

# BOYS TOWN NATIONAL RESEARCH HOSPITAL

## **WavEd User's Guide**

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### **ABSTRACT**

WavEd is a computer program for displaying and editing digitized acoustic waveforms on an IBM-PC. The program can read and write several different sampled-data file formats. WavEd's editing capabilities include copy, delete, insert, extract, and scale of specified segments of the waveform. WavEd also records and plays back these digitized waveforms PCs equipped with appropriate ADC and DAC hardware. WavEd has limited analysis capabilities for speech waveforms, including RMS value, Fourier transform, linear prediction (LPC) coefficients, and formant frequencies. This document describes version 2.18 of the WavEd program.

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## 1 Introduction

WavEd is a waveform editor for the IBM-PC that allows you to interact with digitized signals. WavEd reads and writes sampled-data files and displays their contents on the screen. The program can read and write (1) ILS sampled-data files, (2) NeXT sound (.snd) files, (3) MATLAB (.mat) data files, (4) MS Windows (.wav) waveform files, (5) ASCII text files (with one number per line), and other 8-bit or 16-bit integer data files. WavEd can also write BTNRH PLT files and C source code files.

WavEd can record from an analog-to-digital converter (ADC) or play back to a digital-to-analog converter (DAC). The program currently supports (1) the Data Translation 12-bit 2801-A I/O board, (2) the Covox Voice Master 8-bit digitizer board, and (3) the Sound Blaster board for both recording and playback. WavEd will also output an 8-bit DAC on any I/O port and, when no DAC hardware is present, can output signals through the internal speaker of the PC.

WavEd can display up to 5 signals simultaneously in separate windows. One of the windows is always the "active" window to which the program directs all editing commands. The cursor up-arrow and down-arrow keys and the Tab and Shift+Tab keys change the active window. The F4 function key (or Window Maximize command) will enlarge the active window to fill the screen or return it to the original size.

In "scroll mode", WavEd adjusts the horizontal scale so that each signal value occupies a single pixel. This makes it possible to scroll the waveform (left or right) smoothly and continuously. The F5 function key switches scroll mode on and off. The F1 function key will provide brief summary (help screen) of the function key commands.

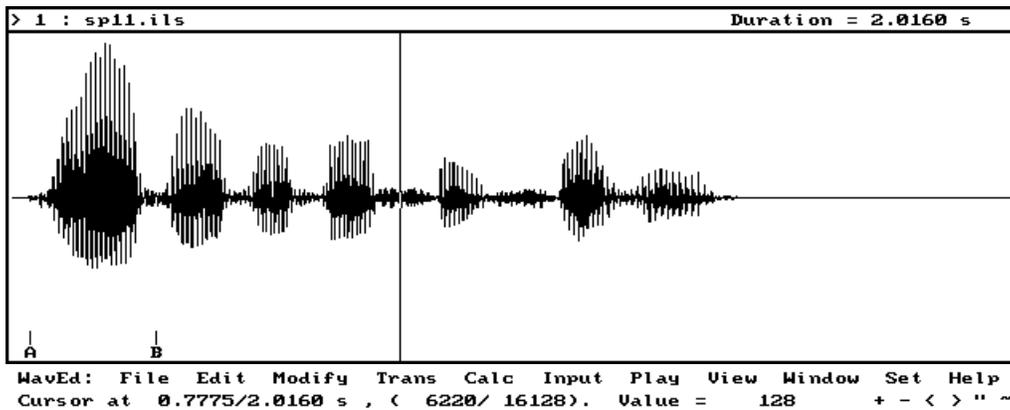
Most WavEd commands are single character (mnemonic) commands. WavEd groups commands that change the length of a signal and/or copy segments to and from the clip window under the "edit" or 'e' command (cut, copy, delete, paste, replace). WavEd commands that only change the sample values of the signal in the currently active window are grouped under the "modify" or 'm' command (bits, compress, invert, linear prediction error, offset, remove DC, scale, center clip, zero). A few analysis commands are grouped under the "calculate" or 'c' command. For speech waveforms, linear prediction coefficients (LPC), acoustic tube sections, and formants can be computed for any selected segment. A Fourier transform and LPC error computation are grouped under the Transform command.

Most of the editing commands use "marks" to specify a segment of the waveform. These marks are positions in the waveform that are labeled by a single letter (A-Z) of the user's choice. When the user saves a waveform in ILS format (the default), the letter marks also are saved with the ILS header and will be displayed the next time the file is used. Because marks are used to specify locations within the waveform for defining segments, three implicit marks are understood to refer to the first point (Home key), end point (End key), the cursor location (period). Waveform segments can also be selected with a mouse by clicking the left mouse button with the mouse cursor positioned on the waveform displayed in the active window.

WavEd was based on a similar program by Louis Goldstein and Vance Maverick called WAVE. The command structure of WavEd is similar to WAVE, but the source code has been entirely rewritten. Edward Carney has contributed to the programming of the I/O devices.

Installation of the program is simple. Just put the file WAVED.EXE into any directory included in the DOS path. The next two sections provide more detailed information about using the WavEd program.

## 2 Description of the Waveform Window



The figure above is a sample window from the WavEd program. Up to five windows can be displayed on the screen at the same time. On a color monitor, the border of the active window is pink and the border of the inactive windows is gray. Inactive windows can be viewed, but not manipulated.

The "title bar" along the top of the window provides information about the window and its contents. The number '1' in the upper-left corner indicates the window number. The '>' sign in front of the window number indicates that this is the active or current window. The file name appears after the window number. On the right side of the title bar, the duration of the segment of the signal currently displayed is indicated.

The main portion of the window contains the waveform. The vertical line extending from the top to the bottom of the display is the signal cursor. This cursor is visible in the currently active window and is not visible in the inactive ones. The cursor position can be changed to any location in the window. Along the bottom of the window are short vertical lines below which are the letters 'A' and 'B'. The user sets these marks and to indicate portions of the waveform that are of particular interest. The user can delete, relocate, or add new marks, as desired.

Below the waveform windows is a "message line" that lists the commands available to the user at the present time. To select a command, type the first upper-case letter of the command or click on the command with the mouse. Additional queries and messages also appear on the message line.

The "status line" at the bottom of the screen provides additional information about the contents of the active window. The first number on the status line indicates the position of the signal cursor. In this case, the cursor position is 0.7775 seconds from the beginning of the signal. The total duration of the signal (2.0160 seconds) appears after the cursor position. A '/' separates the cursor position and total duration. The corresponding number of samples for these two values appears next. The current sample number is 6220 and the total number of sample is 16128. The next item on the status line indicates that the sample value at this cursor position is 128.

At the right side of the status line is a "tool bar" containing symbols that provide a quick way to invoke frequently used commands by clicking on the appropriate symbol with the mouse cursor. The '+' is for "zoom in", the '-' is for "zoom out", the '<' is for "pan left", the '>' is for "pan right", the '"' is for "replay" and the '~' is for "scroll mode".

### 3 Functional Description

#### Command Line Usage

The syntax for executing the WavEd program from the DOS command line is:

```
waved [options] file ...
```

where the options are:

```
-h      Write the help screen to a file.  
-g N    Select graphics adapter N, where N = CGA, HGC, EGA, VGA  
-m      monochrome mode for EGA and VGA displays  
-p N    use I/O device N, where N = DT, LPT, SB, or VMK.
```

and "file" is the name of a sampled-data file. The command line may list up to five file names after the options.

Consistently repeated options may be placed in the environment variable "waved". For example, typing

```
set waved = -p DT
```

will set the I/O device in WavEd to "Data Translation" each time the program starts.

#### Function Key Commands

##### [F1] Help

F1 displays a help screen that contains the version number of the WavEd program and a brief description of the function key commands. Pressing Esc removes the help screen and restores the previous screen.

##### [F2] Signal information

F2 provides the following information about the signal in the active window: the number of the window, the number of samples in the signal, the sample rate, and the number of bits per sample. This information appears on the message line at the bottom of the screen.

##### [F3] Box

F3 toggles the display of a box centered on the cursor. This box indicates the portion of the waveform that will be visible on the screen in scroll mode.

#### **[F4] Window maximize**

F4 toggles between large and small window sizes. In the minimize mode, up to 5 windows can be displayed on the screen simultaneously. In the maximize mode, the active window will occupy the full screen.

#### **[F5] Scroll mode**

F5 is a toggle that allows the user to scroll through the waveform continuously, using the '<' (less than) or ',' (comma) key to scroll left and the '>' (greater than) or '.' (period) key to scroll right. The mouse cursor can also control scrolling by positioning the cursor on the left or right side of the active window. Scrolling changes the location of the cursor and when the user returns to the normal display (by hitting F5 again), the active window shows the cursor at its new position.

### **Keypad Commands**

#### **[Ins] Insert mark**

#### **[Shift+Ins] Insert new mark**

The INS key on the keypad invokes the "insert mark" command, which prompts the user to enter a letter and inserts a mark at the cursor position labeled with the specified letter. If the specified letter is already being used for a mark, the old mark moves to current cursor position.

Pressing the Shift and Ins keys together invokes the "insert new mark" command, which inserts a new mark inserted at the cursor position, labeled with the first unused letter in the alphabet.

#### **[Del] Delete mark**

Pressing the Del key on the keypad invokes the "delete mark" command, which prompts the user to specify a mark and removes this mark from the signal.

#### **<- , -> Move cursor**

The left and right arrow keys on the keypad move the cursor to the left and right, respectively. Pressing the Shift key in conjunction with an arrow key moves the cursor ten points at a time. Pressing the Ctrl key in conjunction with an arrow key moves the cursor fifty points at a time.

#### **[Home] Move cursor to beginning of window**

#### **[End] Move cursor to beginning of window**

These keys move the cursor to the beginning and end of the current window, respectively. Home and End also specify the implicit marks at the beginning and end of the waveform for commands that require the specification of a segment.

#### **[Ctrl+Home] Move cursor to beginning of signal**

#### **[Ctrl+End] Move cursor to beginning of signal**

These keys move the cursor to the beginning and end of the signal, respectively. The window will move to the beginning or end of the file, if necessary.

- +       Zoom in**
- Zoom out**

Pressing the '+' or '-' key on the keypad expands or contracts the horizontal scale of the waveform display. The '+' key (zoom in) halves the number of sample points displayed (with a minimum of 4 points). The '-' key (zoom out) doubles the number of sample points displayed. The position of the signal cursor does not change after these commands. Clicking the mouse on the '+' or '-' symbol in the lower-right corner of the screen also invokes the zoom in or zoom out commands.

- [PgUp] Pan left**
- [PgDn] Pan right**

When less than the entire signal appears within the window, the PgUp or PgDn key shifts the position of the window to the left or right. The Pan Left and Pan Right command shift the window positioning by half the number of sample point currently displayed. Clicking the mouse on the '<' or '>' symbol in the lower-right corner of the screen or clicking on the left or right edges of the window also invokes the pan left or pan right command.

## **Edit Mode Commands**

This section describes the WavEd commands available when the active window is in edit mode. This is the normal mode, identified by the word "WavEd" at the left of the command line. Most of the commands described here are also available in scroll mode, identified by the words "SCROLL MODE" at the left of the command line.

Many of the commands require the user to specify a segment of the signal in the window on which the command will operate. One way to specify a segment is to place marks at appropriate places within the signal using the Insert Mark command described above. These marks are labeled with (and referred to by) a single letter from A to Z. Three other marks are always implicitly defined: (1) the beginning of the signal, (2) the end of the signal, and (3) the cursor position. These three marks are referred to with the Home key, the End key and the '.' (period), respectively. As a shortcut, entering a '\*' for the first mark will select the entire signal (from Home to End) as the specified segment. Another way to specify a segment is to click on the beginning and end of positions with the mouse cursor.

## **F       File**

Pressing 'f' invokes a set of file manipulation commands used for loading signals from files, saving signals to files, and exiting from the WavEd program.

The "wild card" characters '\*' and '?' may be used to obtain a list of matching files whenever the user is prompted for a filename. For example, typing "\*.ils" will provide a list of all the files in the current directory with a ".ils" extension. Select filenames from this list by using the Tab and Shift+Tab keys, the cursor arrow keys, or clicking on the name with the mouse cursor.

## **L Load a sampled-data file into a window**

The user specifies a filename and the program displays the content of the file in the current window (if it is empty) or in a new window (up to a maximum five windows). The WavEd program will try to determine the type of sampled-data file from the contents of the file. The program currently recognizes (1) ILS sampled-data files, (2) NeXT sound (.snd) files, (3) MATLAB (.mat) data files, (4) MS Windows (.wav) waveform files, and (5) ASCII text files (with one number per line). If the file is not one of these types, then the program assumes that the file contains 16-bit integer data with no header. Use the custom load command to read other types of sampled data files.

## **R Reload the sampled-data file in the current window**

This command replaces the content of the current window by the sampled-data in the file specified in the title bar of the window. This provides a way to undo changes made to the signal.

## **C Custom load a data file as a new waveform**

This command allows the user to load sampled data from file types that WavEd does not recognize automatically. The user is first prompted for: (1) the header size to indicate the number of bytes that precede the sampled data in the file, (2) the trailer size to indicate the number of bytes that follow the sampled data in the file, (3) the number of bytes per sampled data point. If the number of bytes is 1, then the user specifies whether the data format is (1) mulaw, (2) unsigned, or (3) signed. If the number of bytes is 2, then the user indicates whether the program should swap the byte order. Finally, the user specifies a filename and the program displays the content of the file in the current window (if it is empty) or in a new window (up to a maximum of five windows).

## **S Save window into a data file**

The user specifies a segment of the signal and the name of a file. The program will save the segment to a file with the specified name. If the file previously existed, the user confirms overwriting the previous file. The new file will be of the same type as the file most recently loaded into this window or defaults to an ILS sampled-data file. To specify a new file type, use the Save As command.

## **A Save the window as a specified type of data file**

This command allows the user to choose file format when saving data. The choices are:

- C** C source code (8-bit data)
- I** ILS sampled data
- L** List format: ASCII text file (one number per line)
- P** PLT file (which can be plotted with the BTNRH PLT program)
- S** NeXT (.snd) sound file format
- M** Matlab (.mat) data file (16-bit integer data)
- W** MS Windows (.wav) waveform file format

**N** No header, 16-bit integer data

## **E Edit**

Pressing "e" invokes a set of commands that modify the signal or move a portion of it to the clip window. The clip window, normally hidden, is much like the other signal windows. Some commands use the clip window for temporary storage of signals. Note that the edit commands only modify the "active" or "current" window. The edit commands do not change the original data in the file until the user saves the new window with the File Save command (described above).

### **T** Cut segment and place in clip window

The user specifies the beginning and end of a segment. The program removes the specified segment from the active window and places it in the clip window, overwriting any previous contents of the clip window.

### **C** Copy a segment to the clip window

The user specifies the beginning and end of a segment. The program copies this segment clip window without changing the active window.

### **D** Delete segment

The user specifies the beginning and end of a segment. The program removes the specified segment from the signal.

### **P** Paste from the clip window

The user specifies a position in the currently active window. The program inserts the contents of the clip window in front of the specified position.

### **R** Replace with contents of clip window

This command copies the signal from the clip window to the current window overwriting the previous contents of the current window.

### **S** Insert silence

This command inserts a silent interval (zero valued samples) in front of some position in the active window. The user specifies the duration of silence (in milliseconds) and the position.

### **M** Mark

This command provides several ways to manipulate signal marks. The options are:

**N** Insert a new mark (same as Shift+Ins).

**I** Insert a mark (same as Ins).

- D** Delete a mark (same as Del).
- G** Go to a mark (changes the cursor position).
- B** Blank (remove all) marks from the signal.

**V** Change sample value

The user specifies the sample number (default is the cursor position) and a new value for this sample (default is the current value).

**X** Extend the length of the signal

This command adds a silent interval (zero valued samples) so that the total number of samples in the signal will be a multiple of 256 samples. Some programs require ILS files to have complete blocks of 256 samples. If the length of the signal is already a multiple of 256 samples, then this command does nothing.

**M** **Modify**

Pressing "m" invokes a menu of commands that allows the user to change characteristics of a specified segment of the signal in the currently active window. The commands are:

**B** Bits

This command reformats the signal to make it compatible with a specific type of digital-to-analog converter (DAC). The options are:

- A** 16-bit, signed data.
- B** 12-bit, unsigned data.
- C** 8-bit, unsigned data.

**C** Compress

This command performs a compression of the signal by taking each sample value to a power less than one. The user specifies the exponent.

**I** Invert

This command multiplies the sample values of the signal by -1. This has the effect of inverting the waveform.

**O** Offset

This command adds a constant to each sample in the specified segment.

**D** Remove DC component

This command subtracts the DC component (average sample value) from each sample in the specified segment.

## **S Scale**

This command multiplies each sample in the specified segment by a scale factor.

## **T Center-clip**

This command sets every sample with a value below some threshold to zero.

## **Z Zero**

This command sets all sample values in the specified segment to zero.

## **R Reverse**

This command reverses the order of the samples within the specified.

## **T Transform**

The transform commands apply a transformation to a specified segment and place the result in the clip window. You can see the result of the transformation by making the clip window visible with the View Clip command or by using the Edit Replace command to overwrite the previous content of the window with transformed version of the signal.

### **L Linear prediction residual**

This command computes the error (residual) of a linear prediction (LP) computation. For a speech waveform, this removes most of the influence of the vocal tract from the glottal pulses. The user specifies the number of LP coefficients to use in the computation.

### **F Fourier Transform**

This command computes the magnitude of the Fourier transform of a specified segment and places it in a window as a new waveform. The program adjusts the time scale of the new waveform so that time in msec corresponds to the frequency in hertz.

## **C Calculate**

The calculate commands act on the signal in the active window, but do not modify either this window or the clip window. The options are:

### **A Acoustic tube areas**

This command provides a list of acoustic tube areas for a specified segment of the waveform. These areas represent the cross-sectional areas of an acoustic tube that are computed from linear prediction coefficients.

### **D Duration of segment**

This command calculates the duration in milliseconds (and number of samples) of a specified segment.

**F** Formants based on LPC spectrum

This command provides a list of spectral peaks (and their band widths) based on a linear prediction spectrum of a specified segment.

**L** Linear Prediction coefficients (LPC)

This command provides a list of linear prediction coefficients for the specified segment.

**R** Root-mean-square (RMS) value of segment

This command computes the root-mean-square (RMS) and average (DC) value of a specified segment.

**I** **Input waveform from ADC**

These commands use real-time input from the analog-to-digital converter (ADC).

**A** Acoustic Tube Areas

Real-time graphic display of acoustic tube area functions based on sampling from the ADC. The area function is computed from linear prediction coefficients and provides an estimate of vocal tract cross-sectional areas.

**L** Level input check on ADC

This command presents graphic display of the waveform amplitude based on real-time input from the ADC. It is useful for checking the level of an input signal prior to recording.

**R** Record input from ADC

This puts real-time input from the ADC into the current waveform buffer. The duration of input can be set with the Set Time command. The ADC device must be also be specified with the Set Device command.

**P** Play signal to DAC

This command applies to the waveform in the currently active window. The user specifies the segment to be played. If the data format of the signal does not match the selected DAC, the user will be asked if the signal should be reformatted. Once the desired segment for playback has been selected, the same segment can be replayed by pressing Enter or by clicking on the "" symbol in the lower-right corner of the screen with the mouse cursor.

**V** **View (not available in scroll mode)**

**A** View all

This command contracts the horizontal scale of the waveform so that the entire signal appears in the window.

**C** View clip

This command makes the clip window visible or hides the clip window, if already showing.

**S** View segment

This command expands the horizontal scale of the waveform so that the window only shows a specified segment.

**P** Pan left or right

This command shifts the position of the window left or right by one-half the number of samples currently displayed without changing the horizontal scale of the waveform. Pan left (right) can also be invoked by pressing the PgUp (PgDn) key or clicking on the '<' (>) symbol in the lower-right corner of the screen with the mouse cursor.

**Z** Zoom in or out

The horizontal scale of the waveform is expanded (zoom in) or contracted (zoom out) by showing half as many or twice as many sample points. The cursor position is not changed. Zoom in (out) can also be invoked by pressing the '+' ('-') key or by clicking on the '+' ('-') symbol in the lower-right corner of the screen.

**W** **Window (not available in scroll mode)**

**N** New window

This command adds an empty signal window to those already displayed on the screen. The maximum number of signal windows is five.

**C** Close window

This command deletes the contents of the current window and closes it.

**S** Scroll mode

Toggles scroll mode on the currently active window. This command can also be invoked by pressing the '~' key or by clicking on the '~' symbol in the lower-right corner of the screen.

**M** Maximize window

Toggles the size of the signal windows between full screen and partial screen.

**D** Duplicate window

Creates a new window with a copy of the contents of the currently active window.

**U** Move window up

Changes the order of the windows, if more than one is displayed, so that the currently active window is move up toward the top of the screen.

## **S Set signal and program parameters**

This command invokes a menu of commands that allow the user to set the input/output device, the ADC and DAC rates, and the maximum record time from the ADC. The commands are:

### **R Program and signal sampling rates:**

#### **A ADC rate**

The ADC sampling rate of the currently active window determines the sampling rate of the analog-to-digital converter (ADC). The default rate is 10000 samples per second. If the window contains a signal, setting the ADC rate will modify the sampling rate associated with that signal.

#### **D DAC rate**

The DAC sampling rate of the currently active window determines the sampling rate of the digital-to-analog converter (DAC). The default rate is 10000 samples per second. If the window contains a signal, setting the DAC rate will determine the playback rate, but will not modify the sampling rate associated with that signal.

### **T Record time**

Sets the maximum record time for recording input from the ADC in seconds. The default is one second. Recordings may be terminated before the maximum time has elapsed by pressing any key on the keyboard. The maximum record time is limited by the maximum size that the program can allocate to a signal, which is about 130000.

### **D I/O Device**

A menu is displayed on the message line, allowing the user to choose among the supported I/O devices:

**D** Data Translation 2801-A I/O board [12-bit unsigned]

**S** Sound Blaster [8-bit unsigned]

**I** Internal speaker of the PC [1 bit DAC, output only]

**P** PC I/O port (LPT, VMK, or other) [8-bit unsigned]

**Q** Quikki (not supported in current version) [16-bit signed]

## **H Help screen**

Typing "h" (or the F1 function key) invokes a 1-page help screen describing the function keys. Press Esc key to remove the help screen.

**[Tab]**            **change active window to next window**  
**[Shift+Tab]**    **change active window to previous window**

Makes the next or previous window the active one. The same result is achieved by using the up and down arrow keys.

**[Ctrl+L]**        **Redraw screen**

Redraws the screen to insure that the displayed information is correct. This command would never be needed if the program always updated the screen properly.

## 4 Summary of Commands

### Function and Keypad Keys

- [F1]** Help screen. (Description of function keys.)
- [F2]** Signal information.
- [F3]** Toggle scroll-range box.
- [F4]** Maximize window.
- [F5]** Toggle scroll mode:
  - < > pan left and right
  - [Esc]** return to edit mode
- [Ins]** Insert a mark (prompt for label).
  - [Shift+Ins]** Insert a new mark (no prompt).
- [Del]** Delete a mark (prompt for label).
  
- <- Cursor left.
- > Cursor right.
  - [Shift+arrow]** Cursor moves 10.
  - [Ctrl+arrow]** Cursor moves 50.
- [Home]** Cursor moves to beginning of window,
  - [Ctrl+Home]** moves to beginning of signal
- [End]** Cursor moves to end of window,
  - [Ctrl+End]** moves to beginning of signal
- + Zoom in
- Zoom out
- [PgUp]** Pan left.
- [PgDn]** Pan right.

## Keyboard commands

### F File:

- L** Load a signal from a sampled-data file into a new window.
- R** Reload a signal from sampled-data file into current window.
- C** (Custom) load a signal from sampled-data file with specified: Header size, Trailer size, Bytes per sample, and data format.
- S** Save a segment of the signal in the current window to a sampled-data file.
- A** Save as one of the following types of data file:
  - C** C source code (8 bit data)
  - I** ILS sampled data (16-bit data).
  - L** List (ASCII).
  - P** PLT file (ASCII).
  - S** NeXT .snd sound file (16-bit data).
  - M** MATLAB .mat data file (16-bit data).
  - W** MS Windows .wav waveform file (8-bit data).
  - N** No header (16-bit data)
- X** Exit the program (return to DOS).

### E Edit:

- T** Cut a segment from the current window to the clip window.
- C** Copy a segment from the current window to the clip window.
- D** Delete a segment from the current window.
- P** Paste from the clip window into the current window.
- R** Replace the contents of the current window with the contents of the clip window.
- S** Insert zero (silent) interval.
- M** Edit the marks attached to the signal in the current window:
  - N** Insert a new mark (no prompt for label).
  - I** Insert a mark (prompt for label).
  - D** Delete (remove) a mark (prompt for label).
  - G** Go to mark (prompt for label).
  - B** Blank (remove) all marks.
- V** Edit (change) a single sample value.
- X** Extend the signal so that the number of samples is a multiple of 256.

### M Modify a segment of the signal in the current window:

- B** Change the data format (number of bits per sample):
  - A** 16-bit, signed
  - B** 12-bit, unsigned
  - C** 8-bit, unsigned
- C** Perform logarithmic compression of signal values.
- I** Invert signal. (Multiply signal by -1.)
- O** Add a constant value (offset) to sample values.
- D** Remove DC component (average sample value) from signal.
- S** Multiply sample values by a scale factor.
- T** Center-clip: Set signal to zero below a specified threshold value.
- Z** Set the segment to zero.
- R** Reverse the order of samples (time-reverse).

### T Transform the signal in the current window. Result is placed in the clip window.

- L** Compute the linear prediction error signal.
- F** Fourier transform.

- C** Calculate:
- A** Area of acoustic tube sections.
  - D** Duration of segment.
  - F** Formants based on peaks in the LPC spectrum.
  - L** Linear prediction coefficients (LPC).
  - R** Root-mean-square (RMS) value of segment
- I** Input from analog-to-digital converter (ADC):
- A** (Real-time) acoustic tube areas displayed graphically.
  - L** Check the level of the ADC input.
  - R** Record a signal from the ADC into the current window.
- P** Play (output) a segment of the signal in the current window to the digital-to-analog converter (DAC).
- V** View (not available in scroll mode):
- A** Show all of the signal in the current window.
  - C** Show (or hide) the clip window.
  - S** Show a specified segment of the signal.
  - P** Pan the window to the Left or Right to show other parts of the signal.
  - Z** Zoom the window In or Out to show fewer or more samples.
- W** Window (not available in scroll mode):
- N** Open a new window, up to 5 windows maximum (not including the clip window).
  - C** Close current window. (Any contents will be deleted).
  - S** Toggles Edit and Scroll modes for the current window.
  - M** Maximize current window.
  - D** Duplicate the contents of the current window in a new window.
  - U** Change the order of windows on the screen to move the current window up.
- S** Set:
- D** Device:
    - D** Data Translation.
    - S** Sound Blaster.
    - I** Internal speaker of the PC (1 bit DAC only).
    - P** PC I/O port (lpt, vmk, or other).
    - Q** Quikki (only in versions compiled with Turbo C).
  - R** Sample rate:
    - A** Set ADC sample rate.
    - D** Set DAC sample rate.
- H** Help screen (command summary).
- Enter scroll mode.
  - Exit scroll mode, submenus, queries, etc..
  - [Enter]** Replay signal to DAC.
  - [Tab]** Go to next window.
  - [Shift+Tab]** Go to previous window.
  - [Ctrl+L]** Redraw screen.

## Mouse commands

- [Left-click]** On inactive window in edit mode to make it become the current (active) window.  
On the title bar of the current window to maximize the window.  
On the waveform in the current window to position the signal cursor.  
On the items on the menu line to select.  
To indicate "no" to a (Y/N) query.  
To remove an information box or text query.
- [Right-click]** On the title bar of the current window to "blank" all signal marks.  
On the waveform of the current window to place new signal marks.  
Elsewhere to replay a previously selected segment of the current window.  
To indicate "yes" to a (Y/N) query.  
To complete a text query or accept a selection in a file name box.

## 5 Error Messages

**"Can't expand the signal buffer."**

There's not enough memory available to insert the requested amount of silence.

**"Can't open [file]."**

The indicated file could not be opened in the current directory.

**"Error reading XXX file header."**

The input file type was recognized as XXX, but a problem was encountered reading the header.

**"Invalid number of coefficients."**

The number of LPC requested is invalid either because (1) it's not a positive number, (2) it's more than 50 (the maximum allowed by the program), or (3) it's more than the number of points in the segment.

**"Invalid token number."**

The input file was recognized as a BTNI token file, but the requested token number was either less than 1 or greater than the number of tokens in the file.

**"Memory allocation error."**

There's not enough memory available to read the signal in the input file.

**"No points in segment."**

An calculation was requested on a segment that contains no points. The endpoint of a segment is not considered to be part of the segment.

**"No signal."**

**"No signal in clip window."**

An operation was requested on a window that does not contain any signal.

**"No signal in file."**

An operation was requested on a file that does not contain any signal.

**"Not enough room in signal buffer."**

The "insert zero" command can't insert the requested amount of silence, because the signal size limit (32512) would be exceeded.

**"Problem allocating memory for FFT."**

The additional memory required for FFT computation was not available.

**"Problem allocating memory for LPC."**

The additional memory required for LPC computation was not available.

**"Problem opening filename box."**

**"Problem opening info box."**

The text boxes used to display file names, help screens, LPC values, and other information require additional memory to save the portion of the screen under the text box.

**"Singular autocorrelation matrix."**

The linear prediction equations are degenerate, and it is not possible to calculate the LPC as specified. Try a smaller number of LPC's or a different segment.

**"Too many points (NPTS) for FFT."**

The FFT is limited to segments of 16384 points or less. The selected segment has NPTS samples, which exceeds this limit.

**"Too many points in segment."**

Programming error. Shouldn't happen.

**"Truncating signal from [size] to 131072 samples."**

The program will not allocate signal buffers larger than 131072 samples.

**"Undefined signal ADC rate."**

The duration of the segment can't be computed because the ADC rate is not a positive number.

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