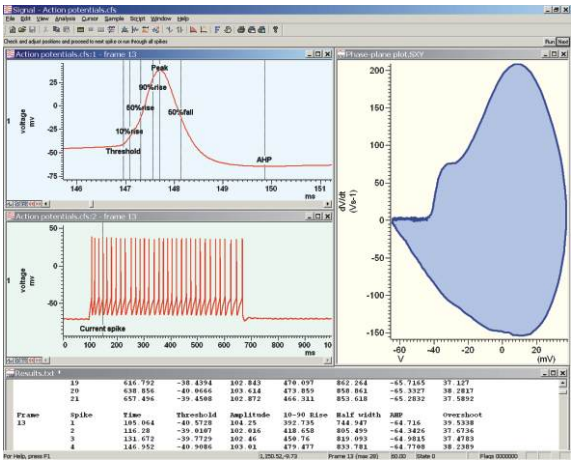
Sweep-based data acquisition and analysis system



Stimulus and response recording with multiple simultaneous measurements



Dynamic clamp in action



Automated action potential analysis

Signal is a sweep-based data acquisition and analysis package. Uses range from a simple storage oscilloscope to complex applications requiring stimulus generation, data capture, control of external equipment and custom analysis. This flexibility makes it ideal for a wide range of applications including transient capture, patch and voltage clamp, LTP studies and evoked response.

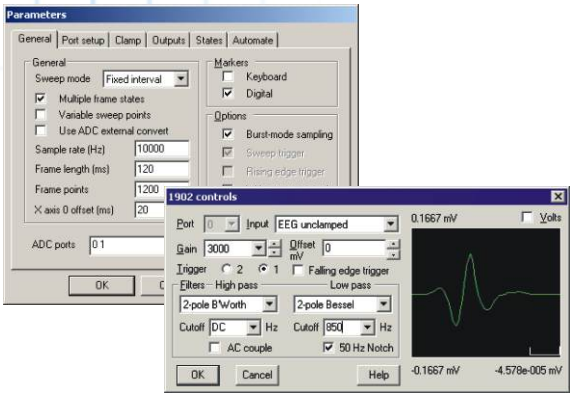
- Signal is simple to set up for data capture and analysis.
- Signal has the sampling and analysis features most researchers need in a user-friendly environment. A built-in script language automates repetitive tasks and provides additional tools for custom analyses and applications.
- Signal includes functions for specific application areas including whole cell and patch clamp electrophysiology and evoked response with control of magnetic and other stimulus devices.
- Signal imports data recorded by many other systems, so you can take advantage of this extremely versatile system to analyse existing data.

The powerful data capture and time-saving analysis functions of Signal together with one of the CED1401 family of laboratory interfaces make an extremely flexible and cost-effective addition to any laboratory.

Features

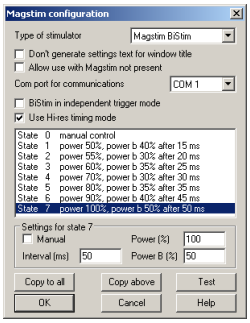
- Record sweeps of waveform and marker data, free-running, gap-free or time-locked to a stimulus or response
- Perform analysis on-line and off-line including waveform averaging (with error bars), power spectra and amplitude histograms
- Detect and measure waveform features in raw data and average result views and generate XY measurement plots both on-line and off-line
- Generate simple and complex protocols of waveform and digital output and modify the output interactively, even while sampling
- Derive ‘virtual channels’ from existing waveforms, defined by user-supplied expressions (channel arithmetic)
- Automate and customise analyses and repetitive tasks
- Digitally filter (FIR and IIR) via interactive dialogs or scripts
- Configure multiple views of the same data file and overlay data from multiple sweeps and channels, even during sampling
- Design stimulus outputs graphically, react very quickly to sampled data and apply complex interaction between inputs and outputs with scripts
- Analyse whole-cell voltage and current clamp (leak subtraction, curve fitting) and single channel patch clamp analysis (open/closed time, burst duration histograms etc.)
- Apply curve fitting using a variety of fit equations; fit coefficients can be plotted automatically to an XY view
- Carry out dynamic clamp experiments using 15 different mathematical models to simulate ion channel function

The Micro1401 and Power1401

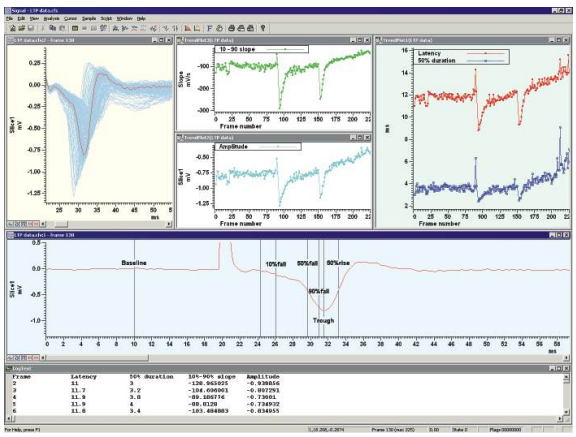


Sampling setup and amplifier control

CED1902 isolated pre-amplifier



Magstim control in multiple states mode



LTP analysis with tabulated results

Acquisition

- Record and display fast sweeps of waveform data to disk with over 15 million data points per sweep with a Power1401
- Output pulse, sine, ramp and up to 256 stored waveforms while sampling
- Generate sets of varying stimuli on up to 8 waveform and 16 digital outputs
- Sample multiple waveform inputs at aggregate rates up to 1MHz
- Easily switch sampling configurations or output protocols
- Capture free-running or triggered sweeps with post or peri-trigger modes
- Trigger data capture from external pulse, waveform threshold crossing or internal clock
- Sample variable numbers of points in different sweeps
- Tag frames to indicate state or artefacts for selective review and analysis
- Perform built-in and custom analyses on incoming sampled data
- Configure dynamically programmable amplifiers including the CED1902 low-noise isolated pre-amplifier and the Power1401 gain option
- Read back settings and configuration from Axon Multiclamp amplifiers
- Sample at arbitrary or varying rates with external convert input option

Typical applications and script-driven functions

Evoked response and TMS Output fixed, random and pseudo-random sets of pulses with on-line and off-line waveform averages and measurements of latencies, amplitudes and areas. Auto-averaging enables the user to specify the last *n* frames to form an average and measurements can be taken automatically from the results. Signal can control Magstim transcranial magnetic stimulators during data acquisition, including adjusting stimulator amplitude and timing with checks on stimulator condition. Settings are stored in the corresponding data frame.

LTP and LTD studies Generate single, paired and trains of pulses on multiple outputs. Signal automatically measures baselines, amplitudes, latencies, areas, durations, percentage rise and decay times, and population spike parameters for single or multiple responses per frame.

Whole cell voltage and current clamp Interactively control holding potentials and pulse outputs using the graphical sequencer. Construct I/V plots, leak subtraction and curve fits on-line and off-line. Use dynamic clamping to simulate ion channels, leaks and synapses.

Single channel patch clamp Detect single and multi-level channel openings on-line and off-line automatically. Produce measurements such as open/closed times and amplitudes and display result histograms.

EMG Record single and multiple channels of EMG with software control of amplifiers such as the CED1902. Perform rectification and smoothing at the touch of a button or under script control. Produce power spectra that update as new data sweeps are captured.

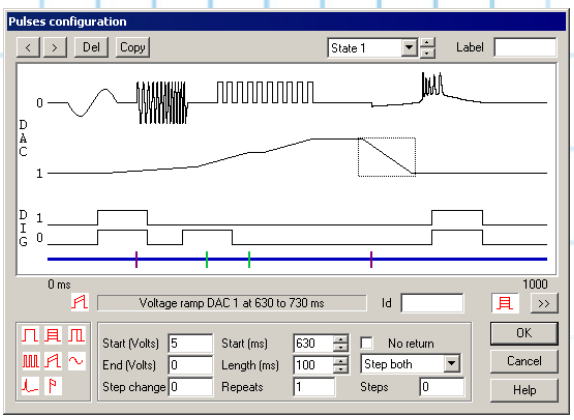
Transients Detect waveforms rising or falling below a threshold as a trigger. Capture peri-trigger data up to the available size of memory inside your CED1401. Optionally output stimuli in response to the trigger.

Auditory evoked potentials Generate complex stimulus protocols and reports under script control. Features include: automatic artefact rejection, digital filtering, generation of sub and grand averages and feature detection using active cursors.

Complex stimuli and experimental control

Signal can generate a large range of output stimuli, with two methods available for specifying outputs. The graphical pulse editor covers the majority of stimulus requirements in an easy to use drag and drop environment where you build up to 256 sets of up to 500 pulses. Outputs are fixed or they can change amplitude and duration on repeats. You can also modify them while sampling continues.

If your requirements cannot be entirely met with the pulse editor you can define your outputs as a text sequence of instructions. This makes it possible to control the sequence interactively with the script language. Further experiment control options including communication through serial lines are also available with the script language.



Output pulse editor

Output states control

Advanced features

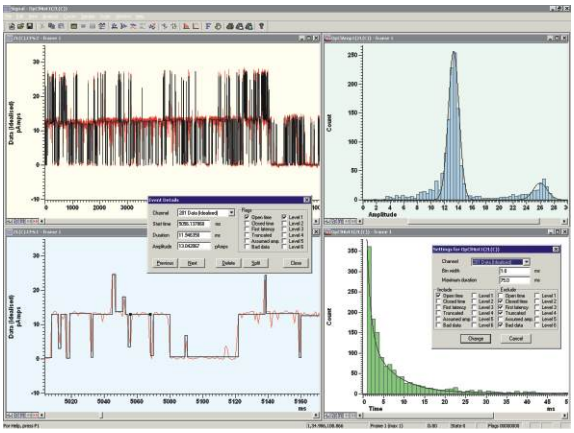
Multiple sampling conditions Signal includes a comprehensive multiple output states system that provides differing pulse outputs or stimuli while sampling. The order and repeats of each stimulus can be sequenced using a predefined protocol or executed randomly, semi-randomly or under manual control. Each frame of data is marked to indicate the stimulus that was used.

Voltage and current clamp Signal generates all of the stimuli needed for voltage and current clamp protocols. Multiple sets of stimuli can be stored in one sampling configuration. Automated on-line measurement of seal and membrane resistance can be made during recordings. Leak-subtraction and I/V plots are always available even while sampling. Curve fitting can be applied to raw waveform data, leak subtracted data and I/V plots.

Ion channels, leaks and synapses can be simulated with the built-in dynamic clamp support. Optimised look-up tables and fast arithmetic are utilised in the Power1401 mk II interface for maximum output data rates. Up to 15 selectable models can be used and switched between while sampling.

Single channel patch clamp Signal produces idealised current traces from patch data showing detected transition events. The idealised trace is editable by dragging open/closed times and amplitudes; there are additional tools for splitting and combining events. Amplitude histograms from raw or idealised data and dwell time histograms from idealised traces are available. Derived histograms can be characterised by a number of fit types.

A special feature is the reverse convolution fitting of an amplifier's step response (SCAN analysis) to filtered single channel patch clamp data allowing superior time resolution of events.



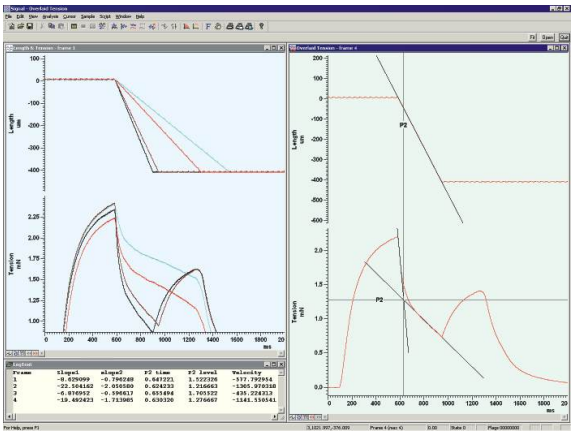
Single channel patch clamp analysis

Script language

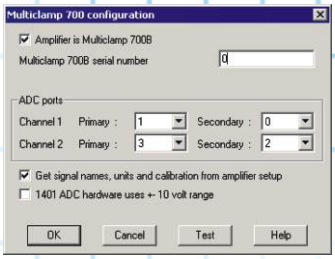
From complete beginners to experienced programmers, everybody can benefit from the built-in script language. Even simple automation of repetitive tasks with known parameters can save hours or even days of tedious analysis. Advanced scripts can provide complete experiment control with on-line application of original algorithms to sampled data in real-time.

The script language allows you to generate your own user interface, and there is a macro recording facility to provide a starting point for new scripts. The script language also includes data manipulation tools such as multi-dimensional arrays and matrix functions.

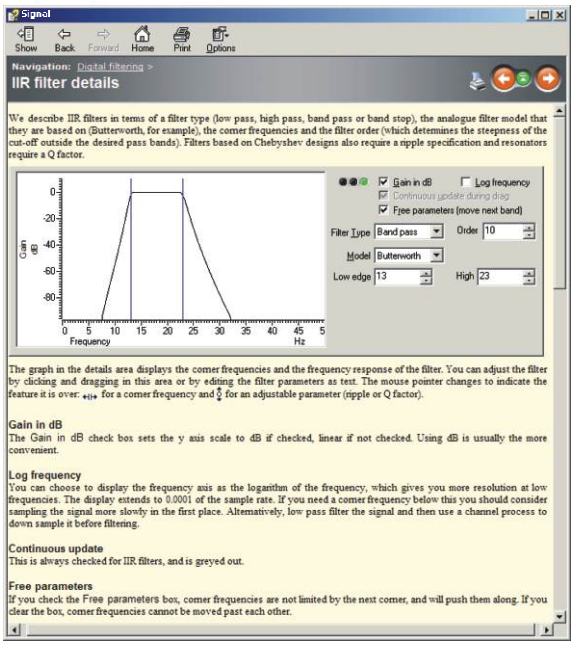
CED maintains a library of example scripts for a wide range of common and specialised applications. If the scripts included with the Signal software or those available from our web site do not fulfil your exact requirements, please contact us to discuss the available options. These include modification of existing scripts and a dedicated script-writing service.



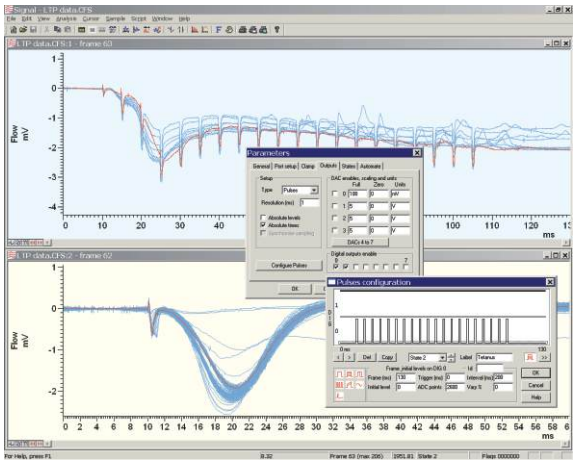
Control of muscle length with analysis of resultant tension slopes



Control of external equipment



Signal on-line help: Digital filtering



Data capture with independent frame length per stimulus type

Signal version 5 features

- Simulate ion channels, leaks and synapses with built-in dynamic clamping support. Up to 15 clamping models can be used concurrently when sampling
- Improved voltage and current clamping system with up to 8 clamping sets; each clamping set comprising a pair of channels and a controlling DAC
- Easier to use graphical pulses configuration dialog with better timing information via a new 'control track'
- Digital marker generation palette item in pulses dialog
- Extended arbitrary waveform output. Drag and drop up to 256 waveforms on to the output pulses control track or call them from a text sequencer
- Automatically rescaling Y axis with corresponding channel SI unit update
- Specify data line thickness with channel specific 'pen width' function
- Identify matched and unmatched braces in script and sequence editors to verify expressions
- Control cursors and cursor regions dialogs from a script
- New script commands to remove white space and selected characters from text in a string variable
- Convenient Watch window addition to the script debugger for monitoring local and global variables

Service and support

When you buy a system from CED, you are buying from a company with over 40 years of experience in data acquisition. We have one of the best customer support packages currently available, which includes:

- Free telephone and email help desks plus on-line forum
- Software and hardware development responsive to user feedback
- Swift fault diagnosis and hardware servicing
- Software updates available free within major revisions
- Low cost hardware upgrades
- Three year warranty on major hardware
- Regular email newsletters
- Invitations to CED training days

System requirements

For sampling, Signal version 5 requires a CED Micro1401, Power1401 or 1401*plus* intelligent laboratory interface and a PC with Windows NT 2000, Windows XP, Windows Vista or Windows 7. Both 64-bit and 32-bit OS versions are supported. We recommend a minimum of 2GB of RAM. Signal dynamic clamping requires a CED Power1401 mk II intelligent laboratory interface.

Signal can export data to other applications as text, binary or image files. The Signal data format (CFS) is freely available to programmers wishing to read and write Signal data files.

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