# TAC

## V3.0

*Analysis of Single-Channel Recordings*

**Bruxton Corporation**

## Product

This manual describes TAC.

## Sales and Support

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# Contents

# 1 Introduction

**Sections**



## 1.1 Document

This is a reference manual for TAC.

### 1.1.1 Adobe Acrobat

If you are viewing this document in Adobe Acrobat, you can enable Bookmarks and Page in the View menu to see an outline of the document that you can use for navigation.

### 1.1.2 Printing

The book is intended for double-sided printing.

The pages are laid out for printing on US Letter paper (8.5 by 11 inches) and intended for trimming to 8 by 10 inches.

## 1.2 Specifications

TAC provides the ability to analyze recordings of data from single ion channels.

### 1.2.1 Data Files

TAC reads data files in one of the formats listed in table 1.

Table 1 Data file formats

| Vendor | File format |
|---|---|
| Axon Instruments | ABF (pClamp 6.x, AxoScope) |
| Axon Instruments | pClamp 5.x |
| Bruxton Corporation | Acquire |
| HEKA elektronik | Pulse |
| WaveMetrics | IGOR Pro binary wave |
| any | Raw continuous |

### 1.2.2 Data File Limitations

TAC supports data files from a range of data acquisition programs. We base support of these file formats on information supplied by the program vendors, and on sample files supplied by vendors and users. We cannot promise that TAC will read all files produced by all versions of data acquisition programs we support.

If you have questions about whether TAC can read files produced by a specific version of a data acquisition program, please contact your distributor.

### 1.2.3 Storage Devices

TAC will read data from any system file device such as a disk drive.

TAC will read acquired data from a DAT drive. The supported tape drives are shown in table 2.

Table 2 Supported tape drives

| Manufacturer | Product | Mechanism |
|---|---|---|
| Hewlett-Packard | JetStore 5000 | 35480A |
| Hewlett-Packard | JetStore 6000 | C1533A |
| Hewlett-Packard | SureStore 5000 | 35480A |
| Hewlett-Packard | SureStore 6000 | C1533A |
| Hewlett-Packard | SureStore 12000 | C1553A |

Vendors sometimes package a tape mechanism and sell it under a name other than the one used by the manufacturer. If you have such a tape drive, TAC will support it, as long as the mechanism is identical to a supported mechanism.

### 1.2.4 System Requirements

TAC will operate under Microsoft Windows (including Windows NT, Windows 95, and Windows 3.x) and on the Apple Macintosh.

Under Microsoft Windows 3.x, Windows 95, and Windows NT, TAC requires a 486DX or better processor. It will not operate without built-in floating point.

Under Microsoft Windows NT, TAC supports only processors compatible with the Intel x86 series. TAC does not support RISC processors.

Under Microsoft Windows 3.x, TAC requires Win32s.

On the Apple Macintosh, TAC requires a PowerPC system or a system with a 68040 or better processor. TAC will not operate without built-in floating point.

On all platforms, TAC requires at least 8MB free memory for operation.

## 1.3 Installation

On Microsoft Windows, the distribution contains the program “setup.exe”. Execute this program to install TAC. You must attach the hardware dongle to the parallel port of your computer before running TAC.

To use TAC under Microsoft Windows 3.x, you must have Win32s installed before you execute “setup.exe”.

On the Apple Macintosh, copy the TAC folder from the distribution to your hard disk. You must attach the hardware dongle to the ADB of your computer. It is usually most convenient to attach the dongle between the keyboard and the mouse.

If you are upgrading from a TAC V2.0 or earlier, you may have received an old-style dongle, shaped like a box. This type of dongle requires the file “EvE INIT” to be present in the Extension Folder on your hard drive when your computer is started. A copy of this file is supplied.

## 1.4 Terms

This section describes the terms under which TAC is provided to you.

### 1.4.1 Research Use Only

TAC is intended for research use only by persons trained in its use. TAC is not intended for clinical use.

### 1.4.2 License

TAC is copyrighted, and is protected both by copyright law and by international treaty. When you purchase TAC, you have a license to use it, subject to the following terms:

You may:

1. move this software from one computer to another.
2. copy this software to use it and to back it up.
3. transfer this software permanently.

You may not:

1. allow more than one person to use this software at one time.
2. remove or obscure any copyright notice.
3. disassemble, decompile, or reverse-engineer this software.

### 1.4.3 Warranty

This section describes the warranty we provide with TAC, which is very limited.

1. You can return TAC for any reason, as long as you do so during the return period. Your distributor will specify a return period. If not, the return period is 30 days from the date you receive TAC.
2. We provide TAC to you "as is". If it does not do what you want, or what you think it should do, or what you think we promised it would do, your remedy is to return it, subject to the conditions above.
3. You are responsible for the consequences of using TAC. Again, you can return TAC, subject to the conditions above.

BRUXTON CORPORATION AND YOUR DISTRIBUTOR DISCLAIM ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO TAC, INCLUDING BUT NOT LIMITED TO WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT.

THE ENTIRE LIABILITY OF BRUXTON CORPORATION AND YOUR DISTRIBUTOR, AND YOUR EXCLUSIVE REMEDY SHALL BE RETURN OF THE PRICE PAID IN EXCHANGE FOR RETURN OF TAC.

THIS LIMITED WARRANTY IS VOID IF FAILURE OF TAC HAS RESULTED FROM MODIFICATION, ACCIDENT, ABUSE, OR MISAPPLICATION.

IN NO EVENT WILL BRUXTON CORPORATION OR ITS DISTRIBUTORS BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY LOSS OF PROFITS, LOST SAVINGS, OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF YOUR USE OR INABILITY TO USE TAC.

This Agreement is governed by the laws of the State of Washington.

If you have any questions concerning this Agreement, please contact Bruxton Corporation.

# 2 Data Analysis



This chapter explains in detail how to use TAC to analyze data.

## 2.1 Sweeps

TAC and TACFit treat a data file as a set of sweeps, where a sweep is a sequence of data points collected at a fixed interval. For example, a file might consist of 30 sweeps. One of the sweeps might contain 5000 data points collected at intervals of 0.2ms. Sweeps can be of any length, and a file can contain any number of sweeps. ☞ *Figure 1.*

TAC handles a sweep as a unit. It reads, processes, and displays the data in a sweep together.

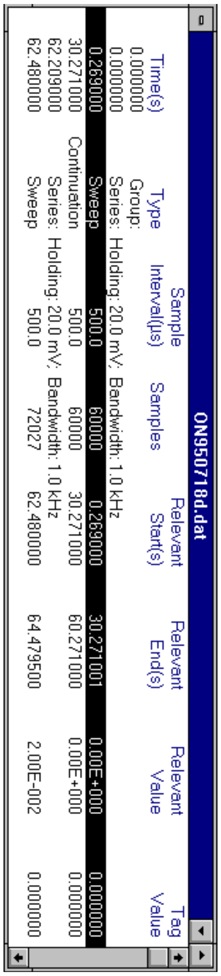
TACFit handles the events in a sweep together. For example, TACFit can collapse a sequence of events in a sweep into a burst. TACFit will not collapse events into a burst if the events are not in the same sweep.

### 2.1.1 Continuation Sweep

A sweep may be followed by continuation sweeps. TAC handles each sweep and any continuation sweeps individually.

When TAC exports an event table to TACFit, it collapses a sweep and any continuation sweeps into a single sweep. TACFit then treats all events in a sweep and any continuation sweeps together.

For example, suppose TAC has a sweep followed by a continuation sweep. In TACFit, the interval between the last event in the sweep and the first event in the continuation sweep is collapsed to a single level (ignoring complicating factors such as burst resolution and multiple openings). ☞ *Figure 2.*



ON950718d.dat

| Time(s) | Type | Sample Interval(µs) | Samples | Relevant Start(s) | Relevant End(s) | Relevant Value | Tag Value |
|---|---|---|---|---|---|---|---|
| 0.000000 | Group: | | | | | | |
| 0.000000 | Series: Holding: 20.0 mV; Bandwidth: 1.0 kHz | | | | | | |
| 0.269000 | Sweep | 500.0 | 60000 | 0.269000 | 30.271001 | 0.00E+000 | 0.000000 |
| 30.271000 | Continuation | 500.0 | 60000 | 30.271000 | 60.271000 | 0.00E+000 | 0.000000 |
| 62.209000 | Series: Holding: 20.0 mV; Bandwidth: 1.0 kHz | | | | | | |
| 62.480000 | Sweep | 500.0 | 72027 | 62.480000 | 64.479500 | 2.00E-002 | 0.000000 |

Figure 1 TAC Events window showing sweeps

### 2.1.2 Long Sweep

TAC creates continuation sweeps automatically if a sweep is too large for the sweep buffer. For example, suppose the sweep buffer size is set to 100,000 data points, and TAC encounters a sweep of 150,000 data points. It breaks the sweep into a sweep of 100,000 data points and a continuation sweep of 50,000 data points. This

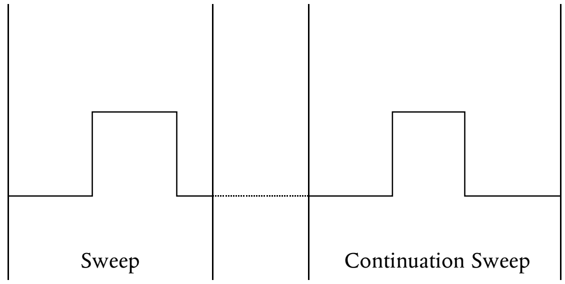



Figure 2 Continuation sweep

allows files with sweeps of arbitrary size to be processed. Use File: Settings to set the sweep buffer size. ☞ *File: Settings, p. 35.*

TAC splits sweeps in this manner only for continuous data files. It does not split sweeps in pulsed data files.

### 2.1.3 Event Screening

Some data acquisition packages can perform event screening during recording. This means that data is only recorded if something “interesting” happens during a data segment, such as a threshold transition. Segments without transitions are discarded. This feature is useful to eliminate long quiet stretches in recordings.

When TAC processes a file recorded with event screening, it treats a group of segments as a sweep followed by continuation sweeps. TACFit then processes the events in the group of segments together.

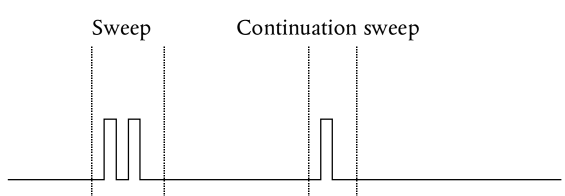



Figure 3 Continuation sweeps from event screening

For example, suppose a data file contains a sweep recorded at a sampling interval of 0.2ms. The sweep was recorded with event screening. The first 1000 points were recorded at the beginning of the sweep, followed by a gap of 2000 points, followed by another group of 1000 points. That is, the recording program stored the first 200ms of data, discarded the next 400ms, then recorded the next 200ms.

TAC treats this file as a sweep of 1000 data points followed with a gap of 400ms by a continuation sweep of 1000 data points.

TACFit treats the file as a sweep of 800ms. All events are clustered in the first 200ms or the last 200ms, with no events in the intervening 400ms.

## 2.2 Data Scaling

The data files read by TAC contain acquired data, usually represented as integer values from the A/D converter. TAC converts these values into the currents that they represent. To do so it must take into account the characteristics of the A/D converter and the amplification between the pipette and the A/D converter. This conversion is referred to as *scaling*.

Scaling is controlled by parameters in the data file itself, parameters you supply when you open the file, and entries in the Data: Filter dialog. ☞ *Data Files, p. 107*. ☞ *Data: Filter, p. 41*.

### 2.2.1 A/D Range

The A/D converter measures an analog voltage and converts this voltage to a digital value. The converter is usually specified in terms of the resolution of the digital output in bits and the analog input voltage range in volts.

An $n$ bit A/D converter generally creates values in the range:

$$\text{data} \in [-2^{n-1} .. 2^{n-1} - 1] \tag{1}$$

For example, a 16 bit A/D converter generally creates values in the range [-32768..+32767].

These integer values represent corresponding voltages. An A/D converter is usually specified as having an input range of $\pm v$ volts. In that case, a single bit change in the A/D converter output represents a voltage change of:

$$\Delta v/\text{bit} = \frac{2v}{2^n} \tag{2}$$

For example, a 12-bit ±10V A/D converter has a resolution of:

$$\frac{2 \cdot 10\text{V}}{2^{12}\text{bits}} = 4.8828\text{mV/bit} \tag{3}$$

The Instrutech ITC16 uses a 16-bit converter with a range of ±10.24V:

$$\frac{2 \cdot 10.24\text{V}}{2^{16}\text{bits}} = 0.3125\text{mV/bit} \tag{4}$$

Most data files include information about the resolution of the A/D converter used as well as the input voltage range, so TAC can determine the A/D scaling information from the file.

### 2.2.2 Amplification

Patch clamping measures small currents, so an amplifier is required to convert the currents measured at the pipette into voltages for the A/D converter. The amplification, $\alpha$, is usually specified as millivolts of output per picoampere of input. A gain of 1mV/pA is an absolute gain of:

$$1\,\mathrm{mV/pA} = 10^{9}\,\mathrm{V/A} \tag{5}$$

The units of amplification are volts of output per ampere of input, or impedance. A gain of 1mV/pA can be expressed as a gain of 1GΩ

Most data files include information about the amplifier settings used to record data. In some cases the data acquisition program reads the amplification directly from the patch clamp amplifier. However, in many cases it cannot. You enter the amplification while performing acquisition. If you do not enter the correct value, or enter no value at all, the resulting scaling will be incorrect.

### 2.2.3 Scaling

The A/D and amplifier combination converts pipette currents into integer values according to:

$$\Delta i/\mathrm{bit} = \frac{2v}{2^{n}} \cdot \frac{1}{\alpha} \tag{6}$$

Where $v$ is the half-range of the A/D converter in volts, $n$ is the resolution of the A/D converter in bits, and the $\alpha$ is the amplifier gain in V/A. In this case a "bit" means a 1-bit change in the acquired data value.

For example, suppose that a patch clamp amplifier is set to 100mV/pA. If the resulting signal is then processed by an Instrutech ITC16, we have:

$$\begin{aligned}\Delta i/\mathrm{bit} &= \frac{2 \cdot 10.24\mathrm{V}}{2^{16}\mathrm{bit}} \cdot \left(\frac{100\times10^{-3}\mathrm{V}}{10^{-12}\mathrm{A}}\right)^{-1} \\ &= 3.125\times10^{-15}\mathrm{A/bit} \\ &= 3.125\mathrm{fA/bit}\end{aligned} \tag{7}$$

This represents the total scaling of the data acquisition system, including both amplification and digitization.

### 2.2.4 Scaling Units

Some data acquisition programs deal in known units, such as picoamperes. In this case TAC can determine the complete scaling itself.

Some data acquisition programs allow you to enter the units as an arbitrary text string. For example, you can enter units of "pA" for picoamperes, but you can also enter any other string, such as "xy". For such data files, TAC makes no attempt to interpret the units you supplied to the acquisition program. Instead, it determines the correct units automatically and requires you to confirm them when you open the data file.

When you confirm the units, you are presented with the choices shown in table 3. Choose the entry that corresponds to the scaling you used.

Table 3 Scaling Units

| Scaling Units | Value |
|---|---|
| mV/pA | $10^{9}$ V/A |
| mV/nA | $10^{6}$ V/A |
| mV/µA | $10^{3}$ V/A |
| mV/mA | $10^{0}$ V/A |
| mV/A | $10^{-3}$ V/A |

### 2.2.5 Data Multiplier

Ideally the A/D parameters and amplification are recorded correctly in the data file, and TAC can determine the scaling to use to convert the acquired data to pipette currents. However, the amplification value is sometimes not recorded properly. This can be corrected with the "data multiplier", which is entered in the Data: Filter dialog box. ☞ *Data: Filter, p. 41.*

The data multiplier, β, is treated as an additional amplification, so the entire scaling becomes:

$$\Delta i/\mathrm{bit} = \frac{2v}{2^n} \cdot \frac{\beta}{\alpha} \qquad (8)$$

Typical errors and their corrections include:

1 Inverted sign. A more negative voltage represents a more positive current. Set the data multiplier to -1.

2 Unity amplification. The amplification recorded in the data file is 1, that is, 1A/V. This is obviously incorrect. Determine the correct amplification in A/V, and enter the inverse. For example, if the actual amplification was 100mV/pA (a factor of $10^{11}$ A/V), enter $10^{-11}$.

## 2.3 Data Filtering

This section describes how TAC filters acquired data from the data file before display and event detection.

### 2.3.1 Nyquist Theorem

The Nyquist theorem states that the highest frequency that can be reconstructed from sampled data is half the sampling rate. For example, if the sampling rate is 10kHz, the highest frequency that can be reconstructed from the sampled data points is 5kHz (Oppenheim and Shafer, 1975, P. 26).

Users of data acquisition systems generally use the following terms:

1 Nyquist rate: for a signal, the lowest sampling rate that can be used to completely reconstruct the data. This is twice the highest frequency contained in the signal.

2 Nyquist frequency: for a given sampling rate, the highest frequency that can be reconstructed. This is half the sampling rate.

The Nyquist theorem is fundamental to data acquisition (Crochiere and Rabiner, 1983, P. 18).

If you sample below the Nyquist rate, higher frequency signals appear in the sampled data, aliased to a lower frequency.

In a data acquisition system, an anti-aliasing filter should be used to remove any frequency components above the Nyquist frequency.

A patch clamp amplifier can deliver a bandwidth of perhaps 100kHz. However, the higher frequencies contain a great deal of noise, so an analog filter is used to reduce the high frequency noise and provide a good signal-to-noise ratio.

For the Bessel filters normally used in patch clamping, the transition from passband to stopband is so gradual that you must sample at least five times the corner frequency of the filter to avoid aliasing of signals in the transition band. If you use a sharper filter, you could sample at perhaps 2.5 times the corner frequency of the filter and still avoid aliasing of transition band signals.

## 2.3.2 TAC Filtering

The filtering supplied by TAC allows you to perform the following actions on the data:

1 Filtering to improve the signal-to-noise ratio using a gaussian FIR filter. Filtering is performed if the filter frequency is set below the Nyquist frequency for the sampling rate. ☞ *Gaussian Filter, p. 10.*

2 Decimation to reduce the amount of data. Decimation is performed if the filter frequency and the points per wave parameters allow it. If decimation is performed, it is in addition to filtering, never by itself. ☞ *Decimation, p. 10.*

3 Interpolation to increase the apparent density of sampled data points. Interpolation is performed if the filter frequency is set at or above the Nyquist frequency for the sampling rate. Interpolation is used to double the number of data points. ☞ *Interpolation, p. 11.*

Filtering is controlled by parameters in the data file itself and entries in the Data: Filter dialog box. ☞ *Data: Filter, p. 41.*

## 2.3.3 Gaussian Filter

TAC filters the acquired raw data using a Gaussian filter to reduce noise. The user should choose the corner frequency of the filter to optimize event detection (Colquhoun and Sigworth, 1995).

### Gaussian Filter Properties

A Gaussian filter has a frequency response of:

$$H(f) = \exp(-\frac{\ln 2}{2} \cdot \left(\frac{f}{f_c}\right)^2) \quad (9)$$

where $f$ is the signal frequency and $f_c$ is the corner frequency of the filter (Colquhoun and Sigworth, 1995).

The frequency response of two cascaded Gaussian filters is:

$$\frac{1}{f_c^2} = \frac{1}{f_1^2} + \frac{1}{f_2^2} \quad (10)$$

Since the analog signal should be filtered prior to acquisition in order to avoid aliasing, the digital filter applied by TAC is cascaded with the filter used during acquisition. For example, suppose that the analog signal is filtered at 5kHz and a further filter of 2.5kHz is applied using TAC. If we assume that the analog filter can be approximated by a Gaussian, the cascaded filter frequency is:

$$\frac{1}{f_c^2} = \frac{1}{5000^2} + \frac{1}{2500^2} \quad (11)$$

which yields an $f_c$ of 2.24kHz. This is the filter frequency that must be considered when the events are analyzed (Magleby, 1992, P. 765).

## 2.3.4 Decimation

The number of data points kept after filtering depends on the Points per wave setting in the Data: Filter dialog box. ☞ *Data: Filter, p. 41.*

Consider the case where a sweep sampled at 100kHz is filtered to a bandwidth of 1kHz. In this case the output data has at least 100 points per full wave cycle at the highest frequency in the filtered data, ignoring the filter rolloff. This is excessive, as the data is well-described by many fewer data points. For most purposes, 5 points per full wave cycle at the highest frequency is sufficient. Data points can be discarded.

Data is sometimes sampled far above the Nyquist frequency after filtering. ☞ *Figure 4.*

Figure 4 Acquired data, highly oversampled

This data might be well represented by only half as many data points. ☞ *Figure 5.*

Figure 5 Acquired data, oversampled

If TAC can discard half the data points, it can process the remaining data more quickly.

The process of discarding data points is called decimation. The decimation ratio, *d,* is defined as:

$$d = n_i / n_o \tag{12}$$

where $n_i$ is the number of input (sampled) data points and $n_o$ is the number of output (decimated) data points.

TAC performs decimation by calculating the ideal sampling rate $s_{\mathrm{ideal}}$ from the filter frequency and the points per wave:

$$s_{\mathrm{ideal}} = f_c \cdot p \tag{13}$$

where $f_c$ is the filter frequency and $p$ is the points per wave. For example, in the above case, the filter frequency is 1kHz and the points per wave 5, so the ideal sampling rate would be 5kHz instead of an actual sampling rate of 100kHz.

If the ideal sampling rate is less than the actual sampling rate, TAC can perform decimation. TAC only performs decimation by an integer factor, calculating the decimation ratio as:

$$d = \lfloor s_{\mathrm{acual}} / s_{\mathrm{ideal}} \rfloor \tag{14}$$

In the example given, TAC would decimate by a factor of 20, that is, it would produce one filtered data point for every 20 acquired data points.

### 2.3.5 Interpolation

In cases where the acquired raw data points are too sparse, TAC can use interpolation to generate additional data points. The additional points reduce errors in the determination of the transition time of an event (Colquhoun and Sigworth, 1995). TAC uses a cubic spline algorithm, which is appropriate for sequences of data points that undergo abrupt changes in value (Chapra and Canale, 1988, P. 387).

For example, consider a set of data points. ☞ *Figure 6.*

A cubic spline interpolation fits a curve to the points. The curve passes through each of the sampled data points. ☞ *Figure 7.*

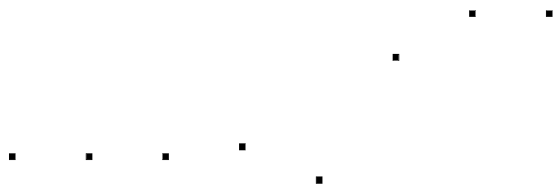


Figure 6  Acquired data, sparsely sampled

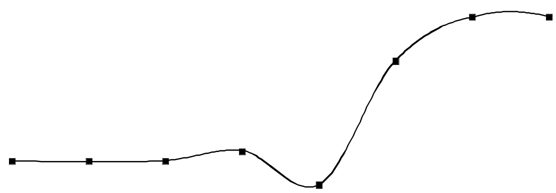


Figure 7  Acquired data showing cubic spline interpolation

TAC doubles the number of points by adding interpolated points along the spline curve. ☞ *Figure 8.*

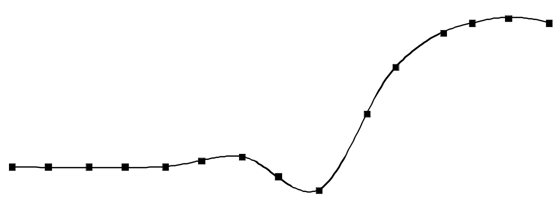


Figure 8  Acquired data with doubled data points

TAC interpolates if the user sets the filter frequency is at or above the Nyquist frequency of the sampled raw data. In that case, TAC performs no filtering, and instead doubles the number of data points through interpolation. ☞ *Nyquist Theorem, p. 9.*

The interpolated values produced by a cubic spline will overshoot when presented with an impulse. ☞ *Figure 9.*

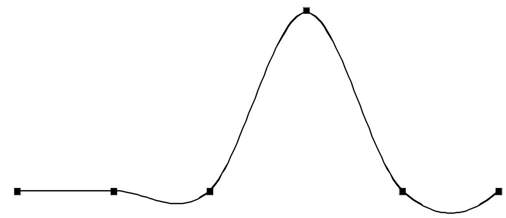


Figure 9  Acquired data containing an impulse

The overshoot produced by interpolation can lead to the detection of otherwise unresolvable events, because it can increase the amplitude of an otherwise sub-threshold event. ☞ *Figure 10.*

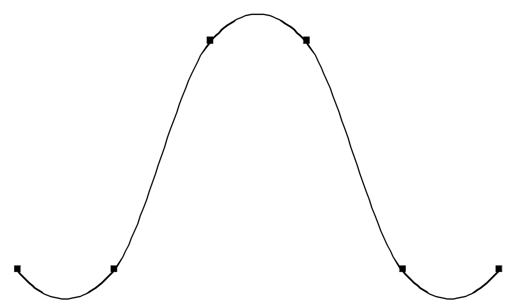


Figure 10  Acquired data with overshoot produced by interpolation

To examine the effect of interpolation, use the Data: Filter dialog box. Set the frequency at or above the Nyquist frequency for your data, then compare the results with filtering turned on and off. ☞ *Data: Filter, p. 41.*

TAC uses a standard cubic spline algorithm (Press, et al, 1992, P. 115). This is not the same as the algorithm used by earlier patch-clamp event-analysis programs (Colquhoun and Sigworth, 1995). A cubic spline is used because it only adds interpolated data points. It does not modify the original data points. Algorithms such as the B-Spline are more efficient to compute, but modify the original data points (Foley, 1992, P. 491).

## 2.4 Leak Template

Data acquired in response to a stimulus contains capacitive transients due to transitions in the stimulus. In practice these transients greatly exceed the amplitude of single-channel events, so they must be removed before event detection can be performed. (Sigworth and Zhou, 1992). This correction is called leak subtraction.

### 2.4.1 P/N Leak Subtraction

As an alternative to manual leak subtraction, some data acquisition programs allow the capacitive response to be removed automatically using $P/N$ leak subtraction. In this case a sequence of reduced stimuli are applied, the responses summed, then subtracted from the response to the full-scale stimulus to obtain a corrected sweep. The stimulus scaling is chosen so the reduced stimuli do not cause ion channel transitions.

If $P/N$ subtraction is used, TAC reads the corrected data, and leak subtraction in TAC is not needed.

### 2.4.2 Manual Leak Subtraction

Leak subtraction is performed by determining the passive capacitive response to the stimulus, then subtracting this response from the measured stimulus response. The result is the data to be analyzed for event transitions.

TAC allows you to calculate the capacitive response, and subtract it from the measured response. To do this, you manually select sweeps containing passive responses, and average them. This averaged sweep is then subtracted from each measured sweep before event detection.

The averaged sweep is called the leak template.

### 2.4.3 Complications

When you select sweeps to be added to the leak template, you should select sweeps containing only a passive response, not an active response (i.e. channel opening). To do this, you must manually view sweeps, selecting those with no channel openings.

In some cases, you may not be able to locate sufficient sweeps without channel openings to form a good average. TAC provides a solution, because you can add only those segments containing no openings to the average. To do this, you must select segments containing no openings as the relevant segment, then add them to the leak template.

As you build up the leak template by summing sweeps, the noise increases as $\sqrt{N}$, where N is the number of sweeps summed. You can eliminate this noise using curve fitting. If the stimulus pulse is a sequence of voltage steps, the passive response will be a sequence of current steps, with exponential relaxation from one current level to another. TAC allows you to select segments of the leak template and replace them with a fit curve. This eliminates noise.

If you use the relevant segment feature of TAC to add only passive responses to the leak template, and you have channels with a high open probability, you may find that you have no data for some parts of the leak template, resulting in discontinuities. You can obtain a continuous leak template by calculating a fit curve over the discontinuities. ☞ *Figure 11.*

## 2.5 Data Histogram

This section describes how TAC creates and fits data histograms.

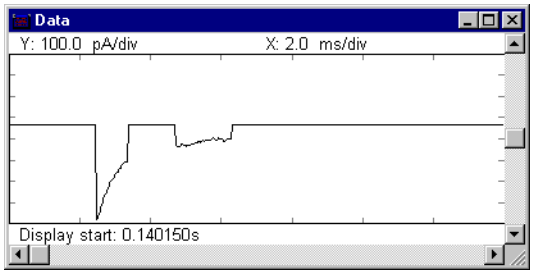



Figure 11 Leak template with missing data

### 2.5.1 Data Histogram

An data histogram divides a range of measured currents into a set of histogram bins, and counts the number of samples that fall in each bin.

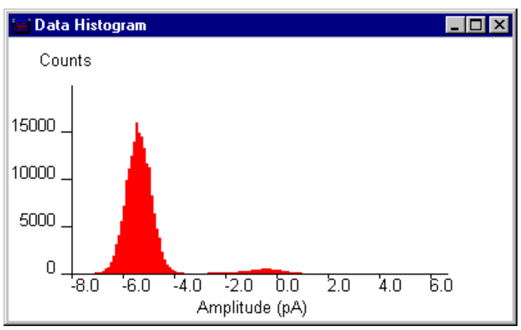



Figure 12 Data histogram

#### Histogram Bins

A sample $k$ with current $i_k$ is counted in histogram bin $j$ if:

$$m + jw \le i_k < m + (j+1)w \qquad (15)$$

where $m$ is the minimum value of the histogram and $w$ is the width of a histogram bin. $j$ can be calculated directly:

$$j = \left\lfloor \frac{i_k - m}{w} \right\rfloor \qquad (16)$$

The sample is not counted in the histogram if $j$ is less than zero or if $j$ is greater than or equal to the number of bins.

#### Bin Amplitude

The mean current in a histogram bin is:

$$\bar{i}_j = m + (j + 1/2)w \qquad (17)$$

This is the value used as the current of a histogram bin for export and computation. ☞ *TAC Histogram Window, p. 118.*

#### Filters

The Histogram: Settings dialog can be used to exclude regions of the amplitude histogram. TAC considers histogram bins that intersect an excluded region to be invalid, and does not use them in fitting. ☞ *Histogram: Settings, p. 52.*

A bin contained completely within an excluded region has a count of zero. For example, if you have a histogram with a minimum current of 0pA and a bin width of 1pA, and you exclude samples from 10pA to 12pA, the two bins 10 to 11pA and 11 to 12pA will have counts of zero.

TAC considers bins completely contained within excluded regions to be invalid, and does not include them when calculating the likelihood value. This effectively removes them from automatic fitting. ☞ *Likelihood, p. 28.*

A bin with a range intersecting an excluded region is also considered invalid. For example, if you have a histogram with a minimum current of 0pA and a bin width of 1pA, and you exclude samples from 10.5pA to 11.5pA, the two bins 10 to 11pA and 11 to 12pA will be considered invalid, because the number of counts they contain cannot be directly compared with other bins.

### 2.5.2 Theoretical Curve

The probability density function of the sampled data is represented as a sum of gaussian functions.

#### Probability Density

Each data sample is assumed to represent the current passing through a channel in a given state. Assuming that the background noise is gaussian, the probability density of a channel amplitude is (Colquhoun and Sigworth, 1995):

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}}\exp\left[-\frac{(x-A)^2}{2\sigma^2}\right] \tag{18}$$

where $f(x)$ is the probability density of an amplitude $x$, $A$ is the channel amplitude, and $\sigma$ is the standard deviation of the channel amplitude.

A recording usually contains at least two amplitudes (open and closed), and perhaps more. Therefore the amplitude is fit to a sum of $n$ gaussians:

$$f(x) = \sum_{i=1}^{n}\frac{a_i}{\sigma_i\sqrt{2\pi}}\exp\left[-\frac{(x-A_i)^2}{2\sigma_i^2}\right] \tag{19}$$

where $f(x)$ is the total probability density of a given amplitude value $x$, $A_i$ is the $i$th channel amplitude, $\sigma_i$ is the standard deviation of the $i$th channel amplitude, and $a_i$ is the fraction of the data represented by the $i$th amplitude.

#### Probability

The equation for the amplitude is specified in terms of a probability density. Also useful is the probability of an sample within a particular range. First we consider the probability of a sample of amplitude less than $x$.

The probability $F$ of an amplitude less than $x$ is:

$$F(x) = \int_{-\infty}^{x} f(t)\,dt \tag{20}$$

Substituting equation (36), we have:

$$F(x) = \int_{-\infty}^{x}\sum_{i=1}^{n}\frac{a_i}{\sigma_i\sqrt{2\pi}}\exp\left[-\frac{(t-A_i)^2}{2\sigma_i^2}\right]dt \tag{21}$$

This can be rewritten as:

$$F(x) = \sum_{i=1}^{n}\frac{a_i}{2}\left[1+\operatorname{erf}\left(\frac{x-A_i}{\sigma_i\sqrt{2}}\right)\right] \tag{22}$$

#### Probability of a Range

The probability of a sample value within a range $(x_1, x_2)$ is:

$$F(x_1, x_2) = \int_{x_1}^{x_2} f(t)\,dt \tag{23}$$

Substituting equation (19), we have:

$$F(x_1, x_2) = \int_{x_1}^{x_2}\sum_{i=1}^{n}\frac{a_i}{\sigma_i\sqrt{2\pi}}\exp\left[-\frac{(t-A_i)^2}{2\sigma_i^2}\right]dt \tag{24}$$

This can be rewritten as:

$$F(x_1, x_2) = \sum_{i=1}^{n} \frac{a_i}{2}\left[\operatorname{erf}\left(\frac{x_2 - A_i}{\sigma_i\sqrt{2}}\right) - \operatorname{erf}\left(\frac{x_1 - A_i}{\sigma_i\sqrt{2}}\right)\right] \qquad (25)$$

### 2.5.3 Fitting

TAC uses the method of maximum likelihood. To do this, it must calculate the probability of obtaining a particular histogram given a set of parameters (Sigworth and Sine, 1987). ☞ *Likelihood, p. 28.*

#### Manual Fitting

TAC uses the probability density function described by equation (19) to compute the expected number of events in each amplitude histogram bin for comparison with the actual histogram. Both are displayed in the Amplitude Histogram window. ☞ *Fit, p. 97.*

You can adjust the amplitude ($A$), standard deviation ($\sigma$), and weight ($a$) of each term of the probability density function manually. ☞ *Changing Parameters, p. 98.*

#### Normalization

The probability density function in equation (19) is normalized so the integral is 1:

$$\int_{-\infty}^{\infty} \sum_{i=1}^{n} \frac{a_i}{\sigma_i\sqrt{2\pi}} \exp\left[-\frac{(x - A_i)^2}{2\sigma_i^2}\right] dx = 1 \qquad (26)$$

which simplifies to:

$$\sum_{i=1}^{n} a_i = 1 \qquad (27)$$

#### Automatic Fitting

The automatic fitting maximizes the likelihood function of equation (74) by varying the $a_i$, $A_i$ and $\sigma_i$ parameters using Powell's method (Press, et al, 1992, P. 412).

The $a_i$ parameter values resulting from maximizing are normalized using equation (27).

## 2.6 Events

Both TAC and TACFit define an "event" as a transition from one amplitude to another. An event has the following parameters:

**Time** The time of the transition, defined as the time at the midpoint of the change in amplitude.

**Pre-amplitude** The amplitude of the data preceding the transition.

**Post-amplitude** The amplitude of the data following the transition.

**Level** The level number following the transition. ☞ *Event Level Number, p. 16.*

### 2.6.1 Event Amplitude

TAC defines the amplitude of an event transition as the change in current from the pre-amplitude to the post-amplitude. ☞ *Figure 13.*

### 2.6.2 Event Level Number

Each event is assigned a nominal level number. This level number can be used during analysis to select only specific events.

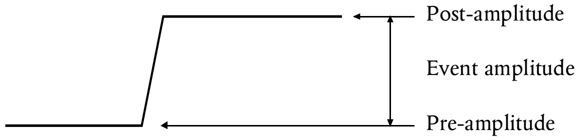



Figure 13 Pre-amplitude, post-amplitude, and event amplitude

Normally a sweep begins at level zero. Every transition in the direction of increasing current increases the level number by one, and every transition in the direction of decreasing current decreases the level number by one. For example, figure 14 shows a sweep alternating between level zero and level -1.

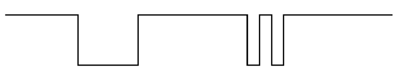


Figure 14 Sweep alternating between levels 0 and -1

You must manually compensate in sweeps that do not begin at level zero. ☞ *Data: Settings, p. 42.*

## 2.7 Event Detection

When TAC performs event detection, it fits an idealized event trace to the filtered raw data.

TAC detects events by searching the data to find a threshold crossing. For accurate analysis, the transition time associated with the event should be the half-amplitude of the transition (Magleby, 1992, P. 767).

The half-amplitude time may not be the same as the time of threshold crossing. In order to obtain an accurate half-amplitude time, TAC performs the following procedure:

1 TAC detects a transition.

2 TAC creates an initial estimate of the pre-amplitude and post-amplitude of the transition.

3 Based on the initial estimate, TAC refines the detection criteria for threshold crossing. It uses the refined detection criteria to locate the 50% point of the transition.

4 TAC determines the pre-amplitude and post-amplitude of the event.

TAC determines the pre- and post-amplitude using a search based on a moving average. The parameters that control the search are set using Data: Settings. ☞ *Data: Settings, p. 42.*

TAC searches over an interval with a duration of the risetime times the search value. It searches from the transition time backward for the pre-amplitude and from the transition time forward for the post-amplitude.

The search is performed by calculating a moving average. The duration of the moving average is the risetime value. Both the mean (moving average) and variance are calculated at each point. The mean value associated with the smallest variance is used.

If the smallest variance exceeds the a limit, TAC considers the amplitude estimate invalid. The limit is the product of the noise estimate and the noise limit value. If the amplitude is invalid, TAC cannot proceed with automatic event detection.

## 2.8 Segments

For pulsed data analysis, TAC treats a sweep as a sequence of segments. ☞ *Figure 15.*

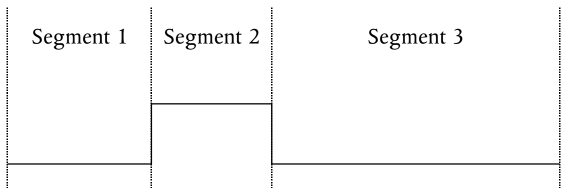



Figure 15 Segments in a sweep

### 2.8.1 Relevant Segment

Typically a pulsed data acquisition program applies a variable stimulus during one segment. The stimulus value is the “relevant value”. The data collected during this segment is the data to be analyzed. This is the “relevant segment”. ☞ *Figure 16.*

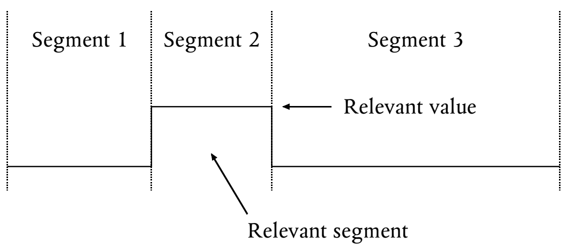



Figure 16 Relevant segment

TAC performs event detection only within the relevant segment. The relevant value can be used during data analysis. This allows you to plot, for example, the time to the first event (first latency) against the stimulus voltage.

TAC allows you to choose the relevant segment and the relevant value independently. For example, the relevant value might be the duration of the segment preceding the relevant segment. ☞ *Figure 17.*

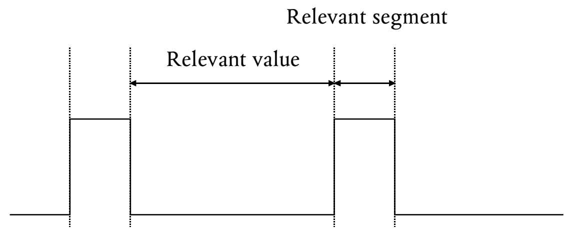



Figure 17 Relevant segment with relevant value from other segment

### 2.8.2 Pulsed Data Event Detection

To analyze pulsed data:

1 Select the segment containing events to be detected. This is the relevant segment.

2 Select the segment with an associated stimulus value (amplitude or duration). This is the relevant value.

3 Lock the relevant segment so you do not change it accidentally. ☞ *Data: Status, p. 43.*

### 2.8.3 Continuous Data Event Detection

You can make use of the relevant segment, event for continuous data analysis.

Sometimes continuous data has stretches on which you would like to perform event detection, and other stretches that you want to avoid. You can adjust the relevant segment of a sweep to include a stretch of good data, and perform event detection limited to that stretch. You can then move the relevant segment to another good stretch and perform event detection again.

To analyze continuous data:

1 Unlock the relevant segment to allow you to set the segment with the mouse. ☞ *Data: Status, p. 43.*

2 Using either the mouse or the Data: Status dialog, set the relevant segment to the first good stretch of data.

3 Perform event detection on the good stretch.

4 Update the relevant segment to the next good stretch and return to step 3

## 2.9 Levels

TACFit converts levels from the list of events into a table of levels. This section explains the steps involved.

### 2.9.1 Background

TAC generates a list of events, which are transitions from one amplitude to another. ☞ *Events, p. 16.* TACFit performs statistics on levels, which are durations at a specific amplitude. ☞ *Figure 18.*

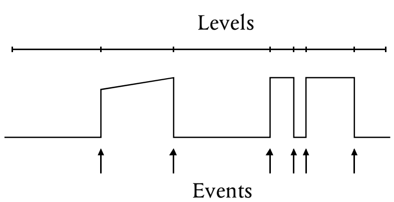



Figure 18 Events and levels

TACFit converts the events detected by TAC into a table of levels for processing.

### 2.9.2 Level

TACFit uses the term "level" to mean a period of time between transitions, that is, between two events. A level represents the dwell time of a channel in a current amplitude.

A level is always delimited by events. The period between the beginning of a sweep and the first transition in a sweep is not a level, nor is the period between the last transition in a sweep and the end of the sweep.

A level has the following parameters:

**File** The file in which the level occurs.

**Sweep** The sweep in which the level occurs.

**Duration** The time between transitions.

**Amplitude** Either of two definitions:

1 the current amplitude during the level

2 the change in amplitude at the beginning of the level.

If a level begins with a burst, the current amplitude during the level is the current amplitude at the end of the burst, and the change in amplitude is the change from before the burst to the end of the burst. ☞ *Burst Resolution, p. 20.*

**Level number** The level number of the event that begins the level. ☞ *Event Level Number, p. 16.*

### 2.9.3 Events to Levels

When TACFit creates a level, it computes the parameters of the level as follows:

**Sweep** The sweep number of the events that delimit the level.

**Duration** The difference in time between the event that begins the level and the event that ends the level.

**Amplitude** The amplitude depends on the definition selected. ☞ *Settings: Events, p. 72.*

**Level number** The level number of the event that begins the level. ☞ *Event Level Number, p. 16.*

**Tag value** The tag value associated with the event that begins the level.

Levels can be created either for an entire sweep, or only for the relevant segment of a sweep. ☞ *Settings: Events, p. 72.*

## 2.9.4 First and Last Levels

TACFit converts the time between the beginning of a sweep (or relevant segment) and the first event to a level, and the time between the last event and the end of the sweep (or relevant segment) to a level. These two levels are computed specially.

### First Level

The level between the beginning of the sweep (or relevant segment) and the first event has a duration of the time from the beginning of the relevant segment of the sweep to the first event, and an amplitude equal to the pre-amplitude of the first event. The level number is one greater than or one less than the level number of the first event, depending on the direction of transition.

### Last Level

The level between the last event and the end of the sweep (or relevant segment) has a duration of the time from the last event to the end of the relevant segment of the sweep. The other parameters are computed as for any other level.

### Analysis

For continuous data analysis the first and last levels should be ignored. The start and end of the sweep is arbitrary in time, therefore the duration of the first and last levels contains no useful information.

For pulsed data analysis, the first and last levels may provide useful information. For example, the duration of the first level in is the first latency.

The first and last levels in a sweep can be ignored using the Settings: Level dialog. ☞ *Settings: Level, p. 75.*

## 2.9.5 Burst Resolution

When TACFit computes levels from events, it applies the burst resolution to collapse bursts of events into a single level. It does this by ignoring pairs of events when both of the following rules apply:

1. The first event of the pair is a transition towards the base level and the second event of the pair is a transition back to the original level.

2. The difference in time between the two events is less than the burst resolution.

A short transition away from the baseline is treated as an individual event, not as part of a burst. ☞ *Figure 19.*

A short transition to the baseline is treated as part of a burst, and ignored.

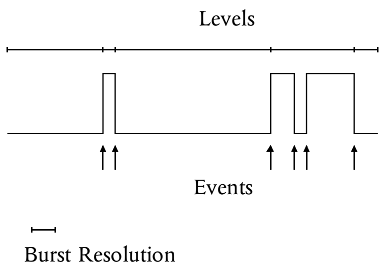



Figure 19 Burst resolution

**Pre- and Post- amplitude**

When TACFit collapses events, it removes pairs of events that follow an event. It then recomputes the parameters of the remaining event:

1 The pre-amplitude of the event is the pre-amplitude of the first event of the burst.

2 The time of transition is the time of transition of the first event of the burst.

3 The post-amplitude of the event is the post-amplitude of the first event of the burst.

### 2.9.6 Multiple Openings

A multiple opening is a level that differs from the base level by more than one level. ☞ *Figure 20.*

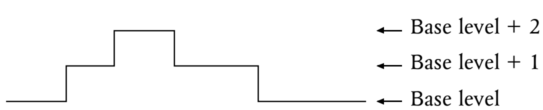



Figure 20 Multiple openings

The level at “Base level + 2” would be treated as a multiple opening.

Multiple openings complicate data analysis. In the example presented:

1 one channel could be open for the entire duration, and a second channel could be opening and closing to cause “Base level + 2”.

2 one channel could be open for the initial period of “Base level + 1” and through the period of “Base level + 2”. A second channel could be opening at the start of “Base level + 2” and remaining open until the end of the final “Base level + 1” period.

TACFit does not analyze multiple openings. The Settings: Events dialog may be used to control how multiple openings are treated. ☞ *Settings: Events, p. 72.*

Normally, TACFit treats sequences of openings containing multiple openings as a single opening to the highest level. In the example presented, the entire duration at “Base level + 1” and “Base level + 2” would be a single level of level number 2.

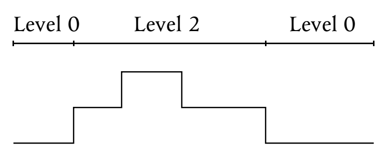



Figure 21 Multiple openings set to “Highest”

Normally such openings should be filtered out. For example, the filter might be set to accept only levels with level numbers in the range 0 to 1. ☞ *Settings: Level, p. 75.*

This approach tends to select against long open times, since long open times are more likely to show overlaps between channels.

An alternative technique is to specify that multiple openings be fragmented into multiple levels. ☞ *Settings: Events, p. 72.*

In this case, each amplitude in a multiple opening is treated as a separate level. ☞ *Figure 22.*

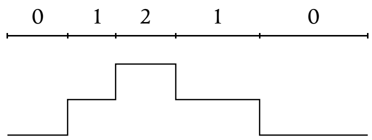



Figure 22 Multiple openings set to "Fragment"

The results can be processed by filtering out all level 2 events. This results in open times that are too short.

### 2.9.7 Duration Correction

The durations of levels with short durations are systematically distorted by the filtering performed by the data acquisition system and by TAC itself. TACFit can perform a correction to compensate for this error (Colquhoun and Sigworth, 1995). ☞ *Duration Histogram: Correction, p. 88.*

The correction is applied to levels with an uncorrected duration, $w_t$, that satisfies:

$$w_t < \frac{1}{2f_c} \tag{28}$$

where $f_c$ is the filter corner frequency.

The correction is:

$$w_0 = w_t + a_1 \exp\left(-\frac{w_t}{a_1} - a_2 w_t^2 - a_3 w_t^3\right) \tag{29}$$

where:

$$\begin{aligned} a_1 &= 0.5382\,T_r \\ a_2 &= 0.837/T_r^2 \\ a_3 &= 1.120/T_r^3 \end{aligned} \tag{30}$$

and:

$$T_r = \frac{1}{f_c}\sqrt{\frac{\ln 2}{2\pi}} = 0.3321 f_c \tag{31}$$

The correction is made when the duration histogram is calculated. It is not made to either the levels table or to the statistics.

## 2.10 Amplitude Histogram Fitting

This section describes how TACFit creates and fits amplitude histograms.

### 2.10.1 Amplitude Histogram

An amplitude histogram divides a range of amplitudes into a set of histogram bins, and counts the number of filtered levels with amplitudes in each bin.

#### Histogram Bins

A filtered level $l$ with amplitude $a_l$ is counted in amplitude histogram bin $j$ if:

$$m + jw \le a_l < m + (j+1)w \tag{32}$$

where $m$ is the minimum value of the histogram and $w$ is the width of a histogram bin. $j$ can be calculated directly:

$$j = \left\lfloor \frac{a_l - m}{w} \right\rfloor \quad (33)$$

The level is not counted in the histogram if $j$ is less than zero or if $j$ is greater than or equal to the number of bins.

### Bin Amplitude

The mean amplitude of a level in a histogram bin is:

$$\bar{a}_j = m + (j + 1/2)w \quad (34)$$

This is the value used as the amplitude of a histogram bin for export and computation. ☞ *TACFit Amplitude Histogram Window, p. 118.*

### Filters

The Settings: Level dialog can be used to exclude regions of the amplitude histogram. TACFit considers histogram bins that intersect an excluded region to be invalid, and does not use them in fitting. ☞ *Settings: Level, p. 75.*

A bin contained completely within an excluded region has a count of zero. For example, if you have an amplitude histogram with a minimum amplitude of 0pA and a bin width of 1pA, and you exclude levels with amplitudes from 10pA to 12pA, the two bins 10 to 11pA and 11 to 12pA will have counts of zero.

TACFit considers bins completely contained within excluded regions to be invalid, and does not include them when calculating the likelihood value. This effectively removes them from automatic fitting. ☞ *Likelihood, p. 28.*

A bin with a range intersecting an excluded region is also considered invalid. For example, if you have an amplitude histogram with a minimum amplitude of 0pA and a bin width of 1pA, and you exclude levels with amplitudes from 10.5pA to 11.5pA, the two bins 10 to 11pA and 11 to 12pA will be considered invalid, because the number of counts they contain cannot be directly compared with other bins.

## 2.10.2 Theoretical Curve

The probability density function of the channel amplitudes is represented as a sum of gaussian functions.

### Probability Density

Assuming that the background noise is gaussian, the probability density of a channel amplitude is (Colquhoun and Sigworth, 1995):

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{(x-A)^2}{2\sigma^2}\right] \quad (35)$$

where $f(x)$ is the probability density of an amplitude $x$, $A$ is the channel amplitude, and $\sigma$ is the standard deviation of the channel amplitude.

A recording usually contains at least two amplitudes (open and closed), and perhaps more. Therefore the amplitude is fit to a sum of $n$ gaussians:

$$f(x) = \sum_{i=1}^{n} \frac{a_i}{\sigma_i\sqrt{2\pi}} \exp\left[-\frac{(x-A_i)^2}{2\sigma_i^2}\right] \quad (36)$$

where $f(x)$ is the total probability density of a given amplitude value $x$, $A_i$ is the $i$th channel amplitude, $\sigma_i$ is the standard deviation of the $i$th channel amplitude, and $a_i$ is the fraction of the data represented by the $i$th amplitude.

**Probability**

The equation for the amplitude is specified in terms of a probability density. Also useful is the probability of an event within a particular range. First we consider the probability of an event of amplitude less than *x*.

The probability *F* of an amplitude less than *x* is:

$$F(x) = \int_{-\infty}^{x} f(t)\,dt \tag{37}$$

Substituting equation (36), we have:

$$F(x) = \int_{-\infty}^{x} \sum_{i=1}^{n} \frac{a_i}{\sigma_i\sqrt{2\pi}} \exp\left[-\frac{(t-A_i)^2}{2\sigma_i^2}\right] dt \tag{38}$$

This can be rewritten as:

$$F(x) = \sum_{i=1}^{n} \frac{a_i}{2}\left[1 + \operatorname{erf}\left(\frac{x-A_i}{\sigma_i\sqrt{2}}\right)\right] \tag{39}$$

**Probability of a Range**

The probability of an event occurring within a range ($x_1$, $x_2$) is:

$$F(x_1, x_2) = \int_{x_1}^{x_2} f(t)\,dt \tag{40}$$

Substituting equation (36), we have:

$$F(x_1, x_2) = \int_{x_1}^{x_2} \sum_{i=1}^{n} \frac{a_i}{\sigma_i\sqrt{2\pi}} \exp\left[-\frac{(t-A_i)^2}{2\sigma_i^2}\right] dt \tag{41}$$

This can be rewritten as:

$$F(x_1, x_2) = \sum_{i=1}^{n} \frac{a_i}{2}\left[\operatorname{erf}\left(\frac{x_2-A_i}{\sigma_i\sqrt{2}}\right) - \operatorname{erf}\left(\frac{x_1-A_i}{\sigma_i\sqrt{2}}\right)\right] \tag{42}$$

## 2.10.3 Fitting

TACFit uses the method of maximum likelihood. To do this, it must calculate the probability of obtaining a particular amplitude histogram given a set of parameters (Sigworth and Sine, 1987). ☞ *Likelihood, p. 28.*

**Manual Fitting**

TACFit uses the probability density function described by equation (36) to compute the expected number of events in each amplitude histogram bin for comparison with the actual histogram. Both are displayed in the Amplitude Histogram window. ☞ *Fit, p. 97.*

You can adjust the amplitude (*A*), standard deviation (σ), and weight (*a*) of each term of the probability density function manually. ☞ *Changing Parameters, p. 98.*

**Normalization**

The probability density function in equation (36) is normalized so the integral is 1:

$$\int_{-\infty}^{\infty} \sum_{i=1}^{n} \frac{a_i}{\sigma_i\sqrt{2\pi}} \exp\left[-\frac{(x-A_i)^2}{2\sigma_i^2}\right] dx = 1 \tag{43}$$

which simplifies to:

$$\sum_{i=1}^{n} a_i = 1 \tag{44}$$

**Automatic Fitting**

The automatic fitting maximizes the likelihood function of equation (74) by varying the $a_i$, $A_i$ and $\sigma_i$ parameters using Powell's method (Press, et al, 1992, P. 412).

The $a_i$ parameter values resulting from maximizing are normalized using equation (44).

## 2.11 Duration Histogram Fitting

This section describes how TACFit creates and fits duration histograms.

### 2.11.1 Duration Histogram

A duration histogram divides a range of durations into a set of histogram bins, and counts the number of filtered durations in each bin.

**Histogram Bins**

TACFit uses a logarithmic duration histogram. Each histogram bin $j$ covers the time range:

$$(me^{j\Delta x}, me^{j\Delta x}\Delta x) \tag{45}$$

where $m$ is the minimum duration value of the histogram and $\Delta x$ is the width of a histogram bin, measured as a ratio.

A filtered level $l$ with duration $t$ is counted in duration histogram bin $j$ if (Sigworth and Sine, 1987):

$$me^{j\Delta x} \le t < me^{(j+1)\Delta x} \tag{46}$$

For a given duration $t$, $j$ can be calculated directly:

$$j = \left\lfloor \frac{\log(t/m)}{\Delta x} \right\rfloor \tag{47}$$

The level is not counted in the histogram if the duration $t$ is less than $m$ or if $j$ is greater than or equal to the number of histogram bins.

Since $m$, $j$, $t$, and $\Delta x$ are always positive and non-zero, equation (46) can be rewritten:

$$\ln m + j\Delta x \le \ln t < \ln m + (j+1)\Delta x \tag{48}$$

**Bin Duration**

The geometric mean duration of a level in a histogram bin is:

$$\dot{t} = me^{(j+1/2)\Delta x} \tag{49}$$

This is the value used as the duration of a histogram bin for export and computation. ☞ *TACFit Duration Histogram Window, p. 119.*

**Filters**

The Settings: Level dialog can be used to exclude regions of the duration histogram. TACFit considers histogram bins that intersect an excluded region to be invalid, and does not use them in fitting. ☞ *Settings: Level, p. 75.*

### 2.11.2 Theoretical Curve

The probability distribution function of the level durations is represented as a sum of exponentials.

### Probability Density: Linear Time

For a linear time axis, the probability density function for a distribution consisting of a single exponential is (Colquhoun and Sigworth, 1995):

$$f(t) = \frac{1}{\tau}e^{-t/\tau} \tag{50}$$

and the probability density function for a distribution consisting of $N$ exponentials is:

$$f(t) = \sum_{i=1}^{N} \frac{a_i}{\tau_i}e^{-t/\tau_i} \tag{51}$$

where $a$ is the weight of a given term.

### Probability Density: Log Time

For a logarithmic time axis, the probability density function for a distribution consisting of a single exponential is (Sigworth and Sine, 1987):

$$g(x) = g_0(x - \ln\tau) \tag{52}$$

where:

$$\begin{aligned} x &= \ln t \\ g_0(x) &= \exp[x - \exp(x)] \end{aligned} \tag{53}$$

The function $g(x)$ defined in equation (52) has the following properties:

1 A change in $\tau$ changes only the $x$-axis position, not the maximum value.

2 The maximum value of $1/e$ occurs when $x = \ln\tau$.

3 The maximum value is independent of $\tau$.

4 The integral of the function is 1, that is:

$$\int_0^{\infty} g(x) = 1 \tag{54}$$

The probability density function for a distribution consisting of $N$ exponentials is:

$$g(x) = \sum_{i=1}^{N} a_i g_0(x - \ln\tau_i) \tag{55}$$

### Probability: Linear Time

The probability distribution function for a single exponential distribution is:

$$F(t) = 1 - e^{-t/\tau} \tag{56}$$

and the probability distribution function for a distribution consisting of $N$ exponentials is (Sigworth and Sine, 1987):

$$F(t) = 1 - \sum_{i=1}^{N} a_i e^{-t/\tau_i} \tag{57}$$

where:

$$\sum_{i=1}^{N} a_i = 1 \tag{58}$$

### Probability: Log Time

The probability distribution function for a single exponential distribution is:

$$G(x) = F(e^x) = 1 - \exp[-e^x/\tau] \tag{59}$$

this can be rewritten as:

$$G(x) = 1 - \exp[-\exp(x - \ln\tau)] \quad (60)$$

Note that:

$$\frac{d}{dx}G(x) = g(x) \quad (61)$$

where g(x) is defined in equation (52).

Therefore:

$$\int_{-\infty}^{\infty} g(x) = G(x)\Big|_{-\infty}^{\infty} = 1 \quad (62)$$

### Probability of a Range

The probability of an event occurring within a range $(t_1, t_2)$ is:

$$F(t_1, t_2) = F(t_2) - F(t_1) \quad (63)$$

which can be expanded to:

$$F(t_1, t_2) = \sum_{i=1}^{N} a_i e^{-t_1/\tau_i} - \sum_{i=1}^{N} a_i e^{-t_2/\tau_i} \quad (64)$$

and simplified to:

$$F(t_1, t_2) = \sum_{i=1}^{N} a_i [e^{-t_1/\tau_i} - e^{-t_2/\tau_i}] \quad (65)$$

## 2.11.3 Fitting

TACFit uses the method of maximum likelihood. To do this, it must calculate the probability of obtaining a particular duration histogram given a set of parameters (Sigworth and Sine, 1987). ☞ *Likelihood, p. 28.*

### Manual Fitting

TACFit uses the probability density function described by equation (55) to compute the expected number of events in each duration histogram bin for comparison with the actual histogram. Both are displayed in the Duration Histogram window. ☞ *Fit, p. 100.*

You can adjust the time constant (τ) and weight (*a*) of each term of the probability density function manually. ☞ *Changing Parameters, p. 101.*

### Normalization

The probability density function in equation (55) is normalized so the integral is 1:

$$\int_{-\infty}^{\infty} \sum_{i=1}^{N} a_i g_0(x - \ln\tau_i) dx = 1 \quad (66)$$

which implies:

$$\sum_{i=1}^{N} a_i = 1 \quad (67)$$

### Automatic Fitting

The automatic fitting maximizes the likelihood function of equation (74) by varying the $a_i$ and $\tau_i$ parameters using Powell's method (Press, et al, 1992, P. 412).

The $a_i$ parameter values resulting from maximizing are normalized using equation (67).

## 2.12 Likelihood

This section describes how the likelihood of a histogram is computed.

### 2.12.1 Likelihood Calculation

TACFit uses the method of maximum likelihood. To do this, it must calculate the probability of obtaining a particular histogram given a set of parameters (Sigworth and Sine, 1987).

#### Histogram Region

The histogram covers a region, $R$. The region is constructed of one or more segments.

The probability, $F(R)$, that an event is in the region $R$ covered by the histogram is:

$$F(R) = \sum_{s_i \in R} F(\min(s_i), \max(s_i)) \tag{68}$$

#### Histogram Likelihood

The likelihood, $L$, of an event being in a histogram bin $(x_1, x_2)$ is:

$$L(x_1, x_2) = \frac{F(x_1, x_2)}{F(R)} \tag{69}$$

The likelihood of a set of events $X$ is the product of the individual likelihoods:

$$L(X) = \prod_{x \in X} L(x) \tag{70}$$

From this, it follows that the likelihood of $n$ events in a histogram bin $(x_1, x_2)$ is:

$$L(x_1, x_2, n) = \left[\frac{F(x_1, x_2)}{F(R)}\right]^n \tag{71}$$

and the likelihood of a histogram $H$ is:

$$L(H) = \prod_i \left[\frac{F(x_i, x_{i+1})}{F(R)}\right]^{n_i} \tag{72}$$

where $n_i$ is the number of events in histogram bin $i$.

Given that the total number of events in $R$ is $N(R)$:

$$L(H) = F(R)^{-N(R)} \prod_i F(x_i, x_{i+1})^{n_i} \tag{73}$$

#### Log Likelihood

For computational convenience, the log likelihood is used instead:

$$\ln L(H) = -N(R) \ln F(R) + \sum_i n_i \ln F(x_i, x_{i+1}) \tag{74}$$

where $N(R)$ is the total number of events in the range of the histogram.

### 2.12.2 Comparison

Ideally, the likelihood value for a histogram should be compared against a standard value. This section describes the simple technique used by TACFit for this purpose.

#### Perfect Fit

A simple method of computing a standard value is to compute the likelihood of a “perfect fit”, that is, one in which the expected number of events in a histogram bin is the same as the number of events actually in the bin.

In this case:

$$F(x_i, x_{i+1}) = \frac{n_i}{N(R)} \tag{75}$$

Substituting this into (74), we have:

$$\ln L(H) = -N(R)\ln F(R) + \sum_i n_i \ln \frac{n_i}{N(R)} \tag{76}$$

therefore:

$$\begin{aligned} \ln L(H) &= -N(R)\ln F(R) - \sum_i n_i \ln N(R) + \sum_i n_i \ln n_i \\ &= -N(R)[\ln F(R) + \ln N(R)] + \sum_i n_i \ln n_i \end{aligned} \tag{77}$$

#### Relative Likelihood

The likelihood value displayed by TACFit is the difference between the likelihood of a perfect fit and the actual likelihood from (74):

$$\begin{aligned} \ln L(H) &= -N(R)\ln F(R) + \sum_i n_i \ln F(x_i, x_{i+1}) \\ &\quad - \left(-N(R)[\ln F(R) + \ln N(R)] + \sum_i n_i \ln n_i\right) \end{aligned} \tag{78}$$

this can be simplified:

$$\ln L(H) = N(R)\ln N(R) + \sum_i n_i \ln \frac{F(x_i, x_{i+1})}{n_i} \tag{79}$$

## 2.13 Stationarity

The stationarity plot is calculated by applying a gaussian filter to the sequence of levels for a sweep. The time constant of the gaussian filter is set by the user. ☞ *Stationarity: Settings, p. 92.*

### 2.13.1 Computation

The stationarity plot $P(t)$ is calculated as:

$$P(t) = \frac{\sum_{s=1}^{S} \sum_{n=1}^{N} (W_{n,s} * F(\tau))(t)}{S} \tag{80}$$

where $F(\tau)$ is a gaussian filter with time constant $\tau$, $W_{n,s}$ is the weight of level $n$ of sweep $s$, and $(W_{n,s} * F(\tau))(t)$ is the convolution of the two at time $t$.

If level $n$ of sweep $s$ begins at time $t_{n,s}$ and has duration $d_{n,s}$, then $W_{n,s}$ is constant over the interval $[t_{n,s}, t_{n,s} + d_{n,s})$, and zero outside that interval.

## 2.13.2 Use

A common use of the stationarity is to determine the time course of the probability of a channel being open, or $P_o(t)$. To do this:

1 Select only open levels in the Settings: Level dialog. ☞ *Settings: Level, p. 75.*

2 Select the range of sweeps of interest in the Settings: Sweep dialog. If you are interested in averaging across the time course of all sweeps, select all sweeps. If you are interested only in a specific sweep, select that sweep. ☞ *Settings: Sweep, p. 74.*

3 Select a weight of 1 (one) in the Stationarity: Settings dialog. This will weight all levels equally. ☞ *Stationarity: Settings, p. 92.*

To determine if the channel open duration changes with time, use the level duration as the weight in the Stationarity: Settings dialog. You will also want to select a time constant that is long compared to the channel open duration. ☞ *Stationarity: Settings, p. 92.*

# 3 TAC Menu



## 3.1 File

The File menu contains operations that have to do with file reading and writing. ☞ *Figure 23.*


Figure 23 File menu

Some menu items are enabled only when a data file is open, and others are enabled only if no data file is open.

### 3.1.1 File: Open

File: Open displays a standard file open dialog. ☞ *Figure 24.*

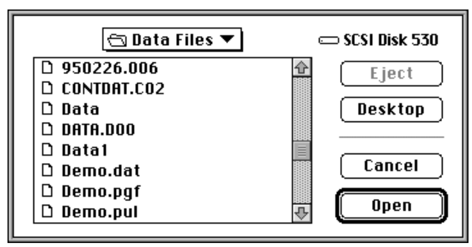



Figure 24 File: Open dialog

Select the data file to read. The data file must be of the type selected in the File: Settings dialog. ☞ *File: Settings, p. 35.*

Depending on the data file type, TAC will display a dialog for additional file-specific parameters. The file types for which this will happen are shown in table 4.

Table 4 File formats requiring additional parameters

| File type | Parameters |
|---|---|
| Axon pCLAMP 5.x | ☞ *Axon pCLAMP 5.x, p. 108.* |
| Axon pCLAMP 6.x | ☞ *Axon pCLAMP 6.x (ABF), p. 107.* |
| Bruxton Acquire | ☞ *Bruxton Corporation, p. 109.* |
| HEKA Pulse | ☞ *HEKA Pulse, p. 110.* |
| Raw continuous | ☞ *Raw Continuous, p. 111.* |

If the data scaling in the selected file is outside of the range of physical possibility for single-channel recording, TAC adjusts the data multiplier to compensate. ☞ *Data: Filter, p. 41.* ☞ *Data Scaling, p. 7.*

When a file is opened, the first sweep will be automatically read into memory and displayed.

File: Open is enabled only if no file is open. To open a different file, first close the currently open file. ☞ *File: Close, p. 32.*

## 3.1.2 File: Close

File: Close closes the currently open file. All open windows will be closed.

If you have made changes to the event table since you last saved it, TAC will display a dialog allowing you to save the event table to a file. ☞ *File: Save Events, p. 34.*

File: Close is enabled only if a data file is open.

## 3.1.3 File: Tape Drive

File: Tape Drive brings up a submenu of tape operations. ☞ *Figure 25.*

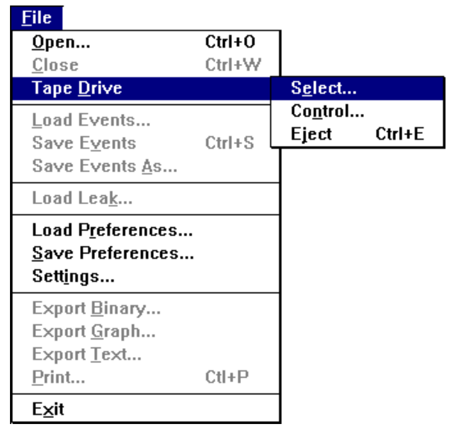



Figure 25 File: Tape Drive submenu

### Tape Drive: Select

Tape Drive: Select brings up a dialog to select the tape drive to use. ☞ *Figure 26.*


Figure 26 Tape Drive: Select dialog

If no tape drive is present, selecting the menu item displays an alert instead of the dialog.

**Tape Drive** A popup menu that displays the available tape drives. Each tape drive is displayed with the associated SCSI ID. Only supported tape drive mechanisms are displayed. ☞ *Storage Devices, p. 2.*

**Cancel** Close the dialog, making no changes to the parameters.

**OK** Update the parameters and close the dialog.

**Tape Drive: Control**

Tape Drive: Control brings up a dialog to perform control operations on the tape drive. ☞ *Figure 27.*

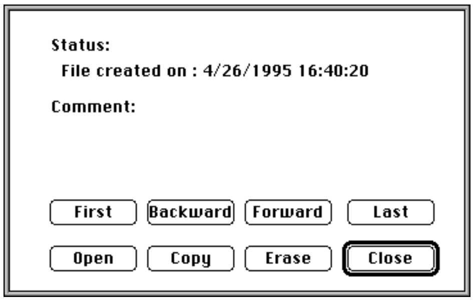



Figure 27 Tape Drive: Control dialog

This dialog will not appear unless a tape is in the selected tape drive.

You use the dialog to locate the desired file on the tape. You can then open the file. TAC processes only Bruxton Corporation Acquire files on tape. TAC cannot process other files on tape, such as those written by a backup utility.

The entries in the dialog are:

**Status** This entry describes the current position of the tape. If the tape is positioned at a file, this entry displays the creation date and time of the current file on the tape.

**Comment** This entry displays the comment in the current tape file. The entry is blank if the current file has no comment.

**First** Move to the first file on the tape.

**Backward** Move backward one file on the tape. The tape will not move past the beginning of the tape.

**Forward** Move forward one file on the tape. The tape will not move past the end of the data on the tape.

**Last** Move to the last file on the tape.

**Open** Open the current tape file. TAC will display a dialog for additional file-specific parameters. ☞ *Bruxton Corporation, p. 109.*

**Copy** Copy the current tape file to disk. TAC displays a file save dialog. Specify the name of the file to create on disk. TAC then copies the file from the tape to disk. You can then open the disk file using File: Open. ☞ *File: Open, p. 31.*

**Erase** Erase the current file and all subsequent files from the tape.

**Close** Close the dialog.

**Tape Drive: Eject**

Tape Drive: Eject ejects the tape currently in the tape drive.

### 3.1.4 File: Load Events

File: Load Events loads an event table created by TAC or TACFit into TAC.

When you select File: Load Events, the standard file selection dialog appears. ☞ *Figure 28.*

TAC cannot load event tables containing events from multiple data files. TAC never creates such event tables. TACFit creates event tables containing events from multiple files if File: Add is used. ☞ *File: Add, p. 66.*

After you load an event table, the event table file becomes the current event table file for File: Save Events. ☞ *File: Save Events, p. 34.*

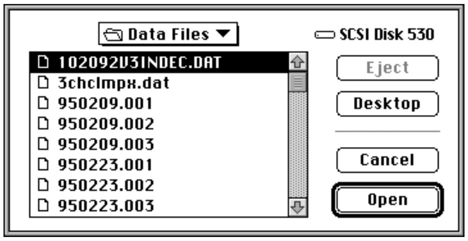



Figure 28 File: Load Events dialog

File: Load Events is enabled only if a data file is open. The event table must not contain any events. If the event table contains events, TAC will display a dialog to allow you to cancel the operation or erase all events currently in the event table. Erasing all the events is equivalent to selecting Events: Erase All. ☞ *Events: Erase All, p. 49.*

### 3.1.5 File: Save Events

File: Save Events writes the contents of the event table with the data file information to the current event table file in a form that can be read by TACFit.

If no current event table file exists, the program performs File: Save Events as instead. This allows you to select an event table file. The event table file you select becomes the current event table file. The file remains the current event table file until the current data file is closed. ☞ *File: Save Events as, p. 34.*

The event table file is written in a text format that can be read by other programs, including spreadsheets. ☞ *Event File, p. 121.*

File: Save Events is enabled only if a data file is open.

### 3.1.6 File: Save Events as

File: Save Events as writes the current contents of the event table to a file you select. The file is written in the same form as written by File: Save Events. ☞ *File: Save Events, p. 34.*

When you select File: Save Events as, a standard file selection dialog appears. ☞ *Figure 29.*

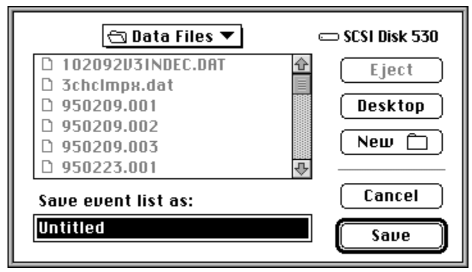



Figure 29 File: Save Events as dialog

Specify a file. This file becomes the current event table file. The file remains the current event table file until the current data file is closed. ☞ *File: Save Events, p. 34.*

File: Save Events as is enabled only if a data file is open.

### 3.1.7 File: Load Leak

File: Load Leak loads a leak template into TAC. ☞ *Leak Template, p. 121.*

When you select File: Load Leak, a standard file selection dialog appears. ☞ *Figure 30.*

If a leak template exists, you will be prompted with an alert. The existing leak template will be replaced by the new one if you choose to continue.

File: Load Leak is enabled only if a data file is open.

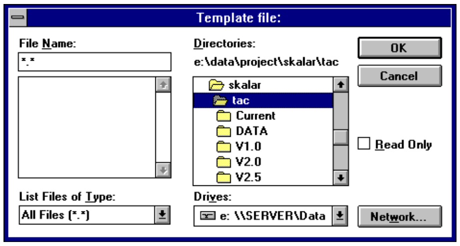



Figure 30 File: Load Leak dialog

### 3.1.8 File: Save Preferences

File: Save Preferences writes the current program settings into a file. This file can be read back into the program. ☞ *File: Load Preferences, p. 35.*

When you select File: Save Preferences, the standard file selection dialog appears. ☞ *Figure 31.*

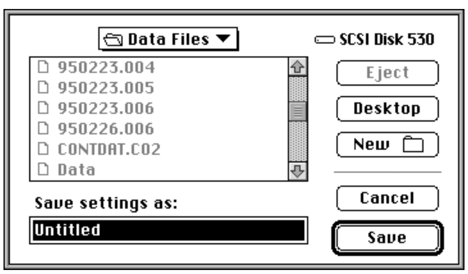



Figure 31 File: Save Preferences dialog

Specify a file. The current preferences will be written into this file. The preferences control almost all program settings. ☞ *Preferences File, p. 122.*

File: Save Preferences is always enabled.

### 3.1.9 File: Load Preferences

File: Load Preferences reads the program settings from a file. This file must have been created by the current version of TAC. ☞ *File: Save Preferences, p. 35.*

When you select File: Load Preferences, the standard file selection dialog appears. ☞ *Figure 32.*

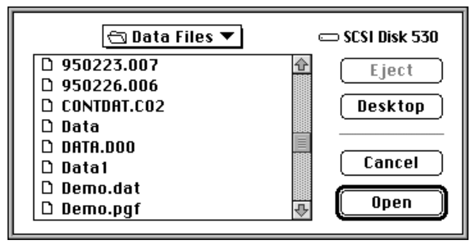



Figure 32 File: Read Preferences dialog

Select a file. The program settings will be read from the file. The preferences control almost all program settings. ☞ *Preferences File, p. 122.*

File: Load Preferences is enabled only if no data file is open.

### 3.1.10 File: Settings

File: Settings allows you to control the basic settings of the program, including the type of data file to process.

When you select File: Settings, a dialog appears. This dialog also appears automatically when the program starts, unless specifically suppressed using “Do not show this dialog on startup”. ☞ *Figure 33.*

**Data file type** The type of data file to expect. ☞ *Figure 34.*

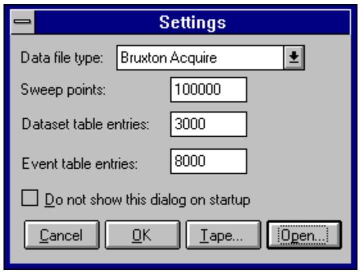



Figure 33 File: Settings dialog

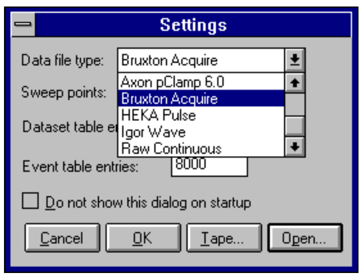



Figure 34 File: Settings data file type

The data file types are shown in table 5.

Table 5 File: Settings file formats

| File type | Reference |
|---|---|
| Axon pCLAMP 5.x | ☞ *Axon pCLAMP 5.x, p. 108.* |
| Axon pCLAMP 6.x | ☞ *Axon pCLAMP 6.x (ABF), p. 107.* |
| Bruxton Acquire | ☞ *Bruxton Corporation, p. 109.* |
| HEKA Pulse | ☞ *HEKA Pulse, p. 110.* |
| IGOR Pro Wave | ☞ *IGOR Wave, p. 111.* |
| Raw continuous | ☞ *Raw Continuous, p. 111.* |

**Sweep points** The maximum number of data points in a single sweep. For continuous files, the program will process sweeps with more data points than this value, but it will break them into multiple sweeps for processing. For pulsed data files, TAC will not process sweeps with more data points than this value. ☞ *Continuation Sweep, p. 5.*

**Dataset table entries** The maximum number of entries in the dataset table.

**Event table entries** The maximum number of events in the event table.

**Do not show this dialog on startup** If this box is not checked, the File: Settings dialog will appear each time the program is started. If you do not want to make changes to the settings when you start the program, check this box, and the dialog will not be shown when the program starts.

**Cancel** Close the dialog, making no changes to the parameters.

**OK** Update the parameters according to the current values in the dialog.

**Tape** Bring up the Tape Drive: Control dialog to open a tape file. ☞ *Tape Drive: Control, p. 33.*

**Open** Update the parameters according to the current values in the dialog (as for OK). Then bring up the File: Open dialog. ☞ *File: Open, p. 31.*

File: Settings is enabled only if no data file is open.

### 3.1.11 File: Export Binary

File: Export Binary writes the data in the active window as a binary file. It can only be used on the Data window. For a description of the data exported, see the description of the window. ☞ *Binary Export, p. 113.*

When you select File: Export Binary, a dialog appears. ☞ *Figure 35.*

**File type** Select the format of the binary file to write. ☞ *Figure 36.*


Figure 35 File: Export Binary dialog

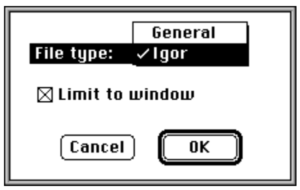



Figure 36 File: Export Binary file type

The supported file types are:

1 General. A sequence of four-byte floating-point data values.

2 IGOR. A binary wave that can be read by WaveMetrics IGOR PRO.

**Limit to window** If this box is checked, only the data currently displayed in the active window is exported. If this box is not checked, the entire sweep will be exported.

**Cancel** Close the dialog without exporting data and without updating any parameters.

**OK** Update the parameters and export the data. A standard file save dialog appears. Specify a file to use for export. The data will be written into the file.

File: Export Binary is enabled only if the active window is the Data window.

## 3.1.12 File: Export Graph

File: Export Graph writes the data in the active window as graphic file. ☞ *Figure 37.*

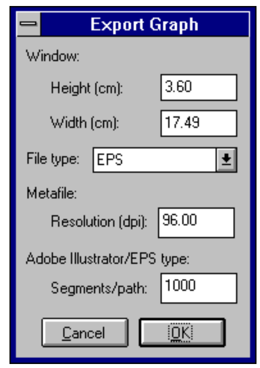



Figure 37 File: Export Graph dialog

By default, the dimensions of the exported graph are the same as those of the active window. For example, if the active window is 15cm wide by 10cm high, the default dimensions of the exported graph will be 15cm by 10cm. You can explicitly override the default size using the Height and Width entries.

**Window**

**Height** The height of the exported graph.

**Width** The width of the exported graph.

**File Type**

**File type** The format of the exported graph. ☞ *Figure 38.*

The supported formats are:

1 Adobe Illustrator. ☞ *Adobe Illustrator (AI), p. 114.*

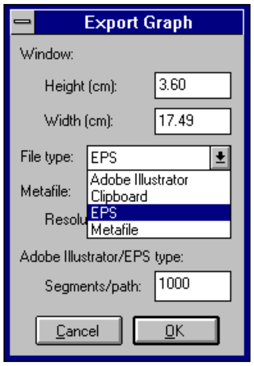



Figure 38  File: Export Graph file type

2 Clipboard. ☞ *Clipboard, p. 115.*

3 EPS. ☞ *EPS, p. 115.*

4 PICT (Macintosh). ☞ *PICT, p. 116.*

5 Metafile (Microsoft Windows). ☞ *Windows Metafile, p. 117.*

Clipboard export is the same as PICT or metafile export, except that the graph is stored in the clipboard instead of as a file. ☞ *Graphic Export, p. 114.*

#### Metafile

**Resolution** The resolution of the output graph in dots per inch. This applies only to Windows metafile format.

#### Adobe Illustrator/EPS type

**Segments/path** Exporting the data window can produce a data trace with many small line segments. For Adobe Illustrator and EPS files, these segments are collected into paths. Some programs cannot easily manipulate paths with more than a few thousand segments. If you have such a program, you can use this entry to limit the number of segments per path. TAC will break the trace into as many paths as necessary. ☞ *Adobe Illustrator (AI), p. 114.* ☞ *EPS, p. 115.*

#### Other

**Cancel** Close the dialog without exporting and without updating any parameters.

**OK** Update the parameters and export the graph. Unless clipboard export is selected, a standard file save dialog appears. Specify a file to use for the graph. The graph will be written into the file.

File: Export Graph is enabled whenever the program has an active window. It is never enabled if no data file is open.

### 3.1.13 File: Export Text

File: Export Text writes the data in the active window as a text file. For a description of the data exported, see the description of each window. ☞ *Text Export, p. 117.* ☞ *Figure 35.*

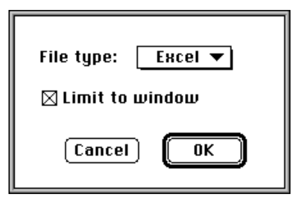



Figure 39  File: Export Text dialog

**File type** Select the format of the text file to write. ☞ *Figure 40.*

The formats are:

1 Excel.

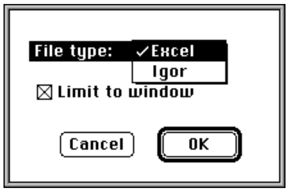



Figure 40 File: Export Text file type

2 IGOR.

**Limit to window** If this box is checked, only the data currently displayed in the active window is exported. If this box is not checked, all data of the same type as the active window will be exported. For example, if the active window is the event table window, the entire event table will be exported.

**Cancel** Close the dialog without exporting data and without updating any parameters.

**OK** Update the parameters and export the data. A standard file save dialog appears. Specify a file to use for export. The data will be written into the file.

File: Export Text is enabled whenever the program has an active window. It is never enabled if no data file is open.

## 3.1.14 File: Print

File: Print prints the active window. The printed graph has the same dimensions as the active window.

The dialog displayed depends on the printer currently selected. The dialogs shown are for a Hewlett-Packard LaserJet 4M printer. ☞ *Figure 41*. ☞ *Figure 42*.

The printed results you obtain depend on your printer and your printer driver.

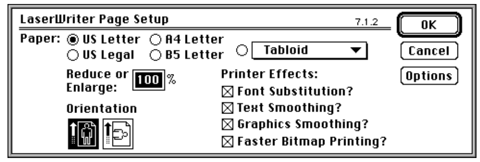



Figure 41 HP LaserJet 4M Page Setup dialog

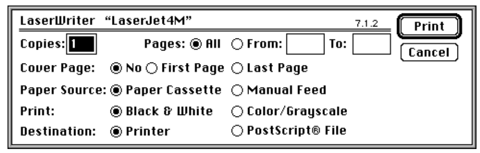



Figure 42 HP LaserJet 4M Print dialog

File: Print is enabled whenever the program has an active window. It is never enabled if no data file is open.

## 3.1.15 File: Quit

File: Quit exits from TAC. File: Quit exists only on the Apple Macintosh.

If the event table has been modified since it was last saved, TAC will ask if you want to save the updated event table. ☞ *File: Save Events, p. 34.*

The current TAC settings are written into the preferences file. When TAC is next started, the settings will be restored. ☞ *Preferences File, p. 122.*

File: Quit is always enabled.

## 3.1.16 File: Exit

File: Exit exits from TAC. File: Exit exists only under Microsoft Windows.

If the event table has been modified since it was last saved, TAC will ask if you want to save the updated event table. ☞ *File: Save Events, p. 34.*

The current TAC settings are written into the preferences file. When TAC is next started, the settings will be restored. ☞ *Preferences File, p. 122.*

File: Exit is always enabled.

## 3.2 Edit

The Edit menu contains operations that have to do with the clipboard. The menu is displayed only on the Macintosh. ☞ *Figure 43.*

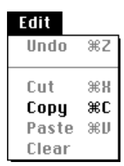



Figure 43 Edit menu

### 3.2.1 Edit: Undo

Edit: Undo is never enabled.

### 3.2.2 Edit: Cut

Edit: Cut is enabled only when a dialog is active. It moves the current selection to the clipboard.

Edit: Cut cannot be used on any TAC window.

### 3.2.3 Edit: Copy

When a dialog is active, Edit: Copy copies the current selection to the clipboard.

When a TAC window is active, Edit: Copy copies the graphic image of the active window to the clipboard. Selecting Edit: Copy is equivalent to using File: Export Graph and selecting the clipboard as the export target. ☞ *File: Export Graph, p. 37.*

### 3.2.4 Edit: Paste

Edit: Paste is enabled only when a dialog is active. It copies the contents of the clipboard to the current cursor position.

Edit: Paste cannot be used on any TAC window.

### 3.2.5 Edit: Clear

Edit: Clear is never enabled.

## 3.3 View

The View menu allows you to choose the active window. ☞ *Figure 44.*


Figure 44 View menu

If you select a window that is not currently displayed, the window will be created.

### 3.3.1 View: Data

View: Data brings up the Data window. ☞ *Data, p. 55*.

### 3.3.2 View: Dataset

View: Dataset brings up the Dataset window. ☞ *Dataset, p. 58*.

### 3.3.3 View: Events

View: Events brings up the Events window. ☞ *Events, p. 60*.

### 3.3.4 View: Histogram

View: Histogram brings up the Histogram window. ☞ *Histogram, p. 61*.

## 3.4 Data

The Data menu allows you to perform operations related to the data window. ☞ *Figure 45*.

The menu appears only if the data window is the active window. ☞ *Data, p. 55*.

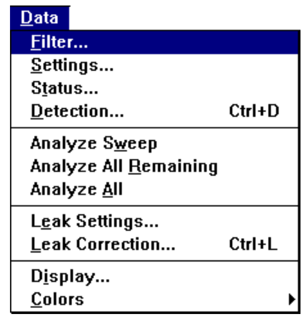



Figure 45 Data menu

### 3.4.1 Data: Filter

Data: Filter allows you to set the digital filter. When you select Data: Filter, a dialog appears. ☞ *Figure 46*.

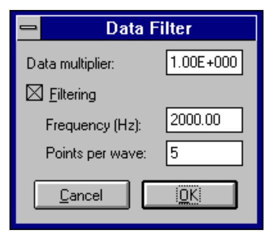



Figure 46 TAC Data: Filter dialog

**Data multiplier** The data multiplier is a scale factor applied to the acquired raw data to correct errors in scaling. Each raw data value will be multiplied by this factor. Set the data multiplier to 1.0 for normal operation. ☞ *Scaling, p. 8*.

### Filtering

The following entries control data filtering.

**Filtering** If this box is checked, TAC filters raw data to the specified frequency. If this box is not checked, TAC uses the original raw data with no filtering.

**Frequency** The corner frequency of the digital filter applied by TAC, in Hertz. ☞ *Data Filtering, p. 9.*

**Points per wave** This parameter controls the decimation performed during digital filtering. It represents the number of data points per period at the filter corner frequency. ☞ *Decimation, p. 10.*

The Data: Status dialog displays the actual sampling interval after filtering. ☞ *Data: Status, p. 43.*

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters. If you have updated parameters, and have events in the event table, TAC will warn you that you have changed the event detection parameters, and events detected in the future may not be consistent with events detected previously.

## 3.4.2 Data: Settings

Data: Settings displays and controls the technique used for event detection. ☞ *Figure 47.*

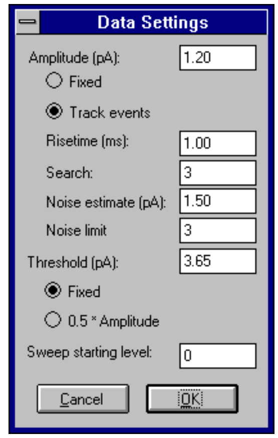



Figure 47 Data: Settings dialog

### Amplitude

**Amplitude** The amplitude estimation technique. The value is the current amplitude estimate.

1. Fixed. TAC uses the specified value as the amplitude of each detected event, regardless of the actual event amplitude. The amplitude value remains unchanged.
2. Tracks events. TAC measures the amplitude of each event. If an event is detected with a duration less than the full risetime, TAC uses the amplitude of the previous event.

**Risetime** The full rise time of a transition. The easiest way to set this value is to measure the risetime from an actual transition.

**Search** The product of search and risetime determines the duration over which the amplitude search is performed. Typically this value should be set to 3, which results in a search duration of three times the full rise time of a transition.

**Noise estimate** The noise amplitude.

**Noise limit** When determining the amplitude of an event, TAC uses a moving average. If the standard deviation of the moving average exceeds the product of the noise estimate and the noise limit, the estimate is considered invalid. Typically this value should be set to 3.

#### Threshold

**Threshold** The threshold calculation technique. The value is the current threshold for event detection. A data value that differs from the post-amplitude of the previous event by more than this value will be interpreted as a threshold crossing.

1 Fixed. The specified threshold value is used for all event detection.

2 0.5 * Amplitude. The event detection threshold is set to 0.5 times the amplitude before each event is detected.

#### Other

**Sweep starting level** The starting level number of the first event detected in a sweep. Usually this is zero.

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

### 3.4.3 Data: Status

Data: Status displays information regarding the current sweep. ☞ *Figure 48.*

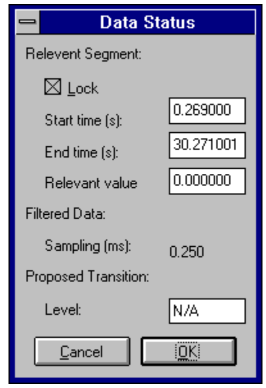



Figure 48 Data: Status dialog

#### Relevant Segment

The entries related to the relevant segment are:

**Lock** Do not allow changes to the start or end of the relevant segment. In the window, the relevant segment markers cannot be moved with the mouse. ☞ *Relevant Segment, p. 55.*

**Start time** The starting time of the relevant segment within the sweep. If you change this field and “Lock” is enabled, “OK” will be disabled.

**End time** The end time of the relevant segment within the sweep. If you change this field and “Lock” is enabled, “OK” will be disabled.

**Relevant value** The data value associated with the relevant segment. If you change this field and “Lock” is enabled, “OK” will be disabled.

#### Filtered Data

The actual values of calculated parameters.

**Sampling** The sampling interval of the filtered data. This takes into account any interpolation or decimation of the raw data performed during filtering. Change this value using the Data: Filter dialog. ☞ *Data: Filter, p. 41.*

**Proposed Transition**

The dialog displays parameters of the proposed transition.

**Level** During event detection, the level number of the proposed transition. Otherwise N/A is displayed.

**Other**

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

## 3.4.4 Data: Detection

Data: Detection begins event detection. A dialog appears, containing the commands used in event detection. The dialog remains on the screen until manual event detection is terminated. You can stop the manual event detection by closing the dialog.

When TAC begins event detection, it searches for a proposed event in the relevant segment of the current sweep. The event is displayed in the data window, and the user can select one of the commands in the dialog.

The commands in the dialog can be selected using either the pushbuttons in the dialog or the specified keyboard keys. The keyboard keys will be recognized only if either the dialog or the data window is active.

The keyboard keys are defined so you can access them without moving your hands from the home position on a QWERTY keyboard. Both upper and lower case are recognized, so "F" and "f" are both interpreted as "Accept". ☞ *Figure 49*.


Figure 49 Data: Detection dialog

The commands in the dialog are:

**Accept (F)** Accept the current proposed event. The event is entered in the event table, and TAC advances to the following proposed event. This button is enabled only if a proposed event is detected in the relevant segment of the current sweep.

**Undo (D)** Remove the previous detected event from the event table. TAC backs up to the end of the event before the previous event, and searches for a new proposed event. This button is always enabled.

**Skip (S)** Ignore the current proposed event and continue searching for an event. This button is enabled only if a proposed event is detected in the relevant segment of the current sweep.

**Jump (J)** Do not accept the current proposed event, but enter the jump into the event table. The jump is not included when the event table is exported. This button is enabled only if a proposed event is detected in the relevant segment of the current sweep.

**Next (K)** Advance to the next sweep. This button is not enabled when processing the last sweep in a file.

Event detection begins following the last detected event in the sweep, or the beginning of the relevant segment of the current sweep, whichever is later.

### 3.4.5 Data: Analyze Sweep

Data: Analyze Sweep begins automatic event detection. Event detection starts from the last detected event in the current sweep or the beginning of the relevant segment, whichever is later, and continues to the end of the relevant segment of the sweep.

### 3.4.6 Data: Analyze All Remaining

Data: Analyze All Remaining begins automatic event detection. Event detection starts from the last detected event in the current sweep, or the beginning of the relevant segment of the current sweep, whichever is later, and continues to the end of the file.

### 3.4.7 Data: Analyze All

Data: Analyze All begins automatic event detection. The event detection starts from the last detected event in the first sweep, or the beginning of the relevant segment of the first sweep, whichever is later, and continues to the end of the file.

### 3.4.8 Data: Leak Settings

Data: Leak Settings controls the parameters used for building the leak template. ☞ *Figure 50.*

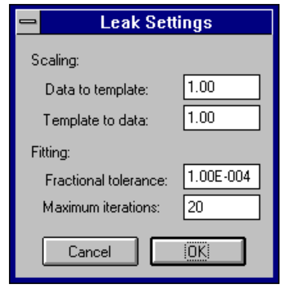



Figure 50 Data: Leak Settings dialog

#### Scaling

**Data to template** The scaling factor applied to the acquired data before adding the acquired data to the leak template.

**Template to data** The scaling factor applied to the leak template before subtracting the leak template from the acquired data.

#### Fitting

The following parameters affect only the fitting of an exponential to a portion of the leak template.

**Fractional tolerance** The termination criteria for the fit to the leak template. The fit iterates until the "chi-square" value changes by less than this fraction between iterations. ☞ *Leak Template, p. 13.*

**Maximum iterations** The maximum number of iterations for the fit. If the fit does not meet the fractional tolerance criteria after this number of iterations, the fit terminates with an error.

#### Other

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

### 3.4.9 Data: Leak Correction

Data: Leak Correction displays a dialog that contains commands used during leak correction. ☞ *Figure 51.*


Figure 51 Data: Leak Correction dialog

The commands in the dialog are:

**Previous** Move to the previous sweep. This is disabled when processing the first sweep in the file.

**Next** Move to the next sweep. This is disabled when processing the last sweep in the file.

**Add** Add the data within the relevant segment of the current sweep into the leak template. This is disabled if the current sweep is a different size than the leak template.

**Undo** Undo the last operation to the leak template. This is always enabled.

**Clear** Discard the leak template data. This is always enabled.

**Fit Exp** Fit the relevant segment of the leak template to an exponential. This is enabled only if the leak template exists.

**Fit Ramp** Fit the relevant segment of the leak template to a ramp. This is enabled only if the leak template exists.

**Fit Level** Fit the relevant segment of the leak template to a level. This is enabled only if the leak template exists.

**Correct** If this box is checked, TAC subtracts the leak template from the acquired data. This is disabled if the current sweep is a different size than the leak template.

## 3.4.10 Data: Display

Data: Display controls the format of the raw data display. ☞ *Figure 52*.

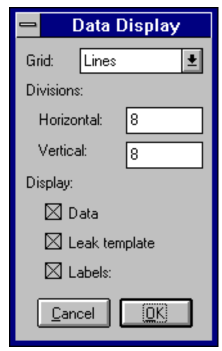



Figure 52 Data: Display dialog

**Grid** The grid style. ☞ *Figure 53*.

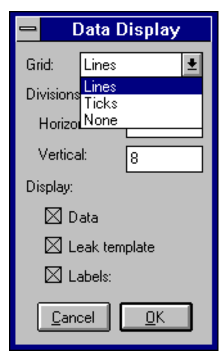



Figure 53 Data: Display grid

The choices are:

1 Lines. Displays lines on the background.

2 Ticks. Displays tick marks on the axes for each grid division, but no grid lines.

3 None. Displays neither lines nor tick marks.

**Divisions**

**Horizontal** The number of grid divisions displayed from left to right in the window.

**Vertical** The number of grid divisions displayed from top to bottom in the window.

**Display**

**Data** If this box is checked, the acquired data is displayed.

**Leak template** If this box is checked, the leak template is displayed.

**Labels** If this box is checked, the horizontal and vertical scaling are displayed.

**Other**

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog. The data window is updated if any parameters are changed.

### 3.4.11 Data: Colors

Data: Colors allows you to select the colors used in the raw data display. It brings up a submenu. ☞ *Figure 54.*

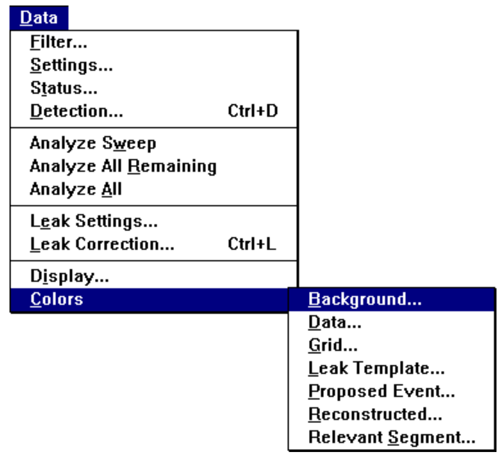



Figure 54 Data: Colors submenu

When you select a submenu item, TAC displays the standard color selection dialog. Select the color you want to use for the specified item. The items are:

**Background** The window background.

**Data** The raw data trace.

**Grid** The grid lines or the tick marks. ☞ *Data: Display, p. 46.*

**Leak Template** The leak template trace.

**Proposed Event** The proposed event during event detection.

**Reconstructed** The reconstructed event trace.

**Relevant Segment** The vertical lines marking the beginning and ending of the relevant segment.

## 3.5 Dataset

The Dataset menu allows you to perform operations on the Dataset window. ☞ *Figure 55.*


Figure 55 Dataset menu

The Dataset menu is displayed only if the Dataset window is the currently active window. ☞ *Dataset, p. 58.*

### 3.5.1 Dataset: Restore Relevant

Restore the relevant segment information for each sweep to the specification in the acquired data file.

You can manually adjust the start and end of relevant segment. This replaces all manual adjustments with the original relevant segment in the data file. ☞ *Relevant Segment, p. 55.*

### 3.5.2 Dataset: Colors

Dataset: Colors allows you to selected the colors used in the Dataset window. It brings up a submenu. ☞ *Figure 56.*

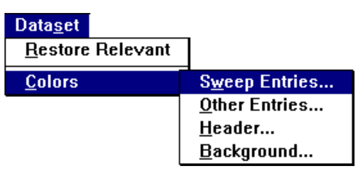



Figure 56 Dataset: Colors submenu

When you select a submenu item, TAC displays the standard color selection dialog. Select the color you want to use for the specified item. The items are:

**Sweep Entries** Sweeps and continuation sweeps. ☞ *Sweeps, p. 5.*

**Other Entries** Dataset window entries other than sweeps, such as groups and series.

**Header** The column heading labels.

**Background** The window background.

## 3.6 Events

The Events menu allows you to perform operations on the event table, and to control the display of the event table. ☞ *Figure 57.*

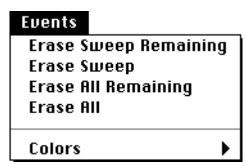



Figure 57 Events menu

The events menu appears only if the Events window is the currently active window. ☞ *Events, p. 60.*

### 3.6.1 Events: Erase Sweep Remaining

Erase all detected events starting with the first event occurred after the display start time of the Data window until the end of the current sweep. ☞ *Current Sweep, p. 60.*

### 3.6.2 Events: Erase Sweep

Erase all detected events in the current sweep. ☞ *Current Sweep, p. 60.*

### 3.6.3 Events: Erase All Remaining

Erase all detected events starting with the first event occurred after the display start time of the Data window until the end of the file.

### 3.6.4 Events: Erase All

Erase all detected events in the file.

### 3.6.5 Events: Colors

Events: Colors allows you to select the colors used in the event table display. It brings up a submenu. ☞ *Figure 58.*

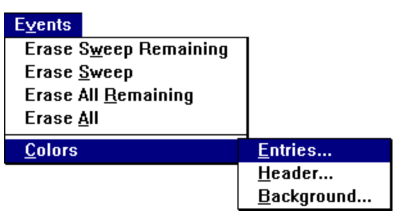



Figure 58 Events: Colors submenu

When you select a submenu item, TAC displays the standard color selection dialog. Select the color you want to use for the specified item. The items are:

**Entries** Detected events.

**Header** The column heading labels.

**Background** The window background.

## 3.7 Histogram

The Histogram menu allows you to control the display of an all-points histogram of the acquired data in the current sweep. ☞ *Figure 59.*

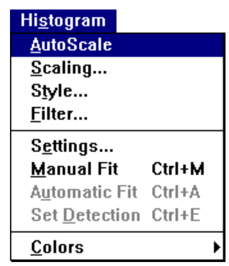



Figure 59 Histogram menu

The menu appears only if the histogram window is the active window. ☞ *Histogram, p. 61.*

### 3.7.1 Histogram: Autoscale

Histogram: Autoscale sets the scaling parameters for the all-points histogram so all data is displayed.

After you use Histogram: Autoscale, you can adjust the scaling using Histogram: Scaling for a better appearance. ☞ *Histogram: Scaling, p. 49.*

### 3.7.2 Histogram: Scaling

Histogram: Scaling controls the scaling of the all-points data histogram. ☞ *Figure 60.*

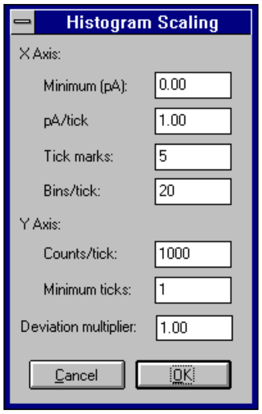



Figure 60 Histogram: Scaling dialog

#### X Axis

The entries that control the X axis scaling are:

**Minimum** The minimum data value to display in the histogram. Any sampled data points less than the minimum value will not be included in the histogram.

**pA/tick** The amplitude range expressed by each x axis tick mark.

**Tick marks** The number of tick marks to display across the x axis of the histogram. For example, if the number of tick marks is 5 and the pA/tick is 1, the histogram will have a total range of 5pA.

**Bins/tick** The resolution of the histogram, expressed as a number of histogram bins per tick mark. For example, if the bins/tick is 20 and the pA/tick is 1, each bin corresponds to 0.05pA.

#### Y Axis

The entries that control the Y axis scaling are:

**Counts/tick** The number of counts per vertical tick mark. For example, if the counts/tick is 2000 and a histogram bin counts 3000 data points, the histogram will display a vertical bar 1.5 tick spacings high.

**Minimum ticks** The minimum number of vertical tick marks to display. For example, if the counts/tick is 2000 and the minimum ticks is set to 1, the histogram will display only one vertical division if no bin contains more than 2000 counts. If a bin contains 3000 counts, the histogram will display at least two vertical divisions.

#### Other

**Deviation multiplier** A multiplier for displaying the standard deviation of the fit to the histogram. For example, if the multiplier is set to 2, the displayed standard deviation is twice the actual value.

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog. The histogram window is updated if any parameters are changed.

### 3.7.3 Histogram: Style

Histogram: Style brings up a dialog that allows you to set the display of the all-points histogram. ☞ *Figure 61.*

#### Curves

The entries that control the display of the curves.


Figure 61 Histogram: Style dialog

**Histogram** Select the style for the display of the histogram. ☞ *Figure 62.*

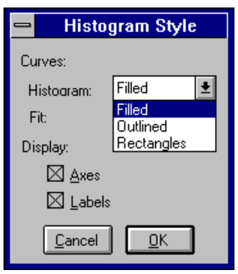



Figure 62 Histogram: Style histogram

The choices are:

1 Filled. The entire area underneath the histogram data is displayed in a solid color.

2 Outlined. The histogram curve itself is displayed as an outline with no fill.

3 Rectangles. Each bin of the histogram is drawn as an unfilled rectangle.

**Fit** Select the style for the display of the fit to the histogram. ☞ *Figure 63.*

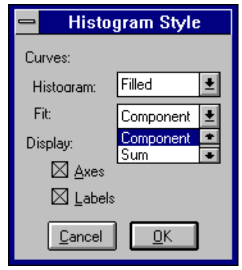



Figure 63 Histogram: Style fit

The choices are:

1 Component. Display each fit component as a separate curve.

2 Sum. Display the sum of the fit component curves as a single curve.

3 Both. Display both the individual fit component curves and the sum curve.

### Display

**Axes** If this box is checked, display axes on the graph.

**Labels** If this box is checked, display axis labels on the graph.

### Other

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog. The histogram window is updated if any parameters are changed.

### 3.7.4 Histogram: Filter

Histogram: Filter allows you to select the range to process. ☞ *Figure 64.*

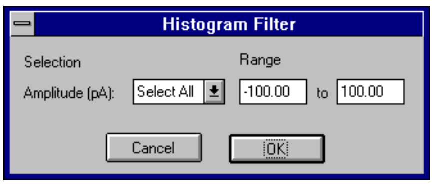



Figure 64  Histogram: Filter dialog

A data value must satisfy the selection criteria to be considered in the histogram calculation.

**Selection**  The type of filter. ☞ *Figure 65.*

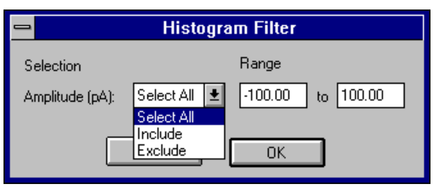



Figure 65  Histogram: Filter amplitude

The choices are:

1. Select all. Do not filter data.
2. Include. Select only data within the specified range.
3. Exclude. Select only data outside the specified range.

**Other**

**Cancel**  Close the dialog without updating any parameters.

**OK**  Update the parameters and close the dialog. The histogram window is updated if any parameters are changed.

### 3.7.5 Histogram: Settings

Histogram: Settings controls the parameters used when fitting data histogram. ☞ *Figure 66.*

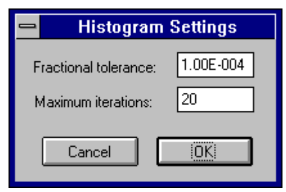



Figure 66  Histogram: Settings dialog

**Fractional tolerance**  The termination criteria for the fit. The fit iterates until the likelihood value changes by less than this fraction between iterations.

**Maximum iterations**  The maximum number of iterations for the fit. If the automatic fit does not meet the fractional tolerance criteria after this number of iterations, the fit terminates with an error.

**Cancel**  Close the dialog without updating any parameters.

**OK**  Update the parameters and close the dialog.

### 3.7.6 Histogram: Manual Fit

Histogram: Manual Fit brings up the histogram fit window and begins manual fitting. ☞ *Histogram Fit, p. 63.* ☞ *Data Histogram, p. 13.*

### 3.7.7 Histogram: Automatic Fit

Histogram: Automatic Fit causes TAC to perform an automatic fit to the data histogram. ☞ *Data Histogram, p. 13.*

### 3.7.8 Histogram: Set Detection

Histogram: Set Detection causes TAC to set the event detection parameters according to the fit to the data histogram. At least two fit components are required. The fit component which has the greatest weight is considered the base level.

The parameters that are set in the Data: Settings dialog are: ☞ *Data: Settings, p. 42.*

1 The noise estimate is set to the greatest standard deviation among the fit components.

2 The threshold is set to half the difference between the current of the base level and the current of the nearest fit component.

### 3.7.9 Histogram: Colors

Histogram: Colors allows you to select the colors used in the histogram display. It brings up a submenu. ☞ *Figure 67.*

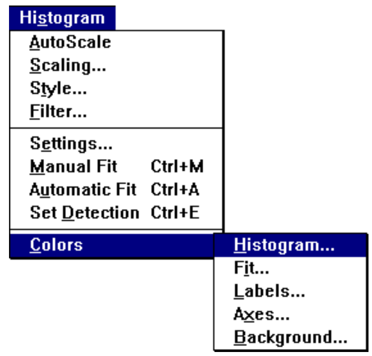



Figure 67 Histogram: Color menu

When you select a submenu item, TAC displays the standard color selection dialog. Select the color you want to use for the specified item. The items are:

**Histogram** The histogram itself.

**Fit** The fit curve. If the fit curve is not easily visible, alter the histogram color and fit curve color to increase the contrast between them.

**Labels** The axis labels.

**Axes** The axes themselves.

**Background** The window background.

# 4 TAC Windows

| Section | |
|---|---|
|  |

## 4.1 Data

The Data window displays the acquired data of the current sweep, the idealized data of the current sweep, and the leak template. During event detection, the window displays the proposed event. The title of the window is always “Data”. ☞ *Figure 68.*

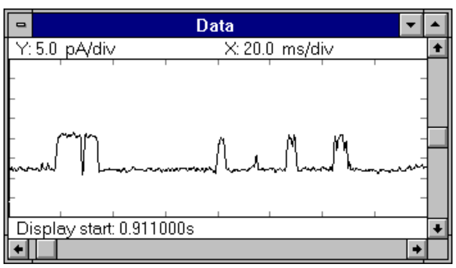



Figure 68 Data Window

### 4.1.1 Data Traces

**Acquired Data**

The Data window displays the acquired data of the current sweep, after filtering. You can set the color of the data trace using the Data: Colors menu. ☞ *Data: Colors, p. 47.*

**Idealized Data**

If the current sweep contains detected events, the events are displayed as an idealized data trace. You can set the color of the idealized data trace using the Data: Colors menu. ☞ *Data: Colors, p. 47.*

**Leak Template**

If a leak template exists, the Data window displays the leak template data. You can set the color of the leak template trace using the Data: Colors menu. ☞ *Data: Colors, p. 47.*

**Relevant Segment**

The Data window displays vertical markers at the start and end of the relevant segment. If the relevant segment is the entire sweep, the markers are displayed at the beginning and end of the sweep. ☞ *Figure 69.*

If the relevant segment is not locked, you can select and drag the relevant segment markers with the mouse. Locking is controlled by the Data: Status dialog. You can also set the start and end of the relevant segment explicitly using the Data: Status dialog. ☞ *Data: Status, p. 43.*

You can set the color of the relevant segment markers using the Data: Colors menu. ☞ *Data: Colors, p. 47.*

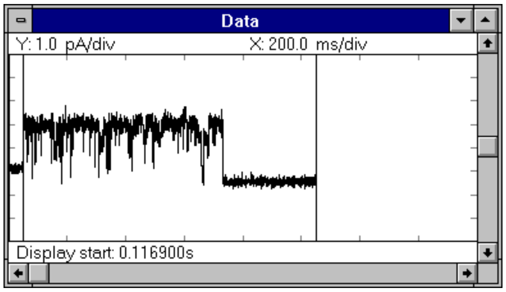



Figure 69 Data window with relevant segment markers

## 4.1.2 Scaling

You can control both the horizontal and vertical scaling of the data in the window.

### Horizontal

The horizontal scaling of the data window is controlled by the x scaling value at the top of the window. For example, if the x scaling is 5ms/div, each horizontal grid division represents 5 milliseconds. If the number of grid divisions displayed is 8, the window displays 40 milliseconds of data.

To change the horizontal scaling, click on the x scaling value with the mouse. Hold the mouse button down while dragging the mouse up or down. Dragging the mouse up expands the trace horizontally, while dragging the mouse down compresses the trace. The data traces will be rescaled when you release the mouse button.

### Vertical

The vertical scaling of the data window is controlled by the y scaling value at the top of the window. For example, if the y scaling is 0.5pA/div, each vertical grid division represents 0.5 picoamperes. If the number of grid divisions displayed is 8, the window displays a range of 4 pA.

To change the vertical scaling, click on the Y scaling value with the mouse. Hold the mouse button down while dragging the mouse up or down. Dragging the mouse up expands the trace vertically, while dragging the mouse down compresses the trace. The data traces will be rescaled when you release the mouse button.

### Grid

The number of horizontal and vertical grid divisions can be set using the Data: Display dialog. Using this dialog, you can also control how the grid is displayed. ☞ *Data: Display, p. 46.*

## 4.1.3 Status Line

The status line at the bottom of the window displays the start time of the data. During event detection it displays the parameters of the proposed event.

### Display start

The time represented by the first (leftmost) data point in the window.

### Proposed event

The parameters of the proposed event. ☞ *Status Line, p. 58.*

## 4.1.4 Scrolling

You can scroll the window both horizontally and vertically using either keyboard keys or the scroll bars.

### Scroll Bars and Arrow Keys

You can scroll the data window using the vertical and horizontal scroll bars of the window. You can scroll the window horizontally only within the current sweep.

You can also scroll using the arrow keys on the keyboard. The left and right arrow keys scroll horizontally, while the up and down arrow keys scroll vertically.

### Direction

The scrolling operates in the same manner as a word processor or spreadsheet. The data window behaves as a window into a larger data display area:

1 If you scroll to the right, you move the window to the right within the sweep. The existing data moves to the left to make room for the new data.

2 If you scroll to the left, you move the window to the left within the sweep. The existing data moves to the right to make room for the new data.

3 If you scroll down, you move the window down within the range of currents. The existing data moves up to make room for the new data.

4 If you scroll up, you move the window up within the range of currents. The existing data moves down to make room for the new data.

## 4.1.5 Proposed Event

During event detection, the data window displays the proposed event. The event is displayed graphically superimposed on the data and as text at the bottom of the data window. The initial estimate of the proposed event is determined by TAC. ☞ *Figure 70.*

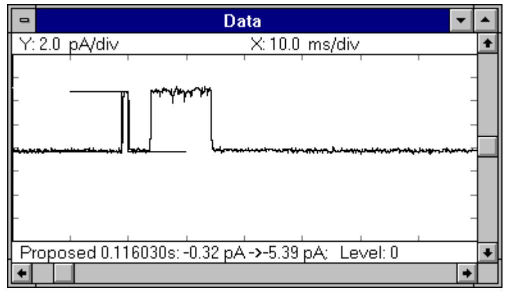



Figure 70 Data window showing proposed event

### Graphical Display

The data window displays the proposed event graphically as three line segments:

1 a horizontal segment representing the amplitude before the event

2 a vertical segment representing the time of the event

3 a horizontal segment representing the amplitude after the event.

Each horizontal segment is one grid division long. This makes the segments easy to see, even if the event is of short duration. The height of the vertical segment represents the amplitude change of the event.

You can alter the proposed event by the segments with the mouse. The proposed transition cannot be set earlier than the transition of the previous event plus half of the risetime.

If you select Amplitude: Fixed in the Data: Settings dialog, the amplitude of the proposed event will remain fixed as you drag a horizontal segment. For example, if you drag the preamplitude, the postamplitude will move as well. ☞ *Data: Settings, p. 42.*

You can control the color of the proposed event using the Data: Colors menu. ☞ *Data: Colors, p. 47.*

**Status Line**

The proposed event is also displayed as text at the bottom of the window. The text includes the time of the transition, the data amplitude before the transition, the data amplitude after the transition, and the level number after the transition. ☞ *Event Amplitude, p. 16.* ☞ *Event Level Number, p. 16.*

If TAC detects an unresolved transition, it displays “Unresolved” in parentheses following the proposed transition time. If TAC cannot determine the data amplitude before the transition, it displays “Uncertain” in parentheses following the data amplitude before the transition. If TAC cannot determine the data amplitude after the transition, it displays “Uncertain” in parentheses following the data amplitude after the transition.

The level number following the transition can be modified using Data: Status dialog. ☞ *Data: Status, p. 43.*

### 4.1.6 Deleting Events

You can select individual events in the idealized data trace. This feature is available only when event detection is not being performed.

Select an event by clicking with the mouse on the vertical line that represents the event transition in the Data window. The event will change to the proposed event color. ☞ *Data: Colors, p. 47.*

A selected event can be deleted using the “Delete” key. The preceding and following events will then be connected. ☞ *Figure 71.*

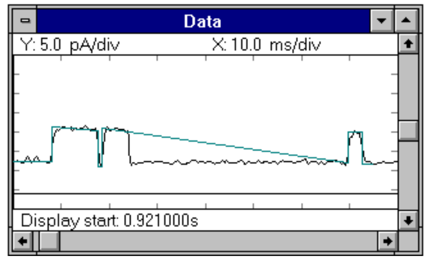



Figure 71 Data window after deleting an event

## 4.2 Dataset

The Dataset window displays the contexts of the data file as text. ☞ *Figure 72.*

### 4.2.1 Entries

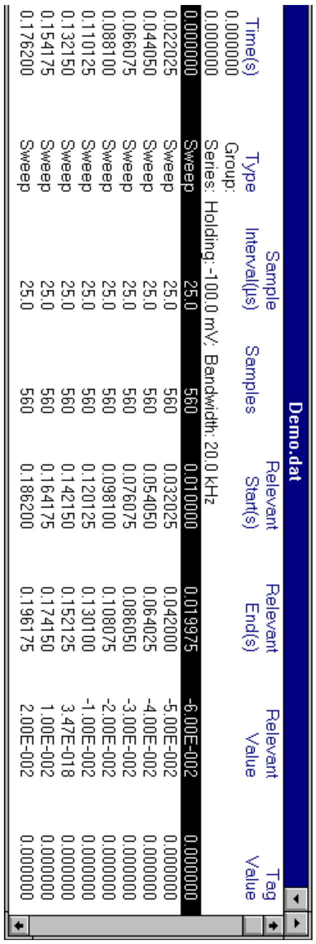
Each entry in the dataset window is displayed as a line of text. The contents of a line varies with the type of entry, but the following information is displayed for each entry:

**Time** The start time of the entry in seconds. The file starts at time zero.

The start time of each sweep, series, or group is calculated with respect to the start time of the file.

TAC adjusts the starting time of a series, sweep, or group so that time increases monotonically. This corrects for errors in the time base used in data acquisition programs.

As an example of how a problem can arise, suppose a data acquisition program records the starting time of each sweep from the system clock. If at time 0 it begins recording a sweep of 10 seconds, at the end of the sweep the time should be exactly 10 seconds. However, if the system clock is slower than the acquisition clock, the system time at the end of the sweep could be 9 seconds. If the acquisition program immediately starts a second



Demo.dat

| Time(s) | Type | Sample Interval(µs) | Samples | Relevant Start(s) | Relevant End(s) | Relevant Value | Tag Value |
|---|---|---|---|---|---|---|---|
| 0.000000 | Group: | | | | | | |
| 0.000000 | Series: Holding: -100.0 mV; Bandwidth: 20.0 kHz | | | | | | |
| 0.000000 | Sweep | 25.0 | 560 | 0.010000 | 0.019975 | -6.00E-002 | 0.000000 |
| 0.022025 | Sweep | 25.0 | 560 | 0.032025 | 0.042000 | -5.00E-002 | 0.000000 |
| 0.044050 | Sweep | 25.0 | 560 | 0.054050 | 0.064025 | -4.00E-002 | 0.000000 |
| 0.066075 | Sweep | 25.0 | 560 | 0.076075 | 0.086050 | -3.00E-002 | 0.000000 |
| 0.088100 | Sweep | 25.0 | 560 | 0.098100 | 0.108075 | -2.00E-002 | 0.000000 |
| 0.110125 | Sweep | 25.0 | 560 | 0.120125 | 0.130100 | -1.00E-002 | 0.000000 |
| 0.132150 | Sweep | 25.0 | 560 | 0.142150 | 0.152125 | 3.47E-018 | 0.000000 |
| 0.154175 | Sweep | 25.0 | 560 | 0.164175 | 0.174150 | 1.00E-002 | 0.000000 |
| 0.176200 | Sweep | 25.0 | 560 | 0.186200 | 0.196175 | 2.00E-002 | 0.000000 |

Figure 72 Dataset Window

sweep, that sweep could have a starting time of 9 seconds. Time will appear to go backwards, because the last sample of the first sweep will have been taken after the first sample of the second sweep.

TAC avoids this problem as follows:

1 Each time TAC processes a sweep, it determines from the sampling rate and number of samples the time at which the sweep ended. This becomes the earliest possible start time for any subsequent entries.

2 If a subsequent sweep, series, or group begins before the earliest possible start time, TAC uses the earliest possible start time instead of the start time recorded in the data file.

Because of this feature, the listed starting time might not be the same as that reported by the data acquisition program that created the file.

**Type** The type of entry.

The types of entries that Dataset window shown are:

1 Group. A “group” is a sequence of series. Groups are included only if supplied by the data file.

2 Series. A “series” is a sequence of sweeps. Each series displays the holding potential used between sweeps in the series and the filter bandwidth used to acquire data.

   Some data file formats do not include the bandwidth. In that case, the bandwidth is estimated as the Nyquist frequency of the sampling interval.

3 Sweep. A “sweep” is a sequence of data points acquired as a unit.

4 Continuation Sweep. TAC creates if a sweep is too large for the sweep buffer. ☞ *Continuation Sweep, p. 5.*

**Sample Interval** The sampling interval.

**Samples** The number of data samples in the sweep.

**Relevant Start** The start time of the relevant segment. If the relevant segment is the entire sweep, this is the start time of the sweep.

**Relevant End** The end time of the relevant segment. If the relevant segment is the entire sweep, this is the end time of the sweep.

**Relevant Value** The value associated with the relevant segment.

**Tag Value** A tag value associated with the sweep. This value is never set by TAC. It can be set using another program such as a spreadsheet. The value can then be used to aid analysis.

The duration of the sweep is the product of the number of samples and the sampling interval.

If a sweep is marked as a continuation sweep, it represents the continuation of the previous sweep. ☞ *Continuation Sweep, p. 5.*

### 4.2.2 Current Sweep

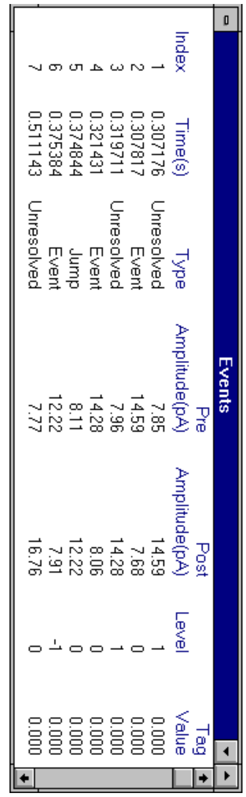
The current sweep is the sweep being processed and displayed in the Data window. It is highlighted in the Dataset window. Click on a different sweep in the Dataset window with mouse to change the current sweep.

### 4.2.3 Scrolling

You can scroll the dataset window using the vertical scroll bar of the window.

## 4.3 Events

The Events window displays the detected events of the current sweep. ☞ *Current Sweep, p. 60.* ☞ *Figure 73.*


Events

| Index | Time(s) | Type | Pre Amplitude(pA) | Post Amplitude(pA) | Level | Tag Value |
|---|---|---|---|---|---|---|
| 1 | 0.307176 | Unresolved | 7.85 | 14.59 | 1 | 0.000 |
| 2 | 0.307817 | Event | 14.59 | 7.68 | 0 | 0.000 |
| 3 | 0.319711 | Unresolved | 7.96 | 14.28 | 1 | 0.000 |
| 4 | 0.321431 | Event | 14.28 | 8.06 | 0 | 0.000 |
| 5 | 0.374844 | Jump | 8.11 | 12.22 | 0 | 0.000 |
| 6 | 0.375384 | Event | 12.22 | 7.91 | -1 | 0.000 |
| 7 | 0.511143 | Unresolved | 7.77 | 16.76 | 0 | 0.000 |

Figure 73 Events window

### 4.3.1 Entries

Each entry in the Events window is displayed as a line of text. The following information is displayed for each entry:

**Index** The index number of the entry in the event table. Entries are numbered sequentially starting at one. All entries are numbered, regardless of type. Since the Events window displays the detected events of the current sweep, the index of the first event in the Events window may not be one.

**Time** The time of the entry in seconds. The file starts at time zero. ☞ *The type of entry., p. 59.*

**Type** The type of entry. TAC has the following event types. They are defined as:

1 Event. An “Event” is a fully resolved transition detected by TAC and entered into the event table. ☞ *Data: Detection, p. 44.*

2 Jump. A “Jump” is a detected transition and entered into the event table. However it is not an “Event”. Jumps are not exported and are ignored for further processing. ☞ *Data: Detection, p. 44.*

3 Manual. A “Manual” is a transition that you manually set and entered into event table.

4 Unresolved. A “Unresolved” is an unresolved transition detected by TAC and entered into event table.

**Pre-amplitude** The absolute current level before the event. ☞ *Event Amplitude, p. 16.*

**Post-amplitude** The absolute current level following the event. ☞ *Event Amplitude, p. 16.*

**Level** The event level number following the event. ☞ *Event Level Number, p. 16.*

**Tag Value** A tag value associated with the event. This value is never set by TAC. It can be set using another program such as a spreadsheet. The value can then be used to aid analysis.

### 4.3.2 Scrolling

You can scroll the Events window using the vertical scroll bar of the window.

## 4.4 Histogram

The Histogram window displays a histogram of the filtered raw data of the current sweep. The format and scaling of the display are controlled by the Histogram menu. ☞ *Current Sweep, p. 60.* ☞ *Figure 74.*

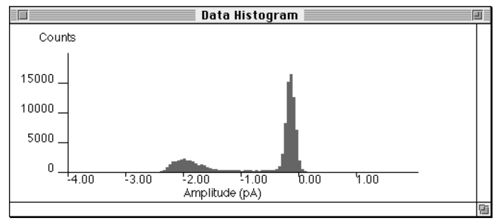



Figure 74 Histogram window

You can control the colors of the individual window elements using the Histogram: Colors menu item. ☞ *Histogram: Colors, p. 53.*

### 4.4.1 Axes

The horizontal axis of the histogram is labeled with the mean current flow of the histogram bins. The vertical axis is labeled in counts, that is, the number of data points in a bin.

The scaling of the axes is established by the Histogram: Scaling menu item. ☞ *Histogram: Scaling, p. 49.*

### 4.4.2 Histogram

The histogram is computed from the filtered data of the current sweep. The value of each histogram bin is the number of data points in the bin. The histogram bins excluded by Histogram: Filter are always zero. ☞ *Histogram: Filter, p. 52.*

### 4.4.3 Fit

The graph optionally displays a curve showing a theoretical fit to the histogram. The theoretical curve is a sum of gaussian functions. ☞ *Data Histogram, p. 13.* ☞ *Figure 75.*

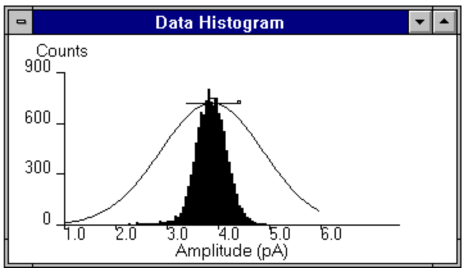



Figure 75 Histogram window with theoretical fit curve

#### Displaying the Fit

If the histogram does not contain a fit curve, you can bring up a fit curve either by:

1 double-clicking in the histogram window.

2 bringing up the Histogram Fit window. ☞ *Histogram: Manual Fit, p. 53.*

If the histogram contains a fit curve, you can remove it by closing the Histogram Fit window. ☞ *Histogram Fit, p. 63.*

You can choose to display individual components of the theoretical curve, the sum, or both. ☞ *Histogram: Style, p. 50.*

#### Control Points

The fit curve has control points displayed as large empty squares. Each large square displays a horizontal line connected to a smaller empty square. The pair represents a term of the fit.

#### Changing Parameters

Each term has three parameters:

1 The amplitude value, $A$ in the equation, specified by the $x$ coordinate of the larger square. Move the square horizontally with the mouse to change the amplitude value.

2 The weight assigned to the component, $d$ in the equation, specified by the $y$ coordinate of the larger square. Move the square vertically with the mouse to change the assigned weight.

3 The standard deviation of the component, $\sigma$ in the equation, specified by the horizontal distance of the smaller square from the larger square. Move the smaller square horizontally with the mouse to change the standard deviation.

The smaller square is easy to see if a term has a large standard deviation. ☞ *Figure 76.*

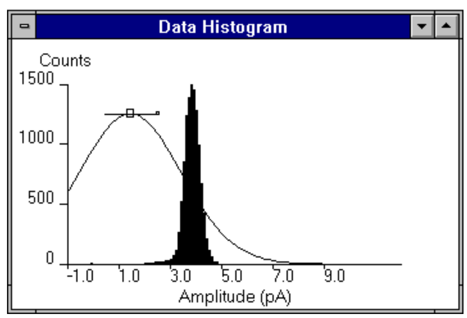



Figure 76 Histogram window with theoretical curve, showing control points

### Adding and Removing Terms

To add a new term, double-click on the histogram x axis. A new term will appear at the selected position.

To remove an existing term, double-click on the larger square for that term. The term will disappear.

## 4.5 Histogram Fit

The Histogram Fit window displays the parameters of the theoretical curve displayed in the Histogram window. ☞ *Figure 77.*

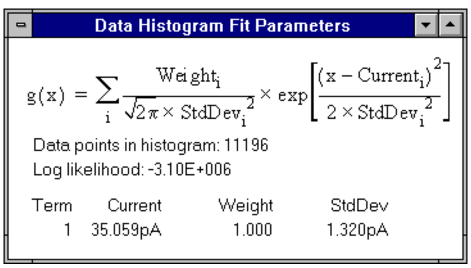



Figure 77 Histogram Fit window

Whenever the window is displayed, the theoretical curve is also displayed in the Histogram window. When the window is closed, the theoretical curve is removed from the Histogram window.

The window displays the parameters of each term of the theoretical fit. One row of parameters is displayed for each term of the fit. The row contains the current amplitude, the weight, and the standard deviation of the term.

The Histogram Fit window has no menu of its own, and can be affected only through the menu of the Histogram window.

# 5 TACFit Menu

| Section | |
|---|---|


## 5.1 File

The File menu contains all operations that have to do with file reading and writing. Some menu items are enabled only when an event file is open, and others are enabled only if no event file is open. ☞ *Figure 78.*

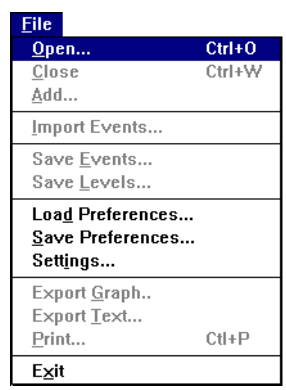



Figure 78 File menu

### 5.1.1 File: Open

File: Open displays the standard file open dialog. ☞ *Figure 79.*

Select the event file to read. The file must be in the standard event file format produced by TAC. ☞ *Event File, p. 121.* After TACFit reads the file, it displays the Event and Level windows. ☞ *Event, p. 102.* ☞ *Level, p. 103.*

The file is assigned file number one. Events read from the file are tagged with the file number.

File: Open is enabled only if no event file is open.

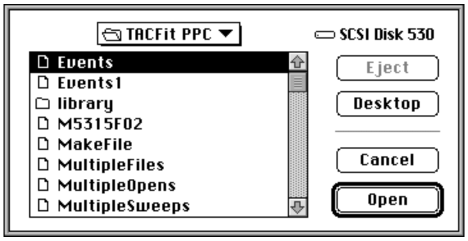



Figure 79 File: Open dialog

### 5.1.2 File: Close

File: Close discards all events in the event table.

File: Close is enabled only if the event table is not empty.

### 5.1.3 File: Add

File: Add displays the standard file selection dialog. ☞ *Figure 80.*

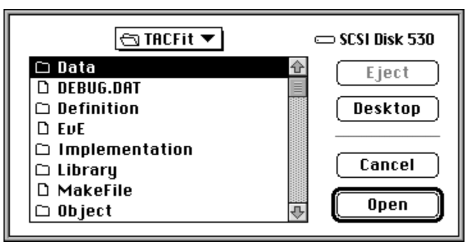



Figure 80 File: Add dialog

Select the event file to read. The file must be in the standard event file format produced by TAC. ☞ *Event File, p. 121.* The events in the file will be appended to the event table.

The file is assigned a sequential number. The file number of a file read using File: Add is at least two. Events read from the file are tagged with the file number.

File: Add is enabled only if at least one event file is open.

### 5.1.4 File: Import Events

File: Import Events displays the standard file selection dialog. ☞ *Figure 81.*

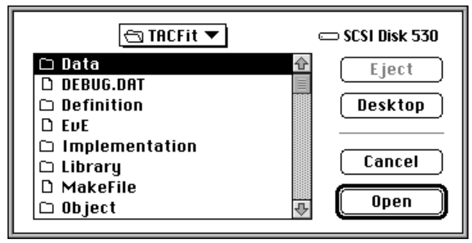



Figure 81 File: Import Events dialog

Select the file containing events to import. The file format is different from the standard event file format produced by TAC. It contains only events, no files and sweeps. ☞ *Event File, p. 121.*

TACFit replaces the events with the new ones.

File: Import Events is enabled when at least one event file is open.

### 5.1.5 File: Save Events

File: Save Events writes the events to a file in the standard event file format produced by TAC. This file can be read back into TAC or TACFit. ☞ *Event File, p. 121.*

When you select File: Save Events, the standard file save dialog appears. ☞ *Figure 82.*

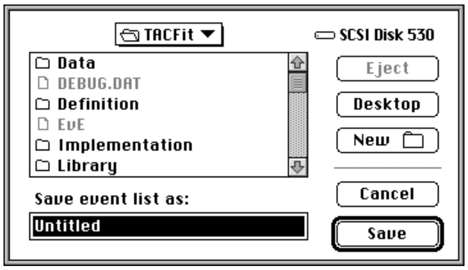



Figure 82 File: Save Events dialog

Specify a file. The events will be written into the file.

If you used File: Add to read event tables into TACFit, TAC cannot read the file produced by File: Save Events. ☞ *File: Add, p. 66.*

File: Save Events is enabled when at least one event file is open.

### 5.1.6 File: Save Levels

File: Save Levels writes the current levels table to a file. The file has the format of the standard event file, so it can be read back into TAC or TACFit.

When you select File: Save Levels, the standard file save dialog appears. ☞ *Figure 83.*

Specify a file. The levels will be written into the file.

If you used File: Add to read events into TACFit, TAC cannot read the file produced by File: Save Levels. ☞ *File: Add, p. 66.*

When the levels are written, all levels are included, regardless of whether or not they are selected. The levels

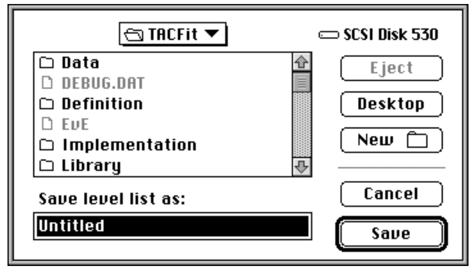



Figure 83 File: Save Levels dialog

have bursts, as specified by Settings: Events, replaced with single levels. ☞ *Settings: Events, p. 72.*

File: Save Levels is enabled when at least one event file is open.

### 5.1.7 File: Load Preferences

File: Load Preferences reads the program settings from a file. This file must have been created by the current version of TACFit. ☞ *File: Save Preferences, p. 68.*

When you select File: Load Preferences, the standard file selection dialog appears. ☞ *Figure 84.*

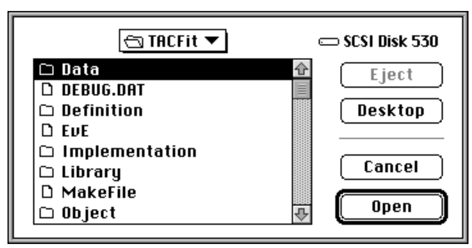



Figure 84 File: Load Preferences dialog

Select a file. The program settings will be read from the file. ☞ *Preferences File, p. 122.*

File: Load Preferences is enabled only if the event table is empty.

### 5.1.8 File: Save Preferences

File: Save Preferences writes the current program settings into a file. This file can be read back into the program. ☞ *File: Load Preferences, p. 67.*

When you select File: Save Preferences the standard file save dialog appears. ☞ *Figure 85.*

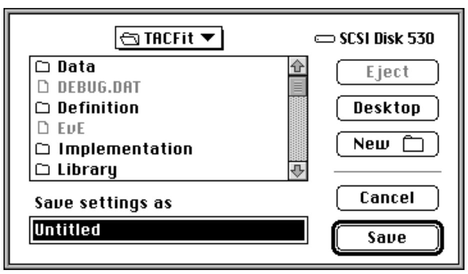



Figure 85 File: Save Preferences dialog

Specify a file. The current preferences will be written into this file. ☞ *Preferences File, p. 122.*

File: Save Preferences is always enabled.

### 5.1.9 File: Settings

File: Settings allows you to control the basic settings of the program.

When you select File: Settings, a dialog appears. This dialog also appears automatically when the program starts, unless specifically suppressed using "Do not show this dialog on startup". ☞ *Figure 86.*

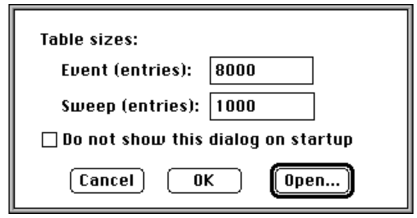



Figure 86 File: Settings dialog

#### Table sizes

**Event** The maximum number of events that can be stored in the event table.

**Sweep** The maximum number of sweeps that can be stored in the sweep table.

#### Other

**Do not show this dialog on startup** If this box is not checked, the File: Settings dialog will appear each time the program is started. If you do not want to make changes to the settings when you start the program, check this box, and the dialog will not be shown when the program starts.

**Cancel** Close the dialog, making no changes to the parameters.

**OK** Update the parameters and close the dialog.

**Open** Update the parameters and close the dialog (as for OK). Then bring up the File: Open dialog. ☞ *File: Open, p. 65.*

File: Settings is enabled only if the event table is empty.

### 5.1.10 File: Export Graph

File: Export Graph writes the data in the active window as graphic file. When you select File: Export Graph, a dialog appears. ☞ *Figure 87.*

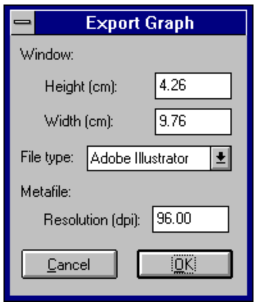



Figure 87 File: Export Graph dialog

By default, the dimensions of the exported graph are the same as those of the active window. For example, if the active window is 15cm wide by 10cm high, the default dimensions of the exported graph will be 15cm by 10cm. You can explicitly override the default size using the *Height* and *Width* entries.

**Window**

**Height** The height of the exported graph.

**Width** The width of the exported graph.

**File Type**

**File type** The format of the exported graph.☞ *Figure 88.*

The supported formats are:

1 Adobe Illustrator. ☞ *Adobe Illustrator (AI), p. 114.*


Figure 88 File: Export Graph file type

2 Clipboard. ☞ *Clipboard, p. 115.*

3 EPS. ☞ *EPS, p. 115.*

4 PICT (Macintosh). ☞ *PICT, p. 116.*

5 Metafile (Microsoft Windows). ☞ *Windows Metafile, p. 117.*

Clipboard export is the same as PICT or metafile export, except that the graph is stored in the clipboard instead of as a file. ☞ *Graphic Export, p. 114.*

**Metafile**

**Resolution** The resolution of the output graph in dots per inch. This applies only to Windows metafile format.

**Other**

**Cancel** Close the dialog without exporting and without updating any parameters.

**OK** Export the graph and close the dialog. Unless clipboard export is selected, a standard file save dialog appears. Specify a file to use for the graph. The graph will be written into the file.

File: Export Graph is enabled whenever the program has an active window. It is never enabled if no data file is open.

### 5.1.11 File: Export Text

File: Export Text writes the data in the active window as a text file. For a description of the data exported, see the description of each window. ☞ *Text Export, p. 117.*

When you select File: Export Text, a dialog appears. ☞ *Figure 89.*


Figure 89  File: Export Text dialog

**File type**  Select the format of the text file to write. The available formats are *Excel* and *IGOR*. ☞ *Text Export, p. 117.*

**Limit to window**  If this box is checked, only the data currently displayed in the active window is exported. If this box is not checked, all data of the same type as the active window is exported. For example, if the active window is the levels window, the entire list of levels is exported.

**Cancel**  Close the dialog without exporting data and without updating any parameters.

**OK**  Export the data and close the dialog. A standard file save dialog appears. Specify a file to use for export. The data will be written into the file.

File: Export Text is enabled whenever the program has an active window. It is never enabled if no data file is open.

### 5.1.12 File: Print

File: Print prints the active window. The printed window has the same dimensions as the active window.

The dialog displayed depends on the printer currently selected. The dialogs shown are for a Hewlett-Packard LaserJet 4M printer. ☞ *Figure 90.* ☞ *Figure 91.*

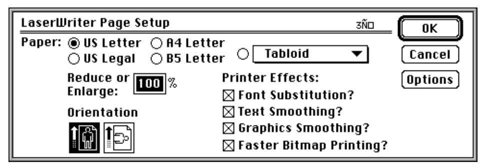



Figure 90  File: Print page setup dialog for an HP LaserJet 4M

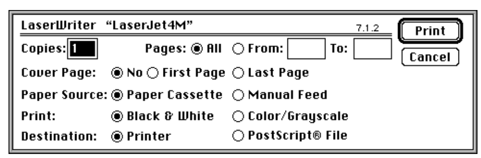



Figure 91  File: Print dialog for an HP LaserJet 4M

The results you obtain from printing will depend on your printer and your printer driver.

File: Print is enabled whenever the program has an active window. It is never enabled if no data file is open.

### 5.1.13 File: Quit

File: Quit exits from TACFit.

The current TACFit settings are written into the default preferences file. When TACFit is next started, the settings will be restored. ☞ *Preferences File, p. 122.*

File: Quit is always enabled.

### 5.1.14 File: Exit

File: Exit exits from TACFit.

The current TACFit settings are written into the default preferences file. When TACFit is next started, the settings will be restored. ☞ *Preferences File, p. 122.*

File: Exit is always enabled.

## 5.2 Edit

The Edit menu contains operations that have to do with the clipboard. The menu is displayed only on the Macintosh. ☞ *Figure 92.*

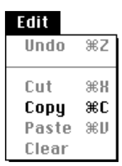



Figure 92 Edit menu

### 5.2.1 Edit: Undo

Edit: Undo is never enabled.

### 5.2.2 Edit: Cut

Edit: Cut is enabled only when a dialog is active. It moves the current selection to the clipboard.

Edit: Cut cannot be used on any TACFit window.

### 5.2.3 Edit: Copy

When a dialog is active, Edit: Copy copies the current selection to the clipboard.

When a TACFit window is active, Edit: Copy copies the graphic image of the active window to the clipboard. Selecting Edit: Copy is equivalent to using File: Export Graph and selecting the clipboard as the export target. ☞ *File: Export Graph, p. 69.*

### 5.2.4 Edit: Paste

Edit: Paste is enabled only when a dialog is active. It copies the contents of the clipboard to the current cursor position.

Edit: Paste cannot be used on any TACFit window.

### 5.2.5 Edit: Clear

Edit: Clear is never enabled.

## 5.3 Settings

The Settings menu allows you to control how TACFit processes levels. ☞ *Figure 93.*


Figure 93 Settings menu

## 5.3.1 Settings: Events

The Settings: Events dialog allows you to control how events are translated to levels. ☞ *Figure 94.*

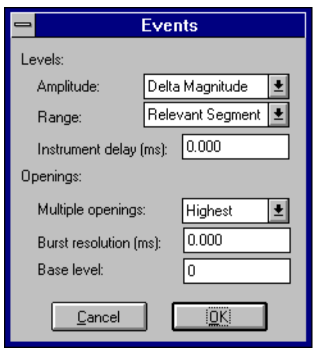



Figure 94 Settings: Events dialog

### Levels

**Amplitude** This entry specifies how the amplitude of a level is to be calculated. ☞ *Figure 95.* ☞ *Events to Levels, p. 19.*

The supported methods are:

1 Absolute. The amplitude of a level is the post-amplitude of the event that begins the level. For example, if the pre-amplitude of the event that begins the level is 0.2pA, and the post-amplitude -1.3pA, the amplitude of the level is -1.3pA. ☞ *Figure 96.*

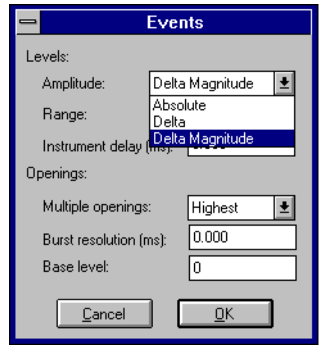



Figure 95 Settings: Events amplitude selections

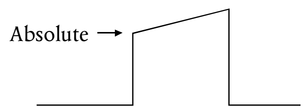



Figure 96 Absolute amplitude

2 Delta. The amplitude of a level is the change from the pre-amplitude to the post-amplitude of the event that begins the level. For example, if the pre-amplitude of the event that begins the level is 0.2pA, and the post-amplitude -1.3pA, the amplitude of the level is -1.5pA. ☞ *Figure 97.*

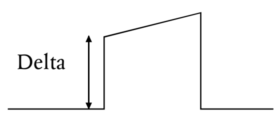



Figure 97 Delta amplitude

3 Delta Magnitude. The amplitude of a level is the absolute value of the change from the pre-amplitude to the post-amplitude of the event that begins the level. For example, if the pre-amplitude of the event that begins the level is 0.2pA, and the post-amplitude -1.3pA, the amplitude of the level is 1.5pA.

**Range** This entry specifies what events are to be converted to levels. ☞ *Figure 98.*

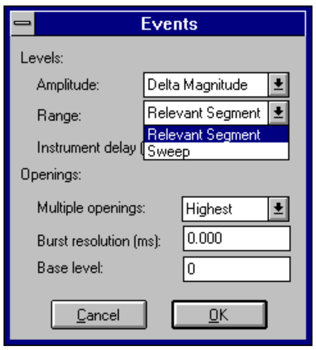



Figure 98 Settings: Events range selections

The supported selections are:

1 Relevant Segment. Convert only events within the relevant segment to levels. This is the most common setting for analysis of pulsed data.

2 Sweep. Convert all events within each sweep to levels. This is the most common setting for analysis of continuous data.

If you changed the relevant segment position during event detection in TAC, you may find that the relevant segment is only a portion of the sweep.

**Instrument delay** The delay between stimulus and response in the instrumentation. The duration of the first level of each sweep is corrected by subtracting this value. The instrument delay can be left at zero for continuous data analysis. It is needed only for first latency analysis on pulsed data files.

## Openings

**Multiple openings** This entry specifies how multiple openings are translated to levels. ☞ *Figure 99.* ☞ *Multiple Openings, p. 21.*

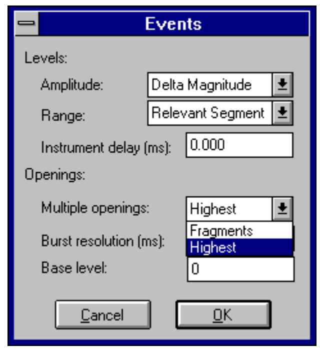



Figure 99 Settings: Events

The supported methods are:

1 Fragments. Multiple openings are treated the same as other events, with the effect that the openings are broken into fragments. That is, each interval from one event to the next is treated as a level. For example, if the base level is 0, and a sequence of events makes the transitions 0, 1, 2, 1, 2, 1, 0, six levels will result, one for each of the six intervals: 0 to 1, 1 to 2, 2 to 1, 1 to 2, 2 to 1, and 1 to 0. ☞ *Figure 100.*

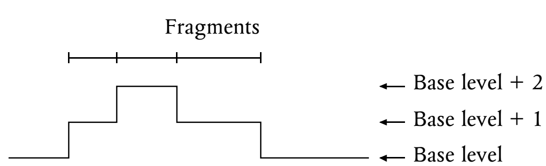



Figure 100 Multiple openings set to “Fragments”

2 Highest. Sequences of events containing multiple openings are translated to a single level. The level number is the greatest level number in the sequence. For example, if the base level is 0, and a sequence of events makes the transitions 0, 1, 2, 1, 2, 1, 0, one level will result, with a level number of 2. ☞ *Figure 101.*

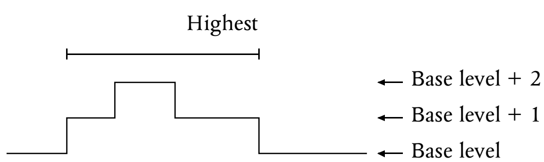



Figure 101 Multiple openings set to "Highest"

**Burst resolution** TACFit can collapse bursts into single levels. A transition towards the base level with a duration less than the burst resolution will be treated as part of the current level. For example, if the base level is zero, a transition from level one to level zero will be treated as part of the current level if the next transition is a transition back to level one and occurs within the burst resolution. ☞ *Burst Resolution, p. 20.*

**Base level** The level number to interpret as the baseline. This is normally zero.

### Other

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog. If you have made any changes, TACFit will recalculate the list of levels and the histogram.

## 5.3.2 Settings: Reset

Reset the filter settings. After resetting, all entries in the levels table are selected except first and last levels in a sweep. All filter dialogs are updated as shown in table 6.

Table 6 Dialogs updated by Settings: Reset

| Dialog | Reference |
|---|---|
| Settings: Sweep | ☞ *Settings: Sweep, p. 74.* |
| Settings: Level | ☞ *Settings: Level, p. 75.* |
| Settings: Preceding | ☞ *Settings: Preceding, p. 77.* |
| Settings: Following | ☞ *Settings: Following, p. 77.* |

## 5.3.3 Settings: Sweep

Settings: Sweep allows you to select sweeps for processing. ☞ *Figure 102.*

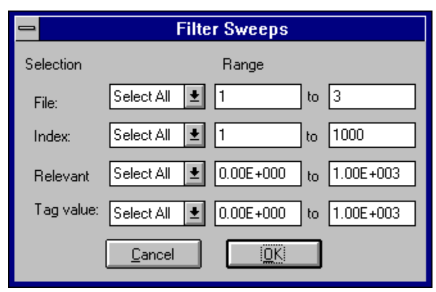



Figure 102 Settings: Sweep dialog

The dialog includes a set of criteria. A sweep must satisfy all criteria to be selected for processing. Levels in sweeps not selected are ignored.

### Criteria

The criteria in the dialog are:

**File** The file numbers to select. As each file is imported using File: Add, it is sequentially assigned a file number. ☞ *File: Add, p. 66.*

**Index** The sweep number within the file.

**Relevant value** The relevant values to select. The relevant value associated with a sweep is usually defined by the file type.

**Tag value** The tag values to select. The tag value associated with a sweep must be assigned by a program such as Microsoft Excel. Neither TAC nor TACFit assign tag values.

### Selection

Each criterion has a condition and an associated range. ☞ *Figure 103.*

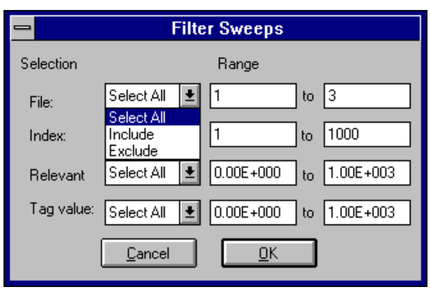



Figure 103 Settings: Sweep dialog selection conditions

The conditions are:

1 Select all. Ignore the range, selecting all sweeps by this criteria.

2 Include. Select only sweeps with associated values in the range. For example, if a file range of 1 to 3 is specified, only sweeps in the first three files are accepted.

3 Exclude. Select all sweeps except those with associated values in the range. For example, if a file range of 1 to 3 is specified, only sweeps in files following the first three files are accepted.

### Other

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog. If you have made any changes, TACFit will refilter the list of levels and recalculate graphs.

## 5.3.4 Settings: Level

The Settings: Level dialog allows you to select which levels are processed. ☞ *Figure 104.*

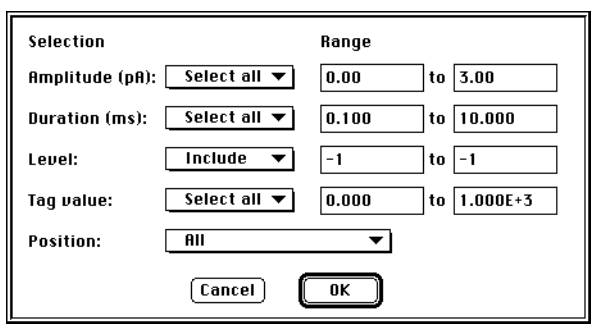



Figure 104 Settings: Level dialog

The dialog includes a set of criteria. A level must satisfy all criteria to be selected for processing. Levels not selected are ignored.

### Criteria

A level must satisfy all specified criteria to be processed. The criteria in the dialog are:

**Amplitude** Selects levels by amplitude. If you filter levels based on amplitude, any excluded amplitude range will not be considered in the further analysis.

**Duration** Selects levels by duration. If you filter levels based on duration, any excluded duration range will not be considered in the further analysis.

**Level** Selects levels by level number.

**Tag value** Selects levels by tag value. This is the tag value associated with the level, not the tag value associated with the sweep. To select levels by sweep tag value, use Settings: Sweep. ☞ *Settings: Sweep, p. 74.*

**Position** Selects levels by position in the sweep.

### Selection

For each criterion except position, the dialog allows the same range selections. ☞ *Figure 105.*

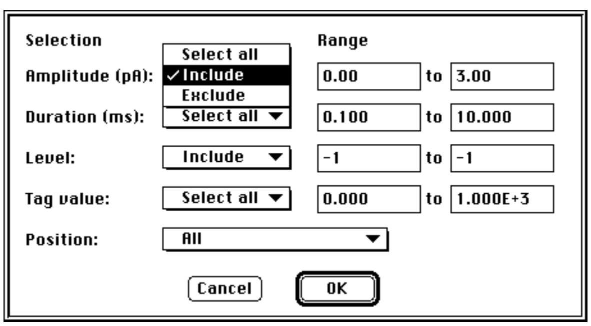



Figure 105 Settings: Level dialog selection conditions

The selections are:

1 Select all. Do not filter levels by this attribute.

2 Include. Select only those levels that are within the specified range.

3 Exclude. Select only those levels that are outside the specified range.

For example, if you include only durations between 1 and 3ms, levels with durations shorter than 1ms or longer than 3ms will be not appear in any histogram.

### Position

For position, the selections are different than for other criteria. ☞ *Figure 106.*

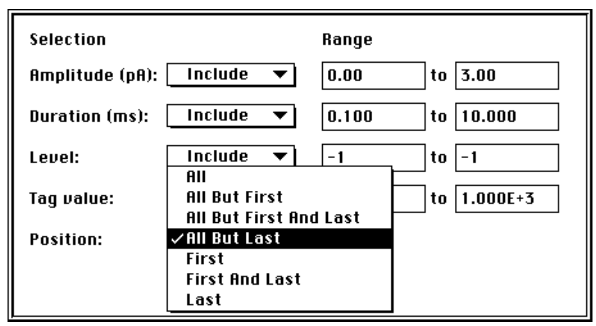



Figure 106 Settings: Level dialog position selections

For position, the selections are:

1 All. Select all levels, regardless of position in the sweep.

2 All But First. Select all levels, except the first level in the sweep.

3 All But First And Last. Select all levels, except the first and last levels in the sweep.

4 All But Last. Select all levels, except the last level in the sweep.

5 First. Select only the first level in a sweep.

6 First And Last. Select the first and last levels in a sweep, excluding all others.

7 Last. Select the last level in a sweep, excluding all others.

The first level in a sweep describes the interval between the start of the relevant segment and the first event in the sweep. The last level in a sweep describes the interval between the last event in the sweep and the end of the relevant segment.

For continuous data analysis, the usual selection is “All But First And Last”. For pulsed data analysis, the usual selection is “All But First And Last” except when doing first-latency analysis, when “First” is the usual selection. Settings: Reset selects “All But First and Last”.

**Other**

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog. If you have made any changes, TACFit will refilter the list of levels and recalculate the histogram.

### 5.3.5 Settings: Preceding

The Settings: Preceding dialog allows you to select which levels are processed. ☞ *Figure 107.*

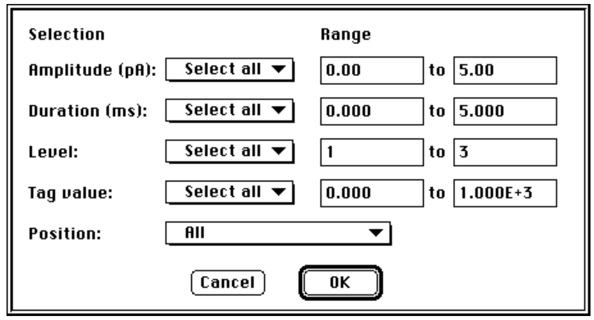



Figure 107 Settings: Preceding dialog

The dialog includes a set of criteria that are applied to the level preceding a given level. If the preceding level meets all the specified criteria, the current level is selected. If the preceding level fails to meet one or more of the criteria, the current level is not selected.

As an example, suppose you want to accept only those levels that are preceded by a level 0 interval with a duration exceeding 10ms:

1 Set the “Duration” criterion to “Exclude” and the corresponding “Range” to “0 to 10”. This selects only intervals exceeding 10ms.

2 Set the “Level” criterion to “Include” and the corresponding “Range” to “0 to 0”. This selects only level “0”.

3 Set all other criteria to “Select All”.

The criteria in the dialog are identical to those for the Settings: Level dialog. ☞ *Settings: Level, p. 75.*

### 5.3.6 Settings: Following

The Settings: Following dialog allows you to select which levels are processed. ☞ *Figure 108.*

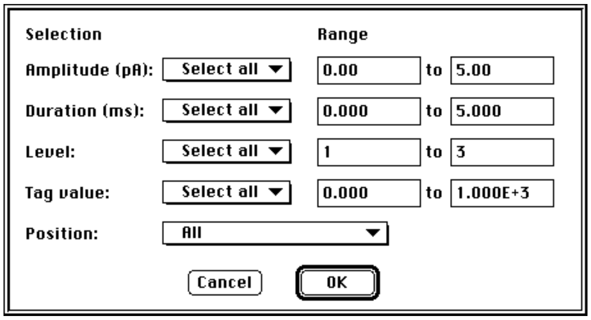



Figure 108 Settings: Following dialog

The dialog includes a set of criteria that are applied to the level following a given level. If the following level meets all the specified criteria, the current level is selected. If the following level fails to meet one or more of the criteria, the current level is not selected.

As an example, suppose you want to accept only those levels that are followed by a level 0 interval with a duration of 0.1ms or less at the end of a sweep:

1 Set the “Duration” criterion to “Include” and the corresponding “Range” to “0 to 0.1”. This selects only intervals of 0.1ms or less.

2 Set the “Level” criterion to “Include” and the corresponding “Range” to “0 to 0”. This selects only level “0”.

3 Set the “Position” criterion to “Last”.

4 Set all other criteria to “Select All”.

The criteria in the dialog are identical to those for the Settings: Level dialog. ☞ *Settings: Level, p. 75.*

## 5.4 View

The View menu allows you to choose the active window. ☞ *Figure 109.*

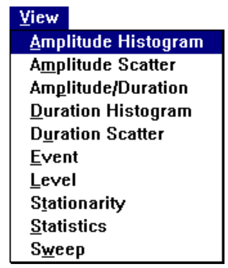



Figure 109 View menu

If you select a window that is not currently displayed, the window will be created.

### 5.4.1 View: Amplitude Histogram

View: Amplitude Histogram brings up the amplitude histogram window. ☞ *Amplitude Histogram, p. 97.*

### 5.4.2 View: Amplitude Scatter

View: Amplitude Scatter brings up the amplitude scatter plot window. ☞ *Amplitude Scatter, p. 99.*

### 5.4.3 View: Amplitude/Duration

View: Amplitude/Duration brings up the amplitude-duration scatter plot window. ☞ *Amplitude/Duration, p. 99.*

### 5.4.4 View: Duration Histogram

View: Duration Histogram brings up the duration histogram window. ☞ *Duration Histogram, p. 100.*

### 5.4.5 View: Duration Scatter

View: Duration Scatter brings up the duration scatter plot window. ☞ *Duration Scatter, p. 101.*

### 5.4.6 View: Event

View: Event brings up the event table window. ☞ *Event, p. 102.*

### 5.4.7 View: Level

View: Level brings up the level list window. ☞ *Level, p. 103.*

### 5.4.8 View: Stationarity

View: Stationarity brings up the stationarity window. ☞ *Stationarity, p. 104.*

### 5.4.9 View: Statistics

View: Statistics brings up the level statistics window. ☞ *Statistics, p. 104.*

### 5.4.10 View: Sweep

View: Sweep brings up the sweeps window. ☞ *Sweep, p. 105.*

## 5.5 Amplitude Histogram

The Amplitude Histogram menu allows you to control the amplitude histogram window. ☞ *Figure 110.*


Figure 110 Amplitude Histogram menu

### 5.5.1 Amplitude Histogram: Scaling

The Amplitude Histogram: Scaling dialog controls the scaling of the amplitude histogram. ☞ *Figure 110.*

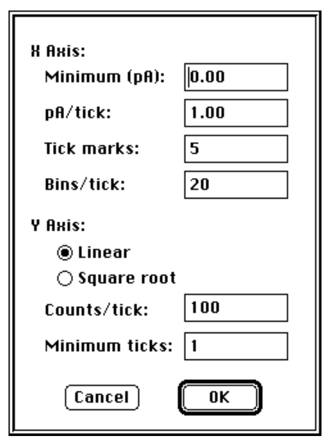



Figure 111 Amplitude Histogram: Scaling dialog

### X Axis

**Minimum value** The minimum amplitude value to display in the histogram. Any levels less than the minimum value will not be included in the histogram.

**pA/tick** The amplitude range expressed by each *x* axis tick mark.

**Tick marks** The number of tick marks to display across the x axis of the histogram. For example, if the number of tick marks is 7 and the pA/tick is 2, the histogram will have a total range of 14pA.

**Bins/tick** The resolution of the histogram, expressed as a number of histogram bins per tick mark. For example, if the pA/tick is 2 and the bins/tick is 10, each bin corresponds to 0.2pA.

### Y Axis

**Linear** Display the Y axis using linear scaling.

**Square root** Display the Y axis using square root scaling. A square root ordinate yields a graph in which the height of one standard deviation is independent of the number of entries in a histogram bin.

**Counts/tick** The number of levels counted per vertical tick mark. For example, if the counts/tick is 500 and a histogram counts 1200 levels, the histogram will display a vertical bar 2.4 tick spacings high.

**Minimum ticks** The minimum number of vertical tick marks to display. For example, if the counts/tick is 500 and the minimum ticks is set to two, the histogram will display two vertical divisions if no bin contains more than 1000 counts. If a bin contains 1200 counts, the histogram will display at least three vertical divisions.

### Other

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

## 5.5.2 Amplitude Histogram: Style

The Amplitude Histogram: Style dialog controls the manner in which the histogram is drawn. ☞ *Figure 112.*

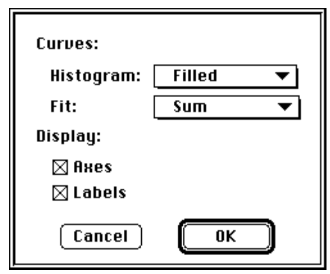



Figure 112 Amplitude Histogram: Style dialog

### Curves

**Histogram** Select the style used to draw the histogram itself. ☞ *Figure 113.*

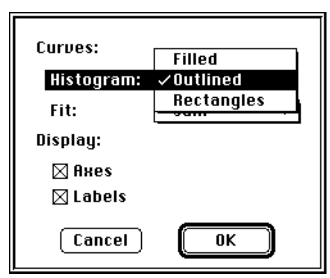



Figure 113 Amplitude Histogram: Style histogram style

The choices are:

1 Filled. The area between the x axis and the histogram curve is shown in the histogram color.

2 Outlined. Only the histogram curve itself is drawn, in the histogram color.

3 Rectangles. Each histogram bin is drawn as a separate unfilled rectangle.

**Fit** Select the style used to draw the fit curve(s). ☞ *Figure 114.*

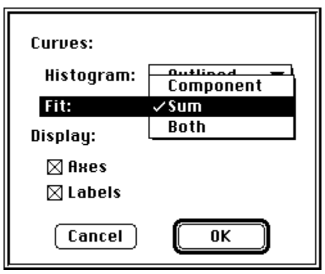



Figure 114 Amplitude Histogram: Style fit curve

The choices are:

1 Component. Display each fit component as a separate curve.

2 Sum. Display the sum of the fit component curves as a single curve.

3 Both. Display both the individual fit component curves and the sum curve.

**Display**

**Axes** If this box is checked, display x and y axes on the histogram.

**Labels** If this box is checked, display x and y axis labels.

**Other**

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

### 5.5.3 Amplitude Histogram: Settings

The Amplitude Histogram: Settings dialog controls the parameters used in automatic fitting of the amplitude histogram. ☞ *Fitting, p. 24.* ☞ *Figure 115.*

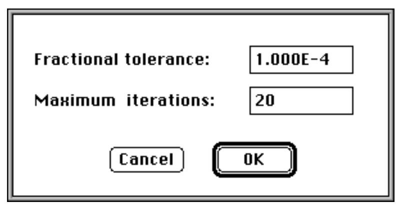



Figure 115 Amplitude Histogram: Settings dialog

**Fractional tolerance** The termination criteria for the automatic fit. The automatic fit iterates until the likelihood value changes by less than this fraction between iterations.

**Maximum iterations** The maximum number of iterations for the automatic fit. If the automatic fit does not meet the fractional tolerance criteria after this number of iterations, the automatic fit terminates with an error.

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

### 5.5.4 Amplitude Histogram: Manual Fit

Amplitude Histogram: Manual Fit brings up the amplitude fit window and begins manual fitting. ☞ *Amplitude Fit, p. 99.* ☞ *Fitting, p. 24.*

### 5.5.5 Amplitude Histogram: Automatic Fit

Amplitude Histogram: Automatic Fit causes TACFit to perform an automatic fit to the amplitude histogram. ☞ *Fitting, p. 24.*

### 5.5.6 Amplitude Histogram: Colors

Amplitude Histogram: Colors allows you to select the colors used in the amplitude histogram window. It brings up a submenu. ☞ *Figure 116.*

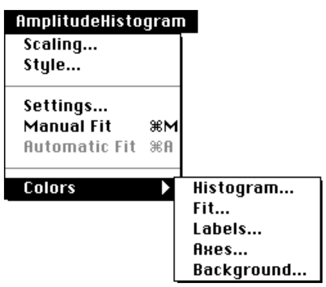



Figure 116 Amplitude Histogram: Colors submenu

When you select a submenu item, TACFit displays the standard color selection dialog. Select the color you want for the specified item. The items are:

**Histogram** The histogram itself.

**Fit** The fit curve. If the fit curve is not easily visible, alter the histogram color and fit curve color to increase the contrast between them.

**Labels** The axis labels.

**Axes** The axes themselves.

**Background** The window background.

## 5.6 Amplitude Scatter

The Amplitude Scatter menu allows you to control the amplitude scatter plot window. ☞ *Figure 117.*


Figure 117 Amplitude Scatter menu

### 5.6.1 Amplitude Scatter: Scaling

Amplitude Scatter: Scaling allows you to control the scaling of the amplitude scatter plot. ☞ *Figure 118.*

**X Axis**

**Value** The value to use for the x coordinate of each point. ☞ *Figure 119.*

The choices are:

1 Level Tag. The tag value associated with the level.

2 Sweep Relevant. The relevant value associated with the sweep containing the level.

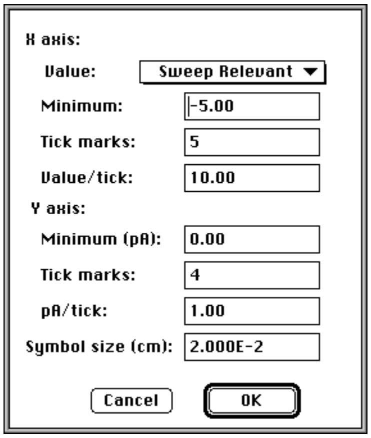



Figure 118 Amplitude Scatter: Scaling

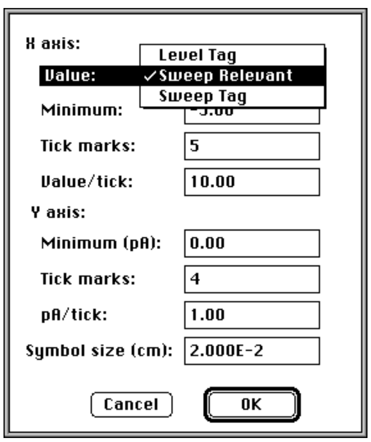



Figure 119 Amplitude Scatter: Scaling X value selection

3 Sweep Tag. The tag value associated with the sweep containing the level.

**Minimum** The minimum value on the X axis.

**Tick marks** The number of ticks on the X axis.

**Value/tick** The interval between ticks on the X axis.

### Y Axis

**Minimum** The minimum value on the Y axis.

**Tick marks** The number of ticks on the Y axis.

**pA/tick** The interval between ticks on the Y axis.

### Other

**Symbol size** The size of each plotted symbol. Each data point is plotted as a square. The symbol size is the length of one side of the square. This parameter is most important when creating graphs for publication.

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

## 5.6.2 Amplitude Scatter: Style

The Amplitude Scatter: Style dialog controls the display of the amplitude scatter plot. ☞ *Figure 120*.

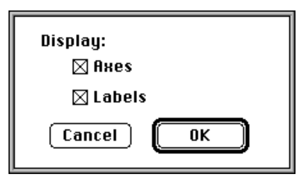



Figure 120 Amplitude Scatter: Style dialog

### Display

**Axes** If this box is checked, display X and Y axes.

**Labels** If this box is checked, display X and Y axis labels.

**Other**

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

### 5.6.3 Amplitude Scatter: Colors

Amplitude Scatter: Colors allows you to select the colors used in the amplitude scatter plot window. The menu item brings up a submenu. ☞ *Figure 121.*

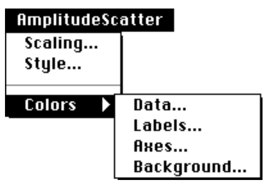



Figure 121 Amplitude Scatter: Colors submenu

When you select a submenu item, TACFit displays the standard color selection dialog. Select the color you want for the specified item. The items are:

**Data** The data points.

**Labels** The axis labels.

**Axes** The axes themselves.

**Background** The window background.

## 5.7 Amplitude/Duration

The Amplitude/Duration menu allows you to control the amplitude-duration scatter plot window. ☞ *Figure 122.*


Figure 122 Amplitude/Duration menu

### 5.7.1 Amplitude/Duration: Scaling

The Amplitude/Duration: Scaling dialog controls the scaling of the amplitude-duration scatter graph. ☞ *Figure 123.*

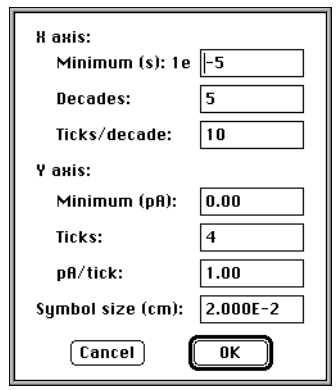



Figure 123 Amplitude/Duration: Scaling dialog

**X Axis**

**Minimum** The minimum duration value to display in the graph. Any levels of less than the minimum duration will not be included in the graph. The value is expressed as a power of ten, so -5 specifies a minimum value of $10^{-5}$ seconds, or 10µs.

**Decades** The number of decades to display across the x axis of the graph. The x axis is logarithmic, so if the minimum duration value is -5 and the number of decades is 5, the graph displays duration values from $10^{-5}$ to $10^{0}$ seconds, or 10µs to 1s.

**Ticks/decade** The number of tick marks to display on the X axis per decade.

### Y Axis

**Minimum** The minimum amplitude value to display in the graph. Any levels less than the minimum value will not be included in the graph.

**Ticks** The number of tick marks to display along the Y axis of the histogram.

**pA/tick** The amplitude range expressed by each Y axis tick mark. For example, if the number of tick marks is 4 and the pA/tick is 1, the histogram will have a total range of 4pA.

### Other

**Symbol size** Each data point is plotted as a square. The symbol size is the length of one side of the square. This parameter is most important when creating graphs for publication.

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

## 5.7.2 Amplitude/Duration: Style

Amplitude/Duration: Style controls the display of the amplitude-duration scatter graph. It brings up a dialog. ☞ *Figure 124.*

### Display

**Axes** If this box is checked, display X and Y axes.

**Labels** If this box is checked, display X and Y axis labels.

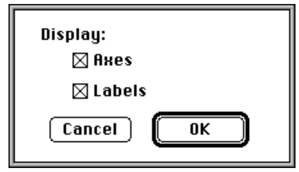



Figure 124 Amplitude/Duration: Style dialog

### Other

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

## 5.7.3 Amplitude/Duration: Colors

Amplitude/Duration: Colors allows you to select the colors used in the amplitude-duration scatter graph. It brings up a submenu. ☞ *Figure 125.*

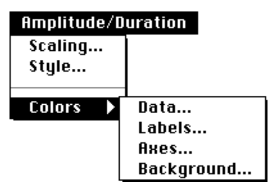



Figure 125 Amplitude/Duration: Colors submenu

When you select a submenu item, TACFit displays the standard color selection dialog. Select the color you want for the specified item. The items are:

**Data** The data points.

**Labels** The axis labels.

**Axes** The axes.

**Background** The window background.

## 5.8 Duration Histogram

The Duration Histogram menu allows you to control the duration histogram window. ☞ *Figure 126.*


Figure 126 Duration Histogram menu

### 5.8.1 Duration Histogram: Scaling

The Duration Histogram: Scaling dialog controls the scaling of the duration histogram. ☞ *Figure 127.*

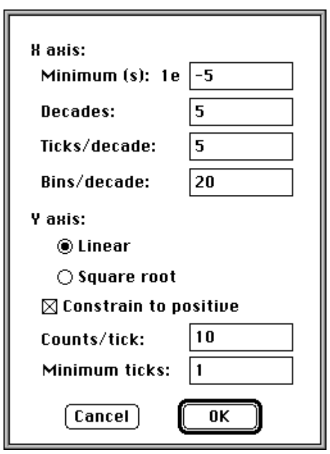



Figure 127 TACFit Duration Histogram: Scaling dialog

**X Axis**

**Minimum** The minimum duration value to display in the histogram. Any levels of less than the minimum duration will not be included in the histogram. The value is expressed as a power of ten, so -6 specifies a minimum value of $10^{-6}$ seconds, or 1µs.

**Decades** The number of decades to display across the x axis of the histogram. The x axis is logarithmic, so if the minimum duration value is -6 and the number of decades is 4, the histogram displays duration values from $10^{-6}$ to $10^{-2}$ seconds, or 1µs to 10ms.

**Ticks/decade** The number of tick marks to display on the x axis per decade.

**Bins/decade** The resolution of the histogram, expressed as a number of histogram bins per decade. The histogram uses a logarithmic x axis, so the ratio of the shortest duration to the longest duration in each bin is the same for all bins. ☞ *Duration Histogram, p. 25.*

**Y Axis**

**Linear** Display the Y axis using linear scaling.

**Square root** Display the Y axis using square root scaling. A square root ordinate yields a graph in which the height of one standard deviation is independent of the number of entries in a histogram bin.

**Constrain to positive** Allow only positive Y values. This option should not be selected when fitting first-latency histograms, as some fit components may have negative amplitudes.

**Counts/tick** The number of levels counted per vertical tick mark. For example, if the counts/tick is 200 and a histogram counts 750 levels, the histogram will display a vertical bar 3.75 tick spacings high.

**Minimum ticks** The minimum number of vertical tick marks to display. For example, if the counts/tick is 200 and the minimum ticks is set to 5, the histogram will display 5 vertical divisions if no bin contains more than 1000 counts. If a bin contains 1200 counts, the histogram will display at least 6 vertical divisions.

### Other

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

## 5.8.2 Duration Histogram: Style

The Duration Histogram: Style dialog sets the style of the duration histogram. ☞ *Figure 128*.

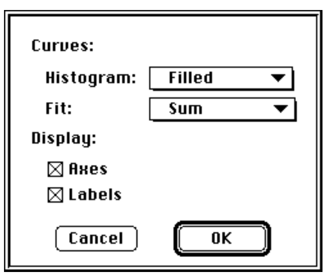



Figure 128 Duration Histogram: Style dialog

### Curves

**Histogram** Select the style used to draw the histogram itself. ☞ *Figure 129*.

The choices are:

1 Filled. The area between the x axis and the histogram curve is shown in the histogram color.

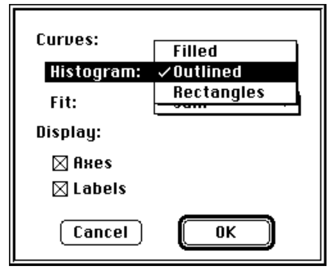



Figure 129 Duration Histogram: Style histogram style

2 Outlined. Only the histogram curve itself is drawn, in the histogram color.

3 Rectangles. Each histogram bin is drawn as a separate unfilled rectangle.

**Fit** Select the style used to draw the fit curve(s). ☞ *Figure 130*.

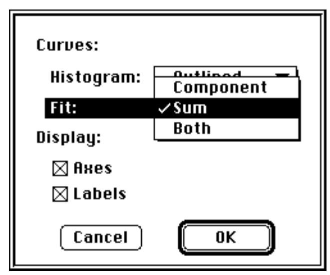



Figure 130 Duration Histogram: Style fit curve

The choices are:

1 Component. Display each fit component as a separate curve.

2 Sum. Display the sum of the fit component curves as a single curve.

3 Both. Display both the individual fit component curves and the sum curve.

### Display

**Axes** If this box is checked, display X and Y axes.

**Labels** If this box is checked, display X and Y axis labels.

### Other

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

## 5.8.3 Duration Histogram: Correction

The Duration Histogram: Correction dialog sets the parameters used to adjust level durations. ☞ *Duration Correction, p. 22.* ☞ *Figure 131.*

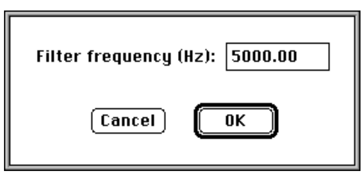



Figure 131  Duration Histogram: Correction dialog

**Filter Frequency** The corner frequency of the low-pass filter used when acquiring and analyzing the data. This is a composite of the TAC filter frequency and the frequency response of the acquisition system. ☞ *Gaussian Filter, p. 10.*

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

## 5.8.4 Duration Histogram: Settings

The Duration Histogram: Settings dialog controls the parameters used in automatic fitting of the duration histogram. ☞ *Fitting, p. 27.* ☞ *Figure 132.*

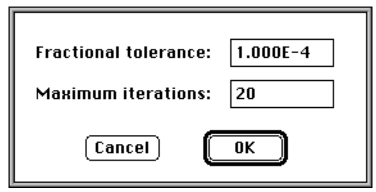



Figure 132  Duration Histogram: Settings dialog

**Fractional tolerance** The termination criteria for the automatic fit. The automatic fit iterates until the likelihood value changes by less than this fraction between iterations.

**Maximum iterations** The maximum number of iterations for the automatic fit. If the automatic fit does not meet the fractional tolerance criteria after this number of iterations, the automatic fit terminates with an error.

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

## 5.8.5 Duration Histogram: Manual Fit

Duration Histogram: Manual Fit brings up the duration fit window and begins manual fitting. ☞ *Duration Fit, p. 101.* ☞ *Fitting, p. 27.*

### 5.8.6 Duration Histogram: Automatic Fit

Duration Histogram: Automatic Fit causes TACFit to perform an automatic fit to the duration histogram. ☞ *Fitting, p. 27.*

### 5.8.7 Duration Histogram: Colors

Duration Histogram: Colors allows you to select the colors used in the duration histogram window. It brings up a submenu. ☞ *Figure 133.*


Figure 133 Duration Histogram: Colors submenu

When you select a submenu item, TACFit displays the standard color selection dialog. Select the color you want for the specified item. The items are:

**Histogram** The histogram itself.

**Fit** The fit curve. If the fit curve is not easily visible, alter the histogram color and fit curve color to increase the contrast between them.

**Labels** The axis labels.

**Axes** The axes themselves.

**Background** The window background.

## 5.9 Duration Scatter

The Duration Scatter menu allows you to control the duration scatter plot window. ☞ *Figure 134.*


Figure 134 Duration Scatter menu

### 5.9.1 Duration Scatter: Scaling

Duration Scatter: Scaling allows you to control the scaling of the duration scatter plot. ☞ *Figure 135.*

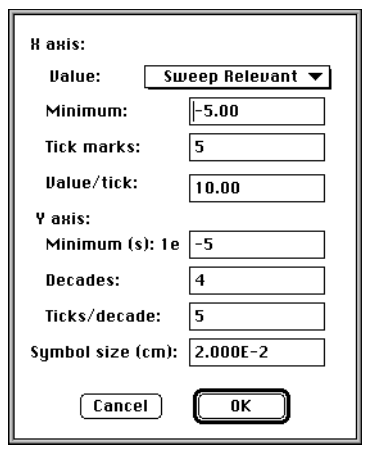



Figure 135 Duration Scatter: Scaling dialog

**X Axis**

**Value** The value to use for the x coordinate of each point. ☞ *Figure 136.*

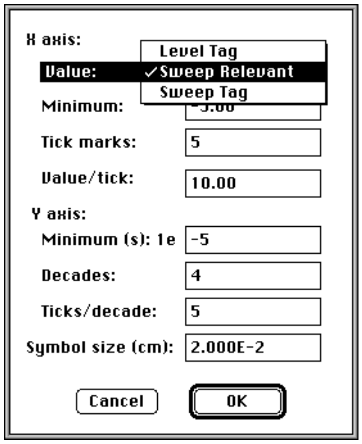



Figure 136 Duration Scatter: Scaling X value

The choices are:

1 Level Tag. The tag value associated with the level.

2 Sweep Relevant. The relevant value associated with the sweep containing the level.

3 Sweep Tag. The tag value associated with the sweep containing the level.

**Minimum** The minimum value on the X axis.

**Tick marks** The number of ticks on the X axis.

**Value/tick** The interval between ticks on the X axis.

**Y Axis**

**Minimum** The minimum value on the Y axis.

**Decades** The number of decades to display across the Y axis of the histogram. The Y axis is logarithmic, so if the minimum duration value is -6 and the number of decades is 4, the histogram displays duration values from $10^{-6}$ to $10^{-2}$ seconds, or 1µs to 10ms.

**Ticks/decade** The number of tick marks to display on the Y axis per decade.

**Other**

**Symbol size** The size of each plotted symbol. Each data point is plotted as a square. The symbol size is the length of one side of the square. This parameter is most important when creating graphs for publication.

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

## 5.9.2 Duration Scatter: Style

The Duration Scatter: Style dialog controls the display of the duration scatter graph. ☞ *Figure 137.*

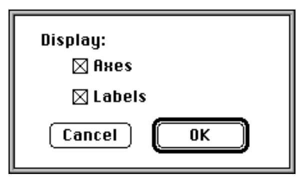



Figure 137 Duration Scatter: Style dialog

**Display**

**Axes** If this box is checked, display X and Y axes.

**Labels** If this box is checked, display X and Y axis labels.

**Other**

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

### 5.9.3 Duration Scatter: Colors

Duration Scatter: Colors allows you to select the colors used in the amplitude scatter graph window. The menu item brings up a submenu. ☞ *Figure 138.*

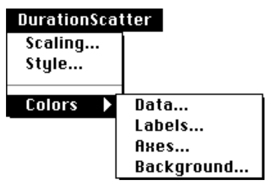



Figure 138 Amplitude Scatter: Colors submenu

When you select a submenu item, TACFit displays the standard color selection dialog. Select the color you want for the specified item. The items are:

**Data** The data.

**Labels** The axis labels.

**Axes** The axes themselves.

**Background** The graph background.

## 5.10 Event

The Event menu allows you to control the event list window. ☞ *Figure 139.*


Figure 139 Event menu

### 5.10.1 Event: Colors

Event: Colors allows you to select the colors used in the event list window. It brings up a submenu. ☞ *Figure 140.*

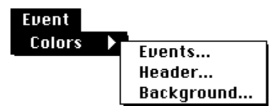



Figure 140 Event: Colors submenu

When you select a submenu item, TACFit displays the standard color selection dialog. Select the color you want for the specified item. The items are:

**Events** The rows containing events.

**Header** The column labels.

**Background** The window background.

## 5.11 Level

The Level menu allows you to control the level table window. ☞ *Figure 141.*


Figure 141 Level menu

### 5.11.1 Level: Colors

Level: Colors allows you to select the colors used in the levels table window. It brings up a submenu. ☞ *Figure 142*.

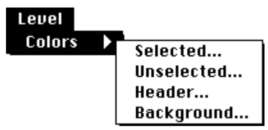



Figure 142 Level: Colors submenu

When you select a submenu item, TACFit displays the standard color selection dialog. Select the color you want for the specified item. The items are:

**Selected** The rows containing levels which are included in the histograms. ☞ *Settings, p. 71.*

**Unselected** The rows containing levels which are not included in the histograms. ☞ *Settings, p. 71.*

**Header** The column labels.

**Background** The window background.

## 5.12 Stationarity

The Stationarity menu allows you to control the Stationarity window. ☞ *Figure 143.*


Figure 143 Stationarity menu

### 5.12.1 Stationarity: Settings

Stationarity: Settings controls how the stationarity plot is calculated. ☞ *Stationarity, p. 29.* ☞ *Figure 144.*

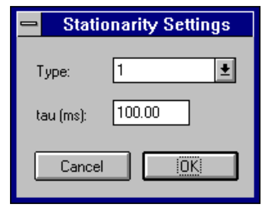



Figure 144 Stationarity: Settings dialog

**Type** The type of stationarity plot. ☞ *Figure 145.*

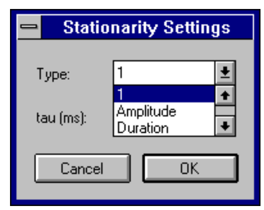



Figure 145 Stationarity: Settings type

The types include:

1 1. Each level is weighted equally. If you want to obtain the open (or close) probability versus time, select this type.

2 Amplitude. Each level is weighted by level amplitude.

3 Duration. Each level is weighted by level duration.

4 Level. Each level is weighted by level number.

**tau** The filter time constant. ☞ *Stationarity, p. 29.*

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

### 5.12.2 Stationarity: Style

Stationarity: Style controls the display of the stationarity plot. ☞ *Figure 146.*


Figure 146 Stationarity: Style dialog

**Display**

**Axes** If this box is checked, display X and Y axes.

**Labels** If this box is checked, display X and Y axis labels.

**Other**

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

### 5.12.3 Stationarity: Colors

Stationarity: Colors allows you to select the colors used in the stationarity window. It brings up a submenu. ☞ *Figure 147.*

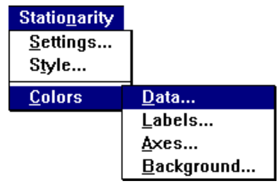



Figure 147 Stationarity: Colors submenu

When you select a submenu item, TACFit displays the standard color selection dialog. Select the color you want for the specified item. The items are:

**Data** The stationarity trace.

**Labels** The axis labels.

**Axes** The axes themselves.

**Background** The window background.

## 5.13 Statistics

The Statistics menu allows you to control the statistics window. ☞ *Figure 148.*


Figure 148 Statistics menu

### 5.13.1 Statistics: Settings

Statistics: Settings controls how the statistics are calculated. ☞ *Figure 149.*

**Reference** The probability of a level is the sum of the duration of the intervals of that level, divided by the total


Figure 149 Statistics: Settings dialog

measurement duration. The reference value specifies how the measurement duration is calculated. ☞ *Figure 150*.


Figure 150 Statistics: Settings reference

The choices are:

1 Levels. The total duration of all selected levels.

2 Relevant Segment. The duration of the relevant segment of each sweep.

3 Sweep. The entire duration of each sweep.

**Cancel** Close the dialog without updating any parameters.

**OK** Update the parameters and close the dialog.

If you select “Levels”, the sum of the probability of each level should be one. ☞ *Statistics, p. 104*.

If you select either “Relevant Segment” or “Sweep”, the sum of the probability of each level may be less than one. This occurs if some levels contained in selected sweeps are not themselves selected.

### 5.13.2 Statistics: Colors

Statistics: Colors allows you to select the colors used in the statistics window. It brings up a submenu. ☞ *Figure 151*.

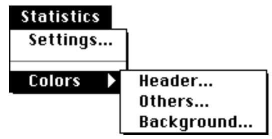



Figure 151 Statistics: Colors submenu

When you select a submenu item, TACFit displays the standard color selection dialog. Select the color you want for the specified item. The items are:

**Header** The column labels.

**Others** The text in the window.

**Background** The window background.

## 5.14 Sweep

The Sweep menu allows you to control the sweep window. ☞ *Figure 152*.


Figure 152 Sweep menu

### 5.14.1 Sweep: Colors

Sweep: Colors allows you to select the colors used in the sweeps window. It brings up a submenu. ☞ *Figure 153*.

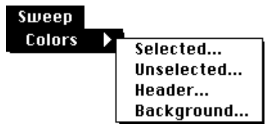



Figure 153 Sweep: Colors submenu

When you select a submenu item, TACFit displays the standard color selection dialog. Select the color you want for the specified item. The items are:

**Selected** Sweeps that are selected for processing.

**Unselected** Sweeps that are not selected for processing.

**Header** The column labels.

**Background** The window background.

# 6 TACFit Windows



## 6.1 Amplitude Histogram

The Amplitude Histogram window displays an amplitude histogram of the filtered levels. ☞ *Figure 154.*

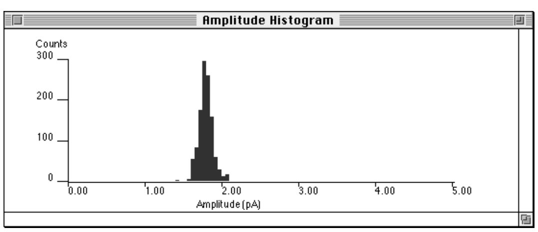



Figure 154 Amplitude Histogram window

You can control the colors of the individual window elements using the Amplitude Histogram: Colors menu item. ☞ *Amplitude Histogram: Colors, p. 82.*

### 6.1.1 Axes

The scaling of the axes is established by the Amplitude Histogram: Scaling menu item. ☞ *Amplitude Histogram: Scaling, p. 79.*

### 6.1.2 Histogram

The histogram is computed from the filtered levels. The levels selected for the histogram are displayed in the Level window. ☞ *Level, p. 103.*

### 6.1.3 Fit

The graph optionally displays a curve showing a theoretical fit to the histogram. The theoretical curve is a sum of gaussian functions. ☞ *Theoretical Curve, p. 23.* ☞ *Figure 155.*

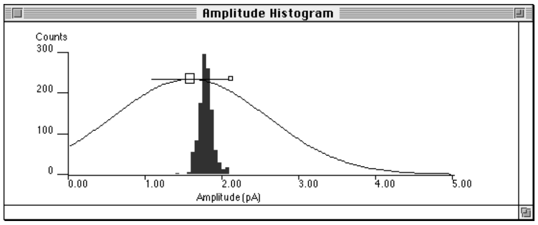



Figure 155 Amplitude Histogram window with theoretical curve

## Displaying the Fit

If the histogram does not contain a fit curve, you can bring up a fit curve either by:

1 double-clicking in the amplitude histogram window.

2 bringing up the Amplitude Fit window. ☞ *Amplitude Histogram: Manual Fit, p. 82.*

If the histogram contains a fit curve, you can remove it by closing the Amplitude Fit window. ☞ *Amplitude Fit, p. 99.*

You can choose to display individual components of the theoretical curve, the sum, or both. ☞ *Amplitude Histogram: Style, p. 80.*

## Control Points

The fit curve has control points displayed as large empty squares. Each large square displays a horizontal line connected to a smaller empty square. The pair represents a term of the fit.

## Changing Parameters

Each term has three parameters:

1 The amplitude value, *A* in the equation, specified by the *x* coordinate of the larger square. Move the square horizontally with the mouse to change the amplitude value.

2 The weight assigned to the component, *a* in the equation, specified by the *y* coordinate of the larger square. Move the square vertically with the mouse to change the assigned weight.

3 The standard deviation of the component, $\sigma$ in the equation, specified by the horizontal distance of the smaller square from the larger square. Move the smaller square horizontally with the mouse to change the standard deviation.

The smaller square is easy to see if a term has a large standard deviation. ☞ *Figure 156.*

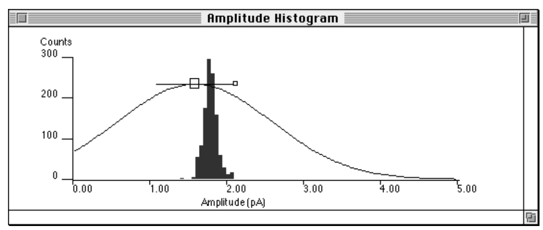



Figure 156 Amplitude Histogram window with theoretical curve, showing control points

## Adding and Removing Terms

To add a new term, double-click on the histogram x axis. A new term will appear at the selected position.

To remove an existing term, double-click on the larger square for that term. The term will disappear.

## 6.2 Amplitude Fit

The Amplitude Fit window displays the parameters of the theoretical curve displayed in the Amplitude Histogram window. ☞ *Figure 157.*

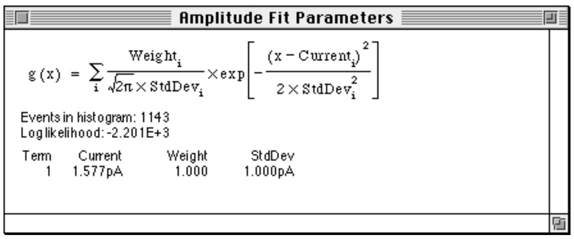



Figure 157 Amplitude Fit window

Whenever the window is displayed, the theoretical curve is also displayed in the Amplitude Histogram window. When the window is closed, the theoretical curve is removed from the Amplitude Histogram window.

The window displays the parameters of each term of the theoretical fit. One row of parameters is displayed for each term of the fit. The row contains the current amplitude, the weight, and the standard deviation of the term. ☞ *Theoretical Curve, p. 23.*

The Amplitude Fit window has no menu of its own, and can be affected only through the menu of the Amplitude Histogram window. ☞ *Amplitude Histogram, p. 79.*

## 6.3 Amplitude Scatter

The Amplitude Scatter window displays a scatter plot of a selected value against level amplitudes. ☞ *Figure 158.*

You can control the colors of the individual window elements using the Amplitude Scatter: Colors menu item. ☞ *Amplitude Scatter: Colors, p. 84.*

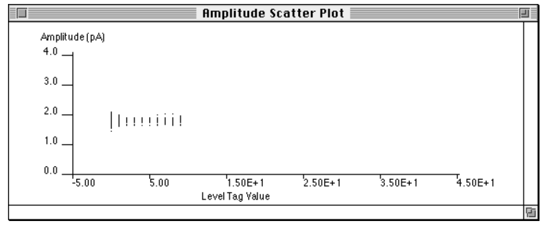



Figure 158 Amplitude Scatter window

### 6.3.1 Axes

The value used for the x axis is established by the Amplitude Scatter: Scaling menu item. The same menu item also establishes the scaling of the axes. ☞ *Amplitude Scatter: Scaling, p. 82.*

### 6.3.2 Data

The graph is prepared from the filtered levels. The levels selected for the graph are displayed in the Level window. ☞ *Level, p. 103.*

## 6.4 Amplitude/Duration

The Amplitude/Duration window displays an amplitude-duration scatter plot of the filtered levels. ☞ *Figure 159.*

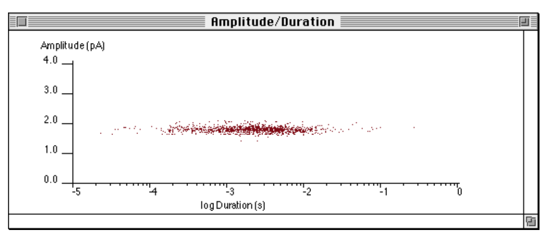



Figure 159 Amplitude/Duration window

You can control the colors of the individual window elements using the Amplitude/Duration: Colors menu item. ☞ *Amplitude/Duration: Colors, p. 85.*

The scaling of the axes is established by the Amplitude/Duration: Scaling menu item. ☞ *Amplitude/Duration: Scaling, p. 84.*

Each data point is a filtered level. The levels selected for the graph are displayed in the Level window. ☞ *Level, p. 103.* The plotted size of each data point is established by the Amplitude/Duration: Scaling menu item. ☞ *Amplitude/Duration: Scaling, p. 84.*

## 6.5 Duration Histogram

The Duration Histogram window displays a duration histogram of the filtered levels. ☞ *Figure 160.*

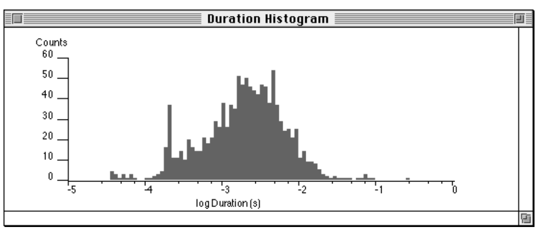



Figure 160 Duration Histogram window

You can control the colors of the individual window elements using the Duration Histogram: Colors menu item. ☞ *Duration Histogram: Colors, p. 89.*

### 6.5.1 Axes

The scaling of the axes is established by the Duration Histogram: Scaling menu item. ☞ *Duration Histogram: Scaling, p. 86.*

### 6.5.2 Histogram

The histogram is computed from the filtered levels. The levels selected for the histogram are displayed in the Level window. ☞ *Level, p. 103.*

### 6.5.3 Fit

The graph optionally displays a curve showing a theoretical fit to the histogram. The theoretical curve is a sum of exponential functions. ☞ *Figure 161.*

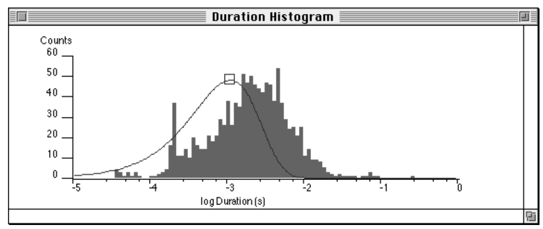



Figure 161 Duration Histogram window with theoretical curve

**Displaying the Fit**

If the histogram does not contain a fit curve, you can bring up a fit curve either by:

1 double-clicking in the duration histogram window.

2 bringing up the Duration Fit window. ☞ *Duration Histogram: Manual Fit, p. 88.*

If the histogram contains a fit curve, you can remove it by closing the Duration Fit window. ☞ *Duration Fit, p. 101.*

You can choose to display individual components of the theoretical curve, the sum, or both. ☞ *Duration Histogram: Style, p. 87.*

### Control Points

The fit curve has control points displayed as empty squares. The point represents a term of the fit.

### Changing Parameters

Each term has two parameters:

1. The time constant, $\tau$, which is specified by the $x$ coordinate of the square. Move the square horizontally with the mouse to change the time constant.

2. The weight assigned to the component, $a$, which is specified by the $y$ coordinate of the square. Move the square vertically with the mouse to change the assigned weight.

### Adding and Removing Terms

To add a new term, double-click on the histogram x axis. A new term will appear at the selected position.

To remove an existing term, double-click on the square for that term. The term will disappear.

## 6.6 Duration Fit

The Duration Fit window displays the parameters of the theoretical curve displayed in the Duration Histogram window. ☞ *Figure 162.*

Whenever the window is displayed, the theoretical curve is also displayed in the Duration Histogram window. When the window is closed, the theoretical curve is removed from the Duration Histogram window.

The window displays the parameters of each term of the theoretical fit. One row of parameters is displayed for each term of the fit. The row contains the time constant and the weight. ☞ *Theoretical Curve, p. 25.*

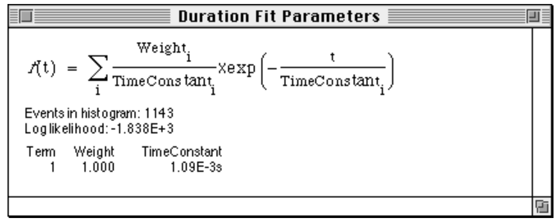



Figure 162 Duration Fit window

The Duration Fit window has no menu of its own, and can be affected only through the menu of the Duration Histogram window. ☞ *Duration Histogram, p. 86.*

## 6.7 Duration Scatter

The Duration Scatter window displays a scatter plot of a selected value against level durations. ☞ *Figure 163.*

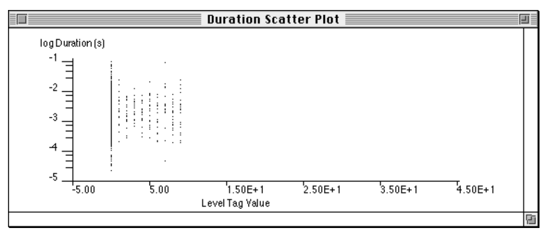



Figure 163 Duration Scatter window

You can control the colors of the individual window elements using the Duration Scatter: Colors menu item. ☞ *Duration Scatter: Colors, p. 91.*

### 6.7.1 Axes

The value used for the x axis is established by the Duration Scatter: Scaling menu item. The same menu item also establishes the scaling of the axes. ☞ *Duration Scatter: Scaling, p. 89.*

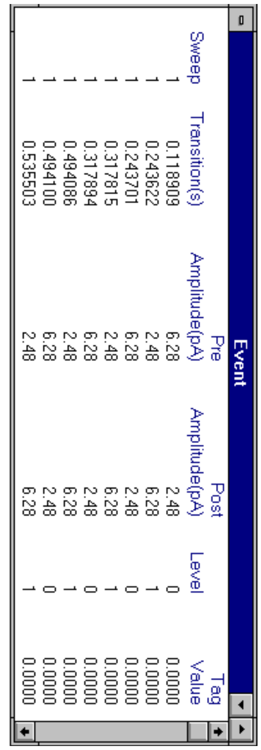
### 6.7.2 Data

The graph is prepared from the filtered levels. The levels selected for the graph are displayed in the Level window. ☞ *Level, p. 103.*

## 6.8 Event

The Event window displays a list of all events read into TACFit. ☞ *Figure 164.*

You can control the colors of the individual window elements using the Event: Colors menu item. ☞ *Event: Colors, p. 91.*




| Sweep | Transition(s) | Pre Amplitude(pA) | Post Amplitude(pA) | Level | Tag Value |
|---|---|---|---|---|---|
| 1 | 0.118909 | 6.28 | 2.48 | 0 | 0.0000 |
| 1 | 0.243622 | 2.48 | 6.28 | 1 | 0.0000 |
| 1 | 0.243701 | 6.28 | 2.48 | 0 | 0.0000 |
| 1 | 0.317815 | 2.48 | 6.28 | 1 | 0.0000 |
| 1 | 0.317894 | 6.28 | 2.48 | 0 | 0.0000 |
| 1 | 0.494086 | 2.48 | 6.28 | 1 | 0.0000 |
| 1 | 0.494100 | 6.28 | 2.48 | 0 | 0.0000 |
| 1 | 0.535503 | 2.48 | 6.28 | 1 | 0.0000 |

Figure 164 Event window

### 6.8.1 Rows

Each row of the window represents one event. The events are listed in order of file, then sweep within a file, then event within a sweep. If the window is not large enough to display all events, you can scroll the data in the window using the vertical scroll bar.

### 6.8.2 Columns

Each column of the window displays one parameter of the events. The columns are:

**Sweep** The sweep number of the event. Sweeps are numbered starting at 1.

**Transition** The transition time of the event relative to the start time of the sweep.

**Pre-amplitude** The current amplitude before the transition. ☞ *Event Amplitude, p. 16.*

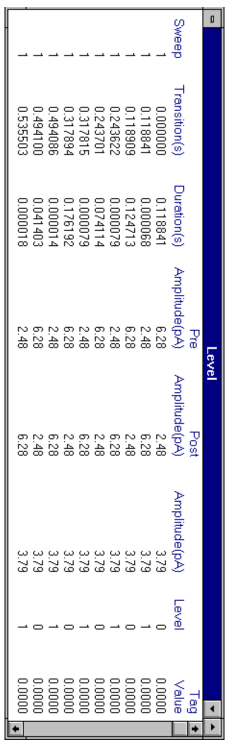
**Post-amplitude** The current amplitude after the transition. ☞ *Event Amplitude, p. 16.*

**Level** The level number following the event. ☞ *Event Level Number, p. 16.*

**Tag Value** An arbitrary value associated with the event. Neither TAC nor TACFit set this value. It can be set in another program.

## 6.9 Level

The Level window displays a list of levels created by TACFit. ☞ *Events to Levels, p. 19.* ☞ *Figure 165.*



Level

| Sweep | Transition(s) | Duration(s) | Pre Amplitude(pA) | Post Amplitude(pA) | Amplitude(pA) | Level | Tag Value |
|---|---|---|---|---|---|---|---|
| 1 | 0.000000 | 0.118841 | 6.28 | 2.48 | 3.79 | 0 | 0.0000 |
| 1 | 0.118841 | 0.000068 | 2.48 | 6.28 | 3.79 | 1 | 0.0000 |
| 1 | 0.118909 | 0.124713 | 6.28 | 2.48 | 3.79 | 0 | 0.0000 |
| 1 | 0.243622 | 0.000079 | 2.48 | 6.28 | 3.79 | 1 | 0.0000 |
| 1 | 0.243701 | 0.074114 | 6.28 | 2.48 | 3.79 | 0 | 0.0000 |
| 1 | 0.317815 | 0.000079 | 2.48 | 6.28 | 3.79 | 1 | 0.0000 |
| 1 | 0.317894 | 0.176192 | 6.28 | 2.48 | 3.79 | 0 | 0.0000 |
| 1 | 0.494086 | 0.000014 | 2.48 | 6.28 | 3.79 | 1 | 0.0000 |
| 1 | 0.494100 | 0.041403 | 6.28 | 2.48 | 3.79 | 0 | 0.0000 |
| 1 | 0.535503 | 0.000018 | 2.48 | 6.28 | 3.79 | 1 | 0.0000 |

Figure 165 Level window

You can control the colors of the individual window elements using the Level: Colors menu item. ☞ *Level: Colors, p. 92.*

### 6.9.1 Rows

Each row of the window represents one level. The levels are listed in order of file, then sweep within a file, then level within a sweep. If the window is not large enough to display all levels, you can scroll the data in the window using the vertical scroll bar.

All levels are displayed, regardless of whether or not they are selected. Control which events are selected using the Settings menu. ☞ *Settings, p. 71.* Selected and unselected events can be displayed in different colors. ☞ *Level: Colors, p. 92.*

### 6.9.2 Columns

Each column of the window displays one parameter of the levels. The columns are:

**Sweep** The number of the sweep within the table.

**Transition** The transition time of the level within the sweep. This is the time of the event that begins the level.

**Duration** The duration of the level.

**PreAmplitude** The amplitude preceding the level. This is the preamplitude of the event that begins the level.

**PostAmplitude** The amplitude of the level. This is the postamplitude of the event that begins the level.

**Amplitude** The amplitude of the level. How the amplitude is calculated is based what you specify in Settings: Events dialog. ☞ *Figure 95.*

**Level** The level number of the level.

**Tag Value** The tag value associated with the event that begins the level.

## 6.10 Stationarity

The Stationarity window displays the stationarity plot of the selected levels. ☞ *Figure 166.*

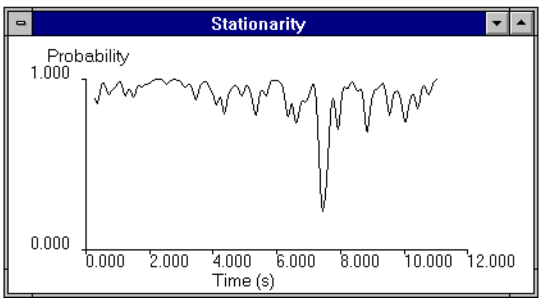



Figure 166 Stationarity window

You can control the colors of the individual window elements using the Stationarity: Colors menu item. ☞ *Stationarity: Colors, p. 93.*

### 6.10.1 Axes

The value used for the x axis is established automatically based on the duration of the shortest sweep selected. The time represents the time within a sweep. ☞ *Stationarity, p. 29.* ☞ *Settings: Sweep, p. 74.*

TACFit scales the Y axis automatically based on the values of the stationarity plot.

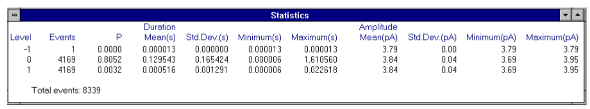
### 6.10.2 Data

The method for preparing the data of the graph is based on the type of stationarity plot you selected in Stationarity: Settings dialog. ☞ *Stationarity: Settings, p. 92.*

Each displayed value is an average across all selected sweeps. ☞ *Stationarity, p. 29.*

## 6.11 Statistics

The Statistics window displays statistics for each level number. ☞ *Figure 167.*



Statistics

| Level | Events | P | Duration Mean(s) | Std.Dev.(s) | Minimum(s) | Maximum(s) | Amplitude Mean(pA) | Std.Dev.(pA) | Minimum(pA) | Maximum(pA) |
|---|---|---|---|---|---|---|---|---|---|---|
| -1 | 1 | 0.0000 | 0.000013 | 0.000000 | 0.000013 | 0.000013 | 3.79 | 0.00 | 3.79 | 3.79 |
| 0 | 4169 | 0.8052 | 0.129543 | 0.165424 | 0.000006 | 1.610560 | 3.84 | 0.04 | 3.69 | 3.95 |
| 1 | 4169 | 0.0032 | 0.000516 | 0.001291 | 0.000006 | 0.022618 | 3.84 | 0.04 | 3.69 | 3.95 |

Total events: 8339

Figure 167 Statistics window

You can control the colors of the individual window elements using the Statistics: Colors menu item. ☞ *Statistics: Colors, p. 94.*

### 6.11.1 Rows

Each row of the window contains statistics for a specified level number. The statistics represent all selected levels with that level number. The selected levels are displayed in the Level window. ☞ *Level, p. 103.*

### 6.11.2 Columns

Each column of the window displays one parameter of the levels. The columns are:

**Level** The level number. Statistics are displayed for all level numbers for which at least one level is selected.

**Events** The number of selected events with that level number.

**P** The probability of the level. The probability is the total duration divided by the reference value. ☞ *Statistics: Settings, p. 93.*

#### Duration

**Mean** The mean duration.

**Std. Dev.** The standard deviation of the mean duration.

**Minimum** The minimum duration.

**Maximum** The maximum duration.

#### Amplitude

**Mean** The mean amplitude.

**Std. Dev.** The standard deviation of the mean amplitude.

**Minimum** The minimum amplitude.

**Maximum** The maximum amplitude.

## 6.12 Sweep

The Sweep window displays a list of all sweeps read into TACFit. ☞ *Figure 168.*

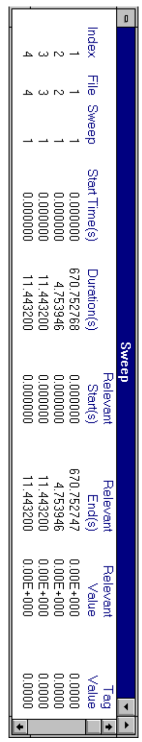



Figure 168 Sweep window

You can control the colors of the individual window elements using the Sweep: Colors menu item. ☞ *Sweep: Colors, p. 94.*

### 6.12.1 Rows

Each row of the window represents one sweep. The sweeps are listed in order of file, then sweep within a file. If the window is not large enough to display all sweeps, you can scroll the data in the window using the vertical scroll bar.

### 6.12.2 Columns

Each column of the window displays one parameter of the sweeps. The columns are:

**Index** The index number of the sweep. Sweeps are numbered sequentially starting from 1.

**File** The file number of the file that contains the sweep. Files are numbered sequentially starting from 1. Sweeps are listed sequentially by file.

**Sweep** The sweep number of the sweep within the file. Sweeps are numbered sequentially starting from 1. Sweeps are listed sequentially by sweep number.

**Start Time** The start time of the sweep.

**Duration** The duration of the sweep.

**Relevant Start** The start time of the relevant segment of the sweep, measured from the beginning of the sweep. If the entire sweep is included, the start time of the relevant segment is zero.

**Relevant End** The end time of the relevant segment of the sweep, measured from the beginning of the sweep. If the entire sweep is included, the end time of the relevant segment is the duration of the sweep.

**Relevant Value** The value associated with the relevant segment.

**Tag Value** The tag value associated with the sweep. This value is never set by TACFit.

# 7 File Formats



## 7.1 Data Files

For the most part, TAC handles all data file formats in an equivalent manner. However, each data file format has unique characteristics which may be important when analyzing data. The following sections describe the special handling of each data file type.

### 7.1.1 Axon pCLAMP 6.x (ABF)

Axon pCLAMP 6.x (ABF) files are generated by the Axon Instruments pCLAMP package, version 6.0 and later, or by AxoScope version 1.x.

When you open an ABF file, a dialog appears. ☞ *Figure 169*.

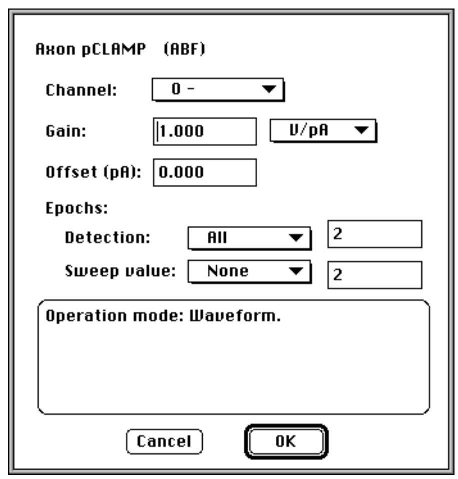



Figure 169 Axon pCLAMP 6.x (ABF) dialog

The entries in the dialog are as follows:

**Channel** The A/D channel containing the data to process.

**Gain** The gain used during acquisition. TAC determines the units based on the range of physical possibility for patch clamp recording. ☞ *Scaling Units, p. 8.*

**Offset** The offset present during recording. This value will be subtracted from each data point when the data is processed. TAC determines this value from the data file. TAC determines the offset units from the gain units.

**Notes** This text box contain notes from TAC about the file and how it will be processed.

### Epochs

**Detection** Specify the epoch to use as the relevant segment for event detection. ☞ *Figure 170.*

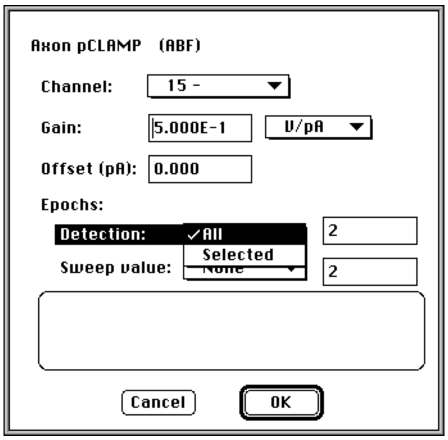



Figure 170 Axon pCLAMP 6.x (ABF)

The choices are:

1 All. Perform event detection on all epochs in an episode.

2 Selected. Perform event detection only on the selected epoch. The selected epoch becomes the relevant segment.

**Sweep value** The relevant value to associate with the sweep. ☞ *Figure 171.*

The choices are:

1 Duration. The duration of the specified epoch. The epoch need not be the same as that used for event detection.

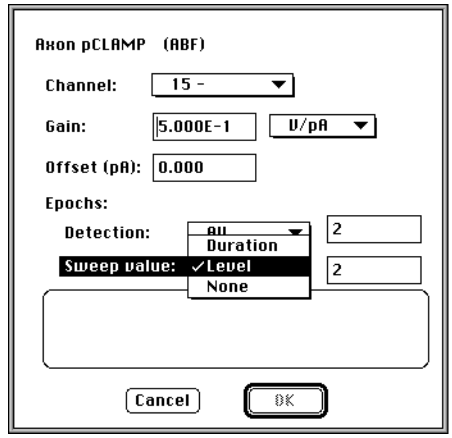



Figure 171 Axon pCLAMP 6.x (ABF)

2 Level. The amplitude level associated with the specified epoch. The epoch need not be the same as that used for event detection.

3 None. Always zero.

### Other

**Cancel** Close the dialog and do not open the data file.

**OK** Close the dialog and open the data file. The specified A/D channel becomes the default setting the next time an Axon pCLAMP 6.x (ABF) file is opened.

## 7.1.2 Axon pCLAMP 5.x

Axon pCLAMP 5.x files are generated by the Axon Instruments CLAMPEX and FETCHEX programs. pCLAMP files can contain data from multiple A/D channels. CLAMPEX data files contain pulsed data, while FETCHEX data files contain continuous data.

When you open an Axon pCLAMP 5.x data file, a dialog appears. ☞ *Figure 172.*

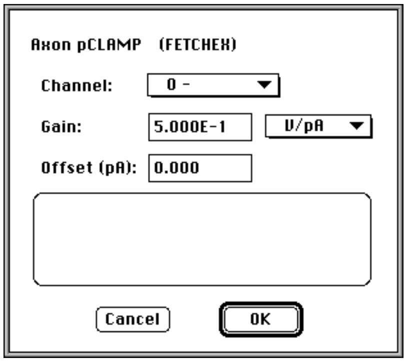



Figure 172 Axon pCLAMP 5.x dialog

The entries in the dialog are as follows:

**(FETCHEX) or (CLAMPEX)** The type of data file selected. TAC determines this automatically, based on the contents of the file.

**Channel** The A/D channel containing the data to process.

**Gain** The gain used during acquisition. TAC determines the units based on the range of physical possibility for patch clamp recording. ☞ *Scaling Units, p. 8.*

**Offset** The offset present during recording. This value will be subtracted from each data point when the data is processed. TAC determines this value from the data file. TAC determines the offset units from the gain units.

**Notes** This text box may contain notes from TAC about how the file will be processed.

**Cancel** Close the dialog and do not open the data file.

**OK** Close the dialog and open the data file. The specified A/D channel becomes the default setting the next time an Axon pCLAMP file is opened.

TAC requires that all data points in a sweep be recorded at the same sampling rate. CLAMPEX can record at two different sampling rates in the same sweep. If TAC encounters a CLAMPEX file using two different sampling rates in each sweep, it will process only the data points recorded at the first sampling interval. In that case TAC will display a note in the dialog.

### 7.1.3 Bruxton Corporation

Bruxton Corporation files are created by the Acquire program from Bruxton Corporation. Bruxton Corporation files may contain data from multiple channels. ☞ *Figure 173.*


Figure 173 Bruxton Corporation dialog

The entries in the dialog are as follows:

**Channel** The data acquisition channel to use for analysis.

**Gain** The gain used during acquisition. TAC determines the units based on the range of physical possibility for patch clamp recording. ☞ *Scaling Units, p. 8.*

**Offset** The offset present during recording. This value will be subtracted from each data point when the data is processed. TAC determines this value from the data file. TAC determines the offset units from the gain units.

**Cancel** Close the dialog and do not open the data file.

**OK** Close the dialog and open the data file using the specified parameters. The parameters become the default settings the next time a Bruxton Corporation file is opened.

## 7.1.4 HEKA Pulse

HEKA Pulse data files are created by the Pulse program from HEKA elektronik.

When HEKA Pulse creates a data file, it creates three separate files, each with a different file extension. The "dat" file contains the raw data. To open a HEKA Pulse file, select the "dat" file in the file selection dialog. The "pgf" and "pul" files must also be present in the same folder, or TAC will not be able to read the data. ☞ *Figure 174.*

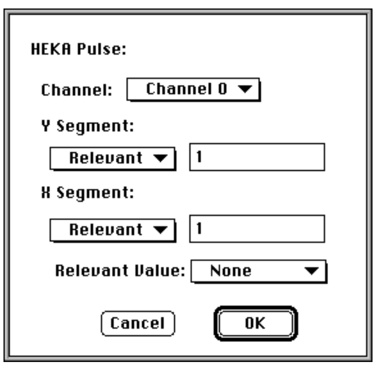



Figure 174 HEKA Pulse dialog

The entries in the dialog are as follows:

**Channel** The A/D channel to process. HEKA Pulse data files may contain a mix of single- and multiple- channel sweeps. TAC reads only those sweeps from the file that include data for the specified A/D channel.

**Y Segment** The relevant segment of the sweep for event detection. ☞ *Figure 175.*

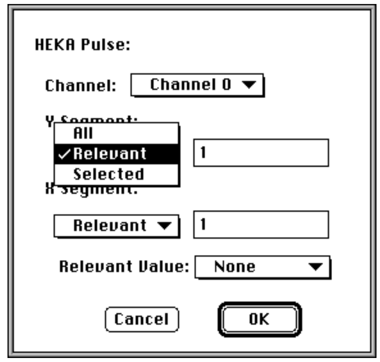



Figure 175 HEKA Pulse

The choices are:

1 All. The relevant segment is the entire sweep.

2 Relevant. The relevant segment is specified in the data file. For example, if the data file specifies that segment 3 is the relevant Y segment, TAC will use segment 3 as the relevant segment.

3 Selected. The relevant segment is specified by the following value in the dialog. For example, if the following value is 2, TAC will use segment 2 as the relevant segment, regardless of the contents of the file.

**X Segment** The segment from which to extract the relevant value. ☞ *Figure 176.*

The choices are:

1 None. The relevant value is zero.

2 Relevant. The relevant value is obtained from the relevant X segment specified in the data file. For

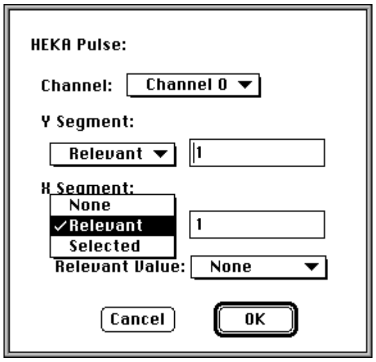



Figure 176 HEKA Pulse

example, if the data file specifies that segment 2 is the relevant x segment, TAC will use segment 2 as segment from which to extract the relevant value.

3 Selected. The relevant value is obtained from the segment specified by the value in the dialog. For example, if the following value is 3, TAC will obtain the relevant value from segment 3.

**Relevant Value** The value to obtain from the relevant segment. ☞ *Figure 177.*

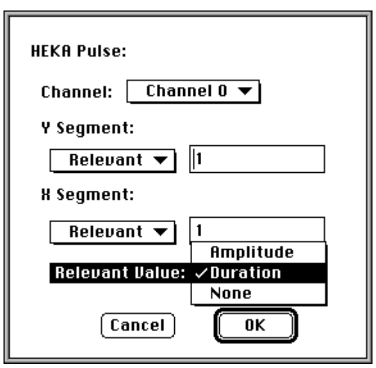



Figure 177 HEKA Pulse

The choices are:

1 Amplitude. Use the amplitude of the x segment as the relevant value.

2 Duration. Use the duration of the x segment as the relevant value.

3 None. Use zero as the relevant value.

**Cancel** Close the dialog and do not open the data file.

**OK** Close the dialog and open the data file. The A/D channel becomes the default setting the next time a HEKA Pulse file is opened.

### 7.1.5 IGOR Wave

IGOR binary wave files are created by the IGOR Pro program from WaveMetrics. IGOR files are treated as a single sweep.

TAC assumes that the data values in IGOR binary wave files are in units of amperes. For example, a data value of $1\times10^{-12}$ is interpreted as 1pA.

### 7.1.6 Raw Continuous

Raw Continuous files contain only a sequence of data points. You must supply all other parameters required by TAC to read a raw continuous file.

Raw continuous files are treated as a single sweep containing data from a single A/D channel. Each data point is a 16-bit integer value or a 32-bit floating-point value. Successive data points are separated in time by the sampling interval. ☞ *Figure 178.*

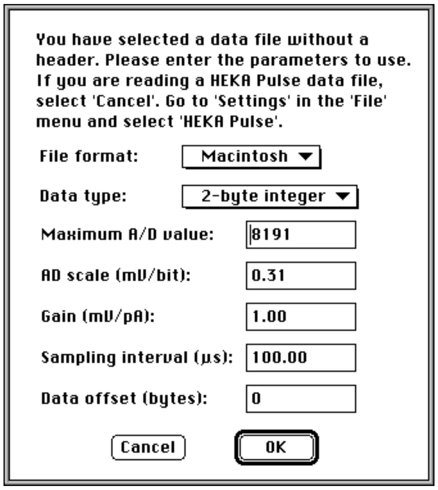



Figure 178  Raw Continuous dialog

The entries in the dialog are as follows:

**File format**  The format of data file. ☞ *Figure 179.*

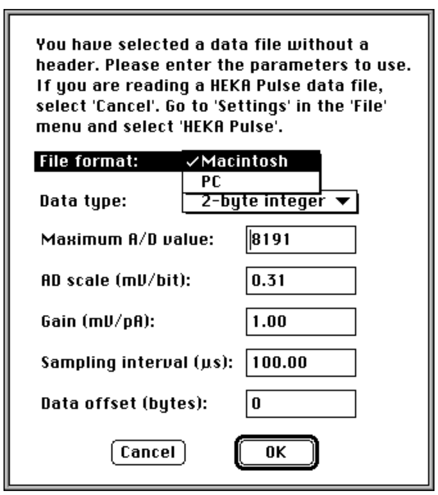



Figure 179  Raw Continuous file format

The choices are:

1 Macintosh. Big-endian format, in which the high-order byte of each value is stored first, followed by bytes in descending significance.

2 PC. Little-endian format, in which the low-order byte of each value is stored first, followed by bytes in ascending significance.

Big-endian format (Macintosh) is used by most UNIX workstations. Little-endian format (PC) is used by DEC PDP-11 and VAX systems.

**Data Type**  The type of data stored in the file. ☞ *Figure 180.*

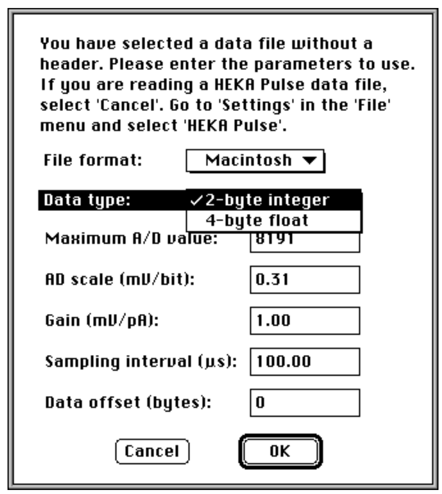



Figure 180  Raw Continuous data type

The choices are:

1 2-byte integer. The data file contains a sequence of 16-bit integers.

2 4-byte float. The data file contains a sequence of 32-bit IEEE floating-point values.

IEEE floating point format is compatible with both PC and Macintosh systems, as well as most UNIX workstations. DEC VAX systems use a slightly different floating-point format that can be converted to and from IEEE format using only a scaling factor.

**Maximum A/D value** The largest value that can occur in the file. This is relevant for integer data only.

**AD scale** The value of a single bit change of the A/D converter. This is relevant for integer data only.

**Gain** The analog gain of the acquisition system. This is relevant for integer data only.

**Sampling interval** The interval between data values.

**Data offset** The offset of the first sample in the file. If the file contains only data, set this value to zero. If the file has a header, set this value to the length of the header.

**Cancel** Close the dialog and do not open the data file.

**OK** Close the dialog and open the data file using the specified parameters. The parameters become the default settings the next time a raw continuous file is opened.

#### Integer Data Scaling

Given an A/D converter with a range of $\pm v$ volts and a resolution of $n$ bits, The A/D scale value can normally be calculated as:

$$\text{AD scale} = \frac{2v}{2^n} \tag{81}$$

For example, a typical $\pm 10\text{V}$ A/D converter has a 20V range. A converter with 12-bit resolution then has a scale value of:

$$\frac{20\text{V}}{2^{12}\text{bits}} = 4.8828\,\text{mV/bit} \tag{82}$$

The Instrutech ITC16 has a range of $\pm 10.24\text{V}$ and 16-bit resolution, so it has a scale value of:

$$\frac{20.48\text{V}}{2^{16}\text{bits}} = 0.3125\,\text{mV/bit} \tag{83}$$

#### Float Data Scaling

Float data values are assumed to represent absolute current in amperes, and are scaled only by the data multiplier. ☞ *Data: Filter, p. 41.*

## 7.2 Binary Export

TAC can export the data in the Data window as binary data. ☞ *Data, p. 55.*

The following sections describe each of the binary export formats.

### 7.2.1 General

General binary files are simply a sequence of 4-byte IEEE floating point values. The format of the values depends on the type of system that TAC runs on. On the Apple Macintosh, the values are in big-endian format. Under Microsoft Windows, the values are in little-endian format.

No header or other information regarding the data is supplied.

For the Data window, the data values represent current in amperes.

### 7.2.2 IGOR

IGOR files are in WaveMetrics IGOR binary wave format. The following information is contained in the exported wave:

1 The data points themselves, as a sequence of floating-point values.

2 The units for the Y axis.

3 The spacing between points on the X axis.

4 The units for the X axis.

For the Data window, the following values are used:

1 The data points represent the current.

2 The Y axis units are amperes.

3 The spacing between points on the X axis is the sampling interval of the filtered data.

4 The units for the X axis are seconds.

## 7.3 Graphic Export

TAC can export a window as a graphic image either as a file or to the clipboard:

TAC and TACFit can export an image of a window as a graphics file. Several common graphics file formats are supported. ☞ *File: Export Graph, p. 37.* ☞ *File: Export Graph, p. 69.*

TAC and TACFit can export an image of a window to the clipboard. Clipboard export uses the Macintosh PICT file format or the Windows metafile format, depending on the platform. ☞ *Edit: Copy, p. 40.* ☞ *File: Export Graph, p. 37.* ☞ *Edit: Copy, p. 71.* ☞ *File: Export Graph, p. 69.*

The following sections describe each of the export formats.

### 7.3.1 Adobe Illustrator (AI)

Adobe Illustrator is a vector drawing program available for the Macintosh and for Windows. Files in Adobe Illustrator format are ideal for high-quality desktop publishing and for editing for publication.

The file format used by Adobe Illustrator has become an industry standard. It is a graphics file format with the following characteristics:

1 Infinite resolution. The coordinates used in Adobe Illustrator files are real numbers, as opposed to integers. Graphics in Adobe Illustrator format can be scaled arbitrarily, and print with the full resolution of the target printer.

2 Editing. The Adobe Illustrator program can read and edit AI files.

3 Compatibility with PostScript. The Adobe Illustrator file format is a form of encapsulated PostScript (EPS). Adobe Illustrator files can be treated as EPS files by any application that supports EPS. TAC and TACFit include a PICT header in the exported AI files, so the files can be displayed by an application that treats them as EPS files. ☞ *EPS, p. 115.*

4 Compatibility across platforms. The graphic image in an Adobe Illustrator file is described using text. Therefore the image can be easily moved between

computer platforms with minimal compatibility problems.

Adobe Illustrator files are ideal for publication because they can be scaled and edited, and print with the full resolution of the output device. No other export file format provides this combination of features.

If Adobe Illustrator files are inserted into documents as EPS files, printing them requires a PostScript printer.

The Adobe Illustrator file format allows a path, such as a data trace, to be defined as a sequence of segments. A trace could be written as a single path with one segment for each data point in the trace. Adobe Illustrator has difficulty manipulating paths with more than a few thousand segments. If you have a long data trace exported as an Adobe Illustrator file, you may not be able to manipulate it if all segments are contained in a single path.

TAC and TACFit allow you to specify the maximum number of segments in a path. The program will break longer traces into multiple paths. ☞ *File: Export Graph, p. 37.* ☞ *File: Export Graph, p. 69.*

### 7.3.2 Clipboard

Clipboard export is suitable for quick creation of graphics for printing. The resolution of clipboard graphics is limited, so clipboard export is usually not suitable for publication.

When TAC or TACFit exports files to the clipboard, it uses either PICT1 or PICT2 format, depending on the format selected by the user. ☞ *PICT, p. 116.*

### 7.3.3 EPS

Files in EPS format are ideal for high-quality desktop publishing. They cannot be edited.

Encapsulated PostScript (EPS) files are PostScript files, but have an additional header that can be read by desktop publishing and graphics programs. EPS files have the following characteristics:

1. Infinite resolution. The coordinates used in PostScript are real numbers, as opposed to integers. EPS graphics can be scaled arbitrarily, and print with the full resolution of the target printer.

2. Inability to edit. If editing is required in a high-quality file format, use Adobe Illustrator format. ☞ *Adobe Illustrator (AI), p. 114.*

3. Compatibility across applications and platforms. Any good word processor, desktop publisher, or graphics program should be able to read EPS files.

PostScript is the standard page description language used for publishing. It is defined by Adobe Systems (Adobe, 1990).

PostScript files represent both graphics and text, and are independent of the resolution of the target printer. That is, a PostScript file should print properly on a low-resolution laser printer and a high-resolution imagesetter. In both cases it uses the full capabilities of the output device. Printing EPS files requires a PostScript printer.

PostScript files cannot be edited because few applications can read and interpret the graphic image in a PostScript file. PostScript is more than a graphics description language, it is also a programming language. A PostScript file can include procedure definitions, loops, and conditional execution. To draw an image specified in a PostScript file, an application must execute the PostScript program. This is beyond the capabilities of most applications.

When TAC or TACFit writes an EPS file, it includes:

1 The PostScript description of the graphic. This description can be interpreted by a PostScript printer.

2 A header specifying the size of the graphic. When an EPS file is inserted into a document, the word processor or desktop publisher must set aside a rectangle to use to print the graphic image. The header specifies the size of the rectangle.

3 A graphic image in PICT1 format. When an EPS file is inserted into a document, the user hopes to see the image on screen. Since the word processor or desktop publisher cannot interpret the PostScript description, TAC and TACFit provide a PICT image that represents the graphic. The application draws the PICT image on the screen, but prints the PostScript graphic.

When a word processor or desktop publisher reads the EPS file, it sets aside a rectangle of the size specified in the header and displays the PICT1 image. When it prints the graphic, it includes the PostScript description in the page it sends to the printer.

The graphic image in PICT1 format cannot be interpreted by most PC applications, so an application on the PC will display the EPS file on the screen as a gray box. The graphic should print correctly.

The PostScript language allows a path, such as a data trace, to be defined as a sequence of segments. A trace could be written as a single path with one segment for each data point in the trace. Some programs and printers may not be able to process paths with more than a few thousand segments. If you have a long data trace exported as an EPS file, you may not be able to print it if all segments are contained in a single path.

TAC allows you to specify the maximum number of segments in a path. The program will break longer traces into multiple paths. ☞ *File: Export Graph, p. 37.*

## 7.3.4 PICT

PICT format is supported on the Macintosh. Files in PICT format are suitable for quick creation of graphics for printing. TAC and TACFit can create either PICT1 files or PICT2 files. In some cases PICT2 files may be suitable for publication.

PICT files are native Macintosh graphic files. The PICT file format has the following characteristics:

1 Finite resolution. The coordinates used in PICT files are integers, so when TAC or TACFit creates a PICT file, it rounds the coordinates to the nearest integer.

2 PICT1 files have a fixed resolution of 72 dots per inch (dpi). PICT2 files have variable resolution. You can set the resolution used for PICT2 files. ☞ *File: Export Graph, p. 37.*

3 Almost all Macintosh applications that handle graphics can handle PICT format, since it is the native graphics format of the Macintosh.

4 You can set the resolution of PICT2 files high enough to be useful for publication. Unfortunately, many applications do not take advantage of the higher resolution of PICT2, and treat PICT2 files as PICT1 files. Test with the application you intend to use for printing before relying on high resolution PICT2 files.

5 Few applications on other platforms can process PICT files.

### 7.3.5 Windows Metafile

Windows metafile format is supported under Microsoft Windows. Files in metafile format are suitable for quick creation of graphics for printing.

The Windows metafile format has the following characteristics:

1. Finite resolution. The coordinates used in metafile files are integers, so when TAC or TACFit creates a metafile file, it rounds the coordinates to the nearest integer.

2. Almost all Windows applications that handle graphics can handle metafile format, since it is the native graphics format of Microsoft Windows.

3. Few applications on other platforms can process metafile files.

## 7.4 Text Export

TAC and TACFit can export the data in a window as text. ☞ *File: Export Text, p. 38.* ☞ *File: Export Text, p. 70.*

### 7.4.1 Formats

Text files can be exported in several formats.

#### Excel

Files in Excel format are text files suitable for reading into a spreadsheet. They have been tested with Microsoft Excel.

A file in Excel format is a table. The rows of the table are records. The columns are data values. Each data value is separated from the value in the next column by a tab character. Data values are represented as integers, fixed point values, or in scientific notation.

The contents of an Excel-format file depend on the exported window.

#### IGOR

Files in IGOR format are text files suitable for reading into the IGOR Pro program from WaveMetrics.

A file in IGOR format is a table with a header. The header allows IGOR to read the file and convert each column into an IGOR wave. The rows of the table are records. The columns are data values. Each data value is separated from the value in the next column by a tab character. Data values are integers, fixed point, or in scientific notation.

The contents of an IGOR-format file depend on the window exported.

The header identifies the file as containing IGOR waves. Each column becomes an IGOR wave of the same name. For example, if a column has the name "Current", the data in that column will be read into a wave named "Current".

### 7.4.2 TAC Data Window

When the data window is exported as a text file, each row of the table contains one filtered raw data point. Successive rows contain successive points.

From left to right, the columns are:

**DataTime** The time in seconds.

**Current** The value of the data point in amperes. This column is included only if the data is present in the data window.

**Template** The value of the leak template data in amperes. This column is included only if the leak template data is present in the data window.

### 7.4.3 TAC Events Window

When the events window is exported as a text file, each row of the table contains one event. Successive rows contain successive events. Only events are exported, not groups, series, sweeps, or jumps.

From left to right, the columns are:

**SweepNum** The sweep number of the event. Sweeps are numbered beginning with 1.

**Transition** The time in seconds from the beginning of the sweep.

**PreAmplitude** The pre-amplitude of the event in amperes.

**PostAmplitude** The post-amplitude of the event in amperes.

**Level** The level number of the event.

**TagValue** The tag value associated with the event.

### 7.4.4 TAC Histogram Window

When the histogram window is exported as a text file, each row of the table contains one histogram bin. Successive rows contain successive bins.

From left to right, the columns are:

**Amplitude** The mean current represented by the histogram bin, in amperes.

**Count** The number of data points in the specified bin.

**Sum** The normalized fit value for the bin. This column is included only if the sum of all the fit components is present in the window.

**Fit0** The normalized fit value of the first component for the bin. This column is included only if the normalized fit value of the component is present in the window. For more components, they are named sequentially as Fit1, Fit2, and so on.

### 7.4.5 TACFit Amplitude Histogram Window

When the amplitude histogram window is exported as a text file, each row of the table contains one histogram bin. Successive rows contain successive bins.

From left to right, the columns are:

**Current** The mean bin current in amperes.

**Count** The number of levels in the bin.

**Sum** The normalized fit value for the bin. This column is included only if the sum of all the fit components is present in the window.

**Fit0** The normalized fit value of the first component for the bin. This column is included only if the normalized fit value of the component is present in the window. For more components, they are named sequentially as Fit1, Fit2, and so on.

### 7.4.6 TACFit Amplitude Fit Window

When the amplitude fit window is exported as a text file, each row of the table contains one component of the fit. Successive rows contain successive components.

From left to right, the columns are:

**Weight** The weight (*a*) of the component.

**Current** The amplitude (*A*) represented by the component, measured in amperes.

**StdDev** The standard deviation ($\sigma$) of the component, measured in amperes.

### 7.4.7 TACFit Amplitude Scatter Window

When the amplitude scatter plot window is exported as a text file, each row of the table contains one data value. Successive rows contain successive values.

From left to right, the columns are:

**X** The x axis value.

**Current** The current in amperes.

### 7.4.8 TACFit Amplitude/Duration Window

When the amplitude/duration window is exported as a text file, each row of the table represents one point of the scatter plot, that is, one filtered level.

From left to right, the columns are:

**Duration** The duration in seconds.

**Current** The amplitude in amperes.

### 7.4.9 TACFit Duration Histogram Window

When the duration histogram window is exported as a text file, each row of the table contains one histogram bin. Successive rows contain successive bins.

From left to right, the columns are:

**Duration** The mean bin duration in seconds. The bins are logarithmically spaced, so the ratio of successive bin durations is a constant.

**Count** The number of levels in the specified bin.

**Sum** The normalized fit value for the bin. This column is included only if the sum of all the fit components is present in the window.

**Fit0** The normalized fit value of the first component for the bin. This column is included only if the normalized fit value of the component is present in the window. For more components, they are named sequentially as Fit1, Fit2, and so on.

### 7.4.10 TACFit Duration Fit Window

When the duration fit window is exported as a text file, each row of the table contains one component of the fit. Successive rows contain successive components.

From left to right, the columns are:

**Weight** The weight (*a*) of the component.

**Time Constant** The time constant ($\tau$) of the component, measured in seconds.

### 7.4.11 TACFit Duration Scatter Window

When the duration scatter plot window is exported as a text file, each row of the table contains one data value. Successive rows contain successive data values.

From left to right, the columns are:

**X** The x axis value.

**Duration** The duration in seconds.

### 7.4.12 TACFit Event Window

When the event window is exported as a text file, each row of the table contains one event. Successive rows contain successive events.

From left to right, the columns are:

**Sweep** The sweep number. Sweeps are numbered beginning with 1.

**Transition** The time in seconds from the beginning of the sweep.

**PreAmplitude** The pre-amplitude of the event in amperes.

**PostAmplitude** The post-amplitude of the event in amperes.

**Level** The level number of the event.

**TagValue** The tag value associated with the event.

### 7.4.13 TACFit Level Window

When the level window is exported as a text file, each row of the table contains one level. Successive rows contain successive level entries.

From left to right, the columns are:

**Sweep** The sweep number. Sweeps are numbered beginning with 1.

**Transition** The time in seconds from the beginning of the sweep.

**Duration** The duration in seconds.

**PreAmplitude** The pre-amplitude in amperes.

**PostAmplitude** The post-amplitude in amperes.

**Amplitude** The amplitude in amperes.

**Level** The level number.

**TagValue** The tag value associated with the level.

### 7.4.14 TACFit Stationarity Window

When the stationarity window is exported as a text file, each row of the table contains one data value. Successive rows contain successive values.

From left to right, the columns are:

**Duration** The duration in seconds.

**Probability** The probability.

### 7.4.15 TACFit Statistics Window

When the statistics window is exported as a text file, each row of the table represents the statistics for one level.

From left to right, the columns are:

**Level** The level number.

**Events** The count of entries.

**Probability** The probability.

**DurationMean** The mean duration in seconds.

**DurationStd** The standard deviation of the duration in seconds.

**DurationMin** The minimum duration in seconds.

**DurationMax** The maximum duration in seconds.

**AmplitudeMean** The mean amplitude in amperes.

**AmplitudeStd** The standard deviation of the amplitude in amperes.

**AmplitudeMin** The minimum amplitude in amperes.

**AmplitudeMax** The maximum amplitude in amperes.

### 7.4.16 TACFit Sweep Window

When the sweep window is exported as a text file, each row of the table represents one sweep. Successive rows represents successive sweeps.

From left to right, the columns are:

**Index** The sweep number. Sweeps are numbered beginning with 1.

**File** The file number of the file containing the sweep. Files are numbered beginning with 1.

**Sweep** The number of the sweep within the file. Sweep numbers within a file begin with 1.

**StartTime** The start time of the sweep within the file in seconds.

**Duration** The duration of the sweep in seconds.

**RelevantStart** The start of the relevant segment within the sweep, in seconds. If the relevant segment is the entire sweep, this value is zero.

**RelevantEnd** The end of the relevant segment within the sweep, in seconds. If the relevant segment is the entire sweep, this value is the duration of the sweep.

**RelevantValue** The relevant value associated with the sweep.

**TagValue** The tag value associated with the sweep.

## 7.5 Leak Template

TAC can import a leak template generated from other source into TAC.

The leak template is stored as text. Each line of the file is a data point. TAC maps the data points from the leak template data point by point with the sweep data.

## 7.6 Event File

Both TAC and TACFit can read and write event files.

Event files are stored as text. Each entry is a row of the file. An event file is divided into several parts. The following sections describe each part.

### 7.6.1 Header

The header consists of a file format version number. The only version numbers currently supported are 1 and 2.

### 7.6.2 Files

If an event file contains events from only a single data file, the files part is not present. TAC reads and writes only event tables without a files part.

If an event file contains events from multiple files, the files part is present. TACFit can read and write event tables with a files part.

The files part begins with a line consisting of the word "Files", followed by one line per file. From left to right, the columns are:

1 The number of sweeps in the corresponding file.

### 7.6.3 Sweeps

The sweep part describes each sweep in each file. The part begins with a line consisting of the word "Sweeps", followed by one line per sweep.

From left to right, the columns are:

1 The index of the sweep. Sweeps are numbered sequentially, beginning at 1.

2 The starting time of the sweep within the file, measured in seconds.

3 The duration of the sweep in seconds.

4 The start time of the relevant segment within the sweep, measured in seconds.

5 The end time of the relevant segment within the sweep, measured in seconds.

6 The relevant value associated with the sweep.

7 The tag value associated with the sweep.

### 7.6.4 Events

The event part describes each event in each sweep. The part begins with a line consisting of the word "Events", followed by one line per event.

From left to right, the columns are:

1 The sweep containing the event. Sweeps are numbered beginning with 1.

2 The time in seconds from the beginning of the sweep.

3 The pre-amplitude of the event in amperes.

4 The post-amplitude of the event in amperes.

5 The level number of the event.

6 The tag value associated with the event.

## 7.7 Preferences File

A Preferences File contains all of the settings for TAC or TACFit, including all settings made in dialogs, all window positions and sizes, and parameters such as the scaling of the data window.

### 7.7.1 Default Preferences

When TAC starts, it reads the default preferences file "TAC.set". TACFit uses the "TACFit.set" file. On the Macintosh, these files are located in the Preferences folder of the System folder. Under Microsoft Windows, these files are located in the folder in which TAC is installed.

When TAC or TACFit exit, they update their default preferences file according to the current parameters. The next time the program is started, it will read these preferences and return to the same settings as were in effect when it exited.

Both TAC and TACFit have built-in defaults if no default preferences file exists.

### 7.7.2 Multiple Preferences Files

You can create and use additional preferences files. This is useful if you analyze various types of data files, and keep the default settings for each type in a separate preferences file.

To create a preferences file, use File: Save Preferences. ☞ *File: Save Preferences, p. 35.* ☞ *File: Save Preferences, p. 68.*

To read an existing preferences file, use File: Load Preferences. ☞ *File: Load Preferences, p. 35.* ☞ *File: Load Preferences, p. 67.*

### 7.7.3 File Format

Preference files are stored as ASCII text:

1 Each line of the file is a single parameter.

2 Each parameter in the program is stored in sequence.

3 All parameters are always stored, even if some are not used. For example, the size and position of each window is stored, regardless of whether or not the window is displayed.

4 The first parameter of the preferences file is the version number of the preference file that the current version of TAC or TACFit produces. If that is not the same as the current version, TAC or TACFit will not read the file. Some previous versions of TAC did not include the version number.

# 8 Product



## 8.1 Bibliography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## 8.2 Questions

This section provides answers to common questions.

### 8.2.1 Amplitude Histogram

The following questions address the amplitude histogram in TACFit.

1 I expect two peaks, one at the baseline and one at the open channel amplitude. Why do I see only one peak?

You probably have relative level amplitudes selected in the *Settings: Levels* dialog box. Select absolute amplitudes instead. ☞ *Settings: Events, p. 72.*

2 Why are whole groups of events missing?

You probably filtered them out. The settings could be left over from a previous run of TACFit. Select all events using Settings: Reset. ☞ *Settings: Reset, p. 74.*

### 8.2.2 Data Files

The following questions address data file handling in TAC.

1 How is the channel number for a data file established?

Many data file formats support multiple channels of acquired data. When you select a file in such a format, TAC opens a dialog box to obtain the channel number. Each data file format has a specified dialog box. ☞ *Data Files, p. 107.*

When a data file is successfully opened, the parameters you specify in the dialog box are stored as part of the preferences. They are used as default parameters the next time you open a data file of the same format.

If the default channel is missing, channel 0 is used instead. For example, suppose a data file with four channels is opened and channel 2 is selected. Now another data file of the same format is opened, but this data file has only two channels of acquired data. Channel 2 does not exist in the file. The dialog box displays channel 0 as the default channel number.

2 The scaling of the data is wrong. How do I fix it?

Incorrect scaling usually indicates one of the following problems: a) The data multiplier has been left set to a value other than one from a previous file, or b) The file was recorded with incorrect scaling.

The data multiplier must be changed. ☞ *Data Multiplier, p. 8.*

### 8.2.3 Data Filtering

The following questions address how data is filtered by TAC.

1 Why did TAC change the filter frequency I specified?

TAC is limited to filtering the acquired raw data to a frequency approximately 1/200th of the original sampling frequency. For example, if the data is acquired at 100kHz, TAC is not able to filter at below about 500Hz.

If TAC encounters a sweep with a sampling frequency high enough that it cannot filter the data using the settings specified by the user, TAC updates the filter frequency.

2 The channel opening rise times in my data are longer than I expect. Why?

If you estimate the channel opening rise times from the filter frequency in TAC, you are taking into account only the filtering performed by TAC itself. However, the measurement system itself filters the data as well (Colquhoun and Sigworth, 1995, P. 193) (Magleby, 1992, P. 765). ☞ *Gaussian Filter, p. 10.*

### 8.2.4 Duration Histogram

The following questions address the duration histogram in TACFit.

1 Why is the histogram skewed at short durations?

Perhaps the correction for the filter frequency is not set properly. This is adjusted using the Duration: Correction menu item. ☞ *Duration Histogram: Correction, p. 88.*

2 Why does the histogram have too many short durations and too few long durations?

Perhaps you have bursts of short events which should be removed. This is adjusted using the Settings: Events menu item. ☞ *Settings: Events, p. 72.*

3 Why are whole groups of events missing?

You probably filtered them out. The settings could be left over from a previous run of TACFit. Select all events using Settings: Reset. ☞ *Settings: Reset, p. 74.*

### 8.2.5 Event Detection

The following questions address event detection in TAC.

1 A sweep begins with an open channel. How do I set the proper level?

Before starting event detection in the sweep, set the sweep starting level in the Data: Settings dialog box to the correct starting level number. For example, for a single open channel, this number would normally be 1. Do not forget to reset this value to zero before beginning event detection on another sweep. ☞ *Data: Settings, p. 42.*

2 TAC detected a baseline shift as an event. How do I ignore this?

Use the jump command. The shift will be entered into the event table, so TAC can properly track the baseline, but it will not be treated as an event during analysis. ☞ *Data: Detection, p. 44.*

### 8.2.6 Printing

The following questions address printing graphics.

1 How do I set the size of the printed graph?

The printed graph is the same size as the active window on the screen. Resize the window on the screen to print a graph at a different size.

2 Why are all lines printed in black? Some of them should be gray.

TAC and TACFit print graphics using the colors you set. However, many printer drivers default to printing all colors as black. On high-resolution printers, the results usually much better if you select grayscale or color printing.

The print setup dialog box for your printer usually offers you a choice of printing in black or grayscale. Select grayscale for better results. If you have a color printer, the printer setup dialog should allow you to select color output.

### 8.2.7 TAC Setup

The following questions address the setup and configuration of TAC.

1 TAC will not run. How do I fix this?

If your machine does not have enough memory to run TAC, the system will give you a message. You can change the amount of memory allocated to TAC using “Get Info” in the finder.

It is possible that your default preferences file has become corrupted. You will find it in the Preferences folder of the System folder. Discard it. TAC will then use built-in defaults, and may run. ☞ *Default Preferences, p. 122*.

TAC checks parameters while reading the preferences file. If a parameter is of an invalid type or out of range, TAC will ignore the preferences file and use default values instead.

2 How much memory does TAC require?

Most of the memory used by TAC is needed for the data areas, which contain the acquired data and the event table. The sizes of these areas are established by the settings in the File: Settings dialog box. ☞ *File: Settings, p. 35*.

The memory used is as follows:

Each sweep point requires 12 bytes of storage. For 100,000 sweep points the program requires about 1200Kb.

Each event table entry requires approximately 50 bytes of storage. For 8,000 events the program requires about 400Kb.

3 How do I change settings after checking “Do not show this dialog box on startup”?

If you check “Do not show this dialog box on startup”, but later want to make changes to the settings, follow the procedure: a) Start the program. The File: Open dialog box will appear. b) Select *Cancel* in the dialog box. It will disappear. c) Select File: Settings from the menu. The dialog box will appear.

4 I have a two-color (black and white) display. How can I make TAC easier to use?

Make the following changes: a) The grid lines in the raw data window interfere with the graph. Display tick marks instead of grid lines. ☞ *Data: Display, p. 46*. b) Ensure that all windows have their background color set to white.

### 8.2.8 TACFit Setup

The following questions address the setup and configuration of TACFit.

1 TACFit will not run. How do I fix this?

If your machine does not have enough memory to run TACFit, the system will give you a message. You can change the amount of memory allocated to TACFit using “Get Info” in the finder.

It is possible that your default preferences file has become corrupted. You will find it in the Preferences folder of the System Folder. Discard it. TACFit will then use built-in defaults, and may run. ☞ *Default Preferences, p. 122*.

TACFit checks parameters while reading the preferences file. If a parameter is of an invalid type or out of range, TACFit will ignore the preferences file and use default values instead.

2 How much memory does TACFit require?

Most of the memory used by TACFit is needed for storage of the event table and levels table. The sizes of these areas are established by the settings in the File: Settings dialog box. ☞ *File: Settings, p. 68*.

Each event table entry requires approximately 50 bytes of storage. The levels table is about the same size as the event table, and requires approximately the same amount of memory for storage. Therefore the total requirements are 100 bytes per event. For 8,000 events the program requires about 800Kb.

3 How do I change settings after checking “Do not show this dialog box on startup”?

If you check “Do not show this dialog box on startup”, but later want to make changes to the settings, follow the procedure: a) Start the program. The File: Open dialog box will appear. b) Select *Cancel* in the dialog box. It will disappear. c) Select File: Settings from the menu. The dialog box will appear.

4 I have a two-color (black and white) display. How can I make TACFit easier to use?

Ensure that all windows have their background color set to white.