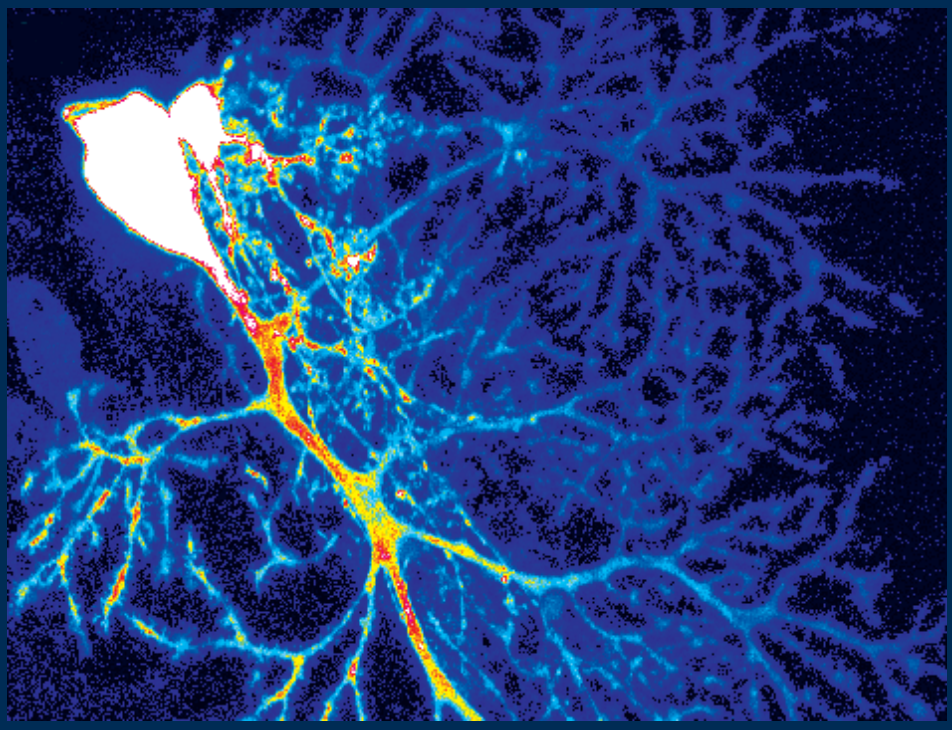
Electrophysiology Electrochemistry

PULSE / PULSEFIT

Software for electrophysiological research, data acquisition, review and online analysis



Features

PULSE

- Digital Oscilloscope
- Versatile Pulse Generator
- Parameter Monitoring
- Data Tree Editor
- Online Analysis

PULSEFIT

- Data Review
- Cursor-operated measuring Features
- Fit of Data Traces
- Fit of Parameters

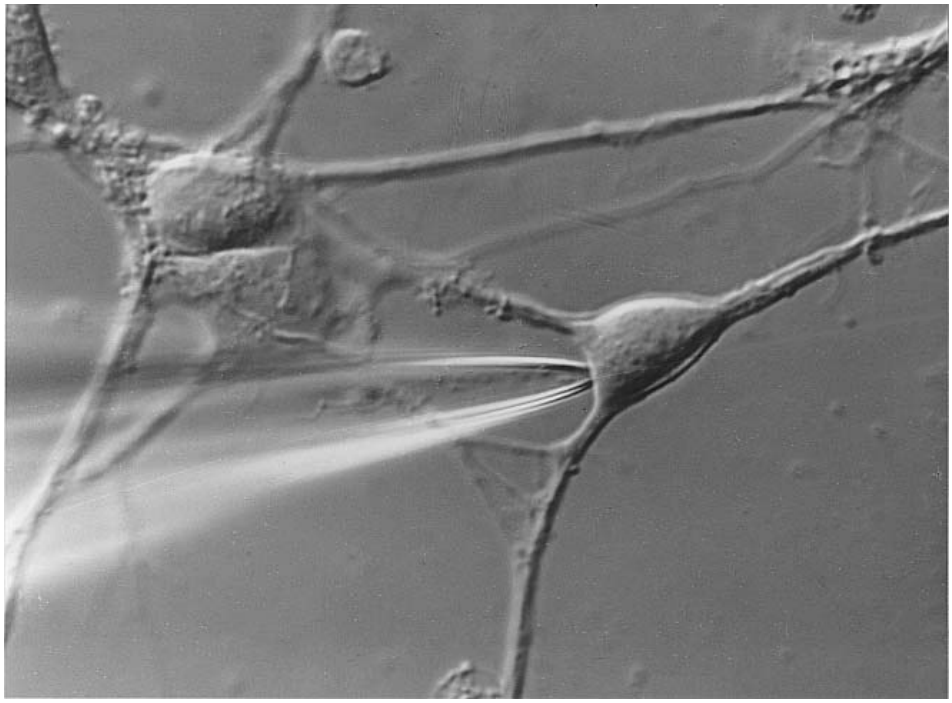
HEKA

HEKA provides the finest instruments today to achieve the needed progress of tomorrow...

PULSE/PULSEFIT

PULSE and PULSEFIT - a versatile program for physiological research

PULSE is easily adaptable to any individual approach for performing electrophysiological experiments.



PULSE/PULSEFIT - a program which first thinks of data analysis

The consideration of all measuring parameters has made PULSE the most powerful program for electrophysiological clamp experiments. It has been developed with the help of leading laboratories worldwide to meet the requirements of the scientific community. PULSE and PULSEFIT thus provides the optimal solution for data acquisition and evaluation.
Further programs such as TAC and PULSETOOLS can immediately process the data obtained with PULSE. Export functions transfer the data to other programs such as Igor, or as ASCII (MAC and DOS). The "extensions" of PULSE (LOCK-IN, FURA, and X-CHART) provide the link from clamp to further experiments.

PULSE/PULSEFIT - a reliable and convenient program

PULSE and PULSEFIT constitute the perfect combination of simple operation and comprehensive functionality. For the beginner, the operation can be limited to the essential functions. Intuitive operation and uncompromising simplification of complicated adjustments quickly enable the user to perform more complex experiments and evaluations.
The experienced patch-clamp investigator will be fascinated by the versatility of the program and logical structure of the functions. The outstanding user interface of the program with "virtual control keys" can be defined by the user to meet his requirements. From the very first day you can record data from your experiments with PULSE.
PULSE and PULSEFIT provide the optimum in user convenience.

PULSE/PULSEFIT - a program for your amplifier, too

PULSE is custom-made for application with the EPC 9 and EPC 10 patch clamp amplifiers, but any other amplifier also receives a tremendous boost with PULSE, which supports all patch-clamp and voltage-clamp amplifiers. Therefore, you can operate various set-ups with different amplifiers and purposes in a laboratory with the same software.
All data are available in the same documented format, and you can thus prepare filters for your own programs. Do you have questions? If so, a hotline is at your disposal!

Picture front page:
Purkinje neuron and Bergmann glial cell in a cerebellar slice preperation, T. Möller, MDC, Berlin

PULSE/PULSEFIT

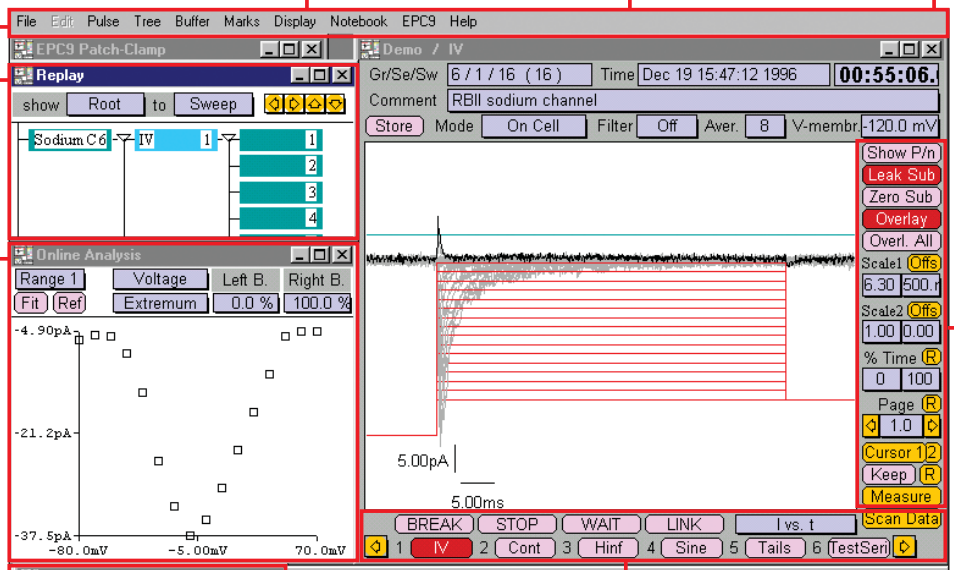
PULSE provides sophisticated tools for electrophysiological experiments

Tree
Export your data (e.g. single sweep, online analysis results) to printer, IGOR files (presenting and analysing program) or ASCII (MAC or DOS).

Buffer
Add, substract or accumulate your measured sweeps.

Marks
Tag several entries in the data file to perform one action to all of them (e.g. print, average).

Display
Change the display of the oscilloscope (e.g. grid, dimmed overlay).



Replay
Acquired data and old data files can be reviewed and edited.

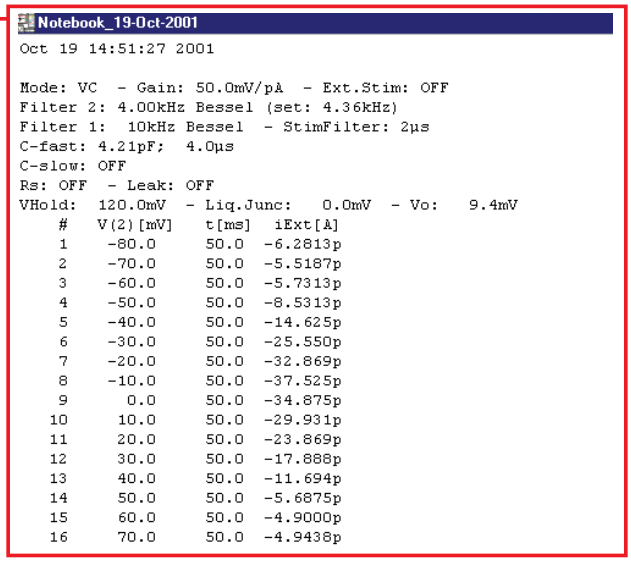
Online Analysis
Immediate analysis of the just acquired or replayed data. The analysis result is shown as a function of a variety of parameters, specified by the user.

Parameters
Parameters allow the additional data acquisition of different values as RMS noise, pipette resistance, seal resistance or user defined parameters (e.g. pH).

Sequence Pool
Pool of available pulse templates. Up to six template controls are displayed at a time, which can be stopped or interrupted by the tools.

Functions
Function features allow the displaying of measured responses like leak current…

Notebook
During stimulation and replay the results of the online analysis are displayed in the notebook. These data columns can be exported to disk or copied to the clipboard.



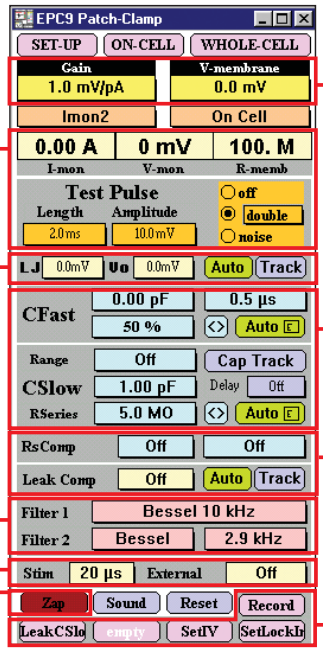
Notebook_19-Oct-2001

```
Oct 19 14:51:27 2001

Mode: VC  - Gain: 50.0mV/pA  - Ext.Stim: OFF
Filter 2: 4.00kHz Bessel (set: 4.36kHz)
Filter 1:  10kHz Bessel  - StimFilter: 2µs
C-fast: 4.21pF;  4.0µs
C-slow: OFF
Rs: OFF  - Leak: OFF
VHold:  120.0mV  - Liq.Junc:   0.0mV  - Vo:   9.4mV
    #   V(2)[mV]    t[ms]  iExt[A]
    1    -80.0      50.0  -6.2813p
    2    -70.0      50.0  -5.5187p
    3    -60.0      50.0  -5.7313p
    4    -50.0      50.0  -8.5313p
    5    -40.0      50.0  -14.625p
    6    -30.0      50.0  -25.550p
    7    -20.0      50.0  -32.869p
    8    -10.0      50.0  -37.525p
    9      0.0      50.0  -34.875p
   10     10.0      50.0  -29.931p
   11     20.0      50.0  -23.869p
   12     30.0      50.0  -17.888p
   13     40.0      50.0  -11.694p
   14     50.0      50.0  -5.6875p
   15     60.0      50.0  -4.9000p
   16     70.0      50.0  -4.9438p
```

EPC 9 - the virtual front panel

The Pulse Generator window provides the layout of a stimulation pulse sequence



Test Pulse
There are two test pulse modes: built-in test pulses (double or single) and use of a stimulation template from the pulse generator as test pulse.

Controls
All values can be set automatically or manually by either the mouse or the keyboard.

Filters
Two built-in high quality hardware filters (Butterworth/Bessel) perform excellent signal conditioning and remove the expense of purchasing additional filter instruments.

Stimulus
The stimulus can be filtered by activating the stimulus switch.

Zap Pulse
A high voltage pulse is applied to the pipette in order to rupture the patch membrane. The parameters (duration and amplitude) can be specified.

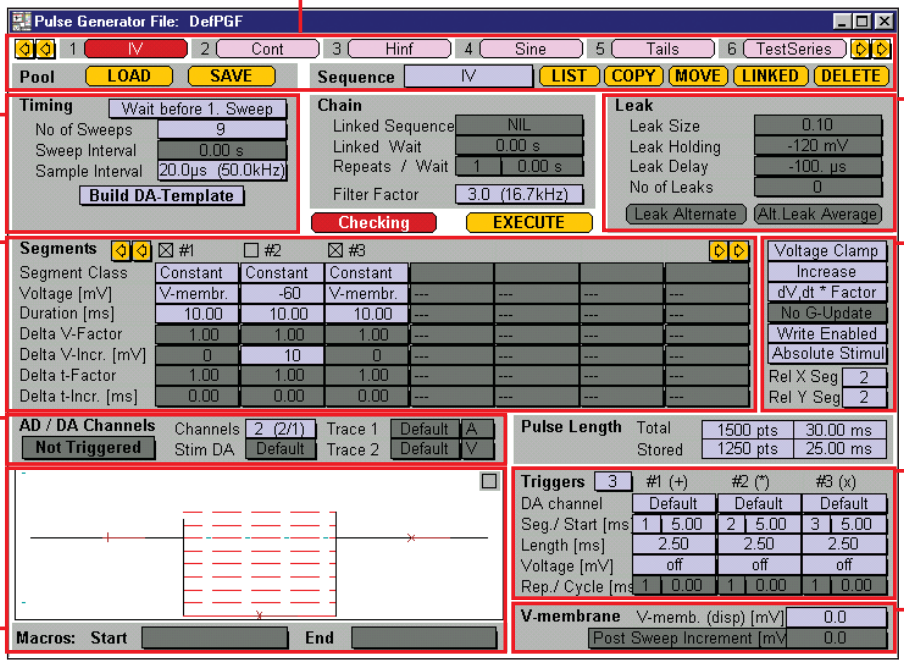
Documentation
All EPC 9 settings are stored with the raw data for easy reconstruction, analysis, and documentation of your experimental procedures.

Automatic Compensations
Automatic routines for leak and capacitive transient compensations, perform these tasks faster and more accurate than even the most experienced experimentor. Capacitance tracking allows continuous updating of membrane capacitance and series resistance compensation during recording sessions.

Leak and Rs Compensation
This controls a hardware leak compensation. The series resistance compensation corrects for membrane voltage errors under conditions of high access resistance between pipette and cell interior.

Macros
Macro features allow the recording of routine functions and then accessing these Macros by a simple mouse click.

Sequence Pool
It is a paging bar with a nearly unlimited number of sequences. Loads, saves, copies etc. the pool of available stimulation sequences.



Timing
Determines the number of the sweeps, the sweep- and the sample interval.

Segments
A pulse pattern consists of an arbitrary number of segments.

AD/DA Channels
Switch between different trigger modes and choose the right channels for acquisition.

Sequence Cartoon
After each editing operation the pulse pattern is displayed in the cartoon.

Leak
Determines different parameters of the leak pulses.

Increment Mode
The variable determines the order of increment of the segment voltage/ duration.

Triggers
There are up to 3 triggers chooseable.

V-Membrane
Displays the presently selected holding potential.

PULSEFIT - all common fit routines in the field of electrophysiology are available

Sweep Fit Control

Buttons for the control of fits to raw data traces. "Auto" repeats the same kind of Sweep Fit for all Sweeps of a series automatically.

Simplex Fit

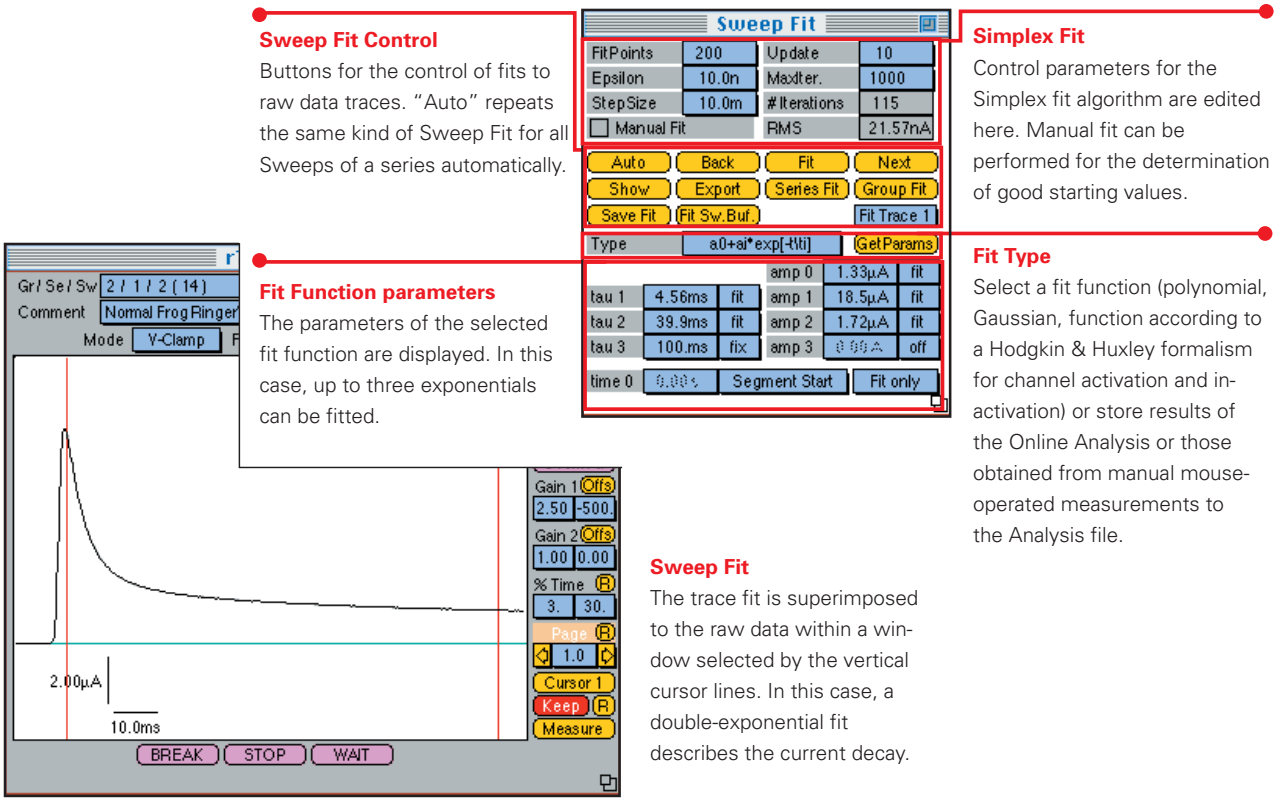
Control parameters for the Simplex fit algorithm are edited here. Manual fit can be performed for the determination of good starting values.

Fit Function parameters

The parameters of the selected fit function are displayed. In this case, up to three exponentials can be fitted.

Fit Type

Select a fit function (polynomial, Gaussian, function according to a Hodgkin & Huxley formalism for channel activation and inactivation) or store results of the Online Analysis or those obtained from manual mouse-operated measurements to the Analysis file.

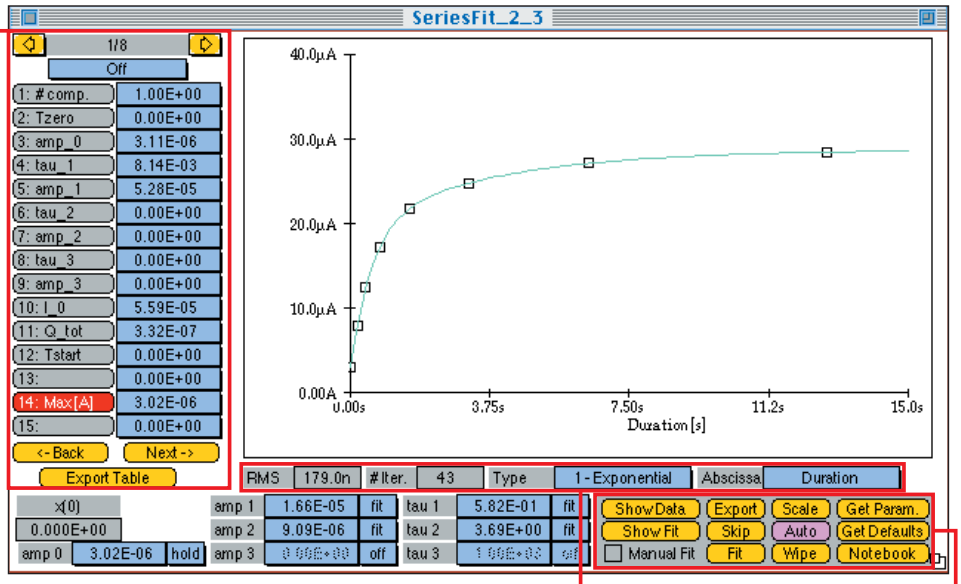


Sweep Fit

The trace fit is superimposed to the raw data within a window selected by the vertical cursor lines. In this case, a double-exponential fit describes the current decay.

Sweep Fit Results Table:

The results determined by Sweep Fit are stored in the Analysis File and are available in Series Fit for further analysis. These parameters can be displayed as a function of other parameters or various abscissa variables like potential or duration of the relevant segment.



Fit Types

Fit functions supported by Series Fit are: Polynomials, Exponentials, Boltzmann functions, and current-voltage relationships. In this example recovery from inactivation is analyzed. The peak current in a test segment is plotted versus the exponentially increasing duration of an interpulse segment. The theoretical curve describes a double exponential recovery.

Series Fit Control

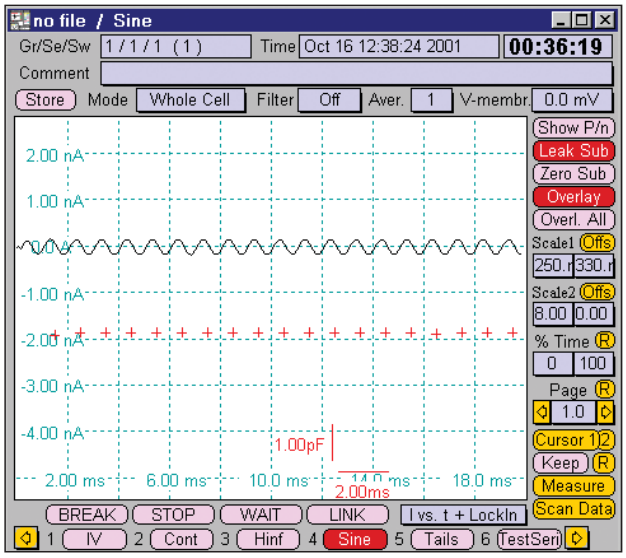
Control buttons for Series Fit. Selected data and fits can be exported in various formats. Individual data points can be skipped so they are not considered for the fit.

Capacitance measurements with PULSE

The PULSE software and our EPC 9 or EPC 10 patch clamp amplifier combine to provide you with everything you need if you are interested in membrane capaci-tance measurements. The EPC 9 or EPC 10 is the ideal patch clamp amplifier for capacitance measurements because all the relevant parameters are under its control. Digital control of filter settings, gain and compensation networks allows the admittance of the signal source at the amplifier's input to be determined based on the amplifier's own calibration. No external filters are required for standard measure-ments.

In 1982 Neher and Marty introduced the lock-in amplifier into the patch clamp field for measurement of membrane capacitance using a single sine-wave frequency. For determining the appropriate phase setting, they used a simple and easy trick - dithering of the compensation network while changing the phase for obtaining a maximum signal. This method is appropriate under stationary conditions.

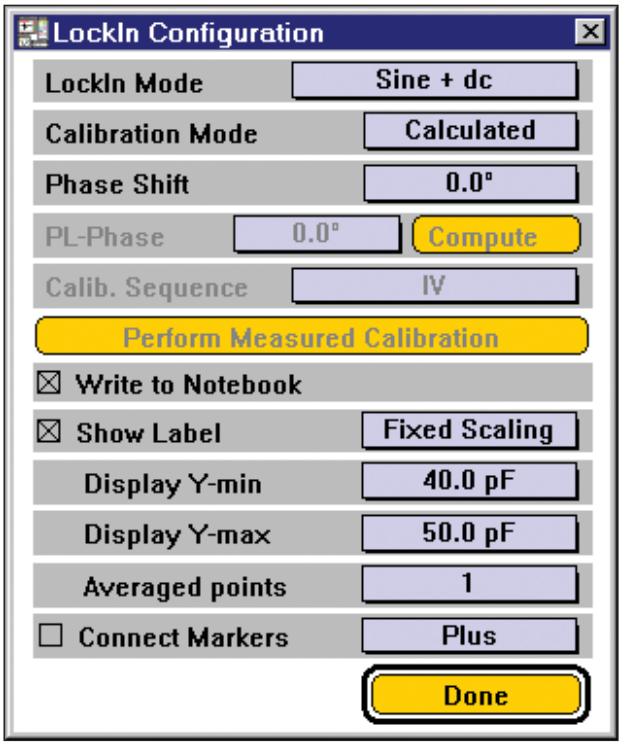
Commonly used extensions, however, particularly the automatic 'phase tracking', is prone to errors (see Gillis in B. Sakmann & E. Neher Eds. Single Channel Recording 2nd Edition, Plenum). For this reason several novel schemes, including 2 frequency methods, have been suggested in the meantime. The minimum requirement for determining the three unknowns of the equivalent circuit of the cell under study involves three experimental parameters. The 1 1/2 frequency method (or Lindau-Neher technique) uses real and imaginary part of a sine-wave signal plus the DC-conductance to determine membrane capacitance, membrane conductance, and access resistance. This technique was adopted long ago by leading patch clamp laboratories. It is fully implemented in the PULSE software together with two further variants of capacitance measurement.



The PULSE software implements both the classical single frequency and the 1 1/2 frequency (or Lindau-Neher) technique in a convenient user-friendly way. It provides 'internal calibration' which automatically corrects for phase-shifts and frequency dependent attenuation, so that the admittance of the external circuit is obtained in calibrated SI units. On this basis the parameters of the equivalent circuit are calculated 'online' according to Lindau & Neher.

In addition, the EPC 9 or EPC 10 offers automatic capacitance compensation. When activated repetitively (capacitance tracking!) this provides a continuous readout of capacitance. The experimentor can observe the residual capacitive current for a validation of correct compensation.

Since the amplifier 'knows' the settings of the compensation network, the 1 1/2 frequency method can operate while the bulk of the capacitance is compensated. Consequently the amplifier can be operated at high gain without saturating. High gain implies low noise. The high resolution admittance measurement of the residual capacitance together with the compensation circuit provides an effective dynamic range which has yet to be achieved with any other instrument.



PULSE/PULSEFIT

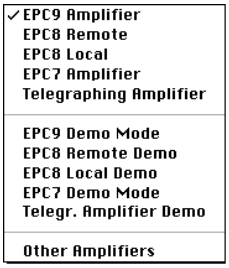
Technical specifications

PULSE

Data acquisition

- 2 channels A/D and 1 channel D/A (stimulation)
- 3 channels D/A (Trigger, auxiliary stimulation channels)

Amplifier



All 'clamp' amplifiers are supported. Several amplifier windows for e.g. EPC 9, EPC 10 and Telegraphing Amplifiers are available. Other amplifier windows can be generated.

Extensions to Pulse

- X-CHART
  Multichannel chart recorder for up to 16 channels.
- FURA
  Performs synchronized ratiometric fluorescence- and electrophysiological measurements.
- LOCK-IN
  Software lock-in to measure membrane capacitance.

PULSEFIT

PULSEFIT is an analysis program for pulsed data files. Data can be analyzed on three hierarchical levels:

Sweep Fit

Fit of raw data traces. Within specified windows various functions can be fitted with a Simplex algorithm to the raw data traces:

Raw Data Fits

- Polynomials
- Exponentials
- Gaussian Fit
- Versatile functions according to Hodgkin & Huxley gating formalism

Series Fit

Fit of parameters as derived from the fit to raw traces (e.g. peak current) on the level of a series of traces as a function of various parameters (e.g. pulse, potential):

Result Fits

- Polynomials
- Exponentials
- Boltzmann Laws
- Various Current-Voltage Relationships

Group Fit

Fit of parameters as derived from the fit to data on the level of a series (e.g. reversal potentials) as a function of various parameters (e.g. concentration of an ingredient of the bathing saline):

Parameter Fits

- Polynomials
- Exponentials
- Boltzmann Laws
- Dose-Response Curves

PULSE/PULSEFIT

In/Out & data management

- Export to ASCII (MAC and DOS) format), IGOR
- Printout of raw data and Online Analysis results

Graphical representation

- Oscilloscope
- Zoom
- Dimmed Overlay
- Absolute and relative Cursor Measurements

Processing

- p/n Leak Correction
- Zero Correction
- Software Gaussian Filter
- Buffer (basic arithmetic Operation)
- Fit of Data Traces

Miscellaneous

- Runs on Mac OS up to version 9 and Windows 98/NT/2000/XP
- Macro Recording
- Online Analysis

Hardware requirements

- For Data acquisition
  EPC 10 or EPC 9 amplifier or LIH 1600, ITC-16 or ITC-18 acquisition interface
- Computer
  See data sheet "Recommended Configuration"

Related Products

X-CHART
Software implemented chart-recorder.

FURA
Extension for synchronized ratiometric fluorescence measurements

PULSETOOLS
Software for data reorganisation, editing and averaging. Amplitude histograms and noise analysis.

PULSESIM
Modeling and simulation of data based on kinetic schemes or discrete Markov models.

EPC 10
The fully computer controlled patch clamp amplifier with built-in interface board.

LIH 1600
16 bit multi-channel data acquisition system

EPC 8
The successor of the EPC 7. Manual or digital control selectable.

EPC 7 PLUS
The classic patch clamp amplifier for single channel and whole-cell measurements.

PIP 5
Temperature controlled micro pipette puller.

Service & Support

As the first manufacturer of patch clamp amplifiers in the world HEKA knows the needs of scientists. We provide exceptional pre and post sales customer support from our trained international sales representatives and our own technical support advisors. With thousands of high performance hardware and software products in daily use worldwide we understand all aspects of data acquisition systems not just the software.

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