

# Tack

## The Manual

### Introduction:

This manual describes the operation of the Tack data analysis program. The current revision of this program is 3.20. This software and manual are copyright 1993 through 1989 by George B. Grant, Somerville, MA 02144.

### Compatibilities:

Tack runs on IBM PC compatible computer systems. It operates entirely in graphics mode. As such, it requires a compatible graphics display adapter. Tack supports all major display adapters (Hercules, CGA, EGA, VGA) and has drivers for several other graphics display adapters including Super VGA. Tack works with a Microsoft compatible mouse.

Tack is a data analysis program. It can read data files created by Patchit, Ninja or those written in the pClamp version 5.1 file format.

### Starting Up:

Tack runs entirely in graphics (not text) mode. In order for it to run, a graphics driver for the graphics adapter that is installed in the computer must be available in the directory in which the Tack executable file is. These drivers have the file extension ".bgi". The drivers required for the following screen types are as follows:

<u>Display Adapter</u>	<u>Display Driver</u>
Hercules (Hercules Graphics Adapter)	herc.bgi
CGA (Color Graphics Adapter)	cga.bgi
EGA (Enhanced Graphics Adapter)	egavga.bgi
VGA (Video Graphics Adapter)	egavga.bgi
Super VGA	svga16m.bgi
(Supports several common SVGA cards and the VESA standard SVGA interface)	
IBM 8514 Graphics Adapter	ibm8514.bgi
AT&T 400-Line Graphics Adapter	att400.bgi
3270 PC Graphics Adapter	pc3270

By default, Tack will automatically try to detect the proper graphics driver for the computer. If the proper driver is not found by Tack (in the same directory as Tack) when it is started it will end with an error message. Otherwise the program will start and Tack's main screen will appear.

### The Screen:

Tack's main screen is divided into three areas. The menu bar is on the top of the screen, it

allows the user to access all of the Tack's commands. The right-most portion of the menu bar shows the amount of free conventional (real mode) memory available for Tack's use. The lower part of the screen shows the status line. This line displays information about the current status of the program (which data file, channel and record is currently selected). The data display area fills the screen between the menu bar and the status line.

### **General:**

Tack is a data analysis program. It can load multiple data files. Each file will be loaded into its own "buffer". New buffers can be created by the copy buffer operation or by the result of adding, subtracting or averaging existing buffers. A buffer, like a file, can contain multiple channels of data and multiple records (a record is equivalent to a Clampex "episode"). Most of Tack's functions work on individual buffers, and these commonly default to the current buffer. The current buffer is indicated on the status line at the bottom of the screen. Buffers are named with the letters of the alphabet and the current buffer can be changed (when no menus are active) by typing the letter of that buffer. The current buffer can be changed to the next/previous buffer by typing the up/down arrow key. Similarly, the current channel (in the current buffer) can be changed (when no menus are active) by typing the number of the channel. Note that channels are numbered from 0 (i.e. 0 is the first channel, 1 is the second). The current channel can be changed to the next/previous channel by typing the right/left arrow key. If the buffer only has one channel of data then you won't be able to switch channels, obviously. The current record works slightly differently. When you select it (e.g., by **Display:Record**) it is both selected and displayed. The next/previous record can be selected (and displayed) by typing the plus/minus key.

In many of Tacks' functions, you will need to select a range of timing within a data record. For these cases you have the option of numerically selecting the timing (by entering the times at the prompt) or by cursor selecting the timing. If you choose to select the timing with cursor selection, then the screen will be redrawn and the data record will be shown. You can use the mouse or cursor keys to move the cursor. The home and end keys move the cursor to the beginning and end of the data trace respectively. The left and right arrow keys move the cursor to the one data point to the left and right on the data trace respectively. Holding down the shift key while typing the left and right arrow keys causes the cursor to move by the step indicated by the "step" value shown on the top line of the screen. This step value can be changed by typing the plus key, which doubles this value (it eventually rolls over). Holding down the CTRL key while typing the left and right arrow keys causes the cursor to move by 1/20th of the width of the displayed data. The cursor can be moved under mouse control by holding down the left mouse button and moving the mouse to the left and right. NOTE that if there are more data points in the displayed data trace than there are points on the screen, then the cursor (while under mouse control) will not move in increments of the data points. For the finest control of timing you will need to use the cursor keys in this case. Typing the "ESC" key allows you to cancel the timing selection operation. Typing the Enter key, or the right mouse button accepts the timing for this cursor. During the cursor selection operation, the value (both real and 12-bit) of the data and the time will be shown on lower line of the screen.

### **Help:**

On-line help is available throughout Tack. Just type the F1 key and a relevant help

message will pop up. The help file "Tack.hlp" must be in the same directory as Tack and the graphics driver files.

### **Accessing the Menus:**

The menu bar has a series of pull down menus. A menu (e.g. "File") can be accessed in a number of ways. 1) A menu can be pulled down by clicking on the desired menu entry with the mouse. 2) A menu can be pulled down by holding down the ALT key while the selection letter of the desired menu is typed (the selection letter is usually the first letter of the word and is shown underlined and in a different color from the rest of that word (unless the current graphics display only supports two colors, or the color configuration has been messed with)). For example, to pull down the File menu, type ALT-F. 3) A menu can be pulled down by first activating the menu bar with the F10 or "/" key. The file menu will drop down, but not be selected. The selection letter of any of the main menu items can then be typed in order to access that particular menu.

Certain functions on the individual menus can be accessed directly, without pulling down the menus, by typing a hot-key (the hot-keys are shown to the left of a menu entry, on its menu). For instance, the F8 key will cause Tack to load a data file if pressed when the menu bar is not activated.

### **The Menus:**

#### **File Menu:**

Load File: Selecting this option allows the user to load a new data file into Tack. If there are data files in the current directory (files with the extension ".dat"), a selection box will appear listing the available data files. A data file may be cursor selected from this box (with the mouse or keyboard) or else the name of a file may be typed in (do not type the ".dat" extension). To change directories, type the F2 key, or click the left mouse button in the upper, directory, window and type the pathname of the desired directory. The list of data files will be updated for this new directory.

Save File: Selecting this option allows the user to save the contents of the currently selected buffer to a new data file. You will be prompted to specify the name of the data file (do not type the ".dat" extension). If a file of this name already exists, Tack will warn you and give you the option of overwriting that file or else of choosing a new filename. You will then be asked if you wish to keep the original file's time stamp. If you specify that you want to do that thing, then the file creation date and time will be set to that of the original file. If you specify not (don't keep original file time stamp), then the creation date and time will be set to the current date and time. This option is very useful if you like to sort your files by date.

Export: Selecting this option allows the user to export data from Tack in a variety of numerical formats. The export menu has eleven options:

Buffer: Selecting this item allows the user to specify the buffer whose data will be exported. The buffer selection box lists the letter corresponding to the buffer and the name of the file that was originally loaded into the buffer (unless the buffer contains the result of a combination (addition, subtraction, etc.) of data from two or more buffers, in

which case the name is "untitled").

Channel: Selecting this item allows the user to select the channel of data in the specified buffer that will be exported. Only one channel of data may be exported in a single operation. If you need to export data on multiple channels, you will need to perform the export operation separate times, creating multiple files.

Records: Selecting this item allows the user to select which records of data in the selected buffer, on the selected channel are to be exported.

Time: Selecting this item allows the user to select the timing of the data to be exported. The user has the option of cursor selecting the timing from the data traces or else of entering the times numerically.

Format: Selecting this item allows the user to specify the export format for the data. Two formats are available, Ascii and Asystant+. The Ascii format is a text file containing the data as numbers separated by a user-specified character (the comma "," character is typically used). The Asystant+ format writes a binary data file that can be read by the Asystant+ data analysis program.

X Values: Selecting this item allows the user to select what values will be written in the data file for the X axis (the right-most column of data). This option is not available for the Asystant+ export format. Three X axis options are available:

Time: The time (in milliseconds) of the data point.

Point #: The numerical point (beginning from 0) in the data at which the point occurs.

None: No value is entered for the X axis.

Y Values: Selecting this item allows the user to select the format of the values that are to be exported from the data. The normal format is "Real Values", which causes the values to be the true value of the data (this takes into account the gain). The other format is "12 Bit" in which case the values written are the 12-bit values (-2048 -> 2047) recorded by the data acquisition board.

Sample: Selecting this item allows the user to select whether or not to undersample the data in the exported file. The data can either not be undersampled or else undersampled by a factor as much as 20 (every twentieth data point is written to the data file). This feature is useful if your exported data files are too large.

Go!: Selecting this item causes the export operation to begin. You will be prompted for the name of the file to which the data will be exported. If a file of this name already exists, Tack will warn you and give you the option of overwriting the file or else of choosing a new name.

Quit: Selecting this item cancels this operation and the data is not exported.

DOS Shell: When this is selected the user temporarily exits to DOS to perform simple commands. In order to allow this, Tack "spawns" a copy of the DOS command interpreter. Note that Tack is still loaded in memory so there will be less DOS memory available to execute a command. Type "EXIT" at the DOS command line ("C:\>") to return to Tack.

Plot: When this option is selected Tack plots (or prints) data traces to the currently selected printer/plotter using the currently displayed data as its guide. If a printer/plotter has not been selected then Tack will nag you to select one (see **Config:Printer**).

If Tack has been configured to print to file, you will be prompted for the name of the

file to write. You will then be prompted to hit any key to begin printing, you may abort the process here with the ESC key or the right mouse button. Otherwise, Tack will print/plot. As mentioned, Tack uses what is on the screen as its guide for printing. All displayed buffers will be printed at their current scale factor. If scale bars are displayed (see **Display:Scale Bars**), then they will be printed. Note that Tack will only print once per buffer. That means that if you have displayed data records from a single buffer more than once on the screen (for instance using different magnifications) then only one will be printed/plotted.

About: When this option is selected Tack will display informative things about itself, these can be selected from the submenu:

Data: Selecting this item causes information to be displayed about the data stored in one of Tack's buffers. If more than one buffer is loaded, then you will be prompted for the buffer to display information about. A menu appears with the following items:

A/D Info: General information about the data and how it was sampled.

Gain List: Displays the gains for all of the channels and records of data in the buffer.

D/A Info: Displays information about the Output waveform used during data acquisition.

Comments: Displays any comments recorded with the data file.

Quit: Closes the menu.

Memory: Selecting this item causes a box to appear citing information about the memory available and in use by Tack. There are three types of memory used by Tack.

Conventional Memory: This is the memory used by all DOS real mode programs it is limited to a maximum of 640 Kilobytes (KB). Tack will show you the total amount and the amount available.

XMS Memory: This is memory above the 1 Megabyte boundary that can be accessed by Tack if an XMS driver (such as Microsoft's Himem.sys) is loaded. XMS memory allows Tack to store a great deal of data without filling up the DOS (conventional) memory area. If XMS is available Tack will store data in it. The handle to and the amount of XMS memory used by each buffer are shown.

Disk Memory: This shows the total amount and available amount of disk space on the current disk.

Tack: Selecting this item causes a box to appear citing information about Tack (it's current revision level), a copyright notice and information about its author (me!).

Quit Program: Selecting this item allows the user to exit the program.

### **Buffer Menu:**

Copy Buffer: Selecting this option allows the user to copy the data in one of Tack's buffers to another buffer. The copy buffer menu has four entries:

Source Buffer: This is the buffer from which the data is to be copied. If only one buffer is loaded, then this is automatically set to that buffer. Otherwise, selecting this item brings up a selection box from which the user can choose the buffer to copy from.

Dest Buffer: The buffer to which the data is to be copied. Selecting this item brings up a selection box from which the user can select the buffer to copy to. The user can either

overwrite existing data in an already loaded buffer or else copy into a new buffer.

Go!: Selecting this item causes the buffer to be copied.

Quit: Selecting this item cancels this operation and the buffer is not copied.

Delete: Selecting this option allows the user to delete various things from Tack's memory (not disk). The delete menu has five entries:

Buffer: Selecting this allows the user to delete the contents of a single buffer. Select the buffer you wish to delete from the selection box that appears. Once a buffer is deleted, all buffers above it are shifted down. So, if you have four buffers loaded (A-D) and delete buffer B, then you will end up with three buffers (A-C), where buffer B now contains what was in C previously and buffer C contains what was in D previously.

All Buffers: Selecting this allows the user to delete all data that is loaded in Tack. The contents of all buffers are deleted.

Channel: Selecting this allows the user to delete a single channel of data from the current buffer. If there is only one channel of data in the current buffer, then the entire buffer will be deleted. The current buffer is shown on the bottom of the screen on the status line.

Records: Selecting this allows the user to delete a range of data records from the current buffer. If you select all of the records in the buffer, then the entire buffer will be deleted. The current buffer is shown on the bottom of the screen on the status line. If the current buffer contains multiple channels of data, then the selected range of records will be deleted from all channels in the buffer.

Quit: Selecting this item exits from this menu.

Modify: Selecting this option allows the user to modify various aspects of data that is loaded in Tack's memory (not disk). The modify menu has five entries:

Sampling Int: Selecting this allows the user to change the sampling interval of the data in the current buffer. The value for the sampling interval entered here must be larger than the existing sampling interval, and must be an integer multiple of the old value. Tack will enforce this.

NOTE: It is not good practice to change the sampling interval of data after it has been recorded. This feature was implemented as a means of reducing the number of data points for generating HPGL plots (as some programs to which HPGL data is imported cannot handle HPGL plots with large numbers of points).

Timing: Selecting this allows the user to change the timing of the data in the current buffer. The new timing range can be entered either numerically or graphically (by cursor selecting the timing in the data trace with the mouse and cursor keys).

Gain: Selecting this item allows the user to change the gain for the data in the current buffer.

NOTE: The gain of the data is not likely to change after the data has been recorded. This feature was implemented in order to allow you to correct for stupid errors.

Data: Selecting this allows the user to change the values of the data loaded into Tack's buffers. The modify data menu has five options:

Buffer: This allows the user to select the buffer whose data will be modified.

Channel: This allows the user to select the channel of data in the selected buffer

whose data will be modified.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, will be modified.

Operation: This allows the user to select the operation to perform on the data. Five operators are available, these allow the user to combine the selected data with a user-specified factor:

\* Multiply: This multiplies the selected data by a user-specified factor. The user will be queried as to whether to scale the gain of the data accordingly. You would typically answer yes.

/ Divide: This divides the selected data by a user-specified factor. The user will be queried as to whether to scale the gain of the data accordingly. You would typically answer yes.

+ Add: This adds to the data a user-specified factor. Note that in this case, the user-specified factor is 12-bit, i.e., -2048 to 2047.

- Subtract: This subtracts from the selected data a user-specified factor. Note that in this case, the user-specified factor is 12-bit, i.e., -2048 to 2047.

Separate Recs: This separates (stagger) the data records from each other by a user-specified factor. Note that in this case, the user-specified factor is 12-bit, i.e., -2048 to 2047.

Go: Selecting this causes the selected operation to be performed on the selected data.

Quit: Selecting this closes the menu. The selected operation is not performed on the selected data.

Quit: Selecting this item exits this menu.

Add: Selecting this option allows the user to add the data in two of Tacks' buffers together. The resultant data may be stored in another buffer or overwrite one of the original buffers. Between the two buffers, channel 0 is added to channel 0, channel 1 is added to channel 1, etc., and record 1 is added to record 1, record 2 is added to record 2 etc. If the buffers have unequal numbers of records or channels, then Tack will use the least common denominator between the two buffers.

NOTE: Tack does not check that the gains for the two buffers are the same. You should ensure that the data you wish to add together were recorded at the same gains! Or else you must scale the data to compensate for the different gains (use **Buffer:Modify:Data**).

The add menu has five entries:

X Adder: This is one of the two buffers to add together. Selecting this brings up a selection box from which the user can select this buffer.

Y Addend: This is the buffer which is to be added to the adder buffer (above). Selecting this brings up a selection box from which the user can select this buffer.

Z = X+Y Dest: This is the buffer to which the result of the addition operation is to be written. Selecting this brings up a selection box from which the user can select the destination buffer. The user can either overwrite existing data in loaded buffers or else copy the buffer's contents to a new buffer.

Go!: Selecting this causes the buffer addition to occur.

Quit: Selecting this cancels this operation, the buffer addition does not occur.

Subtract: Selecting this option allows the user to subtract the data in one of Tacks' buffers from the data in another buffer. The resultant data may be stored in another buffer or overwrite one of the original buffers. Between the two buffers, channel 0 is subtracted from channel 0, channel 1 is subtracted from channel 1, etc., and record 1 is subtracted from record 1, record 2 is subtracted from record 2 etc. If the buffers have unequal numbers of records or channels, then Tack will use the least common denominator between the two buffers.

NOTE: Tack does not check that the gains for the two buffers are the same. You should ensure that the data you wish to subtract were recorded at the same gains! Or else you must scale the data to compensate for the different gains (use **Buffer:Modify:Data**).

The subtract menu has five entries:

X Subtractor: This is the buffer from which the subtrahend buffer is to be subtracted. Selecting this brings up a selection box from which the user can select this buffer.

Y Subtrahend: This is the buffer which is to be subtracted from the subtractor buffer (above). Selecting this brings up a selection box from which the user can select this buffer.

Z = X-Y Dest: This is the buffer to which the result of the subtraction operation is to be written. Selecting this brings up a selection box from which the user can select the destination buffer. The user can either overwrite existing data in loaded buffers or else copy the buffer's contents to a new buffer.

Go!: Selecting this causes the buffer subtraction to occur.

Quit: Selecting this cancels the operation and the buffer subtraction does not occur.

Average: Selecting this option allows the user to average the data in two of Tacks' buffers. The resultant data may be stored in another buffer or overwrite one of the original buffers. Between the two buffers, channel 0 is averaged with channel 0, channel 1 is averaged with channel 1, etc., record 1 is averaged with record 1, record 2 is averaged with record 2 etc. If the buffers have unequal numbers of records or channels, then Tack will use the least common denominator between the two buffers.

NOTE: Tack does not check that the gains for the two buffers are the same. You should ensure that the data you wish to average were recorded at the same gains! Or else you must scale the data to compensate for the different gains (use **Buffer:Modify:Data**).

The average menu has five entries:

X Buffer 1: This is one of the buffers to average. Only two buffers may be averaged together. Selecting this item brings up a selection box from which the user can select this buffer.

Y Buffer 2: This is the other buffer to average. Only two buffers may be averaged together. Selecting this item brings up a selection box from which the user can select this buffer.

Z Destination: This is the buffer to which the result of the averaging operation is to be written. Selecting this item brings up a selection box from which the user can select the destination buffer. The user can either overwrite existing data in loaded buffers or else copy the buffer's contents to a new buffer.

Go!: Selecting this causes the buffers to be averaged.

Quit: Selecting this cancels this operation, the buffers are not averaged.



## **Edit Menu:**

Normalize: Selecting this option allows the user to subtract baseline data from data. The normalize menu has six entries:

Buffer: This allows the user to select the buffer whose data will be normalized.

Channel: This allows the user to select the channel of data in the selected buffer whose data will be normalized.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, will be normalized.

Timing: This allows the user to select the timing of the baseline segment of the data. The user may select the baseline timing either graphically or numerically.

Go!: Selecting this item causes the selected data records to be normalized.

Quit: Selecting this item cancels this operation, the selected data records are not normalized.

Leak Subtract: Selecting this option allows the user to subtract a "leak" current (time-invariant current, that scales linearly with voltage) from the data. This function is implemented for data records that represent current. The leak subtract menu has eight entries:

Buffer: This allows the user to select the buffer whose data will be leak subtracted.

Channel: This allows the user to select the channel of data in the selected buffer whose data will be leak subtracted.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, will be leak subtracted.

Input Res: This allows the user to specify the resistance that will be used to calculate the leak current. The user can enter the input resistance (in megaohms) or else can choose to calculate the input resistance from the data. If you choose to calculate the input resistance, when you select go (see below), you will be transferred to function that will calculate this (see **Measure:Input Resistance**, below).

V (mV): This allows the user to specify the voltage range for the range of records that you wish to leak subtract. If more than one record is specified, you will be prompted for a voltage and an increment. The voltage, should be the voltage for the starting record, the increment specifies how much the voltage is to be incremented with each successive record. The starting voltage should be relative to the holding potential.

Timing: This allows the user to select the range of timing in the data records that will be leak subtracted. This timing may be selected either graphically or numerically.

Go!: Selecting this item causes the selected data records to be leak subtracted.

Quit: Selecting this item cancels this operation, the selected data records are not leak subtracted.

Average Recs: Selecting this option allows the user to overwrite a data record in a buffer with the average of a range of data records from that buffer. The average recs menu has six entries:

Buffer: This allows the user to select the buffer whose data records will be averaged.

Channel: This allows the user to select the channel of data in the selected buffer whose

data records will be averaged.

Records to Average: This allows the user to select which data records, on the selected channel, in the selected buffer, will be averaged.

Overwrite Record: This allows the user to select the data record that will be overwritten with the average of the records specified above.

Go!: Selecting this item causes the selected data records to be averaged.

Quit: Selecting this item cancels this operation, the selected data records are not averaged.

Scale 'n Sub: Selecting this option allows the user to subtract from a range of data records a scaled copy of the data in a given record. The algorithm used is as follows:

$$\text{record\#i} = \text{record\#i} - \text{factor} * \text{model\_rec},$$

where

$$\text{factor} = (\text{i} - \text{zero\_level}) / (\text{model\_rec} - \text{zero\_level}).$$

The normalize menu has six entries:

Buffer: This allows the user to select the buffer whose data records will be scaled and subtracted.

Channel: This allows the user to select the channel of data in the selected buffer whose data will be scaled and subtracted.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, will have a scaled copy of the model record (see below) subtracted from them.

Model Rec: This allows the user to specify which data record to scale and subtract from the other specified records in this buffer.

Zero Level: This allows the user to specify the record at which the data traces would change sign. This does not have to be an integer value, you may use a fractional value if needed. This value is used in calculating the scaling factor (see above).

Go!: Selecting this item causes the scale 'n sub operation to occur.

Quit: Selecting this item cancels this operation, the scale 'n sub operation does not occur.

Smooth: Selecting this option allows the user to smooth (low-pass filter) the data. The smooth menu has eight entries:

Buffer: This allows the user to select the buffer whose data will be smoothed.

Channel: This allows the user to select the channel of data in the selected buffer whose data will be smoothed.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, will be smoothed.

Timing: This allows the user to select the range of timing in the selected data records, over which the data will be smoothed. The user may select this timing either graphically or numerically.

Smooth By: Selecting this allows the user to select the smoothing method that will be used. Three smoothing methods are available, a Gaussian filter, a moving average (rolling window) and a FFT (fast fourier transform)-based algorithm. The Gaussian Filter lowpass filters the data with a user-specified -3db cutoff freq. This uses the algorithm from "Single Channel Recording" ed. B. Sakmann & E. Neher, Chap 11. The moving average algorithm successively takes the local average of a number of data

points around some central data point and then replaces the central data point with the average. The FFT algorithm, performs a FFT on the data, and then low pass filters it and then reverse FFTs it. This uses an algorithm from Numerical Recipes in C.

Cutoff Freq/Window Size/Degree: Selecting this allows the user to specify the parameter that determines the amount of smoothing that will happen to the data. This menu entry has a different name depending on what smoothing algorithm is selected. Cutoff freq - this specifies the -3db cutoff frequency for the Gaussian Filter. Window Size - this specifies the width of the window over which the data will be locally averaged for the Moving Average algorithm. Degree - this specifies the point in frequency space where the smoothing begins for the FFT algorithm. For the latter two algorithms, higher values give more smoothing.

Go!: Selecting this item causes the selected data records to be smoothed.

Quit: Selecting this item cancels this operation, the selected data records are not smoothed.

### **Display Menu:**

Buffer: Selecting this item allows the user to select the current buffer. If more than one buffer is loaded, a selection box will appear from which the user can select a buffer. The current buffer is indicated on the status line at the bottom of the display. Buffers may also be selected with the up or down cursor keys or by typing the letter of the buffer (these only work no menu is currently selected).

Channel: Selecting this item allows the user to select the current channel of data in the current buffer. The current channel is shown on the status line on the bottom of the display.

Record: Selecting this item allows the user to select the current data record in the current buffer on the current channel. The current record is then displayed on the screen. This differs from the **Display:Buffer** and **Display:Channel** in that in addition to selecting the record, the data is also displayed on the screen. The current record is shown on the status line on the bottom of the display.

Clear Screen: Selecting this option clears the data display area.

All Records: Selecting this option causes all of the records in the currently selected buffer on the currently selected channel to be displayed in the data display area. The current record is set to the last record in the buffer.

Zoom: Selecting this option allows the user to zoom in on (or reset the zoom of) the currently displayed data records. The zoom menu has four options.

Dynamic: This allows the user to select the scale factor, offset factor and range of timing used for zooming in on the data, in a dynamic fashion. The user marquee-selects the part of the data traces to zoom in on. All displayed data traces are redrawn to zoom in on the selected area.

Select the area in the data traces that you want to zoom in on. Use the mouse or keyboard: Marquee-select a region using the mouse (click and drag). Once you release

the mouse button you will zoom in. Or: Use the cursor keys to move the box. Hold the shift key down while using the cursor keys in order to resize the box. For both of these ops, the amount of box movement for each keystroke is controlled by the step factor, which can be increased or decreased using the + and - keys. Hit return when done, or else cancel with ESC.

Manual: Selecting this allows you to set the scale factor, offset factor and timing range used for scaling manually. You will select these values for a single buffer at a time and any displayed data for this buffer will be redrawn at the new zoom factors. There are six entries on the manual zoom menu.

Buffer: This allows you to select the buffer whose data records you will be setting the scale, offset and timing ranges for.

Scale by: This allows you to enter manually the scale factor at which records are displayed (magnified by). When you enter a value for this parameter, all displayed records will redraw at this scale factor.

Offset: This allows you to enter manually the offset factor by which records are vertically offset when displayed. 0 would cause no offset, 1.0 would cause the displayed records to move to the top of the screen, -1.0 to the bottom of the screen etc. If a number is entered for this parameter, all displayed records will redraw using this offset factor.

Timing: This allows you to enter manually the range of timing over which records in the currently selected buffer will be displayed.

Reset: This causes the scale factor, offset factor and timing range to be reset for the currently selected buffer. All displayed records for the currently selected buffer are redrawn.

Quit: Selecting this exits this menu.

Reset: This causes the scale factor, offset factor and timing range to be reset for all displayed data in ALL buffers. All displayed records are redrawn.

Quit: Selecting this exits this menu.

Scale Bars: This allows the user to display scale bars for your data. The scale bars are displayed for the data in the currently selected (and displayed) record, on the selected channel in the selected buffer. The scale bar menu has five entries.

Height: This allows the user to enter the height, or amplitude of the scale bar.

Width: Enter the width (in msec) of the scale bar.

Label?: This allows you to select whether or not to label the scale bars.

Go!: Selecting this draws and allows you to control the placement of the scale bars. The screen clears and you can move and change the orientation of the scale bars. Use the cursor keys or mouse to move the scale bars around the screen. The "+" key changes the cursor key movement increment. Hitting The space bar rotates the scale bars. Hit Enter when done, or ESC to cancel.

Quit: Selecting this cancels the operation, the scale bars are not drawn.

### **Measure Menu:**

Dynamic Scan: Selecting this allows the user to take measurements from the current record, on the current channel in the current buffer. Using the cursor, you can measure values and

times from the data. The lower line of the screen indicates the value of the data at the time where the cursor is. Use the cursor keys or the mouse to move the cursor (vertical scan bar). For cursor movement, the + key changes the movement increment. Ctrl-Cursor Keys make bigger jumps. The Enter key (or right mouse button) drops the 1st cursor and starts a second cursor. The ESC key aborts the dynamic scan operation. If two cursors are in place then hitting the F2 key will calculate the mean of the data over the timing range, hitting the F3 key will calculate the minimum and maximum values of the data over the timing range, hitting the F4 key will calculate the area under the curve for the timing range. Hitting the F5 key fits a line ( $mx+b$ ) to the data for the timing range.

Values: Selecting this allows you to make a series of measurements from the data. The measurements can be displayed graphically or numerically and can be saved to a file. The measure values menu has ten options.

Type: Selecting this allows you to specify the type of measurement that will be made from the data. The five measurement types are: Average Value, Minimum Value, Maximum Value, Point Value, and Integral Value. Average value calculates the average of the data over the timing selected, the mean and standard deviation will be calculated. Minimum and Maximum Value find the minimum and maximum value, respectively for the data over the timing selected. Point value calculates the value of the data at a single point in time. Integral value calculates the integral of the data (area under the data curve) over the timing selected.

Buffer: This allows the user to select the buffer whose data you wish to make the measurements of.

Channel: This allows the user to select the channel of data in the selected buffer whose data you wish to make measurements of.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, you wish to make measurements of.

X Axis Values: This allows the user to enter the type of values that will be put on the X axis of the data plot (and which would be put in the first column of an ASCII data file). The X axis may be either the record number or voltage. For voltage, the values are entered as such: the voltage of the first record in the series, and an increment, which is how much the voltage is incremented with each successive record.

Baseline Timing: This allows the user to select the range of time in the data records which is the baseline for measuring the values. The timing can be selected numerically or by cursor selection. If you have selected to make measurements relative to the baseline, the average value of the data over the baseline timing will be subtracted from the values measured over the data timing.

Data Timing: This allows the user to select the range of time in the data records within which the values will be measured. The timing can be selected numerically or by cursor selection. Note that if you are measuring at a single point in time, this will be only a single time point.

Measurements: This allows the user to specify whether the measurements that you make should be the actual values of the data or relative to a baseline measurement.

Go!: Selecting this causes the measurement operation to proceed. If you have chosen to graphically select any of the timing, the screen will clear and allow you to do this. After

the timings have all been selected, the measurements will be plotted on the screen and you have several options. Hit any key to bring up the menus.

File Data: This allows the user to put the numerical measurements into an ASCII (text) file for use in other programs.

View Data: This allows the user to view the numerical data.

Review Plot: Selecting this clears away the menus so that you can see the plot unobstructed.

Quit: Selecting this leaves this menu.

Quit: Selecting this leaves the measure values menu.

Mean/Variance: Selecting this allows you to make a mean/variance plot from your data. The variance of the data will be plotted vs the mean. This is useful for estimating single channel conductances from whole-cell currents. The mean/variance plot can be displayed graphically or numerically and can be saved to a file. The measure mean/variance menu has seven options.

Buffer: This allows the user to select the buffer whose data you wish to make the mean/variance analysis from.

Channel: This allows the user to select the channel of data in the selected buffer whose data you wish to make the mean/variance analysis from.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, you wish to make the mean/variance analysis from.

Data Timing: This allows the user to select the range of time in the data records over which the mean and variance will be measured. The timing can be selected numerically or by cursor selection.

Subdivisions: This allows the user to subdivide the timing specified by Data Timing (above) into multiple, equally sized subdivisions. This allows you to generate multiple mean/variance data points from each record.

Go!: Selecting this causes the mean/variance measurements to proceed. If you have chosen to graphically select any of the timing, the screen will clear and allow you to do this. After the timings have all been selected, the mean/variance plot will appear on the screen and you have several options. Hit any key to bring up the menus.

File Data: This allows the user to put the mean and variance measurements into an ASCII (text) file for use in other programs.

View Data: This allows the user to view the numerical data.

Review Plot: Selecting this clears away the menus so that you can see the plot unobstructed.

Quit: Selecting this leaves this menu.

Quit: Selecting this leaves the measure mean/variance menu.

Histogram: Selecting this allows you to make a histogram from your data. The frequency of occurrence of data values within the specified bin width will be plotted. The histogram can be displayed graphically or numerically and the data can be saved to a file. The histogram menu has nine options.

Buffer: This allows the user to select the buffer whose data you wish to make the histogram from.

Channel: This allows the user to select the channel of data in the selected buffer whose data you wish to make the histogram from.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, you wish to make the histogram from.

Timing: This allows the user to select the range of time in the data records over which the histogram will be measured. The timing can be selected numerically or by cursor selection.

Histogram Range: This allows the user to select the range of values within the data records, over which the histogram will be calculated.

Width of Bin: This allows the user to select the size of the bin used in calculating the histogram. The number and width of the bins are interrelated with the histogram range.

Number of Bins: This allows the user to select the number of bins used for the histogram. The number and width of the bins are interrelated with the histogram range.

Go!: Selecting this causes the histogram calculation to proceed. If you have chosen to graphically select the timing, the screen will clear and allow you to do this. After the timing has been selected, the histogram plot will appear on the screen and you have several options. Hit any key to bring up the menus.

File Data: This allows the user to put the histogram measurements into an ASCII (text) file for use in other programs.

View Data: This allows the user to view the histogram data in a numerical format.

Review Plot: Selecting this clears away the menus so that you can see the histogram plot unobstructed.

Quit: Selecting this leaves this menu.

Quit: Selecting this leaves the measure histogram menu.

Power Spectrum: Selecting this allows the user to generate a power spectrum from data. The power spectrum can be displayed graphically or numerically and the data can be saved to a file. The power spectrum menu has nine options.

Buffer: This allows the user to select the buffer whose data you wish to make the power spectrum from.

Channel: This allows the user to select the channel of data in the selected buffer whose data you wish to make the power spectrum from.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, you wish to make the power spectrum from.

Timing: This allows the user to select the range of time in the data records over which the power spectrum will be measured. The timing can be selected numerically or by cursor selection.

Number of Poles: This allows the user to select the number of poles (or order) for the power spectrum. This determines the sharpness of the spectral features you can measure in the spectrum. In practice you want to limit the order to a few times the number of sharp spectral features that you want to fit. Limiting it in this fashion will smooth the spectrum somewhat, but this is often desirable. Try values of 10-50 for 1000 to 10000 data points. Note that the algorithm used can be quirky for large numbers of poles and will suggest spurious peaks in the spectrum, or might find multiple peaks for a single true spectral peak. So try to use the smallest values.

Frequency Range: This allows the user to select the frequency range over which the power spectrum will be calculated. Note that the maximum frequency for which you can calculate the power spectrum is limited to one half the sampling frequency. The frequency range and interval are interrelated and limited to 16383 data points.

Freq Interval: This allows the user to select the frequency interval for the power spectrum. The frequency interval and range are interrelated and limited to 16383 data points.

Go!: Selecting this cause the power spectrum calculation to proceed. If you have chosen to graphically select the timing, the screen will clear and allow you to do this. After the timing has been selected, the power spectrum will be calculated and plotted on the screen, you then have several options. Hit any key to bring up the menus.

File Data: This allows the user to put the power spectrum measurements into an ASCII (text) file for use in other programs.

View Data: This allows the user to view the power spectrum data in a numerical format.

View Coefficients: This allows the user to view the coefficients used in generating the power spectrum. This probably isn't very useful to you.

Review Plot: Selecting this clears away the menus so that you can see the power spectrum plot unobstructed.

Quit: Selecting this leaves this menu.

Quit: Selecting this leaves the measure power spectrum menu.

Input Resistance: Selecting this allows the user to calculate the input resistance for data recorded under voltage-clamp. The input resistance is best calculated from data that has no voltage-activated currents. The input resistance menu has eight entries:

Buffer: This allows the user to select the buffer whose data you wish to calculate the input resistance from.

Channel: This allows the user to select the channel of data in the selected buffer whose data you wish to calculate the input resistance from.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, whose data you wish to calculate the input resistance from.

V (mV): This allows the user to specify the voltage range for the range of records that you wish to calculate the input resistance from. If more than one record is specified, you will be prompted for a voltage and an increment. The voltage, should be the voltage for the starting record, the increment specifies how much the voltage is to be incremented with each successive record. The starting voltage should be relative to the holding potential.

Baseline Timing: This allows the user to select the range of timing in the data records that is the baseline for calculating the input resistance. The baseline timing may be selected either graphically or numerically.

Data Timing: This allows the user to select the range of timing in the data records over which the input resistance will be calculated. This timing may be selected either graphically or numerically.

Go!: Selecting this item causes the input resistance to be calculated and displayed in megaohms. If you have chosen to graphically select the timing(s), the screen will first clear and allow you to do this.



Quit: Selecting this item cancels this operation, the input resistance is not calculated.

Cell Capacitance: Selecting this allows the user to calculate the cell capacitance for data recorded under voltage-clamp. The capacitance is measured by calculating the area under a voltage-clamp current transient. Data should be leak subtracted first, no voltage-activated currents should be active in the data. The cell capacitance menu has eight entries:

Buffer: This allows the user to select the buffer whose data you wish to calculate the cell capacitance from.

Channel: This allows the user to select the channel of data in the selected buffer whose data you wish to calculate the cell capacitance from.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, whose data you wish to calculate the cell capacitance from.

V (mV): This allows the user to specify the voltage range for the range of records that you wish to calculate the cell capacitance from. If more than one record is specified, you will be prompted for a voltage and an increment. The voltage, should be the voltage for the starting record, the increment specifies how much the voltage is to be incremented with each successive record. The starting voltage should be relative to the holding potential.

Baseline Timing: This allows the user to select the range of timing in the data records that is the baseline for calculating the cell capacitance. The baseline timing may be selected either graphically or numerically.

Data Timing: This allows the user to select the range of timing in the data records over which the cell capacitance will be calculated. This timing should encompass the full width of the capacitive transient. The data timing may be selected either graphically or numerically.

Go!: Selecting this item causes the cell capacitance to be calculated and displayed in picofarads. If you have chosen to graphically select the timing(s), the screen will first clear and allow you to do this.

Quit: Selecting this item cancels this operation, the cell capacitance is not calculated.

Series Resistance: Selecting this allows the user to calculate the series resistance for data recorded under voltage-clamp. The series resistance is measured by calculating the height of a voltage-clamp transient. Data should be leak-subtracted first. Note that this method is not the best method to calculate  $R_s$ , and will give an underestimate. The series resistance menu has eight entries:

Buffer: This allows the user to select the buffer whose data you wish to calculate the series resistance from.

Channel: This allows the user to select the channel of data in the selected buffer whose data you wish to calculate the series resistance from.

Records: This allows the user to select which data records, on the selected channel, in the selected buffer, whose data you wish to calculate the series resistance from.

V (mV): This allows the user to specify the voltage range for the range of records that you wish to calculate the series resistance from. If more than one record is specified, you will be prompted for a voltage and an increment. The voltage, should be the voltage for the starting record, the increment specifies how much the voltage is to be incremented

with each successive record. The starting voltage should be relative to the holding potential.

Baseline Timing: This allows the user to select the range of timing in the data records that is the baseline for calculating the series resistance. The baseline timing may be selected either graphically or numerically.

Data Timing: This allows the user to select the range of timing in the data records over which the series resistance will be calculated. This timing may be selected either graphically or numerically.

Go!: Selecting this item causes the series resistance to be calculated and displayed in megaohms. If you have chosen to graphically select the timing(s), the screen will first clear and allow you to do this.

Quit: Selecting this item cancels this operation, the series resistance is not calculated.

### **Config Menu:**

Graphics Display: Selecting this option allows the user to specify the type of graphics display installed and the display resolution that Tack should use. Normally, the graphics autodetect setting should be used. For a given display type to be used, the requisite display driver file (they have the extension ".bgi") MUST be present in the same directory as Tack.

Display Type: Selecting this option allows the user to select a graphics display type. Twelve settings are available.

*Note: If your computer does not support the display type that you have selected, you may well crash the program when you try to switch display types.*

Resolution: Selecting this option allows the user to select a display resolution for the selected display type. Note that some display types have only one available resolution.

*Note: If your computer's display adapter does not support the resolution that you have selected, you may well crash the program when you try to switch display resolutions.*

Okay: Selecting this option causes any changes that have been made to the graphics display type and resolution to go into effect.

Cancel: Selecting this option causes any changes that have been made to the graphics display type and resolution to be cancelled.

Colors: When this option is selected a color demonstration window appears and a menu appears from which the user can select the colors of the various components of the Tack screen. The various components are the menu bar, status line, popup boxes and data window. For menus, the user can control the background, text, frame and select letter colors. For the status line, the user can control the background and text colors. For popup boxes, the user can control the background, text and frame colors. For the data window, the user can control the background, frame and axis colors as well as the colors for the data in up to eight buffers.

Menus:

Status Line:

Popup Boxes:

Data Window:

When the user selects one of these menu options, another menu appears from which the user can select the color for the elements of the windows (i.e. frame color of popup window). Clicking on an element will select the next available color for that element, this will be shown in the color demonstration window. Typing the select letter of that element will do the same. Holding the SHIFT key down while typing the select letter of that element will select the previous color for that element. Select Okay when you are done setting the colors.

Use Defaults: When this option is selected, the colors of all of the elements of the Tack display revert to their default settings.

Okay: Selecting this option causes any changes that have been made to the color scheme to go into effect.

Cancel: Selecting this option causes any changes that have been made to the color scheme to be cancelled.

Font: Selecting this option allows the user to specify the font that will be used by Tack. For all but the default font, the requisite font file (they have the extension ".chr") MUST be present in the same directory as Tack. An example of some text written in the selected font is displayed.

Font: Selecting this option allows the user to select the font family that will be used by Tack. Eleven font families are available. The default font is a bit-mapped font, the others are stroked (outline) fonts.

Height: Selecting this option allows the user to set the height of the font that will be used by Tack. If the selected font family is the default, bit-mapped font, the height and the width must be the same.

Width: Selecting this option allows the user to set the width of the font that will be used by Tack. If the selected font family is the default, bit-mapped font, the height and the width must be the same.

Okay: Selecting this option causes any changes that have been made to the font to go into effect.

Cancel: Selecting this option causes any changes that have been made to the font to be cancelled.

Printer: Selecting this option allows the user to specify the type of printer that Tack will use and its configuration.

Printer: Selecting this option allows the user to specify the type of printer that is installed. Six printer options are available:

None: No printer is attached.

Apple Imagewriter II: This printer configuration will also work with a C-Itoh 8510.

IBM Proprinter: This printer configuration will also work with many other Epson compatible printers.

HP Laserjet 2: This printer configuration will also work with many other PCL-4 compatible printers.

HP Plotter (HPGL): This printer configuration will also work with many other HPGL compatible printers. It is useful to select this mode and print to a file in order to export data traces for use in other programs.

HP Laserjet 3: This printer configuration uses the HPGL mode of PCL-5. BUT, unless your printer has a bunch of memory it may not work. Use Laserjet Series II mode in that case.

Destination: Selecting this option tells Tack where to find your printer. The destination can be to file, or the selected parallel or serial port. If the destination is file, then whenever you print, the print job will go to a file in the format used by the selected printer. Printing to file is useful for exporting data traces in a graphical format, using HPGL files. If the destination is a serial port, the menu that appears will allow you to configure Tack to use the same serial port configuration as the serial printer you have attached.

Orientation: Selecting this option allows the user to set the orientation for the print job, landscape (wide) or portrait (narrow).

Settings: Selecting this option allows the user to controls settings for specific printers. For dot matrix printers, this allows you to set whether the print will be bold (two passes) or normal. For Laserjet printers, this allows you to set the print resolution in dots per inch (dpi).

Okay: Selecting this option causes any changes that have been made to the printer configuration to be saved.

Cancel: Selecting this option causes any changes that have been made to the printer configuration to be cancelled.

Display Options: Selecting this option allows the user to control aspects of how data is displayed on the screen.

Show all pts in record: If this is enabled then Tack will display all of the data points for a given record on the screen. That is, if there are more data points in a record than there are pixels on the screen horizontally then Tack will show multiple Y points for each X point. If this is disabled then Tack will only display one Y point for each X point. Disabling this feature causes the display to draw faster.

Connect the points: If this is enabled then Tack will connect the data points on the screen with lines. This causes the display of data to look nicer, but significantly slows the display of data.

Grid and Axes: Selecting this option allows the user to configure how the grid and axes in the data window(s) are displayed. There are five items on this menu:

X Axis: Selecting this option allows the user to specify where X axes are to be placed in each data window. The user can select a variety of X axes varying from none to three, appearing at the top, middle and bottom of each window.

Y Axis: Selecting this option allows the user to specify where Y axes are to be placed in each data window. The user can select a variety of Y axes varying from none to three, appearing at the left, middle and right of each window.

Grid: Selecting this option allows the user to specify the appearance of the grid in the data window(s). The grid can be horizontal, vertical, both horizontal & vertical or neither. The spacing of the grid is determined by the number of divisions (see next item).

Division: Selecting this option allows the user to specify the number of divisions for both the X and Y axes. The number of divisions determines where the ticks are

placed on the X and Y axes and the spacing of the grid.

Line Style: Selecting this option allows the user to specify the line style for the grid. The line style is specified by a hexadecimal number (0 -> FFFF) which specifies how the line is displayed. FFFF corresponds to a solid line, while 0 corresponds to no line. A value of 0F0F would make a dashed line, while 1 would make a faintly dotted line.

Okay: Selecting this option exits the display options menu.

Other Options: Selecting this option allows the user to control several very important aspects of Tack's operation. These are described below:

XMS: Enabling this feature allows Tack to use memory accessed via the XMS specification in order to store data acquired before writing it to disk. XMS memory is memory above the 1 MB boundary on PC-AT class computers (80286 and above class microprocessors). This memory can only be accessed if you have installed the XMS driver HIMEM.SYS (supplied free of charge by Microsoft), or a compatible XMS driver (e.g. Desqview's QEMM memory manager) in your config.sys file. The use of XMS allows Tack to store data above the conventional memory area, which allows more room for Tack to work. This feature need not be disabled unless you suspect a problem or else have other needs.

Sounds: Selecting this toggles the state of sound generation by Tack. If sounds are disabled, then Tack will make no noise.

Okay: Selecting this causes any changes that have been made to the items on this menu to be saved.

Cancel: Selecting this causes any changes that have been made to the items on this menu to be discarded.

Write Config File: Selecting this option causes the current configuration data to be written to the Tack.cfg configuration file. Only the items that are on controlled by config menu are stored in this file. These are:

- Graphics display adapter & resolution
- Colors
- Font
- Printer
- Sounds
- Display Settings (Show All Pts, Connect the Pts, Grid)
- XMS Usage

## **Conclusion**

I hope that you understand all of the features that I have described here and that Tack serves you well. I would appreciate your comments on the program and manual. I **always** want to know about bugs in my program and will endeavor to fix them as speedily as is possible. I am not responsible for any loss of data or damage caused by this program. I also would value your suggestions for new features and ways to improve this program. I can be reached at the following addresses:

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