CAMBRIDGE ELECTRONIC DESIGN LIMITED

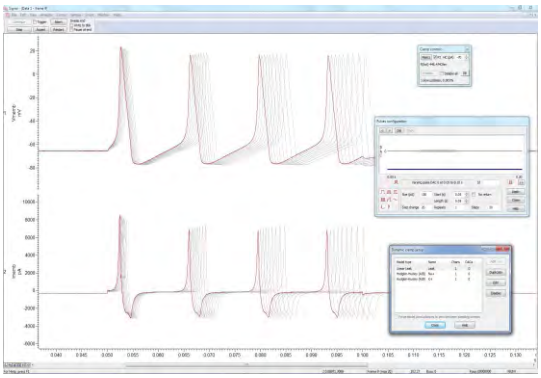
DATA ACQUISITION & ANALYSIS

Signal 9 – Sweep based data acquisition & analysis system

Signal is a sweep based data acquisition and analysis package. Its 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, evoked response and Transcranial Magnetic Stimulation (TMS).

- Signal is simple to set up for data capture and analysis
- Signal provides, in a user-friendly environment, the tools for sampling and analysis that most researchers need. A built-in script language automates repetitive tasks with additional functions for custom analyses and applications
- Signal includes functions for specific application areas including dynamic clamp, whole cell and patch clamp electrophysiology and evoked response studies 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 package to analyse existing data

The powerful data capture and time-saving analysis functions of Signal together with one of the CED 1401 family of laboratory interfaces make an extremely flexible and cost effective addition to any laboratory.



Action potentials simulated by dynamic clamp

Typical applications

Evoked response and TMS Output fixed, random and pseudo-random sets of pulses with on- and off-line waveform averaging and measurements of latencies, amplitudes and areas. Signal can control supported 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. Automatically measure features including baselines, amplitudes, latencies, areas, durations, percentage rise and decay times, and population spike parameters for single or multiple responses per frame.

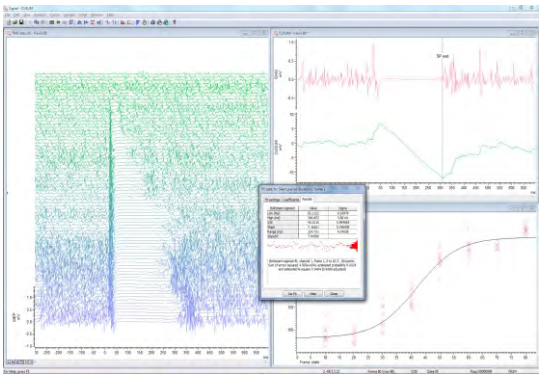
Whole cell voltage and current clamp Interactively control holding potentials and pulse outputs using a graphical pulse editor. Construct I/V plots, leak subtraction and curve fits both on- and off-line.

Dynamic clamp High speed, fully integrated functions to simulate ion channels and leaks and use simulated synapses to generate hybrid networks.

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.

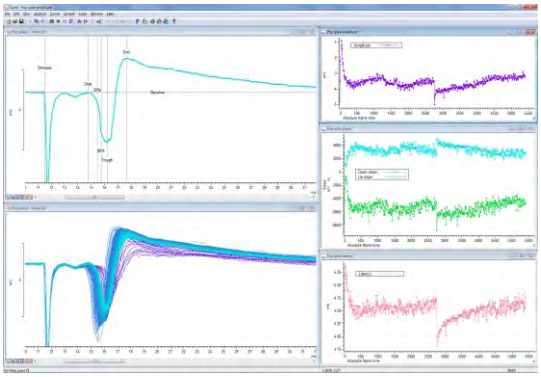
EMG Record single and multiple channels of EMG with software control of amplifiers such as the CED1902. Perform rectification and smoothing at the touch of a button or under script control. Produce power spectra that update as new data sweeps are captured.

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



TMS: Measurement of silent period duration using CUSUM method

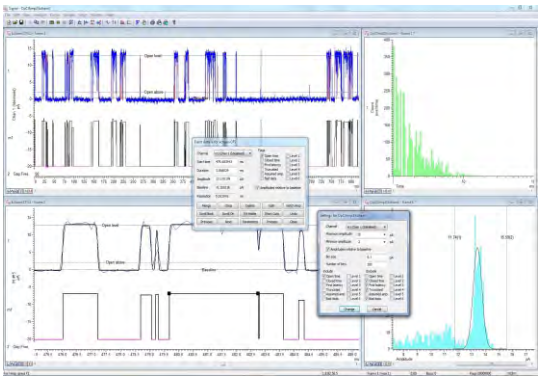
General features



LTP analysis with multiple measurement plots

- Record sweeps of waveform and marker data, free-running, gap-free or time-locked to a stimulus or response as well as recording from third-party devices such as Intan, DSI and Delsys
- View current information and latest measurements at a distance using stretchable Info windows with large font
- Perform analysis on 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 measurement plots both on and off-line in XY views or channels in the data file
- Mark detected data features and events. Markers can be added interactively, by automated measurement processes or by a script
- Generate simple and complex protocols of waveform and digital output and modify the output interactively, even while sampling
- Design stimulus outputs graphically, react quickly to changes in sampled data and interact between inputs and outputs using scripts
- Derive 'virtual channels' defined by user-supplied expressions for channel arithmetic, spectral analysis and stimulus waveform generation
- Easily manipulate data using menu or keyboard driven functions. Options include rectification, DC removal, smoothing, rescaling and time shift
- 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
- Apply curve fitting using a variety of fit equations; fit coefficients can be plotted automatically to an XY view
- Import data files recorded with other acquisition systems. Formats include Axon, EDF, HEKA, ASCII and binary
- Export data to other applications as text, binary or image files, write .mat files to export data to MATLAB®. The Signal data format (CFS) is freely available to programmers wishing to read and write Signal data files
- Control up to 10 auxiliary devices during sampling, such as those from Magstim, MagVenture, Deymed, Mag & more, Neurosoft, Digitimer DS8R and CED3304

Patch clamp electrophysiology specific features



Single channel patch clamp analysis

- Optional 'clamping' functions to set the system up specifically for whole cell or single channel recordings. Up to 8 clamping sets comprising a pair of recording channels and a stimulation DAC can be defined for use
- Membrane analysis option displays measurements of total resistance, access and membrane conductance, capacitive transient decay time constant and membrane capacitance
- On or off-line subtraction of scaled leak trace, including capacitive transients
- Generate single channel idealised traces based on thresholds or the reverse convolution fitting of an amplifier's step response (SCAN analysis)
- Edit idealised traces by dragging durations and amplitudes. Transition events can be manually split or combined
- Produce amplitude, dwell time and burst duration histograms from idealised traces
- Simulate ion channels, leaks and synapses with built-in high speed dynamic clamping support. Up to 15 clamping models can be used concurrently when sampling
- Read settings and configuration from Axon Multiclamp 700, Axoclamp 900 and HEKA EPC800 amplifiers as well as analogue telegraph scaling from other amplifiers

Data acquisition using a CED 1401

The CED Micro1401 and Power1401

- Record and display fast sweeps of waveform data to disk with up to 400 million data points per sweep with a Power1401
- Output pulse, sine, ramp and stored waveforms while sampling
- Set up multiple output states, each providing differing pulse outputs or stimuli. Sequence the order and repeats of each state cyclically, randomly, semi-randomly, manually or to a predefined protocol. Frames are marked with the state used
- Generate accurate timing markers indicating when stimuli were triggered
- 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 and 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
- Gap free option for acquisition of continuous data
- Sample varying numbers of points in different sweeps
- Perform built-in and custom analyses on incoming sampled data
- Configure software controllable amplifiers including the CED1902 low-noise isolated pre-amplifier, Digitimer D440, D360 and D360R isolated amplifiers and the Power1401 gain option

MEP recording system

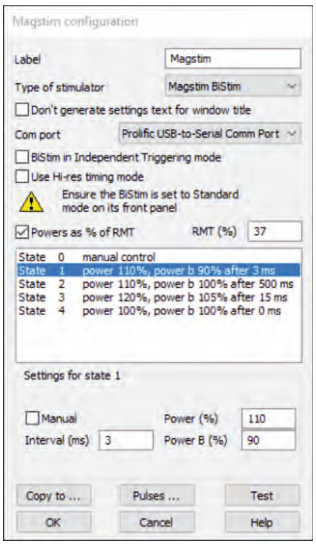
- Sample at arbitrary or varying rates with external convert input option
- Simultaneously review earlier frames together with incoming data using duplicate windows
- Automatically reject or tag frames containing high amplitude artefacts
- Set default levels for analogue and digital outputs between recordings to prevent unwanted stimulation effects
- Automatically adjust channel scaling in response to gain changes detected from either patch clamp amplifier telegraphs or supported software controlled amplifiers

Complex stimuli and experiment control

Signal incorporates a powerful sequencer function for generating digital and analogue outputs for stimulus control. Sequences are run within the 1401 interface to ensure highly accurate timing independent of the host PC operating system. There are 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 linked to the multiple states system. Outputs are fixed or they can change amplitude and duration on repeats. You can also modify the outputs 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 or by using the script language running on the host PC to pass variables and tables of values to the 1401. It also enables you to produce pulse protocols either time-locked to the recording frames or free running. Further experiment control options including communication through serial lines are also available using the script language.



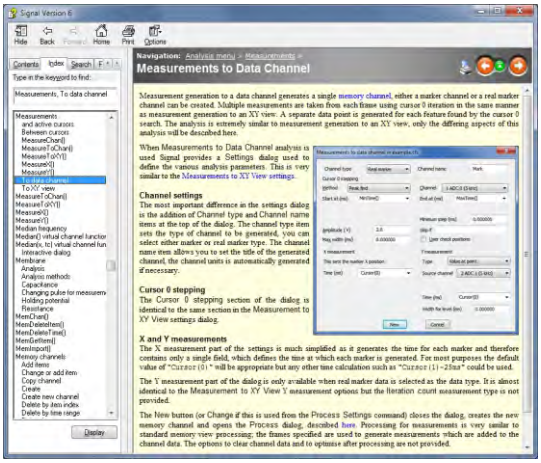
Stimulators configuration dialog

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. Scripts can be set to execute automatically at specified points during sampling. 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 as well as a dedicated script-writing service.



Signal on-line help

Service and support

When you buy a system from CED, you are buying from a company with over 50 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
- Three year warranty on major hardware

Signal user training days

System requirements

For sampling, Signal version 9 requires a model in the CED Power1401 or Micro1401 range of CED laboratory interfaces, and a PC with Windows 7/8/10/11 or an Intel Macintosh running Windows. We recommend a minimum of 8GB of RAM. Signal dynamic clamping requires a CED Power1401-3A, Power1401-3, or a Micro1401-4.

Both 32-bit and 64-bit versions of Signal are supplied; either version of the software can be used on systems running a 64-bit OS

Visit our website or contact us for more information

CAMBRIDGE ELECTRONIC DESIGN LIMITED
DATA ACQUISITION & ANALYSIS

ced.co.uk

Technical Centre, 139 Cambridge Road, Milton, Cambridge CB24 6AZ, UK. **Tel:** (01223) 420186
Email: info@ced.co.uk **International Tel:** [44] (0)1223 420186 **USA and Canada:** 1-800-345-7794
For worldwide sales email us at sales@ced.co.uk

Trademarks and tradenames are acknowledged to be the trademarks and tradenames of the respective holders. © CED 08/2026